POCKET COMPANION

UNITED STATES STEEL

Joseph, P.F.
39 W. 1 [illegible] Ave

F. C. MILLER

No 226 3/4 Diam 6" TAKE UP
141" OVERALL

Mc Master Carr
Supply Co
640 West Lake St

26" OVERALL

40' of 1 1/8 I beam

TOPICAL INDEX

B131

Pocket Companion

INFORMATION AND TABLES FOR
ENGINEERS AND DESIGNERS
AND OTHER DATA
PERTAINING TO
STRUCTURAL
STEEL

CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh, Pa. Chicago, Ill.

TENNESSEE COAL, IRON AND RAILROAD COMPANY
Birmingham, Ala.

COLUMBIA STEEL COMPANY
San Francisco, Cal.

Exporters of their Products
UNITED STATES STEEL PRODUCTS COMPANY
New York, N. Y.

UNITED STATES STEEL

G12104XVM236

Twenty-Fourth Edition - May 1, 1934

Reprinted 1936

CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh, Pa. Chicago, Ill.

TENNESSEE COAL, IRON AND RAILROAD COMPANY
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San Francisco, Cal.

Printed in U. S. A.

FOREWORD

THE twenty-fourth edition of the Pocket Companion has been revised and enlarged. It contains the profiles and data for sections most suitable for all structural purposes, including bridge, building, car and ship construction. It supersedes and cancels all previous publications relating to structural sections.

The sections have been grouped under the headings: "Regular," for which there is a constant demand and which can be procured readily from the mill; "Special," for which there is a fluctuating demand and infrequent rollings.

This edition is issued jointly by

CARNEGIE-ILLINOIS STEEL CORPORATION
TENNESSEE COAL, IRON AND RAILROAD COMPANY
COLUMBIA STEEL COMPANY

Each company sells all the products listed, although each may not manufacture all of them.

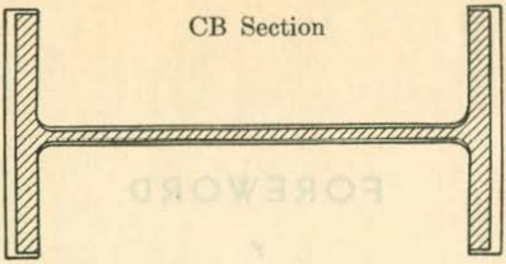
The symbols used with certain sections indicate that they are produced in that district only:

- **Ⓒ Produced in Pittsburgh district.**
- **Φ Produced in Chicago district.**
- **Ⓛ Produced by Lorain division of Carnegie-Illinois Steel Corporation.**

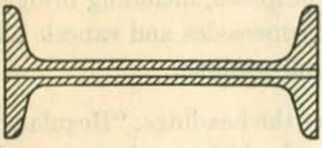
The tabulated loads, except in a few cases, are given in **Kips,** thousands of pounds.

METHOD OF INCREASING SECTION AREAS

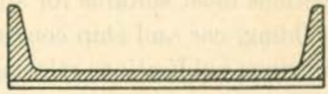
CB Section



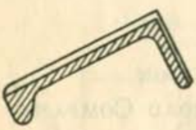
I-Beam



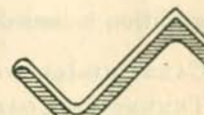
Channel



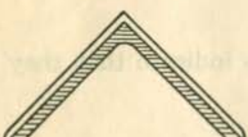
Bulb Angle



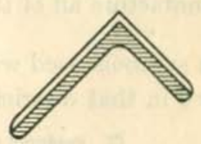
Zee



Equal Angle



Unequal Angle



The above figures show the method of increasing the sectional areas and weights of structural steel shapes. Cross hatched portions represent the minimum sections and the blank portions the added areas.

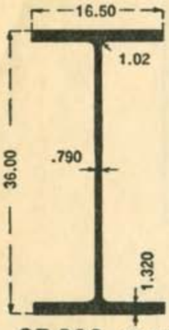
In the case of Channels and Standard Beams the enlargement of the section adds an equal amount to the thickness of the web and the width of the flanges. In the case of CB Sections equal thicknesses of metal are added to the web thickness and flange width and proportional additions to the flange thickness. In the case of Angles and Zees, the effect of spreading the rolls is to increase slightly the length of the legs. In the case of Ship Building Bulb Angles, as a rule each increase or decrease in web thickness carries with it about one-half that increase or decrease in the flange thickness.

Inasmuch as the roll passes are modified in the wear of the rolls, the actual dimensions will not always conform to the theoretical, even in the case of the minimum weight sections. Designers and detailers of structural work should arrange for ample clearances.

REGULAR SHAPES

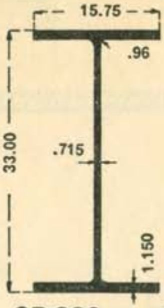
Structural Shapes shown in this section, for which there is a popular and constant demand, may be secured promptly from frequent rollings. Designers should keep this in mind when making up their specification, to avoid unnecessary delay.

C B SECTIONS



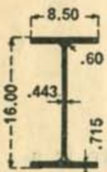
CB 362 36x16½
300, 280, 260,
250, 240, 230 lbs.

CB 361 36x12
194, 182, 170, 160, 150 lbs.

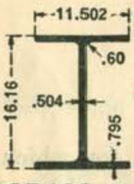


CB 332 33x15¾
240, 220, 210, 200 lbs.

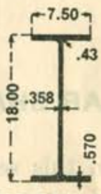
CB 331 33x11½
152, 141, 132, 125 lbs.



CB 162 16x8½
78, 71, 64, 58 lbs.

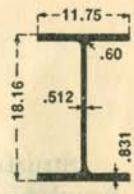


CB 163 16x11½
114, 105, 96, 88 lbs.



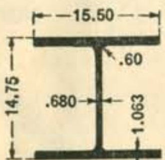
CB 181 18x7½
55, 50, 47 lbs.

CB 182 18x8¾
85, 77, 70, 64 lbs.



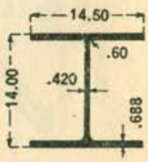
CB 183 18x11¾
124, 114, 105, 96 lbs.

CB 161 16x7
50, 45, 40, 36 lbs.

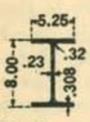


CB 146 14x16

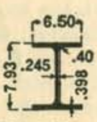
426, 412, 398, 384, 370, 356, 342, 328, 320, 314,
300, 287, 273, 264, 255, 246, 237, 228, 219,
211, 202, 193, 184, 176, 167, 158, 150, 142 lbs.



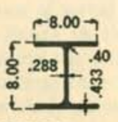
CB 145 14x14½
136, 127, 119, 111,
103, 95, 87 lbs.



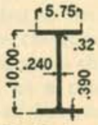
CB 81 8x5¼
21, 19, 17 lbs.



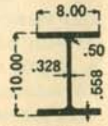
CB 82 8x6½
27, 24 lbs.



CB 83 8x8
67, 58, 48, 40,
35, 33, 31 lbs.



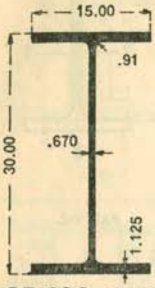
CB 101 10x5¾
29, 26, 23, 21 lbs.



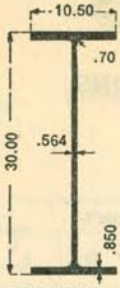
CB 102 10x8
45, 41, 37, 33 lbs.

WEIGHTS UNDERLINED CORRESPOND TO NORMAL DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

C B SECTIONS



CB 302 30x15
210, 200, 190, 180, 172 lbs.

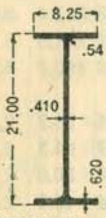


CB 301 30x10½
132, 124, 116, 108 lbs.

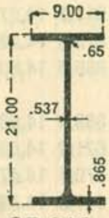
CB 272 27x14
177, 163, 154, 145 lbs.

CB 271 27x10
114, 106, 98, 91 lbs.

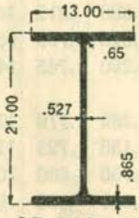
CB 243 24x14
160, 150, 140, 130 lbs.



CB 211 21x8¼
73, 68, 63, 59 lbs.

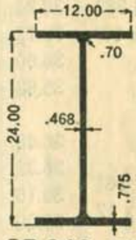


CB 212 21x9
103, 96, 89, 82 lbs.

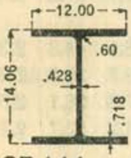


CB 213 21x13
142, 132, 122, 112 lbs.

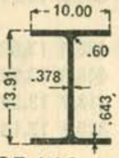
CB 241 24x9
94, 87, 80, 74 lbs.



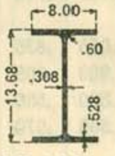
CB 242 24x12
120, 110, 100 lbs.



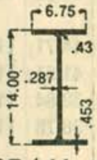
CB 144 14x12
84, 78 lbs.



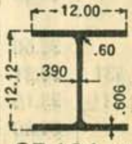
CB 143 14x10
74, 68, 61 lbs.



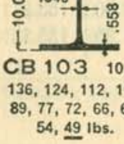
CB 142 14x8
58, 53, 48, 43 lbs.



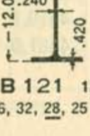
CB 141 14x6¾
42, 38, 34, 30 lbs.



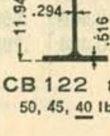
CB 124 12x12
190, 176, 161, 147, 133, 120, 106, 99, 92, 85, 79, 72, 65 lbs.



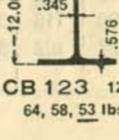
CB 103 10x10
136, 124, 112, 100, 89, 77, 72, 66, 60, 54, 49 lbs.



CB 121 12x6½
36, 32, 28, 25 lbs.



CB 122 12x8
50, 45, 40 lbs.



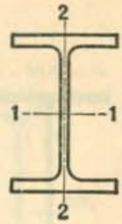
CB 123 12x10
64, 58, 53 lbs.

WEIGHTS UNDERLINED CORRESPOND TO NORMAL DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

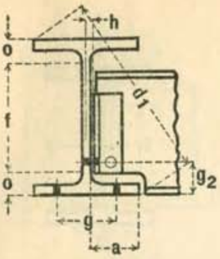
ELEMENTS

CB SECTIONS

ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange		Web Thickness	Axis 1-1			Axis 2-2		
				Width	Thickness		I	S	r	I	S	r
	In.	Lbs.	In.²	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
	36.72	300	88.17	16.655	1.680	.945	20290.2	1105.1	15.17	1225.2	147.1	3.73
	36.50	280	82.32	16.595	1.570	.885	18819.3	1031.2	15.12	1127.5	135.9	3.70
CB 362	36.24	260	76.56	16.555	1.440	.845	17233.8	951.1	15.00	1020.6	123.3	3.65
36 x 16½	36.12	250	73.49	16.525	1.380	.815	16465.9	911.7	14.97	969.6	117.4	3.63
	36.00	240	70.60	16.500	1.320	.790	15724.0	873.6	14.92	920.1	111.5	3.61
	35.88	230	67.73	16.475	1.260	.765	14988.4	835.5	14.88	870.9	105.7	3.59
	36.48	194	57.11	12.117	1.260	.770	12103.4	663.6	14.56	355.4	58.7	2.49
CB 361	36.32	182	53.54	12.072	1.180	.725	11281.5	621.2	14.52	327.7	54.3	2.47
36 x 12	36.16	170	49.98	12.027	1.100	.680	10470.0	579.1	14.47	300.6	50.0	2.45
	36.00	160	47.09	12.000	1.020	.653	9738.8	541.0	14.38	275.4	45.9	2.42
	35.84	150	44.16	11.972	.940	.625	9012.1	502.9	14.29	250.4	41.8	2.38
	33.50	240	70.52	15.865	1.400	.830	13585.1	811.1	13.88	874.3	110.2	3.52
CB 332	33.25	220	64.73	15.810	1.275	.775	12312.1	740.6	13.79	782.4	99.0	3.48
33 x 15¾	33.12	210	61.78	15.783	1.210	.748	11664.5	704.4	13.74	735.6	93.2	3.45
	33.00	200	58.79	15.750	1.150	.715	11048.2	669.6	13.71	691.7	87.8	3.43
	33.50	152	44.71	11.565	1.055	.635	8147.6	486.4	13.50	256.1	44.3	2.39
CB 331	33.31	141	41.51	11.535	.960	.605	7442.2	446.8	13.39	229.7	39.8	2.35
33 x 11½	33.15	132	38.84	11.510	.880	.580	6856.8	413.7	13.29	207.8	36.1	2.31
	33.00	125	36.78	11.500	.805	.570	6354.7	385.1	13.14	188.2	32.7	2.26
	30.38	210	61.78	15.105	1.315	.775	9872.4	649.9	12.64	707.9	93.7	3.38
CB 302	30.25	200	58.76	15.070	1.250	.740	9340.5	617.6	12.61	665.7	88.3	3.37
30 x 15	30.12	190	55.90	15.040	1.185	.710	8825.9	586.1	12.57	624.6	83.1	3.34
	30.00	180	52.89	15.000	1.125	.670	8328.2	555.2	12.55	585.6	78.1	3.33
	29.88	172	50.65	14.985	1.065	.655	7891.5	528.2	12.48	550.1	73.4	3.30
	30.30	132	38.83	10.551	1.000	.615	5753.1	379.7	12.17	185.0	35.1	2.18
CB 301	30.16	124	36.45	10.521	.930	.585	5347.1	354.6	12.11	169.7	32.3	2.16
30 x 10½	30.00	116	34.13	10.500	.850	.564	4919.1	327.9	12.00	153.2	29.2	2.12
	29.82	108	31.77	10.484	.760	.548	4461.0	299.2	11.85	135.1	25.8	2.06



CB SECTIONS

I DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

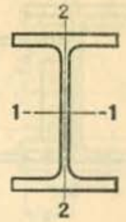
Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange		Web		Distance						Usual Gage
			Width	Thickness	Thickness	Half Thickness	a	f	o	d_1	Min. g_2	Clear. h	g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
	300	36 3/4	16 5/8	1 11/16	15/16	1/2	7 7/8	31 1/8	2 13/16	40 3/8	4	9/16	5 1/2
	280	36 1/2	16 5/8	1 9/16	7/8	7/16	7 7/8	31 1/8	2 11/16	40 1/8	4	1/2	5 1/2
CB 362	260	36 1/4	16 1/2	1 7/16	7/8	7/16	7 7/8	31 1/8	2 9/16	39 7/8	3 3/4	1/2	5 1/2
36	250	36 1/8	16 1/2	1 3/8	13/16	7/16	7 7/8	31 1/8	2 1/2	39 3/4	3 3/4	1/2	5 1/2
	240	36	16 1/2	1 5/16	13/16	7/16	7 7/8	31 1/8	2 7/16	39 5/8	3 3/4	1/2	5 1/2
	230	35 7/8	16 1/2	1 1/4	3/4	3/8	7 7/8	31 1/8	2 3/8	39 1/2	3 1/2	7/16	5 1/2
	194	36 1/2	12 1/8	1 1/4	13/16	3/8	5 5/8	32 1/4	2 1/8	38 1/2	3 1/4	7/16	5 1/2
CB 361	182	36 3/8	12 1/8	1 3/16	3/4	3/8	5 5/8	32 1/4	2 1/16	38 3/8	3 1/4	7/16	5 1/2
36	170	36 1/8	12	1 1/8	11/16	3/8	5 5/8	32 1/4	1 15/16	38 1/8	3 1/4	7/16	5 1/2
	160	36	12	1	11/16	5/16	5 5/8	32 1/4	1 7/8	38	3	3/8	5 1/2
	150	35 7/8	12	15/16	5/8	5/16	5 5/8	32 1/4	1 13/16	37 7/8	3	3/8	5 1/2
	240	33 1/2	15 7/8	1 3/8	7/8	7/16	7 1/2	28 5/8	2 7/16	37 1/8	3 3/4	1/2	5 1/2
CB 332	220	33 1/4	15 3/4	1 1/4	13/16	3/8	7 1/2	28 5/8	2 5/16	36 7/8	3 1/2	7/16	5 1/2
33	210	33 1/8	15 3/4	1 3/16	3/4	3/8	7 1/2	28 5/8	2 1/4	36 3/4	3 1/2	7/16	5 1/2
	200	33	15 3/4	1 1/8	3/4	3/8	7 1/2	28 5/8	2 3/16	36 5/8	3 1/2	7/16	5 1/2
	152	33 1/2	11 5/8	1 1/16	5/8	5/16	5 1/2	29 3/4	1 7/8	35 1/2	3	3/8	5 1/2
CB 331	141	33 1/4	11 1/2	15/16	5/8	5/16	5 1/2	29 3/4	1 3/4	35 1/4	3	3/8	5 1/2
33	132	33 1/8	11 1/2	7/8	5/8	5/16	5 1/2	29 3/4	1 11/16	35 1/8	3	3/8	5 1/2
	125	33	11 1/2	13/16	9/16	5/16	5 1/2	29 3/4	1 5/8	35	2 3/4	3/8	5 1/2
	210	30 3/8	15 1/8	1 5/16	13/16	3/8	7 1/8	25 3/4	2 5/16	34	3 1/2	7/16	5 1/2
	200	30 1/4	15 1/8	1 1/4	3/4	3/8	7 1/8	25 3/4	2 1/4	33 7/8	3 1/2	7/16	5 1/2
CB 302	190	30 1/8	15	1 3/16	3/4	3/8	7 1/8	25 3/4	2 3/16	33 3/4	3 1/2	7/16	5 1/2
30	180	30	15	1 1/8	11/16	3/8	7 1/8	25 3/4	2 1/8	33 5/8	3 1/4	7/16	5 1/2
	172	29 7/8	15	1 1/16	11/16	5/16	7 1/8	25 3/4	2 1/16	33 1/2	3 1/4	3/8	5 1/2
	132	30 1/4	10 1/2	1	5/8	5/16	5	26 7/8	1 11/16	32 1/8	3	3/8	5 1/2
CB 301	124	30 1/8	10 1/2	15/16	5/8	5/16	5	26 7/8	1 5/8	31 7/8	3	3/8	5 1/2
30	116	30	10 1/2	7/8	9/16	5/16	5	26 7/8	1 9/16	31 3/4	2 3/4	3/8	5 1/2
	108	29 7/8	10 1/2	3/4	9/16	5/16	5	26 7/8	1 1/2	31 5/8	2 3/4	3/8	5 1/2

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

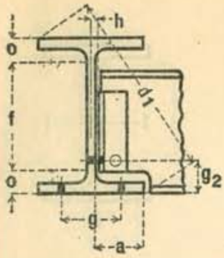
ELEMENTS

CB SECTIONS

ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange Width	Flange Thickness	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
	27.31	177	52.10	14.090	1.190	.725	6728.6	492.8	11.36	518.9	73.7	3.16
CB 272	27.12	163	47.93	14.035	1.095	.670	6141.5	452.9	11.32	468.7	66.8	3.13
27 x 14	27.00	154	45.30	14.000	1.035	.635	5775.8	427.8	11.29	437.6	62.5	3.11
	26.88	145	42.68	13.965	.975	.600	5414.3	402.9	11.26	406.9	58.3	3.09
	27.28	114	33.53	10.070	.932	.570	4080.5	299.2	11.03	149.6	29.7	2.11
CB 271	27.14	106	31.17	10.035	.862	.535	3761.2	277.2	10.98	136.1	27.1	2.09
27 x 10	27.00	98	28.82	10.000	.792	.500	3446.5	255.3	10.94	122.9	24.6	2.07
	26.84	91	26.77	9.983	.712	.483	3129.2	233.2	10.81	109.0	21.8	2.02
	24.72	160	47.04	14.091	1.135	.656	5110.3	413.5	10.42	492.6	69.9	3.23
CB 243	24.56	150	44.10	14.063	1.055	.628	4733.5	385.5	10.36	452.5	64.3	3.20
24 x 14	24.41	140	41.16	14.029	.980	.594	4376.1	358.6	10.31	414.5	59.1	3.17
	24.25	130	38.21	14.000	.900	.565	4009.5	330.7	10.24	375.2	53.6	3.13
CB 242	24.31	120	35.29	12.088	.930	.556	3635.3	299.1	10.15	254.0	42.0	2.68
24 x 12	24.16	110	32.36	12.042	.855	.510	3315.0	274.4	10.12	229.1	38.0	2.66
	24.00	100	29.43	12.000	.775	.468	2987.3	248.9	10.08	203.5	33.9	2.63
	24.29	94	27.63	9.061	.872	.516	2683.0	220.9	9.85	102.2	22.6	1.92
CB 241	24.16	87	25.58	9.025	.807	.480	2467.8	204.3	9.82	92.9	20.6	1.91
24 x 9	24.00	80	23.54	9.000	.727	.455	2229.7	185.8	9.73	82.4	18.3	1.87
	23.87	74	21.77	8.975	.662	.430	2033.8	170.4	9.67	73.8	16.5	1.84
	21.46	142	41.76	13.132	1.095	.659	3403.1	317.2	9.03	385.9	58.8	3.04
CB 213	21.31	132	38.81	13.087	1.020	.614	3141.6	294.8	9.00	353.8	54.1	3.02
21 x 13	21.16	122	35.85	13.040	.945	.567	2883.2	272.5	8.97	322.1	49.4	3.00
	21.00	112	32.93	13.000	.865	.527	2620.6	249.6	8.92	289.7	44.6	2.96
	21.29	103	30.27	9.071	1.010	.608	2268.0	213.1	8.66	119.9	26.4	1.99
CB 212	21.14	96	28.21	9.038	.935	.575	2088.9	197.6	8.60	109.3	24.2	1.97
21 x 9	21.00	89	26.15	9.000	.865	.537	1919.2	182.8	8.57	99.4	22.1	1.95
	20.86	82	24.10	8.962	.795	.499	1752.4	168.0	8.53	89.6	20.0	1.93
	21.24	73	21.46	8.295	.740	.455	1600.3	150.7	8.64	66.2	16.0	1.76
CB 211	21.13	68	20.02	8.270	.685	.430	1478.3	139.9	8.59	60.4	14.6	1.74
21 x 8¼	21.00	63	18.52	8.250	.620	.410	1343.6	128.0	8.52	53.8	13.0	1.70
	20.91	59	17.36	8.230	.575	.390	1246.8	119.3	8.47	49.2	12.0	1.68



CB SECTIONS

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

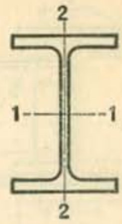
Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange		Web		Distance						Usual Gage
			Width	Thickness	Thickness	Half Thickness	a	f	o	d_1	Min. g_2	Clear. h	g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
CB 272 27	177	27 1/4	14 1/8	1 3/16	3/4	3/8	6 3/4	23	2 1/8	30 3/4	3 1/4	7/16	5 1/2
	163	27 1/8	14	1 1/8	11/16	3/8	6 3/4	23	2 1/16	30 5/8	3 1/4	7/16	5 1/2
	154	27	14	1 1/16	5/8	5/16	6 3/4	23	2	30 1/2	3 1/4	3/8	5 1/2
	145	26 7/8	14	1	5/8	5/16	6 3/4	23	1 15/16	30 3/8	3 1/4	3/8	5 1/2
CB 271 27	114	27 1/4	10 1/8	15/16	9/16	5/16	4 3/4	24	1 5/8	29 1/8	2 3/4	3/8	5 1/2
	106	27 1/8	10	7/8	9/16	5/16	4 3/4	24	1 9/16	29	2 3/4	3/8	5 1/2
	98	27	10	13/16	1/2	1/4	4 3/4	24	1 1/2	28 7/8	2 3/4	5/16	5 1/2
	91	26 7/8	10	11/16	1/2	1/4	4 3/4	24	1 7/16	28 3/4	2 3/4	5/16	5 1/2
CB 243 24	160	24 3/4	14 1/8	1 1/8	11/16	5/16	6 3/4	20 3/4	2	28 1/2	3 1/4	3/8	5 1/2
	150	24 1/2	14 1/8	1 1/16	5/8	5/16	6 3/4	20 3/4	1 7/8	28 1/4	3 1/4	3/8	5 1/2
	140	24 3/8	14	1	5/8	5/16	6 3/4	20 3/4	1 13/16	28 1/8	3	3/8	5 1/2
	130	24 1/4	14	7/8	9/16	5/16	6 3/4	20 3/4	1 3/4	28	3	3/8	5 1/2
CB 242 24	120	24 1/4	12 1/8	15/16	9/16	5/16	5 3/4	20 7/8	1 11/16	27 1/8	3	3/8	5 1/2
	110	24 1/8	12	7/8	1/2	1/4	5 3/4	20 7/8	1 5/8	27	2 3/4	5/16	5 1/2
	100	24	12	3/4	1/2	1/4	5 3/4	20 7/8	1 9/16	26 7/8	2 3/4	5/16	5 1/2
CB 241 24	94	24 1/4	9	7/8	9/16	1/4	4 1/4	21 3/8	1 7/16	25 7/8	2 3/4	5/16	5 1/2
	87	24 1/8	9	13/16	1/2	1/4	4 1/4	21 3/8	1 3/8	25 3/4	2 3/4	5/16	5 1/2
	80	24	9	3/4	1/2	1/4	4 1/4	21 3/8	1 5/16	25 5/8	2 1/2	5/16	5 1/2
	74	23 7/8	9	11/16	7/16	1/4	4 1/4	21 3/8	1 1/4	25 1/2	2 1/2	5/16	5 1/2
CB 213 21	142	21 1/2	13 1/8	1 1/8	11/16	3/8	6 1/4	17 3/4	1 7/8	25 1/4	3	7/16	5 1/2
	132	21 1/4	13 1/8	1	5/8	5/16	6 1/4	17 3/4	1 3/4	25	3	3/8	5 1/2
	122	21 1/8	13	15/16	9/16	5/16	6 1/4	17 3/4	1 11/16	24 7/8	3	3/8	5 1/2
	112	21	13	7/8	9/16	1/4	6 1/4	17 3/4	1 5/8	24 3/4	3	5/16	5 1/2
CB 212 21	103	21 1/4	9 1/8	1	5/8	5/16	4 1/4	18	1 5/8	23 1/8	3	3/8	5 1/2
	96	21 1/8	9	15/16	9/16	5/16	4 1/4	18	1 9/16	23	2 3/4	3/8	5 1/2
	89	21	9	7/8	9/16	5/16	4 1/4	18	1 1/2	22 7/8	2 3/4	3/8	5 1/2
	82	20 7/8	9	13/16	1/2	1/4	4 1/4	18	1 7/16	22 3/4	2 3/4	5/16	5 1/2
CB 211 21	73	21 1/4	8 1/4	3/4	1/2	1/4	4	18 5/8	1 5/16	22 7/8	2 1/2	5/16	5 1/2
	68	21 1/8	8 1/4	11/16	7/16	1/4	4	18 5/8	1 1/4	22 3/4	2 1/2	5/16	5 1/2
	63	21	8 1/4	5/8	7/16	1/4	4	18 5/8	1 3/16	22 5/8	2 1/2	5/16	5 1/2
	59	20 7/8	8 1/4	9/16	3/8	3/16	4	18 5/8	1 1/8	22 1/2	2 1/2	1/4	5 1/2

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

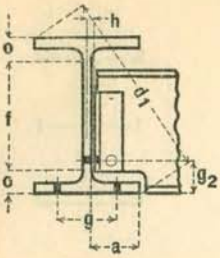
ELEMENTS

CB SECTIONS

ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange Width	Flange Thickness	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
	18.64	124	36.45	11.889	1.071	.651	2227.1	239.0	7.82	281.9	47.4	2.78
CB 183	18.48	114	33.51	11.833	.991	.595	2033.8	220.1	7.79	255.6	43.2	2.76
18 x 11¾	18.32	105	30.86	11.792	.911	.554	1852.5	202.2	7.75	231.0	39.2	2.73
	18.16	96	28.22	11.750	.831	.512	1674.7	184.4	7.70	206.8	35.2	2.71
	18.32	85	24.97	8.838	.911	.526	1429.9	156.1	7.57	99.4	22.5	2.00
CB 182	18.16	77	22.63	8.787	.831	.475	1286.8	141.7	7.54	88.6	20.2	1.98
18 x 8¾	18.00	70	20.56	8.750	.751	.438	1153.9	128.2	7.49	78.5	17.9	1.95
	17.87	64	18.80	8.715	.686	.403	1045.8	117.0	7.46	70.3	16.1	1.93
CB 181	18.12	55	16.19	7.532	.630	.390	889.9	98.2	7.41	42.0	11.1	1.61
18 x 7½	18.00	50	14.71	7.500	.570	.358	800.6	89.0	7.38	37.2	9.9	1.59
	17.90	47	13.81	7.492	.520	.350	736.4	82.3	7.30	33.5	9.0	1.56
	16.64	114	33.51	11.629	1.035	.631	1642.6	197.4	7.00	254.6	43.8	2.76
CB 163	16.48	105	30.87	11.582	.955	.584	1497.5	181.7	6.96	230.7	39.8	2.73
16 x 11½	16.32	96	28.22	11.533	.875	.535	1355.1	166.1	6.93	207.2	35.9	2.71
	16.16	88	25.87	11.502	.795	.504	1222.6	151.3	6.87	185.2	32.2	2.67
	16.32	78	22.92	8.586	.875	.529	1042.6	127.8	6.74	87.5	20.4	1.95
CB 162	16.16	71	20.86	8.543	.795	.486	936.9	115.9	6.70	77.9	18.2	1.93
16 x 8½	16.00	64	18.80	8.500	.715	.443	833.8	104.2	6.66	68.4	16.1	1.91
	15.86	58	17.04	8.464	.645	.407	746.4	94.1	6.62	60.5	14.3	1.88
	16.25	50	14.70	7.073	.628	.380	655.4	80.7	6.68	34.8	9.8	1.54
CB 161	16.12	45	13.24	7.039	.563	.346	583.3	72.4	6.64	30.5	8.7	1.52
16 x 7	16.00	40	11.77	7.000	.503	.307	515.5	64.4	6.62	26.5	7.6	1.50
	15.85	36	10.59	6.992	.428	.299	446.3	56.3	6.49	22.1	6.3	1.45



CB SECTIONS

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

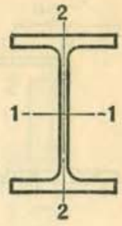
Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance d_1	Distance Min. g_2	Distance Clear. h	Usual Gage g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
CB 183 18	124	18 5/8	11 7/8	1 1/16	11/16	5/16	5 5/8	15 1/8	1 3/4	22 1/8	3	3/8	5 1/2
	114	18 1/2	11 7/8	1	5/8	5/16	5 5/8	15 1/8	1 11/16	22	3	3/8	5 1/2
	105	18 3/8	11 3/4	15/16	9/16	5/16	5 5/8	15 1/8	1 5/8	21 7/8	2 3/4	3/8	5 1/2
	96	18 1/8	11 3/4	13/16	1/2	1/4	5 5/8	15 1/8	1 1/2	21 3/4	2 3/4	5/16	5 1/2
CB 182 18	85	18 3/8	8 7/8	15/16	9/16	1/4	4 1/8	15 3/8	1 1/2	20 3/8	2 3/4	5/16	5 1/2
	77	18 1/8	8 3/4	13/16	1/2	1/4	4 1/8	15 3/8	1 3/8	20 1/8	2 3/4	5/16	5 1/2
	70	18	8 3/4	3/4	7/16	1/4	4 1/8	15 3/8	1 5/16	20	2 3/4	5/16	5 1/2
	64	17 7/8	8 3/4	11/16	7/16	3/16	4 1/8	15 3/8	1 1/4	20	2 1/2	1/4	5 1/2
CB 181 18	55	18 1/8	7 1/2	5/8	3/8	3/16	3 5/8	15 7/8	1 1/8	19 5/8	2 1/2	1/4	3 1/2
	50	18	7 1/2	9/16	3/8	3/16	3 5/8	15 7/8	1 1/16	19 1/2	2 1/4	1/4	3 1/2
	47	17 7/8	7 1/2	1/2	3/8	3/16	3 5/8	15 7/8	1	19 3/8	2 1/4	1/4	3 1/2
CB 163 16	114	16 5/8	11 5/8	1 1/16	5/8	5/16	5 1/2	13 1/8	1 3/4	20 3/8	3	3/8	5 1/2
	105	16 1/2	11 5/8	15/16	5/8	5/16	5 1/2	13 1/8	1 11/16	20 1/4	3	3/8	5 1/2
	96	16 3/8	11 1/2	7/8	9/16	5/16	5 1/2	13 1/8	1 5/8	20	2 3/4	3/8	5 1/2
	88	16 1/8	11 1/2	13/16	1/2	1/4	5 1/2	13 1/8	1 1/2	19 7/8	2 3/4	5/16	5 1/2
CB 162 16	78	16 3/8	8 5/8	7/8	9/16	1/4	4	13 3/8	1 1/2	18 1/2	2 3/4	5/16	5 1/2
	71	16 1/8	8 1/2	13/16	1/2	1/4	4	13 3/8	1 3/8	18 1/4	2 3/4	5/16	5 1/2
	64	16	8 1/2	11/16	7/16	1/4	4	13 3/8	1 5/16	18 1/8	2 1/2	5/16	5 1/2
	58	15 7/8	8 1/2	5/8	7/16	1/4	4	13 3/8	1 1/4	18	2 1/2	5/16	5 1/2
CB 161 16	50	16 1/4	7 1/8	5/8	3/8	3/16	3 3/8	14	1 1/8	17 3/4	2 1/2	1/4	3 1/2
	45	16 1/8	7	9/16	3/8	3/16	3 3/8	14	1 1/16	17 5/8	2 1/4	1/4	3 1/2
	40	16	7	1/2	5/16	3/16	3 3/8	14	1	17 1/2	2 1/4	1/4	3 1/2
	36	15 7/8	7	7/16	5/16	3/16	3 3/8	14	15/16	17 3/8	2 1/4	1/4	3 1/2

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

ELEMENTS

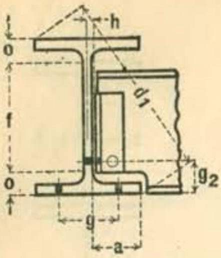
CB SECTIONS

ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange Width	Flange Thickness	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	$In.^2$	In.	In.	In.	$In.^4$	$In.^3$	In.	$In.^4$	$In.^3$	In.
	18.69	426	125.25	16.695	3.033	1.875	6610.3	707.4	7.26	2359.5	282.7	4.34
	18.50	412	121.15	16.645	2.938	1.825	6309.7	682.1	7.22	2264.9	272.1	4.32
	18.31	398	116.98	16.590	2.843	1.770	6013.7	656.9	7.17	2169.7	261.6	4.31
	18.12	384	112.93	16.540	2.748	1.720	5727.5	632.2	7.12	2078.1	251.3	4.29
	17.94	370	108.78	16.475	2.658	1.655	5454.2	608.1	7.08	1986.0	241.1	4.27
	17.75	356	104.68	16.420	2.563	1.600	5179.4	583.6	7.03	1895.7	230.9	4.26
	17.56	342	100.59	16.365	2.468	1.545	4911.5	559.4	6.99	1806.9	220.8	4.24
	17.38	328	96.43	16.295	2.378	1.475	4656.1	535.8	6.95	1718.5	210.9	4.22
	17.19	314	92.30	16.235	2.283	1.415	4399.4	511.9	6.90	1631.4	201.0	4.20
	17.00	300	88.20	16.175	2.188	1.355	4149.5	488.2	6.86	1546.0	191.2	4.19
	16.81	287	84.37	16.130	2.093	1.310	3912.1	465.5	6.81	1466.5	181.8	4.17
	16.62	273	80.22	16.065	1.998	1.245	3673.2	442.0	6.77	1382.9	172.2	4.15
	16.50	264	77.63	16.025	1.938	1.205	3526.0	427.4	6.74	1331.2	166.1	4.14
CB 146	16.37	255	74.98	15.990	1.873	1.170	3372.6	412.0	6.71	1278.1	159.9	4.13
14 x 16	16.25	246	72.33	15.945	1.813	1.125	3228.9	397.4	6.68	1226.6	153.9	4.12
	16.12	237	69.69	15.910	1.748	1.090	3080.9	382.2	6.65	1174.8	147.7	4.11
	16.00	228	67.06	15.865	1.688	1.045	2942.4	367.8	6.62	1124.8	141.8	4.10
	15.87	219	64.36	15.825	1.623	1.005	2798.2	352.6	6.59	1073.2	135.6	4.08
	15.75	211	62.07	15.800	1.563	.980	2671.4	339.2	6.56	1028.6	130.2	4.07
	15.63	202	59.39	15.750	1.503	.930	2538.8	324.9	6.54	979.7	124.4	4.06
	15.50	193	56.73	15.710	1.438	.890	2402.4	310.0	6.51	930.1	118.4	4.05
	15.38	184	54.07	15.660	1.378	.840	2274.8	295.8	6.49	882.7	112.7	4.04
	15.25	176	51.73	15.640	1.313	.820	2149.6	281.9	6.45	837.9	107.1	4.02
	15.12	167	49.09	15.600	1.248	.780	2020.8	267.3	6.42	790.2	101.3	4.01
	15.00	158	46.47	15.550	1.188	.730	1900.6	253.4	6.40	745.0	95.8	4.00
	14.88	150	44.08	15.515	1.128	.695	1786.9	240.2	6.37	702.5	90.6	3.99
	14.75	142	41.85	15.500	1.063	.680	1672.2	226.7	6.32	660.1	85.2	3.97
	16.81	*320	94.12	16.710	2.093	1.890	4141.7	492.8	6.63	1635.1	195.7	4.17
	14.75	136	39.98	14.740	1.063	.660	1593.0	216.0	6.31	567.7	77.0	3.77
	14.62	127	37.33	14.690	.998	.610	1476.7	202.0	6.29	527.6	71.8	3.76
CB 145	14.50	119	34.99	14.650	.938	.570	1373.1	189.4	6.26	491.8	67.1	3.75
14 x 14½	14.37	111	32.65	14.620	.873	.540	1266.5	176.3	6.23	454.9	62.2	3.73
	14.25	103	30.26	14.575	.813	.495	1165.8	163.6	6.21	419.7	57.6	3.72
	14.12	95	27.94	14.545	.748	.465	1063.5	150.6	6.17	383.7	52.8	3.71
	14.00	87	25.56	14.500	.688	.420	966.9	138.1	6.15	349.7	48.2	3.70

*Column Core Section.



CB SECTIONS

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance d_1	Distance Min. g_2	Distance Clear. h	Usual Gage g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
	426	18 3/4	16 3/4	3 1/16	1 7/8	15/16	7 3/8	11 3/8	3 5/8	25 1/8	5	1	
	412	18 1/2	16 5/8	2 15/16	1 13/16	15/16	7 3/8	11 3/8	3 9/16	24 7/8	4 3/4	1	
	398	18 1/4	16 5/8	2 13/16	1 13/16	7/8	7 3/8	11 3/8	3 7/16	24 3/4	4 3/4	15/16	
	384	18 1/8	16 1/2	2 3/4	1 3/4	7/8	7 3/8	11 3/8	3 3/8	24 5/8	4 3/4	15/16	
	370	18	16 1/2	2 11/16	1 11/16	13/16	7 3/8	11 3/8	3 1/4	24 3/8	4 1/2	7/8	
	356	17 3/4	16 3/8	2 9/16	1 5/8	13/16	7 3/8	11 3/8	3 3/16	24 1/4	4 1/2	7/8	
	342	17 1/2	16 3/8	2 7/16	1 9/16	13/16	7 3/8	11 3/8	3 1/16	24	4 1/4	7/8	
	328	17 3/8	16 1/4	2 3/8	1 1/2	3/4	7 3/8	11 3/8	3	23 7/8	4 1/4	13/16	
	314	17 1/4	16 1/4	2 5/16	1 7/16	3/4	7 3/8	11 3/8	2 7/8	23 3/4	4 1/4	13/16	
	300	17	16 1/8	2 3/16	1 3/8	11/16	7 3/8	11 3/8	2 13/16	23 1/2	4	3/4	
	287	16 3/4	16 1/8	2 1/16	1 5/16	11/16	7 3/8	11 3/8	2 11/16	23 3/8	4	3/4	
	273	16 5/8	16 1/8	2	1 1/4	5/8	7 3/8	11 3/8	2 5/8	23 1/8	4	11/16	
	264	16 1/2	16	1 15/16	1 1/4	5/8	7 3/8	11 3/8	2 9/16	23	3 3/4	11/16	
CB 146 14	255	16 3/8	16	1 7/8	1 3/16	5/8	7 3/8	11 3/8	2 1/2	23	3 3/4	11/16	3 — 5 1/2 — 3
	246	16 1/4	16	1 13/16	1 1/8	9/16	7 3/8	11 3/8	2 7/16	22 7/8	3 3/4	5/8	
	237	16 1/8	15 7/8	1 3/4	1 1/8	9/16	7 3/8	11 3/8	2 3/8	22 3/4	3 3/4	5/8	
	228	16	15 7/8	1 11/16	1 1/16	9/16	7 3/8	11 3/8	2 5/16	22 5/8	3 1/2	5/8	
	219	15 7/8	15 7/8	1 5/8	1	1/2	7 3/8	11 3/8	2 1/4	22 1/2	3 1/2	9/16	
	211	15 3/4	15 3/4	1 9/16	1	1/2	7 3/8	11 3/8	2 3/16	22 3/8	3 1/2	9/16	
	202	15 5/8	15 3/4	1 1/2	15/16	1/2	7 3/8	11 3/8	2 1/8	22 1/4	3 1/2	9/16	
	193	15 1/2	15 3/4	1 7/16	7/8	7/16	7 3/8	11 3/8	2 1/16	22 1/8	3 1/4	1/2	
	184	15 3/8	15 5/8	1 3/8	7/8	7/16	7 3/8	11 3/8	2	22	3 1/4	1/2	
	176	15 1/4	15 5/8	1 5/16	13/16	7/16	7 3/8	11 3/8	1 15/16	21 7/8	3 1/4	1/2	
	167	15 1/8	15 5/8	1 1/4	13/16	3/8	7 3/8	11 3/8	1 7/8	21 3/4	3 1/4	7/16	
	158	15	15 1/2	1 3/16	3/4	3/8	7 3/8	11 3/8	1 13/16	21 5/8	3	7/16	
	150	14 7/8	15 1/2	1 1/8	11/16	3/8	7 3/8	11 3/8	1 3/4	21 1/2	3	7/16	
	142	14 3/4	15 1/2	1 1/16	11/16	3/8	7 3/8	11 3/8	1 11/16	21 1/2	3	7/16	
	*320	16 3/4	16 3/4	2 1/16	1 7/8	15/16	7 3/8	11 3/8	2 11/16	23 3/4	4	1	
	136	14 3/4	14 3/4	1 1/16	11/16	3/8	7	11 3/8	1 11/16	20 7/8	3	7/16	5 1/2
	127	14 5/8	14 3/4	1	5/8	5/16	7	11 3/8	1 5/8	20 3/4	3	3/8	5 1/2
	119	14 1/2	14 5/8	15/16	9/16	5/16	7	11 3/8	1 9/16	20 5/8	2 3/4	3/8	5 1/2
CB 145 14	111	14 3/8	14 5/8	7/8	9/16	5/16	7	11 3/8	1 1/2	20 1/2	2 3/4	3/8	5 1/2
	103	14 1/4	14 5/8	13/16	1/2	1/4	7	11 3/8	1 7/16	20 1/2	2 3/4	5/16	5 1/2
	95	14 1/8	14 1/2	3/4	1/2	1/4	7	11 3/8	1 3/8	20 1/4	2 3/4	5/16	5 1/2
	87	14	14 1/2	11/16	7/16	1/4	7	11 3/8	1 5/16	20 1/4	2 1/2	5/16	5 1/2

*Column Core Section.

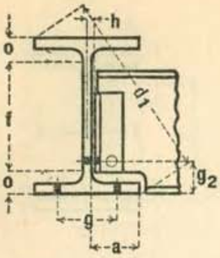
Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

ELEMENTS

CB SECTIONS

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange		Web Thick-ness	Axis 1-1			Axis 2-2		
				Width	Thick-ness		I	S	r	I	S	r
	In.	Lbs.	In.²	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
CB 144	14.18	84	24.71	12.023	.778	.451	928.4	130.9	6.13	225.5	37.5	3.02
14 x 12	14.06	78	22.94	12.000	.718	.428	851.2	121.1	6.09	206.9	34.5	3.00
CB 143	14.19	74	21.76	10.072	.783	.450	796.8	112.3	6.05	133.5	26.5	2.48
14 x 10	14.06	68	20.00	10.040	.718	.418	724.1	103.0	6.02	121.2	24.1	2.46
	13.91	61	17.94	10.000	.643	.378	641.5	92.2	5.98	107.3	21.5	2.45
	14.06	58	17.06	8.098	.718	.406	597.9	85.0	5.92	63.7	15.7	1.93
CB 142	13.94	53	15.59	8.062	.658	.370	542.1	77.8	5.90	57.5	14.3	1.92
14 x 8	13.81	48	14.11	8.031	.593	.339	484.9	70.2	5.86	51.3	12.8	1.91
	13.68	43	12.65	8.000	.528	.308	429.0	62.7	5.82	45.1	11.3	1.39
	14.24	42	12.34	6.801	.573	.338	432.2	60.7	5.92	28.1	8.3	1.51
CB 141	14.12	38	11.17	6.776	.513	.313	385.3	54.6	5.87	24.6	7.3	1.49
14 x 6¾	14.00	34	10.00	6.750	.453	.287	339.2	48.5	5.83	21.3	6.3	1.46
	13.86	30	8.81	6.733	.383	.270	289.6	41.8	5.73	17.5	5.2	1.41
	14.38	190	55.86	12.670	1.736	1.060	1892.5	263.2	5.82	589.7	93.1	3.25
	14.12	176	51.79	12.615	1.606	1.005	1712.5	242.6	5.75	538.4	85.4	3.22
	13.88	161	47.38	12.515	1.486	.905	1541.8	222.2	5.70	486.2	77.7	3.20
	13.62	147	43.24	12.450	1.356	.840	1374.4	201.8	5.64	436.8	70.2	3.18
	13.38	133	39.11	12.365	1.236	.755	1221.2	182.5	5.59	389.9	63.1	3.16
	13.12	120	35.31	12.320	1.106	.710	1071.7	163.4	5.51	345.1	56.0	3.13
CB 124	12.88	106	31.19	12.230	.986	.620	930.7	144.5	5.46	300.9	49.2	3.11
12 x 12	12.75	99	29.09	12.190	.921	.580	858.5	134.7	5.43	278.2	45.7	3.09
	12.62	92	27.06	12.155	.856	.545	788.9	125.0	5.40	256.4	42.2	3.08
	12.50	85	24.98	12.105	.796	.495	723.3	115.7	5.38	235.5	38.9	3.07
	12.38	79	23.22	12.080	.736	.470	663.0	107.1	5.34	216.4	35.8	3.05
	12.25	72	21.16	12.040	.671	.430	597.4	97.5	5.31	195.3	32.4	3.04
	12.12	65	19.11	12.000	.606	.390	533.4	88.0	5.28	174.6	29.1	3.02
CB 123	12.31	64	18.83	10.060	.701	.405	528.3	85.8	5.29	119.0	23.7	2.51
12 x 10	12.19	58	17.06	10.014	.641	.359	476.1	78.1	5.28	107.4	21.4	2.51
	12.06	53	15.59	10.000	.576	.345	426.2	70.7	5.23	96.1	19.2	2.48
CB 122	12.19	50	14.71	8.077	.641	.371	394.5	64.7	5.18	56.4	14.0	1.96
12 x 8	12.06	45	13.24	8.042	.576	.336	350.8	58.2	5.15	50.0	12.4	1.94
	11.94	40	11.77	8.000	.516	.294	310.1	51.9	5.13	44.1	11.0	1.94
	12.24	36	10.59	6.565	.540	.305	280.8	45.9	5.15	23.7	7.2	1.50
CB 121	12.12	32	9.41	6.533	.480	.273	246.8	40.7	5.12	20.6	6.3	1.48
12 x 6½	12.00	28	8.23	6.500	.420	.240	213.5	35.6	5.09	17.5	5.4	1.46
	11.87	25	7.39	6.500	.355	.240	183.4	30.9	4.98	14.5	4.5	1.40



CB SECTIONS

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

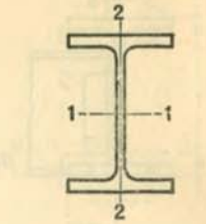
Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance d_1	Min. g_2	Clear. h	Usual Gage g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
CB 144 14	84	14 1/8	12	3/4	7/16	1/4	5 3/4	11 3/8	1 3/8	18 5/8	2 3/4	5/16	5 1/2
	78	14	12	11/16	7/16	1/4	5 3/4	11 3/8	1 5/16	18 1/2	2 1/2	5/16	5 1/2
CB 143 14	74	14 1/4	10 1/8	13/16	7/16	1/4	4 3/4	11 3/8	1 3/8	17 1/2	2 3/4	5/16	5 1/2
	68	14	10	11/16	7/16	1/4	4 3/4	11 3/8	1 5/16	17 1/4	2 1/2	5/16	5 1/2
	61	13 7/8	10	5/8	3/8	3/16	4 3/4	11 3/8	1 1/4	17 1/8	2 1/2	1/4	5 1/2
CB 142 14	58	14	8 1/8	11/16	7/16	3/16	3 7/8	11 3/8	1 5/16	16 1/4	2 1/2	1/4	5 1/2
	53	14	8	11/16	3/8	3/16	3 7/8	11 3/8	1 1/4	16 1/8	2 1/2	1/4	5 1/2
	48	13 3/4	8	9/16	3/8	3/16	3 7/8	11 3/8	1 3/16	16	2 1/2	1/4	5 1/2
	43	13 5/8	8	1/2	5/16	3/16	3 7/8	11 3/8	1 1/8	15 7/8	2 1/2	1/4	5 1/2
CB 141 14	42	14 1/4	6 3/4	9/16	3/8	3/16	3 1/4	12 1/8	1 1/16	15 3/4	2 1/4	1/4	3 1/2
	38	14 1/8	6 3/4	1/2	5/16	3/16	3 1/4	12 1/8	1	15 3/4	2 1/4	1/4	3 1/2
	34	14	6 3/4	7/16	5/16	3/16	3 1/4	12 1/8	15/16	15 5/8	2 1/4	1/4	3 1/2
	30	13 7/8	6 3/4	3/8	5/16	1/8	3 1/4	12 1/8	7/8	15 1/2	2 1/4	3/16	3 1/2
CB 124 12	190	14 3/8	12 5/8	1 3/4	1 1/16	9/16	5 3/4	9 3/4	2 5/16	19 1/4	3 3/4	5/8	5 1/2
	176	14 1/8	12 5/8	1 5/8	1	1/2	5 3/4	9 3/4	2 3/16	19	3 1/2	9/16	5 1/2
	161	13 7/8	12 1/2	1 1/2	15/16	7/16	5 3/4	9 3/4	2 1/16	18 3/4	3 1/2	1/2	5 1/2
	147	13 5/8	12 1/2	1 3/8	7/8	7/16	5 3/4	9 3/4	1 15/16	18 1/2	3 1/4	1/2	5 1/2
	133	13 3/8	12 3/8	1 1/4	3/4	3/8	5 3/4	9 3/4	1 13/16	18 1/4	3 1/4	7/16	5 1/2
	120	13 1/8	12 3/8	1 1/8	3/4	3/8	5 3/4	9 3/4	1 11/16	18	3	7/16	5 1/2
	106	12 7/8	12 1/4	1	5/8	5/16	5 3/4	9 3/4	1 9/16	17 7/8	3	3/8	5 1/2
	99	12 3/4	12 1/4	15/16	5/8	5/16	5 3/4	9 3/4	1 1/2	17 3/4	2 3/4	3/8	5 1/2
	92	12 5/8	12 1/8	7/8	9/16	5/16	5 3/4	9 3/4	1 7/16	17 1/2	2 3/4	3/8	5 1/2
	85	12 1/2	12 1/8	13/16	1/2	1/4	5 3/4	9 3/4	1 3/8	17 1/2	2 3/4	5/16	5 1/2
	79	12 3/8	12 1/8	3/4	1/2	1/4	5 3/4	9 3/4	1 5/16	17 3/8	2 3/4	5/16	5 1/2
	72	12 1/4	12	11/16	7/16	1/4	5 3/4	9 3/4	1 1/4	17 1/4	2 1/2	5/16	5 1/2
	65	12 1/8	12	5/8	3/8	3/16	5 3/4	9 3/4	1 3/16	17 1/8	2 1/2	1/4	5 1/2
CB 123 12	64	12 1/4	10	11/16	7/16	3/16	4 7/8	9 3/4	1 5/16	15 7/8	2 1/2	1/4	5 1/2
	58	12 1/4	10	5/8	3/8	3/16	4 7/8	9 3/4	1 1/4	15 7/8	2 1/2	1/4	5 1/2
	53	12	10	9/16	3/8	3/16	4 7/8	9 3/4	1 3/16	15 5/8	2 1/2	1/4	5 1/2
CB 122 12	50	12 1/4	8 1/8	5/8	3/8	3/16	3 7/8	9 3/4	1 1/4	14 5/8	2 1/2	1/4	5 1/2
	45	12	8	9/16	3/8	3/16	3 7/8	9 3/4	1 3/16	14 1/2	2 1/2	1/4	5 1/2
	40	12	8	1/2	5/16	3/16	3 7/8	9 3/4	1 1/8	14 3/8	2 1/2	1/4	5 1/2
CB 121 12	36	12 1/4	6 5/8	9/16	5/16	3/16	3 1/8	10 3/8	15/16	14	2 1/4	1/4	3 1/2
	32	12 1/8	6 1/2	1/2	5/16	1/8	3 1/8	10 3/8	7/8	13 3/4	2 1/4	3/16	3 1/2
	28	12	6 1/2	7/16	1/4	1/8	3 1/8	10 3/8	13/16	13 3/4	2 1/4	3/16	3 1/2
	25	11 7/8	6 1/2	3/8	1/4	1/8	3 1/8	10 3/8	3/4	13 5/8	2 1/4	3/16	3 1/2

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

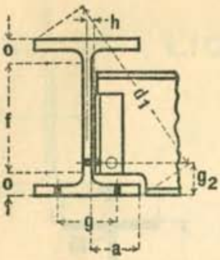
ELEMENTS

CB SECTIONS

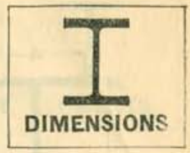
ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange		Web Thickness	Axis 1-1			Axis 2-2		
				Width	Thickness		I	S	r	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
CB 103 10 x 10	11.88	136	40.03	10.575	1.498	.915	917.2	154.4	4.79	295.9	56.0	2.72
	11.62	124	36.46	10.505	1.368	.845	813.1	139.9	4.72	264.8	50.4	2.69
	11.38	112	32.92	10.415	1.248	.755	718.7	126.3	4.67	235.4	45.2	2.67
	11.12	100	29.43	10.345	1.118	.685	625.0	112.4	4.61	206.6	39.9	2.65
	10.88	89	26.19	10.275	.998	.615	542.4	99.7	4.55	180.6	35.2	2.63
	10.62	77	22.67	10.195	.868	.535	457.2	86.1	4.49	153.4	30.1	2.60
	10.50	72	21.18	10.170	.808	.510	420.7	80.1	4.46	141.8	27.9	2.59
	10.38	66	19.41	10.117	.748	.457	382.5	73.7	4.44	129.2	25.5	2.58
	10.25	60	17.66	10.075	.683	.415	343.7	67.1	4.41	116.5	23.1	2.57
	10.12	54	15.88	10.028	.618	.368	305.7	60.4	4.39	103.9	20.7	2.56
	10.00	49	14.40	10.000	.558	.340	272.9	54.6	4.35	93.0	18.6	2.54
CB 102 10 x 8	10.12	45	13.24	8.022	.618	.350	248.6	49.1	4.33	53.2	13.3	2.00
	10.00	41	12.06	8.000	.558	.328	222.4	44.5	4.29	47.7	11.9	1.99
	9.88	37	10.88	7.978	.498	.306	196.9	39.9	4.25	42.2	10.6	1.97
	9.75	33	9.71	7.964	.433	.292	170.9	35.0	4.20	36.5	9.2	1.94
CB 101 10 x 5¾	10.22	29	8.53	5.799	.500	.289	157.3	30.8	4.29	15.2	5.2	1.34
	10.12	26	7.65	5.769	.450	.259	139.7	27.6	4.27	13.4	4.6	1.32
	10.00	23	6.77	5.750	.390	.240	120.6	24.1	4.22	11.3	3.9	1.29
	9.90	21	6.19	5.750	.340	.240	106.3	21.5	4.14	9.7	3.4	1.25
CB 83 8 x 8	9.00	67	19.70	8.287	.933	.575	271.8	60.4	3.71	88.6	21.4	2.12
	8.75	58	17.06	8.222	.808	.510	227.3	52.0	3.65	74.9	18.2	2.10
	8.50	48	14.11	8.117	.683	.405	183.7	43.2	3.61	60.9	15.0	2.08
	8.25	40	11.76	8.077	.558	.365	146.3	35.5	3.53	49.0	12.1	2.04
	8.12	35	10.30	8.027	.493	.315	126.5	31.1	3.50	42.5	10.6	2.03
	8.06	33	9.70	8.012	.463	.300	117.9	29.3	3.49	39.7	9.9	2.02
	8.00	31	9.12	8.000	.433	.288	109.7	27.4	3.47	37.0	9.2	2.01
CB 82 8 x 6½	8.03	27	7.93	6.528	.448	.273	94.1	23.4	3.44	20.8	6.4	1.62
	7.93	24	7.06	6.500	.398	.245	82.5	20.8	3.42	18.2	5.6	1.61
CB 81 8 x 5¼	8.19	21	6.18	5.272	.403	.252	73.8	18.0	3.45	9.13	3.5	1.22
	8.09	19	5.59	5.264	.353	.244	64.7	16.0	3.40	7.87	3.0	1.19
	8.00	17	5.00	5.250	.308	.230	56.4	14.1	3.36	6.72	2.6	1.16



CB SECTIONS



DIMENSIONS OF SECTIONS FOR DETAILING

Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange		Web		Distance						Usual Gage
			Width	Thickness	Thickness	Half Thickness	a	f	o	d_1	Min. g_2	Clear. h	g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
	136	11 7/8	10 5/8	1 1/2	15/16	1/2	4 7/8	7 7/8	2	16	3 1/4	9/16	5 1/2
	124	11 5/8	10 1/2	1 3/8	7/8	7/16	4 7/8	7 7/8	1 7/8	15 3/4	3 1/4	1/2	5 1/2
	112	11 3/8	10 3/8	1 1/4	3/4	3/8	4 7/8	7 7/8	1 3/4	15 1/2	3	7/16	5 1/2
	100	11 1/8	10 3/8	1 1/8	11/16	3/8	4 7/8	7 7/8	1 5/8	15 1/4	3	7/16	5 1/2
	89	10 7/8	10 1/4	1	5/8	5/16	4 7/8	7 7/8	1 1/2	15	2 3/4	3/8	5 1/2
CB 103 10	77	10 5/8	10 1/4	7/8	9/16	5/16	4 7/8	7 7/8	1 3/8	14 3/4	2 3/4	3/8	5 1/2
	72	10 1/2	10 1/8	13/16	1/2	1/4	4 7/8	7 7/8	1 5/16	14 5/8	2 3/4	5/16	5 1/2
	66	10 3/8	10 1/8	3/4	7/16	1/4	4 7/8	7 7/8	1 1/4	14 1/2	2 1/2	5/16	5 1/2
	60	10 1/4	10 1/8	11/16	7/16	1/4	4 7/8	7 7/8	1 3/16	14 3/8	2 1/2	5/16	5 1/2
	54	10 1/8	10	5/8	3/8	3/16	4 7/8	7 7/8	1 1/8	14 1/4	2 1/2	1/4	5 1/2
	49	10	10	9/16	3/8	3/16	4 7/8	7 7/8	1 1/16	14 1/8	2 1/2	1/4	5 1/2
	45	10 1/8	8	5/8	3/8	3/16	3 7/8	7 7/8	1 1/8	13	2 1/2	1/4	5 1/2
CB 102 10	41	10	8	9/16	5/16	3/16	3 7/8	7 7/8	1 1/16	12 7/8	2 1/2	1/4	5 1/2
	37	9 7/8	8	1/2	5/16	3/16	3 7/8	7 7/8	1	12 3/4	2 1/4	1/4	5 1/2
	33	9 3/4	8	7/16	5/16	3/16	3 7/8	7 7/8	15/16	12 5/8	2 1/4	1/4	5 1/2
	29	10 1/4	5 3/4	1/2	5/16	3/16	2 3/4	8 1/2	7/8	11 3/4	2 1/4	1/4	2 3/4
CB 101 10	26	10 1/8	5 3/4	7/16	1/4	1/8	2 3/4	8 1/2	13/16	11 3/4	2 1/4	3/16	2 3/4
	23	10	5 3/4	3/8	1/4	1/8	2 3/4	8 1/2	3/4	11 5/8	2 1/4	3/16	2 3/4
	21	9 7/8	5 3/4	5/16	1/4	1/8	2 3/4	8 1/2	11/16	11 1/2	2	3/16	2 3/4
	67	9	8 1/4	15/16	9/16	5/16	3 7/8	6 3/8	1 5/16	12 1/4	2 3/4	3/8	5 1/2
	58	8 3/4	8 1/4	13/16	1/2	1/4	3 7/8	6 3/8	1 3/16	12	2 1/2	5/16	5 1/2
	48	8 1/2	8 1/8	11/16	7/16	3/16	3 7/8	6 3/8	1 1/16	11 7/8	2 1/2	1/4	5 1/2
CB 83 8	40	8 1/4	8 1/8	9/16	3/8	3/16	3 7/8	6 3/8	15/16	11 5/8	2 1/4	1/4	5 1/2
	35	8 1/8	8	1/2	5/16	3/16	3 7/8	6 3/8	7/8	11 1/2	2 1/4	1/4	5 1/2
	33	8	8	7/16	5/16	3/16	3 7/8	6 3/8	7/8	11 3/8	2 1/4	1/4	5 1/2
	31	8	8	7/16	5/16	3/16	3 7/8	6 3/8	13/16	11 3/8	2 1/4	1/4	5 1/2
CB 82	27	8	6 1/2	7/16	5/16	1/8	3 1/8	6 3/8	7/8	10 3/8	2 1/4	3/16	3 1/2
8	24	7 7/8	6 1/2	3/8	1/4	1/8	3 1/8	6 3/8	13/16	10 1/4	2 1/4	3/16	3 1/2
	21	8 1/4	5 1/4	3/8	1/4	1/8	2 1/2	6 3/4	3/4	9 3/4	2 1/4	3/16	2 3/4
CB 81 8	19	8 1/8	5 1/4	3/8	1/4	1/8	2 1/2	6 3/4	11/16	9 5/8	2 1/4	3/16	2 3/4
	17	8	5 1/4	5/16	1/4	1/8	2 1/2	6 3/4	5/8	9 5/8	2 1/4	3/16	2 3/4

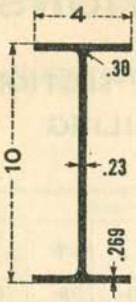
Gages g_2 are based on 1¼″ edge distance (⅞″ maximum rivet).

LIGHT BEAMS

CBL12 12x4

22, 19, 16.5 lbs.

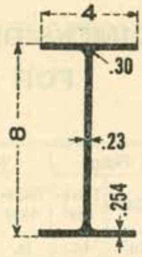
C



CBL10 10x4

19, 17, 15 lbs.

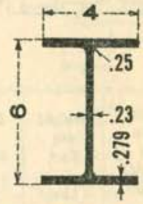
C



CBL8 8x4

15, 13 lbs.

C

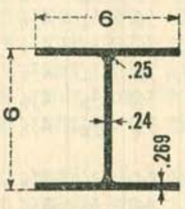


CBL6 6x4

16, 12 lbs.

C

STANCHIONS

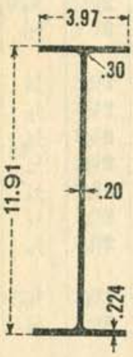


CBS6 6x6

18, 15.5 lbs.

C

JOISTS



CBJ12 12x4

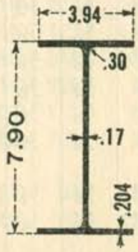
14 lbs.

C

CBJ10 10x4

11.5 lbs.

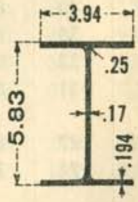
C



CBJ8 8x4

10 lbs.

C



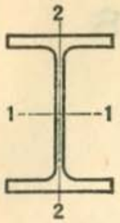
CBJ6 6x4

8.5 lbs.

C

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES

RANGE OF WEIGHTS PER LINEAR FOOT



LIGHT BEAMS, STANCHIONS AND JOISTS

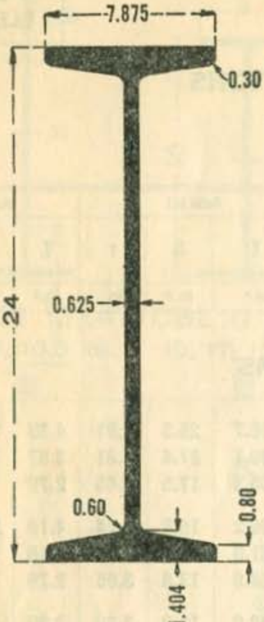
ELEMENTS

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange		Web Thickness	Axis 1-1			Axis 2-2		
				Width	Thickness		I	S	r	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
LIGHT BEAMS												
CBL 12 12 x 4 C	12.31	22	6.47	4.030	.424	.260	155.7	25.3	4.91	4.55	2.26	0.84
	12.16	19	5.62	4.010	.349	.240	130.1	21.4	4.81	3.67	1.83	0.81
	12.00	16½	4.86	4.000	.269	.230	105.3	17.5	4.65	2.79	1.39	0.76
CBL 10 10 x 4 C	10.25	19	5.61	4.020	.394	.250	96.2	18.8	4.14	4.19	2.08	0.86
	10.12	17	4.98	4.010	.329	.240	81.8	16.2	4.05	3.45	1.72	0.83
	10.00	15	4.40	4.000	.269	.230	68.8	13.8	3.95	2.79	1.39	0.80
CBL 8 8 x 4 C	8.12	15	4.43	4.015	.314	.245	48.0	11.8	3.29	3.30	1.65	0.86
	8.00	13	3.83	4.000	.254	.230	39.5	9.88	3.21	2.62	1.31	0.83
CBL 6 6 x 4 C	6.25	16	4.72	4.030	.404	.260	31.7	10.1	2.59	4.32	2.14	0.96
	6.00	12	3.53	4.000	.279	.230	21.7	7.24	2.48	2.89	1.44	0.90
STANCHIONS												
CBS 6 6 x 6 C	6.09	18	5.28	6.025	.314	.265	35.5	11.7	2.59	11.0	3.64	1.44
	6.00	15½	4.59	6.000	.269	.240	30.1	10.0	2.56	9.19	3.06	1.42
JOISTS												
CBJ 12 12 x 4 C	11.91	14	4.14	3.970	.224	.200	88.2	14.8	4.61	2.25	1.13	0.74
CBJ 10 10 x 4 C	9.87	11½	3.39	3.950	.204	.180	51.9	10.5	3.92	2.01	1.02	0.77
CBJ 8 8 x 4 C	7.90	10	2.95	3.940	.204	.170	30.8	7.79	3.23	1.99	1.01	0.82
CBJ 6 6 x 4 C	5.83	8½	2.50	3.940	.194	.170	14.8	5.07	2.43	1.89	0.96	0.87

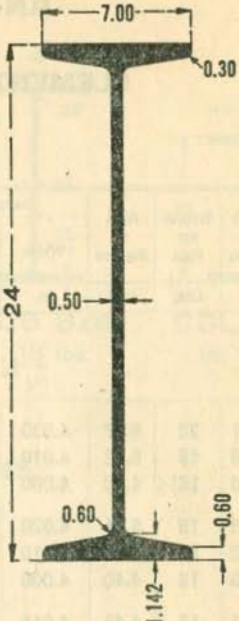
For detailing dimensions, see pages 231 and 233.

AMERICAN STANDARD BEAMS



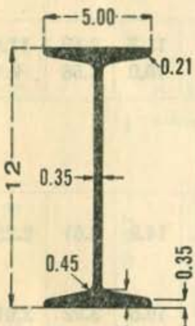
B18 24x7⅞

120, 115, 110, 105.9 lbs.



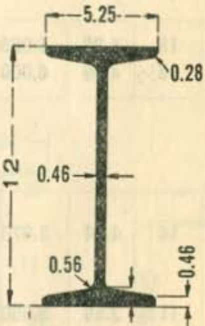
B1 24x7

100, 95, 90, 85, 79.9 lbs.



B9 12x5

35, 31.8 lbs.



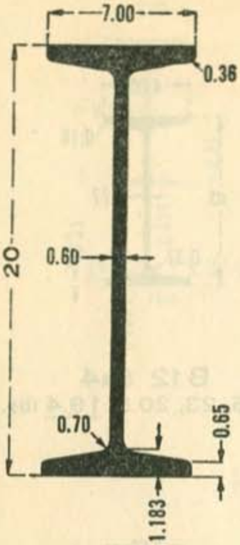
B8 12x5¼

55, 50, 45, 40.8 lbs.

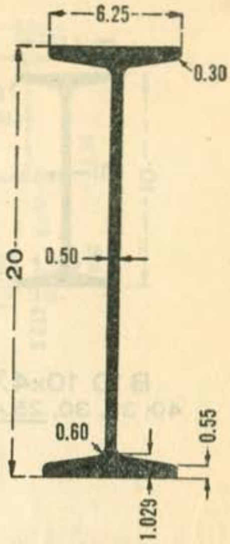
WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES

RANGE OF WEIGHTS PER LINEAR FOOT

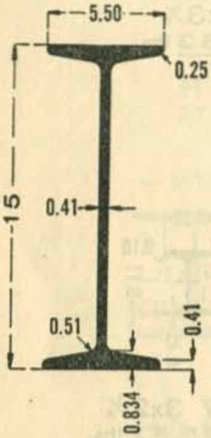
AMERICAN STANDARD BEAMS



B 2 20x7
100, 95, 90, 85, 81.4 lbs.

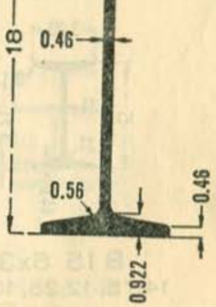


B 3 20x6¼
75, 70, 65.4 lbs.



B 7 15x5½
55, 50, 45, 42.9 lbs.

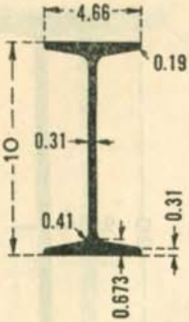
B 6 15x6
75, 70, 65, 60.8 lbs



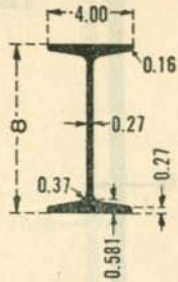
B 4 18x6
70, 65, 60, 54.7 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

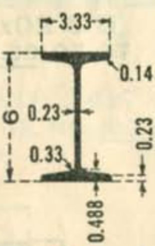
AMERICAN STANDARD BEAMS



B 10 10x4⅝
40, 35, 30, 25.4 lbs.

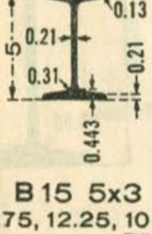


B 12 8x4
25.5, 23, 20.5, 18.4 lbs.

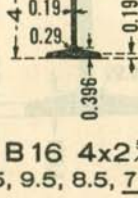


B 14 6x3⅜
17.25, 14.75, 12.5 lbs.

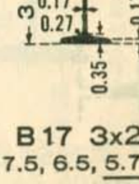
B 13 7x3⅝
20, 17.5, 15.3 lbs.



B 15 5x3
14.75, 12.25, 10 lbs.



B 16 4x2⅝
10.5, 9.5, 8.5, 7.7 lbs.

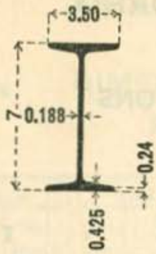


B 17 3x2⅜
7.5, 6.5, 5.7 lbs.

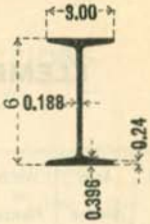
WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES

RANGE OF WEIGHTS PER LINEAR FOOT

STANDARD MILL BEAMS

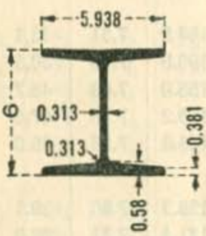


B 42 7x3½
12 lbs.

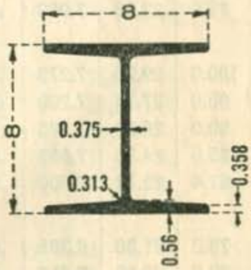


B 41 6x3
10 lbs.

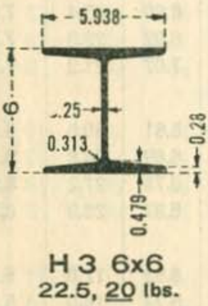
H-BEAMS



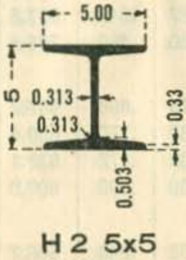
H 3A 6x6
27.5, 25 lbs.



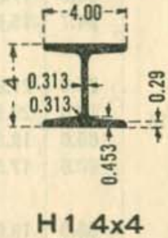
H 4 8x8
37.7, 34.3, 32.6 lbs.



H 3 6x6
22.5, 20 lbs.



H 2 5x5
18.9 lbs.



H 1 4x4
13.8 lbs.

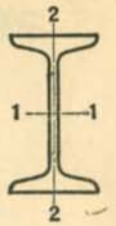
WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

ELEMENTS

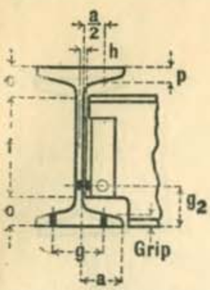
BEAMS

AMERICAN STANDARD

ELEMENTS OF SECTIONS



Section Index and Nominal Size	Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Web Thick-ness	Axis 1-1			Axis 2-2		
						I	S	r	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
B 18 24x7⅞	24	120.0	35.13	8.048	.798	3010.8	250.9	9.26	84.9	21.1	1.56
		115.0	33.67	7.987	.737	2940.5	245.0	9.35	82.8	20.7	1.57
		110.0	32.18	7.925	.675	2869.1	239.1	9.44	80.6	20.3	1.58
		105.9	30.98	7.875	.625	2811.5	234.3	9.53	78.9	20.0	1.60
B 1 24 x 7	24	100.0	29.25	7.247	.747	2371.8	197.6	9.05	48.4	13.4	1.29
		95.0	27.79	7.186	.686	2301.5	191.8	9.08	47.0	13.0	1.30
		90.0	26.30	7.124	.624	2230.1	185.8	9.21	45.5	12.8	1.32
		85.0	24.84	7.063	.563	2159.8	180.0	9.33	44.2	12.5	1.33
		79.9	23.33	7.000	.500	2087.2	173.9	9.46	42.9	12.2	1.36
B 2 20 x 7	20	100.0	29.20	7.273	.873	1648.3	164.8	7.51	52.4	14.4	1.34
		95.0	27.74	7.200	.800	1599.7	160.0	7.59	50.5	14.0	1.35
		90.0	26.26	7.126	.726	1550.3	155.0	7.68	48.7	13.7	1.36
		85.0	24.80	7.053	.653	1501.7	150.2	7.78	47.0	13.3	1.38
		81.4	23.74	7.000	.600	1466.3	146.6	7.86	45.8	13.1	1.39
B 3 20x6¼	20	75.0	21.90	6.391	.641	1263.5	126.3	7.60	30.1	9.4	1.17
		70.0	20.42	6.317	.567	1214.2	121.4	7.71	28.9	9.2	1.19
		65.4	19.08	6.250	.500	1169.5	116.9	7.83	27.9	8.9	1.21
B 4 18 x 6	18	70.0	20.46	6.251	.711	917.5	101.9	6.70	24.5	7.8	1.09
		65.0	18.98	6.169	.629	877.7	97.5	6.80	23.4	7.6	1.11
		60.0	17.50	6.087	.547	837.8	93.1	6.92	22.3	7.3	1.13
		54.7	15.94	6.000	.460	795.5	88.4	7.07	21.2	7.1	1.15
B 6 15 x 6	15	75.0	21.85	6.278	.868	687.2	91.6	5.61	30.6	9.8	1.18
		70.0	20.38	6.180	.770	659.6	87.9	5.69	28.8	9.3	1.19
		65.0	18.91	6.082	.672	632.1	84.3	5.78	27.2	8.9	1.20
		60.8	17.68	6.000	.590	609.0	81.2	5.87	26.0	8.7	1.21
B 7 15x5½	15	55.0	16.06	5.738	.648	508.7	67.8	5.63	17.0	5.9	1.03
		50.0	14.59	5.640	.550	481.1	64.2	5.74	16.0	5.7	1.05
		45.0	13.12	5.542	.452	453.6	60.5	5.88	15.0	5.4	1.07
		42.9	12.49	5.500	.410	441.8	58.9	5.95	14.6	5.3	1.08



BEAMS

AMERICAN STANDARD

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

Section Index and Depth	Weight per Foot	Flange: Width	Flange: Thickness, p	Web: Thickness	Web: Half Thickness	Distance: a	Distance: f	Distance: o	Distance: Min. g_2	Distance: Clear. h	Distance: Gage g	Distance: Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
	120.0	8	1 1/8	13/16	7/16	3 5/8	20 1/8	1 15/16	3 1/4	1/2	4	1 1/8	1
B 18	115.0	8	1 1/8	3/4	3/8	3 5/8	20 1/8	1 15/16	3 1/4	7/16	4	1 1/8	1
24	110.0	7 7/8	1 1/8	11/16	3/8	3 5/8	20 1/8	1 15/16	3 1/4	7/16	4	1 1/8	1
	105.9	7 7/8	1 1/8	5/8	5/16	3 5/8	20 1/8	1 15/16	3 1/4	3/8	4	1 1/8	1
	100.0	7 1/4	7/8	3/4	3/8	3 1/4	20 3/4	1 5/8	3	7/16	4	7/8	1
B 1	95.0	7 1/8	7/8	11/16	3/8	3 1/4	20 3/4	1 5/8	3	7/16	4	7/8	1
24	90.0	7 1/8	7/8	5/8	5/16	3 1/4	20 3/4	1 5/8	3	3/8	4	7/8	1
	85.0	7 1/8	7/8	9/16	5/16	3 1/4	20 3/4	1 5/8	3	3/8	4	7/8	1
	79.9	7	7/8	1/2	1/4	3 1/4	20 3/4	1 5/8	3	5/16	4	7/8	1
	100.0	7 1/4	15/16	7/8	7/16	3 1/4	16 1/2	1 3/4	3 1/4	1/2	4	15/16	1
B 2	95.0	7 1/4	15/16	13/16	7/16	3 1/4	16 1/2	1 3/4	3 1/4	1/2	4	15/16	1
20	90.0	7 1/8	15/16	3/4	3/8	3 1/4	16 1/2	1 3/4	3 1/4	7/16	4	15/16	1
	85.0	7	15/16	11/16	5/16	3 1/4	16 1/2	1 3/4	3 1/4	3/8	4	7/8	1
	81.4	7	15/16	5/8	5/16	3 1/4	16 1/2	1 3/4	3 1/4	3/8	4	7/8	1
B 3	75.0	6 3/8	13/16	5/8	5/16	2 7/8	16 7/8	1 9/16	3	3/8	3 1/2	13/16	7/8
20	70.0	6 3/8	13/16	9/16	5/16	2 7/8	16 7/8	1 9/16	3	3/8	3 1/2	13/16	7/8
	65.4	6 1/4	13/16	1/2	1/4	2 7/8	16 7/8	1 9/16	3	5/16	3 1/2	3/4	7/8
	70.0	6 1/4	11/16	3/4	3/8	2 3/4	15 1/4	1 3/8	2 3/4	7/16	3 1/2	11/16	7/8
B 4	65.0	6 1/8	11/16	5/8	5/16	2 3/4	15 1/4	1 3/8	2 3/4	3/8	3 1/2	11/16	7/8
18	60.0	6 1/8	11/16	9/16	5/16	2 3/4	15 1/4	1 3/8	2 3/4	3/8	3 1/2	11/16	7/8
	54.7	6	11/16	1/2	1/4	2 3/4	15 1/4	1 3/8	2 3/4	5/16	3 1/2	11/16	7/8
	75.0	6 1/4	13/16	7/8	7/16	2 3/4	11 3/4	1 5/8	3	1/2	3 1/2	13/16	7/8
B 6	70.0	6 1/8	13/16	13/16	3/8	2 3/4	11 3/4	1 5/8	3	7/16	3 1/2	13/16	7/8
15	65.0	6 1/8	13/16	11/16	3/8	2 3/4	11 3/4	1 5/8	3	7/16	3 1/2	13/16	7/8
	60.8	6	13/16	5/8	5/16	2 3/4	11 3/4	1 5/8	3	3/8	3 1/2	13/16	7/8
	55.0	5 3/4	5/8	11/16	5/16	2 1/2	12 1/2	1 1/4	2 3/4	3/8	3 1/2	5/8	3/4
B 7	50.0	5 5/8	5/8	9/16	5/16	2 1/2	12 1/2	1 1/4	2 3/4	3/8	3 1/2	9/16	3/4
15	45.0	5 1/2	5/8	7/16	1/4	2 1/2	12 1/2	1 1/4	2 3/4	5/16	3 1/2	9/16	3/4
	42.9	5 1/2	5/8	7/16	1/4	2 1/2	12 1/2	1 1/4	2 3/4	5/16	3 1/2	9/16	3/4

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

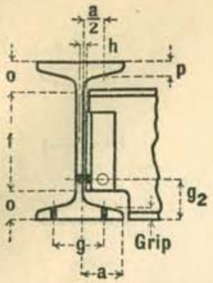
ELEMENTS

BEAMS

AMERICAN STANDARD

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1			Axis 2-2		
						I	S	r	I	S	r
	In.	Lbs.	$In.^2$	In.	In.	$In.^4$	$In.^3$	In.	$In.^4$	$In.^3$	In.
B 8 12 x 5¼	12	55.0	16.04	5.600	.810	319.3	53.2	4.46	17.3	6.2	1.04
		50.0	14.57	5.477	.687	301.6	50.3	4.55	16.0	5.8	1.05
		45.0	13.10	5.355	.565	284.1	47.3	4.66	14.8	5.5	1.06
		40.8	11.84	5.250	.460	268.9	44.8	4.77	13.8	5.3	1.08
B 9 12 x 5	12	35.0	10.20	5.078	.428	227.0	37.8	4.72	10.0	3.9	0.99
		31.8	9.26	5.000	.350	215.8	36.0	4.83	9.5	3.8	1.01
B 10 10 x 4⅝	10	40.0	11.69	5.091	.741	158.0	31.6	3.68	9.4	3.7	0.90
		35.0	10.22	4.944	.594	145.8	29.2	3.78	8.5	3.4	0.91
		30.0	8.75	4.797	.447	133.5	26.7	3.91	7.6	3.2	0.93
		25.4	7.38	4.660	.310	122.1	24.4	4.07	6.9	3.0	0.97
B 12 8 x 4	8	25.5	7.43	4.262	.532	68.1	17.0	3.03	4.7	2.2	0.80
		23.0	6.71	4.171	.441	64.2	16.0	3.09	4.4	2.1	0.81
		20.5	5.97	4.079	.349	60.2	15.1	3.18	4.0	2.0	0.82
		18.4	5.34	4.000	.270	56.9	14.2	3.26	3.8	1.9	0.84
B 13 7 x 3⅝	7	20.0	5.83	3.860	.450	41.9	12.0	2.68	3.1	1.6	0.74
		17.5	5.09	3.755	.345	38.9	11.1	2.77	2.9	1.6	0.76
		15.3	4.43	3.660	.250	36.2	10.4	2.86	2.7	1.5	0.78
B 14 6 x 3⅜	6	17.25	5.02	3.565	.465	26.0	8.7	2.28	2.3	1.3	0.68
		14.75	4.29	3.443	.343	23.8	7.9	2.36	2.1	1.2	0.69
		12.5	3.61	3.330	.230	21.8	7.3	2.46	1.8	1.1	0.72
B 15 5 x 3	5	14.75	4.29	3.284	.494	15.0	6.0	1.87	1.7	1.0	0.63
		12.25	3.56	3.137	.347	13.5	5.4	1.95	1.4	0.91	0.63
		10.0	2.87	3.000	.210	12.1	4.8	2.05	1.2	0.82	0.65
B 16 4 x 2⅝	4	10.5	3.05	2.870	.400	7.1	3.5	1.52	1.0	0.70	0.57
		9.5	2.76	2.796	.326	6.7	3.3	1.56	0.91	0.65	0.58
		8.5	2.46	2.723	.253	6.3	3.2	1.60	0.83	0.61	0.58
		7.7	2.21	2.660	.190	6.0	3.0	1.64	0.77	0.58	0.59
B 17 3 x 2⅜	3	7.5	2.17	2.509	.349	2.9	1.9	1.15	0.59	0.47	0.52
		6.5	1.88	2.411	.251	2.7	1.8	1.19	0.51	0.43	0.52
		5.7	1.64	2.330	.170	2.5	1.7	1.23	0.46	0.40	0.53



BEAMS

AMERICAN STANDARD

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

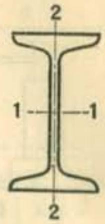
Section Index and Depth	Weight per Foot	Flange Width	Flange Thickness, p	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance Min. g_2	Distance Clear. h	Distance Gage g	Distance Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
B 8	55.0	5 5/8	11/16	13/16	7/16	2 3/8	9 3/8	1 5/16	2 3/4	1/2	3	5/8	3/4
12	50.0	5 1/2	11/16	11/16	3/8	2 3/8	9 3/8	1 5/16	2 3/4	7/16	3	5/8	3/4
	45.0	5 3/8	11/16	9/16	5/16	2 3/8	9 3/8	1 5/16	2 3/4	3/8	3	5/8	3/4
	40.8	5 1/4	11/16	1/2	1/4	2 3/8	9 3/8	1 5/16	2 3/4	5/16	3	5/8	3/4
B 9	35.0	5 1/8	9/16	7/16	1/4	2 3/8	9 3/4	1 1/8	2 1/2	5/16	3	1/2	3/4
12	31.8	5	9/16	3/8	3/16	2 3/8	9 3/4	1 1/8	2 1/2	1/4	3	1/2	3/4
B 10	40.0	5 1/8	1/2	3/4	3/8	2 1/8	8	1	2 1/2	7/16	2 3/4	1/2	3/4
10	35.0	5	1/2	5/8	5/16	2 1/8	8	1	2 1/2	3/8	2 3/4	1/2	3/4
	30.0	4 3/4	1/2	7/16	1/4	2 1/8	8	1	2 1/2	5/16	2 3/4	1/2	3/4
	25.4	4 5/8	1/2	5/16	3/16	2 1/8	8	1	2 1/2	1/4	2 3/4	1/2	3/4
B 12	25.5	4 1/4	7/16	9/16	1/4	1 7/8	6 1/4	7/8	2 1/4	5/16	2 1/4.	7/16	3/4
8	23.0	4 1/8	7/16	7/16	1/4	1 7/8	6 1/4	7/8	2 1/4	5/16	2 1/4	7/16	3/4
	20.5	4 1/8	7/16	3/8	3/16	1 7/8	6 1/4	7/8	2 1/4	1/4	2 1/4	7/16	3/4
	18.4	4	7/16	5/16	1/8	1 7/8	6 1/4	7/8	2 1/4	3/16	2 1/4	7/16	3/4
B 13	20.0	3 7/8	3/8	7/16	1/4	1 3/4	5 3/8	13/16	2	5/16	2 1/4	3/8	5/8
7	17.5	3 3/4	3/8	3/8	3/16	1 3/4	5 3/8	13/16	2	1/4	2 1/4	3/8	5/8
	15.3	3 5/8	3/8	1/4	1/8	1 3/4	5 3/8	13/16	2	3/16	2 1/4	3/8	5/8
B 14	17.25	3 5/8	3/8	1/2	1/4	1 1/2	4 1/2	3/4	2	5/16	2	3/8	5/8
6	14.75	3 1/2	3/8	3/8	3/16	1 1/2	4 1/2	3/4	2	1/4	2	3/8	5/8
	12.5	3 3/8	3/8	1/4	1/8	1 1/2	4 1/2	3/4	2	3/16	2	5/16	5/8
B 15	14.75	3 1/4	5/16	1/2	1/4	1 3/8	3 5/8	11/16	2	5/16	1 3/4	5/16	1/2
5	12.25	3 1/8	5/16	3/8	3/16	1 3/8	3 5/8	11/16	2	1/4	1 3/4	5/16	1/2
	10.0	3	5/16	1/4	1/8	1 3/8	3 5/8	11/16	2	3/16	1 3/4	5/16	1/2
B 16	10.5	2 7/8	5/16	7/16	3/16	1 1/4	2 3/4	5/8	2	1/4	1 1/2	5/16	1/2
4	9.5	2 3/4	5/16	5/16	3/16	1 1/4	2 3/4	5/8	2	1/4	1 1/2	5/16	1/2
	8.5	2 3/4	5/16	1/4	1/8	1 1/4	2 3/4	5/8	2	3/16	1 1/2	5/16	1/2
	7.7	2 5/8	5/16	3/16	1/8	1 1/4	2 3/4	5/8	2	3/16	1 1/2	5/16	1/2
B 17	7.5	2 1/2	1/4	3/8	3/16	1 1/8	1 7/8	9/16		1/4	1 1/2	1/4	3/8
3	6.5	2 3/8	1/4	1/4	1/8	1 1/8	1 7/8	9/16		3/16	1 1/2	1/4	3/8
	5.7	2 3/8	1/4	3/16	1/8	1 1/8	1 7/8	9/16		3/16	1 1/2	1/4	3/8

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

ELEMENTS

BEAMS

STANDARD MILL

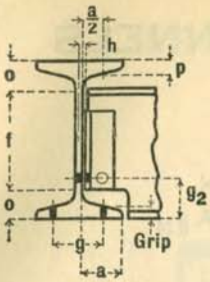


ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
CB 42 7 x 3½	7	12	3.52	3.500	.188	29.8	8.5	2.91	2.1	1.18	0.77
CB 41 6 x 3	6	10	2.91	3.000	.188	17.8	5.9	2.47	1.3	0.85	0.66

H-BEAMS

Section Index and Nominal Size	Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
H 4 8 x 8	8	37.7	11.00	8.125	.500	120.8	30.2	3.31	36.9	9.1	1.83
		34.3	10.00	8.000	.375	115.5	28.9	3.40	35.1	8.8	1.87
		32.6	9.50	7.938	.313	112.8	28.2	3.45	34.2	8.6	1.90
H 3A 6 x 6	6	27.5	8.08	6.063	.438	49.3	16.4	2.47	16.0	5.3	1.41
		25.0	7.33	5.938	.313	47.0	15.7	2.53	14.9	5.0	1.43
H 3 6 x 6	6	22.5	6.61	6.063	.375	41.0	13.7	2.49	12.2	4.0	1.36
		20.0	5.86	5.938	.250	38.8	12.9	2.57	11.4	3.8	1.39
H 2 5 x 5	5	18.9	5.47	5.000	.313	23.8	9.5	2.08	7.8	3.1	1.20
H 1 4 x 4	4	13.8	3.99	4.000	.313	10.7	5.3	1.64	3.6	1.8	0.95



BEAMS

STANDARD MILL

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

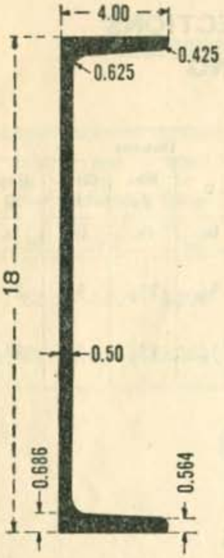
Section Index and Depth	Weight per Foot	Flange		Web		Distance							Max. Flange Rivet
		Width	Thickness, p	Thickness	Half Thickness	a	f	o	Min. g_2	Clear. h	Gage g	Grip	
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
© B 42 7	12	3½	5/16	3/16	1/8	1⅝	5¾	⅝	1⅞	3/16	2	5/16	⅝
© B 41 6	10	3	5/16	3/16	1/8	1⅜	4¾	⅝	1⅞	3/16	1¾	5/16	½

H-BEAMS

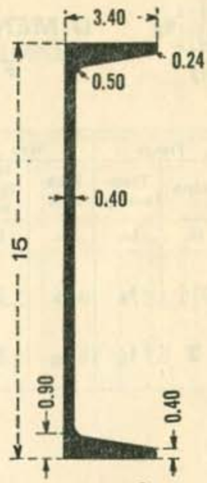
Section Index and Depth	Weight per Foot	Flange		Web		Distance						Max. Flange Rivet
		Width	Thickness, p	Thickness	Half Thickness	a	f	o	Min. g_2	Gage g	Grip	
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
H 4 8	37.7	8⅛	7/16	½	¼	3 13/16	6¼	⅞	2¼	5	7/16	⅞
	34.3	8	7/16	⅜	3/16	3 13/16	6¼	⅞	2¼	5	7/16	⅞
	32.6	8	7/16	5/16	3/16	3 13/16	6¼	⅞	2¼	5	7/16	⅞
H 3A 6	27.5	6⅛	½	7/16	¼	2 13/16	4¼	⅞	2¼	3½	½	⅞
	25.0	6	½	5/16	3/16	2 13/16	4¼	⅞	2¼	3½	½	⅞
H 3 6	22.5	6⅛	⅜	⅜	3/16	2⅞	4 7/16	¾	2	3½	⅜	⅞
	20.0	6	⅜	¼	⅛	2⅞	4 7/16	¾	2	3½	⅜	⅞
H 2 5	18.9	5	7/16	5/16	3/16	2⅜	3⅜	13/16	2	2¾	7/16	¾
H 1 4	13.8	4	⅜	5/16	3/16	1⅞	2½	¾	2	2¼	⅜	⅝

Gages g_2 are based on 1¼″ edge distance (⅞″ maximum rivet).

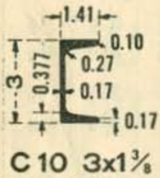
AMERICAN STANDARD CHANNELS



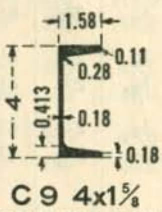
▣ C 60 18x4
58, 51.9, 45.8, 42.7 lbs.



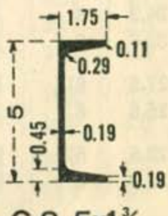
C 1 15x3⅜
55, 50, 45,
40, 35, 33.9 lbs.



C 10 3x1⅜
6, 5, 4.1 lbs.



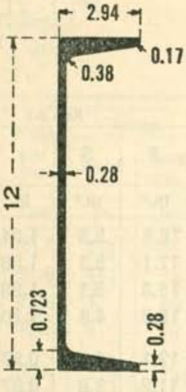
C 9 4x1⅝
7.25, 6.25, 5.4 lbs.



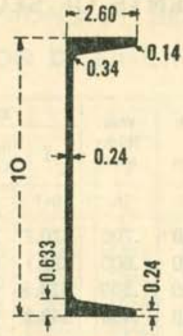
C 8 5x1¾
11.5, 9.0, 6.7 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

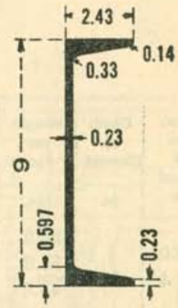
AMERICAN STANDARD CHANNELS



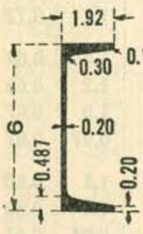
C 2 12x3
40, 35, 30, 25, 20.7 lbs.



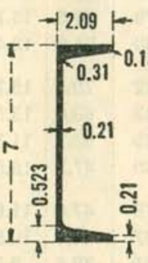
C 3 10x2⅝
35, 30, 25, 20, 15.3 lbs.



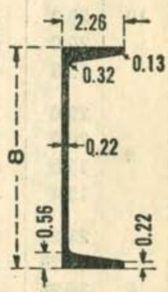
C 4 9x2½
25, 20, 15, 13.4 lbs.



C 7 6x2
15.5, 13,
10.5, 8.2 lbs.



C 6 7x2⅛
19.75, 17.25,
14.75, 12.25, 9.8 lbs.



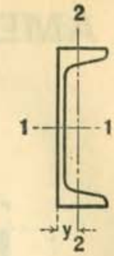
C 5 8x2¼
21.25, 18.75, 16.25,
13.75, 11.5 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

ELEMENTS

CHANNELS

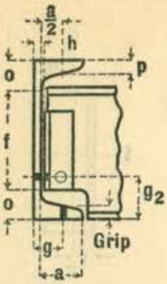
AMERICAN STANDARD



ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r	Axis 2-2 y
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
†C 60 18 x 4	18	58.0	16.98	4.200	.700	670.7	74.5	6.29	18.5	5.6	1.04	0.88
		51.9	15.18	4.100	.600	622.1	69.1	6.40	17.1	5.3	1.06	0.87
		45.8	13.38	4.000	.500	573.5	63.7	6.55	15.8	5.1	1.09	0.89
		42.7	12.48	3.950	.450	549.2	61.0	6.64	15.0	4.9	1.10	0.90
C 1 15 x 3⅜	15	55.0	16.11	3.814	.814	429.0	57.2	5.16	12.1	4.1	0.87	0.82
		50.0	14.64	3.716	.716	401.4	53.6	5.24	11.2	3.8	0.87	0.80
		45.0	13.17	3.618	.618	373.9	49.8	5.33	10.3	3.6	0.88	0.79
		40.0	11.70	3.520	.520	346.3	46.2	5.44	9.3	3.4	0.89	0.78
		35.0	10.23	3.422	.422	318.7	42.5	5.58	8.4	3.2	0.91	0.79
		33.9	9.90	3.400	.400	312.6	41.7	5.62	8.2	3.2	0.91	0.79
C 2 12 x 3	12	40.0	11.73	3.415	.755	196.5	32.8	4.09	6.6	2.5	0.75	0.72
		35.0	10.26	3.292	.632	178.8	29.8	4.18	5.9	2.3	0.76	0.69
		30.0	8.79	3.170	.510	161.2	26.9	4.28	5.2	2.1	0.77	0.68
		25.0	7.32	3.047	.387	143.5	23.9	4.43	4.5	1.9	0.79	0.68
		20.7	6.03	2.940	.280	128.1	21.4	4.61	3.9	1.7	0.81	0.70
C 3 10 x 2⅝	10	35.0	10.27	3.180	.820	115.2	23.0	3.34	4.6	1.9	0.67	0.69
		30.0	8.80	3.033	.673	103.0	20.6	3.42	4.0	1.7	0.67	0.65
		25.0	7.33	2.886	.526	90.7	18.1	3.52	3.4	1.5	0.68	0.62
		20.0	5.86	2.739	.379	78.5	15.7	3.66	2.8	1.3	0.70	0.61
		15.3	4.47	2.600	.240	66.9	13.4	3.87	2.3	1.2	0.72	0.64
C 4 9 x 2½	9	25.0	7.33	2.812	.612	70.5	15.7	3.10	3.0	1.4	0.64	0.61
		20.0	5.86	2.648	.448	60.6	13.5	3.22	2.4	1.2	0.65	0.59
		15.0	4.39	2.485	.285	50.7	11.3	3.40	1.9	1.0	0.67	0.59
		13.4	3.89	2.430	.230	47.3	10.5	3.49	1.8	0.97	0.67	0.61
C 5 8 x 2¼	8	21.25	6.23	2.619	.579	47.6	11.9	2.77	2.2	1.1	0.60	0.59
		18.75	5.49	2.527	.487	43.7	10.9	2.82	2.0	1.0	0.60	0.57
		16.25	4.76	2.435	.395	39.8	9.9	2.89	1.8	0.94	0.61	0.56
		13.75	4.02	2.343	.303	35.8	9.0	2.99	1.5	0.86	0.62	0.56
		11.5	3.36	2.260	.220	32.3	8.1	3.10	1.3	0.79	0.63	0.58
C 6 7 x 2	7	19.75	5.79	2.509	.629	33.1	9.4	2.39	1.8	0.96	0.56	0.58
		17.25	5.05	2.404	.524	30.1	8.6	2.44	1.6	0.86	0.56	0.55
		14.75	4.32	2.299	.419	27.1	7.7	2.51	1.4	0.79	0.57	0.53
		12.25	3.58	2.194	.314	24.1	6.9	2.59	1.2	0.71	0.58	0.53
		9.8	2.85	2.090	.210	21.1	6.0	2.72	0.98	0.63	0.59	0.55

† C60 is not an American Standard Channel.



CHANNELS

AMERICAN STANDARD

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

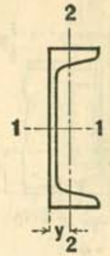
Section Index and Depth	Weight per Foot	Flange		Web		Distance							Max. Flange Rivet
		Width	Thickness, p	Thickness	Half Thickness	a	f	o	Min. g_2	Clear. h	Gage g	Grip	
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
†C 60 18	58.0	4 1/4	5/8	11/16	3/8	3 1/2	15 3/8	1 5/16	2 3/4	3/4	2 1/2	5/8	1
	51.9	4 1/8	5/8	5/8	5/16	3 1/2	15 3/8	1 5/16	2 3/4	11/16	2 1/2	5/8	1
	45.8	4	5/8	1/2	1/4	3 1/2	15 3/8	1 5/16	2 3/4	9/16	2 1/2	5/8	1
	42.7	4	5/8	7/16	1/4	3 1/2	15 3/8	1 5/16	2 3/4	1/2	2 1/2	5/8	1
C 1 15	55.0	3 7/8	5/8	13/16	7/16	3	12 3/8	1 5/16	2 3/4	7/8	2 1/4	11/16	1
	50.0	3 3/4	5/8	3/4	3/8	3	12 3/8	1 5/16	2 3/4	13/16	2 1/4	5/8	1
	45.0	3 5/8	5/8	5/8	5/16	3	12 3/8	1 5/16	2 3/4	11/16	2 1/4	5/8	1
	40.0	3 1/2	5/8	9/16	1/4	3	12 3/8	1 5/16	2 3/4	5/8	2	5/8	1
	35.0	3 3/8	5/8	7/16	1/4	3	12 3/8	1 5/16	2 3/4	1/2	2	5/8	1
	33.9	3 3/8	5/8	7/16	3/16	3	12 3/8	1 5/16	2 3/4	1/2	2	5/8	1
C 2 12	40.0	3 3/8	1/2	3/4	3/8	2 5/8	9 7/8	1 1/16	2 1/2	13/16	2	1/2	7/8
	35.0	3 1/4	1/2	5/8	5/16	2 5/8	9 7/8	1 1/16	2 1/2	11/16	2	1/2	7/8
	30.0	3 1/8	1/2	1/2	1/4	2 5/8	9 7/8	1 1/16	2 1/2	9/16	1 3/4	1/2	7/8
	25.0	3	1/2	3/8	3/16	2 5/8	9 7/8	1 1/16	2 1/2	7/16	1 3/4	1/2	7/8
	20.7	3	1/2	5/16	1/8	2 5/8	9 7/8	1 1/16	2 1/2	3/8	1 3/4	1/2	7/8
C 3 10	35.0	3 1/8	7/16	13/16	7/16	2 3/8	8 1/8	15/16	2 1/2	7/8	1 3/4	1/2	3/4
	30.0	3	7/16	11/16	3/8	2 3/8	8 1/8	15/16	2 1/2	3/4	1 3/4	7/16	3/4
	25.0	2 7/8	7/16	9/16	1/4	2 3/8	8 1/8	15/16	2 1/2	5/8	1 3/4	7/16	3/4
	20.0	2 3/4	7/16	3/8	3/16	2 3/8	8 1/8	15/16	2 1/2	7/16	1 1/2	7/16	3/4
	15.3	2 5/8	7/16	1/4	1/8	2 3/8	8 1/8	15/16	2 1/2	5/16	1 1/2	7/16	3/4
C 4 9	25.0	2 3/4	7/16	5/8	5/16	2 1/4	7 1/4	7/8	2 1/2	11/16	1 1/2	7/16	3/4
	20.0	2 5/8	7/16	7/16	1/4	2 1/4	7 1/4	7/8	2 1/2	1/2	1 1/2	7/16	3/4
	15.0	2 1/2	7/16	5/16	3/16	2 1/4	7 1/4	7/8	2 1/2	3/8	1 3/8	7/16	3/4
	13.4	2 3/8	7/16	1/4	1/8	2 1/4	7 1/4	7/8	2 1/2	5/16	1 3/8	3/8	3/4
C 5 8	21.25	2 5/8	3/8	5/8	5/16	2	6 3/8	13/16	2 1/4	11/16	1 1/2	3/8	3/4
	18.75	2 1/2	3/8	1/2	1/4	2	6 3/8	13/16	2 1/4	9/16	1 1/2	3/8	3/4
	16.25	2 3/8	3/8	7/16	3/16	2	6 3/8	13/16	2 1/4	1/2	1 1/2	3/8	3/4
	13.75	2 3/8	3/8	5/16	3/16	2	6 3/8	13/16	2 1/4	3/8	1 3/8	3/8	3/4
	11.5	2 1/4	3/8	1/4	1/8	2	6 3/8	13/16	2 1/4	5/16	1 3/8	3/8	3/4
C 6 7	19.75	2 1/2	3/8	5/8	5/16	1 7/8	5 3/8	13/16	2	11/16	1 1/2	3/8	5/8
	17.25	2 3/8	3/8	9/16	1/4	1 7/8	5 3/8	13/16	2	5/8	1 1/2	3/8	5/8
	14.75	2 1/4	3/8	7/16	1/4	1 7/8	5 3/8	13/16	2	1/2	1 1/4	3/8	5/8
	12.25	2 1/4	3/8	5/16	3/16	1 7/8	5 3/8	13/16	2	3/8	1 1/4	3/8	5/8
	9.8	2 1/8	3/8	1/4	1/8	1 7/8	5 3/8	13/16	2	5/16	1 1/4	3/8	5/8

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).
† C 60 is not an American Standard Channel.

ELEMENTS

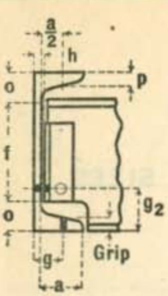
CHANNELS

AMERICAN STANDARD



ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r	Axis 2-2 y
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
C 7 6 x 2	6	15.5	4.54	2.279	.559	19.5	6.5	2.07	1.3	0.73	0.53	0.55
		13.0	3.81	2.157	.437	17.3	5.8	2.13	1.1	0.65	0.53	0.52
		10.5	3.07	2.034	.314	15.1	5.0	2.22	0.87	0.57	0.53	0.50
		8.2	2.39	1.920	.200	13.0	4.3	2.34	0.70	0.50	0.54	0.52
C 8 5 x 1¾	5	11.5	3.36	2.032	.472	10.4	4.1	1.76	0.82	0.54	0.49	0.51
		9.0	2.63	1.885	.325	8.8	3.5	1.83	0.64	0.45	0.49	0.48
		6.7	1.95	1.750	.190	7.4	3.0	1.95	0.48	0.38	0.50	0.49
C 9 4 x 1⅝	4	7.25	2.12	1.720	.320	4.5	2.3	1.47	0.44	0.35	0.46	0.46
		6.25	1.82	1.647	.247	4.1	2.1	1.50	0.38	0.32	0.45	0.46
		5.4	1.56	1.580	.180	3.8	1.9	1.56	0.32	0.29	0.45	0.46
C 10 3 x 1½	3	6.0	1.75	1.596	.356	2.1	1.4	1.08	0.31	0.27	0.42	0.46
		5.0	1.46	1.498	.258	1.8	1.2	1.12	0.25	0.24	0.41	0.44
		4.1	1.19	1.410	.170	1.6	1.1	1.17	0.20	0.21	0.41	0.44



CHANNELS

AMERICAN STANDARD

DIMENSIONS

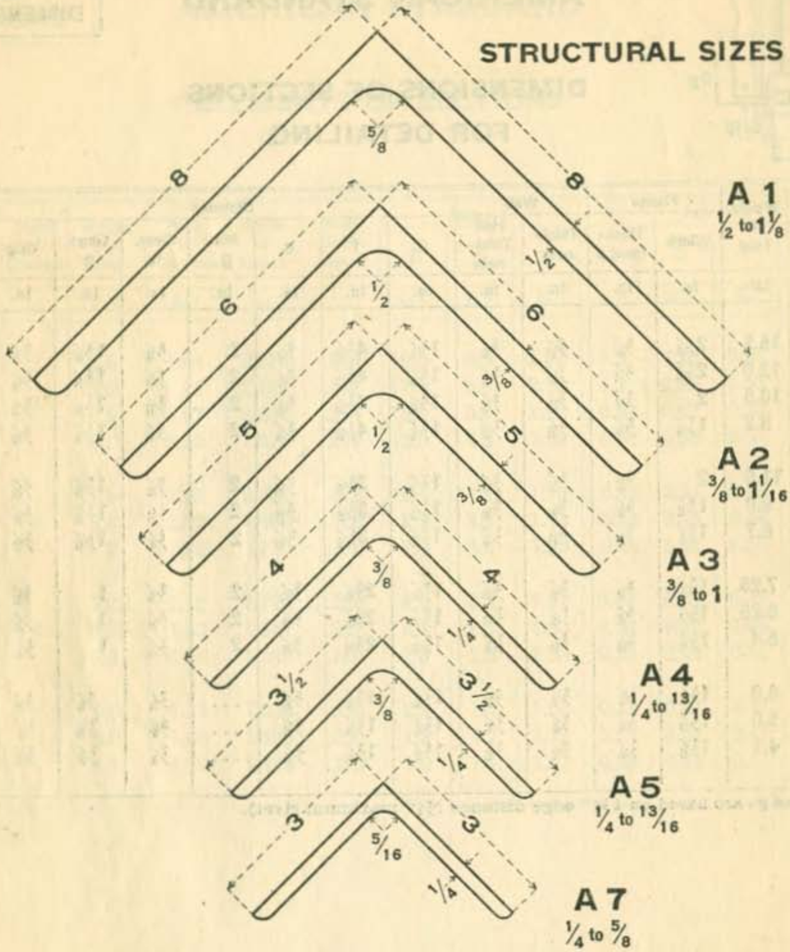
DIMENSIONS OF SECTIONS FOR DETAILING

Section Index and Depth	Weight per Foot	Flange Width	Flange Thickness, p	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance Min. g_2	Distance Clear. h	Distance Gage g	Distance Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
	15.5	2¼	⅜	9/16	5/16	1¾	4½	¾	2	⅝	1⅜	⅜	⅝
C 7	13.0	2⅛	⅜	7/16	¼	1¾	4½	¾	2	½	1⅜	5/16	⅝
6	10.5	2	⅜	5/16	3/16	1¾	4½	¾	2	⅜	1⅛	⅜	⅝
	8.2	1⅞	⅜	3/16	⅛	1¾	4½	¾	2	¼	1⅛	5/16	⅝
C 8	11.5	2	5/16	½	¼	1½	3⅝	11/16	2	9/16	1⅛	5/16	½
5	9.0	1⅞	5/16	5/16	3/16	1½	3⅝	11/16	2	⅜	1⅛	5/16	½
	6.7	1¾	5/16	3/16	⅛	1½	3⅝	11/16	2	¼	1⅛	5/16	½
C 9	7.25	1¾	5/16	5/16	3/16	1⅜	2¾	⅝	2	⅜	1	5/16	½
4	6.25	1⅝	5/16	¼	⅛	1⅜	2¾	⅝	2	5/16	1	5/16	½
	5.4	1⅝	5/16	3/16	⅛	1⅜	2¾	⅝	2	¼	1	¼	½
	6.0	1⅝	¼	⅜	3/16	1¼	1¾	⅝	...	7/16	⅞	5/16	½
C 10	5.0	1½	¼	¼	⅛	1¼	1¾	⅝	...	5/16	⅞	¼	½
3	4.1	1⅜	¼	3/16	⅛	1¼	1¾	⅝	...	¼	⅞	¼	½

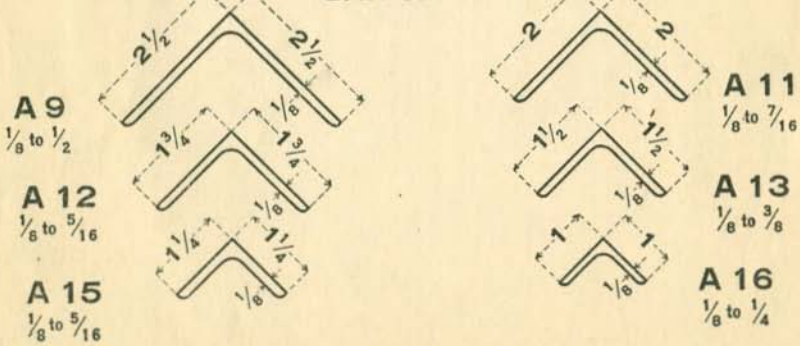
Gages g_2 are based on 1¼″ edge distance (¾″ maximum rivet).

ANGLES—EQUAL LEGS

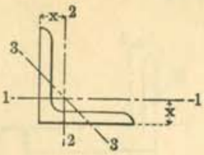
STRUCTURAL SIZES



BAR SIZES



PROFILES SHOW MINIMUM DIMENSIONS IN INCHES
RANGE OF THICKNESSES



EQUAL ANGLES

ELEMENTS

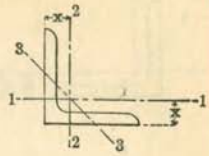
ELEMENTS OF SECTIONS

Section Index	Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2				Axis 3-3
					I	S	r	x	r min.
	Inches	In.	Pounds	In.²	In.⁴	In.³	In.	In.	In.
		1 1/8	56.9	16.73	98.0	17.5	2.42	2.41	1.55
		1 1/16	54.0	15.87	93.5	16.7	2.43	2.39	1.56
		1	51.0	15.00	89.0	15.8	2.44	2.37	1.56
		15/16	48.1	14.12	84.3	14.9	2.44	2.34	1.56
		7/8	45.0	13.23	79.6	14.0	2.45	2.32	1.56
A 1	8 x 8	13/16	42.0	12.34	74.7	13.1	2.46	2.30	1.57
		3/4	38.9	11.44	69.7	12.2	2.47	2.28	1.57
		11/16	35.8	10.53	64.6	11.2	2.48	2.25	1.58
		5/8	32.7	9.61	59.4	10.3	2.49	2.23	1.58
		9/16	29.6	8.68	54.1	9.3	2.50	2.21	1.58
		1/2	26.4	7.75	48.6	8.4	2.51	2.19	1.58
		© 1 1/16	39.6	11.62	37.2	9.0	1.79	1.89	1.16
		1	37.4	11.00	35.5	8.6	1.80	1.86	1.16
		15/16	35.3	10.37	33.7	8.1	1.80	1.84	1.16
		7/8	33.1	9.73	31.9	7.6	1.81	1.82	1.17
		13/16	31.0	9.09	30.1	7.2	1.82	1.80	1.17
		3/4	28.7	8.44	28.2	6.7	1.83	1.78	1.17
A 2	6 x 6	11/16	26.5	7.78	26.2	6.2	1.83	1.75	1.17
		5/8	24.2	7.11	24.2	5.7	1.84	1.73	1.17
		9/16	21.9	6.43	22.1	5.1	1.85	1.71	1.18
		1/2	19.6	5.75	19.9	4.6	1.86	1.68	1.18
		7/16	17.2	5.06	17.7	4.1	1.87	1.66	1.19
		3/8	14.9	4.36	15.4	3.5	1.88	1.64	1.19
		1	30.6	9.00	19.6	5.8	1.48	1.61	0.96
		15/16	28.9	8.50	18.7	5.5	1.48	1.59	0.96
		7/8	27.2	7.98	17.8	5.2	1.49	1.57	0.96
		13/16	25.4	7.47	16.8	4.9	1.50	1.55	0.97
		3/4	23.6	6.94	15.7	4.5	1.50	1.52	0.97
A 3	5 x 5	11/16	21.8	6.40	14.7	4.2	1.51	1.50	0.97
		5/8	20.0	5.86	13.6	3.9	1.52	1.48	0.97
		9/16	18.1	5.31	12.4	3.5	1.53	1.46	0.98
		1/2	16.2	4.75	11.3	3.2	1.54	1.43	0.98
		7/16	14.3	4.18	10.0	2.8	1.55	1.41	0.98
		3/8	12.3	3.61	8.7	2.4	1.56	1.39	0.99
		13/16	19.9	5.84	8.1	3.0	1.18	1.29	0.77
		3/4	18.5	5.44	7.7	2.8	1.19	1.27	0.77
		11/16	17.1	5.03	7.2	2.6	1.19	1.25	0.77
		5/8	15.7	4.61	6.7	2.4	1.20	1.23	0.77
A 4	4 x 4	9/16	14.3	4.18	6.1	2.2	1.21	1.21	0.78
		1/2	12.8	3.75	5.6	2.0	1.22	1.18	0.78
		7/16	11.3	3.31	5.0	1.8	1.23	1.16	0.78
		3/8	9.8	2.86	4.4	1.5	1.23	1.14	0.79
		5/16	8.2	2.40	3.7	1.3	1.24	1.12	0.79
		1/4	6.6	1.94	3.0	1.0	1.25	1.09	0.79

ELEMENTS

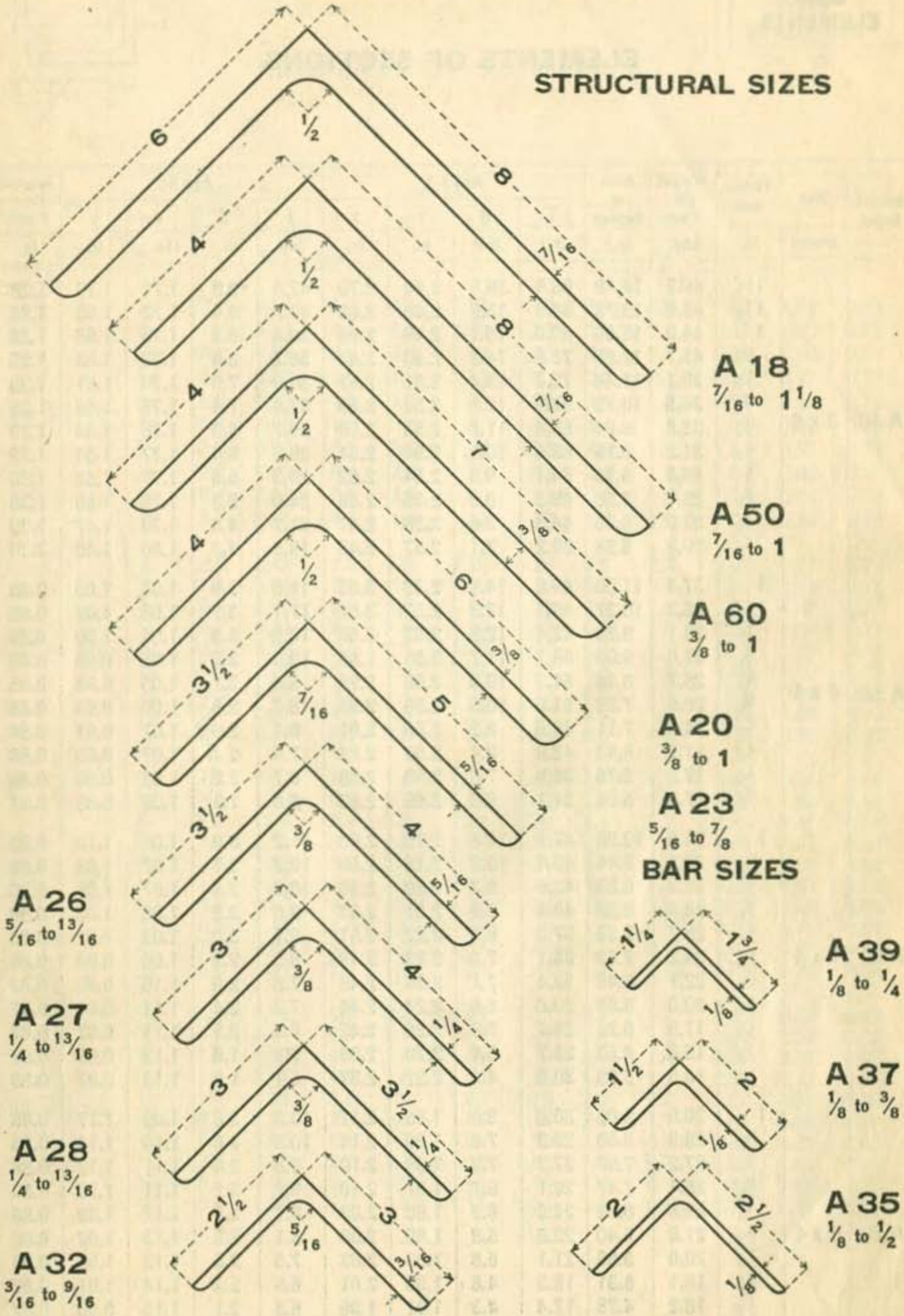
EQUAL ANGLES

ELEMENTS OF SECTIONS



Section Index	Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2 I	S	r	x	Axis 3-3 r min.
	Inches	In.	Pounds	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.
A 5	$3\frac{1}{2} \times 3\frac{1}{2}$	$\frac{13}{16}$	17.1	5.03	5.3	2.3	1.02	1.17	0.67
		$\frac{3}{4}$	16.0	4.69	5.0	2.1	1.03	1.15	0.67
		$\frac{11}{16}$	14.8	4.34	4.7	2.0	1.04	1.12	0.67
		$\frac{5}{8}$	13.6	3.98	4.3	1.8	1.04	1.10	0.68
		$\frac{9}{16}$	12.4	3.62	4.0	1.6	1.05	1.08	0.68
		$\frac{1}{2}$	11.1	3.25	3.6	1.5	1.06	1.06	0.68
		$\frac{7}{16}$	9.8	2.87	3.3	1.3	1.07	1.04	0.68
		$\frac{3}{8}$	8.5	2.48	2.9	1.2	1.07	1.01	0.69
		$\frac{5}{16}$	7.2	2.09	2.5	0.98	1.08	0.99	0.69
		$\frac{1}{4}$	5.8	1.69	2.0	0.79	1.09	0.97	0.69
A 7	3×3	$\frac{5}{8}$	11.5	3.36	2.6	1.3	0.88	0.98	0.57
		$\frac{9}{16}$	10.4	3.06	2.4	1.2	0.89	0.95	0.58
		$\frac{1}{2}$	9.4	2.75	2.2	1.1	0.90	0.93	0.58
		$\frac{7}{16}$	8.3	2.43	2.0	0.95	0.91	0.91	0.58
		$\frac{3}{8}$	7.2	2.11	1.8	0.83	0.91	0.89	0.58
		$\frac{5}{16}$	6.1	1.78	1.5	0.71	0.92	0.87	0.59
		$\frac{1}{4}$	4.9	1.44	1.2	0.58	0.93	0.84	0.59
A 9	$2\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{2}$	7.7	2.25	1.2	0.73	0.74	0.81	0.47
		$\frac{7}{16}$	6.8	2.00	1.1	0.65	0.75	0.78	0.48
		$\frac{3}{8}$	5.9	1.73	0.98	0.57	0.75	0.76	0.48
		$\frac{5}{16}$	5.0	1.47	0.85	0.48	0.76	0.74	0.49
		$\frac{1}{4}$	4.1	1.19	0.70	0.39	0.77	0.72	0.49
		$\frac{3}{16}$	3.07	0.90	0.55	0.30	0.78	0.69	0.49
		$\frac{1}{8}$	2.08	0.61	0.38	0.20	0.79	0.67	0.50
A 11	2×2	$\frac{7}{16}$	5.3	1.56	0.54	0.40	0.59	0.66	0.39
		$\frac{3}{8}$	4.7	1.36	0.48	0.35	0.59	0.64	0.39
		$\frac{5}{16}$	3.92	1.15	0.42	0.30	0.60	0.61	0.39
		$\frac{1}{4}$	3.19	0.94	0.35	0.25	0.61	0.59	0.39
		$\frac{3}{16}$	2.44	0.71	0.28	0.19	0.62	0.57	0.40
		$\frac{1}{8}$	1.65	0.48	0.19	0.13	0.63	0.55	0.40
A 12	$1\frac{3}{4} \times 1\frac{3}{4}$	$\frac{5}{16}$	3.39	1.00	0.27	0.23	0.52	0.55	0.34
		$\frac{1}{4}$	2.77	0.81	0.23	0.19	0.53	0.53	0.34
		$\frac{3}{16}$	2.12	0.62	0.18	0.14	0.54	0.51	0.35
		$\frac{1}{8}$	1.44	0.42	0.13	0.10	0.55	0.48	0.35
A 13	$1\frac{1}{2} \times 1\frac{1}{2}$	$\frac{3}{8}$	3.35	0.98	0.19	0.19	0.44	0.51	0.29
		$\frac{5}{16}$	2.86	0.84	0.16	0.16	0.44	0.49	0.29
		$\frac{1}{4}$	2.34	0.69	0.14	0.13	0.45	0.47	0.29
		$\frac{3}{16}$	1.80	0.53	0.11	0.10	0.46	0.44	0.29
		$\frac{1}{8}$	1.23	0.36	0.08	0.07	0.46	0.42	0.30
A 15	$1\frac{1}{4} \times 1\frac{1}{4}$	$\frac{5}{16}$	2.33	0.68	0.09	0.11	0.36	0.42	0.24
		$\frac{1}{4}$	1.92	0.56	0.08	0.09	0.37	0.40	0.24
		$\frac{3}{16}$	1.48	0.43	0.06	0.07	0.38	0.38	0.24
		$\frac{1}{8}$	1.01	0.30	0.04	0.05	0.38	0.35	0.25
A 16	1×1	$\frac{1}{4}$	1.49	0.44	0.04	0.06	0.29	0.34	0.19
		$\frac{3}{16}$	1.16	0.34	0.03	0.04	0.30	0.32	0.19
		$\frac{1}{8}$	0.80	0.23	0.02	0.03	0.31	0.30	0.19

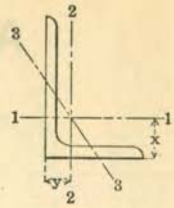
ANGLES—UNEQUAL LEGS



PROFILES SHOW MINIMUM DIMENSIONS IN INCHES
RANGE OF THICKNESSES

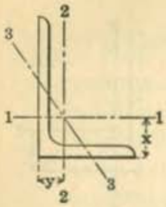
L
ELEMENTS

UNEQUAL ANGLES



ELEMENTS OF SECTIONS

Section Index	Size	Thickness	Weight per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
					I	S	r	x	I	S	r	y	r min.
	Inches	In.	Lbs.	In.²	In.⁴	In.³	In.	In.	In.⁴	In.³	In.	In.	In.
A 18	8 x 6	1 1/8	49.3	14.48	88.9	16.8	2.48	2.70	42.5	9.9	1.71	1.70	1.28
		1 1/16	46.8	13.75	84.9	15.9	2.48	2.68	40.7	9.4	1.72	1.68	1.28
		1	44.2	13.00	80.8	15.1	2.49	2.65	38.8	8.9	1.73	1.65	1.28
		15/16	41.7	12.25	76.6	14.3	2.50	2.63	36.8	8.4	1.73	1.63	1.28
		7/8	39.1	11.48	72.3	13.4	2.51	2.61	34.9	7.9	1.74	1.61	1.28
		13/16	36.5	10.72	67.9	12.5	2.52	2.59	32.8	7.4	1.75	1.59	1.29
		3/4	33.8	9.94	63.4	11.7	2.53	2.56	30.7	6.9	1.76	1.56	1.29
		11/16	31.2	9.15	58.8	10.8	2.54	2.54	28.6	6.4	1.77	1.54	1.29
		5/8	28.5	8.36	54.1	9.9	2.54	2.52	26.3	5.9	1.77	1.52	1.30
		9/16	25.7	7.56	49.3	8.9	2.55	2.50	24.0	5.3	1.78	1.50	1.30
		1/2	23.0	6.75	44.3	8.0	2.56	2.47	21.7	4.8	1.79	1.47	1.30
		7/16	20.2	5.93	39.2	7.1	2.57	2.45	19.3	4.2	1.80	1.45	1.30
A 50	8 x 4	1	37.4	11.00	69.6	14.1	2.52	3.05	11.6	3.9	1.03	1.05	0.85
		15/16	35.3	10.37	66.1	13.3	2.52	3.02	11.1	3.7	1.03	1.02	0.85
		7/8	33.1	9.73	62.4	12.5	2.53	3.00	10.5	3.5	1.04	1.00	0.85
		13/16	31.0	9.09	58.7	11.7	2.54	2.98	10.0	3.3	1.05	0.98	0.85
		3/4	28.7	8.44	54.9	10.9	2.55	2.95	9.4	3.1	1.05	0.95	0.85
		11/16	26.5	7.78	51.0	10.0	2.56	2.93	8.7	2.8	1.06	0.93	0.85
		5/8	24.2	7.11	46.9	9.2	2.56	2.91	8.1	2.6	1.07	0.91	0.86
		9/16	21.9	6.43	42.8	8.4	2.58	2.88	7.4	2.4	1.07	0.88	0.86
		1/2	19.6	5.75	38.5	7.5	2.59	2.86	6.7	2.2	1.08	0.86	0.86
		7/16	17.2	5.06	34.1	6.6	2.60	2.83	6.0	1.9	1.09	0.83	0.87
A 60	7 x 4	1	34.0	10.00	47.7	10.8	2.18	2.60	11.2	3.9	1.06	1.10	0.85
		15/16	32.1	9.44	45.4	10.3	2.19	2.58	10.7	3.7	1.07	1.08	0.86
		7/8	30.2	8.86	42.9	9.7	2.20	2.55	10.2	3.5	1.07	1.05	0.86
		13/16	28.2	8.28	40.4	9.0	2.21	2.53	9.6	3.2	1.08	1.03	0.86
		3/4	26.2	7.69	37.8	8.4	2.22	2.51	9.1	3.0	1.09	1.01	0.86
		11/16	24.2	7.09	35.1	7.8	2.23	2.49	8.5	2.8	1.09	0.99	0.86
		5/8	22.1	6.49	32.4	7.1	2.24	2.46	7.8	2.6	1.10	0.96	0.86
		9/16	20.0	5.88	29.6	6.5	2.24	2.44	7.2	2.4	1.11	0.94	0.87
		1/2	17.9	5.25	26.7	5.8	2.25	2.42	6.5	2.1	1.11	0.92	0.87
		7/16	15.8	4.63	23.7	5.1	2.26	2.39	5.8	1.9	1.12	0.89	0.88
		3/8	13.6	3.99	20.6	4.4	2.27	2.37	5.1	1.6	1.13	0.87	0.88
A 20	6 x 4	1	30.6	9.00	30.8	8.0	1.85	2.17	10.8	3.8	1.09	1.17	0.85
		15/16	28.9	8.50	29.3	7.6	1.86	2.14	10.3	3.6	1.10	1.14	0.85
		7/8	27.2	7.98	27.7	7.2	1.86	2.12	9.8	3.4	1.11	1.12	0.86
		13/16	25.4	7.47	26.1	6.7	1.87	2.10	9.2	3.2	1.11	1.10	0.86
		3/4	23.6	6.94	24.5	6.2	1.88	2.08	8.7	3.0	1.12	1.08	0.86
		11/16	21.8	6.40	22.8	5.8	1.89	2.06	8.1	2.8	1.13	1.06	0.86
		5/8	20.0	5.86	21.1	5.3	1.90	2.03	7.5	2.5	1.13	1.03	0.86
		9/16	18.1	5.31	19.3	4.8	1.90	2.01	6.9	2.3	1.14	1.01	0.87
		1/2	16.2	4.75	17.4	4.3	1.91	1.99	6.3	2.1	1.15	0.99	0.87
		7/16	14.3	4.18	15.5	3.8	1.92	1.96	5.6	1.8	1.16	0.96	0.87
		3/8	12.3	3.61	13.5	3.3	1.93	1.94	4.9	1.6	1.17	0.94	0.88



UNEQUAL ANGLES

L
ELEMENTS

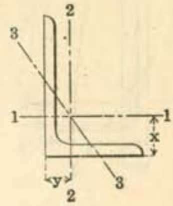
ELEMENTS OF SECTIONS

Section Index	Size	Thick-ness	Weight per Foot	Area of Section	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 1-1 x	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r	Axis 2-2 y	Axis 3-3 r min.
	Inches	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.
A 23	5 x 3½	7/8	22.7	6.67	15.7	4.9	1.53	1.79	6.2	2.5	0.96	1.04	0.75
		13/16	21.3	6.25	14.8	4.6	1.54	1.77	5.9	2.4	0.97	1.02	0.75
		3/4	19.8	5.81	13.9	4.3	1.55	1.75	5.6	2.2	0.98	1.00	0.75
		11/16	18.3	5.37	13.0	4.0	1.56	1.72	5.2	2.1	0.98	0.97	0.75
		5/8	16.8	4.92	12.0	3.7	1.56	1.70	4.8	1.9	0.99	0.95	0.75
		9/16	15.2	4.47	11.0	3.3	1.57	1.68	4.4	1.7	1.00	0.93	0.75
		1/2	13.6	4.00	10.0	3.0	1.58	1.66	4.0	1.6	1.01	0.91	0.75
		7/16	12.0	3.53	8.9	2.6	1.59	1.63	3.6	1.4	1.01	0.88	0.76
		3/8	10.4	3.05	7.8	2.3	1.60	1.61	3.2	1.2	1.02	0.86	0.76
		5/16	8.7	2.56	6.6	1.9	1.61	1.59	2.7	1.0	1.03	0.84	0.76
A 26	4 x 3½	13/16	18.5	5.43	7.8	2.9	1.19	1.36	5.5	2.3	1.01	1.11	0.72
		3/4	17.3	5.06	7.3	2.8	1.20	1.34	5.2	2.1	1.01	1.09	0.72
		11/16	16.0	4.68	6.9	2.6	1.21	1.32	4.9	2.0	1.02	1.07	0.72
		5/8	14.7	4.30	6.4	2.4	1.22	1.29	4.5	1.8	1.03	1.04	0.72
		9/16	13.3	3.90	5.9	2.1	1.23	1.27	4.2	1.7	1.03	1.02	0.72
		1/2	11.9	3.50	5.3	1.9	1.23	1.25	3.8	1.5	1.04	1.00	0.72
		7/16	10.6	3.09	4.8	1.7	1.24	1.23	3.4	1.3	1.05	0.98	0.72
		3/8	9.1	2.67	4.2	1.5	1.25	1.21	3.0	1.2	1.06	0.96	0.73
		5/16	7.7	2.25	3.6	1.3	1.26	1.18	2.6	1.0	1.07	0.93	0.73
A 27	4 x 3	13/16	17.1	5.03	7.3	2.9	1.21	1.44	3.5	1.7	0.83	0.94	0.64
		3/4	16.0	4.69	6.9	2.7	1.22	1.42	3.3	1.6	0.84	0.92	0.64
		11/16	14.8	4.34	6.5	2.5	1.22	1.39	3.1	1.5	0.84	0.89	0.64
		5/8	13.6	3.98	6.0	2.3	1.23	1.37	2.9	1.4	0.85	0.87	0.64
		9/16	12.4	3.62	5.6	2.1	1.24	1.35	2.7	1.2	0.86	0.85	0.64
		1/2	11.1	3.25	5.0	1.9	1.25	1.33	2.4	1.1	0.86	0.83	0.64
		7/16	9.8	2.87	4.5	1.7	1.25	1.30	2.2	1.0	0.87	0.80	0.64
		3/8	8.5	2.48	4.0	1.5	1.26	1.28	1.9	0.87	0.88	0.78	0.64
		5/16	7.2	2.09	3.4	1.2	1.27	1.26	1.7	0.74	0.89	0.76	0.65
		1/4	5.8	1.69	2.8	1.0	1.28	1.24	1.4	0.60	0.89	0.74	0.65
A 28	3½ x 3	13/16	15.8	4.62	5.0	2.2	1.04	1.23	3.3	1.7	0.85	0.98	0.62
		3/4	14.7	4.31	4.7	2.1	1.04	1.21	3.1	1.5	0.85	0.96	0.62
		11/16	13.6	4.00	4.4	1.9	1.05	1.19	3.0	1.4	0.86	0.94	0.62
		5/8	12.5	3.67	4.1	1.8	1.06	1.17	2.8	1.3	0.87	0.92	0.62
		9/16	11.4	3.34	3.8	1.6	1.07	1.15	2.5	1.2	0.87	0.90	0.62
		1/2	10.2	3.00	3.5	1.5	1.07	1.13	2.3	1.1	0.88	0.88	0.62
		7/16	9.1	2.65	3.1	1.3	1.08	1.10	2.1	0.98	0.89	0.85	0.62
		3/8	7.9	2.30	2.7	1.1	1.09	1.08	1.8	0.85	0.90	0.83	0.62
		5/16	6.6	1.93	2.3	0.96	1.10	1.06	1.6	0.72	0.90	0.81	0.63
		1/4	5.4	1.56	1.9	0.78	1.11	1.04	1.3	0.58	0.91	0.79	0.63

L ELEMENTS

UNEQUAL ANGLES

ELEMENTS OF SECTIONS



Section Index	Size	Thickness	Weight per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
					I	S	r	x	I	S	r	y	r min.
	Inches	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.
A 32	3 x 2½	9/16	9.5	2.78	2.3	1.2	0.91	1.02	1.4	0.82	0.72	0.77	0.52
		½	8.5	2.50	2.1	1.0	0.91	1.00	1.3	0.74	0.72	0.75	0.52
		7/16	7.6	2.21	1.9	0.93	0.92	0.98	1.2	0.66	0.73	0.73	0.52
		⅜	6.6	1.92	1.7	0.81	0.93	0.96	1.0	0.58	0.74	0.71	0.52
		5/16	5.6	1.62	1.4	0.69	0.94	0.93	0.90	0.49	0.74	0.68	0.53
		¼	4.5	1.31	1.2	0.56	0.95	0.91	0.74	0.40	0.75	0.66	0.53
		3/16	3.39	1.00	0.91	0.43	0.95	0.89	0.58	0.31	0.76	0.64	0.53
A 35	2½ x 2	½	6.8	2.00	1.1	0.70	0.75	0.88	0.64	0.46	0.56	0.63	0.42
		7/16	6.1	1.78	1.0	0.62	0.76	0.85	0.58	0.41	0.57	0.60	0.42
		⅜	5.3	1.55	0.91	0.55	0.77	0.83	0.51	0.36	0.58	0.58	0.42
		5/16	4.5	1.31	0.79	0.47	0.78	0.81	0.45	0.31	0.58	0.56	0.42
		¼	3.62	1.06	0.65	0.38	0.78	0.79	0.37	0.25	0.59	0.54	0.42
		3/16	2.75	0.81	0.51	0.29	0.79	0.76	0.29	0.20	0.60	0.51	0.43
		© ⅛	1.86	0.55	0.35	0.20	0.80	0.74	0.20	0.13	0.61	0.49	0.43
A 37	2 x 1½	⅜	3.99	1.17	0.43	0.34	0.61	0.71	0.21	0.20	0.42	0.46	0.32
		5/16	3.39	1.00	0.38	0.29	0.62	0.69	0.18	0.17	0.42	0.44	0.32
		¼	2.77	0.81	0.32	0.24	0.62	0.66	0.15	0.14	0.43	0.41	0.32
		3/16	2.12	0.62	0.25	0.18	0.63	0.64	0.12	0.11	0.44	0.39	0.32
		⅛	1.44	0.42	0.17	0.13	0.64	0.62	0.09	0.08	0.45	0.37	0.33
A 39	1¾ x 1¼	¼	2.34	0.69	0.20	0.18	0.54	0.60	0.09	0.10	0.35	0.35	0.27
		3/16	1.80	0.53	0.16	0.14	0.55	0.58	0.07	0.08	0.36	0.33	0.27
		© ⅛	1.23	0.36	0.11	0.09	0.56	0.56	0.05	0.05	0.37	0.31	0.27

STEEL SHEET PILING

Steel sheet piling has proven to be reliable, efficient, and economical for subaqueous and underground construction. In addition to its uses in deep cofferdams, trenches, and excavations where it is pulled and redriven on other work, its application has been extended to a great variety of permanent types of construction, such as cut-off and core walls for dams, wharves and slips, sea walls and jetties for the protection of shores and beaches, and retaining walls around bridge piers or building foundations to eliminate scour or the lateral movements of materials below foundations.

A series of sections of both straight and arch web types are rolled which economically fulfill the requirements for a great variety of conditions. The deep arch web has high beam strength combined with minimum weight. Straight web sections are suitable for cut-off and core walls, where great beam strength is not required and in cellular work where interlock tension is important. The shallow arch web is used under difficult driving conditions where greater stiffness is required than that of the straight web piling.

These Piling sections have the thumb and finger type of interlock. They interlock throughout their entire length, the joints are flexible and strong, easy to drive and pull and also provide practical watertightness. This type of joint has a maximum number of points of contact and the short, hooked finger insures a maximum interlock strength with minimum weight.

These sections are grouped into two general classes; large and small interlocks. In the first are sections M 107, M 108, M 117 and M 106 which interlock together and are used where high interlock strength is required or where hard driving is encountered. In the second are sections M 110, M 112, M 113, M 115 and M 116, which likewise interlock together. Sections M 112 and M 113 are proportioned for maximum interlock strength in tension for cellular and master-pile-arc construction, combined with the greatest economy in weight.

Supplementing the standard series, Carnegie-Illinois Steel Corporation has added the Z type sections which have a much higher beam strength than can be obtained with the above sections without fabrication.

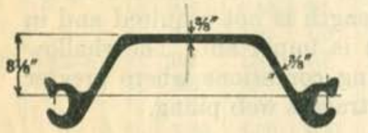
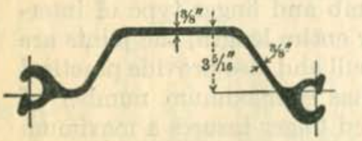
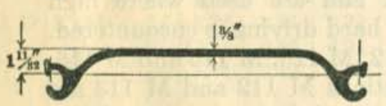
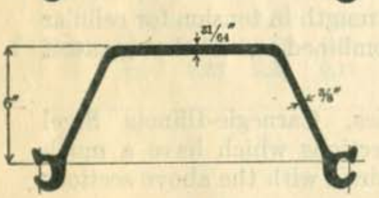
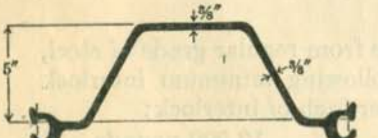
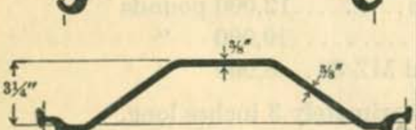
If necessary, the sections when made from regular grade of steel, will be guaranteed to develop the following minimum interlock strength in direct tension, in pounds per inch of interlock:

M 107, M 108, M 112 and M 113	12,000 pounds
M 117 and M 106	10,000 "
M 110, M 115, M 116, MZ 38 and MZ 32	8,000 "

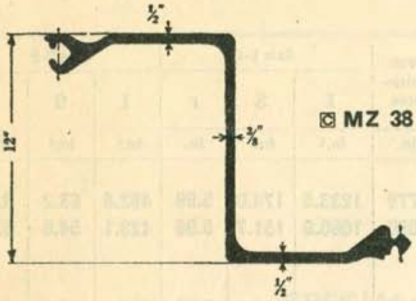
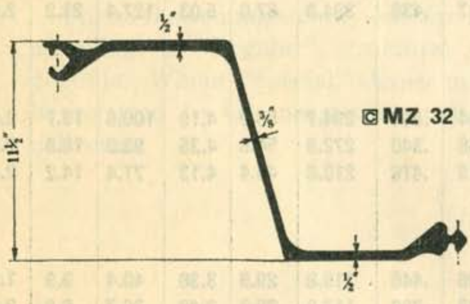
Values are based on test pieces approximately 3 inches long.

Full information for designing piling structures is given in Steel Sheet Piling handbook.

STEEL SHEET PILING SECTIONS

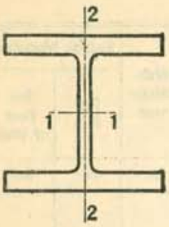
Profile		Section Index	Driving Distance Per Pile	Weight Per Foot	Weight Per Square Foot of Wall	Web Thickness	Section Modulus Per Pile	Section Modulus Per Foot of Wall
			In.	Lbs.	Lbs.	In.	In.^{3}	In.^{3}
	INTERLOCK WITH EACH OTHER	M 108	15	43.8	35.0	½	3.8	3.1
		M 107	15	38.8	31.0	⅜	3.7	3.0
		M 106	14	36.2	31.0	⅜	10.3	8.9
		M 117	15	38.8	31.0	⅜	8.9	7.1
	INTERLOCK WITH EACH OTHER	M 113	16	37.3	28.0	½	3.3	2.5
		M 112	16	30.7	23.0	⅜	3.2	2.4
		M 110	16	42.7	32.0	31/64	20.4	15.3
		M 116	16	36.0	27.0	⅜	14.3	10.7
		M 115	19⅝	36.0	22.0	⅜	8.8	5.4

STEEL SHEET PILING SECTIONS—Z PILES

Profile		Driving Distance Per Pile	Weight Per Foot	Weight Per Square Foot of Wall	Web Thickness	Section Modulus Per Pile	Section Modulus Per Foot of Wall
		In.	Lbs.	Lbs.	In.	In.^{3}	In.^{3}
	⊠ MZ 38	18	57.0	38.0	⅜	70.2	46.8
	⊠ MZ 32	21	56.0	32.0	⅜	67.0	38.3

The integral rolled Z sections have a higher section modulus than any of the standard series, with resulting higher beam strength. The ball and socket type interlock reduces to a minimum the friction in the interlock during driving.

Due to the high beam strength the Z piles are used in long lengths and in difficult driving. They are especially suitable for deep water structures such as docks, wharves, piers, bulkheads, canal locks, sea walls, breakwaters, jetties and deep cofferdams.



BEARING PILES

CB SECTIONS

ELEMENTS

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	FLANGE Width	FLANGE Thickness	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	$In.^2$	In.	In.	In.	$In.^4$	$In.^3$	In.	$In.^4$	$In.^3$	In.
CBP 146	14.18	117	34.42	15.599	.778	.779	1233.5	174.0	5.99	492.8	63.2	3.78
14 x 16	13.99	102	30.00	15.500	.681	.680	1060.9	151.7	5.95	423.1	54.6	3.75
CBP 145	13.86	89	26.19	14.696	.616	.616	909.1	131.2	5.89	326.2	44.4	3.53
14 x 14½	13.70	73	21.46	14.518	.538	.438	762.2	111.3	5.96	274.5	37.8	3.58
CBP 124	12.12	74	21.76	12.217	.607	.607	566.5	93.5	5.10	184.7	30.2	2.91
*CB 124	12.12	65	19.11	12.000	.606	.390	533.4	88.0	5.28	174.6	29.1	3.02
CBP 124	11.78	53	15.59	12.046	.437	.436	394.8	67.0	5.03	127.4	21.2	2.86
12 x 12												
CBP 103	10.01	57	16.76	10.224	.564	.564	294.7	58.9	4.19	100.6	19.7	2.45
*CB 103	10.00	49	14.40	10.000	.558	.340	272.9	54.6	4.35	93.0	18.6	2.54
CBP 103	9.72	42	12.35	10.078	.418	.418	210.8	43.4	4.13	71.4	14.2	2.40
10 x 10												
CBP 83	8.03	36	10.60	8.158	.446	.446	119.8	29.9	3.36	40.4	9.9	1.95
*CB 83	8.06	33	9.70	8.012	.463	.300	117.9	29.3	3.49	39.7	9.9	2.02
8 x 8												

Sections especially developed for use as Bearing Piles with uniform Web and Flange Thickness.

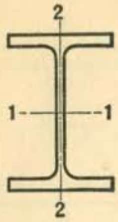
Refer to pages 322 to 324 for discussion on tne use of Steel Bearing Piles.

*Regular Sections, also published elsewhere.

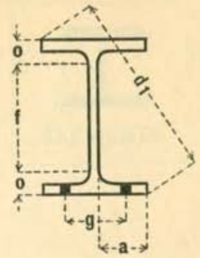
SPECIAL SECTIONS

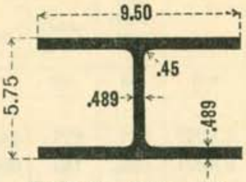
Structural shapes in this group are, due to a fluctuating demand, rolled only at irregular intervals, and then generally after special arrangements have been made with the mill.

Unless the tonnage of any one size is sufficient in itself to warrant a rolling, a "Regular" structural shape should be specified if possible. Where "Special" shapes must be used the matter should be referred to the nearest district office for information as to deliveries.



CB SECTIONS
FOR
SUBWAY COLUMNS





CB 61 $5\frac{3}{4} \times 9\frac{1}{2}$

ELEMENTS OF SECTIONS

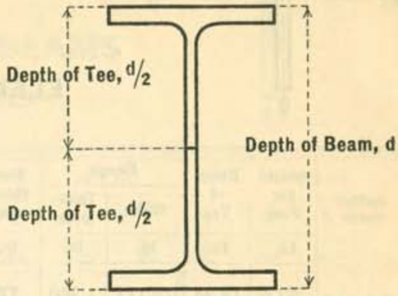
Section Index and Nominal Size	Depth of Section	Weight per Foot	Area of Section	Flange Width	Flange Thickness	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
CB 61 $5\frac{3}{4} \times 9\frac{1}{2}$	6.842	88	25.87	10.046	1.035	1.035	187.3	54.7	2.69	175.4	34.9	2.60
	6.666	80	23.52	9.959	.947	.948	164.9	49.5	2.65	156.3	31.4	2.58
	6.444	70	20.58	9.846	.836	.835	138.7	43.0	2.60	133.3	27.1	2.54
	6.216	60	17.63	9.733	.722	.722	113.9	36.7	2.54	111.1	22.8	2.51
	5.986	50	14.70	9.617	.607	.606	91.0	30.4	2.49	90.1	18.7	2.48
	5.750	40	11.76	9.500	.489	.489	69.6	24.2	2.43	69.9	14.7	2.44

DIMENSIONS FOR DETAILING

Section Index and Nominal Depth	Weight per Foot	Depth of Section	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance d_1	Usual Gage g
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
CB 61 $5\frac{3}{4}$	88	$6\frac{7}{8}$	10	$1\frac{1}{16}$	$1\frac{1}{16}$	$\frac{9}{16}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$1\frac{1}{2}$	$12\frac{1}{4}$	$5\frac{1}{2}$
	80	$6\frac{5}{8}$	10	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$1\frac{3}{8}$	12	$5\frac{1}{2}$
	70	$6\frac{1}{2}$	$9\frac{7}{8}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{7}{16}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$1\frac{5}{16}$	$11\frac{7}{8}$	$5\frac{1}{2}$
	60	$6\frac{1}{4}$	$9\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{8}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$1\frac{3}{16}$	$11\frac{5}{8}$	$5\frac{1}{2}$
	50	6	$9\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$1\frac{1}{16}$	$11\frac{3}{8}$	$5\frac{1}{2}$
	40	$5\frac{3}{4}$	$9\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$4\frac{1}{2}$	$3\frac{7}{8}$	$\frac{15}{16}$	$11\frac{1}{8}$	$5\frac{1}{2}$

Gages g_2 are based on $1\frac{1}{4}''$ edge distance ($\frac{7}{8}''$ maximum rivet.)

SPECIAL LARGE TEES



Larger tees than the standard tee sections can be obtained either from CB sections or standard beams by splitting on rotary shears at the mill. Elements for these tees are given below and on following pages.

For beams 8″ to 36″ inclusive the web thickness should not be greater than 1 inch for structural carbon steel or ¾ inch for structural silicon steel. Sections of greater web thickness can be flame cut.

The following tolerances, over or under, apply to the depth d/2 of the tee which is one-half of the beam depth:

Beams 8″ to 15″, incl. - 3/16″ Beams 20″ to 24″, incl. - 5/16″

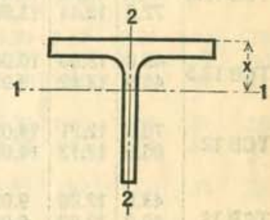
Beams 15″ to 20″, incl. - ¼″ Beams over 24″ - - - ⅜″

The above tolerances for depth of tees include the allowable tolerances in depth for the beams before splitting. Tolerances both for dimensions and straightness as set up for the beams from which the tees are cut will apply.

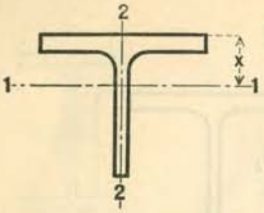
For the sake of economy these tees should be ordered in pairs.

All special large tees are produced in Pittsburgh district only.

LARGE TEES
CUT FROM
CB SECTIONS
ELEMENTS OF SECTIONS



Section Index	Weight per Foot	Depth of Tee	Flange		Stem Thick-ness	Area of Section	Axis 1-1				Axis 2-2		
			Width	Thick-ness			I	S	r	x	I	S	r
	Lb.	In.	In.	In.	In.	In.²	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
TCB 18	150	18.36	16.655	1.680	.945	44.09	1222.7	85.9	5.27	4.13	612.6	73.6	3.73
	140	18.25	16.595	1.570	.885	41.16	1133.3	79.9	5.25	4.07	563.7	67.9	3.70
	130	18.12	16.555	1.440	.845	38.28	1059.2	75.4	5.26	4.07	510.3	61.6	3.65
	125	18.06	16.525	1.380	.815	36.74	1014.6	72.4	5.25	4.04	484.8	58.7	3.63
	120	18.00	16.500	1.320	.790	35.30	975.0	69.8	5.26	4.03	460.0	55.8	3.61
	115	17.94	16.475	1.260	.765	33.86	935.8	67.2	5.26	4.02	435.5	52.9	3.59



LARGE TEES

CUT FROM

CB SECTIONS

ELEMENTS OF SECTIONS

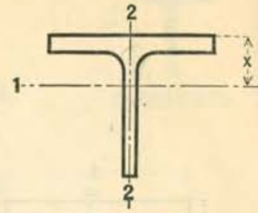
Section Index	Weight per Foot	Depth of Tee	Flange Width	Flange Thickness	Stem Thickness	Area of Section	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 1-1 x	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r
	Lb.	In.	In.	In.	In.	$In.^2$	$In.^4$	$In.^3$	In.	In.	$In.^4$	$In.^3$	In.
	97.0	18.24	12.117	1.260	.770	28.56	904.0	67.3	5.63	4.81	177.7	29.3	2.49
	91.0	18.16	12.072	1.180	.725	26.77	844.0	63.0	5.61	4.77	163.9	27.1	2.47
TCB 18	85.0	18.08	12.027	1.100	.680	24.99	784.7	58.8	5.60	4.74	150.3	25.0	2.45
	80.0	18.00	12.000	1.020	.653	23.54	741.0	56.0	5.61	4.76	137.7	22.9	2.42
	75.0	17.92	11.972	.940	.625	22.08	696.7	53.0	5.62	4.79	125.2	20.9	2.38
	110.0	16.63	15.810	1.275	.775	32.36	754.1	58.4	4.83	3.71	391.2	49.5	3.48
TCB 16.5	105.0	16.56	15.783	1.210	.748	30.89	720.3	56.0	4.83	3.70	367.8	46.6	3.45
	100.0	16.50	15.750	1.150	.715	29.40	683.6	53.3	4.82	3.67	345.8	43.9	3.43
	70.5	16.66	11.535	.960	.605	20.76	551.8	44.7	5.16	4.30	114.9	19.9	2.35
TCB 16.5	66.0	16.58	11.510	.880	.580	19.42	518.5	42.4	5.17	4.33	103.9	18.1	2.31
	62.5	16.50	11.500	.805	.570	18.39	495.7	41.0	5.19	4.42	94.1	16.4	2.26
	95.0	15.06	15.040	1.185	.710	27.95	520.4	44.1	4.31	3.26	312.3	41.5	3.34
TCB 15	90.0	15.00	15.000	1.125	.670	26.45	488.6	41.4	4.30	3.21	292.8	39.0	3.33
	86.0	14.94	14.985	1.065	.655	25.32	471.0	40.2	4.31	3.23	275.1	36.7	3.30
TCB 15	58.0	15.00	10.500	.850	.564	17.07	371.8	33.6	4.67	3.94	76.6	14.6	2.12
	54.0	14.91	10.484	.760	.548	15.88	349.5	32.1	4.69	4.03	67.6	12.9	2.06
	81.5	13.56	14.035	1.095	.670	23.96	358.7	33.7	3.87	2.92	234.4	33.4	3.13
TCB 13.5	77.0	13.50	14.000	1.035	.635	22.65	337.4	31.8	3.86	2.89	218.8	31.3	3.11
	72.5	13.44	13.965	.975	.600	21.34	316.3	29.9	3.85	2.85	203.5	29.1	3.09
TCB 13.5	49.0	13.50	10.000	.792	.500	14.41	247.2	24.4	4.14	3.38	61.5	12.3	2.07
	45.5	13.42	9.983	.712	.483	13.38	231.9	23.2	4.16	3.44	54.5	10.9	2.02
TCB 12	70.0	12.21	14.029	.980	.594	20.60	238.4	24.5	3.40	2.48	207.3	29.5	3.17
	65.0	12.13	14.000	.900	.565	19.13	222.6	23.1	3.41	2.47	187.6	26.8	3.13
	43.5	12.08	9.025	.807	.480	12.79	171.3	18.8	3.66	2.96	46.5	10.3	1.91
TCB 12	40.0	12.00	9.000	.727	.455	11.77	158.4	17.6	3.67	2.98	41.2	9.2	1.87
	37.0	11.94	8.975	.662	.430	10.88	147.0	16.4	3.67	2.99	36.9	8.2	1.84
	34.0	10.57	8.270	.685	.430	10.01	102.8	12.9	3.20	2.59	30.2	7.30	1.74
TCB 10.5	31.5	10.50	8.250	.620	.410	9.26	95.7	12.1	3.21	2.61	26.9	6.52	1.70
	29.5	10.46	8.230	.575	.390	8.68	89.8	11.5	3.22	2.61	24.6	5.98	1.68
	27.5	9.06	7.532	.630	.390	8.09	59.6	8.63	2.71	2.16	21.0	5.57	1.61
TCB 9	25.0	9.00	7.500	.570	.358	7.35	53.9	7.85	2.71	2.14	18.6	4.96	1.59
	23.5	8.95	7.492	.520	.350	6.91	51.3	7.57	2.72	2.18	16.8	4.48	1.56
	22.5	8.06	7.039	.563	.346	6.62	37.8	6.10	2.39	1.87	15.2	4.33	1.52
TCB 8	20.0	8.00	7.000	.503	.307	5.88	33.2	5.37	2.37	1.82	13.3	3.79	1.50
	18.0	7.93	6.992	.428	.299	5.30	30.7	5.10	2.41	1.90	11.1	3.17	1.45

LARGE TEES

CUT FROM

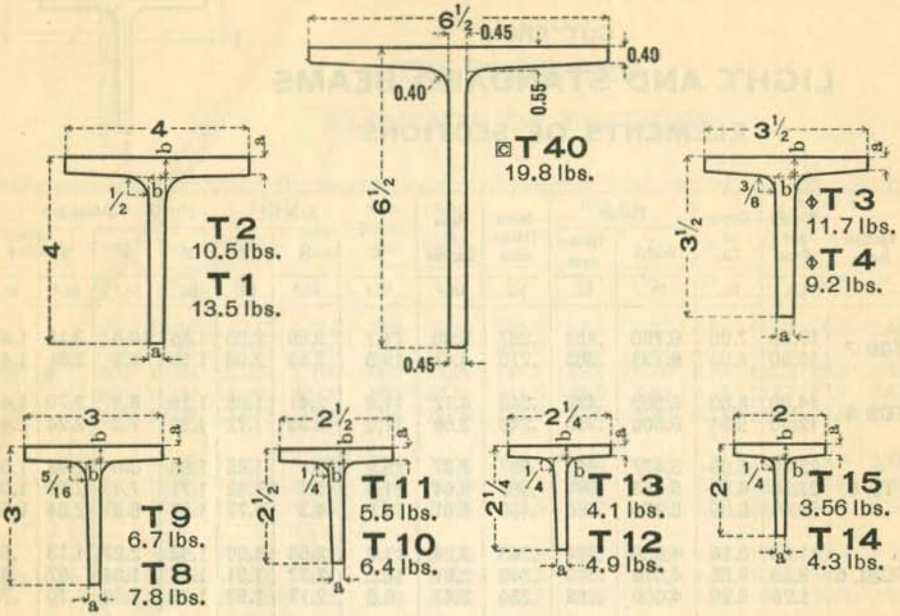
LIGHT AND STANDARD BEAMS

ELEMENTS OF SECTIONS

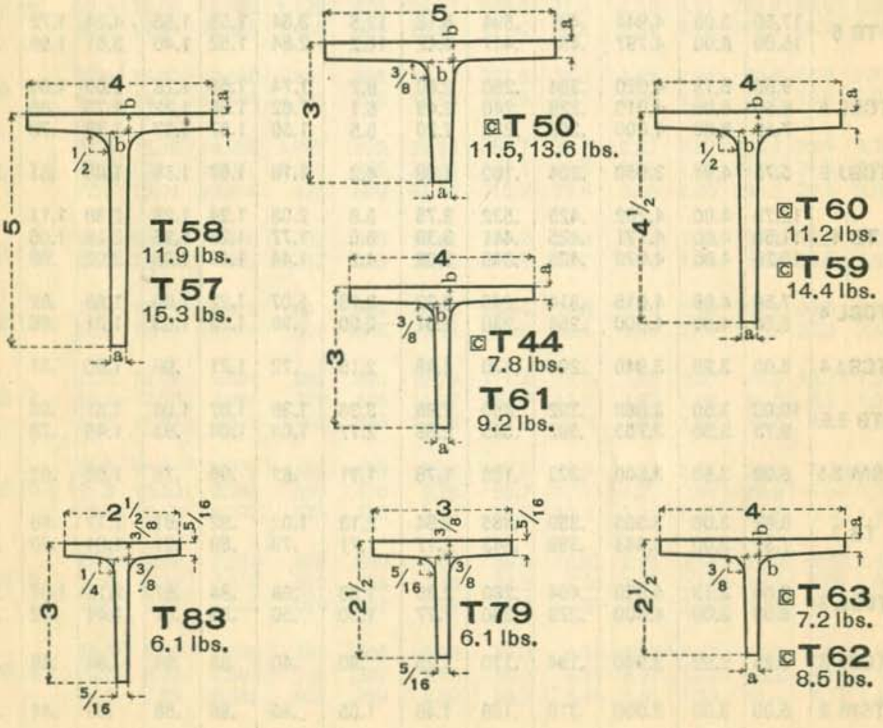


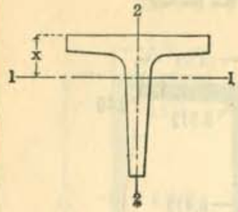
Section Index	Weight per Foot	Depth of Tee	Flange		Stem Thick-ness	Area of Section	Axis 1-1				Axis 2-2		
			Width	Thick-ness			I	S	r	x	I	S	r
	Lb.	In.	In.	In.	In.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
TCB 7	17.00	7.00	6.750	.453	.287	5.00	21.1	3.86	2.05	1.55	10.6	3.15	1.46
	15.00	6.93	6.733	.383	.270	4.41	19.0	3.55	2.08	1.59	8.8	2.61	1.41
TCB 6	14.00	6.00	6.500	.420	.240	4.12	11.6	2.41	1.68	1.19	8.8	2.70	1.46
	12.50	5.94	6.500	.355	.240	3.69	11.0	2.35	1.72	1.26	7.3	2.24	1.40
TB 6	25.00	6.00	5.477	.660	.687	7.37	25.2	6.1	1.85	1.83	8.0	2.93	1.04
	22.50	6.00	5.355	.660	.565	6.64	21.9	5.1	1.82	1.71	7.4	2.77	1.06
	20.40	6.00	5.250	.660	.460	6.01	18.9	4.3	1.77	1.57	6.9	2.64	1.07
TCBL 6	11.00	6.16	4.030	.424	.260	3.24	11.7	2.58	1.90	1.63	2.27	1.13	.84
	9.50	6.08	4.010	.349	.240	2.81	10.2	2.32	1.91	1.67	1.84	.92	.81
	8.25	6.00	4.000	.269	.230	2.43	9.0	2.13	1.93	1.76	1.39	.70	.76
TCBJ 6	7.00	5.96	3.970	.224	.200	2.07	7.7	1.83	1.92	1.76	1.13	.57	.74
TB 5	17.50	5.00	4.944	.491	.594	5.16	12.5	3.64	1.56	1.55	4.24	1.72	.91
	15.00	5.00	4.797	.491	.447	4.42	10.2	2.84	1.52	1.40	3.81	1.59	.93
TCBL 5	9.50	5.13	4.020	.394	.250	2.80	6.7	1.74	1.55	1.28	2.09	1.04	.86
	8.50	5.06	4.010	.329	.240	2.49	6.1	1.62	1.56	1.32	1.73	.86	.83
	7.50	5.00	4.000	.269	.230	2.20	5.5	1.50	1.57	1.37	1.39	.70	.80
TCBJ 5	5.75	4.94	3.950	.204	.180	1.69	4.2	1.16	1.57	1.35	1.00	.51	.77
TB 4	12.75	4.00	4.262	.425	.532	3.75	5.8	2.08	1.24	1.23	2.36	1.11	.79
	11.50	4.00	4.171	.425	.441	3.39	5.0	1.77	1.22	1.15	2.19	1.05	.80
	10.25	4.00	4.079	.425	.349	3.02	4.2	1.44	1.19	1.05	2.02	.99	.82
TCBL 4	7.50	4.06	4.015	.314	.245	2.22	3.29	1.07	1.22	1.00	1.65	.82	.86
	6.50	4.00	4.000	.254	.230	1.91	2.90	.98	1.23	1.03	1.31	.66	.83
TCBJ 4	5.00	3.95	3.940	.204	.170	1.48	2.15	.72	1.21	.96	1.00	.51	.82
TB 3.5	10.00	3.50	3.860	.392	.450	2.95	3.36	1.36	1.07	1.04	1.61	.83	.74
	8.75	3.50	3.755	.392	.345	2.58	2.77	1.08	1.04	.93	1.46	.78	.75
TSM 3.5	6.00	3.50	3.500	.323	.188	1.76	1.71	.62	.99	.76	1.05	.62	.79
TB 3	8.62	3.00	3.565	.359	.465	2.54	2.13	1.02	.92	.91	1.17	.66	.68
	7.37	3.00	3.443	.359	.343	2.17	1.71	.78	.89	.81	1.04	.60	.69
TCBL 3	8.00	3.13	4.030	.404	.260	2.36	1.66	.68	.84	.67	2.16	1.07	.96
	6.00	3.00	4.000	.279	.230	1.77	1.30	.56	.86	.67	1.44	.72	.90
TCBJ 3	4.25	2.92	3.940	.194	.170	1.25	.90	.40	.85	.64	.94	.48	.87
TSM 3	5.00	3.00	3.000	.310	.188	1.46	1.05	.45	.85	.68	.66	.44	.67

EQUAL TEES



UNEQUAL TEES





TEES

EQUAL AND UNEQUAL

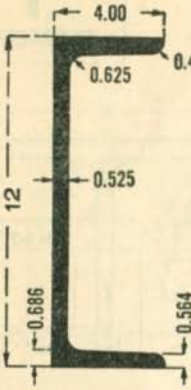
T ELEMENTS

ELEMENTS OF SECTIONS

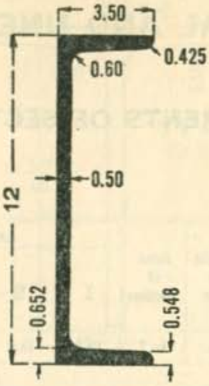
Section Index	Size: Flange	Size: Stem	Thickness: Toe, a	Thickness: Root, b	Weight per Foot	Area of Section	Axis 1-1: I	Axis 1-1: S	Axis 1-1: r	Axis 1-1: x	Axis 2-2: I	Axis 2-2: S	Axis 2-2: r
	In.	In.	In.	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
EQUAL TEES													
			*	*									
⊡T 40	6½	6½	.40,.45	.55,.45	19.8	5.80	23.5	5.0	2.01	1.76	10.1	3.1	1.32
T 1	4	4	½	9/16	13.5	3.97	5.7	2.0	1.20	1.18	2.8	1.4	0.84
T 2	4	4	3/8	7/16	10.5	3.09	4.5	1.6	1.21	1.13	2.1	1.1	0.83
ΦT 3	3½	3½	½	9/16	11.7	3.44	3.7	1.5	1.04	1.05	1.9	1.1	0.74
ΦT 4	3½	3½	3/8	7/16	9.2	2.68	3.0	1.2	1.05	1.01	1.4	0.81	0.73
T 8	3	3	3/8	7/16	7.8	2.27	1.8	0.86	0.90	0.88	0.90	0.60	0.63
T 9	3	3	5/16	3/8	6.7	1.95	1.6	0.74	0.90	0.86	0.75	0.50	0.62
T 10	2½	2½	3/8	7/16	6.4	1.87	1.0	0.59	0.74	0.76	0.52	0.42	0.53
T 11	2½	2½	5/16	3/8	5.5	1.60	0.88	0.50	0.74	0.74	0.44	0.35	0.52
T 12	2¼	2¼	5/16	3/8	4.9	1.43	0.65	0.41	0.67	0.68	0.33	0.29	0.48
T 13	2¼	2¼	¼	5/16	4.1	1.19	0.52	0.32	0.66	0.65	0.25	0.22	0.46
T 14	2	2	5/16	3/8	4.3	1.26	0.44	0.31	0.59	0.61	0.23	0.23	0.43
T 15	2	2	¼	5/16	3.56	1.05	0.37	0.26	0.59	0.59	0.18	0.18	0.42
UNEQUAL TEES													
			*	*									
⊡T 50	5	3⅛	½,13/32	9/16, 5/8	13.6	4.00	2.7	1.1	0.82	0.76	5.2	2.1	1.14
	5	3	3/8,13/32	7/16, 5/8	11.5	3.37	2.4	1.1	0.84	0.76	3.9	1.6	1.10
T 57	4	5	½	9/16	15.3	4.50	10.8	3.1	1.55	1.56	2.8	1.4	0.79
T 58	4	5	3/8	7/16	11.9	3.49	8.5	2.4	1.56	1.51	2.1	1.1	0.78
⊡T 59	4	4½	½	9/16	14.4	4.23	7.9	2.5	1.37	1.37	2.8	1.4	0.81
⊡T 60	4	4½	3/8	7/16	11.2	3.29	6.3	2.0	1.39	1.31	2.1	1.1	0.80
T 61	4	3	3/8	7/16	9.2	2.68	2.0	0.90	0.86	0.78	2.1	1.1	0.89
⊡T 44	4	3	5/16	3/8	7.8	2.29	1.7	0.77	0.87	0.75	1.8	0.88	0.88
⊡T 62	4	2½	3/8	7/16	8.5	2.48	1.2	0.62	0.69	0.62	2.1	1.0	0.92
⊡T 63	4	2½	5/16	3/8	7.2	2.12	1.0	0.53	0.69	0.60	1.8	0.88	0.91
T 79	3	2½	5/16	3/8	6.1	1.77	0.94	0.52	0.73	0.68	0.75	0.50	0.65
T 83	2½	3	5/16	3/8	6.1	1.77	1.5	0.72	0.92	0.92	0.44	0.35	0.50

* Where two dimensions are shown, the first is for the flange, the second for the stem.

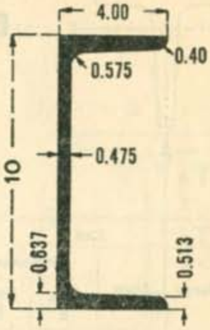
SHIP BUILDING CHANNELS



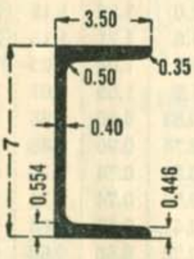
C 21 12x4
44.7, 40.6, 36.5, 34.5 lbs.



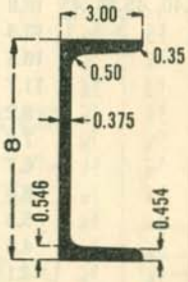
C 171 12x3½
41.1, 37.0, 32.9, 30.9 lbs.



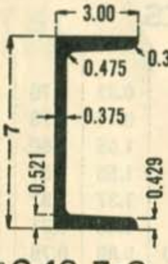
C 26 10x4
37.0, 33.6, 30.2, 28.5 lbs.



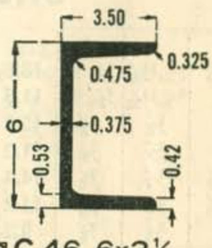
C 41 7x3½
25.0, 22.7, 20.3, 19.1 lbs.



C 37 8x3
25.5, 22.7, 20, 19.3, 18.7 lbs.



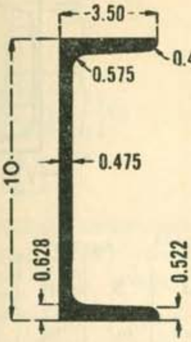
C 42 7x3
20.0, 17.6, 16.4 lbs.



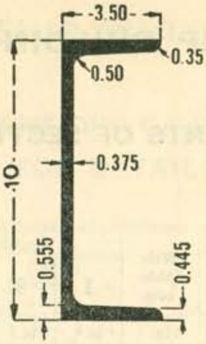
C 46 6x3½
22.0, 20.0, 18.0, 16.9 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

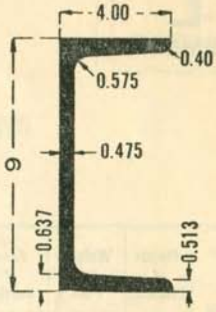
SHIP BUILDING CHANNELS



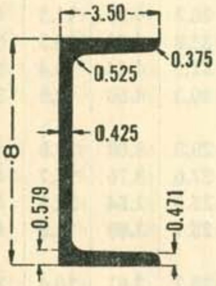
▣C 27 10x3½
35.1, 31.7, 28.3, 26.6, 24.9 lbs.



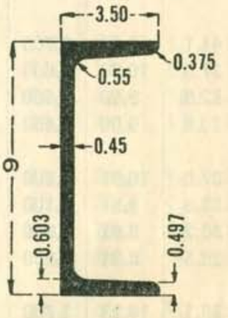
▣C 28 10x3½
25.3, 23.6, 21.9 lbs.



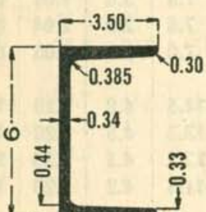
▣C 31 9x4
34.7, 31.7, 28.6, 27.1 lbs.



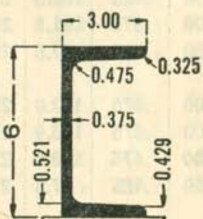
▣C 36 8x3½
28.2, 25.5, 22.8, 21.4 lbs.



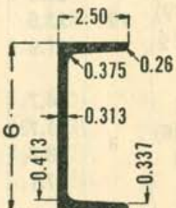
▣C 32 9x3½
31.6, 28.5, 25.4, 23.9 lbs.



▣C 109 and
⊕C 56 6x3½
15.3 lbs.



▣C 47 6x3
16.3, 15.1 lbs.



▣C 48 6x2½
13.3, 12.0 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN. IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

ELEMENTS

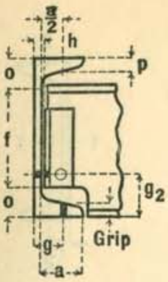
CHANNELS

SHIP BUILDING

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Web Thick-ness	Axis 1-1			Axis 2-2			
						I	S	r	I	S	r	y
	In.	Lbs.	In.²	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.	In.
C 21 (BSC 26) 12 x 4	12	44.7	13.05	4.200	.725	245.0	40.8	4.33	16.8	5.3	1.14	1.04
		40.6	11.85	4.100	.625	230.6	38.4	4.41	15.5	5.1	1.15	1.04
		36.5	**10.65**	**4.000**	**.525**	**216.2**	**36.0**	**4.51**	**14.2**	**4.8**	**1.16**	**1.06**
		34.5	10.05	3.950	.475	209.0	34.8	4.57	13.5	4.7	1.16	1.07
C 171 (BSC 25) 12 x 3½	12	41.1	12.00	3.700	.700	217.8	36.3	4.26	11.3	4.0	0.97	0.89
		37.0	10.80	3.600	.600	203.4	33.9	4.34	10.3	3.8	0.98	0.89
		32.9	**9.60**	**3.500**	**.500**	**189.0**	**31.5**	**4.44**	**9.4**	**3.6**	**0.99**	**0.89**
		30.9	9.00	3.450	.450	181.8	30.3	4.50	8.9	3.5	0.99	0.90
C 26 (BSC 21) 10 x 4	10	37.0	10.81	4.200	.675	146.3	29.3	3.68	14.9	4.8	1.18	1.10
		33.6	9.81	4.100	.575	138.0	27.6	3.75	13.7	4.6	1.18	1.11
		30.2	**8.81**	**4.000**	**.475**	**129.7**	**25.9**	**3.84**	**12.5**	**4.3**	**1.19**	**1.13**
		28.5	8.31	3.950	.425	125.5	25.1	3.89	11.8	4.2	1.19	1.15
C 27 (BSC 20) 10 x 3½	10	35.1	10.23	3.700	.675	133.6	26.7	3.61	10.4	3.8	1.01	0.95
		31.7	9.23	3.600	.575	125.2	25.0	3.69	9.5	3.6	1.01	0.95
		28.3	**8.23**	**3.500**	**.475**	**116.9**	**23.4**	**3.77**	**8.6**	**3.4**	**1.02**	**0.96**
		26.6	7.73	3.450	.425	112.7	22.5	3.82	8.1	3.3	1.02	0.97
		24.9	7.23	3.400	.375	108.6	21.7	3.88	7.6	3.2	1.03	0.98
C 28 (BSC 19) 10 x 3½	10	25.3	7.38	3.550	.425	106.0	21.2	3.79	7.9	3.0	1.04	0.94
		23.6	**6.88**	**3.500**	**.375**	**101.8**	**20.4**	**3.85**	**7.5**	**2.9**	**1.04**	**0.96**
		21.9	6.38	3.450	.325	97.6	19.5	3.91	7.0	2.8	1.05	0.98
C 31 (BSC 18) 9 x 4	9	34.7	10.13	4.200	.675	113.0	25.1	3.34	14.5	4.8	1.20	1.15
		31.7	9.23	4.100	.575	106.9	23.8	3.40	13.3	4.5	1.20	1.16
		28.6	**8.33**	**4.000**	**.475**	**100.9**	**22.4**	**3.48**	**12.1**	**4.3**	**1.20**	**1.18**
		27.1	7.88	3.950	.425	97.8	21.7	3.52	11.4	4.2	1.20	1.20
C 32 (BSC 17) 9 x 3½	9	31.6	9.21	3.700	.650	99.4	22.1	3.29	9.7	3.6	1.03	0.98
		28.5	8.31	3.600	.550	93.4	20.7	3.35	8.8	3.4	1.03	0.98
		25.4	**7.41**	**3.500**	**.450**	**87.3**	**19.4**	**3.43**	**8.0**	**3.2**	**1.04**	**1.00**
		23.9	6.96	3.450	.400	84.3	18.7	3.48	7.5	3.1	1.04	1.01

Dimensions and properties of the British Standard Sections are indicated in **bold type.**



CHANNELS

SHIP BUILDING

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

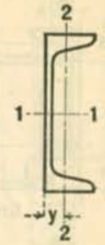
Section Index and Depth	Weight per Foot	Flange Width	Flange Thickness, p	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance Min. g_2	Distance Clear. h	Distance Gage g	Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
C 21	44.7	4¼	⅝	¾	⅜	3½	9⅜	1 5/16	2½	13/16	2½	⅝	1
(BSC 26)	40.6	4⅛	⅝	⅝	5/16	3½	9⅜	1 5/16	2½	11/16	2½	⅝	1
12	36.5	4	⅝	9/16	¼	3½	9⅜	1 5/16	2½	⅝	2½	⅝	1
	34.5	4	⅝	½	¼	3½	9⅜	1 5/16	2½	9/16	2½	⅝	1
C 171	41.1	3¾	⅝	11/16	⅜	3	9½	1¼	2½	¾	2¼	⅝	⅞
(BSC 25)	37.0	3⅝	⅝	⅝	5/16	3	9½	1¼	2½	11/16	2¼	⅝	⅞
12	32.9	3½	⅝	½	¼	3	9½	1¼	2½	9/16	2¼	9/16	⅞
	30.9	3½	⅝	7/16	¼	3	9½	1¼	2½	½	2¼	9/16	⅞
C 26	37.0	4¼	9/16	11/16	⅜	3½	7½	1¼	2½	¾	2½	9/16	⅞
(BSC 21)	33.6	4⅛	9/16	9/16	5/16	3½	7½	1¼	2½	⅝	2½	9/16	⅞
10	30.2	4	9/16	½	¼	3½	7½	1¼	2½	9/16	2½	9/16	⅞
	28.5	4	9/16	7/16	¼	3½	7½	1¼	2½	½	2½	9/16	⅞
	35.1	3¾	9/16	11/16	⅜	3	7⅝	1 3/16	2½	¾	2	9/16	⅞
C 27	31.7	3⅝	9/16	9/16	5/16	3	7⅝	1 3/16	2½	⅝	2	9/16	⅞
(BSC 20)	28.3	3½	9/16	½	¼	3	7⅝	1 3/16	2½	9/16	2	9/16	⅞
10	26.6	3½	9/16	7/16	¼	3	7⅝	1 3/16	2½	½	2	9/16	⅞
	24.9	3⅜	9/16	⅜	3/16	3	7⅝	1 3/16	2½	7/16	2	9/16	⅞
C 28	25.3	3½	½	7/16	¼	3⅛	7⅞	1 1/16	2½	½	2	½	⅞
(BSC 19)	23.6	3½	½	⅜	3/16	3⅛	7⅞	1 1/16	2½	7/16	2	½	⅞
10	21.9	3½	½	5/16	3/16	3⅛	7⅞	1 1/16	2½	⅜	2	½	⅞
C 31	34.7	4¼	9/16	11/16	⅜	3½	6½	1¼	2½	¾	2½	9/16	⅞
(BSC 18)	31.7	4⅛	9/16	9/16	5/16	3½	6½	1¼	2½	⅝	2½	9/16	⅞
9	28.6	4	9/16	½	¼	3½	6½	1¼	2½	9/16	2½	9/16	⅞
	27.1	4	9/16	7/16	¼	3½	6½	1¼	2½	½	2½	9/16	⅞
C 32	31.6	3¾	9/16	11/16	5/16	3	6¾	1⅛	2½	¾	2	9/16	⅞
(BSC 17)	28.5	3⅝	9/16	9/16	5/16	3	6¾	1⅛	2½	⅝	2	9/16	⅞
9	25.4	3½	9/16	7/16	¼	3	6¾	1⅛	2½	½	2	9/16	⅞
	23.9	3½	9/16	7/16	3/16	3	6¾	1⅛	2½	½	2	9/16	⅞

Gages g_2 are based on 1¼″ edge distance (⅞″ maximum rivet).

ELEMENTS

CHANNELS

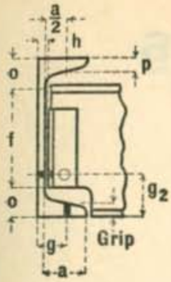
SHIP BUILDING



ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Web Thickness	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r	Axis 2-2 y
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
C 36 (BSC 13) 8 x 3½ ⊡	8	28.2	8.23	3.700	.625	71.8	18.0	2.95	9.0	3.4	1.05	1.02
		25.5	7.43	3.600	.525	67.6	16.9	3.02	8.2	3.2	1.05	1.02
		22.8	**6.63**	**3.500**	**.425**	**63.3**	**15.8**	**3.09**	**7.4**	**3.0**	**1.05**	**1.04**
		21.4	6.23	3.450	.375	61.2	15.3	3.13	6.9	2.9	1.05	1.05
C 37 (BSC 12) 8 x 3 ⊡	8	25.5	7.43	3.225	.600	62.6	15.6	2.90	5.8	2.5	0.89	0.86
		22.7	6.63	3.125	.500	58.3	14.6	2.97	5.3	2.3	0.89	0.85
		20.0	5.83	3.025	.400	54.0	13.5	3.05	4.7	2.2	0.90	0.86
		19.3	**5.63**	**3.000**	**.375**	**53.0**	**13.2**	**3.07**	**4.5**	**2.1**	**0.90**	**0.87**
		18.7	5.43	2.975	.350	51.9	13.0	3.09	4.4	2.1	0.90	0.88
C 41 (BSC 10) 7 x 3½	7	25.0	7.30	3.700	.600	49.9	14.3	2.62	8.3	3.2	1.07	1.06
		22.7	6.60	3.600	.500	47.1	13.5	2.67	7.5	3.0	1.07	1.07
		20.3	**5.90**	**3.500**	**.400**	**44.2**	**12.6**	**2.74**	**6.7**	**2.8**	**1.07**	**1.09**
		19.1	5.55	3.450	.350	42.8	12.2	2.78	6.3	2.7	1.07	1.11
C 42 (BSC 9) 7 x 3 ⊡	7	20.0	5.82	3.100	.475	40.2	11.5	2.63	4.7	2.1	0.90	0.88
		17.6	**5.12**	**3.000**	**.375**	**37.3**	**10.7**	**2.70**	**4.2**	**2.0**	**0.90**	**0.90**
		16.4	4.77	2.950	.325	35.9	10.2	2.74	3.9	1.9	0.90	0.91
C 46 (BSC 8) 6 x 3½ ⊡	6	22.0	6.42	3.700	.575	33.0	11.0	2.27	7.6	2.9	1.09	1.12
		20.0	5.82	3.600	.475	31.2	10.4	2.32	6.9	2.8	1.09	1.13
		18.0	**5.22**	**3.500**	**.375**	**29.4**	**9.8**	**2.38**	**6.1**	**2.6**	**1.08**	**1.15**
		16.9	4.92	3.450	.325	28.5	9.5	2.41	5.7	2.5	1.08	1.17
⊡C 109 ΦC 56 6 x 3½	6	15.3	4.48	3.500	.340	25.3	8.4	2.38	5.1	2.1	1.08	1.08
C 47 (BSC 7) 6 x 3 ⊡	6	**16.3**	**4.75**	**3.000**	**.375**	**25.8**	**8.6**	**2.33**	**4.0**	**1.9**	**0.91**	**0.95**
		15.1	4.37	2.938	.313	24.7	8.2	2.38	3.6	1.8	0.91	0.97
C 48 (BSC 5) 6 x 2½ ⊡	6	13.3	3.90	2.563	.375	19.7	6.6	2.25	2.1	1.2	0.74	0.71
		12.0	**3.52**	**2.500**	**.313**	**18.6**	**6.2**	**2.30**	**2.0**	**1.1**	**0.75**	**0.72**

Dimensions and properties of the British Standard Sections are indicated in **bold type.**



CHANNELS

SHIP BUILDING

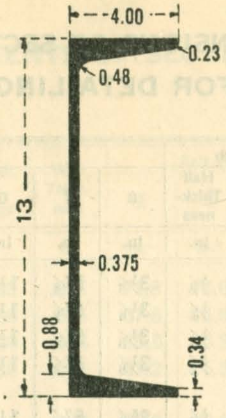
DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

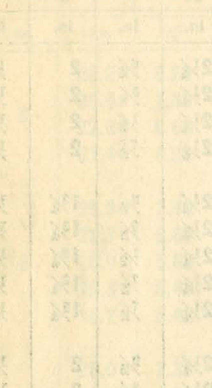
Section Index and Depth	Weight per Foot	Flange Width	Flange Thickness, p	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance Min. g_2	Distance Clear. h	Distance Gage g	Distance Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
C 36	28.2	3¾	½	⅝	5/16	3⅛	5⅞	1 1/16	2¼	11/16	2	½	⅞
(BSC 13)	25.5	3⅝	½	9/16	¼	3⅛	5⅞	1 1/16	2¼	⅝	2	½	⅞
8	22.8	3½	½	7/16	¼	3⅛	5⅞	1 1/16	2¼	½	2	½	⅞
🄲	21.4	3½	½	⅜	3/16	3⅛	5⅞	1 1/16	2¼	7/16	2	½	⅞
	25.5	3¼	½	⅝	5/16	2⅝	5⅞	1 1/16	2¼	11/16	1¾	½	⅞
C 37	22.7	3⅛	½	½	¼	2⅝	5⅞	1 1/16	2¼	9/16	1¾	½	⅞
(BSC 12)	20.0	3	½	7/16	3/16	2⅝	5⅞	1 1/16	2¼	½	1¾	½	⅞
8	19.3	3	½	⅜	3/16	2⅝	5⅞	1 1/16	2¼	7/16	1¾	½	⅞
🄲	18.7	3	½	⅜	3/16	2⅝	5⅞	1 1/16	2¼	7/16	1¾	½	⅞
C 41	25.0	3¾	½	⅝	5/16	3⅛	4⅞	1 1/16	2¼	11/16	2	½	⅞
(BSC 10)	22.7	3⅝	½	½	¼	3⅛	4⅞	1 1/16	2¼	9/16	2	½	⅞
7	20.3	3½	½	7/16	3/16	3⅛	4⅞	1 1/16	2¼	½	2	½	⅞
	19.1	3½	½	⅜	3/16	3⅛	4⅞	1 1/16	2¼	7/16	2	½	⅞
C 42 (BSC 9)	20.0	3⅛	½	½	¼	2⅝	5	1	2¼	9/16	1¾	½	⅞
7	17.6	3	½	⅜	3/16	2⅝	5	1	2¼	7/16	1¾	½	⅞
🄲	16.4	3	½	5/16	3/16	2⅝	5	1	2¼	⅜	1¾	½	⅞
C 46	22.0	3¾	½	9/16	5/16	3⅛	4	1	2¼	⅝	2	½	⅞
(BSC 8)	20.0	3⅝	½	½	¼	3⅛	4	1	2¼	9/16	2	½	⅞
6	18.0	3½	½	⅜	3/16	3⅛	4	1	2¼	7/16	2	½	⅞
🄲	16.9	3½	½	5/16	3/16	3⅛	4	1	2¼	⅜	2	½	⅞
🄲C 109 ΦC 56 6 🄲	15.3	3½	⅜	⅜	3/16	3⅛	4⅜	13/16	2	7/16	2	⅜	⅞
C 47 (BSC 7)	16.3	3	½	⅜	3/16	2⅝	4	1	2¼	7/16	1¾	½	¾
6 🄲	15.1	3	½	5/16	3/16	2⅝	4	1	2¼	⅜	1¾	½	¾
C 48 (BSC 5)	13.3	2⅝	⅜	⅜	3/16	2⅛	4½	¾	2	7/16	1½	⅜	⅝
6 🄲	12.0	2½	⅜	5/16	3/16	2⅛	4½	¾	2	⅜	1½	⅜	⅝

Gages, g, are usual standard gages, but may be varied if conditions require.
Gages g_2 are based on 1¼″ edge distance (⅞″ maximum rivet).

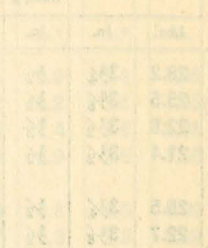
CAR BUILDING CHANNELS



C 20 13x4
50, 45, 40,
37, 35, 31.8 lbs.



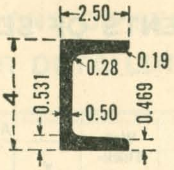
C 170 12x4
50, 48.6, 46.6,
44.5, 40, 35 lbs.



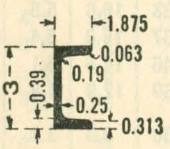
C 211 7x4
18.8 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

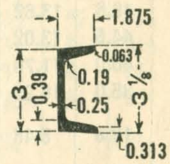
CAR BUILDING CHANNELS



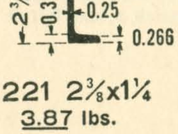
C 200 4x2½
13.8 lbs.



C 192 3x1⅞
10.3, 9, 7.1, 6.5, 5.8 lbs.



C 193 and ⊕C 21 3x1⅞
10.3, 9, 7.1, 6.5, 5.8 lbs.



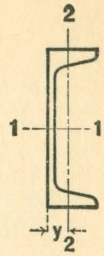
C 221 2⅜x1¼
3.87 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN, IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

ELEMENTS

CHANNELS

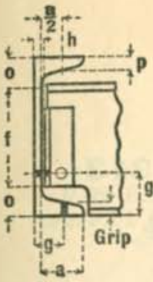
CAR BUILDING



ELEMENTS OF SECTIONS

Section Index and Nominal Size	Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Web Thick-ness	Axis 1-1			Axis 2-2			
						I	S	r	I	S	r	y
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
C 20 13 x 4	13	50.0	14.66	4.412	.787	312.9	48.1	4.62	16.7	4.9	1.07	0.98
		45.0	13.18	4.298	.673	292.0	44.9	4.71	15.3	4.6	1.08	0.97
		40.0	11.71	4.185	.560	271.4	41.7	4.82	13.9	4.3	1.09	0.97
		37.0	10.82	4.117	.492	258.9	39.8	4.89	13.0	4.2	1.10	0.98
		35.0	10.24	4.072	.447	250.7	38.6	4.95	12.5	4.0	1.10	0.99
		31.8	9.30	4.000	.375	237.5	36.5	5.05	11.6	3.9	1.11	1.01
C 170 12 x 4	12	50.0	14.64	4.135	.835	268.1	44.7	4.28	17.8	5.8	1.10	1.06
		48.6	14.22	4.100	.800	263.0	43.8	4.30	17.3	5.7	1.10	1.05
		46.6	13.62	4.050	.750	255.8	42.6	4.33	16.6	5.5	1.11	1.05
		44.5	13.02	4.000	.700	248.6	41.4	4.37	16.0	5.4	1.11	1.05
		40.0	11.70	3.890	.590	232.8	38.8	4.46	14.5	5.1	1.12	1.05
		35.0	10.23	3.767	.467	215.1	35.8	4.59	12.9	4.8	1.12	1.07
C 211 7 x 4	7	18.8	5.48	4.000	.350	42.9	12.2	2.80	8.3	3.0	1.23	1.23
C 200 4 x 2½ ▣	4	13.8	4.00	2.500	.500	8.8	4.4	1.49	2.2	1.4	0.74	0.86
* ▣C 192	3	10.3	3.02	2.250	.625	3.4	2.3	1.06	1.16	0.76	0.62	0.73
▣C 193		9.0	2.64	2.125	.500	3.1	2.1	1.09	0.97	0.68	0.61	0.71
⌽C 21		7.1	2.08	1.938	.313	2.7	1.8	1.14	0.71	0.56	0.58	0.68
3 x 1⅞		6.5	1.89	1.875	.250	2.6	1.7	1.17	0.63	0.52	0.58	0.67
		5.8	1.68	1.805	.180	2.4	1.6	1.20	0.53	0.47	0.56	0.68
C 221 2⅜ x 1¼ ▣	2⅜	3.87	1.14	1.188	.250	0.87	0.73	0.88	0.14	0.18	0.35	0.40

*▣C 193 and ⌽C 21 are identical with C 192 except flanges are flared outward to 3⅛″ at the toe of flanges. ⌽C 21 not rolled to 5.8 lb.



CHANNELS

CAR BUILDING

DIMENSIONS

DIMENSIONS OF SECTIONS FOR DETAILING

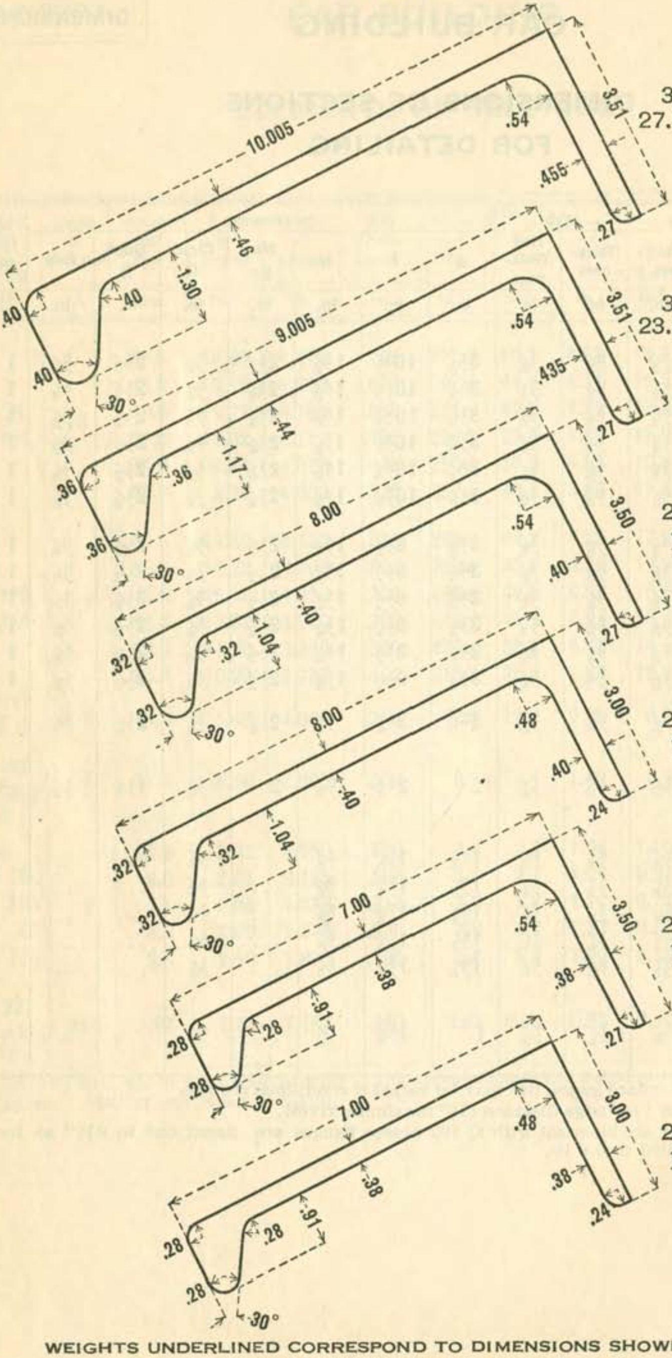
Section Index and Depth	Weight per Foot	Flange Width	Flange Thickness, p	Web Thickness	Web Half Thickness	Distance a	Distance f	Distance o	Distance Min. g_2	Distance Clear. h	Distance Gage g	Distance Grip	Max. Flange Rivet
	Lbs.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
C 20 13	50.0	4 3/8	5/8	13/16	7/16	3 5/8	10 3/8	1 5/16	2 3/4	7/8	2 1/2	5/8	1
	45.0	4 1/4	5/8	11/16	3/8	3 5/8	10 3/8	1 5/16	2 3/4	3/4	2 1/2	5/8	1
	40.0	4 1/8	5/8	9/16	5/16	3 5/8	10 3/8	1 5/16	2 3/4	5/8	2 1/2	9/16	1
	37.0	4 1/8	5/8	1/2	1/4	3 5/8	10 3/8	1 5/16	2 3/4	9/16	2 1/2	9/16	1
	35.0	4 1/8	5/8	7/16	1/4	3 5/8	10 3/8	1 5/16	2 3/4	1/2	2 1/2	9/16	1
	31.8	4	5/8	3/8	3/16	3 5/8	10 3/8	1 5/16	2 3/4	7/16	2 1/2	9/16	1
C 170 12	50.0	4 1/8	11/16	7/8	7/16	3 3/8	9 1/2	1 1/4	2 1/2	15/16	2 1/2	11/16	1
	48.6	4 1/8	11/16	13/16	7/16	3 3/8	9 1/2	1 1/4	2 1/2	7/8	2 1/2	11/16	1
	46.6	4	11/16	3/4	3/8	3 3/8	9 1/2	1 1/4	2 1/2	13/16	2 1/2	11/16	1
	44.5	4	11/16	11/16	3/8	3 3/8	9 1/2	1 1/4	2 1/2	3/4	2 1/2	11/16	1
	40.0	3 7/8	11/16	5/8	5/16	3 3/8	9 1/2	1 1/4	2 1/2	11/16	2 1/2	11/16	1
	35.0	3 3/4	11/16	1/2	1/4	3 3/8	9 1/2	1 1/4	2 1/2	9/16	2 1/2	11/16	1
C 211 7	18.8	4	7/16	3/8	3/16	3 5/8	5 1/4	7/8	2 1/4	7/16	2 1/2	3/8	7/8
C 200 4 🄲	13.8	2 1/2	1/2	1/2	1/4	2	2 3/8	13/16	2	9/16	1 1/2	1/2	5/8
*	10.3	2 1/4	3/8	5/8	5/16	1 5/8	1 7/8	9/16	...	11/16	...	..	..
🄲C192	9.0	2 1/8	3/8	1/2	1/4	1 5/8	1 7/8	9/16	...	9/16	...	..	..
🄲C193	7.1	2	3/8	5/16	3/16	1 5/8	1 7/8	9/16	...	3/8	...	..	..
ΦC21	6.5	1 7/8	3/8	1/4	1/8	1 5/8	1 7/8	9/16	...	5/16	...	..	..
3	5.8	1 3/4	3/8	3/16	1/8	1 3/8	1 7/8	9/16	...	1/4	...	..	..
C 221 2 3/8 🄲	3.87	1 1/4	5/16	1/4	1/8	1	1 3/8	1/2	...	5/16	...	..	..

Gages, g, are usual standard gages, but may be varied if conditions require.

Gages g_2 are based on 1 1/4″ edge distance (7/8″ maximum rivet).

* 🄲 C 193 and Φ C 21 are identical with C 192 except flanges are flared out to 3 1/8″ at toe of flanges. ΦC 21 not rolled to 5.8 lb.

BULB ANGLES
SHIP BUILDING



BA 313
34.7, 32.3, 29.9
27.2, 24.8, 22.4 lbs.

BA 312
30.8, 28.6, 26.4
23.8, 21.6, 19.4 lbs.

BA 311
24.3, 22.3, 20.0
18.0, 16.0 lbs.

BA 310
23.3, 21.4, 19.2
17.3, 15.4 lbs.

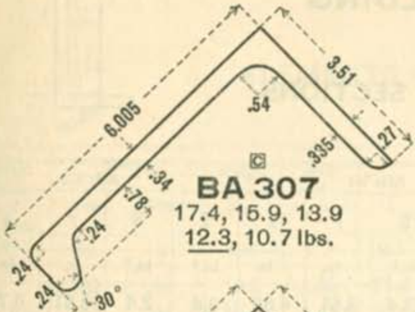
BA 309
21.1, 19.3, 17.1
15.3, 13.6 lbs.

BA 308
20.2, 18.4, 16.4
14.7, 12.9 lbs.

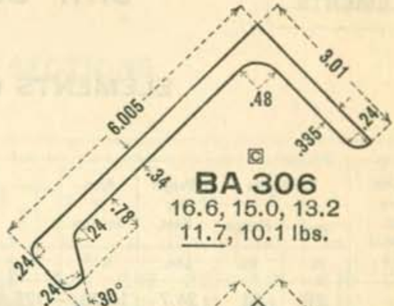
WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN. IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

BULB ANGLES

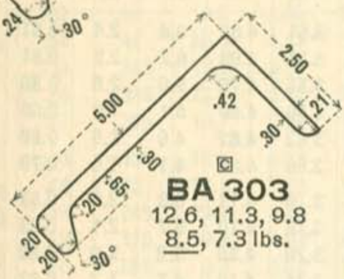
SHIP BUILDING



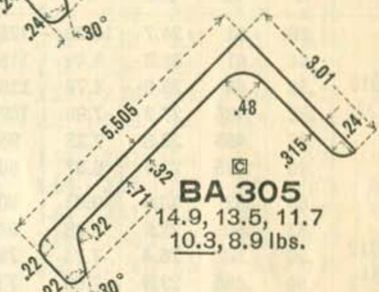
BA 307
17.4, 15.9, 13.9
12.3, 10.7 lbs.



BA 306
16.6, 15.0, 13.2
11.7, 10.1 lbs.

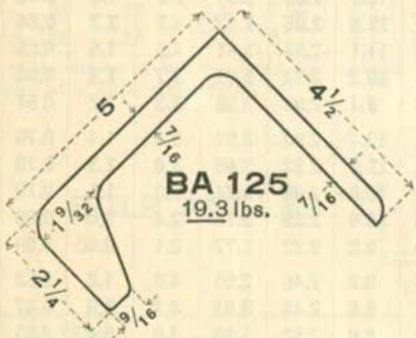


BA 303
12.6, 11.3, 9.8
8.5, 7.3 lbs.

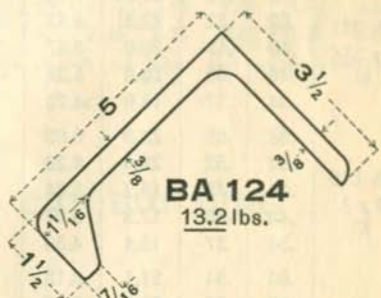


BA 305
14.9, 13.5, 11.7
10.3, 8.9 lbs.

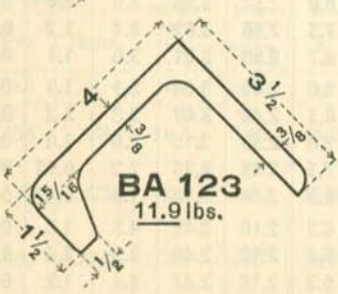
CAR BUILDING



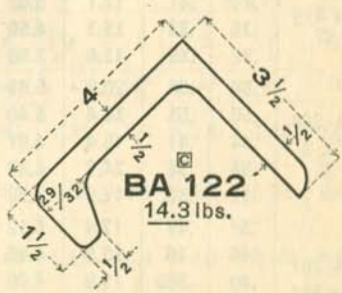
BA 125
19.3 lbs.



BA 124
13.2 lbs.



BA 123
11.9 lbs.

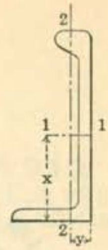


BA 122
14.3 lbs.

WEIGHTS UNDERLINED CORRESPOND TO DIMENSIONS SHOWN. IN INCHES
RANGE OF WEIGHTS PER LINEAR FOOT

ELEMENTS

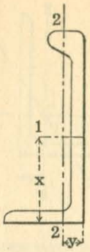
BULB ANGLES
SHIP BUILDING



ELEMENTS OF SECTIONS

Section Index and Nominal Size	Thickness		Weight per Foot	Area of Section	Axis 1-1				Axis 2-2			
	Web	Flange			I	S	r	x	I	S	r	y
	In.	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.
BA 313 10 x 3½ $\boxed{C}$	.70	.64	34.7	10.20	125.6	23.4	3.51	4.69	6.8	2.4	0.81	0.79
	.64	.61	32.3	9.49	118.1	22.1	3.53	4.69	6.2	2.2	0.81	0.77
	.58	**.58**	**29.9**	**8.78**	**110.7**	**20.9**	**3.55**	**4.70**	**5.6**	**2.0**	**0.80**	**0.75**
	.52	.485	27.2	7.98	102.9	19.6	3.59	4.80	5.1	1.8	0.80	0.72
	.46	**.455**	**24.8**	**7.28**	**95.4**	**18.4**	**3.62**	**4.82**	**4.6**	**1.6**	**0.80**	**0.70**
	.40	.425	22.4	6.57	88.0	17.2	3.66	4.85	4.1	1.5	0.79	0.68
BA 312 9 x 3½ $\boxed{C}$	.68	.62	30.8	9.03	90.1	18.2	3.16	4.11	6.3	2.2	0.83	0.80
	.62	.59	28.6	8.38	84.6	17.2	3.18	4.10	5.7	2.1	0.83	0.78
	.56	**.56**	**26.4**	**7.74**	**79.0**	**16.1**	**3.20**	**4.10**	**5.2**	**1.9**	**0.82**	**0.75**
	.50	.465	23.8	7.00	73.3	15.1	3.24	4.19	4.7	1.7	0.82	0.72
	.44	**.435**	**21.6**	**6.35**	**67.7**	**14.1**	**3.27**	**4.21**	**4.2**	**1.5**	**0.82**	**0.70**
	.38	.405	19.4	5.70	62.2	13.1	3.30	4.22	3.7	1.4	0.81	0.68
BA 311 8 x 3½ $\boxed{C}$	.58	.55	24.3	7.14	57.0	12.7	2.83	3.53	5.2	1.9	0.85	0.78
	.52	**.52**	**22.3**	**6.55**	**53.0**	**11.8**	**2.85**	**3.52**	**4.7**	**1.7**	**0.84**	**0.76**
	.46	.43	20.0	5.87	48.9	11.1	2.89	3.61	4.2	1.5	0.85	0.72
	.40	**.40**	**18.0**	**5.28**	**44.9**	**10.2**	**2.92**	**3.61**	**3.7**	**1.3**	**0.84**	**0.70**
	.34	.37	16.0	4.70	40.9	9.4	2.95	3.62	3.3	1.2	0.84	0.69
BA 310 8 x 3 $\boxed{C}$	.58	.55	23.3	6.85	53.9	12.4	2.80	3.67	3.4	1.4	0.70	0.68
	.52	**.52**	**21.4**	**6.28**	**50.1**	**11.5**	**2.82**	**3.66**	**3.0**	**1.3**	**0.70**	**0.66**
	.46	.43	19.2	5.64	46.2	10.8	2.86	3.74	2.8	1.1	0.70	0.63
	.40	**.40**	**17.3**	**5.07**	**42.4**	**10.0**	**2.89**	**3.75**	**2.4**	**1.0**	**0.69**	**0.61**
	.34	.37	15.4	4.50	38.5	9.2	2.92	3.77	2.1	0.90	0.69	0.59
BA 309 7 x 3½ $\boxed{C}$	.56	.54	21.1	6.19	37.5	9.2	2.46	2.95	4.8	1.8	0.88	0.80
	.50	**.51**	**19.3**	**5.67**	**34.7**	**8.6**	**2.48**	**2.93**	**4.3**	**1.6**	**0.87**	**0.78**
	.44	.41	17.1	5.03	32.0	8.0	2.52	3.03	3.9	1.4	0.88	0.74
	.38	**.38**	**15.3**	**4.50**	**29.2**	**7.3**	**2.55**	**3.02**	**3.4**	**1.2**	**0.87**	**0.72**
	.32	.35	13.6	3.98	26.4	6.7	2.58	3.01	3.0	1.1	0.87	0.71
BA 308 7 x 3 $\boxed{C}$	.56	.54	20.2	5.91	35.4	9.0	2.45	3.08	3.1	1.3	0.72	0.69
	.50	**.51**	**18.4**	**5.40**	**32.8**	**8.3**	**2.46**	**3.07**	**2.8**	**1.2**	**0.72**	**0.67**
	.44	.41	16.4	4.81	30.2	7.8	2.50	3.15	2.5	1.0	0.72	0.64
	.38	**.38**	**14.7**	**4.30**	**27.5**	**7.1**	**2.53**	**3.15**	**2.2**	**0.93**	**0.72**	**0.62**
	.32	.35	12.9	3.79	24.9	6.5	2.56	3.15	1.9	0.82	0.71	0.60
BA 307 6 x 3½ $\boxed{C}$	.52	.49	17.4	5.12	22.7	6.3	2.10	2.42	4.3	1.6	0.92	0.82
	.46	**.46**	**15.9**	**4.65**	**20.8**	**5.8**	**2.12**	**2.40**	**3.9**	**1.4**	**0.91**	**0.80**
	.40	.365	13.9	4.06	19.0	5.3	2.16	2.47	3.4	1.2	0.91	0.76
	.34	**.335**	**12.3**	**3.60**	**17.2**	**4.8**	**2.19**	**2.46**	**3.0**	**1.1**	**0.91**	**0.74**
	.28	.305	10.7	3.13	15.3	4.4	2.21	2.45	2.6	0.94	0.91	0.73

Sections shown in **bold type** have the nominal lengths of web and flange, also the thicknesses of same are equal or approximately so.



BULB ANGLES

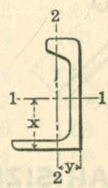
SHIP BUILDING

ELEMENTS

ELEMENTS OF SECTIONS

Section Index and Nominal Size	Thickness		Weight per Foot	Area of Section	Axis 1-1				Axis 2-2			
	Web	Flange			I	S	r	x	I	S	r	y
	In.	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.
	.52	.49	16.6	4.86	21.4	6.1	2.10	2.53	2.8	1.2	0.76	0.70
BA 306	**.46**	**.46**	**15.0**	**4.41**	**19.7**	**5.6**	**2.11**	**2.51**	**2.5**	**1.1**	**0.75**	**0.68**
6 x 3	.40	.365	13.2	3.87	17.9	5.2	2.15	2.59	2.2	0.91	0.75	0.64
$\boxed{C}$	**.34**	**.335**	**11.7**	**3.42**	**16.2**	**4.7**	**2.18**	**2.58**	**1.9**	**0.80**	**0.75**	**0.63**
	.28	.305	10.1	2.97	14.5	4.3	2.21	2.58	1.6	0.70	0.74	0.61
	.50	.46	14.9	4.37	16.1	4.9	1.92	2.27	2.6	1.1	0.78	0.71
BA 305	**.44**	**.43**	**13.4**	**3.94**	**14.7**	**4.5**	**1.93**	**2.25**	**2.3**	**1.0**	**0.77**	**0.69**
5½ x 3	.38	.345	11.7	3.44	13.4	4.1	1.97	2.31	2.0	0.85	0.77	0.65
$\boxed{C}$	**.32**	**.315**	**10.3**	**3.02**	**12.0**	**3.7**	**2.00**	**2.30**	**1.8**	**0.75**	**0.77**	**0.63**
	.26	.285	8.9	2.60	10.6	3.3	2.02	2.28	1.5	0.65	0.76	0.62
	.48	.44	12.6	3.68	11.1	3.8	1.74	2.12	1.5	0.75	0.63	0.61
BA 303	**.42**	**.41**	**11.3**	**3.30**	**10.1**	**3.5**	**1.75**	**2.10**	**1.3**	**0.67**	**0.63**	**0.58**
5 x 2½	.36	.33	9.8	2.88	9.1	3.1	1.78	2.06	1.1	0.56	0.63	0.55
$\boxed{C}$	**.30**	**.30**	**8.5**	**2.50**	**8.1**	**2.7**	**1.81**	**2.03**	**0.97**	**0.49**	**0.62**	**0.53**
	.24	.27	7.3	2.13	7.1	2.4	1.83	2.01	0.81	0.42	0.62	0.51

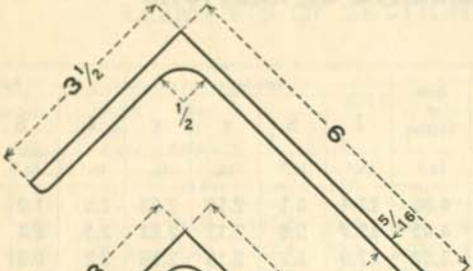
Sections shown in **bold type** have the nominal lengths of web and flange, also the thicknesses of same are equal or approximately so.

BULB ANGLES  CAR BUILDING

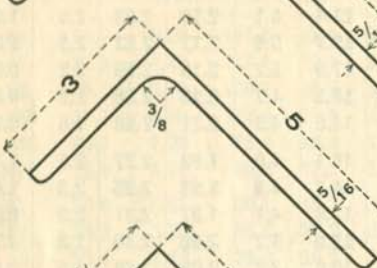
Section Index and Nominal Size	Thickness		Weight per Foot	Area of Section	Axis 1-1				Axis 2-2			
	Web	Flange			I	S	r	x	I	S	r	y
	In.	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.
BA 125 5 x 4½	.438	.438	19.3	5.66	20.8	7.9	1.91	2.39	7.9	2.4	1.18	1.23
BA 124 5 x 3½	.375	.375	13.2	3.82	13.5	4.9	1.88	2.22	3.3	1.2	0.92	0.86
BA 122 4 x 3½ $\boxed{C}$	.500	.500	14.3	4.21	8.7	3.7	1.44	1.65	3.9	1.5	0.96	0.99
BA 123 4 x 3½	.375	.375	11.9	3.48	7.9	3.5	1.50	1.77	3.1	1.2	0.94	0.94

ANGLES—UNEQUAL LEGS

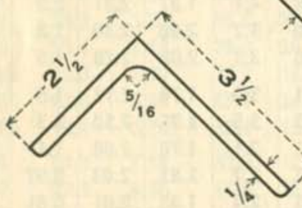
STRUCTURAL SIZES



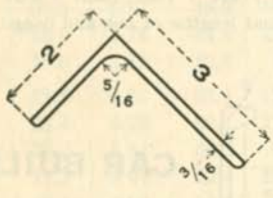
A 21
$\frac{5}{16}$ to 1



A 24
$\frac{5}{16}$ to $\frac{13}{16}$

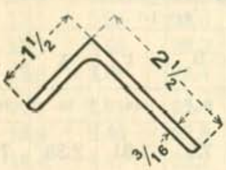


A 29
$\frac{1}{4}$ to $\frac{11}{16}$

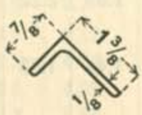


A 33
$\frac{3}{16}$ to $\frac{1}{2}$

BAR SIZES

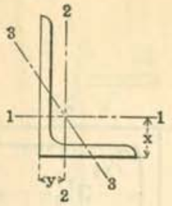


A 48
$\frac{3}{16}$ to $\frac{5}{16}$



A 40
$\frac{1}{8}$, $\frac{3}{16}$

PROFILES SHOW MINIMUM DIMENSIONS IN INCHES
RANGE OF THICKNESSES



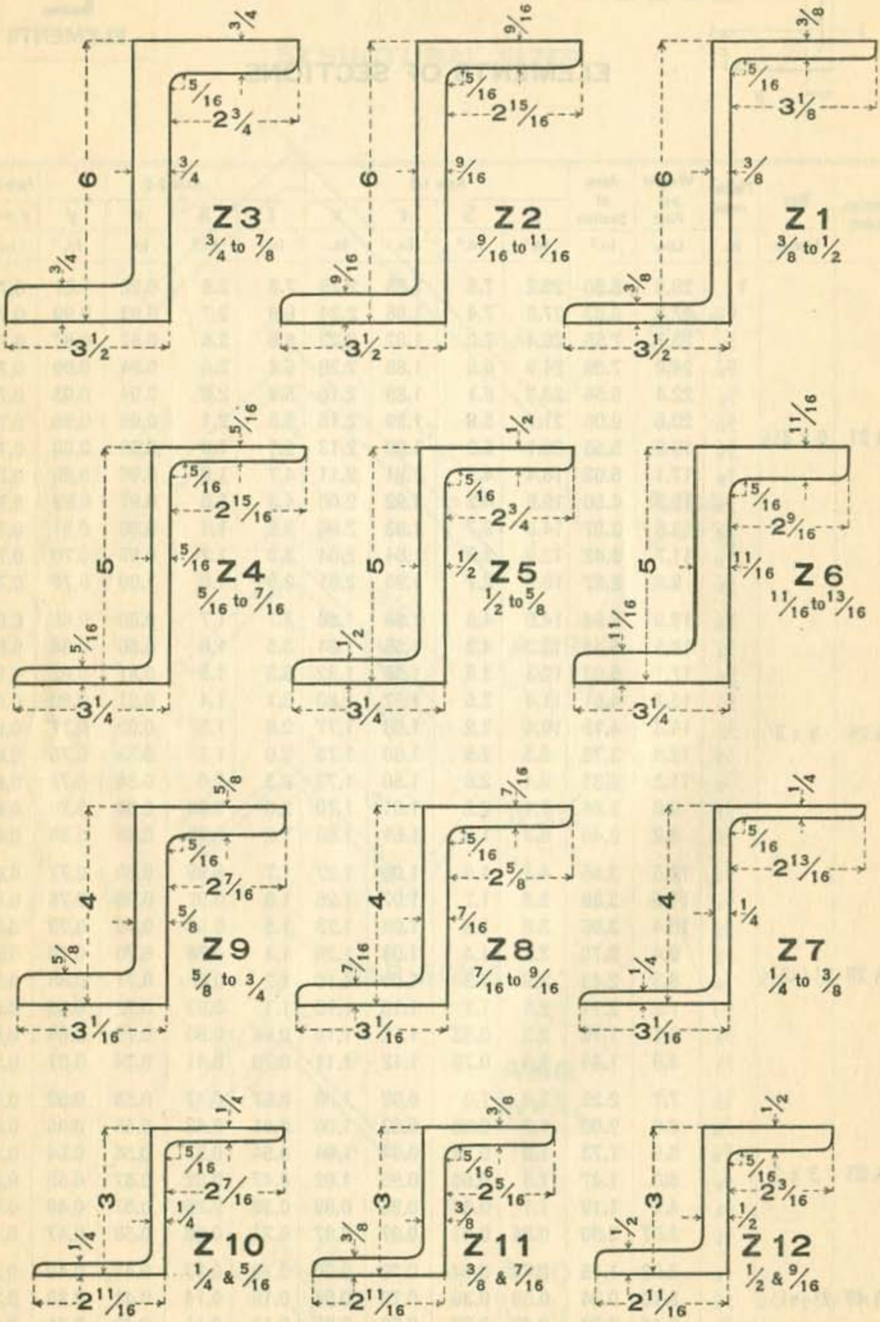
UNEQUAL ANGLES

L
ELEMENTS

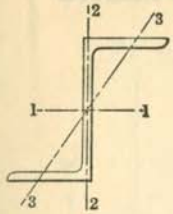
ELEMENTS OF SECTIONS

Section Index	Size	Thick-ness	Weight per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
					I	S	r	x	I	S	r	y	r min.
	Inches	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.
A 21	6 x 3½	1	28.9	8.50	29.2	7.8	1.85	2.26	7.2	2.9	0.92	1.01	0.74
		15/16	27.3	8.03	27.8	7.4	1.86	2.24	6.9	2.7	0.93	0.99	0.74
		7/8	25.7	7.55	26.4	7.0	1.87	2.22	6.6	2.6	0.93	0.97	0.75
		13/16	24.0	7.06	24.9	6.6	1.88	2.20	6.2	2.4	0.94	0.95	0.75
		3/4	22.4	6.56	23.3	6.1	1.89	2.18	5.8	2.3	0.94	0.93	0.75
		11/16	20.6	6.06	21.7	5.6	1.89	2.15	5.5	2.1	0.95	0.90	0.75
		5/8	18.9	5.55	20.1	5.2	1.90	2.13	5.1	1.9	0.96	0.88	0.75
		9/16	17.1	5.03	18.4	4.7	1.91	2.11	4.7	1.8	0.96	0.86	0.75
		1/2	15.3	4.50	16.6	4.2	1.92	2.08	4.3	1.6	0.97	0.83	0.76
		7/16	13.5	3.97	14.8	3.7	1.93	2.06	3.8	1.4	0.98	0.81	0.76
		3/8	11.7	3.42	12.9	3.3	1.94	2.04	3.3	1.2	0.99	0.79	0.77
		5/16	9.8	2.87	10.9	2.7	1.95	2.01	2.9	1.0	1.00	0.76	0.77
A 24	5 x 3	13/16	19.9	5.84	14.0	4.5	1.55	1.86	3.7	1.7	0.80	0.86	0.64
		3/4	18.5	5.44	13.2	4.2	1.55	1.84	3.5	1.6	0.80	0.84	0.64
		11/16	17.1	5.03	12.3	3.9	1.56	1.82	3.3	1.5	0.81	0.82	0.64
		5/8	15.7	4.61	11.4	3.5	1.57	1.80	3.1	1.4	0.81	0.80	0.64
		9/16	14.3	4.18	10.4	3.2	1.58	1.77	2.8	1.3	0.82	0.77	0.65
		1/2	12.8	3.75	9.5	2.9	1.59	1.75	2.6	1.1	0.83	0.75	0.65
		7/16	11.3	3.31	8.4	2.6	1.60	1.73	2.3	1.0	0.84	0.73	0.65
		3/8	9.8	2.86	7.4	2.2	1.61	1.70	2.0	0.89	0.84	0.70	0.65
		5/16	8.2	2.40	6.3	1.9	1.61	1.68	1.8	0.75	0.85	0.68	0.66
A 29	3½x2½	11/16	12.5	3.65	4.1	1.9	1.06	1.27	1.7	0.99	0.69	0.77	0.53
		5/8	11.5	3.36	3.8	1.7	1.07	1.25	1.6	0.92	0.69	0.75	0.53
		9/16	10.4	3.06	3.6	1.6	1.08	1.23	1.5	0.84	0.70	0.73	0.53
		1/2	9.4	2.75	3.2	1.4	1.09	1.20	1.4	0.76	0.70	0.70	0.53
		7/16	8.3	2.43	2.9	1.3	1.09	1.18	1.2	0.68	0.71	0.68	0.54
		3/8	7.2	2.11	2.6	1.1	1.10	1.16	1.1	0.59	0.72	0.66	0.54
		5/16	6.1	1.78	2.2	0.93	1.11	1.14	0.94	0.50	0.73	0.64	0.54
		1/4	4.9	1.44	1.8	0.75	1.12	1.11	0.78	0.41	0.74	0.61	0.54
A 33	3 x 2	1/2	7.7	2.25	1.9	1.0	0.92	1.08	0.67	0.47	0.55	0.58	0.43
		7/16	6.8	2.00	1.7	0.89	0.93	1.06	0.61	0.42	0.55	0.56	0.43
		3/8	5.9	1.73	1.5	0.78	0.94	1.04	0.54	0.37	0.56	0.54	0.43
		5/16	5.0	1.47	1.3	0.66	0.95	1.02	0.47	0.32	0.57	0.52	0.43
		1/4	4.1	1.19	1.1	0.54	0.95	0.99	0.39	0.26	0.57	0.49	0.43
		3/16	3.07	0.90	0.84	0.41	0.97	0.97	0.31	0.20	0.58	0.47	0.44
A 48	2½x1½	5/16	3.92	1.15	0.71	0.44	0.79	0.90	0.19	0.17	0.41	0.40	0.32
		1/4	3.19	0.94	0.59	0.36	0.79	0.88	0.16	0.14	0.41	0.38	0.32
		3/16	2.44	0.72	0.46	0.28	0.80	0.85	0.13	0.11	0.42	0.35	0.33
A 40	1⅜ x ⅞	3/16	1.32	0.39	0.071	0.081	0.43	0.49	0.022	0.035	0.24	0.24	0.19
		1/8	0.91	0.27	0.051	0.056	0.44	0.47	0.017	0.026	0.25	0.22	0.20

ZEES



PROFILES SHOW MINIMUM DIMENSIONS IN INCHES
RANGE OF THICKNESSES



ZEES

ELEMENTS

ELEMENTS OF SECTIONS

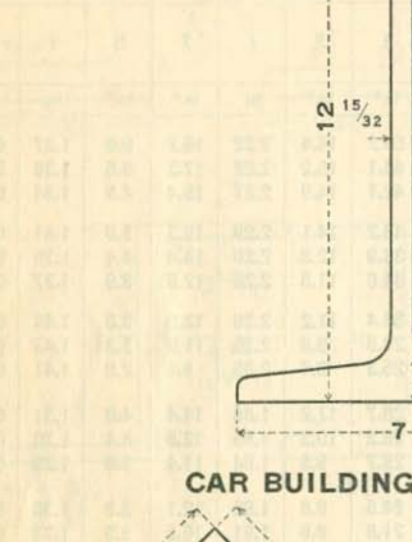
Section Index	Size: Depth	Size: Flange	Size: Thickness	Weight per Foot	Area of Section	Axis 1-1: I	Axis 1-1: S	Axis 1-1: r	Axis 2-2: I	Axis 2-2: S	Axis 2-2: r	Axis 3-3: r min.
	In.	In.	In.	Lbs.	In.^{2}	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
Z 3	6 1/8	3 5/8	7/8	34.6	10.17	50.2	16.4	2.22	19.2	6.0	1.37	0.83
	6 1/16	3 9/16	13/16	32.0	9.40	46.1	15.2	2.22	17.3	5.5	1.36	0.82
	6	3 1/2	3/4	29.4	8.63	42.1	14.0	2.21	15.4	4.9	1.34	0.81
Z 2	6 1/8	3 5/8	11/16	28.1	8.25	43.2	14.1	2.29	16.3	5.0	1.41	0.84
	6 1/16	3 9/16	5/8	25.4	7.46	38.9	12.8	2.28	14.4	4.4	1.39	0.82
	6	3 1/2	9/16	22.8	6.68	34.6	11.5	2.28	12.6	3.9	1.37	0.81
Z 1	6 1/8	3 5/8	1/2	21.1	6.19	34.4	11.2	2.36	12.9	3.8	1.44	0.84
	6 1/16	3 9/16	7/16	18.4	5.39	29.8	9.8	2.35	11.0	3.3	1.43	0.83
	6	3 1/2	3/8	15.7	4.59	25.3	8.4	2.35	9.1	2.8	1.41	0.83
Z 6	5 1/8	3 3/8	13/16	28.4	8.33	28.7	11.2	1.86	14.4	4.8	1.31	0.76
	5 1/16	3 5/16	3/4	26.0	7.64	26.2	10.3	1.85	12.8	4.4	1.30	0.74
	5	3 1/4	11/16	23.7	6.96	23.7	9.5	1.84	11.4	3.9	1.28	0.73
Z 5	5 1/8	3 3/8	5/8	22.6	6.64	24.5	9.6	1.92	12.1	3.9	1.35	0.76
	5 1/16	3 5/16	9/16	20.2	5.94	21.8	8.6	1.91	10.5	3.5	1.33	0.75
	5	3 1/4	1/2	17.9	5.25	19.2	7.7	1.91	9.1	3.0	1.31	0.74
Z 4	5 1/8	3 3/8	7/16	16.4	4.81	19.1	7.4	1.99	9.2	2.9	1.38	0.77
	5 1/16	3 5/16	3/8	14.0	4.10	16.2	6.4	1.99	7.7	2.5	1.37	0.76
	5	3 1/4	5/16	11.6	3.40	13.4	5.3	1.98	6.2	2.0	1.35	0.75
Z 9	4 1/8	3 3/16	3/4	23.0	6.75	15.0	7.3	1.49	11.2	4.0	1.29	0.68
	4 1/16	3 1/8	11/16	20.9	6.14	13.5	6.7	1.48	10.0	3.6	1.27	0.67
	4	3 1/16	5/8	18.9	5.55	12.1	6.1	1.48	8.7	3.2	1.25	0.66
Z 8	4 1/8	3 3/16	9/16	18.0	5.27	12.7	6.2	1.55	9.3	3.2	1.33	0.68
	4 1/16	3 1/8	1/2	15.9	4.66	11.2	5.5	1.55	8.0	2.8	1.31	0.67
	4	3 1/16	7/16	13.8	4.05	9.7	4.8	1.55	6.7	2.4	1.29	0.66
Z 7	4 1/8	3 3/16	3/8	12.5	3.66	9.6	4.7	1.62	6.8	2.3	1.36	0.69
	4 1/16	3 1/8	5/16	10.3	3.03	7.9	3.9	1.62	5.5	1.8	1.34	0.68
	4	3 1/16	1/4	8.2	2.41	6.3	3.1	1.62	4.2	1.4	1.33	0.67
Z 12	3 1/16	2 3/4	9/16	14.3	4.18	5.3	3.4	1.12	5.7	2.3	1.17	0.54
	3	2 11/16	1/2	12.6	3.69	4.6	3.1	1.12	4.9	2.0	1.15	0.53
Z 11	3 1/16	2 3/4	7/16	11.5	3.36	4.6	3.0	1.17	4.8	1.9	1.19	0.55
	3	2 11/16	3/8	9.8	2.86	3.9	2.6	1.16	3.9	1.6	1.17	0.54
Z 10	3 1/16	2 3/4	5/16	8.5	2.48	3.6	2.4	1.21	3.6	1.4	1.21	0.56
	3	2 11/16	1/4	6.7	1.97	2.9	1.9	1.21	2.8	1.1	1.19	0.55

MISCELLANEOUS CAR BUILDING SECTIONS

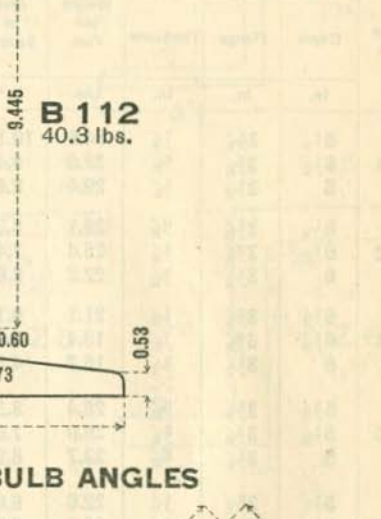
CENTER SILL SECTION

B 112
40.3 lbs.

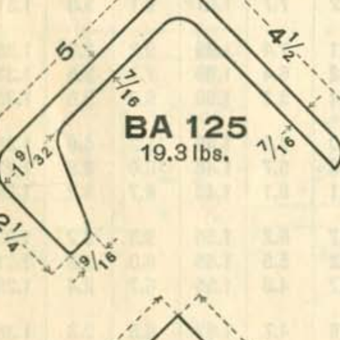
CAR BUILDING BULB ANGLES



BA 125
19.3 lbs.



BA 124
13.2 lbs.

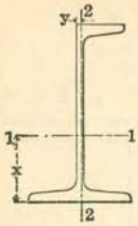


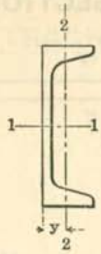
BA 123
11.9 lbs.

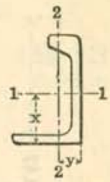
BA 122
14.3 lbs.

PROFILES SHOW DIMENSIONS IN INCHES

CAR BUILDING SECTIONS—ELEMENTS







Section Index	Depth	Weight per Foot	Area	Width of Flange	Thickness of Web	Axis 1-1 I	Axis 1-1 S	Axis 1-1 r	Axis 1-1 x	Axis 2-2 I	Axis 2-2 S	Axis 2-2 r	Axis 2-2 y
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.
CAR CENTER SILL SECTION													
B 112	12	40.3	11.72	3¼,7	15/32	238.1	31.9	4.51	4.54	21.8	5.9	1.36	0.43
CHANNELS-CAR BUILDING													
C 20	13	50.0	14.66	4.412	.787	312.9	48.1	4.62		16.7	4.9	1.07	0.98
		45.0	13.18	4.298	.673	292.0	44.9	4.71		15.3	4.6	1.08	0.97
		40.0	11.71	4.185	.560	271.4	41.7	4.82		13.9	4.3	1.09	0.97
		37.0	10.82	4.117	.492	258.9	39.8	4.89		13.0	4.2	1.10	0.98
		35.0	10.24	4.072	.447	250.7	38.6	4.95		12.5	4.0	1.10	0.99
		31.8	9.30	4.000	.375	237.5	36.5	5.05		11.6	3.9	1.11	1.01
C 170	12	50.0	14.64	4.135	.835	268.1	44.7	4.28		17.8	5.8	1.10	1.06
		48.6	14.22	4.100	.800	263.0	43.8	4.30		17.3	5.7	1.10	1.05
		46.6	13.62	4.050	.750	255.8	42.6	4.33		16.6	5.5	1.11	1.05
		44.5	13.02	4.000	.700	248.6	41.4	4.37		16.0	5.4	1.11	1.05
		40.0	11.70	3.890	.590	232.8	38.8	4.46		14.5	5.1	1.12	1.05
		35.0	10.23	3.767	.467	215.1	35.8	4.59		12.9	4.8	1.12	1.07
C 211	7	18.8	5.48	4.000	.350	42.9	12.2	2.80		8.3	3.0	1.23	1.23
C 200 ⊡	4	13.8	4.00	2.500	.500	8.8	4.4	1.49		2.2	1.4	0.74	0.86
* ⊡C192 ⊡C193 ΦC21	3	10.3	3.02	2.250	.625	3.4	2.3	1.06		1.16	0.76	0.62	0.73
		9.0	2.64	2.125	.500	3.1	2.1	1.09		0.97	0.68	0.61	0.71
		7.1	2.08	1.938	.313	2.7	1.8	1.14		0.71	0.56	0.58	0.68
		6.5	1.89	1.875	.250	2.6	1.7	1.17		0.63	0.52	0.58	0.67
		5.8	1.68	1.805	.180	2.4	1.6	1.20		0.53	0.47	0.56	0.68
C 221 ⊡	2⅜	3.87	1.14	1.188	.250	0.87	0.73	0.88		0.14	0.18	0.35	0.40
BULB ANGLES-CAR BUILDING													
BA125	5	19.3	5.66	4½	.438	20.8	7.9	1.91	2.39	7.9	2.4	1.18	1.23
BA124	5	13.2	3.82	3½	.375	13.5	4.9	1.88	2.22	3.3	1.2	0.92	0.86
BA122 ⊡	4	14.3	4.21	3½	.500	8.7	3.7	1.44	1.65	3.9	1.5	0.96	0.99
BA123	4	11.9	3.48	3½	.375	7.9	3.5	1.50	1.77	3.1	1.2	0.94	0.94

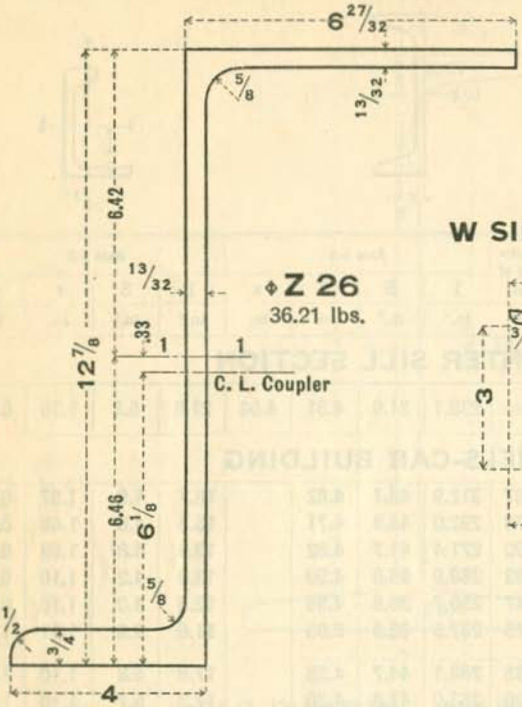
Profiles of Channels are shown on pages 60 and 61.

*⊡C 193 and Φ C 21 are identical with C 192 except flanges are flared out to 3⅛″ at the toe of flanges.

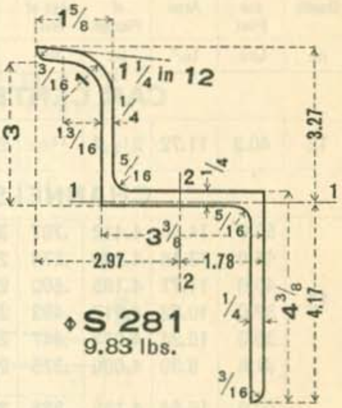
ΦC 21 not rolled to 5.8 lb.

MISCELLANEOUS CAR BUILDING SECTIONS

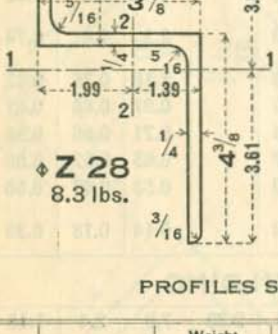
HALF CENTER SILL SECTION



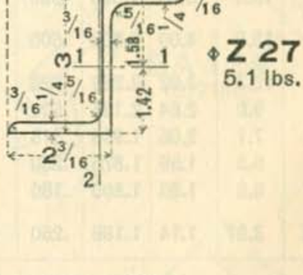
W SIDE PLATE SECTION



SIDE PLATE SECTION



SIDE POST SECTION



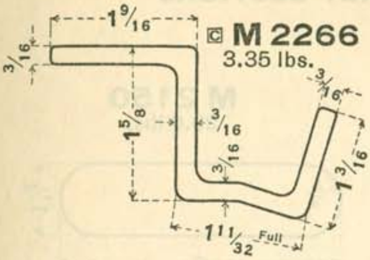
PROFILES SHOW DIMENSIONS IN INCHES

Section Index	Depth	Weight per Foot	Area	Axis 1-1 I	Axis 1-1 S	Axis 2-2 I	Axis 2-2 S
	In.	Lbs.	In.²	In.⁴	In.³	In.⁴	In.³
ΦZ 26	12 7/8	36.21	10.65	276.10	42.75		
ΦZ 28	3 3/8	8.30	2.44	6.53	1.81	4.48	2.25
ΦZ 27	3	5.10	1.50	2.13	1.34	1.16	0.58
ΦS 281	7 1/16	9.83	2.89	11.26	2.70	6.94	2.34

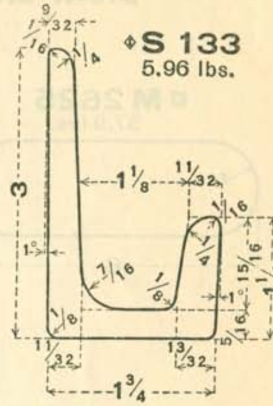
MISCELLANEOUS CAR BUILDING SECTIONS

CAR DOOR TRACK SECTIONS

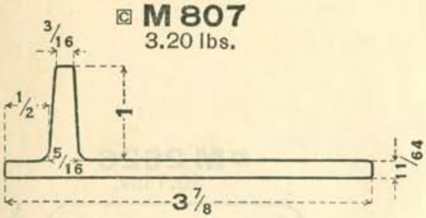
M 2266
3.35 lbs.



S 133
5.96 lbs.

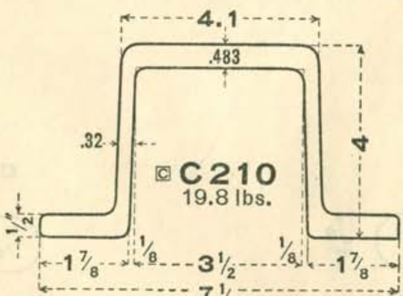


M 807
3.20 lbs.



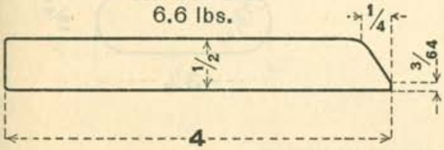
DOOR SPREADER SECTION

C 210
19.8 lbs.

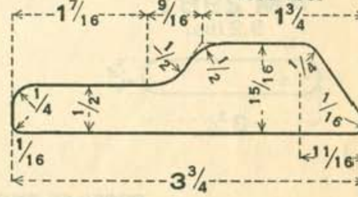


BELT RAIL SECTIONS

M 1038
6.6 lbs.



S 142
8.3 lbs.

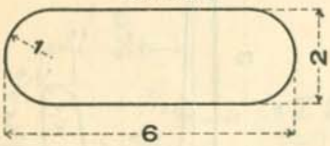


PROFILES SHOW DIMENSIONS IN INCHES

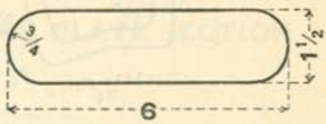
MISCELLANEOUS CAR BUILDING SECTIONS

DRAW BAR AND DRAFT KEY SECTIONS

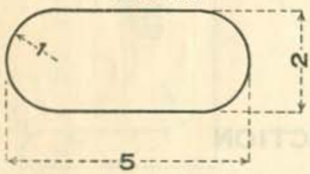
□ M 2625
37.9 lbs.



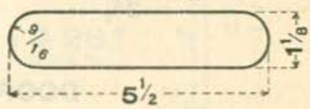
M 2150
29.0 lbs.



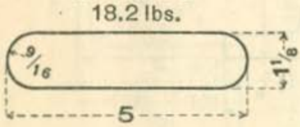
◆ S 181
31.1 lbs.



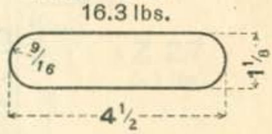
□ M 2626
20.1 lbs.



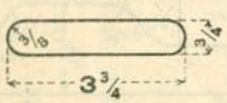
M 1850
18.2 lbs.



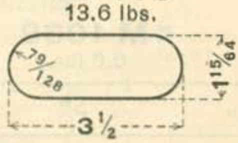
□ M 1851
16.3 lbs.



□ M 2981
9.2 lbs.



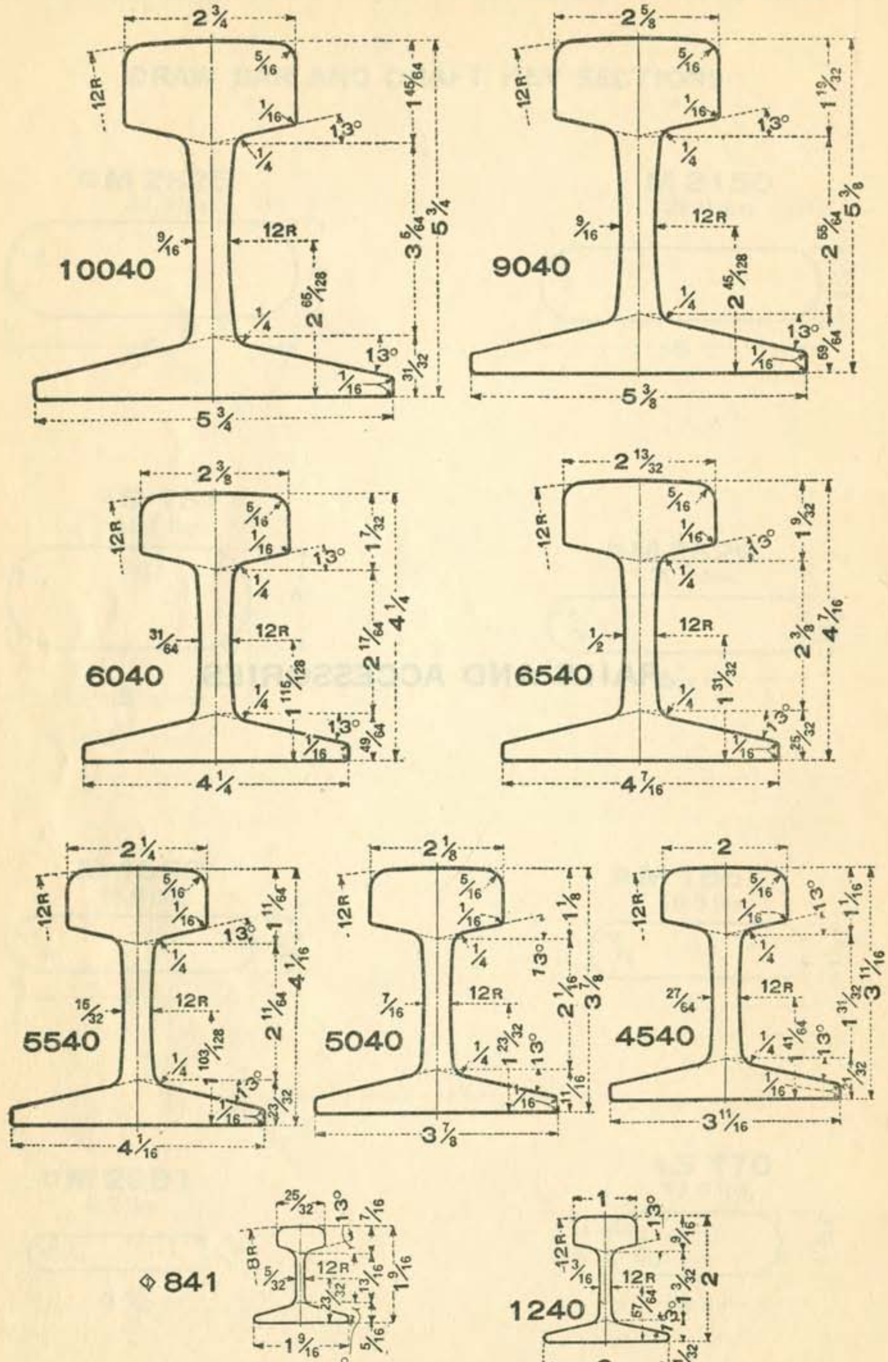
◆ S 170
13.6 lbs.



PROFILES SHOW DIMENSIONS IN INCHES

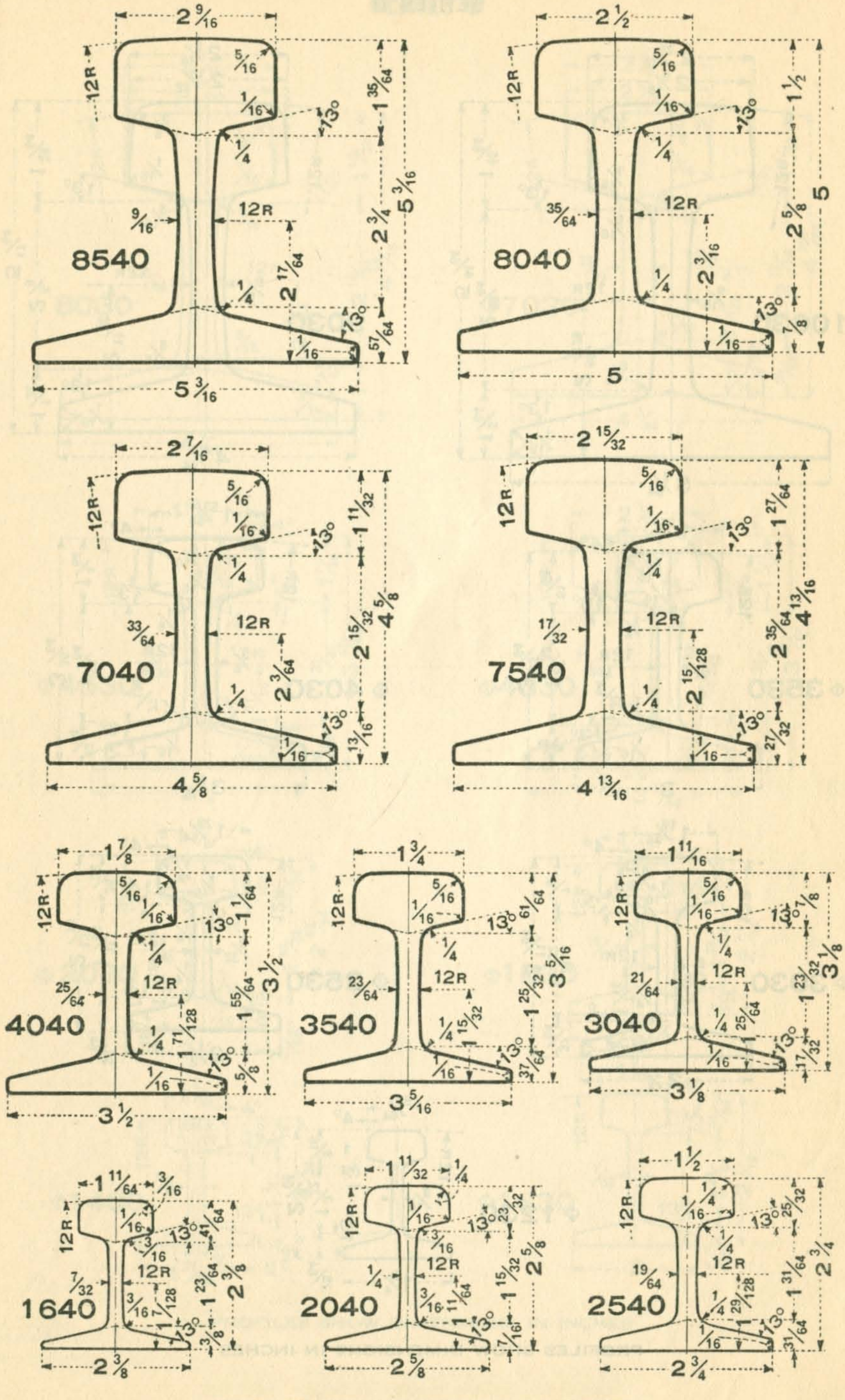
RAILS AND ACCESSORIES

AMERICAN SOCIETY OF CIVIL ENGINEERS—RAILS



PROFILES SHOW DIMENSIONS IN INCHES

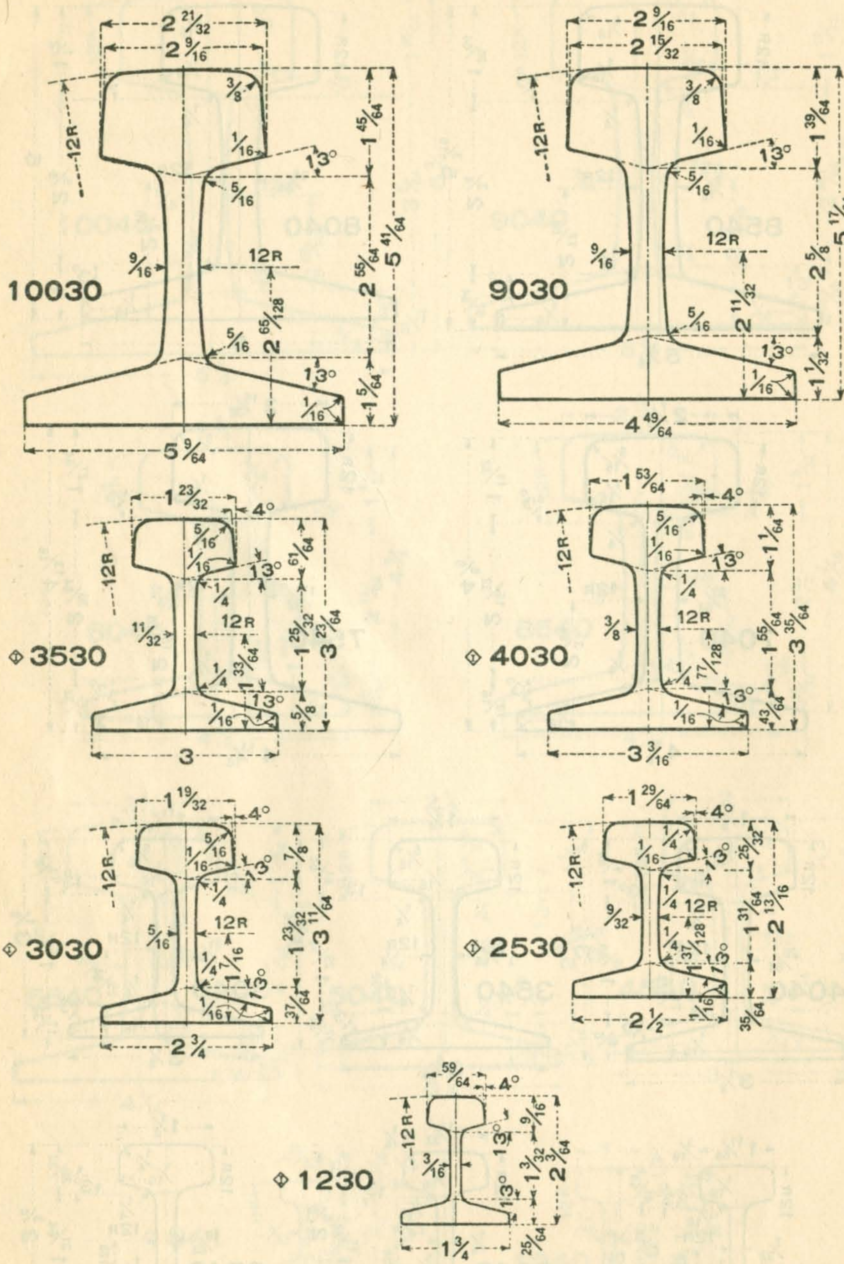
AMERICAN SOCIETY OF CIVIL ENGINEERS—RAILS



PROFILES SHOW DIMENSIONS IN INCHES

AMERICAN RAILWAY ASSOCIATION—RAILS

SERIES B

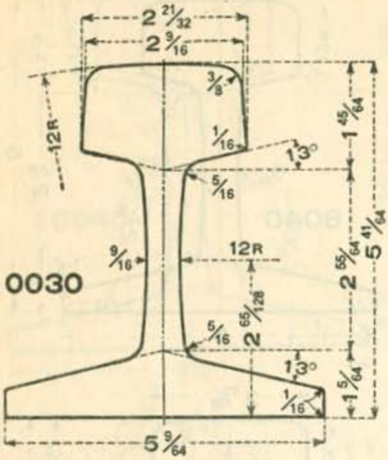


PROFILES SHOW DIMENSIONS IN INCHES

AMERICAN RAILWAY ASSOCIATION—RAILS

SERIES B

10030



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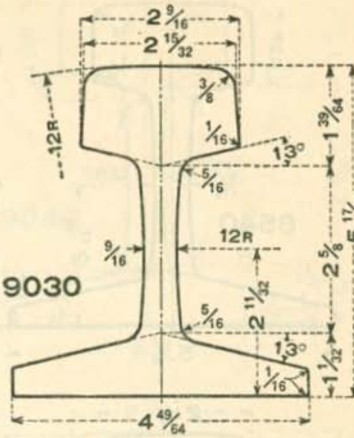
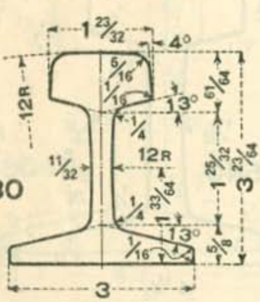


⊕ 3530



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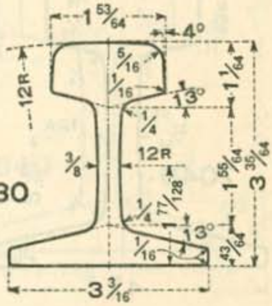

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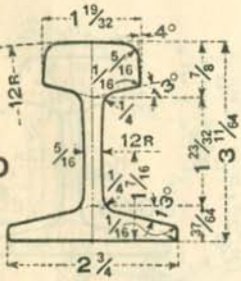

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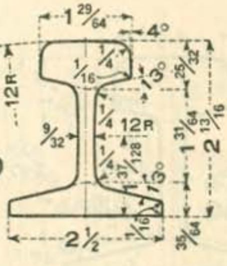

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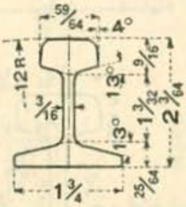
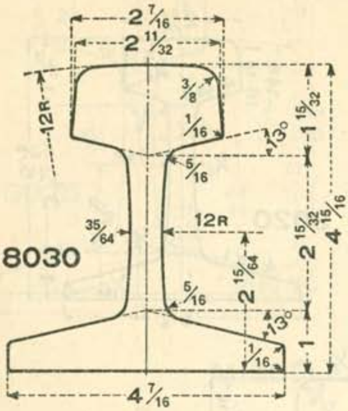


PROFILES SHOW DIMENSIONS IN INCHES

AMERICAN RAILWAY ASSOCIATION—RAILS

SERIES B



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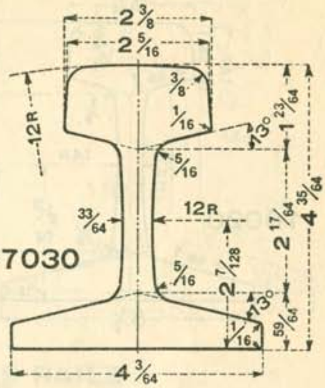
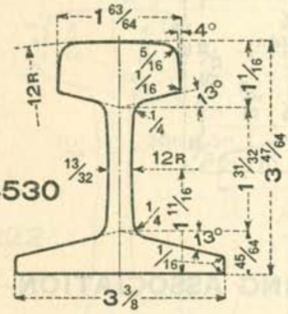


⌽7030



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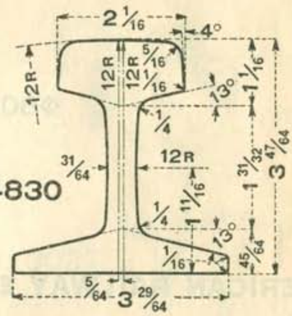

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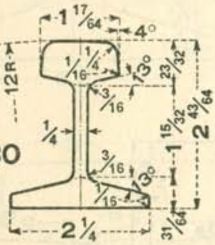

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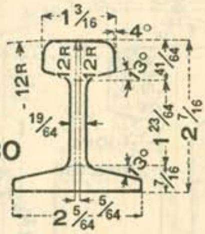

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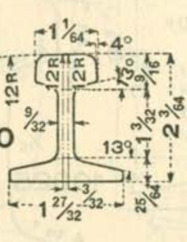

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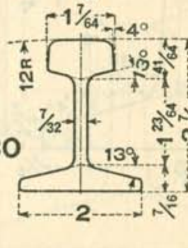
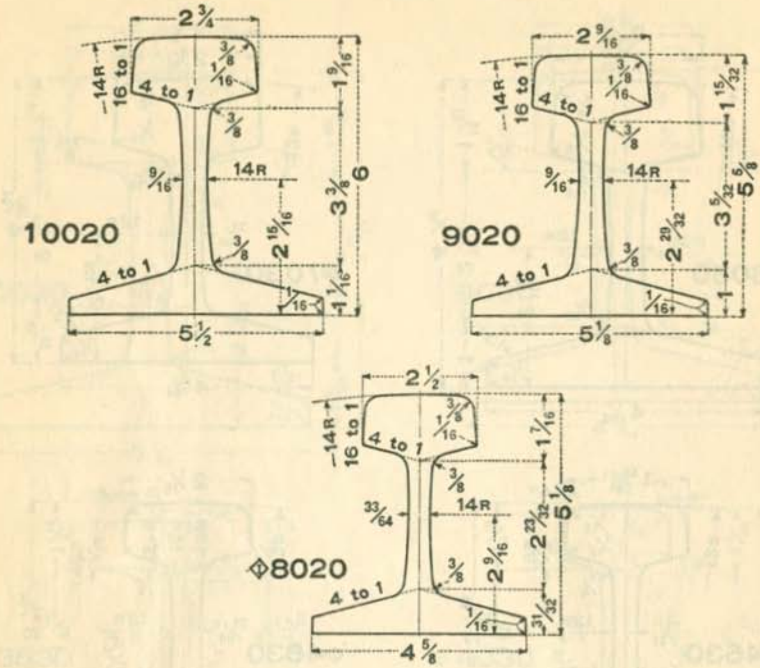


⌽1630

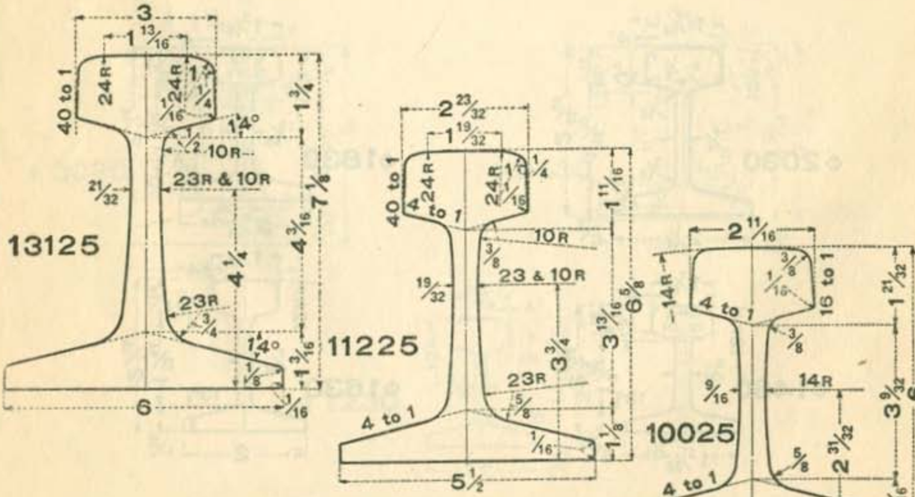
PROFILES SHOW DIMENSIONS IN INCHES

AMERICAN RAILWAY ASSOCIATION—RAILS

SERIES A

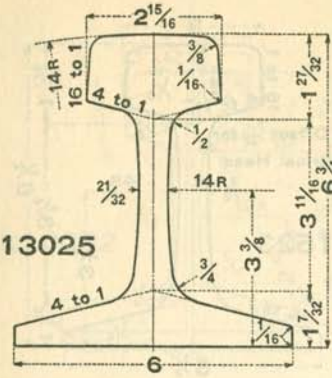


AMERICAN RAILWAY ENGINEERING ASSOCIATION—RAILS



PROFILES SHOW DIMENSIONS IN INCHES

AMERICAN RAILWAY ENGINEERING ASSOCIATION—RAILS



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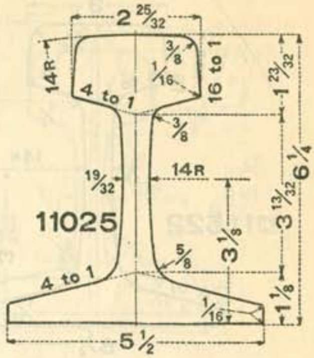
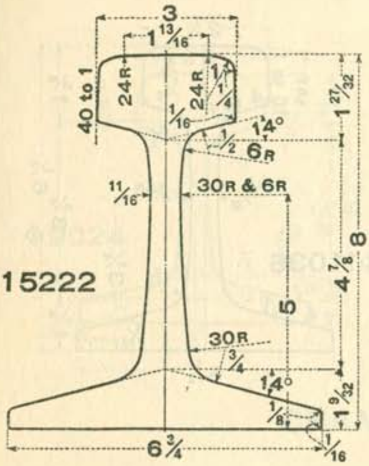
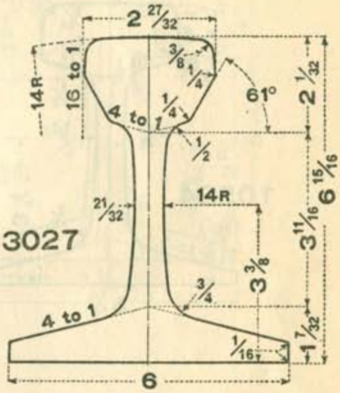


11025

MISCELLANEOUS RAILS



© 15222



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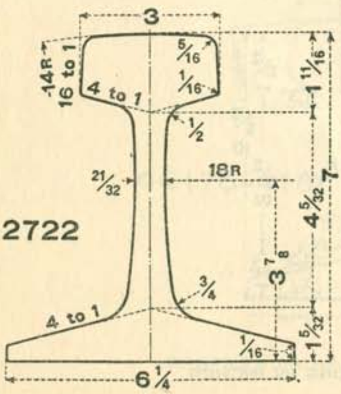
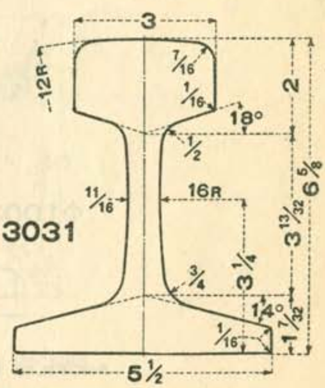


12722

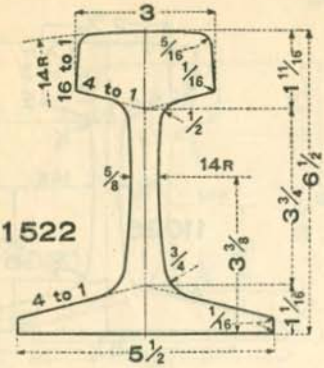


13031

PROFILES SHOW DIMENSIONS IN INCHES

*Furnished only by special arrangement.

MISCELLANEOUS RAILS



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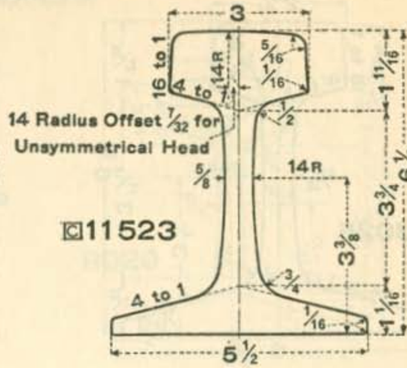

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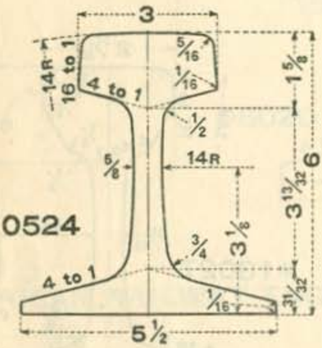

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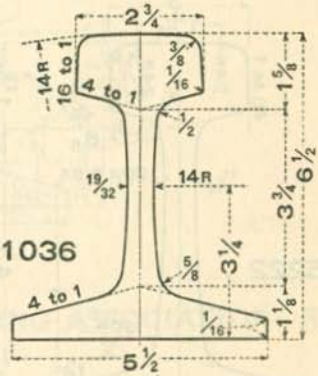

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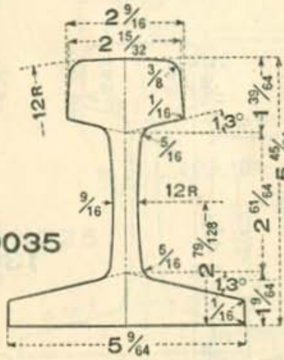

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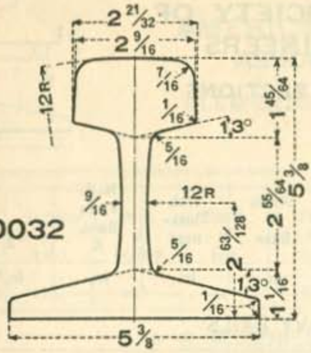
PROFILES SHOW DIMENSIONS IN INCHES

MISCELLANEOUS RAILS



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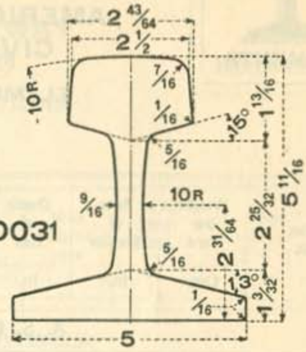

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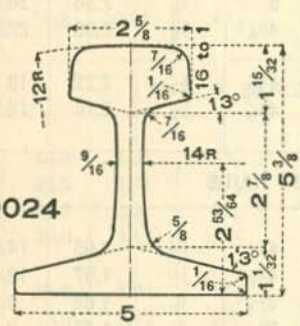

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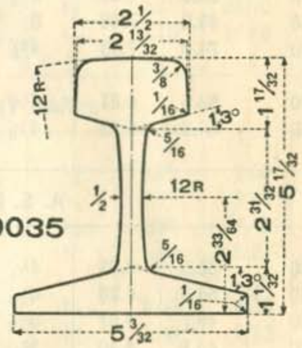
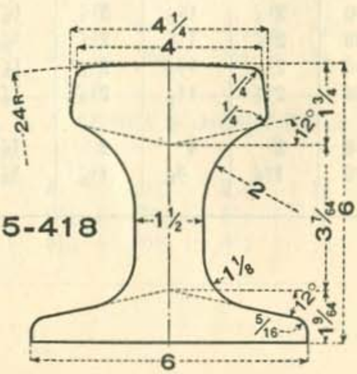


⊕9035

CRANE RAIL



▣©175-418

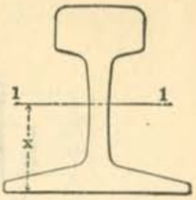
PROFILES SHOW DIMENSIONS IN INCHES

ELEMENTS

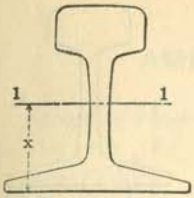
RAILS

AMERICAN SOCIETY OF CIVIL ENGINEERS

ELEMENTS OF SECTIONS



Section Index	Weight per Yard	Area of Section	Depth of Rail	Width of Head	Width of Base	Web Thickness	N. A. From Base, X	Axis 1-1 I	Axis 1-1 S
	Lbs.	In.^{2}	In.	In.	In.	In.	In.	In.^{4}	In.^{3}
A. S. C. E.—HEAVY RAILS									
10040	100.4	9.84	5 3/4	2 3/4	5 3/4	9/16	2.73	43.97	14.55
9040	90.1	8.83	5 5/8	2 5/8	5 5/8	9/16	2.55	34.39	12.19
8540	85.0	8.33	5 3/16	2 9/16	5 3/16	9/16	2.47	30.07	11.08
8040	80.2	7.86	5	2 1/2	5	9/16	2.38	26.38	10.07
7540	74.8	7.33	4 13/16	2 1/2	4 13/16	1/2	2.30	22.86	9.10
7040	69.5	6.81	4 5/8	2 7/16	4 5/8	1/2	2.22	19.70	8.19
6540	64.6	6.33	4 7/16	2 3/8	4 7/16	1/2	2.14	16.90	7.37
A. S. C. E.—LIGHT RAILS									
6040	60.5	5.93	4 1/4	2 3/8	4 1/4	1/2	2.05	14.56	6.62
5540	54.9	5.38	4 1/16	2 1/4	4 1/16	1/2	1.97	12.03	5.75
5040	49.7	4.87	3 7/8	2 1/8	3 7/8	7/16	1.88	9.94	4.98
4540	44.9	4.40	3 11/16	2	3 11/16	7/16	1.78	8.13	4.25
4040	40.2	3.94	3 1/2	1 7/8	3 1/2	3/8	1.68	6.57	3.62
3540	35.1	3.44	3 5/16	1 3/4	3 5/16	3/8	1.60	5.17	3.02
3040	30.1	3.00	3 1/8	1 11/16	3 1/8	5/16	1.52	4.06	2.53
2540	24.4	2.39	2 3/4	1 1/2	2 3/4	5/16	1.33	2.50	1.77
2040	20.4	2.00	2 5/8	1 3/8	2 5/8	1/4	1.27	1.94	1.43
1640	15.8	1.55	2 3/8	1 3/16	2 3/8	1/4	1.15	1.24	1.01
1240	12.0	1.18	2	1	2	3/16	0.96	0.66	0.63
Φ 841	8.0	0.78	1 9/16	13/16	1 9/16	3/16	0.70	0.27	0.31



RAILS

AMERICAN RAILWAY ASSOCIATION

ELEMENTS OF SECTIONS

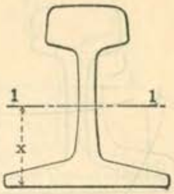
ELEMENTS

Section Index	Weight per Yard	Area of Section	Depth of Rail	Width of Head	Width of Base	Web Thickness	N. A. From Base, X	Axis 1-1	
								I	S
	Lbs.	In.^{2}	In.	In.	In.	In.	In.	In.^{4}	In.^{3}
A. R. A. SERIES B—HEAVY RAILS									
10030	100.5	9.85	$5\frac{5}{8}$	$2\frac{5}{8}$	$5\frac{1}{8}$	$\frac{9}{16}$	2.63	41.30	13.70
9030	90.5	8.87	$5\frac{1}{4}$	$2\frac{9}{16}$	$4\frac{3}{4}$	$\frac{9}{16}$	2.44	32.30	11.45
8030	80.7	7.91	$4\frac{15}{16}$	$2\frac{7}{16}$	$4\frac{7}{16}$	$\frac{9}{16}$	2.27	25.10	9.38
Φ7030	70.3	6.89	$4\frac{9}{16}$	$2\frac{3}{8}$	$4\frac{1}{16}$	$\frac{1}{2}$	2.16	18.60	7.79
A. R. A. SERIES B—LIGHT RAILS									
Φ4830	48.0	4.71	$3\frac{3}{4}$	$2\frac{1}{16}$	$3\frac{7}{16}$	$\frac{5}{16}$	1.75	8.90	4.50
Φ4530	45.0	4.41	$3\frac{3}{4}$	2	$3\frac{3}{8}$	$\frac{3}{8}$	1.75	8.75	4.48
Φ4030	40.0	3.92	$3\frac{9}{16}$	$1\frac{13}{16}$	$3\frac{3}{16}$	$\frac{3}{8}$	1.67	7.12	3.35
Φ3530	35.0	3.43	$3\frac{3}{8}$	$1\frac{3}{4}$	3	$\frac{3}{8}$	1.58	5.27	3.03
Φ3030	30.0	2.94	$3\frac{3}{16}$	$1\frac{9}{16}$	$2\frac{3}{4}$	$\frac{5}{16}$	1.50	4.38	2.61
Φ2530	25.0	2.45	$2\frac{13}{16}$	$1\frac{7}{16}$	$2\frac{1}{2}$	$\frac{1}{4}$	1.30	2.72	1.80
Φ2030	20.0	1.96	$2\frac{11}{16}$	$1\frac{1}{4}$	$2\frac{1}{4}$	$\frac{1}{4}$	1.25	1.94	1.36
Φ1830	18.0	1.76	$2\frac{7}{16}$	$1\frac{3}{16}$	$2\frac{1}{16}$	$\frac{5}{16}$	1.14	1.45	1.12
Φ1630	16.0	1.57	$2\frac{7}{16}$	$1\frac{1}{8}$	2	$\frac{1}{4}$	1.13	1.31	0.99
Φ1430	14.0	1.37	$2\frac{1}{16}$	1	$1\frac{7}{8}$	$\frac{1}{4}$	0.92	0.76	0.66
Φ1230	12.0	1.18	$2\frac{1}{16}$	$\frac{15}{16}$	$1\frac{3}{4}$	$\frac{3}{16}$	0.91	0.68	0.60
A. R. A. SERIES A—HEAVY RAILS									
10020	100.4	9.84	6	$2\frac{3}{4}$	$5\frac{1}{2}$	$\frac{9}{16}$	2.75	48.94	15.04
9020	90.0	8.82	$5\frac{5}{8}$	$2\frac{9}{16}$	$5\frac{1}{8}$	$\frac{9}{16}$	2.54	38.70	12.56
Φ8020	80.2	7.86	$5\frac{1}{8}$	$2\frac{1}{2}$	$4\frac{5}{8}$	$\frac{1}{2}$	2.31	28.80	10.24

ELEMENTS

RAILS

ELEMENTS OF SECTIONS



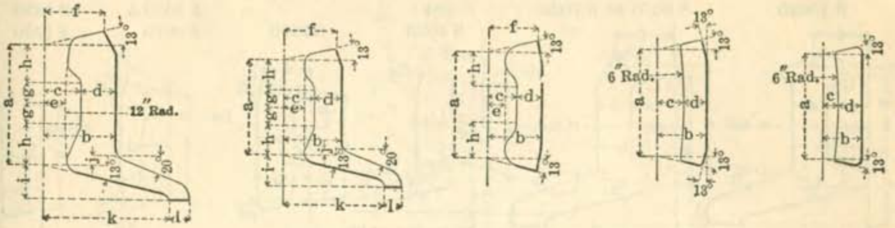
Section Index	Weight per Yard	Area of Section	Depth of Rail	Width of Head	Width of Base	Web Thickness	N. A. From Base, x	Axis 1-1 I	Axis 1-1 S
	Lbs.	In.^{2}	In.	In.	In.	In.	In.	In.^{4}	In.^{3}
AMERICAN RAILWAY ENGINEERING ASSOCIATION RAILS									
13125	131.2	12.86	7 1/8	3	6	21/32	3.20	89.00	23.00
†13025	129.6	12.71	6 3/4	2 15/16	6	21/32	3.03	77.40	20.80
11225	112.4	11.02	6 5/8	2 23/32	5 1/2	19/32	2.98	65.80	18.10
†11025	110.4	10.82	6 1/4	2 13/16	5 1/2	5/8	2.83	57.00	16.70
10025	101.5	9.95	6	2 11/16	5 3/8	9/16	2.75	49.00	15.10
MISCELLANEOUS RAILS									
15222	152.0	14.90	8	3	6 3/4	11/16	3.50	130.00	29.00
13031	129.5	12.70	6 5/8	3	5 1/2	11/16	3.09	72.80	20.60
*13027	129.1	12.66	6 15/16	2 7/8	6	11/16	3.08	81.16	21.03
12722	127.3	12.48	7	3	6 1/4	11/16	3.10	83.70	21.50
🄲11523	114.6	11.26	6 1/2	3	5 1/2	5/8	3.03	64.34	18.53
🄲11522	114.4	11.24	6 1/2	3	5 1/2	5/8	3.00	64.00	18.28
◈11036	111.5	10.93	6 1/2	2 3/4	5 1/2	9/16	2.90	62.46	17.35
10524	104.7	10.26	6	3	5 1/2	5/8	2.88	49.86	15.96
◈10035	100.5	9.85	5 11/16	2 9/16	5 1/8	9/16	2.53	42.20	13.31
🄲10032	100.1	9.82	5 5/8	2 11/16	5 3/8	9/16	2.55	41.30	13.41
10031	101.7	9.97	5 11/16	2 11/16	5	9/16	2.63	41.90	13.71
◈ 9035	90.0	8.82	5 9/16	2 1/2	5 1/8	1/2	2.47	36.72	12.02
◈ 9024	90.9	8.91	5 3/8	2 5/8	5	9/16	2.41	34.15	11.50
CRANE RAIL									
🄲Ⓛ175-418	175.00	17.15	6	4 1/4	6	1 1/2	3.02	71.45	23.65

*Furnished only by special arrangement.
†Sections 13025 and 11025 withdrawn from AREA manual.

SPLICE BARS

AMERICAN SOCIETY OF CIVIL ENGINEERS

S 10040 to S 5540 — S 5040 to S 3040 — S 2540 — S 2040 — S 1640 to S 840



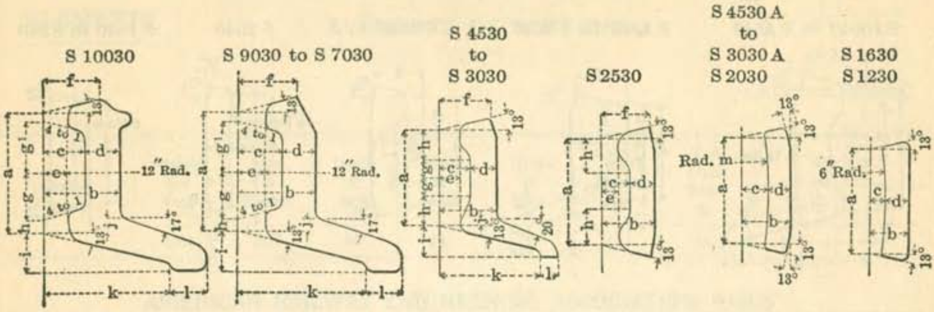
Section Index	Weight per Foot, Unfinished	a	b	c	d	e	f	g	h	i	j	k	l
	Pounds	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
A. S. C. E.—FOR HEAVY RAILS													
S 10040	15.8	3 5/64	1 23/32	27/32	7/8	15/32	1 3/8	1/2	1 5/128	27/32	9/32	3 1/8	1/2
S 9040	13.5	2 55/64	1 5/8	13/16	13/16	15/32	1 5/16	1/2	119/128	51/64	15/64	2 15/16	1/2
S 8540	12.4	2 3/4	1 37/64	51/64	25/32	15/32	1 9/32	1/2	7/8	49/64	7/32	2 27/32	1/2
S 8040	11.5	2 5/8	1 17/32	25/32	3/4	29/64	1 1/4	7/16	7/8	3/4	3/16	2 3/4	7/16
S 7540	10.7	2 35/64	1 31/64	49/64	23/32	7/16	1 15/64	7/16	107/128	23/32	21/128	2 21/32	7/16
S 7040	10.0	2 15/32	1 27/64	47/64	11/16	27/64	1 7/32	7/16	51/64	23/32	11/64	2 1/2	7/16
S 6540	9.2	2 3/8	1 23/64	45/64	21/32	13/32	1 13/64	7/16	3/4	11/16	5/32	2 13/32	7/16
A. S. C. E.—FOR LIGHT RAILS													
S 6040	8.4	2 17/64	1 19/64	43/64	5/8	25/64	1 3/16	7/16	89/128	43/64	21/128	2 5/16	3/8
S 5540	7.5	2 11/64	1 15/64	41/64	19/32	3/8	1 1/8	7/16	83/128	5/8	5/32	2 7/32	3/8
S 5040	6.6	2 1/16	1 1/8	19/32	17/32	3/8	1 1/32	13/32	5/8	5/8	9/64	2 1/16	3/8
*S 4540	5.8	1 31/32	1 3/64	35/64	1/2	23/64	31/32	13/32	37/64	19/32	7/64	1 31/32	3/8
*S 4040	5.0	1 55/64	31/32	1/2	15/32	11/32	29/32	13/32	67/128	9/16	9/128	1 7/8	5/16
*S 3540	4.6	1 25/32	57/64	29/64	7/16	5/16	27/32	11/32	35/64	33/64	7/64	1 25/32	5/16
*S 3040	3.97	1 23/32	27/32	7/16	13/32	5/16	25/32	13/32	29/64	1/2	5/64	1 11/16	5/16
*S 2540	2.20	1 31/64	3/4	13/32	11/32	9/32	11/16	9/32	59/128	....	....	....	....
*S 2040	1.87	1 15/32	11/16	3/8	5/16	....	....	....	....	....	....	....	....
*S 1640	1.70	1 23/64	37/64	17/64	5/16	....	....	....	....	....	....	....	....
*S 1240	1.36	1 3/32	17/32	7/32	5/16	....	....	....	....	....	....	....	....
* ΦS 840	0.75	13/16	7/16	7/32	7/32	....	....	....	....	....	....	....	....

*Same as Splice Bars for A. R. A. Light Rails, except Section Index.

S 840 is used with 841 Rail.

SPLICE BARS

AMERICAN RAILWAY ASSOCIATION



A. R. A. SERIES B—FOR HEAVY RAILS

Section Index	Weight per Foot, Unfinished	a	b	c	d	e	f	g	g¹	h	i	j	k	l	m
	Pounds	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
ΦS 9030	14.4	2 5/8	1 23/32	29/32	13/16	15/32	1 9/32	1 1/32	29/32	9/32	29/32	17/64	2 105/128	27/32	...

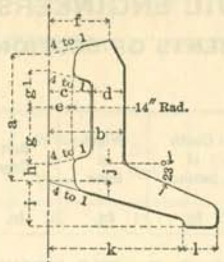
A. R. A. SERIES B—FOR LIGHT RAILS

Section Index	Weight per Foot, Unfinished	a	b	c	d	e	f	g	g¹	h	i	j	k	l	m
*S4530	5.8	1 31/32	1 3/64	35/64	1/2	23/64	31/32	13/32	.....	37/64	19/32	7/64	1 31/32	3/8	...
ΦS4530A	4.5	1 31/32	1 3/32	17/32	9/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
*S4030	5.0	1 55/64	31/32	1/2	15/32	11/32	29/32	13/32	.....	67/128	9/16	9/128	1 7/8	5/16	...
ΦS4030A	3.74	1 55/64	1	1/2	1/2	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
*S3530	4.6	1 25/32	57/64	29/64	7/16	5/16	27/32	11/32	.....	35/64	33/64	7/64	1 25/32	5/16	...
ΦS3530A	3.06	1 25/32	7/8	7/16	7/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
*S3030	3.97	1 23/32	27/32	7/16	13/32	5/16	25/32	13/32	.....	29/64	1/2	5/64	1 11/16	5/16	...
ΦS3030A	2.96	1 23/32	27/32	13/32	7/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
*S2530	2.20	1 31/64	3/4	13/32	11/32	9/32	11/16	9/32	.....	59/128	.....	.....	.....	.....	...
*S2030	1.87	1 15/32	11/16	3/8	5/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
*S1630	1.70	1 23/64	37/64	17/64	5/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	...
*S1230	1.36	1 3/32	17/32	7/32	5/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	...

*Carnegie-Illinois Steel Corporation uses the A. S. C. E. Section Index for these Splice Bars.
S 1630 is used with 1830 Rail.
S 1230 is used with 1430 Rail.

SPLICE BARS

AMERICAN RAILWAY ASSOCIATION

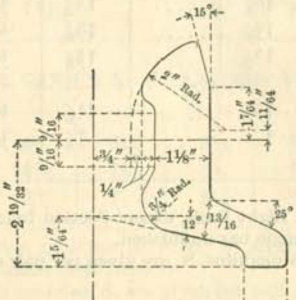


Section Index	Weight per Foot, Unfinished	a	b	c	d	e	f	g	g¹	h	i	j	k	l
	Pounds	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
A. R. A. SERIES A—FOR HEAVY RAILS														
ΦS10020	19.0	3⅜	1 23/32	31/32	¾	15/32	1⅜	1 7/32	¾	21/32	1	15/32	3 3/16	⅞
ΦS 9020	16.6	3 5/32	1 21/32	15/16	23/32	15/32	1 9/32	1 11/32	19/32	9/16	15/16	7/16	3	13/16
ΦS 8020	13.4	2 23/32	1 17/32	⅞	21/32	57/128	1¼	1 15/64	39/64	23/64	29/32	25/64	2¾	¾

SPLICE BAR

FOR

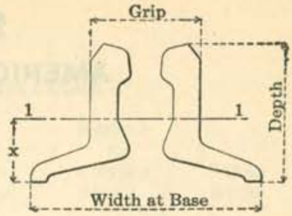
Ⓛ CRANE RAIL SECTION 175 No. 418



Weight per Foot, 19.22 Pounds.

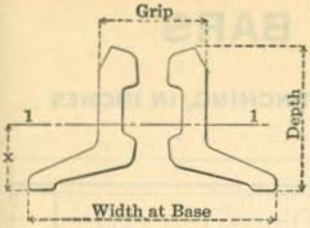
ELEMENTS

SPLICE BARS
AMERICAN SOCIETY OF CIVIL ENGINEERS
ELEMENTS OF SECTIONS



Section Index	†Weight per Foot	†Area of Section	Depth of Section	Width at Base	Bolt Grip	Web Thick-ness	N. A. From Base, x	Axis 1-1 ‡I	Axis 1-1 ‡S
	Lbs.	In.²	In.	In.	In.	In.	In.	In.⁴	In.³
A. S. C. E.—FOR HEAVY RAILS									
S 10040	15.8	4.65	4¼	7¼	3 7/16	7/8	1.91	13.43	5.82
S 9040	13.5	3.97	4	6⅞	3¼	13/16	1.81	10.30	4.79
S 8540	12.4	3.65	3 13/16	6¾	3⅛	13/16	1.71	8.43	4.02
S 8040	11.5	3.38	3 11/16	6⅜	3 1/16	¾	1.68	7.39	3.75
S 7540	10.7	3.15	3½	6⅛	3	¾	1.65	6.02	3.28
S 7040	10.0	2.95	3½	5⅞	2⅞	11/16	1.61	5.82	3.15
S 6540	9.2	2.71	3⅜	5⅝	2¾	11/16	1.56	4.85	2.73
A. S. C. E.—FOR LIGHT RAILS									
S 6040	8.4	2.47	3 3/16	5⅜	2⅝	⅝	1.51	4.04	2.38
S 5540	7.5	2.21	3 1/16	5¼	2½	⅝	1.41	3.41	2.07
S 5040	6.6	1.95	2 15/16	4⅞	2¼	9/16	1.37	2.72	1.74
*S 4540	5.8	1.70	2¾	4¾	2⅛	½	1.29	....	....
*S 4040	5.0	1.47	2⅝	4⅜	2	½	1.27	....	....
*S 3540	4.6	1.35	2½	4⅛	1 13/16	7/16	1.19	....	....
*S 3040	3.97	1.17	2⅜	4	1 11/16	⅜	1.10	....	....
*S 2540	2.20	0.65	1 13/16	....	1½	⅜	0.90	....	....
*S 2040	1.87	0.55	1¾	....	1⅜	5/16	0.86	....	....
*S 1640	1.70	0.50	1 9/16	....	1 3/16	5/16	0.79	....	....
*S 1240	1.36	0.40	1 5/16	....	1 1/16	5/16	0.65	....	....
*ΦS 840	0.75	0.22	1	....	⅞	¼	0.49	....	....

*Same as Splice Bars for A. R. A. Light Rails, except Section Index.
†Weight and area are given per single bar unfinished.
‡Moment of inertia, I, and section modulus, S, are given per pair of bars.
S 840 is used with 841 Rail.



SPLICE BARS

AMERICAN RAILWAY ASSOCIATION

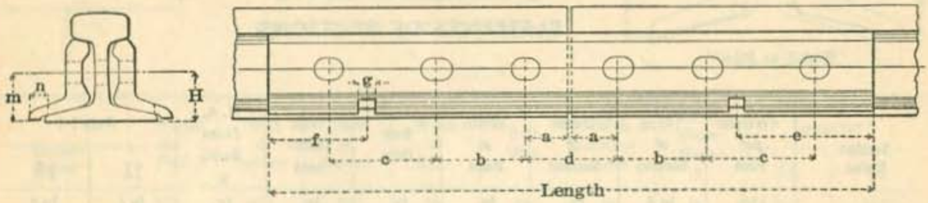
ELEMENTS OF SECTIONS

Section Index	†Weight per Foot	†Area of Section	Depth of Section	Width at Base	Bolt Grip	Web Thickness	N. A. From Base, x	Axis 1-1 ‡I	Axis 1-1 ‡S
	Lbs.	In.²	In.	In.	In.	In.	In.	In.⁴	In.³
A. R. A. SERIES B—FOR HEAVY RAILS									
ΦS 10030	16.9	4.98	4 1/8	7 3/4	3 7/16	13/16	1.83	14.34	6.30
ΦS 9030	14.4	4.24	3 7/8	7 3/8	3 7/16	13/16	1.67	10.16	4.71
ΦS 8030	12.6	3.72	3 5/8	6 15/16	3 3/16	3/4	1.59	7.70	3.79
ΦS 7030	11.9	3.50	3 3/8	6 7/16	3 1/8	3/4	1.47	6.28	3.36
A. R. A. SERIES B—FOR LIGHT RAILS									
*S 4530	5.8	1.70	2 3/4	4 3/4	2 1/8	1/2	1.29	....	....
ΦS 4530 A	4.5	1.31	2 3/8	....	2 3/16	9/16	....	....	....
*S 4030	5.0	1.47	2 5/8	4 3/8	2	1/2	1.27	....	....
ΦS 4030 A	3.74	1.10	2 1/4	....	2	1/2	....	....	....
*S 3530	4.6	1.35	2 1/2	4 1/8	1 13/16	7/16	1.19	....	....
ΦS 3530 A	3.06	0.90	2 1/8	....	1 3/4	7/16	....	....	....
*S 3030	3.97	1.17	2 3/8	4	1 11/16	3/8	1.10	....	....
ΦS 3030 A	2.96	0.87	2	....	1 11/16	7/16	....	....	....
*S 2530	2.20	0.65	1 13/16	....	1 1/2	3/8	0.90	....	....
*S 2030	1.87	0.55	1 3/4	....	1 3/8	5/16	0.86	....	....
*S 1630	1.70	0.50	1 5/8	....	1 3/16	5/16	0.79	....	....
*S 1230	1.36	0.40	1 5/16	....	1 1/16	5/16	0.65	....	....
A. R. A. SERIES A—FOR HEAVY RAILS									
ΦS 10020	19.0	5.60	4 3/4	8 1/8	3 7/16	3/4	2.02	21.30	7.88
ΦS 9020	16.6	4.90	4 7/16	7 5/8	3 5/16	3/4	1.91	16.10	6.36
ΦS 8020	13.4	3.95	3 15/16	7	3 1/16	11/16	1.72	10.13	4.57

*Carnegie-Illinois Steel Corporation uses the A. S. C. E. Section Index for these Splice Bars.
†Weight and area are given per single bar unfinished.
‡Moment of inertia, I, and section modulus, S, are given per pair of bars.

RAILS AND SPLICE BARS

DIMENSIONS FOR STANDARD DRILLING AND PUNCHING, IN INCHES



Rails, Lb. per Yd.	Hole in Rail	Hole in Splice Bar	a	b	c	d	e	f	g	Length
100 to 90	1 1/4	1 1/8 x 1 3/8	2 1/2	5	6	5 1/16	7 1/2	5 1/2	11/16	34
85 to 75	1 1/8	1 x 1 1/4	2 1/2	5	6	5 1/16	7 1/2	5 1/2	11/16	34
70 to 70	1	7/8 x 1 1/8	2 1/2	5	6	5 1/16	7 1/2	5 1/2	11/16	34
65 to 50	1	7/8 x 1 1/8	2 1/2	5	...	5 1/16	6 1/2	2 1/2	11/16	24
45 to 40	7/8	13/16 x 1 1/8	2 1/2	5	...	5 1/8	3 7/8	1 1/8	3/4	20
35 to 30	3/4	11/16 x 31/32	2	4	...	4 1/8	...	...	...	16 1/8
25 to 12	5/8	9/16 x 3/4	2	4	...	4 1/8	...	...	...	16 1/8

A. S. C. E.—HEAVY

Rails	Splice Bars	H	m	n
10040	S 10040	2 65/128	2 49/128	13/16
9040	S 9040	2 45/128	2 29/128	13/16
8540	S 8540	2 17/64	2 9/64	13/16
8040	S 8040	2 3/16	2 1/16	3/4
7540	S 7540	2 15/128	1 127/128	3/4
7040	S 7040	2 3/64	1 61/64	11/16
6540	S 6540	1 31/32	1 7/8	11/16

A. S. C. E.—LIGHT

Rails	Splice Bars	H	m	n
6040	S 6040	1 115/128	1 103/128	5/8
5540	S 5540	1 103/128	1 91/128	5/8
5040	S 5040	1 23/32	1 21/32	9/16
4540	S 4540	1 41/64	1 37/64	9/16
4040	S 4040	1 71/128	1 63/128	1/2
3540	S 3540	1 15/32	1 13/32	1/2
3040	S 3040	1 25/64	1 23/64	1/2
2540	S 2540	1 29/128	.....	.....
2040	S 2040	1 11/64	.....	.....
1640	S 1640	1 7/128	.....	.....
1240	S 1240	57/64	.....	.....
841	S 840	11/16	.....	.....

A. R. A. SERIES A—HEAVY

Rails	Splice Bars	H	m	n
10020	S 10020	2 3/4	2 11/16	1 3/8
9020	S 9020	2 37/64	2 33/64	1 5/16
8020	S 8020	2 21/64	2 17/64	1 1/4

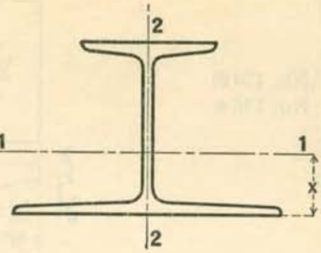
A. R. A. SERIES B—HEAVY

Rails	Splice Bars	H	m	n
10030	S 10030	2 65/128	2 49/128	1 3/8
9030	S 9030	2 11/32	2 7/32	1 11/32
8030	S 8030	2 15/64	2 7/64	1 5/16
7030	S 7030	2 7/128	1 119/128	1 1/4

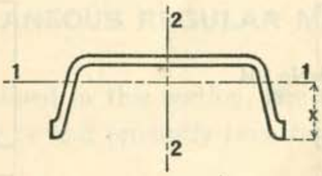
A. R. A. SERIES B—LIGHT

Rails	Splice Bars	H	m	n
4830	S 4530	1 11/16	1 37/64	.....
	S 4530 A	1 11/16	.....	.....
4530	S 4530	1 11/16	1 37/64	.....
	S 4530 A	1 11/16	.....	.....
4030	S 4030	1 77/128	1 63/128	.....
	S 4030 A	1 77/128	.....	.....
3530	S 3530	1 33/64	1 13/32	.....
	S 3530 A	1 33/64	.....	.....
3030	S 3030	1 7/16	1 23/64	.....
	S 3030 A	1 7/16	.....	.....
2530	S 2530	1 29/128	.....	.....
2030	S 2030	1 11/64	.....	.....
1830	S 1630	1 7/128	.....	.....
1630	S 1630	1 7/128	.....	.....
1430	S 1230	57/64	.....	.....
1230	S 1230	57/64	.....	.....

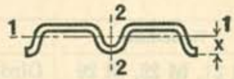
CROSS TIES



Section Index	Depth of Section	Weight per Foot	Area of Section	Width of Flange		Thickness of Web	Axis 1-1				Axis 2-2		
				Top	Bottom		I	S	r	x	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
©M 29	5.50	24.0	7.01	5.0	8.0	.375	35.4	11.3	2.25	2.38	16.8	4.2	1.55
©M 21	5.50	20.0	5.71	4.5	8.0	.250	30.9	9.7	2.33	2.33	14.9	3.7	1.62
©M 25	4.25	14.5	4.10	4.0	6.0	.250	13.0	5.5	1.78	1.88	6.1	2.0	1.22
©M 24	3.00	9.4	2.77	3.0	4.5	.203	4.2	2.5	1.24	1.32	2.9	1.3	1.03

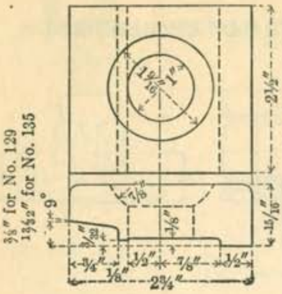


Section Index	Depth of Section	Weight per Foot	Area of Section	Width of Section		Thickness of Web	Axis 1-1				Axis 2-2		
				Top	Bottom		I	S	r	x	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
©M27A	2.39	12.4	3.65	5.5	7.0	.391	1.63	0.93	0.67	1.75	20.8	5.9	2.39
©M27	2.25	9.0	2.62	5.5	7.0	.250	1.28	0.79	0.70	1.62	16.8	4.8	2.53
©M20	2.00	6.0	1.72	4.5	6.0	.188	0.71	0.51	0.64	1.41	8.4	2.8	2.22
©M18	1.50	4.2	1.21	3.4	5.0	.156	0.31	0.31	0.50	1.00	3.6	1.5	1.73

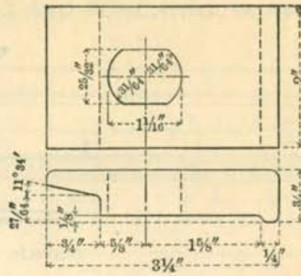


Section Index	Depth of Section	Weight per Foot	Area of Section	Width of Section	Thickness	Axis 1-1				Axis 2-2		
						I	S	r	x	I	S	r
	In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
©M 26A	$\frac{13}{16}$	3.25	0.95	$4\frac{3}{4}$	.141	0.068	0.136	0.27	0.50	1.94	0.82	1.43
©M 19A	$\frac{11}{16}$	2.50	0.74	$4\frac{1}{4}$	.125	0.034	0.077	0.21	0.44	1.23	0.58	1.29

RAIL CLIPS



No. 129 ▣
No. 135 Φ



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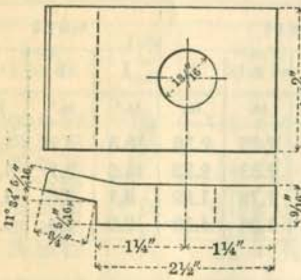

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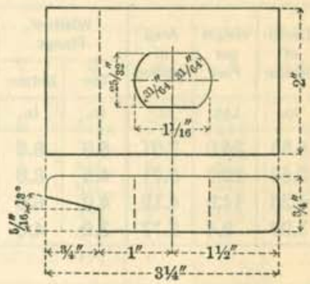
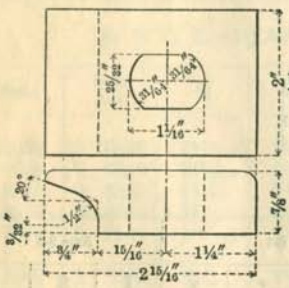


No. 106 ▣



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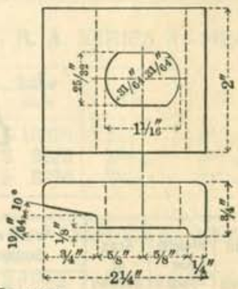
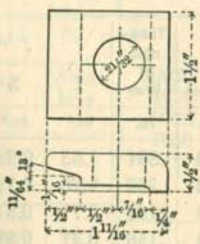


No. 103 ▣



No. 114 ▣

Clip Number	Weight per Foot, Pounds	Weight, Finished, Pounds	Clips for Tie Sections	Clips for Rail Sections
Φ135	7.3	1.27	M 21, M 25, M 29	Girder Rails, Screw Spikes
▣129	7.3	1.27	M 21, M 25, M 29	Girder Rails, Screw Spikes
▣128	6.0	0.87	M 21, M 25, M 29	100 to 60 lbs. A. R. A.-B.
▣120	5.6	0.81	M 18, M 20, M 27	50 to 25 lbs. A. S. C. E. and A. R. A.
▣106	7.2	1.05	M 21, M 25, M 29	100 to 60 lbs. A. S. C. E.
▣104	7.2	1.02	M 21, M 25, M 29	100 to 60 lbs. Angle Bars
▣103	4.3	0.58	M 21, M 25, M 29	100 to 55 lbs. A. S. C. E.
▣114	2.24	0.24	M 24	50 to 20 lbs. A. S. C. E.

Clips can be furnished with standard $^{25}/_{32}$" diameter holes or with holes of any size consistent with section, but unless specifically ordered clips will be furnished as shown.

MISCELLANEOUS REGULAR MATERIAL

Material outlined in this section, like that of the Regular Shapes section, may be had promptly from frequent rollings.

PLATES ROLLED IN PITTSBURGH DISTRICT

RECTANGULAR UNIVERSAL PLATES—CARBON STEEL

UNIVERSAL MILL PLATES, ONE-FOURTH INCH AND OVER—EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches												
		48-46 Wide	45-41 Wide	40-39 Wide	38-37 Wide	36-35 Wide	34-31 Wide	30-26 Wide	25-20 Wide	19-17 Wide	16-15 Wide	14-12 Wide	11-10 Wide	9⅞-6⅛ Wide
¼	10.20					720	840	1080	1080	1080	1080	1080	1080	1080
5/16	12.75	1200	1200	1260	1320	1320	1320	1380	1380	1200	1200	1200	1200	1080
⅜	15.30	1320	1320	1380	1440	1500	1500	1500	1500	1308	1308	1200	1200	1080
7/16	17.85	1428	1428	1500	1500	1500	1500	1500	1500	1356	1356	1356	1356	1080
½	20.40	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1080
9/16	22.95	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1080
⅝	25.50	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1080
¾	30.60	1248	1332	1500	1476	1500	1320	1500	1500	1500	1500	1500	1500	1080
⅞	35.70	1068	1140	1284	1260	1332	1128	1332	1392	1416	1452	1500	1500	1080
1	40.80	936	996	1128	1104	1164	996	1164	1212	1248	1260	1452	1500	1020
1⅛	45.90	828	888	996	984	1032	876	1032	1080	1104	1128	1284	1500	960
1¼	51.00	744	804	900	876	924	792	924	972	996	1008	1152	1476	900
1⅜	56.10	684	720	816	804	840	720	840	888	900	924	1056	1344	780
1½	61.20	624	660	744	732	768	660	768	804	828	840	960	1224	720
1⅝	66.30	576	612	696	672	708	612	708	744	768	780	888	1128	660
1¾	71.40	528	564	636	624	660	564	660	696	708	720	828	1056	600
1⅞	76.50	492	528	600	588	624	528	624	648	660	672	768	984	600
2	81.60	468	492	564	552	576	492	576	600	624	624	720	924	540

Plates of greater dimensions than shown in above table may be submitted for special consideration.

PLATES ROLLED IN CHICAGO DISTRICT

RECTANGULAR UNIVERSAL PLATES—CARBON STEEL

UNIVERSAL MILL PLATES, THREE-SIXTEENTH INCH AND OVER—EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches												
		60-57 Wide	56-53 Wide	52-49 Wide	48-43 Wide	42-37 Wide	36-31 Wide	30-25 Wide	24-15 Wide	14-10 Wide	9 Wide	8 Wide	7 Wide	6⅛ Wide
$\frac{3}{16}$	7.65	....	....	....	....	....	....	....	960	960	960	960	960	960
$\frac{1}{4}$	10.20	800	900	1000	1200	1500	1550	1620	1620	1080	960	960	960	960
$\frac{5}{16}$	12.75	1000	1100	1200	1440	1500	1550	1620	1620	1080	960	960	960	960
$\frac{3}{8}$	15.30	1080	1200	1380	1440	1500	1550	1620	1620	1080	960	960	960	960
$\frac{7}{16}$	17.85	1080	1200	1380	1440	1500	1550	1620	1620	1080	960	960	960	960
$\frac{1}{2}$	20.40	1080	1200	1380	1440	1500	1550	1620	1620	1080	1080	1080	1080	1080
$\frac{9}{16}$	22.95	1080	1100	1300	1400	1500	1550	1620	1620	1200	1080	1080	1080	1080
$\frac{5}{8}$	25.50	1080	1080	1250	1380	1500	1550	1620	1620	1200	1080	1080	1080	960
$\frac{11}{16}$	28.05	1080	1080	1200	1350	1480	1480	1500	1500	1200	1080	1080	1080	960
$\frac{3}{4}$	30.60	1080	1080	1200	1350	1480	1480	1500	1500	1200	1080	1080	1080	840
$\frac{7}{8}$	35.70	1000	1000	1100	1300	1440	1440	1440	1440	1200	1080	960	960	744
1	40.80	900	950	1050	1250	1380	1380	1380	1380	1200	1080	960	840	720
$1\frac{1}{8}$	45.90	850	925	1000	1200	1260	1260	1260	1260	960	1080	960	840	720
$1\frac{1}{4}$	51.00	800	900	975	1160	1160	1160	1160	1160	960	840	840	720	660
$1\frac{3}{8}$	56.10	780	850	950	1100	1120	1120	1120	1120	840	720	720	660	660
$1\frac{1}{2}$	61.20	740	800	925	1000	1015	1015	1015	1015	780	660	720	600	600
$1\frac{5}{8}$	66.30	700	750	870	920	940	940	940	940	780	660	660	600	540
$1\frac{3}{4}$	71.40	675	725	800	850	870	870	870	870	660	600	600	540	540
$1\frac{7}{8}$	76.50	650	700	750	790	810	810	810	810	660	540	600	480	540
2	81.60	600	650	700	740	755	755	755	755	660	540	540	480	480

Plates of greater dimensions than shown in table may be submitted for special consideration.

PLATES ROLLED IN PITTSBURGH DISTRICT

RECTANGULAR AND CIRCULAR PLATES—CARBON STEEL

SHEARED PLATES, THREE-SIXTEENTH INCH AND OVER—EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches																			Diam., Inches
		128 Wide	126 Wide	120 Wide	114 Wide	108 Wide	102 Wide	96 Wide	90 Wide	84 Wide	78 Wide	72 Wide	66 Wide	60 Wide	54 Wide	48 Wide	42 Wide	36 Wide	30 Wide	24 Wide	
3/16	7.65								270	320	345	375	420	470	480	480	480	480	480	480	90
1/4	10.20				175	250	280	300	330	375	400	430	475	525	530	530	530	530	530	500	115
5/16	12.75			240	270	320	360	380	420	440	460	480	500	560	550	575	550	550	550	550	120
3/8	15.30	220	240	270	320	365	380	410	450	500	550	600	600	620	620	620	600	600	600	550	130
7/16	17.85	240	270	300	360	370	410	430	460	510	550	600	630	630	640	640	600	600	600	600	130
1/2	20.40	260	270	320	365	400	450	480	510	550	580	610	630	630	640	640	600	600	600	600	130
9/16	22.95	260	270	330	373	420	470	500	530	570	600	620	640	640	640	640	600	600	600	600	130
5/8	25.50	260	300	350	390	450	500	520	540	600	620	620	640	640	640	640	600	600	600	600	130
11/16	28.05	260	300	360	420	450	500	520	540	600	620	620	640	640	640	640	600	600	600	580	130
3/4	30.60	260	300	360	400	450	490	520	540	600	620	620	640	640	640	640	600	600	600	580	130
13/16	33.15	260	300	340	385	440	490	510	530	600	620	620	640	640	640	640	600	580	570	550	130
7/8	35.70	260	300	330	375	440	480	510	530	600	620	620	640	640	640	640	600	580	550	550	130
1	40.80	250	300	300	340	440	460	500	530	580	600	600	630	630	640	640	580	580	520	500	130
1 1/8	45.90	250	300	300	330	410	440	450	500	550	580	580	620	620	640	640	580	580	520	500	130
1 1/4	51.00	240	270	300	310	380	400	420	490	530	550	550	600	600	600	600	560	560	520	450	130
1 1/2	61.20	220	230	260	280	330	320	340	420	440	480	530	600	600	600	600	540	540	470	430	130
1 3/4	71.40	200	200	220	240	280	270	300	380	380	410	450	490	550	550	550	540	540	430	380	130
2	81.60	180	180	190	210	240	240	260	320	330	360	400	440	480	500	500	500	500	400	350	130
2 1/4	91.80	150	160	170	190	210	210	230	280	295	320	350	390	420	450	450	450	450	300	200	130

Plates 36″ wide and under by 1/4″ thick and heavier, also plates up to 48″ wide and 5/16″ thick and heavier, can be rolled on Universal Mill.
For greater length and Universal Mill Sizes, see Universal Mill Plate Table.
Plates of greater dimensions than shown in above table may be submitted for special consideration.

PLATES ROLLED IN CHICAGO DISTRICT

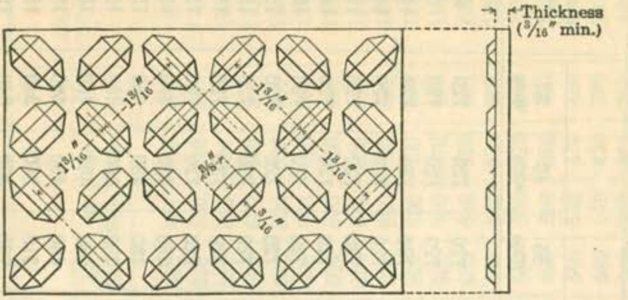
RECTANGULAR AND CIRCULAR PLATES—CARBON STEEL

SHEARED PLATES, ONE-EIGHTH INCH AND OVER—EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches														Diam., Inches
		150 Wide	144 Wide	138 Wide	132 Wide	126 Wide	120 Wide	108 Wide	96 Wide	90 Wide	84 Wide	72 Wide	55 Wide	48 Wide	30 Wide	
1/8	5.10	...	...	...	...	...	...	...	...	...	720	720	720	720	720	84
3/16	7.65	...	...	...	...	...	...	...	...	...	720	720	720	720	720	84
1/4	10.20	...	300	350	385	405	425	475	530	565	720	720	720	720	720	146
5/16	12.75	270	340	380	405	425	445	495	555	595	720	720	720	720	720	146
3/8	15.30	300	390	410	425	450	470	520	590	625	720	720	720	720	720	148
7/16	17.85	330	420	435	455	480	500	555	630	670	720	720	720	720	720	148
1/2	20.40	360	445	465	485	505	530	590	665	710	760	820	720	720	720	150
9/16	22.95	380	490	510	535	560	585	650	735	780	820	820	720	720	720	152
5/8	25.50	400	515	555	580	605	635	705	780	780	820	820	720	720	720	152
11/16	28.05	416	525	580	615	645	680	750	780	780	820	820	720	720	720	152
3/4	30.60	432	540	610	640	675	710	780	780	780	820	820	720	720	720	152
13/16	33.15	438	525	610	645	675	710	780	780	780	820	820	480	480	480	152
7/8	35.70	444	525	610	650	680	710	780	780	780	820	820	480	480	480	152
1	40.80	460	510	600	640	670	700	780	780	780	820	820	480	480	480	152
1 1/8	45.90	475	490	550	595	620	655	725	780	780	820	820	480	480	480	152
1 1/4	51.00	490	490	520	570	595	625	695	760	780	820	820	480	480	480	152
1 1/2	61.20	450	450	470	490	515	540	600	675	720	775	820	310	340	340	152
1 3/4	71.40	400	405	425	445	465	490	540	610	650	700	810	280	300	340	152
2	81.60	350	370	390	405	425	445	435	560	595	640	745	250	264	340	152

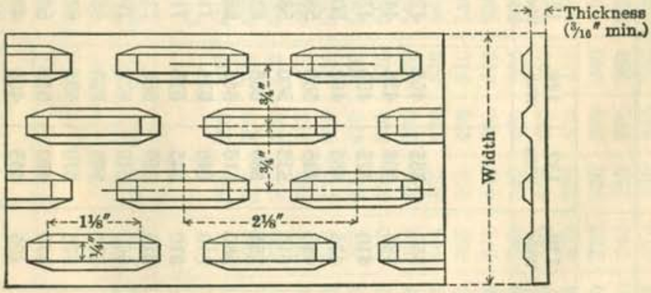
Plates less than 1/8" to and including 3/32" in thickness may be submitted for special consideration.
Plates up to 60" wide by 1/4" thick and heavier, can be rolled on Universal Mill.
For greater lengths and Universal Mill sizes, see Universal Mill Plate Table.
Plates of greater dimensions than shown in above table may be submitted for special consideration.

MULTIGRIP FLOOR PLATE



Section Index	Thickness, Inches	Width and Length, Inches: Over 6 to 15	Over 15 to 30	30 to 60	Over 60 to 84	Weight per Sq. Foot, Pounds
⊕ S300	¾	120	240	480	. . .	31.65
	⅝	120	240	480	. . .	26.55
	½	120	240	480	480	21.45
	7/16	120	240	480	480	18.90
	⅜	120	240	480	480	16.35
	5/16	120	240	480	480	13.80
	¼	120	240	480	480	11.25
	3/16	120	240	480	480	8.70

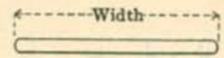
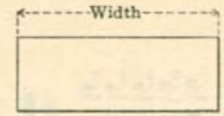
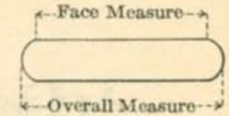
CARNEGIE-ILLINOIS FLOOR PLATE



Section Index	Thickness, Inches	Width and Length, Inches: Over 6 to 12	Over 12 to 24	Over 24 to 36	Over 36 to 48	Over 48 to 60	Over 60 to 66	Over 66 to 72	Weight per Sq. Foot, Pounds
Ⓒ M 41	¾		120	180	280	264	240	218	31.65
	⅝		180	200	300	300	260	240	26.55
	½	120	240	240	320	360	300	240	21.45
	7/16	120	240	240	340	360	300	240	18.90
	⅜	120	240	300	340	360	300	240	16.35
	5/16	120	240	300	320	360	300	240	13.80
	¼	120	240	300	320	360	240	220	11.25
	3/16	120	240	300	320	360	240	200	8.70

Inquiries for plates over ¾" thick may be submitted for consideration.
See page 373 a for additional information on Floor Plates.

FLAT ROLLED STEEL

Width, Inches	BAND EDGE	SQUARE EDGE	ROUND EDGE
			
	Thickness, B. W. G.	Thickness, Inches	Thickness, Inches
3/8 to 7/16	No. 23 to No. 10	1/8 to 5/16	1/8 to 1/4—Face Measure only
Over 7/16 to 1	No. 23 to No. 6	1/8 to 7/8	1/8 to 5/8—Face or Overall Measure
Over 1 to 2	No. 23 to No. 6	3/16 to 1 3/4	3/16 to 1 — " " " "
Over 2 to 3 1/2	No. 22 to No. 6	1/4 to 2 1/2	1/4 to 1 — " " " "
Over 3 1/2 to 5	No. 18 to No. 6	1/4 to 2 1/2	1/4 to 1 — " " " "
Over 5 to 6	No. 16 to No. 1	1/4 to 2 1/2	5/16 to 1 — " " " "
Over 6 to 8	No. 16 to No. 1	1/4 to 3 1/2	5/16 to 3/4— " " " "
Over 8 to 10	No. 14 to No. 1	1/4 to 3 1/2 *	
Over 10 to 15 1/2	No. 13 to No. 1	1/4 to 2 *	
Over 15 1/2 to 18	No. 12 to No. 1	1/4 to 2 *	
Over 18 to 18 5/8	No. 11 to No. 1	1/4 to 2 *	
Over 18 5/8 to 24		1/4 to 2 *	

The Over-all Measure is determined by adding to Face Measure:

One-half of the thickness for all sizes up to 1/2″, inclusive, in thickness.

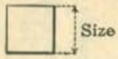
5/16″ for all sizes over 1/2″ to 3/4″, inclusive, in thickness.

3/8″ for all sizes over 3/4″ in thickness.

*Sizes 10 inches and wider are furnished with Universal Mill Edges.
Sizes not listed will be considered.

BARS ROLLED IN PITTSBURGH DISTRICT

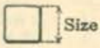
SQUARES



Size 1/4″ to 2″, inclusive, advancing by 64ths.
Size 2 1/32″ to 3 1/2″, inclusive, advancing by 32ds.
Size 3 9/16″ to 5 1/2″, inclusive, advancing by 16ths.

Squares can also be rolled to decimal dimensions, if so arranged.
Squares 7/8″ and smaller can be furnished in coils.

ROUND CORNERED SQUARES



Size 1/4″ to 3/8″,	inclusive, radius of rounding	1/32″
Over 3/8″ to 25/32″,	" " " "	1/16″
Over 25/32″ to 1 1/8″,	" " " "	1/8″
Over 1 1/8″ to 1 9/16″,	" " " "	1/4″
Over 1 9/16″ to 5 1/2″,	" " " "	5/16″

Sizes not listed will be considered.
Weights approximately same as Squares of corresponding sizes.

ROUNDS

Size 1/4″ to 1 3/4″, inclusive, advancing by 64ths.
Size 1 25/32″ to 3 1/2″, inclusive, advancing by 32ds.
Size 3 9/16″ to 7″, inclusive, advancing by 16ths.
Size 7 1/8″ and 7 1/4″.

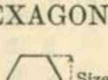
Rounds can also be rolled to decimal dimensions, if so arranged.
Rounds 7/8″ and smaller can be furnished in coils.

HALF ROUNDS

Size 3/8″ to 7/8″, inclusive, advancing by 64ths.
Size 15/16″ to 1 3/4″, inclusive, advancing by 16ths.
Size 2″, 2 1/2″, 3″.

Weights are half the weights of Rounds of corresponding diameters.

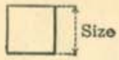
HEXAGONS



Size 3/8″ to 1 11/16″, inclusive, advancing by 32ds.
Size 1 3/4″ to 3 5/16″, inclusive, advancing by 16ths.

BARS ROLLED IN CHICAGO DISTRICT

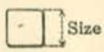
SQUARES



Size $\frac{1}{4}''$ to $\frac{13}{16}''$, inclusive, advancing by 32ds.
Size $\frac{7}{8}''$ to $2\frac{3}{8}''$, inclusive, advancing by 16ths.
Size $2\frac{1}{2}''$ to $3\frac{1}{2}''$, inclusive, advancing by 4ths.
Size $\frac{23}{64}''$, $\frac{25}{64}''$, $\frac{37}{64}''$, $\frac{39}{64}''$, $\frac{43}{64}''$, $\frac{63}{64}''$, $1\frac{5}{32}''$, $1\frac{9}{32}''$, $1\frac{13}{32}''$, $1\frac{17}{32}''$, $1\frac{21}{32}''$, $1\frac{31}{32}''$, $2\frac{5}{8}''$, $2\frac{7}{8}''$, $4''$.

Size various decimals from .314 to 1.378.
Sizes up to and including $\frac{7}{8}''$ can be furnished in coils.

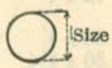
ROUND CORNERED SQUARES



Size $\frac{3}{4}''$, $\frac{7}{8}''$.
Size $1\frac{1}{2}''$ to $3\frac{7}{8}''$, inclusive, advancing by 8ths.
Size $1\frac{19}{32}''$, $2\frac{3}{16}''$, $2\frac{11}{16}''$, $3\frac{9}{16}''$, $4''$, $4\frac{5}{8}''$.
$2\frac{3}{4}''$ Gothic round cornered square.

Weights approximately same as squares of corresponding sizes.

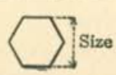
ROUNDS



Size $\frac{19}{64}''$ to $1\frac{5}{8}''$, inclusive, advancing by 64ths.
Size $1\frac{11}{16}''$ to $5\frac{1}{4}''$, inclusive, advancing by 16ths.
Size $5\frac{3}{8}''$ to $6\frac{1}{4}''$, inclusive, advancing by 8ths.
Size $1\frac{47}{64}''$, $1\frac{31}{32}''$, $2\frac{15}{32}''$, $2\frac{19}{32}''$, $5\frac{9}{16}''$, $6\frac{1}{16}''$.

Size various decimals from .304 to 2.362.
Sizes up to $1\frac{9}{64}''$, inclusive, can be furnished in coils.

HEXAGONS



Size $\frac{5}{16}''$ to $\frac{29}{32}''$, inclusive, advancing by 32ds.
Size $\frac{15}{16}''$ to $3\frac{1}{16}''$, inclusive, advancing by 16ths.
Size $\frac{31}{64}''$, $\frac{35}{64}''$, $\frac{39}{64}''$, 1.418.

Sizes up to $\frac{7}{8}''$, inclusive, can be furnished in coils.

ROLLED STEEL PLATES FOR COLUMN BASES

The following rolled widths and thicknesses are standard sizes of rolled steel plates for use as column bases. Selections from these sizes will facilitate manufacture and delivery.

ROLLED SIZES

All dimensions are given in inches

14 x 1¼	28 x 3	44 x 5
14 x 1½	28 x 3½	44 x 5½
16 x 1½	32 x 3½	48 x 5½
16 x 2	32 x 4	48 x 6
		48 x 6½
20 x 2	36 x 4	
20 x 2½	36 x 4½	52 x 6
20 x 3		52 x 6½
	40 x 4½	
24 x 2	40 x 5	56 x 6½
24 x 2½		56 x 7
24 x 3		56 x 8

All plates are of open hearth steel.

USEFUL DATA, TOLERANCES, ETC.

AREAS AND WEIGHTS, RECTANGULAR SECTIONS

AREAS AND WEIGHTS, ROUNDS AND SQUARES

TOLERANCES FOR STRUCTURAL SHAPES

ECONOMY TABLES FOR CB SECTIONS

WEIGHTS OF RECTANGULAR SECTIONS

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.053	.106	.159	.213	.266	.319	.372	.425	.478	.531	.584	.638	.691	.744	.797	.850
1/2	.106	.213	.319	.425	.531	.638	.744	.850	.956	1.063	1.169	1.275	1.381	1.488	1.594	1.700
3/4	.159	.319	.478	.638	.797	.956	1.116	1.275	1.434	1.594	1.753	1.913	2.072	2.231	2.391	2.550
1	.213	.425	.638	.850	1.063	1.275	1.488	1.700	1.913	2.125	2.338	2.550	2.763	2.975	3.188	3.400
1 1/4	.266	.531	.797	1.063	1.328	1.594	1.859	2.125	2.391	2.656	2.922	3.188	3.453	3.719	3.984	4.250
1 1/2	.319	.638	.956	1.275	1.594	1.913	2.231	2.550	2.869	3.188	3.506	3.825	4.144	4.463	4.781	5.100
1 3/4	.372	.744	1.116	1.488	1.859	2.231	2.603	2.975	3.347	3.719	4.091	4.463	4.834	5.206	5.578	5.950
2	.425	.850	1.275	1.700	2.125	2.550	2.975	3.400	3.825	4.250	4.675	5.100	5.525	5.950	6.375	6.800
2 1/4	.478	.956	1.434	1.913	2.391	2.869	3.347	3.825	4.303	4.781	5.259	5.738	6.216	6.694	7.172	7.650
2 1/2	.531	1.063	1.594	2.125	2.656	3.188	3.719	4.250	4.781	5.313	5.844	6.375	6.906	7.438	7.969	8.500
2 3/4	.584	1.169	1.753	2.338	2.922	3.506	4.091	4.675	5.259	5.844	6.428	7.013	7.597	8.181	8.766	9.350
3	.638	1.275	1.913	2.550	3.188	3.825	4.463	5.100	5.738	6.375	7.013	7.650	8.288	8.925	9.563	10.20
3 1/4	.691	1.381	2.072	2.763	3.453	4.144	4.834	5.525	6.216	6.906	7.597	8.288	8.978	9.669	10.36	11.05
3 1/2	.744	1.488	2.231	2.975	3.719	4.463	5.206	5.950	6.694	7.438	8.181	8.925	9.669	10.41	11.16	11.90
3 3/4	.797	1.594	2.391	3.188	3.984	4.781	5.578	6.375	7.172	7.969	8.766	9.563	10.36	11.16	11.95	12.75
4	.850	1.700	2.550	3.400	4.250	5.100	5.950	6.800	7.650	8.500	9.350	10.20	11.05	11.90	12.75	13.60
4 1/4	.903	1.806	2.709	3.613	4.516	5.419	6.322	7.225	8.128	9.031	9.934	10.84	11.74	12.64	13.55	14.45
4 1/2	.956	1.913	2.869	3.825	4.781	5.738	6.694	7.650	8.606	9.563	10.52	11.48	12.43	13.39	14.34	15.30
4 3/4	1.000	2.019	3.028	4.038	5.047	6.056	7.066	8.075	9.084	10.09	11.10	12.11	13.12	14.13	15.14	16.15
5	1.063	2.125	3.188	4.250	5.313	6.375	7.438	8.500	9.563	10.63	11.69	12.75	13.81	14.88	15.94	17.00
5 1/4	1.116	2.231	3.347	4.463	5.578	6.694	7.809	8.925	10.04	11.16	12.27	13.39	14.50	15.62	16.73	17.85
5 1/2	1.169	2.338	3.506	4.675	5.844	7.013	8.181	9.350	10.52	11.69	12.86	14.03	15.19	16.36	17.53	18.70
5 3/4	1.222	2.444	3.666	4.888	6.109	7.331	8.553	9.775	11.00	12.22	13.44	14.66	15.88	17.11	18.33	19.55
6	1.275	2.550	3.825	5.100	6.375	7.650	8.925	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40
6 1/4	1.328	2.656	3.984	5.313	6.641	7.969	9.297	10.63	11.95	13.28	14.61	15.94	17.27	18.59	19.92	21.25
6 1/2	1.381	2.763	4.144	5.525	6.906	8.288	9.669	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10
6 3/4	1.434	2.869	4.303	5.738	7.172	8.606	10.04	11.48	12.91	14.34	15.78	17.21	18.65	20.08	21.52	22.95
7	1.488	2.975	4.463	5.950	7.438	8.925	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80
7 1/4	1.541	3.081	4.622	6.163	7.703	9.244	10.78	12.33	13.87	15.41	16.95	18.49	20.03	21.57	23.11	24.65
7 1/2	1.594	3.188	4.781	6.375	7.969	9.563	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50
7 3/4	1.647	3.294	4.941	6.588	8.234	9.881	11.53	13.18	14.82	16.47	18.12	19.76	21.41	23.06	24.70	26.35
8	1.700	3.400	5.100	6.800	8.500	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20
8 1/4	1.753	3.506	5.259	7.013	8.766	10.52	12.27	14.03	15.78	17.53	19.28	21.04	22.79	24.54	26.30	28.05
8 1/2	1.806	3.613	5.419	7.225	9.031	10.84	12.64	14.45	16.26	18.06	19.87	21.68	23.48	25.29	27.09	28.90
8 3/4	1.859	3.719	5.578	7.438	9.297	11.16	13.02	14.88	16.73	18.59	20.45	22.31	24.17	26.03	27.89	29.75
9	1.913	3.825	5.738	7.650	9.563	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60
9 1/4	1.966	3.931	5.897	7.863	9.828	11.79	13.76	15.73	17.69	19.66	21.62	23.59	25.55	27.52	29.48	31.45
9 1/2	2.019	4.038	6.056	8.075	10.09	12.11	14.13	16.15	18.17	20.19	22.21	24.23	26.24	28.26	30.28	32.30
9 3/4	2.072	4.144	6.216	8.288	10.36	12.43	14.50	16.58	18.65	20.72	22.79	24.86	26.93	29.01	31.08	33.15
10	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
¼	.016	.031	.047	.063	.078	.094	.109	.125	.141	.156	.172	.188	.203	.219	.234	.250
½	.031	.063	.094	.125	.156	.188	.219	.250	.281	.313	.344	.375	.406	.438	.469	.500
¾	.047	.094	.141	.188	.234	.281	.328	.375	.422	.469	.516	.563	.609	.656	.703	.750
1	.063	.125	.188	.250	.313	.375	.438	.500	.563	.625	.688	.750	.813	.875	.938	1.000
1¼	.078	.156	.234	.313	.391	.469	.547	.625	.703	.781	.859	.938	1.016	1.094	1.172	1.250
1½	.094	.188	.281	.375	.469	.563	.656	.750	.844	.938	1.031	1.125	1.219	1.313	1.406	1.500
1¾	.109	.219	.328	.438	.547	.656	.766	.875	.984	1.094	1.203	1.313	1.422	1.531	1.641	1.750
2	.125	.250	.375	.500	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625	1.750	1.875	2.000
2¼	.141	.281	.422	.563	.703	.844	.984	1.125	1.266	1.406	1.547	1.688	1.828	1.969	2.109	2.250
2½	.156	.313	.469	.625	.781	.938	1.094	1.250	1.406	1.563	1.719	1.875	2.031	2.188	2.344	2.500
2¾	.172	.344	.516	.688	.859	1.031	1.203	1.375	1.547	1.719	1.891	2.063	2.234	2.406	2.578	2.750
3	.188	.375	.563	.750	.938	1.125	1.313	1.500	1.688	1.875	2.063	2.250	2.438	2.625	2.813	3.000
3¼	.203	.406	.609	.813	1.016	1.219	1.422	1.625	1.828	2.031	2.234	2.438	2.641	2.844	3.047	3.250
3½	.219	.438	.656	.875	1.094	1.313	1.531	1.750	1.969	2.188	2.406	2.625	2.844	3.063	3.281	3.500
3¾	.234	.469	.703	.938	1.172	1.406	1.641	1.875	2.109	2.344	2.578	2.813	3.047	3.281	3.516	3.750
4	.250	.500	.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000	3.250	3.500	3.750	4.000
4¼	.266	.531	.797	1.063	1.328	1.594	1.859	2.125	2.391	2.656	2.922	3.188	3.453	3.719	3.984	4.250
4½	.281	.563	.844	1.125	1.406	1.688	1.969	2.250	2.531	2.813	3.094	3.375	3.656	3.938	4.219	4.500
4¾	.297	.594	.891	1.188	1.484	1.781	2.078	2.375	2.672	2.969	3.266	3.563	3.859	4.156	4.453	4.750
5	.313	.625	.938	1.250	1.563	1.875	2.188	2.500	2.813	3.125	3.438	3.750	4.063	4.375	4.688	5.000
5¼	.328	.656	.984	1.313	1.641	1.969	2.297	2.625	2.953	3.281	3.609	3.938	4.266	4.594	4.922	5.250
5½	.344	.688	1.031	1.375	1.719	2.063	2.406	2.750	3.094	3.438	3.781	4.125	4.469	4.813	5.156	5.500
5¾	.359	.719	1.078	1.438	1.797	2.156	2.516	2.875	3.234	3.594	3.953	4.313	4.672	5.031	5.391	5.750
6	.375	.750	1.125	1.500	1.875	2.250	2.625	3.000	3.375	3.750	4.125	4.500	4.875	5.250	5.625	6.000
6¼	.391	.781	1.172	1.563	1.953	2.344	2.734	3.125	3.516	3.906	4.297	4.688	5.078	5.469	5.859	6.250
6½	.406	.813	1.219	1.625	2.031	2.438	2.844	3.250	3.656	4.063	4.469	4.875	5.281	5.688	6.094	6.500
6¾	.422	.844	1.266	1.688	2.109	2.531	2.953	3.375	3.797	4.219	4.641	5.063	5.484	5.906	6.328	6.750
7	.438	.875	1.313	1.750	2.188	2.625	3.063	3.500	3.938	4.375	4.813	5.250	5.688	6.125	6.563	7.000
7¼	.453	.906	1.359	1.813	2.266	2.719	3.172	3.625	4.078	4.531	4.984	5.438	5.891	6.344	6.797	7.250
7½	.469	.938	1.406	1.875	2.344	2.813	3.281	3.750	4.219	4.688	5.156	5.625	6.094	6.563	7.031	7.500
7¾	.484	.969	1.453	1.938	2.422	2.906	3.391	3.875	4.359	4.844	5.328	5.813	6.297	6.781	7.266	7.750
8	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500	5.000	5.500	6.000	6.500	7.000	7.500	8.000
8¼	.516	1.031	1.547	2.063	2.578	3.094	3.609	4.125	4.641	5.156	5.672	6.188	6.703	7.219	7.734	8.250
8½	.531	1.063	1.594	2.125	2.656	3.188	3.719	4.250	4.781	5.313	5.844	6.375	6.906	7.438	7.969	8.500
8¾	.547	1.094	1.641	2.188	2.734	3.281	3.828	4.375	4.922	5.469	6.016	6.563	7.109	7.656	8.203	8.750
9	.563	1.125	1.688	2.250	2.813	3.375	3.938	4.500	5.063	5.625	6.188	6.750	7.313	7.875	8.438	9.000
9¼	.578	1.156	1.734	2.313	2.891	3.469	4.047	4.625	5.203	5.781	6.359	6.938	7.516	8.094	8.672	9.250
9½	.594	1.188	1.781	2.375	2.969	3.563	4.156	4.750	5.344	5.938	6.531	7.125	7.719	8.313	8.906	9.500
9¾	.609	1.219	1.828	2.438	3.047	3.656	4.266	4.875	5.484	6.094	6.703	7.313	7.922	8.531	9.141	9.750
10	.625	1.250	1.875	2.500	3.125	3.750	4.375	5.000	5.625	6.250	6.875	7.500	8.125	8.750	9.375	10.00

WEIGHTS OF RECTANGULAR SECTIONS

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
10¼	2.178	4.356	6.534	8.713	10.89	13.07	15.25	17.43	19.60	21.78	23.96	26.14	28.32	30.49	32.67	34.85
10½	2.231	4.463	6.694	8.925	11.16	13.39	15.62	17.85	20.08	22.31	24.54	26.78	29.01	31.24	33.47	35.70
10¾	2.284	4.569	6.853	9.138	11.42	13.71	15.99	18.28	20.56	22.84	25.13	27.41	29.70	31.98	34.27	36.55
11	2.338	4.675	7.013	9.350	11.69	14.03	16.36	18.70	21.04	23.38	25.71	28.05	30.39	32.73	35.06	37.40
11¼	2.391	4.781	7.172	9.563	11.95	14.34	16.73	19.13	21.52	23.91	26.30	28.69	31.08	33.47	35.86	38.25
11½	2.444	4.888	7.331	9.775	12.22	14.66	17.11	19.55	21.99	24.44	26.88	29.33	31.77	34.21	36.66	39.10
11¾	2.497	4.994	7.491	9.988	12.48	14.98	17.48	19.98	22.47	24.97	27.47	29.96	32.46	34.96	37.45	39.95
12	2.550	5.100	7.650	10.20	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80
12½	2.656	5.313	7.969	10.63	13.28	15.94	18.59	21.25	23.91	26.56	29.22	31.88	34.53	37.19	39.84	42.50
13	2.763	5.525	8.288	11.05	13.81	16.58	19.34	22.10	24.86	27.63	30.39	33.15	35.91	38.68	41.44	44.20
13½	2.869	5.738	8.606	11.48	14.34	17.21	20.08	22.95	25.82	28.69	31.56	34.43	37.29	40.16	43.03	45.90
14	2.975	5.950	8.925	11.90	14.88	17.85	20.83	23.80	26.78	29.75	32.73	35.70	38.68	41.65	44.62	47.60
14½	3.081	6.163	9.244	12.33	15.41	18.49	21.57	24.65	27.73	30.81	33.89	36.98	40.06	43.14	46.22	49.30
15	3.188	6.375	9.563	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.06	38.25	41.44	44.63	47.81	51.00
15½	3.294	6.588	9.881	13.18	16.47	19.76	23.06	26.35	29.64	32.94	36.23	39.53	42.82	46.11	49.41	52.70
16	3.400	6.800	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00	37.40	40.80	44.20	47.60	51.00	54.40
16½	3.506	7.013	10.52	14.03	17.53	21.04	24.54	28.05	31.56	35.06	38.57	42.08	45.58	49.09	52.59	56.10
17	3.613	7.225	10.84	14.45	18.06	21.68	25.29	28.90	32.51	36.13	39.74	43.35	46.96	50.58	54.19	57.80
17½	3.719	7.438	11.16	14.88	18.59	22.31	26.03	29.75	33.47	37.19	40.91	44.63	48.34	52.06	55.78	59.50
18	3.825	7.650	11.48	15.30	19.13	22.95	26.78	30.60	34.43	38.25	42.08	45.90	49.73	53.55	57.38	61.20
18½	3.931	7.863	11.79	15.73	19.66	23.59	27.52	31.45	35.38	39.31	43.24	47.18	51.11	55.04	58.97	62.90
19	4.038	8.075	12.11	16.15	20.19	24.23	28.26	32.30	36.34	40.38	44.41	48.45	52.49	56.53	60.56	64.60
19½	4.144	8.288	12.43	16.58	20.72	24.86	29.01	33.15	37.29	41.44	45.58	49.73	53.87	58.01	62.16	66.30
20	4.250	8.500	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.00
20½	4.356	8.713	13.07	17.43	21.78	26.14	30.49	34.85	39.21	43.56	47.92	52.28	56.63	60.99	65.34	69.70
21	4.463	8.925	13.39	17.85	22.31	26.78	31.24	35.70	40.16	44.63	49.09	53.55	58.01	62.48	66.94	71.40
21½	4.569	9.138	13.71	18.28	22.84	27.41	31.98	36.55	41.12	45.69	50.26	54.83	59.39	63.96	68.53	73.10
22	4.675	9.350	14.03	18.70	23.38	28.05	32.73	37.40	42.08	46.75	51.43	56.10	60.78	65.45	70.13	74.80
22½	4.781	9.563	14.34	19.13	23.91	28.69	33.47	38.25	43.03	47.81	52.59	57.38	62.16	66.94	71.72	76.50
23	4.888	9.775	14.66	19.55	24.44	29.33	34.21	39.10	43.99	48.88	53.76	58.65	63.54	68.43	73.31	78.20
23½	4.994	9.988	14.98	19.98	24.97	29.96	34.96	39.95	44.94	49.94	54.93	59.93	64.92	69.91	74.91	79.90
24	5.100	10.20	15.30	20.40	25.50	30.60	35.70	40.80	45.90	51.00	56.10	61.20	66.30	71.40	76.50	81.60
25	5.313	10.63	15.94	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.44	63.75	69.06	74.38	79.69	85.00
26	5.525	11.05	16.58	22.10	27.63	33.15	38.68	44.20	49.73	55.25	60.78	66.30	71.83	77.35	82.88	88.40
27	5.738	11.48	17.21	22.95	28.69	34.43	40.16	45.90	51.64	57.38	63.11	68.85	74.59	80.33	86.06	91.80
28	5.950	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55	59.50	65.45	71.40	77.35	83.30	89.25	95.20
29	6.163	12.33	18.49	24.65	30.81	36.98	43.14	49.30	55.46	61.63	67.79	73.95	80.11	86.28	92.44	98.60
30	6.375	12.75	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.13	76.50	82.88	89.25	95.63	102.0
31	6.588	13.18	19.76	26.35	32.94	39.53	46.11	52.70	59.29	65.88	72.46	79.05	85.64	92.23	98.81	105.4
32	6.800	13.60	20.40	27.20	34.00	40.80	47.60	54.40	61.20	68.00	74.80	81.60	88.40	95.20	102.0	108.8

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
10¼	.641	1.281	1.922	2.563	3.203	3.844	4.484	5.125	5.766	6.406	7.047	7.688	8.328	8.969	9.609	10.25
10½	.656	1.313	1.969	2.625	3.281	3.938	4.594	5.250	5.906	6.563	7.219	7.875	8.531	9.188	9.844	10.50
10¾	.672	1.344	2.016	2.688	3.359	4.031	4.703	5.375	6.047	6.719	7.391	8.063	8.734	9.406	10.08	10.75
11	.688	1.375	2.063	2.750	3.438	4.125	4.813	5.500	6.188	6.875	7.563	8.250	8.938	9.625	10.31	11.00
11¼	.703	1.406	2.109	2.813	3.516	4.219	4.922	5.625	6.328	7.031	7.734	8.438	9.141	9.844	10.55	11.25
11½	.719	1.438	2.156	2.875	3.594	4.313	5.031	5.750	6.469	7.188	7.906	8.625	9.344	10.06	10.78	11.50
11¾	.734	1.469	2.203	2.938	3.672	4.406	5.141	5.875	6.609	7.344	8.078	8.813	9.547	10.28	11.02	11.75
12	.750	1.500	2.250	3.000	3.750	4.500	5.250	6.000	6.750	7.500	8.250	9.000	9.750	10.50	11.25	12.00
12½	.781	1.563	2.344	3.125	3.906	4.688	5.469	6.250	7.031	7.813	8.594	9.375	10.16	10.94	11.72	12.50
13	.813	1.625	2.438	3.250	4.063	4.875	5.688	6.500	7.313	8.125	8.938	9.750	10.56	11.38	12.19	13.00
13½	.844	1.688	2.531	3.375	4.219	5.063	5.906	6.750	7.594	8.438	9.281	10.13	10.97	11.81	12.66	13.50
14	.875	1.750	2.625	3.500	4.375	5.250	6.125	7.000	7.875	8.750	9.625	10.50	11.38	12.25	13.13	14.00
14½	.906	1.813	2.719	3.625	4.531	5.438	6.344	7.250	8.156	9.063	9.969	10.88	11.78	12.69	13.59	14.50
15	.938	1.875	2.813	3.750	4.688	5.625	6.563	7.500	8.438	9.375	10.31	11.25	12.19	13.13	14.06	15.00
15½	.969	1.938	2.906	3.875	4.844	5.813	6.781	7.750	8.719	9.688	10.66	11.63	12.59	13.56	14.53	15.50
16	1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.000	9.000	10.00	11.00	12.00	13.00	14.00	15.00	16.00
16½	1.031	2.063	3.094	4.125	5.156	6.188	7.219	8.250	9.281	10.31	11.34	12.38	13.41	14.44	15.47	16.50
17	1.063	2.125	3.188	4.250	5.313	6.375	7.438	8.500	9.563	10.63	11.69	12.75	13.81	14.88	15.94	17.00
17½	1.094	2.188	3.281	4.375	5.469	6.563	7.656	8.750	9.844	10.94	12.03	13.13	14.22	15.31	16.41	17.50
18	1.125	2.250	3.375	4.500	5.625	6.750	7.875	9.000	10.13	11.25	12.38	13.50	14.63	15.75	16.88	18.00
18½	1.156	2.313	3.469	4.625	5.781	6.938	8.094	9.250	10.41	11.56	12.72	13.88	15.03	16.19	17.34	18.50
19	1.188	2.375	3.563	4.750	5.938	7.125	8.313	9.500	10.69	11.88	13.06	14.25	15.44	16.63	17.81	19.00
19½	1.219	2.438	3.656	4.875	6.094	7.313	8.531	9.750	10.97	12.19	13.41	14.63	15.84	17.06	18.28	19.50
20	1.250	2.500	3.750	5.000	6.250	7.500	8.750	10.00	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00
20½	1.281	2.563	3.844	5.125	6.406	7.688	8.969	10.25	11.53	12.81	14.09	15.38	16.66	17.94	19.22	20.50
21	1.313	2.625	3.938	5.250	6.563	7.875	9.188	10.50	11.81	13.13	14.44	15.75	17.06	18.38	19.69	21.00
21½	1.344	2.688	4.031	5.375	6.719	8.063	9.406	10.75	12.09	13.44	14.78	16.13	17.47	18.81	20.16	21.50
22	1.375	2.750	4.125	5.500	6.875	8.250	9.625	11.00	12.38	13.75	15.13	16.50	17.88	19.25	20.63	22.00
22½	1.406	2.813	4.219	5.625	7.031	8.438	9.844	11.25	12.66	14.06	15.47	16.88	18.28	19.69	21.09	22.50
23	1.438	2.875	4.313	5.750	7.188	8.625	10.06	11.50	12.94	14.38	15.81	17.25	18.69	20.13	21,56	23.00
23½	1.469	2.938	4.406	5.875	7.344	8.813	10.28	11.75	13.22	14.69	16.16	17.63	19.09	20.56	22.03	23.50
24	1.500	3.000	4.500	6.000	7.500	9.000	10.50	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00
25	1.563	3.125	4.688	6.250	7.813	9.375	10.94	12.50	14.06	15.63	17.19	18.75	20.31	21.88	23.44	25.00
26	1.625	3.250	4.875	6.500	8.125	9.750	11.38	13.00	14.63	16.25	17.88	19.50	21.13	22.75	24.38	26.00
27	1.688	3.375	5.063	6.750	8.438	10.13	11.81	13.50	15.19	16.88	18.56	20.25	21.94	23.63	25.31	27.00
28	1.750	3.500	5.250	7.000	8.750	10.50	12.25	14.00	15.75	17.50	19.25	21.00	22.75	24.50	26.25	28.00
29	1.813	3.625	5.438	7.250	9.063	10.88	12.69	14.50	16.31	18.13	19.94	21.75	23.56	25.38	27.19	29.00
30	1.875	3.750	5.625	7.500	9.375	11.25	13.13	15.00	16.88	18.75	20.63	22.50	24.38	26.25	28.13	30.00
31	1.938	3.875	5.813	7.750	9.688	11.63	13.56	15.50	17.44	19.38	21.31	23.25	25.19	27.13	29.06	31.00
32	2.000	4.000	6.000	8.000	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00

WEIGHTS OF RECTANGULAR SECTIONS

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
33	7.013	14.03	21.04	28.05	35.06	42.08	49.09	56.10	63.11	70.13	77.14	84.15	91.16	98.18	105.2	112.2
34	7.225	14.45	21.68	28.90	36.13	43.35	50.58	57.80	65.03	72.25	79.48	86.70	93.93	101.2	108.4	115.6
35	7.438	14.88	22.31	29.75	37.19	44.63	52.06	59.50	66.94	74.38	81.81	89.25	96.69	104.1	111.6	119.0
36	7.650	15.30	22.95	30.60	38.25	45.90	53.55	61.20	68.85	76.50	84.15	91.80	99.45	107.1	114.8	122.4
37	7.863	15.73	23.59	31.45	39.31	47.18	55.04	62.90	70.76	78.63	86.49	94.35	102.2	110.1	117.9	125.8
38	8.075	16.15	24.23	32.30	40.38	48.45	56.53	64.60	72.68	80.75	88.83	96.90	105.0	113.1	121.1	129.2
39	8.288	16.58	24.86	33.15	41.44	49.73	58.01	66.30	74.59	82.88	91.16	99.45	107.7	116.0	124.3	132.6
40	8.500	17.00	25.50	34.00	42.50	51.00	59.50	68.00	76.50	85.00	93.50	102.0	110.5	119.0	127.5	136.0
41	8.713	17.43	26.14	34.85	43.56	52.28	60.99	69.70	78.41	87.13	95.84	104.6	113.3	122.0	130.7	139.4
42	8.925	17.85	26.78	35.70	44.63	53.55	62.48	71.40	80.33	89.25	98.18	107.1	116.0	125.0	133.9	142.8
43	9.138	18.28	27.41	36.55	45.69	54.83	63.96	73.10	82.24	91.38	100.5	109.7	118.8	127.9	137.1	146.2
44	9.350	18.70	28.05	37.40	46.75	56.10	65.45	74.80	84.15	93.50	102.9	112.2	121.6	130.9	140.3	149.6
45	9.563	19.13	28.69	38.25	47.81	57.38	66.94	76.50	86.06	95.63	105.2	114.8	124.3	133.9	143.4	153.0
46	9.775	19.55	29.33	39.10	48.88	58.65	68.43	78.20	87.98	97.75	107.5	117.3	127.1	136.9	146.6	156.4
47	9.988	19.98	29.96	39.95	49.94	59.93	69.91	79.90	89.89	99.88	109.9	119.9	129.8	139.8	149.8	159.8
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80	102.0	112.2	122.4	132.6	142.8	153.0	163.2
49	10.41	20.83	31.24	41.65	52.06	62.48	72.89	83.30	93.71	104.1	114.5	125.0	135.4	145.8	156.2	166.6
50	10.63	21.25	31.88	42.50	53.13	63.75	74.38	85.00	95.63	106.3	116.9	127.5	138.1	148.8	159.4	170.0
51	10.84	21.68	32.51	43.35	54.19	65.03	75.86	86.70	97.54	108.4	119.2	130.1	140.9	151.7	162.6	173.4
52	11.05	22.10	33.15	44.20	55.25	66.30	77.35	88.40	99.45	110.5	121.6	132.6	143.7	154.7	165.8	176.8
53	11.26	22.53	33.79	45.05	56.31	67.58	78.84	90.10	101.4	112.6	123.9	135.2	146.4	157.7	168.9	180.2
54	11.48	22.95	34.43	45.90	57.38	68.85	80.33	91.80	103.3	114.8	126.2	137.7	149.2	160.7	172.1	183.6
55	11.69	23.38	35.06	46.75	58.44	70.13	81.81	93.50	105.2	116.9	128.6	140.3	151.9	163.6	175.3	187.0
56	11.90	23.80	35.70	47.60	59.50	71.40	83.30	95.20	107.1	119.0	130.9	142.8	154.7	166.6	178.5	190.4
57	12.11	24.23	36.34	48.45	60.56	72.68	84.79	96.90	109.0	121.1	133.2	145.4	157.5	169.6	181.7	193.8
58	12.33	24.65	36.98	49.30	61.63	73.95	86.28	98.60	110.9	123.3	135.6	147.9	160.2	172.6	184.9	197.2
59	12.54	25.08	37.61	50.15	62.69	75.23	87.76	100.3	112.8	125.4	137.9	150.5	163.0	175.5	188.1	200.6
60	12.75	25.50	38.25	51.00	63.75	76.50	89.25	102.0	114.8	127.5	140.3	153.0	165.8	178.5	191.3	204.0
61	12.96	25.93	38.89	51.85	64.81	77.78	90.74	103.7	116.7	129.6	142.6	155.6	168.5	181.5	194.4	207.4
62	13.18	26.35	39.53	52.70	65.88	79.05	92.23	105.4	118.6	131.8	144.9	158.1	171.3	184.5	197.6	210.8
63	13.39	26.78	40.16	53.55	66.94	80.33	93.71	107.1	120.5	133.9	147.3	160.7	174.0	187.4	200.8	214.2
64	13.60	27.20	40.80	54.40	68.00	81.60	95.20	108.8	122.4	136.0	149.6	163.2	176.8	190.4	204.0	217.6
65	13.81	27.63	41.44	55.25	69.06	82.88	96.69	110.5	124.3	138.1	151.9	165.8	179.6	193.4	207.2	221.0
66	14.03	28.05	42.08	56.10	70.13	84.15	98.18	112.2	126.2	140.3	154.3	168.3	182.3	196.4	210.4	224.4
67	14.24	28.48	42.71	56.95	71.19	85.43	99.66	113.9	128.1	142.4	156.6	170.9	185.1	199.3	213.6	227.8
68	14.45	28.90	43.35	57.80	72.25	86.70	101.2	115.6	130.1	144.5	159.0	173.4	187.9	202.3	216.8	231.2
69	14.66	29.33	43.99	58.65	73.31	87.98	102.6	117.3	132.0	146.6	161.3	176.0	190.6	205.3	219.9	234.6
70	14.88	29.75	44.63	59.50	74.38	89.25	104.1	119.0	133.9	148.8	163.6	178.5	193.4	208.3	223.1	238.0
71	15.09	30.18	45.26	60.35	75.44	90.53	105.6	120.7	135.8	150.9	166.0	181.1	196.1	211.2	226.3	241.4
72	15.30	30.60	45.90	61.20	76.50	91.80	107.1	122.4	137.7	153.0	168.3	183.6	198.9	214.2	229.5	244.8

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
33	2.063	4.125	6.188	8.250	10.31	12.38	14.44	16.50	18.56	20.63	22.69	24.75	26.81	28.88	30.94	33.00
34	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
35	2.188	4.375	6.563	8.750	10.94	13.13	15.31	17.50	19.69	21.88	24.06	26.25	28.44	30.63	32.81	35.00
36	2.250	4.500	6.750	9.000	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00	29.25	31.50	33.75	36.00
37	2.313	4.625	6.938	9.250	11.56	13.88	16.19	18.50	20.81	23.13	25.44	27.75	30.06	32.38	34.69	37.00
38	2.375	4.750	7.125	9.500	11.88	14.25	16.63	19.00	21.38	23.75	26.13	28.50	30.88	33.25	35.63	38.00
39	2.438	4.875	7.313	9.750	12.19	14.63	17.06	19.50	21.94	24.38	26.81	29.25	31.69	34.13	36.56	39.00
40	2.500	5.000	7.500	10.00	12.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00
41	2.563	5.125	7.688	10.25	12.81	15.38	17.94	20.50	23.06	25.63	28.19	30.75	33.31	35.88	38.44	41.00
42	2.625	5.250	7.875	10.50	13.13	15.75	18.38	21.00	23.63	26.25	28.88	31.50	34.13	36.75	39.38	42.00
43	2.688	5.375	8.063	10.75	13.44	16.13	18.81	21.50	24.19	26.88	29.56	32.25	34.94	37.63	40.31	43.00
44	2.750	5.500	8.250	11.00	13.75	16.50	19.25	22.00	24.75	27.50	30.25	33.00	35.75	38.50	41.25	44.00
45	2.813	5.625	8.438	11.25	14.06	16.88	19.69	22.50	25.31	28.13	30.94	33.75	36.56	39.38	42.19	45.00
46	2.875	5.750	8.625	11.50	14.38	17.25	20.13	23.00	25.88	28.75	31.63	34.50	37.38	40.25	43.13	46.00
47	2.938	5.875	8.813	11.75	14.69	17.63	20.56	23.50	26.44	29.38	32.31	35.25	38.19	41.13	44.06	47.00
48	3.000	6.000	9.000	12.00	15.00	18.00	21.00	24.00	27.00	30.00	33.00	36.00	39.00	42.00	45.00	48.00
49	3.063	6.125	9.188	12.25	15.31	18.38	21.44	24.50	27.56	30.63	33.69	36.75	39.81	42.88	45.94	49.00
50	3.125	6.250	9.375	12.50	15.63	18.75	21.88	25.00	28.13	31.25	34.38	37.50	40.63	43.75	46.88	50.00
51	3.188	6.375	9.563	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.06	38.25	41.44	44.63	47.81	51.00
52	3.250	6.500	9.750	13.00	16.25	19.50	22.75	26.00	29.25	32.50	35.75	39.00	42.25	45.50	48.75	52.00
53	3.313	6.625	9.938	13.25	16.56	19.88	23.19	26.50	29.81	33.13	36.44	39.75	43.06	46.38	49.69	53.00
54	3.375	6.750	10.13	13.50	16.88	20.25	23.63	27.00	30.38	33.75	37.13	40.50	43.88	47.25	50.63	54.00
55	3.438	6.875	10.31	13.75	17.19	20.63	24.06	27.50	30.94	34.38	37.81	41.25	44.69	48.13	51.56	55.00
56	3.500	7.000	10.50	14.00	17.50	21.00	24.50	28.00	31.50	35.00	38.50	42.00	45.50	49.00	52.50	56.00
57	3.563	7.125	10.69	14.25	17.81	21.38	24.94	28.50	32.06	35.63	39.19	42.75	46.31	49.88	53.44	57.00
58	3.625	7.250	10.88	14.50	18.13	21.75	25.38	29.00	32.63	36.25	39.88	43.50	47.13	50.75	54.38	58.00
59	3.688	7.375	11.06	14.75	18.44	22.13	25.81	29.50	33.19	36.88	40.56	44.25	47.94	51.63	55.31	59.00
60	3.750	7.500	11.25	15.00	18.75	22.50	26.25	30.00	33.75	37.50	41.25	45.00	48.75	52.50	56.25	60.00
61	3.813	7.625	11.44	15.25	19.06	22.88	26.69	30.50	34.31	38.13	41.94	45.75	49.56	53.38	57.19	61.00
62	3.875	7.750	11.63	15.50	19.38	23.25	27.13	31.00	34.88	38.75	42.63	46.50	50.38	54.25	58.13	62.00
63	3.938	7.875	11.81	15.75	19.69	23.63	27.56	31.50	35.44	39.38	43.31	47.25	51.19	55.13	59.06	63.00
64	4.000	8.000	12.00	16.00	20.00	24.00	28.00	32.00	36.00	40.00	44.00	48.00	52.00	56.00	60.00	64.00
65	4.063	8.125	12.19	16.25	20.31	24.38	28.44	32.50	36.56	40.63	44.69	48.75	52.81	56.88	60.94	65.00
66	4.125	8.250	12.38	16.50	20.63	24.75	28.88	33.00	37.13	41.25	45.38	49.50	53.63	57.75	61.88	66.00
67	4.188	8.375	12.56	16.75	20.94	25.13	29.31	33.50	37.69	41.88	46.06	50.25	54.44	58.63	62.81	67.00
68	4.250	8.500	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.00
69	4.313	8.625	12.94	17.25	21.56	25.88	30.19	34.50	38.81	43.13	47.44	51.75	56.06	60.38	64.69	69.00
70	4.375	8.750	13.13	17.50	21.88	26.25	30.63	35.00	39.38	43.75	48.13	52.50	56.88	61.25	65.63	70.00
71	4.438	8.875	13.31	17.75	22.19	26.63	31.06	35.50	39.94	44.38	48.81	53.25	57.69	62.13	66.56	71.00
72	4.500	9.000	13.50	18.00	22.50	27.00	31.50	36.00	40.50	45.00	49.50	54.00	58.50	63.00	67.50	72.00

WEIGHTS OF RECTANGULAR SECTIONS

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
73	15.51	31.03	46.54	62.05	77.56	93.08	108.6	124.1	139.6	155.1	170.6	186.2	201.7	217.2	232.7	248.2
74	15.73	31.45	47.18	62.90	78.63	94.35	110.1	125.8	141.5	157.3	173.0	188.7	204.4	220.2	235.9	251.6
75	15.94	31.88	47.81	63.75	79.69	95.63	111.6	127.5	143.4	159.4	175.3	191.3	207.2	223.1	239.1	255.0
76	16.15	32.30	48.45	64.60	80.75	96.90	113.1	129.2	145.4	161.5	177.7	193.8	210.0	226.1	242.3	258.4
77	16.36	32.73	49.09	65.45	81.81	98.18	114.5	130.9	147.3	163.6	180.0	196.4	212.7	229.1	245.4	261.8
78	16.58	33.15	49.73	66.30	82.88	99.45	116.0	132.6	149.2	165.8	182.3	198.9	215.5	232.1	248.6	265.2
79	16.79	33.58	50.36	67.15	83.94	100.7	117.5	134.3	151.1	167.9	184.7	201.5	218.2	235.0	251.8	268.6
80	17.00	34.00	51.00	68.00	85.00	102.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0
81	17.21	34.43	51.64	68.85	86.06	103.3	120.5	137.7	154.9	172.1	189.3	206.6	223.8	241.0	258.2	275.4
82	17.43	34.85	52.28	69.70	87.13	104.6	122.0	139.4	156.8	174.3	191.7	209.1	226.5	244.0	261.4	278.8
83	17.64	35.28	52.91	70.55	88.19	105.8	123.5	141.1	158.7	176.4	194.0	211.7	229.3	246.9	264.6	282.2
84	17.85	35.70	53.55	71.40	89.25	107.1	125.0	142.8	160.7	178.5	196.4	214.2	232.1	249.9	267.8	285.6
85	18.06	36.13	54.19	72.25	90.31	108.4	126.4	144.5	162.6	180.6	198.7	216.8	234.8	252.9	270.9	289.0
86	18.28	36.55	54.83	73.10	91.38	109.7	127.9	146.2	164.5	182.8	201.0	219.3	237.6	255.9	274.1	292.4
87	18.49	36.98	55.46	73.95	92.44	110.9	129.4	147.9	166.4	184.9	203.4	221.9	240.3	258.8	277.3	295.8
88	18.70	37.40	56.10	74.80	93.50	112.2	130.9	149.6	168.3	187.0	205.7	224.4	243.1	261.8	280.5	299.2
89	18.91	37.83	56.74	75.65	94.56	113.5	132.4	151.3	170.2	189.1	208.0	227.0	245.9	264.8	283.7	302.6
90	19.13	38.25	57.38	76.50	95.63	114.8	133.9	153.0	172.1	191.3	210.4	229.5	248.6	267.8	286.9	306.0
91	19.34	38.68	58.01	77.35	96.69	116.0	135.4	154.7	174.0	193.4	212.7	232.1	251.4	270.7	290.1	309.4
92	19.55	39.10	58.65	78.20	97.75	117.3	136.9	156.4	176.0	195.5	215.1	234.6	254.2	273.7	293.3	312.8
93	19.76	39.53	59.29	79.05	98.81	118.6	138.3	158.1	177.9	197.6	217.4	237.2	256.9	276.7	296.4	316.2
94	19.98	39.95	59.93	79.90	99.88	119.9	139.8	159.8	179.8	199.8	219.7	239.7	259.7	279.7	299.6	319.6
95	20.19	40.38	60.56	80.75	100.9	121.1	141.3	161.5	181.7	201.9	222.1	242.3	262.4	282.6	302.8	323.0
96	20.40	40.80	61.20	81.60	102.0	122.4	142.8	163.2	183.6	204.0	224.4	244.8	265.2	285.6	306.0	326.4
97	20.61	41.23	61.84	82.45	103.1	123.7	144.3	164.9	185.5	206.1	226.7	247.4	268.0	288.6	309.2	329.8
98	20.83	41.65	62.48	83.30	104.1	125.0	145.8	166.6	187.4	208.3	229.1	249.9	270.7	291.6	312.4	333.2
99	21.04	42.08	63.11	84.15	105.2	126.2	147.3	168.3	189.3	210.4	231.4	252.5	273.5	294.5	315.6	336.6
100	21.25	42.50	63.75	85.00	106.3	127.5	148.8	170.0	191.3	212.5	233.8	255.0	276.3	297.5	318.8	340.0
102	21.68	43.35	65.03	86.70	108.4	130.1	151.7	173.4	195.1	216.8	238.4	260.1	281.8	303.5	325.1	346.8
104	22.10	44.20	66.30	88.40	110.5	132.6	154.7	176.8	198.9	221.0	243.1	265.2	287.3	309.4	331.5	353.6
106	22.53	45.05	67.58	90.10	112.6	135.2	157.7	180.2	202.7	225.3	247.8	270.3	292.8	315.4	337.9	360.4
108	22.95	45.90	68.85	91.80	114.8	137.7	160.7	183.6	206.6	229.5	252.5	275.4	298.4	321.3	344.3	367.2
110	23.38	46.75	70.13	93.50	116.9	140.3	163.6	187.0	210.4	233.8	257.1	280.5	303.9	327.3	350.6	374.0
112	23.80	47.60	71.40	95.20	119.0	142.8	166.6	190.4	214.2	238.0	261.8	285.6	309.4	333.2	357.0	380.8
114	24.23	48.45	72.68	96.90	121.1	145.4	169.6	193.8	218.0	242.3	266.5	290.7	314.9	339.2	363.4	387.6
116	24.65	49.30	73.95	98.60	123.3	147.9	172.6	197.2	221.9	246.5	271.2	295.8	320.5	345.1	369.8	394.4
118	25.08	50.15	75.23	100.3	125.4	150.5	175.5	200.6	225.7	250.8	275.8	300.9	326.0	351.1	376.1	401.2
120	25.50	51.00	76.50	102.0	127.5	153.0	178.5	204.0	229.5	255.0	280.5	306.0	331.5	357.0	382.5	408.0

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
73	4.563	9.125	13.69	18.25	22.81	27.38	31.94	36.50	41.06	45.63	50.19	54.75	59.31	63.88	68.44	73.00
74	4.625	9.250	13.88	18.50	23.13	27.75	32.38	37.00	41.63	46.25	50.88	55.50	60.13	64.75	69.38	74.00
75	4.688	9.375	14.06	18.75	23.44	28.13	32.81	37.50	42.19	46.88	51.56	56.25	60.94	65.63	70.31	75.00
76	4.750	9.500	14.25	19.00	23.75	28.50	33.25	38.00	42.75	47.50	52.25	57.00	61.75	66.50	71.25	76.00
77	4.813	9.625	14.44	19.25	24.06	28.88	33.69	38.50	43.31	48.13	52.94	57.75	62.56	67.38	72.19	77.00
78	4.875	9.750	14.63	19.50	24.38	29.25	34.13	39.00	43.88	48.75	53.63	58.50	63.38	68.25	73.13	78.00
79	4.938	9.875	14.81	19.75	24.69	29.63	34.56	39.50	44.44	49.38	54.31	59.25	64.19	69.13	74.06	79.00
80	5.000	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00
81	5.063	10.13	15.19	20.25	25.31	30.38	35.44	40.50	45.56	50.63	55.69	60.75	65.81	70.88	75.94	81.00
82	5.125	10.25	15.38	20.50	25.63	30.75	35.88	41.00	46.13	51.25	56.38	61.50	66.63	71.75	76.88	82.00
83	5.188	10.38	15.56	20.75	25.94	31.13	36.31	41.50	46.69	51.88	57.06	62.25	67.44	72.63	77.81	83.00
84	5.250	10.50	15.75	21.00	26.25	31.50	36.75	42.00	47.25	52.50	57.75	63.00	68.25	73.50	78.75	84.00
85	5.313	10.63	15.94	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.44	63.75	69.06	74.38	79.69	85.00
86	5.375	10.75	16.13	21.50	26.88	32.25	37.63	43.00	48.38	53.75	59.13	64.50	69.88	75.25	80.63	86.00
87	5.438	10.88	16.31	21.75	27.19	32.63	38.06	43.50	48.94	54.38	59.81	65.25	70.69	76.13	81.56	87.00
88	5.500	11.00	16.50	22.00	27.50	33.00	38.50	44.00	49.50	55.00	60.50	66.00	71.50	77.00	82.50	88.00
89	5.563	11.13	16.69	22.25	27.81	33.38	38.94	44.50	50.06	55.63	61.19	66.75	72.31	77.88	83.44	89.00
90	5.625	11.25	16.88	22.50	28.13	33.75	39.38	45.00	50.63	56.25	61.88	67.50	73.13	78.75	84.38	90.00
91	5.688	11.38	17.06	22.75	28.44	34.13	39.81	45.50	51.19	56.88	62.56	68.25	73.94	79.63	85.31	91.00
92	5.750	11.50	17.25	23.00	28.75	34.50	40.25	46.00	51.75	57.50	63.25	69.00	74.75	80.50	86.25	92.00
93	5.813	11.63	17.44	23.25	29.06	34.88	40.69	46.50	52.31	58.13	63.94	69.75	75.56	81.38	87.19	93.00
94	5.875	11.75	17.63	23.50	29.38	35.25	41.13	47.00	52.88	58.75	64.63	70.50	76.38	82.25	88.13	94.00
95	5.938	11.88	17.81	23.75	29.69	35.63	41.56	47.50	53.44	59.38	65.31	71.25	77.19	83.13	89.06	95.00
96	6.000	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00	66.00	72.00	78.00	84.00	90.00	96.00
97	6.063	12.13	18.19	24.25	30.31	36.38	42.44	48.50	54.56	60.63	66.69	72.75	78.81	84.88	90.94	97.00
98	6.125	12.25	18.38	24.50	30.63	36.75	42.88	49.00	55.13	61.25	67.38	73.50	79.63	85.75	91.88	98.00
99	6.188	12.38	18.56	24.75	30.94	37.13	43.31	49.50	55.69	61.88	68.06	74.25	80.44	86.63	92.81	99.00
100	6.250	12.50	18.75	25.00	31.25	37.50	43.75	50.00	56.25	62.50	68.75	75.00	81.25	87.50	93.75	100.0
102	6.375	12.75	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.13	76.50	82.88	89.25	95.63	102.0
104	6.500	13.00	19.50	26.00	32.50	39.00	45.50	52.00	58.50	65.00	71.50	78.00	84.50	91.00	97.50	104.0
106	6.625	13.25	19.88	26.50	33.13	39.75	46.38	53.00	59.63	66.25	72.88	79.50	86.13	92.75	99.38	106.0
108	6.750	13.50	20.25	27.00	33.75	40.50	47.25	54.00	60.75	67.50	74.25	81.00	87.75	94.50	101.3	108.0
110	6.875	13.75	20.63	27.50	34.38	41.25	48.13	55.00	61.88	68.75	75.63	82.50	89.38	96.25	103.1	110.0
112	7.000	14.00	21.00	28.00	35.00	42.00	49.00	56.00	63.00	70.00	77.00	84.00	91.00	98.00	105.0	112.0
114	7.125	14.25	21.38	28.50	35.63	42.75	49.88	57.00	64.13	71.25	78.38	85.50	92.63	99.75	106.9	114.0
116	7.250	14.50	21.75	29.00	36.25	43.50	50.75	58.00	65.25	72.50	79.75	87.00	94.25	101.5	108.8	116.0
118	7.375	14.75	22.13	29.50	36.88	44.25	51.63	59.00	66.38	73.75	81.13	88.50	95.88	103.3	110.6	118.0
120	7.500	15.00	22.50	30.00	37.50	45.00	52.50	60.00	67.50	75.00	82.50	90.00	97.50	105.0	112.5	120.0

SQUARE AND ROUND BARS

WEIGHTS AND AREAS

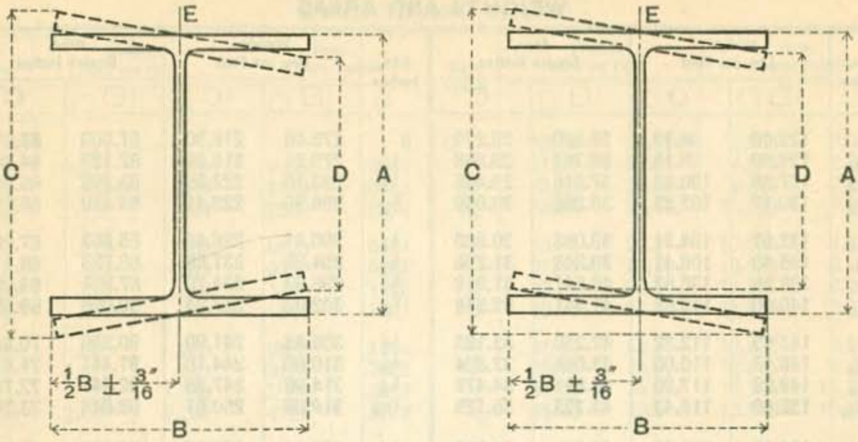
Size, Inches	Weight, Lbs. per Foot		Area, Square Inches		Size, Inches	Weight, Lbs. per Foot		Area, Square Inches	
	□	○	□	○		□	○	□	○
0					3	30.60	24.03	9.000	7.069
1/16	.013	.010	.0039	.0031	1/16	31.89	25.05	9.379	7.366
1/8	.053	.042	.0156	.0123	1/8	33.20	26.08	9.766	7.670
3/16	.120	.094	.0352	.0276	3/16	34.54	27.13	10.160	7.980
1/4	.213	.167	.0625	.0491	1/4	35.91	28.21	10.563	8.296
5/16	.332	.261	.0977	.0767	5/16	37.31	29.30	10.973	8.618
3/8	.478	.376	.1406	.1105	3/8	38.73	30.42	11.391	8.946
7/16	.651	.511	.1914	.1503	7/16	40.18	31.55	11.816	9.281
1/2	.850	.668	.2500	.1963	1/2	41.65	32.71	12.250	9.621
9/16	1.076	.845	.3164	.2485	9/16	43.15	33.89	12.691	9.968
5/8	1.328	1.043	.3906	.3068	5/8	44.68	35.09	13.141	10.321
11/16	1.607	1.262	.4727	.3712	11/16	46.23	36.31	13.598	10.680
3/4	1.913	1.502	.5625	.4418	3/4	47.81	37.55	14.063	11.045
13/16	2.245	1.763	.6602	.5185	13/16	49.42	38.81	14.535	11.416
7/8	2.603	2.044	.7656	.6013	7/8	51.05	40.10	15.016	11.793
15/16	2.988	2.347	.8789	.6903	15/16	52.71	41.40	15.504	12.177
1	3.400	2.670	1.0000	.7854	4	54.40	42.73	16.000	12.566
1/16	3.838	3.015	1.1289	.8866	1/16	56.11	44.07	16.504	12.962
1/8	4.303	3.380	1.2656	.9940	1/8	57.85	45.44	17.016	13.364
3/16	4.795	3.766	1.4102	1.1075	3/16	59.62	46.83	17.535	13.772
1/4	5.313	4.172	1.5625	1.2272	1/4	61.41	48.23	18.063	14.186
5/16	5.857	4.600	1.7227	1.3530	5/16	63.23	49.66	18.598	14.607
3/8	6.428	5.049	1.8906	1.4849	3/8	65.08	51.11	19.141	15.033
7/16	7.026	5.518	2.0664	1.6230	7/16	66.95	52.58	19.691	15.466
1/2	7.650	6.008	2.2500	1.7671	1/2	68.85	54.07	20.250	15.904
9/16	8.301	6.519	2.4414	1.9175	9/16	70.78	55.59	20.816	16.349
5/8	8.978	7.051	2.6406	2.0739	5/8	72.73	57.12	21.391	16.800
11/16	9.682	7.604	2.8477	2.2365	11/16	74.71	58.67	21.973	17.257
3/4	10.413	8.178	3.0625	2.4053	3/4	76.71	60.25	22.563	17.721
13/16	11.170	8.773	3.2852	2.5802	13/16	78.74	61.85	23.160	18.190
7/8	11.953	9.388	3.5156	2.7612	7/8	80.80	63.46	23.766	18.665
15/16	12.763	10.024	3.7539	2.9483	15/16	82.89	65.10	24.379	19.147
2	13.600	10.681	4.0000	3.1416	5	85.00	66.76	25.000	19.635
1/16	14.463	11.359	4.2539	3.3410	1/16	87.14	68.44	25.629	20.129
1/8	15.353	12.058	4.5156	3.5466	1/8	89.30	70.14	26.266	20.629
3/16	16.270	12.778	4.7852	3.7583	3/16	91.49	71.86	26.910	21.135
1/4	17.213	13.519	5.0625	3.9761	1/4	93.71	73.60	27.563	21.648
5/16	18.182	14.280	5.3477	4.2000	5/16	95.96	75.36	28.223	22.166
3/8	19.178	15.062	5.6406	4.4301	3/8	98.23	77.15	28.891	22.691
7/16	20.201	15.866	5.9414	4.6664	7/16	100.53	78.95	29.566	23.221
1/2	21.250	16.690	6.2500	4.9087	1/2	102.85	80.78	30.250	23.758
9/16	22.326	17.534	6.5664	5.1572	9/16	105.20	82.62	30.941	24.301
5/8	23.428	18.400	6.8906	5.4119	5/8	107.58	84.49	31.641	24.850
11/16	24.557	19.287	7.2227	5.6727	11/16	109.98	86.38	32.348	25.406
3/4	25.713	20.195	7.5625	5.9396	3/4	112.41	88.29	33.063	25.967
13/16	26.895	21.123	7.9102	6.2126	13/16	114.87	90.22	33.785	26.535
7/8	28.103	22.072	8.2656	6.4918	7/8	117.35	92.17	34.516	27.109
15/16	29.338	23.042	8.6289	6.7771	15/16	119.86	94.14	35.254	27.688
3	30.600	24.033	9.0000	7.0686	6	122.40	96.13	36.000	28.274

SQUARE AND ROUND BARS

WEIGHTS AND AREAS

Size, Inches	Weight, Lbs. per Foot		Area, Square Inches		Size, Inches	Weight, Lbs. per Foot		Area, Square Inches	
	□	○	□	○		□	○	□	○
6	122.40	96.13	36.000	28.274	9	275.40	216.30	81.000	63.617
1/16	124.96	98.15	36.754	28.866	1/16	279.24	219.31	82.129	64.504
1/8	127.55	100.18	37.516	29.465	1/8	283.10	222.35	83.266	65.397
3/16	130.17	102.23	38.285	30.069	3/16	286.99	225.41	84.410	66.296
1/4	132.81	104.31	39.063	30.680	1/4	290.91	228.48	85.563	67.201
5/16	135.48	106.41	39.848	31.296	5/16	294.86	231.58	86.723	68.112
3/8	138.18	108.53	40.641	31.919	3/8	298.83	234.70	87.891	69.029
7/16	140.90	110.66	41.441	32.548	7/16	302.83	237.84	89.066	69.953
1/2	143.65	112.82	42.250	33.183	1/2	306.85	241.00	90.250	70.882
9/16	146.43	115.00	43.066	33.824	9/16	310.90	244.18	91.441	71.818
5/8	149.23	117.20	43.891	34.472	5/8	314.98	247.38	92.641	72.760
11/16	152.06	119.43	44.723	35.125	11/16	319.08	250.61	93.848	73.708
3/4	154.91	121.67	45.563	35.785	3/4	323.21	253.85	95.063	74.662
13/16	157.79	123.93	46.410	36.450	13/16	327.37	257.12	96.285	75.622
7/8	160.70	126.22	47.266	37.122	7/8	331.55	260.40	97.516	76.589
15/16	163.64	128.52	48.129	37.800	15/16	335.76	263.71	98.754	77.561
7	166.60	130.85	49.000	38.485	10	340.00	267.04	100.000	78.540
1/16	169.59	133.19	49.879	39.175	1/16	344.26	270.38	101.254	79.525
1/8	172.60	135.56	50.766	39.871	1/8	348.55	273.75	102.516	80.516
3/16	175.64	137.95	51.660	40.574	3/16	352.87	277.14	103.785	81.513
1/4	178.71	140.36	52.563	41.282	1/4	357.21	280.55	105.063	82.516
5/16	181.81	142.79	53.473	41.997	5/16	361.58	283.99	106.348	83.525
3/8	184.93	145.24	54.391	42.718	3/8	365.98	287.44	107.641	84.541
7/16	188.07	147.71	55.316	43.445	7/16	370.40	290.91	108.941	85.563
1/2	191.25	150.21	56.250	44.179	1/2	374.85	294.41	110.250	86.590
9/16	194.45	152.72	57.191	44.918	9/16	379.33	297.92	111.566	87.624
5/8	197.68	155.26	58.141	45.664	5/8	383.83	301.46	112.891	88.664
11/16	200.93	157.81	59.098	46.415	11/16	388.36	305.02	114.223	89.710
3/4	204.21	160.39	60.063	47.173	3/4	392.91	308.59	115.563	90.763
13/16	207.52	162.99	61.035	47.937	13/16	397.49	312.19	116.910	91.821
7/8	210.85	165.60	62.016	48.707	7/8	402.10	315.81	118.266	92.886
15/16	214.21	168.24	63.004	49.483	15/16	406.74	319.45	119.629	93.957
8	217.60	170.90	64.000	50.265	11	411.40	323.11	121.000	95.033
1/16	221.01	173.58	65.004	51.054	1/16	416.09	326.80	122.379	96.116
1/8	224.45	176.29	66.016	51.849	1/8	420.80	330.50	123.766	97.205
3/16	227.92	179.01	67.035	52.649	3/16	425.54	334.22	125.160	98.301
1/4	231.41	181.75	68.063	53.456	1/4	430.31	337.97	126.563	99.402
5/16	234.93	184.52	69.098	54.269	5/16	435.11	341.73	127.973	100.510
3/8	238.48	187.30	70.141	55.088	3/8	439.93	345.52	129.391	101.623
7/16	242.05	190.11	71.191	55.914	7/16	444.78	349.33	130.816	102.743
1/2	245.65	192.93	72.250	56.745	1/2	449.65	353.16	132.250	103.869
9/16	249.28	195.78	73.316	57.583	9/16	454.55	357.00	133.691	105.001
5/8	252.93	198.65	74.391	58.426	5/8	459.48	360.87	135.141	106.139
11/16	256.61	201.54	75.473	59.276	11/16	464.43	364.76	136.598	107.284
3/4	260.31	204.45	76.563	60.132	3/4	469.41	368.68	138.063	108.434
13/16	264.04	207.38	77.660	60.994	13/16	474.42	372.61	139.535	109.591
7/8	267.80	210.33	78.766	61.863	7/8	479.45	376.56	141.016	110.754
15/16	271.59	213.31	79.879	62.737	15/16	484.51	380.54	142.504	111.923
9	275.40	216.30	81.000	63.617	12	489.60	384.53	144.000	113.098

TOLERANCES FOR CB SECTIONS



ROLLING TOLERANCES

Size, Depth	A Depth		B Width of Flange		C and D Out of Square or Parallel	C Maximum Depth at any Point	E Web Off Center
	Over	Under	Over	Under			
Up to and including 12″	1/8″	1/8″	1/4″	3/16″	C minus D Not more than 3/16″	Not more than 1/4″ over normal	Not more than 3/16″
Over 12″	1/8″	1/8″	1/4″	3/16″	C minus D Not more than 1/4″	Not more than 1/4″ over normal	Not more than 3/16″

CUTTING TOLERANCES

Size, Depth	Up to 30′-0″, Incl.		Over 30′-0″		Special Tolerances
	Over	Under	Over	Under	
Beams 8″ to 24″, inclusive	3/8″	3/8″	3/8″ plus 1/16″ for each 5′-0″ or fraction thereof above 30′-0″	3/8″	Where tolerances are shown all over, nothing under, the plus tolerance applying to ordered length is the sum of the plus and minus tolerances shown in this table.
Beams over 24″	1/2″	1/2″	1/2″ plus 1/16″ for each 5′-0″ or fraction thereof above 30′-0″	1/2″	
Columns all Sizes	1/2″	1/2″	1/2″ plus 1/16″ for each 5′-0″ or fraction thereof above 30′-0″	1/2″	

Ends Out of Square: 1/64″ per inch of depth or flange width if greater than depth.

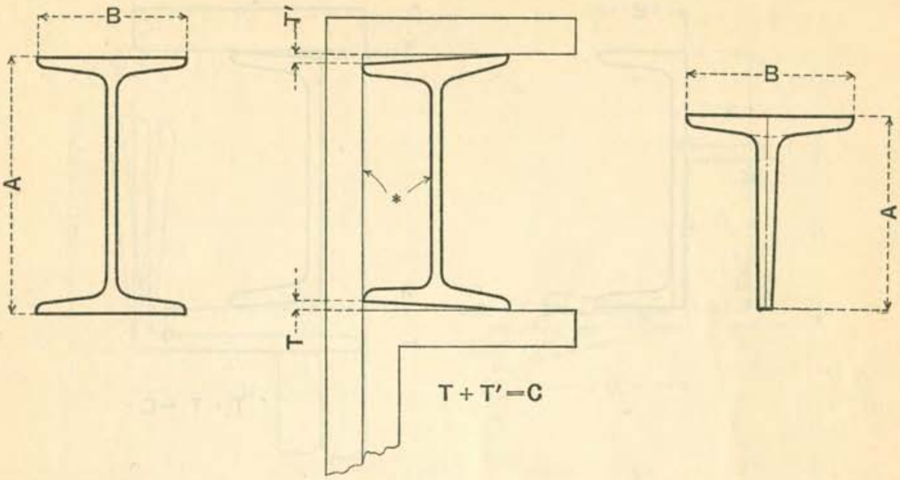
Allowance for Milling: For material which is to be milled customer should state on orders whether one or both ends are to be milled, what allowance has been made and whether we are to cut to standard or special tolerances as given above.

We recommend for material to be milled that ordered lengths be made as follows:
For milling one end only: Finished length plus 5/8″.
For milling both ends: Finished length plus 7/8″.

Camber and Sweep: Tolerances for Beams: $\frac{1}{8}'' \times \frac{\text{total length (in feet)}}{\text{ten feet}}$ or 1/2″ maximum.

Where sections are specified on orders as columns, the following tolerances will apply:
Lengths up to 30′-0″: $\frac{1}{8}'' \times \frac{\text{total length (in feet)}}{\text{ten feet}}$.
Lengths over 30′-0″: Not over 3/8″ total.

TOLERANCES FOR STANDARD BEAMS AND TEES



*Back of Square and Web to be parallel when measuring for out of Square.

ROLLING TOLERANCES

Size, Depth	A Depth		B Width of Flanges		C Out of Square or Parallel	Weight	
	Over	Under	Over	Under		Over	Under
3" to 7", Incl.	3/32"	1/16"	1/8"	1/8"	1/32" per Inch of Flange Width	2½%	2½%
8" to 14", Incl.	1/8"	3/32"	5/32"	5/32"		2½%	2½%
15" to 24", Incl.	3/16"	1/8"	3/16"	3/16"		2½%	2½%

CUTTING TOLERANCES

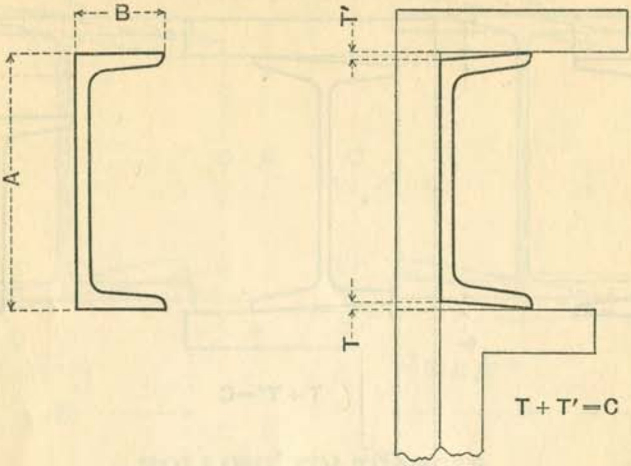
Size, Depth	Up to 10'-0", Incl.		Over 10'-0" to 20'-0", Incl.		Over 20'-0" to 30'-0", Incl.		Over 30'-0" to 40'-0", Incl.		Over 40'-0" to 50'-0", Incl.		Over 50'-0"	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Structural Beams	3/8"	3/8"	3/8"	3/8"	3/8"	3/8"	5/8"	3/8"	7/8"	3/8"	1"	3/8"
Structural Tees	3/4"	0	3/4"	0	3/4"	0	1"	0	1¼"	0	1¼"	0

Cold or Hot Sawing Off Square: 1/64" per Inch of Depth.

$$\text{Camber Tolerance} = \tfrac{1}{8}'' \times \frac{\text{total length (in feet)}}{\text{five feet}}.$$

Weight Tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per Linear Foot as the case may be.

TOLERANCES FOR CHANNELS



ROLLING TOLERANCES

Size, Depth	A Depth		B Width of Flanges		C Out of Square or Parallel	Weight	
	Over	Under	Over	Under		Over	Under
3" to 7", Incl.	3/32"	1/16"	1/8"	1/8"	1/32" per Inch of Flange Width	2½%	2½%
8" to 14", Incl.	1/8"	3/32"	1/8"	5/32"		2½%	2½%
15" to 18", Incl.	3/16"	1/8"	1/8"	3/16"		2½%	2½%

CUTTING TOLERANCES

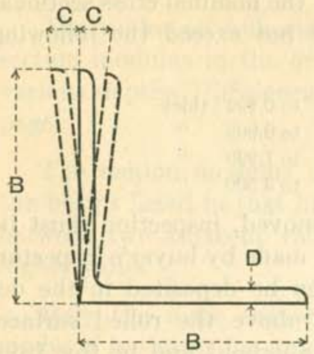
Size, Depth	Up to 10'-0", Incl.		Over 10'-0" to 20'-0", Incl.		Over 20'-0" to 30'-0", Incl.		Over 30'-0" to 40'-0", Incl.		Over 40'-0" to 50'-0", Incl.		Over 50'-0"	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Structural	3/8"	3/8"	3/8"	3/8"	3/8"	3/8"	5/8"	3/8"	7/8"	3/8"	1"	3/8"

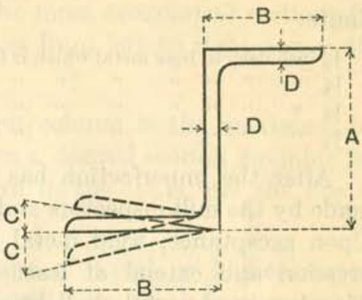
Cold or Hot Sawing Off Square: 1/64" per Inch of Depth.

$$\text{Camber Tolerance} = \tfrac{1}{8}'' \times \frac{\text{total length (in feet)}}{\text{five feet}}.$$

Weight Tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per Linear Foot as the case may be.

TOLERANCES FOR STRUCTURAL ANGLES AND ZEES





ROLLING TOLERANCES

Size, Length of Leg	Gages	A Depth of Section		B Length of Leg		C Out of Square	D Gage		Weight	
		Over	Under	Over	Under		Over	Under	Over	Under
3″ to 4″, Incl.	All	⅛″	1/16″	⅛″	3/32″	1½° or 3/128″ per Inch of Leg Length	2½%	2½%	2½%	2½%
5″ to 6″, Incl.	All	⅛″	1/16″	⅛″	⅛″		2½%	2½%	2½%	2½%
Over 6″	All	⅛″	1/16″	3/16″	⅛″		2½%	2½%	2½%	2½%

CUTTING TOLERANCES

Size, Length of Leg	Gages	Up to 10′-0″, Incl.		Over 10′-0″ to 20′-0″, Incl.		Over 20′-0″ to 30′-0″, Incl.		Over 30′-0″ to 40′-0″, Incl.		Over 40′-0″	
		Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Structural	All	¾″	0	¾″	0	¾″	0	1″	0	1¼″	0

Cold or Hot Sawing Off Square: 1½ Degrees or 3/128″ per Inch of Leg Length.

$$\text{Camber Tolerance} = \tfrac{1}{8}'' \times \frac{\text{total length (in feet)}}{\text{five feet}}.$$

Weight Tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per Linear Foot as the case may be.

Longer Leg of Unequal Leg Angle determines size for Tolerances.

SURFACE IMPERFECTIONS

Surface imperfections in structural shapes may be removed by chipping to a depth necessary to reach sound metal but not to exceed one and one-half (1.5) per cent of the nominal cross sectional area. The depth of the chipping shall not exceed the following limits:

1/16 inch deep in base metal which is from	0.375″	to 0.499″	thick
1/8 " " " " " " " "	0.500	to 0.999	"
1/4 " " " " " " " "	1.000	to 1.999	"
3/8 " " " " " " " "	2.000	to 3.500	"

After the imperfection has been removed, inspection must be made by the mill inspectors and may be made by buyer's inspector. Upon acceptance, weld metal shall then be deposited in the depression and extend at least 1/8 inch above the rolled surface. The deposited metal shall be sound throughout and be free from excessive oxides, non-metallic inclusions and gas pockets. It shall penetrate every recess in the base metal and shall be thoroughly fused with it along all surfaces and edges of fusion. Along the edges of deposit the weld metal shall merge with a gradual taper into the base metal without re-entrant projection (overlap). The base metal along the edges of the removed area shall not be reduced in thickness (undercut) by welding operator.

After welding, all metal projecting above the rolled surface shall be removed by chipping or grinding to produce a workmanlike finish.

CAMBERING OF CB SECTIONS

The maximum camber at mid-length of beam that the mill can secure without crippling of the web is 3½ inches. The maximum length that can be conveniently handled is 75 feet, but all the sections and weights cannot be furnished to this length.

Cambering is subject to a plus or minus tolerance of 3/8 inch at mid-length of beam.

MINIMUM LENGTHS AND MAXIMUM CAMBER

Section Index	Camber at Center					
	3½″	3″	2½″	2″	1½″	1″
	Minimum Lengths in Feet					
CB 362, 361, 332, 331, 302, 301, 272, 271, 243, 242, 241 ..... B 18, 2, 6	55	50	45	40	35	27
CB 213, 212, 211, 183, 182, 181, 163, 162, 161, 143, 142, 141, 122, 121, 102, 101, 82, 81 ... B 1, 3, 4, 7, 8, 9, 10, 12	50	45	40	35	30	24

EXPLANATION OF TABLE OF

ECONOMY OF CB BEAMS BY SECTION MODULUS

The tables on following pages list CB Sections for the given section modulus in the order of the most economical sections for various depths. Efficiencies decrease from left to right across the page.

The section modulus in the first column is the maximum for the beams listed in that line. When a desired section modulus lies between two adjacent values shown in the table, use the line of higher value.

Only the most economical shape of equal or higher section modulus is shown for any given depth. No depth is given whose most economical shape is surpassed in economy by a beam of less depth. In general, the shapes given under the heading "First Selection" are the most economical. There are, however, cases in which deeper beams of equal economy are available. If the "First Selection" is too deep for framing, use the next selection in that line which has a suitable depth. It will be the most economical CB Section for the given conditions of required strength and depth.

EXAMPLE. Select a beam for section modulus of 150 with depth not over 17 inches.

In the table, opposite the next higher section modulus, namely 150.6 we find that CB 211 x 73 is the most economical section but since the depth must be less than 17 inches, we find under column "Third Selection" that CB 163 x 88 is the proper one to use. The actual depth of this section is 16.16 inches and the section modulus 151.3 inches^3.

All beams are to be secured against lateral deflection.

ECONOMY OF CB BEAMS BY SECTION MODULUS

Section Modulus, Inches³	CB SECTION—INDEX AND WEIGHT PER FOOT					
	First Selection	Second Selection	Third Selection	Fourth Selection	Fifth Selection	Sixth Selection
1105.1	CB 362 x 300					
1031.2	CB 362 x 280					
951.1	CB 362 x 260					
911.7	CB 362 x 250					
873.6	CB 362 x 240					
835.5	CB 362 x 230					
811.1	CB 362 x 230	CB 332 x 240				
740.6	CB 332 x 220					
704.4	CB 332 x 210					
669.6	CB 332 x 200					
663.6	CB 361 x 194	CB 332 x 200				
649.9	CB 361 x 194	CB 332 x 200	CB 302 x 210			
621.2	CB 361 x 182	CB 332 x 200	CB 302 x 210			
617.6	CB 361 x 182	CB 332 x 200	CB 302 x 200			
586.1	CB 361 x 182	CB 302 x 190				
579.1	CB 361 x 170	CB 302 x 190				
555.2	CB 361 x 170	CB 302 x 180				
541.0	CB 361 x 160	CB 302 x 180				
528.2	CB 361 x 160	CB 302 x 172				
502.9	CB 361 x 150	CB 302 x 172				
492.8	CB 361 x 150	CB 302 x 172	CB 272 x 177			
486.4	CB 361 x 150	CB 331 x 152	CB 302 x 172	CB 272 x 177		
452.9	CB 361 x 150	CB 331 x 152	CB 272 x 163			
446.8	CB 331 x 141	CB 272 x 163				
427.8	CB 331 x 141	CB 272 x 154				
413.5	CB 331 x 132	CB 272 x 154	CB 243 x 160			
402.9	CB 331 x 132	CB 272 x 145	CB 243 x 160			
385.5	CB 331 x 132	CB 272 x 145	CB 243 x 150			
385.1	CB 331 x 125	CB 272 x 145	CB 243 x 150			
379.7	CB 331 x 125	CB 301 x 132	CB 272 x 145	CB 243 x 150		
358.6	CB 331 x 125	CB 301 x 132	CB 243 x 140			
354.6	CB 301 x 124	CB 243 x 140				
330.7	CB 301 x 124	CB 243 x 130				
327.9	CB 301 x 116	CB 242 x 130				
317.2	CB 301 x 116	CB 242 x 130	CB 213 x 142			
299.1	CB 301 x 108	CB 271 x 114	CB 242 x 120	CB 213 x 142		
294.8	CB 301 x 108	CB 271 x 114	CB 242 x 120	CB 213 x 132		
277.2	CB 271 x 106	CB 242 x 120	CB 213 x 132			
274.4	CB 271 x 106	CB 242 x 110	CB 213 x 132			
272.5	CB 271 x 106	CB 242 x 110	CB 213 x 122			
255.3	CB 271 x 98	CB 242 x 110	CB 213 x 122			
249.6	CB 271 x 98	CB 242 x 110	CB 213 x 112			
248.9	CB 271 x 98	CB 242 x 100	CB 213 x 112			
239.0	CB 271 x 98	CB 242 x 100	CB 213 x 112	CB 183 x 124		
233.2	CB 271 x 91	CB 242 x 100	CB 213 x 112	CB 183 x 124		
220.9	CB 271 x 91	CB 241 x 94	CB 213 x 112	CB 183 x 124		
220.1	CB 271 x 91	CB 241 x 94	CB 213 x 112	CB 183 x 114		
216.0	CB 271 x 91	CB 241 x 94	CB 213 x 112	CB 183 x 114	CB 145 x 136	
213.1	CB 271 x 91	CB 241 x 94	CB 212 x 103	CB 183 x 114	CB 145 x 136	
204.3	CB 241 x 87	CB 212 x 103	CB 183 x 114	CB 145 x 136		
202.0	CB 241 x 87	CB 212 x 103	CB 183 x 105	CB 145 x 127		
197.4	CB 241 x 87	CB 212 x 96	CB 183 x 105	CB 163 x 114	CB 145 x 127	

ECONOMY OF CB BEAMS BY SECTION MODULUS

Section Modulus, Inches[3]	CB SECTION—INDEX AND WEIGHT PER FOOT					
	First Selection	Second Selection	Third Selection	Fourth Selection	Fifth Selection	Sixth Selection
189.4	CB 241 x 87	CB 212 x 96	CB 183 x 105	CB 163 x 114	CB 145 x 119	
185.8	CB 241 x 80	CB 212 x 96	CB 183 x 105	CB 163 x 114	CB 145 x 119	
184.4	CB 241 x 80	CB 212 x 96	CB 183 x 96	CB 163 x 114	CB 145 x 119	
182.8	CB 241 x 80	CB 212 x 89	CB 183 x 96	CB 163 x 114	CB 145 x 119	
181.7	CB 241 x 80	CB 212 x 89	CB 183 x 96	CB 163 x 105	CB 145 x 119	
176.3	CB 241 x 80	CB 212 x 89	CB 183 x 96	CB 163 x 105	CB 145 x 111	
170.4	CB 241 x 74	CB 212 x 89	CB 183 x 96	CB 163 x 105	CB 145 x 111	
168.0	CB 241 x 74	CB 212 x 82	CB 183 x 96	CB 163 x 105	CB 145 x 111	
166.1	CB 241 x 74	CB 212 x 82	CB 183 x 96	CB 163 x 96	CB 145 x 111	
163.4	CB 241 x 74	CB 212 x 82	CB 183 x 96	CB 163 x 96	CB 145 x 103	CB 124 x 120
156.1	CB 241 x 74	CB 212 x 82	CB 182 x 85	CB 163 x 96	CB 145 x 103	CB 124 x 120
151.3	CB 241 x 74	CB 212 x 82	CB 182 x 85	CB 163 x 88	CB 145 x 103	CB 124 x 120
150.6	CB 211 x 73	CB 182 x 85	CB 163 x 88	CB 145 x 95	CB 124 x 120	
144.5	CB 211 x 73	CB 182 x 85	CB 163 x 88	CB 145 x 95	CB 124 x 106	
141.7	CB 211 x 73	CB 182 x 77	CB 163 x 88	CB 145 x 95	CB 124 x 106	
139.9	CB 211 x 68	CB 182 x 77	CB 163 x 88	CB 145 x 95	CB 124 x 106	
138.1	CB 211 x 68	CB 182 x 77	CB 145 x 87	CB 124 x 106		
134.7	CB 211 x 68	CB 182 x 77	CB 145 x 87	CB 124 x 99		
130.9	CB 211 x 68	CB 182 x 77	CB 144 x 84	CB 124 x 99		
128.2	CB 211 x 68	CB 182 x 70	CB 144 x 84	CB 124 x 99		
127.8	CB 211 x 63	CB 182 x 70	CB 162 x 78	CB 144 x 84	CB 124 x 99	
125.0	CB 211 x 63	CB 182 x 70	CB 162 x 78	CB 144 x 84	CB 124 x 92	
121.1	CB 211 x 63	CB 182 x 70	CB 162 x 78	CB 144 x 78	CB 124 x 92	
119.3	CB 211 x 59	CB 182 x 70	CB 162 x 78	CB 144 x 78	CB 124 x 92	
117.0	CB 211 x 59	CB 182 x 64	CB 162 x 78	CB 144 x 78	CB 124 x 92	
115.7	CB 211 x 59	CB 182 x 64	CB 162 x 71	CB 144 x 78	CB 124 x 85	
112.3	CB 211 x 59	CB 182 x 64	CB 162 x 71	CB 143 x 74	CB 124 x 85	CB 103 x 100
107.1	CB 211 x 59	CB 182 x 64	CB 162 x 71	CB 143 x 74	CB 124 x 79	CB 103 x 100
104.2	CB 211 x 59	CB 182 x 64	CB 162 x 64	CB 143 x 74	CB 124 x 79	CB 103 x 100
103.0	CB 211 x 59	CB 182 x 64	CB 162 x 64	CB 143 x 68	CB 124 x 79	CB 103 x 100
99.7	CB 211 x 59	CB 182 x 64	CB 162 x 64	CB 143 x 68	CB 124 x 79	CB 103 x 89
98.2	CB 181 x 55	CB 162 x 64	CB 143 x 68	CB 124 x 79	CB 103 x 89	
97.5	CB 181 x 55	CB 162 x 64	CB 143 x 68	CB 124 x 72	CB 103 x 89	
94.1	CB 181 x 55	CB 162 x 58	CB 143 x 68	CB 124 x 72	CB 103 x 89	
92.2	CB 181 x 55	CB 162 x 58	CB 143 x 61	CB 124 x 72	CB 103 x 89	
89.0	CB 181 x 50	CB 162 x 58	CB 143 x 61	CB 124 x 72	CB 103 x 89	
88.0	CB 181 x 50	CB 162 x 58	CB 143 x 61	CB 124 x 65	CB 103 x 89	
86.1	CB 181 x 50	CB 162 x 58	CB 143 x 61	CB 124 x 65	CB 103 x 77	
85.8	CB 181 x 50	CB 162 x 58	CB 143 x 61	CB 123 x 64	CB 103 x 77	
85.0	CB 181 x 50	CB 162 x 58	CB 142 x 58	CB 123 x 64	CB 103 x 77	
82.3	CB 181 x 47	CB 162 x 58	CB 142 x 58	CB 123 x 64	CB 103 x 77	
80.7	CB 181 x 47	CB 161 x 50	CB 142 x 58	CB 123 x 64	CB 103 x 77	
80.1	CB 181 x 47	CB 161 x 50	CB 142 x 58	CB 123 x 64	CB 103 x 72	
78.1	CB 181 x 47	CB 161 x 50	CB 142 x 58	CB 123 x 58	CB 103 x 72	
77.8	CB 181 x 47	CB 161 x 50	CB 142 x 53	CB 123 x 58	CB 103 x 72	
73.7	CB 181 x 47	CB 161 x 50	CB 142 x 53	CB 123 x 58	CB 103 x 66	
72.4	CB 161 x 45	CB 142 x 53	CB 123 x 58	CB 103 x 66		
70.7	CB 161 x 45	CB 142 x 53	CB 123 x 53	CB 103 x 66		
70.2	CB 161 x 45	CB 142 x 48	CB 123 x 53	CB 103 x 66		
67.1	CB 161 x 45	CB 142 x 48	CB 123 x 53	CB 103 x 60		
64.7	CB 161 x 45	CB 142 x 48	CB 122 x 50	CB 103 x 60		
64.4	CB 161 x 40	CB 142 x 48	CB 122 x 50	CB 103 x 60		

ECONOMY OF CB BEAMS BY SECTION MODULUS

Section Modulus, Inches³	CB SECTION—INDEX AND WEIGHT PER FOOT					
	First Selection	Second Selection	Third Selection	Fourth Selection	Fifth Selection	Sixth Selection
62.7	CB 161 x 40	CB 142 x 43	CB 122 x 50	CB 103 x 60		
60.7	CB 161 x 40	CB 141 x 42	CB 122 x 50	CB 103 x 60		
60.4	CB 161 x 40	CB 141 x 42	CB 122 x 50	CB 103 x 54	CB 83 x 67	
58.2	CB 161 x 40	CB 141 x 42	CB 122 x 45	CB 103 x 54	CB 83 x 67	
56.3	CB 161 x 36	CB 141 x 42	CB 122 x 45	CB 103 x 54	CB 83 x 67	
54.6	CB 161 x 36	CB 141 x 38	CB 122 x 45	CB 103 x 49	CB 83 x 67	
51.9	CB 161 x 36	CB 141 x 38	CB 122 x 40	CB 103 x 49	CB 83 x 58	
49.1	CB 161 x 36	CB 141 x 38	CB 122 x 40	CB 102 x 45	CB 83 x 58	
48.5	CB 141 x 34	CB 122 x 40	CB 102 x 45	CB 83 x 58		
45.9	CB 141 x 34	CB 121 x 36	CB 102 x 45	CB 83 x 58		
44.5	CB 141 x 34	CB 121 x 36	CB 102 x 41	CB 83 x 58		
43.2	CB 141 x 34	CB 121 x 36	CB 102 x 41	CB 83 x 48		
41.8	CB 141 x 30	CB 121 x 36	CB 102 x 41	CB 83 x 48		
40.7	CB 141 x 30	CB 121 x 32	CB 102 x 41	CB 83 x 48		
39.9	CB 141 x 30	CB 121 x 32	CB 102 x 37	CB 83 x 48		
35.5	CB 121 x 28	CB 102 x 37	CB 83 x 40			
35.0	CB 121 x 28	CB 102 x 33	CB 83 x 40			
31.1	CB 121 x 28	CB 102 x 33	CB 83 x 35			
30.8	CB 121 x 25	CB 101 x 29	CB 83 x 35			
29.3	CB 121 x 25	CB 101 x 29	CB 83 x 33			
27.6	CB 121 x 25	CB 101 x 26	CB 83 x 33			
27.4	CB 121 x 25	CB 101 x 26	CB 83 x 31			
25.3	CBL 12 x 22	CB 101 x 26	CB 83 x 31			
24.1	CBL 12 x 22	CB 101 x 23	CB 83 x 31			
23.4	CBL 12 x 22	CB 101 x 23	CB 82 x 27			
21.4	CBL 12 x 19	CB 101 x 21	CB 82 x 27			
20.8	CBL 12 x 19	CB 101 x 21	CB 82 x 24			
18.8	CBL 12 x 19	CBL 10 x 19	CB 82 x 24			
18.0	CBL 12 x 19	CBL 10 x 19	CB 81 x 21			
17.5	CBL 12 x 16½	CBL 10 x 19	CB 81 x 21			
16.2	CBL 12 x 16½	CBL 10 x 17	CB 81 x 21			
16.0	CBL 12 x 16½	CBL 10 x 17	CB 81 x 19			
14.1	CBL 12 x 16½	CBL 10 x 17	CB 81 x 17			
13.8	CBL 10 x 15	CB 81 x 17				
11.8	CBL 10 x 15	CBL 8 x 15				
10.1	CBL 10 x 15	CBL 8 x 15	CBL 6 x 16			
9.9	CBL 8 x 13	CBL 6 x 16				
7.2	CBL 6 x 12					

ELEMENTS OF SECTIONS

In the computation of the values of structural shapes for the various conditions under which they are subjected to stress, the following mathematical expressions are used.

Neutral Axis is the line, in the cross section of a beam or column in a state of flexure, on which there is neither tension nor compression. The neutral axis passes through the center of gravity of the section when unit stresses do not exceed the elastic limit of the material. In the usual position of structural sections there are two neutral axes, perpendicular to each other, their normal position with relation to the section being designated by x and y.

Moment of Inertia, I, is the sum of the products obtained by multiplying each of the elementary areas of which the section is composed, by the square of its normal distance from a neutral axis of the section or from any axis of moments assumed for purposes of calculation.

Section Modulus, S, is the moment of inertia divided by the normal distance from the axis to which it refers, to extreme fiber of the section.

The section modulus is used to determine the stress in the extreme fiber of a section, subjected to bending stresses, by dividing the bending moment by the section modulus referred to neutral axis normal to line of action of the load; both values in like units of measure. The section modulus required is obtained by dividing the bending stress by the allowable unit stress, both values in like units of measure. The proper section is then obtained for the section modulus by reference to the tables of Elements of Sections.

Radius of Gyration, r, is the normal distance from a neutral axis to the center of gyration, the point where the entire area is considered to be concentrated and have the same moment of inertia as the actual area. The radius of gyration of a section referred to a neutral axis, or any axis of moments, is equal to the square root of the quotient obtained by dividing the moment of inertia about that axis by the area.

The radius of gyration of a section is used to ascertain the safe load this section will sustain when used in compression, as a strut or column. The unbraced length in inches of the section in compression divided by the least radius of gyration is its ratio of slenderness, l/r.

GENERAL NOTATION IN FORMULAS

The following notation applies to formulas and tables for elements or physical properties of sections, also to flexure formulas and other data given for beams under various loading conditions:

A = Area of section, in square inches.
n = Distance from center line of gravity to extreme fiber, in inches.
I = Moment of inertia about center line of gravity, in inches^4.
M_s = Static moment, in inches^3.
S = Section modulus, in inches^3.
r = Radius of gyration, in inches.
f = Bending stress in extreme fiber, in pounds per square inch.
f_b = Resistance of web, in pounds per square inch.
E = Modulus of elasticity, in pounds per square inch.
b = Width of flange of section, in inches.
d = Depth of section, in inches.
B = Minimum end bearing for maximum allowable shear in web.
L = Length of section, in feet.
l = Length of section, in inches.
W, W_1, W_2 = Superimposed loads supported by beam, in pounds.
w = Superimposed load, in pounds per unit length or area.
W_{max} = Maximum safe load at point given, in pounds.
R, R_1 = Reactions at points of support, in pounds.
V = Vertical shear, in pounds.
M, M_1, M_2 = Bending moments at points given, in inch pounds.
M_{max} = Maximum bending moment, in inch pounds.
M_r = Maximum resisting moment, in inch pounds.
D, D_1 = Deflections at points given, in inches.
D_{max} = Maximum deflection at point given, in inches.

The common relations existing between the properties of any shape of uniform cross section are the following:

$$I = Ar^2 \qquad r = \sqrt{\frac{I}{A}} \qquad S = \frac{I}{n}$$

The moment of inertia, I_1, which is about an axis parallel to the neutral axis of the section and at z distance from it, is: $I_1 = I + Az^2$.

The moment of resistance to the internal stresses of a beam resisting flexure must be equal to the moment of the external forces producing bending.

$$M_r = M_{max} = f\frac{I}{n} = f\,S.$$

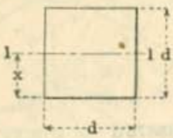
The moment of resistance and the bending moment must, therefore, be expressed in same units of moment, force times length, generally in inch-pounds.

The modulus of elasticity is the ratio between unit stress and the elongation caused by that stress in one unit of length, up to the elastic limit; for steel the modulus of elasticity is 29,000,000 pounds per square inch.

ELEMENTS OF SECTIONS

SQUARE

Axis of moments through center



$$A = d^2$$

$$x = \frac{d}{2}$$

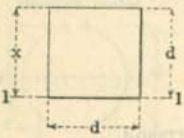
$$I_{1\text{-}1} = \frac{d^4}{12}$$

$$S_{1\text{-}1} = \frac{d^3}{6}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{12}} = 0.288675\,d$$

SQUARE

Axis of moments on base



$$A = d^2$$

$$x = d$$

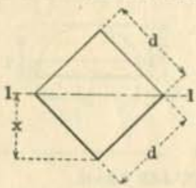
$$I_{1\text{-}1} = \frac{d^4}{3}$$

$$S_{1\text{-}1} = \frac{d^3}{3}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{3}} = 0.577350\,d$$

SQUARE

Axis of moments on diagonal



$$A = d^2$$

$$x = \frac{d}{\sqrt{2}} = 0.707107\,d$$

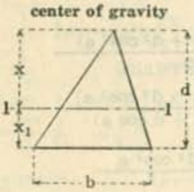
$$I_{1\text{-}1} = \frac{d^4}{12}$$

$$S_{1\text{-}1} = \frac{d^3}{6\sqrt{2}} = 0.117851\,d^3$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{12}} = 0.288675\,d$$

TRIANGLE

Axis of moments through center of gravity



$$A = \frac{bd}{2}$$

$$x = \frac{2d}{3} \qquad x_1 = \frac{d}{3}$$

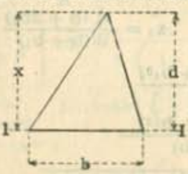
$$I_{1\text{-}1} = \frac{bd^3}{36}$$

$$S_{1\text{-}1} = \frac{bd^2}{24}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{18}} = 0.235702\,d$$

TRIANGLE

Axis of moments on base



$$A = \frac{bd}{2}$$

$$x = d$$

$$I_{1\text{-}1} = \frac{bd^3}{12}$$

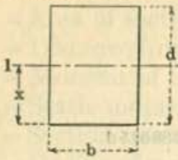
$$S_{1\text{-}1} = \frac{bd^2}{12}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{6}} = 0.408248\,d$$

ELEMENTS OF SECTIONS

RECTANGLE

Axis of moments through center



$$A = bd$$

$$x = \frac{d}{2}$$

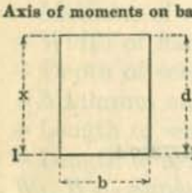
$$I_{1\text{-}1} = \frac{bd^3}{12}$$

$$S_{1\text{-}1} = \frac{bd^2}{6}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{12}} = 0.288675\,d$$

RECTANGLE

Axis of moments on base



$$A = bd$$

$$x = d$$

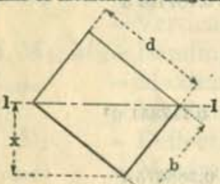
$$I_{1\text{-}1} = \frac{bd^3}{3}$$

$$S_{1\text{-}1} = \frac{bd^2}{3}$$

$$r_{1\text{-}1} = \frac{d}{\sqrt{3}} = 0.577350\,d$$

RECTANGLE

Axis of moments on diagonal



$$A = bd$$

$$x = \frac{bd}{\sqrt{b^2+d^2}}$$

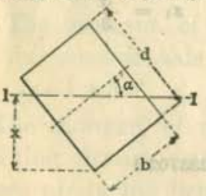
$$I_{1\text{-}1} = \frac{b^3\,d^3}{6\,(b^2+d^2)}$$

$$S_{1\text{-}1} = \frac{b^2\,d^2}{6\sqrt{b^2+d^2}}$$

$$r_{1\text{-}1} = \frac{bd}{\sqrt{6\,(b^2+d^2)}}$$

RECTANGLE

Axis of moments any line through center of gravity



$$A = bd$$

$$x = \frac{b \sin \alpha + d \cos \alpha}{2}$$

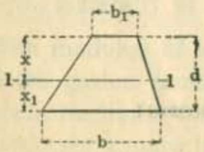
$$I_{1\text{-}1} = \frac{bd\,(b^2 \sin^2 \alpha + d^2 \cos^2 \alpha)}{12}$$

$$S_{1\text{-}1} = \frac{bd\,(b^2 \sin^2 \alpha + d^2 \cos^2 \alpha)}{6\,(b \sin \alpha + d \cos \alpha)}$$

$$r_{1\text{-}1} = \sqrt{\frac{b^2 \sin^2 \alpha + d^2 \cos^2 \alpha}{12}}$$

TRAPEZOID

Axis of moments through center of gravity



$$A = \frac{d(b + b_1)}{2}$$

$$x = \frac{d(b_1 + 2b)}{3(b + b_1)} \qquad x_1 = \frac{d\,(b + 2b_1)}{3\,(b + b_1)}$$

$$I_{1\text{-}1} = \frac{d^3\,(b^2 + 4\,bb_1 + b_1^2)}{36\,(b + b_1)}$$

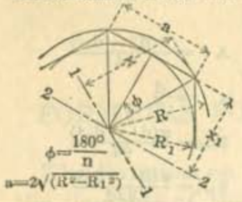
$$S_{1\text{-}1} = \frac{d^2\,(b^2 + 4\,bb_1 + b_1^2)}{12\,(b_1 + 2\,b)}$$

$$r_{1\text{-}1} = \frac{d}{6\,(b + b_1)}\sqrt{2\,(b^2 + 4\,bb_1 + b_1^2)}$$

ELEMENTS OF SECTIONS

REGULAR POLYGON

Axis of moments through center



$\phi = \frac{180^\circ}{n}$

$a = 2\sqrt{(R^2 - R_1^2)}$

n = Number of Sides

$$A = \tfrac{1}{4} n a^2 \cot\phi = \tfrac{1}{2} n R^2 \sin 2\phi = n R_1^2 \tan\phi$$

$$x = R = \frac{a}{2 \sin\phi} \qquad x_1 = R_1 = \frac{a}{2 \tan\phi}$$

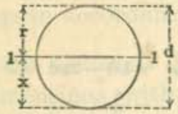
$$I_{1\text{-}1} = \frac{A(6R^2 - a^2)}{24} = I_{2\text{-}2} = \frac{A(12R_1^2 + a^2)}{48}$$

$$S_{1\text{-}1} = \frac{A(6R^2 - a^2)}{24R} \qquad S_{2\text{-}2} = \frac{A(12R_1^2 + a^2)}{48R_1}$$

$$r_{1\text{-}1} = \sqrt{\frac{6R^2 - a^2}{24}} = r_{2\text{-}2} = \sqrt{\frac{12R_1^2 + a^2}{48}}$$

CIRCLE

Axis of moments through center



$$A = \frac{\pi d^2}{4} = \pi r^2 \qquad 0.78540\, d^2 = 3.14159\, r^2$$

$$x = \frac{d}{2} = r$$

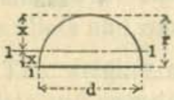
$$I_{1\text{-}1} = \frac{\pi d^4}{64} = \frac{\pi r^4}{4} \qquad 0.04909\, d^4 = 0.78540\, r^4$$

$$S_{1\text{-}1} = \frac{\pi d^3}{32} = \frac{\pi r^3}{4} \qquad 0.09818\, d^3 = 0.78540\, r^3$$

$$r_{1\text{-}1} = \frac{d}{4} = \frac{r}{2}$$

HALF CIRCLE

Axis of moments through center of gravity



$$A = \frac{\pi r^2}{2} = 1.57080\, r^2$$

$$x = r\left(1 - \frac{4}{3\pi}\right) = 0.57559\, r \qquad x_1 = \frac{4r}{3\pi} = 0.42441\, r$$

$$I_{1\text{-}1} = r^4\left(\frac{\pi}{8} - \frac{8}{9\pi}\right) = 0.10976\, r^4$$

$$S_{1\text{-}1} = \frac{r^3}{24}\,\frac{(9\pi^2 - 64)}{(3\pi - 4)} = 0.19069\, r^3$$

$$r_{1\text{-}1} = r\,\frac{\sqrt{9\pi^2 - 64}}{6\pi} = 0.26434\, r$$

HALF ELLIPSE

$$A = \tfrac{1}{2}\pi ab$$

$$m = \tfrac{4}{3}\tfrac{a}{\pi}$$

$$I_{1\text{-}1} = \tfrac{1}{8}\pi ab^3 \qquad I_{2\text{-}2} = \tfrac{1}{8}\pi a^3 b$$

$$I_{4\text{-}4} = a^3 b\left(\tfrac{\pi}{8} - \tfrac{8}{9\pi}\right)$$

QUARTER ELLIPSE

p = parameter

$y^2 = 2px - \frac{px^2}{a}$

$$A = \pi\tfrac{1}{4} ab$$

$$m = \tfrac{4}{3}\tfrac{a}{\pi} \qquad n = \tfrac{4}{3}\tfrac{b}{\pi}$$

$$I_{1\text{-}1} = \tfrac{1}{16}\pi ab^3 \qquad I_{2\text{-}2} = \tfrac{1}{16}\pi a^3 b$$

$$I_{3\text{-}3} = ab^3\left(\tfrac{\pi}{16} - \tfrac{4}{9\pi}\right) \qquad I_{4\text{-}4} = a^3 b\left(\tfrac{\pi}{16} - \tfrac{4}{9\pi}\right)$$

ELLIPTIC COMPLEMENT

Circular Complement Radius, $r = a = b$

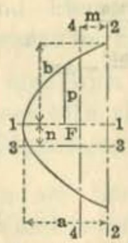
$$A = ab\left(1 - \tfrac{\pi}{4}\right)$$

$$m = \frac{a}{6\left(1 - \frac{\pi}{4}\right)} \qquad n = \frac{b}{6\left(1 - \frac{\pi}{4}\right)}$$

$$I_{1\text{-}1} = ab^3\left(\tfrac{1}{3} - \tfrac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

$$I_{2\text{-}2} = a^3 b\left(\tfrac{1}{3} - \tfrac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

PARABOLA



$$A = \tfrac{4}{3} ab$$

$$m = \tfrac{2}{5} a$$

$$I_{1\text{-}1} = \tfrac{4}{15} ab^3 \qquad I_{2\text{-}2} = \tfrac{32}{105} a^3 b$$

$$I_{4\text{-}4} = \tfrac{16}{175} a^3 b$$

HALF PARABOLA

p = parameter

$y^2 = 2px$

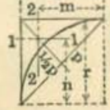
$$A = \tfrac{2}{3} ab$$

$$m = \tfrac{2}{5} a \qquad n = \tfrac{3}{8} b$$

$$I_{1\text{-}1} = \tfrac{2}{15} ab^3 \qquad I_{2\text{-}2} = \tfrac{16}{105} a^3 b$$

$$I_{3\text{-}3} = \tfrac{19}{480} ab^3 \qquad I_{4\text{-}4} = \tfrac{8}{175} a^3 b$$

PARABOLIC COMPLEMENT



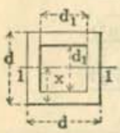
$$A = \tfrac{1}{6} r^2$$

$$m = n = \tfrac{4}{5} r$$

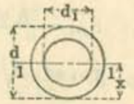
$$I_{1\text{-}1} = I_{2\text{-}2} = \tfrac{11}{2100} r^4$$

ELEMENTS OF SECTIONS

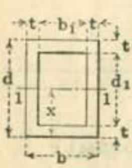
Axis of Moments through Center of Gravity



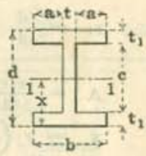
$$A = d^2 - d_1^2$$
$$x = \frac{d}{2}$$
$$I_{1-1} = \frac{d^4 - d_1^4}{12}$$
$$S_{1-1} = \frac{d^4 - d_1^4}{6d}$$
$$r_{1-1} = \sqrt{\frac{d^2 + d_1^2}{12}}$$



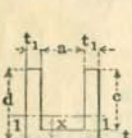
$$A = \frac{\pi(d^2 - d_1^2)}{4}$$
$$x = \frac{d}{2}$$
$$I_{1-1} = \frac{\pi(d^4 - d_1^4)}{64}$$
$$S_{1-1} = \frac{\pi(d^4 - d_1^4)}{32d}$$
$$r_{1-1} = \frac{\sqrt{d^2 + d_1^2}}{4}$$



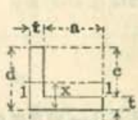
$$A = bd - b_1d_1$$
$$x = \frac{d}{2}$$
$$I_{1-1} = \frac{bd^3 - b_1d_1^3}{12}$$
$$S_{1-1} = \frac{bd^3 - b_1d_1^3}{6d}$$
$$r_{1-1} = \sqrt{\frac{bd^3 - b_1d_1^3}{12A}}$$



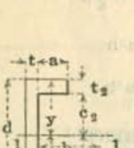
$$A = bd - 2ac$$
$$x = \frac{d}{2}$$
$$I_{1-1} = \frac{bd^3 - 2ac^3}{12}$$
$$S_{1-1} = \frac{bd^3 - 2ac^3}{6d}$$
$$r_{1-1} = \sqrt{\frac{bd^3 - 2ac^3}{12A}}$$



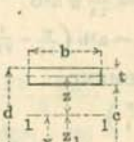
$$A = 2dt_1 + at$$
$$x = \frac{d^2t_1 + \frac{1}{2}t^2a}{A}$$
$$I_{1-1} = \frac{2t_1d^3 + at^3}{3} - Ax^2$$
$$S_{1-1} = \frac{I}{d-x}$$
$$r_{1-1} = \sqrt{\frac{I}{A}}$$



$$A = t(a+d)$$
$$x = \frac{\frac{1}{2}d^2t + \frac{1}{2}t^2a}{A}$$
$$I_{1-1} = \frac{td^3 + at^3}{3} - Ax^2$$
$$S_{1-1} = \frac{I}{d-x}$$
$$r_{1-1} = \sqrt{\frac{I}{A}}$$



$$A = dt + b_1t_1 + at_2$$
$$x = \frac{\frac{1}{2}d^2t + \frac{1}{2}t_1^2b_1 + at_2(d - \frac{1}{2}t_2)}{A}$$
$$I_{1-1} = \frac{bx^3 - b_1c_1^3 + (a+t)y^3 - ac_2^3}{3}$$
$$S_{1-1} = \frac{I}{d-x}$$
$$r_{1-1} = \sqrt{\frac{I}{A}}$$



$$A = bt + b_1t_1$$
$$x = \frac{bt(d - \frac{1}{2}t) + \frac{1}{2}b_1t_1^2}{A}$$
$$I_{1-1} = \frac{bt^3}{12} + btz^2 + \frac{b_1t_1^3}{12} + b_1t_1z_1^2$$
$$S_{1-1} = \frac{I}{x}$$
$$r_{1-1} = \sqrt{\frac{I}{A}}$$

FORMULAS FOR ELEMENTS OF ROLLED SECTIONS

The formulas on the following pages are for the computation of the elements of the sections as tabulated on preceding pages, and are based upon the theoretical straight-line dimensions, treating the sections as made of simple geometrical figures, rectangles, triangles, etc., with or without an allowance for fillets and roundings in accordance with the following rules:

CB Sections. Areas and Elements are based upon rectilinear dimensions, with allowance for fillets.

The weights are based upon the total area with allowance for fillets.

Beams and Channels. American Standard Sections. Areas and Elements are based upon rectilinear dimensions, without allowance for fillets and roundings.

The weights are based upon the total area with allowance for fillets and roundings, in accordance with the rules adopted by the Association of American Steel Manufacturers.

Angles, Tees and Zees. Areas and Elements are based upon rectilinear dimensions, without allowance for fillets and roundings.

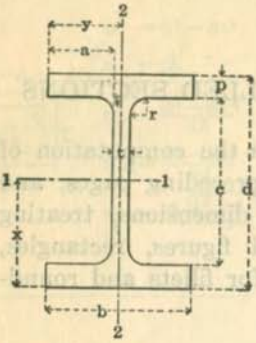
Weights are based upon the net area with a certain allowance for fillets and roundings, in accordance with the rules adopted by the Association of American Steel Manufacturers.

Bulb Angles. Areas and Elements are based upon rectilinear dimensions with allowance for fillets and roundings. The formulas given are applicable only to the British Standard Sections.

Weights are based upon the total area with allowance for fillets and roundings.

ELEMENTS OF SECTIONS

C B SECTIONS



$$A = dt + 4ap + \frac{2}{3}r^2$$

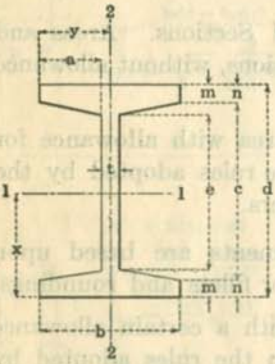
$$x = \frac{d}{2}$$

$$y = \frac{b}{2}$$

$$I_{1\text{-}1} = \frac{bd^3 - 2ac^3}{12} + 4\left[\frac{11}{2100}r^4 + \frac{1}{6}r^2\left(\frac{c}{2} - \frac{r}{5}\right)^2\right]$$

$$I_{2\text{-}2} = \frac{2pb^3 + ct^3}{12} + 4\left[\frac{11}{2100}r^4 + \frac{1}{6}r^2\left(\frac{t}{2} + \frac{r}{5}\right)^2\right]$$

BEAMS



$$A = dt + 2a(m+n)$$

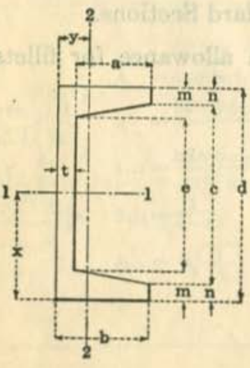
$$x = \frac{d}{2}$$

$$y = \frac{b}{2}$$

$$I_{1\text{-}1} = \frac{bd^3 - \dfrac{a}{4(m-n)}(c^4 - e^4)}{12}$$

$$I_{2\text{-}2} = \frac{2nb^3 + et^3 + \dfrac{m-n}{4a}(b^4 - t^4)}{12}$$

CHANNELS



$$A = dt + a(m+n)$$

$$x = \frac{d}{2}$$

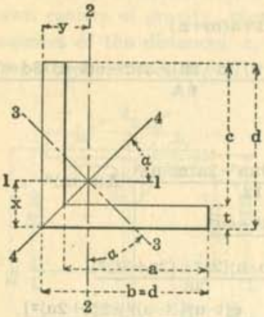
$$y = \frac{b^2n + \dfrac{ct^2}{2} + \dfrac{a(m-n)}{3}(b+2t)}{A}$$

$$I_{1\text{-}1} = \frac{bd^3 - \dfrac{a}{8(m-n)}(c^4 - e^4)}{12}$$

$$I_{2\text{-}2} = \frac{2nb^3 + et^3 + \dfrac{m-n}{2a}(b^4 - t^4)}{3} - Ay^2$$

ELEMENTS OF SECTIONS

EQUAL ANGLES



$$A = t(b+c)$$

$$x = \frac{b^2+ct}{2(b+c)}$$

$$y = x$$

$$\alpha = 45^\circ$$

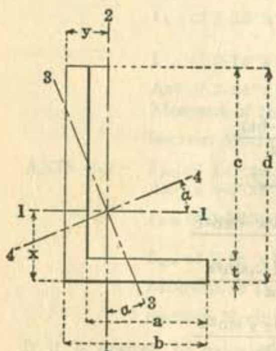
$$I_{1-1} = \frac{t(b-x)^3+bx^3-a(x-t)^3}{3}$$

$$I_{2-2} = I_{1-1}$$

$$I_{3-3} = \frac{ct^3+c^3t+3ct(b-4x+2t)^2+t^4+6t^2(2x-t)^2}{12}$$

$$I_{4-4} = \frac{ct^3+c^3t+3ctb^2+t^4}{12}$$

UNEQUAL ANGLES



$$A = t(b+c)$$

$$x = \frac{t(b+2c)+c^2}{2(b+c)}$$

$$y = \frac{t(2a+d)+a^2}{2(a+d)}$$

$$\operatorname{Tan} 2\alpha = \frac{t[(2y-t)d(d-2x)+a(2x-t)(b+t-2y)]}{2(I_{1-1}-I_{2-2})}$$

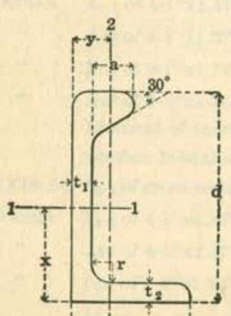
$$I_{1-1} = \frac{t(d-x)^3+bx^3-a(x-t)^3}{3}$$

$$I_{2-2} = \frac{t(b-y)^3+dy^3-c(y-t)^3}{3}$$

$$I_{3-3} = \frac{I_{2-2}\cos^2\alpha-I_{1-1}\sin^2\alpha}{\cos 2\alpha}$$

$$I_{4-4} = \frac{I_{1-1}\cos^2\alpha-I_{2-2}\sin^2\alpha}{\cos 2\alpha}$$

BULB ANGLES—British Standard



$$A = dt_1+(b-t_1)t_2+.7334a^2+.1610r^2$$

$$x = \frac{\frac{1}{2}\left[d^2t_1+(b-t_1)t_2^2\right]+.73(d-.4a)a^2}{A}$$

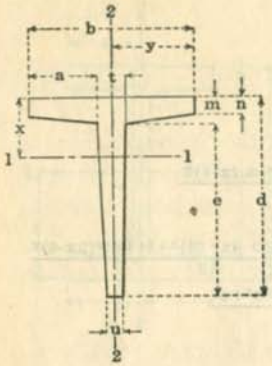
$$y = \frac{\frac{1}{2}\left[dt_1^2+t_2\left(b^2-t_1^2\right)\right]+.73a^2(t_1+.44a)}{A}$$

$$I_{1-1} = .34\left(\left[d^3t_1+(b-t_1)t_2^3\right]+.73a^2(d-.4a)^2-Ax^2\right)$$

$$I_{2-2} = \frac{1}{3}\left[b^3t_2+(d-t_2)t_1^3\right]+.73a^2(t_1+\tfrac{1}{2}a)^2-Ay^2$$

ELEMENTS OF SECTIONS

TEES



$$A = \frac{e(t+u)}{2} + mt + a(m+n)$$

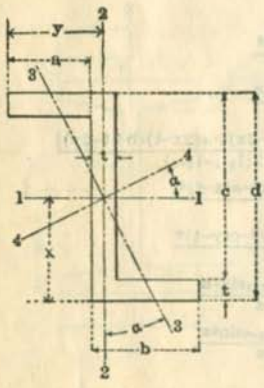
$$x = \frac{6an^2 + 2a(m-n)(m+2n) + 3td^2 - e(t-u)(3d-e)}{6A}$$

$$y = \frac{b}{2}$$

$$I_{1\text{-}1} = \frac{e^3(3u+t) + 4bm^3 - 2a(m-n)^3}{12} - A(x-m)^2$$

$$I_{2\text{-}2} = \frac{nb^3 + (m-n)t^3 + eu^3}{12} + \frac{a(m-n)[2a^2 + (2a+3t)^2]}{36} + \frac{e(t-u)[(t-u)^2 + 2(t+2u)^2]}{144}$$

ZEES



$$A = t(d+2a)$$

$$x = \frac{d}{2}$$

$$y = \frac{2b-t}{2}$$

$$\operatorname{Tan} 2\alpha = \frac{(dt-t^2)\ (b^2-bt)}{I_{1\text{-}1} - I_{2\text{-}2}}$$

$$I_{1\text{-}1} = \frac{bd^3 - a(d-2t)^3}{12}$$

$$I_{2\text{-}2} = \frac{d(b+a)^3 - 2a^3c - 6ab^2c}{12}$$

$$I_{3\text{-}3} = \frac{I_{2\text{-}2}\cos^2\alpha - I_{1\text{-}1}\sin^2\alpha}{\cos 2\alpha}$$

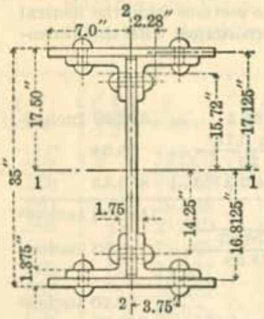
$$I_{4\text{-}4} = \frac{I_{1\text{-}1}\cos^2\alpha - I_{2\text{-}2}\sin^2\alpha}{\cos 2\alpha}$$

COMPOUND SECTIONS

Moments of Inertia, Section Moduli, and Radii of Gyration

The moment of inertia, I, of a compound section about its neutral axis is equal to the sum of the moments of inertia, I_p, of all component parts about axes through their own centers of gravity, plus the areas, A_p, of the component parts multiplied by the squares of the distances, z, of their own centers of gravity from the neutral axis of the compound section, or

Moment of Inertia	$I = \Sigma[I_p + A_p z^2]$
Section Modulus	$S = \frac{I}{n}$
Radius of Gyration	$r = \sqrt{\frac{I}{A}}$



EXAMPLE 1. Required the moments of inertia and the section moduli about axes 1-1 and 2-2 of a compound section to be used as a girder, composed of

1 Web Plate	33"x½"
4 Flange Angles	6"x4"x⅝"
2 Flange Plates	14"x¾"

basing the properties on the gross area of the section.

Determine the distances, z, of the center lines of gravity of plates and angles, from the neutral axes of the compound section, from the dimensions given, then for

AXIS 1-1

I_{1-1} of 4-6"x4"x⅝"	Angles	$= 4 \times 7.5$	$=$	30.00 Inches⁴
Az^2 of 4-6"x4"x⅝"	"	$= 4 \times 5.86 \times 15.72^2$	$=$	5792.46 "
I_{1-1} of 1-33"x½"	Plate	$= 1 \times \frac{0.50 \times 33^3}{12}$	$=$	1497.38 "
I_{1-1} of 2-14"x¾"	"	$= 2 \times \frac{14 \times 0.75^3}{12}$	$=$	0.98 "
Az^2 of 2-14"x¾"	"	$= 2 \times 10.50 \times 17.125^2$	$=$	6158.58 "
Moment of Inertia, gross section				13479.40 Inches⁴
Section Modulus,	" "	$= \frac{13479.40}{17.50}$	$=$	770.26 Inches³

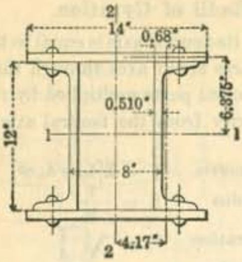
AXIS 2-2

I_{2-2} of 4-6"x4"x⅝"	Angles	$= 4 \times 21.1$	$=$	84.40 Inches⁴
Az^2 of 4-6"x4"x⅝"	"	$= 4 \times 5.86 \times 2.28^2$	$=$	121.85 "
I_{2-2} of 1-33"x½"	Plate	$= 1 \times \frac{33 \times 0.50^3}{12}$	$=$	0.34 "
I_{2-2} of 2-14"x¾"	"	$= 2 \times \frac{0.75 \times 14^3}{12}$	$=$	343.00 "
Moment of Inertia, gross section				549.59 Inches⁴
Section Modulus,	" "	$= \frac{549.59}{7}$	$=$	78.51 Inches³

It it is desired to calculate the properties of the net section, viz., to deduct the area of the rivet holes, proceed as follows, assuming that 1" holes for ⅞" rivets are to be deducted and that not more than one rivet will be driven in any one leg of the angles in the same plane of the section.

AXIS 1-1	I_{1-1} of gross section			$=$	13479.40 Inches⁴
Deduct	I_{1-1} of 4-1"x1.375" Rectangles		$= 4 \times \frac{1 \times 1.375^3}{12}$	$=$	0.87 "
"	Az^2 of 4-1"x1.375"	"	$= 4 \times 1.375 \times 16.8125^2$	$=$	1554.63 "
"	I_{1-1} of 2-1"x1.75"	"	$= 2 \times \frac{1.75 \times 1^3}{12}$	$=$	0.29 "
"	Az^2 of 2-1"x1.75"	"	$= 2 \times 1.75 \times 14.25^2$	$=$	710.72 "
	Moment of Inertia, net section				11212.89 Inches⁴
	Section Modulus,	" "	$= \frac{11212.89}{17.50}$	$=$	640.74 Inches³
AXIS 2-2	I_{2-2} of gross section			$=$	549.59 Inches⁴
Deduct	I_{2-2} of 4-1"x1.375" Rectangles		$= 4 \times \frac{1.375 \times 1^3}{12}$	$=$	0.46 "
"	Az^2 of 4-1"x1.375"	"	$= 4 \times 1.375 \times 3.75^2$	$=$	77.34 "
"	I_{2-2} of 2-1"x1.75"	"	$= 2 \times \frac{1 \times 1.75^3}{12}$	$=$	0.89 "
	Moment of Inertia, net section				470.90 Inches⁴
	Section Modulus,	" "	$= \frac{470.90}{7}$	$=$	67.27 Inches³

COMPOUND SECTIONS—Concluded



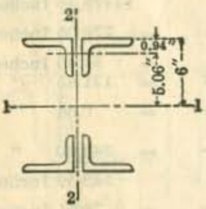
EXAMPLE 2. Required the moments of inertia and radii of gyration about axes 1-1 and 2-2 of a column section composed as follows:—

2 Channels 12″ x 30 pounds per foot,
2 Flange Plates 14″ x ¾″,

properties to be based on the gross section, no deduction being made for holes.

Determine the distances, z, of center lines of gravity for the various sections from the neutral axes 1-1 and 2-2, in accordance with the dimensions given, then for

AXIS 1-1	I_{1-1} of 2-12″ Channels 30 lbs.	$= 2 \times 161.2 =$	322.40 Inches^4
	I_{1-1} of 2-14″x¾″ Plates	$= 2 \times \frac{14 \times 0.75^3}{12} =$	0.98 "
	Az^2 of 2-14″x¾″ "	$= 2 \times 10.5 \times 6.375^2 =$	853.45 "
	Moment of Inertia, gross section		1176.83 Inches^4
	Radius of Gyration, " "	$= \sqrt{\frac{1176.83}{38.58}} =$	5.52 Inches
AXIS 2-2	I_{2-2} of 2-12″ Channels 30 lbs.	$= 2 \times 5.2 =$	10.40 Inches^4
	Az^2 of 2-12″ Channels 30 lbs.	$= 2 \times 8.79 \times 4.17^2 =$	305.70 "
	I_{2-2} of 2-14″x¾″ Plates	$= 2 \times \frac{0.75 \times 14^3}{12} =$	343.00 "
	Moment of Inertia, gross section		659.10 Inches^4
	Radius of Gyration, " "	$= \sqrt{\frac{659.10}{38.58}} =$	4.13 Inches



EXAMPLE 3. Required the radii of gyration about axes 1-1 and 2-2 of a strut section composed as follows:—

4-6″ x 4″ x ⅜″ Angles latticed by 5/16″ bars, properties to be based on the gross section of angles, no deductions being made for rivet holes nor any allowance for lattice bars.

Determine the distances, z, of center lines of gravity of angles from neutral axes 1-1 and 2-2 in accordance with the dimensions given, then for

AXIS 1-1	I_{1-1} of 4-6″x4″x⅜″ Angles	$= 4 \times 4.9 =$	19.60 Inches^4
	Az^2 of 4-6″x4″x⅜″ "	$= 4 \times 3.61 \times 5.06^2 =$	369.72 "
	Moment of Inertia, gross section		389.32 Inches^4
	Radius of Gyration, " "	$= \sqrt{\frac{389.32}{14.44}} =$	5.19 Inches

AXIS 2-2 From tables of radii of gyration for 2 angles placed back to back axis 2-2, ⅜″ apart, r_{2-2} of 4-6″ x 4″ x ⅜″ angles = 2.97 Inches.

Where sections are assembled without any web or flange plates, as, for example, latticed channel columns or latticed angle struts, the radius of gyration, r_{1-1} can be readily obtained, without considering the moment of inertia from the radius of gyration, r of one section about its neutral axis, and the distance, z, between the center of gravity of the section and the neutral axis parallel to the axis of section.

$$r_{1-1} = \sqrt{\frac{I + Az^2}{A}}, \text{ where } \frac{I}{A} = r^2, \text{ and } r_{1-1} = \sqrt{r^2 + z^2}$$

Thus, in the above example,

$$r_{1-1} = \sqrt{1.17^2 + 5.06^2} = 5.19 \text{ Inches.}$$

MOMENTS OF INERTIA OF RECTANGLES

IN WIDTHS OF 1 INCH

NEUTRAL AXIS THROUGH CENTER NORMAL TO DEPTH

To obtain the Moment of Inertia of any rectangle, multiply the tabular value for its depth by its width in inches. For deeper rectangles of tabular thickness, multiply the tabular values for half their depth by 8; or for one-third their depth by 27, etc.

Depth, Inches	$I_{1\text{-}1}$ Inches^4	Depth, Inches	$I_{1\text{-}1}$ Inches^4	Depth, Inches	$I_{1\text{-}1}$ Inches^4	Depth, Inches	$I_{1\text{-}1}$ Inches^4	Depth, Inches	$I_{1\text{-}1}$ Inches^4	Depth, Inches	$I_{1\text{-}1}$ Inches^4
0	.000	6	18.000	12	144.000	18	486.000	24	1152.000	30	2250.000
1/8	.000	1/8	19.149	1/8	148.547	1/8	496.195	1/8	1170.094	1/8	2278.243
1/4	.001	1/4	20.345	1/4	153.189	1/4	506.533	1/4	1188.376	1/4	2306.721
3/8	.004	3/8	21.590	3/8	157.926	3/8	517.012	3/8	1206.848	3/8	2335.434
1/2	.010	1/2	22.885	1/2	162.760	1/2	527.635	1/2	1225.510	1/2	2364.385
5/8	.020	5/8	24.231	5/8	167.692	5/8	538.403	5/8	1244.364	5/8	2393.575
3/4	.035	3/4	25.629	3/4	172.723	3/4	549.317	3/4	1263.410	3/4	2423.004
7/8	.056	7/8	27.079	7/8	177.853	7/8	560.376	7/8	1282.650	7/8	2452.674
1	.083	7	28.583	13	183.083	19	571.583	25	1302.083	31	2482.583
1/8	.119	1/8	30.142	1/8	188.416	1/8	582.939	1/8	1321.713	1/8	2512.737
1/4	.163	1/4	31.757	1/4	193.850	1/4	594.444	1/4	1341.538	1/4	2543.132
3/8	.217	3/8	33.428	3/8	199.389	3/8	606.099	3/8	1361.561	3/8	2573.771
1/2	.281	1/2	35.156	1/2	205.031	1/2	617.906	1/2	1381.781	1/2	2604.656
5/8	.358	5/8	36.944	5/8	210.779	5/8	629.866	5/8	1402.202	5/8	2635.787
3/4	.447	3/4	38.790	3/4	216.634	3/4	641.978	3/4	1422.821	3/4	2667.165
7/8	.549	7/8	40.698	7/8	222.596	7/8	654.245	7/8	1443.644	7/8	2698.792
2	.667	8	42.667	14	228.667	20	666.667	26	1464.667	32	2730.667
1/8	.800	1/8	44.698	1/8	234.847	1/8	679.245	1/8	1485.893	1/8	2762.792
1/4	.949	1/4	46.793	1/4	241.137	1/4	691.840	1/4	1507.324	1/4	2795.168
3/8	1.116	3/8	48.952	3/8	247.538	3/8	704.874	3/8	1528.961	3/8	2827.797
1/2	1.302	1/2	51.177	1/2	254.052	1/2	717.927	1/2	1550.802	1/2	2860.677
5/8	1.507	5/8	53.468	5/8	260.679	5/8	731.141	5/8	1572.851	5/8	2893.812
3/4	1.733	3/4	55.827	3/4	267.421	3/4	744.514	3/4	1595.108	3/4	2927.202
7/8	1.980	7/8	58.254	7/8	274.277	7/8	758.051	7/8	1617.575	7/8	2960.849
3	2.250	9	60.750	15	281.250	21	771.750	27	1640.250	33	2994.750
1/8	2.543	1/8	63.317	1/8	288.340	1/8	785.613	1/8	1663.136	1/8	3028.911
1/4	2.861	1/4	65.954	1/4	295.548	1/4	799.652	1/4	1686.236	1/4	3063.329
3/8	3.204	3/8	68.665	3/8	302.875	3/8	813.836	3/8	1709.547	3/8	3098.009
1/2	3.573	1/2	71.448	1/2	310.323	1/2	828.198	1/2	1733.073	1/2	3132.948
5/8	3.970	5/8	74.305	5/8	317.891	5/8	842.727	5/8	1756.814	5/8	3168.150
3/4	4.395	3/4	77.238	3/4	325.582	3/4	857.426	3/4	1780.770	3/4	3203.614
7/8	4.849	7/8	80.247	7/8	333.396	7/8	872.294	7/8	1804.943	7/8	3239.341
4	5.333	10	83.333	16	341.333	22	887.333	28	1829.333	34	3275.333
1/8	5.849	1/8	86.498	1/8	349.396	1/8	902.545	1/8	1853.943	1/8	3311.592
1/4	6.397	1/4	89.741	1/4	357.585	1/4	917.928	1/4	1878.773	1/4	3348.117
3/8	6.978	3/8	93.064	3/8	365.900	3/8	933.486	3/8	1903.823	3/8	3384.909
1/2	7.594	1/2	96.469	1/2	374.344	1/2	949.219	1/2	1929.094	1/2	3421.969
5/8	8.244	5/8	99.955	5/8	382.916	5/8	965.127	5/8	1954.588	5/8	3459.300
3/4	8.931	3/4	103.525	3/4	391.618	3/4	981.212	3/4	1980.305	3/4	3496.900
7/8	9.655	7/8	107.178	7/8	400.452	7/8	997.475	7/8	2006.249	7/8	3534.772
5	10.417	11	110.917	17	409.417	23	1013.917	29	2032.417	35	3572.917
1/8	11.218	1/8	114.741	1/8	418.515	1/8	1030.538	1/8	2058.811	1/8	3611.334
1/4	12.059	1/4	118.652	1/4	427.746	1/4	1047.340	1/4	2085.434	1/4	3650.027
3/8	12.941	3/8	122.652	3/8	437.113	3/8	1064.323	3/8	2112.285	3/8	3688.994
1/2	13.865	1/2	126.740	1/2	446.615	1/2	1081.490	1/2	2139.365	1/2	3728.240
5/8	14.832	5/8	130.918	5/8	456.253	5/8	1098.839	5/8	2166.676	5/8	3767.763
3/4	15.843	3/4	135.186	3/4	466.030	3/4	1116.374	3/4	2194.218	3/4	3807.561
7/8	16.898	7/8	139.547	7/8	475.945	7/8	1134.094	7/8	2221.992	7/8	3847.641
6	18.000	12	144.000	18	486.000	24	1152.000	30	2250.000	36	3888.000

MOMENTS OF INERTIA OF RECTANGLES

IN WIDTHS FROM ¼ INCH TO 1 INCH

NEUTRAL AXIS THROUGH CENTER NORMAL TO DEPTH

This table may be used in computing the Moments of Inertia of Plate Girders, Columns, and other compound sections in which plates are used.

Depth, Inches	Width, Inches									
	¼	5⁄16	⅜	7⁄16	½	9⁄16	⅝	¾	⅞	1
1	.021	.026	.031	.037	.042	.047	.052	.063	.073	.083
2	.167	.208	.250	.292	.333	.375	.417	.500	.583	.667
3	.563	.703	.844	.984	1.125	1.266	1.406	1.688	1.969	2.250
4	1.333	1.667	2.000	2.333	2.667	3.000	3.333	4.000	4.667	5.333
5	2.604	3.255	3.906	4.557	5.208	5.859	6.510	7.813	9.115	10.42
6	4.500	5.625	6.750	7.875	9.000	10.13	11.25	13.50	15.75	18.00
7	7.146	8.932	10.72	12.51	14.29	16.08	17.87	21.44	25.01	28.58
8	10.67	13.33	16.00	18.67	21.33	24.00	26.67	32.00	37.33	42.67
9	15.19	18.98	22.78	26.58	30.38	34.17	37.97	45.56	53.16	60.75
10	20.83	26.04	31.25	36.46	41.67	46.88	52.08	62.50	72.92	83.33
11	27.73	34.66	41.59	48.53	55.46	62.39	69.32	83.19	97.05	110.9
12	36.00	45.00	54.00	63.00	72.00	81.00	90.00	108.0	126.0	144.0
13	45.77	57.21	68.66	80.10	91.54	103.0	114.4	137.3	160.2	183.1
14	57.17	71.46	85.75	100.0	114.3	128.6	142.9	171.5	200.1	228.7
15	70.31	87.89	105.5	123.0	140.6	158.2	175.8	210.9	246.1	281.3
16	85.33	106.7	128.0	149.3	170.7	192.0	213.3	256.0	298.7	341.3
17	102.4	127.9	153.5	179.1	204.7	230.3	255.9	307.1	358.2	409.4
18	121.5	151.9	182.3	212.6	243.0	273.4	303.8	364.5	425.3	486.0
19	142.9	178.6	214.3	250.1	285.8	321.5	357.2	428.7	500.1	571.6
20	166.7	208.3	250.0	291.7	333.3	375.0	416.7	500.0	583.3	666.7
21	192.9	241.2	289.4	337.6	385.9	434.1	482.3	578.8	675.3	771.8
22	221.8	277.3	332.8	388.2	443.7	499.1	554.6	665.5	776.4	887.3
23	253.5	316.8	380.2	443.6	507.0	570.3	633.7	760.4	887.2	1014
24	288.0	360.0	432.0	504.0	576.0	648.0	720.0	864.0	1008	1152
25	325.5	406.9	488.3	569.7	651.0	732.4	813.8	976.6	1139	1302
26	366.2	457.7	549.3	640.8	732.3	823.9	915.4	1099	1282	1465
27	410.1	512.6	615.1	717.6	820.1	922.6	1025	1230	1435	1640
28	457.3	571.7	686.0	800.3	914.7	1029	1143	1372	1601	1829
29	508.1	635.1	762.2	889.2	1016	1143	1270	1524	1778	2032
30	562.5	703.1	843.8	984.4	1125	1266	1406	1688	1969	2250
32	682.7	853.3	1024	1195	1365	1536	1707	2048	2389	2731
34	818.8	1024	1228	1433	1638	1842	2047	2457	2866	3275
36	972.0	1215	1458	1701	1944	2187	2430	2916	3402	3888
38	1143	1429	1715	2001	2286	2572	2858	3430	4001	4573
40	1333	1667	2000	2333	2667	3000	3333	4000	4667	5333
42	1544	1929	2315	2701	3087	3473	3859	4631	5402	6174
44	1775	2218	2662	3106	3549	3993	4437	5324	6211	7099
46	2028	2535	3042	3549	4056	4563	5070	6084	7097	8111
48	2304	2880	3456	4032	4608	5184	5760	6912	8064	9216
50	2604	3255	3906	4557	5208	5859	6510	7813	9115	10417
52	2929	3662	4394	5126	5859	6591	7323	8788	10253	11717
54	3281	4101	4921	5741	6561	7381	8201	9842	11482	13122
56	3659	4573	5488	6403	7317	8232	9147	10976	12805	14635
58	4065	5081	6097	7113	8130	9146	10162	12195	14227	16259
60	4500	5625	6750	7875	9000	10125	11250	13500	15750	18000

MOMENTS OF INERTIA OF RECTANGLES

IN WIDTHS FROM ¼ INCH TO 1 INCH

NEUTRAL AXIS THROUGH CENTER NORMAL TO DEPTH

This table may be used in computing the Moments of Inertia of Plate Girders, Columns, and other compound sections in which plates are used.

Depth, Inches	Width, Inches ¼	5/16	⅜	7/16	½	9/16	⅝	¾	⅞	1
62	4965	6206	7448	8689	9931	11172	12413	14896	17378	19861
64	5461	6827	8192	9557	10923	12288	13653	16384	19114	21845
66	5990	7487	8984	10482	11979	13476	14974	17969	20963	23958
68	6551	8188	9826	11464	13102	14739	16377	19652	22928	26203
70	7146	8932	10719	12505	14292	16078	17865	21438	25010	28583
72	7776	9720	11664	13608	15552	17496	19440	23328	27216	31104
74	8442	10553	12663	14774	16884	18995	21105	25327	29548	33769
76	9145	11432	13718	16004	18291	20577	22863	27436	32009	36581
78	9887	12358	14830	17301	19773	22245	24716	29660	34603	39546
80	10667	13333	16000	18667	21333	24000	26667	32000	37333	42667
82	11487	14359	17230	20102	22974	25845	28717	34460	40204	45947
84	12348	15435	18522	21609	24696	27783	30870	37044	43218	49392
86	13251	16564	19877	23190	26503	29815	33128	39754	46379	53005
88	14197	17747	21296	24845	28395	31944	35493	42592	49691	56789
90	15188	18984	22781	26578	30375	34172	37969	45563	53156	60750
92	16223	20278	24334	28390	32446	36501	40557	48668	56779	64891
94	17304	21630	25956	30282	34608	38933	43259	51911	60563	69215
96	18432	23040	27648	32258	36864	41472	46080	55296	64512	73728
98	19608	24510	29412	34314	39217	44119	49021	58825	68629	78433
100	20833	26042	31250	36458	41667	46875	52083	62500	72916	83333
102	22109	27636	33163	38690	44217	49744	55271	66326	77380	88434
104	23435	29293	35152	41011	46870	52728	58587	70304	82022	93739
106	24813	31016	37219	43422	49626	55829	62032	74438	86845	99251
108	26244	32805	39366	45927	52488	59049	65610	78732	91854	104976
110	27729	34662	41594	48526	55459	62391	69323	83188	97052	110917
112	29269	36587	43904	51221	58539	65856	73173	87808	102442	117077
114	30866	38582	46298	54015	61731	69447	77164	92597	108029	123462
116	32519	40648	48778	56908	65038	73167	81297	97556	113816	130075
118	34230	42787	51345	59902	68460	77017	85574	102689	119804	136919
120	36000	45000	54000	63000	72000	81000	90000	108000	126000	144000
122	37830	47288	56745	66203	75661	85118	94576	113491	132406	151321
124	39721	49652	59582	69512	79443	89373	99303	119164	139024	158885
126	41675	52093	62512	72930	83349	93768	104186	125024	145861	166698
128	43691	54613	65536	76459	87382	98304	109227	131072	152918	174763
130	45771	57213	68656	80099	91542	102984	114427	137312	160198	183083
132	47916	59895	71874	83853	95832	107811	119790	143748	167706	191664
134	50127	62659	75191	87723	100255	112786	125318	150382	175445	200509
136	52405	65507	78608	91709	104811	117912	131013	157216	183418	209621
138	54752	68439	82127	95815	109503	123191	136879	164255	191630	219006
140	57167	71458	85750	100042	114333	128625	142917	171500	200084	228667
142	59652	74565	89478	104391	119304	134216	149129	178955	208781	238607
144	62208	77760	93312	108864	124416	139968	155520	186624	217728	248832
146	64836	81045	97254	113463	129673	145882	162091	194509	226927	259345
148	67537	84422	101306	118190	135075	151959	168843	202612	236380	270149
150	70313	87891	105469	123047	140625	158203	175781	210938	246094	281250

RADII OF GYRATION FOR TWO ANGLES

The following tables of Radii of Gyration for Two Angles are used for computing the safe resistance to compressive stress of two angles, back to back, when used as a strut or a compression chord of a roof truss or a similar member.

The two angles must be held together securely by stay rivets, so spaced that the two angles act as a unit.

The resistance of a compressive member is determined by its ratio of slenderness, l/r, that is the ratio of the unbraced length in inches of the compression member to its least radius of gyration.

To obtain the allowable compressive stress, compute, from the compression formula in use, the allowable unit stress corresponding to the ratio of slenderness derived from the least radius of gyration of the two angles in consideration, and multiply that value by the area of the two angles.

In the two examples which follow the least radius of the two angles in Example 1 is taken about axis 1-1, and the least radius of the two angles in Example 2 is taken about axis 2-2.

Example 1. Section given. Required the safe load in compression on a strut composed of two angles 4″ x 4″ x ⅜″, back to back, with an unsupported length of 9 feet.

Area of Section, $A = 2 \times 2.86 = 5.72$ square inches.

Least Radius, Axis 1-1, $r = 1.23$, by interpolation.

Ratio of Slenderness, $l/r = 9 \times 12 \div 1.23 = 87.8$.

Allowed Unit Stress f, by A. I. S. C. formula = 12,603 pounds per sq. inch.

Safe Load, $A \times f = 5.72 \times 12{,}603 = 72{,}100$ pounds.

Example 2. Load given. Required a section for a member in compression 12′-3″ long, made of two angles separated by ½ inch gusset plates, to resist a total load of 68,000 pounds; ratio of slenderness not to exceed 120.

A. I. S. C. formula, Unit Stress $f = 10{,}000$ pounds for $l/r = 120$.

Approximate Area of Angles, $A = 68{,}000 \div 10{,}000 = 6.80$ square inches.

Assume 2 Angles, 5″ x 3″ x 7/16″, 5-inch legs, back to back.

Area of Section, $A = 2 \times 3.31 = 6.62$ square inches.

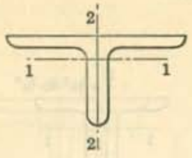
Least Radius, Axis 2-2, $r = 1.29$ inches, by interpolation.

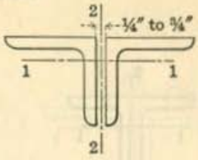
Ratio of Slenderness, $l/r = 12.25 \times 12 \div 1.29 = 114.0$.

Allowed Unit Stress f, by A. I. S. C. formula = 10,453 pounds per sq. inch.

Safe Load, $A \times f = 6.62 \times 10{,}453 = 69{,}200$ pounds.

RADII OF GYRATION FOR TWO EQUAL ANGLES



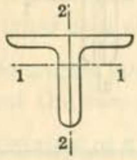


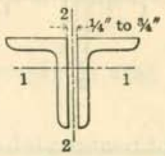
Single Angle			Area of Two Angles, Inches²	Radii of Gyration of Two Angles, Inches					
Size, Inches	Thickness, Inches	Weight, Pounds per Foot		Axis 1-1	Axis 2-2				
					In Contact	¼″ Apart	⅜″ Apart	½″ Apart	¾″ Apart
8 x 8	1⅛	56.9	33.46	2.42	3.42	3.51	3.55	3.60	3.69
	13/16	42.0	24.68	2.46	3.37	3.46	3.50	3.55	3.64
	½	26.4	15.50	2.50	3.33	3.41	3.45	3.50	3.59
6 x 6	1	37.4	22.00	1.80	2.59	2.68	2.72	2.77	2.87
	11/16	26.5	15.56	1.83	2.54	2.63	2.67	2.71	2.81
	⅜	14.9	8.72	1.88	2.49	2.58	2.62	2.66	2.75
5 x 5	1	30.6	18.00	1.48	2.19	2.28	2.33	2.38	2.47
	11/16	21.8	12.80	1.51	2.13	2.22	2.26	2.31	2.40
	⅜	12.3	7.22	1.56	2.09	2.17	2.21	2.26	2.35
4 x 4	13/16	19.9	11.68	1.18	1.75	1.85	1.89	1.94	2.04
	½	12.8	7.50	1.22	1.70	1.78	1.83	1.88	1.98
	¼	6.6	3.88	1.25	1.66	1.75	1.79	1.84	1.93
3½ x 3½	13/16	17.1	10.06	1.02	1.55	1.65	1.70	1.75	1.85
	½	11.1	6.50	1.06	1.50	1.59	1.64	1.69	1.78
	¼	5.8	3.38	1.09	1.46	1.55	1.59	1.64	1.73
3 x 3	⅝	11.5	6.72	0.88	1.32	1.41	1.46	1.51	1.61
	¼	4.9	2.88	0.93	1.25	1.34	1.38	1.43	1.53
2½ x 2½	½	7.7	4.50	0.74	1.09	1.19	1.24	1.29	1.39
	¼	4.1	2.38	0.77	1.05	1.14	1.19	1.24	1.34
2 x 2	7/16	5.3	3.12	0.59	0.88	0.98	1.03	1.08	1.19
	¼	3.19	1.88	0.61	0.85	0.94	0.99	1.04	1.14

Values of Radii of Gyration for intermediate thicknesses of angles in above and following tables may be obtained by interpolation.

RADII OF GYRATION FOR TWO UNEQUAL ANGLES

Long Legs Vertical

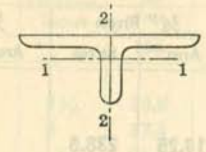


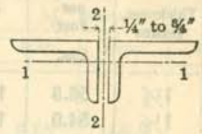


Single Angle			Area of Two Angles, Inches²	Radii of Gyration of Two Angles, Inches					
Size, Inches	Thickness, Inches	Weight, Pounds per Foot		Axis 1-1	Axis 2-2				
					In Contact	1/4" Apart	3/8" Apart	1/2" Apart	3/4" Apart
8 x 6	1	44.2	26.00	2.49	2.39	2.48	2.52	2.57	2.66
	3/4	33.8	19.88	2.53	2.35	2.44	2.48	2.52	2.61
	7/16	20.2	11.86	2.57	2.31	2.39	2.43	2.48	2.56
8 x 4	1	37.4	22.00	2.52	1.47	1.56	1.61	1.66	1.76
	3/4	28.7	16.88	2.55	1.42	1.51	1.56	1.60	1.69
	7/16	17.2	10.12	2.60	1.37	1.45	1.49	1.53	1.62
7 x 4	1	34.0	20.00	2.18	1.53	1.62	1.67	1.72	1.82
	11/16	24.2	14.19	2.23	1.48	1.56	1.61	1.65	1.75
	3/8	13.6	7.98	2.27	1.43	1.51	1.55	1.59	1.68
6 x 4	1	30.6	18.00	1.85	1.60	1.69	1.74	1.79	1.89
	11/16	21.8	12.80	1.89	1.55	1.63	1.68	1.73	1.82
	3/8	12.3	7.22	1.93	1.50	1.58	1.62	1.67	1.76
6 x 3½	1	28.9	17.00	1.85	1.37	1.47	1.51	1.56	1.66
	11/16	20.6	12.12	1.89	1.31	1.41	1.45	1.49	1.60
	5/16	9.8	5.74	1.95	1.25	1.33	1.37	1.42	1.50
5 x 3½	7/8	22.7	13.34	1.53	1.42	1.51	1.56	1.61	1.71
	5/16	8.7	5.12	1.61	1.33	1.41	1.45	1.50	1.59
5 x 3	13/16	19.9	11.68	1.55	1.18	1.27	1.32	1.37	1.47
	5/16	8.2	4.80	1.61	1.09	1.17	1.22	1.26	1.35
4 x 3½	13/16	18.5	10.86	1.19	1.50	1.59	1.64	1.69	1.79
	5/16	7.7	4.50	1.26	1.42	1.51	1.55	1.60	1.69
4 x 3	13/16	17.1	10.06	1.21	1.25	1.35	1.40	1.45	1.55
	1/4	5.8	3.38	1.28	1.16	1.24	1.28	1.33	1.43
3½ x 3	13/16	15.8	9.24	1.04	1.30	1.40	1.45	1.50	1.60
	1/4	5.4	3.12	1.11	1.20	1.29	1.34	1.38	1.48
3½ x 2½	11/16	12.5	7.30	1.06	1.03	1.13	1.18	1.23	1.33
	1/4	4.9	2.88	1.12	0.95	1.04	1.09	1.13	1.23
3 x 2½	9/16	9.5	5.56	0.91	1.05	1.15	1.20	1.25	1.35
	1/4	4.5	2.64	0.95	1.00	1.09	1.13	1.18	1.28
3 x 2	1/2	7.7	4.50	0.92	0.80	0.89	0.94	1.00	1.10
	1/4	4.1	2.38	0.95	0.74	0.84	0.88	0.93	1.03
2½ x 2	1/2	6.8	4.00	0.75	0.84	0.94	0.99	1.04	1.15
	1/4	3.62	2.12	0.78	0.80	0.89	0.93	0.98	1.08

RADII OF GYRATION FOR TWO UNEQUAL ANGLES

Short Legs Vertical





Single Angle			Area of Two Angles, Inches²	Radii of Gyration of Two Angles, Inches					
Size, Inches	Thickness, Inches	Weight, Pounds per Foot		Axis 1-1	Axis 2-2				
					In Contact	¼″ Apart	⅜″ Apart	½″ Apart	¾″ Apart
8 x 6	1	44.2	26.00	1.73	3.64	3.73	3.78	3.83	3.92
	¾	33.8	19.88	1.76	3.60	3.69	3.73	3.78	3.87
	7/16	20.2	11.86	1.80	3.55	3.64	3.68	3.73	3.82
8 x 4	1	37.4	22.00	1.03	3.95	4.05	4.10	4.15	4.25
	¾	28.7	16.88	1.06	3.90	4.00	4.04	4.09	4.19
	7/16	17.2	10.12	1.09	3.84	3.93	3.98	4.03	4.12
7 x 4	1	34.0	20.00	1.06	3.40	3.49	3.54	3.59	3.69
	11/16	24.2	14.19	1.09	3.34	3.43	3.48	3.53	3.63
	⅜	13.6	7.98	1.13	3.28	3.37	3.42	3.47	3.56
6 x 4	1	30.6	18.00	1.09	2.85	2.95	2.99	3.04	3.14
	11/16	21.8	12.80	1.13	2.79	2.89	2.93	2.98	3.08
	⅜	12.3	7.22	1.17	2.74	2.83	2.87	2.92	3.02
6 x 3½	1	28.9	17.00	0.92	2.92	3.02	3.07	3.12	3.22
	11/16	20.6	12.12	0.95	2.87	2.96	3.01	3.06	3.16
	5/16	9.8	5.74	1.00	2.81	2.90	2.95	3.00	3.09
5 x 3½	⅞	22.7	13.34	0.96	2.36	2.45	2.50	2.55	2.65
	5/16	8.7	5.12	1.03	2.26	2.35	2.39	2.44	2.54
5 x 3	13/16	19.9	11.68	0.80	2.42	2.52	2.57	2.62	2.72
	5/16	8.2	4.80	0.85	2.33	2.42	2.47	2.52	2.61
4 x 3½	13/16	18.5	10.86	1.01	1.81	1.91	1.96	2.01	2.11
	5/16	7.7	4.50	1.07	1.73	1.81	1.86	1.91	2.00
4 x 3	13/16	17.1	10.06	0.83	1.88	1.98	2.03	2.08	2.18
	¼	5.8	3.38	0.89	1.78	1.87	1.92	1.96	2.06
3½ x 3	13/16	15.8	9.24	0.85	1.61	1.71	1.76	1.81	1.91
	¼	5.4	3.12	0.91	1.52	1.61	1.65	1.70	1.80
3½ x 2½	11/16	12.5	7.30	0.69	1.66	1.75	1.80	1.86	1.96
	¼	4.9	2.88	0.74	1.58	1.67	1.71	1.76	1.86
3 x 2½	9/16	9.5	5.56	0.72	1.37	1.46	1.51	1.56	1.66
	¼	4.5	2.64	0.75	1.31	1.40	1.45	1.50	1.59
3 x 2	½	7.7	4.50	0.55	1.42	1.52	1.57	1.62	1.72
	¼	4.1	2.38	0.57	1.38	1.47	1.52	1.57	1.67
2½ x 2	½	6.8	4.00	0.56	1.15	1.25	1.30	1.35	1.46
	¼	3.62	2.12	0.59	1.11	1.20	1.25	1.30	1.40

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses— 2 Holes Deducted					
				7/8″ Rivets		3/4″ Rivets		5/8″ Rivets	
		Lbs.	In.^{2}	Area	Stress	Area	Stress	Area	Stress
8 x 8	1 1/8	56.9	16.73	14.48	260.6				
	1 1/16	54.0	15.87	13.74	247.3				
	1	51.0	15.00	13.00	234.0	13.25	238.5		
	15/16	48.1	14.12	12.24	220.3	12.48	224.6		
	7/8	45.0	13.23	11.48	206.6	11.70	210.6		
	13/16	42.0	12.34	10.71	192.8	10.92	196.6		
	3/4	38.9	11.44	9.94	178.9	10.13	182.3		
	11/16	35.8	10.53	9.15	164.7	9.33	167.9		
	5/8	32.7	9.61	8.36	150.5	8.52	153.4	8.67	156.1
	9/16	29.6	8.68	7.55	135.9	7.70	138.6	7.84	141.1
	1/2	26.4	7.75	6.75	121.5	6.87	123.7	7.00	126.0
8 x 6	1 1/8	49.3	14.48	12.23	220.1				
	1 1/16	46.8	13.75	11.62	209.2				
	1	44.2	13.00	11.00	198.0	11.25	202.5		
	15/16	41.7	12.25	10.37	186.7	10.61	191.0		
	7/8	39.1	11.48	9.73	175.1	9.95	179.1		
	13/16	36.5	10.72	9.09	163.6	9.30	167.4		
	3/4	33.8	9.94	8.44	151.9	8.63	155.3		
	11/16	31.2	9.15	7.77	139.9	7.95	143.1		
	5/8	28.5	8.36	7.11	128.0	7.27	130.9	7.42	133.6
	9/16	25.7	7.56	6.43	115.7	6.58	118.4	6.72	121.0
	1/2	23.0	6.75	5.75	103.5	5.87	105.7	6.00	108.0
	7/16	20.2	5.93	5.05	90.9	5.16	92.9	5.27	94.9
8 x 4	1	37.4	11.00	9.00	162.0	9.25	166.5		
	15/16	35.3	10.37	8.49	152.8	8.73	157.1		
	7/8	33.1	9.73	7.98	143.6	8.20	147.6		
	13/16	31.0	9.09	7.46	134.3	7.67	138.1		
	3/4	28.7	8.44	6.94	124.9	7.13	128.3		
	11/16	26.5	7.78	6.40	115.2	6.58	118.4		
	5/8	24.2	7.11	5.86	105.5	6.02	108.4	6.17	111.1
	9/16	21.9	6.43	5.30	95.4	5.45	98.1	5.59	100.6
	1/2	19.6	5.75	4.75	85.5	4.87	87.7	5.00	90.0
	7/16	17.2	5.06	4.18	75.2	4.29	77.2	4.40	79.2
7 x 4	1	34.0	10.00	8.00	144.0	8.25	148.5		
	15/16	32.1	9.44	7.56	136.1	7.80	140.4		
	7/8	30.2	8.86	7.11	128.0	7.33	131.9		
	13/16	28.2	8.28	6.65	119.7	6.86	123.5		
	3/4	26.2	7.69	6.19	111.4	6.38	114.8		
	11/16	24.2	7.09	5.71	102.8	5.89	106.0		
	5/8	22.1	6.49	5.24	94.3	5.40	97.2	5.55	99.9
	9/16	20.0	5.88	4.75	85.5	4.90	88.2	5.04	90.7
	1/2	17.9	5.25	4.25	76.5	4.37	78.7	4.50	81.0
	7/16	15.8	4.63	3.75	67.5	3.86	69.5	3.97	71.5
	3/8	13.6	3.99	3.24	58.3	3.33	59.9	3.43	61.7

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses— 2 Holes Deducted					
				7/8″ Rivets		3/4″ Rivets		5/8″ Rivets	
		Lbs.	In.²	Area	Stress	Area	Stress	Area	Stress
6 x 6	1 1/16	39.6	11.62	9.49	170.8				
	1	37.4	11.00	9.00	162.0	9.25	166.5		
	15/16	35.3	10.37	8.49	152.8	8.73	157.1		
	7/8	33.1	9.73	7.98	143.6	8.20	147.6		
	13/16	31.0	9.09	7.46	134.3	7.67	138.1		
	3/4	28.7	8.44	6.94	124.9	7.13	128.3		
	11/16	26.5	7.78	6.40	115.2	6.58	118.4		
	5/8	24.2	7.11	5.86	105.5	6.02	108.4	6.17	111.1
	9/16	21.9	6.43	5.30	95.4	5.45	98.1	5.59	100.6
	1/2	19.6	5.75	4.75	85.5	4.87	87.7	5.00	90.0
	7/16	17.2	5.06	4.18	75.2	4.29	77.2	4.40	79.2
	3/8	14.9	4.36	3.61	65.0	3.70	66.6	3.80	68.4
6 x 4	1	30.6	9.00	7.00	126.0	7.25	130.5		
	15/16	28.9	8.50	6.62	119.2	6.86	123.5		
	7/8	27.2	7.98	6.23	112.1	6.45	116.1		
	13/16	25.4	7.47	5.84	105.1	6.05	108.9		
	3/4	23.6	6.94	5.44	97.9	5.63	101.3		
	11/16	21.8	6.40	5.02	90.4	5.20	93.6		
	5/8	20.0	5.86	4.61	83.0	4.77	85.9	4.92	88.6
	9/16	18.1	5.31	4.18	75.2	4.33	77.9	4.47	80.5
	1/2	16.2	4.75	3.75	67.5	3.87	69.7	4.00	72.0
	7/16	14.3	4.18	3.30	59.4	3.41	61.4	3.52	63.4
	3/8	12.3	3.61	2.86	51.5	2.95	53.1	3.05	54.9
6 x 3 1/2	1	28.9	8.50	6.50	117.0	6.75	121.5		
	15/16	27.3	8.03	6.15	110.7	6.39	115.0		
	7/8	25.7	7.55	5.80	104.4	6.02	108.4		
	13/16	24.0	7.06	5.43	97.7	5.64	101.5		
	3/4	22.4	6.56	5.06	91.1	5.25	94.5		
	11/16	20.6	6.06	4.68	84.2	4.86	87.5		
	5/8	18.9	5.55	4.30	77.4	4.46	80.3	4.61	83.0
	9/16	17.1	5.03	3.90	70.2	4.05	72.9	4.19	75.4
	1/2	15.3	4.50	3.50	63.0	3.62	65.2	3.75	67.5
	7/16	13.5	3.97	3.09	55.6	3.20	57.6	3.31	59.6
	3/8	11.7	3.42	2.67	48.1	2.76	49.7	2.86	51.5
	5/16	9.8	2.87	2.24	40.3	2.32	41.8	2.40	43.2

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses— 2 Holes Deducted					
				7/8″ Rivets		3/4″ Rivets		5/8″ Rivets	
		Lbs.	In.^{2}	Area	Stress	Area	Stress	Area	Stress
5 x 5	1	30.6	9.00	7.00	126.0	7.25	130.5		
	15/16	28.9	8.50	6.62	119.2	6.86	123.5		
	7/8	27.2	7.98	6.23	112.1	6.45	116.1		
	13/16	25.4	7.47	5.84	105.1	6.05	108.9		
	3/4	23.6	6.94	5.44	97.9	5.63	101.3		
	11/16	21.8	6.40	5.02	90.4	5.20	93.6		
	5/8	20.0	5.86	4.61	83.0	4.77	85.9	4.92	88.6
	9/16	18.1	5.31	4.18	75.2	4.33	77.9	4.47	80.5
	1/2	16.2	4.75	3.75	67.5	3.87	69.7	4.00	72.0
	7/16	14.3	4.18	3.30	59.4	3.41	61.4	3.52	63.4
	3/8	12.3	3.61	2.86	51.5	2.95	53.1	3.05	54.9
5 x 3½	7/8	22.7	6.67	4.92	88.6	5.14	92.5		
	13/16	21.3	6.25	4.62	83.2	4.83	86.9		
	3/4	19.8	5.81	4.31	77.6	4.50	81.0		
	11/16	18.3	5.37	3.99	71.8	4.17	75.1		
	5/8	16.8	4.92	3.67	66.1	3.83	68.9	3.98	71.6
	9/16	15.2	4.47	3.34	60.1	3.49	62.8	3.63	65.3
	1/2	13.6	4.00	3.00	54.0	3.12	56.2	3.25	58.5
	7/16	12.0	3.53	2.65	47.7	2.76	49.7	2.87	51.7
	3/8	10.4	3.05	2.30	41.4	2.39	43.0	2.49	44.8
	5/16	8.7	2.56	1.93	34.7	2.01	36.2	2.09	37.6
5 x 3	13/16	19.9	5.84	4.21	75.8	4.42	79.6		
	3/4	18.5	5.44	3.94	70.9	4.13	74.3		
	11/16	17.1	5.03	3.65	65.7	3.83	68.9		
	5/8	15.7	4.61	3.36	60.5	3.52	63.4	3.67	66.1
	9/16	14.3	4.18	3.05	54.9	3.20	57.6	3.34	60.1
	1/2	12.8	3.75	2.75	49.5	2.87	51.7	3.00	54.0
	7/16	11.3	3.31	2.43	43.7	2.54	45.7	2.65	47.7
	3/8	9.8	2.86	2.11	38.0	2.20	39.6	2.30	41.4
	5/16	8.2	2.40	1.77	31.9	1.85	33.3	1.93	34.7

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses—1 Hole Deducted					
				7/8″ Rivets		3/4″ Rivets		5/8″ Rivets	
		Lbs.	In.^{2}	Area	Stress	Area	Stress	Area	Stress
	1 1/16	39.6	11.62	10.56	190.1				
	1	37.4	11.00	10.00	180.0	10.12	182.2		
	15/16	35.3	10.37	9.43	169.7	9.55	171.9		
	7/8	33.1	9.73	8.85	159.3	8.96	161.3		
	13/16	31.0	9.09	8.28	149.0	8.38	150.8		
6 x 6	3/4	28.7	8.44	7.69	138.4	7.78	140.0		
	11/16	26.5	7.78	7.09	127.6	7.18	129.2		
	5/8	24.2	7.11	6.48	116.6	6.56	118.1	6.64	119.5
	9/16	21.9	6.43	5.87	105.7	5.94	106.9	6.01	108.2
	1/2	19.6	5.75	5.25	94.5	5.31	95.6	5.37	96.7
	7/16	17.2	5.06	4.62	83.2	4.67	84.1	4.73	85.1
	3/8	14.9	4.36	3.98	71.6	4.03	72.5	4.07	73.3
	1	30.6	9.00	8.00	144.0	8.12	146.2		
	15/16	28.9	8.50	7.56	136.1	7.68	138.2		
	7/8	27.2	7.98	7.10	127.8	7.21	129.8		
	13/16	25.4	7.47	6.66	119.9	6.76	121.7		
	3/4	23.6	6.94	6.19	111.4	6.28	113.0		
6 x 4	11/16	21.8	6.40	5.71	102.8	5.80	104.4		
	5/8	20.0	5.86	5.23	94.1	5.31	95.6	5.39	97.0
	9/16	18.1	5.31	4.75	85.5	4.82	86.8	4.89	88.0
	1/2	16.2	4.75	4.25	76.5	4.31	77.6	4.37	78.7
	7/16	14.3	4.18	3.74	67.3	3.79	68.2	3.85	69.3
	3/8	12.3	3.61	3.23	58.1	3.28	59.0	3.32	59.8
	1	28.9	8.50	7.50	135.0	7.62	137.2		
	15/16	27.3	8.03	7.09	127.6	7.21	129.8		
	7/8	25.7	7.55	6.67	120.1	6.78	122.0		
	13/16	24.0	7.06	6.25	112.5	6.35	114.3		
	3/4	22.4	6.56	5.81	104.6	5.90	106.2		
6 x 3 1/2	11/16	20.6	6.06	5.37	96.7	5.46	98.3		
	5/8	18.9	5.55	4.92	88.6	5.00	90.0	5.08	91.4
	9/16	17.1	5.03	4.47	80.5	4.54	81.7	4.61	83.0
	1/2	15.3	4.50	4.00	72.0	4.06	73.1	4.12	74.2
	7/16	13.5	3.97	3.53	63.5	3.58	64.4	3.64	65.5
	3/8	11.7	3.42	3.04	54.7	3.09	55.6	3.13	56.3
	5/16	9.8	2.87	2.56	46.1	2.60	46.8	2.64	47.5
	1	30.6	9.00	8.00	144.0	8.12	146.2		
	15/16	28.9	8.50	7.56	136.1	7.68	138.2		
	7/8	27.2	7.98	7.10	127.8	7.21	129.8		
	13/16	25.4	7.47	6.66	119.9	6.76	121.7		
	3/4	23.6	6.94	6.19	111.4	6.28	113.0		
5 x 5	11/16	21.8	6.40	5.71	102.8	5.80	104.4		
	5/8	20.0	5.86	5.23	94.1	5.31	95.6	5.39	97.0
	9/16	18.1	5.31	4.75	85.5	4.82	86.8	4.89	88.0
	1/2	16.2	4.75	4.25	76.5	4.31	77.6	4.37	78.7
	7/16	14.3	4.18	3.74	67.3	3.79	68.2	3.85	69.3
	3/8	12.3	3.61	3.23	58.1	3.28	59.0	3.32	59.8

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses—1 Hole Deducted					
				7/8″ Rivets		3/4″ Rivets		5/8″ Rivets	
		Lbs.	In.^{2}	Area	Stress	Area	Stress	Area	Stress
5 x 3½	7/8	22.7	6.67	5.79	104.2	5.90	106.2		
	13/16	21.3	6.25	5.44	97.9	5.54	99.7		
	3/4	19.8	5.81	5.06	91.1	5.15	92.7		
	11/16	18.3	5.37	4.68	84.2	4.77	85.9		
	5/8	16.8	4.92	4.29	77.2	4.37	78.7	4.45	80.1
	9/16	15.2	4.47	3.91	70.4	3.98	71.6	4.05	72.9
	1/2	13.6	4.00	3.50	63.0	3.56	64.1	3.62	65.2
	7/16	12.0	3.53	3.09	55.6	3.14	56.5	3.20	57.6
	3/8	10.4	3.05	2.67	48.1	2.72	49.0	2.76	49.7
	5/16	8.7	2.56	2.25	40.5	2.29	41.2	2.33	41.9
5 x 3	13/16	19.9	5.84	5.03	90.5	5.13	92.3		
	3/4	18.5	5.44	4.69	84.4	4.78	86.0		
	11/16	17.1	5.03	4.34	78.1	4.43	79.7		
	5/8	15.7	4.61	3.98	71.6	4.06	73.1	4.14	74.5
	9/16	14.3	4.18	3.62	65.2	3.69	66.4	3.76	67.7
	1/2	12.8	3.75	3.25	58.5	3.31	59.6	3.37	60.7
	7/16	11.3	3.31	2.87	51.7	2.92	52.6	2.98	53.6
	3/8	9.8	2.86	2.48	44.6	2.53	45.5	2.57	46.3
	5/16	8.2	2.40	2.09	37.6	2.13	38.3	2.17	39.1
4 x 4	13/16	19.9	5.84	5.03	90.5	5.13	92.3		
	3/4	18.5	5.44	4.69	84.4	4.78	86.0		
	11/16	17.1	5.03	4.34	78.1	4.43	79.7		
	5/8	15.7	4.61	3.98	71.6	4.06	73.1	4.14	74.5
	9/16	14.3	4.18	3.62	65.2	3.69	66.4	3.76	67.7
	1/2	12.8	3.75	3.25	58.5	3.31	59.6	3.37	60.7
	7/16	11.3	3.31	2.87	51.7	2.92	52.6	2.98	53.6
	3/8	9.8	2.86	2.48	44.6	2.53	45.5	2.57	46.3
	5/16	8.2	2.40	2.09	37.6	2.13	38.3	2.17	39.1
	1/4	6.6	1.94	1.69	30.4	1.72	31.0	1.75	31.5
4 x 3½	13/16	18.5	5.43	4.62	83.2	4.72	85.0		
	3/4	17.3	5.06	4.31	77.6	4.40	79.2		
	11/16	16.0	4.68	3.99	71.8	4.08	73.4		
	5/8	14.7	4.30	3.67	66.1	3.75	67.5	3.83	68.9
	9/16	13.3	3.90	3.34	60.1	3.41	61.4	3.48	62.6
	1/2	11.9	3.50	3.00	54.0	3.06	55.1	3.12	56.2
	7/16	10.6	3.09	2.65	47.7	2.70	48.6	2.76	49.7
	3/8	9.1	2.67	2.29	41.2	2.34	42.1	2.38	42.8
	5/16	7.7	2.25	1.94	34.9	1.98	35.6	2.02	36.4
4 x 3	13/16	17.1	5.03	4.22	76.0	4.32	77.8		
	3/4	16.0	4.69	3.94	70.9	4.03	72.5		
	11/16	14.8	4.34	3.65	65.7	3.74	67.3		
	5/8	13.6	3.98	3.35	60.3	3.43	61.7	3.51	63.2
	9/16	12.4	3.62	3.06	55.1	3.13	56.3	3.20	57.6
	1/2	11.1	3.25	2.75	49.5	2.81	50.6	2.87	51.7
	7/16	9.8	2.87	2.43	43.7	2.48	44.6	2.54	45.7
	3/8	8.5	2.48	2.10	37.8	2.15	38.7	2.19	39.4
	5/16	7.2	2.09	1.78	32.0	1.82	32.8	1.86	33.5
	1/4	5.8	1.69	1.44	25.9	1.47	26.5	1.50	27.0

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses— 1 Hole Deducted					
				$\frac{7}{8}''$ Rivets		$\frac{3}{4}''$ Rivets		$\frac{5}{8}''$ Rivets	
		Lbs.	In.^{2}	Area	Stress	Area	Stress	Area	Stress
3½ x 3½	$\frac{13}{16}$	17.1	5.03	4.22	76.0	4.32	77.8		
	$\frac{3}{4}$	16.0	4.69	3.94	70.9	4.03	72.5		
	$\frac{11}{16}$	14.8	4.34	3.65	65.7	3.74	67.3		
	$\frac{5}{8}$	13.6	3.98	3.35	60.3	3.43	61.7	3.51	63.2
	$\frac{9}{16}$	12.4	3.62	3.06	55.1	3.13	56.3	3.20	57.6
	$\frac{1}{2}$	11.1	3.25	2.75	49.5	2.81	50.6	2.87	51.7
	$\frac{7}{16}$	9.8	2.87	2.43	43.7	2.48	44.6	2.54	45.7
	$\frac{3}{8}$	8.5	2.48	2.10	37.8	2.15	38.7	2.19	39.4
	$\frac{5}{16}$	7.2	2.09	1.78	32.0	1.82	32.8	1.86	33.5
	$\frac{1}{4}$	5.8	1.69	1.44	25.9	1.47	26.5	1.50	27.0
3½ x 3	$\frac{13}{16}$	15.8	4.62	3.81	68.6	3.91	70.4		
	$\frac{3}{4}$	14.7	4.31	3.56	64.1	3.65	65.7		
	$\frac{11}{16}$	13.6	4.00	3.31	59.6	3.40	61.2		
	$\frac{5}{8}$	12.5	3.67	3.04	54.7	3.12	56.2	3.20	57.6
	$\frac{9}{16}$	11.4	3.34	2.78	50.0	2.85	51.3	2.92	52.6
	$\frac{1}{2}$	10.2	3.00	2.50	45.0	2.56	46.1	2.62	47.2
	$\frac{7}{16}$	9.1	2.65	2.21	39.8	2.26	40.7	2.32	41.8
	$\frac{3}{8}$	7.9	2.30	1.92	34.6	1.97	35.5	2.01	36.2
	$\frac{5}{16}$	6.6	1.93	1.62	29.2	1.66	29.9	1.70	30.6
	$\frac{1}{4}$	5.4	1.56	1.31	23.6	1.34	24.1	1.37	24.7
3½ x 2½	$\frac{11}{16}$	12.5	3.65	2.96	53.3	3.05	54.9		
	$\frac{5}{8}$	11.5	3.36	2.73	49.1	2.81	50.6	2.89	52.0
	$\frac{9}{16}$	10.4	3.06	2.50	45.0	2.57	46.3	2.64	47.5
	$\frac{1}{2}$	9.4	2.75	2.25	40.5	2.31	41.6	2.37	42.7
	$\frac{7}{16}$	8.3	2.43	1.99	35.8	2.04	36.7	2.10	37.8
	$\frac{3}{8}$	7.2	2.11	1.73	31.1	1.78	32.0	1.82	32.8
	$\frac{5}{16}$	6.1	1.78	1.47	26.5	1.51	27.2	1.55	27.9
	$\frac{1}{4}$	4.9	1.44	1.19	21.4	1.22	22.0	1.25	22.5
3 x 3	$\frac{5}{8}$	11.5	3.36	2.73	49.1	2.81	50.6	2.89	52.0
	$\frac{9}{16}$	10.4	3.06	2.50	45.0	2.57	46.3	2.64	47.5
	$\frac{1}{2}$	9.4	2.75	2.25	40.5	2.31	41.6	2.37	42.7
	$\frac{7}{16}$	8.3	2.43	1.99	35.8	2.04	36.7	2.10	37.8
	$\frac{3}{8}$	7.2	2.11	1.73	31.1	1.78	32.0	1.82	32.8
	$\frac{5}{16}$	6.1	1.78	1.47	26.5	1.51	27.2	1.55	27.9
	$\frac{1}{4}$	4.9	1.44	1.19	21.4	1.22	22.0	1.25	22.5
3 x 2½	$\frac{9}{16}$	9.5	2.78	2.22	40.0	2.29	41.2	2.36	42.5
	$\frac{1}{2}$	8.5	2.50	2.00	36.0	2.06	37.1	2.12	38.2
	$\frac{7}{16}$	7.6	2.21	1.77	31.9	1.82	32.8	1.88	33.8
	$\frac{3}{8}$	6.6	1.92	1.54	27.7	1.59	28.6	1.63	29.3
	$\frac{5}{16}$	5.6	1.62	1.31	23.6	1.35	24.3	1.39	25.0
	$\frac{1}{4}$	4.5	1.31	1.06	19.1	1.09	19.6	1.12	20.2
	$\frac{3}{16}$	3.39	1.00	.81	14.6	.83	14.9	.86	15.5

TENSION VALUES FOR ANGLES

ALLOWABLE NET VALUES IN KIPS

Unit Stress, 18 Kips per Square Inch

For one angle in tension with eccentric end connection the tabulated values should be reduced.

Size, Inches	Thickness, Inches	Weight per Foot	Area	Net Areas and Stresses— 1 Hole Deducted: ¾″ Rivets		⅝″ Rivets	
		Lbs.	In.²	Area	Stress	Area	Stress
3 x 2	½	7.7	2.25	1.81	32.6	1.87	33.7
	7/16	6.8	2.00	1.61	29.0	1.67	30.1
	⅜	5.9	1.73	1.40	25.2	1.44	25.9
	5/16	5.0	1.47	1.20	21.6	1.24	22.3
	¼	4.1	1.19	0.97	17.5	1.00	18.0
	3/16	3.07	0.90	0.73	13.1	0.76	13.7
2½ x 2½	½	7.7	2.25	1.81	32.6	1.87	33.7
	7/16	6.8	2.00	1.61	29.0	1.67	30.1
	⅜	5.9	1.73	1.40	25.2	1.44	25.9
	5/16	5.0	1.47	1.20	21.6	1.24	22.3
	¼	4.1	1.19	0.97	17.5	1.00	18.0
	3/16	3.07	0.90	0.73	13.1	0.76	13.7
	⅛	2.08	0.61	0.50	9.0	0.51	9.2
2½ x 2	½	6.8	2.00	1.56	28.1	1.62	29.2
	7/16	6.1	1.78	1.39	25.0	1.45	26.1
	⅜	5.3	1.55	1.22	22.0	1.26	22.7
	5/16	4.5	1.31	1.04	18.7	1.08	19.4
	¼	3.62	1.06	0.84	15.1	0.87	15.7
	3/16	2.75	0.81	0.64	11.5	0.67	12.1
	⅛	1.86	0.55	0.44	7.9	0.45	8.1
2½ x 1½	5/16	3.92	1.15			0.92	16.6
	¼	3.19	0.94			0.75	13.5
	3/16	2.44	0.72			0.58	10.4
2 x 2	7/16	5.3	1.56			1.23	22.1
	⅜	4.7	1.36			1.07	19.3
	5/16	3.92	1.15			0.92	16.6
	¼	3.19	0.94			0.75	13.5
	3/16	2.44	0.71			0.57	10.3
	⅛	1.65	0.48			0.38	6.8
2 x 1½	⅜	3.99	1.17			0.88	15.8
	5/16	3.39	1.00			0.77	13.9
	¼	2.77	0.81			0.62	11.2
	3/16	2.12	0.62			0.48	8.6
	⅛	1.44	0.42			0.32	5.8

STRESSES IN BEAMS

In the application of the principles of structural mechanics to determine what sections should be used safely to sustain superimposed loads under specified conditions of loading, it is necessary to ascertain, first, the effects produced on the structure by the loads under those conditions; second, to decide what unit strength the material, the use of which is contemplated, has to resist the stresses produced within the structure by the loading; and, third, to select a section whose section modulus is equivalent to the ratio found to exist between the stresses tending to cause deformation within the structure and the unit strength of the material to resist them.

Reactions. In the simple case of a beam supported at both ends, each support reacts with an upward pressure called the reaction of the support. The sum of these two reactions is equal to the total load on the beam.

Shear. The loads and the reactions of the supports are vertical forces tending to shear or cut the beam across and the stresses they produce within the beam are, therefore, called shearing stresses. The shear at each support is equal to the reaction of the support; the shear at any point between the supports is equal to the reaction of a support less the total load between that support and the point; or, if the reaction acting upward is considered as positive and the loads, acting downwards, as negative, the shear at any point is the algebraic sum of the vertical forces acting on the beam between that point and either support.

If such a simple beam supported at both ends carries a load uniformly distributed over its entire length, the reaction and the shear at each support is equal to one-half the total load on the beam, but the shear decreases uniformly to zero at the center of the span; if the load is concentrated at the center of the span, the reaction and the shear at each support are also equal to one-half the total load, but the shear is uniform throughout the entire length of the beam.

Bending Moment. The loads on the beam and the reactions of the supports constitute external forces which produce bending stress in the beam. The summation of the moments of the external forces about any point is called the bending moment and varies from point to point. It attains a maximum value at a point where the shear is either zero or changes from positive to negative or vice versa. If the loads are concentrated at several points, the maximum bending moment always occurs at the point of application of one of the loads so located that the sum of all the loads on the beam between one support up to and including that load is equal to or greater than the reaction of the support.

Vertical Deflection. Bending stress within a beam produces flexure, and the deflection, or the amount of its departure from a straight line, is the measure of the deformation which the beam has undergone in its resistance to bending stress. So long as the stress is within the safe limits allowed for the material, the deflection is negligible so far as it concerns the beam itself; it may, however, be of sufficient magnitude to cause the disruption of other materials of less strength which are in contact with or supported by the beam, such as plaster. In such cases the limit of allowable deflection may determine the choice of a section.

Lateral Deflection. The stresses within a beam under transverse loading are compressive on one side of the neutral axis and tensile on the other. The tensile stresses tend to hold the beam in a straight line between the supports, while the compressive stresses tend to deflect it in a lateral direction, just as the bending stresses as a whole tend to deflect it in a vertical plane. On long spans unsupported against sidewise deflection, this consideration may influence the choice of sections.

Method of Computation. A complete investigation of the strength of beams under transverse loading must take into account every element—the bending moment, the vertical deflection, the lateral deflection and the shearing stress; though under the usual loading conditions the first alone determines the size and weight of section.

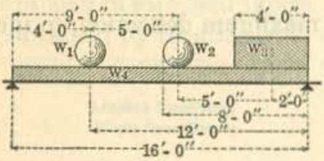
In the calculation of bending stresses, the loads are usually expressed in pounds, the span length and the distance between the loads in feet; the resulting bending moments are in foot-pounds, and the proper section can be selected from the tables. The section modulus of the required section is obtained by dividing the maximum bending moment in inch-pounds by the allowed unit stress in pounds per square inch. In such calculations it is assumed that the neutral axis of the section is normal to the line of action of the load. When this is not the case, correction must be made for the eccentricity of the loading.

General formulas for the bending moments and vertical deflections of beams under the usual conditions of loading, and also diagrams illustrative of those conditions are given on following pages. The general method of computation for the maximum bending moment of a beam supported at ends and loaded at various points is as follows:

First. Find the reaction at the left (right) support by multiplying each load by its distance from the right (left) support and dividing the sum of these products by the length of the span.

Second. Starting from the left (right) end of the beam, add the successive loads until a point is reached where the sum of the loads equals or exceeds the reaction of the left (right) support; the point of maximum bending moment is located at this point.

Third. Multiply the reaction at the left (right) support by its distance from the point of maximum bending moment and subtract the sum of the products of all loads to the left (right) of this point by the corresponding distance from this point; the difference between these moments is the maximum bending moment.



Example: Required the size of a steel beam to support the following quiescent loads over a clear span of 16 feet between supports, at a maximum unit stress not to exceed 18,000 pounds per square inch. The top flange of the beam must be braced laterally at proper intervals.

W_1 = 16,000 pounds, 4 feet from left support.
W_2 = 18,000 " 9 " " "
W_3 = 2,000 " per foot, uniform up to 4 feet from right support.
W_4 = 60 " " " assumed weight of beam uniformly distributed over entire span.

Left Reaction, $\dfrac{16000 \times 12 + (60 \times 16)8 + 18000 \times 7 + (2000 \times 4) \times 2}{16} = 21{,}355$ lbs.

Right Reaction, $\dfrac{16000 \times 4 + (60 \times 16)8 + 18000 \times 9 + (2000 \times 4) \times 14}{16} = 21{,}605$ lbs.

Sum of reactions = sum of loads = $W_1 + W_2 + W_3 + W_4$ = 42,960 lbs.

Points of maximum moment $(60 \times 4) + 16{,}000 = 16{,}240 < 21{,}355$

$(60 \times 9) + 16{,}000 + 18{,}000 = 34{,}540 > 21{,}355$

therefore the point of maximum bending moment is at point of load W_2.

Maximum bending moment, $21355 \times 9 - 16000 \times 5 - (60 \times 9) \times 4.5 = 109{,}765$ ft.-lbs.

or, $21605 \times 7 - (2000 \times 4) \times 5 - (60 \times 7) \times 3.5 = 109{,}765$ ft.-lbs.

Required section modulus $= \dfrac{109{,}765 \times 12}{18{,}000} = \dfrac{1{,}317{,}180}{18{,}000} = 73.2$ in.^{3}

As the section modulus of the 18 inch 54.7 pound American Standard, or the 16 inch 45 pound CB Section approximate this value, either of these sections may be used.

If the allowed unit stress were 16000 pounds per square inch, the required section modulus would be $\dfrac{109{,}765 \times 12}{16{,}000} = \dfrac{1{,}317{,}180}{16{,}000} = 82.4$ in.^{3}

NOTATIONS USED IN FLEXURE FORMULAS

W = Superimposed load, in pounds.
R = Reaction, in pounds.
V = Vertical shear, in pounds.
M = Bending moment, in inch-pounds.
f = Bending stress on extreme fiber, in pounds per square inch.
I = Moment of inertia of beam, in inches^4.
S = Section modulus of beam, in inches^3.
E = Modulus of elasticity, in pounds per square inch.
D = Deflection, in inches.
l = Length of span, in inches.
k = Distance from end to load, or support, divided by span, in inches.
g = Distance from end to nearest point of zero moment, in inches.
e = Distance from end to point of maximum positive moment, in inches.
h = Distance from end to point of maximum deflection, in inches.
$<$ = Is less than.
$>$ = Is greater than.
Σ = The sum of.

LOAD COEFFICIENTS, C, FOR CONTINUOUS BEAMS OF EQUAL SPANS

Moment = CWl Shear = CW

EQUAL SPANS		No. 40 				No. 48 			
		SHEAR		MOMENT		SHEAR		MOMENT	
No. of Spans	Span No.	Left End +	Right End −	Where Shear = 0 +	At Support −	Left End +	Right End −	Where Shear = 0 +	At Support −
2	1	.375	.625	.070	....	.312	.688	.156	....
	2	.625	.375	.070	.125	.688	.312	.156	.188
3	1	.400	.600	.080	....	.350	.650	.175	....
	2	.500	.500	.025	.100	.500	.500	.100	.150
	3	.600	.400	.080	.100	.650	.350	.175	.150
4	1	.393	.607	.077	....	.339	.661	.169	....
	2	.536	.464	.036	.107	.554	.446	.116	.161
	3	.464	.536	.036	.071	.446	.554	.116	.107
	4	.607	.393	.077	.107	.661	.339	.169	.161
5	1	.395	.605	.078	....	.342	.658	.172	....
	2	.526	.474	.034	.105	.539	.461	.112	.158
	3	.500	.500	.046	.079	.500	.500	.132	.118
	4	.474	.526	.034	.079	.461	.539	.112	.118
	5	.605	.395	.078	.105	.658	.342	.172	.158
Ends Fixed	Any Span	.500	.500	.042	.083	.500	.500	.125	.125

STATIC LOADS ON BEAMS

Explanation of Tables—Case 1 Taken as a Unit of Comparison

For Case 2. A beam with ends fixed will carry 1½ times as much uniform load, with .3 the deflection, as the same beam would carry were the ends supported as in Case 1.

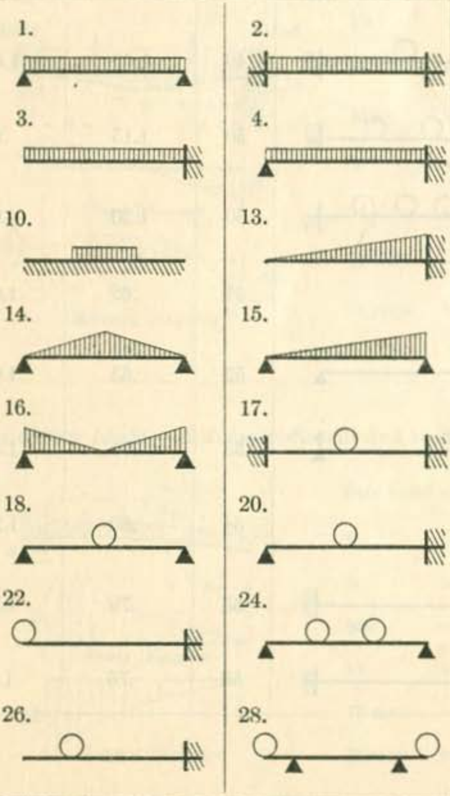
For Case 18. A beam with load concentrated at the center will carry only ½ as much load, with .8 the deflection, as the same beam would carry were the load distributed uniformly over the entire span as in Case 1.

LOAD COEFFICIENTS, C.

The safe load tables give the total uniformly distributed loads for Case 1.

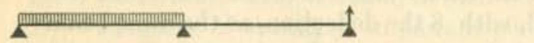
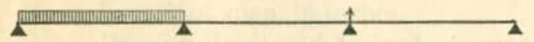
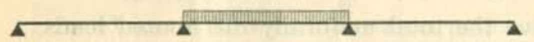
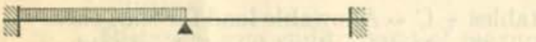
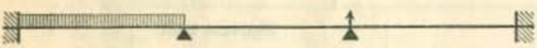
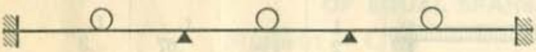
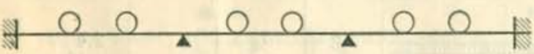
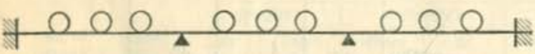
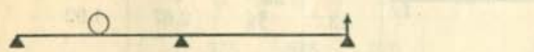
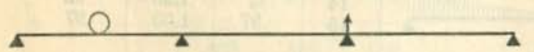
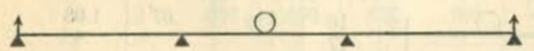
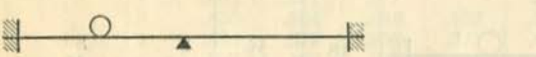
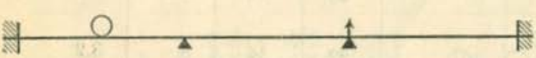
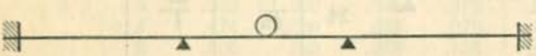
Uniform load in safe load tables ÷ C = Allowable load for that case.
Load obtained by formula × C = Uniform load in safe load tables.

Loading Conditions, Single Span Beams



Case No.	Maximum Load: Relative Load	Maximum Load: Load Coefficient, C	Relative Deflection
1	1	1	1
2	1½	.67	.3
3	¼	4	2.4
4	1	1	.42
10	$\frac{l}{2a}$	$\frac{2a}{l}$	
13	⅜	2.67	1.92
14	¾	1.33	.96
15	.97	1.03	.97
16	1½	.67	1.08
17	1	1	.4
18	½	2	.8
20	⅔	1.5	.48
22	⅛	8	3.2
24	$\frac{l}{4a}$	$\frac{4a}{l}$	
26	$\frac{1}{8(1-k)}$	$8(1-k)$	
28	$\frac{l}{4a}$	$\frac{4a}{l}$	

STATIC LOADS ON BEAMS

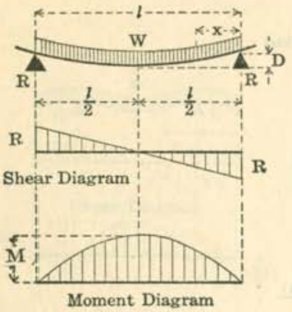
Loading Conditions, Continuous Beams, Equal Spans	Case No.	Maximum Load	
		Relative Load	Load Coefficient, C
	41	1.50	.67
	42	1.30	.77
	43	1.33	.75
	44	1.67	.60
	45	1.20	.83
	46	1.18	.85
	47	1.81	.55
	49	1.00	1.00
	50	1.13	.89
	50	1.20	.83
	51	.62	1.63
	52	.63	1.60
	53	.71	1.40
	54	.80	1.25
	55	.79	1.27
	56	.75	1.33

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

1. Beam supported at ends—uniformly distributed load



Moment Diagram

Safe Load = Tabular Load

$$V_x = \frac{W(l-2x)}{2l}$$

$$R = \frac{W}{2}$$

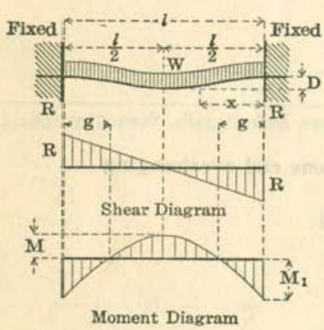
$$M_x = \frac{Wx(l-x)}{2l}$$

$$M = \frac{Wl}{8}$$

$$W\ max. = \frac{8fS}{l}$$

$$D\ max. = \frac{5Wl^3}{384EI}$$

2. Beam fixed at ends—uniformly distributed load



Moment Diagram

Safe Load = 1.5 × Tabular Load

$$V_x = \frac{W}{2l}(l-2x)$$

$$R = \frac{W}{2}$$

$$M_x = \frac{W}{12}\left(6x - l - \frac{6x^2}{l}\right)$$

$$M = \frac{Wl}{24}$$

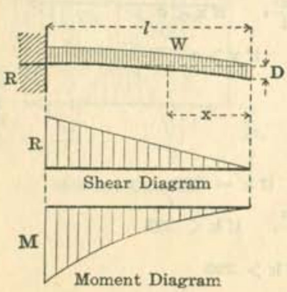
$$M_1 = \frac{Wl}{12}$$

$$W\ max. = \frac{12\,fS}{l}$$

$$D\ max. = \frac{Wl^3}{384\ EI}$$

$$g = .211\,l$$

3. Cantilever beam—uniformly distributed load



Moment Diagram

Safe Load = .25 × Tabular Load

$$V_x = \frac{Wx}{l}$$

$$R = W$$

$$M_x = \frac{Wx^2}{2l}$$

$$M = \frac{Wl}{2}$$

$$W\ max. = \frac{2\,fS}{l}$$

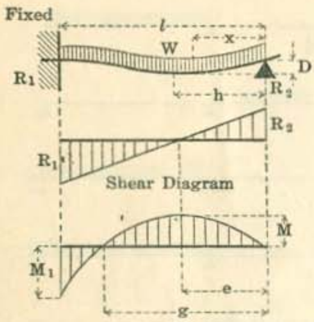
$$D\ max. = \frac{Wl^3}{8\ EI}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

4. Load uniformly distributed—one end fixed, one end supported



Moment Diagram

Safe Load = Tabular Load

$$R_1 = \frac{5W}{8}$$

$$R_2 = \frac{3W}{8}$$

$$V_x = \frac{W(3l-8x)}{8l}$$

$$M = .07\,Wl$$

$$M_1 = \frac{Wl}{8}$$

$$M_x = \frac{Wx(3l-4x)}{8l}$$

$$e = \frac{3l}{8}$$

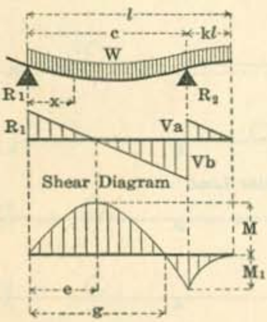
$$g = \frac{3l}{4}$$

$$h = .422l$$

$$D\ \text{max.} = \frac{.0054Wl^3}{EI}$$

$$W\ \text{max.} = \frac{8fS}{l}$$

5. Load uniformly distributed—one end supported, one end overhanging



Moment Diagram

$$R_1 = \frac{W(1-2k)}{2(1-k)}$$

$$R_2 = \frac{W}{2(1-k)}$$

$$V_a = Wk$$

$$V_b = R_2 - V_a$$

$$M = \frac{Wl(1-2k)^2}{8(1-k)^2}$$

$$M_1 = \frac{Wk^2l}{2} \qquad M_1 = M, \text{ if } k = .293$$

$$M_x = R_1x - \frac{Wx^2}{2l}, \quad \text{if } x < c$$

$$M_x = \frac{W(l-x)^2}{2l}, \quad \text{if } x > c$$

$$e = \frac{l(1-2k)}{2(1-k)}$$

$$g = \frac{l(1-2k)}{(1-k)}$$

$$W\ \text{max.} = \frac{23.3\ fS}{l}, \quad \text{if } k = .293$$

$$W\ \text{max.} = \frac{8fS\,(1-k)^2}{l(1-2k)^2}, \quad \text{if } k < .293$$

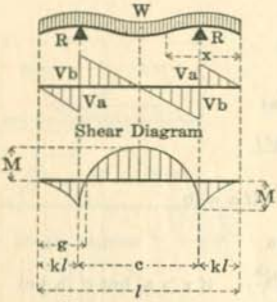
$$W\ \text{max.} = \frac{2\,fS}{k^2l}, \quad \text{if } k > .293$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

6. Beam continuous over two supports—uniformly distributed load



Moment Diagram

$$R = \frac{W}{2}$$

$$Va = Wk$$

$$Vb = R - Va$$

$$M = \frac{Wl(1-4k)}{8}, \quad \text{M is minus,} \quad \text{if } kl > \frac{c}{2}$$

$$M_1 = \frac{Wk^2l}{2}, \quad M = M_1, \quad \text{if } k = .207$$

$$Mx = \frac{Wx^2}{2l}, \quad \text{if } x < kl$$

$$Mx = \frac{W[l(x-kl)-x^2]}{2l}, \quad \text{if } x > kl, \text{ but} < (kl + c)$$

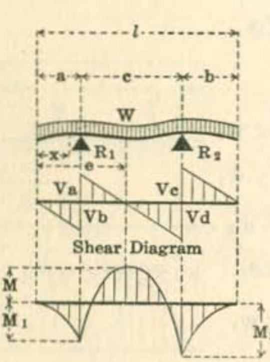
$$W \text{ max.} = \frac{46.7\, fS}{l}, \quad \text{if } k = .207$$

$$W \text{ max.} = \frac{8\, fS}{l(1-4k)}, \quad \text{if } k < .207$$

$$W \text{ max.} = \frac{2\, fS}{k^2l}, \quad \text{if } k > .207$$

$$g = \frac{l(1-\sqrt{1-4k})}{2}$$

7. Load uniformly distributed over two supports—unsymmetrical ends



Moment Diagram

$$R_1 = \frac{W(l-2b)}{2c}$$

$$R_2 = \frac{W(l-2a)}{2c}$$

$$Va = R_1 - Vb$$

$$Vb = \frac{Wa}{l}$$

$$Vc = \frac{Wb}{l}$$

$$Vd = R_2 - Vc$$

$$M = \frac{R_1^2 l}{2W} - R_1 a$$

$$M_1 = \frac{Wa^2}{2l}$$

$$M_2 = \frac{Wb^2}{2l}$$

$$Mx = \frac{Wx^2}{2l}, \quad \text{if } x < a$$

$$Mx = R_1(x-a) - \frac{Wx^2}{2l}, \quad \text{if } x > a, \text{ but} < (a + c)$$

$$e = \frac{l(l-2b)}{2c}$$

$$W \text{ max.} = \frac{2\, fSl}{a^2}, \quad \text{if } M_1 > M \text{ or } M_2$$

$$W \text{ max.} = \frac{8\, fSc^2}{l(l-2b)^2 - 4ac(l-2b)}, \quad \text{if } M > M_1 \text{ or } M_2$$

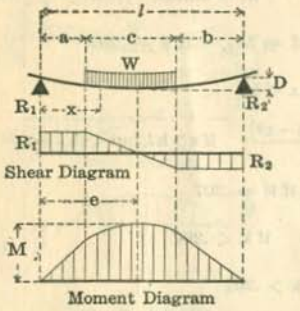
$$W \text{ max.} = \frac{2\, fSl}{b^2}, \quad \text{if } M_2 > M \text{ or } M_1$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

8. Beam supported at ends—uniform load partially distributed



Moment Diagram

$$R_1 = \frac{W(2b+c)}{2l}$$

$$R_2 = \frac{W(2a+c)}{2l}$$

$$V_x = R_1 - \frac{W}{c}(x-a)$$

$$M = \frac{R_1(2aW + R_1c)}{2W}$$

$$M = \frac{W}{2}\left(b + \frac{c}{4}\right), \quad \text{if } a = b$$

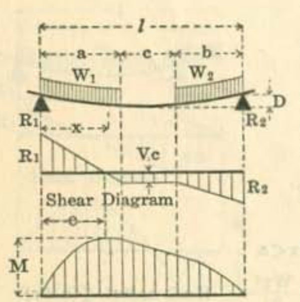
$$M_x = R_1x, \quad \text{if } x < a$$

$$M_x = R_1x - \frac{W(x-a)^2}{2c}, \quad \text{if } x > a, \text{ but } < (a+c)$$

$$W \max. = \frac{8fSl^2}{4al(2b+c) + c(2b+c)^2}$$

$$e = a + \frac{R_1c}{W}$$

9. Beam supported at ends—uniform load partially discontinuous



Moment Diagram

$$R_1 = \frac{W_1(2l-a) + W_2b}{2l}$$

$$R_2 = \frac{W_2(2l-b) + W_1a}{2l}$$

$$V_c = \frac{W_2b - W_1a}{2l}$$

$$M = \frac{R_1^2a}{2W_1}, \quad \text{if } R_1 < W_1$$

$$M = \frac{R_2^2b}{2W_2}, \quad \text{if } R_1 > W_1$$

$$M_x = R_1x - \frac{W_1x^2}{2a}, \quad \text{if } x < a$$

$$M_x = R_1x - \frac{W_1(2x-a)}{2}, \quad \text{if } x > a, \text{ but } < (a+c)$$

$$e = \frac{R_1a}{W_1}, \quad \text{if } R_1 < W_1$$

$$e = l - \frac{R_2b}{W_2}, \quad \text{if } R_1 > W_1$$

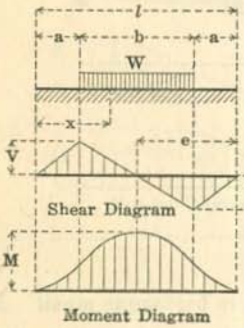
NOTE: In case shown, $R_1 < W_1$.

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

10. Uniform pressure on foundation—load partially distributed



$$\text{Safe Load} = \frac{l}{2a} \times \text{Tabular Load}$$

$$V = \frac{Wa}{l}$$

$$M = \frac{Wa}{4}$$

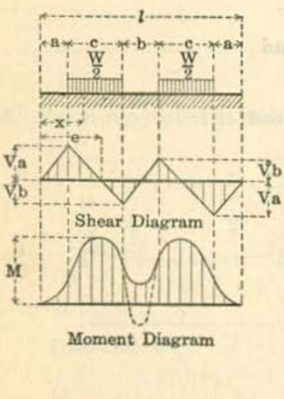
$$M_x = \frac{Wx^2}{2l}, \quad \text{if } x < a$$

$$M_x = \frac{Wa\,[l(2x-a)-2x^2]}{2l(l-2a)}, \quad \text{if } x > a, \text{ but } < (a+b)$$

$$W\ \text{max.} = \frac{4\,fS}{a}$$

$$e = \frac{l}{2}$$

11. Uniform pressure on foundation—loads partially distributed



$$V_a = \frac{Wa}{l}$$

$$V_b = \frac{Wb}{2l}$$

$$M = \frac{W\,a^2}{2(l-2c)}$$

$$M_x = \frac{Wx^2}{2l}, \quad \text{if } x < a$$

$$M_x = \frac{W\,[2cx^2 - l(x-a)^2]}{4cl}, \quad \text{if } x > a, \text{ but } < (a+c)$$

$$M_x = \frac{W\,[l(2a+c-2x)+2x^2]}{4l}, \quad \text{if } x > (a+c), \text{ but not } > \frac{l}{2}$$

Moment at Center is Negative if $\left(a+\frac{c}{2}\right) < \frac{l}{4}$

$$e = \frac{la}{l-2c}$$

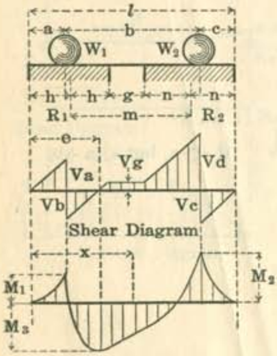
$$W\ \text{max.} = \frac{2\,fS(l-2c)}{a^2}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

12. Uniform pressure on foundations—concentrated loads at any two points



Moment Diagram

$$R_1 = \frac{W_1(b+c-n)-W_2(n-c)}{m}$$

$$R_2 = \frac{W_2(m+n-c)-W_1(h-a)}{m}$$

$$Va = \frac{R_1a}{2h}$$

$$Vb = W_1 - Va$$

$$Vc = \frac{R_2c}{2n}$$

$$Vd = W_2 - Vc$$

$$Vg = R_1 - W_1$$

$$M_1 = \frac{R_1a^2}{4h}$$

$$M_2 = \frac{R_2c^2}{4n}$$

$$M_3 = W_1\left(a - \frac{2W_1h}{2R_1}\right)$$

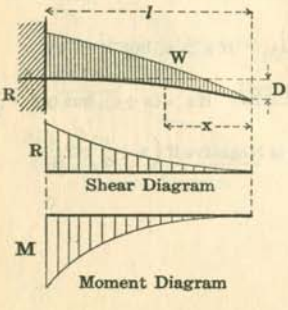
$$Mx = \frac{R_1x^2}{4h}, \quad \text{if } x < a$$

$$Mx = \frac{R_1x^2}{4h} - W_1(x-a), \quad \text{if } x > a, \text{ but } < 2h$$

$$Mx = R_1(x-h) - W_1(x-a), \quad \text{if } x > 2h, \text{ but } < (2h+g)$$

$$e = \frac{2W_1h}{R_1}$$

13. Cantilever beam—Load increasing uniformly to fixed end



Safe Load = .375 × Tabular Load

$$Vx = \frac{Wx^2}{l^2}$$

$$R = W$$

$$Mx = \frac{Wx^3}{3l^2}$$

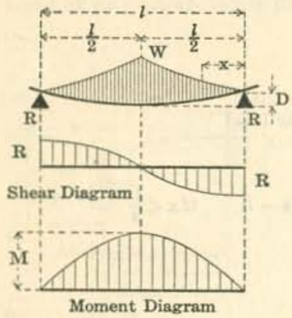
$$M = \frac{Wl}{3}$$

$$W \text{ max.} = \frac{3fS}{l}$$

$$D \text{ max.} = \frac{Wl^3}{15EI}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS
DIAGRAMS AND FORMULAS
STATIC LOADS ON BEAMS

14. Beam supported at ends—load increasing uniformly to center



Safe Load = .75 × Tabular Load

$$Vx = \frac{W(l^2 - 4x^2)}{2l^2}, \quad \text{if } x < \frac{l}{2}$$

$$R = \frac{W}{2}$$

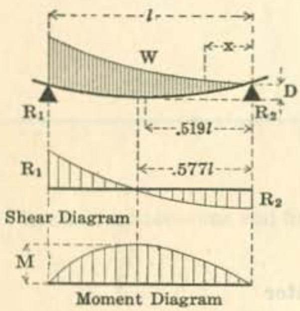
$$Mx = Wx\left(\tfrac{1}{2} - \frac{2x^2}{3l^2}\right), \quad \text{if } x < \frac{l}{2}$$

$$M = \frac{Wl}{6}$$

$$W\ max. = \frac{6fS}{l}$$

$$D\ max. = \frac{Wl^3}{60\,EI}$$

15. Beam supported at ends—load increasing uniformly to one end



Safe Load = .97 × Tabular Load

$$Vx = \frac{W(l^2 - 3x^2)}{3l^2}$$

$$R_1 = \frac{2W}{3}$$

$$R_2 = \frac{W}{3}$$

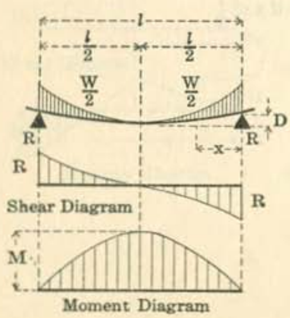
$$Mx = \frac{Wx(l^2 - x^2)}{3l^2}$$

$$M = .128\ Wl$$

$$W\ max. = \frac{7.79\ fS}{l}$$

$$D\ max. = \frac{.013044\ Wl^3}{EI}$$

16. Beam supported at ends—load decreasing uniformly to center



Safe Load = 1.5 × Tabular Load

$$Vx = W\left(\frac{2x}{l} - \frac{2x^2}{l^2} - \tfrac{1}{2}\right), \quad \text{if } x < \frac{l}{2}$$

$$R = \frac{W}{2}$$

$$Mx = Wx\left(\tfrac{1}{2} - \frac{x}{l} + \frac{2x^2}{3l^2}\right)$$

$$M = \frac{Wl}{12}$$

$$W\ max. = \frac{12\ fS}{l}$$

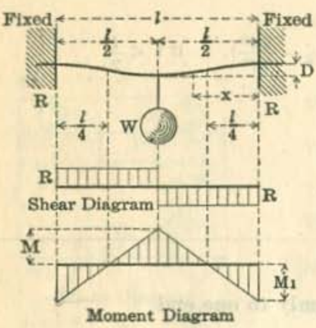
$$D\ max. = \frac{3Wl^3}{320\ EI}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

17. Beam fixed at ends—single load at center



Safe Load = Tabular Load

$$R = \frac{W}{2}$$

$$Mx = \frac{W}{8}(4x - l), \quad \text{if } x < \frac{l}{2}$$

$$M = \frac{Wl}{8}$$

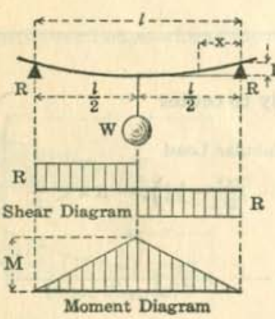
$$M_1 = \frac{Wl}{8}$$

$$W\ max. = \frac{8\,fS}{l}$$

$$D\ max. = \frac{Wl^3}{192\,EI}$$

18. Beam supported at ends—concentrated load at center

w/2



Safe Load = .5 × Tabular Load

$$R = \frac{W}{2}$$

$$Mx = \frac{Wx}{2}, \quad \text{if } x < \frac{l}{2}$$

$$M = \frac{Wl}{4}$$

$$W\ max. = \frac{4\,fS}{l}$$

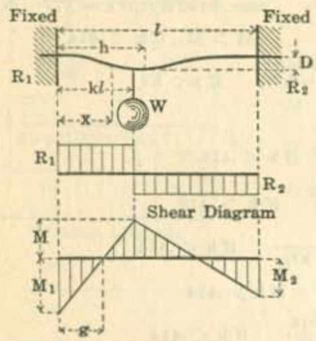
$$D\ max. = \frac{Wl^3}{48\,EI}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

19. Load at any point—ends fixed



$R_1 = W(1 - 3k^2 + 2k^3)$

$R_2 = Wk^2(3 - 2k)$

$M = 2Wk^2l(1-k)^2, \quad \text{if } k < .5$

$M_1 = Wkl(1-k)^2, \quad \text{if } k < .5$

$M_2 = Wk^2l(1-k), \quad \text{if } k < .5$

$M_1 > M \text{ or } M_2, \quad \text{if } k < .5$

$Mx = R_1x - M_1, \quad \text{if } x < kl$

$Mx = R_2(l - x) - M_2, \quad \text{if } x > kl$

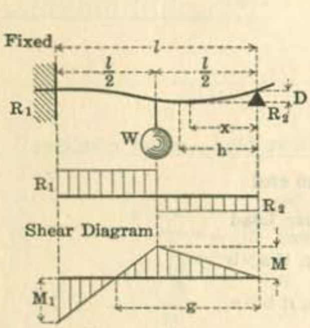
$g = \dfrac{kl}{1 + 2k}$

$h = \dfrac{l}{3 - 2k}, \quad \text{if } k < .5$

$W \text{ max.} = \dfrac{fS}{kl(1-k)^2}, \quad \text{if } k < .5$

$D \text{ max.} = \dfrac{2Wk^2l^3(1-k)^3}{3\,EI(3-2k)^2}, \quad \text{if } k < .5$

20. Load at center—one end fixed, one end supported



Safe Load = .67 × Tabular Load

$R_1 = \dfrac{11\,W}{16}$

$R_2 = \dfrac{5\,W}{16}$

$M = \dfrac{5\,Wl}{32}$

$M_1 = \dfrac{3\,Wl}{16}$

$Mx = \dfrac{5\,Wx}{16}, \quad \text{if } x < \dfrac{l}{2}$

$Mx = \dfrac{Wl}{2} - \dfrac{11\,Wx}{16}, \quad \text{if } x > \dfrac{l}{2}$

$g = \dfrac{8\,l}{11}$

$h = .447\,l$

$W \text{ max.} = \dfrac{16\,fS}{3\,l}$

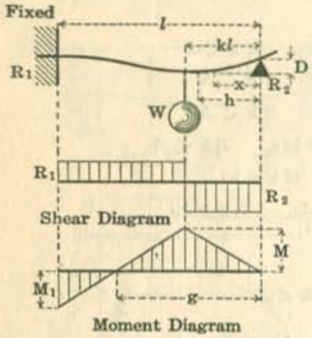
$D = \dfrac{.0093\,Wl^3}{EI}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

21. Load at any point—one end fixed, one end supported



$$R_1 = \frac{Wk(3-k^2)}{2}$$

$$R_2 = \frac{W(2-3k+k^3)}{2}$$

$$M = \frac{Wkl(2-3k+k^3)}{2}, \qquad \text{max. } (.174Wl), \text{ if } k = .366$$

$$M_1 = \frac{Wkl(1-k^2)}{2}, \qquad \text{max. } (.192Wl), \text{ if } k = .577$$

$$M > M_1, \text{ if } k < .414$$

$$Mx = R_2x, \quad \text{if } x < kl$$

$$Mx = R_2x - W(x-kl), \quad \text{if } x > kl$$

$$g = \frac{2l}{(3-k^2)}$$

$$h = \frac{l(1+k^2)}{(3-k^2)}, \quad \text{if } k < .414$$

$$h = l\sqrt{\frac{k}{(2+k)}}, \quad \text{if } k > .414$$

$$W \text{ max.} = \frac{2fS}{kl(2-3k+k^3)}, \quad \text{if } k < .414$$

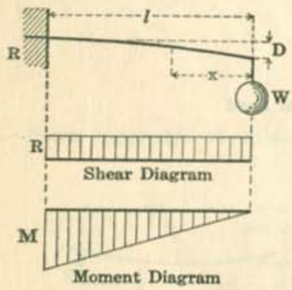
$$W \text{ max.} = \frac{2fS}{kl(1-k^2)}, \quad \text{if } k > .414$$

$$D = \frac{Wkl^3(1-k^2)^3}{3(3-k^2)^2 EI}, \quad \text{if } k < .414$$

$$D = \frac{Wkl^3(k-1)^2\sqrt{\frac{k}{2+k}}}{6EI}, \quad \text{if } k > .414$$

$$D \text{ max.} = \frac{.0098Wl^3}{EI}, \quad \text{if } k = .414$$

22. Cantilever beam—concentrated load at free end



Safe Load $= .125 \times$ Tabular Load

$$R = W$$

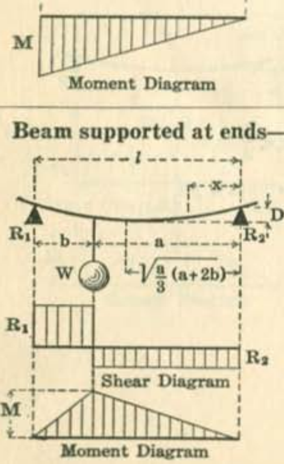
$$Mx = Wx$$

$$M = Wl$$

$$W \text{ max.} = \frac{fS}{l}$$

$$D \text{ max.} = \frac{Wl^3}{3EI}$$

23. Beam supported at ends—concentrated load near one end



Safe Load $= \frac{l^2}{8ab} \times$ Tabular Load

$$R_1 = \frac{Wa}{l}, \quad \text{max. if } a > b$$

$$R_2 = \frac{Wb}{l}, \quad \text{max. if } b > a$$

$$Mx = \frac{Wbx}{l}, \quad \text{if } x < a$$

$$M = \frac{Wab}{l}$$

$$W \text{ max.} = \frac{fSl}{ab}$$

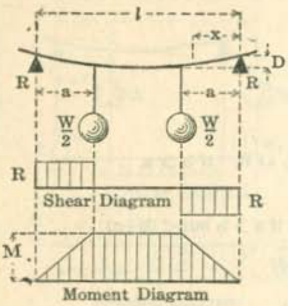
$$D \text{ max.} = \frac{Wab(a+2b)\sqrt{3a(a+2b)}}{27EIl}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

24. Beam supported at ends—two symmetrical concentrated loads



$$\text{Safe Load} = \frac{l}{4a} \times \text{Tabular Load}$$

$$R = \frac{W}{2}$$

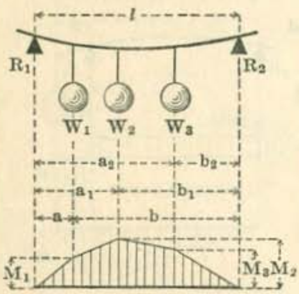
$$Mx = \frac{Wx}{2}, \quad \text{if } x < a$$

$$M = \frac{Wa}{2}$$

$$W\ \text{max.} = \frac{2\,fS}{a}$$

$$D\ \text{max.} = \frac{Wa}{12\,EI}\left(\tfrac{3}{4}l^2 - a^2\right)$$

25. Beam supported at ends—three concentrated loads



$$R_1 = \frac{W_1 b + W_2 b_1 + W_3 b_2}{l}$$

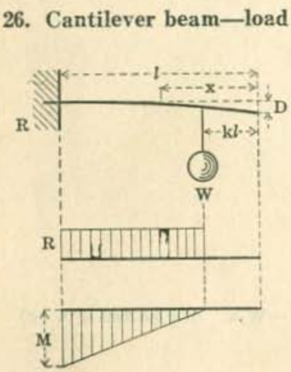
$$R_2 = \frac{W_1 a + W_2 a_1 + W_3 a_2}{l}$$

$$M_1 \text{ at } W_1 = R_1 a, \quad \text{max. if } W_1 = \text{or} > R_1$$

$$M_2 \text{ at } W_2 = R_1 a_1 - W_1 (a_1 - a), \quad \begin{cases} \text{max. if } W_2 + W_1 = \text{or} > R_1 \\ \text{max. if } W_2 + W_3 = \text{or} > R_2 \end{cases}$$

$$M_3 \text{ at } W_3 = R_1 a_2 - W_1 (a_2 - a) - W_2 (a_2 - a_1), \quad \text{max. if } W_3 = \text{or} > R_2$$

26. Cantilever beam—load at any point



$$\text{Safe Load} = \frac{1}{8(1-k)} \times \text{Tabular Load}$$

$$R = W$$

$$M = Wl(1-k)$$

$$Mx = W(x - kl)$$

$$W\ \text{max.} = \frac{fS}{l(1-k)}$$

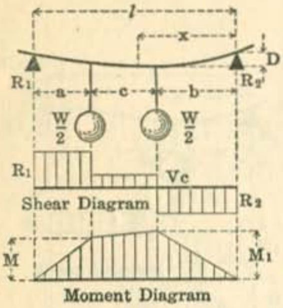
$$D\ \text{max.} = \frac{Wl^3(2 - 3k + k^3)}{6\,EI}$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

27. Beam supported at ends—two unsymmetrical concentrated loads



$$R_1 = \frac{W\,(c + 2b)}{2l}$$

$$R_2 = \frac{W\,(c + 2a)}{2l}$$

$$Vc = \frac{W\,(b - a)}{2l}$$

$$M = \frac{Wa\,(c + 2b)}{2l}$$

$$M_1 = \frac{Wb\,(c + 2a)}{2l}, \quad \text{max. at b, if } b > a$$

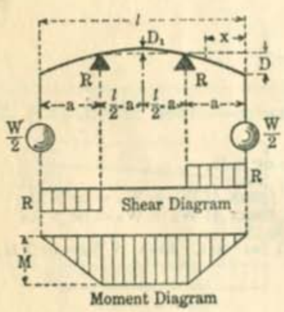
$$Mx = R_2x, \quad \text{if } x < b$$

$$Mx = \frac{W\,(bl - bx + ax)}{2l}, \quad \text{if } x > b \text{ but} < (b+c)$$

$$W\text{max.} = \frac{2\,l\,fS}{b\,(c + 2a)}, \quad \text{if } a < b$$

$$W\text{max.} = \frac{2l\,fS}{a\,(c + 2b)}, \quad \text{if } a > b$$

28. Beam continuous over two supports—two exterior symmetrical loads



$$\text{Safe Load} = \frac{l}{4a} \times \text{Tabular Load}$$

$$R = \frac{W}{2}$$

$$Mx = \frac{Wx}{2}, \quad \text{if } x < a$$

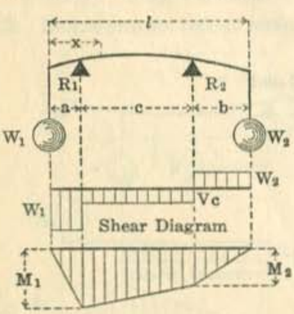
$$M = \frac{Wa}{2}$$

$$W\text{ max.} = \frac{2\,fS}{a}$$

$$D = \frac{Wa\,(3al - 4a^2)}{12\,EI}$$

$$D_1 = \frac{Wa\,(l - 2a)^2}{16\,EI}$$

29. Unequal loads at ends—overhanging unsymmetrically



$$R_1 = \frac{W_1a - W_2b}{c} + W_1$$

$$R_2 = \frac{W_2b - W_1a}{c} + W_2$$

$$Vc = \frac{W_1a - W_2b}{c}$$

$$M_1 = W_1a$$

$$M_2 = W_2b$$

$$Mx = W_1x, \quad \text{if } x < a$$

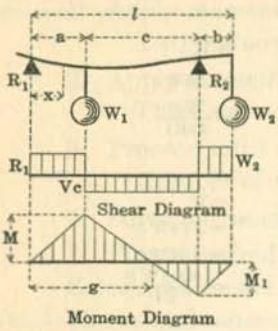
$$Mx = \frac{(W_1a - W_2b)\,(x - a)}{c} - W_1a, \quad \text{if } x > a\text{, but} < (a + c)$$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

30. Load between supports and at one end—loaded end overhanging



$R_1 = \dfrac{W_1c - W_2b}{a+c}$

$R_2 = \dfrac{W_1a + W_2l}{a+c}$

$Vc = \dfrac{W_1a + W_2b}{a+c}$

$M = \dfrac{a(W_1c - W_2b)}{a+c}$

$M_1 = W_2b$

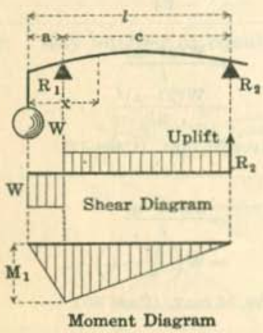
$Mx = R_1x, \quad \text{if } x < a$

$Mx = R_1x - W_1(x-a), \quad \text{if } x > a, \text{ but } < (a+c)$

$Mx = W_2(l-x), \quad \text{if } x > (a+c)$

$g = \dfrac{W_1a(a+c)}{W_1a + W_2b}$

31. Load at one overhanging end



Safe Load $= \dfrac{l}{8a} \times$ Tabular Load

$R_1 = \dfrac{Wl}{c}$

$R_2 = \dfrac{Wa}{c}$ (Uplift)

$M_1 = Wa$

$Mx = Wx, \quad \text{if } x < a$

$Mx = \dfrac{Wa(l-x)}{c}, \quad \text{if } x > a$

$W \text{ max.} = \dfrac{fS}{a}$

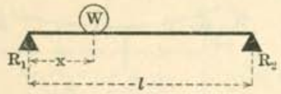
MOVING LOADS ON BEAMS

Maximum shear occurs at one support when one of the loads is at that support, and equals the total reaction.

Maximum moment occurs under one of the loads when that load is as far from one end as the center of gravity of all the loads is from the other end.

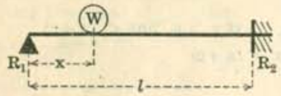
The position of load for maximum shear, or moment, is found by trial.

32. See also Case 23.



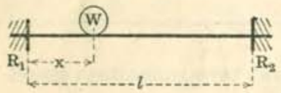
V max.	(at R_1 if $x=0$)	$=W$
M max.	(at W if $x=.5l$)	$=.25Wl$
D max.	(at W if $x=.5l$)	$=\frac{Wl^3}{48EI}$

33. See also Case 21.



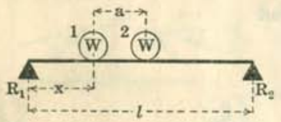
V max.	(at R_1 if $x=0$)	$=W$
+M max.	(at W if $x=.366l$)	$=.174Wl$
−M max.	(at R_2 if $x=.577l$)	$=.192Wl$
D max.	(at W if $x=.414l$)	$=\frac{.0098Wl^3}{EI}$

34. See also Case 19.



V max.	(at R_1 if $x=0$)	$=W$
+M max.	(at W if $x=.5l$)	$=.125Wl$
−M max.	(at R_1 if $x=.333l$)	$=.148Wl$
−M max.	(at R_2 if $x=.667l$)	$=.148Wl$
D max.	(at W if $x=.5l$)	$=\frac{.0052Wl^3}{EI}$

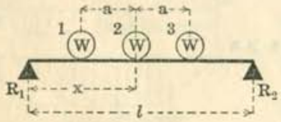
35.



V max.	(at R_1 if $x=0$)	$=\frac{W(2l-a)}{l}$
M max.	$\left(\text{at 1 if } x=\frac{2l-a}{4}\right)$	$=\frac{W(2l-a)^2}{8l}$

if $a > .586l$, one load gives M max. (Case 32)

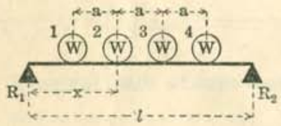
36.



V max.	(at R_1 if $x=a$)	$=\frac{3W(l-a)}{l}$
M max.	(at 2 if $x=.5l$)	$=W\left(\frac{3l}{4}-a\right)$

if $a > .450l$, two loads give M max. (Case 35)

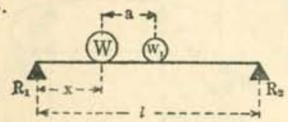
37.



V max.	(at R_1 if $x=a$)	$=\frac{2W(2l-3a)}{l}$
M max.	$\left(\text{at 2 if } x=\frac{2l-a}{4}\right)$	$=W\left(l-2a+\frac{a^2}{4l}\right)$

if $a > .268l$, three loads give M max. (Case 36)

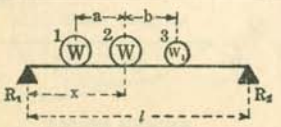
38.



V max.	(at R_1 if $x=0$)	$=W+W_1\frac{l-a}{l}$
M max.	$\left[\text{at W if } x=\frac{1}{2}\left(l-\frac{W_1a}{W+W_1}\right)\right]$	$=\left(W+W_1\right)\frac{x^2}{l}$

M max. may occur for one load (Case 32)

39.



V max.	(at R_1 if $x=a$)	$=W+\frac{W(l-a)+W_1(l-a-b)}{l}$
M max.	$\left[\text{at 2 if } x=\frac{1}{2}\left(l-\frac{W_1b-Wa}{W_1+2W}\right)\right]$	$=\frac{W_1+2W}{l}x^2-Wa$

M max. may occur for two loads (Case 35)

CONTINUOUS BEAMS

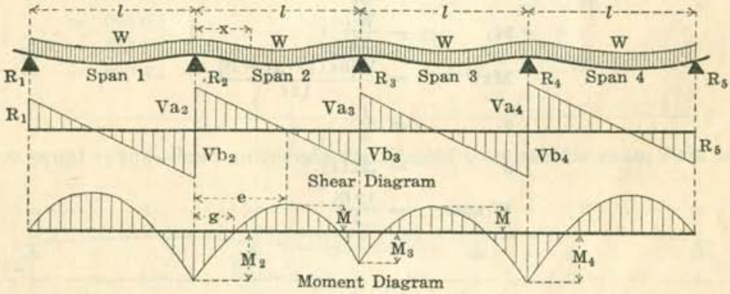
To obtain moments, shears and reactions for cases 40 and 48, it is necessary to employ the general moment equation given under each case, ie: $M_2 + 4M_3 + M_4 = -\frac{Wl}{2}$ for case 40, and $M_2 + 4M_3 + M_4 = -\frac{3\,Wl}{4}$ for case 48. The procedure is as follows:

1. Apply moment equation to spans 1 and 2.
   Two unknowns result, M_2 and M_3.
2. Apply moment equation to spans 2 and 3.
   Three unknowns result, M_2, M_3 and M_4.
3. Proceed until all spans have been considered.
   Number of unknowns = Number of equations.
4. Solve for moments at all supports.
5. Figure desired values by formulas given.

Subscripts should agree with spans under consideration.
Shears and moments must have proper signs.

BEAMS UNDER VARIOUS LOADING CONDITIONS
DIAGRAMS AND FORMULAS
STATIC LOADS ON BEAMS

40. Any number of equal spans—load uniformly distributed, ends supported



FOR ANY TWO ADJACENT SPANS
(Spans 2 and 3)

$M_2 + 4M_3 + M_4 = -\frac{Wl}{2}$

$Va_2 = \frac{M_3 - M_2}{l} + \frac{W}{2}$

$Vb_3 = W - Va_2$

$Va_3 = \frac{M_4 - M_3}{l} + \frac{W}{2}$

$Vb_4 = W - Va_3$

$R_2 = Va_2 + Vb_2$

$R_3 = Va_3 + Vb_3$

$R_4 = Va_4 + Vb_4$

FOR ANY SPAN
(Span 2)

$Vx = Va_2 - \frac{Wx}{l}$

$M = M_2 + \frac{Va_2{}^2 l}{2W}$

$Mx = M_2 + Va_2 x - \frac{Wx^2}{2l}$

$e = \frac{Va_2 l}{W}$

g = x in formula for Mx, if Mx=0

NOTE: In applying formulas to any other two adjacent spans, change subscripts of W, l, M, V, R and x to have same relation to spans under consideration as those above have to spans 2 and 3.

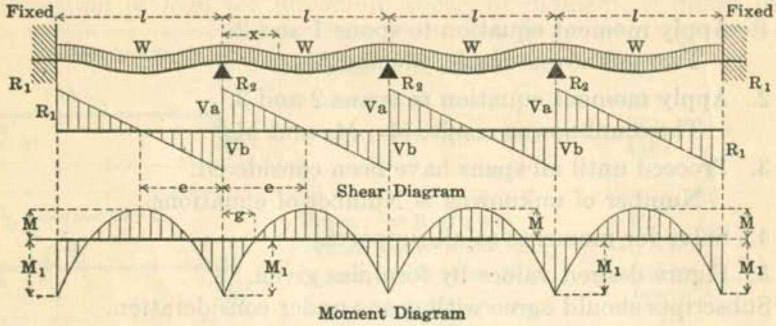
For values of shear and moment in beams of five spans or less, see table, Page 156.

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

41. Any number of equal spans—load uniformly distributed, ends fixed



Safe Load = 1.5 × Tabular Load

$R_1 = \frac{W}{2}$

$R_2 = W$

$Va = \frac{W}{2}$

$Vb = \frac{W}{2}$

$M = \frac{Wl}{24}$

$M_1 = \frac{Wl}{12}$

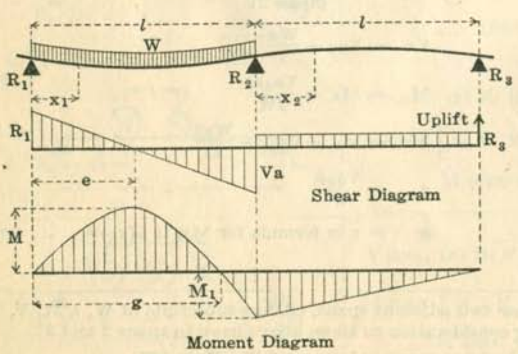
$Mx = \frac{W[6x(l-x) - l^2]}{12l}$

$e = \frac{l}{2}$

$g = .211l$

$W \text{ max.} = \frac{12fS}{l}$

42. Two equal spans—load uniformly distributed over one span, ends supported



Safe Load = 1.30 × Tabular Load.

$R_1 = .438W$

$R_2 = .625W$

$R_3 = .0625W$

$Va = .563W$

$M = .096Wl$

$M_1 = .063Wl$

$Mx_1 = \frac{Wx_1(7l - 8x_1)}{16l}$

$Mx_2 = \frac{W(x_2 - l)}{16}$

$e = .438l$

$g = .875l$

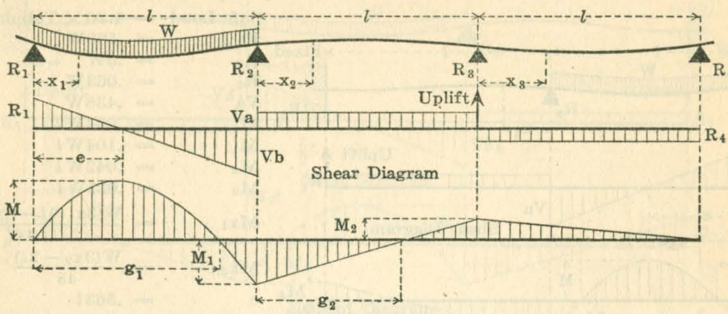
$W \text{ max.} = \frac{10.42fS}{l}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

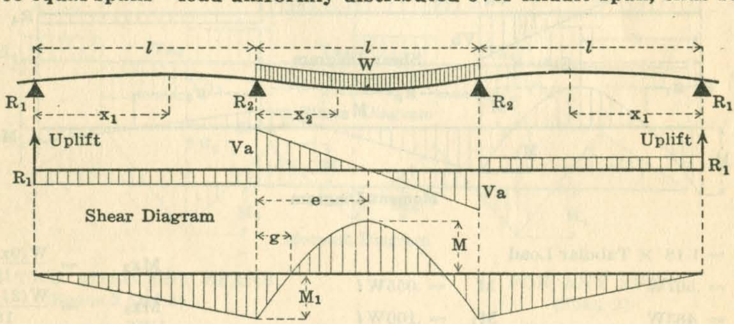
43. Three equal spans—load uniformly distributed over one end span, ends supported



Moment Diagram

Safe Load	= $1.33 \times$ Tabular Load		Mx_1	= $\dfrac{Wx_1(13l - 15x_1)}{30l}$
R_1	= $.433W$			
R_2	= $.65W$		Mx_2	= $\dfrac{W(5x_2 - 4l)}{60}$
R_3	= $.1W$			
R_4	= $.017W$		Mx_3	= $\dfrac{W(l - x_3)}{60}$
Va	= $.083W$		e	= $.433l$
Vb	= $.567W$		g_1	= $.867l$
M	= $.094Wl$		g_2	= $.8l$
M_1	= $.067Wl$		W max.	= $\dfrac{10.64\ fS}{l}$
M_2	= $.017Wl$			

44. Three equal spans—load uniformly distributed over middle span, ends supported



Moment Diagram

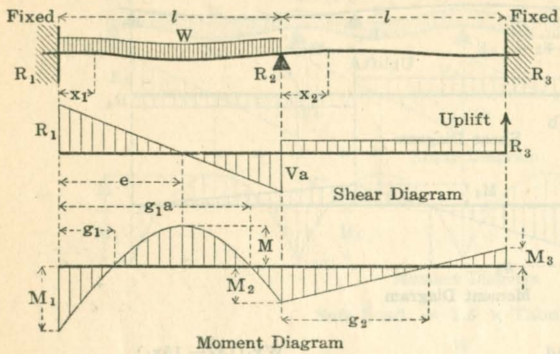
Safe Load	= $1.67 \times$ Tabular Load		Mx_1	= $.05Wx_1$
R_1	= $.05W$		Mx_2	= $\dfrac{W[10x_2(l - x_2) - l^2]}{20l}$
R_2	= $.55W$			
Va	= $.5W$		e	= $.5l$
M	= $.075Wl$		g	= $.113l$
M_1	= $.05Wl$		W max.	= $\dfrac{13.33\ fS}{l}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

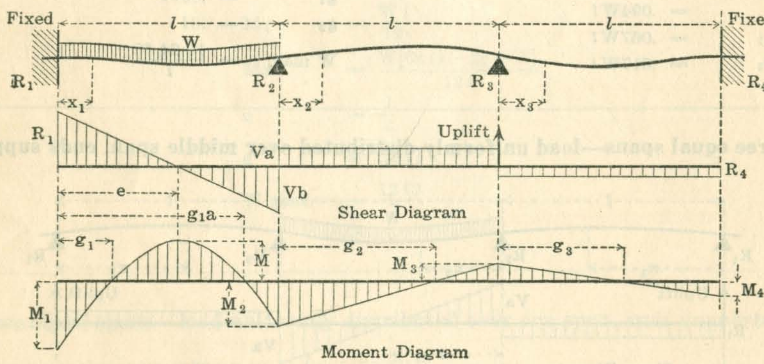
STATIC LOADS ON BEAMS

45. Two equal spans—load uniformly distributed over one span, ends fixed



Safe Load	=	1.20 × Tabular Load
R_1	=	.563W
R_2	=	.5W
R_3	=	.063W
Va	=	.438W
M	=	.054Wl
M_1	=	.104Wl
M_2	=	.042Wl
M_3	=	.021Wl
Mx_1	=	$\frac{W[3x_1(9l-8x_1)-5l]}{48l}$
Mx_2	=	$\frac{W(3x_2-2l)}{48}$
e	=	.563l
g_1	=	.234l
g_1a	=	.891l
g_2	=	.667l
W max.	=	$\frac{9.62\ fS}{l}$

46. Three equal spans—load uniformly distributed over one end span, ends fixed



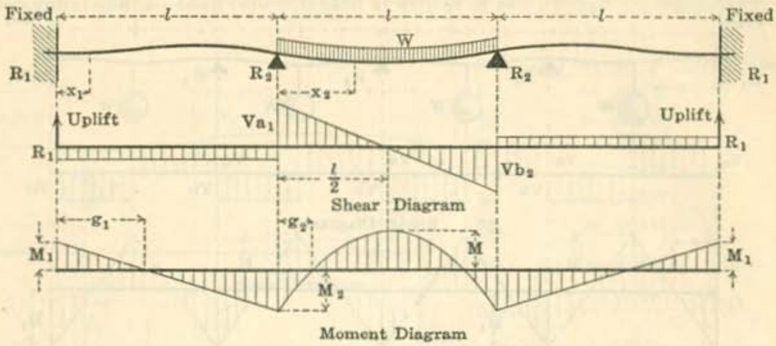
Safe Load	= 1.18 × Tabular Load			Mx_2	= $\frac{W(9x_2-7l)}{180}$
R_1	= .567W	M	= .055Wl	Mx_3	= $\frac{W(2l-3x_3)}{180}$
R_2	= .483W	M_1	= .106Wl	W max.	= $\frac{9.43\ fS}{l}$
R_3	= .067W	M_2	= .039Wl	e	= .567l
R_4	= .017W	M_3	= .011Wl	g_1	= .235l
Va	= .05W	M_4	= .006Wl	g_1a	= .898l
Vb	= .433W	Mx_1	= $\frac{W(102x_1l-90x_1^2-19l^2)}{180l}$	g_2	= .778l
				g_3	= .667l

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

47. Three equal spans—load uniformly distributed over middle span, ends fixed



Safe Load = 1.81 × Tabular Load

$R_1 = .083W$

$R_2 = .583W$

$Va_1 = .5W$

$Vb_2 = .5W$

$M = .069Wl$

$M_1 = .028Wl$

$M_2 = .056Wl$

$Mx_1 = \frac{W(l-3x_1)}{36}$

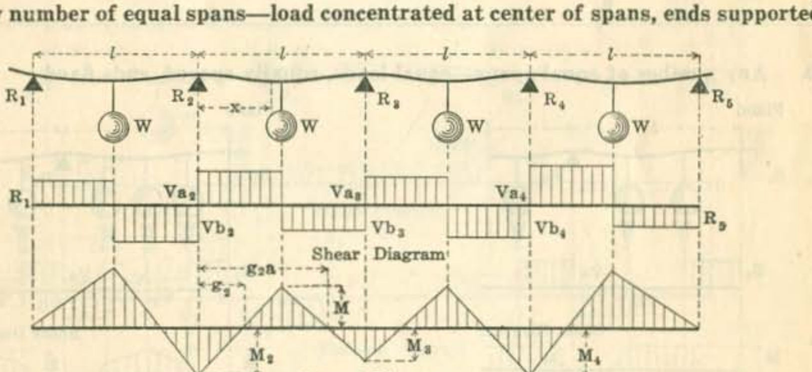
$Mx_2 = \frac{W[9x_2(l-x_2)-l^2]}{18l}$

$g_1 = .333l$

$g_2 = .127l$

$W\ max. = \frac{14.5\,fS}{l}$

48. Any number of equal spans—load concentrated at center of spans, ends supported



FOR TWO ADJACENT SPANS
(Spans 2 and 3)

$M_2 + 4M_3 + M_4 = -\frac{3Wl}{4}$

$R_2 = Va_2 + Vb_2$

$R_3 = Va_3 + Vb_3$

$R_4 = Va_4 + Vb_4$

$Va_2 = \frac{M_3 - M_2}{l} + \frac{W}{2}$

$Vb_3 = W - Va_2$

$Va_3 = \frac{M_4 - M_3}{l} + \frac{W}{2}$

$Vb_4 = W - Va_3$

FOR ANY SPAN
(Span 2)

$M = M_2 + \frac{Va_2 l}{2}$

$Mx = M_2 + Va_2x, \quad \text{if } x < \frac{l}{2}$

$Mx = M_2 + Va_2x - W(x - \frac{l}{2}), \quad \text{if } x > \frac{l}{2}$

$g_2 = \frac{-M_2}{Va_2}$

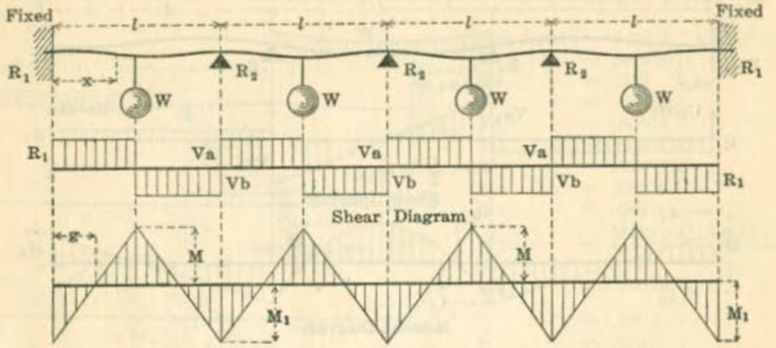
$g_2a = \frac{-(M_2 + \frac{1}{2}Wl)}{(Va_2 - W)}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

49. Any number of equal spans—load concentrated at center of spans, ends fixed



Moment Diagram

Safe Load = Tabular Load

$R_1 = \frac{W}{2}$

$R_2 = W$

$Va = \frac{W}{2}$

$Vb = \frac{W}{2}$

$M = \frac{Wl}{8}$

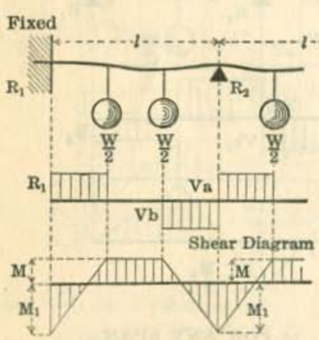
$M_1 = \frac{Wl}{8}$

$Mx = \frac{W(4x - l)}{8}$, if $x < \frac{l}{2}$

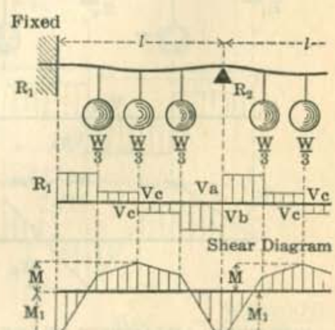
$Mx = \frac{W(3l - 4x)}{8}$, if $x > \frac{l}{2}$

$g = \frac{l}{4}$

50. Any number of equal spans—equal loads, equally spaced, ends fixed



Moment Diagram



Moment Diagram

TWO LOADS ON EACH SPAN

Safe Load = 1.125 × Tabular Load

$R_1 = \frac{W}{2}$ $M = \frac{Wl}{18}$

$R_2 = W$

$Va = \frac{W}{2}$ $M_1 = \frac{Wl}{9}$

$Vb = \frac{W}{2}$ $W\ max. = \frac{9\ fS}{l}$

THREE LOADS ON EACH SPAN

Safe Load = 1.2 × Tabular Load

$R_1 = \frac{W}{2}$ $Vc = \frac{W}{6}$

$R_2 = W$ $M = \frac{Wl}{16}$

$Va = \frac{W}{2}$ $M_1 = \frac{5Wl}{48}$

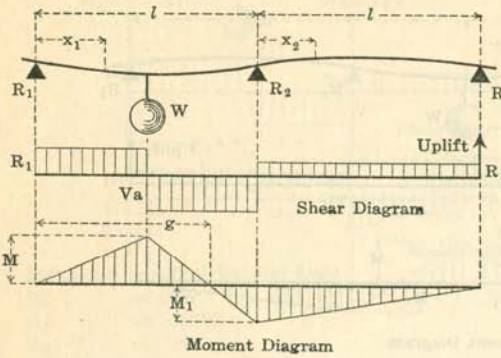
$Vb = \frac{W}{2}$ $W\ max. = \frac{9.6\ fS}{l}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

51. Two equal spans—load concentrated at center of one span, ends supported



Safe Load = .62 × Tabular Load

$R_1 = .406W$

$R_2 = .688W$

$R_3 = .094W$

$Va = .594W$

$M = .203Wl$

$M_1 = .094Wl$

$Mx_1 = .406Wx_1, \quad \text{if } x_1 < \frac{l}{2}$

$Mx_1 = \frac{W(16l - 19x_1)}{32}, \quad \text{if } x_1 > \frac{l}{2}$

$Mx_2 = \frac{3W(x_2 - l)}{32}$

$g = .842l$

$W \max. = \frac{4.93\,fS}{l}$

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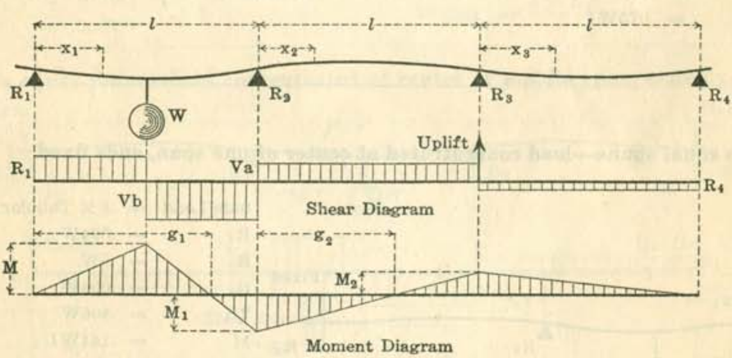
52. Three equal spans—load concentrated at center of end span, ends supported



Safe Load = .625 × Tabular Load

$R_1 = .4W$

$R_2 = .725W$

$R_3 = .15W$

$R_4 = .025W$

$Va = .125W$

$Vb = .6W$

$M = .2Wl$

$M_1 = .1Wl$

$M_2 = .025Wl$

$Mx_1 = .4Wx_1, \quad \text{if } x_1 < \frac{l}{2}$

$Mx_1 = \frac{W(5l - 6x_1)}{10}, \quad \text{if } x_1 > \frac{l}{2}$

$Mx_2 = \frac{W(5x_2 - 4l)}{40}$

$Mx_3 = \frac{W(l - x_3)}{40}$

$g_1 = .833l$

$g_2 = .8l$

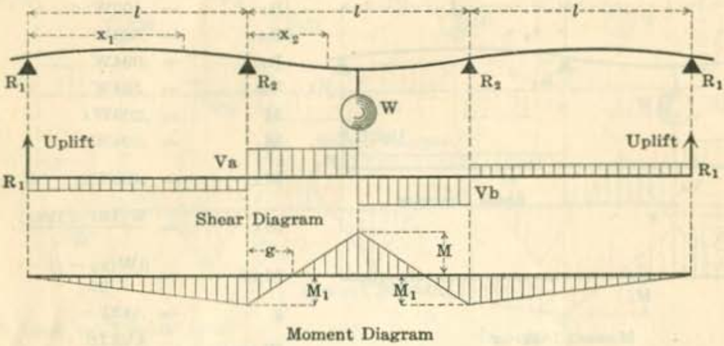
$W \max. = \frac{5\,fS}{l}$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

53. Three equal spans—load concentrated at center of middle span, ends supported



Safe Load $= .71 \times$ Tabular Load

$R_1 = .075W$

$R_2 = .575W$

$Va = .5W$

$Vb = .5W$

$M = .175Wl$

$M_1 = .075Wl$

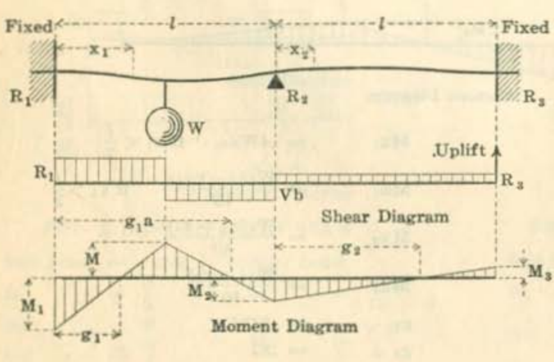
$Mx_1 = .075Wx_1$

$Mx_2 = \frac{W(20x_2 - 3l)}{40}$, if $x_2 < \frac{l}{2}$

$g = .15l$

$W \text{ max.} = \frac{5.71\,fS}{l}$

54. Two equal spans—load concentrated at center of one span, ends fixed



Safe Load $= .8 \times$ Tabular Load

$R_1 = .594W$

$R_2 = .5W$

$R_3 = .094W$

$Vb = .406W$

$M = .141Wl$

$M_1 = .156Wl$

$M_2 = .062Wl$

$M_3 = .031Wl$

$Mx_1 = \frac{W(19x_1 - 5l)}{32}$, if $x_1 < \frac{l}{2}$

$Mx_1 = \frac{W(11l - 13x_1)}{32}$, if $x_1 > \frac{l}{2}$

$Mx_2 = \frac{W(3x_2 - 2l)}{32}$

$g_1 = .263l$

$g_1a = .846l$

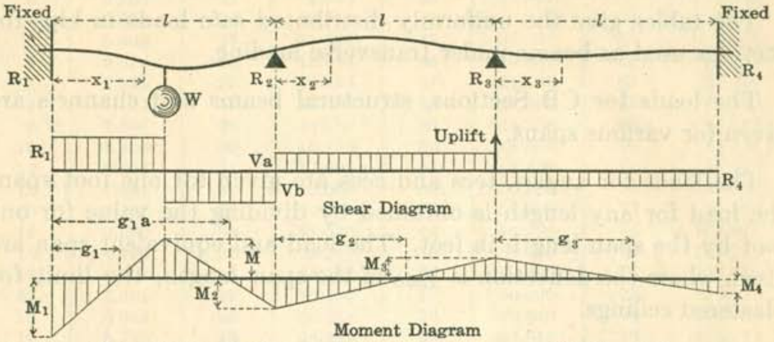
$g_2 = .667l$

BEAMS UNDER VARIOUS LOADING CONDITIONS

DIAGRAMS AND FORMULAS

STATIC LOADS ON BEAMS

55. Three equal spans—load concentrated at center of one end span, ends fixed



Safe Load $= .79 \times$ Tabular Load

$R_1 = .6W$

$R_2 = .475W$

$R_3 = .1W$

$R_4 = .025W$

$Va = .075W$

$Vb = .4W$

$M = .142Wl$

$M_1 = .158Wl$

$M_2 = .058Wl$

$M_3 = .017Wl$

$M_4 = .008Wl$

$Mx_1 = \frac{W(72x_1 - 19l)}{120}$, if $x_1 < \frac{l}{2}$

$Mx_1 = \frac{W(41l - 48x_1)}{120}$, if $x_1 > \frac{l}{2}$

$Mx_2 = \frac{W(9x_2 - 7l)}{120}$

$Mx_3 = \frac{W(2l - 3x_3)}{120}$

$g_1 = .263l$

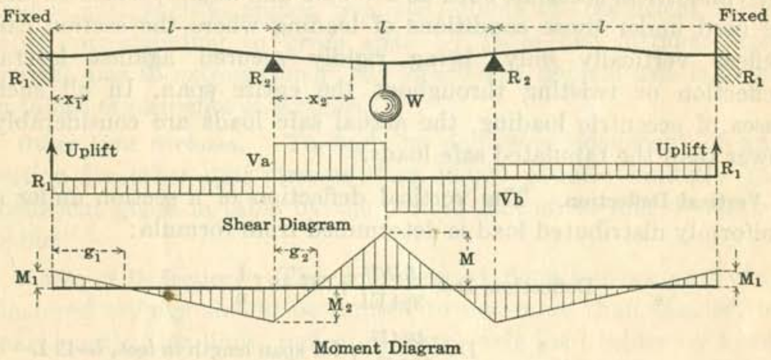
$g_1a = .854l$

$g_2 = .778l$

$g_3 = .667l$

$W \max. = \frac{6.33\,fS}{l}$

56. Three equal spans—load concentrated at center of middle span, ends fixed



Safe Load $= .75 \times$ Tabular Load

$R_1 = .125W$

$R_2 = .625W$

$Va = .5W$

$Vb = .5W$

$M = .167Wl$

$M_1 = .042Wl$

$M_2 = .083Wl$

$Mx_1 = \frac{W(l - 3x_1)}{24}$

$Mx_2 = \frac{W(6x_2 - l)}{12}$, if $x_2 < \frac{l}{2}$

$g_1 = .333l$

$g_2 = .167l$

$W \max. = \frac{6\,fS}{l}$

SAFE LOADS FOR SECTIONS USED AS BEAMS

EXPLANATION OF TABLES

The tables give the uniformly distributed safe loads in kips for sections used as beams under transverse loading.

The loads for CB Sections, structural beams and channels are given for various spans.

The loads for angles, tees and zees are given for one foot span; the load for any length is obtained by dividing the value for one foot by the span length in feet. The load and equivalent span are given where the deflection is 1/360 of the span length, the limit for plastered ceilings.

All loads are based on a unit stress of 18,000 pounds per square inch. They include the weight of the section, which should be deducted to find the net load.

It is assumed in all cases that the loads are applied normal to the axis 1-1 as shown in the tables of elements of sections, and that the beam deflects vertically in the plane of bending only. If the conditions of loading involve the introduction of forces outside this plane of loading, the allowable safe loads must be determined from the general theory of flexure, in accordance with the mode of application of the load and its character. This applies particularly to unsymmetrical sections, such as zee bars and angles, which should be used under those conditions of loading where the section can deflect vertically only, being rigidly secured against lateral deflection or twisting throughout the entire span. In all such cases of eccentric loading, the actual safe loads are considerably lower than the tabulated safe loads.

Vertical Deflection. The vertical deflection of a section under a uniformly distributed load is determined from formula:

$$\text{Deflection, } D = \frac{5\,Wl^3}{384\,EI}\,;\quad Wl = 8\,f\,\frac{I}{n}$$

$$\text{"} \quad D = \frac{40\,fl^2}{384\,En}\,;\ \text{for span length in feet, } l = 12\,L$$

$$\text{"} \quad D = \frac{15\,fL^2}{En}\ \text{inches}$$

Steel, E=29,000,000; for unit stress of 18,000 pounds:

$$\text{Deflection, } D = \frac{0.01862L^2}{2n} \qquad \text{Deflection, } D = \frac{\text{Coefficient}}{2n}$$

n=distance from center line of gravity to extreme fiber.

DEFLECTION COEFFICIENTS FOR UNIT STRESS OF 18,000 POUNDS

Span, Feet	Coefficient 18,000	Span, Feet	Coefficient 18,000	Span, Feet	Coefficient 18,000	Span, Feet	Coefficient 18,000
1	0.019	21	8.212	41	31.301	61	69.288
2	0.074	22	9.012	42	32.847	62	71.578
3	0.168	23	9.850	43	34.430	63	73.906
4	0.298	24	10.726	44	36.050	64	76.270
5	0.466	25	11.638	45	37.707	65	78.672
6	0.670	26	12.588	46	39.401	66	81.112
7	0.912	27	13.574	47	41.133	67	83.588
8	1.192	28	14.599	48	42.902	68	86.102
9	1.508	29	15.660	49	44.708	69	88.653
10	1.862	30	16.759	50	46.552	70	91.241
11	2.253	31	17.894	51	48.432	71	93.867
12	2.681	32	19.068	52	50.350	72	96.530
13	3.147	33	20.278	53	52.306	73	99.230
14	3.650	34	21.526	54	54.298	74	101.967
15	4.190	35	22.810	55	56.328	75	104.741
16	4.767	36	24.132	56	58.395	76	107.553
17	5.381	37	25.492	57	60.499	77	110.402
18	6.033	38	26.888	58	62.640	78	113.288
19	6.722	39	28.322	59	64.819	79	116.212
20	7.448	40	29.793	60	67.035	80	119.172

The deflection, in inches, of sections subjected to transverse stresses due to uniformly distributed loads are obtained as follows:

Symmetrical Sections. For unit stress of 18,000 pounds to find the deflection in inches of a section symmetrical about the neutral axis, such as beams, channels, zees, etc., divide the coefficient in the table corresponding to given span by the depth of the section in inches.

Unsymmetrical Sections. For unit stress of 18,000 pounds to find the deflection in inches of a section not symmetrical about the neutral axis, such as angles, tees, etc., divide the coefficient in the table corresponding to given span by twice the distance from neutral axis to extreme fiber; the location of neutral axis is given in tables of elements of sections.

Other Unit Stresses. To find the deflection coefficient of any section for other unit stresses than 18,000 pounds, multiply the coefficient given in table by the desired unit stress and divide by 18,000.

Limits of Deflection. The deflection of floor beams carrying plastered ceilings should be limited to not more than 1/360 of the span length; this limit, indicated in the safe load tables by lower zig-zag line, is derived from the following formulas:

$$\text{Deflection, } D_{max} = \frac{12L}{360} = \frac{15fL^2}{En} \qquad f = 18{,}000, \quad L_{max.} = 3.580n$$

Lateral Deflection of Beams. In the usual construction of buildings the compression flanges of beams are secured against lateral deflection by the floor system, by tie rods placed at proper intervals, or by other means, and under these conditions the full tabular loads may be applied.

Limiting Ratios of Span Length to Flange Width

When lateral bracing is not provided and the unbraced span length as compared with the flange width of the beam is excessive, it may be found economical to use two beams or a beam and channel securely fastened together; in crane girder construction a channel with flanges turned downward and riveted to the top flange of a beam makes a very efficient construction.

If, however, a single section is to be used for an excessive ratio of span length to flange width, the tabular safe loads must be reduced. Various permissible ratios of span length to flange width, l/b, and formulas for reduction of stresses are in use.

The table below gives the reduction in per cent of the tabular safe loads is accordance with the Specification of the American Institute of Steel Construction. The maximum allowable ratio of l/b is limited to 40.

thus:

$$f_c = \frac{20{,}000}{1 + \frac{1}{2000}(l/b)^2}$$

Full stress 18,000 lbs., up to ratio, $l/b = 15$

Maximum allowable ratio, $l/b = 40$

Lateral deflection may result from vertical loading, or it may be induced by the thrust of floor arches or by other forces not coincident with axis of principal bending stress.

Stresses due to horizontal thrust should either be neutralized by tie rods, or the safe resistance of the beam should be computed to provide for the combined stresses due to the action of both vertical and horizontal forces, so as not to exceed the allowable unit stress.

Reduction of Tabular Safe Loads due to Lateral Deflection

Various Ratios of Span Length to Flange Width of Beam, l/b.

American Institute of Steel Construction Code.

Ratio, Length to Width l/b	Per Cent. Tabular Safe Load A. I. S. C. 18,000	Ratio, Length to Width l/b	Per Cent. Tabular Safe Load A. I. S. C. 18,000	Ratio, Length to Width l/b	Per Cent. Tabular Safe Load A. I. S. C. 18,000	Ratio, Length to Width l/b	Per Cent. Tabular Safe Load A. I. S. C. 18,000
	100	21	91.0	27.5	80.6	34	70.4
15	100.0	21.5	90.3	28	79.8	34.5	69.7
15.5	99.2	22	89.5	28.5	79.0	35	68.9
16	98.5	22.5	88.7	29	78.2	35.5	68.2
16.5	97.8	23	87.9	29.5	77.4	36	67.4
17	97.1	23.5	87.1	30	76.6	36.5	66.7
17.5	96.4	24	86.3	30.5	75.8	37	66.0
18	95.6	24.5	85.5	31	75.1	37.5	65.2
18.5	94.9	25	84.7	31.5	74.3	38	64.5
19	94.1	25.5	83.9	32	73.5	38.5	63.8
19.5	93.4	26	83.0	32.5	72.7	39	63.1
20	92.6	26.5	82.2	33	71.9	39.5	62.4
20.5	91.8	27	81.4	33.5	71.2	40	61.7

Shearing Stresses. The safe load tables for beams and channels are computed solely with reference to safe unit stresses due to flexure, and the safe loads uniformly distributed on the spans given will not produce excessive shearing stresses in the web.

Web Shear Limited by Buckling. The shearing stresses acting in the web of a beam produce two stresses of equal intensity, compression and tension, respectively, acting at right angles to each other and at angles of 45 degrees with the neutral axis. The intensity of each of these stresses is equal to the $\sqrt{2}\times$ intensity of the vertical shearing stress. The compressive stresses tend to buckle the web, which, however, is not entirely free to buckle, because the tensile stresses acting at right angles have the effect of stiffening it. The web may be figured as composed of a series of columns inclined at an angle of 45 degrees with the neutral axis.

The following method should be used to determine the total safe loads due to web shear.

V = Maximum allowable web shear in pounds.
A = Gross area of web.
t = Web thickness in inches.
c = Distance between flanges in inches.
f_s = Unit stress for shear in pounds per square inch.

On the gross area of the web where c is not more than 60 times t, $f_s = 12{,}000$ pounds per square inch.

On the gross area of the webs of beams and girders where the web is not stiffened and c is more than 60 times t, the maximum shear per square inch, f_s equal to V/A, shall not exceed:

$$\frac{18{,}000}{1+\dfrac{c^2}{7{,}200\,t^2}}$$

For web crippling at ends of beam or at points of concentrated loading, see discussion on following pages.

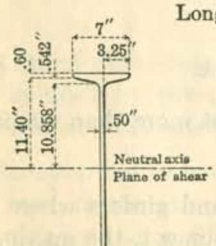
When beams support heavy loads concentrated near the supports, or when beams of short spans have uniformly distributed loads to their full carrying capacity as regards flexure, the bending moments may be small in comparison with the reactions at the supports, and the beams may fail along the neutral plane as a result of longitudinal shearing stresses, or may buckle as a result of the combined longitudinal and vertical web stresses. On such spans the safe shearing or buckling strength of the web may limit the carrying capacity, so that the deciding factor may be the resistance of the web to shearing stresses, rather than the resistance of the flanges to bending stresses.

Longitudinal Shear. At any point in any section of a beam, the horizontal and vertical components of the web stress are equal to each other and proportional to the vertical shear; their intensities are dependent upon the distance of the point from the neutral axis. In order to determine the intensity of the vertical shearing stress at a given point in a vertical section of the beam, therefore, it is sufficient to find the equal intensity of the horizontal shearing stress at the same point in the horizontal plane.

The longitudinal unit shear is zero at the upper and lower flanges of the beam and is maximum at the neutral plane. It is greatest at the supports and zero where there is no vertical shear.

The intensity of the longitudinal shear at any point in any section is the product of the vertical shear, V, for that section and the static moment, M_s, of the section included between the horizontal plane of shear through that point and the extreme fibers on the same side of the neutral plane divided by the product of the moment of inertia of the beam and the web thickness at the plane of shear;

$$\text{Longitudinal unit shear} = \frac{V\,M_s}{t\,I}.$$



Example—Required the maximum longitudinal shear per square inch in a 24″ 79.9 lb. beam loaded with two symmetrical loads of 100,000 pounds each, disregarding the weight of the beam.

M_s of Flange Rectangle	$= 7 \times .60 \times 11.7$	$= 49.1$
M_s of Flange Triangles	$= 3.25 \times .542 \times 11.22$	$= 19.8$
M_s of Web	$= 11.40 \times .50 \times 5.70$	$= 32.5$
Total Static Moment		101.4 in.^{3}
Moment of Inertia of Beam, Axis 1-1,		$I = 2087.2$ in.^{4}

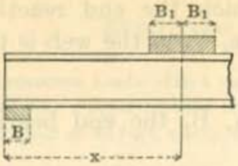
$$\text{Longitudinal Shear} = \frac{100000 \times 101.4}{2087.2 \times .50} = 9716 \text{ lb. per sq. in.}$$

Under usual conditions of loading, the longitudinal shear need not be considered.

Buckling Values of Beam Webs. The vertical shearing stresses or the vertical compressive components of the web stress may, under some conditions, exceed the safe resistance of the beam to buckling, so that a web, which is amply secure against the safe allowed shear, will not be of sufficient strength when considered as a column.

In such cases provision must be made for security against buckling of the web either by stiffeners or by increasing its thickness.

Experiments with beams of various depths and web thicknesses have demonstrated that the length of the web which can be assumed to resist buckling stresses is equal to the end bearing plus one-fourth of the depth of the beam; the following formulas have been deduced:



Safe end reaction $R = f_b \times t\,(B + \frac{d}{4})$

Safe interior load $W = 2\,f_b \times t\,(B_1 + \frac{d}{4})$

Minimum end distance $x = (B + B_1 + \frac{d}{2})$

R = End reaction.
W = Concentrated load.
t = Web thickness.
c = Depth of beam between flanges.
d = Depth of beam.
B = Distance over which end reaction is applied.
B_1 = Half the distance over which concentrated load is applied.
f_b = Safe resistance of web to buckling.

The first formula above applies to any condition of loading.

The second formula is for a single interior load. It can be applied to a system of concentrated loads, provided the sum of the distances at B_1 is not less than B. For concentrated loadings the distance x should not be less than $(B + B_1 + \frac{d}{4})$.

For values in the tables both flanges were considered fixed and for computation of f_b the following formula was used, corresponding to a maximum shearing stress of 12,000 pounds, f_b maximum not to exceed 15,000 pounds per square inch.

$$f_b = \frac{18000}{1 + \frac{1}{18000}(l/r)^2}, \quad l = .5d \quad r^2 = \frac{1}{12}t^2, \quad f_b = \frac{18000}{1 + \frac{1}{6000}(d/t)^2}$$

When only one flange is fixed l should be considered as .7d and the formula is

$$f_b = \frac{18000}{1 + \frac{1}{3000}(d/t)^2}$$

The tables give the following values for beams and channels with unsupported webs where both flanges are considered fixed:

1. The allowable shear, V, on the gross area of the beam or channel webs $= f_s\,dt$.

Unit shear $f_s = 12{,}000$ pounds per square inch when $\frac{c}{t}$ is equal to or less than 60.

$$f_s = \frac{18000}{1 + \frac{1}{7200}(c/t)^2} \text{ when } \frac{c}{t} \text{ is greater than 60.}$$

2. Span limit to develop V.

3. The allowable web resistance f_b, in pounds per square inch.

4. The distance B, the length over which the end reaction must be distributed when the shearing stress, V, in the web is the maximum allowable.

5. The allowable end reaction, R, when, B, the end bearing distance equals $3\frac{1}{2}$ inches.

Maximum Bending Moments. In addition to data referring to maximum loads on beams and channels as computed from the web resistance, the tables give also the maximum bending moment in foot-pounds, which may be used instead of the section modulus to ascertain the proper section.

Effect of Impact on Stresses. The safe loads in tables are for quiescent or static loads. The effect of moving loads may be taken care of either by reducing the allowable unit stresses, or by increasing the theoretical loads.

When a load is suddenly applied as in the case of a rolling load, the resultant stresses are greater than those due to an equal quiescent load, in some cases as much as 100 per cent.

When an instantaneously applied load produces impact or percussion, the resultant stresses are dynamic and are measured by the laws governing the energy of bodies in motion.

The following formulas give the unit stress and deflection due to a load falling on center of a beam rigidly supported at both ends when the weight of beam is negligible as compared with that of falling load, and when no account is taken of the local distortion due to impact or percussion at point of application of load.

W = Weight of falling load, in pounds. h = Height of fall, in inches.

f = Extreme unit stress due to static effect of load, W, in pounds per square inch.

f_d = Extreme unit stress due to impact of load, W, in pounds per square inch.

D = Deflection due to static effect of load, W, in inches.

D_d = Deflection due to impact of load, W, in inches.

$$f_d = f\left(1 + \sqrt{\frac{2h}{D} + 1}\right) \qquad D_d = D\left(1 + \sqrt{\frac{2h}{D} + 1}\right)$$

It must be noted, however, that when the weight of the beam is a real factor, theoretical formulas do not agree with observed results and practical tests give values which are far less than those indicated by theoretical formulas; this is notably true in drop-tests of axles.

Large Copes. Where beams have long or deep copes the webs should be investigated for safety as regards shear and bearing.

Examples of the Use of Beam Safe Load Tables

Transverse Loads—Fixed Spans. Required the proper size of a beam laterally braced to support a superimposed or net load of 88,000 pounds uniformly distributed over a clear span of 42 feet, assuming a unit stress of 18,000 pounds.

From the table of safe loads on page 202, it is found that beam CB 301, 30″ x 10½″—116 pounds, will support a gross load of 93,700 pounds. The weight of beam is $42 \times 116 = 4{,}872$ pounds. The net safe load is, therefore, $93{,}700 - 4{,}872 = 88{,}828$ pounds.

Transverse Loads—Free Spans. Required the reduced safe load on beam CB 212, 21″ x 9″—82 pounds, for a span of 21 feet without any lateral support or bracing, in accordance with A. I. S. C. formula for 18,000 pounds.

Tabular load, page 210 is 96,000 pounds. Ratio, $l/b = \frac{21 \times 12}{9} = 28.0$

Reduced safe load, page 184 is $96{,}000 \times 0.798 = 76{,}608$ pounds.

Vertical Shear. Required the maximum load which beam B 18, 24″ 105.9 x 85 pounds, can support without exceeding web unit resistance of 12,000 pounds.

From tables on page 194, the maximum end reaction is 180,000 pounds and the maximum load is $2 \times 180{,}000 = 360{,}000$ pounds.

Vertical Deflection. 1. Required the proper size and the deflection of a beam supporting a net load of 12,500 pounds, concentrated in the middle of a 21-foot span, for a unit stress of 18,000 pounds, assuming that the beam is braced against lateral deflection.

The specified concentrated load is equivalent to a uniformly distributed load of $2 \times 12{,}500 = 25{,}000$ pounds.

In table on page 220, it is found that beam CB 141, 14″ x 6¾″—34 pounds, will support a gross load of 27,700 pounds or a net load of $27{,}700 - 21 \times 34 = 26{,}986$ pounds.

The deflection produced by a uniformly distributed load of 27,700 pounds is found from the coefficient given in the same table and on page 183 to be $8.21 \div 14 = 0.59''$. The deflection for the specified load concentrated in the middle of the span, page 157, is approximately 4/5 of 0.59″ or 0.47″.

2. Required the deflection of a riveted girder, 37 inches deep, for a span of 35 feet and a unit stress of 14,000 pounds.

Required deflection, table on page 183, $= \frac{22.81}{37} \times \frac{14000}{18000} = 0.48''$.

3. Required the deflection of angle 6″ x 4″ x 7/16″ about an axis parallel to the short leg, rigidly secured laterally, and loaded to capacity of 3287 pounds, for a span of 14 feet and a unit stress of 18,000 pounds.

Required deflection, page 183, is $\frac{3.65}{2 \times (6 - 1.96)} = 0.45''$.

4. Required the deflection of channel C 3, 10″ x 15.3 pounds, laid flat and loaded to capacity of 1300 pounds, for a span of 12 feet and a unit stress of 20,000 pounds.

Required deflection, page 183, $= \frac{2.68}{2\ (2.60 - 0.64)} \times \frac{20{,}000}{18{,}000} = 0.76''$.

BEAM VALUES

CB SECTIONS

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

Section Index and Nominal Depth	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V — WEB SHEARING — End Reaction	Span Limit	WEB BUCKLING — Unit Stress	End Bearing	*End Reaction for B=3½"
	d		t	M max.	V max.	L min.	fb	B min.	Rmax.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
CB 362 36	36.72	300	.945	1657650	416400	15.92	14380	21.46	172320
	36.50	280	.885	1546800	387630	15.96	14020	22.11	156690
	36.24	260	.845	1426650	367470	15.53	13780	22.50	146210
	36.12	250	.815	1367550	353250	15.49	13560	22.93	138480
	36.00	240	.790	1310400	341280	15.36	13370	23.31	132050
	35.88	230	.765	1253250	329380	15.22	13170	23.72	125650
CB 361 36	36.48	194	.770	995400	337080	11.81	13100	24.30	127290
	36.32	182	.725	931800	315980	11.80	12690	25.26	115750
	36.16	170	.680	868650	295070	11.78	12230	26.43	104320
	36.00	160	.653	811500	282100	11.51	11950	27.16	97520
	35.84	150	.625	754350	268800	11.23	11630	28.02	90550
CB 332 33	33.50	240	.830	1216650	333660	14.59	14160	20.02	139530
	33.25	220	.775	1110900	309230	14.37	13770	20.66	126100
	33.12	210	.748	1056600	297290	14.22	13570	21.02	119540
	33.00	200	.715	1004400	283140	14.19	13280	21.56	111600
CB 331 33	33.50	152	.635	729600	255270	11.43	12300	24.32	92720
	33.31	141	.605	670200	241830	11.09	11960	25.10	85570
	33.15	132	.580	620550	230720	10.76	11660	25.84	79680
	30.00	125	.570	577650	225720	10.24	11550	26.04	77350
CB 302 30	30.38	210	.775	974850	282530	13.80	14330	17.84	123220
	30.25	200	.740	926400	268620	13.79	14080	18.22	115250
	30.12	190	.710	879150	256620	13.70	13850	18.57	108440
	30.00	180	.670	832800	241200	13.81	13490	19.18	99430
	29.88	172	.655	792300	234860	13.49	13370	19.36	96030
CB 301 30	30.30	132	.615	569550	223610	10.19	12820	20.80	87290
	30.16	124	.585	531900	211720	10.05	12470	21.48	80560
	30.00	116	.564	491850	203040	9.69	12230	21.93	75890
	29.82	108	.548	448800	196100	9.15	12050	22.24	72350
CB 272 27	27.31	177	.725	739200	237600	12.44	14560	15.69	109000
	27.12	163	.670	679350	218040	12.46	14140	16.24	97380
	27.00	154	.635	641700	205740	12.48	13830	16.68	90030
	26.88	145	.600	604350	193540	12.49	13490	17.19	82710
CB 271 27	27.28	114	.570	448800	186600	9.62	13030	18.31	76630
	27.14	106	.535	415800	174240	9.55	12600	19.07	69320
	27.00	98	.500	382950	162000	9.46	12110	20.00	62080
	26.84	91	.483	349800	155560	8.99	11880	20.39	58600
CB 243 24	24.72	160	.656	620250	194600	12.75	14560	14.20	92430
	24.56	150	.628	578250	185080	12.50	14340	14.41	86840
	24.41	140	.594	537900	173990	12.37	14050	14.75	80120
	24.25	130	.565	496050	164420	12.07	13770	15.07	74410

*See page 185.

CB SECTIONS

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

BEAM VALUES

Section Index and Nominal Depth	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V: WEB SHEARING: End Reaction	Span Limit	WEB BUCKLING: Unit Stress	End Bearing	*End Reaction for B=3½"
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
CB 242 24	24.31	120	.556	448650	162200	11.06	13650	15.29	72690
	24.16	110	.510	411600	147860	11.13	13100	16.09	63740
	24.00	100	.468	373350	134780	11.08	12520	17.01	55640
CB 241 24	24.29	94	.516	331350	150400	8.81	13150	16.10	64930
	24.16	87	.480	306450	139160	8.81	12660	16.87	57960
	24.00	80	.455	278700	131040	8.51	12300	17.42	53160
	23.87	74	.430	255600	123170	8.30	11890	18.12	48410
CB 213 21	21.46	142	.659	475800	169710	11.21	15000	11.80	87630
	21.31	132	.614	442200	157010	11.27	14990	11.73	81250
	21.16	122	.567	408750	143970	11.36	14610	12.09	72810
	21.00	112	.527	374400	132800	11.28	14230	12.45	65630
CB 212 21	21.29	103	.608	319650	155330	8.23	14950	11.77	80170
	21.14	96	.575	296400	145870	8.13	14690	11.98	74210
	21.00	89	.537	274200	135320	8.10	14340	12.32	67400
	20.86	82	.499	252000	124910	8.07	13940	12.74	60620
CB 211 21	21.24	73	.455	226050	115970	7.80	13200	13.99	52930
	21.13	68	.430	209850	109030	7.70	12840	14.47	48470
	21.00	63	.410	192000	103320	7.43	12520	14.87	44930
	20.91	59	.390	178950	97860	7.31	12170	15.39	41420
CB 183 18	18.64	124	.651	358500	145620	9.85	15000	10.25	79680
	18.48	114	.595	330150	131950	10.01	15000	10.16	72470
	18.32	105	.554	303300	121790	9.96	15000	10.08	67150
	18.16	96	.512	276600	111570	9.92	14880	10.10	61250
CB 182 18	18.32	85	.526	234150	115640	8.10	14970	10.10	63640
	18.16	77	.475	212550	103510	8.21	14470	10.52	55280
	18.00	70	.438	192300	94610	8.13	14050	10.88	49220
	17.87	64	.403	175500	86420	8.12	13560	11.35	43530
CB 181 18	18.12	55	.390	147300	84800	6.95	13240	11.90	41460
	18.00	50	.358	133500	77330	6.91	12660	12.56	36270
	17.90	47	.350	123450	75180	6.57	12540	12.66	34990
CB 163 16	16.64	114	.631	296100	126000	9.40	15000	9.15	72500
	16.48	105	.584	272550	115490	9.44	15000	9.06	66750
	16.32	96	.535	249150	104770	9.51	15000	8.98	60830
	16.16	88	.504	226950	97740	9.29	15000	8.89	57000
CB 162 16	16.32	78	.529	191700	103600	7.40	15000	8.98	60150
	16.16	71	.486	173850	94250	7.38	15000	8.89	54970
	16.00	64	.443	156300	85060	7.35	14790	8.99	49130
	15.86	58	.407	141150	77460	7.29	14370	9.28	43640

*See page 185.

BEAM VALUES

CB SECTIONS

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

Section Index and Nominal Depth	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V — WEB SHEARING End Reaction	Span Limit	WEB BUCKLING Unit Stress	End Bearing	*End Reaction for B=3½″
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
CB 161 16	16.25	50	.380	121050	74100	6.53	13800	10.07	39650
	16.12	45	.346	108600	66930	6.49	13220	10.61	34440
	16.00	40	.307	96600	58940	6.56	12390	11.49	28530
	15.85	36	.299	84450	56870	5.94	12260	11.55	27350
CB 145 14	14.50	119	.570	284100	99180	11.46	15000	7.98	60920
	14.37	111	.540	264450	93120	11.36	15000	7.90	57450
	14.25	103	.495	245400	84650	11.60	15000	7.84	52440
	14.12	95	.465	225900	78790	11.47	15000	7.77	49030
	14.00	87	.420	207150	70560	11.74	15000	7.70	44100
CB 144 14	14.18	84	.451	196350	76740	10.23	15000	7.80	47660
	14.06	78	.428	181650	72210	10.06	15000	7.73	45040
CB 143 14	14.19	74	.450	168450	76630	8.79	15000	7.81	47570
	14.06	68	.418	154500	70530	8.76	15000	7.73	43980
	13.91	61	.378	138300	63100	8.77	14690	7.89	38730
CB 142 14	14.06	58	.406	127500	68500	7.45	15000	7.73	42720
	13.94	53	.370	116700	61890	7.54	14560	8.01	37620
	13.81	48	.339	105300	56180	7.50	14100	8.30	33230
	13.68	43	.308	94050	50560	7.44	13550	8.70	28870
CB 141 14	14.24	42	.338	91050	57760	6.31	13890	8.74	33150
	14.12	38	.313	81900	53040	6.18	13440	9.08	29580
	14.00	34	.287	72750	48220	6.04	12890	9.54	25890
	13.86	30	.270	62700	44910	5.58	12510	9.83	23520
CB 124 12	12.50	85	.495	173550	74250	9.35	15000	6.88	49190
	12.38	79	.470	160650	69820	9.20	15000	6.81	46500
	12.25	72	.430	146250	63210	9.25	15000	6.74	42330
	12.12	65	.390	132000	56720	9.31	15000	6.67	38200
CB 123 12	12.31	64	.405	128700	59830	8.60	15000	6.77	39960
	12.19	58	.359	117150	52510	8.92	15000	6.70	35260
	12.06	53	.345	106050	49930	8.50	14950	6.66	33610
CB 122 12	12.19	50	.371	97050	54270	7.15	15000	6.70	36440
	12.06	45	.336	87300	48630	7.18	14820	6.75	32440
	11.94	40	.294	77850	42120	7.39	14120	7.16	26920
CB 121 12	12.24	36	.305	68850	44800	6.15	14190	7.29	28390
	12.12	32	.273	61050	39710	6.15	13550	7.71	24150
	12.00	28	.240	53400	34560	6.18	12710	8.34	19820
	11.87	25	.240	46350	34190	5.42	12790	8.17	19850
CB 103 10	10.38	66	.457	110550	56920	7.77	15000	5.71	41780
	10.25	60	.415	100650	51050	7.89	15000	5.64	37740
	10.12	54	.368	90600	44690	8.11	15000	5.57	33290
	10.00	49	.340	81900	40800	8.03	15000	5.50	30600

*See page 185.

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BEAM VALUES

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

Section Index and Nominal Depth	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V — WEB SHEARING — End Reaction	Span Limit	WEB BUCKLING — Unit Stress	End Bearing	*End Reaction for B=3½"
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
CB 102 10	10.12	45	.350	73650	42500	6.93	15000	5.57	31660
	10.00	41	.328	66750	39360	6.78	15000	5.50	29520
	9.88	37	.306	59850	36280	6.60	15000	5.43	27400
	9.75	33	.292	52500	34160	6.15	15000	5.36	26010
CB 101 10	10.22	29	.289	46200	35440	5.21	14900	5.68	26070
	10.12	26	.259	41400	31450	5.26	14350	5.93	22410
	10.00	23	.240	36150	28800	5.02	13960	6.10	20100
	9.90	21	.240	32250	28510	4.52	14020	6.00	20110
CB 83 8	8.12	35	.315	46650	30690	6.08	15000	4.47	26130
	8.06	33	.300	43950	29020	6.06	15000	4.43	24820
	8.00	31	.288	41100	27650	5.95	15000	4.40	23760
CB 82 8	8.03	27	.273	35100	26310	5.34	15000	4.42	22550
	7.93	24	.245	31200	23310	5.35	15000	4.36	20150
CB 81 8	8.19	21	.252	27000	24770	4.36	15000	4.51	20970
	8.09	19	.244	24000	23690	4.05	15000	4.45	20210
	8.00	17	.230	21150	22080	3.83	14980	4.41	18950
LIGHT BEAMS									
CBL 12 12	12.31	22	.260	37950	38410	3.95	13104	8.20	22410
	12.16	19	.240	32100	35020	3.67	12606	8.54	19780
	12.00	16.5	.230	26250	33120	3.17	12382	8.63	18510
CBL 10 10	10.25	19	.250	28200	30750	3.67	14061	6.19	21310
	10.12	17	.240	24300	29150	3.33	13885	6.22	20090
	10.00	15	.230	20700	27600	3.00	13688	6.27	18890
CBL 8 8	8.12	15	.245	17700	23870	2.97	15000	4.47	20320
	8.00	13	.230	14820	22080	2.68	14980	4.41	18950
CBL 6 6	6.25	16	.260	15150	19500	3.11	15000	3.44	19770
	6.00	12	.230	10860	16560	2.62	15000	3.30	17270
STANCHIONS									
CBS 6 6	6.09	18	.265	17550	19370	3.62	15000	3.35	19970
	6.00	15.5	.240	15000	17280	3.47	15000	3.30	18000
JOISTS									
CBJ 12 12	11.91	14	.200	22200	28580	3.11	11313	9.65	14660
CBJ 10 10	9.87	11.5	.180	15750	21320	2.96	11991	7.41	12880
CBJ 8 8	7.90	10	.170	11685	16120	2.90	13236	5.19	12320
CBJ 6 6	5.83	8.5	.170	7605	11893	2.55	15000	3.22	12660

*See page 185.

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MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

Section Index	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V — WEB SHEARING: End Reaction	WEB SHEARING: Span Limit	WEB BUCKLING: Unit Stress	WEB BUCKLING: End Bearing	*End Reaction for B=3½"
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
B 18	24	120.0	.798	376350	229820	6.55	15000	13.20	113720
		115.0	.737	367550	212260	6.93	15000	13.20	105020
		110.0	.675	358650	194400	7.38	14870	13.37	95330
		105.9	.625	351450	180000	7.81	14450	13.95	85800
B 1	24	100.0	.747	296400	215140	5.51	15000	13.20	106450
		95.0	.686	287700	197570	5.82	14950	13.26	97430
		90.0	.624	278700	179710	6.20	14440	13.95	85600
		85.0	.563	270000	162140	6.66	13820	14.85	73900
		79.9	.500	260850	144000	7.25	13010	16.14	61780
B 2	20	100.0	.873	247200	209520	4.72	15000	11.00	111310
		95.0	.800	240000	192000	5.00	15000	11.00	102000
		90.0	.726	232500	174240	5.34	15000	11.00	92570
		85.0	.653	225300	156720	5.75	15000	11.00	83260
		81.4	.600	219900	144000	6.11	15000	11.00	76500
B 3	20	75.0	.641	189450	153840	4.93	15000	11.00	81730
		70.0	.567	182100	136080	5.35	14910	11.10	71850
		65.4	.500	175350	120000	5.85	14210	11.89	60390
B 4	18	70.0	.711	152850	153580	3.98	15000	9.90	85320
		65.0	.629	146250	135860	4.31	15000	9.90	75480
		60.0	.547	139650	118150	4.73	15000	9.90	65640
		54.7	.460	132600	99360	5.34	14340	10.56	52770
B 6	15	75.0	.868	137400	156240	3.52	15000	8.25	94400
		70.0	.770	131850	138600	3.81	15000	8.25	83740
		65.0	.672	126450	120960	4.18	15000	8.25	73080
		60.8	.590	121800	106200	4.59	15000	8.25	64160
B 7	15	55.0	.648	101700	116640	3.49	15000	8.25	70470
		50.0	.550	96300	99000	3.89	15000	8.25	59810
		45.0	.452	90750	81360	4.46	15000	8.25	49160
		42.9	.410	88350	73800	4.79	14720	8.48	43750
B 8	12	55.0	.810	79800	116640	2.74	15000	6.60	78980
		50.0	.687	75450	98930	3.05	15000	6.60	66980
		45.0	.565	70950	81360	3.49	15000	6.60	55090
		40.8	.460	67200	66240	4.06	15000	6.60	44850
B 9	12	35.0	.428	56700	61630	3.68	15000	6.60	41730
		31.8	.350	54000	50400	4.28	15000	6.60	34130
B 10	10	40.0	.741	47400	88920	2.13	15000	5.50	66690
		35.0	.594	43800	71280	2.45	15000	5.50	53460
		30.0	.447	40050	53640	2.99	15000	5.50	40230
		25.4	.310	36600	37200	3.94	15000	5.50	27900

*See page 185.

BEAMS
AMERICAN STANDARD

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

BEAM

VALUES

Section Index	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V				*End Reaction for B=3½"
					WEB SHEARING		WEB BUCKLING		
					End Reaction	Span Limit	Unit Stress	End Bearing	
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
B 12	8	25.5	.532	25500	51070	2.00	15000	4.40	43890
		23.0	.441	24000	42340	2.27	15000	4.40	36380
		20.5	.349	22650	33500	2.70	15000	4.40	28790
		18.4	.270	21300	25920	3.29	15000	4.40	22280
B 13	7	20.0	.450	18000	37800	1.90	15000	3.85	35440
		17.5	.345	16650	28980	2.30	15000	3.85	27170
		15.3	.250	15600	21000	2.96	15000	3.85	19690
†B 42	7	12.0	.188	12750	15790	3.23	14620	4.00	14430
B 14	6	17.25	.465	13050	33480	1.55	15000	3.30	34880
		14.75	.343	11850	24700	1.93	15000	3.30	25730
		12.50	.230	10950	16560	2.63	15000	3.30	17250
†B 41	6	10.0	.188	8850	13540	2.62	15000	3.30	14100
B 15	5	14.75	.494	9000	29640	1.22	15000	2.75	35200
		12.25	.347	8100	20820	1.56	15000	2.75	24720
		10.0	.210	7200	12600	2.30	15000	2.75	14960
B 16	4	10.5	.400	5250	19200	1.11	15000	2.20	27000
		9.5	.326	4950	15650	1.28	15000	2.20	22010
		8.5	.253	4800	12140	1.56	15000	2.20	17080
		7.7	.190	4500	9120	1.96	15000	2.20	12830
B 17	3	7.5	.349	2850	12560	0.92	15000	1.75	22250
		6.5	.251	2700	9040	1.18	15000	1.75	16000
		5.7	.170	2550	6120	1.62	15000	1.75	10840
H-BEAMS									
†H 4 8	8.000	37.7	.500	45300	48000	3.78	15000	4.40	41250
	8.000	34.3	.375	43350	36000	4.82	15000	4.40	30940
	8.000	32.6	.313	42300	30050	5.63	15000	4.40	25820
†H 3A 6	6.000	27.5	.438	24600	31540	3.12	15000	3.30	32850
	6.000	25.0	.313	23550	22540	4.18	15000	3.30	23480
†H 3 6	6.000	22.5	.375	20550	27000	3.04	15000	3.30	28130
	6.000	20.0	.250	19350	18000	4.30	15000	3.30	18750
†H 2 5	5.000	18.9	.313	14250	18780	3.04	15000	2.75	22300
†H 1 4	4.000	13.8	.313	7950	15020	2.12	15000	2.20	21130

†Standard Mill Sections, not American Standard Beams. *See page 185.

CHANNEL

VALUES

CHANNELS
AMERICAN STANDARD

MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

Section Index	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V: WEB SHEARING: End Reaction	*VALUES FOR END REACTION V: WEB SHEARING: Span Limit	*VALUES FOR END REACTION V: WEB BUCKLING: Unit Stress	*VALUES FOR END REACTION V: WEB BUCKLING: End Bearing	*End Reaction for B=3½″
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
†C 60 ©	18	58.0	.700	111750	151200	2.96	15000	9.90	84000
		51.9	.600	103650	129600	3.20	15000	9.90	72000
		45.8	.500	95550	108000	3.54	14800	10.09	59210
		42.7	.450	91500	97200	3.77	14210	10.70	51160
C 1	15	55.0	.814	85800	146520	2.34	15000	8.25	88520
		50.0	.716	80400	128880	2.50	15000	8.25	77870
		45.0	.618	74700	111240	2.69	15000	8.25	67210
		40.0	.520	69300	93600	2.96	15000	8.25	56550
		35.0	.422	63750	75960	3.36	14870	8.36	45490
		33.9	.400	62550	72000	3.48	14580	8.59	42290
C 20	13	50.0	.787	72150	122770	2.35	15000	7.15	79680
		45.0	.673	67350	104990	2.57	15000	7.15	68140
		40.0	.560	62550	87360	2.86	15000	7.15	56700
		37.0	.492	59700	76750	3.11	15000	7.15	49820
		35.0	.447	57900	69730	3.32	15000	7.15	45260
		31.8	.375	54750	58500	3.74	15000	7.15	37960
C 2	12	40.0	.755	49200	108720	1.81	15000	6.60	73610
		35.0	.632	44700	91010	1.97	15000	6.60	61620
		30.0	.510	40350	73440	2.20	15000	6.60	49730
		25.0	.387	35850	55730	2.57	15000	6.60	37730
		20.7	.280	32100	40320	3.19	13780	7.45	25080
C 3	10	35.0	.820	34500	98400	1.40	15000	5.50	73800
		30.0	.673	30900	80760	1.53	15000	5.50	60570
		25.0	.526	27150	63120	1.72	15000	5.50	47340
		20.0	.379	23550	45480	2.07	15000	5.50	34110
		15.3	.240	20100	28800	2.79	13960	6.10	20100
C 4	9	25.0	.612	23550	66100	1.43	15000	4.95	52790
		20.0	.448	20250	48380	1.67	15000	4.95	38640
		15.0	.285	16950	30780	2.20	15000	4.95	24580
		13.4	.230	15750	24840	2.54	14340	5.28	18960
C 5	8	21.25	.579	17850	55580	1.29	15000	4.40	47770
		18.75	.487	16350	46750	1.40	15000	4.40	40180
		16.25	.395	14850	37920	1.57	15000	4.40	32590
		13.75	.303	13500	29090	1.86	15000	4.40	25000
		11.5	.220	12150	21120	2.30	14750	4.51	17850

†C 60–18″ Channel, is a Ship Building Channel, not American Standard. *See page 185.

CHANNELS
AMERICAN STANDARD
MAXIMUM BENDING MOMENTS AND WEB RESISTANCES

Bending Stress 18 Kips—Shearing Stress 12 Kips

CHANNEL [VALUES

Section Index	Depth of Beam	Weight per Foot	Web Thickness	Maximum Bending Moment	*VALUES FOR END REACTION V — WEB SHEARING — End Reaction	Span Limit	WEB BUCKLING — Unit Stress	End Bearing	*End Reaction for B=3½″
	d		t	M max.	V max.	L min.	fb	B min.	R max.
	Inches	Pounds	Inches	Foot Pounds	Pounds	Feet	Pounds per Sq. In.	Inches	Pounds
		19.75	.629	14100	52840	1.07	15000	3.85	49530
		17.25	.524	12900	44020	1.17	15000	3.85	41270
C 6	7	14.75	.419	11550	35200	1.31	15000	3.85	33000
		12.25	.314	10350	26380	1.57	15000	3.85	24730
		9.8	.210	9000	17640	2.04	15000	3.85	16540
		15.5	.559	9750	40250	0.97	15000	3.30	41930
C 7	6	13.0	.437	8700	31460	1.11	15000	3.30	32780
		10.5	.314	7500	22610	1.33	15000	3.30	23550
		8.2	.200	6450	14400	1.79	15000	3.30	15000
		11.5	.472	6150	28320	0.87	15000	2.75	33630
C 8	5	9.0	.325	5250	19500	1.08	15000	2.75	23160
		6.7	.190	4500	11400	1.58	15000	2.75	13540
		7.25	.320	3450	15360	0.90	15000	2.20	21600
C 9	4	6.25	.247	3150	11860	1.06	15000	2.20	16670
		5.4	.180	2850	8640	1.32	15000	2.20	12150
		6.0	.356	2100	12820	0.66	15000	1.65	22700
C 10	3	5.0	.258	1800	9290	0.78	15000	1.65	16450
		4.1	.170	1650	6120	1.08	15000	1.65	10840

*See page 185.

BEAM 36″ LOADS

CB SECTIONS

ALLOWABLE UNIFORM LOADS IN KIPS

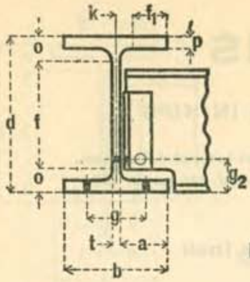
Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

see page 184

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	CB 362 36″ x 16½″ 300 Lbs.	280 Lbs.	260 Lbs.	250 Lbs.	240 Lbs.	230 Lbs.	CB 361 36″ x 12″ 194 Lbs.	182 Lbs.	170 Lbs.	160 Lbs.	150 Lbs.	Coefficient of Deflection
							674.2	632.0	590.1	564.2	537.6	
12							663.6	621.2	579.1	541.0	502.9	2.68
13							612.6	573.4	534.6	499.4	464.2	3.15
14							568.8	532.5	496.4	463.7	431.1	3.65
15	832.8	775.3	734.9	706.5	682.6	658.8	530.9	497.0	463.3	432.8	402.3	4.19
16	828.8	773.4	713.3	683.8	655.2	626.6	497.7	465.9	434.3	405.8	377.2	4.77
17	780.1	727.9	671.4	643.6	616.7	589.8	468.4	438.5	408.8	381.9	355.0	5.38
18	736.7	687.5	634.1	607.8	582.4	557.0	442.4	414.1	386.1	360.7	335.3	6.03
19	698.0	651.3	600.7	575.8	551.7	527.7	419.1	392.3	365.7	341.7	317.6	6.72
20	663.1	618.7	570.7	547.0	524.2	501.3	398.2	372.7	347.5	324.6	301.7	7.45
21	631.5	589.3	543.5	521.0	499.2	477.4	379.2	355.0	330.9	309.1	287.4	8.21
22	602.8	562.5	518.8	497.3	476.5	455.7	362.0	338.8	315.9	295.1	274.3	9.01
23	576.6	538.0	496.2	475.7	455.8	435.9	346.2	324.1	302.1	282.3	262.4	9.85
24	552.6	515.6	475.6	455.9	436.8	417.8	331.8	310.6	289.6	270.5	251.5	10.73
25	530.4	495.0	456.5	437.6	419.3	401.0	318.5	298.2	278.0	259.7	241.4	11.64
26	510.0	475.9	439.0	420.8	403.2	385.6	306.3	286.7	267.3	249.7	232.1	12.59
27	491.2	458.3	422.7	405.2	388.3	371.3	294.9	276.1	257.4	240.4	223.5	13.57
28	473.6	441.9	407.6	390.7	374.4	358.1	284.4	266.2	248.2	231.9	215.5	14.60
29	457.3	426.7	393.6	377.3	361.5	345.7	274.6	257.0	239.6	223.9	208.1	15.66
30	442.0	412.5	380.4	364.7	349.4	334.2	265.4	248.5	231.6	216.4	201.2	16.76
31	427.8	399.2	368.2	352.9	338.2	323.4	256.9	240.5	224.2	209.4	194.7	17.89
32	414.4	386.7	356.7	341.9	327.6	313.3	248.9	233.0	217.2	202.9	188.6	19.07
33	401.9	375.0	345.9	331.5	317.7	303.8	241.3	225.9	210.6	196.7	182.9	20.28
34	390.0	364.0	335.7	321.8	308.3	294.9	234.2	219.2	204.4	190.9	177.5	21.53
35	378.9	353.6	326.1	312.6	299.5	286.5	227.5	213.0	198.5	185.5	172.4	22.81
36	368.4	343.7	317.0	303.9	291.2	278.5	221.2	207.1	193.0	180.3	167.6	24.13
37	358.4	334.4	308.5	295.7	283.3	271.0	215.2	201.5	187.8	175.5	163.1	25.49
38	349.0	325.6	300.3	287.9	275.9	263.8	209.6	196.2	182.9	170.8	158.8	26.89
39	340.0	317.3	292.6	280.5	268.8	257.1	204.2	191.1	178.2	166.5	154.7	28.32
40	331.5	309.4	285.3	273.5	262.1	250.7	199.1	186.4	173.7	162.3	150.9	29.79
42	315.7	294.6	271.7	260.5	249.6	238.7	189.6	177.5	165.5	154.6	143.7	32.85
44	301.4	281.2	259.4	248.6	238.3	227.9	181.0	169.4	157.9	147.5	137.2	36.05
46	288.3	269.0	248.1	237.8	227.9	218.0	173.1	162.1	151.1	141.1	131.2	39.40
48	276.3	257.8	237.8	227.9	218.4	208.9	165.9	155.3	144.8	135.2	125.7	42.90
50	265.2	247.5	228.3	218.8	209.7	200.5	159.3	149.1	139.0	129.8	120.7	46.55
52	255.0	238.0	219.5	210.4	201.6	192.8	153.1	143.4	133.6	124.8	116.1	50.35
54	245.6	229.2	211.4	202.6	194.1	185.7	147.5	138.0	128.7	120.2	111.8	54.30
56	236.8	221.0	203.8	195.4	187.2	179.0	142.2	133.1	124.1	115.9	107.8	58.40
58	228.6	213.4	196.8	188.6	180.7	172.9	137.3	128.5	119.8	111.9	104.0	62.64
60	221.0	206.2	190.2	182.3	174.7	167.1	132.7	124.2	115.8	108.2	100.6	67.04
62	213.9	199.6	184.1	176.5	169.1	161.7	128.4	120.2	112.1	104.7	97.3	71.58
64	207.2	193.4	178.3	170.9	163.8	156.7	124.4	116.5	108.6	101.4	94.3	76.27
66	200.9	187.5	172.9	165.8	158.8	151.9	120.7	112.9	105.3	98.4	91.4	81.11
68	195.0	182.0	167.8	160.9	154.2	147.4	117.1	109.6	102.2	95.5	88.7	86.10

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM 36″ DATA

Notation	CB 362 36″ x 16 1/2″						CB 361 36″ x 12″				
	Nominal Depth and Flange Width—Weight per Foot										
	300 Lbs.	280 Lbs.	260 Lbs.	250 Lbs.	240 Lbs.	230 Lbs.	194 Lbs.	182 Lbs.	170 Lbs.	160 Lbs.	150 Lbs.
ELEMENTS											
I_{1-1}	20290.2	18819.3	17233.8	16465.9	15724.0	14988.4	12103.4	11281.5	10470.0	9738.8	9012.1
S_{1-1}	1105.1	1031.2	951.1	911.7	873.6	835.5	663.6	621.2	579.1	541.0	502.9
I_{2-2}	1225.2	1127.5	1020.6	969.6	920.1	870.9	355.4	327.7	300.6	275.4	250.4
S_{2-2}	147.1	135.9	123.3	117.4	111.5	105.7	58.7	54.3	50.0	45.9	41.8
DIMENSIONS AND GAGES IN INCHES											
d	36 3/4	36 1/2	36 1/4	36 1/8	36	35 7/8	36 1/2	36 3/8	36 1/8	36	35 7/8
b	16 5/8	16 5/8	16 1/2	16 1/2	16 1/2	16 1/2	12 1/8	12 1/8	12	12	12
t	15/16	7/8	7/8	13/16	13/16	3/4	13/16	3/4	11/16	11/16	5/8
p	1 11/16	1 9/16	1 7/16	1 3/8	1 5/16	1 1/4	1 1/4	1 3/16	1 1/8	1	15/16
a	7 7/8	7 7/8	7 7/8	7 7/8	7 7/8	7 7/8	5 5/8	5 5/8	5 5/8	5 5/8	5 5/8
f	31 1/8	31 1/8	31 1/8	31 1/8	31 1/8	31 1/8	32 1/4	32 1/4	32 1/4	32 1/4	32 1/4
f_1	6 13/16	6 13/16	6 13/16	6 13/16	6 13/16	6 13/16	4 7/8	4 7/8	4 7/8	4 7/8	4 7/8
o	2 13/16	2 11/16	2 9/16	2 1/2	2 7/16	2 3/8	2 1/8	2 1/16	1 15/16	1 7/8	1 13/16
k	1 1/2	1 7/16	1 7/16	1 7/16	1 7/16	1 3/8	1 3/16	1 3/16	1 1/8	1 1/8	1 1/8
g usual	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2
g_2	4	4	3 3/4	3 3/4	3 3/4	3 1/2	3 1/4	3 1/4	3 1/4	3	3
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.											
M max	1658	1547	1427	1368	1310	1253	995	932	869	812	754
V max	416	388	367	353	341	329	337	316	295	282	269
L min	15.92	15.96	15.53	15.49	15.36	15.22	11.81	11.80	11.78	11.51	11.23
fb	14380	14020	13780	13560	13370	13170	13100	12690	12230	11950	11630
fbt	13590	12410	11640	11050	10565	10075	10085	9200	8320	7800	7270
B min	21.46	22.11	22.50	22.93	23.31	23.72	24.30	25.26	26.43	27.16	28.02
R max	172	157	146	138	132	126	127	116	104	98	91
RA	162	162	162	162	162	162	162	162	162	162	162
LRA	40.93	38.19	35.23	33.77	32.36	30.94	24.58	23.01	21.45	20.04	18.63
Wt.CA	61	61	61	61	61	61	61	61	61	61	61
RH	260	260	260	260	260	260	260	260	260	260	260
LRH	25.50	23.80	21.95	21.04	20.16	19.28	15.31	14.34	13.36	12.48	11.61
Wt.CH	94	94	94	94	94	94	94	94	94	94	94
Q	13261	12374	11413	10940	10483	10026	7963	7454	6949	6492	6035

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3 1/2″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
33″
LOADS

CB SECTIONS

ALLOWABLE UNIFORM LOADS IN KIPS

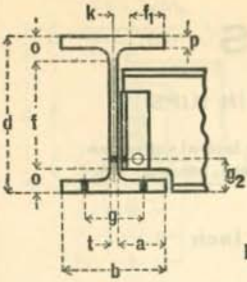
Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	CB 332 33″ x 15¾″ 240 Lbs.	220 Lbs.	210 Lbs.	200 Lbs.	CB 331 33″ x 11½″ 152 Lbs.	141 Lbs.	132 Lbs.	125 Lbs.	Coefficient of Deflection
							461.4	451.4	
11					510.5	483.7	451.3	420.1	2.25
12					486.4	446.8	413.7	385.1	2.68
13					449.0	412.4	381.9	355.5	3.15
14	667.3	618.5	594.6	566.3	416.9	383.0	354.6	330.1	3.65
15	648.9	592.5	563.5	535.7	389.1	357.4	331.0	308.1	4.19
16	608.3	555.5	528.3	502.2	364.8	335.1	310.3	288.8	4.77
17	572.5	522.8	497.2	472.7	343.3	315.4	292.0	271.8	5.38
18	540.7	493.7	469.6	446.4	324.3	297.9	275.8	256.7	6.03
19	512.3	467.7	444.9	422.9	307.2	282.2	261.3	243.2	6.72
20	486.7	444.4	422.6	401.8	291.8	268.1	248.2	231.1	7.45
21	463.5	423.2	402.5	382.6	277.9	255.3	236.4	220.1	8.21
22	442.4	404.0	384.2	365.2	265.3	243.7	225.7	210.1	9.01
23	423.2	386.4	367.5	349.4	253.8	233.1	215.8	200.9	9.85
24	405.6	370.3	352.2	334.8	243.2	223.4	206.9	192.6	10.73
25	389.3	355.5	338.1	321.4	233.5	214.5	198.6	184.8	11.64
26	374.4	341.8	325.1	309.0	224.5	206.2	190.9	177.7	12.59
27	360.5	329.2	313.1	297.6	216.2	198.6	183.9	171.2	13.57
28	347.6	317.4	301.9	287.0	208.5	191.5	177.3	165.0	14.60
29	335.6	306.5	291.5	277.1	201.3	184.9	171.2	159.4	15.66
30	324.4	296.2	281.8	267.8	194.6	178.7	165.5	154.0	16.76
31	314.0	286.7	272.7	259.2	188.3	173.0	160.1	149.1	17.89
32	304.2	277.7	264.2	251.1	182.4	167.6	155.1	144.4	19.07
33	294.9	269.3	256.1	243.5	176.9	162.5	150.4	140.0	20.28
34	286.3	261.4	248.6	236.3	171.7	157.7	146.0	135.9	21.53
35	278.1	253.9	241.5	229.6	166.8	153.2	141.8	132.0	22.81
36	270.4	246.9	234.8	223.2	162.1	148.9	137.9	128.4	24.13
37	263.1	240.2	228.5	217.2	157.8	144.9	134.2	124.9	25.49
38	256.1	233.9	222.4	211.5	153.6	141.1	130.6	121.6	26.89
39	249.6	227.9	216.7	206.0	149.7	137.5	127.3	118.5	28.32
40	243.3	222.2	211.3	200.9	145.9	134.0	124.1	115.5	29.79
42	231.7	211.6	201.3	191.3	139.0	127.7	118.2	110.0	32.85
44	221.2	202.0	192.1	182.6	132.7	121.9	112.8	105.0	36.05
46	211.6	193.2	183.8	174.7	126.9	116.6	107.9	100.5	39.40
48	202.8	185.1	176.1	167.4	121.6	111.7	103.4	96.3	42.90
50	194.7	177.7	169.1	160.7	116.7	107.2	99.3	92.4	46.55
52	187.2	170.9	162.6	154.5	112.2	103.1	95.5	88.9	50.35
54	180.2	164.6	156.5	148.8	108.1	99.3	91.9	85.6	54.30
56	173.8	158.7	150.9	143.5	104.2	95.7	88.6	82.5	58.40
58	167.8	153.2	145.7	138.5	100.6	92.4	85.6	79.7	62.64
60	162.2	148.1	140.9	133.9	97.3	89.4	82.7	77.0	67.04
62	157.0	143.3	136.3	129.6	94.1	86.5	80.1	74.5	71.58
64	152.1	138.9	132.1	125.6	91.2	83.8	77.6	72.2	76.27

Nominal Depth and Flange Width—Weight per Foot

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 33" DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 332 33" x 15 3/4"				CB 331 33" x 11 1/2"			
	240 Lbs.	220 Lbs.	210 Lbs.	200 Lbs.	152 Lbs.	141 Lbs.	132 Lbs.	125 Lbs.
ELEMENTS								
I_{1-1}	13585.1	12312.1	11664.5	11048.2	8147.6	7442.2	6856.8	6354.7
S_{1-1}	811.1	740.6	704.4	669.6	486.4	446.8	413.7	385.1
I_{2-2}	874.3	782.4	735.6	691.7	256.1	229.7	207.8	188.2
S_{2-2}	110.2	99.0	93.2	87.8	44.3	39.8	36.1	32.7
DIMENSIONS AND GAGES IN INCHES								
d	33 1/2	33 1/4	33 1/8	33	33 1/2	33 1/4	33 1/8	33
b	15 7/8	15 3/4	15 3/4	15 3/4	11 5/8	11 1/2	11 1/2	11 1/2
t	7/8	13/16	3/4	3/4	5/8	5/8	5/8	9/16
p	1 3/8	1 1/4	1 3/16	1 1/8	1 1/16	15/16	7/8	13/16
a	7 1/2	7 1/2	7 1/2	7 1/2	5 1/2	5 1/2	5 1/2	5 1/2
f	28 5/8	28 5/8	28 5/8	28 5/8	29 3/4	29 3/4	29 3/4	29 3/4
f_1	6 9/16	6 9/16	6 9/16	6 9/16	4 3/4	4 3/4	4 3/4	4 3/4
o	2 7/16	2 5/16	2 1/4	2 3/16	1 7/8	1 3/4	1 11/16	1 5/8
k	1 3/8	1 3/8	1 5/16	1 5/16	1 1/16	1 1/16	1 1/16	1 1/16
g usual	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2
g_2	3 3/4	3 1/2	3 1/2	3 1/2	3	3	3	2 3/4
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	1217	1111	1057	1004	730	670	621	578
V max	334	309	297	283	255	242	231	226
L min	14.59	14.37	14.22	14.19	11.43	11.09	10.76	10.24
fb	14160	13770	13570	13280	12300	11960	11660	11550
fbt	11750	10675	10150	9500	7810	7235	6760	6580
B min	20.02	20.66	21.02	21.56	24.32	25.10	25.84	26.04
R max	140	126	120	112	93	86	80	77
RA	146	146	146	146	146	143	137	135
LRA	33.33	30.44	28.95	27.52	19.99	18.75	18.12	17.12
Wt.CA	54	54	54	54	54	54	54	54
RH	227	227	227	227	227	222	213	209
LRH	21.44	19.58	18.62	17.70	12.86	12.08	11.65	11.06
Wt.CH	75	75	75	75	75	75	75	75
Q	9733	8887	8453	8035	5837	5362	4964	4621

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
30"
LOADS

CB SECTIONS

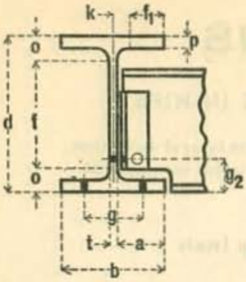
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot									Coefficient of Deflection
	CB 302 30" x 15"					CB 301 30" x 10½"				
	210 Lbs.	200 Lbs.	190 Lbs.	180 Lbs.	172 Lbs.	132 Lbs.	124 Lbs.	116 Lbs.	108 Lbs.	
								406.1	292.2	
10						447.2	423.4	393.5	359.0	1.86
11						414.2	386.8	357.7	326.4	2.25
12						379.7	354.6	327.9	299.2	2.68
13	565.1	537.2	513.2	482.4	469.7	350.5	327.3	302.7	276.2	3.15
14	557.1	529.4	502.4	475.9	452.7	325.5	303.9	281.1	256.5	3.65
15	519.9	494.1	468.9	444.2	422.6	303.8	283.7	262.3	239.4	4.19
16	487.4	463.2	439.6	416.4	396.2	284.8	266.0	245.9	224.4	4.77
17	458.8	436.0	413.7	391.9	372.8	268.0	250.3	231.5	211.2	5.38
18	433.3	411.7	390.1	370.1	352.1	253.1	236.4	218.6	199.5	6.03
19	410.5	390.1	370.2	350.7	333.6	239.8	224.0	207.1	189.0	6.72
20	389.9	370.6	351.7	333.1	316.9	227.8	212.8	196.7	179.5	7.45
21	371.4	352.9	334.9	317.3	301.8	217.0	202.6	187.4	171.0	8.21
22	354.5	336.9	319.7	302.8	288.1	207.1	193.4	178.9	163.2	9.01
23	339.1	322.2	305.8	289.7	275.6	198.1	185.0	171.1	156.1	9.85
24	325.0	308.8	293.1	277.6	264.1	189.9	177.3	164.0	149.6	10.73
25	312.0	296.4	281.3	266.5	253.5	182.3	170.2	157.4	143.6	11.64
26	300.0	285.0	270.5	256.2	243.8	175.2	163.7	151.3	138.1	12.59
27	288.8	274.5	260.5	246.8	234.8	168.8	157.6	145.7	133.0	13.57
28	278.5	264.7	251.2	237.9	226.4	162.7	152.0	140.5	128.2	14.60
29	268.9	255.6	242.5	229.7	218.6	157.1	146.7	135.7	123.8	15.66
30	260.0	247.0	234.4	222.1	211.3	151.9	141.8	131.2	119.7	16.76
31	251.6	239.1	226.9	214.9	204.5	147.0	137.3	126.9	115.8	17.89
32	243.7	231.6	219.8	208.2	198.1	142.4	133.0	123.0	112.2	19.07
33	236.3	224.6	213.1	201.9	192.1	138.1	128.9	119.2	108.8	20.28
34	229.4	218.0	206.9	196.0	186.4	134.0	125.2	115.7	105.6	21.53
35	222.8	211.7	200.9	190.4	181.1	130.2	121.6	112.4	102.6	22.81
36	216.6	205.9	195.4	185.1	176.1	126.6	118.2	109.3	99.7	24.13
37	210.8	200.3	190.1	180.1	171.3	123.1	115.0	106.3	97.0	25.49
38	205.2	195.0	185.1	175.3	166.8	119.9	112.0	103.5	94.5	26.89
39	200.0	190.0	180.3	170.8	162.5	116.8	109.1	100.9	92.1	28.32
40	195.0	185.3	175.8	166.6	158.5	113.9	106.4	98.4	89.8	29.79
42	185.7	176.5	167.5	158.6	150.9	108.5	101.3	93.7	85.5	32.85
44	177.2	168.4	159.8	151.4	144.1	103.6	96.7	89.4	81.6	36.05
46	169.5	161.1	152.9	144.8	137.8	99.1	92.5	85.5	78.1	39.40
48	162.5	154.4	146.5	138.8	132.0	94.9	88.6	82.0	74.8	42.90
50	156.0	148.2	140.7	133.2	126.8	91.1	85.1	78.7	71.8	46.55
52	150.0	142.5	135.3	128.1	121.9	87.6	81.8	75.7	69.0	50.35
54	144.4	137.2	130.2	123.4	117.4	84.4	78.8	72.9	66.5	54.30
56	139.3	132.3	125.6	119.0	113.2	81.4	76.0	70.3	64.1	58.40
58	134.5	127.8	121.3	114.9	109.3	78.6	73.4	67.8	61.9	62.64
60	130.0	123.5	117.2	111.0	105.6	75.9	70.9	65.6	59.8	67.04

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 30″ DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot								
	CB 302 30″ x 15″					CB 301 30″ x 10½″			
	210 Lbs.	200 Lbs.	190 Lbs.	180 Lbs.	172 Lbs.	132 Lbs.	124 Lbs.	116 Lbs.	108 Lbs.
	ELEMENTS								
I_{1-1}	9872.4	9340.5	8825.9	8328.2	7891.5	5753.1	5347.1	4919.1	4461.0
S_{1-1}	649.9	617.6	586.1	555.2	528.2	379.7	354.6	327.9	299.2
I_{2-2}	707.9	665.7	624.6	585.6	550.1	185.0	169.7	153.2	135.1
S_{2-2}	93.7	88.3	83.1	78.1	73.4	35.1	32.3	29.2	25.8
	DIMENSIONS AND GAGES IN INCHES								
d	30⅜	30¼	30⅛	30	29⅞	30¼	30⅛	30	29⅞
b	15⅛	15⅛	15	15	15	10½	10½	10½	10½
t	13/16	¾	¾	11/16	11/16	⅝	⅝	9/16	9/16
p	1 5/16	1¼	1 3/16	1⅛	1 1/16	1	15/16	⅞	¾
a	7⅛	7⅛	7⅛	7⅛	7⅛	5	5	5	5
f	25¾	25¾	25¾	25¾	25¾	26⅞	26⅞	26⅞	26⅞
f_1	6¼	6¼	6¼	6¼	6¼	4¼	4¼	4¼	4¼
o	2 5/16	2¼	2 3/16	2⅛	2 1/16	1 11/16	1⅝	1 9/16	1½
k	1 5/16	1 5/16	1¼	1¼	1¼	1	1	1	1
g usual	5½	5½	5½	5½	5½	5½	5½	5½	5½
g_2	3½	3½	3½	3¼	3¼	3	3	2¾	2¾
	MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	975	926	879	833	792	570	532	492	449
V max	283	269	257	241	235	224	212	203	196
L min	13.80	13.79	13.70	13.81	13.49	10.19	10.05	9.69	9.15
fb	14330	14080	13850	13490	13370	12820	12470	12230	12050
fbt	11105	10420	9830	9040	8755	7880	7295	6900	6605
B min	17.84	18.22	18.57	19.18	19.36	20.80	21.48	21.93	22.24
R max	123	115	108	99	96	87	81	76	72
RA	130	130	130	130	130	129	123	118	115
LRA	30.00	28.50	27.05	25.62	24.38	17.66	17.30	16.67	15.61
Wt.CA	48	48	48	48	48	48	48	48	48
RH	195	195	195	195	195	194	184	178	173
LRH	20.00	19.00	18.03	17.08	16.25	11.74	11.56	11.05	10.38
Wt.CH	66	66	66	66	66	66	66	66	66
Q	7799	7411	7033	6662	6338	4556	4255	3935	3590

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3¼″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 27″ LOADS

CB SECTIONS

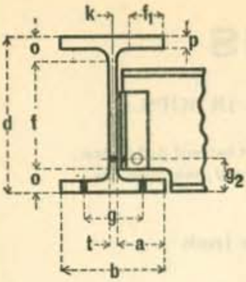
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	CB 272 27″ x 14″				CB 271 27″ x 10″				
	177 Lbs.	163 Lbs.	154 Lbs.	145 Lbs.	114 Lbs.	106 Lbs.	98 Lbs.	91 Lbs.	
								311.1	
9					373.2	348.5	324.0	310.9	1.51
10					359.0	332.6	306.4	279.8	1.86
11					326.4	302.4	278.5	254.4	2.25
12	475.2	436.1	411.5	387.1	299.2	277.2	255.3	233.2	2.68
13	454.9	418.1	394.9	371.9	276.2	255.9	235.7	215.3	3.15
14	422.4	388.2	366.7	345.3	256.5	237.6	218.8	199.9	3.65
15	394.2	362.3	342.2	322.3	239.4	221.8	204.2	186.6	4.19
16	369.6	339.7	320.9	302.2	224.4	207.9	191.5	174.9	4.77
17	347.9	319.7	302.0	284.4	211.2	195.7	180.2	164.6	5.38
18	328.5	301.9	285.2	268.6	199.5	184.8	170.2	155.5	6.03
19	311.2	286.0	270.2	254.5	189.0	175.1	161.2	147.3	6.72
20	295.7	271.7	256.7	241.7	179.5	166.3	153.2	139.9	7.45
21	281.6	258.8	244.5	230.2	171.0	158.4	145.9	133.3	8.21
22	268.8	247.0	233.3	219.8	163.2	151.2	139.3	127.2	9.01
23	257.1	236.3	223.2	210.2	156.1	144.6	133.2	121.7	9.85
24	246.4	226.5	213.9	201.5	149.6	138.6	127.7	116.6	10.73
25	236.5	217.4	205.3	193.4	143.6	133.1	122.5	111.9	11.64
26	227.4	209.0	197.4	186.0	138.1	127.9	117.8	107.6	12.59
27	219.0	201.3	190.1	179.1	133.0	123.2	113.5	103.6	13.57
28	211.2	194.1	183.3	172.7	128.2	118.8	109.4	99.9	14.60
29	203.9	187.4	177.0	166.7	123.8	114.7	105.6	96.5	15.66
30	197.1	181.2	171.1	161.2	119.7	110.9	102.1	93.3	16.76
31	190.8	175.3	165.6	156.0	115.8	107.3	98.8	90.3	17.89
32	184.8	169.8	160.4	151.1	112.2	104.0	95.7	87.5	19.07
33	179.2	164.7	155.6	146.5	108.8	100.8	92.8	84.8	20.28
34	173.9	159.8	151.0	142.2	105.6	97.8	90.1	82.3	21.53
35	169.0	155.3	146.7	138.1	102.6	95.0	87.5	80.0	22.81
36	164.3	151.0	142.6	134.3	99.7	92.4	85.1	77.7	24.13
37	159.8	146.9	138.7	130.7	97.0	89.9	82.8	75.6	25.49
38	155.6	143.0	135.1	127.2	94.5	87.5	80.6	73.6	26.89
39	151.6	139.4	131.6	124.0	92.1	85.3	78.6	71.8	28.32
40	147.8	135.9	128.3	120.9	89.8	83.2	76.6	70.0	29.79
42	140.8	129.4	122.2	115.1	85.5	79.2	72.9	66.6	32.85
44	134.4	123.5	116.7	109.9	81.6	75.6	69.6	63.6	36.05
46	128.6	118.1	111.6	105.1	78.1	72.3	66.6	60.8	39.40
48	123.2	113.2	106.9	100.7	74.8	69.3	63.8	58.3	42.90
50	118.3	108.7	102.7	96.7	71.8	66.5	61.3	56.0	46.55
52	113.7	104.5	98.7	93.0	69.0	64.0	58.9	53.8	50.35

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM
27″
DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 272 27″ x 14″				CB 271 27″ x 10″			
	177 Lbs.	163 Lbs.	154 Lbs.	145 Lbs.	114 Lbs.	106 Lbs.	98 Lbs.	91 Lbs.
ELEMENTS								
I_{1-1}	6728.6	6141.5	5775.8	5414.3	4080.5	3761.2	3446.5	3129.2
S_{1-1}	492.8	452.9	427.8	402.9	299.2	277.2	255.3	233.2
I_{2-2}	518.9	468.7	437.6	406.9	149.6	136.1	122.9	109.0
S_{2-2}	73.7	66.8	62.5	58.3	29.7	27.1	24.6	21.8
DIMENSIONS AND GAGES IN INCHES								
d	27 1/4	27 1/8	27	26 7/8	27 1/4	27 1/8	27	26 7/8
b	14 1/8	14	14	14	10 1/8	10	10	10
t	3/4	11/16	5/8	5/8	9/16	9/16	1/2	1/2
p	1 3/16	1 1/8	1 1/16	1	15/16	7/8	13/16	11/16
a	6 3/4	6 3/4	6 3/4	6 3/4	4 3/4	4 3/4	4 3/4	4 3/4
f	23	23	23	23	24	24	24	24
f_1	5 13/16	5 13/16	5 13/16	5 13/16	4 1/8	4 1/8	4 1/8	4 1/8
o	2 1/8	2 1/16	2	1 15/16	1 5/8	1 9/16	1 1/2	1 7/16
k	1 3/16	1 3/16	1 3/16	1 3/16	7/8	7/8	7/8	7/8
g usual	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2
g_2	3 1/4	3 1/4	3 1/4	3 1/4	2 3/4	2 3/4	2 3/4	2 3/4
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	739	679	642	604	449	416	383	350
V max	238	218	206	194	187	174	162	156
L min	12.44	12.46	12.48	12.49	9.62	9.55	9.46	8.99
fb	14460	14140	13830	13490	13030	12600	12110	11880
fbt	10555	9475	8785	8095	7425	6740	6055	5740
B min	15.69	16.24	16.68	17.19	18.31	19.07	20.00	20.39
R max	109	97	90	83	77	69	62	59
RA	114	114	114	110	105	98	92	89
LRA	25.94	23.84	22.52	21.98	17.10	16.97	16.65	15.72
Wt.CA	42	42	42	42	42	42	42	42
RH	179	179	179	173	165	154	144	139
LRH	16.52	15.18	14.34	13.97	10.88	10.80	10.64	10.07
Wt.CH	58	58	58	58	58	58	58	58
Q	5914	5435	5134	4835	3590	3326	3064	2798

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 24" LOADS

CB SECTIONS

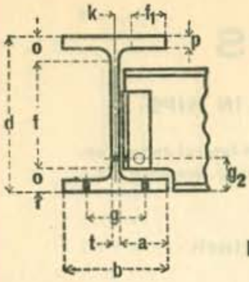
ALLOWABLE UNIFORM LOADS IN KIPS

**Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.**

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot							Coefficient of Deflection
	CB 243 24" x 14"				CB 242 24" x 12"			
	160 Lbs.	150 Lbs.	140 Lbs.	130 Lbs.	120 Lbs.	110 Lbs.	100 Lbs.	
					324.4	295.7	269.6	
12	389.2	370.2	348.0	328.8	299.1	274.4	248.9	2.68
13	381.7	355.8	331.0	305.3	276.1	253.3	229.8	3.15
14	354.4	330.4	307.4	283.5	256.4	235.2	213.3	3.65
15	330.8	308.4	286.9	264.6	239.3	219.5	199.1	4.19
16	310.1	289.1	269.0	248.0	224.3	205.8	186.7	4.77
17	291.9	272.1	253.1	233.4	211.1	193.7	175.7	5.38
18	275.7	257.0	239.1	220.5	199.4	182.9	165.9	6.03
19	261.2	243.5	226.5	208.9	188.9	173.3	157.2	6.72
20	248.1	231.3	215.2	198.4	179.5	164.6	149.3	7.45
21	236.3	220.3	204.9	189.0	170.9	156.8	142.2	8.21
22	225.5	210.3	195.6	180.4	163.1	149.7	135.8	9.01
23	215.7	201.1	187.1	172.5	156.1	143.2	129.9	9.85
24	206.8	192.8	179.3	165.4	149.6	137.2	124.5	10.73
25	198.5	185.0	172.1	158.7	143.6	131.7	119.5	11.64
26	190.8	177.9	165.5	152.6	138.0	126.6	114.9	12.59
27	183.8	171.3	159.4	147.0	132.9	122.0	110.6	13.57
28	177.2	165.2	153.7	141.7	128.2	117.6	106.7	14.60
29	171.1	159.5	148.4	136.8	123.8	113.5	103.0	15.66
30	165.4	154.2	143.4	132.3	119.6	109.8	99.6	16.76
31	160.1	149.2	138.8	128.0	115.8	106.2	96.3	17.89
32	155.1	144.6	134.5	124.0	112.2	102.9	93.3	19.07
33	150.4	140.2	130.4	120.3	108.8	99.8	90.5	20.28
34	145.9	136.1	126.6	116.7	105.6	96.8	87.8	21.53
35	141.8	132.2	122.9	113.4	102.5	94.1	85.3	22.81
36	137.8	128.5	119.5	110.2	99.7	91.5	83.0	24.13
37	134.1	125.0	116.3	107.3	97.0	89.0	80.7	25.49
38	130.6	121.7	113.2	104.4	94.5	86.7	78.6	26.89
39	127.2	118.6	110.3	101.8	92.0	84.4	76.6	28.32
40	124.1	115.7	107.6	99.2	89.7	82.3	74.7	29.79
42	118.1	110.1	102.5	94.5	85.5	78.4	71.1	32.85
44	112.8	105.1	97.8	90.2	81.6	74.8	67.9	36.05
46	107.9	100.6	93.5	86.3	78.0	71.6	64.9	39.40
48	103.4	96.4	89.6	82.7	74.8	68.6	62.2	42.90

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 24" DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot						
	CB 243 24" x 14"				CB 242 24" x 12"		
	160 Lbs.	150 Lbs.	140 Lbs.	130 Lbs.	120 Lbs.	110 Lbs.	100 Lbs.
ELEMENTS							
I_{1-1}	5110.3	4733.5	4376.1	4009.5	3635.3	3315.0	2987.3
S_{1-1}	413.5	385.5	358.6	330.7	299.1	274.4	248.9
I_{2-2}	492.6	452.5	414.5	375.2	254.0	229.1	203.5
S_{2-2}	69.9	64.3	59.1	53.6	42.0	38.0	33.9
DIMENSIONS AND GAGES IN INCHES							
d	$24\frac{3}{4}$	$24\frac{1}{2}$	$24\frac{3}{8}$	$24\frac{1}{4}$	$24\frac{1}{4}$	$24\frac{1}{8}$	24
b	$14\frac{1}{8}$	$14\frac{1}{8}$	14	14	$12\frac{1}{8}$	12	12
t	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
p	$1\frac{1}{8}$	$1\frac{1}{16}$	1	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{7}{8}$	$\frac{3}{4}$
a	$6\frac{3}{4}$	$6\frac{3}{4}$	$6\frac{3}{4}$	$6\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{3}{4}$
f	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{7}{8}$	$20\frac{7}{8}$	$20\frac{7}{8}$
f_1	6	6	6	6	$5\frac{1}{16}$	$5\frac{1}{16}$	$5\frac{1}{16}$
o	2	$1\frac{7}{8}$	$1\frac{13}{16}$	$1\frac{3}{4}$	$1\frac{11}{16}$	$1\frac{5}{8}$	$1\frac{9}{16}$
k	1	1	1	1	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{15}{16}$
g usual	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$
g_2	$3\frac{1}{4}$	$3\frac{1}{4}$	3	3	3	$2\frac{3}{4}$	$2\frac{3}{4}$
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.							
M Max	620	578	538	496	449	412	373
V max	195	185	174	164	162	148	135
L min	12.75	12.50	12.37	12.07	11.06	11.13	11.08
fb	14560	14340	14050	13770	13650	13100	12520
fbt	9550	9010	8345	7780	7590	6680	5855
B min	14.20	14.41	14.75	15.07	15.29	16.09	17.01
R max	92	87	80	74	73	64	56
RA	97	97	94	89	88	80	74
LRA	25.58	23.85	22.89	22.29	20.39	20.58	20.18
Wt.CA	36	36	36	36	36	36	36
RH	162	162	156	148	146	134	123
LRH	15.31	14.28	13.79	13.41	12.29	12.29	12.14
Wt.CH	50	50	50	50	50	50	50
Q	4962	4626	4303	3968	3589	3293	2987

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = $3\frac{1}{2}$".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
24″
21″
LOADS

CB SECTIONS

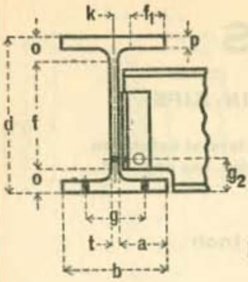
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 241 24″ x 9″				CB 213 21″ x 13″				Coefficient of Deflection
	94 Lbs.	87 Lbs.	80 Lbs.	74 Lbs.	142 Lbs.	132 Lbs.	122 Lbs.	112 Lbs.	
	300.8	278.3	262.1	246.3					
9	294.5	272.4	247.7	227.2					1.51
10	265.1	245.2	223.0	204.5					1.86
11	241.0	222.9	202.7	185.9	339.4	314.0	287.9	265.6	2.25
12	220.9	204.3	185.8	170.4	317.2	294.8	272.5	249.6	2.68
13	203.9	188.6	171.5	157.3	292.8	272.1	251.5	230.4	3.15
14	189.3	175.1	159.3	146.1	271.9	252.7	233.6	213.9	3.65
15	176.7	163.4	148.6	136.3	253.8	235.8	218.0	199.7	4.19
16	165.7	153.2	139.4	127.8	237.9	221.1	204.4	187.2	4.77
17	155.9	144.2	131.2	120.3	223.9	208.1	192.4	176.2	5.38
18	147.3	136.2	123.9	113.6	211.5	196.5	181.7	166.4	6.03
19	139.5	129.0	117.3	107.6	200.3	186.2	172.1	157.6	6.72
20	132.5	122.6	111.5	102.2	190.3	176.9	163.5	149.8	7.45
21	126.2	116.7	106.2	97.4	181.3	168.5	155.7	142.6	8.21
22	120.5	111.4	101.3	92.9	173.0	160.8	148.6	136.1	9.01
23	115.3	106.6	96.9	88.9	165.5	153.8	142.2	130.2	9.85
24	110.5	102.2	92.9	85.2	158.6	147.4	136.3	124.8	10.73
25	106.0	98.1	89.2	81.8	152.3	141.5	130.8	119.8	11.64
26	102.0	94.3	85.8	78.6	146.4	136.1	125.8	115.2	12.59
27	98.2	90.8	82.6	75.7	141.0	131.0	121.1	110.9	13.57
28	94.7	87.6	79.6	73.0	135.9	126.3	116.8	107.0	14.60
29	91.4	84.5	76.9	70.5	131.3	122.0	112.8	103.3	15.66
30	88.4	81.7	74.3	68.2	126.9	117.9	109.0	99.8	16.76
31	85.5	79.1	71.9	66.0	122.8	114.1	105.5	96.6	17.89
32	82.8	76.6	69.7	63.9	119.0	110.6	102.2	93.6	19.07
33	80.3	74.3	67.6	62.0	115.3	107.2	99.1	90.8	20.28
34	78.0	72.1	65.6	60.1	112.0	104.0	96.2	88.1	21.53
35	75.7	70.0	63.7	58.4	108.8	101.1	93.4	85.6	22.81
36	73.6	68.1	61.9	56.8	105.7	98.3	90.8	83.2	24.13
37	71.6	66.3	60.3	55.3	102.9	95.6	88.4	81.0	25.49
38	69.8	64.5	58.7	53.8	100.2	93.1	86.1	78.8	26.89
39	68.0	62.9	57.2	52.4	97.6	90.7	83.8	76.8	28.32
40	66.3	61.3	55.7	51.1	95.2	88.4	81.8	74.9	29.79
42	63.1	58.4	53.1	48.7	90.6	84.2	77.9	71.3	32.85
44	60.2	55.7	50.7	46.5					36.05
46	57.6	53.3	48.5	44.5					39.40
48	55.2	51.1	46.4	42.6					42.90

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM 24" 21" DATA

Notation	CB 241 24" x 9"				CB 213 21" x 13"			
	94 Lbs.	87 Lbs.	80 Lbs.	74 Lbs.	142 Lbs.	132 Lbs.	122 Lbs.	112 Lbs.
ELEMENTS								
I_{1-1}	2683.0	2467.8	2229.7	2033.8	3403.1	3141.6	2883.2	2620.6
S_{1-1}	220.9	204.3	185.8	170.4	317.2	294.8	272.5	249.6
I_{2-2}	102.2	92.9	82.4	73.8	385.9	353.8	322.1	289.7
S_{2-2}	22.6	20.6	18.3	16.5	58.8	54.1	49.4	44.6
DIMENSIONS AND GAGES IN INCHES								
d	24¼	24⅛	24	23⅞	21½	21¼	21⅛	21
b	9	9	9	9	13⅛	13⅛	13	13
t	9/16	½	½	7/16	11/16	⅝	9/16	9/16
p	⅞	13/16	¾	11/16	1⅛	1	15/16	⅞
a	4¼	4¼	4¼	4¼	6¼	6¼	6¼	6¼
f	21⅜	21⅜	21⅜	21⅜	17¾	17¾	17¾	17¾
f_1	3¾	3¾	3¾	3¾	5 9/16	5 9/16	5 9/16	5 9/16
o	1 7/16	1⅜	1 5/16	1¼	1⅞	1¾	1 11/16	1⅝
k	¾	¾	¾	¾	15/16	15/16	15/16	15/16
g usual	5½	5½	5½	5½	5½	5½	5½	5½
g_2	2¾	2¾	2½	2½	3	3	3	3
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	331	306	279	256	476	442	409	374
V max	150	139	131	123	170	157	144	133
L min	8.81	8.81	8.51	8.30	11.21	11.27	11.36	11.28
fb	13150	12660	12300	11890	15000	14990	14610	14230
fbt	6785	6075	5595	5115	9885	9205	8285	7500
B min	16.10	16.87	17.42	18.12	11.80	11.73	12.09	12.45
R max	65	58	53	48	88	81	73	66
RA	81	76	72	68	81	81	74	69
LRA	16.36	16.13	15.48	15.04	23.50	21.84	22.09	21.70
Wt.CA	36	36	36	36	30	30	30	30
RH	135	126	119	113	130	129	119	111
LRH	9.82	9.73	9.37	9.05	14.64	13.71	13.74	13.49
Wt.CH	50	50	50	50	41	41	41	41
Q	2651	2452	2230	2045	3806	3538	3270	2995

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
21″
LOADS

CB SECTIONS

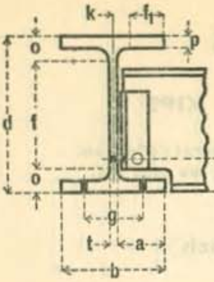
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 212 21″ x 9″				CB 211 21″ x 8¼″				Coefficient of Deflection
	103 Lbs.	96 Lbs.	89 Lbs.	82 Lbs.	73 Lbs.	68 Lbs.	63 Lbs.	59 Lbs.	
					231.9	218.1	206.6	195.7	
8	310.7	291.7	270.6	249.8	226.1	209.9	192.0	179.0	1.19
9	284.1	263.5	243.7	224.0	200.9	186.5	170.7	159.1	1.51
10	255.7	237.1	219.4	201.6	180.8	167.9	153.6	143.2	1.86
11	232.5	215.6	199.4	183.3	164.4	152.6	139.6	130.1	2.25
12	213.1	197.6	182.8	168.0	150.7	139.9	128.0	119.3	2.68
13	196.7	182.4	168.7	155.1	139.1	129.1	118.2	110.1	3.15
14	182.7	169.4	156.7	144.0	129.2	119.9	109.7	102.3	3.65
15	170.5	158.1	146.2	134.4	120.6	111.9	102.4	95.4	4.19
16	159.8	148.2	137.1	126.0	113.0	104.9	96.0	89.5	4.77
17	150.4	139.5	129.0	118.6	106.4	98.8	90.4	84.2	5.38
18	142.1	131.7	121.9	112.0	100.5	93.3	85.3	79.5	6.03
19	134.6	124.8	115.5	106.1	95.2	88.4	80.8	75.3	6.72
20	127.9	118.6	109.7	100.8	90.4	83.9	76.8	71.6	7.45
21	121.8	112.9	104.5	96.0	86.1	79.9	73.1	68.2	8.21
22	116.2	107.8	99.7	91.6	82.2	76.3	69.8	65.1	9.01
23	111.2	103.1	95.4	87.7	78.6	73.0	66.8	62.2	9.85
24	106.6	98.8	91.4	84.0	75.4	70.0	64.0	59.7	10.73
25	102.3	94.8	87.7	80.6	72.3	67.2	61.4	57.3	11.64
26	98.4	91.2	84.4	77.5	69.6	64.6	59.1	55.1	12.59
27	94.7	87.8	81.2	74.7	67.0	62.2	56.9	53.0	13.57
28	91.3	84.7	78.3	72.0	64.6	60.0	54.9	51.1	14.60
29	88.2	81.8	75.6	69.5	62.4	57.9	53.0	49.4	15.66
30	85.2	79.0	73.1	67.2	60.3	56.0	51.2	47.7	16.76
31	82.5	76.5	70.8	65.0	58.3	54.2	49.5	46.2	17.89
32	79.9	74.1	68.6	63.0	56.5	52.5	48.0	44.7	19.07
33	77.5	71.9	66.5	61.1	54.8	50.9	46.5	43.4	20.28
34	75.2	69.7	64.5	59.3	53.2	49.4	45.2	42.1	21.53
35	73.1	67.7	62.7	57.6	51.7	48.0	43.9	40.9	22.81
36	71.0	65.9	60.9	56.0	50.2	46.6	42.7	39.8	24.13
37	69.1	64.1	59.3	54.5	48.9	45.4	41.5	38.7	25.49
38	67.3	62.4	57.7	53.1	47.6	44.2	40.4	37.7	26.89
39	65.6	60.8	56.2	51.7	46.4	43.0	39.4	36.7	28.32
40	63.9	59.3	54.8	50.4	45.2	42.0	38.4	35.8	29.79
42	60.9				43.1				32.85

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 21″ DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	CB 212 21″ x 9″				CB 211 21″ x 8¼″			
	103 Lbs.	96 Lbs.	89 Lbs.	82 Lbs.	73 Lbs.	68 Lbs.	63 Lbs.	59 Lbs.
ELEMENTS								
I_{1-1}	2268.0	2088.9	1919.2	1752.4	1600.3	1478.3	1343.6	1246.8
S_{1-1}	213.1	197.6	182.8	168.0	150.7	139.9	128.0	119.3
I_{2-2}	119.9	109.3	99.4	89.6	66.2	60.4	53.8	49.2
S_{2-2}	26.4	24.2	22.1	20.0	16.0	14.6	13.0	12.0
DIMENSIONS AND GAGES IN INCHES								
d	21¼	21⅛	21	20⅞	21¼	21⅛	21	20⅞
b	9⅛	9	9	9	8¼	8¼	8¼	8¼
t	⅝	9/16	9/16	½	½	7/16	7/16	⅜
p	1	15/16	⅞	11/16	¾	11/16	⅝	9/16
a	4¼	4¼	4¼	4¼	4	4	4	4
f	18	18	18	18	18⅝	18⅝	18⅝	18⅝
f_1	3 9/16	3 9/16	3 9/16	3 9/16	3⅜	3⅜	3⅜	3⅜
o	1⅝	1 9/16	1½	1 7/16	1 5/16	1¼	1 3/16	1⅛
k	15/16	15/16	15/16	15/16	¾	¾	¾	¾
g usual	5½	5½	5½	5½	5½	5½	5½	5½
g_2	3	2¾	2¾	2¾	2½	2½	2½	2½
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	320	296	274	252	226	210	192	179
V max	155	146	135	125	116	109	103	98
L min	8.23	8.13	8.10	8.07	7.80	7.70	7.43	7.31
fb	14950	14690	14340	13940	13200	12840	12520	12170
fbt	9085	8445	7705	6955	6010	5520	5135	4745
B min	11.77	11.98	12.32	12.74	13.99	14.47	14.87	15.39
R max	80	74	67	61	53	48	45	41
RA	80	75	70	65	60	56	54	51
LRA	15.98	15.81	15.67	15.51	15.07	14.99	14.22	14.04
Wt.CA	30	30	30	30	30	30	30	30
RH	128	121	113	105	96	90	86	82
LRH	9.99	9.80	9.71	9.60	9.42	9.33	8.93	8.73
Wt.CH	41	41	41	41	41	41	41	41
Q	2557	2371	2194	2016	1808	1679	1536	1432

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 18″ LOADS

CB SECTIONS

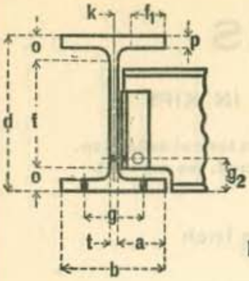
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 183 18″ x 11¾″				CB 182 18″ x 8¾″				Coefficient of Deflection
	124 Lbs.	114 Lbs.	105 Lbs.	96 Lbs.	85 Lbs.	77 Lbs.	70 Lbs.	64 Lbs.	
					231.3	207.0	189.2	172.8	
9	291.2		243.6	223.2	208.1	188.9	170.9	156.0	1.51
10	286.8		242.6	221.3	187.3	170.0	153.8	140.4	1.86
		263.9							
11	260.7	240.1	220.6	201.2	170.3	154.6	139.9	127.6	2.25
12	239.0	220.1	202.2	184.4	156.1	141.7	128.2	117.0	2.68
13	220.6	203.2	186.6	170.2	144.1	130.8	118.3	108.0	3.15
14	204.9	188.7	173.3	158.1	133.8	121.5	109.9	100.3	3.65
15	191.2	176.1	161.8	147.5	124.9	113.4	102.6	93.6	4.19
16	179.3	165.1	151.7	138.3	117.1	106.3	96.2	87.8	4.77
17	168.7	155.4	142.7	130.2	110.2	100.0	90.5	82.6	5.38
18	159.3	146.7	134.8	122.9	104.1	94.5	85.5	78.0	6.03
19	150.9	139.0	127.7	116.5	98.6	89.5	81.0	73.9	6.72
20	143.4	132.1	121.3	110.6	93.7	85.0	76.9	70.2	7.45
21	136.6	125.8	115.5	105.4	89.2	81.0	73.3	66.9	8.21
22	130.4	120.1	110.3	100.6	85.1	77.3	69.9	63.8	9.01
23	124.7	114.8	105.5	96.2	81.4	73.9	66.9	61.0	9.85
24	119.5	110.1	101.1	92.2	78.1	70.9	64.1	58.5	10.73
25	114.7	105.6	97.1	88.5	74.9	68.0	61.5	56.2	11.64
26	110.3	101.6	93.3	85.1	72.0	65.4	59.2	54.0	12.59
27	106.2	97.8	89.9	82.0	69.4	63.0	57.0	52.0	13.57
28	102.4	94.3	86.7	79.0	66.9	60.7	54.9	50.1	14.60
29	98.9	91.1	83.7	76.3	64.6	58.6	53.0	48.4	15.66
30	95.6	88.0	80.9	73.8	62.4	56.7	51.3	46.8	16.76
31	92.5	85.2	78.3	71.4	60.4	54.9	49.6	45.3	17.89
32	89.6	82.5	75.8	69.2	58.5	53.1	48.1	43.9	19.07
33	86.9	80.0	73.5	67.1	56.8	51.5	46.6	42.5	20.28
34	84.4	77.7	71.4	65.1	55.1	50.0	45.2	41.3	21.53
35	81.9	75.5	69.3	63.2	53.5	48.6	44.0		22.81
36	79.7	73.4							24.13

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 18″ DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	CB 183 18″ x 11¾″				CB 182 18″ x 8¾″			
	Nominal Depth and Flange Width—Weight per Foot							
	124 Lbs.	114 Lbs.	105 Lbs.	96 Lbs.	85 Lbs.	77 Lbs.	70 Lbs.	64 Lbs.
ELEMENTS								
I_{1-1}	2227.1	2033.8	1852.5	1674.7	1429.9	1286.8	1153.9	1045.8
S_{1-1}	239.0	220.1	202.2	184.4	156.1	141.7	128.2	117.0
I_{2-2}	281.9	255.6	231.0	206.8	99.4	88.6	78.5	70.3
S_{2-2}	47.4	43.2	39.2	35.2	22.5	20.2	17.9	16.1
DIMENSIONS AND GAGES IN INCHES								
d	18⅝	18½	18⅜	18⅛	18⅜	18⅛	18	17⅞
b	11⅞	11⅞	11¾	11¾	8⅞	8¾	8¾	8¾
t	11/16	⅝	9/16	½	9/16	½	7/16	7/16
p	1 1/16	1	15/16	13/16	15/16	13/16	¾	11/16
a	5⅝	5⅝	5⅝	5⅝	4⅛	4⅛	4⅛	4⅛
f	15⅛	15⅛	15⅛	15⅛	15⅜	15⅜	15⅜	15⅜
f_1	5	5	5	5	3 9/16	3 9/16	3 9/16	3 9/16
o	1¾	1 11/16	1⅝	1½	1½	1⅜	1 5/16	1¼
k	⅞	⅞	⅞	⅞	13/16	13/16	13/16	13/16
g usual	5½	5½	5½	5½	5½	5½	5½	5½
g_2	3	3	2¾	2¾	2¾	2¾	2¾	2½
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	359	330	303	277	234	213	192	176
V max	146	132	122	112	116	104	95	86
L min	9.85	10.01	9.96	9.92	8.10	8.21	8.13	8.12
fb	15000	15000	15000	14880	14970	14470	14050	13560
fbt	9765	8925	8310	7620	7875	6875	6150	5465
B min	10.25	10.16	10.08	10.10	10.10	10.52	10.88	11.35
R max	80	72	67	61	64	55	49	44
RA	65	62	58	54	55	50	46	42
LRA	22.06	21.30	20.92	20.49	17.03	17.00	16.72	16.71
Wt.CA	21	21	21	21	21	21	21	21
RH	130	124	116	108	110	100	92	84
LRH	11.03	10.65	10.46	10.24	8.51	8.50	8.36	8.36
Wt.CH	29	29	29	29	29	29	29	29
Q	2868	2641	2426	2213	1873	1700	1538	1404

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
18″
16″
LOADS

CB SECTIONS

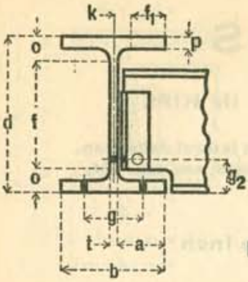
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot							Coefficient of Deflection
	CB 181 18″ x 7½″			CB 163 16″ x 11½″				
	55 Lbs.	50 Lbs.	47 Lbs.	114 Lbs.	105 Lbs.	96 Lbs.	88 Lbs.	
	169.6	154.7	150.4					
7	168.3	152.6	141.1					0.91
8	147.3	133.5	123.5					1.19
9	130.9	118.7	109.7	252.0	231.0	209.5	195.5	1.51
10	117.8	106.8	98.8	236.9	218.0	199.3	181.6	1.86
11	107.1	97.1	89.8	215.3	198.2	181.2	165.1	2.25
12	98.2	89.0	82.3	197.4	181.7	166.1	151.3	2.68
13	90.6	82.2	76.0	182.2	167.7	153.3	139.7	3.15
14	84.2	76.3	70.5	169.2	155.7	142.4	129.7	3.65
15	78.6	71.2	65.8	157.9	145.4	132.9	121.0	4.19
16	73.7	66.8	61.7	148.1	136.3	124.6	113.5	4.77
17	69.3	62.8	58.1	139.3	128.3	117.2	106.8	5.38
18	65.5	59.3	54.9	131.6	121.1	110.7	100.9	6.03
19	62.0	56.2	52.0	124.7	114.8	104.9	95.6	6.72
20	58.9	53.4	49.4	118.4	109.0	99.7	90.8	7.45
21	56.1	50.9	47.0	112.8	103.8	94.9	86.5	8.21
22	53.6	48.5	44.9	107.7	99.1	90.6	82.5	9.01
23	51.2	46.4	42.9	103.0	94.8	86.7	78.9	9.85
24	49.1	44.5	41.2	98.7	90.9	83.1	75.7	10.73
25	47.1	42.7	39.5	94.8	87.2	79.7	72.6	11.64
26	45.3	41.1	38.0	91.1	83.9	76.7	69.8	12.59
27	43.6	39.6	36.6	87.7	80.8	73.8	67.2	13.57
28	42.1	38.1	35.3	84.6	77.9	71.2	64.8	14.60
29	40.6	36.8	34.1	81.7	75.2	68.7	62.6	15.66
30	39.3	35.6	32.9	79.0	72.7	66.4	60.5	16.76
31	38.0	34.5	31.9	76.4	70.3	64.3	58.6	17.89
32	36.8	33.4	30.9	74.0	68.1	62.3	56.7	19.07
33	35.7	32.4	29.9					20.28
34	34.7	31.4	29.0					21.53
35	33.7	30.5	28.2					22.81

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 18" 16" DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	CB 181 18" x 7½"			CB 163 16" x 11½"			
	Nominal Depth and Flange Width—Weight per Foot						
	55 Lbs.	50 Lbs.	47 Lbs.	114 Lbs.	105 Lbs.	96 Lbs.	88 Lbs.
ELEMENTS							
I_{1-1}	889.9	800.6	736.4	1642.6	1497.5	1355.1	1222.6
S_{1-1}	98.2	89.0	82.3	197.4	181.7	166.1	151.3
I_{2-2}	42.0	37.2	33.5	254.6	230.7	207.2	185.2
S_{2-2}	11.1	9.9	9.0	43.8	39.8	35.9	32.2
DIMENSIONS AND GAGES IN INCHES							
d	18⅛	18	17⅞	16⅝	16½	16⅜	16⅛
b	7½	7½	7½	11⅝	11⅝	11½	11½
t	⅜	⅜	⅜	⅝	⅝	9/16	½
p	⅝	9/16	½	1 1/16	15/16	⅞	13/16
a	3⅝	3⅝	3⅝	5½	5½	5½	5½
f	15⅞	15⅞	15⅞	13⅛	13⅛	13⅛	13⅛
f_1	3⅛	3⅛	3⅛	4⅞	4⅞	4⅞	4⅞
o	1⅛	1 1/16	1	1¾	1 11/16	1⅝	1½
k	⅝	⅝	⅝	⅞	⅞	⅞	⅞
g usual	3½	3½	3½	5½	5½	5½	5½
g_2	2½	2¼	2¼	3	3	2¾	2¾
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.							
M max	147	134	123	296	273	249	227
V max	85	77	75	126	115	105	98
L min	6.95	6.91	6.57	9.40	9.44	9.51	9.29
fb	13240	12660	12540	15000	15000	15000	15000
fbt	5160	4535	4385	9465	8760	8025	7560
B min	11.90	12.56	12.66	9.15	9.06	8.98	8.89
R max	41	36	35	73	67	61	57
RA	41	38	37	65	61	56	53
LRA	14.37	14.05	13.35	18.22	17.87	17.80	17.13
Wt.CA	21	21	21	21	21	21	21
RH	82	76	74	130	122	112	106
LRH	7.19	7.03	6.67	9.11	8.94	8.90	8.56
Wt.CH	29	29	29	29	29	29	29
Q	1178	1068	988	2369	2180	1993	1816

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
16″
LOADS

CB SECTIONS

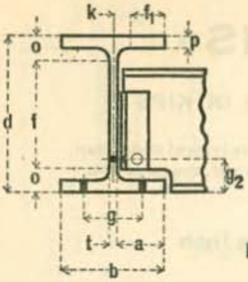
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	CB 162 16″ x 8½″				CB 161 16″ x 7″				
	78 Lbs.	71 Lbs.	64 Lbs.	58 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	36 Lbs.	
								113.7	
6					148.2	133.9	117.9	112.6	0.67
7	207.2	188.5	170.1	154.9	138.3	124.1	110.4	96.5	0.91
8	191.7	173.9	156.3	141.2	121.1	108.6	96.6	84.5	1.19
9	170.4	154.5	138.9	125.5	107.6	96.5	85.9	75.1	1.51
10	153.4	139.1	125.0	112.9	96.8	86.9	77.3	67.6	1.86
11	139.4	126.4	113.7	102.7	88.0	79.0	70.3	61.4	2.25
12	127.8	115.9	104.2	94.1	80.7	72.4	64.4	56.3	2.68
13	118.0	107.0	96.2	86.9	74.5	66.8	59.4	52.0	3.15
14	109.5	99.3	89.3	80.7	69.2	62.1	55.2	48.3	3.65
15	102.2	92.7	83.4	75.3	64.6	57.9	51.5	45.0	4.19
16	95.9	86.9	78.2	70.6	60.5	54.3	48.3	42.2	4.77
17	90.2	81.8	73.6	66.4	57.0	51.1	45.5	39.7	5.38
18	85.2	77.3	69.5	62.7	53.8	48.3	42.9	37.5	6.03
19	80.7	73.2	65.8	59.4	51.0	45.7	40.7	35.6	6.72
20	76.7	69.5	62.5	56.5	48.4	43.4	38.6	33.8	7.45
21	73.0	66.2	59.5	53.8	46.1	41.4	36.8	32.2	8.21
22	69.7	63.2	56.8	51.3	44.0	39.5	35.1	30.7	9.01
23	66.7	60.5	54.4	49.1	42.1	37.8	33.6	29.4	9.85
24	63.9	58.0	52.1	47.1	40.4	36.2	32.2	28.2	10.73
25	61.3	55.6	50.0	45.2	38.7	34.8	30.9	27.0	11.64
26	59.0	53.5	48.1	43.4	37.2	33.4	29.7	26.0	12.59
27	56.8	51.5	46.3	41.8	35.9	32.2	28.6	25.0	13.57
28	54.8	49.7	44.7	40.3	34.6	31.0	27.6	24.1	14.60
29	52.9	48.0	43.1	38.9	33.4	30.0	26.6	23.3	15.66
30	51.1	46.4	41.7	37.6	32.3	29.0	25.8	22.5	16.76
31	49.5	44.9	40.3	36.4	31.2	28.0	24.9	21.8	17.89
32	47.9				30.3				19.07

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 16″ DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 162 16″ x $8\frac{1}{2}$″				CB 161 16″ x 7″			
	78 Lbs.	71 Lbs.	64 Lbs.	58 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	36 Lbs.
ELEMENTS								
I_{1-1}	1042.6	936.9	833.8	746.4	655.4	583.3	515.5	446.3
S_{1-1}	127.8	115.9	104.2	94.1	80.7	72.4	64.4	56.3
I_{2-2}	87.5	77.9	68.4	60.5	34.8	30.5	26.5	22.1
S_{2-2}	20.4	18.2	16.1	14.3	9.8	8.7	7.6	6.3
DIMENSIONS AND GAGES IN INCHES								
d	$16\frac{3}{8}$	$16\frac{1}{8}$	16	$15\frac{7}{8}$	$16\frac{1}{4}$	$16\frac{1}{8}$	16	$15\frac{7}{8}$
b	$8\frac{5}{8}$	$8\frac{1}{2}$	$8\frac{1}{2}$	$8\frac{1}{2}$	$7\frac{1}{8}$	7	7	7
t	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{5}{16}$
p	$\frac{7}{8}$	$\frac{13}{16}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{7}{16}$
a	4	4	4	4	$3\frac{3}{8}$	$3\frac{3}{8}$	$3\frac{3}{8}$	$3\frac{3}{8}$
f	$13\frac{3}{8}$	$13\frac{3}{8}$	$13\frac{3}{8}$	$13\frac{3}{8}$	14	14	14	14
f_1	$3\frac{7}{16}$	$3\frac{7}{16}$	$3\frac{7}{16}$	$3\frac{7}{16}$	$2\frac{15}{16}$	$2\frac{15}{16}$	$2\frac{15}{16}$	$2\frac{15}{16}$
o	$1\frac{1}{2}$	$1\frac{3}{8}$	$1\frac{5}{16}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{16}$	1	$\frac{15}{16}$
k	$\frac{7}{8}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{9}{16}$
g usual	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$
g_2	$2\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	192	174	156	141	121	109	97	84
V max	104	94	85	77	74	67	59	57
L min	7.40	7.38	7.35	7.29	6.53	6.49	6.56	5.94
fb	15000	15000	14790	14370	13800	13220	12390	12260
fbt	7935	7290	6550	5845	5240	4575	3805	3665
B min	8.98	8.89	8.99	9.28	10.07	10.61	11.49	11.55
R max	60	55	49	44	40	34	29	27
RA	56	51	47	43	40	36	32	31
LRA	13.69	13.64	13.30	13.13	12.11	12.07	12.08	10.90
Wt.CA	21	21	21	21	21	21	21	21
RH	112	102	94	86	80	72	64	62
LRH	6.85	6.82	6.65	6.57	6.05	6.03	6.04	5.45
Wt.CH	29	29	29	29	29	29	29	29
Q	1534	1391	1250	1129	968	869	773	676

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when $B = 3\frac{1}{2}$″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = $12\ S_{1-1}$.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 14" LOADS

CB SECTIONS

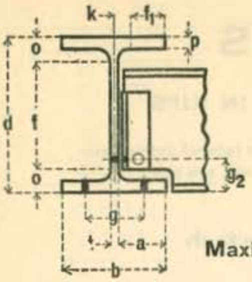
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 145 14" x 14½"					CB 144 14" x 12"		CB 143 14" x 10"			Coefficient of Deflection
	119 Lbs.	111 Lbs.	103 Lbs.	95 Lbs.	87 Lbs.	84 Lbs.	78 Lbs.	74 Lbs.	68 Lbs.	61 Lbs.	
								153.3	141.1	126.2	
9								149.7	137.3	122.9	1.51
10						153.5	144.4	134.8	123.6	110.6	1.86
11	198.4	186.2	169.3	157.6	141.1	142.8	132.1	122.5	112.4	100.6	2.25
12	189.4	176.3	163.6	150.6	138.1	130.9	121.1	112.3	103.0	92.2	2.68
13	174.8	162.7	151.0	139.0	127.5	120.8	111.8	103.7	95.1	85.1	3.15
14	162.3	151.1	140.2	129.1	118.4	112.2	103.8	96.3	88.3	79.0	3.65
15	151.5	141.0	130.9	120.5	110.5	104.7	96.9	89.8	82.4	73.8	4.19
16	142.1	132.2	122.7	113.0	103.6	98.2	90.8	84.2	77.3	69.2	4.77
17	133.7	124.4	115.5	106.3	97.5	92.4	85.5	79.3	72.7	65.1	5.38
18	126.3	117.5	109.1	100.4	92.1	87.3	80.7	74.9	68.7	61.5	6.03
19	119.6	111.3	103.3	95.1	87.2	82.7	76.5	70.9	65.1	58.2	6.72
20	113.6	105.8	98.2	90.4	82.9	78.5	72.7	67.4	61.8	55.3	7.45
21	108.2	100.7	93.5	86.1	78.9	74.8	69.2	64.2	58.9	52.7	8.21
22	103.3	96.2	89.2	82.1	75.3	71.4	66.1	61.3	56.2	50.3	9.01
23	98.8	92.0	85.4	78.6	72.1	68.3	63.2	58.6	53.7	48.1	9.85
24	94.7	88.2	81.8	75.3	69.1	65.5	60.6	56.2	51.5	46.1	10.73
25	90.9	84.6	78.5	72.3	66.3	62.8	58.1	53.9	49.4	44.3	11.64
26	87.4	81.4	75.5	69.5	63.7	60.4	55.9	51.8	47.5	42.6	12.59
27	84.2	78.4	72.7	66.9	61.4	58.2	53.8	49.9	45.8	41.0	13.57
28	81.2	75.6	70.1	64.5	59.2	56.1	51.9	48.1	44.1		14.60

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 14″ DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot									
	CB 145 14″ x 14½″					CB 144 14″x12″		CB 143 14″ x 10″		
	119 Lbs.	111 Lbs.	103 Lbs.	95 Lbs.	87 Lbs.	84 Lbs.	78 Lbs.	74 Lbs.	68 Lbs.	61 Lbs.
	ELEMENTS									
I_{1-1}	1373.1	1266.5	1165.8	1063.5	966.9	928.4	851.2	796.8	724.1	641.5
S_{1-1}	189.4	176.3	163.6	150.6	138.1	130.9	121.1	112.3	103.0	92.2
I_{2-2}	491.8	454.9	419.7	383.7	349.7	225.5	206.9	133.5	121.2	107.3
S_{2-2}	67.1	62.2	57.6	52.8	48.2	37.5	34.5	26.5	24.1	21.5
	DIMENSIONS AND GAGES IN INCHES									
d	14½	14⅜	14¼	14⅛	14	14⅛	14	14¼	14	13⅞
b	14⅝	14⅝	14⅝	14½	14½	12	12	10⅛	10	10
t	9/16	9/16	½	½	7/16	7/16	7/16	7/16	7/16	⅜
p	15/16	⅞	13/16	¾	11/16	¾	11/16	13/16	11/16	⅝
a	7	7	7	7	7	5¾	5¾	4¾	4¾	4¾
f	11⅜	11⅜	11⅜	11⅜	11⅜	11⅜	11⅜	11⅜	11⅜	11⅜
f_1	6 7/16	6 7/16	6 7/16	6 7/16	6 7/16	5 3/16	5 3/16	4 3/16	4 3/16	4 3/16
o	1 9/16	1½	1 7/16	1⅜	1 5/16	1⅜	1 5/16	1⅜	1 5/16	1¼
k	⅞	⅞	⅞	13/16	13/16	13/16	13/16	13/16	13/16	13/16
g usual	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½
g_2	2¾	2¾	2¾	2¾	2½	2¾	2½	2¾	2½	2½
	MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.									
M max	284	264	245	226	207	196	182	168	155	138
V max	99	93	85	79	71	77	72	77	71	63
L min	11.46	11.36	11.60	11.47	11.74	10.23	10.06	8.79	8.76	8.77
fb	15000	15000	15000	15000	15000	15000	15000	15000	15000	14690
fbt	8550	8100	7425	6975	6300	6765	6420	6750	6270	5551
B min	7.98	7.90	7.84	7.77	7.70	7.80	7.73	7.81	7.73	7.89
R max	61	57	52	49	44	48	45	48	44	39
RA	45	43	39	37	33	36	34	35	33	30
LRA	25.25	24.60	25.17	24.42	25.11	21.82	21.37	19.25	18.73	18.44
Wt.CA	15	15	15	15	15	15	15	15	15	15
RH	90	86	78	74	66	72	68	70	66	60
LRH	12.63	12.30	12.58	12.21	12.55	10.91	10.69	9.63	9.36	9.22
Wt.CH	22	22	22	22	22	22	22	22	22	22
Q	2273	2116	1963	1807	1657	1571	1453	1348	1236	1106

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
14″
LOADS

CB SECTIONS

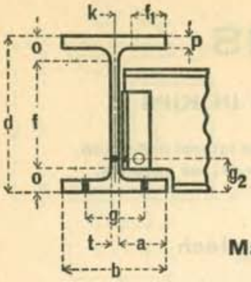
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	CB 142 14″ x 8″				CB 141 14″ x 6¾″				
	58 Lbs.	53 Lbs.	48 Lbs.	43 Lbs.	42 Lbs.	38 Lbs.	34 Lbs.	30 Lbs.	
								89.8	
6					115.5	106.1	96.4	83.6	0.67
7	137.0	123.8	112.4	101.1	104.1	93.6	83.1	71.7	0.91
8	127.5	116.7	105.3	94.1	91.1	81.9	72.8	62.7	1.19
9	113.3	103.7	93.6	83.6	80.9	72.8	64.7	55.7	1.51
10	102.0	93.4	84.2	75.2	72.8	65.5	58.2	50.2	1.86
11	92.7	84.9	76.6	68.4	66.2	59.6	52.9	45.6	2.25
12	85.0	77.8	70.2	62.7	60.7	54.6	48.5	41.8	2.68
13	78.5	71.8	64.8	57.9	56.0	50.4	44.8	38.6	3.15
14	72.9	66.7	60.2	53.7	52.0	46.8	41.6	35.8	3.65
15	68.0	62.2	56.2	50.2	48.6	43.7	38.8	33.4	4.19
16	63.8	58.4	52.7	47.0	45.5	41.0	36.4	31.4	4.77
17	60.0	54.9	49.6	44.3	42.8	38.5	34.2	29.5	5.38
18	56.7	51.9	46.8	41.8	40.5	36.4	32.3	27.9	6.03
19	53.7	49.1	44.3	39.6	38.3	34.5	30.6	26.4	6.72
20	51.0	46.7	42.1	37.6	36.4	32.8	29.1	25.1	7.45
21	48.6	44.5	40.1	35.8	34.7	31.2	27.7	23.9	8.21
22	46.4	42.4	38.3	34.2	33.1	29.8	26.5	22.8	9.01
23	44.3	40.6	36.6	32.7	31.7	28.5	25.3	21.8	9.85
24	42.5	38.9	35.1	31.4	30.4	27.3	24.3	20.9	10.73
25	40.8	37.3	33.7	30.1	29.1	26.2	23.3	20.1	11.64
26	39.2	35.9	32.4	28.9	28.0	25.2	22.4	19.3	12.59
27	37.8	34.6	31.2	27.9	27.0	24.3	21.6	18.6	13.57
28	36.4				26.0	23.4	20.8		14.60

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 14" DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	CB 142 14" x 8"				CB 141 14" x 6 3/4"			
	58 Lbs.	53 Lbs.	48 Lbs.	43 Lbs.	42 Lbs.	38 Lbs.	34 Lbs.	30 Lbs.
ELEMENTS								
I_{1-1}	597.9	542.1	484.9	429.0	432.2	385.3	339.2	289.6
S_{1-1}	85.0	77.8	70.2	62.7	60.7	54.6	48.5	41.8
I_{2-2}	63.7	57.5	51.3	45.1	28.1	24.6	21.3	17.5
S_{2-2}	15.7	14.3	12.8	11.3	8.3	7.3	6.3	5.2
DIMENSIONS AND GAGES IN INCHES								
d	14	14	13 3/4	13 5/8	14 1/4	14 1/8	14	13 7/8
b	8 1/8	8	8	8	6 3/4	6 3/4	6 3/4	6 3/4
t	7/16	3/8	3/8	5/16	3/8	5/16	5/16	5/16
p	11/16	11/16	9/16	1/2	9/16	1/2	7/16	3/8
a	3 7/8	3 7/8	3 7/8	3 7/8	3 1/4	3 1/4	3 1/4	3 1/4
f	11 3/8	11 3/8	11 3/8	11 3/8	12 1/8	12 1/8	12 1/8	12 1/8
f_1	3 1/4	3 1/4	3 1/4	3 1/4	2 13/16	2 13/16	2 13/16	2 13/16
o	1 5/16	1 1/4	1 3/16	1 1/8	1 1/16	1	15/16	7/8
k	13/16	13/16	3/4	3/4	9/16	9/16	9/16	9/16
g usual	5 1/2	5 1/2	5 1/2	5 1/2	3 1/2	3 1/2	3 1/2	3 1/2
g_2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/4	2 1/4	2 1/4	2 1/4
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	128	117	105	94	91	82	73	63
V max	69	62	56	51	58	53	48	45
L min	7.45	7.54	7.50	7.44	6.31	6.18	6.04	5.58
fb	15000	14560	14100	13550	13890	13440	12890	12510
fbt	6090	5385	4780	4170	4695	4205	3700	3375
B min	7.73	8.01	8.30	8.70	8.74	9.08	9.54	9.83
R max	43	38	33	29	33	30	26	24
RA	32	29	27	24	27	25	23	21
LRA	15.94	16.10	15.60	15.68	13.49	13.10	12.65	11.94
Wt.CA	15	15	15	15	15	15	15	15
RH	64	58	54	48	54	50	46	42
LRH	7.97	8.05	7.80	7.84	6.74	6.55	6.33	5.97
Wt.CH	22	22	22	22	22	22	22	22
Q	1020	934	842	752	728	655	582	502

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 12″ LOADS

CB SECTIONS

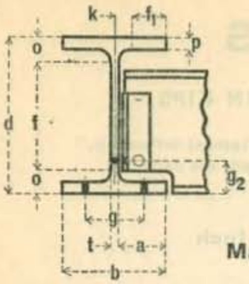
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	CB 124 12″ x 12″				CB 123 12″ x 10″			CB 122 12″ x 8″			Coefficient of Deflection
	85 Lbs.	79 Lbs.	72 Lbs.	65 Lbs.	64 Lbs.	58 Lbs.	53 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	
								108.5	97.3	84.2	
8					119.7	105.0	99.9	97.1	87.3	77.9	1.19
9	148.5	139.6	126.4	113.4	114.4	104.1	94.3	86.3	77.6	69.2	1.51
10	138.8	128.5	117.0	105.6	103.0	93.7	84.8	77.6	69.8	62.3	1.86
11	126.2	116.8	106.4	96.0	93.6	85.2	77.1	70.6	63.5	56.6	2.25
12	115.7	107.1	97.5	88.0	85.8	78.1	70.7	64.7	58.2	51.9	2.68
13	106.8	98.9	90.0	81.2	79.2	72.1	65.3	59.7	53.7	47.9	3.15
14	99.2	91.8	83.6	75.4	73.5	66.9	60.6	55.5	49.9	44.5	3.65
15	92.6	85.7	78.0	70.4	68.6	62.5	56.6	51.8	46.6	41.5	4.19
16	86.8	80.3	73.1	66.0	64.4	58.6	53.0	48.5	43.7	38.9	4.77
17	81.7	75.6	68.8	62.1	60.6	55.1	49.9	45.7	41.1	36.6	5.38
18	77.1	71.4	65.0	58.7	57.2	52.1	47.1	43.1	38.8	34.6	6.03
19	73.1	67.6	61.6	55.6	54.2	49.3	44.7	40.9	36.8	32.8	6.72
20	69.4	64.3	58.5	52.8	51.5	46.9	42.4	38.8	34.9	31.1	7.45
21	66.1	61.2	55.7	50.3	49.0	44.6	40.4	37.0	33.3	29.7	8.21
22	63.1	58.4	53.2	48.0	46.8	42.6	38.6	35.3	31.7	28.3	9.01
23	60.4	55.9	50.9	45.9	44.8	40.7	36.9	33.8	30.4	27.1	9.85
24	57.9	53.6	48.8	44.0	42.9	39.1	35.4	32.4	29.1	26.0	10.73
25	55.5	51.4			41.2						11.64

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM 12″ DATA

Notation	CB 124 12″ x 12″				CB 123 12″ x 10″			CB 122 12″ x 8″		
	85 Lbs.	79 Lbs.	72 Lbs.	65 Lbs.	64 Lbs.	58 Lbs.	53 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.
ELEMENTS										
I_{1-1}	723.3	663.0	597.4	533.4	528.3	476.1	426.2	394.5	350.8	310.1
S_{1-1}	115.7	107.1	97.5	88.0	85.8	78.1	70.7	64.7	58.2	51.9
I_{2-2}	235.5	216.4	195.3	174.6	119.0	107.4	96.1	56.4	50.0	44.1
S_{2-2}	38.9	35.8	32.4	29.1	23.7	21.4	19.2	14.0	12.4	11.0
DIMENSIONS AND GAGES IN INCHES										
d	12 1/2	12 3/8	12 1/4	12 1/8	12 1/4	12 1/4	12	12 1/4	12	12
b	12 1/8	12 1/8	12	12	10	10	10	8 1/8	8	8
t	1/2	1/2	7/16	3/8	7/16	3/8	3/8	3/8	3/8	5/16
p	13/16	3/4	11/16	5/8	11/16	5/8	9/16	5/8	9/16	1/2
a	5 3/4	5 3/4	5 3/4	5 3/4	4 7/8	4 7/8	4 7/8	3 7/8	3 7/8	3 7/8
f	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4	9 3/4
f_1	5 3/16	5 3/16	5 3/16	5 3/16	4 1/4	4 1/4	4 1/4	3 1/4	3 1/4	3 1/4
o	1 3/8	1 5/16	1 1/4	1 3/16	1 5/16	1 1/4	1 3/16	1 1/4	1 3/16	1 1/8
k	13/16	13/16	13/16	13/16	13/16	3/4	3/4	3/4	3/4	3/4
g usual	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2
g_2	2 3/4	2 3/4	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	174	161	146	132	129	117	106	97	87	78
V max	74	70	63	57	60	53	50	54	49	42
L min	9.35	9.20	9.25	9.31	8.60	8.92	8.50	7.15	7.18	7.39
fb	15000	15000	15000	15000	15000	15000	14950	15000	14820	14120
fbt	7425	7050	6450	5850	6075	5385	5160	5565	4980	4150
B min	6.88	6.81	6.74	6.67	6.77	6.70	6.66	6.70	6.75	7.16
R max	49	47	42	38	40	35	34	36	32	27
RA	39	37	34	31	32	28	27	29	26	23
LRA	17.80	17.37	17.21	17.03	16.09	16.74	15.71	13.39	13.43	13.54
Wt.CA	15	15	15	15	15	15	15	15	15	15
RH	78	74	68	62	64	56	54	58	52	46
LRH	8.90	8.68	8.60	8.52	8.04	8.37	7.86	6.69	6.72	6.77
Wt.CH	22	22	22	22	22	22	22	22	22	22
Q	1388	1285	1170	1056	1030	937	848	776	698	623

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
12″
10″
LOADS

CB SECTIONS

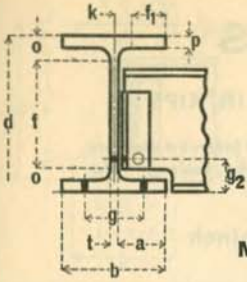
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 121 12″ x 6½″				CB 103 10″ x 10″				Coefficient of Deflection
	36 Lbs.	32 Lbs.	28 Lbs.	25 Lbs.	66 Lbs.	60 Lbs.	54 Lbs.	49 Lbs.	
				68.4					
6	89.6	79.4	69.1	61.8					0.67
7	78.7	69.8	61.0	53.0	113.8	102.1			0.91
8	68.9	61.1	53.4	46.4	110.6	100.7	89.4	81.6	1.19
9	61.2	54.3	47.5	41.2	98.3	89.5	80.5	72.8	1.51
10	55.1	48.8	42.7	37.1	88.4	80.5	72.5	65.5	1.86
11	50.1	44.4	38.8	33.7	80.4	73.2	65.9	59.6	2.25
12	45.9	40.7	35.6	30.9	73.7	67.1	60.4	54.6	2.68
13	42.4	37.6	32.9	28.5	68.0	61.9	55.8	50.4	3.15
14	39.3	34.9	30.5	26.5	63.2	57.5	51.8	46.8	3.65
15	36.7	32.6	28.5	24.7	59.0	53.7	48.3	43.7	4.19
16	34.4	30.5	26.7	23.2	55.3	50.3	45.3	41.0	4.77
17	32.4	28.7	25.1	21.8	52.0	47.4	42.6	38.5	5.38
18	30.6	27.1	23.7	20.6	49.1	44.7	40.3	36.4	6.03
19	29.0	25.7	22.5	19.5	46.5	42.4	38.1	34.5	6.72
20	27.5	24.4	21.4	18.5	44.2	40.3	36.2	32.8	7.45
21	26.2	23.3	20.3	17.7	42.1	38.3	34.5		8.21
22	25.0	22.2	19.4	16.9					9.01
23	23.9	21.2	18.6	16.1					9.85
24	23.0	20.4	17.8	15.5					10.73

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections



CB SECTIONS

ESSENTIAL DATA

BEAM 12" 10" DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 121 12" x 6 1/2"				CB 103 10" x 10"			
	36 Lbs.	32 Lbs.	28 Lbs.	25 Lbs.	66 Lbs.	60 Lbs.	54 Lbs.	49 Lbs.
ELEMENTS								
I_{1-1}	280.8	246.8	213.5	183.4	382.5	343.7	305.7	272.9
S_{1-1}	45.9	40.7	35.6	30.9	73.7	67.1	60.4	54.6
I_{2-2}	23.7	20.6	17.5	14.5	129.2	116.5	103.9	93.0
S_{2-2}	7.2	6.3	5.4	4.5	25.5	23.1	20.7	18.6
DIMENSIONS AND GAGES IN INCHES								
d	12 1/4	12 1/8	12	11 7/8	10 3/8	10 1/4	10 1/8	10
b	6 5/8	6 1/2	6 1/2	6 1/2	10 1/8	10 1/8	10	10
t	5/16	5/16	1/4	1/4	7/16	7/16	3/8	3/8
p	9/16	1/2	7/16	3/8	3/4	11/16	5/8	9/16
a	3 1/8	3 1/8	3 1/8	3 1/8	4 7/8	4 7/8	4 7/8	4 7/8
f	10 3/8	10 3/8	10 3/8	10 3/8	7 7/8	7 7/8	7 7/8	7 7/8
f_1	2 3/4	2 3/4	2 3/4	2 3/4	4 5/16	4 5/16	4 5/16	4 5/16
o	15/16	7/8	13/16	3/4	1 1/4	1 3/16	1 1/8	1 1/16
k	1/2	1/2	1/2	1/2	11/16	11/16	11/16	11/16
g usual	3 1/2	3 1/2	3 1/2	3 1/2	5 1/2	5 1/2	5 1/2	5 1/2
g_2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	69	61	53	46	111	101	91	82
V max	45	40	35	34	57	51	45	41
L min	6.15	6.15	6.18	5.42	7.77	7.89	8.11	8.03
fb	14190	13550	12710	12790	15000	15000	15000	15000
fbt	4330	3700	3050	3070	6855	6225	5520	5100
B min	7.29	7.71	8.34	8.17	5.71	5.64	5.57	5.50
R max	28	24	20	20	42	38	33	31
RA	24	21	19	19	48	44	39	36
LRA	11.48	11.63	11.24	9.76	9.21	9.15	9.29	9.10
Wt.CA	15	15	15	15	15	15	15	15
RH	48	42	38	38				
LRH	5.74	5.81	5.62	4.88				
Wt.CH	22	22	22	22				
Q	551	488	427	371	884	805	725	655

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3 1/2".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
10″
LOADS

CB SECTIONS

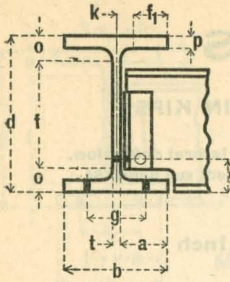
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 102 10″ x 8″ 45 Lbs.	CB 102 10″ x 8″ 41 Lbs.	CB 102 10″ x 8″ 37 Lbs.	CB 102 10″ x 8″ 33 Lbs.	CB 101 10″ x 5¾″ 29 Lbs.	CB 101 10″ x 5¾″ 26 Lbs.	CB 101 10″ x 5¾″ 23 Lbs.	CB 101 10″ x 5¾″ 21 Lbs.	Coefficient of Deflection
								57.0	
5								51.6	0.47
					70.9	62.9	57.6		
6	85.0	78.7	72.6	68.3	61.6	55.2	48.2	43.0	0.67
7	84.2	76.3	68.4	60.0	52.8	47.3	41.3	36.9	0.91
8	73.7	66.8	59.9	52.5	46.2	41.4	36.2	32.3	1.19
9	65.5	59.3	53.2	46.7	41.1	36.8	32.1	28.7	1.51
10	58.9	53.4	47.9	42.0	37.0	33.1	28.9	25.8	1.86
11	53.6	48.5	43.5	38.2	33.6	30.1	26.3	23.5	2.25
12	49.1	44.5	39.9	35.0	30.8	27.6	24.1	21.5	2.68
13	45.3	41.1	36.8	32.3	28.4	25.5	22.2	19.8	3.15
14	42.1	38.1	34.2	30.0	26.4	23.7	20.7	18.4	3.65
15	39.3	35.6	31.9	28.0	24.6	22.1	19.3	17.2	4.19
16	36.8	33.4	29.9	26.3	23.1	20.7	18.1	16.1	4.77
17	34.7	31.4	28.2	24.7	21.7	19.5	17.0	15.2	5.38
18	32.7	29.7	26.6	23.3	20.5	18.4	16.1	14.3	6.03
19	31.0	28.1	25.2	22.1	19.5	17.4	15.2	13.6	6.72
20	29.5	26.7	23.9	21.0	18.5	16.6	14.5	12.9	7.45
21	28.1				17.6	15.8			8.21

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM
10"
DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 102 10" x 8"				CB 101 10" x 5 3/4"			
	45 Lbs.	41 Lbs.	37 Lbs.	33 Lbs.	29 Lbs.	26 Lbs.	23 Lbs.	21 Lbs.
ELEMENTS								
I_{1-1}	248.6	222.4	196.9	170.9	157.3	139.7	120.6	106.3
S_{1-1}	49.1	44.5	39.9	35.0	30.8	27.6	24.1	21.5
I_{2-2}	53.2	47.7	42.2	36.5	15.2	13.4	11.3	9.7
S_{2-2}	13.3	11.9	10.6	9.2	5.2	4.6	3.9	3.4
DIMENSIONS AND GAGES IN INCHES								
d	10 1/8	10	9 7/8	9 3/4	10 1/4	10 1/8	10	9 7/8
b	8	8	8	8	5 3/4	5 3/4	5 3/4	5 3/4
t	3/8	5/16	5/16	5/16	5/16	1/4	1/4	1/4
p	5/8	9/16	1/2	7/16	1/2	7/16	3/8	5/16
a	3 7/8	3 7/8	3 7/8	3 7/8	2 3/4	2 3/4	2 3/4	2 3/4
f	7 7/8	7 7/8	7 7/8	7 7/8	8 1/2	8 1/2	8 1/2	8 1/2
f_1	3 5/16	3 5/16	3 5/16	3 5/16	2 7/16	2 7/16	2 7/16	2 7/16
o	1 1/8	1 1/16	1	15/16	7/8	13/16	3/4	11/16
k	11/16	11/16	11/16	11/16	7/16	7/16	7/16	7/16
g usual	5 1/2	5 1/2	5 1/2	5 1/2	2 3/4	2 3/4	2 3/4	2 3/4
g_2	2 1/2	2 1/2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	74	67	60	53	46	41	36	32
V max	43	39	36	34	35	31	29	29
L min	6.93	6.78	6.60	6.15	5.21	5.26	5.02	4.52
fb	15000	15000	15000	15000	14900	14350	13960	14020
fbt	5250	4920	4590	4380	4305	3715	3350	3365
B min	5.57	5.50	5.43	5.36	5.68	5.93	6.10	6.00
R max	32	30	27	26	26	22	20	20
RA	37	34	32	31	30	27	25	25
LRA	7.96	7.85	7.48	6.77	6.16	6.13	5.78	5.16
Wt.CA	15	15	15	15	15	15	15	15
Q	589	534	479	420	370	331	289	258

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in Feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
8″
LOADS

CB SECTIONS

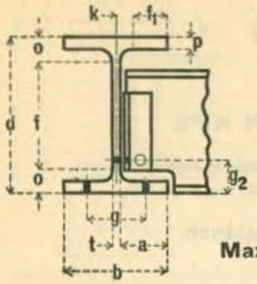
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	CB 83 8″ x 8″			CB 82 8″ x 6½″		CB 81 8″ x 5¼″			
	35 Lbs.	33 Lbs.	31 Lbs.	27 Lbs.	24 Lbs.	21 Lbs.	19 Lbs.	17 Lbs.	
								44.2	
4						49.5	47.4	42.3	0.30
5						43.2	38.4	33.8	0.47
			55.3	52.6	46.6				
6	61.4	58.0	54.8	46.8	41.6	36.0	32.0	28.2	0.67
7	53.3	50.2	47.0	40.1	35.7	30.9	27.4	24.2	0.91
8	46.7	44.0	41.1	35.1	31.2	27.0	24.0	21.2	1.19
9	41.5	39.1	36.5	31.2	27.7	24.0	21.3	18.8	1.51
10	37.3	35.2	32.9	28.1	25.0	21.6	19.2	16.9	1.86
11	33.9	32.0	29.9	25.5	22.7	19.6	17.5	15.4	2.25
12	31.1	29.3	27.4	23.4	20.8	18.0	16.0	14.1	2.68
13	28.7	27.0	25.3	21.6	19.2	16.6	14.8	13.0	3.15
14	26.7	25.1	23.5	20.1	17.8	15.4	13.7	12.1	3.65
15	24.9	23.4	21.9	18.7	16.6	14.4	12.8	11.3	4.19
16	23.3	22.0	20.6	17.6	15.6	13.5	12.0	10.6	4.77
17	22.0	20.7	19.3	16.5	14.7	12.7	11.3	10.0	5.38

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

BEAM 8" DATA

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	CB 83 8" x 8"			CB 82 8" x 6½"		CB 81 8" x 5¼"		
	35 Lbs.	33 Lbs.	31 Lbs.	27 Lbs.	24 Lbs.	21 Lbs.	19 Lbs.	17 Lbs.
ELEMENTS								
I_{1-1}	126.5	117.9	109.7	94.1	82.5	73.8	64.7	56.4
S_{1-1}	31.1	29.3	27.4	23.4	20.8	18.0	16.0	14.1
I_{2-2}	42.5	39.7	37.0	20.8	18.2	9.13	7.87	6.72
S_{2-2}	10.6	9.9	9.2	6.4	5.6	3.5	3.0	2.6
DIMENSIONS AND GAGES IN INCHES								
d	8⅛	8	8	8	7⅞	8¼	8⅛	8
b	8	8	8	6½	6½	5¼	5¼	5¼
t	5/16	5/16	5/16	5/16	¼	¼	¼	¼
p	½	7/16	7/16	7/16	⅜	⅜	⅜	5/16
a	3⅞	3⅞	3⅞	3⅛	3⅛	2½	2½	2½
f	6⅜	6⅜	6⅜	6⅜	6⅜	6¾	6¾	6¾
f_1	3 7/16	3 7/16	3 7/16	2¾	2¾	2 3/16	2 3/16	2 3/16
o	⅞	⅞	13/16	⅞	13/16	¾	11/16	⅝
k	9/16	9/16	9/16	½	½	½	½	½
g usual	5½	5½	5½	3½	3½	2¾	2¾	2¾
g_2	2¼	2¼	2¼	2¼	2¼	2	2	2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	47	44	41	35	31	27	24	21
V max	31	29	28	26	23	25	24	22
L min	6.08	6.06	5.95	5.34	5.35	4.36	4.05	3.83
fb	15000	15000	15000	15000	15000	15000	15000	14980
fbt	4725	4500	4320	4095	3675	3780	3660	3445
B min	4.47	4.43	4.40	4.42	4.36	4.51	4.45	4.41
R max	26	25	24	23	20	21	20	19
RA	33	32	30	29	26	26	26	24
LRA	5.65	5.49	5.48	4.84	4.80	4.15	3.69	3.53
Wt.CA	15	15	15	15	15	15	15	15
Q	373	352	329	281	250	216	192	169

M max = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
L min = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM 12″ to 6″ LOADS

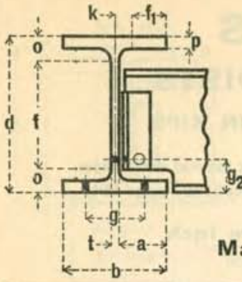
CB SECTIONS
LIGHT BEAMS
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	CBL 12 12″ x 4″			CBL 10 10″ x 4″			CBL 8 8″ x 4″		CBL 6 6″ x 4″		Coefficient of Deflection
	22 Lbs.	19 Lbs.	16½ Lbs.	19 Lbs.	17 Lbs.	15 Lbs.	15 Lbs.	13 Lbs.	16 Lbs.	12 Lbs.	
						55.2	47.7	44.2		33.1	
3	76.8	70.0	66.2	61.5	58.3	55.1	47.3	39.5	39.0	29.0	0.17
4	75.9	64.2	52.6	56.3	48.5	41.3	35.5	29.7	30.5	21.7	0.30
5	60.7	51.4	42.1	45.1	38.8	33.0	28.4	23.7	24.4	17.4	0.47
6	50.6	42.8	35.1	37.6	32.3	27.5	23.7	19.8	20.3	14.5	0.67
7	43.4	36.7	30.1	32.2	27.7	23.6	20.3	16.9	17.4	12.4	0.91
8	38.0	32.1	26.3	28.2	24.3	20.6	17.7	14.8	15.2	10.9	1.19
9	33.7	28.5	23.4	25.0	21.6	18.3	15.8	13.2	13.5	9.7	1.51
10	30.4	25.7	21.1	22.5	19.4	16.5	14.2	11.9	12.2	8.7	1.86
11	27.6	23.3	19.1	20.5	17.6	15.0	12.9	10.8	11.1	7.9	2.25
12	25.3	21.4	17.5	18.8	16.2	13.8	11.8	9.9	10.2	7.2	2.68
13	23.4	19.8	16.2	17.3	14.9	12.7	10.9	9.1	9.4	6.7	3.15
14	21.7	18.3	15.0	16.1	13.9	11.8	10.1	8.5	8.7		3.65
15	20.2	17.1	14.0	15.0	12.9	11.0	9.5	7.9			4.19
16	19.0	16.1	13.2	14.1	12.1	10.3	8.9	7.4			4.77
17	17.9	15.1	12.4	13.3	11.4	9.7	8.3	7.0			5.38
18	16.9	14.3	11.7	12.5	10.8	9.2					6.03
19	16.0	13.5	11.1	11.9	10.2	8.7					6.72
20	15.2	12.8	10.5	11.3	9.7	8.3					7.45
21	14.5	12.2	10.0	10.7	9.2						8.21
22	13.8	11.7	9.6								9.01
23	13.2	11.2	9.2								9.85
24	12.7	10.7	8.8								10.73
25	12.1										11.64

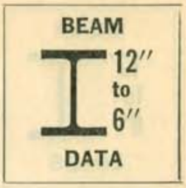
Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS
LIGHT BEAMS
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch



Notation	CBL 12 12″ x 4″			CBL 10 10″ x 4″			CBL 8 8″ x 4″		CBL 6 6″ x 4″	
	22 Lbs.	19 Lbs.	16.5 Lbs.	19 Lbs.	17 Lbs.	15 Lbs.	15 Lbs.	13 Lbs.	16 Lbs.	12 Lbs.
ELEMENTS										
I_{1-1}	155.7	130.1	105.3	96.2	81.8	68.8	48.0	39.5	31.7	21.7
S_{1-1}	25.3	21.4	17.5	18.8	16.2	13.8	11.8	9.88	10.1	7.24
I_{2-2}	4.55	3.67	2.79	4.19	3.45	2.79	3.30	2.62	4.32	2.89
S_{2-2}	2.26	1.83	1.39	2.08	1.72	1.39	1.65	1.31	2.14	1.44
DIMENSIONS AND GAGES IN INCHES										
d	12 1/4	12 1/8	12	10 1/4	10 1/8	10	8 1/8	8	6 1/4	6
b	4	4	4	4	4	4	4	4	4	4
t	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
p	7/16	3/8	1/4	3/8	5/16	1/4	5/16	1/4	3/8	1/4
a	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8
f	10 3/4	10 3/4	10 3/4	8 7/8	8 7/8	8 7/8	6 7/8	6 7/8	4 7/8	4 7/8
f_1	1 9/16	1 9/16	1 9/16	1 9/16	1 9/16	1 9/16	1 9/16	1 9/16	1 5/8	1 5/8
o	3/4	11/16	5/8	11/16	5/8	9/16	5/8	9/16	11/16	9/16
k	7/16	7/16	7/16	7/16	7/16	7/16	7/16	7/16	3/8	3/8
g usual	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4
g_2	2	2	1 3/4	2	2	1 3/4	2	1 3/4	2	1 3/4
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	38	32	26	28	24	21	18	15	15	11
V max	38	35	33	31	29	28	24	22	20	17
L min	3.95	3.67	3.17	3.67	3.33	3.00	2.97	2.68	3.11	2.62
fb	13100	12610	12380	14060	13890	13690	15000	14980	15000	15000
fbt	3405	3025	2850	3515	3330	3150	3675	3445	3900	3450
B min	8.20	8.54	8.63	6.19	6.22	6.27	4.47	4.41	3.44	3.30
R max	22	20	19	21	20	19	20	19	20	17
RA	20	19	18	26	25	24	26	24	14	12
LRA	7.59	6.76	5.83	4.34	3.89	3.45	2.72	2.47	4.33	3.62
Wt.CA	15	15	15	15	15	15	15	15	8	8
RH	41	38	36							
LRH	3.70	3.38	2.92							
Wt.CH	30	30	30							
Q	304	257	210	226	194	166	142	119	121	87

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
12″ to 6″
LOADS

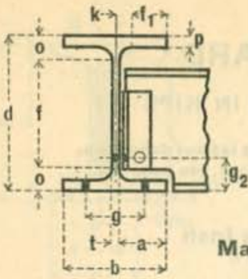
CB SECTIONS
STANCHIONS AND JOISTS
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	STANCHIONS		JOISTS				Coefficient of Deflection
	Nominal Depth and Flange Width—Weight per Foot						
	CBS 6 6″ x 6″		CBJ 12 12″ x 4″	CBJ 10 10″ x 4″	CBJ 8 8″ x 4″	CBJ 6 6″ x 4″	
	18 Lbs.	15½ Lbs.	14 Lbs.	11½ Lbs.	10 Lbs.	8½ Lbs.	
				42.6	32.3	23.8	
3	38.7	34.6	57.2	42.0	31.2	20.3	0.17
4	35.1	30.0	44.4	31.5	23.4	15.2	0.30
5	28.1	24.0	35.5	25.2	18.7	12.2	0.47
6	23.4	20.0	29.6	21.0	15.6	10.1	0.67
7	20.1	17.1	25.4	18.0	13.4	8.7	0.91
8	17.6	15.0	22.2	15.8	11.7	7.6	1.19
9	15.6	13.3	19.7	14.0	10.4	6.8	1.51
10	14.0	12.0	17.8	12.6	9.3	6.1	1.86
11	12.8	10.9	16.1	11.5	8.5	5.5	2.25
12	11.7	10.0	14.8	10.5	7.8	5.1	2.68
13	10.8	9.2	13.7	9.7	7.2	4.7	3.15
14			12.7	9.0	6.7		3.65
15			11.8	8.4	6.2		4.19
16			11.1	7.9	5.8		4.77
17			10.4	7.4	5.5		5.38
18			9.9	7.0			6.03
19			9.3	6.6			6.72
20			8.9	6.3			7.45
21			8.5				8.21
22			8.1				9.01
23			7.7				9.85
24			7.4				10.73

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CB SECTIONS

STANCHIONS and JOISTS

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM 12″ to 6″ DATA

Notation	Nominal Depth and Flange Width—Weight per Foot					
	CBS 6 6″ x 6″		CBJ 12 12″ x 4″	CBJ 10 10″ x 4″	CBJ 8 8″ x 4″	CBJ 6 6″ x 4″
	18 Lbs.	15.5 Lbs.	14 Lbs.	11.5 Lbs.	10 Lbs.	8.5 Lbs.
ELEMENTS						
I_{1-1}	35.5	30.1	88.2	51.9	30.8	14.8
S_{1-1}	11.7	10.0	14.8	10.5	7.79	5.07
I_{2-2}	11.0	9.19	2.25	2.01	1.99	1.89
S_{2-2}	3.64	3.06	1.13	1.02	1.01	.96
DIMENSIONS AND GAGES IN INCHES						
d	6⅛	6	11⅞	9⅞	7⅞	5⅞
b	6	6	4	4	4	4
t	¼	¼	3/16	3/16	3/16	3/16
p	5/16	¼	¼	3/16	3/16	3/16
a	2⅞	2⅞	1⅞	1⅞	1⅞	1⅞
f	4⅞	4⅞	10¾	8⅞	6⅞	5
f_1	2⅝	2⅝	1⅝	1⅝	1⅝	1⅝
o	⅝	9/16	9/16	½	½	7/16
k	⅜	⅜	⅜	⅜	⅜	⅜
g usual	3½	3½	2¼	2¼	2¼	2¼
g_2	1¾	1¾	1¾	1¾	1¾	1¾
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.						
M max	18	15	22	16	12	8
V max	19	17	29	21	16	12
L min	3.62	3.47	3.11	2.96	2.90	2.56
fb	15000	15000	11310	11990	13240	15000
fbt	3975	3600	2265	2160	2250	2550
B min	3.35	3.30	9.65	7.41	5.19	3.21
R max	20	18	15	13	12	13
RA	14	13	16	19	18	9
LRA	5.01	4.62	5.55	3.32	2.60	3.38
Wt.CA	8	8	15	15	15	8
RH			32			
LRH			2.78			
Wt.CH			30			
Q	140	120	178	126	93	61

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
24″
LOADS

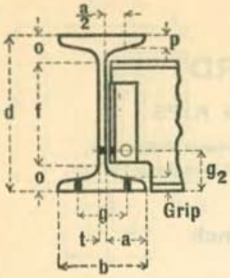
BEAMS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot									Coefficient of Deflection
	B 18 24″ x 7⅞″				B 1 24″ x 7″					
	120 Lbs.	115 Lbs.	110 Lbs.	105.9 Lbs.	100 Lbs.	95 Lbs.	90 Lbs.	85 Lbs.	79.9 Lbs.	
					430.3	395.1				
6	495.6	424.5			395.3	383.6	359.4	324.3		0.67
7	430.1	420.1	388.8	360.0	338.8	328.8	318.6	308.6	288.0	0.91
8	376.4	367.6	358.6	351.4	296.5	287.7	278.8	270.0	260.9	1.19
9	334.5	326.7	318.8	312.4	263.5	255.7	247.8	240.0	231.9	1.51
10	301.1	294.1	286.9	281.2	237.2	230.2	223.0	216.0	208.7	1.86
11	273.7	267.3	260.8	255.6	215.6	209.2	202.7	196.4	189.7	2.25
12	250.9	245.0	239.1	234.3	197.7	191.8	185.8	180.0	173.9	2.68
13	231.6	226.2	220.7	216.3	182.4	177.0	171.5	166.1	160.6	3.15
14	215.1	210.0	204.9	200.8	169.4	164.4	159.3	154.3	149.1	3.65
15	200.7	196.0	191.3	187.4	158.1	153.4	148.7	144.0	139.1	4.19
16	188.2	183.8	179.3	175.7	148.2	143.8	139.4	135.0	130.5	4.77
17	177.1	173.0	168.8	165.4	139.5	135.4	131.2	127.0	122.8	5.38
18	167.3	163.4	159.4	156.2	131.8	127.9	123.9	120.0	116.0	6.03
19	158.5	154.8	151.0	148.0	124.8	121.1	117.4	113.7	109.9	6.72
20	150.5	147.0	143.5	140.6	118.6	115.1	111.5	108.0	104.4	7.45
21	143.4	140.0	136.6	133.9	112.9	109.6	106.2	102.8	99.4	8.21
22	136.9	133.7	130.4	127.8	107.8	104.6	101.4	98.2	94.9	9.01
23	130.9	127.8	124.7	122.2	103.1	100.1	97.0	93.9	90.7	9.85
24	125.5	122.5	119.5	117.1	98.8	95.9	92.9	90.0	87.0	10.73
25	120.4	117.6	114.8	112.5	94.9	92.1	89.2	86.4	83.5	11.64
26	115.8	113.1	110.4	108.1	91.2	88.5	85.8	83.1	80.3	12.59
27	111.5	108.9	106.3	104.1	87.8	85.2	82.6	80.0	77.3	13.57
28	107.5	105.0	102.5	100.4	84.7	82.2	79.6	77.1	74.5	14.60
29	103.8	101.4	98.9	96.9	81.8	79.4	76.9	74.5	72.0	15.66
30	100.4	98.0	95.6	93.7	79.1	76.7	74.3	72.0	69.6	16.76
31	97.1	94.9	92.6	90.7	76.5	74.2	71.9	69.7	67.3	17.89
32	94.1	91.9	89.7	87.9	74.1	71.9	69.7	67.5	65.2	19.07
33	91.2	89.1	86.9	85.2	71.9	69.7	67.6	65.4	63.3	20.28
34	88.6	86.5	84.4	82.7	69.8	67.7	65.6	63.5	61.4	21.53
35	86.0	84.0	82.0	80.3	67.8	65.8	63.7	61.7	59.6	22.81
36	83.6	81.7	79.7	78.1	65.9	63.9	61.9	60.0	58.0	24.13
37	81.4	79.5	77.5	76.0	64.1	62.2	60.3	58.4	56.4	25.49
38	79.2	77.4	75.5	74.0	62.4	60.6	58.7	56.8	54.9	26.89
39	77.2	75.4	73.6	72.1	60.8	59.0	57.2	55.4	53.5	28.32
40	75.3	73.5	71.7	70.3	59.3	57.5	55.8	54.0	52.2	29.79
42	71.7	70.0	68.3	66.9	56.5	54.8	53.1	51.4	49.7	32.85
44	68.4	66.8	65.2	63.9	53.9	52.3	50.7	49.1	47.4	36.05
46	65.5	63.9	62.4	61.1	51.6	50.0	48.5	47.0	45.4	39.40
48	62.7	61.3	59.8	58.6	49.4	47.9	46.5	45.0	43.5	42.90

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM
I 24″
DATA

Notation	Nominal Depth and Flange Width—Weight per Foot								
	B 18 24″ x $7\frac{7}{8}$″				B 1 24″ x 7″				
	120 Lbs.	115 Lbs.	110 Lbs.	105.9 Lbs.	100 Lbs.	95 Lbs.	90 Lbs.	85 Lbs.	79.9 Lbs.
ELEMENTS									
I_{1-1}	3010.8	2940.5	2869.1	2811.5	2371.8	2301.5	2230.1	2159.8	2087.2
S_{1-1}	250.9	245.0	239.1	234.3	197.6	191.8	185.8	180.0	173.9
I_{2-2}	84.9	82.8	80.6	78.9	48.4	47.0	45.5	44.2	42.9
S_{2-2}	21.1	20.7	20.3	20.0	13.4	13.0	12.8	12.5	12.2
DIMENSIONS AND GAGES IN INCHES									
d	24	24	24	24	24	24	24	24	24
b	8	8	$7\frac{7}{8}$	$7\frac{7}{8}$	$7\frac{1}{4}$	$7\frac{1}{8}$	$7\frac{1}{8}$	$7\frac{1}{8}$	7
t	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{1}{2}$
p	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$
a	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$
Grip	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$
f	$20\frac{1}{8}$	$20\frac{1}{8}$	$20\frac{1}{8}$	$20\frac{1}{8}$	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{3}{4}$	$20\frac{3}{4}$
o	$1\frac{15}{16}$	$1\frac{15}{16}$	$1\frac{15}{16}$	$1\frac{15}{16}$	$1\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{5}{8}$
g usual	4	4	4	4	4	4	4	4	4
g_2	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$	3	3	3	3	3
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.									
M max	376	368	359	351	296	288	279	270	261
V max	230	212	194	180	215	198	180	162	144
L min	6.55	6.93	7.38	7.81	5.51	5.82	6.20	6.66	7.25
fb	15000	15000	14870	14450	15000	14950	14440	13820	13010
fbt	11970	11055	10035	9030	11205	10255	9010	7780	6505
B min	13.20	13.20	13.37	13.95	13.20	13.26	13.95	14.85	16.14
R max	114	105	95	86	106	97	86	74	62
RA	97	97	97	97	97	97	97	88	79
LRA	15.52	15.15	14.79	14.49	12.22	11.86	11.49	12.27	13.21
Wt.CA	36	36	36	36	36	36	36	36	36
RH	162	162	162	162	162	162	162	148	131
LRH	9.29	9.07	8.86	8.68	7.32	7.10	6.88	7.30	7.96
Wt.CH	50	50	50	50	50	50	50	50	50
Q	3011	2940	2869	2812	2371	2302	2230	2160	2087

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = $3\frac{1}{2}$″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
20″
LOADS

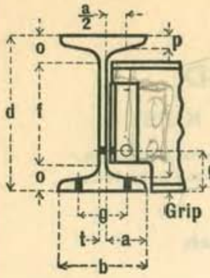
BEAMS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	B 2 20″ x 7″					B 3 20″ x 6¼″			
	100 Lbs.	95 Lbs.	90 Lbs.	85 Lbs.	81.4 Lbs.	75 Lbs.	70 Lbs.	65.4 Lbs.	
	419.0					307.7			
5	395.6	384.0	348.5	313.4		303.2	272.2	240.0	0.47
6	329.7	319.9	310.1	300.3	288.0	252.7	242.8	233.9	0.67
7	282.6	274.2	265.8	257.4	251.4	216.6	208.1	200.5	0.91
8	247.2	239.9	232.5	225.2	219.9	189.5	182.1	175.4	1.19
9	219.8	213.3	206.7	200.2	195.5	168.5	161.9	155.9	1.51
10	197.8	192.0	186.0	180.2	176.0	151.6	145.7	140.3	1.86
11	179.8	174.5	169.1	163.8	160.0	137.8	132.5	127.6	2.25
12	164.8	160.0	155.0	150.2	146.6	126.3	121.4	116.9	2.68
13	152.2	147.7	143.1	138.6	135.3	116.6	112.1	108.0	3.15
14	141.3	137.1	132.9	128.7	125.7	108.3	104.1	100.2	3.65
15	131.9	128.0	124.0	120.1	117.3	101.1	97.1	93.6	4.19
16	123.6	120.0	116.3	112.6	110.0	94.8	91.1	87.7	4.77
17	116.4	112.9	109.4	106.0	103.5	89.2	85.7	82.6	5.38
18	109.9	106.6	103.4	100.1	97.8	84.2	80.9	78.0	6.03
19	104.1	101.0	97.9	94.8	92.6	79.8	76.7	73.9	6.72
20	98.9	96.0	93.0	90.1	88.0	75.8	72.8	70.2	7.45
21	94.2	91.4	88.6	85.8	83.8	72.2	69.4	66.8	8.21
22	89.9	87.2	84.6	81.9	80.0	68.9	66.2	63.8	9.01
23	86.0	83.5	80.9	78.3	76.5	65.9	63.3	61.0	9.85
24	82.4	80.0	77.5	75.1	73.3	63.2	60.7	58.5	10.73
25	79.1	76.8	74.4	72.1	70.4	60.6	58.3	56.1	11.64
26	76.1	73.8	71.6	69.3	67.7	58.3	56.0	54.0	12.59
27	73.3	71.1	68.9	66.7	65.2	56.2	54.0	52.0	13.57
28	70.6	68.6	66.4	64.4	62.8	54.2	52.0	50.1	14.60
29	68.2	66.2	64.2	62.1	60.7	52.3	50.2	48.4	15.66
30	65.9	64.0	62.0	60.1	58.7	50.5	48.6	46.8	16.76
31	63.8	61.9	60.0	58.1	56.8	48.9	47.0	45.3	17.89
32	61.8	60.0	58.1	56.3	55.0	47.4	45.5	43.9	19.07
33	59.9	58.2	56.4	54.6	53.3	45.9	44.2	42.5	20.28
34	58.2	56.5	54.7	53.0	51.8	44.6	42.9	41.3	21.53
35	56.5	54.8	53.2	51.5	50.3	43.3	41.6	40.1	22.81
36	54.9	53.3	51.7	50.1	48.9	42.1	40.5	39.0	24.13
37	53.5	51.9	50.3	48.7	47.6	41.0	39.4	37.9	25.49
38	52.1	50.5	49.0	47.4	46.3	39.9	38.3	36.9	26.89

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

BEAM I 20″ DATA

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot							
	B 2 20″ x 7″					B 3 20″ x 6¼″		
	100 Lbs.	95 Lbs.	90 Lbs.	85 Lbs.	81.4 Lbs.	75 Lbs.	70 Lbs.	65.4 Lbs.
ELEMENTS								
I_{1-1}	1648.3	1599.7	1550.3	1501.7	1466.3	1263.5	1214.2	1169.5
S_{1-1}	164.8	160.0	155.0	150.2	146.6	126.3	121.4	116.9
I_{2-2}	52.4	50.5	48.7	47.0	45.8	30.1	28.9	27.9
S_{2-2}	14.4	14.0	13.7	13.3	13.1	9.4	9.2	8.9
DIMENSIONS AND GAGES IN INCHES								
d	20	20	20	20	20	20	20	20
b	7¼	7¼	7⅛	7	7	6⅜	6⅜	6¼
t	⅞	13/16	¾	11/16	⅝	⅝	9/16	½
p	15/16	15/16	15/16	15/16	15/16	13/16	13/16	13/16
a	3¼	3¼	3¼	3¼	3¼	2⅞	2⅞	2⅞
Grip	15/16	15/16	15/16	⅞	⅞	13/16	13/16	¾
f	16½	16½	16½	16½	16½	16⅞	16⅞	16⅞
o	1¾	1¾	1¾	1¾	1¾	1 9/16	1 9/16	1 9/16
g usual	4	4	4	4	4	3½	3½	3½
g_2	3¼	3¼	3¼	3¼	3¼	3	3	3
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	247	240	233	225	220	189	182	175
V max	210	192	174	157	144	154	136	120
L min	4.72	5.00	5.34	5.75	6.11	4.93	5.35	5.85
fb	15000	15000	15000	15000	15000	15000	14910	14210
fbt	13095	12000	10890	9795	9000	9615	8455	7105
B min	11.00	11.00	11.00	11.00	11.00	11.00	11.10	11.89
R max	111	102	93	83	77	82	72	60
RA	81	81	81	81	79	81	74	66
LRA	12.21	11.85	11.48	11.13	11.13	9.36	9.84	10.63
Wt.CA	30	30	30	30	30	30	30	30
RH	130	130	130	130	126	130	119	105
LRH	7.61	7.38	7.15	6.93	6.98	5.83	6.12	6.68
Wt.CH	41	41	41	41	41	41	41	41
Q	1978	1920	1860	1802	1759	1516	1457	1403

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
18″
15″
LOADS

BEAMS

AMERICAN STANDARD

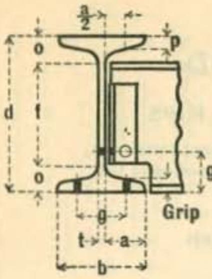
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	B 4 18″ x 6″				B 6 15″ x 6″				
	70 Lbs.	65 Lbs.	60 Lbs.	54.7 Lbs.	75 Lbs.	70 Lbs.	65 Lbs.	60.8 Lbs.	
	307.2				312.5	277.2			
4	305.8	271.7	236.3		274.9	263.8	241.9	212.4	0.30
5	244.7	234.0	223.4		219.9	211.1	202.3	194.9	0.47
				198.7					
6	203.9	195.0	186.2	176.8	183.3	175.9	168.5	162.4	0.67
7	174.8	167.2	159.6	151.5	157.1	150.8	144.5	139.2	0.91
8	152.9	146.3	139.6	132.6	137.4	131.9	126.4	121.8	1.19
9	135.9	130.0	124.1	117.9	122.2	117.3	112.4	108.3	1.51
10	122.3	117.0	111.7	106.1	110.0	105.5	101.1	97.4	1.86
11	111.2	106.4	101.6	96.4	100.0	95.9	91.9	88.6	2.25
12	101.9	97.5	93.1	88.4	91.6	88.0	84.3	81.2	2.68
13	94.1	90.0	85.9	81.6	84.6	81.2	77.8	75.0	3.15
14	87.4	83.6	79.8	75.8	78.5	75.4	72.2	69.6	3.65
15	81.6	78.0	74.5	70.7	73.3	70.4	67.4	65.0	4.19
16	76.5	73.1	69.8	66.3	68.7	66.0	63.2	60.9	4.77
17	72.0	68.8	65.7	62.4	64.7	62.1	59.5	57.3	5.38
18	68.0	65.0	62.1	58.9	61.1	58.6	56.2	54.1	6.03
19	64.4	61.6	58.8	55.8	57.9	55.5	53.2	51.3	6.72
20	61.2	58.5	55.9	53.0	55.0	52.8	50.6	48.7	7.45
21	58.3	55.7	53.2	50.5	52.4	50.3	48.2	46.4	8.21
22	55.6	53.2	50.8	48.2	50.0	48.0	46.0	44.3	9.01
23	53.2	50.9	48.6	46.1	47.8	45.9	44.0	42.4	9.85
24	51.0	48.8	46.5	44.2	45.8	44.0	42.1	40.6	10.73
25	48.9	46.8	44.7	42.4	44.0	42.2	40.5	39.0	11.64
26	47.1	45.0	43.0	40.8	42.3	40.6	38.9	37.5	12.59
27	45.3	43.3	41.4	39.3	40.7	39.1	37.5	36.1	13.57
28	43.7	41.8	39.9	37.9	39.3	37.7	36.1	34.8	14.60
29	42.2	40.4	38.5	36.6	37.9	36.4	34.9	33.6	15.66
30	40.8	39.0	37.2	35.4					16.76
31	39.5	37.8	36.0	34.2					17.89
32	38.2	36.6	34.9	33.1					19.07
33	37.1	35.5	33.8	32.1					20.28
34	36.0	34.4	32.9	31.2					21.53
35	35.0	33.4	31.9	30.3					22.81

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM
18″
15″
DATA

Notation	Nominal Depth and Flange Width—Weight per Foot							
	B 4 18″ x 6″				B 6 15″ x 6″			
	70 Lbs.	65 Lbs.	60 Lbs.	54.7 Lbs.	75 Lbs.	70 Lbs.	65 Lbs.	60.8 Lbs.
ELEMENTS								
I_{1-1}	917.5	877.7	837.8	795.5	687.2	659.6	632.1	609.0
S_{1-1}	101.9	97.5	93.1	88.4	91.6	87.9	84.3	81.2
I_{2-2}	24.5	23.4	22.3	21.2	30.6	28.8	27.2	26.0
S_{2-2}	7.8	7.6	7.3	7.1	9.8	9.3	8.9	8.7
DIMENSIONS AND GAGES IN INCHES								
d	18	18	18	18	15	15	15	15
b	6¼	6⅛	6⅛	6	6¼	6⅛	6⅛	6
t	¾	⅝	9/16	½	⅞	13/16	11/16	⅝
p	11/16	11/16	11/16	11/16	13/16	13/16	13/16	13/16
a	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2¾
Grip	11/16	11/16	11/16	11/16	13/16	13/16	13/16	13/16
f	15¼	15¼	15¼	15¼	11¾	11¾	11¾	11¾
o	1⅜	1⅜	1⅜	1⅜	1⅝	1⅝	1⅝	1⅝
g usual	3½	3½	3½	3½	3½	3½	3½	3½
g_2	2¾	2¾	2¾	2¾	3	3	3	3
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	153	146	140	133	137	132	126	122
V max	154	136	118	99	156	139	121	106
L min	3.98	4.31	4.73	5.34	3.52	3.81	4.18	4.59
fb	15000	15000	15000	14340	15000	15000	15000	15000
fbt	10665	9435	8205	6595	13020	11550	10080	8850
B min	9.90	9.90	9.90	10.56	8.25	8.25	8.25	8.25
R max	85	75	66	53	94	84	73	64
RA	65	65	58	48	65	65	65	62
LRA	9.41	9.00	9.63	11.05	8.46	8.11	7.78	7.86
Wt.CA	21	21	21	21	21	21	21	21
RH	130	130	115	97	130	130	130	124
LRH	4.70	4.50	4.86	5.47	4.23	4.06	3.89	3.93
Wt.CH	30	30	30	30	30	30	30	30
Q	1223	1170	1117	1061	1099	1055	1012	974

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
R max = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA,LRH = Min. Span in Feet to develop RA or RH.
Wt.CA,CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
15″
12″
LOADS

BEAMS

AMERICAN STANDARD

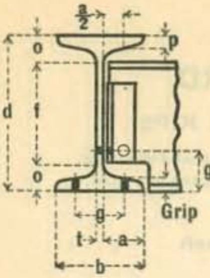
ALLOWABLE UNIFORM LOADS IN KIPS

**Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.**

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	B 7 15″ x 5½″				B 8 12″ x 5¼″				B 9 12″ x 5″		Coefficient of Deflection
	55 Lbs.	50 Lbs.	45 Lbs.	42.9 Lbs.	55 Lbs.	50 Lbs.	45 Lbs.	40.8 Lbs.	35 Lbs.	31.8 Lbs.	
					233.3						
3	233.3	198.0			212.9	197.9	162.7		123.3		0.17
4	203.5	192.5	162.7	147.6	159.7	150.8	142.0	132.5	113.5	100.8	0.30
5	162.8	154.0	145.1	141.4	127.7	120.7	113.6	107.6	90.8	86.3	0.47
6	135.7	128.3	120.9	117.8	106.5	100.5	94.7	89.7	75.7	71.9	0.67
7	116.3	110.0	103.6	101.0	91.3	86.2	81.2	76.8	64.9	61.7	0.91
8	101.7	96.2	90.7	88.4	79.8	75.4	71.0	67.2	56.8	54.0	1.19
9	90.4	85.5	80.6	78.5	71.0	67.0	63.1	59.8	50.5	48.0	1.51
10	81.4	77.0	72.6	70.7	63.9	60.3	56.8	53.8	45.4	43.2	1.86
11	74.0	70.0	66.0	64.3	58.1	54.8	51.6	48.9	41.3	39.2	2.25
12	67.8	64.2	60.5	58.9	53.2	50.3	47.3	44.8	37.8	36.0	2.68
13	62.6	59.2	55.8	54.4	49.1	46.4	43.7	41.4	34.9	33.2	3.15
14	58.1	55.0	51.8	50.5	45.6	43.1	40.6	38.4	32.4	30.8	3.65
15	54.3	51.3	48.4	47.1	42.6	40.2	37.9	35.9	30.3	28.8	4.19
16	50.9	48.1	45.3	44.2	39.9	37.7	35.5	33.6	28.4	27.0	4.77
17	47.9	45.3	42.7	41.6	37.6	35.5	33.4	31.6	26.7	25.4	5.38
18	45.2	42.8	40.3	39.3	35.5	33.5	31.6	29.9	25.2	24.0	6.03
19	42.8	40.5	38.2	37.2	33.6	31.8	29.9	28.3	23.9	22.7	6.72
20	40.7	38.5	36.3	35.3	31.9	30.2	28.4	26.9	22.7	21.6	7.45
21	38.8	36.7	34.5	33.7	30.4	28.7	27.1	25.6	21.6	20.6	8.21
22	37.0	35.0	33.0	32.1	29.0	27.4	25.8	24.4	20.6	19.6	9.01
23	35.4	33.5	31.5	30.7	27.8	26.2	24.7	23.4	19.7	18.8	9.85
24	33.9	32.1	30.2	29.5	26.6	25.1	23.7	22.4	18.9	18.0	10.73
25	32.6	30.8	29.0	28.3							11.64
26	31.3	29.6	27.9	27.2							12.59
27	30.1	28.5	26.9	26.2							13.57
28	29.1	27.5	25.9	25.2							14.60
29	28.1	26.5	25.0	24.4							15.66

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM
15″
12″
DATA

Notation	Nominal Depth and Flange Width—Weight per Foot									
	B 7 15″ x 5½″				B 8 12″ x 5¼″				B 9 12″ x 5″	
	55 Lbs.	50 Lbs.	45 Lbs.	42.9 Lbs.	55 Lbs.	50 Lbs.	45 Lbs.	40.8 Lbs.	35 Lbs.	31.8 Lbs.
ELEMENTS										
I_{1-1}	508.7	481.1	453.6	441.8	319.3	301.6	284.1	268.9	227.0	215.8
S_{1-1}	67.8	64.2	60.5	58.9	53.2	50.3	47.3	44.8	37.8	36.0
I_{2-2}	17.0	16.0	15.0	14.6	17.3	16.0	14.8	13.8	10.0	9.5
S_{2-2}	5.9	5.7	5.4	5.3	6.2	5.8	5.5	5.3	3.9	3.8
DIMENSIONS AND GAGES IN INCHES										
d	15	15	15	15	12	12	12	12	12	12
b	5¾	5⅝	5½	5½	5⅝	5½	5⅜	5¼	5⅛	5
t	11/16	9/16	7/16	7/16	13/16	11/16	9/16	½	7/16	⅜
p	⅝	⅝	⅝	⅝	11/16	11/16	11/16	11/16	9/16	9/16
a	2½	2½	2½	2½	2⅜	2⅜	2⅜	2⅜	2⅜	2⅜
Grip	⅝	9/16	9/16	9/16	11/16	11/16	⅝	⅝	½	½
f	12½	12½	12½	12½	9⅜	9⅜	9⅜	9⅜	9¾	9¾
o	1¼	1¼	1¼	1¼	1 5/16	1 5/16	1 5/16	1 5/16	1⅛	1⅛
g usual	3½	3½	3½	3½	3	3	3	3	3	3
g_2	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2½	2½
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	102	96	91	88	80	75	71	67	57	54
V max	117	99	81	74	117	99	81	66	62	50
L min	3.49	3.89	4.46	4.79	2.74	3.05	3.49	4.06	3.68	4.28
fb	15000	15000	15000	14720	15000	15000	15000	15000	15000	15000
fbt	9720	8250	6780	6035	12150	10305	8475	6900	6420	5250
B min	8.25	8.25	8.25	8.48	6.60	6.60	6.60	6.60	6.60	6.60
R max	70	60	49	44	79	67	55	45	42	34
RA	65	58	47	43	49	49	45	36	34	28
LRA	6.26	6.64	7.72	8.22	6.51	6.16	6.31	7.47	6.67	7.71
Wt.CA	21	21	21	21	15	15	15	15	15	15
RH	130	116	95	86	97	97	89	72	67	55
LRH	3.13	3.32	3.82	4.11	3.29	3.11	3.19	3.73	3.39	3.93
Wt.CH	30	30	30	30	22	22	22	22	30	30
Q	814	770	726	707	638	604	568	538	454	432

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
10″
8″
LOADS

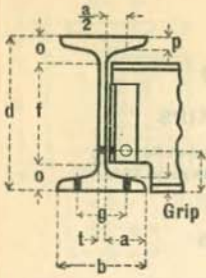
BEAMS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: B 10 10″ x 4⅝″				B 12 8″ x 4″				Coefficient of Deflection
	40 Lbs.	35 Lbs.	30 Lbs.	25.4 Lbs.	25.5 Lbs.	23 Lbs.	20.5 Lbs.	18.4 Lbs.	
	177.8	142.6	107.3		102.1	84.7	67.0		
3	126.4	116.6	106.8	74.4	68.1	64.2	60.2	51.8	0.17
4	94.8	87.5	80.1	73.3	51.0	48.1	45.2	42.7	0.30
5	75.8	70.0	64.1	58.6	40.8	38.5	36.1	34.1	0.47
6	63.2	58.3	53.4	48.8	34.0	32.1	30.1	28.4	0.67
7	54.2	50.0	45.8	41.9	29.2	27.5	25.8	24.4	0.91
8	47.4	43.7	40.1	36.6	25.5	24.1	22.6	21.3	1.19
9	42.1	38.9	35.6	32.6	22.7	21.4	20.1	19.0	1.51
10	37.9	35.0	32.0	29.3	20.4	19.3	18.1	17.1	1.86
11	34.5	31.8	29.1	26.6	18.6	17.5	16.4	15.5	2.25
12	31.6	29.2	26.7	24.4	17.0	16.0	15.1	14.2	2.68
13	29.2	26.9	24.6	22.5	15.7	14.8	13.9	13.1	3.15
14	27.1	25.0	22.9	20.9	14.6	13.7	12.9	12.2	3.65
15	25.3	23.3	21.4	19.5	13.6	12.8	12.0	11.4	4.19
16	23.7	21.9	20.0	18.3	12.8	12.0	11.3	10.7	4.77
17	22.3	20.6	18.8	17.2	12.0	11.3	10.6	10.0	5.38
18	21.1	19.4	17.8	16.3					6.03
19	20.0	18.4	16.9	15.4					6.72
20	19.0	17.5	16.0	14.7					7.45

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM 10″ 8″ DATA

Notation	Nominal Depth and Flange Width—Weight per Foot							
	B 10 10″ x 4 5/8″				B 12 8″ x 4″			
	40 Lbs.	35 Lbs.	30 Lbs.	25.4 Lbs.	25.5 Lbs.	23 Lbs.	20.5 Lbs.	18.4 Lbs.
ELEMENTS								
I_{1-1}	158.0	145.8	133.5	122.1	68.1	64.2	60.2	56.9
S_{1-1}	31.6	29.2	26.7	24.4	17.0	16.0	15.1	14.2
I_{2-2}	9.4	8.5	7.6	6.9	4.7	4.4	4.0	3.8
S_{2-2}	3.7	3.4	3.2	3.0	2.2	2.1	2.0	1.9
DIMENSIONS AND GAGES IN INCHES								
d	10	10	10	10	8	8	8	8
b	5 1/8	5	4 3/4	4 5/8	4 1/4	4 1/8	4 1/8	4
t	3/4	5/8	7/16	5/16	9/16	7/16	3/8	5/16
p	1/2	1/2	1/2	1/2	7/16	7/16	7/16	7/16
a	2 1/8	2 1/8	2 1/8	2 1/8	1 7/8	1 7/8	1 7/8	1 7/8
Grip	1/2	1/2	1/2	1/2	7/16	7/16	7/16	7/16
f	8	8	8	8	6 1/4	6 1/4	6 1/4	6 1/4
o	1	1	1	1	7/8	7/8	7/8	7/8
g usual	2 3/4	2 3/4	2 3/4	2 3/4	2 1/4	2 1/4	2 1/4	2 1/4
g_2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/4	2 1/4	2 1/4	2 1/4
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	47	44	40	37	26	24	23	21
V max	89	71	54	37	51	42	34	26
L min	2.13	2.45	2.99	3.94	2.00	2.27	2.70	3.29
fb	15000	15000	15000	15000	15000	15000	15000	15000
fbt	11115	8910	6705	4650	7980	6615	5235	4050
B min	5.50	5.50	5.50	5.50	4.40	4.40	4.40	4.40
R max	67	53	40	28	44	36	29	22
RA	65	62	47	33	56	46	37	28
LRA	2.92	2.83	3.41	4.44	1.82	2.09	2.45	3.04
Wt.CA	15	15	15	15	15	15	15	15
Wt.CH	30	30	30	30				
Q	379	350	320	293	204	192	181	170

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
RH = Max. Value of Shop Rivets in Kips in one Connection Series H. See page of Connections.
Rivet Values in Outstanding Legs must be investigated.
LRA, LRH = Min. Span in Feet to develop RA or RH.
Wt.CA, CH = Weight in pounds of one Connection Series A or H, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

BEAM
7″
6″
LOADS

BEAMS

AMERICAN STANDARD

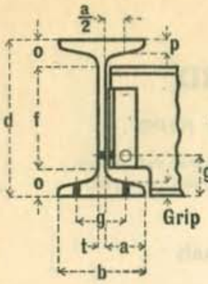
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot								Coefficient of Deflection
	B 13 7″ x 3⅝″			*B 42 Ⓒ7″ x 3½″	B 14 6″ x 3⅜″			*B 41 Ⓒ6″ x 3″	
	20 Lbs.	17.5 Lbs.	15.3 Lbs.	12 Lbs.	17.25 Lbs.	14.75 Lbs.	12.5 Lbs.	10 Lbs.	
	75.6				67.0	49.4			
2	71.9	58.0	42.0	31.6	52.0	47.6	33.1	27.1	0.07
3	47.9	44.5	41.4	31.5	34.7	31.8	29.0	23.6	0.17
4	36.0	33.4	31.1	25.5	26.0	23.8	21.8	17.7	0.30
5	28.8	26.7	24.8	20.4	20.8	19.1	17.4	14.2	0.47
6	24.0	22.3	20.7	17.0	17.3	15.9	14.5	11.8	0.67
7	20.5	19.1	17.7	14.6	14.9	13.6	12.4	10.1	0.91
8	18.0	16.7	15.5	12.8	13.0	11.9	10.9	8.9	1.19
9	16.0	14.8	13.8	11.3	11.6	10.6	9.7	7.9	1.51
10	14.4	13.4	12.4	10.2	10.4	9.5	8.7	7.1	1.86
11	13.1	12.1	11.3	9.3	9.5	8.7	7.9	6.4	2.25
12	12.0	11.1	10.4	8.5	8.7	7.9	7.3	5.9	2.68
13	11.1	10.3	9.6	7.8	8.0	7.3	6.7	5.4	3.15
14	10.3	9.5	8.9	7.3					3.65
15	9.6	8.9	8.3	6.8					4.19

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.
*Standard Mill Section, not American Standard.



BEAMS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

BEAM I 7" 6" DATA

Notation	Nominal Depth and Flange Width—Weight per Foot							
	B 13 7" x 3 5/8"			*B 42 [C] 7" x 3 1/2"	B 14 6" x 3 3/8"			*B 41 [C] 6" x 3"
	20 Lbs.	17.5 Lbs.	15.3 Lbs.	12 Lbs.	17.25 Lbs.	14.75 Lbs.	12.5 Lbs.	10 Lbs.
ELEMENTS								
I_{1-1}	41.9	38.9	36.2	29.8	26.0	23.8	21.8	17.8
S_{1-1}	12.0	11.1	10.4	8.5	8.7	7.9	7.3	5.9
I_{2-2}	3.1	2.9	2.7	2.1	2.3	2.1	1.8	1.3
S_{2-2}	1.6	1.6	1.5	1.18	1.3	1.2	1.1	0.85
DIMENSIONS AND GAGES IN INCHES								
d	7	7	7	7	6	6	6	6
b	3 7/8	3 3/4	3 5/8	3 1/2	3 5/8	3 1/2	3 3/8	3
t	7/16	3/8	1/4	3/16	1/2	3/8	1/4	3/16
p	3/8	3/8	3/8	5/16	3/8	3/8	3/8	5/16
a	1 3/4	1 3/4	1 3/4	1 5/8	1 1/2	1 1/2	1 1/2	1 3/8
Grip	3/8	3/8	3/8	5/16	3/8	3/8	5/16	5/16
f	5 3/8	5 3/8	5 3/8	5 3/4	4 1/2	4 1/2	4 1/2	4 3/4
o	5/16	5/16	5/16	5/8	3/4	3/4	3/4	5/8
g usual	2 1/4	2 1/4	2 1/4	2	2	2	2	1 3/4
g_2	2	2	2	1 7/8	2	2	2	1 7/8
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.								
M max	18	17	16	13	13	12	11	9.0
V max	38	29	21	16	33	25	17	14.0
L min	1.90	2.30	2.96	3.23	1.55	1.93	2.63	2.62
fb	15000	15000	15000	14620	15000	15000	15000	15000
fbt	6750	5175	3750	2750	6975	5145	3450	2820
B min	3.85	3.85	3.85	4.00	3.30	3.30	3.30	3.30
R max	35	27	20	14	35	26	17	14
RA	24	18	13	9	24	18	12	9
LRA	3.00	3.70	4.80	1.52	2.18	2.63	3.65	1.69
Wt.CA	8	8	8	8	8	8	8	8
Q	144	133	125	102	104	95	88	71

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

*Standard Mill Section, not American Standard.

BEAM
5″
4″
3″
LOADS

BEAMS

AMERICAN STANDARD

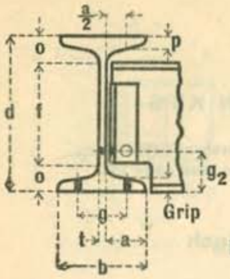
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot: B 15 5″ x 3″			B 16 4″ x 2⅝″				B 17 3″ x 2⅜″			Coefficient of Deflection
	14.75 Lbs.	12.25 Lbs.	10 Lbs.	10.5 Lbs.	9.5 Lbs.	8.5 Lbs.	7.7 Lbs.	7.5 Lbs.	6.5 Lbs.	5.7 Lbs.	
								25.1			
1	59.3	41.6		38.4	31.3	24.3	18.2	23.1	18.1	12.2	0.02
2	36.1	32.4	25.2	21.3	20.1	18.9	17.9	11.5	10.7	9.9	0.07
3	24.1	21.6	19.3	14.2	13.4	12.6	11.9	7.7	7.1	6.6	0.17
4	18.1	16.2	14.5	10.6	10.0	9.5	8.9	5.8	5.3	5.0	0.30
5	14.4	13.0	11.6	8.5	8.0	7.6	7.2	4.6	4.3	4.0	0.47
6	12.0	10.8	9.7	7.1	6.7	6.3	6.0	3.9	3.6	3.3	0.67
7	10.3	9.3	8.3	6.1	5.7	5.4	5.1	3.3	3.0	2.8	0.91
8	9.0	8.1	7.3	5.3	5.0	4.7	4.5	2.9	2.7	2.5	1.19
9	8.0	7.2	6.4	4.7	4.5	4.2	4.0				1.51
10	7.2	6.5	5.8	4.3	4.0	3.8	3.6				1.86
11	6.6	5.9	5.3								2.25

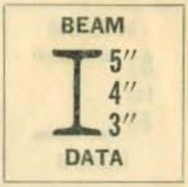
Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



BEAMS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch



Notation	Nominal Depth and Flange Width—Weight per Foot									
	B 15 5" x 3"			B 16 4" x 2 5/8"				B 17 3" x 2 3/8"		
	14.75 Lbs.	12.25 Lbs.	10.0 Lbs.	10.5 Lbs.	9.5 Lbs.	8.5 Lbs.	7.7 Lbs.	7.5 Lbs.	6.5 Lbs.	5.7 Lbs.
ELEMENTS										
I_{1-1}	15.0	13.5	12.1	7.1	6.7	6.3	6.0	2.9	2.7	2.5
S_{1-1}	6.0	5.4	4.8	3.5	3.3	3.2	3.0	1.9	1.8	1.7
I_{2-2}	1.7	1.4	1.2	1.0	0.91	0.83	0.77	0.59	0.51	0.46
S_{2-2}	1.0	0.91	0.82	0.70	0.65	0.61	0.58	0.47	0.43	0.40
DIMENSIONS AND GAGES IN INCHES										
d	5	5	5	4	4	4	4	3	3	3
b	3 1/4	3 1/8	3	2 7/8	2 3/4	2 3/4	2 5/8	2 1/2	2 3/8	2 3/8
t	1/2	3/8	1/4	7/16	5/16	1/4	3/16	3/8	1/4	3/16
p	5/16	5/16	5/16	5/16	5/16	5/16	5/16	1/4	1/4	1/4
a	1 3/8	1 3/8	1 3/8	1 1/4	1 1/4	1 1/4	1 1/4	1 1/8	1 1/8	1 1/8
Grip	5/16	5/16	5/16	5/16	5/16	5/16	5/16	1/4	1/4	1/4
f	3 5/8	3 5/8	3 5/8	2 3/4	2 3/4	2 3/4	2 3/4	1 7/8	1 7/8	1 7/8
o	11/16	11/16	11/16	5/8	5/8	5/8	5/8	9/16	9/16	9/16
g usual	1 3/4	1 3/4	1 3/4	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
g_2	2	2	2	2	2	2	2			
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	9.0	8.1	7.2	5.3	5.0	4.8	4.5	2.9	2.7	2.6
V max	30	21	13	19	16	12	9.1	13	9.0	6.1
L min	1.22	1.56	2.30	1.11	1.28	1.56	1.96	0.92	1.18	1.62
fb	15000	15000	15000	15000	15000	15000	15000	15000	15000	15000
fbt	7410	5205	3150	6000	4890	3795	2850	5235	3765	2550
B min	2.75	2.75	2.75	2.20	2.20	2.20	2.20	1.65	1.65	1.65
R max	35	25	15	27	22	17	13	22	16	11
RA	26	18	11							
LRA	1.38	1.80	2.62							
Wt.CA	8	8	8							
Q	72	65	58	42	40	38	36	23	22	20

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square incl
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when $B = 3\frac{1}{2}''$.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength $= 12\ S_{1-1}$.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

H-BEAM
8″
to
4″
LOADS

H-BEAMS

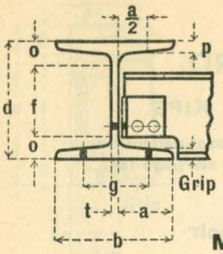
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot									Coefficient of Deflection
	H 4 8″ x 8″			H 3A 6″ x 6″		H 3 6″ x 6″		H 2 5″ x 5″	H 1 4″ x 4″	
	37.7 Lbs.	34.3 Lbs.	32.6 Lbs.	27.5 Lbs.	25 Lbs.	22.5 Lbs.	20 Lbs.	18.9 Lbs.	13.8 Lbs.	
									30.0	
3	96.0			63.1		54.0		37.6	21.2	0.17
4	90.6	72.0		49.3	45.1	41.0	36.0	28.5	15.9	0.30
5	72.5	69.4	60.1	39.4	37.6	32.8	31.0	22.8	12.7	0.47
6	60.4	57.8	56.4	32.9	31.4	27.4	25.9	19.0	10.6	0.67
7	51.8	49.5	48.3	28.2	26.9	23.4	22.2	16.3	9.1	0.91
8	45.3	43.4	42.3	24.6	23.5	20.5	19.4	14.3	8.0	1.19
9	40.3	38.5	37.6	21.9	20.9	18.2	17.2	12.7	7.1	1.51
10	36.2	34.7	33.8	19.7	18.8	16.4	15.5	11.4	6.4	1.86
11	32.9	31.5	30.8	17.9	17.1	14.9	14.1	10.4		2.25
12	30.2	28.9	28.2	16.4	15.7	13.7	12.9			2.68
13	27.9	26.7	26.0	15.2	14.5	12.6	11.9			3.15
14	25.9	24.8	24.2							3.65
15	24.2	23.1	22.6							4.19
16	22.7	21.7	21.2							4.77
17	21.3	20.4	19.9							5.38

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



H-BEAMS

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

Notation	Nominal Depth and Flange Width—Weight per Foot								
	H 4 8" x 8"			H 3A 6" x 6"		H 3 6" x 6"		H 2 5" x 5"	H 1 4" x 4"
	37.7 Lbs.	34.3 Lbs.	32.6 Lbs.	27.5 Lbs.	25 Lbs.	22.5 Lbs.	20 Lbs.	18.9 Lbs.	13.8 Lbs.
ELEMENTS									
I_{1-1}	120.8	115.5	112.8	49.3	47.0	41.0	38.8	23.8	10.7
S_{1-1}	30.2	28.9	28.2	16.4	15.7	13.7	12.9	9.5	5.3
I_{2-2}	36.9	35.1	34.2	16.0	14.9	12.2	11.4	7.8	3.6
S_{2-2}	9.1	8.8	8.6	5.3	5.0	4.0	3.8	3.1	1.8
DIMENSIONS AND GAGES IN INCHES									
d	8	8	8	6	6	6	6	5	4
b	8⅛	8	7 15/16	6 1/16	5 15/16	6 1/16	5 15/16	5	4
t	½	⅜	5/16	7/16	5/16	⅜	¼	5/16	5/16
p	7/16	7/16	7/16	½	½	⅜	⅜	7/16	⅜
a	3 13/16	3 13/16	3 13/16	2 13/16	2 13/16	2⅞	2⅞	2⅜	1⅞
Grip	7/16	7/16	7/16	½	½	⅜	⅜	7/16	⅜
f	6¼	6¼	6¼	4¼	4¼	4⅜	4⅜	3⅜	2½
o	⅞	⅞	⅞	⅞	⅞	13/16	13/16	13/16	¾
g usual	5	5	5	3½	3½	3½	3½	2¾	2¼
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.									
M max	45	43	42	25	24	21	19	14	8
V max	48	36	30	32	23	27	18	19	15
L min	3.78	4.82	5.63	3.12	4.18	3.04	4.30	3.04	2.12
fb	15000	15000	15000	15000	15000	15000	15000	15000	15000
fbt	7500	5625	4695	6570	4695	5625	3750	4695	4695
B min	4.40	4.40	4.40	3.30	3.30	3.30	3.30	2.75	2.20
R max	41	31	26	33	23	28	19	22	21
RA	53	39	33	23	16	20	13	16	
LRA	3.42	4.45	5.13	4.28	5.89	4.11	5.95	3.56	
Wt.CA	15	15	15	8	8	8	8	8	
Q	362	347	338	197	188	164	155	114	64

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

CHANNEL
18″
15″
LOADS

CHANNELS

AMERICAN STANDARD

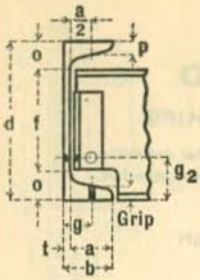
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection. For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot										Coefficient of Deflection
	*C 60 18″ x 4″				C 1 15″ x 3⅜″						
	58.0 Lbs.	51.9 Lbs.	45.8 Lbs.	42.7 Lbs.	55 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	35 Lbs.	33.9 Lbs.	
	302.4				293.0	257.8	222.5	187.2			
3	298.1	259.2	216.0	194.4	228.8	214.2	199.4	184.7	151.9	144.0	0.17
4	223.6	207.4	191.2	183.1	171.6	160.7	149.5	138.5	127.5	125.0	0.30
5	178.9	165.9	152.9	146.5	137.3	128.5	119.6	110.8	102.0	100.0	0.47
6	149.1	138.3	127.5	122.1	114.4	107.1	99.7	92.4	85.0	83.4	0.67
7	127.8	118.5	109.2	104.6	98.1	91.8	85.5	79.2	72.9	71.4	0.91
8	111.8	103.7	95.6	91.5	85.8	80.3	74.8	69.3	63.7	62.5	1.19
9	99.4	92.2	85.0	81.4	76.3	71.4	66.5	61.6	56.7	55.6	1.51
10	89.4	83.0	76.5	73.2	68.6	64.3	59.8	55.4	51.0	50.0	1.86
11	81.3	75.4	69.5	66.6	62.4	58.4	54.4	50.4	46.4	45.5	2.25
12	74.5	69.1	63.7	61.0	57.2	53.6	49.8	46.2	42.5	41.7	2.68
13	68.8	63.8	58.8	56.3	52.8	49.4	46.0	42.6	39.2	38.5	3.15
14	63.9	59.3	54.6	52.3	49.0	45.9	42.7	39.6	36.4	35.7	3.65
15	59.6	55.3	51.0	48.8	45.8	42.8	39.9	36.9	34.0	33.3	4.19
16	55.9	51.8	47.8	45.8	42.9	40.2	37.4	34.6	31.9	31.3	4.77
17	52.6	48.8	45.0	43.1	40.4	37.8	35.2	32.6	30.0	29.4	5.38
18	49.7	46.1	42.5	40.7	38.1	35.7	33.2	30.8	28.3	27.8	6.03
19	47.1	43.7	40.2	38.5	36.1	33.8	31.5	29.2	26.8	26.3	6.72
20	44.7	41.5	38.2	36.6	34.3	32.1	29.9	27.7	25.5	25.0	7.45
21	42.6	39.5	36.4	34.9	32.7	30.6	28.5	26.4	24.3	23.8	8.21
22	40.7	37.7	34.8	33.3	31.2	29.2	27.2	25.2	23.2	22.7	9.01
23	38.9	36.1	33.2	31.8	29.8	27.9	26.0	24.1	22.2	21.7	9.85
24	37.3	34.6	31.9	30.5	28.6	26.8	24.9	23.1	21.2	20.8	10.73
25	35.8	33.2	30.6	29.3	27.5	25.7	23.9	22.2	20.4	20.0	11.64
26	34.4	31.9	29.4	28.2	26.4	24.7	23.0	21.3	19.6	19.2	12.59
27	33.1	30.7	28.3	27.1	25.4	23.8	22.2	20.5	18.9	18.5	13.57
28	31.9	29.6	27.3	26.2	24.5	23.0	21.4	19.8	18.2	17.9	14.60
29	30.8	28.6	26.4	25.3	23.7	22.2	20.6	19.1	17.6	17.2	15.66
30	29.8	27.7	25.5	24.4							16.76
31	28.8	26.8	24.7	23.6							17.89
32	28.0	25.9	23.9	22.9							19.07
33	27.1	25.1	23.2	22.2							20.28
34	26.3	24.4	22.5	21.5							21.53
35	25.5	23.7	21.8	20.9							22.81

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.
*C 60-18″ Channel, is a Ship Building Channel, not American Standard.



CHANNELS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL 18″ 15″ DATA

Notation	Nominal Depth and Flange Width—Weight per Foot									
	⊠*C 60 18″ x 4″				C 1 15″ x 3⅜″					
	58 Lbs.	51.9 Lbs.	45.8 Lbs.	42.7 Lbs.	55 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	35 Lbs.	33.9 Lbs.
ELEMENTS										
I_{1-1}	670.7	622.1	573.5	549.2	429.0	401.4	373.9	346.3	318.7	312.6
S_{1-1}	74.5	69.1	63.7	61.0	57.2	53.6	49.8	46.2	42.5	41.7
I_{2-2}	18.5	17.1	15.8	15.0	12.1	11.2	10.3	9.3	8.4	8.2
S_{2-2}	5.6	5.3	5.1	4.9	4.1	3.8	3.6	3.4	3.2	3.2
DIMENSIONS AND GAGES IN INCHES										
d	18	18	18	18	15	15	15	15	15	15
b	4¼	4⅛	4	4	3⅞	3¾	3⅝	3½	3⅜	3⅜
t	11/16	⅝	½	7/16	11/16	¾	⅝	9/16	7/16	7/16
p	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝
a	3½	3½	3½	3½	3	3	3	3	3	3
Grip	⅝	⅝	⅝	⅝	11/16	⅝	⅝	⅝	⅝	⅝
f	15⅜	15⅜	15⅜	15⅜	12⅜	12⅜	12⅜	12⅜	12⅜	12⅜
o	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16
g usual	2½	2½	2½	2½	2¼	2¼	2¼	2	2	2
g_2	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2¾	2¾
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	112	104	96	92	86	80	75	69	64	63
V max	151	130	108	97	147	129	111	94	76	72
L min	2.96	3.20	3.54	3.77	2.34	2.50	2.69	2.96	3.36	3.48
fb	15000	15000	14800	14210	15000	15000	15000	15000	14870	14580
fbt	10500	9000	7400	6395	12210	10740	9270	7800	6275	5835
B min	9.90	9.90	10.09	10.70	8.25	8.25	8.25	8.25	8.36	8.59
R max	84	72	59	51	89	78	67	57	45	42
RA	65	63	53	47	65	65	65	55	44	42
LRA	6.88	6.58	7.21	7.79	5.28	4.95	4.60	5.04	5.80	5.96
Wt.CA	21	21	21	21	21	21	21	21	21	21
Q	894	829	764	732	686	643	598	554	510	500

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.
*C 60—18″, is a Ship Building Channel, not American Standard.

CHANNEL
13″
12″
LOADS

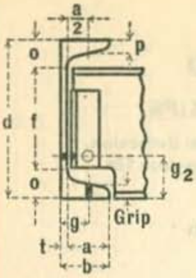
CHANNELS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot											Coefficient of Deflection
	C 13″ x 4″						C 12″ x 3″					
	50 Lbs.	45 Lbs.	40 Lbs.	37 Lbs.	35 Lbs.	31.8 Lbs.	40 Lbs.	35 Lbs.	30 Lbs.	25 Lbs.	20.7 Lbs.	
							217.4	182.0				
2	245.5	210.0	174.7				196.5	178.8	146.9	111.5		0.07
3	192.6	179.7	167.0	153.5	139.5	117.0	131.0	119.2	107.5	95.7	80.6	0.17
4	144.4	134.8	125.2	119.5	115.7	109.6	98.3	89.4	80.6	71.8	64.1	0.30
5	115.5	107.8	100.2	95.6	92.6	87.7	78.6	71.5	64.5	57.4	51.2	0.47
6	96.3	89.9	83.5	79.7	77.1	73.1	65.5	59.6	53.7	47.8	42.7	0.67
7	82.5	77.0	71.6	68.3	66.1	62.6	56.2	51.1	46.1	41.0	36.6	0.91
8	72.2	67.4	62.6	59.7	57.8	54.8	49.1	44.7	40.3	35.9	32.0	1.19
9	64.2	59.9	55.7	53.1	51.4	48.7	43.7	39.7	35.8	31.9	28.5	1.51
10	57.8	53.9	50.1	47.8	46.3	43.8	39.3	35.8	32.2	28.7	25.6	1.86
11	52.5	49.0	45.5	43.5	42.1	39.9	35.7	32.5	29.3	26.1	23.3	2.25
12	48.1	44.9	41.7	39.8	38.6	36.5	32.8	29.8	26.9	23.9	21.4	2.68
13	44.4	41.5	38.5	36.8	35.6	33.7	30.2	27.5	24.8	22.1	19.7	3.15
14	41.3	38.5	35.8	34.1	33.1	31.3	28.1	25.5	23.0	20.5	18.3	3.65
15	38.5	35.9	33.4	31.9	30.9	29.2	26.2	23.8	21.5	19.1	17.1	4.19
16	36.1	33.7	31.3	29.9	28.9	27.4	24.6	22.3	20.2	17.9	16.0	4.77
17	34.0	31.7	29.5	28.1	27.2	25.8	23.1	21.0	19.0	16.9	15.1	5.38
18	32.1	30.0	27.8	26.6	25.7	24.4	21.8	19.9	17.9	15.9	14.2	6.03
19	30.4	28.4	26.4	25.2	24.4	23.1	20.7	18.8	17.0	15.1	13.5	6.72
20	28.9	27.0	25.0	23.9	23.1	21.9	19.7	17.9	16.1	14.4	12.8	7.45
21	27.5	25.7	23.9	22.8	22.0	20.9	18.7	17.0	15.4	13.7	12.2	8.21
22	26.3	24.5	22.8	21.7	21.0	19.9	17.9	16.3	14.7	13.0	11.6	9.01
23	25.1	23.4	21.8	20.8	20.1	19.1	17.1	15.5	14.0	12.5	11.1	9.85
24	24.1	22.5	20.9	19.9	19.3	18.3	16.4	14.9	13.4	12.0	10.7	10.73
25	23.1	21.6	20.0	19.1	18.5	17.5						11.64
26	22.2	20.7	19.3	18.4	17.8	16.9						12.59

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CHANNELS

AMERICAN STANDARD

ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL 13″ 12″ DATA

Notation	Nominal Depth and Flange Width—Weight per Foot: C 20 13″ x 4″						C 2 12″ x 3″				
	50 Lbs.	45 Lbs.	40 Lbs.	37 Lbs.	35 Lbs.	31.8 Lbs.	40 Lbs.	35 Lbs.	30 Lbs.	25 Lbs.	20.7 Lbs.
ELEMENTS											
I_{1-1}	312.9	292.0	271.4	258.9	250.7	237.5	196.5	178.8	161.2	143.5	128.1
S_{1-1}	48.1	44.9	41.7	39.8	38.6	36.5	32.8	29.8	26.9	23.9	21.4
I_{2-2}	16.7	15.3	13.9	13.0	12.5	11.6	6.6	5.9	5.2	4.5	3.9
S_{2-2}	4.9	4.6	4.3	4.2	4.0	3.9	2.5	2.3	2.1	1.9	1.7
DIMENSIONS AND GAGES IN INCHES											
d	13	13	13	13	13	13	12	12	12	12	12
b	4⅜	4¼	4⅛	4⅛	4⅛	4	3⅜	3¼	3⅛	3	3
t	13/16	11/16	9/16	½	7/16	⅜	¾	⅝	½	⅜	5/16
p	⅝	⅝	⅝	⅝	⅝	⅝	½	½	½	½	½
a	3⅝	3⅝	3⅝	3⅝	3⅝	3⅝	2⅝	2⅝	2⅝	2⅝	2⅝
Grip	⅝	⅝	9/16	9/16	9/16	9/16	½	½	½	½	½
f	10⅜	10⅜	10⅜	10⅜	10⅜	10⅜	9⅞	9⅞	9⅞	9⅞	9⅞
o	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
g usual	2½	2½	2½	2½	2½	2½	2	2	1¾	1¾	1¾
g_2	2¾	2¾	2¾	2¾	2¾	2¾	2½	2½	2½	2½	2½
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.											
M max	72	67	63	60	58	55	49	45	40	36	32
V max	123	105	87	77	70	59	109	91	73	56	40
L min	2.35	2.57	2.86	3.11	3.32	3.74	1.81	1.97	2.20	2.57	3.19
fb	15000	15000	15000	15000	15000	15000	15000	15000	15000	15000	13780
fbt	11805	10095	8400	7380	6705	5625	11325	9480	7650	5805	3860
B min	7.15	7.15	7.15	7.15	7.15	7.15	6.60	6.60	6.60	6.60	7.45
R max	80	68	57	50	45	38	74	62	50	38	25
RA	49	49	44	39	35	30	49	49	40	30	22
LRA	5.89	5.50	5.69	6.12	6.62	7.30	4.02	3.65	4.04	4.78	5.84
Wt.CA	15	15	15	15	15	15	15	15	15	15	15
Q	577	539	500	478	463	438	394	358	323	287	257

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet

CHANNEL
10" 9"
LOADS

CHANNELS

AMERICAN STANDARD

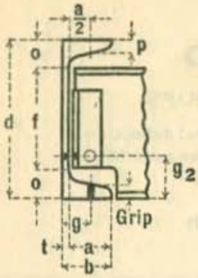
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot									Coefficient of Deflection
	C 3 10" x 2⅝"					C 4 9" x 2½"				
	35 Lbs.	30 Lbs.	25 Lbs.	20 Lbs.	15.3 Lbs.	25 Lbs.	20 Lbs.	15 Lbs.	13.4 Lbs.	
	196.8	161.5	126.2			132.2	96.8			
2	138.3	123.6	108.9	91.0	57.6	94.0	80.8	61.6	49.7	0.07
3	92.2	82.4	72.6	62.8	53.5	62.7	53.8	45.0	42.1	0.17
4	69.1	61.8	54.4	47.1	40.1	47.0	40.4	33.8	31.5	0.30
5	55.3	49.4	43.5	37.7	32.1	37.6	32.3	27.0	25.2	0.47
6	46.1	41.2	36.3	31.4	26.8	31.4	26.9	22.5	21.0	0.67
7	39.5	35.3	31.1	26.9	22.9	26.9	23.1	19.3	18.0	0.91
8	34.6	30.9	27.2	23.5	20.1	23.5	20.2	16.9	15.8	1.19
9	30.7	27.5	24.2	20.9	17.8	20.9	17.9	15.0	14.0	1.51
10	27.7	24.7	21.8	18.8	16.1	18.8	16.2	13.5	12.6	1.86
11	25.1	22.5	19.8	17.1	14.6	17.1	14.7	12.3	11.5	2.25
12	23.0	20.6	18.1	15.7	13.4	15.7	13.5	11.3	10.5	2.68
13	21.3	19.0	16.7	14.5	12.3	14.5	12.4	10.4	9.7	3.15
14	19.8	17.7	15.6	13.5	11.5	13.4	11.5	9.7	9.0	3.65
15	18.4	16.5	14.5	12.6	10.7	12.5	10.8	9.0	8.4	4.19
16	17.3	15.4	13.6	11.8	10.0	11.8	10.1	8.4	7.9	4.77
17	16.3	14.5	12.8	11.1	9.4	11.1	9.5	8.0	7.4	5.38
18	15.4	13.7	12.1	10.5	8.9	10.4	9.0	7.5	7.0	6.03
19	14.6	13.0	11.5	9.9	8.4	9.9	8.5	7.1	6.6	6.72
20	13.8	12.4	10.9	9.4	8.0					7.45

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CHANNELS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL 10" 9" DATA

Notation	C 3 10" x 2 5/8" 35 Lbs.	30 Lbs.	25 Lbs.	20 Lbs.	15.3 Lbs.	C 4 9" x 2 1/2" 25 Lbs.	20 Lbs.	15 Lbs.	13.4 Lbs.
ELEMENTS									
I_{1-1}	115.2	103.0	90.7	78.5	66.9	70.5	60.6	50.7	47.3
S_{1-1}	23.0	20.6	18.1	15.7	13.4	15.7	13.5	11.3	10.5
I_{2-2}	4.6	4.0	3.4	2.8	2.3	3.0	2.4	1.9	1.8
S_{2-2}	1.9	1.7	1.5	1.3	1.2	1.4	1.2	1.0	0.97
DIMENSIONS AND GAGES IN INCHES									
d	10	10	10	10	10	9	9	9	9
b	3 1/8	3	2 7/8	2 3/4	2 5/8	2 3/4	2 5/8	2 1/2	2 3/8
t	13/16	11/16	9/16	3/8	1/4	5/8	7/16	5/16	1/4
p	7/16	7/16	7/16	7/16	7/16	7/16	7/16	7/16	7/16
a	2 3/8	2 3/8	2 3/8	2 3/8	2 3/8	2 1/4	2 1/4	2 1/4	2 1/4
Grip	1/2	7/16	7/16	7/16	7/16	7/16	7/16	7/16	3/8
f	8 1/8	8 1/8	8 1/8	8 1/8	8 1/8	7 1/4	7 1/4	7 1/4	7 1/4
o	15/16	15/16	15/16	15/16	15/16	7/8	7/8	7/8	7/8
g usual	1 3/4	1 3/4	1 3/4	1 1/2	1 1/2	1 1/2	1 1/2	1 3/8	1 3/8
g_2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.									
M max	35	31	27	24	20	24	20	17	16
V max	98	81	63	45	28	66	48	31	25
L min	1.40	1.53	1.72	2.07	2.79	1.43	1.67	2.20	2.54
fb	15000	15000	15000	15000	13960	15000	15000	15000	14340
fbt	12300	10095	7890	5685	3350	9180	6720	4275	3300
B min	5.50	5.50	5.50	5.50	6.10	4.95	4.95	4.95	5.28
R max	74	61	47	34	20	53	39	25	19
RA	65	65	55	40	25	64	47	30	24
LRA	2.12	1.90	1.97	2.36	3.22	1.47	1.72	2.26	2.63
Wt.CA	15	15	15	15	15	15	15	15	15
Q	276	247	217	188	161	188	162	136	126

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3 1/2".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

CHANNEL
8″
7″
LOADS

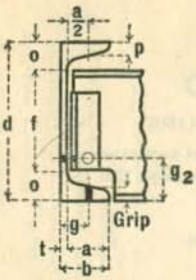
CHANNELS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot										Coefficient of Deflection
	C 5 8″ x 2¼″					C 6 7″ x 2⅛″					
	21.25 Lbs.	18.75 Lbs.	16.25 Lbs.	13.75 Lbs.	11.5 Lbs.	19.75 Lbs.	17.25 Lbs.	14.75 Lbs.	12.25 Lbs.	9.8 Lbs.	
	111.2	93.5	75.8	58.2		105.7	88.0	70.4	52.8		
2	71.4	65.5	59.7	53.8	42.2	56.7	51.5	46.4	41.2	35.3	0.07
3	47.6	43.7	39.8	35.8	32.3	37.8	34.3	30.9	27.5	24.1	0.17
4	35.7	32.8	29.8	26.9	24.2	28.3	25.8	23.2	20.6	18.1	0.30
5	28.6	26.2	23.9	21.5	19.4	22.7	20.6	18.6	16.5	14.5	0.47
6	23.8	21.9	19.9	17.9	16.2	18.9	17.2	15.5	13.7	12.0	0.67
7	20.4	18.7	17.0	15.4	13.8	16.2	14.7	13.3	11.8	10.3	0.91
8	17.9	16.4	14.9	13.4	12.1	14.2	12.9	11.6	10.3	9.0	1.19
9	15.9	14.6	13.3	11.9	10.8	12.6	11.4	10.3	9.2	8.0	1.51
10	14.3	13.1	11.9	10.8	9.7	11.3	10.3	9.3	8.2	7.2	1.86
11	13.0	11.9	10.8	9.8	8.8	10.3	9.4	8.4	7.5	6.6	2.25
12	11.9	10.9	9.9	9.0	8.1	9.4	8.6	7.7	6.9	6.0	2.68
13	11.0	10.1	9.2	8.3	7.5	8.7	7.9	7.1	6.3	5.6	3.15
14	10.2	9.4	8.5	7.7	6.9	8.1	7.4	6.6	5.9	5.2	3.65
15	9.5	8.7	8.0	7.2	6.5	7.6	6.9	6.2	5.5	4.8	4.19
16	8.9	8.2	7.5	6.7	6.1						4.77
17	8.4	7.7	7.0	6.3	5.7						5.38

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CHANNELS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL 8" 7" DATA

Notation	Nominal Depth and Flange Width—Weight per Foot									
	C 5 8" x 2 1/4"					C 6 7" x 2 1/8"				
	21.25 Lbs.	18.75 Lbs.	16.25 Lbs.	13.75 Lbs.	11.5 Lbs.	19.75 Lbs.	17.25 Lbs.	14.75 Lbs.	12.25 Lbs.	9.8 Lbs.
ELEMENTS										
I_{1-1}	47.6	43.7	39.8	35.8	32.3	33.1	30.1	27.1	24.1	21.1
S_{1-1}	11.9	10.9	9.9	9.0	8.1	9.4	8.6	7.7	6.9	6.0
I_{2-2}	2.2	2.0	1.8	1.5	1.3	1.8	1.6	1.4	1.2	0.98
S_{2-2}	1.1	1.0	0.94	0.86	0.79	0.96	0.86	0.79	0.71	0.63
DIMENSIONS AND GAGES IN INCHES										
d	8	8	8	8	8	7	7	7	7	7
b	2 5/8	2 1/2	2 3/8	2 3/8	2 1/4	2 1/2	2 3/8	2 1/4	2 1/4	2 1/8
t	5/8	1/2	7/16	5/16	1/4	5/8	9/16	7/16	5/16	1/4
p	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
a	2	2	2	2	2	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8
Grip	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
f	6 3/8	6 3/8	6 3/8	6 3/8	6 3/8	5 3/8	5 3/8	5 3/8	5 3/8	5 3/8
o	13/16	13/16	13/16	13/16	13/16	13/16	13/16	13/16	13/16	13/16
g usual	1 1/2	1 1/2	1 1/2	1 3/8	1 3/8	1 1/2	1 1/2	1 1/4	1 1/4	1 1/4
g_2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2	2	2	2	2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.										
M max	18	16	15	14	12	14	13	12	10	9.0
V max	56	47	38	29	21	53	44	35	26	18
L min	1.29	1.40	1.57	1.86	2.30	1.07	1.17	1.31	1.57	2.04
fb	15000	15000	15000	15000	14750	15000	15000	15000	15000	15000
fbt	8685	7305	5925	4545	3245	9435	7860	6285	4710	3150
B min	4.40	4.40	4.40	4.40	4.51	3.85	3.85	3.85	3.85	3.85
R max	48	40	33	25	18	50	41	33	25	17
RA	61	51	41	32	23	32	28	22	16	11
LRA	1.17	1.28	1.45	1.69	2.11	1.76	1.84	2.10	2.59	3.27
Wt.CA	15	15	15	15	15	8	8	8	8	8
Q	143	131	119	108	97	113	103	92	83	72

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B min = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3 1/2".
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections.
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

CHANNEL
6″
5″
LOADS

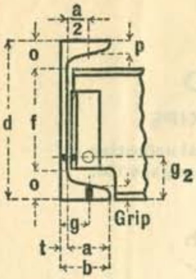
CHANNELS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot							Coefficient of Deflection
	C 7 6″ x 1⅞″				C 8 5″ x 1¾″			
	15.5 Lbs.	13 Lbs.	10.5 Lbs.	8.2 Lbs.	11.5 Lbs.	9 Lbs.	6.7 Lbs.	
	80.5				56.6			
1	77.8	62.9	45.2	28.8	49.7	39.0	22.8	0.02
2	38.9	34.5	30.1	26.0	24.8	21.2	17.8	0.07
3	25.9	23.0	20.1	17.3	16.6	14.1	11.9	0.17
4	19.5	17.3	15.1	13.0	12.4	10.6	8.9	0.30
5	15.6	13.8	12.0	10.4	9.9	8.5	7.1	0.47
6	13.0	11.5	10.0	8.7	8.3	7.1	5.9	0.67
7	11.1	9.9	8.6	7.4	7.1	6.0	5.1	0.91
8	9.7	8.6	7.5	6.5	6.2	5.3	4.4	1.19
9	8.6	7.7	6.7	5.8	5.5	4.7	4.0	1.51
10	7.8	6.9	6.0	5.2	5.0	4.2	3.6	1.86
11	7.1	6.3	5.5	4.7	4.5	3.8	3.2	2.25
12	6.5	5.8	5.0	4.3				2.68
13	6.0	5.3	4.6	4.0				3.15

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CHANNELS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL 6″ 5″ DATA

Notation	Nominal Depth and Flange Width—Weight per Foot						
	C 7 6″ x 1 7/8″				C 8 5″ x 1 3/4″		
	15.5 Lbs.	13 Lbs.	10.5 Lbs.	8.2 Lbs.	11.5 Lbs.	9 Lbs.	6.7 Lbs.
ELEMENTS							
I_{1-1}	19.5	17.3	15.1	13.0	10.4	8.8	7.4
S_{1-1}	6.5	5.8	5.0	4.3	4.1	3.5	3.0
I_{2-2}	1.3	1.1	0.87	0.70	0.82	0.64	0.48
S_{2-2}	0.73	0.65	0.57	0.50	0.54	0.45	0.38
DIMENSIONS AND GAGES IN INCHES							
d	6	6	6	6	5	5	5
b	2 1/4	2 1/8	2	1 7/8	2	1 7/8	1 3/4
t	9/16	7/16	5/16	3/16	1/2	5/16	3/16
p	3/8	3/8	3/8	3/8	5/16	5/16	5/16
a	1 3/4	1 3/4	1 3/4	1 3/4	1 1/2	1 1/2	1 1/2
Grip	3/8	3/8	3/8	5/16	5/16	5/16	5/16
f	4 1/2	4 1/2	4 1/2	4 1/2	3 5/8	3 5/8	3 5/8
o	3/4	3/4	3/4	3/4	11/16	11/16	11/16
g usual	1 3/8	1 3/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
g_2	2	2	2	2	2	2	2
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.							
M max	9.8	8.7	7.5	6.5	6.2	5.3	4.5
V max	40	31	23	14	28	20	11
L min	0.97	1.11	1.33	1.79	0.87	1.08	1.58
fb	15000	15000	15000	15000	15000	15000	15000
fbt	8385	6555	4710	3000	7080	4875	2850
B min	3.30	3.30	3.30	3.30	2.75	2.75	2.75
R max	42	33	24	15	34	23	14
RA	29	23	16	11	25	17	10
LRA	1.34	1.51	1.88	2.35	0.98	1.24	1.80
Wt.CA	8	8	8	8	8	8	8
Q	78	70	60	52	49	42	36

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
Bmin = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3 1/2″.
RA = Max. Value of Shop Rivets in Kips in one Connection Series A. See page of Connections
LRA = Min. Span in feet to develop RA.
Wt.CA = Weight in pounds of one Connection Series A, including Web Rivets.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

CHANNEL
4″ [3″
LOADS

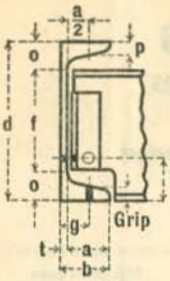
CHANNELS
AMERICAN STANDARD
ALLOWABLE UNIFORM LOADS IN KIPS

Applicable only when sections are braced against lateral deflection.
For unbraced sections safe loads must be reduced, see page 184.

Maximum Bending Stress 18 Kips per Square Inch

Span in Feet	Nominal Depth and Flange Width—Weight per Foot						Coefficient of Deflection
	C 9 4″ x 1⅝″			C 10 3″ x 1⅜″			
	7.25 Lbs.	6.25 Lbs.	5.4 Lbs.	6 Lbs.	5 Lbs.	4.1 Lbs.	
	30.7			25.6	18.6		
1	27.3	23.7	17.3	16.4	14.7	12.2	0.02
2	13.6	12.5	11.4	8.2	7.3	6.5	0.07
3	9.1	8.3	7.6	5.5	4.9	4.4	0.17
4	6.8	6.2	5.7	4.1	3.7	3.3	0.30
5	5.5	5.0	4.6	3.3	2.9	2.6	0.47
6	4.5	4.2	3.8	2.7	2.4	2.2	0.67
7	3.9	3.6	3.3	2.3	2.1	1.9	0.91
8	3.4	3.1	2.8	2.1	1.8	1.6	1.19
9	3.0	2.8	2.5				1.51
10	2.7	2.5	2.3				1.86

Loads above upper horizontal lines will produce maximum allowable shear in webs.
Loads below lower horizontal lines will produce excessive deflections.



CHANNELS
AMERICAN STANDARD
ESSENTIAL DATA

Maximum Shear 12 Kips per Square Inch

Maximum Bending Stress 18 Kips per Square Inch

CHANNEL
4″
3″
DATA

Notation	Nominal Depth and Flange Width—Weight per Foot					
	C 9 4″ x 1⅝″			C 10 3″ x 1⅜″		
	7.25 Lbs.	6.25 Lbs.	5.4 Lbs.	6 Lbs.	5 Lbs.	4.1 Lbs.
ELEMENTS						
I_{1-1}	4.5	4.1	3.8	2.1	1.8	1.6
S_{1-1}	2.3	2.1	1.9	1.4	1.2	1.1
I_{2-2}	0.44	0.38	0.32	0.31	0.25	0.20
S_{2-2}	0.35	0.32	0.29	0.27	0.24	0.21
DIMENSIONS AND GAGES IN INCHES						
d	4	4	4	3	3	3
b	1¾	1⅝	1⅝	1⅝	1½	1⅜
t	5/16	¼	3/16	⅜	¼	3/16
p	5/16	5/16	5/16	¼	¼	¼
a	1⅜	1⅜	1⅜	1¼	1¼	1¼
Grip	5/16	5/16	¼	5/16	¼	¼
f	2¾	2¾	2¾	1¾	1¾	1¾
o	⅝	⅝	⅝	⅝	⅝	⅝
g usual	1	1	1	⅞	⅞	⅞
g_2	2	2	2			
MAXIMUM BENDING MOMENTS, WEB RESISTANCES, ETC.						
M max	3.5	3.2	2.9	2.1	1.8	1.7
V max	15	12	8.6	13	9.3	6.1
L min	0.90	1.06	1.32	0.66	0.78	1.08
fb	15000	15000	15000	15000	15000	15000
fbt	4800	3705	2700	5340	3870	2550
B min	2.20	2.20	2.20	1.65	1.65	1.65
R max	22	17	12	23	16	11
Q	28	25	23	17	14	13

Mmax = Max. Bending Moment in Foot-Kips. Vmax = Max. Web Shear in Kips.
Lmin = Min. Span in feet to develop Vmax.
fb = Allowable Unit Stress for Web Buckling in pounds per square inch.
fbt = Value of Web in Buckling per inch of length, in pounds.
B = Min. End Bearing in inches to develop Vmax.
Rmax = Max. End Reaction in Kips when B = 3½″.
Q = Coefficient of Strength = 12 S_{1-1}.
To obtain safe uniformly distributed load in Kips, divide Q by the required span in feet.

ANGLE

LOADS

UNEQUAL ANGLES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Shorter Leg

Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 260 x Deflection	
		Safe Load	Safe Load	Length, Feet
8 x 6	1 1/8	201.60	10.61	19.0
	1 1/16	190.80	10.04	19.0
	1	181.32	9.47	19.2
	15/16	171.24	8.91	19.2
	7/8	160.92	8.34	19.3
	13/16	150.60	7.77	19.4
	3/4	140.04	7.19	19.5
	11/16	129.24	6.61	19.5
	5/8	118.44	6.03	19.6
	9/16	107.40	5.45	19.7
	1/2	96.24	4.86	19.8
	7/16	84.84	4.27	19.9
8 x 4	1	169.20	9.56	17.7
	15/16	159.60	8.97	17.8
	7/8	150.00	8.38	17.9
	13/16	140.40	7.80	18.0
	3/4	130.80	7.23	18.1
	11/16	120.00	6.59	18.2
	5/8	110.40	6.07	18.2
	9/16	100.80	5.51	18.3
	1/2	90.00	4.89	18.4
	7/16	79.20	4.28	18.5
7 x 4	1	129.60	8.20	15.8
	15/16	123.60	7.82	15.8
	7/8	116.40	7.32	15.9
	13/16	108.00	6.75	16.0
	3/4	100.80	6.26	16.1
	11/16	93.60	5.81	16.1
	5/8	85.20	5.23	16.3
	9/16	78.00	4.79	16.3
	1/2	69.60	4.24	16.4
	7/16	61.20	3.71	16.5
	3/8	52.80	3.18	16.6

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
6 x 4	1	96.24	7.02	13.7
	15/16	91.08	6.59	13.8
	7/8	85.80	6.18	13.9
	13/16	80.40	5.76	14.0
	3/4	75.00	5.35	14.0
	11/16	69.36	4.92	14.1
	5/8	63.72	4.49	14.2
	9/16	57.96	4.06	14.3
	1/2	52.08	3.63	14.4
	7/16	45.96	3.18	14.5
	3/8	39.84	2.74	14.5
6 x 3 1/2	1	93.96	7.02	13.4
	15/16	88.92	6.61	13.5
	7/8	83.76	6.19	13.5
	13/16	78.60	5.78	13.6
	3/4	73.20	5.35	13.7
	11/16	67.80	4.92	13.8
	5/8	62.28	4.49	13.9
	9/16	56.64	4.07	13.9
	1/2	50.88	3.63	14.0
	7/16	45.00	3.19	14.1
	3/8	39.00	2.75	14.2
	5/16	32.88	2.30	14.3
5 x 3 1/2	7/8	58.56	5.10	11.5
	13/16	54.96	4.75	11.6
	3/4	51.36	4.41	11.6
	11/16	47.64	4.06	11.7
	5/8	43.80	3.71	11.8
	9/16	39.84	3.35	11.9
	1/2	35.88	3.00	12.0
	7/16	31.68	2.63	12.1
	3/8	27.48	2.26	12.1
	5/16	23.28	1.91	12.2
5 x 3	13/16	53.40	4.75	11.2
	3/4	49.92	4.41	11.3
	11/16	46.32	4.07	11.4
	5/8	42.60	3.72	11.5
	9/16	38.76	3.35	11.6
	1/2	34.92	3.00	11.6
	7/16	30.96	2.64	11.7
	3/8	26.88	2.28	11.8
	5/16	22.68	1.91	11.9

ANGLE
LOADS

UNEQUAL ANGLES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Shorter Leg

Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
4 x 3½	13/16	35.04	3.71	9.5
	3/4	33.00	3.47	9.5
	11/16	30.72	3.20	9.6
	5/8	28.20	2.91	9.7
	9/16	25.80	2.64	9.8
	1/2	23.16	2.35	9.9
	7/16	20.64	2.08	9.9
	3/8	18.00	1.80	10.0
	5/16	15.12	1.50	10.1
4 x 3	13/16	34.44	3.76	9.2
	3/4	32.16	3.48	9.2
	11/16	29.88	3.20	9.3
	5/8	27.60	2.93	9.4
	9/16	25.20	2.66	9.5
	1/2	22.68	2.37	9.6
	7/16	20.16	2.08	9.7
	3/8	17.52	1.80	9.7
	5/16	14.76	1.51	9.8
	1/4	12.00	1.22	9.9
3½ x 3	13/16	26.40	3.25	8.1
	3/4	24.60	3.00	8.2
	11/16	22.92	2.77	8.3
	5/8	21.12	2.53	8.3
	9/16	19.32	2.30	8.4
	1/2	17.40	2.05	8.5
	7/16	15.48	1.80	8.6
	3/8	13.56	1.57	8.7
	5/16	11.52	1.32	8.7
	1/4	9.36	1.06	8.8
3½ x 2½	11/16	22.20	2.78	8.0
	5/8	20.52	2.55	8.1
	9/16	18.72	2.30	8.1
	1/2	16.92	2.06	8.2
	7/16	15.12	1.82	8.3
	3/8	13.20	1.57	8.4
	5/16	11.16	1.32	8.4
	1/4	9.00	1.05	8.6
3 x 2½	9/16	13.80	1.95	7.1
	1/2	12.48	1.74	7.2
	7/16	11.16	1.54	7.2
	3/8	9.72	1.33	7.3
	5/16	8.28	1.12	7.4
	1/4	6.72	0.90	7.5

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
3 x 2	1/2	12.00	1.75	6.9
	7/16	10.68	1.54	6.9
	3/8	9.36	1.33	7.0
	5/16	7.92	1.12	7.1
	1/4	6.48	0.90	7.2
2½ x 2	1/2	8.40	1.45	5.8
	7/16	7.56	1.28	5.9
	3/8	6.60	1.10	6.0
	5/16	5.64	0.93	6.1
	1/4	4.56	0.75	6.1
	3/16	3.48	0.56	6.2
	▣ 1/8	2.40	0.38	6.3
2½ x 1½	5/16	5.28	0.92	5.7
	1/4	4.32	0.75	5.8
	3/16	3.36	0.57	5.9
2¼ x 1½ ▣	1/2	6.48	1.30	5.0
	7/16	5.76	1.13	5.1
	3/8	5.04	0.98	5.2
	5/16	4.32	0.83	5.2
	1/4	3.60	0.68	5.3
	3/16	2.76	0.51	5.4
2 x 1½	3/8	4.08	0.88	4.6
	5/16	3.48	0.74	4.7
	1/4	2.88	0.60	4.8
	3/16	2.16	0.44	4.9
	1/8	1.50	0.30	4.9
2 x 1¼ ▣	1/4	2.75	0.60	4.6
	3/16	2.12	0.45	4.7
1¾ x 1¼	1/4	2.11	0.51	4.1
	3/16	1.64	0.39	4.2
	1/8	1.13	0.27	4.3
1½ x 1¼ ▣	5/16	1.92	0.55	3.5
	1/4	1.56	0.44	3.6
	3/16	1.21	0.33	3.7

ANGLE

LOADS

UNEQUAL ANGLES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Longer Leg

Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
8 x 6	1⅛	118.80	7.71	15.4
	1 1/16	112.80	7.28	15.5
	1	107.04	6.87	15.6
	15/16	101.16	6.47	15.6
	⅞	95.28	6.06	15.7
	13/16	89.28	5.65	15.8
	¾	83.16	5.23	15.9
	11/16	76.92	4.82	16.0
	⅝	70.56	4.40	16.0
	9/16	64.08	3.98	16.1
	½	57.48	3.55	16.2
	7/16	50.76	3.12	16.3
8 x 4	1	46.80	4.42	10.6
	15/16	44.40	4.15	10.7
	⅞	42.00	3.93	10.7
	13/16	39.60	3.67	10.8
	¾	37.20	3.41	10.9
	11/16	33.60	3.05	11.0
	⅝	31.20	2.81	11.1
	9/16	28.80	2.57	11.2
	½	26.40	2.36	11.2
	7/16	22.80	2.02	11.3
7 x 4	1	46.80	4.50	10.4
	15/16	44.40	4.23	10.5
	⅞	42.00	3.96	10.6
	13/16	38.40	3.62	10.6
	¾	36.00	3.36	10.7
	11/16	33.60	3.11	10.8
	⅝	31.20	2.86	10.9
	9/16	28.80	2.62	11.0
	½	25.20	2.29	11.0
	7/16	22.80	2.05	11.1
	⅜	19.20	1.71	11.2
6 x 4	1	45.48	4.49	10.1
	15/16	43.08	4.21	10.2
	⅞	40.68	3.95	10.3
	13/16	38.16	3.68	10.4
	¾	35.64	3.41	10.5
	11/16	33.12	3.14	10.5
	⅝	30.48	2.87	10.6
	9/16	27.72	2.59	10.7
	½	24.96	2.32	10.8
	7/16	22.20	2.04	10.9
	⅜	19.20	1.75	11.0
6 x 3½	1	34.80	3.91	8.9
	15/16	32.88	3.66	9.0
	⅞	31.08	3.43	9.1
	13/16	29.16	3.19	9.1
	¾	27.24	2.96	9.2
	11/16	25.32	2.72	9.3
	⅝	23.28	2.48	9.4
	9/16	21.24	2.25	9.5
	½	19.08	2.00	9.6
	7/16	16.92	1.76	9.6
	⅜	14.76	1.51	9.7
	5/16	12.48	1.27	9.8
5 x 3½	⅞	30.24	3.43	8.8
	13/16	28.44	3.20	8.9
	¾	26.64	2.98	9.0
	11/16	24.72	2.73	9.1
	⅝	22.80	2.50	9.1
	9/16	20.76	2.26	9.2
	½	18.72	2.02	9.3
	7/16	16.68	1.78	9.4
	⅜	14.52	1.54	9.5
	5/16	12.24	1.29	9.5
5 x 3	13/16	20.88	2.73	7.7
	¾	19.56	2.53	7.7
	11/16	18.12	2.32	7.8
	⅝	16.68	2.12	7.9
	9/16	15.24	1.91	8.0
	½	13.80	1.71	8.1
	7/16	12.24	1.51	8.1
	⅜	10.68	1.30	8.2
	5/16	9.00	1.08	8.3

ANGLE

LOADS

UNEQUAL ANGLES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Longer Leg

Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
4 x 3½	13/16	27.60	3.22	8.6
	3/4	25.80	2.99	8.6
	11/16	24.00	2.76	8.7
	5/8	22.08	2.51	8.8
	9/16	20.16	2.27	8.9
	1/2	18.24	2.04	9.0
	7/16	16.20	1.80	9.0
	3/8	14.16	1.56	9.1
	5/16	12.00	1.31	9.2
4 x 3	13/16	20.16	2.74	7.4
	3/4	18.84	2.53	7.4
	11/16	17.52	2.32	7.6
	5/8	16.20	2.12	7.6
	9/16	14.76	1.92	7.7
	1/2	13.32	1.71	7.8
	7/16	11.88	1.51	7.9
	3/8	10.44	1.31	7.9
	5/16	8.88	1.11	8.0
	1/4	7.20	0.89	8.1
3½ x 3	13/16	19.80	2.74	7.2
	3/4	18.48	2.53	7.3
	11/16	17.28	2.34	7.4
	5/8	15.96	2.14	7.4
	9/16	14.52	1.93	7.5
	1/2	13.20	1.74	7.6
	7/16	11.76	1.53	7.7
	3/8	10.20	1.31	7.8
	5/16	8.64	1.10	7.8
	1/4	6.96	0.88	7.9
3½ x 2½	11/16	11.88	1.92	6.2
	5/8	11.04	1.76	6.3
	9/16	10.08	1.59	6.3
	1/2	9.12	1.42	6.4
	7/16	8.16	1.25	6.5
	3/8	7.08	1.07	6.6
	5/16	6.00	0.90	6.7
	1/4	4.92	0.73	6.8
3 x 2½	9/16	9.84	1.59	6.2
	1/2	8.88	1.42	6.3
	7/16	7.92	1.25	6.3
	3/8	6.96	1.08	6.4
	5/16	5.88	0.90	6.5
	1/4	4.80	0.73	6.6
3 x 2	1/2	5.64	1.11	5.1
	7/16	5.04	0.98	5.2
	3/8	4.44	0.85	5.2
	5/16	3.84	0.72	5.3
	1/4	3.00	0.58	5.4
2½ x 2	1/2	5.52	1.12	4.9
	7/16	4.92	0.98	5.0
	3/8	4.32	0.85	5.1
	5/16	3.72	0.72	5.2
	1/4	3.00	0.58	5.2
	3/16	2.40	0.45	5.3
	⊡ 1/8	1.62	0.30	5.4
2½ x 1½	5/16	2.04	0.52	3.9
	1/4	1.68	0.41	4.1
	3/16	1.32	0.32	4.1
2¼ x 1½ ⊡	1/2	3.12	0.85	3.7
	7/16	2.76	0.74	3.7
	3/8	2.40	0.63	3.8
	5/16	2.04	0.53	3.9
	1/4	1.68	0.42	4.0
	3/16	1.32	0.33	4.0
2 x 1½	3/8	2.40	0.65	3.7
	5/16	2.04	0.54	3.8
	1/4	1.68	0.43	3.9
	3/16	1.32	0.33	4.0
	1/8	0.90	0.22	4.0
2 x 1¼ ⊡	1/4	1.16	0.35	3.3
	3/16	0.90	0.27	3.4
1¾ x 1¼	1/4	1.14	0.35	3.2
	3/16	0.90	0.27	3.3
	1/8	0.62	0.19	3.4
1½ x 1¼ ⊡	5/16	1.36	0.45	3.0
	1/4	1.12	0.36	3.1
	3/16	0.88	0.27	3.2

ANGLE

LOADS

EQUAL ANGLES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Either Leg

Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
8 x 8	1 1/8	210.36	10.51	20.0
	1 1/16	200.04	9.96	20.1
	1	189.60	9.40	20.2
	15/16	179.04	8.84	20.2
	7/8	168.24	8.28	20.3
	13/16	157.32	7.71	20.4
	3/4	146.28	7.14	20.5
	11/16	135.00	6.56	20.6
	5/8	123.60	5.98	20.7
	9/16	112.08	5.41	20.7
	1/2	100.44	4.83	20.8
6 x 6	$\boxed{C}$ 1 1/16	108.36	7.37	14.7
	1	102.84	6.94	14.8
	15/16	97.32	6.54	14.9
	7/8	91.56	6.12	15.0
	13/16	85.80	5.70	15.0
	3/4	79.92	5.29	15.1
	11/16	74.04	4.87	15.2
	5/8	67.92	4.44	15.3
	9/16	61.68	4.02	15.4
	1/2	55.32	3.58	15.5
	7/16	48.84	3.14	15.5
	3/8	42.36	2.71	15.6
5 x 5	1	69.60	5.73	12.1
	15/16	65.88	5.39	12.2
	7/8	62.04	5.05	12.3
	13/16	58.20	4.71	12.4
	3/4	54.36	4.36	12.5
	11/16	50.40	4.02	12.5
	5/8	46.32	3.68	12.6
	9/16	42.12	3.32	12.7
	1/2	37.80	2.96	12.8
	7/16	33.48	2.61	12.9
	3/8	29.04	2.25	12.9
4 x 4	13/16	36.12	3.72	9.7
	3/4	33.72	3.45	9.8
	11/16	31.32	3.18	9.8
	5/8	28.80	2.91	9.9
	9/16	26.28	2.63	10.0
	1/2	23.64	2.34	10.1
	7/16	21.00	2.06	10.2
	3/8	18.24	1.78	10.2
	5/16	15.48	1.50	10.3
	1/4	12.60	1.21	10.4

Size, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
3 1/2 x 3 1/2	13/16	27.00	3.24	8.3
	3/4	25.32	3.01	8.4
	11/16	23.52	2.76	8.5
	5/8	21.72	2.53	8.6
	9/16	19.80	2.29	8.7
	1/2	17.88	2.05	8.7
	7/16	15.84	1.80	8.8
	3/8	13.80	1.55	8.9
	5/16	11.76	1.31	9.0
	1/4	9.48	1.05	9.1
3 x 3	5/8	15.60	2.16	7.2
	9/16	14.28	1.95	7.3
	1/2	12.84	1.73	7.4
	7/16	11.40	1.52	7.5
	3/8	9.96	1.32	7.6
	5/16	8.52	1.12	7.6
	1/4	6.96	0.90	7.7
2 1/2 x 2 1/2	1/2	8.76	1.45	6.1
	7/16	7.80	1.27	6.2
	3/8	6.84	1.10	6.2
	5/16	5.76	0.92	6.3
	1/4	4.68	0.74	6.4
	3/16	3.60	0.55	6.5
	1/8	2.40	0.37	6.6
2 x 2	7/16	4.80	1.00	4.8
	3/8	4.20	.86	4.9
	5/16	3.60	.72	5.0
	1/4	3.00	.59	5.1
	3/16	2.28	.45	5.1
	1/8	1.56	.30	5.2
1 3/4 x 1 3/4	5/16	2.76	.64	4.3
	1/4	2.28	.52	4.4
	3/16	1.68	.38	4.4
	1/8	1.20	.26	4.6
1 1/2 x 1 1/2	3/8	2.28	.64	3.5
	5/16	1.94	.54	3.6
	1/4	1.61	.44	3.7
	3/16	1.25	.33	3.8
	1/8	0.86	.22	3.9
1 1/4 x 1 1/4	5/16	1.31	.44	3.0
	1/4	1.09	.36	3.0
	3/16	0.85	.27	3.1
	1/8	0.59	.18	3.2
1 x 1	1/4	0.67	.28	2.4
	3/16	0.53	.22	2.4
	1/8	0.37	.15	2.5

TEES AND ZEES

ALLOWABLE UNIFORM LOAD IN KIPS

Neutral Axis Parallel to Flanges
Applicable only when sections are rigidly secured against lateral deflection

Maximum Bending Stress 18 Kips per Square Inch

LOADS

TEES

Size Flange x Stem, Inches	Weight per Foot, Pounds	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
© 6½ x 6½	19.8	59.40	3.50	17.0
4 x 4	13.5	24.24	2.40	10.1
4 x 4	10.5	18.96	1.85	10.3
Φ 3½ x 3½	11.7	18.0	2.05	8.8
Φ 3½ x 3½	9.2	14.4	1.62	8.9
3 x 3	7.8	10.32	1.36	7.6
3 x 3	6.7	8.88	1.16	7.7
2½ x 2½	6.4	7.08	1.14	6.2
2½ x 2½	5.5	6.00	0.95	6.3
2¼ x 2¼	4.9	4.92	0.88	5.6
2¼ x 2¼	4.1	3.84	0.67	5.7
2 x 2	4.3	3.72	0.75	5.0
2 x 2	3.56	3.12	0.62	5.0

Size Flange x Stem, Inches	Weight per Foot, Pounds	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
© 5 x 3⅛	13.6	13.55	1.60	8.5
© 5 x 3	11.5	12.75	1.59	8.0
4 x 5	15.3	37.56	3.05	12.3
4 x 5	11.9	29.16	2.33	12.5
© 4 x 4½	14.4	30.48	2.72	11.2
© 4 x 4½	11.2	23.76	2.08	11.4
4 x 3	9.2	10.80	1.36	7.9
© 4 x 3	7.8	9.24	1.15	8.1
© 4 x 2½	8.5	7.44	1.11	6.7
© 4 x 2½	7.2	6.36	0.94	6.8
3 x 2½	6.1	6.24	0.96	6.5
2½ x 3	6.1	8.64	1.16	7.4

ZEES

Size Depth x Flange, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
6⅛ x 3⅝	⅞	196.80	17.95	11.0
6 1/16 x 3 9/16	13/16	182.64	16.83	10.9
6 x 3½	¾	168.48	15.68	10.7
6⅛ x 3⅝	11/16	169.20	15.43	11.0
6 1/16 x 3 9/16	⅝	153.84	14.18	10.9
6 x 3½	9/16	138.60	12.91	10.7
6⅛ x 3⅝	½	134.64	12.28	11.0
6 1/16 x 3 9/16	7/16	117.96	10.87	10.9
6 x 3½	⅜	101.28	9.43	10.7
5⅛ x 3⅜	13/16	134.40	14.65	9.2
5 1/16 x 3 5/16	¾	124.08	13.69	9.1
5 x 3¼	11/16	113.64	12.70	9.0
5⅛ x 3⅜	⅝	114.84	12.52	9.2
5 1/16 x 3 5/16	9/16	103.44	11.42	9.1
5 x 3¼	½	92.16	10.30	9.0
5⅛ x 3⅜	7/16	89.28	9.73	9.2
5 1/16 x 3 5/16	⅜	76.68	8.46	9.1
5 x 3¼	5/16	64.08	7.16	9.0

Size Depth x Flange, Inches	Thickness, Inches	1 Foot Span	Maximum Span 360 x Deflection	
		Safe Load	Safe Load	Length, Feet
4⅛ x 3 3/16	¾	87.12	11.80	7.4
4 1/16 x 3⅛	11/16	79.80	10.97	7.3
4 x 3 1/16	⅝	72.60	10.14	7.2
4⅛ x 3 3/16	9/16	74.16	10.04	7.4
4 1/16 x 3⅛	½	66.00	9.08	7.3
4 x 3 1/16	7/16	57.96	8.10	7.2
4⅛ x 3 3/16	⅜	56.04	7.59	7.4
4 1/16 x 3⅛	5/16	46.92	6.45	7.3
4 x 3 1/16	¼	37.68	5.26	7.2
3 1/16 x 2¾	9/16	41.16	7.51	5.5
3 x 2 11/16	½	36.72	6.84	5.4
3 1/16 x 2¾	7/16	35.76	6.52	5.5
3 x 2 11/16	⅜	30.84	5.74	5.4
3 1/16 x 2¾	5/16	28.56	5.21	5.5
3 x 2 11/16	¼	23.04	4.29	5.4

PLATE AND ANGLE GIRDERS

Girders, built up of plates and angles, are used for heavy loads and long spans where rolled sections are insufficient.

Loads upon a plate and angle girder develop compressive and tensile stresses resisted by the upper and lower flanges respectively, and shearing stresses resisted by the web plate.

The most economical section is the single web girder; box girders with double or triple webs are used where great length of span combined with lateral stiffness are required.

WEB. The web plate governs the depth of the girder which, to avoid excessive deflection, should not be less than $\frac{1}{15}$ of the span. The thickness depends upon the shear which is greatest at the point of support and should not be less than $\frac{1}{160}$ of the unsupported distance between the flanges; the web is reinforced by stiffeners at intervals to prevent buckling.

Web Shear and Stiffeners. Web plates subjected to direct vertical shear must resist buckling; the allowable vertical shear may be obtained from the table on page 274, based on a maximum shearing stress of 12000 pounds, giving allowable unit web shear, V/A, total vertical shear ÷ gross area of web, for various ratios of c/t, distance between flanges ÷ thickness of web.

Stiffeners are required at the ends and at points of concentrated loads and at other points where the clear distance between flange angles, **c**, exceeds allowable safe stresses obtained from table, and also where **c** is greater than 60 times the thickness of the web; stiffeners are generally in pairs, one on each side of the web, bearing closely against the projecting leg of the flange angles; the pitch of rivets in stiffeners should not exceed 6 inches.

FLANGES. The flange area is so proportioned that the maximum compressive or tensile unit stress, $f=\frac{n\,M}{I}$, when applied to the net section of the girder does not exceed the maximum allowable unit stress.

When the flanges are alike, as they usually are, the preliminary investigation is simplified by assuming that the stresses in them are uniformly distributed, and the resultants act at the center of gravity of the flanges.

A = Area of one flange d = Effective depth t = Web thickness

Total Moment of Resistance, $M = f\left(A\,d + \frac{d^2\,t}{6}\right) = f\,d\left(A + \frac{d\,t}{6}\right)$.

The net moment of resistance of the web plate, with allowance for reduction of area due to web splices is generally taken as $f\,\frac{d^2t}{8}$, or:

Net Moment of Resistance, $M = f\left(A\,d + \frac{d^2\,t}{8}\right) = f\,d\left(A + \frac{d\,t}{8}\right)$.

d is the approximate distance between centers of gravity of flange angles, or distance out to out of angles when flange plates are used.

The final design of the girder is obtained in accordance with the method given for the computation of compound sections.

Flange Plates. When the girder carries a uniformly distributed load, the flange areas vary as the ordinates of a parabola, and the theoretical length of the flange plate is

$$L_1 = L\sqrt{\frac{a_1}{A}} \qquad L_2 = L\sqrt{\frac{a_2}{A}} \qquad L_3 = L\sqrt{\frac{a_3}{A}}$$

L=Length of girder. A=Total Area of Flange.
L_1, L_2, L_3=Length of flange plates, beginning with outside plate.
a_1, a_2, a_3=Total area of flange plates, from outer to inner plates.

Sufficient length, usually from 12 to 18 inches, is added to each end of plate to take up the shear; the plate next to the flange angle is extended to full length of the girder, to resist lateral deflection.

EXAMPLE. Required the length of flange plates of a 60-inch girder, 60 feet long, the flange including flange angles, two flange plates and one-eighth of web plate; rivets ⅞" dia.

2—Angles	6" x 3½" x ½"	Net Area 9.00−2.00=7.00 sq. in.
1—Inner Flange Plate	14" x 7/16"	" " 6.13−0.87=5.26 "
1—Outer Flange Plate	14" x ⅜"	" " 5.25−0.75=4.50 "
⅛—Web Plate	60" x ⅜"	" " 2.81 =2.81 "
		19.57 sq. in.

Outer plate, $L_1 = 60\sqrt{\frac{4.50}{19.57}} = 28.8$ ft. say 32 ft. Inner plate, $L_2 = 60\sqrt{\frac{4.50+5.26}{19.57}} = 42.4$ ft. full length.

Maximum End and Flange Stress. In addition to a girder having sufficient flange area to resist the maximum bending moment, it must also be capable of withstanding stresses at the ends.

The end resistance of a riveted girder depends on: First, the resistance of the web plate to shearing; second, the resistance of the flange rivets to bearing, it being assumed that the bearing value of rivets does not exceed twice their value in single shear.

The difference in flange stress between any two points is the horizontal shear which is transmitted into the web by the flange rivets between those points; it can not be greater than the end reaction considered as distributed along the flange within a length equal to the distance, a, between rivet lines when there is one line in each flange. When there are two lines of rivets in the flanges the distance is measured midway between them.

Web Stress: $d \times t \times f$ = Maximum End Resistance if less than flange stress.
d = Depth. t = Thickness of web. f = Allowable unit shearing stress.

Flange Stress: $\frac{aR}{p}$ = Maximum End Resistance if less than Web stress.

a = Effective distance = $(d + \frac{1}{2}'') - 2 \times$ distance from back of angles, to rivet line or to point midway for two rivet lines.

R = Bearing value of one rivet. p = Minimum pitch between two rivets.

Required the maximum end resistance of a girder, properly stiffened at ends.

EXAMPLE 1. Girder composed of 1—Web Plate, 42″ x 5/16″
4—Flange Angles, 5″ x 3½″.

Web Stress: $42 \times \frac{5}{16} \times 12{,}000 = 157{,}500$ pounds.

Flange Rivets: $a = (42'' + \frac{1}{2}'') - 4\frac{1}{2}'' = 38''$; $38 \div 2\frac{3}{4} = 13$ Rivets.

Bearing value of ⅞″ dia. rivet: $\frac{7}{8} \times \frac{5}{16} \times 30{,}000 = 8{,}200$ pounds.

Flange Stress: $8{,}200 \times 13 = 106{,}600$ pounds = Maximum End Resistance.

EXAMPLE 2. Girder composed of 1—Web Plate, 48″ x ⅜″
4—Flange Angles, 6″ x 6″.

Web Stress: $48 \times \frac{3}{8} \times 12{,}000 = 216{,}000$ pounds = Maximum End Resistance.

Flange Rivets: $a = (48'' + \frac{1}{2}'') - 7'' = 41\frac{1}{2}''$; $41\frac{1}{2} \div 1\frac{3}{4} = 24$ Rivets.

Bearing value of ⅞″ dia. rivet: $\frac{7}{8} \times \frac{3}{8} \times 30{,}000 = 9{,}840$ pounds.

Flange Stress: $9{,}840 \times 24 = 236{,}160$ pounds.

Rivet Spacing in Flanges. It follows that the rivets connecting the web plate with the flange angles are required to transmit the horizontal shearing stress from the web to the flange, which horizontal shear in any panel is equal to the vertical shear at center of panel multiplied by its length and divided by the vertical distance, a.

As the shear increases from the point of greatest bending moment towards the supports, the number of rivets in vertical legs of the flange angles must also increase as the supports are approached.

Pitch of rivets in flange angles, $p = \frac{aR}{V}$

V = Total vertical shear at the panel under consideration.

R = Resistance of one rivet, i. e., the bearing or shearing value, whichever is smaller.

a = Effective distance between upper and lower lines of rivets.

The formula gives the theoretical rivet spacing for any point in the flanges due to the total shear, but in practice the pitch is computed from the maximum stress in each panel, in nearest ¼ inch.

EXAMPLE. A girder composed of 5″ x 3½″ angles and 36″ x 5/16″ web, 30 ft. long, divided into 3-foot panels, supports a uniformly distributed load of 72 tons, or 4,800 pounds per foot.

Required rivet pitch in panels, when distance between rivet lines = 32 inches.

	Shearing Stress, Pounds	Horizontal Stress, Pounds per Inch
Panel 1.	144,000 ÷ 2 = 72,000	72,000 ÷ 32 = 2,250
" 2.	72,000 — (4,800 x 3) = 57,600	57,600 ÷ 32 = 1,800
" 3.	72,000 — (4,800 x 6) = 43,200	43,200 ÷ 32 = 1,350
" 4.	72,000 — (4,800 x 9) = 28,800	28,800 ÷ 32 = 900

Bearing value of ⅞″ dia. rivet: $\frac{7}{8} \times \frac{5}{16} \times 30{,}000 = 8{,}200$ pounds.

Panel 1.	Rivet Pitch	8,200 ÷ 2,250 = 3.6	say 3½″ spacing
" 2.	" "	8,200 ÷ 1,800 = 4.5	" 4½″ "
" 3.	" "	8,200 ÷ 1,350 = 6.1	" 6″ maximum spacing
" 4.	" "	8,200 ÷ 900 = 9.1	" 6″ " "

When the load rests directly on the top or bottom flange, the rivets connecting this flange with the web plate are also required to distribute the load; then the resultant stress on rivets on the loaded flange is represented by the resultant of horizontal shear and vertical load.

EXAMPLE. Loads bearing directly on one flange only, then for first panel, in foregoing example:

Horizontal Shear 2,250 pounds per inch. Vertical Load 400 pounds per inch.

Resultant Stress $\sqrt{2{,}250^2 + 400^2} = 2{,}285$ pounds. Rivet Pitch $8{,}200 \div 2{,}285 = 3.58''$.

Flange Plates. At the end of each flange plate, sufficient rivets must be provided to transmit the allowable stress on the net section of the plate to the adjacent members.

EXAMPLE. Required number of rivets, ⅞″ dia., for 14″ x 7⁄16″ Inner flange plate.
14″ x 7⁄16″ Inner flange plate, net area: (6.13–.875) = 5.26 sq. in.
Resistance: 5.26 x 18,000 = 94,680 pounds.
Shearing value of ⅞″ dia. rivet: .6013 x 13,500 = 8,120 pounds.
94,680 ÷ 8,120 = 12 rivets, or:
Two lines of 6 rivets each end of plate, spaced 3 inches to 3½ inches.

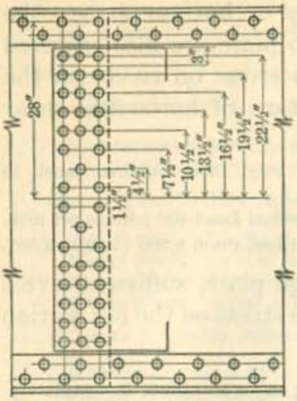
SPLICES. In long and deep girders or in girders made from stock lengths, it is often necessary to splice the web plate or also flange angles and plates.

The resistance of all splice plates must be such as to develop the full resisting strength of the rivets in the splice, especially when rivet stresses are to be transmitted through narrow plates.

Web Splices. As there is no vertical shearing stress in the middle of the girder under a uniformly distributed load, web splices are sometimes made at that point, but, generally, the web is spliced in two places equidistant from the center.

The rivets in the web splice must transmit the web stresses so that no additional stresses are imparted to the flange rivets.

The rivets are not equally stressed; the stress is zero at the neutral axis and increases uniformly to a maximum at extreme distance. The moment stress of each rivet is as its distance from neutral axis, and the moment of resistance as the square of its distance from neutral axis.



EXAMPLE:

Required the web splice in a 60-inch girder with ⅜ inch web plate capable of resisting the bending moment at 18,000 pounds fiber stress, one-eighth of the web area being considered as flange acting at the extreme edge of the plate. Concentrated load 125,000 pounds, 2 feet from center. Span 50 feet. Splice at center.

Each side of joint must be provided with enough rivets to resist;

a. The full shear at the splice acting vertically. The stress on each rivet is the total shear at splice ÷ number of rivets on each side of joint.

b. That portion of the bending moment which is taken by ⅛ of the web acting horizontally. The maximum stress is this value ÷ the Section Modulus of the rivet group.

$$
\begin{aligned}
6 \times 22.5^2 &= 3{,}038\\
6 \times 19.5^2 &= 2{,}281\\
6 \times 16.5^2 &= 1{,}633\\
6 \times 13.5^2 &= 1{,}093\\
6 \times 10.5^2 &= 661\\
4 \times 7.5^2 &= 225\\
2 \times 4.5^2 &= 41\\
4 \times 1.5^2 &= 9\\
I &= 8{,}981
\end{aligned}
$$

$$S = \frac{8{,}981}{22.5} = 399$$

The resultant of these two forces is the maximum stress on each rivet in extreme line of splice plate.

a. The shear at center = smaller end reaction

$$= \frac{125{,}000 \times 23}{50} = 57{,}500 \text{ lbs.}$$

The shear per rivet = 57,500 ÷ 40 = 1,438 lbs.

b. The Section Modulus of the rivet group for rivets of unit value = 399 in.^{3}.

Moment resisted by ⅛ of web = 60 x ⅜ x ⅛ x 60 x 18,000 = 3,037,500 inch-pounds

Stress per rivet = 3,037,500 ÷ 399 = 7,613 lbs.

Maximum in extreme line is $\sqrt{7{,}613^2 + 1{,}438^2} = 7{,}748$ lbs.

Maximum allowable stress per rivet is governed by bearing on ⅜" plate at 30,000 lbs. = 9,840 lbs. for ⅞" rivet at outside line in girder 28" from center.

Maximum value at extreme line of rivets in splice is $\frac{9{,}840 \times 22.5}{28} = 7{,}910$ lbs.

To determine thickness of splice plates

Stress in center of plate 22.5" from center of girder $= \frac{18{,}000 \times 22.5}{30} = 13{,}500$ pounds per square inch. Consider the moment carried by the extreme rivets to be resisted by the portion of the splice adjacent to these rivets. In this case the upper 3" of splice plates should develop the extreme row of rivets.

Horizontal stress in three extreme rivets is 7,613 x 3 = 22,839 lbs. and $\frac{22{,}839}{13{,}500} = 1.69$ square inches net.

$3'' - 1'' = 2''$, $\frac{1.69}{2 \times 2} = .42'' = \frac{7}{16}''$ = required thickness of splice plates.

GENERAL REQUIREMENTS FOR RIVETING

1. In proportioning rivets the nominal diameter of the rivet shall be used, and in deducting rivet holes they shall be taken $\frac{1}{8}$ inch greater than the nominal diameter of the rivets.

2. The minimum distance between centers of rivet holes shall be three diameters of the rivet, but the distance shall preferably be not less than:

$4\frac{1}{2}''$ for $1\frac{1}{4}''$ rivets	$3''$ for $\frac{7}{8}''$ rivets	$2''$ for $\frac{5}{8}''$ rivets
$4''$ " $1\frac{1}{8}''$ "	$2\frac{1}{2}''$ " $\frac{3}{4}''$ "	$1\frac{3}{4}''$ " $\frac{1}{2}''$ "
$3\frac{1}{2}''$ " $1''$ "		

3. The maximum pitch in the line of stress of compression members composed of plates and shapes shall not exceed 16 times the thinnest outside plate or shape, nor 20 times the thinnest enclosed plate with a maximum of 12 inches; at right angles to the direction of stress the distance between lines of rivets shall not exceed 30 times the thinnest plate or shape.

4. For angles in built-up sections with two gage lines, with rivets staggered, the maximum pitch in the line of stress in each gage line shall not exceed 24 times the thinnest plate, with a maximum of 18 inches.

5. The minimum distance from the center of any rivet hole to a sheared edge shall be:

$2\frac{1}{4}''$ for $1\frac{1}{4}''$ rivets	$1\frac{1}{2}''$ for $\frac{7}{8}''$ rivets	$1\frac{1}{8}''$ for $\frac{5}{8}''$ rivets
$2''$ " $1\frac{1}{8}''$ "	$1\frac{1}{4}''$ " $\frac{3}{4}''$ "	$1''$ " $\frac{1}{2}''$ "
$1\frac{3}{4}''$ " $1''$ "		

The maximum distance from any edge shall be 8 times the thickness of the plate.

6. The pitch of the rivets at the end of built-up compression members shall not exceed 4 times the diameter of the rivet for a length equal to $1\frac{1}{2}$ times the maximum width of the member.

ALLOWABLE WEB SHEAR, V/A

IN POUNDS PER SQUARE INCH

FOR VARIOUS RATIOS, c/t

Maximum Shearing Stress 12 Kips per Square Inch

c/t	V/A	c/t	V/A	c/t	V/A
60	12000	78	9756	96	7895
61	11868	79	9642	97	7803
62	11734	80	9529	98	7712
63	11604	81	9418	99	7623
64	11473	82	9308	100	7535
65	11343	83	9199	105	7111
66	11215	84	9091	110	6722
67	11087	85	8984	115	6345
68	10961	86	8880	120	6000
69	10835	87	8775	125	5676
70	10711	88	8672	130	5378
71	10587	89	8571	135	5097
72	10465	90	8471	140	4836
73	10344	91	8372	145	4592
74	10224	92	8274	150	4364
75	10105	93	8177	155	4151
76	9988	94	8082	160	3951
77	9871	95	7988		

V = Total vertical shear.
A = Gross area of web.
c = Distance between flanges.
t = Thickness of web.

PLATE AND ANGLE GIRDERS—APPROXIMATE DESIGN

In preliminary design of a symmetrical girder or in cases where extreme accuracy is not essential it is sufficient to base the transverse resistance of the section on the moment of inertia of the two flanges, obtained from the general formula:

$$M = f\frac{I}{n} = f\,A\,d, \qquad A = \frac{M}{f\,d}, \qquad 2\,A = \frac{2\,M}{f\,d}$$

where A is the area of either top or bottom flange, 2 A the combined area of top and bottom flange angles and plates, and d is the total depth of the girder.

The tables which follow give the moment of inertia of four flange angles and two flange plates of various sizes for depths of girders from 36 to 84 inches. Sizes not given can be obtained by interpolation of nearest values.

In proportioning the flange angles and plates it is desirable to allow at least one-third of the required flange area for flange angles.

The results correspond nearly to the net moment of inertia of the section, the omission of the section modulus of the web plate offsetting a reduction for rivet holes.

Example. Plate and Angle Girder, limited to a depth of 38½ inches, to resist a maximum bending moment of 1,000,000 foot-pounds, unit stress 18,000 pounds:

$$2\,A = \frac{2\,M}{f\,d} = \frac{2 \times 12 \times 1{,}000{,}000}{18{,}000 \times 38} = 35.1 \text{ sq. in.; } \quad \text{then from table:}$$

4—Flange Angles, 6″ x 4″ x 7/16″	A = 16.7 sq. in.
2—Flange Plates, 14″ x ¾″	A = 21.0 "
	37.7 sq. in.

Including for a more exact computation a web plate, 36″ x ⅝″, with proper reduction of 1″ dia. holes; then

$$I = \frac{M\,d}{2\,f} = \frac{12 \times 1{,}000{,}000 \times 38}{2 \times 18{,}000} = 12{,}667 \text{ in.}^4\text{, from table.}$$

4—Flange Angles,	6″ x 4″ x 7/16″ d_1 = 36½″	I = 5,040 in.^{4}
2—Flange Plates,	14″ x ¾″ d_1 = 36½″	I = 7,280 in.^{4}
1—Web Plate,	36″ x ⅝″ d = 36″	I = 2,430 in.^{4}
		Gross I = 14,750 in.^{4}

Deduct

4—Flange Holes,	1″ x 1 3/16″ l = 18″	I = 1,540 in.^{4}
2—Web Holes,	1″ x 1½″ l_1 = 16″	I = 768 in.^{4}
		Net I = 12,442 in.^{4}

CRANE-RUNWAY GIRDERS

Design. In the design of crane-runway girders, the following conditions must be provided for:

1. Bending moment due to maximum reaction of crane load, which is the sum of the total reaction from the crane load and movable parts of the crane when in the position of the maximum travel toward the girder plus one-half the weight of the crane girder.

2. Provision must be made against lateral deflection in case of an excessive ratio of span length to flange width. For the purpose of simplicity in Example 1 which follows the necessary width will be secured by means of a channel riveted to the top flange.

3. In addition to the tendency to deflect laterally due to total transverse load, provision must also be made against lateral impact due to the reaction of the crane load when suddenly started or stopped. This reaction is transmitted directly to the top flange of the girder and is variously assumed to bear a definite relation to the vertical force, in some cases as low as 1/20 and in other cases as high as 1/5 or even higher.

4. The web of girder must be of sufficient strength to resist the total reaction from crane occurring at extreme end or point of bearing of runway girder.

5. The unit stress should be limited to 15,000 pounds for the compression flange and 18,000 pounds for the tension flange.

6. Due allowance must be made for impact due to the rolling load or the sudden application of the load, by adding a certain percentage (say 25%) to the total static moment.

The computations for bending moment and lateral deflection due to transverse loading are made in accordance with usual practice in the design of girders. The lateral impact against top flange of girder may be computed from the following formulas:

M_1 = Bending Moment in inch-pounds due to transverse load.
n = Ratio of Lateral Impact Moment to M_1 as 1/20, 1/10, 1/5.
nM_1 = Bending Moment due to lateral impact.
I_{1-1} = Moment of Inertia of girder referred to Axis 1-1.
I_{t2-2} = Moment of Inertia of top flange of girder, Axis 2-2.
S_{2-2} = Section Modulus of girder, Axis 2-2.
f = Maximum allowable unit stress.
f_t = Unit Stress (tension) in bottom flange due to transverse load.
f_c = Unit Stress (compression) in top flange due to transverse load.
f_{c1} = Unit Stress (compression) in top flange due to lateral impact load.
x = Distance from Axis 1-1 to top of girder.
y = Distance from Axis 1-1 to bottom of girder.
z = Distance from Axis 2-2 to edge of top flange.

Then $M_1 : n\,M_1 = \frac{f_c I_{1-1}}{x} : \frac{f_{c1} I_{t2-2}}{z}$ and $\frac{f_c}{f_{c1}} = \frac{x\, I_{t2-2}}{n\, I_{1-1}\, z}$ and $M_1 \text{ max.} = \dfrac{f\, I_{1-1}}{x + \frac{n\, I_{1-1}\, z}{I_{t2-2}}}$

$f_{c1} = \frac{f_c\, n\, I_{1-1}\, z}{I_{t2-2}\, x}$, $f_c = \frac{M_1\, x}{I_{1-1}}$, $f_t = \frac{M_1\, y}{I_{1-1}}$

f max. in top flange $= f_c + f_{c1} = f_c \left(1 + \frac{n\, I_{1-1}\, z}{I_{t2-2}\, x}\right)$ and must not exceed the maximum allowable unit stress.

For symmetrical sections where top and bottom flanges are of equal section modulus, $\frac{I_{1-1}}{x}$ becomes S_{1-1} and $\frac{I_{t2-2}}{z}$ becomes $\frac{S_{2-2}}{2}$ and the formulas become

f max. in top flange $= f_c \left(1 + \frac{2\, n\, S_{1-1}}{S_{2-2}}\right)$ and M_1 max. $= f \left(\frac{S_{1-1} \times S_{2-2}}{S_{2-2} + 2\, n\, S_{1-1}}\right)$

The examples shown are hypothetical and are chosen merely to indicate the method of approach and the fact that in many cases a satisfactory girder may be selected from the CB Series.

It will be quite apparent, however, that in most cases the bottom flanges will not be stressed to full capacity and that a more efficient girder could be designed by using plates and angles carefully selected to secure the maximum allowable stresses in both the top and bottom flanges.

EXAMPLE 1. Crane-runway girder having 30-foot span to support a moving load on 2 wheels 10 feet apart. Total load on each wheel 24,750 pounds due to the total crane load and moving parts plus one-half the weight of the crane girder. Assume the force tending to deflect the girder laterally to be 1/20 of the vertical force. Assume CB 301 108 lb. and C 1, 15″ 35 lb. channel riveted to top flange.

M_1 for live load = 257,813 ft.-lbs.

Add 25% for impact = 64,453 ft.-lbs.

$$M_1 \text{ for dead load} = \frac{143 \times 30^2}{8} = \underline{16{,}090} \text{ ft.-lbs.}$$

Total M_1 = 338,356 ft.-lbs.

$$\text{Load reduction, for } \frac{l}{b} \text{ ratio of } \frac{30 \times 12}{15} \text{ or } 24 = 86.3\%.$$

$$\text{Equivalent } M_1 = \frac{338{,}356}{86.3} = 392{,}070 \text{ ft.-lbs.} = 4{,}704{,}840 \text{ in.-lbs.}$$

Bending Stresses. The Moments of Inertia are for net sections with allowance for 1-inch diameter holes. Unit stress for transverse load and lateral impact is 15,000 lbs. per sq. in. in top flange.

$$M_1 \text{ max.} = \frac{f\, I_{1-1}}{x + \dfrac{n\, I_{1-1}\, z}{I_{t2-2}}} = \frac{15{,}000 \times 5791.4}{12.46 + \dfrac{5791.4 \times 7.5}{20 \times 365.0}} = 4{,}718{,}670 \text{ in.-lbs.} = \text{moment of resistance}$$

$$f \text{ max., top flange} = \frac{M_1\, x}{I_{1-1}}\left(1 + \frac{n\, I_{1-1}\, z}{I_{t2-2}\, x}\right) = \frac{12.46 \times 4{,}704{,}840}{5791.4} \times \left(1 + \frac{5791.4 \times 7.5}{20 \times 365.0 \times 12.46}\right) = 14{,}955 \text{ lbs. per sq. in.}$$

$$f_t, \text{ bottom flange} = \frac{M_1\, y}{I_{1-1}} = \frac{4{,}704{,}840 \times 17.78}{5791.4} = 14{,}444 \text{ lbs. per sq. in.}$$

This comes well within the maximum allowable stress, 18,000 lbs. per sq. in.

Web Resistance. From the table of bending moments and web resistances we find that the web of Section CB 301, 108 lb. is good for a load of 72,350 pounds with a minimum end bearing of 3½ inches, and as the total end reaction due to the wheel loads is less than this, the web is amply strong.

EXAMPLE 2. Crane-runway girder having a 20-foot span is to resist a maximum bending moment of 320,000 ft.-lbs. for live load. The girder to consist of a 36-inch beam with 16½-inch flange width.

Assume 240 lbs. per ft. $n = 1/10$ f max. in compression flange = 15,000 lbs. per sq. in.

M_1 for live load = 320,000 ft.-lbs.

Add 25% for impact = 80,000 ft.-lbs.

$$M_1 \text{ for dead load} = \frac{240 \times 20^2}{8} = \underline{12{,}000} \text{ ft.-lbs.}$$

Total M_1 = 412,000 ft.-lbs. = 4,944,000 in.-lbs.

$$\text{For } \frac{l}{b} \text{ ratio} = \frac{20 \times 12}{16.5} = 14.5, \text{ therefore no reduction is required.}$$

$S_{1-1} = 873.6$ in.³ $S_{2-2} = 111.5$ in.³

$$\text{Then } M_1 \text{ max.} = f\left(\frac{S_{1-1} \times S_{2-2}}{S_{2-2} + 2\, n\, S_{1-1}}\right) = 15{,}000\left(\frac{873.6 \times 111.5}{111.5 + 2 \times .1 \times 873.6}\right) = 5{,}104{,}800 \text{ in.-lbs.}$$

$$f_c \text{ and } f_t = \frac{4{,}944{,}000}{873.6} = 5{,}659 \text{ lbs. per sq. in.}$$

$$f \text{ max. in top flange} = f_c\left(1 + \frac{2\, n\, S_{1-1}}{S_{2-2}}\right) = 5{,}659 \times \left(1 + \frac{2 \times 873.6}{10 \times 111.5}\right) = 14{,}527 \text{ lbs. per sq. in.}$$

IN EXAMPLE 2.

If $n = 1/15$,

$$M_1 \text{ max.} = 15{,}000\left(\frac{873.6 \times 111.5}{111.5 + 2 \times .067 \times 873.6}\right) = 6{,}392{,}547 \text{ in.-lbs.}$$

$$f_c \text{ and } f_t = \frac{4{,}944{,}000}{873.6} = 5{,}659 \text{ lbs. per sq. in.}$$

$$f \text{ max., top flange} = 5{,}659\left(1 + \frac{2 \times 873.6}{15 \times 111.5}\right) = 11{,}571 \text{ lbs. per sq. in.}$$

Allowable = 15,000; hence, for this case the beam would be good for an increase in bending moment of 29.3% or 6,392,590 in.-lbs.

In Example 2 the gross value of the beam has been used for simplicity, but designers should take into account the necessary reduction for rivet holes if flanges are punched.

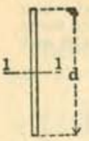
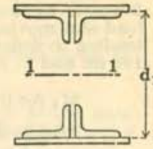


PLATE GIRDERS

Moments of Inertia

and

Areas of Component Parts



Depth d	I_{1-1} OF ONE WEB PLATE, Thickness in Inches								
	1/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8
36	243	1458	1701	1944	2430	2916	3402	3888	4374
42	385	2315	2701	3087	3859	4631	5402	6174	6946
48	576	3456	4032	4608	5760	6912	8064	9216	10368
54	820	4921	5741	6561	8201	9842	11482	13122	14762
60	1125	6750	7875	9000	11250	13500	15750	18000	20250
72	1944	11664	13608	15552	19440	23328	27216	31104	34992
84	3087	18522	21609	24696	30869	37042	43220	49392	55564

Depth d_1	I_{1-1} OF TWO FLANGE PLATES (For One Inch of Width) Thickness in Inches										
	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2
36 1/2	255	297	342	431	520	611	703	891	1084	1281	1484
42 1/2	345	402	462	581	702	823	946	1197	1453	1714	1982
48 1/2	448	523	600	754	910	1067	1225	1547	1876	2210	2552
54 1/2	565	659	756	950	1145	1342	1540	1943	2353	2769	3194
60 1/2	695	811	926	1168	1407	1648	1891	2383	2884	3392	3908
72 1/2	996	1162	1328	1660	2012	2356	2701	3400	4108	4825	5552
84 1/2	1351	1576	1800	2265	2725	3189	3655	4596	5548	6510	7484

I_{1-1} OF FOUR FLANGE ANGLES, Thickness in Inches

Size	Depth d_1	3/8	7/16	1/2	5/8	3/4	7/8	Size	Depth d_1	3/8	7/16	1/2	5/8	3/4	7/8
	36 1/2	4350	5040	5690	6980	8220	9410		36 1/2	4870	5640	6400	7860	9270	10630
	42 1/2	5980	6920	7820	9610	11330	12970		42 1/2	6770	7840	8890	10930	12910	14820
	48 1/2	7870	9110	10310	12670	14940	17120		48 1/2	8980	10400	11800	14520	17160	19710
6 x 4	54 1/2	10020	11560	13130	16150	19050	21830	6 x 6	54 1/2	11500	13320	15120	18620	22010	25300
	60 1/2	12430	14380	16290	20040	23660	27130		60 1/2	14340	16610	18850	23230	27480	31590
	72 1/2	18020	20860	23650	29110	34370	39430		72 1/2	20950	24280	27570	33990	40230	46260
	84 1/2	24660	28540	32370	39860	47090	54040		84 1/2	28820	33420	37940	46790	55410	63750

I_{1-1} OF FOUR FLANGE ANGLES, Thickness in Inches

Size	Depth d_1	7/16	1/2	5/8	3/4	7/8	1	Size	Depth d_1	1/2	5/8	3/4	7/8	1	1 1/8
	36 1/2	6770	7690	9470	11200	12850	14480		36 1/2	8190	10100	11950	13750	15490	17180
	42 1/2	9380	10650	13120	15540	17850	20130		42 1/2	11460	14140	16750	19280	21740	24150
	48 1/2	12410	14100	17380	20590	23680	26720		48 1/2	15280	18880	22370	25770	29080	32310
8 x 6	54 1/2	15870	18030	22240	26360	30330	34230	8 x 8	54 1/2	19660	24300	28810	33210	37500	41680
	60 1/2	19750	22450	27710	32850	37810	42690		60 1/2	24600	30420	36080	41600	46990	52260
	72 1/2	28800	32750	40440	47970	55240	62410		72 1/2	36160	44730	53080	61240	69230	77030
	84 1/2	39560	44990	55580	65950	75980	85870		84 1/2	49940	61800	73390	84690	95780	106610

AREA OF FOUR ANGLES

Size	Thickness in Inches							
	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8
6 x 4	14.4	16.7	19.0	23.4	27.8	31.9		
6 x 6	17.4	20.2	23.0	28.4	33.8	38.9		
8 x 6		23.7	27.0	33.4	39.8	45.9	52.0	
8 x 8			31.0	38.4	45.8	52.9	60.0	66.9

AREA OF TWO FLANGE PLATES

Width	Thickness in Inches								
	1/16	3/8	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2
12	1.50	9.0	12.0	15.0	18.0	21.0	24.0	30.0	36.0
14	1.75	10.5	14.0	17.5	21.0	24.5	28.0	35.0	42.0
16	2.00	12.0	16.0	20.0	24.0	28.0	32.0	40.0	48.0
18	2.25	13.5	18.0	22.5	27.0	31.5	36.0	45.0	54.0
20	2.50	15.0	20.0	25.0	30.0	35.0	40.0	50.0	60.0
24	3.00	18.0	24.0	30.0	36.0	42.0	48.0	60.0	72.0

AREA OF ONE WEB PLATE

Depth	Thickness in Inches			
	1/16	1/4	3/8	1/2
36	2.25	9.0	13.5	18.0
42	2.63	10.5	15.8	21.0
48	3.00	12.0	18.0	24.0
54	3.38	13.5	20.3	27.0
60	3.75	15.0	22.5	30.0
72	4.50	18.0	27.0	36.0
84	5.25	21.0	31.5	42.0

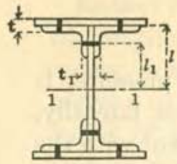
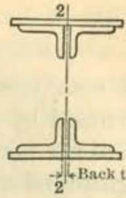


PLATE GIRDERS

Moments of Inertia of Holes and Component Parts



Back to Back, b to b

Distance l or l_1	I_{1-1} OF ONE HOLE, Thickness of Metal t or t_1 and Area of Hole for ⅞" Rivet														
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2¼	2½	2¾	3
	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75	1.88	2.00	2.25	2.50	2.75	3.00
16	192	224	256	288	320	352	384	416	448	480	512	576	640	704	768
18	243	284	324	365	405	446	486	527	567	608	648	729	810	891	972
18½	257	299	342	385	428	471	513	556	599	642	685	770	856	941	1027
19	271	316	361	406	451	496	542	587	632	677	722	812	903	993	1083
21	331	386	441	496	551	606	662	717	772	827	882	992	1103	1213	1323
21½	347	404	462	520	578	636	693	751	809	867	925	1040	1156	1271	1387
22	363	424	484	545	605	666	726	787	847	908	968	1089	1210	1331	1452
24	432	504	576	648	720	792	864	936	1008	1080	1152	1296	1440	1584	1728
24½	450	525	600	675	750	825	900	975	1050	1125	1201	1351	1501	1651	1801
25	469	547	625	703	781	859	938	1016	1094	1172	1250	1406	1563	1719	1875
27	547	638	729	820	911	1002	1094	1185	1276	1367	1458	1640	1823	2005	2187
27½	567	662	756	851	945	1040	1134	1229	1323	1418	1513	1702	1891	2080	2269
28	588	686	784	882	980	1078	1176	1274	1372	1470	1568	1764	1960	2156	2352
30	675	788	900	1013	1125	1238	1350	1463	1575	1688	1800	2025	2250	2475	2700
30½	698	814	930	1047	1163	1279	1395	1512	1628	1744	1861	2093	2326	2558	2791
31	721	841	961	1081	1201	1321	1442	1562	1682	1802	1922	2162	2403	2643	2883
34	867	1012	1156	1301	1445	1590	1734	1879	2023	2168	2312	2601	2890	3179	3468
36	972	1134	1296	1458	1620	1782	1944	2106	2268	2430	2592	2916	3240	3564	3888
36½	999	1166	1332	1499	1665	1832	1998	2165	2331	2498	2665	2998	3331	3664	3997
37	1027	1198	1369	1540	1711	1882	2054	2225	2396	2567	2738	3080	3423	3765	4107
40	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3600	4000	4400	4800
42	1323	1544	1764	1985	2205	2426	2646	2867	3087	3308	3528	3969	4410	4851	5292
42½	1355	1580	1806	2032	2258	2484	2709	2935	3161	3387	3613	4064	4516	4967	5419
43	1387	1618	1849	2080	2311	2542	2774	3005	3236	3467	3698	4160	4623	5085	5547

I_{2-2} OF TWO FLANGE PLATES, Thickness in Inches

Width	⅜	7/16	½	⅝	¾	⅞	1	1¼	1½	1¾	2
12	108	126	144	180	216	252	288	360	432	504	576
14	172	200	229	286	343	401	458	572	686	802	916
16	256	299	341	426	512	597	682	852	1024	1194	1364
18	365	425	486	608	729	851	972	1216	1458	1702	1944
20	500	583	667	834	1000	1167	1334	1668	2000	2234	2668
24	864	1008	1152	1440	1728	2016	2304	2880	3456	4032	4608

I_{2-2} OF FOUR ANGLES 6 x 4

Dist. b to b	Thickness in Inches					
	⅜	7/16	½	⅝	¾	⅞
⅜	120	140	160	200	240	280
7/16	121	141	162	203	245	290
½	123	144	165	206	250	295
⅝	127	148	170	213	257	300
¾	130	153	176	220	265	310
⅞	136	158	180	227	274	320

I_{2-2} OF FOUR ANGLES 6 x 6

Dist. b to b	Thickness in Inches					
	⅜	7/16	½	⅝	¾	⅞
⅜	120	140	160	200	243	285
7/16	122	142	162	204	247	289
½	124	144	165	208	252	294
⅝	128	149	170	215	260	305
¾	132	154	177	223	270	315
⅞	137	160	183	230	280	326

I_{2-2} OF FOUR ANGLES 8 x 6

Dist. b to b	Thickness in Inches					
	7/16	½	⅝	¾	⅞	1
⅜	322	368	462	554	650	742
7/16	326	372	467	561	657	751
½	330	377	473	568	665	760
⅝	338	386	485	582	680	780
¾	346	396	497	596	698	800
⅞	355	405	510	610	716	820

I_{2-2} OF FOUR ANGLES 8 x 8

Dist. b to b	Thickness in Inches					
	½	⅝	¾	⅞	1	1⅛
⅜	370	462	558	650	748	843
7/16	375	468	565	659	758	854
½	380	474	572	668	768	865
⅝	390	486	586	685	788	888
¾	398	498	602	703	808	910
⅞	408	510	617	720	830	934

COLUMNS AND STRUTS

A compression member, subjected to longitudinal pressure, is shortened by the compression and also tends to deflect laterally, due to the fact that the load cannot be applied coincident with the longitudinal axis and that the material is not perfectly homogeneous. This flexure occurs generally in the direction of the least resisting moment of the section; the load which will cause a column to fail decreases in the ratio of length to least lateral resistance of the section, the ultimate failure being the result of combined stresses due to compression, transverse shear and flexure.

Column Formulas. Under ideal conditions, when it can be assumed that the load is applied axially and that the material is perfectly homogeneous, the resistance of the column would equal its resistance to compressive forces up to the elastic limit, and there would not be any flexure; if, however, a deflection be imparted to the column by a lateral force, the column would ultimately fail by bending.

Euler's Formula, $P = k\frac{\pi^2 EI}{l^2}$ or $\frac{P}{A} = k\frac{\pi^2 E}{(l/r)^2}$, is based upon the foregoing theory, and gives results close to the ultimate strength found for long and slender struts, when k is a constant varying with the condition of end bearing, ($k = 4$ for columns fixed both ends). For shorter and heavier columns, or for lower ratios of l/r the results do not correspond with actual tests.

Rankine's Formula, $P = \frac{Af}{1 + c(l/r)^2}$ or $\frac{P}{A} = \frac{f}{1 + c(l/r)^2}$, represents the type of formula now in general use and the various formulas for proportioning columns which are based upon this general formula agree with actual tests within certain limits. In this formula a certain compressive unit stress for direct crushing is assumed and reduced in ratio of length of column and least radius of gyration, l/r; value of c is an empirical factor, varying with the resistance of the material and with conditions of end bearing.

Straight Line Formulas. In practice, compression members of a greater ratio of slenderness, l/r, than 120 are rarely used, and within this limit the curve can be represented by a straight line, the general formula assuming the simpler form: $\frac{P}{A} = f - c\left(\frac{l}{r}\right)$.

Compression formulas determining the resistance of webs in rolled beams or riveted girders against buckling, or the necessary reduction of safe loads due to lateral deflection of unbraced beams, are likewise based on one or the other types of column formulas.

Ratio of Slenderness. l/r is ratio of the unsupported length of a compression member to its radius of gyration, generally the least radius, excepting when the unsupported length is rigidly braced to prevent deflection in the direction which corresponds to the least radius of gyration. It is, therefore, necessary to determine the radii of gyration and to use the proper ratio of slenderness in any particular case.

Usual practice limits the maximum ratio of l/r for main members under permanent stress, permitting a higher ratio for secondary members under temporary stress, as in wind bracing.

Compressive Unit Stresses. The tables of allowable loads of column sections have been computed in accordance with the formula for steel columns of American Institute of Steel Construction, 1923—Revised 1928.

$$f = \frac{18{,}000}{1 + \frac{1}{18{,}000}(l/r)^2}.$$

Maximum unit stress at $l/r = 60$: 15,000 lb. per sq. inch.

Maximum l/r: Primary members = 120; Secondary members = 200.

Explanation of Tables. The tables give the concentric safe loads in kips and include a selected line of 14-inch CB column sections with cover plates. The loads are based upon the least radius of gyration.

In addition to the safe loads, tables give the moments of inertia and the radii of gyration about both axes of symmetry, for use with other compression formulas or for use in computation of the safe strength of a column braced against flexure in such a manner that the greater radius of gyration may be used.

Combined Compression and Bending Stresses. Generally, the loads are concentric and equally distributed over the cross section of the column or balanced on opposite sides thereof. In the case of beams carried on brackets or other forms of eccentric loading, bending stresses are produced which should be taken into consideration and the column sections so proportioned that the combined stresses do not exceed the allowable compressive and bending stresses in accordance with the following formulas:

P = Concentric load.
P_1 = Eccentric load.
l = Length of column = $l_1 + l_2$, end distances of eccentric load.
l_1 = Distance from top of column to eccentric load.
l_2 = Distance from bottom of column to eccentric load.
f_c = Unit compressive stress for length l of column.
f_{c_1} = Unit compressive stress for length l_2 of column.
f_s = Unit bending stress.
M = Bending moment due to eccentric load.
y = Distance of eccentric load to center of column.
n = Distance of extreme fiber from center of column.
r = Radius of gyration of section in plane of bending.
A = Cross sectional area of section.

Compression due to concentric and eccentric load:

$$P = Af_c \quad , \quad P_1 = Af_{c_1}.$$

When the eccentric load is applied above center, Fig. 1:

$$A = \frac{P}{f_c} + \frac{P_1}{f_{c_1}} + \frac{P_1 y l_2 n}{l f_s r^2}; \quad M\max = \frac{P_1 y l_2}{l}.$$

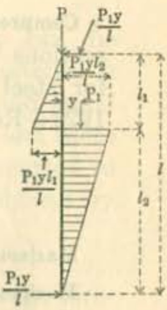


FIG. 1

When the eccentric load is applied at the center, Fig. 2:

$$A = \frac{P}{f_c} + \frac{P_1}{f_{c_1}} + \frac{P_1 y n}{2f_s r^2}; \quad M\max = \frac{P_1 y}{2}.$$

When the eccentric load is applied below center, Fig. 3:

$$A = \frac{P}{f_c} + \frac{P_1 y l_1 n}{l f_s r^2}, \text{ or } A = \frac{P}{f_c} + \frac{P_1}{f_{c_1}} + \frac{P_1 y l_2 n}{l f_s r^2}; \; M\max = \frac{P_1 y l_1}{l}.$$

Use greater value for A.

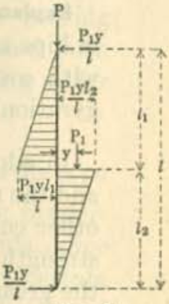


FIG. 2

When the eccentric load is applied at the top, Fig. 4:

$$A = \frac{P + P_1}{f_c} + \frac{P_1 y n}{f_s r^2}; \quad M\max = P_1 y.$$

When the eccentric load is applied at the bottom, Fig. 5:

$$A = \frac{P}{f_c} + \frac{P_1 y n}{f_s r^2}; \qquad M\max = P_1 y.$$

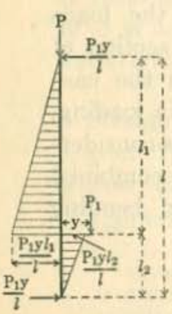


FIG. 3

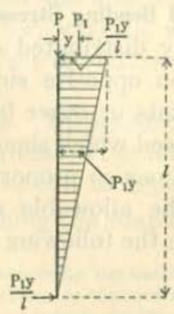


FIG. 4

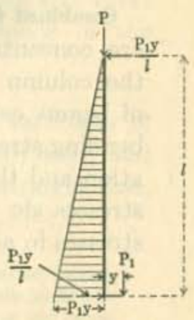


FIG 5.

NOTE: The value of f_s, in the above formulas, is assumed to be 18,000 pounds per square inch for ratios of l/b = 15. Where the ratio of l/b exceeds 15, the value of f_s should be reduced to conform to the standard practice shown on page 184.

Example: Required a CB column, 25 feet in length, to support a concentric load of 383,000 pounds and an eccentric load of 50,000 pounds acting at a distance of 19 inches from center of section, in plane of greatest resistance, Axis 1-1, and at a distance of 5 feet from top of column.

Unit compression and bending stresses in accordance with A. I. S. C. requirements.

Assuming CB 145, 136 pounds, with the following properties:

$A = 39.98$ sq. in. $n = 7.375$ in. $r_{1\text{-}1} = 6.31$ in. $r_{2\text{-}2} = 3.77$ in.

f_c for $l/r = 25 \times 12 \div 3.77 = 79.6$ 13,314 lbs. per sq. in.

f_{c1} for $l_2/r = 20 \times 12 \div 3.77 = 63.7$ 14,689 lbs. per sq. in.

$$A = \frac{383{,}000}{13{,}314} + \frac{50{,}000}{14{,}689} + \frac{50{,}000 \times 19 \times 20 \times 7.375}{25 \times 18{,}000 \times 6.31^2} = 39.99 \text{ sq. in.}$$

Note: The bending factor, A/S, for column sections, may be used to advantage in computation of columns with eccentric load, substituting the value of A/S for n/r^2 in the formula.

In the example the value of A/S, axis 1-1 $= 39.98 \div 216.0 = 0.185$.

$$A = \frac{383{,}000}{13{,}314} + \frac{50{,}000}{14{,}689} + \frac{50{,}000 \times 19 \times 20 \times 0.185}{25 \times 18{,}000} = 39.98 \text{ sq. in.}$$

COMPRESSION UNIT STRESSES

Allowable Unit Stresses in Pounds per Square Inch

by Compression Formula of

American Institute of Steel Construction: $f = \dfrac{18{,}000}{1+\frac{1}{18{,}000}(l/r)^2}$

The following tables give the unit stresses for ratios of l/r in intervals of 0.5. Intermediate values may be found by interpolation from the figures given for the tenth units of l/r by adding or deducting from the nearest tabulated figure the corresponding multiple.

EXAMPLE: Unit stress for $l/r=94.7$ and $l/r=150.8$
$l/r=94.7$ 11989 +3x8.4 or 12031—2x8.4=12014
$l/r=150.8$ 7941 +2x5.9 or 7971—3x5.9= 7953

Main Members—Ratios of l/r up to 120

Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10
60	15000		75	13714		90	12414		105	11163	
.5	14958	8.4	.5	13671	8.7	.5	12371	8.6	.5	11122	8.1
61	14916		76	13627		91	12328		106	11082	
.5	14874	8.4	.5	13584	8.7	.5	12286	8.5	.5	11042	8.0
62	14832		77	13540		92	12243		107	11002	
.5	14790	8.4	.5	13496	8.7	.5	12201	8.5	.5	10962	8.0
63	14748		78	13453		93	12158		108	10922	
.5	14705	8.5	.5	13409	8.7	.5	12116	8.5	.5	10883	7.9
64	14663		79	13366		94	12073		109	10843	
.5	14621	8.5	.5	13322	8.7	.5	12031	8.4	.5	10804	7.9
65	14578		80	13279		95	11989		110	10764	
.5	14535	8.5	.5	13235	8.7	.5	11947	8.4	.5	10725	7.9
66	14493		81	13192		96	11905		111	10686	
.5	14450	8.6	.5	13148	8.7	.5	11863	8.4	.5	10647	7.8
67	14407		82	13105		97	11821		112	10608	
.5	14364	8.6	.5	13061	8.7	.5	11779	8.4	.5	10569	7.8
68	14321		83	13018		98	11737		113	10530	
.5	14278	8.6	.5	12974	8.7	.5	11696	8.3	.5	10491	7.7
69	14235		84	12931		99	11654		114	10453	
.5	14192	8.7	.5	12888	8.7	.5	11613	8.3	.5	10415	7.7
70	14148		85	12844		100	11571		115	10376	
.5	14105	8.7	.5	12801	8.6	.5	11530	8.2	.5	10338	7.6
71	14062		86	12758		101	11489		116	10300	
.5	14019	8.7	.5	12715	8.6	.5	11448	8.2	.5	10262	7.6
72	13975		87	12672		102	11407		117	10224	
.5	13932	8.7	.5	12629	8.6	.5	11366	8.2	.5	10187	7.5
73	13888		88	12585		103	11325		118	10149	
.5	13845	8.7	.5	12542	8.6	.5	11284	8.2	.5	10112	7.5
74	13801		89	12500		104	11244		119	10074	
.5	13758	8.7	.5	12457	8.6	.5	11203	8.1	.5	10037	7.4
75	13714		90	12414		105	11163		120	10000	

COMPRESSION UNIT STRESSES

Allowable Unit Stresses in Pounds per Square Inch

by Compression Formula of

American Institute of Steel Construction: $f = \dfrac{18{,}000}{1 + \dfrac{1}{18{,}000}(l/r)^2}$

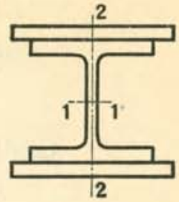
Secondary Members—Ratios of l/r up to 200

Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10	Ratio, l/r	Unit Stress, Pounds	Diff. 0.10
120	10000		140	8617		160	7431		180	6429	
.5	9963	7.4	.5	8585	6.4	.5	7404	5.4	.5	6406	4.6
121	9926		141	8553		161	7377		181	6383	
.5	9890	7.3	.5	8521	6.3	.5	7350	5.4	.5	6360	4.5
122	9853		142	8490		162	7323		182	6338	
.5	9816	7.3	.5	8458	6.3	.5	7296	5.4	.5	6315	4.5
123	9780		143	8427		163	7269		183	6293	
.5	9744	7.2	.5	8396	6.3	.5	7243	5.3	.5	6270	4.5
124	9708		144	8364		164	7217		184	6248	
.5	9672	7.2	.5	8333	6.2	.5	7190	5.3	.5	6226	4.4
125	9636		145	8302		165	7164		185	6204	
.5	9600	7.1	.5	8272	6.1	.5	7138	5.2	.5	6182	4.4
126	9564		146	8241		166	7112		186	6160	
.5	9529	7.1	.5	8210	6.1	.5	7086	5.2	.5	6139	4.3
127	9493		147	8180		167	7061		187	6117	
.5	9458	7.0	.5	8150	6.1	.5	7035	5.1	.5	6095	4.3
128	9423		148	8119		168	7009		188	6074	
.5	9388	7.0	.5	8089	6.0	.5	6984	5.1	.5	6053	4.3
129	9353		149	8060		169	6959		189	6031	
.5	9318	6.9	.5	8030	6.0	.5	6934	5.0	.5	6010	4.2
130	9284		150	8000		170	6908		190	5989	
.5	9249	6.9	.5	7971	5.9	.5	6883	5.0	.5	5968	4.2
131	9215		151	7941		171	6858		191	5947	
.5	9181	6.8	.5	7912	5.9	.5	6834	4.9	.5	5926	4.2
132	9146		152	7882		172	6809		192	5906	
.5	9112	6.8	.5	7853	5.8	.5	6785	4.9	.5	5885	4.1
133	9078		153	7824		173	6760		193	5864	
.5	9045	6.7	.5	7796	5.8	.5	6736	4.9	.5	5844	4.1
134	9011		154	7767		174	6711		194	5824	
.5	8978	6.7	.5	7738	5.7	.5	6687	4.8	.5	5803	4.0
135	8944		155	7710		175	6663		195	5783	
.5	8911	6.6	.5	7681	5.7	.5	6639	4.8	.5	5763	4.0
136	8878		156	7653		176	6615		196	5743	
.5	8845	6.6	.5	7625	5.6	.5	6592	4.7	.5	5723	3.9
137	8812		157	7597		177	6568		197	5703	
.5	8779	6.5	.5	7569	5.6	.5	6545	4.7	.5	5684	3.9
138	8746		158	7541		178	6521		198	5664	
.5	8714	6.5	.5	7514	5.5	.5	6498	4.7	.5	5643	3.9
139	8681		159	7486		179	6475		199	5624	
.5	8649	6.4	.5	7459	5.5	.5	6452	4.6	.5	5606	3.9
140	8617		160	7431		180	6429		200	5586	

CB SECTIONS

COLUMNS WITH COVER PLATES

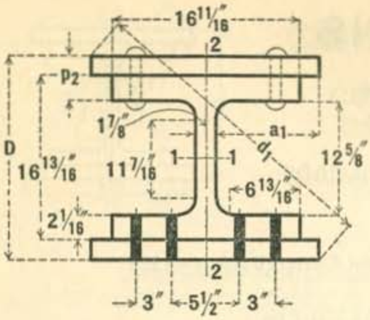
14-INCH CORE



ELEMENTS

Cover Plates		Total Depth	Total Weight per Foot	Total Area	Axis 1-1				Axis 2-2			
Width	Thick-ness				I	S	r	Bending Factor	I	S	r	Bending Factor
In.	In.	In.	Lbs.	Sq. In.	In.⁴	In.³	In.	A ÷ S	In.⁴	In.³	In.	A ÷ S
					CORE SECTION - C B 146 - 320 LBS.							
24	3⅝	24.06	912	268.1	22497	1870	9.16	.143	9987	832	6.10	.322
24	3½	23.81	891	262.1	21638	1818	9.09	.144	9699	808	6.08	.324
24	3⅜	23.56	871	256.1	20797	1765	9.01	.145	9411	784	6.06	.327
24	3¼	23.31	850	250.1	19973	1714	8.94	.146	9123	760	6.04	.329
24	3⅛	23.06	830	244.1	19166	1662	8.86	.147	8835	736	6.02	.332
24	3	22.81	810	238.1	18377	1611	8.79	.148	8547	712	5.99	.334
23	3	22.81	789	232.1	17784	1559	8.75	.149	7719	671	5.77	.346
23	2⅞	22.56	770	226.4	17044	1511	8.68	.150	7465	649	5.74	.349
23	2¾	22.31	750	220.6	16321	1463	8.60	.151	7212	627	5.72	.352
22	2¾	22.31	731	215.1	15791	1416	8.57	.152	6515	592	5.50	.363
22	2⅝	22.06	713	209.6	15115	1370	8.49	.153	6294	572	5.48	.366
22	2½	21.81	694	204.1	14453	1325	8.41	.154	6072	552	5.45	.370
22	2⅜	21.56	675	198.6	13806	1281	8.34	.155	5850	532	5.43	.373
22	2¼	21.31	657	193.1	13175	1236	8.26	.156	5628	512	5.40	.377
22	2⅛	21.06	638	187.6	12558	1193	8.18	.157	5406	491	5.37	.382
22	2	20.81	619	182.1	11955	1149	8.10	.159	5184	471	5.34	.387
22	1⅞	20.56	601	176.6	11367	1106	8.02	.160	4963	451	5.30	.391
22	1¾	20.31	582	171.1	10792	1063	7.94	.161	4741	431	5.26	.397
22	1⅝	20.06	563	165.6	10232	1020	7.86	.162	4519	411	5.22	.403
22	1½	19.81	544	160.1	9686	978	7.78	.164	4297	391	5.18	.410
20	1½	19.81	524	154.1	9182	927	7.72	.166	3635	364	4.86	.424
20	1⅜	19.56	507	149.1	8697	889	7.64	.168	3468	347	4.82	.430
20	1¼	19.31	490	144.1	8225	852	7.55	.169	3302	330	4.79	.436
18	1¼	19.31	473	139.1	7817	810	7.50	.172	2850	317	4.53	.439
18	1⅛	19.06	458	134.6	7403	777	7.42	.173	2729	303	4.50	.444
18	1	18.81	442	130.1	6999	744	7.33	.175	2607	290	4.48	.449

NOTE: Weights do not include rivets. Properties are for gross section.



CB SECTIONS

COLUMNS WITH COVER PLATES

14-INCH CORE

DIMENSIONS

COLUMN LOADS

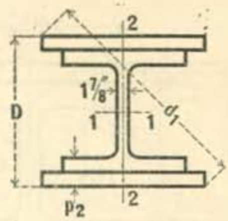
Cover Plates		Column Dimensions				Total Weight per Foot
Width	Thickness	Depth D	Grip P_2	Diagonal d_1	Distance a_1	
In.	In.	In.	In.	In.	In.	Lbs.
CORE SECTION - C B 146 - 320 LBS.						
24	3 5/8	24 1/16	5 11/16	34	11 1/16	912
24	3 1/2	23 13/16	5 9/16	33 13/16	11 1/16	891
24	3 3/8	23 9/16	5 7/16	33 5/8	11 1/16	871
24	3 1/4	23 5/16	5 5/16	33 7/16	11 1/16	850
24	3 1/8	23 1/16	5 3/16	33 5/16	11 1/16	830
24	3	22 13/16	5 1/16	33 1/8	11 1/16	810
23	3	22 13/16	5 1/16	32 3/8	10 9/16	789
23	2 7/8	22 9/16	4 15/16	32 3/16	10 9/16	770
23	2 3/4	22 5/16	4 13/16	32 1/16	10 9/16	750
22	2 3/4	22 5/16	4 13/16	31 5/16	10 1/16	731
22	2 5/8	22 1/16	4 11/16	31 1/8	10 1/16	713
22	2 1/2	21 13/16	4 9/16	31	10 1/16	694
22	2 3/8	21 9/16	4 7/16	30 13/16	10 1/16	675
22	2 1/4	21 5/16	4 5/16	30 5/8	10 1/16	657
22	2 1/8	21 1/16	4 3/16	30 7/16	10 1/16	638
22	2	20 13/16	4 1/16	30 5/16	10 1/16	619
22	1 7/8	20 9/16	3 15/16	30 1/8	10 1/16	601
22	1 3/4	20 5/16	3 13/16	29 15/16	10 1/16	582
22	1 5/8	20 1/16	3 11/16	29 3/4	10 1/16	563
22	1 1/2	19 13/16	3 9/16	29 5/8	10 1/16	544
20	1 1/2	19 13/16	3 9/16	28 1/8	9 1/16	524
20	1 3/8	19 9/16	3 7/16	28	9 1/16	507
20	1 1/4	19 5/16	3 5/16	27 13/16	9 1/16	490
18	1 1/4	19 5/16	3 5/16	26 3/8	8 1/16	473
18	1 1/8	19 1/16	3 3/16	26 3/16	8 1/16	458
18	1	18 13/16	3 1/16	26 1/16	8 1/16	442

COLUMN LOADS

CB SECTIONS

COLUMNS WITH COVER PLATES

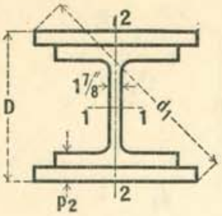
ALLOWABLE CONCENTRIC LOADS IN KIPS



Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	CORE - CB 146 - 320 Lbs.					
	Cover Plates—Width by Thickness—Inches					
	24 x 3⅝	24 x 3½	24 x 3⅜	24 x 3¼	24 x 3⅛	24 x 3
29						3572
30	4022	3932	3842	3752	3662	3570
31	4000	3906	3812	3719	3625	3530
32	3955	3862	3769	3677	3584	3489
33	3911	3818	3726	3634	3543	3449
34	3865	3774	3683	3592	3501	3408
35	3820	3729	3639	3549	3459	3367
36	3774	3685	3595	3506	3417	3325
37	3729	3640	3551	3463	3374	3284
38	3683	3595	3507	3419	3332	3242
39	3637	3550	3463	3376	3290	3201
40	3591	3505	3419	3333	3247	3159
41	3545	3460	3374	3290	3205	3118
42	3499	3415	3330	3246	3163	3076
43	3453	3369	3287	3204	3121	3036
44	3408	3325	3243	3160	3079	2994
45	3363	3280	3199	3118	3037	2954
46	3317	3236	3156	3075	2995	2912
48	3227	3148	3070	2991	2913	2832
50	3139	3062	2985	2908	2832	2752
52	3052	2976	2901	2826	2752	2674
54	2966	2893	2819	2746	2673	2597
56	2883	2811	2739	2668	2597	2522
58	2801	2730	2660	2591	2522	2449
60	2721	2652	2584	2516	2448	2378
62	2642	2576	2509	2443	2377	
Area, In.²	268.1	262.1	256.1	250.1	244.1	238.1
Weight, Lbs./Ft.	912	891	871	850	830	810
Length Ratio	1.50	1.49	1.49	1.48	1.47	1.47
I_{1-1}, In.⁴	22497	21638	20797	19973	19166	18377
S_{1-1}, In.³	1870	1818	1765	1714	1662	1611
r_{1-1}, In.	9.16	9.09	9.01	8.94	8.86	8.79
A/S_{1-1}	.143	.144	.145	.146	.147	.148
I_{2-2}, In.⁴	9987	9699	9411	9123	8835	8547
S_{2-2}, In.³	832	808	784	760	736	712
r_{2-2}, In.	6.10	6.08	6.06	6.04	6.02	5.99
A/S_{2-2}	.322	.324	.327	.329	.332	.334
D, In.	24 1/16	23 13/16	23 9/16	23 5/16	23 1/16	22 13/16
d_1, In.	34	33 13/16	33 5/8	33 7/16	33 1/16	33 1/8
P_2, In.	5 11/16	5 9/16	5 7/16	5 5/16	5 3/16	5 1/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMNS WITH COVER PLATES

ALLOWABLE CONCENTRIC LOADS IN KIPS

COLUMN LOADS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	CORE - CB 146 - 320 Lbs.						
	Cover Plates—Width by Thickness—Inches						
	23 x 3	23 x 2⅞	23 x 2¾	22 x 2¾	22 x 2⅝	22 x 2½	22 x 2⅜
27				3227	3144	3062	2979
28	3482	3396	3309	3207	3121	3034	2948
29	3476	3384	3294	3168	3083	2996	2911
30	3435	3344	3255	3128	3043	2957	2873
31	3394	3304	3216	3087	3004	2919	2836
32	3353	3263	3176	3047	2964	2880	2798
33	3312	3223	3136	3006	2925	2841	2760
34	3270	3182	3096	2966	2885	2802	2722
35	3228	3141	3056	2925	2845	2763	2683
36	3186	3099	3016	2884	2805	2723	2645
37	3144	3058	2975	2843	2765	2684	2607
38	3102	3017	2935	2802	2725	2645	2569
39	3060	2976	2895	2761	2685	2606	2531
40	3018	2935	2854	2721	2646	2568	2493
41	2976	2894	2814	2681	2606	2529	2455
42	2934	2853	2774	2640	2567	2491	2418
43	2893	2813	2735	2601	2527	2452	2381
44	2852	2772	2695	2561	2489	2415	2344
45	2810	2732	2656	2521	2451	2377	2308
46	2770	2692	2617	2483	2413	2340	2271
48	2689	2613	2540	2406	2338	2267	2200
50	2610	2536	2465	2331	2265	2196	2130
52	2533	2460	2391	2258	2193	2126	2062
54	2457	2386	2318	2186	2124	2058	1996
56	2383	2313	2248	2117	2056	1992	1932
58	2310	2243	2179				
Area, In.²	232.1	226.4	220.6	215.1	209.6	204.1	198.6
Weight, Lbs./Ft.	789	770	750	731	713	694	675
Length Ratio	1.52	1.51	1.50	1.56	1.55	1.54	1.54
I_{1-1}, In.⁴	17784	17044	16321	15791	15115	14453	13806
S_{1-1}, In.³	1559	1511	1463	1416	1370	1325	1281
r_{1-1}, In.	8.75	8.68	8.60	8.57	8.49	8.41	8.34
A/S_{1-1}	.149	.150	.151	.152	.153	.154	.155
I_{2-2}, In.⁴	7719	7465	7212	6515	6294	6072	5850
S_{2-2}, In.³	671	649	627	592	572	552	532
r_{2-2}, In.	5.77	5.74	5.72	5.50	5.48	5.45	5.43
A/S_{2-2}	.346	.349	.352	.363	.366	.370	.373
D, In.	22 15/16	22 9/16	22 5/16	22 5/16	22 1/16	21 15/16	21 9/16
d_1, In.	32⅜	32 3/16	32 1/16	31 5/16	31⅛	31	30 15/16
P_2, In.	5 1/16	4 15/16	4 13/16	4 15/16	4 11/16	4 9/16	4 7/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

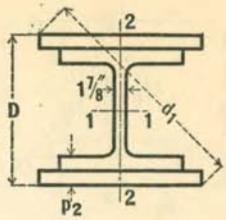
COLUMN

LOADS

CB SECTIONS

COLUMNS WITH COVER PLATES

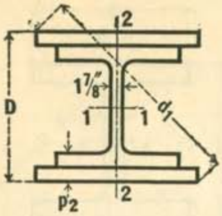
ALLOWABLE CONCENTRIC LOADS IN KIPS



Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	CORE - CB 146 - 320 Lbs. Cover Plates—Width by Thickness—Inches						
	22 x 2¼	22 x 2⅛	22 x 2	22 x 1⅞	22 x 1¾	22 x 1⅝	22 x 1½
25							2402
26		2814	2732	2649	2567	2484	2399
27	2897	2809	2722	2633	2544	2456	2368
28	2861	2774	2687	2599	2511	2423	2336
29	2824	2738	2652	2565	2478	2391	2304
30	2788	2702	2617	2531	2444	2358	2272
31	2751	2666	2582	2496	2410	2325	2240
32	2714	2630	2547	2461	2377	2292	2208
33	2677	2594	2511	2427	2343	2259	2176
34	2639	2557	2475	2392	2309	2226	2143
35	2602	2521	2440	2357	2275	2193	2111
36	2564	2484	2404	2322	2241	2159	2079
37	2527	2448	2368	2287	2207	2126	2047
38	2490	2411	2333	2253	2173	2094	2015
39	2453	2375	2298	2218	2139	2061	1983
40	2416	2339	2263	2184	2106	2028	1951
41	2379	2303	2228	2150	2073	1996	1920
42	2343	2268	2193	2116	2040	1964	1889
43	2305	2232	2159	2082	2007	1931	1858
44	2270	2197	2124	2049	1975	1901	1827
46	2199	2128	2057	1984	1911	1839	1767
48	2130	2060	1991	1920	1849	1778	1709
50	2062	1994	1927	1857	1788	1719	1651
52	1996	1930	1864	1796	1729	1662	1596
54	1931	1867	1803	1737	1671	1606	
56	1869						
Area, In.^{2}	193.1	187.6	182.1	176.6	171.1	165.6	160.1
Weight, Lbs./Ft.	657	638	619	601	582	563	544
Length Ratio	1.53	1.52	1.52	1.51	1.51	1.50	1.50
I_{1-1}, In.^{4}	13175	12558	11955	11367	10792	10232	9686
S_{1-1}, In.^{3}	1236	1193	1149	1106	1063	1020	978
r_{1-1}, In.	8.26	8.18	8.10	8.02	7.94	7.86	7.78
A/S_{1-1}	.156	.157	.159	.160	.161	.162	.164
I_{2-2}, In.^{4}	5628	5406	5184	4963	4741	4519	4297
S_{2-2}, In.^{3}	512	491	471	451	431	411	391
r_{2-2}, In.	5.40	5.37	5.34	5.30	5.26	5.22	5.18
A/S_{2-2}	.377	.382	.387	.391	.397	.403	.410
D, In.	21 5/16	21 1/16	20 13/16	20 9/16	20 5/16	20 1/16	19 13/16
d_1, In.	30⅝	30 7/16	30 5/16	30⅛	29 15/16	29¾	29⅝
P_2, In.	4 5/16	4 3/16	4 1/16	3 15/16	3 13/16	3 11/16	3 9/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMNS WITH COVER PLATES

ALLOWABLE CONCENTRIC LOADS IN KIPS

COLUMN LOADS

Unit Stress—American Institute of Steel Construction—1928

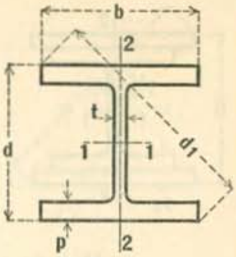
Effective Length in Feet	CORE - CB 146 - 320 Lbs.					
	Cover Plates—Width by Thickness—Inches					
	20 x 1½	20 x 1⅜	20 x 1¼	18 x 1¼	18 x 1⅛	18 x 1
22				2087	2019	1952
23			2162	2076	2004	1934
24	2312	2237	2160	2045	1974	1905
25	2289	2209	2130	2014	1943	1875
26	2257	2177	2099	1982	1912	1845
27	2225	2146	2068	1950	1881	1815
28	2192	2114	2037	1918	1850	1785
29	2159	2081	2006	1886	1819	1754
30	2126	2049	1975	1854	1788	1724
31	2093	2017	1943	1822	1756	1693
32	2060	1984	1912	1790	1725	1663
33	2027	1952	1880	1758	1694	1633
34	1994	1920	1849	1726	1663	1603
35	1961	1888	1818	1695	1633	1574
36	1928	1856	1787	1664	1603	1544
37	1895	1824	1756	1633	1573	1515
38	1863	1793	1725	1602	1543	1487
39	1831	1762	1695	1572	1514	1458
40	1799	1731	1665	1542	1485	1430
41	1768	1700	1636	1513	1456	1402
42	1737	1670	1606	1484	1428	1375
43	1705	1639	1577	1455	1400	1348
44	1675	1611	1549	1427	1373	1322
46	1616	1553	1493	1372	1320	1271
48	1558	1497	1439			
50	1502	1442				
Area, In.^{2}	154.1	149.1	144.1	139.1	134.6	130.1
Weight, Lbs./Ft.	524	507	490	473	458	442
Length Ratio	1.59	1.58	1.58	1.66	1.65	1.64
I_{1-1}, In.^{4}	9182	8697	8225	7817	7403	6999
S_{1-1}, In.^{3}	927	889	852	810	777	744
r_{1-1}, In.	7.72	7.64	7.55	7.50	7.42	7.33
A/S_{1-1}	.166	.168	.169	.172	.173	.175
I_{2-2}, In.^{4}	3635	3468	3302	2850	2729	2607
S_{2-2}, In.^{3}	364	347	330	317	303	290
r_{2-2}, In.	4.86	4.82	4.79	4.53	4.50	4.48
A/S_{2-2}	.424	.430	.436	.439	.444	.449
D, In.	19 11/16	19 9/16	19 5/16	19 5/16	19 1/16	18 13/16
d_1, In.	28 1/8	28	27 13/16	26 3/8	26 5/16	26 1/16
P_2, In.	3 9/16	3 7/16	3 5/16	3 5/16	3 5/16	3 1/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 18" H LOADS

CB SECTIONS

ALLOWABLE CONCENTRIC LOADS IN KIPS

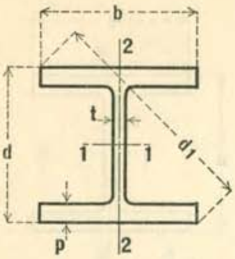


Unit Stress—American Institute of Steel Construction—1928

Nominal Depth and Flange Width—Weight per Foot

Effective Length in Feet	CB 183 18" x 11¾"				CB 182 18" x 8¾"				CB 181 18" x 7½"		
	124 Lbs.	114 Lbs.	105 Lbs.	96 Lbs.	85 Lbs.	77 Lbs.	70 Lbs.	64 Lbs.	55 Lbs.	50 Lbs.	47 Lbs.
7	547	503	463	423	375	339	308	282	243	221	207
8	547	503	463	423	375	339	308	282	243	220	205
9	547	503	463	423	375	339	308	282	233	211	196
10	547	503	463	423	375	338	306	279	223	201	187
11	547	503	463	423	362	327	295	269	212	191	178
12	547	503	463	423	349	315	284	258	202	182	169
13	547	503	463	423	336	303	273	248	192	173	160
14	546	500	459	419	323	291	262	238	182	163	151
15	532	488	448	408	310	279	251	228	172	155	143
16	519	475	436	397	297	268	240	218	163	146	135
17	505	463	424	386	285	256	230	209	154	138	127
18	491	450	412	375	273	245	220	200	146	131	120
19	478	437	400	365	261	234	210	191	138	124	114
20	464	425	389	354	250	224	201	182	130	117	107
21	450	412	377	343	239	214	192	174	123	111	102
22	437	400	366	333	228	205	183	166	117	105	96
23	424	388	354	322	218	196	175	158	111	99	91
24	411	376	343	312	209	187	167	151	105	94	86
25	398	364	332	302	200	179	160	144	100	89	81
26	386	353	322	293	191	171	153	138	94	84	77
27	374	342	312	283	183	164	146	132			
28	362	331	302	274	175	157	140	126			
29	351	320	292	265	168	150	134	121			
30	340	310	282	257	161	144	128	115			
Area, in.²	36.45	33.51	30.86	28.22	24.97	22.63	20.56	18.80	16.19	14.71	13.81
I_{1-1}, in.⁴	2227.1	2033.8	1852.5	1674.7	1429.9	1286.8	1153.9	1045.8	889.9	800.6	736.4
S_{1-1}, in.³	239.0	220.1	202.2	184.4	156.1	141.7	128.2	117.0	98.2	89.0	82.3
r_{1-1}, in.	7.82	7.79	7.75	7.70	7.57	7.54	7.49	7.46	7.41	7.38	7.30
A/S_{1-1}	.153	.152	.153	.153	.160	.160	.160	.161	.165	.165	.168
I_{2-2}, in.⁴	281.9	255.6	231.0	206.8	99.4	88.6	78.5	70.3	42.0	37.2	33.5
S_{2-2}, in.³	47.4	43.2	39.2	35.2	22.5	20.2	17.9	16.1	11.1	9.9	9.0
r_{2-2}, in.	2.78	2.76	2.73	2.71	2.00	1.98	1.95	1.93	1.61	1.59	1.56
A/S_{2-2}	.769	.776	.787	.802	1.110	1.120	1.149	1.168	1.459	1.486	1.534
d, in.	18⅝	18½	18⅜	18⅛	18⅜	18⅛	18	17⅞	18⅛	18	17⅞
d_1, in.	22⅛	22	21⅞	21¾	20½	20⅛	20	20	19⅝	19½	19⅜
b, in.	11⅞	11⅞	11¾	11¾	8⅞	8¾	8¾	8¾	7½	7½	7½
t, in.	11/16	⅝	9/16	½	9/16	½	7/16	7/16	⅜	⅜	⅜
p, in.	1 1/16	1	15/16	13/16	13/16	13/16	¾	11/16	⅝	9/16	½

Safe load values above upper zig-zag line are for ratios of l/r not over 60; those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN H 16″ LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

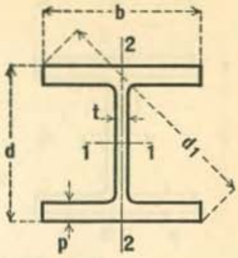
Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot											
	CB 163 16″ x 11½″				CB 162 16″ x 8½″				CB 161 16″ x 7″			
	114 Lbs.	105 Lbs.	96 Lbs.	88 Lbs.	78 Lbs.	71 Lbs.	64 Lbs.	58 Lbs.	50 Lbs.	45 Lbs.	40 Lbs.	36 Lbs.
7	503	463	423	388	344	313	282	256	221	199	177	159
8	503	463	423	388	344	313	282	256	218	195	173	153
9	503	463	423	388	344	313	282	256	208	186	164	146
10	503	463	423	388	341	309	278	250	198	177	156	138
11	503	463	423	388	329	298	267	241	188	168	148	131
12	503	463	423	388	317	287	257	231	178	159	140	123
13	503	463	423	388	304	276	247	222	169	150	132	116
14	500	459	419	382	292	264	237	212	159	142	125	109
15	488	448	408	372	280	253	227	203	150	134	118	103
16	475	436	397	362	268	242	217	194	142	126	111	97
17	463	424	386	352	257	232	207	185	134	119	104	91
18	450	412	375	342	245	221	198	177	126	112	98	85
19	437	401	365	331	235	212	189	169	119	106	93	80
20	425	389	354	321	224	202	180	161	113	100	87	76
21	412	377	343	311	214	193	172	154	106	94	82	71
22	400	366	333	302	204	184	164	146	101	89	78	67
23	388	354	322	292	195	176	157	140	95	84	74	63
24	376	343	312	283	187	168	150	133	90	80	70	60
25	364	333	302	274	178	160	143	127	85	75	66	
26	353	322	293	265	170	153	136	121				
27	342	312	283	256	163	146	130	116				
28	331	302	274	248	156	140	124	111				
29	320	292	265	240	149	134	119	106				
30	310	283	257	232	143	128	114	101				
Area, in.^{2}	33.51	30.87	28.22	25.87	22.92	20.86	18.80	17.04	14.70	13.24	11.77	10.59
I_{1-1}, in.^{4}	1642.6	1497.5	1355.1	1222.6	1042.6	936.9	833.8	746.4	655.4	583.3	515.5	446.3
S_{1-1}, in.^{3}	197.4	181.7	166.1	151.3	127.8	115.9	104.2	94.1	80.7	72.4	64.4	56.3
r_{1-1}, in.	7.00	6.96	6.93	6.87	6.74	6.70	6.66	6.62	6.68	6.64	6.62	6.49
A/S_{1-1}	.170	.170	.170	.171	.179	.180	.180	.181	.182	.183	.183	.188
I_{2-2}, in.^{4}	254.6	230.7	207.2	185.2	87.5	77.9	68.4	60.5	34.8	30.5	26.5	22.1
S_{2-2}, in.^{3}	43.8	39.8	35.9	32.2	20.4	18.2	16.1	14.3	9.8	8.7	7.6	6.3
r_{2-2}, in.	2.76	2.73	2.71	2.67	1.95	1.93	1.91	1.88	1.54	1.52	1.50	1.45
A/S_{2-2}	.765	.776	.786	.803	1.124	1.146	1.168	1.192	1.500	1.522	1.549	1.681
d, in.	16⅝	16½	16⅜	16⅛	16⅜	16⅛	16	15⅞	16¼	16⅛	16	15⅞
d_1, in.	20⅜	20¼	20⅛	19⅞	18½	18¼	18⅛	18	17¾	17⅝	17½	17⅜
b, in.	11⅝	11⅝	11½	11½	8⅝	8½	8½	8½	7⅛	7	7	7
t, in.	⅝	⅝	9/16	½	9/16	½	7/16	7/16	⅜	⅜	5/16	5/16
p, in.	1 1/16	15/16	⅞	13/16	⅞	13/16	11/16	⅝	⅝	9/16	½	7/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200

COLUMN 14″ H LOADS

CB SECTIONS

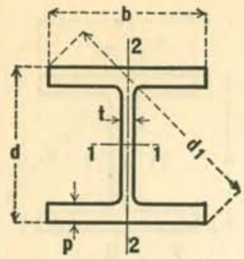
ALLOWABLE CONCENTRIC LOADS IN KIPS



Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot									
	CB 146 14″ x 16″									
	426 Lbs.	412 Lbs.	398 Lbs.	384 Lbs.	370 Lbs.	356 Lbs.	342 Lbs.	328 Lbs.	314 Lbs.	300 Lbs.
20	1879	1817	1755	1694	1632	1570	1509	1446	1385	1323
21	1879	1817	1755	1694	1632	1570	1509	1446	1385	1322
22	1870	1806	1743	1680	1615	1553	1489	1425	1362	1301
23	1841	1778	1715	1653	1589	1528	1466	1402	1340	1279
24	1811	1749	1687	1626	1563	1503	1441	1378	1317	1258
25	1782	1720	1659	1599	1536	1477	1416	1355	1295	1236
26	1751	1691	1631	1571	1510	1452	1392	1332	1271	1213
27	1721	1661	1602	1544	1483	1426	1367	1307	1249	1192
28	1692	1632	1574	1516	1457	1400	1343	1284	1226	1170
29	1661	1602	1546	1489	1430	1375	1317	1259	1202	1147
30	1631	1574	1518	1467	1404	1349	1293	1236	1180	1126
31	1601	1545	1489	1434	1377	1324	1269	1212	1157	1104
32	1571	1515	1461	1407	1351	1299	1243	1189	1135	1083
33	1542	1486	1433	1380	1325	1273	1220	1165	1112	1061
34	1512	1458	1405	1353	1300	1248	1196	1142	1090	1040
35	1483	1430	1379	1326	1273	1223	1171	1120	1068	1019
36	1455	1402	1352	1300	1248	1199	1148	1097	1046	998
37	1426	1374	1325	1274	1223	1175	1125	1075	1025	977
38	1397	1346	1298	1249	1199	1152	1103	1052	1004	958
39	1370	1320	1272	1224	1174	1128	1080	1031	983	938
40	1342	1294	1246	1199	1151	1105	1058	1009	963	918
41	1315	1267	1222	1174	1127	1082	1036	989	943	899
42	1289	1241	1197	1150	1104	1060	1014	969	923	880
43	1263	1216	1172	1127	1081	1038	993	948	903	861
Area, in.^{2}	125.25	121.15	116.98	112.93	108.78	104.68	100.59	96.43	92.30	88.20
I_{1-1}, in.^{4}	6610.3	6309.7	6013.7	5727.5	5454.2	5179.4	4911.5	4656.1	4399.4	4149.5
S_{1-1}, in.^{3}	707.4	682.1	656.9	632.2	608.1	583.6	559.4	535.8	511.9	488.2
r_{1-1}, in.	7.26	7.22	7.17	7.12	7.08	7.03	6.99	6.95	6.90	6.86
A/S_{1-1}	.177	.178	.178	.179	.179	.179	.180	.180	.180	.181
I_{2-2}, in.^{4}	2359.5	2264.9	2169.7	2078.1	1986.0	1895.7	1806.9	1718.5	1631.4	1546.0
S_{2-2}, in.^{3}	282.7	272.1	261.6	251.3	241.1	230.9	220.8	210.9	201.0	191.2
r_{2-2}, in.	4.34	4.32	4.31	4.29	4.27	4.26	4.24	4.22	4.20	4.19
A/S_{2-2}	.443	.445	.447	.449	.451	.453	.456	.457	.459	.461
d, in.	18 3/4	18 1/2	18 1/4	18 1/8	18	17 3/4	17 1/2	17 3/8	17 1/4	17
d_1, in.	25 1/8	24 7/8	24 3/4	24 5/8	24 1/2	24 1/4	24	23 7/8	23 3/4	23 1/2
b, in.	16 3/4	16 5/8	16 5/8	16 1/2	16 1/2	16 3/8	16 3/8	16 1/4	16 1/4	16 1/8
t, in.	1 7/8	1 13/16	1 13/16	1 3/4	1 11/16	1 5/8	1 9/16	1 1/2	1 7/16	1 3/8
p, in.	3 1/16	2 15/16	2 15/16	2 3/4	2 11/16	2 9/16	2 7/16	2 3/8	2 5/16	2 5/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN
H 14″
LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

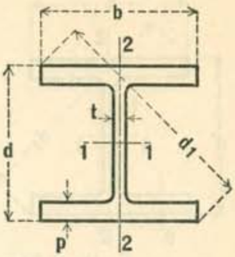
Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot								
	CB 146 14″ x 16″								
	287 Lbs.	273 Lbs.	264 Lbs.	255 Lbs.	246 Lbs.	237 Lbs.	228 Lbs.	219 Lbs.	211 Lbs.
20	1266	1203	1164	1125	1085	1045	1006	965	931
21	1263	1199	1159	1118	1078	1038	997	956	921
22	1242	1179	1140	1100	1060	1021	981	940	905
23	1221	1159	1121	1082	1042	1003	964	924	890
24	1200	1139	1101	1063	1024	985	948	907	874
25	1179	1119	1082	1043	1006	968	930	891	858
26	1158	1099	1062	1024	988	950	913	874	843
27	1137	1078	1042	1005	969	933	896	858	826
28	1116	1058	1023	987	950	914	879	842	811
29	1095	1038	1003	968	932	897	862	825	795
30	1074	1018	984	949	914	879	845	809	779
31	1053	998	964	930	896	862	828	792	763
32	1032	979	945	912	878	845	811	777	748
33	1012	959	926	893	861	827	795	760	732
34	991	940	907	875	843	810	779	745	717
35	971	920	889	857	825	794	763	729	702
36	951	901	870	839	808	777	746	714	687
37	932	883	852	822	791	761	731	699	673
38	912	864	834	805	775	745	716	684	658
39	894	846	817	788	758	729	700	669	644
40	875	828	800	771	742	714	685	655	630
41	856	811	783	755	726	698	671	641	617
42	838	793	766	738	711	684	656	627	603
43	820	776	750	723	695	669	642	613	590
Area, in.²	84.37	80.22	77.63	74.98	72.33	69.69	67.06	64.36	62.07
I_{1-1}, in.⁴	3912.1	3673.2	3526.0	3372.6	3228.9	3080.9	2942.4	2798.2	2671.4
S_{1-1}, in.³	465.5	442.0	427.4	412.0	397.4	382.2	367.8	352.6	339.2
r_{1-1}, in.	6.81	6.77	6.74	6.71	6.68	6.65	6.62	6.59	6.56
A/S_{1-1}	.181	.181	.182	.182	.182	.182	.182	.183	.183
I_{2-2}, in.⁴	1466.5	1382.9	1331.2	1278.1	1226.6	1174.8	1124.8	1073.2	1028.6
S_{2-2}, in.³	181.8	172.2	166.1	159.9	153.9	147.7	141.8	135.6	130.2
r_{2-2}, in.	4.17	4.15	4.14	4.13	4.12	4.11	4.10	4.08	4.07
A/S_{2-2}	.464	.466	.467	.469	.470	.472	.473	.475	.477
d, in.	16¾	16⅝	16½	16⅜	16¼	16⅛	16	15⅞	15¾
d_1, in.	23⅜	23¼	23	23	22⅞	22¾	22⅝	22½	22⅜
b, in.	16⅛	16⅛	16	16	16	15⅞	15⅞	15⅞	15¾
t, in.	1 5/16	1¼	1¼	1 3/16	1⅛	1⅛	1 1/16	1	1
p, in.	2 1/16	2	1 15/16	1⅞	1 13/16	1¾	1 11/16	1⅝	1 9/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 14" H LOADS

CB SECTIONS



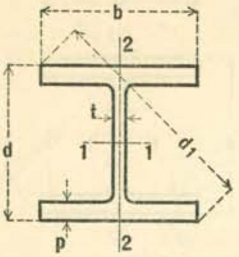
ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot								
	CB 146 14" x 16"								
	202 Lbs.	193 Lbs.	184 Lbs.	176 Lbs.	167 Lbs.	158 Lbs.	150 Lbs.	142 Lbs.	*320 Lbs.
19	891	851	811	776	736	697	661	628	1412
20	891	851	811	776	736	697	660	626	1412
21	880	840	800	764	724	685	649	615	1409
22	866	826	787	751	712	673	638	605	1386
23	851	812	773	738	700	662	627	594	1362
24	836	797	759	725	687	649	615	583	1339
25	820	782	745	711	674	637	604	572	1315
26	805	768	731	698	661	625	592	561	1292
27	790	753	717	684	648	613	581	550	1269
28	774	739	703	671	636	601	569	539	1245
29	759	724	689	657	623	589	558	528	1221
30	744	710	675	644	610	577	546	517	1198
31	729	695	662	631	598	565	535	506	1175
32	714	681	648	618	585	553	524	496	1152
33	700	667	635	605	573	542	513	485	1128
34	685	653	621	592	561	530	502	475	1105
35	670	639	608	580	549	519	491	464	1084
36	656	626	595	567	537	508	480	454	1061
37	642	612	582	555	526	497	470	444	1039
38	629	599	570	543	514	486	460	435	1018
39	615	586	558	531	503	475	450	425	997
40	602	574	546	520	492	465	440	416	976
41	589	561	534	508	481	454	430	407	955
42	576	549	522	497	471	444	421	397	935
Area, in.^{2}	59.39	56.73	54.07	51.73	49.09	46.47	44.08	41.85	94.12
I_{1-1}, in.^{4}	2538.8	2402.4	2274.8	2149.6	2020.8	1900.6	1786.9	1672.2	4141.7
S_{1-1}, in.^{3}	324.9	310.0	295.8	281.9	267.3	253.4	240.2	226.7	492.8
r_{1-1}, in.	6.54	6.51	6.49	6.45	6.42	6.40	6.37	6.32	6.63
A/S_{1-1}	.183	.183	.183	.184	.184	.183	.184	.185	.191
I_{2-2}, in.^{4}	979.7	930.1	882.7	837.9	790.2	745.0	702.5	660.1	1635.1
S_{2-2}, in.^{3}	124.4	118.4	112.7	107.1	101.3	95.8	90.6	85.2	195.7
r_{2-2}, in.	4.06	4.05	4.04	4.02	4.01	4.00	3.99	3.97	4.17
A/S_{2-2}	.477	.479	.480	.483	.485	.485	.487	.491	.481
d, in.	15⅝	15½	15⅜	15¼	15⅛	15	14⅞	14¾	16¾
d_1, in.	22¼	22⅛	22	21⅞	21¾	21⅝	21½	21½	23¾
b, in.	15¾	15¾	15⅝	15⅝	15⅝	15½	15½	15½	16¾
t, in.	15/16	⅞	⅞	13/16	13/16	¾	11/16	11/16	1⅞
p, in.	1½	1 7/16	1⅜	1 5/16	1¼	1 3/16	1⅛	1 1/16	2 1/16

*Core Section.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN
H 14″
LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

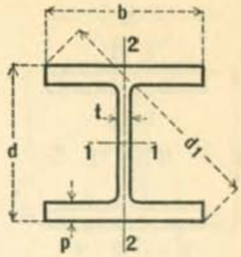
Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot								
	CB 145 14″ x 14½″							CB 144 14″ x 12″	
	136 Lbs.	127 Lbs.	119 Lbs.	111 Lbs.	103 Lbs.	95 Lbs.	87 Lbs.	84 Lbs.	78 Lbs.
15	600	560	525	490	454	419	383	371	344
16	600	560	525	490	454	419	383	363	336
17	600	560	525	490	454	419	383	355	329
18	600	560	525	490	454	419	383	346	321
19	598	558	523	487	451	416	380	338	313
20	587	548	513	478	442	408	373	329	305
21	577	538	504	469	434	400	366	321	297
22	566	528	494	460	426	392	359	312	289
23	555	517	484	451	417	385	351	304	281
24	543	507	474	442	409	377	344	295	273
25	532	496	465	432	400	369	337	287	265
26	521	486	455	423	392	361	330	279	258
27	510	476	445	414	383	353	323	271	251
28	499	466	436	405	375	345	316	263	243
29	488	455	426	396	366	338	309	256	236
30	478	445	417	387	358	330	302	249	229
31	467	435	407	379	350	323	295	241	223
32	456	426	398	370	342	315	288	234	216
33	446	416	389	361	334	308	281	228	210
34	436	406	380	353	326	301	275	221	204
35	426	397	371	345	319	294	268	214	198
36	416	388	363	337	311	287	262	208	192
37	406	379	354	329	304	280	256	202	186
38	397	370	346	321	297	273	250	196	181
Area, in.²	39.98	37.33	34.99	32.65	30.26	27.94	25.56	24.71	22.94
I_{1-1}, in.⁴	1593.0	1476.7	1373.1	1266.5	1165.8	1063.5	966.9	928.4	851.2
S_{1-1}, in.³	216.0	202.0	189.4	176.3	163.6	150.6	138.1	130.9	121.1
r_{1-1}, in.	6.31	6.29	6.26	6.23	6.21	6.17	6.15	6.13	6.09
A/S_{1-1}	.185	.185	.185	.185	.185	.186	.185	.189	.189
I_{2-2}, in.⁴	567.7	527.6	491.8	454.9	419.7	383.7	349.7	225.5	206.9
S_{2-2}, in.³	77.0	71.8	67.1	62.2	57.6	52.8	48.2	37.5	34.5
r_{2-2}, in.	3.77	3.76	3.75	3.73	3.72	3.71	3.70	3.02	3.00
A/S_{2-2}	.519	.520	.521	.525	.525	.529	.530	.659	.665
d, in.	14¾	14⅝	14½	14⅜	14¼	14⅛	14	14⅛	14
d_1, in.	20⅞	20¾	20⅝	20⅝	20½	20¼	20¼	18⅝	18½
b, in.	14¾	14¾	14⅝	14⅝	14⅝	14½	14½	12	12
t, in.	11/16	⅝	9/16	9/16	½	½	7/16	7/16	7/16
p, in.	1 1/16	1	15/16	⅞	13/16	¾	11/16	¾	11/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 14" H LOADS

CB SECTIONS

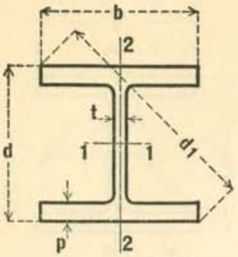
ALLOWABLE CONCENTRIC LOADS IN KIPS



Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	CB 143 14" x 10" 74 Lbs.	68 Lbs.	61 Lbs.	CB 142 14" x 8" 58 Lbs.	53 Lbs.	48 Lbs.	43 Lbs.	CB 141 14" x 6¾" 42 Lbs.	38 Lbs.	34 Lbs.	30 Lbs.
7	326	300	269	256	234	212	190	185	168	150	132
8	326	300	269	256	234	212	190	181	163	145	126
9	326	300	269	256	234	212	190	173	156	138	120
10	326	300	269	253	231	208	186	164	148	131	113
11	326	300	269	244	222	201	179	156	140	124	107
12	326	300	269	235	214	193	172	148	132	117	100
13	321	294	264	225	205	185	165	139	125	110	94
14	312	286	256	216	197	178	158	132	118	104	89
15	303	277	248	207	188	170	151	124	111	98	83
16	294	269	241	198	180	163	145	117	105	92	78
17	285	261	233	189	172	155	138	110	99	86	73
18	276	252	225	181	165	148	132	104	93	81	69
19	267	244	218	173	157	142	126	98	87	76	65
20	258	235	211	165	150	135	120	92	82	72	61
21	249	227	203	158	143	129	115	87	78	68	57
22	240	220	196	151	137	123	109	82	73	64	54
23	232	212	189	144	131	118	104	78	69	60	51
24	224	204	183	137	125	112	99	74	65	57	
25	216	197	176	131	119	107	95	70			
26	208	190	170	125	114	102	91				
27	201	183	164	120	109	98	87				
28	194	177	158	114	104	93	83				
29	187	170	152	109	99	89	79				
30	180	164	147	105	95	85	75				
Area, in.^{2}	21.76	20.00	17.94	17.06	15.59	14.11	12.65	12.34	11.17	10.00	8.81
I_{1-1}, in.^{4}	796.8	724.1	641.5	597.9	542.1	484.9	429.0	432.2	385.3	339.2	289.6
S_{1-1}, in.^{3}	112.3	103.0	92.2	85.0	77.8	70.2	62.7	60.7	54.6	48.5	41.8
r_{1-1}, in.	6.05	6.02	5.98	5.92	5.90	5.86	5.82	5.92	5.87	5.83	5.73
A/S_{1-1}	.194	.194	.195	.201	.200	.201	.202	.203	.205	.206	.211
I_{2-2}, in.^{4}	133.5	121.2	107.3	63.7	57.5	51.3	45.1	28.1	24.6	21.3	17.5
S_{2-2}, in.^{3}	26.5	24.1	21.5	15.7	14.3	12.8	11.3	8.3	7.3	6.3	5.2
r_{2-2}, in.	2.48	2.46	2.45	1.93	1.92	1.91	1.89	1.51	1.49	1.46	1.41
A/S_{2-2}	.821	.830	.834	1.087	1.090	1.102	1.119	1.487	1.530	1.587	1.694
d, in.	14¼	14	13⅞	14	14	13¾	13⅝	14¼	14⅛	14	13⅞
d_1, in.	17½	17¼	17⅛	16¼	16⅛	15⅞	15⅞	15¾	15¾	15⅝	15½
b, in.	10⅛	10	10	8⅛	8	8	8	6¾	6¾	6¾	6¾
t, in.	7/16	7/16	⅜	7/16	⅜	⅜	5/16	⅜	5/16	5/16	5/16
p, in.	13/16	11/16	⅝	11/16	11/16	9/16	½	9/16	½	7/16	⅜

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



COLUMN H 12″ LOADS

CB SECTIONS

ALLOWABLE CONCENTRIC LOADS IN KIPS

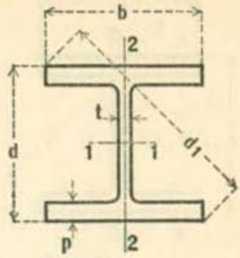
Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot							
	CB 124 12″ x 12″							
	190 Lbs.	176 Lbs.	161 Lbs.	147 Lbs.	133 Lbs.	120 Lbs.	106 Lbs.	99 Lbs.
15	838	777	711	649	587	530	468	436
16	838	777	711	647	584	526	463	431
17	825	762	696	633	572	514	453	422
18	807	746	681	620	559	503	443	412
19	790	729	665	605	546	491	432	402
20	772	713	650	591	533	479	422	392
21	754	695	634	577	520	467	411	382
22	736	679	619	563	507	456	401	373
23	718	662	603	549	495	444	390	363
24	700	646	588	535	482	432	380	353
25	682	629	573	521	469	421	370	344
26	665	613	558	507	457	409	360	334
27	648	597	543	494	445	398	350	325
28	631	581	529	480	432	387	340	316
29	614	565	514	467	421	377	331	307
30	598	550	501	455	409	366	322	299
31	582	535	487	442	398	356	313	290
32	567	521	474	430	387	346	304	282
33	551	507	461	418	376	336	295	274
34	536	493	448	407	366	327	287	266
35	522	479	436	395	355	318	279	258
36	507	466	424	384	345	309	271	251
37	494	453	412	374	336	300	263	244
38	480	441	401	363	326	292	256	237
Area, in.^{2}	55.86	51.79	47.38	43.24	39.11	35.31	31.19	29.09
I_{1-1}, in.^{4}	1892.5	1712.5	1541.8	1374.4	1221.2	1071.7	930.7	858.5
S_{1-1}, in.^{3}	263.2	242.6	222.2	201.8	182.5	163.4	144.5	134.7
r_{1-1}, in.	5.82	5.75	5.70	5.64	5.59	5.51	5.46	5.43
A/S_{1-1}	.212	.213	.213	.214	2.14	.216	.216	.216
I_{2-2}, in.^{4}	589.7	538.4	486.2	436.8	389.9	345.1	300.9	278.2
S_{2-2}, in.^{3}	93.1	85.4	77.7	70.2	63.1	56.0	49.2	45.7
r_{2-2}, in.	3.25	3.22	3.20	3.18	3.16	3.13	3.11	3.09
A/S_{2-2}	.600	.606	.610	.616	.620	.631	.634	.637
d, in.	14⅜	14⅛	13⅞	13⅝	13⅜	13⅛	12⅞	12¾
d_1, in.	19¼	19	18¾	18½	18¼	18⅛	17⅞	17¾
b, in.	12⅝	12⅝	12½	12½	12⅜	12⅜	12¼	12¼
t, in.	1 1/16	1	15/16	⅞	¾	¾	⅝	⅝
p, in.	1¾	1⅝	1½	1⅜	1¼	1⅛	1	15/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 12" H LOADS

CB SECTIONS

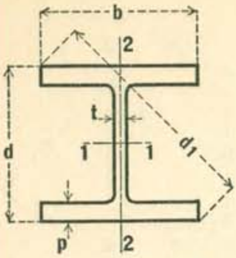


ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot							
	CB 124 12" x 12"					CB 123 12" x 10"		
	92 Lbs.	85 Lbs.	79 Lbs.	72 Lbs.	65 Lbs.	64 Lbs.	58 Lbs.	53 Lbs.
12	406	375	348	317	287	282	256	234
13	406	375	348	317	287	279	253	230
14	406	375	348	317	287	271	246	224
15	406	375	348	317	287	264	239	217
16	401	369	343	312	281	256	232	211
17	392	361	335	305	274	248	225	204
18	383	353	327	298	268	240	217	197
19	373	344	319	290	261	232	211	191
20	364	336	311	283	255	225	204	185
21	355	327	303	276	248	217	197	178
22	346	319	295	268	242	210	190	172
23	337	310	287	261	235	203	184	166
24	328	302	280	254	228	196	177	160
25	319	294	272	247	222	189	171	155
26	310	286	264	240	216	182	165	149
27	302	278	257	233	210	176	159	144
28	293	270	250	227	204	170	154	139
29	285	262	243	220	198	164	149	134
30	277	255	236	214	192	158	143	129
31	269	248	229	208	187	153	138	125
32	261	241	222	202	181	147	133	120
33	254	234	216	196	176	142	129	116
34	247	227	210	190	171	137	124	112
35	240	220	204	185	166	133	120	108
Area, in.^{2}	27.06	24.98	23.22	21.16	19.11	18.83	17.06	15.59
I_{1-1}, in.^{4}	788.9	723.3	663.0	597.4	533.4	528.3	476.1	426.2
S_{1-1}, in.^{3}	125.0	115.7	107.1	97.5	88.0	85.8	78.1	70.7
r_{1-1}, in.	5.40	5.38	5.34	5.31	5.28	5.29	5.28	5.23
A/S_{1-1}	.216	.216	.217	.217	.217	.219	.218	.221
I_{2-2}, in.^{4}	256.4	235.5	216.4	195.3	174.6	119.0	107.4	96.1
S_{2-2}, in.^{3}	42.2	38.9	35.8	32.4	29.1	23.7	21.4	19.2
r_{2-2}, in.	3.08	3.07	3.05	3.04	3.02	2.51	2.51	2.48
A/S_{2-2}	.641	.642	.649	.653	.657	.795	.797	.812
d, in.	$12\frac{5}{8}$	$12\frac{1}{2}$	$12\frac{3}{8}$	$12\frac{1}{4}$	$12\frac{1}{8}$	$12\frac{1}{4}$	$12\frac{1}{4}$	12
d_1, in.	$17\frac{1}{2}$	$17\frac{1}{2}$	$17\frac{3}{8}$	$17\frac{1}{4}$	$17\frac{1}{8}$	$15\frac{7}{8}$	$15\frac{7}{8}$	$15\frac{5}{8}$
b, in.	$12\frac{1}{8}$	$12\frac{1}{8}$	$12\frac{1}{8}$	12	12	10	10	10
t, in.	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{3}{8}$
p, in.	$\frac{7}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{9}{16}$

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN H 12″ LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

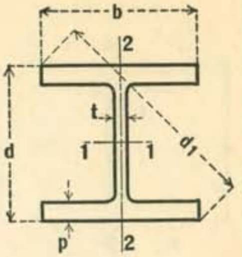
Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot						
	CB 122 12″ x 8″			CB 121 12″ x 6½″			
	50 Lbs.	45 Lbs.	40 Lbs.	36 Lbs.	32 Lbs.	28 Lbs.	25 Lbs.
7	221	199	177	159	141	123	111
8	221	199	177	155	137	119	105
9	221	199	177	148	131	114	100
10	219	196	175	141	124	108	94
11	212	190	169	133	117	102	89
12	204	183	162	126	111	96	84
13	196	175	156	119	105	91	79
14	188	168	150	112	99	85	74
15	180	161	143	106	93	80	69
16	173	154	137	100	88	76	65
17	165	148	131	94	82	71	61
18	158	141	126	89	78	67	57
19	151	135	120	83	73	63	54
20	145	129	115	79	69	59	51
21	138	123	109	74	65	56	48
22	132	117	104	70	61	53	45
23	126	112	100	66	58	50	42
24	120	107	95	63	55	47	
25	115	102	91	59			
26	110	98	87				
27	105	93	83				
28	101	89	79				
29	96	85	76				
30	92	82	73				
Area, in.²	14.71	13.24	11.77	10.59	9.41	8.23	7.39
I_{1-1}, in.⁴	394.5	350.8	310.1	280.8	246.8	213.5	183.4
S_{1-1}, in.³	64.7	58.2	51.9	45.9	40.7	35.6	30.9
r_{1-1}, in.	5.18	5.15	5.13	5.15	5.12	5.09	4.98
A/S_{1-1}	.227	.227	.227	.231	.231	.231	.239
I_{2-2}, in.⁴	56.4	50.0	44.1	23.7	20.6	17.5	14.5
S_{2-2}, in.³	14.0	12.4	11.0	7.2	6.3	5.4	4.5
r_{2-2}, in.	1.96	1.94	1.94	1.50	1.48	1.46	1.40
A/S_{2-2}	1.051	1.068	1.070	1.471	1.494	1.524	1.642
d, in.	12¼	12	12	12¼	12⅛	12	11⅞
d_1, in.	14¾	14½	14½	14	13¾	13¾	13⅝
b, in.	8⅛	8	8	6⅝	6½	6½	6½
t, in.	⅜	⅜	5/16	5/16	5/16	¼	¼
p, in.	⅝	9/16	½	9/16	½	7/16	⅜

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 10″ H LOADS

CB SECTIONS

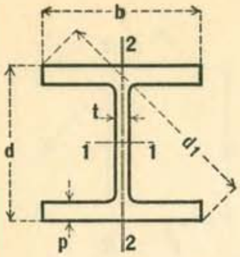


ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot										
	CB 103 10″ x 10″										
	136 Lbs.	124 Lbs.	112 Lbs.	100 Lbs.	89 Lbs.	77 Lbs.	72 Lbs.	66 Lbs.	60 Lbs.	54 Lbs.	49 Lbs.
12	600	547	494	441	393	340	318	291	265	238	216
13	600	547	494	441	393	340	317	290	264	237	214
14	594	539	486	433	384	331	309	283	257	231	209
15	579	526	473	422	374	322	301	275	250	224	203
16	564	511	460	410	364	313	292	267	243	218	197
17	549	497	447	398	353	304	283	259	235	211	191
18	534	483	435	387	343	295	275	251	228	205	185
19	518	469	422	375	333	286	267	244	221	198	179
20	503	455	409	364	322	277	258	236	214	192	173
21	488	441	396	353	312	268	250	228	207	186	168
22	473	428	384	342	302	260	242	221	200	180	162
23	458	414	372	331	293	251	234	214	194	174	156
24	444	401	360	320	283	243	226	207	187	168	151
25	430	388	348	309	274	235	218	200	181	162	146
26	416	376	337	299	265	227	211	193	175	157	141
27	403	364	326	290	256	219	204	186	169	151	136
28	390	352	315	280	247	212	197	180	163	146	131
29	377	340	305	271	239	205	190	174	157	141	127
30	365	329	295	262	231	198	184	168	152	136	123
31	353	318	285	253	223	191	178	162	147	132	118
32	342	308	276	245	216	184	172	157	142	127	114
33	331	298	267	236	209	178	166	151	137	123	110
34	320	288	258	229	202	172	160	146	133	119	107
35	310	279	250	221	195	167	155	141	128	115	103
Area, in.^{2}	40.03	36.46	32.92	28.43	26.19	22.67	21.18	19.41	17.66	15.88	14.40
I_{1-1}, in.^{4}	917.2	813.1	718.7	625.0	542.4	457.2	420.7	382.5	343.7	305.7	272.9
S_{1-1}, in.^{3}	154.4	139.9	126.3	112.4	99.7	86.1	80.1	73.7	67.1	60.4	54.6
r_{1-1}, in.	4.79	4.72	4.67	4.61	4.55	4.49	4.46	4.44	4.41	4.39	4.35
A/S_{1-1}	.259	.261	.261	.262	.263	.263	.264	.263	.263	.263	.264
I_{2-2}, in.^{4}	295.9	264.8	235.4	206.6	180.6	153.4	141.8	129.2	116.5	103.9	93.0
S_{2-2}, in.^{3}	56.0	50.4	45.2	39.9	35.2	30.1	27.9	25.5	23.1	20.7	18.6
r_{2-2}, in.	2.72	2.69	2.67	2.65	2.63	2.60	2.59	2.58	2.57	2.56	2.54
A/S_{2-2}	.715	.723	.728	.738	.744	.753	.759	.761	.765	.767	.774
d, in.	11 7/8	11 5/8	11 3/8	11 1/8	10 7/8	10 5/8	10 1/2	10 3/8	10 1/4	10 1/8	10
d_1, in.	16	15 3/4	15 1/2	15 1/4	15	14 3/4	14 5/8	14 1/2	14 1/2	14 1/4	14 1/8
b, in.	10 5/8	10 1/2	10 3/8	10 3/8	10 1/4	10 1/4	10 1/8	10 1/8	10 1/8	10	10
t, in.	15/16	7/8	3/4	11/16	5/8	9/16	1/2	7/16	7/16	3/8	3/8
p, in.	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	13/16	3/4	11/16	5/8	9/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN

H 10″

LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

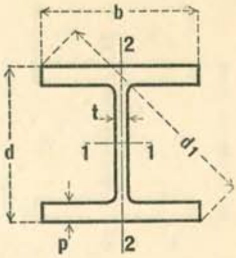
Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot							
	CB 102 10″ x 8″				CB 101 10″ x 5¾″			
	45 Lbs.	41 Lbs.	37 Lbs.	33 Lbs.	29 Lbs.	26 Lbs.	23 Lbs.	21 Lbs.
6	199	181	163	146	128	115	102	93
7	199	181	163	146	126	112	99	89
8	199	181	163	146	120	106	93	84
9	199	181	163	146	113	100	88	79
10	199	181	162	144	106	94	82	74
11	192	174	157	139	100	89	77	69
12	185	168	151	134	94	83	72	64
13	178	162	145	129	88	78	67	60
14	171	156	139	123	82	72	63	56
15	164	149	134	118	77	68	59	52
16	158	143	128	113	72	63	55	48
17	151	137	123	108	67	59	51	45
18	145	131	117	104	63	55	48	42
19	138	126	112	99	59	52	45	39
20	132	120	107	94	55	49	42	37
21	127	115	103	90	52	46	39	
22	121	110	98	86	49	43		
23	116	105	94	82				
24	111	100	90	79				
25	106	96	86	75				
26	101	92	82	72				
27	97	88	78	69				
28	93	84	75	66				
29	89	80	72	63				
Area, in.^{2}	13.24	12.06	10.88	9.71	8.53	7.65	6.77	6.19
I_{1-1}, in.^{4}	248.6	222.4	196.9	170.9	157.3	139.7	120.6	106.3
S_{1-1}, in.^{3}	49.1	44.5	39.9	35.0	30.8	27.6	24.1	21.5
r_{1-1}, in.	4.33	4.29	4.25	4.20	4.29	4.27	4.22	4.14
A/S_{1-1}	.270	.271	.273	.277	.277	.277	.281	.288
I_{2-2}, in.^{4}	53.2	47.7	42.2	36.5	15.2	13.4	11.3	9.7
S_{2-2}, in.^{3}	13.3	11.9	10.6	9.2	5.2	4.6	3.9	3.4
r_{2-2}, in.	2.00	1.99	1.97	1.94	1.34	1.32	1.29	1.25
A/S_{2-2}	.995	1.013	1.026	1.055	1.640	1.663	1.736	1.821
d, in.	10⅛	10	9⅞	9¾	10¼	10⅛	10	9⅞
d_1, in.	13	12⅞	12¾	12⅝	11¾	11¾	11⅝	11½
b, in.	8	8	8	8	5¾	5¾	5¾	5¾
t, in.	⅜	5/16	5/16	5/16	5/16	¼	¼	¼
p, in.	⅝	9/16	½	7/16	½	7/16	⅜	5/16

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN 8″ H LOADS

CB SECTIONS

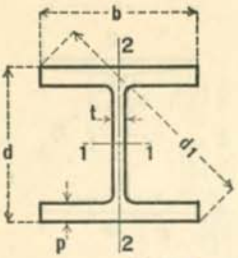


ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot								
	CB 83 8″ x 8″							CB 82 8″ x 6½″	
	67 Lbs.	58 Lbs.	48 Lbs.	40 Lbs.	35 Lbs.	33 Lbs.	31 Lbs.	27 Lbs.	24 Lbs.
8	296	256	212	176	155	146	137	119	106
9	296	256	212	176	155	146	137	114	102
10	296	256	212	176	155	146	137	109	97
11	292	252	207	172	150	141	132	104	93
12	282	243	201	166	145	136	128	99	88
13	273	235	194	160	140	131	123	94	84
14	263	227	186	154	134	126	118	89	79
15	253	218	179	148	129	121	114	85	75
16	244	210	172	142	124	116	109	80	71
17	234	202	165	136	119	111	104	76	67
18	225	193	159	130	114	107	100	72	64
19	216	186	152	125	109	102	96	68	60
20	207	178	146	120	104	98	92	64	57
21	199	171	140	115	100	94	88	61	54
22	191	164	134	110	96	90	84	58	51
23	183	157	128	105	91	86	80	55	48
24	175	150	123	100	88	82	77	52	46
25	168	144	118	96	84	78	73	49	43
26	161	138	113	92	80	75	70	47	41
27	154	132	108	88	77	72	67	44	
28	148	127	104	84	74	69	64		
29	142	122	99	81	70	66	62		
30	136	117	95	78	68	63	59		
31	131	112	91	74	65	61	57		
Area, in.^{2}	19.70	17.06	14.11	11.76	10.30	9.70	9.12	7.93	7.06
I_{1-1}, in.^{4}	271.8	227.3	183.7	146.3	126.5	117.9	109.7	94.1	82.5
S_{1-1}, in.^{3}	60.4	52.0	43.2	35.5	31.1	29.3	27.4	23.4	20.8
r_{1-1}, in.	3.71	3.65	3.61	3.53	3.50	3.49	3.47	3.44	3.42
A/S_{1-1}	.326	.328	.327	.331	.331	.331	.333	.339	.339
I_{2-2}, in.^{4}	88.6	74.9	60.9	49.0	42.5	39.7	37.0	20.8	18.2
S_{2-2}, in.^{3}	21.4	18.2	15.0	12.1	10.6	9.9	9.2	6.4	5.6
r_{2-2}, in.	2.12	2.10	2.08	2.04	2.03	2.02	2.01	1.62	1.61
A/S_{2-2}	.921	.937	.941	.972	.972	.980	.991	1.239	1.261
d, in.	9	8¾	8½	8¼	8⅛	8	8	8	7⅞
d_1, in.	12¼	12	11⅞	11⅝	11½	11⅜	11⅜	10⅜	10¼
b, in.	8¼	8¼	8⅛	8⅛	8	8	8	6½	6½
t, in.	9/16	½	7/16	⅜	5/16	5/16	5/16	5/16	¼
p, in.	15/16	15/16	11/16	9/16	½	7/16	7/16	7/16	⅜

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.



CB SECTIONS

COLUMN H 6″ LOADS

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	Nominal Depth and Flange Width—Weight per Foot: CB 61 5¾″ x 9½″ 88 Lbs.	80 Lbs.	70 Lbs.	60 Lbs.	50 Lbs.	40 Lbs.
11	388	353	309	264	221	176
12	388	353	309	264	221	176
13	388	352	306	261	217	173
14	378	343	298	254	211	168
15	368	333	290	247	205	162
16	357	324	281	239	199	157
17	347	314	273	232	192	152
18	337	305	264	225	186	147
19	326	295	256	218	180	143
20	316	286	248	210	174	138
21	306	277	239	203	168	133
22	296	268	232	197	162	128
23	286	259	224	190	157	124
24	277	250	216	183	151	119
25	268	242	209	177	146	115
26	259	234	202	171	141	111
27	250	226	195	165	136	107
28	242	218	188	159	131	103
29	233	211	181	154	126	99
30	225	203	175	148	122	96
31	218	196	169	143	118	92
32	211	190	163	138	113	89
33	203	183	158	133	109	86
34	197	177	152	129	106	83
35	190	171	147	124	102	80
Area, in.²	25.87	23.52	20.58	17.63	14.70	11.76
I_{1-1}, in.⁴	187.3	164.9	138.7	113.9	91.0	69.6
S_{1-1}, in.³	54.7	49.5	43.0	36.7	30.4	24.2
r_{1-1}, in.	2.69	2.65	2.60	2.54	2.49	2.43
A/S_{1-1}	.473	.475	.479	.480	.484	.486
I_{2-2}, in.⁴	175.4	156.3	133.3	111.1	90.1	69.9
S_{2-2}, in.³	34.9	31.4	27.1	22.8	18.7	14.7
r_{2-2}, in.	2.60	2.58	2.54	2.51	2.48	2.44
A/S_{2-2}	.741	.749	.759	.773	.786	.800
d, in.	6 7/8	6 5/8	6 1/2	6 1/4	6	5 3/4
d_1, in.	12 1/4	12	11 7/8	11 5/8	11 3/8	11 1/8
b, in.	10	10	9 7/8	9 3/4	9 5/8	9 1/2
t, in.	1 1/16	15/16	7/8	3/4	5/8	1/2
p, in.	1 1/16	15/16	15/16	3/4	5/8	1/2

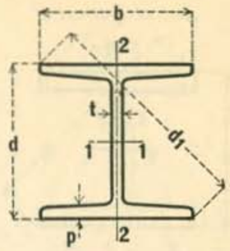
Effective Length in Feet	Nom. Depth and Flange Width—Wt. per Ft.: CBS 6 6″ x 6″ 18 Lbs.	15½ Lbs.	CBL 6 6″ x 4″ 16 Lbs.	12 Lbs.
3	79	69	71	53
4	79	69	71	53
5	79	69	70	51
6	79	69	65	47
7	79	69	60	43
8	76	66	55	39
9	72	63	50	35
10	69	59	45	32
11	65	56	41	29
12	61	53	38	26
13	58	49	34	24
14	54	46	31	22
15	51	44	29	20
16	48	41	26	
17	45	38		
18	42	36		
19	40	34		
20	37	32		
21	35	30		
22	33	28		
23	31	27		
24	29			
Area, in.²	5.28	4.59	4.72	3.53
I_{1-1}, in.⁴	35.5	30.1	31.7	21.7
S_{1-1}, in.³	11.7	10.0	10.1	7.24
r_{1-1}, in.	2.59	2.56	2.59	2.48
A/S_{1-1}	.451	.459	.467	.488
I_{2-2}, in.⁴	11.0	9.19	4.32	2.89
S_{2-2}, in.³	3.64	3.06	2.14	1.44
r_{2-2}, in.	1.44	1.42	.96	.90
A/S_{2-2}	1.45	1.50	2.21	2.45
d, in.	6 1/8	6	6 1/4	6
d_1, in.	8 5/8	8 1/2	7 1/2	7 1/4
b, in.	6	6	4	4
t, in.	1/4	1/4	1/4	1/4
p, in.	5/16	1/4	3/8	1/4

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

COLUMN
8″ to 4″
LOADS

CB SECTIONS
H-BEAMS

ALLOWABLE CONCENTRIC LOADS IN KIPS



Unit Stress—American Institute of Steel Construction—1928

Effective Length in Feet	CB 81 8″ x 5¼″ 21 Lbs.	CB 81 19 Lbs.	CB 81 17 Lbs.	H 4 8″ x 8″ 37.7 Lbs.	H 4 34.3 Lbs.	H 4 32.6 Lbs.	H 3A 6″ x 6″ 27.5 Lbs.	H 3A 25 Lbs.	H 3 6″ x 6″ 22.5 Lbs.	H 3 20 Lbs.	H 2 5″x5″ 18.9 Lbs.	H 1 4″x4″ 13.8 Lbs.
1	93	84	75	165	150	143	121	110	99	88	82	60
2	93	84	75	165	150	143	121	110	99	88	82	60
3	93	84	75	165	150	143	121	110	99	88	82	60
4	93	84	75	165	150	143	121	110	99	88	82	60
5	93	84	75	165	150	143	121	110	99	88	82	59
6	93	84	74	165	150	143	121	110	99	88	82	54
7	88	79	70	165	150	143	121	110	98	88	77	50
8	83	74	65	165	150	143	116	106	93	83	73	46
9	78	69	61	165	150	143	110	100	88	79	68	42
10	72	64	56	160	146	140	104	95	83	75	63	38
11	67	60	52	154	141	135	98	90	78	70	59	35
12	63	55	49	147	135	130	92	84	73	66	55	32
13	58	51	45	141	130	124	87	79	69	62	51	29
14	54	48	42	135	124	119	81	75	64	58	47	26
15	50	44	38	129	119	114	76	70	60	55	44	24
16	47	41	36	123	114	109	72	66	56	51	41	
17	44	38	33	117	108	104	67	62	53	48	38	
18	41	36	31	112	103	100	63	58	50	45	35	
19	38	33	29	106	99	95	59	55	46	42	33	
20	35			101	94	91	56	51	44	40	31	
21				96	90	86	52	48	41	37		
22				92	85	83	49	46	38	35		
23				87	81	79	46	43		33		
24				83	78	75						
25				79	74	72						
Area, in.^{2}	6.18	5.59	5.00	11.00	10.00	9.50	8.08	7.33	6.61	5.86	5.47	3.99
I_{1-1}, in.^{4}	73.8	64.7	56.4	120.8	115.5	112.8	49.3	47.0	41.0	38.8	23.8	10.7
S_{1-1}, in.^{3}	18.0	16.0	14.1	30.2	28.9	28.2	16.4	15.7	13.7	12.9	9.5	5.3
r_{1-1}, in.	3.45	3.40	3.36	3.31	3.40	3.45	2.47	2.53	2.49	2.57	2.08	1.64
A/S_{1-1}	.343	.349	.355	.364	.346	.337	.493	.467	.482	.454	.576	.753
I_{2-2}, in.^{4}	9.13	7.87	6.72	36.9	35.1	34.2	16.0	14.9	12.2	11.4	7.8	3.6
S_{2-2}, in.^{3}	3.5	3.0	2.6	9.1	8.8	8.6	5.3	5.0	4.0	3.8	3.1	1.8
r_{2-2}, in.	1.22	1.19	1.16	1.83	1.87	1.90	1.41	1.43	1.36	1.39	1.20	0.95
A/S_{2-2}	1.76	1.87	1.92	1.209	1.136	1.105	1.535	1.466	1.653	1.542	1.765	2.217
d, in.	8¼	8⅛	8	8	8	8	6	6	6	6	5	4
d_1, in.	9¾	9⅝	9⅝	11 7/16	11 5/16	11¼	8 9/16	8½	8 9/16	8½	7 1/16	5 11/16
b, in.	5¼	5¼	5¼	8⅛	8	7⅝	6 1/16	5 13/16	6 1/16	5 13/16	5	4
t, in.	¼	¼	¼	½	⅜	5/16	7/16	5/16	⅜	¼	5/16	5/16
p, in.	⅜	⅜	5/16	7/16	7/16	7/16	½	½	⅜	⅜	7/16	⅜

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

BEAM COLUMNS—AMERICAN STANDARD SECTIONS

Allowable Concentric Loads in Kips

Depth, In.	24	24	20	20	18	15	15	12	12	10	8	7	6	5	4	3
Weight, lb./ft.	105.9	79.9	81.4	65.4	54.7	60.8	42.9	40.8	31.8	25.4	18.4	15.3	12.5	10.0	7.7	5.7
Effective Length in feet															33.3	24.6
3	464.7	350.0	356.1	286.2	239.1	265.2	187.4	177.6	138.9	110.7	80.1	66.5	54.2	43.1	33.0	23.5
4	464.7	350.0	356.1	286.2	239.1	265.2	187.4	177.6	138.9	110.7	80.1	65.9	52.1	39.7	29.1	20.3
5	464.7	350.0	356.1	286.2	239.1	265.2	187.4	177.6	138.9	109.5	74.9	60.0	46.9	35.1	25.3	17.2
6	464.7	350.0	356.1	286.2	235.6	265.2	180.3	170.9	130.0	101.7	68.3	54.1	41.8	30.7	21.8	14.6
7	464.7	346.4	355.3	271.0	221.2	251.1	168.2	159.5	120.4	93.8	61.8	48.5	37.0	26.8	18.7	12.3
8	464.7	328.9	337.7	254.5	206.8	235.8	156.2	148.1	110.9	86.0	55.7	43.3	32.7	23.4	16.1	10.5
9	445.0	311.0	320.0	238.0	192.6	220.5	144.5	137.0	102.0	78.7	50.1	38.6	28.9	20.4	13.9	
10	424.9	293.2	302.3	222.0	178.7	205.7	133.4	126.4	93.4	71.8	45.0	34.5	25.5	17.9		
11	404.6	275.6	284.5	206.7	165.6	191.6	122.9	116.5	85.5	65.5	40.5	30.8	22.6			
12	384.6	258.7	267.7	192.2	153.3	178.1	113.1	107.2	78.3	59.7	36.5	27.6	20.2			
13	364.9	242.6	251.4	178.6	141.8	165.5	104.1	98.7	71.7	54.5	33.0	24.7				
14	345.8	227.3	235.8	165.9	131.2	153.7	95.8	90.9	65.7	49.8	29.8					
15	327.4	212.9	221.2	154.0	121.5	142.7	88.4	83.8	60.3	45.6						
16	309.8	199.2	207.5	143.2	112.6	132.6	81.6	77.3	55.4	41.8						
17	293.0	186.6	194.6	133.2	104.4	123.4	75.4	71.4								
18	277.1	174.9	182.5	124.0	96.9	114.9	69.8	66.1								
19	262.0	163.9	171.3	115.5	90.1	107.1										
20	247.7	153.8	160.8	107.8		99.9										
21	234.5	144.4	151.2													
22	222.0	135.8	142.3													
23	210.2		133.9													
24	199.2															
25	188.8															
26	179.1															
Area, in.²	30.98	23.33	23.74	19.08	15.94	17.68	12.49	11.84	9.26	7.38	5.34	4.43	3.61	2.87	2.21	1.64
I_{1-1}, in.⁴	2811.5	2087.2	1466.3	1169.5	795.5	609.0	441.8	268.9	215.8	122.1	56.9	36.2	21.8	12.1	6.0	2.5
r_{1-1}, in.	9.53	9.46	7.86	7.83	7.07	5.87	5.95	4.77	4.83	4.07	3.26	2.86	2.46	2.05	1.64	1.23
I_{2-2}, in.⁴	78.9	42.9	45.8	27.9	21.2	26.0	14.6	13.8	9.5	6.9	3.8	2.7	1.8	1.2	0.77	0.46
r_{2-2}, in.	1.60	1.36	1.39	1.21	1.15	1.21	1.08	1.08	1.01	0.97	0.84	0.78	0.72	0.65	0.59	0.53
Weight, lb./ft.	105.9	79.9	81.4	65.4	54.7	60.8	42.9	40.8	31.8	25.4	18.4	15.3	12.5	10.0	7.7	5.7

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for lengths of 60 radii and under.

Safe loads above upper zig-zag line are for ratios of l/r not over 60, between zig-zag lines up to 120 and below lower zig-zag line not over 200.

STEEL PIPE COLUMNS

Allowable Concentric Loads in Kips

STANDARD PIPE

Unit Stress—American Institute of Steel Construction—1928

	Nominal Size, In.	12	12	10	10	10	8	8	6	5	4	3½	3	2½	2
	External Dia., In.	12.750	12.750	10.750	10.750	10.750	8.625	8.625	6.625	5.563	4.500	4.000	3.500	2.875	2.375
	Thickness, In.	.375	.330	.365	.307	.279	.322	.277	.280	.258	.237	.226	.216	.203	.154
Effective Length in Feet	5	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	40.2	33.4	25.0	14.7
	6	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	40.2	33.1	23.2	13.3
	7	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	39.6	31.1	21.3	11.9
	8	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	46.6	37.5	29.1	19.5	10.6
	9	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	44.4	35.4	27.2	17.8	9.5
	10	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	63.1	42.2	33.3	25.2	16.2	8.5
	11	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	60.7	40.1	31.3	23.4	14.7	7.6
	12	218.7	193.2	178.6	151.1	137.7	126.0	109.0	81.8	58.3	37.9	29.3	21.7	13.4	6.8
	13	218.7	193.2	178.6	151.1	137.7	126.0	109.0	79.2	55.9	35.8	27.5	20.1	12.2	6.1
	14	218.7	193.2	178.6	151.1	137.7	126.0	109.0	76.6	53.6	33.8	25.7	18.6	11.1	
	15	218.7	193.2	178.6	151.1	137.7	125.1	108.4	74.0	51.2	31.9	24.0	17.2	10.2	
	16	218.7	193.2	178.6	151.1	137.7	122.2	106.0	71.4	49.0	30.0	22.5	16.0		
	17	218.7	193.2	178.6	151.1	137.7	119.3	103.4	68.8	46.8	28.3	21.0	14.8		
	18	218.7	193.2	178.6	151.1	137.7	116.3	100.9	66.3	44.6	26.7	19.7	13.8		
	19	218.7	193.2	176.6	149.5	136.5	113.3	98.3	63.8	42.6	25.2	18.5	12.1		
	20	218.7	193.2	173.3	146.8	134.0	110.3	95.8	61.4	40.6	23.7	17.3			
	21	218.7	193.2	169.9	144.0	131.4	107.3	93.2	59.1	38.7	22.4	16.2			
	22	218.3	193.1	166.6	141.2	128.9	104.4	90.6	56.8	36.9	21.2	15.2			
	23	215.0	190.2	163.2	138.4	126.3	101.4	88.1	54.6	35.2	20.0				
	24	211.6	187.1	159.8	135.5	123.7	98.6	85.6	52.5	33.5	18.9				
	25	208.2	184.1	156.4	132.7	121.1	95.8	83.2	50.4	32.0	17.9				
	26	204.7	181.1	153.1	129.8	118.5	93.8	80.8	48.4	30.6					
	27	201.2	178.1	149.7	127.0	115.9	90.2	78.4	46.6	29.2					
	28	197.8	174.9	146.3	124.1	113.3	87.6	76.1	44.7	27.8					
	29	194.3	171.9	143.1	121.4	110.8	84.9	73.9	43.0	26.6					
	30	190.8	168.9	139.8	118.6	108.4	82.5	71.7	41.5	25.4					
	Area, in.^{2}	14.58	12.88	11.91	10.07	9.18	8.40	7.27	5.58	4.30	3.17	2.68	2.23	1.70	1.08
	I, in.^{4}	279.3	248.5	160.7	137.4	125.9	72.5	63.4	28.1	15.2	7.23	4.79	3.02	1.53	0.666
	r, in.	4.377	4.393	3.674	3.694	3.703	2.938	2.953	2.245	1.878	1.510	1.337	1.164	0.947	0.787
	Weight, lb./ft.	49.56	43.77	40.48	34.24	31.20	28.55	21.70	18.97	14.62	10.79	9.11	7.58	5.79	3.65

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for ratios of $l/r=60$ and under.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

STEEL PIPE COLUMNS

Allowable Concentric Loads in Kips

EXTRA STRONG PIPE

Unit Stress—American Institute of Steel Construction—1928

Nominal Size, In.	12	10	8	6	5	4	3½	3	2½	2
External Dia., In.	12.750	10.750	8.625	6.625	5.563	4.500	4.000	3.500	2.875	2.375
Thickness, In.	.500	.500	.500	.432	.375	.337	.318	.300	.276	.218
Effective Length in Feet										
5	288.6	241.5	191.4	126.1	91.7	66.1	55.2	45.2	32.8	19.9
6	288.6	241.5	191.4	126.1	91.7	66.1	55.2	44.4	30.3	17.9
7	288.6	241.5	191.4	126.1	91.7	66.1	53.9	41.7	27.8	16.0
8	288.6	241.5	191.4	126.1	91.7	64.3	51.0	38.9	25.2	14.3
9	288.6	241.5	191.4	126.1	91.7	61.2	48.0	36.2	23.0	12.7
10	288.6	241.5	191.4	126.1	88.9	58.1	45.1	33.6	20.9	11.3
11	288.6	241.5	191.4	126.1	85.5	55.0	42.3	31.1	19.0	10.1
12	288.6	241.5	191.4	122.2	82.0	52.0	39.7	28.8	17.3	9.0
13	288.6	241.5	191.4	118.2	78.6	49.0	37.0	26.6	15.7	
14	288.6	241.5	191.4	114.2	75.2	46.2	34.6	24.5	14.3	
15	288.6	241.5	188.7	110.2	71.8	43.5	32.3	22.7	13.0	
16	288.6	241.5	184.2	106.2	68.5	40.9	30.1	21.0		
17	288.6	241.5	179.6	102.3	65.3	38.5	28.1	19.5		
18	288.6	241.5	174.9	98.4	62.2	36.3	26.3	18.1		
19	228.6	237.6	170.3	94.6	59.3	34.2	24.6			
20	288.6	233.1	165.7	91.0	56.5	32.2	23.0			
21	288.6	228.5	161.0	87.4	53.8	30.3	21.5			
22	287.1	223.9	156.5	83.9	51.2	28.6				
23	282.6	219.3	152.0	80.6	48.8	27.1				
24	278.2	214.6	147.6	77.4	46.5	25.7				
25	273.6	210.0	143.3	74.3	44.4					
26	268.9	205.4	139.0	71.3	42.3					
27	264.3	200.8	134.8	68.5	40.4					
28	259.7	196.3	130.6	65.8	38.6					
29	255.0	191.8	126.7	63.2	36.8					
30	250.3	187.2	122.9	60.7	35.1					
Area, in.^{2}	19.24	16.10	12.76	8.41	6.11	4.41	3.68	3.02	2.25	1.48
I, in.^{4}	361.5	212.0	105.7	40.5	20.7	9.61	6.28	3.89	1.92	0.870
r, in.	4.335	3.628	2.878	2.196	1.839	1.477	1.307	1.136	0.924	0.767
Weight, lb./ft.	65.42	54.74	43.39	28.57	20.78	14.98	12.51	10.25	7.66	5.02

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for ratios of $l/r=60$ and under.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

STEEL PIPE COLUMNS

Allowable Concentric Loads in Kips

DOUBLE EXTRA STRONG PIPE

Unit Stress—American Institute of Steel Construction—1928

Nominal Size, In.		8	6	5	4	3½	3	2½	2
External Dia., In.		8.625	6.625	5.563	4.500	4.000	3.500	2.875	2.375
Thickness, In.		.875	.864	.750	.674	.636	.600	.552	.436
Effective Length in Feet	5	319.5	234.6	170.1	121.5	100.8	82.0	56.6	34.1
	6	319.5	234.6	170.1	121.5	100.8	78.0	51.7	30.2
	7	319.5	234.6	170.1	120.8	95.4	72.5	46.8	26.7
	8	319.5	234.6	170.1	114.7	89.6	67.1	42.2	23.5
	9	319.5	234.6	167.5	108.5	83.8	61.9	38.0	20.7
	10	319.5	234.6	160.8	102.4	78.2	57.0	34.2	18.3
	11	319.5	229.3	153.9	96.4	72.8	52.3	30.8	16.2
	12	319.5	221.4	147.0	90.6	67.7	48.0	27.7	
	13	319.5	213.6	140.2	85.0	62.9	44.1	25.0	
	14	317.9	205.7	133.5	79.6	58.4	40.5	22.6	
	15	310.0	197.8	127.1	74.6	54.2	37.3		
	16	302.0	190.0	120.8	70.0	50.4	34.3		
	17	294.0	182.3	114.7	65.6	46.9	31.7		
	18	286.0	174.8	109.0	61.5	43.7			
	19	277.9	167.5	103.5	57.7	40.7			
	20	269.9	160.5	98.2	54.1	38.0			
	21	261.9	153.8	93.3	50.8				
	22	254.0	147.3	88.5	47.8				
	23	246.3	141.0	84.1					
	24	238.7	135.0	80.0					
	25	231.3	129.3	76.0					
	26	224.1	123.8	72.3					
	27	217.0	118.5	68.8					
	28	210.1	113.6	65.5					
	29	203.4	108.9						
	30	196.9	104.4						
Area, in.^{2}		21.30	15.64	11.34	8.10	6.72	5.47	4.03	2.66
I, in.^{4}		162.0	66.3	33.6	15.3	9.85	5.99	2.87	1.31
r, in.		2.757	2.060	1.722	1.374	1.210	1.047	0.844	0.703
Weight, lb./ft.		72.42	53.16	38.55	27.54	22.85	18.58	13.70	9.03

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for ratios of $l/r=60$ and under.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

GRILLAGE FOUNDATIONS

Where column base plates are found to be undesirable or uneconomical, a one or two tier grillage may be used if so desired, depending upon the bearing value of the soil or rock over which the load must be spread.

The lower tier must rest upon a solid bed of concrete of sufficient thickness to distribute the load to the soil.

The spaces between the beams should be filled with, and the beams enclosed in concrete not less than four inches thick.

The minimum clear distance between flanges of beams should be about two inches.

Maximum clear distance for bottom tier beams = ¾ of the flange width. Beams should have pipe separators and should not be painted.

To determine the area in square feet required for the foundation, divide the total load on the column by the bearing value of the soil per square foot which will give the area of the footing in square feet, the shape of which must be determined by local conditions. On the assumption that the loads on the soil are uniformly distributed, the number, size, and weight of the beams are determined from the maximum bending moment, maximum shear or the maximum web resistance to buckling as follows:

W = total load on the foundation in pounds.
L = length of beam in feet.
a = loaded portion in feet.
d = depth of beam in inches.
t = thickness of beam web in inches.
n = number of beams.
f_b = allowable unit web buckling resistance.
f_s = allowable unit web shearing resistance.

The maximum bending moment occurs at the center of the beam and is equal in foot pounds to $\frac{W(L-a)}{8}$, and the section modulus required for each beam is $\frac{12\ W(L-a)}{8\ f\ n}$.

The proper size of beam in any tier with regard to flexure at a unit stress of 18000 pounds per square inch may be found in the safe load table for the length corresponding to (L–a) by dividing the total load by the number of beams.

Or may be found from the table of maximum bending moments by dividing the total bending moment by the number of beams.

Or from the table of properties by dividing the total section modulus required by the number of beams in the tier, which is equal to $\frac{3W(L-a)}{36{,}000}$.

Note, however, that the load on the beam for any span must not exceed the maximum tabular safe load for shear.

The maximum vertical shear occurs at the edge of the column base or at a distance in feet of $\frac{L-a}{2}$ from each end of the beam and is equal to $\frac{W}{L} \times \frac{L-a}{2}$.

Web thickness, t, to resist average shear $= \frac{W}{L} \times \frac{L-a}{2} \times \frac{1}{12{,}000\ n\ d}$ or average vertical shear $= \frac{W}{L} \times \frac{L-a}{2} \times \frac{1}{n\ d\ t}$ which must not exceed 12,000 pounds per square inch.

The maximum buckling stress occurs on a length in inches of $12\ a + d/2$ and is equal, in total, per lineal inch of web to $\frac{W}{12\ a + d/2}$.

Then the required thickness of the web, t, to resist buckling $= \frac{W}{n(12\ a + d/2)\ f_b}$ or the average web resistance per square inch to buckling, $f_b = \frac{W}{n(12\ a + d/2)\ t}$ which must not exceed the tabular values for the allowable buckling resistance on beam webs.

Rolled Steel Column Base Plates: To distribute the loads from columns over girders, grillage beams, etc., solid slabs of rolled steel may be advantageously used in place of cast iron or riveted steel bases, etc.

The method of determining the thickness, t, of the slab with respect to the direction of the upper tier is the same as that used in paragraph under Column Base Plates, $t = \sqrt{\frac{W\ j^2}{6{,}000\ K\ B}}$.

Required thickness of slab, t, with respect to the direction parallel to the bottom tier is obtained by assuming that the maximum bending moment occurs at the point of column load concentration (.95d or .8b, depending on the direction in which the column is turned) and that the reaction from the outside beam in the upper tier is the load, the cantilever span, l being the distance from the point of maximum moment to center line of this beam and $t = \sqrt{\frac{6\ W\ l}{n\ B\ f}}$. See page 314.

EXAMPLE: Design a grillage foundation to distribute the load of 1,323,000 pounds from a column CB 146, 300 lbs. to a concrete pier, the allowable bearing capacity being 500 pounds per square inch.

$\frac{1,323,000}{500} = 2,646$ square inches required in base.

$53'' \times 50'' = 2\,650$ square inches. Make length of bottom tier 50″.

Assume the column base plate 25″ x 27″.

Using j: $t = \sqrt{\frac{1,323,000 \times 7.03^2}{6,000 \times 25 \times 27}} = 4.02''$.

Using l: $t = \sqrt{\frac{6 \times 1,323,000 \times 3.925}{4 \times 27 \times 18,000}} = 4.00$ Use 4″.

Top Tier: 4 beams 53″ long, 8″ centers.

Section modulus per beam $= \frac{1,323,000 \times (53-27)}{8 \times 18,000 \times 4} = 59.7$ in.^{3}

Try 4 Beams 15″ x 50 lbs.

Buckling stress $f_b = \frac{1,323,000}{4\ (27 + 7.5)\ .550} = 17,430$ lbs. per sq. in.

As the maximum allowable f_b is 15,000 lbs., then beams having a thicker web must be used.

Use 4 Beams 15″ x 55 lbs. as their $f_b = 14,800$ lbs.

Shear occurs at edge of slab: $f_s = \frac{1,323,000}{53 \times 4 \times 15 \times .648} \times \frac{53-27}{2}$
$= 8,346$ lbs. per sq. in.

Maximum allowable: $f_s = 12,000$ lbs. per sq. in.

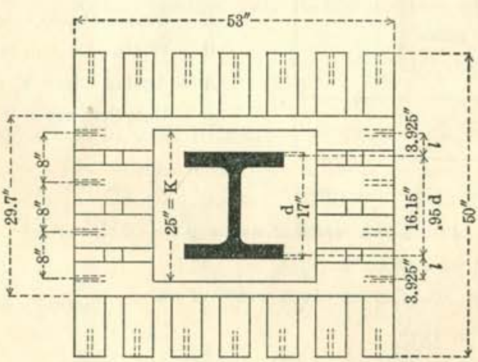
Bottom tier. $50''-29.7''= 20.3''$.

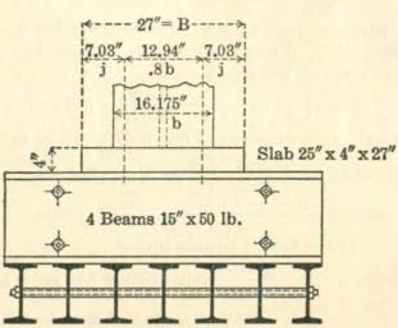
Section modulus per beam $= \frac{1,323,000 \times 20.3}{8 \times 18,000 \times 7} = 26.6$ ins.^{3}

7 — 10″ x 30 lb. Beams

Buckling stress $f_b = \frac{1,323,000}{7\ (29.7+5)\ .447} = 12,180$ lbs. per sq. in.

Shear at outside edges of upper tier $= \frac{1,323,000}{50 \times 7 \times 10 \times .447} \times \frac{50-29.7}{2}$
$= 8,583$ lbs. per sq. in.





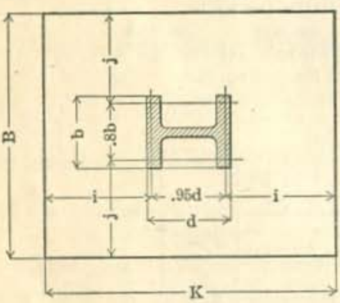
DIMENSIONS OF BASE PLATES FOR CB SECTIONS

The only condition considered in these tables is that of base plates resting on concrete having safe bearing values of 500, 625 and 750 pounds per square inch.

For many of the heavier column loads given, single or double tier grillages may very often be found to be lighter and more economical than base plates on concrete, but grillages should be the subject of study for each specific case and principles governing design may be found on preceding pages.

The column loads given in the following tables for CB Sections are the maximum for each section and weight, or 15,000 pounds multiplied by the area.

For purposes of calculation, the column load P is assumed to be distributed within a rectangle whose dimensions are 0.95d and 0.8b, and the base slab is considered as a cantilever with uniformly distributed load where the span is $i = \frac{K - .95d}{2}$ parallel to web of column, and $j = \frac{B - .8b}{2}$ parallel to flange.



P = Total load on column in pounds.

K = Length of slab in inches.

B = Width of slab in inches.

A = Area of slab = $K \times B$.

p = Unit Pressure = P/A.

M = Moment for 1-inch width of slab $= p\,i\,\frac{i}{2} = \frac{p\,i^2}{2}$ or $\frac{p\,j^2}{2}$

Use greater value of i or j:

S = Section Modulus for 1 inch width of slab $= \frac{M}{18{,}000}$

$= \frac{p\,i^2}{36{,}000}$ or $\frac{p\,j^2}{36{,}000}$

Since $S = \frac{t^2}{6}$, therefore $t^2 = \frac{p\,i^2}{6{,}000}$ or $\frac{p\,j^2}{6{,}000}$

EXAMPLE. Assume a load of 1,879,000 pounds for Column CB 146, 426 lbs. per ft., d = 18.69 inches, b = 16.695 inches, .95d = 17.756 inches, .8b = 13.356 inches, concrete at 500 lbs. per sq. in.

Required area of slab $= \frac{1{,}879{,}000}{500} = 3758$ square inches.

A plate having dimensions 56″ x 67″ will be satisfactory.

Projection $i = \frac{67 - 17.756}{2} = 24.622$ inches.

Projection $j = \frac{56 - 13.356}{2} = 21.322$ inches.

$i^2 = 24.622^2 = 606.24$ square inches.

In formula, $t^2 = \frac{p\,i^2}{6{,}000}$, substituting 500 for p and the value of i^2, then

$t^2 = \frac{500 \times 606.24}{6{,}000} = 50.52$ and thickness $t = 7.11$ inches.

RECOMMENDED SIZES

The following widths and thicknesses are suggested as being sufficient to meet all ordinary requirements. The adoption and use of these sizes as standards will result in better service in the way of shipments from the mill and will also tend to make this class of business more desirable to the rolling mills.

14 x 1¼	28 x 3	44 x 5
14 x 1½	28 x 3½	44 x 5½
16 x 1½	32 x 3½	48 x 5½
16 x 2	32 x 4	48 x 6
		48 x 6½
20 x 2	36 x 4	
20 x 2½	36 x 4½	52 x 6
20 x 3		52 x 6½
	40 x 4½	
24 x 2	40 x 5	56 x 6½
24 x 2½		56 x 7
24 x 3		56 x 8

The thicknesses given above are the thicknesses of the rolled plate.

Allowance for planing plates over 4 inches should be made as shown in tables.

SECTION MODULI FOR BEARING PLATES 1 INCH WIDE

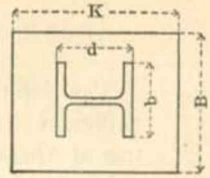
Thickness	S	Thickness	S	Thickness	S	Thickness	S
In.	In.³	In.	In.³	In.	In.³	In.	In.³
1¼	.26	3¼	1.76	5¼	4.59	7¼	8.76
1½	.38	3½	2.04	5½	5.04	7½	9.38
1¾	.51	3¾	2.34	5¾	5.51	7¾	10.01
2	.67	4	2.67	6	6.00	8	10.67
2¼	.84	4¼	3.01	6¼	6.51	8¼	11.34
2½	1.04	4½	3.38	6½	7.04	8½	12.04
2¾	1.26	4¾	3.76	6¾	7.59	8¾	12.76
3	1.50	5	4.17	7	8.17	9	13.50

COLUMN

BASES

COLUMN BASES STANDARD

14 INCH COLUMNS

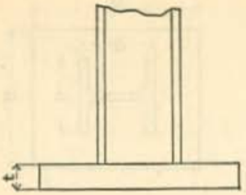


Maximum Bending Stress 18 Kips per Square Inch

Column Section No.	Weight per Foot, Lbs.	Load in Kips	Column Dimensions d, In.	b, In.	Pressure per Sq. In. on Concrete 500 Pounds: Thickness, t, In. Calculated	Finished	Rolled	B, In.	K, In.	Weight Rolled, Lbs.
CB 146	426	1879	18.69	16.695	7.11	7⅝	8	56	67	8505
	412	1817	18.50	16.645	6.84	7⅝	8	56	65	8251
	398	1755	18.31	16.590	6.57	6⅝	7	56	63	6997
	384	1694	18.12	16.540	6.20	6⅛	6½	56	60	6188
	370	1632	17.94	16.475	6.20	6⅛	6½	56	58	5982
	356	1570	17.75	16.420	6.19	6⅛	6½	56	56	5775
	342	1509	17.56	16.365	5.90	6⅛	6½	54	56	5569
	328	1446	17.38	16.295	5.68	5¾	6	52	56	4950
	314	1385	17.19	16.235	5.65	5¾	6	52	53	4685
	300	1323	17.00	16.175	5.49	5¾	6	51	52	4508
	287	1266	16.81	16.130	5.33	5¼	5½	48	53	3964
	273	1203	16.62	16.065	5.08	5¼	5½	48	50	3740
	264	1164	16.50	16.025	5.05	5¼	5½	48	49	3665
	255	1125	16.37	15.990	4.93	5¼	5½	47	48	3516
	246	1085	16.25	15.945	4.86	4¾	5	44	49	3054
	237	1045	16.12	15.910	4.69	4¾	5	44	48	2992
	228	1006	16.00	15.865	4.51	4¾	5	44	46	2867
	219	965	15.87	15.825	4.52	4¾	5	44	44	2743
	211	931	15.75	15.800	4.25	4¾	5	42	44	2618
	202	891	15.63	15.750	4.33	4¼	4½	40	45	2295
	193	851	15.50	15.710	4.06	4¼	4½	40	43	2193
	184	811	15.38	15.660	3.94	4¼	4½	40	41	2091
	176	776	15.25	15.640	3.81	4¼	4½	39	40	1989
	167	736	15.12	15.600	3.84	4	4	36	41	1673
	158	697	15.00	15.550	3.56	4	4	36	39	1591
	150	661	14.88	15.515	3.39	4	4	36	37	1510
	142	628	14.75	15.500	3.26	4	4	35	36	1428
	*320	1412	16.81	16.710	5.58	5¾	6	52	54	4773

*Column Core Section.

Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.



COLUMN BASES STANDARD

14 INCH COLUMNS

Maximum Bending Stress 18 Kips per Square Inch

Column Section No.	Weight per Foot, Lbs.	Pressure per Sq. In. on Concrete: 625 Pounds						750 Pounds					
		Thickness, t, In.			B, In.	K, In.	Weight Rolled, Lbs.	Thickness, t, In.			B, In.	K, In.	Weight Rolled, Lbs.
		Calculated	Finished	Rolled				Calculated	Finished	Rolled			
CB 146	426	6.54	6⅝	7	54	56	5998	6.14	6⅛	6½	48	52	4597
	412	6.24	6⅛	6½	52	56	5363	6.16	6⅛	6½	48	50	4420
	398	6.25	6⅛	6½	52	54	5171	6.12	6⅛	6½	48	49	4332
	384	6.26	6⅛	6½	52	52	4980	5.97	6⅛	6½	47	48	4155
	370	5.99	6⅛	6½	48	54	4774	5.65	5¾	6	45	48	3672
	356	5.69	5¾	6	48	52	4243	5.48	5¾	6	44	48	3590
	342	5.65	5¾	6	48	50	4080	5.53	5¾	6	42	48	3427
	328	5.65	5¾	6	48	48	3917	5.58	5¾	6	40	48	3264
	314	5.34	5¼	5½	46	48	3441	5.13	5¼	5½	42	44	2880
	300	5.15	5¼	5½	44	48	3291	4.93	5¼	5½	40	44	2743
	287	5.02	5¼	5½	44	46	3154	4.80	4¾	5	40	42	2380
	273	5,01	5¼	5½	44	44	3017	4.81	4¾	5	40	40	2267
	264	4.72	4¾	5	42	44	2618	4.62	4¾	5	39	40	2210
	255	4.75	4¾	5	40	45	2550	4.43	4¾	5	38	40	2153
	246	4.47	4¾	5	40	43	2437	4.35	4¼	4½	36	40	1836
	237	4.39	4¾	5	40	42	2380	4.17	4¼	4½	36	39	1790
	228	4.42	4¾	5	40	40	2267	4.13	4¼	4½	36	37	1698
	219	4.23	4¼	4½	39	40	1989	4.11	4¼	4½	36	36	1652
	211	4.05	4¼	4½	37	40	1887	3.92	4	4	35	36	1428
	202	4.04	4	4	36	40	1632	3.74	4	4	33	36	1346
	193	3.77	4	4	36	38	1550	3.73	4	4	32	36	1306
	184	3.79	4	4	36	36	1469	3.43	3½	3½	32	34	1079
	176	3.60	4	4	35	36	1428	3.46	3½	3½	32	32	1015
	167	3.48	4	4	33	36	1346	3.26	3½	3½	31	32	984
	158	3.51	4	4	31	36	1265	3.14	3½	3½	29	32	920
	150	3.16	3½	3½	32	33	1047	3.13	3½	3½	28	32	889
	142	3.13	3½	3½	32	32	1015	2.82	3	3	28	30	714
	*320	5.43	5¼	5½	47	48	3515	5.24	5¼	5½	43	44	2948

*Column Core Section.

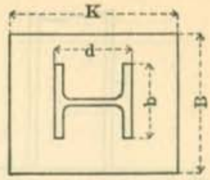
Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.

COLUMN

BASES

COLUMN BASES STANDARD

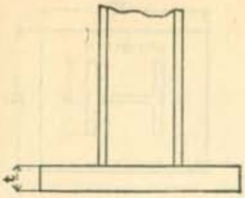
14 and 12 INCH COLUMNS



Maximum Bending Stress 18 Kips per Square Inch

Column Section No.	Weight per Foot, Lbs.	Load in Kips	Column Dimensions d, In.	Column Dimensions b, In.	Pressure per Sq. In. on Concrete 500 Pounds — Thickness, t, In. Calculated	Finished	Rolled	B, In.	K, In.	Weight Rolled, Lbs.
	136	600	14.75	14.740	3.19	4	4	33	36	1346
	127	560	14.62	14.690	3.05	3½	3½	32	35	1111
	119	525	14.50	14.650	2.92	3½	3½	32	33	1047
CB 145	111	490	14.37	14.620	2.77	3½	3½	31	32	984
	103	454	14.25	14.575	2.78	3	3	28	33	795
	95	419	14.12	14.545	2.39	3	3	28	30	714
	87	383	14.00	14.500	2.34	3	3	28	28	666
CB 144	84	371	14.18	12.023	2.49	3	3	27	28	643
	78	344	14.06	12.000	2.24	2½	2½	24	29	493
	190	838	14.38	12.670	4.31	4¼	4½	40	42	2142
	176	777	14.12	12.615	4.16	4¼	4½	39	40	1989
	161	711	13.88	12.515	3.85	4	4	36	40	1632
	147	649	13.62	12.450	3.76	4	4	36	36	1469
	133	587	13.38	12.365	3.34	4	4	33	36	1346
	120	530	13.12	12.320	3.20	3½	3½	32	33	1047
CB 124	106	468	12.88	12.230	2.86	3½	3½	29	32	920
	99	436	12.75	12.190	2.73	3	3	28	31	738
	92	406	12.62	12.155	2.64	3	3	28	29	690
	85	375	12.50	12.105	2.49	3	3	27	28	643
	79	348	12.38	12.080	2.34	3	3	25	28	595
	72	317	12.25	12.040	2.19	2½	2½	24	27	459
	65	287	12.12	12.000	2.07	2½	2½	24	24	408
	64	282	12.31	10.060	2.28	2½	2½	24	24	408
CB 123	58	256	12.19	10.014	1.99	2	2	22	24	299
	53	234	12.06	10.000	1.79	2	2	20	24	272

Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.



COLUMN BASES STANDARD

14 and 12 INCH COLUMNS

Maximum Bending Stress 18 Kips per Square Inch

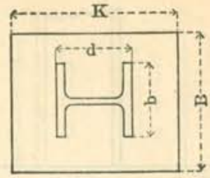
Column Section No.	Weight per Foot, Lbs.	625 Pounds: Thickness, t, In. Calculated	625 Pounds: Thickness, t, In. Finished	625 Pounds: Thickness, t, In. Rolled	625 Pounds: B, In.	625 Pounds: K, In.	625 Pounds: Weight Rolled, Lbs.	750 Pounds: Thickness, t, In. Calculated	750 Pounds: Thickness, t, In. Finished	750 Pounds: Thickness, t, In. Rolled	750 Pounds: B, In.	750 Pounds: K, In.	750 Pounds: Weight Rolled, Lbs.
	136	2.94	3½	3½	30	32	952	2.84	3	3	28	29	690
	127	2.92	3	3	28	32	762	2.68	3	3	27	28	643
	119	2.63	3	3	28	30	714	2.51	3	3	25	28	595
CB 145	111	2.63	3	3	28	28	666	2.37	2½	2½	24	27	459
	103	2.33	3	3	26	28	619	2.19	2½	2½	24	25	425
	95	2.35	2½	2½	24	28	476	2.15	2½	2½	24	24	408
	87	2.03	2	2	24	26	354	1.86	2	2	22	24	299
CB 144	84	2.31	2½	2½	24	25	425	2.03	2	2	20	25	283
	78	2.16	2½	2½	23	24	391	1.89	2	2	19	24	258
	190	4.19	4¼	4½	36	37	1698	3.95	4	4	31	36	1265
	176	3.99	4	4	35	36	1428	3.84	4	4	32	33	1197
	161	3.66	4	4	32	36	1306	3.51	3½	3½	30	32	952
	147	3.52	3½	3½	32	33	1047	3.19	3½	3½	28	31	861
	133	3.21	3½	3½	30	32	952	3.20	3½	3½	28	28	777
	120	2.94	3	3	28	30	714	2.76	3	3	25	28	595
CB 124	106	2.76	3	3	27	28	643	2.51	2½	2½	24	26	442
	99	2.56	3	3	25	28	595	2.53	2½	2½	24	24	408
	92	2.42	2½	2½	24	27	459	2.32	2½	2½	23	24	391
	85	2.31	2½	2½	24	25	425	2.13	2½	2½	21	24	357
	79	2.16	2½	2½	23	24	391	2.00	2	2	20	23	261
	72	2.00	2	2	21	24	286	1.84	2	2	20	21	238
	65	1.85	2	2	20	23	261	1.67	2	2	19	20	215
	64	1.98	2	2	19	24	258	1.93	2	2	19	20	215
CB 123	58	1.91	2	2	20	21	238	1.59	2	2	17	20	193
	53	1.76	2	2	19	20	215	1.49	1½	1½	16	20	136

Pressure per Sq. In. on Concrete: 625 Pounds / 750 Pounds.

Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.

COLUMN BASES STANDARD

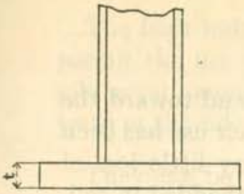
10, 8 and 6 INCH COLUMNS



Maximum Bending Stress 18 Kips per Square Inch

Column Section No.	Weight per Foot, Lbs.	Load in Kips	Column Dimensions d, In.	Column Dimensions b, In.	Pressure per Sq. In. on Concrete 500 Pounds: Thickness, t, In. Calculated	Thickness, t, In. Finished	Thickness, t, In. Rolled	B, In.	K, In.	Weight Rolled, Lbs.
CB 103	136	600	11.88	10.575	3.59	4	4	33	36	1346
	124	547	11.62	10.505	3.42	3½	3½	32	34	1079
	112	494	11.38	10.415	3.27	3½	3½	31	32	984
	100	441	11.12	10.345	3.07	3	3	28	32	762
	89	393	10.88	10.275	2.86	3	3	28	28	666
	77	340	10.62	10.195	2.55	3	3	25	28	595
	72	318	10.50	10.170	2.43	2½	2½	24	27	459
	66	291	10.38	10.117	2.26	2½	2½	24	25	425
	60	265	10.25	10.075	2.06	2½	2½	22	24	374
	54	238	10.12	10.028	2.07	2½	2½	20	24	340
	49	216	10.00	10.000	1.79	2	2	20	22	249
CB 102	45	199	10.12	8.022	1.96	2	2	20	20	227
	41	181	10.00	8.000	1.68	2	2	18	20	204
	37	163	9.88	7.978	1.50	2	2	17	20	193
	33	146	9.75	7.964	1.38	1½	1½	16	19	129
CB 83	67	296	9.00	8.287	2.49	2½	2½	24	25	425
	58	256	8.75	8.222	2.23	2½	2½	22	24	374
	48	212	8.50	8.117	1.97	2	2	20	22	249
	40	176	8.25	8.077	1.74	2	2	18	20	204
	35	155	8.12	8.027	1.75	2	2	16	20	181
	33	146	8.06	8.012	1.60	2	2	16	19	172
	31	137	8.00	8.000	1.39	1½	1½	16	17	116
CB 82	27	119	8.03	6.528	1.41	1½	1½	15	16	102
	24	106	7.93	6.500	1.24	1¼	1¼	14	16	79
CB 61	88	388	6.842	10.046	3.10	3¼	3½	28	28	777
	80	353	6.666	9.959	2.89	3¼	3½	28	25	694
	70	309	6.444	9.846	2.62	2¾	3	26	24	530
	60	264	6.216	9.733	2.34	2¾	3	24	22	449
	50	221	5.986	9.617	2.21	2¼	2½	23	20	326
	40	176	5.750	9.500	1.81	2	2	20	18	204

Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.



COLUMN BASES STANDARD

10, 8 and 6 INCH COLUMNS

Maximum Bending Stress 18 Kips per Square Inch

Column Section No.	Weight per Foot, Lbs.	Pressure per Sq. In. on Concrete: 625 Pounds — Thickness, t, In.: Calculated	Finished	Rolled	B, In.	K, In.	Weight Rolled, Lbs.	750 Pounds — Thickness, t, In.: Calculated	Finished	Rolled	B, In.	K, In.	Weight Rolled, Lbs.
CB 103	136	3.48	3½	3½	30	32	952	3.66	4	4	25	32	907
	124	3.23	3½	3½	28	31	861	3.11	3½	3½	26	28	722
	112	3.19	3½	3½	28	28	777	3.01	3	3	24	28	571
	100	2.82	3	3	25	28	595	2.75	3	3	24	25	510
	89	2.56	2½	2½	24	26	442	2.43	2½	2½	22	24	374
	77	2.38	2½	2½	23	24	391	2.27	2½	2½	20	23	326
	72	2.27	2½	2½	21	24	357	2.11	2½	2½	20	21	297
	66	2.25	2½	2½	20	24	340	2.07	2½	2½	20	20	283
	60	1.94	2	2	20	21	238	1.80	2	2	18	20	204
	54	1.77	2	2	19	20	215	1.83	2	2	16	20	181
	49	1.66	2	2	18	20	204	1.50	1½	1½	16	18	122
CB 102	45	1.67	2	2	16	20	181	1.67	2	2	16	17	154
	41	1.55	2	2	16	18	163	1.52	1½	1½	15	16	102
	37	1.54	1½	1½	14	19	113	1.33	1½	1½	14	16	95
	33	1.24	1¼	1¼	14	17	84	1.34	1½	1½	14	14	83
CB 83	67	2.47	2½	2½	20	24	340	2.35	2½	2½	20	20	283
	58	2.14	2½	2½	20	21	297	2.07	2½	2½	17	20	241
	48	1.92	2	2	17	20	193	1.74	2	2	16	18	163
	40	1.62	2	2	16	18	163	1.49	1½	1½	15	16	102
	35	1.52	1½	1½	16	16	109	1.33	1½	1½	14	15	89
	33	1.37	1½	1½	15	16	102	1.34	1½	1½	14	14	83
	31	1.34	1½	1½	14	16	95	1.17	1¼	1¼	13	14	65
CB 82	27	1.35	1½	1½	12	16	82	1.16	1¼	1¼	12	14	59
	24	1.10	1¼	1¼	12	14	59	1.15	1¼	1¼	10	14	50
CB 61	88	3.22	3¼	3½	28	22	611	2.82	2¾	3	24	22	449
	80	2.85	2¾	3	24	24	490	2.83	2¾	3	24	20	408
	70	2.60	2¾	3	24	21	428	2.45	2¾	3	21	20	357
	60	2.27	2¼	2½	21	20	297	2.16	2¼	2½	20	18	255
	50	1.99	2	2	20	18	204	2.00	2	2	19	16	172
	40	1.70	2	2	18	16	163	1.69	2	2	16	15	136

Plates 4 inches thick and under may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. All orders should specify rolled thickness.

STEEL BEARING PILES

Within recent years, there has been a growing trend toward the use of wide flange CB Sections for bearing piles. Their use has been accelerated through the disclosure that there is very little loss of metal from corrosion when the steel sections are embedded in soil. Uncovering and examination of steel sections in service twenty-five years or more has revealed loss of metal so slight as to be of no practical importance.

There are hundreds of bridges supported by exposed steel bearing piles which have been in service in the Middle West for periods ranging from 25 to 38 years, and are still in satisfactory condition. During the last few years, thousands of steel piles have been driven to support the piers of a number of important bridges, and their use is gradually extending to every class of work for which other types of bearing piles are adaptable.

Load Tests. Maximum test loads developed at various locations are as follows: In Nebraska, in 1932, on 8 inch H 32 lb. sections they ranged from 28 to 170 tons, the latter value being obtained at 44 feet penetration in sand and gravel; on 10 inch H 49 lb. sections, from 69 to 108 tons, with piles driven through sand and gravel with points resting in a clay bed; on 12 inch CB 65 lb. sections, up to 110 tons in tests conducted at the Bonnet-Carre Floodway site in Louisiana, with a penetration of 122 feet in swampy alluvial layers of humus, clay-sand, with pile point in stiff blue clay; on 12 inch H 65 lb. sections, showed maximum capacity of 60.5 tons with 50 to 55 feet penetration in swamp mud, soft clay and sand, and stiff red clay at site of a bridge over Passaic River in New Jersey; and on 12 inch CB 110 lb. sections, near Lake Michigan, at Gary, Indiana, 300 and 307 tons, with penetration of 35 and 45 feet, respectively, in water bearing sand and fine gravel.

While load tests are not available, 10″, 12″ and 14″ CB sections have been driven to absolute refusal with penetrations ranging from 1.5 to 5 feet in shale or soft rock. Temporary false work or bridge loads, in excess of normal column loads for the sections, have been applied for long construction periods without signs of settlement.

Carnegie-Illinois Steel Corporation has available for distribution to interested engineers, a compilation of comprehensive series of loading tests on a considerable number of piles in various sections of the United States.

Advantages. Steel CB section bearing piles are more easily handled and driven than other types of piles of similar capacities.

The high unit loads usually developed by steel CB section piles permit the use of fewer piles with consequent reduction in size of pile group, amount of excavation for footings, and volume of concrete in the pile cap or pier.

They can be driven with a much smaller resultant displacement or rupture of the soil, thus giving greater ultimate carrying capacities for groups of piles where they have to be driven at close spacings to carry very great superimposed loads.

Steel piles are particularly adaptable under the following conditions:

(1) Where they can be driven through loose, unstable fill or soil to a relatively hard strata, where their full strength as a column can easily be developed.

(2) Where considerable penetration through hard driving material, such as sand and gravel, is required in order to reach sufficient depth to prevent undermining by scour or wash of water such as encountered in river construction, or where there is danger of undermining of foundations due to later possible excavation carried to great depths for adjacent structures.

(3) Where extremely great penetration is necessary to secure adequate bearing capacity.

(4) Where piling is subject to attack and destruction by borers or other insects, such as limnoria, teredo, termite or any other destructive organism.

Permanence. Examination of hundreds of bridges in the State of Nebraska resting on 5 inch and 8 inch I-beams, and 8 inch H sections which have been in service 25 to 35 years, showed little, if any, deterioration at 18 inches below stream bed or ground water line. At points 12 inches above normal water line, the loss of metal averaged only 1% in 20 years, or 1/20th of 1% per year. The same condition was found in a group of similar bridges around Chatham, Ontario. Steel sheet piling, withdrawn when rebuilding a bridge pier in the Monongahela River at Pittsburgh, showed practically no loss of metal below the water line after 19 years service. Sewer liner plates, uncovered after 18 years exposure to soil at Newark, N. J., showed loss of metal too slight to measure. Blue black mill scale was still on the plates.

Steel tubular piles uncovered after more than 25 years of service in a New York City foundation, were carefully cleaned and calipered and showed in no case a loss of metal of more than 1/64-inch.

Inspection of eight steel sheet piling structures in service from 17 to 31 years in salt water along the Atlantic Seaboard, all but one in the tropics, showed practically no loss of metal below the water line. Similar conditions were observed in the examination of eight similar structures in fresh water after 19 to 30 years service.

Basically, the surface corrosion of steel is proportionate to the amount of moist atmosphere and dissolved or free oxygen coming in contact with it. It is also well known that the rate of corrosion slows up materially as soon as the steel takes on a film of products of corrosion which in themselves act as a protection for the metal underneath. These products of corrosion also permeate the ground, under certain conditions of earth and moisture for several inches, forming a dense non-porous and impervious encasement around the steel.

In the case of subgrade structures such as foundations, it is apparent that fresh oxygen cannot be brought to the steel either by penetration of air or by subsurface water currents. Under these conditions, no special protection for the steel is therefore required.

In the case of structures such as pile bents, which extend continuously from below a stream bed up to points considerably above high water, some form of protective encasement is desirable in the zone of maximum corrosion, which is usually between the low and high water marks. The encasement should begin at a point about a foot or more below low water and extend up to a point above high water, where maintenance such as painting as applied to the balance of the structure is practicable. Wide flange CB section steel bearing piles, protected as just stated, will certainly have a useful life at least equal to other types of supports which have been generally used heretofore.

As previously stated, steel bearing piles are, of course, immune from attack and destruction by various types of borers, such as teredos or other marine organisms, as well as any kind of insects.

On page 48b are given the elements of the new CBP sections designed for use as bearing piles. They have a uniform thickness of web and flanges to insure uniform life for all parts of the section under normal conditions of exposure.

Other standard CB sections are shown with them, selected to amplify the special CBP sections with the thought that practically all bearing pile requirements will be met by this group. For special conditions, other CB sections may be suitable and may be specified at the discretion of the designer.

Detailed information on the specific application of CB sections as bearing piles may be obtained at any District Office of the Carnegie-Illinois Steel Corporation.

STRESSES IN RIVETS AND PINS

Rivets. In transmitting stresses between riveted pieces, it is customary to disregard friction and to proportion rivets to the entire stress to be transmitted. They must be of sufficient size and number to resist shear and to afford such bearing area as not to cause distortion of the metal at the rivet holes. In the case of beams which frame opposite and of single web girders, this latter condition often necessitates a greater thickness of web than required by the shearing stresses. In a plate girder with 5⁄16″ web, 3⁄4″ rivets connecting the web with the flange angles would have a bearing value at 24,000 pounds unit stress of 5,630 pounds per rivet, while their value in double shear at 12,000 pounds unit stress is 10,600 pounds per rivet; and it might be necessary to increase the web thickness to 3⁄8″ or more in order that the pressure of the rivets upon the metal be not excessive.

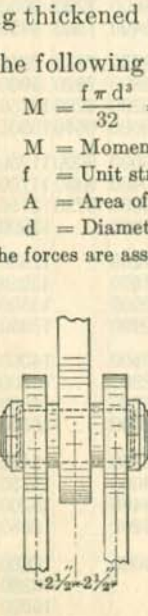
Pins. Pins must be calculated for shearing, bending and bearing stresses, but one of the latter two will in most cases determine the size. When groups of bars are connected to the same pin, as in the lower chord of truss bridges, the size of the bars must be so chosen and the bars so placed that at no point on the pin will there be any excessive bending stress. When the size of pin has been determined from the bending stress, the thickness of the bars or web of the post should be investigated to provide sufficient bearing area, the bars being thickened or pin plates added if necessary.

The following is the formula for flexure applied to pins:

$$M = \frac{f \pi d^3}{32} = \frac{f A d}{8}.$$

M = Moment of forces for any section through pin.
f = Unit stress per square inch, in bending.
A = Area of section, in square inches.
d = Diameter of pin, in inches.

The forces are assumed to act in a plane passing through the axis of the pin.



EXAMPLE 1.—Required the size of a pin carrying a load of 64,000 pounds, at a distance of 5 inches between points of support; maximum unit stress 24,000 pounds per square inch.

Bending moment=64,000 x 5 ÷ 4=80,000 inch-pounds; use a 3¼-inch pin; allowed moment: 80,900 inch-pounds.

EXAMPLE 2.—Required the thickness of metal in the top chord of a bridge to give sufficient bearing area to a 3⅜-inch pin, having to transmit a stress of 121,400 pounds; maximum bearing pressure 24,000 pounds per square inch.

The bearing value of a 3⅜-inch pin for 1-inch thickness of metal is 81,000 pounds; therefore, the thickness of metal required=121,400 ÷ 81,000=1½ inch, or each web of the chord must be ¾ inch thick, including pin plates.

HAND DRIVEN RIVETS AND UNFINISHED BOLTS

SHEARING AND BEARING VALUES, IN POUNDS

Shear 10,000; Bearing 16,000; Enclosed Bearing 20,000 Pounds per Square Inch

Diameter, In.		½		⅝		¾		⅞		1		1⅛		1¼	
Area, In.²		.1963		.3068		.4418		.6013		.7854		.9940		1.2272	
Single Shear		1960		3070		4420		6010		7850		9940		12270	
Double Shear		3930		6140		8840		12030		15710		19880		24540	
Thickness of Plate, In.		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing	
		16000	20000	16000	20000	16000	20000	16000	20000	16000	20000	16000	20000	16000	20000
.125	⅛	1000	1250	1250	1560	1500	1880	1750	2190	2000	2500	2250	2810	2500	3130
.140		1120	1400	1400	1750	1680	2100	1960	2450	2240	2800	2520	3150	2800	3500
.160		1280	1600	1600	2000	1920	2400	2240	2800	2560	3200	2880	3600	3200	4000
.180		1440	1800	1800	2250	2160	2700	2520	3150	2880	3600	3240	4050	3600	4500
.1875	3/16	1500	1880	1880	2340	2250	2810	2630	3280	3000	3750	3380	4220	3750	4690
.200		1600	2000	2000	2500	2400	3000	2800	3500	3200	4000	3600	4500	4000	5000
.220		1760	2200	2200	2750	2640	3300	3080	3850	3520	4400	3960	4950	4400	5500
.240		1920	2400	2400	3000	2880	3600	3360	4200	3840	4800	4320	5400	4800	6000
.250	¼	.....	2500	2500	3130	3000	3750	3500	4380	4000	5000	4500	5630	5000	6250
.260		.....	2600	2600	3250	3120	3900	3640	4550	4160	5200	4680	5850	5200	6500
.280		.....	2800	2800	3500	3360	4200	3920	4900	4480	5600	5040	6300	5600	7000
.300		.....	3000	3000	3750	3600	4500	4200	5250	4800	6000	5400	6750	6000	7500
.3125	5/16	.....	3130	.....	3910	3750	4690	4380	5470	5000	6250	5630	7030	6250	7810
.320		.....	3200	.....	4000	3840	4800	4480	5600	5120	6400	5760	7200	6400	8000
.340		.....	3400	.....	4250	4080	5100	4760	5950	5440	6800	6120	7650	6800	8500
.360		.....	3600	.....	4500	4320	5400	5040	6300	5760	7200	6480	8100	7200	9000
.375	⅜	.....	3750	.....	4690	.....	5630	5250	6560	6000	7500	6750	8440	7500	9370
.380		.....	3800	.....	4750	.....	5700	5320	6650	6080	7600	6840	8550	7600	9500
.400		.....	.....	.....	5000	.....	6000	5600	7000	6400	8000	7200	9000	8000	10000
.420		.....	.....	.....	5250	.....	6300	5880	7350	6720	8400	7560	9450	8400	10500
.4375	7/16	.....	.....	.....	5470	.....	6560	.....	7660	7000	8750	7880	9840	8750	10940
.440		.....	.....	.....	5500	.....	6600	.....	7700	7040	8800	7920	9900	8800	11000
.460		.....	.....	.....	5750	.....	6900	.....	8050	7360	9200	8280	10350	9200	11500
.480		.....	.....	.....	6000	.....	7200	.....	8400	7680	9600	8640	10800	9600	12000
.500	½	.....	.....	.....	.....	.....	7500	.....	8750	.....	10000	9000	11250	10000	12500
.520		.....	.....	.....	.....	.....	7800	.....	9100	.....	10400	9360	11700	10400	13000
.540		.....	.....	.....	.....	.....	8100	.....	9450	.....	10800	9720	12150	10800	13500
.560		.....	.....	.....	.....	.....	8400	.....	9800	.....	11200	.....	12600	11200	14000
.5625	9/16	.....	.....	.....	.....	.....	8440	.....	9850	.....	11250	.....	12660	11250	14060
.580		.....	.....	.....	.....	.....	8700	.....	10150	.....	11600	.....	13050	11600	14500
.600		.....	.....	.....	.....	.....	.....	.....	10500	.....	12000	.....	13500	12000	15000
.620		.....	.....	.....	.....	.....	.....	.....	10850	.....	12400	.....	13950	.....	15500
.625	⅝	.....	.....	.....	.....	.....	.....	.....	10940	.....	12500	.....	14060	.....	15630
.640		.....	.....	.....	.....	.....	.....	.....	11200	.....	12800	.....	14400	.....	16000
.660		.....	.....	.....	.....	.....	.....	.....	11550	.....	13200	.....	14850	.....	16500
.680		.....	.....	.....	.....	.....	.....	.....	11900	.....	13600	.....	15300	.....	17000
.6875	11/16	.....	.....	.....	.....	.....	.....	.....	12030	.....	13750	.....	15470	.....	17190
.700		.....	.....	.....	.....	.....	.....	.....	.....	.....	14000	.....	15750	.....	17500
.720		.....	.....	.....	.....	.....	.....	.....	.....	.....	14400	.....	16200	.....	18000
.740		.....	.....	.....	.....	.....	.....	.....	.....	.....	14800	.....	16650	.....	18500
.750	¾	.....	.....	.....	.....	.....	.....	.....	.....	.....	15000	.....	16880	.....	18750
.8125	13/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18280	.....	20310
.875	⅞	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19690	.....	21870
.9375	15/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23440
1.00	1	8000	10000	10000	12500	12000	15000	14000	17500	16000	20000	18000	22500	20000	25000

POWER DRIVEN RIVETS AND TURNED BOLTS IN REAMED HOLES

SHEARING AND BEARING VALUES, IN POUNDS

Shear 13,500; Bearing 24,000; Enclosed Bearing 30,000 Pounds per Square Inch

Diameter, In.		1/2		5/8		3/4		7/8		1		1 1/8		1 1/4	
Area, In.²		.1963		.3068		.4418		.6013		.7854		.9940		1.2272	
Single Shear		2650		4140		5960		8120		10600		13420		16570	
Double Shear		5300		8280		11930		16240		21200		26840		33130	
Thickness of Plate, In.		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing	
		24000	30000	24000	30000	24000	30000	24000	30000	24000	30000	24000	30000	24000	30000
.125	1/8	1500	1880	1880	2340	2250	2810	2630	3280	3000	3750	3380	4220	3750	4690
.140		1680	2100	2100	2630	2520	3150	2940	3680	3360	4200	3780	4730	4200	5250
.160		1920	2400	2400	3000	2880	3600	3360	4200	3840	4800	4320	5400	4800	6000
.180		2160	2700	2700	3380	3240	4050	3780	4730	4320	5400	4860	6080	5400	6750
.1875	3/16	2250	2810	2810	3520	3380	4220	3940	4920	4500	5630	5060	6330	5630	7030
.200		2400	3000	3000	3750	3600	4500	4200	5250	4800	6000	5400	6750	6000	7500
.220		2640	3300	3300	4130	3960	4950	4620	5780	5280	6600	5940	7430	6600	8250
.240		....	3600	3600	4500	4320	5400	5040	6300	5760	7200	6480	8100	7200	9000
.250	1/4	....	3750	3750	4690	4500	5630	5250	6560	6000	7500	6750	8440	7500	9380
.260		....	3900	3900	4880	4680	5850	5460	6830	6240	7800	7020	8780	7800	9750
.280		....	4200	....	5250	5040	6300	5880	7350	6720	8400	7560	9450	8400	10500
.300		....	4500	....	5630	5400	6750	6300	7880	7200	9000	8100	10130	9000	11250
.3125	5/16	....	4690	....	5860	5630	7030	6560	8200	7500	9380	8440	10550	9380	11720
.320		....	4800	....	6000	5760	7200	6720	8400	7680	9600	8640	10800	9600	12000
.340		....	5100	....	6380	5960	7650	7140	8930	8160	10200	9180	11480	10200	12750
.360		....	....	....	6750	....	8100	7560	9450	8640	10800	9720	12150	10800	13500
.375	3/8	....	....	....	7030	....	8440	7880	9840	9000	11250	10130	12660	11250	14050
.380		....	....	....	7130	....	8550	7980	9980	9120	11400	10260	12830	11400	14250
.400		....	....	....	7500	....	9000	....	10500	9600	12000	10800	13500	12000	15000
.420		....	....	....	7880	....	9450	....	11030	10080	12600	11340	14180	12600	15750
.4375	7/16	....	....	....	8200	....	9840	....	11480	10500	13130	11810	14770	13130	16410
.440		....	....	....	8250	....	9900	....	11550	10560	13200	11880	14850	13200	16500
.460		....	....	....	....	....	10350	....	12080	....	13800	12420	15530	13800	17250
.480		....	....	....	....	....	10800	....	12600	....	14400	12960	16200	14400	18000
.500	1/2	....	....	....	....	....	11250	....	13130	....	15000	....	16880	15000	18750
.520		....	....	....	....	....	11700	....	13650	....	15600	....	17550	15600	19500
.540		....	....	....	....	....	11930	....	14180	....	16200	....	18230	16200	20250
.560		....	....	....	....	....	....	....	14700	....	16800	....	18980	....	21000
.5625	9/16	....	....	....	....	....	....	....	14770	....	16880	....	18980	....	21090
.580		....	....	....	....	....	....	....	15230	....	17400	....	19580	....	21750
.600		....	....	....	....	....	....	....	15750	....	18000	....	20250	....	22500
.620		....	....	....	....	....	....	....	....	....	18600	....	20930	....	23250
.625	5/8	....	....	....	....	....	....	....	....	....	18750	....	21090	....	23440
.640		....	....	....	....	....	....	....	....	....	19200	....	21600	....	24000
.660		....	....	....	....	....	....	....	....	....	19800	....	22280	....	24750
.680		....	....	....	....	....	....	....	....	....	20400	....	22950	....	25500
.6875	11/16	....	....	....	....	....	....	....	....	....	20630	....	23200	....	25780
.700		....	....	....	....	....	....	....	....	....	21000	....	23630	....	26250
.720		....	....	....	....	....	....	....	....	....	....	....	24300	....	27000
.740		....	....	....	....	....	....	....	....	....	....	....	24980	....	27750
.750	3/4	....	....	....	....	....	....	....	....	....	....	....	25310	....	28130
.8125	13/16	....	....	....	....	....	....	....	....	....	....	....	....	....	30470
.875	7/8	....	....	....	....	....	....	....	....	....	....	....	....	....	32810
.9375	15/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.00	1	12000	15000	15000	18750	18000	22500	21000	26250	24000	30000	27000	33750	30000	37500

PINS

Bearing Values on Metal One Inch Thick, in Pounds

Diameter x 1 x Unit Stress

Pin		Unit Stress in Pounds per Square Inch								
Dia., Inches	Area, Sq. In.	15000	16000	18000	20000	22000	24000	25000	27000	30000
1	.785	15000	16000	18000	20000	22000	24000	25000	27000	30000
1¼	1.227	18750	20000	22500	25000	27500	30000	31250	33750	37500
1½	1.767	22500	24000	27000	30000	33000	36000	37500	40500	45000
1¾	2.405	26250	28000	31500	35000	38500	42000	43750	47250	52500
2	3.142	30000	32000	36000	40000	44000	48000	50000	54000	60000
2¼	3.976	33750	36000	40500	45000	49500	54000	56250	60750	67500
2½	4.909	37500	40000	45000	50000	55000	60000	62500	67500	75000
2¾	5.940	41250	44000	49500	55000	60500	66000	68750	74250	82500
3	7.069	45000	48000	54000	60000	66000	72000	75000	81000	90000
3¼	8.296	48750	52000	58500	65000	71500	78000	81250	87750	97500
3½	9.621	52500	56000	63000	70000	77000	84000	87500	94500	105000
3¾	11.045	56250	60000	67500	75000	82500	90000	93750	101250	112500
4	12.566	60000	64000	72000	80000	88000	96000	100000	108000	120000
4¼	14.186	63750	68000	76500	85000	93500	102000	106250	114750	127500
4½	15.904	67500	72000	81000	90000	99000	108000	112500	121500	135000
4¾	17.721	71250	76000	85500	95000	104500	114000	118750	128250	142500
5	19.635	75000	80000	90000	100000	110000	120000	125000	135000	150000
5¼	21.648	78750	84000	94500	105000	115500	126000	131250	141750	157500
5½	23.758	82500	88000	99000	110000	121000	132000	137500	148500	165000
5¾	25.967	86250	92000	103500	115000	126500	138000	143750	155250	172500
6	28.274	90000	96000	108000	120000	132000	144000	150000	162000	180000
6¼	30.680	93750	100000	112500	125000	137500	150000	156250	168750	187500
6½	33.183	97500	104000	117000	130000	143000	156000	162500	175500	195000
6¾	35.785	101250	108000	121500	135000	148500	162000	168750	182250	202500
7	38.485	105000	112000	126000	140000	154000	168000	175000	189000	210000
7¼	41.282	108750	116000	130500	145000	159500	174000	181250	195750	217500
7½	44.179	112500	120000	135000	150000	165000	180000	187500	202500	225000
7¾	47.173	116250	124000	139500	155000	170500	186000	193750	209250	232500
8	50.265	120000	128000	144000	160000	176000	192000	200000	216000	240000
8¼	53.456	123750	132000	148500	165000	181500	198000	206250	222750	247500
8½	56.745	127500	136000	153000	170000	187000	204000	212500	229500	255000
8¾	60.132	131250	140000	157500	175000	192500	210000	218750	236250	262500
9	63.617	135000	144000	162000	180000	198000	216000	225000	243000	270000
9¼	67.201	138750	148000	166500	185000	203500	222000	231250	249750	277500
9½	70.882	142500	152000	171000	190000	209000	228000	237500	256500	285000
9¾	74.662	146250	156000	175500	195000	214500	234000	243750	263250	292500
10	78.540	150000	160000	180000	200000	220000	240000	250000	270000	300000
10¼	82.516	153750	164000	184500	205000	225500	246000	256250	276750	307500
10½	86.590	157500	168000	189000	210000	231000	252000	262500	283500	315000
10¾	90.763	161250	172000	193500	215000	236500	258000	268750	290250	322500
11	95.033	165000	176000	198000	220000	242000	264000	275000	297000	330000
11¼	99.402	168750	180000	202500	225000	247500	270000	281250	303750	337500
11½	103.869	172500	184000	207000	230000	253000	276000	287500	310500	345000
11¾	108.434	176250	188000	211500	235000	258500	282000	293750	317250	352500
12	113.097	180000	192000	216000	240000	264000	288000	300000	324000	360000

PINS

Bending Moments in Thousands of Inch Pounds

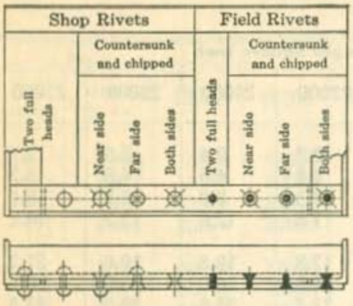
Diameter^3 x 0.098175 x Unit Stress

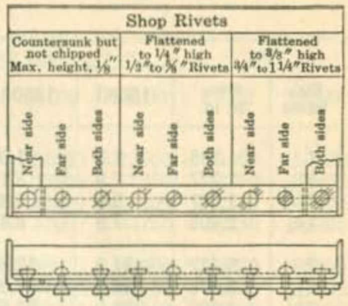
Pin		Unit Stress in Pounds per Square Inch							
Dia., Inches	Area, Sq. In.	15000	16000	18000	20000	22000	24000	25000	27000
1	.785	1.5	1.6	1.8	2.0	2.2	2.4	2.5	2.7
1¼	1.227	2.9	3.1	3.5	3.8	4.2	4.6	4.8	5.2
1½	1.767	5.0	5.3	6.0	6.6	7.3	8.0	8.3	8.9
1¾	2.405	7.9	8.4	9.5	10.5	11.6	12.6	13.2	14.2
2	3.142	11.8	12.6	14.1	15.7	17.3	18.8	19.6	21.2
2¼	3.976	16.8	17.9	20.1	22.4	24.6	26.8	28.0	30.2
2½	4.909	23.0	24.5	27.6	30.7	33.7	36.8	38.3	41.4
2¾	5.940	30.6	32.7	36.8	40.8	44.9	49.0	51.0	55.1
3	7.069	39.8	42.4	47.7	53.0	58.3	63.6	66.3	71.6
3¼	8.296	50.6	53.9	60.7	67.4	74.1	80.9	84.3	91.0
3½	9.621	63.1	67.3	75.8	84.2	92.6	101.0	105.2	113.7
3¾	11.045	77.7	82.8	93.2	103.5	113.9	124.3	129.4	139.8
4	12.566	94.2	100.5	113.1	125.7	138.2	150.8	157.1	169.6
4¼	14.186	113.0	120.6	135.7	150.7	165.8	180.9	188.4	203.5
4½	15.904	134.2	143.1	161.0	178.9	196.8	214.7	223.7	241.6
4¾	17.721	157.8	168.3	189.4	210.4	231.5	252.5	263.0	284.1
5	19.635	184.1	196.4	220.9	245.4	270.0	294.5	306.8	331.3
5¼	21.648	213.1	227.3	255.7	284.1	312.5	340.9	355.2	383.6
5½	23.758	245.0	261.3	294.0	326.7	359.3	392.0	408.3	441.0
5¾	25.967	280.0	298.6	336.0	373.3	410.6	447.9	466.6	503.9
6	28.274	318.1	339.3	381.7	424.1	466.5	508.9	530.1	572.6
6¼	30.680	359.5	383.5	431.4	479.4	527.3	575.2	599.2	647.1
6½	33.183	404.4	431.4	485.3	539.2	593.1	647.1	674.0	728.0
6¾	35.785	452.9	483.1	543.5	603.9	664.3	724.6	754.8	815.2
7	38.485	505.1	538.8	606.1	673.5	740.8	808.2	841.8	909.2
7¼	41.282	561.2	598.6	673.4	748.2	823.1	897.9	935.3	1010.1
7½	44.179	621.3	662.7	745.5	828.4	911.2	994.0	1035.4	1118.3
7¾	47.173	685.5	731.2	822.6	914.0	1005.4	1096.8	1142.5	1233.9
8	50.265	754.0	804.3	904.8	1005.3	1105.8	1206.4	1256.6	1357.2
8¼	53.456	826.9	882.0	992.3	1102.5	1212.8	1323.0	1378.2	1488.4
8½	56.745	904.4	964.7	1085.3	1205.8	1326.4	1447.0	1507.3	1627.9
8¾	60.132	986.5	1052.3	1183.9	1315.4	1446.9	1578.5	1644.2	1775.8
9	63.617	1073.5	1145.1	1288.3	1431.4	1574.5	1717.7	1789.2	1932.4
9¼	67.201	1165.5	1243.2	1398.6	1554.0	1709.4	1864.8	1942.5	2097.9
9½	70.882	1262.6	1346.8	1515.1	1683.5	1851.8	2020.1	2104.3	2272.7
9¾	74.662	1364.9	1455.9	1637.9	1819.9	2001.9	2183.9	2274.9	2456.8
10	78.540	1472.6	1570.8	1767.1	1963.5	2159.8	2356.2	2454.4	2650.7
10¼	82.516	1585.9	1691.6	1903.0	2114.5	2325.9	2537.4	2643.1	2854.5
10½	86.590	1704.7	1818.4	2045.7	2273.0	2500.3	2727.6	2841.2	3068.5
10¾	90.763	1829.4	1951.4	2195.3	2439.2	2683.2	2927.1	3049.1	3293.0
11	95.033	1960.1	2090.7	2352.1	2613.4	2874.8	3136.1	3266.8	3528.1
11¼	99.402	2096.8	2236.5	2516.1	2795.7	3075.2	3354.8	3494.6	3774.2
11½	103.869	2239.7	2389.0	2687.6	2986.2	3284.9	3583.5	3732.8	4031.4
11¾	108.434	2388.9	2548.2	2866.7	3185.3	3503.8	3822.3	3981.6	4300.1
12	113.097	2544.7	2714.3	3053.6	3392.9	3732.2	4071.5	4241.2	4580.5

DETAILS FOR PUNCHING AND RIVETING

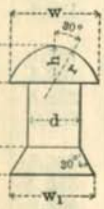
American Bridge Company Standard

Conventional Signs for Riveting





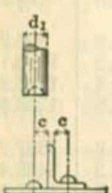
Dimensions of Structural Rivets



	Diameter of Rivet, d, Inches									
	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
w	11/16	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8
h	5/16	3/8	7/16	1/2	5/8	11/16	3/4	7/8	15/16	1
r	7/16	9/16	11/16	13/16	15/16	1	1 1/8	1 1/4	1 3/8	1 1/2
w_1	9/16	3/4	1	1 3/16	1 3/8	1 9/16	1 3/4	2	2 3/16	2 3/8
h_1	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4

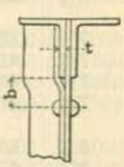
$w = 1\frac{1}{2}\,d + \frac{1}{8}''$ $\quad h = 0.425\,w$ $\quad r = 1\frac{1}{2}\,h.$

Driving Clearance



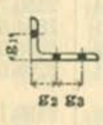
	Diameter of Rivet, d, Inches									
	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
d_1	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4
c	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2

Crimps



$b = t + 1\frac{1}{2}''$ (min. 2")

Usual Gages for Angles



	Width of Leg, Inches														
	8	7	6	5	4	3 1/2	3	2 1/2	2	1 3/4	1 1/2	1 3/8	1 1/4	1	3/4
g_1	4 1/2	4	3 1/2	3	2 1/2	2	1 3/4	1 3/8	1 1/8	1	7/8	7/8	3/4	5/8	1/2
g_2	3	2 1/2	2 1/4	2											
g_3	3	3	2 1/2	1 3/4											
Max. rivet	1 1/8	1	7/8	7/8	7/8	7/8	7/8	3/4	5/8	1/2	3/8	3/8	3/8	1/4	1/4

RIVET SPACING

American Bridge Company Standard

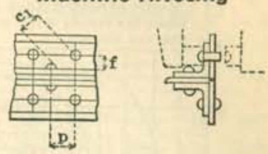
Rivet Stagger

Distance f, in Inches, for Standard Clearance c_1

Diameter of Rivet	Stagger p, in Inches										
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
¾	1⅝	1⅝	1½	1⅜	1¼						
⅞	1⅞	1⅞	1¾	1¾	1⅝	1½	1⅜				
1	2⅛	2	2	1⅞	1⅞	1¾	1⅝	1½			
1⅛	2⅜	2¼	2¼	2⅛	2⅛	2	1⅞	1⅞	1¾		
1¼	2½	2½	2½	2⅜	2⅜	2¼	2¼	2⅛	2	1⅞	1¾

If stagger is necessary, make p and p_1 equal where practical.

Machine Riveting



Gun Riveting

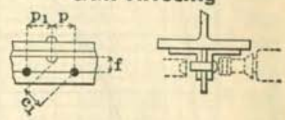
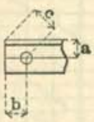
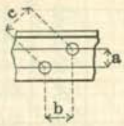
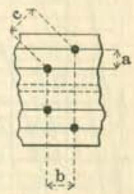


Table of Small Triangles





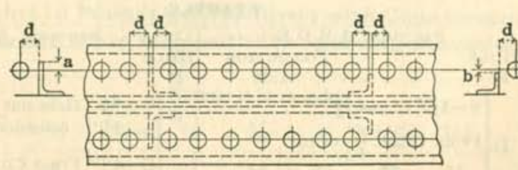


Distance c, in Inches

b, In.	a, Inches																
	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3
1	1 7/16	1½	1⅝	1 11/16	1 13/16	1 15/16	2	2⅛	2¼	2⅜	2 7/16	2 9/16	2 11/16	2 13/16	2 15/16	3 1/16	3 3/16
1⅛	1½	1 9/16	1 11/16	1¾	1⅞	2	2 1/16	2 3/16	2 5/16	2⅜	2½	2⅝	2¾	2⅞	3	3 1/16	3 3/16
1¼	1⅝	1 11/16	1¾	1⅞	1 15/16	2 1/16	2⅛	2¼	2⅜	2 7/16	2 9/16	2 11/16	2 13/16	2 15/16	3	3⅛	3¼
1⅜	1 11/16	1¾	1⅞	1 15/16	2 1/16	2⅛	2¼	2 5/16	2 7/16	2½	2⅝	2¾	2⅞	2 15/16	3 1/16	3 3/16	3 5/16
1½	1 13/16	1⅞	1 15/16	2 1/16	2⅛	2 3/16	2 5/16	2⅜	2½	2⅝	2 11/16	2 13/16	2 15/16	3	3⅛	3¼	3⅜
1⅝	1 15/16	2	2 1/16	2⅛	2 3/16	2 5/16	2⅜	2½	2 9/16	2 11/16	2¾	2⅞	3	3 1/16	3 3/16	3 5/16	3 7/16
1¾	2	2 1/16	2⅛	2¼	2 5/16	2⅜	2½	2 9/16	2 11/16	2¾	2⅞	2 15/16	3 1/16	3⅛	3¼	3⅜	3½
1⅞	2⅛	2 3/16	2¼	2 5/16	2⅜	2½	2 9/16	2⅝	2¾	2 13/16	2 15/16	3	3⅛	3¼	3 5/16	3 7/16	3 9/16
2	2¼	2 5/16	2⅜	2 7/16	2½	2 9/16	2 11/16	2¾	2 13/16	2 15/16	3	3⅛	3 3/16	3 5/16	3⅜	3½	3⅝
2⅛	2⅜	2⅜	2 7/16	2½	2⅝	2 11/16	2¾	2 13/16	2 15/16	3	3⅛	3 3/16	3¼	3⅜	3½	3 9/16	3 11/16
2¼	2 7/16	2½	2 9/16	2⅝	2 11/16	2¾	2⅞	2 15/16	3	3⅛	3 3/16	3¼	3⅜	3 7/16	3 9/16	3⅝	3¾
2⅜	2 9/16	2⅝	2 11/16	2¾	2 13/16	2⅞	2 15/16	3	3⅛	3 3/16	3¼	3⅜	3 7/16	3 9/16	3⅝	3¾	3 13/16
2½	2 11/16	2¾	2 13/16	2⅞	2 15/16	3	3 1/16	3⅛	3 3/16	3¼	3⅜	3 7/16	3 9/16	3⅝	3 11/16	3 13/16	3⅞

Cover Plate Riveting

a, In.	d, In.
½	2½
1	2⅝
1½	2¾
2	2¾
2½	2⅞
3	2⅞
3½	3
4	3⅛
5	3¼
6	3⅜

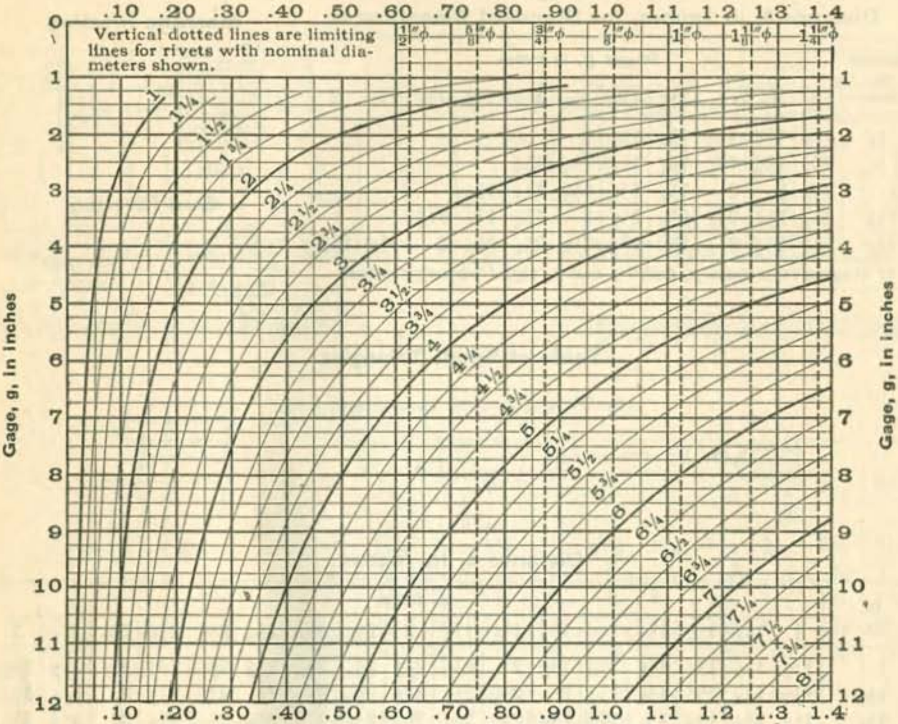


b, In.	d, In.
	2½
½	2⅜
¾	2¼
1	2¼
1¼	2⅛
1½	2
1¾	1¾
2	1½
2¼	1
2½	

NET SECTION OF RIVETED TENSION MEMBERS

A. A. S. H. O. Standard Specifications for Highway Bridges and Incidental Structures, 1931.
A. R. E. A. Specifications for Steel Highway Bridges, 1931.

Curves are values of Stagger, S, in inches



Values of $S^2 \div 4g$, in inches.

In calculating the section of riveted tension members, net sections shall always be used. In deducting rivet holes they shall be taken as ⅛ inch larger than the nominal diameter of rivet.

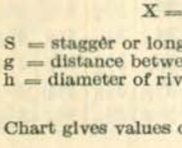
The net section shall be the least area which can be obtained by deducting from the gross sectional area, the area of holes cut by any straight or zigzag section across the member, counting full area of first hole and a fractional part of each succeeding hole, which part is determined by the formula:

$$X = 1 - \frac{S^2}{4gh}$$, in which X is fraction of rivet hole to be deducted.

S = staggêr or longitudinal spacing of rivet with respect to rivet on last gage line.
g = distance between gage lines, or tranverse spacing.
h = diameter of rivet holes, or nominal diameter of rivet plus ⅛ inch.

Chart gives values of $\frac{S^2}{4g}$ to be substituted in above formula. Values of "S" and "g" are always to be taken from the previous hole considered. Note that values for $\frac{S^2}{4g}$ are to be divided by "h" before deduction from 1 to obtain X. Values of $\frac{S^2}{4g}$ to the right of limiting line for any given diameter of rivet are greater than unity when divided by "h"; no deduction for net area is to be made for such cases.

EXAMPLE:



Section A B D E		Section A B C D E	
Hole	Deduction	Hole	Deduction
B	1.00	B	1.00
D: $S = 1\frac{1}{2}''$ $g = 5\frac{3}{4}''$; From Chart $\frac{S^2}{4g} = .10$; $X = 1 - \frac{.10}{.875} =$	.89	C: $S = 3\frac{1}{4}''$ $g = 2\frac{3}{4}''$ Hole not to be considered.	
		D: $S = 1\frac{3}{4}''$ From Chart $\frac{S^2}{4g} = .26$; $g = 3''$ $X = 1 - \frac{.26}{.875} =$	.70
Total Deduction	1.89 holes	Total Deduction	1.70 holes

STRUCTURAL RIVETS

A. I. S. C. Standard

Weights in Pounds per 100 Rivets with Button Heads

Length Under Head, Inches	Diameter of Rivet, Inches ½	⅝	¾	⅞	1	1⅛	1¼
1¼	12						
⅜	13						
½	13	23	35	50	68	91	130
⅝	14	24	36	52	71	95	134
¾	15	25	37	54	74	98	139
⅞	15	26	39	56	77	102	143
2	16	27	41	58	80	105	148
⅛	17	28	43	60	82	109	152
¼	18	29	44	62	85	112	156
⅜	18	30	46	64	88	116	161
½	19	31	47	67	91	119	165
⅝	20	32	49	69	93	123	169
¾	20	34	50	71	96	126	174
⅞	21	35	52	73	99	130	178
3	22	36	54	75	102	133	182
⅛	22	37	55	77	105	137	187
¼	23	38	57	79	107	141	191
⅜	24	39	58	81	110	144	195
½	24	40	60	84	113	148	200
⅝	25	41	61	86	116	151	204
¾	26	42	63	88	118	155	208
⅞	27	43	64	90	121	158	213
4	27	44	66	92	124	162	217
⅛	28	45	68	94	127	165	221
¼	29	47	69	96	130	169	226
⅜	29	48	71	98	132	172	230
½	30	49	72	101	135	176	234
⅝	31	50	74	103	138	179	239
¾	31	51	75	105	141	183	243
⅞	32	52	77	107	143	186	247
Weight of 100 Heads	5.0	9.7	16	24	35	49	78

Length Under Head, Inches	Diameter of Rivet, Inches ⅝	¾	⅞	1	1⅛	1¼
5	53	78	109	146	190	252
⅛	54	80	111	149	193	256
¼	55	82	113	152	197	260
⅜	56	83	115	155	200	265
½	57	85	118	157	204	269
⅝	58	86	120	160	207	273
¾	60	88	122	163	211	278
⅞	61	89	124	166	214	282
6	.....	91	126	169	218	287
⅛	.....	93	128	171	222	291
¼	.....	94	130	174	225	295
⅜	.....	96	132	177	229	300
½	.....	97	135	180	232	304
⅝	.....	99	137	182	236	308
¾	.....	100	139	185	239	313
⅞	.....	102	141	188	243	317
7	.....	104	143	191	246	321
⅛	.....	105	145	194	250	326
¼	.....	107	147	196	253	330
⅜	.....	108	149	199	257	334
½	.....	110	152	202	260	339
⅝	.....	111	154	205	264	343
¾	.....	113	156	207	267	347
⅞	.....	114	158	210	271	352
8	.....	.....	160	213	274	356
⅛	.....	.....	162	216	278	360
¼	.....	.....	164	219	281	365
⅜	.....	.....	166	221	285	369
½	.....	.....	169	224	288	373
⅝	.....	.....	171	227	292	378
¾	.....	.....	173	230	295	382
⅞	.....	.....	175	232	299	386

For Weights in Pounds per 100 Rivets with Countersunk Heads use the above table with the following deductions

Diameter of Rivet, Inches ½	⅝	¾	⅞	1	1⅛	1¼
4	7	11	18	25	36	51

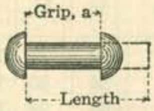
Weights given may vary from those of fabricators owing to differences in the shape of head and should be checked with fabricator.

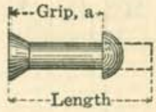
STRUCTURAL RIVETS

A. I. S. C. Standard

Lengths of Undriven Rivets for Various Grips

Dimensions in Inches





Grip, a	Diameter of Rivet 1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
1/2	1 5/8	1 7/8	1 7/8	2	2 1/8		
5/8	1 3/4	2	2	2 1/8	2 1/4		
3/4	1 7/8	2 1/8	2 1/8	2 1/4	2 3/8		
7/8	2	2 1/4	2 1/4	2 3/8	2 1/2		
1	2 1/4	2 3/8	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8
1/8	2 3/8	2 1/2	2 1/2	2 5/8	2 3/4	2 7/8	3
1/4	2 1/2	2 5/8	2 5/8	2 3/4	2 7/8	3	3 1/8
3/8	2 5/8	2 3/4	2 3/4	2 7/8	3	3 1/8	3 1/4
1/2	2 7/8	3	3	3 1/8	3 1/4	3 3/8	3 1/2
5/8	3	3 1/8	3 1/8	3 1/4	3 3/8	3 1/2	3 5/8
3/4	3 1/8	3 1/4	3 1/4	3 1/2	3 5/8	3 3/4	3 7/8
7/8	3 1/4	3 3/8	3 3/8	3 5/8	3 3/4	3 7/8	4
2	3 1/2	3 1/2	3 5/8	3 3/4	3 7/8	4	4 1/8
1/8	3 5/8	3 5/8	3 3/4	3 7/8	4	4 1/8	4 1/4
1/4	3 3/4	3 7/8	3 7/8	4	4 1/8	4 1/4	4 3/8
3/8	4	4	4	4 1/8	4 1/4	4 3/8	4 1/2
1/2	4 1/8	4 1/8	4 1/8	4 1/4	4 3/8	4 1/2	4 5/8
5/8	4 1/4	4 1/4	4 1/4	4 3/8	4 1/2	4 5/8	4 3/4
3/4	4 3/8	4 3/8	4 3/8	4 1/2	4 5/8	4 3/4	4 7/8
7/8	4 5/8	4 5/8	4 5/8	4 5/8	4 3/4	4 7/8	5
3	......	4 3/4	4 3/4	4 7/8	5	5 1/8	5 1/4
1/8	......	4 7/8	4 7/8	5	5 1/8	5 1/4	5 3/8
1/4	......	5	5	5 1/8	5 1/4	5 3/8	5 1/2
3/8	......	5 1/8	5 1/8	5 1/4	5 3/8	5 1/2	5 5/8
1/2	......	5 3/8	5 3/8	5 3/8	5 1/2	5 5/8	5 3/4
5/8	......	5 1/2	5 1/2	5 1/2	5 5/8	5 3/4	5 7/8
3/4	......	5 5/8	5 5/8	5 5/8	5 3/4	5 7/8	6
7/8	......	5 3/4	5 3/4	5 3/4	5 7/8	6	6 1/8
4	......	......	5 7/8	6	6	6 1/8	6 1/4
1/8	......	......	6	6 1/8	6 1/4	6 3/8	6 1/2
1/4	......	......	6 1/8	6 1/4	6 3/8	6 1/2	6 5/8
3/8	......	......	6 3/8	6 1/2	6 1/2	6 5/8	6 3/4
1/2	......	......	6 1/2	6 5/8	6 5/8	6 3/4	6 7/8
5/8	......	......	6 5/8	6 3/4	6 3/4	6 7/8	7
3/4	......	......	6 3/4	6 7/8	6 7/8	7	7 1/8
7/8	......	......	6 7/8	7	7	7 1/8	7 1/4

Grip, a	Diameter of Rivet 7/8	1	1 1/8	1 1/4
5	7 1/8	7 1/8	7 1/4	7 3/8
1/8	7 1/4	7 1/4	7 3/8	7 1/2
1/4	7 3/8	7 3/8	7 1/2	7 5/8
3/8	7 5/8	7 5/8	7 3/4	7 3/4
1/2	7 3/4	7 3/4	7 7/8	7 7/8
5/8	7 7/8	7 7/8	8	8
3/4	8	8	8 1/8	8 1/8
7/8	8 1/8	8 1/8	8 1/4	8 1/4
6	8 3/8	8 3/8	8 3/8	8 3/8
1/8	8 1/2	8 1/2	8 1/2	8 1/2
1/4	8 5/8	8 5/8	8 5/8	8 5/8
3/8	8 3/4	8 3/4	8 3/4	8 3/4
1/2	8 7/8	8 7/8	8 7/8	8 7/8
5/8	9	9	9 1/8	9 1/8
3/4	9 1/8	9 1/8	9 1/4	9 1/4
7/8	9 1/4	9 1/4	9 3/8	9 3/8

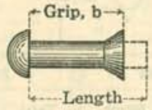
Lengths given may vary from standards of fabricators and should be checked against any such standard.

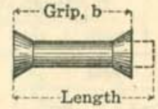
STRUCTURAL RIVETS

A. I. S. C. Standard

Lengths of Undriven Rivets for Various Grips

Dimensions in Inches





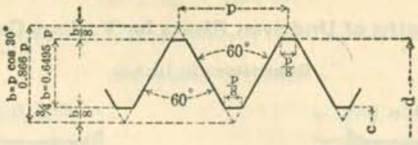
Grip, b	Diameter of Rivet ½	⅝	¾	⅞	1	1⅛	1¼
½	1	1	1⅛	1¼	1¼		
⅝	1⅛	1¼	1¼	1⅜	1⅜		
¾	1⅜	1⅜	1⅜	1½	1½		
⅞	1½	1½	1½	1⅝	1⅝		
1	1⅝	1⅝	1⅝	1¾	1¾	1⅞	1⅞
⅛	1¾	1¾	1⅞	1⅞	1⅞	2	2
¼	2	2	2	2	2	2⅛	2⅛
⅜	2⅛	2⅛	2⅛	2¼	2¼	2⅜	2⅜
½	2¼	2¼	2¼	2⅜	2⅜	2½	2½
⅝	2⅜	2⅜	2⅜	2½	2½	2⅝	2⅝
¾	2⅝	2⅝	2⅝	2⅝	2⅝	2¾	2¾
⅞	2¾	2¾	2¾	2¾	2¾	2⅞	2⅞
2	2⅞	2⅞	2⅞	2⅞	2⅞	3	3
⅛	3⅛	3	3	3	3	3⅛	3⅛
¼	3¼	3⅛	3⅛	3⅛	3¼	3¼	3¼
⅜	3⅜	3⅜	3⅜	3⅜	3⅜	3⅜	3⅜
½	3½	3½	3½	3½	3½	3⅝	3⅝
⅝	3¾	3⅝	3⅝	3⅝	3⅝	3¾	3¾
¾	3⅞	3¾	3¾	3¾	3¾	3⅞	3⅞
⅞	4	3⅞	3⅞	3⅞	3⅞	4	4
3	......	4⅛	4⅛	4⅛	4⅛	4⅛	4⅛
⅛	......	4¼	4¼	4¼	4¼	4¼	4¼
¼	......	4⅜	4⅜	4⅜	4⅜	4⅜	4⅜
⅜	......	4½	4½	4½	4½	4½	4½
½	......	4⅝	4⅝	4⅝	4⅝	4⅝	4⅝
⅝	......	4¾	4¾	4¾	4¾	4⅞	4⅞
¾	......	5	5	5	5	5	5
⅞	......	5⅛	5⅛	5⅛	5⅛	5⅛	5⅛
4	......	......	5¼	5¼	5¼	5¼	5¼
⅛	......	......	5⅜	5⅜	5⅜	5⅜	5⅜
¼	......	......	5½	5½	5½	5½	5½
⅜	......	......	5⅝	5⅝	5⅝	5⅝	5⅝
½	......	......	5¾	5¾	5¾	5¾	5¾
⅝	......	......	6	6	6	6	6
¾	......	......	6⅛	6⅛	6⅛	6⅛	6⅛
⅞	......	......	6¼	6¼	6¼	6¼	6¼

Grip, b	Diameter of Rivet ⅞	1	1⅛	1¼
5	6⅜	6⅜	6⅜	6⅜
⅛	6½	6½	6½	6½
¼	6⅝	6⅝	6⅝	6⅝
⅜	6¾	6¾	6¾	6¾
½	6⅞	6⅞	6⅞	6⅞
⅝	7	7	7	7
¾	7¼	7¼	7¼	7¼
⅞	7⅜	7⅜	7⅜	7⅜
6	7½	7½	7½	7½
⅛	7⅝	7⅝	7⅝	7⅝
¼	7¾	7¾	7¾	7¾
⅜	7⅞	7⅞	7⅞	7⅞
½	8	8	8	8
⅝	8¼	8¼	8¼	8¼
¾	8⅜	8⅜	8⅜	8⅜
⅞	8½	8½	8½	8½

Lengths given may vary from standards of fabricators and should be checked against any such standard.

SCREW THREADS

American Standard Free Fit—Class 2

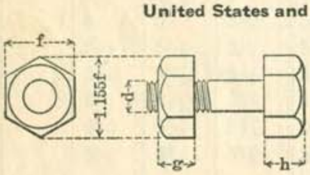


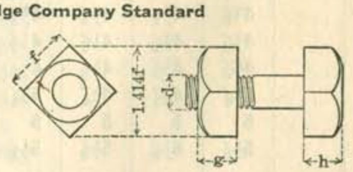
Diameter		Area		Number of Threads, per Inch	Diameter		Area		Number of Threads, per Inch
Major, d, In.	Minor, c, In.	Total, Dia., d, Sq. In.	Net, Dia., c, Sq. In.		Major, d, In.	Minor, c, In.	Total, Dia., d, Sq. In.	Net, Dia., c, Sq. In.	
¼	.185	.049	.027	20	2½	2.175	4.909	3.716	4
⅜	.294	.110	.068	16	2¾	2.425	5.940	4.619	4
½	.400	.196	.126	13					
⅝	.507	.307	.202	11	3	2.675	7.069	5.621	4
¾	.620	.442	.302	10	3¼	2.925	8.296	6.721	4
⅞	.731	.601	.419	9	3½	3.175	9.621	7.919	4
					3¾	3.425	11.045	9.215	4
1	.838	.785	.551	8					
1⅛	.939	.994	.693	7	4	3.675	12.566	10.609	4
1¼	1.064	1.227	.890	7	4¼	3.925	14.186	12.101	4
1⅜	1.158	1.485	1.054	6	4½	4.175	15.904	13.692	4
1½	1.283	1.767	1.294	6	4¾	4.425	17.721	15.380	4
1⅝	1.389	2.074	1.515	5½					
1¾	1.490	2.405	1.744	5	5	4.675	19.635	17.167	4
1⅞	1.615	2.761	2.049	5	5¼	4.925	21.648	19.052	4 *
					5½	5.175	23.758	21.036	4
2	1.711	3.142	2.300	4½	5¾	5.425	25.967	23.117	4
2¼	1.961	3.976	3.021	4½					
					6	5.675	28.274	25.297	4

*Recommended by American Institute of Bolt, Nut and Rivet Manufacturers.
Customers should specify the number of threads required for diameters above 4″.

BOLT HEADS AND NUTS

United States and American Bridge Company Standard





HEADS AND NUTS		U. S. Standard	A. B. Co. Standard
Head	Height, h	0.75 d + 1/16″	0.75 d
	Short Dia., f	1.50 d + ⅛″	1.50 d
Nut	Height, g	d	d
	Short Dia., f	1.50 d + ⅛″	1.50 d + ⅛″

Heads for Bolts 1½″ and under, A. B. Co. Standard.
Heads for Bolts 1⅝″ and over, U. S. Standard.

BOLT HEADS AND NUTS

American Bridge Company Standard

Dia. of Bolt, In.	HEAD					Dia. of Bolt In.	NUT				
	Hexagon Diameter, In.		Height, In.	Square Diameter, In.			Hexagon Diameter, In.		Height In.	Square Diameter, In.	
	Long	Short		Long	Short		Long	Short		Long	Short
1/4	7/16	3/8	3/16	1/2	3/8	1/4	9/16	1/2	1/4	11/16	1/2
3/8	5/8	9/16	1/4	3/4	9/16	3/8	13/16	11/16	3/8	1	11/16
1/2	7/8	3/4	3/8	1 1/16	3/4	1/2	1	7/8	1/2	1 1/4	7/8
5/8	1 1/8	15/16	1/2	1 3/8	15/16	5/8	1 1/4	1 1/16	5/8	1 1/2	1 1/16
3/4	1 1/4	1 1/8	9/16	1 5/8	1 1/8	3/4	1 1/2	1 1/4	3/4	1 3/4	1 1/4
7/8	1 1/2	1 5/16	5/8	1 7/8	1 5/16	7/8	1 5/8	1 7/16	7/8	2	1 7/16
1	1 3/4	1 1/2	3/4	2 1/8	1 1/2	1	1 7/8	1 5/8	1	2 1/4	1 5/8
1 1/8	2	1 11/16	7/8	2 3/8	1 11/16	1 1/8	2 1/8	1 13/16	1 1/8	2 5/8	1 13/16
1 1/4	2 1/8	1 7/8	15/16	2 5/8	1 7/8	1 1/4	2 1/4	2	1 1/4	2 7/8	2
1 3/8	2 3/8	2 1/16	1	2 7/8	2 1/16	1 3/8	2 1/2	2 3/16	1 3/8	3 1/8	2 3/16
1 1/2	2 5/8	2 1/4	1 1/8	3 1/8	2 1/4	1 1/2	2 3/4	2 3/8	1 1/2	3 3/8	2 3/8
1 5/8	3	2 9/16	1 1/4	3 5/8	2 9/16	1 5/8	3	2 9/16	1 5/8	3 5/8	2 9/16
1 3/4	3 1/8	2 3/4	1 3/8	3 7/8	2 3/4	1 3/4	3 1/8	2 3/4	1 3/4	3 7/8	2 3/4
1 7/8	3 3/8	2 15/16	1 1/2	4 1/8	2 15/16	1 7/8	3 3/8	2 15/16	1 7/8	4 1/8	2 15/16
2	3 5/8	3 1/8	1 9/16	4 3/8	3 1/8	2	3 5/8	3 1/8	2	4 3/8	3 1/8
2 1/4	4	3 1/2	1 3/4	5	3 1/2	2 1/4	4	3 1/2	2 1/4	5	3 1/2
2 1/2	4 1/2	3 7/8	1 15/16	5 1/2	3 7/8	2 1/2	4 1/2	3 7/8	2 1/2	5 1/2	3 7/8
2 3/4	4 7/8	4 1/4	2 1/8	6	4 1/4	2 3/4	4 7/8	4 1/4	2 3/4	6	4 1/4
3	5 3/8	4 5/8	2 5/16	6 1/2	4 5/8	3	5 3/8	4 5/8	3	6 1/2	4 5/8
3 1/4	5 3/4	5	2 1/2	7	5	3 1/4	5 3/4	5	3 1/4	7	5
3 1/2	6 1/4	5 3/8	2 11/16	7 5/8	5 3/8	3 1/2	6 1/4	5 3/8	3 1/2	7 5/8	5 3/8
3 3/4	6 5/8	5 3/4	2 7/8	8 1/8	5 3/4	3 3/4	6 5/8	5 3/4	3 3/4	8 1/8	5 3/4
4	7	6 1/8	3 1/16	8 5/8	6 1/8	4	7	6 1/8	4	8 5/8	6 1/8
4 1/4	7 1/2	6 1/2	3 1/4	9 1/4	6 1/2	4 1/4	7 1/2	6 1/2	4 1/4	9 1/4	6 1/2
4 1/2	8	6 7/8	3 7/16	9 3/4	6 7/8	4 1/2	8	6 7/8	4 1/2	9 3/4	6 7/8
4 3/4	8 3/8	7 1/4	3 5/8	10 1/4	7 1/4	4 3/4	8 3/8	7 1/4	4 3/4	10 1/4	7 1/4
5	8 3/4	7 5/8	3 13/16	10 3/4	7 5/8	5	8 3/4	7 5/8	5	10 3/4	7 5/8
5 1/4	9 1/4	8	4	11 1/4	8	5 1/4	9 1/4	8	5 1/4	11 1/4	8
5 1/2	9 5/8	8 3/8	4 3/16	11 7/8	8 3/8	5 1/2	9 5/8	8 3/8	5 1/2	11 7/8	8 3/8
5 3/4	10 1/8	8 3/4	4 3/8	12 3/8	8 3/4	5 3/4	10 1/8	8 3/4	5 3/4	12 3/8	8 3/4
6	10 1/2	9 1/8	4 9/16	12 7/8	9 1/8	6	10 1/2	9 1/8	6	12 7/8	9 1/8

LENGTH OF BOLT THREADS

Length of Bolt, In.	Diameter of Bolt, Inches								
	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
1 to 1 1/2	3/4	3/4	1	1 1/4					
1 5/8 to 2	3/4	3/4	1	1 1/4	1 1/2	1 1/2			
2 1/8 to 2 1/2	3/4	3/4	1	1 1/4	1 1/2	1 3/4	1 3/4		
2 5/8 to 3	7/8	7/8	1	1 1/4	1 1/2	1 3/4	1 3/4	2 1/4	
3 1/8 to 4	7/8	7/8	1 1/4	1 1/4	1 1/2	1 3/4	1 3/4	2 1/4	2 1/2
4 1/8 to 8	1	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4
8 1/8 to 12	1	1	1 1/2	1 3/4	2	2 1/4	2 1/2	3	3
12 1/8 to 20	1	1	1 1/2	2	2	2 1/4	2 1/2	3	3

Bolts are usually threaded about 3 times the diameter; in no case are standard bolts threaded closer to the head than 1/4 inch.

BOLTS WITH SQUARE HEADS AND NUTS

American Bridge Company Standard

Weights in Pounds per 100 Bolts

Length Under Head, Inches	Diameter of Bolt, Inches										
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
1	3.6	6.0	8.5	13							
1 1/4	3.9	6.5	9.2	14	....	36					
1 1/2	4.2	7.0	9.9	15	20	38	61	87			
1 3/4	4.5	7.5	11	16	22	40	64	91	134		
2	4.8	8.0	11	17	24	42	68	96	139		
2 1/4	5.1	8.5	12	18	26	44	71	100	144		
2 1/2	5.4	9.0	13	19	27	46	74	104	149		
2 3/4	5.7	9.5	13	20	28	48	77	108	155		
3	6.0	9.9	14	21	29	50	80	112	161	218	290
3 1/2	6.6	11	16	23	32	54	86	120	171	232	
4	7.2	12	17	25	34	59	92	129	182	245	324
4 1/2	7.8	13	18	27	37	63	98	137	192	259	
5	8.4	14	20	29	39	67	104	145	204	272	358
5 1/2	9.0	15	21	31	42	71	110	153	215	286	
6	9.6	16	23	33	44	75	117	162	225	300	392
6 1/2	....	....	24	35	46	79	122	169	235	314	
7	....	....	25	37	49	83	128	177	246	327	426
7 1/2	....	....	27	39	52	87	134	185	256	341	
8	....	....	28	41	55	91	140	194	267	355	460
9	....	....	31	45	60	100	152	210	288	382	493
10	....	....	....	49	66	108	164	227	310	409	527
12	....	....	....	57	76	124	188	260	353	464	595
14	....	....	....	....	86	141	212	293	397	519	663
16	....	....	....	....	96	157	236	326	440	574	731
18	....	....	....	....	106	174	260	359	483	629	799
20	....	....	....	....	116	190	284	392	526	683	867
22	....	....	....	....	126	207	308	425	570	738	934
24	....	....	....	....	137	223	332	458	613	793	1002
Per Inch Additional	1.2	1.9	2.8	4.0	5.2	8.3	12	16.4	21.7	27.4	33.9

SQUARE NUTS AND BOLT HEADS

Weights in Pounds for One Head and One Nut

Diameter of Bolt, Inches	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8
Square Head and Nut...	2.500	3.510	4.300	5.480	6.660	8.080	9.100
One Inch of Shank......	.420	.500	.589	.682	.780	.890	1.000
Diameter of Bolt, Inches	**2 1/4**	**2 3/8**	**2 1/2**	**2 5/8**	**2 3/4**	**2 7/8**	**3**
Square Head and Nut...	12.000	14.320	15.500	18.000	20.300	24.000	26.200
One Inch of Shank......	1.125	1.250	1.391	1.533	1.683	1.839	2.003

BOLTS WITH HEXAGON HEADS AND NUTS

American Bridge Company Standard

Weights in Pounds per 100 Bolts

Length Under Head, Inches	Diameter of Bolt, Inches							Length Under Head, Inches	Diameter of Bolt, Inches						
	½	⅝	¾	⅞	1	1⅛	1¼		½	⅝	¾	⅞	1	1⅛	1¼
1								8	51	86	133	186	252	338	426
1¼		31						8½	54	90	139	194	263	352	443
1½	16	33	54	78				9	56	94	145	202	274	365	459
1¾	18	35	57	82	118			9½	59	98	151	210	285	379	476
2	20	37	61	87	123			10	62	103	157	219	296	392	493
2¼	22	39	64	91	128			10½	65	107	163	227	307	406	510
2½	23	41	67	95	133			11	67	111	169	235	318	420	527
2¾	24	43	70	99	139			11½	70	115	175	243	329	434	544
3	25	45	73	103	145	201	256	12	72	120	181	252	339	447	561
3¼	26	47	76	107	150	208	265	12½	75	124	187	260	350	461	578
3½	28	49	79	111	156	215	273	13	77	128	193	268	361	474	595
3¾	29	51	82	115	161	222	282	13½	80	132	199	276	372	488	612
4	30	54	85	120	166	228	290	14	82	136	205	285	382	502	629
4¼	31	56	88	124	171	235	299	14½	85	140	211	293	393	516	646
4½	33	58	91	128	177	242	307	15	87	144	217	301	404	530	663
4¾	34	60	94	132	182	249	316	15½	90	148	223	309	415	544	680
5	35	62	97	136	188	255	324	16	92	152	229	318	425	557	697
5¼	36	64	100	140	193	262	333	16½	95	156	235	326	436	571	714
5½	38	66	103	144	199	269	341	17	97	160	241	335	447	585	732
5¾	39	68	106	148	204	276	350	17½	100	164	247	343	458	599	749
6	40	70	110	153	209	283	358	18	102	169	253	351	468	612	765
6¼	41	72	113	157	214	290	367	18½	105	173	259	359	479	626	782
6½	43	74	116	161	220	297	375	19	108	177	265	368	490	639	799
6¾	44	76	119	165	225	304	384	19½	110	181	271	376	501	653	816
7	45	78	121	169	230	310	392	20	113	185	277	384	511	666	833
7¼	47	80	124	173	235	318	401	21	118	193	289	400	533	694	866
7½	48	82	127	177	241	325	409	22	123	202	301	417	554	721	900
7¾	49	84	130	181	246	332	418	23	129	210	313	433	576	748	934
								24	134	219	326	450	597	776	968
Per Inch Additional	5.2	8.3	12.0	16.4	21.7	27.4	33.9								

HEXAGON NUTS AND BOLT HEADS

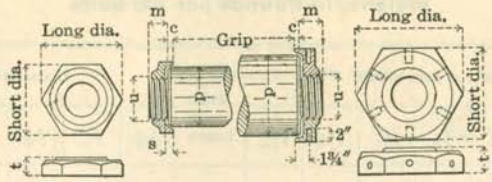
Weights in Pounds for One Head and One Nut

Diameter of Bolt, Inches	1⅜	1½	1⅝	1¾	1⅞	2	2⅛
Hexagon Head and Nut.	2.090	2.950	3.700	4.610	5.680	6.790	8.330
One Inch of Shank......	.420	.500	.589	.682	.780	.890	1.000
Diameter of Bolt, Inches	2¼	2⅜	2½	2⅝	2¾	2⅞	3
Hexagon Head and Nut.	9.650	11.750	13.000	14.700	16.700	19.370	22.000
One Inch of Shank......	1.125	1.250	1.391	1.533	1.683	1.839	2.003

RECESSED PIN NUTS AND COTTER PINS

American Bridge Company Standard

Pressed Steel Nut PN 21 to 33



Cast Steel Nut PN 34 to 47 15/16″ Cored Holes

Thread: American Standard Free Fit—Class 2. Pitch, 6 per Inch.

Diameter of Pin	PIN				NUT						
	Thread			Thickness	Diameter		Recess		Diameter Rough Hole	Weight, Pounds	Pattern No.
p	u	m	c	t	Short Dia.	Long Dia.	Rough Dia.	s			
2, 2¼	1½	1	⅛	⅞	3	3⅜	2⅝	¼	1¼	1	PN 21
2½, 2¾	2	1⅛	⅛	1	3⅝	4⅛	3⅛	¼	1¾	2	PN 22
3, *3¼, 3½	2½	1¼	⅛	1⅛	4⅜	5	3⅞	⅜	2¼	3	PN 23
*3¾, 4	3	1⅜	¼	1¼	4⅞	5⅝	4⅜	⅜	2¾	4	PN 24
*4¼, 4½, *4¾	3½	1½	¼	1⅜	5¾	6⅝	5¼	½	3¼	5	PN 25
5, *5¼	4	1⅝	¼	1½	6¼	7¼	5¾	½	3¾	6	PN 26
5½, *5¾, 6	4½	1¾	¼	1⅝	7	8⅛	6½	⅝	4¼	8	PN 27
*6¼, *6½	5	1⅞	⅜	1¾	7⅝	8⅞	7	⅝	4¾	10	PN 28
*6¾, 7	5½	2	⅜	1⅞	8⅛	9⅜	7½	¾	5¼	12	PN 29
*7¼, *7½	5½	2	⅜	1⅞	8⅝	10	8	¾	5¼	14	PN 30
*7¾, 8, *8¼	6	2¼	⅜	2⅛	9⅜	10⅞	8¾	¾	5¾	19	PN 31
*8½, *8¾, 9	6	2¼	⅜	2⅛	10¼	11⅞	9⅝	¾	5¾	24	PN 32
*9¼, *9½	6	2⅜	⅜	2¼	11¼	13	10⅝	¾	5¾	32	PN 33
*9¾, 10	6	2⅜	⅜	2¼	11¼	13	10⅝	¾	5¾	32	PN 33
11	6	2½	½	2⅞	12½	14⅜	11¾	¾	5¾	60	PN 34
12	6	2⅝	½	2⅞	13½	15⅝	12¾	¾	5¾	73	PN 35
13	7	2¾	½	2⅞	14½	16¾	13¾	¾	6¾	81	PN 36
14	7	3	½	2⅞	15½	17⅞	14¾	¾	6¾	94	PN 37
15	8	3	½	2⅞	16½	19	15¾	¾	7¾	103	PN 38
16	8	3⅛	½	3	17½	20⅛	16¾	¾	7¾	126	PN 39
17	9	3¼	½	3⅛	18½	21¼	17¾	¾	8¾	145	PN 40
18	9	3⅜	½	3¼	19½	22⅜	18¾	¾	8¾	173	PN 41
19	10	3½	½	3⅜	20½	23½	19¾	¾	9¾	196	PN 42
20	10	3½	½	3⅜	21½	24¾	20¾	¾	9¾	222	PN 43
21	11	3½	½	3⅜	22½	26	21¾	¾	10¾	240	PN 44
22	11	3½	½	3⅜	23½	27⅛	22¾	¾	10¾	266	PN 45
23	12	3½	½	3⅜	24½	28¼	23¾	¾	11¾	282	PN 46
24	12	3½	½	3⅜	25½	29⅜	24¾	¾	11¾	310	PN 47

* Special sizes.

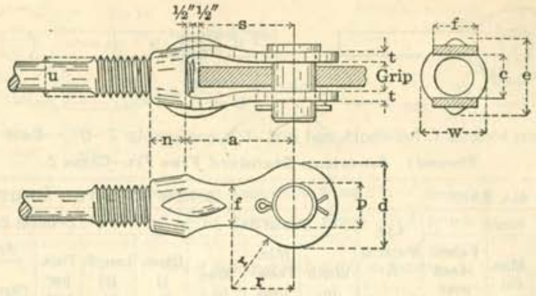
Horizontal or Vertical Cotter Pin Finished.

Horizontal Cotter Pin Over 2″ Finished.

PIN	HEAD	COTTER		PIN	HEAD	COTTER	
p	h	c	d	p	h	c	d
1¼	1½	2	¼	2¾	3⅛	4	⅜
1½	1¾	2½	¼	3	3½	5	½
1¾	2	2¾	¼	3¼	3¾	5	½
2	2⅜	3	⅜	3½	4	6	½
2¼	2⅝	3¼	⅜	3¾	4¼	6	½
2½	2⅞	3¾	⅜				

CLEVISES

American Bridge Company Standard



Grip=thickness of plate + ¼" but must not exceed dimension, c.

Thread: American Standard Free Fit—Class 2.

Clevis Number	UPSET Min.	UPSET Max.	PIN Min.	PIN Max.	HEAD			FORK				NUT			Weight, Pounds
	u	u	p	p	d	t	r	f	s	c	a	n	w	e	
3	1	1⅛	1	1½	3	½	2¼	1½	4	1¼	5	1½	2¼	3 1/16	4
4	1⅛	1⅝	1¼	2	4	½	3	2	5	1¾	6	1¾	2⅞	3⅝	8
5	1½	2⅛	1½	2½	5	⅝	3¾	2½	6	2¼	7	2¼	3¾	4½	17
6	2	2⅝	2	3	6	¾	4½	3	7	2¾	8	2½	4⅜	5⅜	26
7	2¼	3	2½	3½	7	⅞	5¼	3½	8	3¼	9	3	5	6 3/16	40

CLEVIS NUMBERS FOR VARIOUS RODS AND PINS

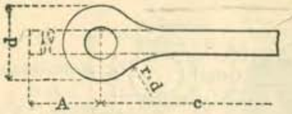
RODS			PINS										
Round	Square	Upset	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½
¾	......	1	3	3	3								
......	¾	1⅛	3	3	3	4	4						
⅞	⅞	1¼		4	4	4	4						
1	......	1⅜		4	4	4	4						
1⅛	1	1½		4	4	4	4	5	5				
1¼	1⅛	1⅝		4	4	4	4	5	5				
1⅜	......	1¾			5	5	5	5	5				
......	1¼	1⅞			5	5	5	5	5				
1½	1⅜	2			5	5	5	5	5	6	6		
1⅝	......	2⅛			5	5	5	5	5	6	6		
1¾	1½	2¼					6	6	6	6	6	7	7
1⅞	1⅝	2⅜					6	6	6	6	6	7	7
2	1¾	2½					6	6	6	6	6	7	7
2⅛	......	2⅝					6	6	6	6	6	7	7
......	1⅞	2¾							7	7	7	7	7
2¼	2	2⅞							7	7	7	7	7
2⅜	2⅛	3							7	7	7	7	7

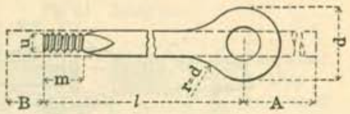
Clevises above and to right of zigzag line may be used with forks straight, clevises below and to left of this line should have forks closed so as not to overstrain pin.

EYE BARS

American Bridge Company Standard

Eye Bar **Adjustable Eye Bar**





Minimum length, *l*, for short end is 6′-6″, preferably 7′-0″.—Left thread.

Thread: American Standard Free Fit—Class 2.

HEADS FOR ALL BARS

Size of Bar: Width In.	Thickness: Max. In.	Thickness: Min. In.	Head: Dia. d In.	Head: Max. Pin In.	Head: Excess Head over Bar %	Add. Material A Ft. In.
2	1	½	4½	1¾	37.5	10½
			5½	2¾		1- 2½
			* 6½	3¾		1- 7½
2½	1	⅝	6	2½	40.0	1- 1¾
			7	3½		1- 5¾
			* 8	4½		1-10¾
3	1½	⅝	7½	3¼	41.7	1- 4½
			8½	4¼		1- 9½
			* 9½	5¼		2- 2½
4	1¾	¾	10	4½	37.5	1- 9
		⅞	11	5½		2- 3
		1	*12	6½		2- 8
5	2	¾	12	5¼	35.0	1-10½
		1	13½	6¾		2- 6
		1	*15	8¼		3- 3
6	2	¾	14	5¾	37.5	2- 1
		1	14¾	6½		2- 4
		1	*16½	8¼		3- 2
7	2	1	16½	7	35.7	2- 6½
		1⅛	17½	8		2-11
		1⅛	*18½	9		3- 4
8	2	1	18	7	37.5	2- 5½
		1⅛	19	8		2- 9½
		1¼	*20	9		3- 4
9	2	1⅛	20	7½	38.9	2- 8½
		1¼	22	9½		3- 4½
10	2	1⅛	22½	9	35.0	3- 2½
		1¼	24	10½		3- 9
		1⅜	*25	11½		4- 1
12	2	1¼	26½	10	37.5	3- 6
		1⅜	28	11½		4- 2
		1½	*29½	13		4- 8
14	2	1⅜	31	12	35.7	4- 3
		1½	33	14		4-10
		1⅝	*34	15		5- 5
16	2	1¾	36	14	37.5	4- 9
		1⅞	*37½	16	34.4	5- 4

SCREW ENDS FOR ADJUSTABLE BARS

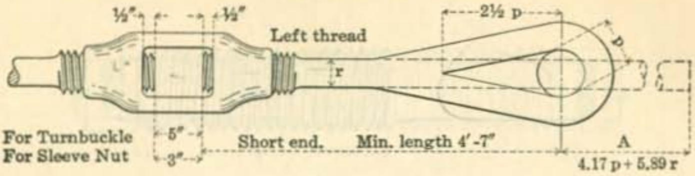
Size of Bar: Width In.	Size of Bar: Min. Thickness In.	Size of Bar: Area In.²	Upset End: Diam. u In.	Upset End: Length m In.	Upset End: Thds. per Inch	At Root of Thread: Diam. In.	At Root of Thread: Area In.²	At Root of Thread: Excess over Bar %	Add. Material B Ft. In.
2	* ⅝	1.25	1¾	4	5	1.49	1.74	39.6	1- 0
	¾	1.50	1⅞	4½	5	1.62	2.05	36.6	1- 0
	⅞	1.75	2	4½	4½	1.71	2.30	31.4	11
2½	* ¾	1.88	2⅛	4½	4½	1.84	2.65	41.2	1- 0
	⅞	2.19	2¼	5	4½	1.96	3.02	38.1	1- 0
	1	2.50	2⅜	5	4	2.09	3.42	36.7	1- 0
3	* ¾	2.25	2¼	5	4½	1.96	3.02	34.3	1- 0
	⅞	2.63	2½	5½	4	2.18	3.72	41.6	1- 1
	1	3.00	2½	5½	4	2.18	3.72	23.9	1- 1
4	* ¾	3.00	2½	5½	4	2.18	3.72	23.9	1- 1
	⅞	3.50	2¾	5½	4	2.43	4.62	32.0	11
	1	4.00	3	6	3½	2.63	5.43	35.7	1- 1
	1⅛	4.50	3¼	6½	3½	2.88	6.51	44.6	1- 2
5	* ¾	3.75	2⅞	6	3½	2.55	5.11	36.2	1- 0
	⅞	4.38	3	6	3½	2.63	5.43	24.1	11
	1	5.00	3¼	6½	3½	2.88	6.51	30.2	1- 0
	1⅛	5.63	3½	7	3¼	3.10	7.55	34.2	1- 1
	1¼	6.25	3¾	7	3	3.32	8.64	38.3	1- 2
6	*1	6.00	3½	7	3¼	3.10	7.55	25.8	1- 0
	1⅛	6.75	3¾	7	3	3.32	8.64	28.0	1- 0
	1¼	7.50	4	7½	3	3.57	9.99	33.2	1- 1
	1⅜	8.25	4¼	8	2⅞	3.80	11.3	37.3	1- 2
7	*1⅛	7.88	4	7½	3	3.57	9.99	26.9	1- 0
	1¼	8.75	4¼	8	2⅞	3.80	11.3	29.5	1- 1
	1⅜	9.63	4½	8½	2¾	4.03	12.7	32.4	1- 2
	1½	10.5	4¾	8½	2⅝	4.26	14.2	35.4	1- 2
8	*1⅛	9.0	4¼	8	2⅞	3.80	11.3	25.9	1- 0
	1¼	10.0	4½	8½	2¾	4.03	12.7	27.4	1- 1
	1⅜	11.0	4¾	8½	2⅝	4.26	14.2	29.3	1- 1
	1½	12.0	5	9	2½	4.48	15.8	31.4	1- 2
	1⅝	13.0	5¼	9½	2½	4.73	17.6	35.2	1- 3
9	*1⅜	12.4	5	9¼	2½	4.48	15.8	28.3	1- 2
	1½	13.5	5¼	9¼	2½	4.73	17.6	30.2	1- 1
	1⅝	14.6	5½	9¾	2⅜	4.95	19.3	31.7	1- 1
10	*1⅜	13.8	5¼	9¼	2½	4.73	17.6	27.8	1- 1
	1½	15.0	5½	9¾	2⅜	4.95	19.3	28.9	1- 1
	1⅝	16.3	5¾	10	2⅜	5.20	21.3	30.8	1- 1
12	*1½	18.0	6	10½	2¼	5.42	23.1	28.3	1- 1
	1⅝	19.5	6¼	10¾	2¼	5.73	25.8	29.6	1- 1
	1¾	21.0	6½	11	2⅛	5.89	27.3	29.7	1- 1

NOTE—For Bars 14″ x 1¾″ (and thicker) with 33″ head add material "A" = 4′-5½″.
Pin holes to be deducted in estimating weight.

*Bars are special.

LOOP RODS AND STUB ENDS

American Bridge Company Standard

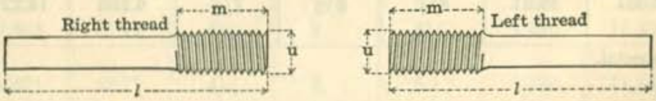


Thread: American Standard Free Fit—Class 2.

Length A for One Loop in Feet and Inches

Diam. of Pin, p	Size of Square or Round Bar, in Inches										
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
1⅛	0- 9½	0-10	0-11	0-11½							
1¼	0-10	0-10½	0-11½	1- 0	1- 1						
1½	0-11	0-11½	1- 0½	1- 1	1- 2	1- 2½					
1¾	1- 0	1- 0½	1- 1½	1- 2	1- 3	1- 3½	1- 4½	1- 5	1- 6		
2	1- 1	1- 1½	1- 2½	1- 3	1- 4	1- 4½	1- 5½	1- 6	1- 7	1- 7½	1- 8½
2¼	1- 2	1- 3	1- 3½	1- 4½	1- 5	1- 5½	1- 6½	1- 7	1- 8	1- 8½	1- 9½
2½	1- 3	1- 4	1- 4½	1- 5½	1- 6	1- 7	1- 7½	1- 8	1- 9	1- 9½	1-10½
2¾	1- 4	1- 5	1- 5½	1- 6½	1- 7	1- 8	1- 8½	1- 9½	1-10	1-11	1-11½
3	1- 5	1- 6	1- 6½	1- 7½	1- 8	1- 9	1- 9½	1-10½	1-11	2- 0	2- 0½
*3¼	1- 6	1- 7	1- 7½	1- 8½	1- 9	1-10	1-10½	1-11½	2- 0	2- 1	2- 1½
3½	1- 7½	1- 8	1- 8½	1- 9½	1-10	1-11	1-11½	2- 0½	2- 1	2- 2	2- 2½
*3¾	1- 8½	1- 9	1-10	1-10½	1-11	2- 0	2- 0½	2- 1½	2- 2	2- 3	2- 3½
4	1- 9½	1-10	1-11	1-11½	2- 0½	2- 1	2- 2	2- 2½	2- 3	2- 4	2- 4½
*4¼		1-11	2- 0	2- 0½	2- 1½	2- 2	2- 3	2- 3½	2- 4½	2- 5	2- 6
4½		2- 0	2- 1	2- 1½	2- 2½	2- 3	2- 4	2- 4½	2- 5½	2- 6	2- 7
*4¾		2- 1	2- 2	2- 2½	2- 3½	2- 4	2- 5	2- 5½	2- 6½	2- 7	2- 8
5		2- 2½	2- 3	2- 3½	2- 4½	2- 5	2- 6	2- 6½	2- 7½	2- 8	2- 9
*5¼			2- 4	2- 5	2- 5½	2- 6	2- 7	2- 7½	2- 8½	2- 9	2-10
5½			2- 5	2- 6	2- 6½	2- 7½	2- 8	2- 9	2- 9½	2-10	2-11
*5¾			2- 6	2- 7	2- 7½	2- 8½	2- 9	2-10	2-10½	2-11½	3- 0
6			2- 7	2- 8	2- 8½	2- 9½	2-10	2-11	2-11½	3- 0½	3- 1
*6¼				2- 9	2- 9½	2-10½	2-11	3- 0	3- 0½	3- 1½	3- 2
6½				2-10	2-10½	2-11½	3- 0	3- 1	3- 1½	3- 2½	3- 3
*6¾				2-11	3- 0	3- 0½	3- 1	3- 2	3- 2½	3- 3½	3- 4
7				3- 0	3- 1	3- 1½	3- 2½	3- 3	3- 3½	3- 4½	3- 5

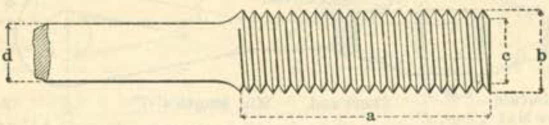
*Pins are special. Maximum shipping length of long end=35 feet.



Dia. of Round	¾		⅞	1	1⅛	1¼	1⅜		1½	1⅝	1¾	1⅞	2
Side of Square		¾	⅞		1	1⅛		1¼	1⅜		1½	1⅝	1¾
Dia. of Upset, u	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½
Length of Upset, m	4	4	4	4	4	4	4	4½	4½	4½	5	5	5½
Length, l	9½	9½	10	10½	10½	11	11½	11½	11½	11½	12	12½	13

UPSET SCREW ENDS FOR SQUARE BARS

American Bridge Company Standard



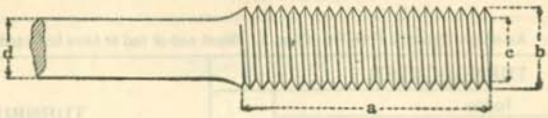
Thread: American Standard Free Fit—Class 2.

BAR			UPSET					
Side of Square d, Inches	Area, Sq. Inches	Weight per Foot, Lbs.	Diameter b, Inches	Length a, Inches	Additional Length for Upset + 10%, Inches	Diameter at Root of Thread c, Inches	Area At Root of Thread, Sq. Inches	Area Excess Over Area of Bar, %
* ¾	0.563	1.91	1⅛	4	4	0.939	0.693	23.2
* ⅞	0.766	2.60	1¼	4	4	1.064	0.890	16.2
1	1.000	3.40	1½	4	4	1.283	1.294	29.4
1⅛	1.266	4.30	1⅝	4	3½	1.389	1.515	19.7
1¼	1.563	5.31	1⅞	4½	4½	1.615	2.049	31.1
1⅜	1.891	6.43	2	4½	4	1.711	2.300	21.7
1½	2.250	7.65	2¼	5	5	1.961	3.021	34.3
1⅝	2.641	8.98	2⅜	5	4½	2.086	3.419	29.5
1¾	3.063	10.41	2½	5½	4½	2.175	3.716	21.3
1⅞	3.516	11.95	2¾	5½	5	2.425	4.619	31.4
2	4.000	13.60	2⅞	6	5	2.550	5.108	27.7
2⅛	4.516	15.35	3	6	4½	2.629	5.428	20.2
2¼	5.063	17.21	3¼	6½	5½	2.879	6.509	28.6
2⅜	5.641	19.18	3½	7	6½	3.100	7.549	33.8
2½	6.250	21.25	3¾	7	7	3.317	8.641	38.3
2⅝	6.891	23.43	3¾	7	5½	3.317	8.641	25.4
2¾	7.563	25.71	4	7½	6½	3.567	9.993	32.1
2⅞	8.266	28.10	4¼	8	7½	3.798	11.330	37.1
3	9.000	30.60	4¼	8	6	3.798	11.330	25.9
3⅛	9.766	33.20	4½	8½	7	4.028	12.741	30.5
3¼	10.563	35.91	4¾	8½	7½	4.255	14.221	34.6

*Upsets are special.

UPSET SCREW ENDS FOR ROUND BARS

American Bridge Company Standard



Thread: American Standard Free Fit—Class 2.

BAR			UPSET						
								Area	
Diameter d, Inches	Area, Sq. Inches	Weight per Foot, Lbs.	Diameter b, Inches	Length a, Inches	Additional Length for Upset + 10%, Inches	Diameter at Root of Thread c, Inches	At Root of Thread, Sq. Inches	Excess Over Area of Bar, %
* ¾	0.442	1.50	1	4	5	0.838	0.551	24.7
* ⅞	0.601	2.04	1¼	4	5½	1.064	0.890	48.0
1	0.785	2.67	1⅜	4	4	1.158	1.054	34.2
1⅛	0.994	3.38	1½	4	4	1.283	1.294	30.2
1¼	1.227	4.17	1⅝	4	4	1.389	1.515	23.5
1⅜	1.485	5.05	1¾	4	4	1.490	1.744	17.5
1½	1.767	6.01	2	4½	4½	1.711	2.300	30.2
1⅝	2.074	7.05	2⅛	4½	4	1.836	2.649	27.7
1¾	2.405	8.18	2¼	5	4	1.961	3.021	25.6
1⅞	2.761	9.39	2⅜	5	4	2.086	3.419	23.8
2	3.142	10.68	2½	5½	4	2.175	3.716	18.3
2⅛	3.547	12.06	2⅝	5½	3½	2.300	4.156	17.2
2¼	3.976	13.52	2⅞	6	4½	2.550	5.108	28.4
2⅜	4.430	15.06	3	6	4½	2.629	5.428	22.5
2½	4.909	16.69	3¼	6½	5½	2.879	6.509	32.6
2⅝	5.412	18.40	3¼	6½	4½	2.879	6.509	20.3
2¾	5.940	20.19	3½	7	5½	3.100	7.549	27.1
2⅞	6.492	22.07	3¾	7	6	3.317	8.641	33.1
3	7.069	24.03	3¾	7	5	3.317	8.641	22.2
3⅛	7.670	26.08	4	7½	6	3.567	9.993	30.3
3¼	8.296	28.21	4	7½	5	3.567	9.993	20.5
3⅜	8.946	30.42	4¼	8	5½	3.798	11.330	26.6
3½	9.621	32.71	4¼	8	5	3.798	11.330	17.8
3⅝	10.321	35.09	4½	8½	5½	4.028	12.741	23.4
3¾	11.045	37.55	4¾	8½	6	4.255	14.221	28.8
3⅞	11.793	40.10	4¾	8½	5½	4.255	14.221	20.6

*Upsets are special.

TURNBUCKLES AND SLEEVE NUTS

American Bridge Company Standard

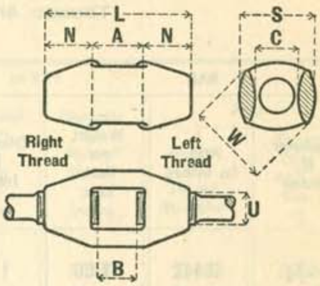
American Standard Free Fit—Class 2.

Threads: American Standard Free Fit—Class 2. Short end of rod to have left hand thread.

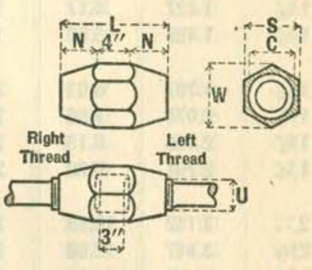
TURNBUCKLES

MATERIAL	Diam. of Screw U (Inches)	Length A (Inches)	Clear B (Inches)	Clear C (Inches)	Nut N (Inches)	Length L (Inches)	Min. Width S (Inches)	Max. Width W (Inches)	Weight Lbs.
DROP FORGED STEEL—WELDLESS	3/8			9/16	9/16	7 1/8	1 1/32	.....	.41
	1/2			11/16	3/4	7 1/2	1 5/16	.....	.70
	5/8			13/16	29/32	7 13/16	1 1/2	.....	.89
	3/4			15/16	1 1/16	8 1/8	1 23/32	.....	1.20
	7/8			1 3/32	1 7/32	8 7/16	1 7/8	.....	1.46
	1			1 9/32	1 3/8	8 3/4	2 1/32	2 5/32	2.27
	1 1/8			1 13/32	1 9/16	9 1/8	2 9/32	.....	2.72
	1 1/4			1 9/16	1 3/4	9 1/2	2 17/32	2 21/32	3.58
	1 3/8			1 11/16	1 15/16	9 7/8	2 3/4	.....	4.13
	1 1/2			1 27/32	2 1/8	10 1/4	3 1/32	.....	5.25
	1 5/8	6	5	1 31/32	2 1/4	10 1/2	3 9/32	.....	5.88
	1 3/4			2 1/8	2 1/2	11	3 9/16	.....	7.05
	1 7/8			2 3/8	2 3/4	11 1/2	4	.....	9.95
	2			2 3/8	2 3/4	11 1/2	4	.....	9.95
	2 1/4			2 11/16	3 3/8	12 3/4	4 5/8	.....	18.00
	2 1/2			3	3 3/4	13 1/2	5	.....	23.25
	2 3/4			3 1/4	4 1/8	14 1/4	5 5/8	.....	31.50
	3			3 5/8	4 1/2	15	6 1/8	.....	39.50
	3 1/4			3 7/8	5 1/4	16 1/2	6 3/4	.....	61.00
	3 1/2			3 7/8	5 1/4	16 1/2	6 3/4	.....	61.00
	3 3/4			4 3/4	6	18	8 1/2	.....	89.00
	4			4 3/4	6	18	8 1/2	.....	89.00
	3 1/4	9		3 7/8	5 1/4	19 1/2	6 3/4	.....	70.00
	3 1/2			3 7/8	5 1/4	19 1/2	6 3/4	.....	70.00
	4 1/4	9	8	5 1/4	6 3/4	22 1/2	9 3/4	.....	152.00
	4 1/2			5 1/4	6 3/4	22 1/2	9 3/4	.....	152.00
	4 3/4			5 1/4	6 3/4	22 1/2	9 3/4	.....	152.00
	5			6	7 1/2	24	10	.....	200.00
FORGED STEEL	5 1/4	9	8	6	7 1/2	24	10 1/2	13	200
	5 1/2			6 3/4	8 5/8	26 1/4	11	14	315
	5 3/4			6 3/4	8 5/8	26 1/4	11 1/2	14	315
	6			7 1/4	9	27	12 1/4	15 1/2	431
	6 1/4			7 1/4	9	27	12 3/4	15 1/2	431
	6 1/2			7 1/2	9 3/4	28 1/2	13 1/4	16 1/2	520

TURNBUCKLES



SLEEVE NUTS



SLEEVE NUTS

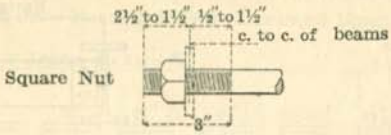
Diam. of Screw U (Inches)	Clear C (Inches)	Nut N (Inches)	Length L (Inches)	Min. Width S (Inches)	Max. Width W (Inches)	Weight Lbs.
4	4 1/8	4 1/2	13	6 1/8	7 1/16	55
4 1/4	4 3/8	4 3/4	13 1/2	6 1/2	7 1/2	65
4 1/2	4 3/4	5	14	6 7/8	7 15/16	75
4 3/4	5	5 1/4	14 1/2	7 1/4	8 3/8	98
5	5 1/4	5 1/2	15	7 5/8	8 7/8	110
5 1/4	5 1/2	5 3/4	15 1/2	8	9 1/4	122
5 1/2	5 3/4	6	16	8 3/8	9 3/4	142
5 3/4	6	6 1/4	16 1/2	8 3/4	10 1/8	157
6	6 1/4	6 1/2	17	9 1/8	10 5/8	176

Sizes and weights of Turnbuckles are Cleveland City Forge Company Standard.

TIE RODS AND ANCHORS

A. I. S. C. Standard

TIE RODS

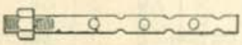


Length of Rod should be specified in Multiples of 3"

Diameter Inches	Total Weight, Lbs., Includes Two Nuts
⅝	.087 × Length, in inches + .21
¾	.125 × " " " + .28
⅞	.170 × " " " + .46
1	.223 × " " " + .70

ANCHORS

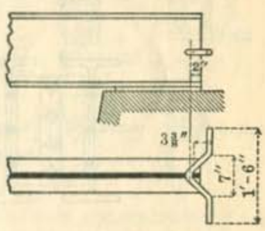
SWEDGE BOLT



Diameter Inches	Length Feet - Inches	Weight Pounds
1	1-0	3.1
1¼	1-3	6.0
1½	1-3	8.7

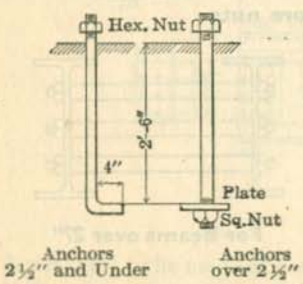
Weight includes one Hexagon Nut

GOVERNMENT ANCHOR



¾" Rod 1' 9" long. Wt., 3 lbs.

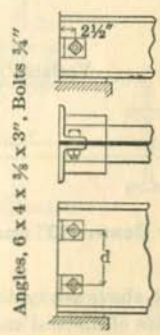
BUILT-IN ANCHOR BOLTS



In general, Built-In Anchor Bolts should extend into the Masonry not less than 2'-6", and farther when necessary.

ANGLE WALL ANCHORS

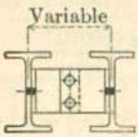
Depth of Beam, Inches	d, Inches	Weight with Bolts, Pounds
10 and under		7
12-14	6	
15-16	9	
18	9	14
20-21	12	
24 and over	12	

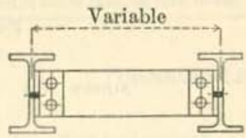


BEAM SEPARATORS

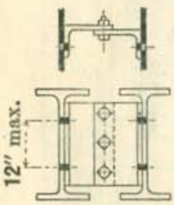
TYPICAL BUILT-UP SEPARATORS

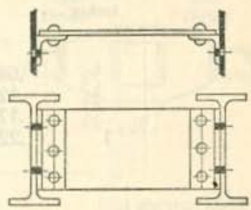
ANGLE — PLATE AND ANGLE



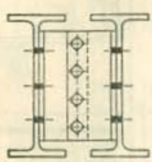


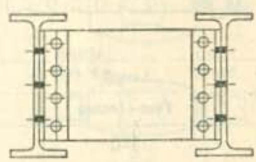
FOR BEAMS 10″ AND UNDER





FOR BEAMS 12″ TO 27″

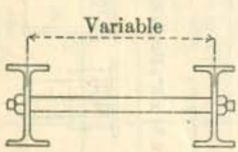




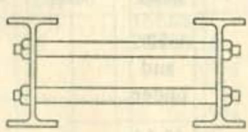
FOR BEAMS OVER 27″

PIPE

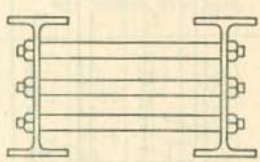
1″ diameter Pipe. Rods with square nuts



For Beams 10″ and under



For Beams 12″ to 27″



For Beams over 27″

The above are typical designs. Separators should be spaced about 6′-0″ apart. The thickness and size of materal and number of bolts and rivets are to suit the various conditions.

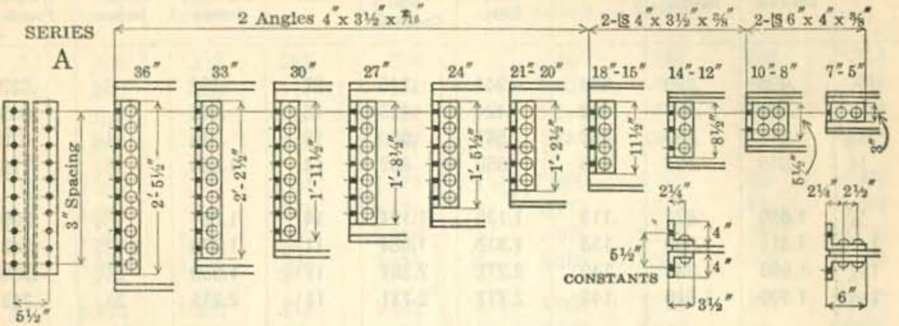
BEAM CONNECTIONS

AMERICAN BRIDGE COMPANY STANDARDS

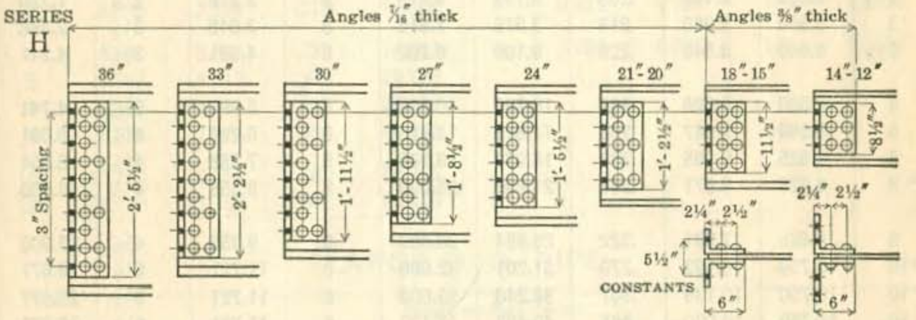
RIVETS ⅞″ OPEN HOLES 15⁄16″

Unit Values in Pounds per Square Inch for Power Driven Rivets.
Shear 13,500—Bearing 24,000—Enclosed Bearing 30,000.

Unit Values in Pounds per Square Inch for Hand Driven Rivets.
Shear 10,000—Bearing 16,000—Enclosed Bearing 20,000.

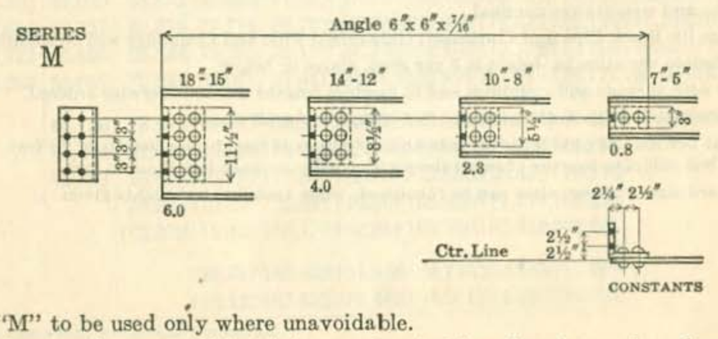


Series "A" to be used for the general run of work provided value is adequate.



Series "H" to be used where extra value is required due to thin web, concentrated load, or short span. Investigate riveting of outstanding legs and provide additional value, if necessary, by larger rivets in single row or double rows in wider leg.

Shear value of angles should be investigated for four rows of open holes.



Series "M" to be used only where unavoidable.

Value of connection = coefficient (given under sketches above), × value of one rivet or bolt, in whichever leg it is the smaller.

For beams over 18″, one-sided connections should be avoided.

PIPE—BLACK AND GALVANIZED

National Tube Company

STANDARD WEIGHT PIPE

Size, Inches	Diameters, Inches External	Diameters, Inches Internal	Thickness, Inches	Weight per Foot, Pounds Plain Ends	Weight per Foot, Pounds Threads and Couplings	Threads per Inch	Couplings Diameter, Inches	Couplings Length, Inches	Couplings Weight, Pounds
1/8	.405	.269	.068	.244	.245	27	.562	7/8	.029
1/4	.540	.364	.088	.424	.425	18	.685	1	.043
3/8	.675	.493	.091	.567	.568	18	.848	1 1/8	.070
1/2	.840	.622	.109	.850	.852	14	1.024	1 3/8	.116
3/4	1.050	.824	.113	1.130	1.134	14	1.281	1 5/8	.209
1	1.315	1.049	.133	1.678	1.684	11 1/2	1.576	1 7/8	.343
1 1/4	1.660	1.380	.140	2.272	2.281	11 1/2	1.950	2 1/8	.535
1 1/2	1.900	1.610	.145	2.717	2.731	11 1/2	2.218	2 3/8	.743
2	2.375	2.067	.154	3.652	3.678	11 1/2	2.760	2 5/8	1.208
2 1/2	2.875	2.469	.203	5.793	5.819	8	3.276	2 7/8	1.720
3	3.500	3.068	.216	7.575	7.616	8	3.948	3 1/8	2.498
3 1/2	4.000	3.548	.226	9.109	9.202	8	4.591	3 5/8	4.241
4	4.500	4.026	.237	10.790	10.889	8	5.091	3 5/8	4.741
5	5.563	5.047	.258	14.617	14.810	8	6.296	4 1/8	8.091
6	6.625	6.065	.280	18.974	19.185	8	7.358	4 1/8	9.554
*8	8.625	8.071	.277	24.696	25.000	8	9.358	4 5/8	13.905
8	8.625	7.981	.322	28.554	28.809	8	9.358	4 5/8	13.905
*10	10.750	10.192	.279	31.201	32.000	8	11.721	6 1/8	29.877
*10	10.750	10.136	.307	34.240	35.000	8	11.721	6 1/8	29.877
10	10.750	10.020	.365	40.483	41.132	8	11.721	6 1/8	29.877
*12	12.750	12.090	.330	43.773	45.000	8	13.958	6 1/8	43.098
12	12.750	12.000	.375	49.562	50.706	8	13.958	6 1/8	43.098

Dimensions and weights are nominal.

Weights are for Black Pipe and Couplings; Galvanized Pipe and Couplings will be slightly heavier.

The permissible variation in weight is 5 per cent, above or below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is 3/4-inch diameter per foot of length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

*Not standard sizes. These sizes can be furnished, when specified to weights given.

PIPE—BLACK AND GALVANIZED

National Tube Company

EXTRA STRONG PIPE   DOUBLE EXTRA STRONG PIPE

Size, Inches	Diameters, Inches		Thickness, Inches	Weight per Foot, Pounds	Size, Inches	Diameters, Inches		Thickness, Inches	Weight per Foot, Pounds
	External	Internal		Plain Ends		External	Internal		Plain Ends
⅛	.405	.215	.095	.314	½	.840	.252	.294	1.714
¼	.540	.302	.119	.535	¾	1.050	.434	.308	2.440
⅜	.675	.423	.126	.738	1	1.315	.599	.358	3.659
½	.840	.546	.147	1.087	1¼	1.660	.896	.382	5.214
¾	1.050	.742	.154	1.473	1½	1.900	1.100	.400	6.408
1	1.315	.957	.179	2.171	2	2.375	1.503	.436	9.029
1¼	1.660	1.278	.191	2.996	2½	2.875	1.771	.552	13.695
1½	1.900	1.500	.200	3.631	3	3.500	2.300	.600	18.583
2	2.375	1.939	.218	5.022	3½	4.000	2.728	.636	22.850
2½	2.875	2.323	.276	7.661	4	4.500	3.152	.674	27.541
3	3.500	2.900	.300	10.252	5	5.563	4.063	.750	38.552
3½	4.000	3.364	.318	12.505	6	6.625	4.897	.864	53.160
4	4.500	3.826	.337	14.983	8	8.625	6.875	.875	72.424
5	5.563	4.813	.375	20.778	...	.....	.....	.....	.....
6	6.625	5.761	.432	28.573	...	.....	.....	.....	.....
8	8.625	7.625	.500	43.388	...	.....	.....	.....	.....
10	10.750	9.750	.500	54.735	...	.....	.....	.....	.....
12	12.750	11.750	.500	65.415	...	.....	.....	.....	.....

LARGE O. D. PIPE

Size, Inches	Weight per Foot, Pounds											
	Thickness, Inches											
	¼	5/16	⅜	7/16	½	9/16	⅝	11/16	¾	⅞	1	1⅛
14	36.713	45.682	54.568	63.371	72.091	80.726	89.279	97.748	106.134	122.654	138.842	154.695
15	39.383	49.020	58.573	68.044	77.431	86.734	95.954	105.091	114.144	132.000	149.522	166.710
16	42.053	52.357	62.579	72.716	82.771	92.742	102.629	112.433	122.154	141.345	160.202	178.725
17	44.723	55.695	66.584	77.389	88.111	98.749	109.304	119.776	130.164	150.690	170.882	190.740
18	47.393	59.032	70.589	82.061	93.451	104.757	115.979	127.118	138.174	160.035	181.562	202.756
20	......	65.708	78.599	91.407	104.131	116.772	129.330	141.804	154.194	178.725	202.923	226.786
21	......	69.045	82.604	96.079	109.471	122.780	136.005	149.146	162.204	......	......	......
22	......	72.383	86.609	100.752	114.811	128.787	142.680	156.489	170.215	......	......	......
24	......	......	94.619	110.097	125.491	140.802	156.030	171.174	186.235	......	......	......
26	......	......	102.629	119.442	136.172	152.818	169.380	185.859	202.255	......	......	......
28	......	......	......	128.787	146.852	164.833	182.730	200.545	218.275	......	......	......
30	......	......	......	138.132	157.532	176.848	196.081	215.230	234.296	......	......	......

Dimensions and weights are nominal.

Weights are for Black Pipe; Galvanized Pipe will be slightly heavier.

Permissible variation in weight, for extra strong pipe, 5 per cent, above or below; for double extra strong pipe, 10 per cent, above or below.

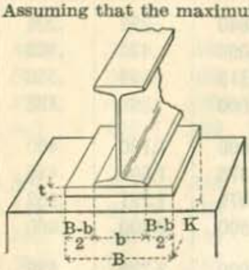
Furnished with plain ends and in random lengths, unless otherwise ordered.

BEARING PLATES

Steel Bearing Plates are provided for the ends of beams resting on masonry, to distribute the pressure over a sufficient area, the allowable unit pressure depending upon the class of masonry used.

The size, area and thickness of a bearing plate depends on the end reaction, the length and width of bearing and allowable unit stress.

Assuming that the maximum bending moment occurs in the center of bearing:



K = Length of bearing plate, in inches.
B = Width of bearing plate, in inches.
t = Thickness of bearing plate, in inches.
b = Flange width of beam, in inches.
w = Allowable unit pressure on masonry.
R = Reaction on bearing plates in pounds = w x K x B

$$M = \frac{R}{2}\times\frac{B}{4} - \frac{R}{2}\times\frac{b}{4} = \frac{R\,(B-b)}{8}$$

$$= \frac{w\,K\,B\,(B-b)}{8} = \frac{f\,K\,t^2}{6}$$

$$t = \sqrt{\frac{3\,w\,B\,(B-b)}{4\,f}}, \quad B\,(B-b) = \frac{4\,f\,t^2}{3\,w}$$

Taking moments at toe of beam flange, for cantilever projection $\frac{B-b}{2}$

$$M = \frac{w\,K(B-b)^2}{8} = \frac{f\,K\,t^2}{6} \qquad t = \tfrac{1}{2}\,(B-b)\sqrt{\frac{3\,w}{f}}$$

These formulas give lower values for M and t, and are applicable only when it can be assumed that middle part, b, of the plate is rigidly held in place, and that there are no bending stresses in center of plate.

Special Bearing Plates

Plates of special sizes may be computed from the foregoing formulas or from the Projection Coefficients, B(B-b), after the required surface of the bearing plate has been determined from the reaction of the beam and the allowable pressure on the masonry.

Example: Required a bearing plate with a wall bearing of 20 inches on masonry sustaining a safe unit pressure of 250 pounds per square inch, to distribute the end reaction of a 24" x 100 lb. beam, supporting a uniformly distributed load over a span of 11 feet, beam and plates calculated for unit stress of 18,000 pounds.

Reaction, R, of 24" x 100 lb. beam, 11 ft. span = 107,800 pounds.
Area of Plate = Reaction ÷ Unit Pressure, 107,800 ÷ 250 = 431.2 sq. inches.
Dimensions of Bearing Plate: K = 22", B = 20", Area = 440 sq. inches.
Projection Coefficient: B (B-b), 20 (20−7.25) = 255.0.
Referring to table of Projection Coefficients: nearest value for unit pressure of 250 pounds and unit stress of 18,000 pounds is 253.5, given for a 1 5/8"-plate.

Exact value from formula:— $t = \sqrt{\frac{3\,w\,B\,(B\text{-}b)}{4\,f}}$

$$= \sqrt{\frac{3 \times 250 \times 20\,(20-7.25)}{4 \times 18{,}000}} = 1.63''.$$

PROJECTION COEFFICIENTS, B (B-b), FOR VARIOUS VALUES OF w AND t

Thickness Inches	Unit Pressure, w, in Pounds Per Square Inch																			
	100	150	200	250	300	350	400	450	500	550	600	625	650	700	750	800	850	900	950	1000
t	Unit Stress 18,000 Pounds																			
3/8	33.8	22.5																		
1/2	60.0	40.0	30.0																	
5/8	93.8	62.5	46.9	37.5	31.3															
3/4	135.0	90.0	67.5	54.0	45.0	38.6	33.8													
7/8	183.8	122.5	91.9	73.5	61.3	52.5	45.9	40.8	36.8											
1	240.0	160.0	120.0	96.0	80.0	68.6	60.0	53.3	48.0	43.6	40.0	38.4	36.9							
1 1/8	303.8	202.5	151.9	121.5	101.3	86.8	75.9	67.5	60.8	55.2	50.6	48.6	46.7	43.4	40.5	38.0	35.7			
1 1/4	375.0	250.0	187.5	150.0	125.0	107.1	93.8	83.3	75.0	68.2	62.5	60.0	57.7	53.6	50.0	46.9	44.1	41.7	39.5	37.5
1 3/8	453.8	302.5	226.9	181.5	151.3	129.6	113.4	100.8	90.8	82.5	75.6	72.6	69.8	64.8	60.5	56.7	53.4	50.4	47.8	45.4
1 1/2		360.0	270.0	216.0	180.0	154.3	135.0	120.0	108.0	98.2	90.0	86.4	83.1	77.2	72.0	67.5	63.5	60.0	56.8	54.0
1 5/8		422.5	316.9	253.5	211.3	181.1	158.4	140.8	126.8	115.2	105.6	101.4	97.5	90.5	84.5	79.2	74.6	70.4	66.7	63.4
1 3/4		490.0	367.5	294.0	245.0	210.0	183.8	163.3	147.0	133.6	122.5	117.6	113.1	105.0	98.0	91.9	86.5	81.7	77.4	73.5
1 7/8			421.9	337.5	281.3	241.1	210.9	187.5	168.8	158.4	140.6	135.0	129.8	120.6	112.5	105.5	99.3	93.8	88.8	84.4
2			480.0	384.0	320.0	274.3	240.0	213.3	192.0	174.6	160.0	153.6	147.7	137.2	128.0	120.0	113.0	106.7	101.0	96.0
2 1/8				433.5	361.3	309.6	270.9	240.8	216.8	197.1	180.6	173.4	166.7	154.8	144.5	135.5	127.5	120.4	114.1	108.4
2 1/4				486.0	405.0	347.1	303.8	270.0	243.0	220.9	202.5	194.4	186.9	173.6	162.0	151.9	143.0	135.0	127.9	121.5
2 3/8					451.3	386.8	338.4	300.8	270.8	246.2	225.6	216.6	208.3	193.4	180.5	169.2	159.3	150.4	142.5	135.4
2 1/2					500.0	428.6	375.0	333.3	300.0	272.8	250.0	240.0	230.8	214.3	200.0	187.5	176.5	166.7	157.9	150.0
2 5/8						472.5	413.4	367.5	330.8	300.7	275.6	264.6	254.4	236.3	220.5	206.7	194.6	183.8	174.1	165.4
2 3/4							453.8	403.3	363.0	330.0	302.5	290.4	279.2	259.3	242.0	226.9	213.6	201.7	191.0	181.5
2 7/8							495.9	440.8	396.8	360.7	330.6	317.4	305.2	283.4	264.5	248.0	233.4	220.4	208.8	198.4
3								480.0	432.0	392.8	360.0	345.6	332.3	308.6	288.0	270.0	254.2	240.0	227.3	216.0

FLOORS AND FLOOR LOADS

Kinds of Loads. Two kinds of loads are carried by structures: live loads and dead loads. Live loads consist of the weight of machinery, merchandise, persons or other moving objects, or of cranes or other handling devices and their loads, and wind loads. Dead loads consist of the actual weight of the structure itself with the walls, floors, partitions, roofs, and all other permanent construction and fixtures. Because dead load stresses are always present, the structure must be proportioned to sustain them at all times without reduction. The live loads may be taken at their full values or reduced in accordance with the probabilities that the structure as a whole or its principal members will not be subject at any time to the full theoretical live loading.

Dead Loads. The permanent load should be calculated from known weights per unit of the material composing floors, partitions, walls, or other permanent construction. The weight assumed for the steel frame itself should be checked after the sections are determined and then the sizes readjusted if necessary.

Live Loads. Live loads vary with the character of the structures. In buildings they consist of uniform loads per square foot of floor area, concentrated loads, such as safes, filing cabinets, or other heavy load concentrations, which may be applied at any point on the floor, and uniform loads per lineal foot of beams or girders. The load which produces the maximum bending moment or reaction is to be used in proportioning sections. The floor system between beams must of course be of sufficient strength to transmit any concentrated load to the beam.

In cities the minimum live loads to be used on the various classes of buildings are fixed by public ordinances, and are given on pages following for the principal cities of the United States in accordance with the most recent building laws. They are intended to cover general conditions and do not include machinery, heavy concentrated or impact loads, for which special provision should be made.

Flat roofs of buildings which may be loaded with people should be treated the same as floors for public dining or assembly rooms.

For warehouses and floors for the storage of heavy merchandise, the tables of Contents of Storage Warehouses on pages 358 and 359 will be found useful in deciding upon the live load to be assumed.

Reduced Live Loads. The design of the floors and the roof is based on an assumed maximum load to which any part of the building may be subjected, consistent with its ultimate use. The total live load assumed is generally greater than the average actual load for the entire floor system and, in addition, maximum loading will not occur simultaneously, so that the actual load transmitted to the columns and footings will be less than the assumed loads.

Usual practice permits a reduction of the theoretical maximum live loads in the computation of column sections and of the column footings, but the ratio of the probable maximum load to the theoretical load varies greatly, so that no general rule can be given, and reference should be made to the building laws of the various cities to establish the permissible reduction in every case.

When the character of the loading will permit, the live load on the main girders may also be reduced. The amount of the reduction will depend on the probable distribution of the loads.

Foundation Loads. Footings should be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible, and the dead loads carried by the footings should include the actual weight of the superstructure and foundations down to the bottom of the footing. The live load should be assumed to be the same as the live load in the lowest tier of columns or in the footings under walls. The area of the footing is determined by dividing the total load by the unit resistance of the soil. From the area thus calculated all the other footings of the building are proportioned according to the ratios of their respective dead loads only. In no case should the load per square foot under any portion of any footing due to the combined dead, live, and wind loads exceed the safe sustaining power of the soil upon which the footing rests.

Fireproof Floor Systems. A modern office or mercantile building is essentially a steel framed structure which supports the dead load of the building and its contents, and is itself protected on all sides by refractory materials. The floors are made fireproof either by the use of structural clay tile flat or segmental arches or by a composite floor slab of tile and reinforced concrete.

MINIMUM LIVE LOADS FOR BUILDINGS

In Accordance with Building Codes of Various Cities

Loads in Pounds per Square Foot

Description of Building	New York, 1932	Chicago, 1924	Chicago, 1934 (Proposed)	Philadelphia, 1930	Detroit, 1911	Detroit, 1934 (Proposed)	Los Angeles, 1926	Cleveland, 1927	Boston, 1924	Baltimore, 1924	St. Louis, 1930
Private Residences, Dwellings	40	40	40	40	50	40	50	60	50	40a	50
Apartment and Tenement Houses	40	40	40	40	50a	40	50	70	50	40a	50
Hotels, Public Spaces, First Fl.	100	100	100	100	80	80	125	125	100	80	100
" Private Rooms, Upper Fl.	40	50	40	40	50	40	50	70	50	40	50
Office Bldgs., Public Spaces, First Fl.	100	100	100	100	125	125	125	125	125	100	100
" " Office Rooms, Upper Fl.	50	50	50	60	75	50	75	70	60	50	60
Hospitals and Asylums	40	50	40	40	...	40	50	80	50	40b	50
Schools, Colleges, Assembly Halls	100	100	75	100	100	125	125	125	100	100	100
" " Class Rooms	75	75	50	50	75	50	75	70	50	50	75
Municipal Buildings, Public Spaces	100	100	100	100	125	100	125	100	100	100	100
Public Spaces, Lobbies, etc.	100	100	100	100	100	100	125	70	100	100	100
Auditoriums, Fixed Seats	75	100	75	100	80	80	75	80	100	75	100
" Movable Seats	100	100	100	100	100	100	125	125	100	100	100
Theatres, Churches, Fixed Seats	75	100	75	100	80h	80	75	80	100	75	100d
Drill and Dance Halls	100	100	100	100	125	125	125	150	100	120	100
Stores, Light Merchandise	75	100	100	110	100e	125	125	100e	125	100	100
" Heavier "	...	...	...	...	175	125	...	...	250	125	150
Warehouses, Light Goods	120	100	100	150	130	150	150	...	125	100	150
" Heavier "	...	...	...	200	200	...	...	...	250	125	150
Factories, Light Manufacture	120f	100f	75	120f	130f	125	125f	...	125f	120f	100f
" Heavier "	...	...	...	150f	...	...	...	...	250f	150f	...
Garages, Stables, Private	75	40	50	100	60	80	...	80	75	60	100
Garages, Public, First Floor	175	100	...	100	80	150	125	150g	150	90g	100
Corridors and Stairs	100	100	100	100	125h	80h	100h	100h	75h	h	h
Sidewalk	300	...	...	120	250	250	250	200	250	200	300
Roof, Flat	40	25	25	30	40	30	30	35	40	30	30
" Slope up to 20° (or 1:3)	40	25	25	30i	40	30	30	30i	25j	30l	30
" " over 20°	30	25	25	30i	40	30	30	30i	25j	30l	30
Wind Pressure	20n	20	25	25	30	30	20o	20m	20p	20^{m}_{n}	30

NOTES ON FLOOR LOADS.

Loads given in tables are Minimum Safe Loads considered uniformly distributed, but all floors must be so designed as to safely carry the full live and dead load, uniformly distributed or concentrated, to which the floors may be subjected. These tables are in condensed form for reference only and no attempt has been made to fully cover exceptions or ranges. Designers should consult city building codes.

When partitions are movable and not definitely fixed, 20 pounds is generally added to the uniformly distributed dead load values for floors.

a. RESIDENCES AND APARTMENTS, First Floor: Detroit, 80; Baltimore, 50.

b. HOSPITALS, First Floor: Boston, 100; Baltimore, 50; Washington, New Orleans, 70.

c. PUBLIC BUILDINGS, Upper Floors: Detroit, 90.

d. AUDITORIUMS AND THEATERS, Galleries: New Orleans, 80. CHURCHES: St. Louis, 75.

e. STORES, First Floors: Detroit, Cleveland, 125; Department Stores, San Francisco, 100.

f. FACTORIES: Floor loads do not include the concentrated weight or the impact load of machinery.

g. PUBLIC GARAGES, Upper Floors: Cleveland, 100; Newark, 120; Denver, 125; Motor Trucks, Baltimore, 175.

h. CORRIDORS AND STAIRS: Generally designed for the loads on corresponding floors, unless noted.
Residences: Buffalo, 50. Apartment Buildings: Los Angeles, 75; Cleveland, 80.
Hotels, Office and Hospital Buildings: Newark, 60.
Schools: Detroit, St. Louis, New Orleans, 70; Los Angles, 100.
Public Buildings: St. Louis, Detroit (proposed), 100.
Assembly Halls: Boston, 100.

MINIMUM LIVE LOADS FOR BUILDINGS

In Accordance with Building Codes of Various Cities

Loads in Pounds per Square Foot

Description of Building	San Francisco, 1926	Pittsburgh, 1924	Buffalo, 1926	Washington, 1930	Milwaukee, 1927	Newark, 1924	Minneapolis, 1934	Cincinnati, 1924	New Orleans, 1927	Denver, 1926	Birmingham, 1928
Private Residences, Dwellings	40	40	40	40	30	40	40	40	40	40a	40
Apartment and Tenement Houses	40	50	50	40	40	40	40	40	40	40a	40
Hotels, Public Spaces, First Fl.	125	80	100	70	60	100	80	100	100	90	100
" Private Rooms, Upper Fl.	40	50	50	40	40	60	40	40	60	70	40
Office Bldgs., Public Spaces, First Fl.	125	100	100	100	100	100	100	100	100	120	100
" " Office Rooms, Upper Fl.	40	60	50	70	50	60	60	50	70	70	50
Hospitals and Asyiums	40	60	50	40b	50	60	40	40	40b	70b	40
Schools, Colleges, Assembly Halls	125	125	100	100	100	100	100	100	125	90	100
" " Class Rooms	75	60	50	40	50	60	60	50	50	75	40
Municipal Buildings, Public Spaces	125	100	100	100	...	100	100	100	125	120	100
Public Halls, Lobbies, etc.	125	100	100	100	100	100	100	100	125	120	100
Auditoriums, Fixed Seats, Flat	75	100	80	70	70	100	80	100	125d	120	70
" Movable Seats	125	100	100	100	100	100	100	100	125d	120	100
Theaters, Churches, Fixed Seats	75	100	80	70	70	100	80	100	125d	90	90
Drill and Dance Halls	...	150	100	100	120	120	125	150	150	120	...
Stores, Light Merchandise	125e	125	120	100	100	120	100	100	100	120	100
" Heavier "	250	...	...	200	...	150	...	150	...	...	...
Warehouses, Light Goods	125	125	150	150	100	200	125	100	200	200	125
" Heavier "	250	...	...	250	...	250	...	150	...	200	250
Factories, Light Manufacture	125f	125f	120f	150f	100f	120f	100f	75f	100f	120f	75f
" Heavier "	250f	150f	...	...	...	150f	...	150f	150f	250f	125f
Garages and Stables, Private	75	...	40t	100	80	120	80	80	...	...	75
Garages, Public, First Floor	100	125	120	250	80	175g	150	100s	100	150	120
Corridors and Stairs	...	100	100h	100	80	80	100	100	70h	100	100
Sidewalk	150	300	300	250	150	300	300	250	300	...	250
Roof, Flat	30	40	30	30	30	40	40	25	30	50	30
" Slope up to 20° (or 1:3)	30i	40k	30	30	30	40	40	25	30	30i	30
" " over 20°	20	40k	30	30	30	30	40	25	30	30i	25
Wind Pressure	15n	25n	30n	30r	30	30	30 m n	20n	25	20n	30 m n q

NOTES ON ROOF LOADS AND WIND PRESSURE.

i. Roof loads are for superficial area of roof; other roof loads are for horizontal projection.

j. Roof load includes wind pressure, vertical to slope: 10 lbs. up to 2:3 slope, 15 lbs. up to 1:1 slope, 20 lbs. over 1:1 slope.

k. Roof load includes snow load of 25 pounds, reduced 1 pound for each degree between 20° and 45°.

l. Roof load for 15° slope, reduced ½ pound for each degree between 15° and 45°.

m. Wind pressures are from grade to top; other wind pressures are for exposed heights.

n. Wind pressures are neglected when buildings do not exceed the maximum height and ratio of height to minimum width of base:
New York, 100–2½:1; Pittsburgh, 150–4:1; San Francisco, 102–3:1; Cincinnati, 100–3:1; Baltimore, Minneapolis, 100–4:1; Buffalo, Birmingham, 1½:1; Denver, 3:1.

o. Wind pressure for buildings over 60 feet—20 lbs.; 60 to 30 feet—15 lbs.; under 30 feet—10 lbs.

p. Wind pressure for buildings over 80 feet—20 lbs.; 80 to 40 feet—15 lbs.; under 40 feet—10 lbs.

q. Wind pressure for high buildings in built-up districts: 25 pounds at tenth story—2½ pounds less for each story below—2½ pounds more for each story above, up to 35 pounds.

r. Wind pressure for buildings less than 40 feet above grade—20 pounds.

t. Ground floor garages, above ground—120 pounds.

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile, Feet	Weights per Square Foot of Floor, Pounds	Recommended Live Loads, Pounds per Square Foot
Building Materials				
Asbestos	50	6	300	
Bricks, Building	45	6	270	
Bricks, Fire Clay	75	6	450	
Cement, Natural	59	6	354	
Cement, Portland	73	6	438	300 to 400
Gypsum	50	6	300	
Lime and Plaster	53	5	265	
Tiles	50	6	300	
Woods, bulk	45	6	270	
Drugs, Paints, Oil, Etc.				
Alum, Pearl, in barrels	33	6	198	
Bleaching Powder, in hogsheads	31	3½	102	
Blue Vitriol, in barrels	45	5	226	
Glycerine, in cases	52	6	312	
Linseed Oil, in barrels	36	6	216	
Linseed Oil, in iron drums	45	4	180	
Logwood Extract, in boxes	70	5	350	
Rosin, in barrels	48	6	288	
Shellac, Gum	38	6	228	
Soaps	50	6	300	200 to 300
Soda Ash, in hogsheads	62	2¾	167	
Soda, Caustic, in iron drums	88	3⅜	294	
Soda, Silicate, in barrels	53	6	318	
Sulphuric Acid	60	1⅝	100	
Toilet Articles	35	6	210	
Varnishes	55	6	330	
White Lead Paste, in cans	174	3½	610	
White, Lead, dry	86	4¾	408	
Red Lead and Litharge, dry	132	3¾	495	
Dry Goods, Cotton, Wool, Etc.				
Burlap, in bales	43	6	258	
Carpets and Rugs	30	6	180	
Coir Yarn, in bales	33	8	264	
Cotton, in bales, American	30	8	240	
Cotton, in bales, Foreign	40	8	320	
Cotton Bleached Goods, in cases	28	8	224	
Cotton Flannel, in cases	12	8	96	
Cotton Sheeting, in cases	23	8	184	
Cotton Yarn, in cases	25	8	200	
Excelsior, compressed	19	8	152	
Hemp, Italian, compressed	22	8	176	200 to 250
Hemp, Manila, compressed	30	8	240	
Jute, compressed	41	8	328	
Linen Damask, in cases	50	5	250	
Linen Goods, in cases	30	8	240	
Linen Towels, in cases	40	6	240	
Silk and Silk Goods	45	8	360	
Sisal, compressed	21	8	168	
Tow, compressed	29	8	232	
Wool, in bales, compressed	48			
Wool, in bales, not compressed	13	8	104	
Wool, Worsteds, in cases	27	8	216	

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile, Feet	Weights per Square Foot of Floor, Pounds	Recommended Live Loads, Pounds per Square Foot
Groceries, Wines, Liquors, Etc.				
Beans, in bags	40	8	320	
Beverages	40	8	320	
Canned Goods, in cases	58	6	348	
Cereals	45	8	360	
Cocoa	35	8	280	
Coffee, Roasted, in bags	33	8	264	
Coffee, Green, in bags	39	8	312	
Dates, in cases	55	6	330	
Figs, in cases	74	5	370	
Flour, in barrels	40	5	200	
Fruits, Fresh	35	8	280	
Meat and Meat Products	45	6	270	250 to 300
Milk, Condensed	50	6	300	
Molasses, in barrels	48	5	240	
Rice, in bags	58	6	348	
Sal Soda, in barrels	46	5	230	
Salt, in bags	70	5	350	
Soap Powder, in cases	38	8	304	
Starch, in barrels	25	6	150	
Sugar, in barrels	43	5	215	
Sugar, in cases	51	6	306	
Tea, in chests	25	8	200	
Wines and Liquors, in barrels	38	6	228	
Hardware, Etc.				
Automobile Parts	40	8	320	
Chain	100	6	600	
Cutlery	45	8	360	
Door Checks	45	6	270	
Electrical Goods and Machinery	40	8	320	
Hinges	64	6	384	
Locks, in cases, packed	31	6	186	
Machinery, Light	20	8	160	
Plumbing, Fixtures	30	8	240	
Plumbing, Supplies	55	6	330	300 to 400
Sash Fasteners	48	6	288	
Screws	101	6	606	
Shafting Steel	125	.	...	
Sheet Tin, in boxes	278	2	556	
Tools, Small, Metal	75	6	450	
Wire Cables, on reels	...	.	425	
Wire, Insulated Copper, in coils	63	5	315	
Wire, Galvanized Iron, in coils	74	4½	333	
Wire, Magnet, on spools	75	6	450	
Miscellaneous				
Automobile Tires	30	6	180	
Automobiles, uncrated	8	.	64	
Books (solidly packed)	65	6	390	
Furniture	20	.	...	
Glass and Chinaware, in crates	40	8	320	
Hides and Leather, in bales	20	8	160	
Hides, Buffalo, in bundles	37	8	296	
Leather and Leather Goods	40	8	320	
Paper, Newspaper, and Strawboards	35	6	210	
Paper, Writing and Calendared	60	6	360	
Rope, in coils	32	6	192	
Rubber, Crude	50	8	400	
Tobacco, bales	35	8	280	

STRUCTURAL CLAY TILE

Fireproof Floor Systems

Hollow Tile Arches. Hollow tile arches usually fill the total depth of the floor beams, and therefore tend to stiffen and brace the building; their weight per square foot is light as compared with other forms of fireproof floor construction of equal strength. Hollow tile floor arches are made either flat or segmental. The segmental arch will develop much greater strength than the flat arch of the same width and depth but, because of the irregular ceiling obtained, is not so generally used. It is not considered in this condensed treatise, but design data may be obtained from the Structural Clay Tile Association or from the publications of clay tile manufacturers.

Thrust of Floor Arches. All forms of hollow tile arches produce side thrust on the floor beams. In the flat arch the blocks have tapered faces and the central block or key wedges the others together; in the segmental arch the thrust is that due to all arch action. It is necessary to counterbalance these thrusts by means of tie rods connecting the webs of the floor beams. In the central bays, owing to the action of adjacent arches, the tie rods are sometimes omitted, but it is necessary to investigate outer beams and channels around openings for additional thrust stresses so that the combined unit stresses produced by vertical loading and horizontal thrusts may not be excessive. With flat arches, ¾-inch tie rods, spaced not over fifteen times the width of the beam flanges, will usually be sufficient. The total thrust of arch, the net area of tie rods required, the maximum distance between tie rods and the section of outer beams for any condition, may be found as follows:

Let

w = Unit load on arch, in pounds per square foot.
D = Distance of arch span, in feet.
L = Length of floor beam supporting the arch, in feet.
R = Effective rise of arch, in inches.
p = Thrust of arch per lineal foot, in pounds.
P = Total thrust of arch per panel, in pounds.
A = Total net area of tie rods per panel, in square inches.
a = Net area of one tie rod, in square inches.
T = Spacing of tie rods, center to center, in feet.
f = Allowable combined unit stress, in pounds per square inch.
$S_{1\text{-}1}$ = Section Modulus of beam, Axis 1-1, in inches^3.
$S_{2\text{-}2}$ = Section Modulus of beam, Axis 2-2, in inches^3.
$M_{1\text{-}1}$ = Bending Moment for vertical loading, in inch-pounds.
$M_{2\text{-}2}$ = Bending Moment for arch thrust, in inch-pounds.

Then

$$p = \frac{3wD^2}{2R} \qquad P = pL$$

$$A = \frac{3wD^2L}{2fR} = \frac{P}{f}$$

$$T = \frac{2afR}{3wD^2} = \frac{af}{p}$$

$$M_{1\text{-}1} = \frac{12L\ (\frac{1}{2}wDL)}{8} = \frac{3wD\ L^2}{4}$$

$$M_{2\text{-}2} = \frac{12T\ (pT)}{12} = pT^2$$

$$f = \frac{M_{1\text{-}1}}{S_{1\text{-}1}} + \frac{M_{2\text{-}2}}{S_{2\text{-}2}}$$

In formula given for $M_{2\text{-}2}$ the beam is considered continuous, supported at intervals by the tie rods. In segmental arches the effective rise is equal to the vertical distance between highest point of concave surface and springing line or chord; the effective rise of a flat arch may be taken at 2.4 inches less than the arch depth.

The allowable combined unit stress in beams should not exceed 18,000 pounds, and tie rods should be placed in line of thrust, usually 3 inches above the bottom of the beam.

NET AREAS OF USUAL SIZES OF TIE RODS

Diameter of Rod, Inches	5/8	3/4	7/8	1
Net area, a, square inches...	0.202	0.302	0.420	0.550

EXAMPLE: A floor panel 18 feet by 6 feet, of 12-inch flat terra cotta blocks, is to support a uniform live and dead load of 150 pounds per square foot. Required the total thrust, total area of rods per panel, maximum spacing of rods, and the proper size beam to carry one-half of the panel without lateral support other than the tie rods.

Entire panel load is $18 \times 6 \times 150 = 16{,}200$ pounds.

Assuming a 10-inch beam, 23.0 pounds, and 3/4-inch tie rods, then

Thrust of arch per lineal foot, $p = \frac{3 \times 150 \times 6^2}{2 \times (12 - 2.4)} = 844$ pounds.

Total thrust of arch, $P = 844 \times 18 = 15{,}200$ pounds.

Total area of tie rods, $A = \frac{15{,}200}{18{,}000} = 0.84$ square inches.

Maximum spacing of tie rods, $T = \frac{0.302 \times 18{,}000}{844} = 6.44$ feet.

Bending Moment, vertical loading, $M_{1\text{-}1} = \frac{3 \times 150 \times 6 \times 18^2}{4} = 218{,}700$ inch-pounds.

Bending Moment, horizontal thrust, $M_{2\text{-}2} = 844 \times 6.44^2 = 35{,}000$ inch-pounds.

Combined unit stress in beam, $f = \frac{218{,}700}{24.4} + \frac{35{,}000}{4.6} = 16{,}560$ pounds.

If tie rods are spaced 6′–0″ centers, then

Bending Moment, horizontal thrust, $M_{2\text{-}2} = 844 \times 6^2 = 30{,}380$ inch-pounds.

Combined unit stress in beam, $f = \frac{218{,}700}{24.4} + \frac{30{,}380}{4.6} = 15{,}560$ pounds.

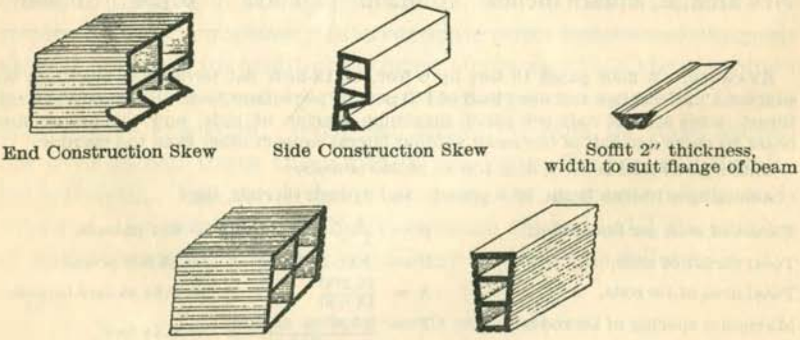
MAXIMUM SPACING IN FEET OF ¾-INCH TIE RODS

For Load of 100 Pounds per Square Foot

Span, Feet	Effective Rise of Arch, R, in Inches											
	4	5	6	7	8	9	10	11	12	13	14	15
3	16.1											
4	9.1	11.3	13.6	15.8								
5	5.8	7.2	8.6	10.1	11.6	13.0	14.5	16.0				
6	4.0	5.0	6.1	7.1	8.1	9.1	10.0	11.0	12.0	13.0	14.1	15.1
7	...	3.7	4.4	5.2	5.9	6.6	7.4	8.1	8.9	9.6	10.3	11.1
8	...	...	3.4	3.9	4.5	5.0	5.6	6.2	6.7	7.3	7.9	8.5
9	...	...	...	...	3.6	4.0	4.5	4.9	5.4	5.8	6.3	6.7
10	...	...	...	...	...	...	3.6	3.9	4.4	4.7	5.1	5.4

To find spacing of rods for any given loading, multiply tabular values by 100 and divide by the given load per square foot.

Description of Tile Flat Arches. Flat Arches as adapted to floors and roofs are made up of various shaped tiles as shown below. The tiles resting against the beams are called skews and the soffit tiles, protecting the bottom of the beam, are held in place by the bevel on the skews. The intermediate tiles are called inters, and the center one the key.



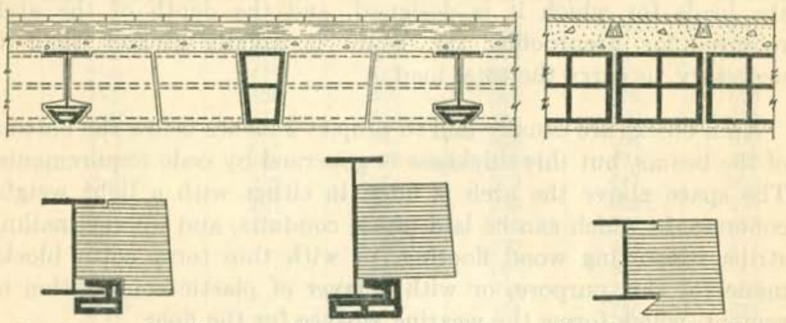
End Construction Skew — Side Construction Skew — Soffit 2″ thickness, width to suit flange of beam

Inter 8″ or 12″ long — Key

TYPICAL TILES FOR FLAT ARCHES

The flat arch has the advantage of light weight and speed in construction. The hung centers are not required for any great length of time and the floors beneath are accessible for work by other trades. The all-tile ceiling provides a good surface for plastering. There are two general types of Flat Arches, namely, the End Construction Flat Arch and the Combination Side and End Construction Flat Arch.

End Construction Flat Arch. This type of Flat Arch consists of end construction skews and inters and side construction keys. This is the most adaptable form of arch, since the end construction skew can be cut to fit different elevations and sizes of beams. It is advisable to keep the bottom flanges of the floor beams as near the same elevation as possible, so that the same bevel which is usually cut for a 2-inch soffit tile may be used throughout and make for uniformity and, therefore, economy of construction. Moreover, this gives a more uniform ceiling level.



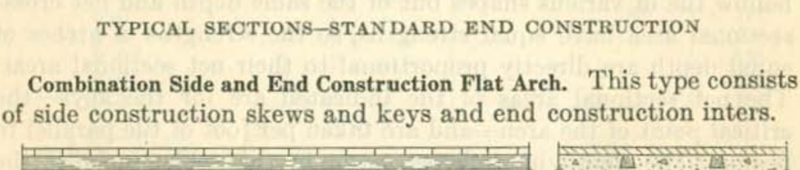
End Construction Skew cut to suit clip tile and flange of beam

Shows bearing of End Construction Butt Skew on spandrel beam

End Construction Skew cut at top and bottom for wide flange beam

TYPICAL SECTIONS—STANDARD END CONSTRUCTION

Combination Side and End Construction Flat Arch. This type consists of side construction skews and keys and end construction inters.



TYPICAL COMBINATION SIDE AND END CONSTRUCTION FLAT ARCH

By making the cells of the skews parallel to the beams, better protection is given to the sides of the beams by the mortar joints and by the shells of the skews. The inters must be set end to end in straight courses from skew to key. The typical section illustrates the method of assembling the various members of this arch.

Side construction skews are made by die to fit the various size standard beams and cannot be changed as can end construction skews. Dies to make skews to fit standard beam shapes are carried in stock by manufacturers. If it is desired to use side construction skews uniformly throughout a building, the floor beams must be on the same level at the bottom. For special conditions, end construction skews can be used and cut to fit.

Designing Data. The depth of the arch must be proportioned to the span between the beams and, to a certain extent, to the load carried. A safe general rule for finding the depth of the arch in inches is to multiply the span in feet by 1½ and add the thickness of the protection below the beams. This is the general code requirement of the larger cities.

Theoretically, a correctly designed and constructed flat arch will always develop the full strength of the steel beam that supports it. Practically, however, the depth of the floor beam is determined by the loads for which it is designed, and the depth of the arch required for fireproofing the beam is usually greater than is necessary to carry the total load.

Arch blocks are usually laid to project 2 inches below the bottom of the beams, but this thickness is governed by code requirements. The space above the arch is filled in either with a light weight concrete, in which can be laid pipes, conduits, and wooden nailing strips supporting wood flooring, or with thin terra cotta blocks made for this purpose, or with a layer of plastic composition of cement, which forms the wearing surface for the floor.

The following table is applicable to all shapes of tile. Generally, hollow tile of various shapes but of the same depth and net cross-sectional area have equal strengths, so the strengths of arches of equal depth are directly proportional to their net sectional areas. The net sectional areas of tile indicated are for the keys—the critical point of the arch—and are taken per foot of tile parallel to beams. The depth of arch, as given in the table, includes the thickness of the soffit tile underneath the bottom of the beam.

Weights of arches have not been deducted from safe loads in the table; this and other dead loads must be deducted to obtain the net safe live load for any arch or span.

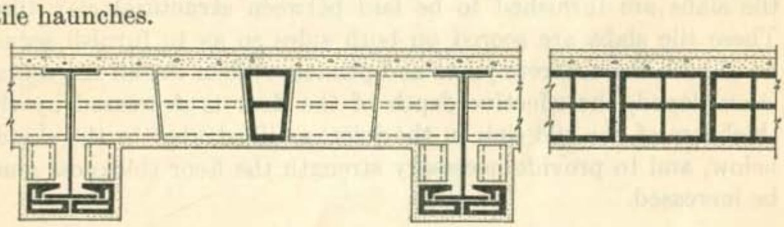
Weights given in the table are for arch in place, including the mortar.

TOTAL SAFE LOADS PER SQUARE FOOT

Dead and Live Loads. Factor of Safety of 7

Arches, In.	8	9	10	12	15
Net Sectional Areas, Sq. In.	27	27	36	36	36
Average Weight, Lbs. per Sq. Ft. of Arch	36	39	42	48	56
Span	Safe Loads in Pounds per Square Foot				
3′-0″	560	630	933	1120	1400
3′-3″	477	537	795	954	1193
3′-6″	411	462	685	823	1028
3′-9″	358	403	597	716	895
4′-0″	315	354	525	630	786
4′-3″	279	314	465	558	697
4′-6″	249	279	415	497	622
4′-9″	223	251	372	447	558
5′-0″	201	227	336	402	504
5′-3″	182	205	305	365	457
5′-6″	...	187	277	333	417
5′-9″	...	171	254	305	381
6′-0″	...	157	233	280	350
6′-3″	...	...	214	258	322
6′-6″	...	...	198	238	298
6′-9″	...	...	...	221	276
7′-0″	...	...	...	206	257
7′-6″	...	...	...	178	223
8′-0″	...	...	...	157	197
8′-6″	...	...	...	...	174
9′-0″	...	...	...	...	155
9′-6″	...	...	...	...	140
10′-0″	...	...	...	...	126

This table should be used as a general guide only, as conditions may make it possible to design more economical arches for a given load than indicated by the table. For example, where a paneled ceiling is not objectionable, a shallow arch may be used on raised tile haunches.



ARCH RAISED ON FLOOR BEAMS FOR PANELED CEILING

The thickness of this arch will be approximately 2 inches less than that shown in the table for the respective span and loading.

Example. Design an arch for a span of 6′-6″ and a load, including plaster, of 150 pounds per square foot. From the table we find that a 10-inch arch with a 2-inch soffit under the beam will carry a total load of 198 pounds per square foot. Deducting 42 pounds, the weight of the arch, gives a capacity of 156 pounds per square foot for the total load. As the effective bearing depth of the 10-inch arch is but 8 inches, it is evident that a raised 8-inch arch, having the same bearing depth, will carry the same load.

Flat Arch is generally sold per square foot of the actual floor area filled by the tile. The design of the floors as to the pieces of the filler tile and the width of the key, which is variable, is furnished by the tile manufacturer to suit the spans and shapes of steel used.

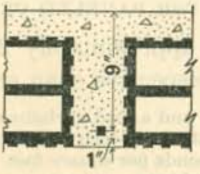
Combination Tile and Reinforced Concrete Ribbed Floor and Roof Construction. This type of floor and roof construction includes systems in which structural clay tile is used as an integral part of the slab, with reinforced concrete ribs running in either one or both directions. If concrete topping is used, the shells of hollow tile in contact with the topping shall be considered as part of the required thickness of top slab, and the shells of hollow clay tile units in contact with concrete in both top slab and ribs shall be included in calculations involving shear and bending. The concrete ribs should be at least 4 inches in width, including tile shells, but this width must be sufficient to allow at least ¾ inch of concrete on either side of reinforcing bars.

These recommendations are based upon Technologic Paper No. 220 of the Bureau of Standards on Tests of Hollow Tile and Concrete Floor Slabs Reinforced in Two Directions, Technologic Paper No. 291 on Tests of Hollow Tile and Concrete Slabs Reinforced in One Direction, and Research Paper, No. 181, on Tests of Composite Beams and Slabs of Hollow Tile and Concrete.

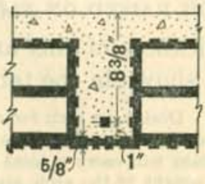
The shells of structural clay tile should be at least ½ inch in thickness.

Combination structural clay tile and concrete floors usually permit of thinner slabs, reduce dead load, and, where plaster is to be applied directly to the slab, provide a good plastering surface. This type of floor offers very high resistance to sound transmission.

When a ceiling with a tile surface over the entire area is required, tile slabs are furnished to be laid between structural clay tiles. These tile slabs are scored on both sides so as to furnish secure bond with the concrete joists and plaster. When the all tile ceiling is employed, the effective depth of the floor is decreased by the thickness of the tile slab in the joist, as illustrated in the sketch below, and to provide necessary strength the floor thickness must be increased.

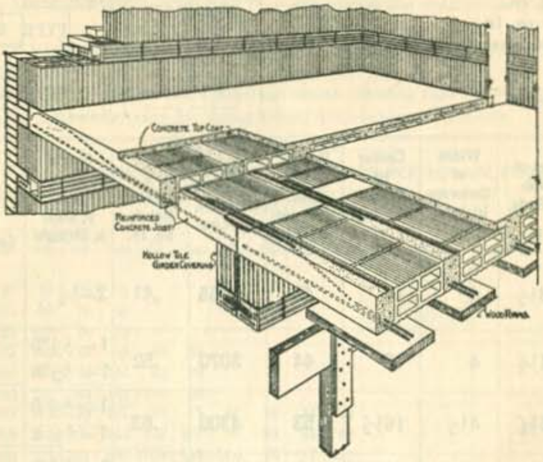


Effective Depth 9"
COMBINATION CEILING



Effective Depth 8⅜"
ALL-TILE CEILING

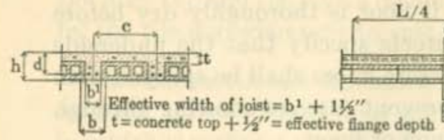
It has been found that an all-tile ceiling is not essential where good construction methods are used for installing the floors, and no stain of the plaster will occur if floor is thoroughly dry before the plaster is applied. Some architects specify that the underside of combination hollow tile and concrete floors shall be sprayed with a coat of mastic preparation to prevent streaks showing through plastered ceilings applied to this type of floor.

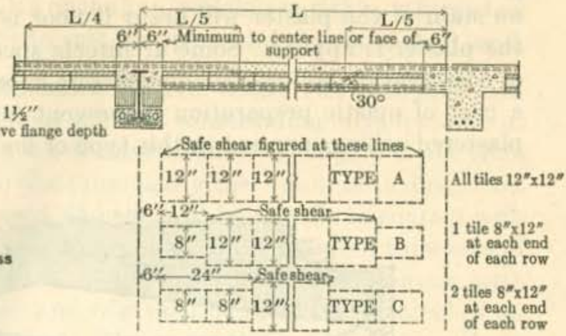


TYPICAL ONE-WAY COMBINATION FLOOR

Note economical wood centering used;
2″ x 8″ or 2″ x 10″ under each joist is sufficient

TILE AND ONE-WAY CONCRETE JOIST SLABS





$f_c = 700$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$v = 60$ lbs. per sq. in., shearing stress
$n = 15$

Dimensions in Inches

Total Depth, h	Effective Flange Depth, t	Top of Slab to Rods, d	Width of Concrete in Joist, b¹	Center to Center of Joists, c	Weight of Slab, Lbs. per Sq. Ft.	Max. Resisting Moment, Ft.-Lbs.	Area of Steel Reinf., Sq. In.	Round Bars (*Square) b, Bent s, Straight	Total Shear in Lbs. for Each Joist: Type A Construction	Total Shear in Lbs. for Each Joist: Type B & C Construction
3+1½	2	3½	4	16	40	1855	.41	2–½	1030	1750
4+1½	2	4½	4	16	44	3070	.52	1–½*b 1–½*s	1300	2250
5+1½	2	5¼	4½	16½	53	4300	.63	1–⅝ b 1–⅝ s	1660	2760
6+1½	2	6¼	4½	16½	56	5954	.73	1–¾ b 1–⅝ s	1970	3285
6+2	2½	6¾	5	17	62	7285	.82	1–¾ b 1–¾ s	2310	3730
7+2	2½	7¾	5	17	71	8900	.88	1–¾ b 1–¾ s	2560	4140
7+2½	3	8¼	5	17	76	10900	1.00	1–⅞ b 1–¾ s	2820	4550
8+2	2½	8½	5	17	76	11100	1.00	1–⅞ b 1–¾ s	2910	4700
8+2½	3	9	5½	17½	82	13220	1.12	1–⅞ b 1–¾ s	3320	5200
9+2	2½	9½	5½	17½	82	13660	1.10	1–⅞ b 1–¾ s	3500	5500
9+2½	3	10	5½	17½	88	15890	1.21	1–⅞ b 1–⅞ s	3690	5800
10+2	2½	10½	5½	17½	89	15880	1.15	1–⅞ b 1–⅞ s	3870	6080
10+2½	3	11	5½	17½	94	18600	1.29	1–1 b 1–⅞ s	4050	6370
12+2	2½	12½	5½	17½	100	20350	1.24	1–1 b 1–⅞ s	4600	7230
12+2½	3	13	5½	17½	106	23950	1.40	1–1 b 1–⅞ s	4800	7530

TILE AND ONE-WAY CONCRETE JOIST SLABS

Compressive stress in stem above neutral axis has not been considered.

Floor Slabs should not be less in thickness than ⅜" for each foot of span.

Floor Slabs should be built with a camber of ¼" to each 10 feet of span.

Safe loads for WL/8 are for slabs freely supported at each end only.

Safe loads for WL/10 are for slabs freely supported at one end and restrained or continuous over the other end for spans of approximately equal length.

Safe loads for WL/12 are for interior continuous spans of practically equal length only.

Moments of continuous spans of unequal length should be determined and slabs designed accordingly.

Weights of slabs are for plain slab only and do not include anything for finished floor or ceiling.

Loads above and to the right of upper dotted line are under the maximum safe shear resistance for type "A" construction.

Loads between heavy lines produce shear stresses greater than allowed for type "A", but are safe for type "B" construction.

Loads under and to the left of heavy lines produce shear stresses safe for type "C" construction.

Examples are given on following page for using other dimensions and loads.

MAXIMUM SAFE LOADS IN POUNDS PER SQUARE FOOT

Moment Factor	SPAN IN FEET																						
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	28	30
WL/ 8	269	187	134	97	71	52	37																
WL/10	346	244	177	131	99	75	56																
WL/12		-	220	165	127	98	75																
WL/ 8	468	332	244	183	140	108	84	65	51														
WL/10	596	426	316	240	186	146	116	92	74														
WL/12		520	388	299	232	184	148	119	98														
WL/ 8			339	257	197	153	121	95	75	58	45	33	24										
WL/10			437	333	260	205	164	132	107	86	69	55	43										
WL/12			535	409	323	257	207	169	139	114	93	77	62										
WL/ 8			484	374	292	230	184	150	122	99	78	64	50	40	30								
WL/10				479	377	302	244	200	164	136	112	94	77	64	52								
WL/12						374	304	252	210	176	146	124	104	88	74								
WL/ 8					349	277	224	181	148	120	98	80	64	52	40	31							
WL/10					452	362	295	242	200	166	138	116	96	80	66	54	44						
WL/12						447	366	303	252	212	178	152	128	108	92	77	65						
WL/ 8					432	345	277	227	185	152	125	103	84	68	55	43	33	24	16				
WL/10					557	449	364	301	249	208	174	146	123	103	86	71	59	48	38				
WL/12							450	375	313	264	223	189	162	138	117	99	85	71	60				
WL/ 8						432	351	288	238	198	164	137	114	94	78	63	51	40	30				
WL/10						559	458	379	316	266	224	190	161	137	116	98	83	69	57	47			
WL/12										334	284	243	208	180	154	133	115	98	84	72			
WL/ 8						442	360	295	244	202	168	141	118	98	81	66	54	42	33				
WL/10							469	388	324	272	230	195	166	141	120	102	86	72	60	49	40		
WL/12										342	291	249	214	184	159	138	118	102	87	74	63		
WL/ 8						516	421	347	288	240	200	168	141	119	99	82	68	55	44	33			
WL/10							547	454	380	320	271	231	197	169	144	123	105	89	75	62	52	33	
WL/12											342	294	253	219	189	184	142	123	106	91	79	56	
WL/ 8						538	438	362	300	250	211	178	149	125	105	88	70	60	48	38	28		
WL/10							568	473	396	333	284	242	207	177	152	130	108	95	80	68	56	38	
WL/12											358	307	265	228	198	172	146	130	112	98	84	62	
WL/ 8							517	428	357	299	252	214	181	153	130	110	92	76	63	51	41		
WL/10									468	396	337	289	248	213	184	159	137	117	101	86	73	51	33
WL/12													315	273	238	208	182	158	139	121	105	79	57
WL/ 8						631	518	427	356	299	252	213	181	153	129	109	91	76	62	50	40		
WL/10									467	396	337	289	248	213	184	158	136	117	100	85	72	50	31
WL/12													316	273	239	207	181	158	138	120	104	78	55
WL/ 8									427	360	304	259	221	188	161	137	117	99	84	69	57	36	
WL/10										473	404	347	300	259	225	195	170	147	128	110	95	69	48
WL/12															289	253	223	195	172	151	133	102	76
WL/ 8							676	561	470	396	336	286	244	210	180	153	130	111	94	78	65	42	24
WL/10										520	445	383	330	287	250	216	188	164	142	123	106	78	55
WL/12															320	279	245	217	190	168	147	114	86
WL/ 8											408	348	299	257	222	192	165	142	122	104	88	61	40
WL/10													400	348	304	266	233	204	179	156	136	103	76
WL/12																		266	236	208	184	145	112

The safe shear on any width of concrete in the joist, other than those given in table on preceding page, is directly proportional to the width.

EXAMPLE. For a 6″ + 1½″ slab where it is desired to make the concrete joist 5 inches wide instead of 4½ inches as shown in the table, the total safe shear resistance is $\frac{5 + 1\frac{1}{2}}{4\frac{1}{2} + 1\frac{1}{2}} \times 1970 = 2134$ pounds for type A construction and would increase in the same proportion for type B and C construction.

If the width of joist is increased, then the distance, c, center to center of joists will increase the same amount, which affects the resisting moment in the same proportion so that for $f_c = 700$ it will be $\frac{17}{16\frac{1}{2}} \times 5954 = 6134$ foot-pounds.

The area of the steel reinforcement is increased in the same proportion and will be $\frac{17}{16\frac{1}{2}} \times 0.73 = 0.75$ square inches.

The required area, A_s, of steel for slabs of the same thickness and with the same width of joist as given in table, but with a lighter load, is directly proportional to the total load.

EXAMPLE. For a 7″ + 2″ slab with a 20-foot span carrying a load of 90 pounds per square foot for WL/12 instead of 117 pounds, the $A_s = 0.88 \times \frac{90 + 71}{117 + 71} = 0.76$ square inches.

WEIGHTS OF
STRUCTURAL CLAY TILE FLOOR

Depth of Arch, Inches	Average Weight Lbs. per Square Foot	
	Flat	Segmental
6	26	30
7	29	..
8	32	36
9	35	..
10	38	40
11	42	..
12	50	..

SIZE AND WEIGHT OF TILES
For Combination Tile and Concrete Construction

Size of Tiles, Inches	Minimum No. of Cells	*Standard Weight, Lbs.
3 x 12 x 12	3	15
4 x 12 x 12	3	16
6 x 12 x 12	3	22
6 x 12 x 12	4	25
8 x 12 x 12	4	30
10 x 12 x 12	4	35
12 x 12 x 12	4	40

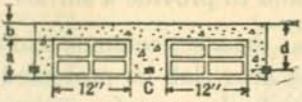
*A tolerance of 5% under or 12½% over will be allowed on the above standard weights. No dimension shall vary more than 3% from the standard for any form of tile.

WEIGHTS OF PARTITION, CEILING, ROOFING AND FURRING TILES

Thickness, Inches	Approx. Weight, Pounds per Sq. Foot				Thickness, Inches	Approx. Weight, Pounds per Sq. Foot			
	Partition	Ceiling	Roofing	Furring		Partition	Ceiling	Roofing	Furring
1½	.....	.....	.....	9	4	16-18	.....	22	.....
2	12-14	12	.....	10	5	18-20	.....	.....	.....
3	15-17	20	20	.....	6	24-26	.....	.....	.....

QUANTITIES OF CONCRETE AND WEIGHT PER SQ. FT.

Of Slab In Combination Floors



Thickness of Concrete and Tile, a + b, Inches	Effective Depth, d, Inches	4″ Joist, C — Weight, Lbs. per Sq. Ft.	4″ Joist, C — Quantities Cu. Ft.	4″ Joist, C — Quantities Cu. Yd.	5″ Joist, C — Weight, Lbs. per Sq. Ft.	5″ Joist, C — Quantities Cu. Ft.	5″ Joist, C — Quantities Cu. Yd.	6″ Joist, C — Weight, Lbs. per Sq. Ft.	6″ Joist, C — Quantities Cu. Ft.	6″ Joist, C — Quantities Cu. Yd.
4 + 1½	4½	42	.208	.0077	43	.223	.0082	45	.236	.0087
5 + 1½	5½	47	.229	.0085	49	.242	.0091	51	.262	.0097
6 + 1½	6¼	53	.251	.0093	55	.272	.0100	57	.292	.0108
7 + 1½	7¼	58	.271	.0100	60	.296	.0109	63	.320	.0108
8 + 1½	8¼	65	.292	.0108	67	.321	.0118	70	.348	.0129
9 + 1½	9	68	.312	.0115	72	.342	.0127	76	.375	.0139
10 + 1½	10	74	.333	.0123	78	.369	.0136	81	.403	.0149
12 + 1½	12	84	.375	.0138	88	.419	.0155	93	.452	.0167
4 + 2	5	48	.251	.0093	50	.265	.0098	51	.279	.0103
5 + 2	6	53	.271	.0100	55	.290	.0107	57	.303	.0112
6 + 2	6¾	59	.292	.0108	62	.314	.0116	63	.333	.0123
7 + 2	7¾	64	.312	.0115	71	.338	.0125	68	.362	.0134
8 + 2	8¾	71	.333	.0123	76	.363	.0134	76	.390	.0144
9 + 2	9½	74	.353	.0130	78	.388	.0143	81	.416	.0154
10 + 2	10½	80	.375	.0138	84	.412	.0152	88	.445	.0165
12 + 2	12½	90	.417	.0153	95	.461	.0170	99	.506	.0187
4 + 2½	5½	54	.291	.0108	55	.306	.0113	57	.319	.0118
5 + 2½	6½	59	.312	.0115	62	.330	.0122	63	.347	.0128
6 + 2½	7¼	64	.333	.0123	67	.355	.0131	69	.374	.0138
7 + 2½	8¼	70	.353	.0130	76	.379	.0140	75	.402	.0149
8 + 2½	9¼	76	.375	.0138	79	.404	.0149	81	.431	.0159
9 + 2½	10	80	.394	.0145	84	.429	.0158	87	.458	.0170
10 + 2½	11	86	.417	.0153	90	.453	.0167	93	.486	.0180
12 + 2½	13	96	.457	.0169	101	.405	.0187	105	.541	.0200
4 + 3	6	60	.333	.0123	61	.347	.0128	63	.361	.0133
5 + 3	7	65	.353	.0130	67	.372	.0137	69	.389	.0144
6 + 3	7¾	71	.375	.0138	73	.397	.0146	77	.416	.0154
7 + 3	8¾	76	.394	.0145	78	.421	.0155	81	.445	.0165
8 + 3	9¾	82	.415	.0153	85	.446	.0165	88	.472	.0175
9 + 3	10½	86	.436	.0161	90	.470	.0174	92	.500	.0185
10 + 3	11½	92	.457	.0169	96	.494	.0183	99	.528	.0195
12 + 3	13½	102	.499	.0184	107	.544	.0201	111	.583	.0216
6 + 3½	8¼	77	.415	.0153	79	.439	.0162	81	.458	.0170
7 + 3½	9¼	81	.436	.0161	84	.463	.0171	86	.486	.0180
8 + 3½	10¼	88	.457	.0169	92	.488	.0180	94	.514	.0190
9 + 3½	11	92	.478	.0177	96	.513	.0190	99	.542	.0200
10 + 3½	12	98	.499	.0184	102	.537	.0199	105	.570	.0211
12 + 3½	14	108	.541	.0201	113	.586	.0217	117	.625	.0231
8 + 4	10¾	95	.499	.0184	97	.529	.0196	100	.556	.0206
9 + 4	11½	98	.520	.0192	101	.554	.0205	105	.583	.0216
10 + 4	12½	104	.541	.0200	108	.578	.0214	111	.611	.0226
12 + 4	14½	113	.583	.0216	119	.627	.0232	123	.666	.0247

WEIGHTS AND AREAS OF REINFORCEMENT BARS

	Size, Inches	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼
SQUARE BARS	Area, Sq. In.	...	...	.25	...	...	...	1.00	1.27	1.50
	Weight, Lbs. per Ft.	...	...	.85	...	...	...	3.40	4.30	5.31
ROUND BARS	Area, Sq. In.	.05	.11	.20	.31	.44	.60	.79	...	...
	Weight, Lbs. per Ft.	.17	.38	.67	1.04	1.50	2.04	2.67	...	...

Fireproofing of Steel. The purpose of covering beams, girders and columns is to place a fire protection over the structural steel frame of buildings, and to provide a surface on which to plaster.

It is necessary that the steel columns and the girders and beams projecting below the floor slab be protected by at least 2 inches of fireproofing material. In case of a serious fire, the integrity of the whole structure depends upon the thorough protection of the columns, girders and floor beams, and no reasonable expense should be spared to accomplish this. Experience has proven that well-burned structural clay tile (burned at a temperature of about 2000° F.) is an adequate protection for structural steel or iron.

The cement mortar filling the space between the tiles and the steel, protects the steel from corrosion.

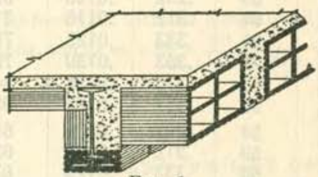


Fig. 1

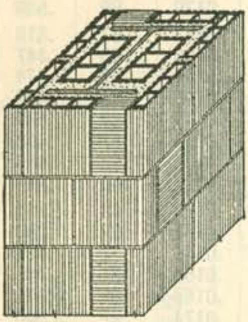


Fig. 2

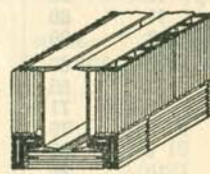


Fig. 3

USUAL METHODS OF PROTECTING STEEL WITH TILE

Tile fireproofing is low in cost, light in weight, can be speedily erected in all kinds of weather, has a good plastering surface and can be obtained in shapes suitable for the widest flange beams. It has ample strength, even with horizontal cell fillers, to carry floor loads of ordinary spans with the factor of safety allowed by building codes. Where the span is long and where there is a considerable load on the floor beam, it is customary to use tile fillers with the cells vertical, which, when filled with concrete, give a continuous solid bearing on the lower flange of the beam.

Girder covering is sold on a basis of the square footage of the actual outside surface of the tile surrounding the beam.

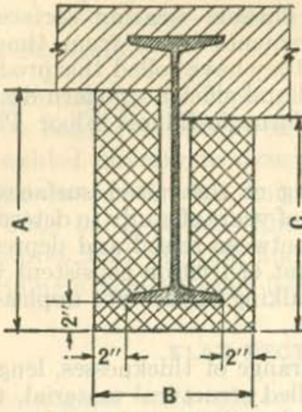


FIG. 4

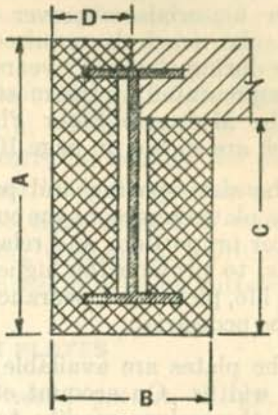


FIG. 5

Estimates can be made of the approximate amount of this tile by taking the linear distance in feet around A+B+C as shown in Fig. 4, or A+B+C+D as shown in Fig. 5, and multiplying this sum by the length of the beam in feet.

In general, the weight of this material will be not over 20 pounds per square foot of superficial surface. However, if concrete is poured into the tile web covering, as is done when tile is used in connection with concrete floor systems, the weight of this concrete must be added.

FLOOR PLATES

Rolled steel plates with anti-skid surfaces are rapidly replacing other materials wherever a dense, durable wearing surface or vehicular track is required. Improvements made from time to time during the many years in which they have rolled this product, are represented by the most advanced and efficient modern designs of the Multigrip Floor Plate and Carnegie-Illinois Floor Plate, which are shown on page 102.

The size, spacing and proportioning of the raised surfaces on these plates represent the culmination of years of study to determine proper proportions and relationships between raised and depressed areas, to provide the highest coefficient of friction consistent with long life, pleasing appearance, and a walking surface not unpleasant to the pedestrian.

The plates are available in a wide range of thicknesses, lengths, and widths. On account of being rolled structural material, they lend themselves readily to forming, bending, or even the most complicated fabrication. The ductility and lack of brittleness of the material enhance its other virtues.

Examination of the plates will reveal raised, flat-surfaced lugs of maximum area, with practically square edges. The full area of the lugs, therefore, immediately available to resist wear, and the square edges provide the greatest possible resistance to slipping or skidding. Enclosed pockets are avoided in the design, so that the plates drain quickly and thoroughly. The accumulation of dirt and debris is avoided, and cleaning is facilitated.

The lighter weight plates are used extensively wherever they are required to support pedestrian traffic in various places where security from slipping is essential, such as the uses listed below:

Stair treads and landings.	Factory aisles and runways.
Elevated platforms.	Sidewalk openings.
Manhole covers.	Ship decks.
Boiler room floors.	Machine shops.
Heavy duty factory floors.	Ramps or temporary runways.

Trench covers over pipe lines or drains in basements and power houses.

And other miscellaneous uses.

The heavier weights of plates, while used for many of the purposes given in the above tabulation, are used principally where vehicular traffic is encountered or other heavy loads are to be supported. A very common application is the placing of heavy plates on the wheel tracks of the traffic lanes on bridges the entire length of the bridge. Plates are generally installed over worn planking, often eliminating reflooring and strengthening the entire bridge roadway. Further benefits are: reduction of vibration; roadway chatter and noise; and the constant annoyance of rising spikes, so dangerous and detrimental to automobile traffic. Tearing of roadway from anti-skid chains is eliminated, and concentrated loads from heavy truck wheels are distributed over a much greater floor area, increasing capacity and reducing strains in the floor. The use of the

FLOOR PLATES

anti-skid traffic plates, therefore, prolongs the life of the structure, reduces maintenance costs, and produces a safer roadway for fast vehicular traffic.

A growing use for these plates on new bridges is in the form of the so called "Battle Deck" roadway in which the floor plates are welded directly to closely spaced carrying beams, the plates and beams acting as a unit so that safe loads are calculated on the basis of T action. The floor plate thus acts as a primary structural load carrying and distributing element in addition to providing a homogeneous leak-proof, anti-skid wearing surface.

FLAT RECTANGULAR PLATES

Rectangular steel plates, plain or raised pattern design, are frequently used in mill floor construction supported by the floor beams on two sides or on all four sides and more or less securely fixed to the flanges of the supporting beams.

The resistance of rectangular plates to superimposed loads may be obtained from the formulas given below; the formulas given for plates supported on four sides apply generally to rectangular plates subjected to pressures normal to surface of plates.

M = Bending moment, due to uniform or concentrated load, inch-pounds.
S = Section modulus, inches³.
f = Unit stress, pounds per square inch.
w = Unit load, pounds per square inch.
P = Concentrated load.
a, b = Sides of plate, inches, $(a<b)$
t = Thickness of plate, inches.
c = Perpendicular distance, from corner to diagonal, d, of plate, inches.
ϕ = Limiting values for steel plates, fixed and not fixed to supports (v. Bach).

Plate supported on two sides, a—Uniformly distributed load.

$$M=\frac{w\,a\,b^2}{8}=f\,S \qquad S=\frac{a\,t^2}{6} \qquad f=\tfrac{3}{4}\,b^2\,\frac{w}{t^2}$$

Plate supported on four sides, a, b—Uniformly distributed load.

$$f=\phi\,\tfrac{1}{2}\,\frac{a^2 b^2}{a^2+b^2}\,\frac{w}{t^2} \qquad f=\phi\,\tfrac{1}{2}\,c^2\,\frac{w}{t^2} \qquad \phi=\tfrac{9}{16}\text{ to }\tfrac{3}{4}$$

Plate supported on four sides, a, b—Concentrated load in center.

$$f=\phi\,\tfrac{3}{2}\,\frac{ab}{a^2+b^2}\,\frac{P}{t^2} \qquad f=\phi\,\tfrac{3}{2}\,\frac{c}{d}\,\frac{P}{t^2} \qquad \phi=1\tfrac{1}{4}\text{ to }1\tfrac{1}{3}$$

When plates are fixed at edges in such a manner as to take full advantage of continuity, $\phi = \frac{9}{16}$ for uniformly distributed loads and $1\frac{1}{4}$ for loads concentrated in the center. When they are fixed at edges so that the full continuity effect cannot be safely assumed, ϕ must be increased in proportion as the degree of fixation is decreased. The maximum values of ϕ are $\frac{3}{4}$ and $1\frac{1}{3}$ respectively.

FLOOR PLATES

BUCKLE PLATES

Buckle plates are sometimes used on highway bridges with paved floors, and are subjected to concentrated live loads, due to the weight of truck wheels and to a uniform load due to the paving.

The resistance of buckle plates, when the buckle is turned up and in compression may be computed from the formulas (Winkler):

Total uniformly distributed load

$$W = 4\,f\,d\,t, \text{ pounds per buckle.}$$

Total concentrated load, in addition to uniform dead load.

$$P = \frac{t\,(100\,f\,d\,t - 25.2\,w\,a\,b)}{6\,d + 15\,t}, \text{ pounds per buckle}$$

a, b = Sides of Buckle, inches.
t = Thickness of plate, inches.
d = Rise of Buckle, inches.
W = Uniformly distributed load.
w = Unit load, pounds per sq. inch.
f = Allowable unit stress, 9,000 lbs. per sq. inch.
P = Concentrated load.

Buckle plates are generally placed with the convex side of the buckle turned down, in tension, in which case their strength is about three times greater; however, the value of f in such cases should not exceed the allowable tensile unit stress permitted by the specifications.

BUCKLES can be lengthwise or crosswise of plate, but different sizes should not be used in the same plate. Plates are buckled one buckle at a time, and the number of buckles is determined by their size, fillets and end flanges, and by length of plate that can be fabricated.

A plate 35 ft. long could have:—
14 buckles No. 11, b=2′-2″, with f=3½″ and e=5¼″ or
9 buckles No. 12, b=3′-8″, with f=2¼″ and e=3″.

CONNECTION HOLES are usually for ⅝″, ¾″ or ⅞″ rivets or bolts. Holes of different sizes in the same plate increase the cost.

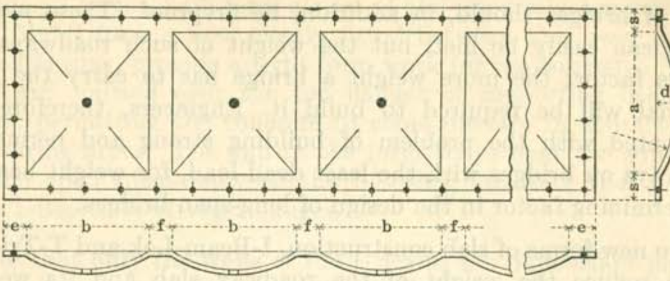
SPACING: Crosswise, usually 6″, with 4½″ Min.
Lengthwise, from 6″ to 12″.
Odd spaces at ends, in even ¼″.

DRAWING must show **Top View** of plate, give **Die Number,** and state whether buckles are turned **up** or **down.** When buckles are turned **down,** the drawing must show a **Drain Hole** in the center of each buckle.

FLOOR PLATES

BUCKLE PLATES

American Bridge Company Standard



Size of Buckle, Inches			Die No.	Size of Buckle, Inches			Die No.	Size of Buckle, Inches			Die No.
a	b	d		a	b	d		a	b	d	
21	21	2½	39	36	36	2	13	45	37	3	6
				36	37	3	29	45	42	3	24
23½	24	2½	38					45	45	3	5
23½	28½	2½	36	37	36	3	28				
23½	47	2½	18	37	38	3	26	47	23½	2½	17
				37	45	3	7	47	42	3	4
24	23½	2½	37					47	54	3½	2
24	30	2½	30	38	37	3	27				
								48	48	3	34
26	44	2	12	41	42	3	23				
								51¼	61	4	16
28½	23½	2½	35	42	41	3	22				
				42	45	3	25	54	47	3½	1
30	24	2½	31	42	47	3	3				
30	30	2½	21	42	66	3½	32	61	51¼	4	15
30	33	2½	20					66	42	3½	33
				44	26	2	11				
32	44	2	10	44	32	2	9				
				44	44	2	8				
33	30	2½	19								
33	33	3	14								

MAXIMUM WIDTH = 94″.

MAXIMUM LENGTH = 35 ft. Plates of greater length can be obtained by splicing.

ALLOWABLE OVERRUN in length or width must be given on drawing, when clearance is close.

END FLANGES e = 2″ Minimum 18″ Maximum

SIDE FLANGES s = 2″ Minimum 6½″ Maximum 4″ or less, preferred.

FILLETS f = 2″ Minimum 6″ Maximum 4″ or less, preferred.

END FLANGES to be made alike if possible. If over 18″, stiffen with angles across plate.

SIDE FLANGES to be made alike if possible. When side flanges must be of unequal width, the plate should be ordered wide enough to make two flanges of the greater width. After plate is buckled, it will be sheared to required width.

BRIDGE FLOOR CONSTRUCTION

The requirements of modern vehicular traffic demand roadways and pavements having uniform, continuous, hard surfaces. They must offer sufficient friction to prevent skidding, and should be of permanent character to require as few repairs as possible. Roadways of bridges should, in addition, be fireproof. These requirements can easily be met, but the weight of such roadways is a serious factor; the more weight a bridge has to carry the more material will be required to build it. Engineers, therefore, are confronted with the problem of building strong and permanent roadways on bridges with the least dead load, for weight becomes a determining factor in the design of long-span bridges.

Two new forms of slab construction, I-Beam-Lok and T-Tri-Lok, which reduce the weight of the roadway slab and its wearing surface, are manufactured by Carnegie-Illinois Steel Corporation.

These units are placed directly upon stringers, to which they are secured by welding. They are filled with concrete, flush with the top of the steel, to form an armored road surface. The resulting structure is a unit slab of steel cells filled with concrete. Vibrating and tamping the concrete with an air or preferably an electric vibrator immediately after pouring is recommended to secure concrete of maximum density.

DESIGN FORMULAS

On the basis of modifications in Westergaard's moment formulas with I-Beams or Tees perpendicular to direction of traffic, when C = 15″, the live load movements for one wheel on slab spans up to 5 feet, become

$$M = \frac{PS}{4E} - .0525P,$$

and, for two wheels on slabs over 5 feet span, moments become

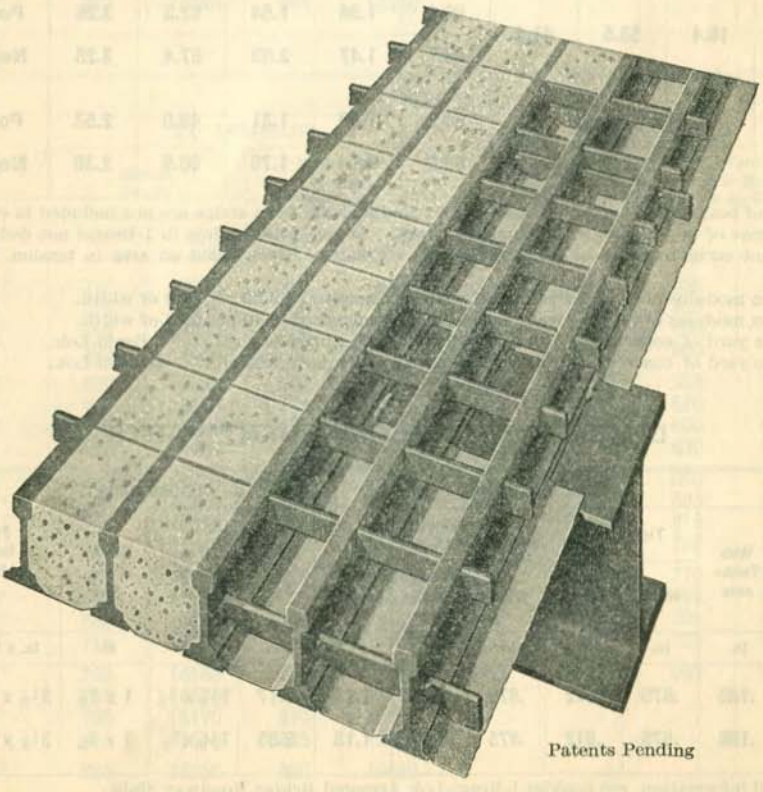
$$M = \frac{PS}{4H} - .0525P.$$

M = Maximum live load moment per foot of width of slab.
P = Wheel load = 12,000 pounds for H-15, and 16,000 pounds for H-20 loading.
S = Slab span in feet.
E = Effective width in feet for one wheel. $E = 2.41\sqrt{S}$ for spans 1′-0″ to 4′-0″, incl. $E = 0.58S + 2.50$ for spans 4′-3″ to 10′-0″, incl.
H = Equivalent effective width for one wheel to give the effect of two wheels on slab arranged for maximum moment. $H = 0.33S + 3.50$ for spans 5′-3″ to 10′-0″, incl.
W = Dead load per square foot of slab.
I = Impact Factor $= \frac{50}{125 + S}$
D.L.M. = Dead Load moment per foot width of slab $= \frac{1}{11} WS^2$.
M + I. M. = Live Load moment + Impact moment per foot width of slab.
M_T = Design Moment = D. L. M. + M + I. M.

I-BEAM-LOK SLABS

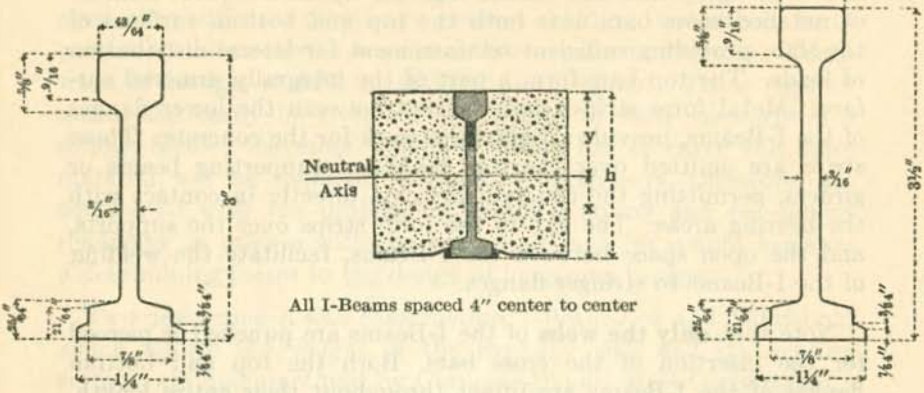
The construction is a series of alternating I-Beams and concrete ribs thoroughly tied and locked together by an adequate number of notched cross bars near both the top and bottom surfaces of the slab, providing sufficient reinforcement for lateral distribution of loads. The top bars form a part of the integrally armored surface. Metal form strips, closely fitted between the lower flanges of the I-Beams, provide a tight form work for the concrete. These strips are omitted over the top flanges of supporting beams or girders, permitting the concrete to come directly in contact with the bearing areas. The gap in the form strips over the supports, and the open space between the I-Beams, facilitate the welding of the I-Beams to stringer flanges.

Note that **only the webs** of the I-Beams are punched or pierced for the insertion of the cross bars. Both the top and bottom flanges of the I-Beams are intact throughout their entire length. The slab is so designed as to have constant moment of inertia for resisting both positive and negative bending moment stresses. The notched cross bars are first inserted flat in the L-shaped web holes, then turned through an arc of 90 degrees, and tack-welded in their final position. These bars hold and lock the I's rigidly at uniformly spaced intervals.



Patents Pending

ELEMENTS OF I-BEAM-LOK SLABS



All I-Beams spaced 4″ center to center

Depth	Average Weight of Steel per Sq. Ft.	*Total Weight of Slab per Sq. Ft.		I per Foot of Slab Width	x	y	Section Modulus per Foot of Slab Width		Moment
		Ordinary Concrete	Light Weight Concrete				Compression Concrete	Tension Steel	
In.	Lbs.	Lbs.	Lbs.	In.⁴	In.	In.	In.³	In.³	
3½	16.4	53.5	41.5	96.0	1.96	1.54	62.3	3.26	Positive
				99.1	1.47	2.03	67.4	3.25	Negative
3	15.5	47.0	36.8	64.2	1.69	1.31	49.0	2.53	Positive
				63.2	1.24	1.76	50.9	2.39	Negative

Areas of beads along bottom flanges of I-Beams and the form strips are not included in computations. Areas of upper slots in I-Beams deducted. Areas of lower slots in I-Beams not deducted as they do not occur in zones of maximum stress. Concrete disregarded on area in tension. Ratio, $n = 15$.

Section modulus of 3½″ I-Beam steel without concrete = 3.02 per foot of width.
Section modulus of 3″ I-Beam steel without concrete = 2.40 per foot of width.
*1 cubic yard of concrete will fill approximately 105 square feet of 3½″ I-Beam-Lok.
*1 cubic yard of concrete will fill approximately 124 square feet of 3″ I-Beam-Lok.

DIMENSIONS OF COMPONENT PARTS

Depth	I-BEAM SECTIONS							CROSS BARS		Form Strips, Size
	Web Thickness	Top Flange		Bottom Flange Without Side Beads		Area	Weight per Foot	Top Bars, Size	Bottom Bars, Size	
		Width	Average Thickness	Width	Average Thickness					
In.	In.	In.	In.	In.	In.	In.²	Lbs.	In.	In.	In. x B.W.G.
3½	.188	.675	.612	.875	.365	1.23	4.17	1⅛ x 3/16	1 x 5/16	3 1/16 x No. 20
3	.188	.675	.612	.875	.365	1.13	3.85	1⅛ x 3/16	1 x 5/16	3 1/16 x No. 20

For full information, see booklet I-Beam-Lok Armored Bridge Roadway Slabs.

I-BEAM-LOK SLABS

UNIT STRESSES IN STEEL AND CONCRETE

IN POUNDS PER SQUARE INCH

Span	H-20 LOADING							
	3½″ I-BEAM-LOK				3″ I-BEAM-LOK			
	Without Overfill		With Overfill of 25 lbs. per Sq. Ft.		Without Overfill		With Overfill of 25 lbs. per Sq. Ft.	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
2′—0″	405	7790	410	7820	515	10000	520	10040
2′—3″	445	8520	445	8560	565	10940	565	10990
2′—6″	485	9250	485	9310	615	11880	615	11930
2′—9″	520	9940	525	10010	660	12760	665	12840
3′—0″	555	10630	560	10710	705	13640	710	13740
3′—3″	585	11250	590	11290	745	14430	750	14540
3′—6″	620	11860	625	11970	785	15220	790	15350
3′—9″	650	12430	655	12540	825	15940	830	16080
4′—0″	680	12990	685	13120	860	16660	870	16820
4′—3″	705	13530	715	13680	895	17320	905	17530
4′—6″	735	14070	745	14240	930	18040	940	18310
4′—9″	760	14600	765	14780	...	.....	...	.....
5′—0″	790	15130	800	15320	...	.....	...	.....
5′—3″	880	16820	890	17030	...	.....	...	.....
5′—6″	910	17410	920	17660	...	.....	...	.....
5′—9″	940	18060	955	18330	...	.....	...	.....

Span	H-15 LOADING							
	3½″ I-BEAM-LOK				3″ I-BEAM-LOK			
	Without Overfill		With Overfill of 25 lbs. per Sq. Ft.		Without Overfill		With Overfill of 25 lbs. per Sq. Ft.	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
2′—0″	310	5890	310	5930	390	7570	395	7620
2′—3″	335	6440	340	6490	425	8270	420	8330
2′—6″	365	7000	370	7050	465	8970	465	9040
2′—9″	390	7510	395	7570	495	9620	500	9710
3′—0″	420	8020	425	8100	530	10270	535	10370
3′—3″	445	8510	450	8600	565	10900	570	11010
3′—6″	470	8990	475	9090	595	11520	600	11660
3′—9″	490	9400	495	9520	625	12060	630	12200
4′—0″	510	9810	520	9950	650	12600	660	12740
4′—3″	535	10220	540	10370	675	13070	685	13280
4′—6″	555	10650	565	10810	705	13620	715	13840
4′—9″	575	11040	585	11230	730	14130	740	14370
5′—0″	595	11430	610	11650	755	14630	770	14900
5′—3″	670	12820	680	13020	845	16400	860	16670
5′—6″	690	13210	700	13450	870	16840	890	17220
5′—9″	715	13690	730	13960	905	17470	920	17850
6′—0″	740	14160	755	14460	935	18100	955	18490
6′—3″	765	14670	785	15000	...	.....	...	.....
6′—6″	790	15170	810	15530	...	.....	...	.....
6′—9″	815	15610	835	15990	...	.....	...	.....
7′—0″	835	16050	860	16450	...	.....	...	.....

I-BEAM-LOK SLABS

H-20 Loading 16,000-pound wheel plus impact ranging from 39.4% on 2′—0″ span to 37.9% on 7′—0″ span.

H-15 Loading 12,000-pound wheel plus impact ranging from 39.4% on 2′—0″ span to 37.9% on 7′—0″ span.

Stresses based on slabs extending continuously over two or more spans with I-Beams transverse to direction of traffic. n ratio = 15

Moments based on wheel load plus impact and dead load of slab.

Two wheel loads, 3′—0″ center to center, figured on spans over 5′—0″.

Concrete stresses in tables are very conservative, as the entire weight of the slab is figured while actually the dead weight of the slab is carried entirely by the steel and only live loads affect the stresses in the concrete.

Portions of tables showing stresses with 25 pound overfill are for use where specifications call for separate wearing surface. It is common practice to omit all wearing surfaces when I-Beam-Lok Armored Surfaces are used. However, when their weight is included in the design, wearing surfaces may be added many years later without over-stressing any portions of the bridge.

Light Weight Concrete. When 3,000 pound strength light weight concrete weighing 98 pounds per cubic foot is used in slabs with an overfill, stresses are reduced in 3½″ deep slabs by an amount equal to 12/25 of the difference in stress between values for slabs with and without overfill, and for 3″ deep slabs, by an amount equal to 10/25 of the difference.

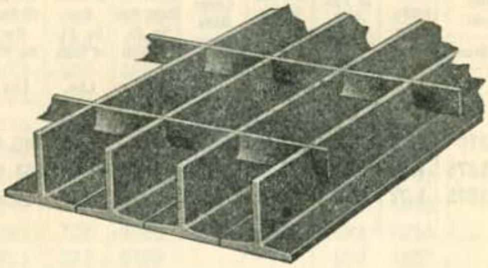
For example:—

With 3½″ slab on 5′ span under H-20 loading, f_c without overfill equals 790 pounds, and with, 800 pounds. The difference is 10 pounds, and 12/25 of same equals 5 pounds. In light weight concrete I-Beam-Lok Armored Slabs with 25 pounds of overfill wearing surface, the reduced concrete unit stress becomes 800 minus 5 or 795 pounds per square inch. The same procedure applies to unit stresses in the steel I-Beams.

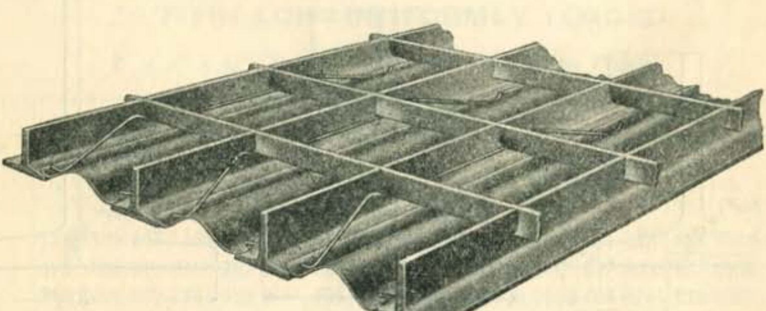
T-TRI-LOK SLABS

T-Tri-Lok is a combination of structural tees with light, flat bars mechanically interlocked with them.

Curved slots are punched at equal intervals along the stem of the tee and above the neutral axis, the direction of the slots being alternated in adjacent tees so that the bar, in being forced into position, is twisted in alternate directions in the successive tees. This feature assures stiffness and rigidity of construction without further fabrication. Standard units can be furnished in widths up to 4 feet and in lengths up to 40 feet. Various sizes of tees and cross bars are offered, the most common being 3″ x 3″ or 3½″ x 3½″ tees with 1″ x 3/16″ cross bars, placed on 4-inch centers.

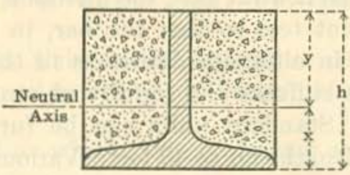


For sidewalks and other light construction, it is advisable to spread tees apart, in which case forming strips are provided to eliminate timber form work.



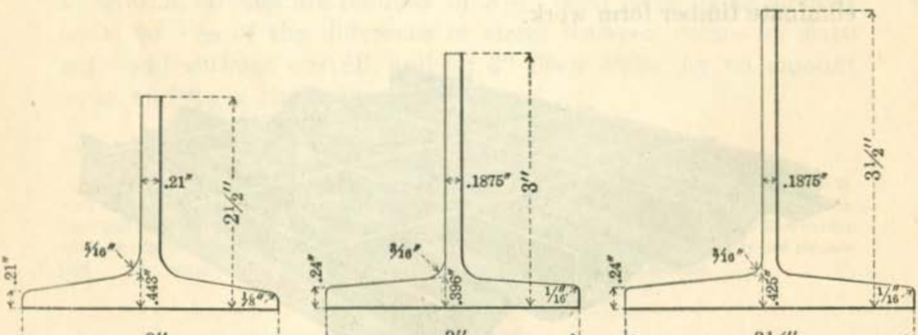
CONSTRUCTION FOR
SIDEWALKS, BUILDING FLOORS AND LIGHTER ROADWAYS

ELEMENTS OF T-TRI-LOK SLABS



Size of Tee				Area of Tee	Weight of Tee Per Lin. Ft.	Weight of Tees Per Sq. Ft. of Slab	Cross Bars	Weight of Cross Bars Per Sq. Ft. of Slab	Weight of Steel Per Sq. Ft. of Slab	Total Weight of Slab Per Sq. Ft.	I Per Foot of Slab Width	x	y
Flange	Stem	Minimum Thickness: Flange	Minimum Thickness: Stem										
In.	In.	In.	In.	In.²	Lbs.	Lbs.	In.	Lbs.	Lbs	Lbs.	⁴	In.	In.
3	2½	.210	.210	1.44	5.0	20.0	1 x 3/16	1.9	21.9	45.4	63.6	.76	1.74
3	3	.240	.1875	1.44	4.9	19.6	1 x 3/16	1.9	21.5	51.1	101.9	.95	2.05
3½	3½	.240	.1875	1.77	6.0	20.6	1 x 3/16	1.9	22.5	57.8	151.0	1.11	2.39

TEES



For Design Formulas, see page 376.

T-TRI-LOK SLABS

UNIT STRESSES IN STEEL AND CONCRETE

IN POUNDS PER SQUARE INCH

Span	3½″ T-TRI-LOK				3″ T-TRI-LOK				2½″ T-TRI-LOK			
	H 20 Loading		H 15 Loading		H 20 Loading		H 15 Loading		H 20 Loading		H 15 Loading	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
2′—0″	403	2807	303	2111	512	3559	385	2676	695	4553	523	3427
2′—3″	442	3079	332	2313	561	3900	422	2933	761	4986	573	3754
2′—6″	478	3330	360	2508	607	4219	457	3177			620	4062
2′—9″	513	3574	387	2696	651	4525	490	3406			665	4357
3′—0″	546	3803	412	2870	693	4817	522	3629			709	4645
3′—3″	579	4033	437	3044	734	5102	553	3844			751	4920
3′—6″	610	4249	460	3204	773	5373	584	4059				
3′—9″	640	4458	484	3372	811	5637	613	4261				
4′—0″	670	4667	506	3525	849	5902	641	4456				
4′—3″	699	4869	529	3685	885	6152	669	4650				
4′—6″	727	5064	550	3831	921	6402	696	4838				
4′—9″	753	5245	570	3971	954	6631	722	5019				
5′—0″	778	5420	590	4110	985	6847	746	5286				
5′—3″	862	6005	653	4549	1091	7584	826	5742				
5′—6″	897	6249	680	4737	1136	7897	860	5978				
5′—9″	931	6485	707	4925	1179	8195	894	6214				
6′—0″	965	6722	733	5106			926	6437				
6′—3″	997	6945	758	5280			958	6659				
6′—6″	1029	7168	780	5433			985	6847				
6′—9″	1060	7384	807	5622			1019	7083				
7′—0″	1091	7600	830	5782			1048	7285				

2″ T-TRI-LOK—UNIFORMLY LOADED

2″ x 2″ x ¼″ Tees, 4″ Centers. Concrete Flush

Load, Lbs. per Sq. Ft.	SPAN IN FEET																	
	4′—0″		4′—6″		5′—0″		5′—6″		6′—0″		6′—6″		7′—0″		8′—0″		9′—0″	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
100	115	1101	145	1394	179	1720	217	2082	258	2477	303	2908	351	3372	459	4404	581	5574
150	172	1652	218	2090	267	2581	325	3123	387	3716	454	4361	527	5058	688	6606		
200	229	2202	290	2787	359	3441	434	4163	516	4955	606	5815	703	6744	918	8809		
250	287	2753	368	3484	448	4301	542	5204	645	6194	757	7269						
300	344	3303	436	4181	538	5161	651	6245	774	7432								
400	457	4404	581	5574	717	6882	868	8327										

In the tables the stress f_c for concrete has been kept below 1200 pounds for the 3″ and 3½″ T-Tri-Lok sections, and below 800 pounds for the 2½″ section.

n, ratio of modulus of elasticity of steel to concrete = 15.

Loads above heavy lines will not produce excessive deflections.

For full information see booklet T-Tri-Lok Bridge Floor Construction.

LIGHT WEIGHT BEAMS

A growing demand has been indicated in the last few years for beam and stanchion sections lighter than standard, or the new popular CB wide flange sections. This need has been filled by our light beams and joists which are now available. They will be found very useful and economical in the design of light floor or roof systems for buildings such as apartments, office buildings, school houses, and residences, or other construction in which a light-weight firesafe floor is essential.

The application of these light-weight sections develops itself into two broad classifications.

First. The first is that in which the beams are used in the same manner as standard-weight structural shapes to transmit floor or roof loads of a panel into main supporting beams or girders of a steel frame building. In this application, the light-weight beams are used at relatively wide spacing such as 3½ to 6 feet on centers, and the material of the supported floor slabs, either concrete or gypsum, is usually carried around the beams as an enveloping fireproof encasement. In this class of construction, the ends of the beams are usually securely riveted or welded to the carrying girders, and the beams themselves are of sufficient size and stability so that no special bridging or bracing of the top flanges of the light beams is required either during or after construction. In this classification, the spans are generally moderate in relation to the depth of the beams, due to the relatively wide spacing requiring beams of considerable strength.

Second. The second classification is that in which they are used at relatively close spacing as joists on maximum permissible spans for the depth of beams, and usually in wall bearing construction, such as school houses, residences, and two or three-story apartment houses, office buildings, or light mercantile structures. In this classification, some form of fireproof slab usually rests on top of the beams or joists with the top flanges embedded some distance in the under side of the slab. There is generally no fireproof encasement around the beams, the sides and bottoms being protected by a fire-resistive ceiling made up of metal lath and several coats of plaster—the base or scratch coat preferably being Portland Cement plaster.

In this class of construction, cross bridging of the beams or joists and the proper staying of the top flanges is of extreme importance, especially where the ends of the beams rest on simple bearings and are not restrained by riveted, bolted or welded connections.

Designers should carefully consider flange width in relation to span, and should provide bridging at proper intervals at least as a construction expedient. While floor slabs, after hardening, will provide adequate bracing to the top flanges of the beams, it is also desirable and good practice on very long spans to provide some means of preventing the beams from moving laterally. This can be accomplished by the conventional type of cross bracing, or by bridging beams or diaphrams cast between the beams integral with the fireproof slabs. Due to the relatively close spacing of the light beams or joists in this form of construction, end reactions are light, so that heavy load concentrations on walls are avoided.

Continuous Spans—School Buildings. These new light-weight CB beam and joist sections permit the design of continuous steel beams over the typical school house arrangement of two classrooms separated by a corridor. Where continuity is thus secured over the two center supports, decided economies are possible.

These advantages warrant their thorough investigation and consideration by every designer.

General. All the light beams and joists are designed with webs of sufficient thickness to provide ample resistance to shear and buckling when loaded to full bending moment capacity on all but the very shortest spans. The rigidity of construction and the deflection are comparable to the results obtained with standard or wide flange beams of similar depth when loaded so that extreme unit stresses in the beams are equal.

For profiles and dimensions, see pages 22 and 23.

For allowable uniform loads and detailing dimensions, see pages 230 to 233.

OPEN WEB STEEL JOISTS

In recent years there has been a marked development in steel joists made up of bars or small shapes to form trusses. These joists are adaptable for bearing on masonry walls, steel beams, or girders to suit various conditions. One notable feature is the fact that the open web affords a space for running conduit for electric wiring or pipes for heating or water systems, or even sewer lines in any direction.

The sizes of open web steel joists are standardized in accordance with Simplified Practice Recommendation No. R 94-30 of the Bureau of Standards of the United States Department of Commerce.

The table on page 382 gives the standard designations together with the maximum resisting moment in inch-pounds, the maximum end reaction in pounds and safe load in pounds per foot per joist when designed in accordance with the stresses recommended by the American Institute of Steel Construction.

Tensile stress = 18,000 pounds per square inch.

Compressive stress $= \dfrac{18{,}000}{1 + \dfrac{l^2}{18{,}000\ r^2}}$ with a maximum of 15,000 pounds per square inch, in which l is the unsupported length of the member and r is the corresponding least radius of gyration of the section, both in inches.

Joists longer than those shown in tables are not manufactured. Joists shorter than those shown in tables are made when for any reason it is not practical to use shallow joists for shorter spans. In computing the carrying capacity of shorter joists, the end reaction should be divided by one-half of the span to determine the safe load per linear foot.

The tables show the overall dimensions, maximum and minimum spans, and other data pertaining to the joists manufactured by the leading producers. Detailed data as to the properties of chord sections, etc., may be obtained from the catalogs of each manufacturer.

Steel joists are designed with the assumption that the top chord will be stayed laterally with concrete slabs at least two inches thick.

No material should be used as centering for the top slab which must be stretched across the top chord of joists or which will exert an undue lateral pull on the top chords of the joists during the pouring of concrete.

Steel joists are not intended to act as structural members except as temporary supporting members during construction. With steel joists just as in the case of wood joists, the lateral support of the top deck is an essential element of construction. The performance of a steel joist floor construction can only be determined by applying the top deck and testing with a uniform load. Concrete decks of quick setting cement can be tested at the end of 24 hours.

The spacing center to center of steel joists should not exceed 24 inches for floors, nor 30 inches for roofs.

The end bearing of steel joists should not be less than $2\frac{1}{2}$ inches on steel members, nor less than 4 inches on masonry.

Before being bridged, steel joists cannot be expected to sustain considerable loads, especially moving loads common in building construction. Loading of unstayed joists may easily result in construction accidents. The safety and success of the work depends largely upon the faithful installation of the bridging.

NUMBER OF LINES OF BRIDGING

Span	Number of Lines of Bridging
Up to 14 feet	One row near center.
14 to 21 feet	Two rows at quarter points, approximately.
21 to 32 feet	Three rows.

Each line of bridging should be capable of transmitting 500 pounds from any one joist and distributing it between the two adjacent joists.

The concrete should be placed in strips at right angles to run of joists. Placing in strips parallel to joists results in severe lateral stresses, which are liable to pull joists out of place and lead to construction accidents.

Cutting of web members or parts of chord sections from open web joists must not be permitted under any circumstances.

OPEN WEB STEEL JOISTS

ALLOWABLE TOTAL LOADS IN POUNDS PER LINEAR FOOT

STEEL JOIST INSTITUTE STANDARDS

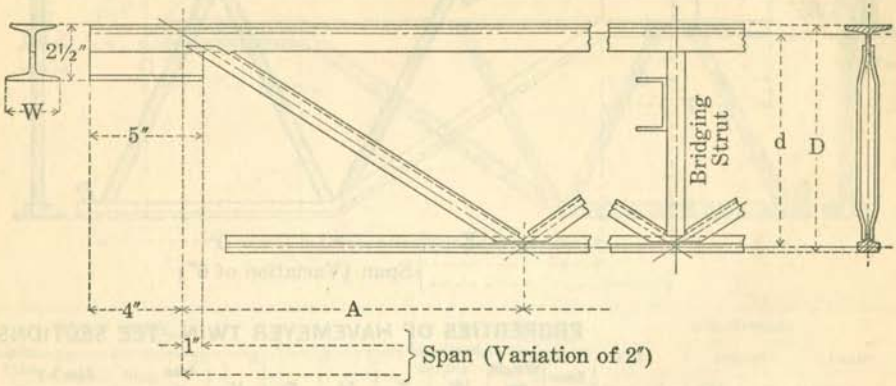
Adopted Aug. 20, 1929. Effective Jan. 1, 1930

American Institute of Steel Construction Unit Stresses

Steel Joist Institute Designation	SJ 81	SJ 82	SJ 102	SJ 103	SJ 104	SJ 123	SJ 124	SJ 125	SJ 126	SJ 145	SJ 146	SJ 147	SJ 166	SJ 167
Depth, Inches	8	8	10	10	10	12	12	12	12	14	14	14	16	16
Resisting Moment, Inch-Pounds	29,500	52,500	63,000	82,000	100,000	92,000	115,000	142,000	175,000	156,000	205,000	246,000	232,000	281,000
Maximum End Reaction, Pounds	1600	1900	1900	1950	2200	2200	2300	2500	2700	2800	3100	3400	3200	3600
Span, Feet														
4	800													
5	640													
6	530													
7	402													
8	308													
9	243													
10	197	350												
11	162	289												
12	137	243	292											
13	116	207	248											
14	100	178	214											
15	87	155	187	243		272								
16	77	137	164	213	260	240								
17	...	...	145	189	230	212								
18	...	...	130	169	205	189	236							
19	...	...	116	151	184	170	212	...	...	288				
20	...	...	105	137	167	153	192	237	...	260				
21	...	...	...	...	...	139	174	215	...	236				
22	...	...	...	...	...	127	158	196	241	215				
23	...	...	...	...	...	116	145	179	221	197	258			
24	...	...	...	...	...	106	133	164	202	180	237			
25	...	...	...	...	...	...	...	...	...	166	218	262	247	
26	...	...	...	...	...	...	...	...	...	154	202	243	229	
27	...	...	...	...	...	...	...	...	...	143	187	225	212	257
28	...	...	...	...	...	...	...	...	...	133	174	209	197	239
29	...	...	...	...	...	...	...	...	...	...	...	...	184	223
30	...	...	...	...	...	...	...	...	...	...	...	...	172	208
31	...	...	...	...	...	...	...	...	...	...	...	...	161	195
32	...	...	...	...	...	...	...	...	...	...	...	...	151	183

GABRIEL OPEN WEB STEEL JOISTS

Manufactured by Gabriel Steel Company



Joist Type	Span		Depth		Chord Areas		W	A	End Diagonal	
	Min.	Max.	D	d	Top	Bottom			Gross Area	Net Area
	Ft.-In.	Ft.-In.	In.	In.	In.^{2}	In.^{2}	In.	Ft.-In.	In.^{2}	In.^{2}
SJ 81	4–0	16–0	8	7.53	.410	.360	2⅝	1–0	.219	.172
SJ 82	4–0	16–0	8	7.47	.528	.442	3	1–0	.250	.203
SJ 102	9–0	20–0	10	9.47	.528	.442	3	1–3	.250	.203
SJ 103	9–0	20–0	10	9.41	.644	.536	3	1–3	.250	.203
SJ 104	9–0	20–0	10	9.35	.745	.620	4	1–3	.281	.234
SJ 123	13–0	23–0	12	11.41	.644	.536	3	1–4	.281	.234
SJ 124	13–0	24–0	12	11.35	.745	.620	4	1–4	.281	.234
SJ 125	13–0	24–0	12	11.29	.845	.705	4	1–5	.313	.266
SJ 126	13–0	24–0	12	11.23	1.090	.910	4½	1–5	.344	.297
SJ 145	17–0	26–0	14	13.29	.845	.705	4	1–5	.313	.266
SJ 146	17–0	28–0	14	13.23	1.090	.910	4½	1–5	.344	.297
SJ 147	17–0	28–0	14	13.19	1.290	1.160	4½	1–5	.375	.328
SJ 166	21–0	30–0	16	15.23	1.090	.910	4½	1–6	.344	.297
SJ 167	21–0	32–0	16	15.19	1.290	1.160	4½	1–6	.375	.328

Gabriel Joists are built to the job spans with one inch variation on each end.

Chord Sections as shown in table are combined with specially designed V-shaped diagonals. The slenderness ratio of the diagonals have been reduced to a minimum.

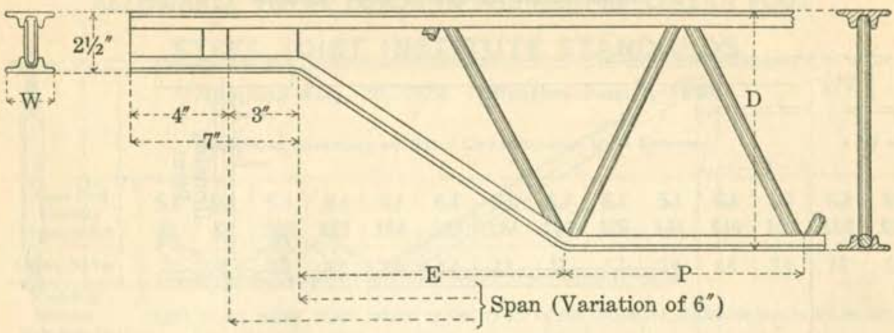
Vertical Bridging Struts are introduced at established panel points to meet the requirements for bridging.

Standard A. S. C. E. Rail Sections, rolled from new billet steel, structural grade, are slit longitudinally to produce the exact top and bottom chord sectional areas required for each case.

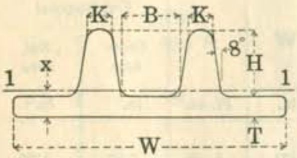
Special Joists are manufactured in all depths for shorter spans than given, when it is desirable to have joists of uniform depth.

HAVEMEYER OPEN WEB STEEL JOISTS

Manufactured by Concrete Steel Company



PROPERTIES OF HAVEMEYER TWIN—TEE SECTIONS



Section Number	Weight per Foot	W	T	H	B	K	Area of Section	Axis 1-1 I	Axis 1-1 r	Axis 1-1 x
	Lbs.	In.	In.	In.	In.	In.	In.^{2}	In.^{4}	In.	In.
1	1.37	1.75	5/32	3/8	7/16	9/64	0.40	0.007	0.13	0.16
2	1.63	1.84	5/32	15/32	1/2	5/32	0.48	0.013	0.16	0.19
3	1.96	1.87	5/32	1/2	1/2	1/4	0.58	0.019	0.18	0.22
4	2.36	2.29	5/32	9/16	9/16	33/128	0.69	0.027	0.20	0.24
5	2.62	2.48	5/32	19/32	9/16	9/32	0.77	0.033	0.21	0.25
6	2.88	2.68	3/16	5/8	5/8	7/32	0.85	0.039	0.21	0.24
7	3.44	2.88	13/64	11/16	5/8	1/4	1.01	0.056	0.24	0.27

Joist Type	Span Min.	Span Max.	D	P	E Min.	E Max.	Top Chord Section Number	Bottom Chord Section Number	Diameter of Web End Members	Diameter of Web Interior Members
	Ft.-In.	Ft.-In.	In.	In.	In.	In.			In.	In.
SJ 81	4–0	16–0	8	8	8	11	1	1	7/16	3/8
SJ 82	4–0	16–0	8	8	8	11	2	1	7/16	3/8
SJ 102	4–0	20–0	10	10	11	15	2	1	7/16	3/8
SJ 103	10–0	20–0	10	10	11	15	3	2	7/16	3/8
SJ 104	10–0	20–0	10	10	11	15	4	3	1/2	7/16
SJ 123	4–0	24–0	12	12	12	15	3	2	1/2	7/16
SJ 124	12–0	24–0	12	12	12	15	4	3	1/2	7/16
SJ 125	12–0	24–0	12	12	12	15	6	4	9/16	1/2
SJ 126	12–0	24–0	12	12	12	15	7	6	9/16	1/2
SJ 145	4–0	28–0	14	14	15	21	5	4	9/16	1/2
SJ 146	14–0	28–0	14	14	15	21	7	6	5/8	1/2
SJ 166	4–0	32–0	16	16	17	24	7	6	5/8	9/16

Havemeyer Steel Joists are made in span lengths varying by 6 inches from minimum to maximum as given in table.

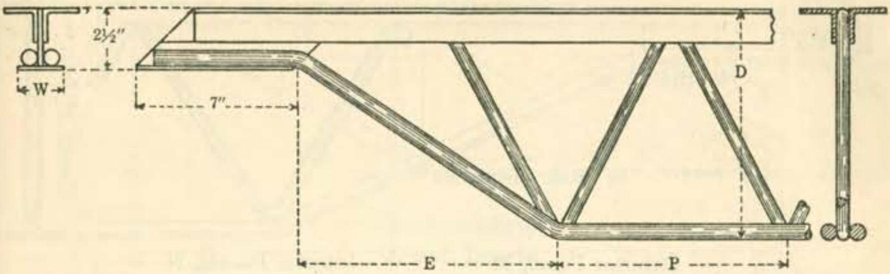
Top and bottom chords consist of special rolled twin-tee sections. Web members are round bars bent into the form of a Warren truss.

Section Numbers for chords and diameters of the web bars for various sizes of joists are shown in lower table. End Filler Sections are ⅛-inch plates bent "U" shape.

Joists are assembled by means of electric welding.

CECO OPEN WEB STEEL JOISTS

Manufactured by Concrete Engineering Company



Joist Type	Overall Length		D	B	E	Top Chord Angles	Bottom Chord Dia.	Web Members					
								End		Interior		Center	
	Min.	Max.						Dia.	P	Dia.	P	Dia.	P
	Ft.-In.	Ft.-In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
SJ 81	5-2	16-8	8	2	12 & 15	¾ x ¾ x ⅛	⅜	7/16	12	......	......	⅜	12
SJ 82	9-2	16-8	8	2	12 & 15	1 x 1 x ⅛	½	7/16	12	......	......	⅜	12
SJ 102	11-2	20-8	10	2	12 & 15	1 x 1 x ⅛	½	7/16	12	⅜	12	⅜	12
SJ 103	11-2	20-8	10	2	12 & 15	1¼ x 1¼ x ⅛	9/16	7/16	12	⅜	12	⅜	12
SJ 104	11-2	20-8	10	3	12 & 15	1½ x 1½ x ⅛	⅝	½	12	7/16	12	⅜	12
SJ 123	13-2	24-8	12	3	21 & 24	1¼ x 1¼ x ⅛	9/16	½	18	7/16	18	7/16	12
SJ 124	13-2	24-8	12	3	21 & 24	1½ x 1½ x ⅛	⅝	9/16	18	7/16	18	7/16	12
SJ 125	13-2	24-8	12	3	21 & 24	1¾ x 1¾ x ⅛	21/32	9/16	18	½	18	7/16	12
SJ 126	13-2	24-8	12	3	21 & 24	1½ x 1½ x 3/16	¾	9/16	18	½	18	7/16	12
SJ 145	15-2	28-8	14	3	21 & 24	1¾ x 1¾ x ⅛	21/32	9/16	18	½	18	½	12
SJ 146	15-2	28-8	14	4	21 & 24	1½ x 1½ x 3/16	¾	⅝	18	9/16	18	½	12
SJ 147	15-2	28-8	14	4	21 & 24	1¾ x 1¾ x 3/16	13/16	⅝	18	9/16	18	½	12
SJ 166	17-2	32-8	16	4	21 & 24	1½ x 1½ x 3/16	¾	⅝	18	9/16	18	9/16	12
SJ 167	17-2	32-8	16	4	21 & 24	1¾ x 1¾ x 3/16	13/16	11/16	18	9/16	18	9/16	12

CECO NAILER JOISTS

80 W	5-2	16-8	8	2	12 & 15	1 x 1 x ⅛	½	7/16	12	......	......	⅜	12
100 W	5-2	20-8	10	2	12 & 15	1 x 1 x ⅛	½	7/16	12	⅜	12	⅜	12
120 W	6-2	24-8	12	3	21 & 24	1 x 1 x ⅛	½	½	18	7/16	18	7/16	12
121 W	6-2	24-8	12	3	21 & 24	1½ x 1½ x ⅛	⅝	9/16	18	7/16	18	7/16	12
141 W	10-2	28-8	14	4	21 & 24	1½ x 1½ x ⅛	⅝	9/16	18	½	18	½	12
161 W	11-2	32-8	14	4	21 & 24	1½ x 1½ x ⅛	⅝	⅝	18	9/16	18	9/16	12

The design of the Ceco Steel Joist is that of a Warren truss. All members are new billet hot rolled steel. Joists are assembled by electric arc welding to develop a minimum of three times the designed stress at the joints.

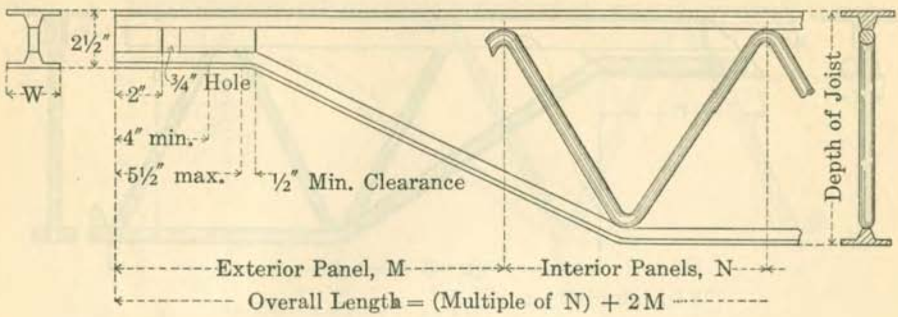
All bottom chord members consist of two round bars; top chords two angles or two round bars; web members one round bar, all of sizes shown. There are as many end and intermediate panels in each joist as are indicated in the table. The remainder of the joist is made of center panels of 12" each in all cases. Bearing plates to be 5/16" thick and vertical end plates to be 2¼" x ¼".

Joists are made in multiples of 6 inches in length. Example: Clear spans over 16'-0" up to 16'-6" the overall length of joist is 17'-2". Clear spans over 16'-6" up to 17'-0" the overall length of joist is 17'-8". Special length can be furnished where necessary.

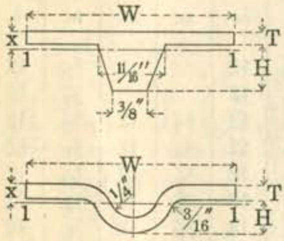
Ceco Steel Joists are made with wood nailer screed on top chord for applying wood floors and roofs.

TRUSCON OPEN WEB STEEL JOISTS

Manufactured by Truscon Steel Company



PROPERTIES OF CHORD SECTIONS



Section Number	Weight per Foot	W	T	H	Area of Section	Axis 1-1 I	Axis 1-1 r	Axis 1-1 x
	Lbs.	In.	In.	In.	In.²	In.⁴	In.	In.
421	1.33	2¼	5/32	11/32	0.39	.0066	.13	.18
422	1.67	2¼	13/64	19/64	0.49	.009	.14	.18
423	1.98	2¼	9/64	½	0.58	.018	.18	.21
424	2.45	2¼	13/64	½	0.72	.025	.19	.22
425	3.03	2½	¼	½	0.89	.031	.19	.23
426	3.48	2½	¼	¾	1.02	.074	.27	.31
427	4.27	2¾	5/16	¾	1.26	.092	.27	.31

Joist Type	Top Chord Section Number	Bottom Chord Section Number	Joist Depth	Web	N	Lengths for Exterior Panels, M, Indicated by Suffix Letters A	B	C	D	E	F
			In.	In.	In.	Ft.-In.	Ft.-In.	Ft.-In.	Ft.-In.	Ft.-In.	Ft.-In.
SJ 81	421	421	8	⅜	9	1– 2½	1– 4	1– 5½			
SJ 82	422	421	8	7/16	9	1– 2½	1– 4	1– 5½			
SJ 102	422	421	10	7/16	11⅛	1– 4⅝	1– 6⅛	1– 7⅝	1– 9⅛		
SJ 103	423	422	10	7/16	11⅛	1– 4⅝	1– 6⅛	1– 7⅝	1– 9⅛		
SJ 104	424	423	10	½	11¼	1– 4¾	1– 6¼	1– 7¾	1– 9¼		
SJ 123	423	422	12	½	13⅝	1– 7⅛	1– 8⅝	1–10⅛	1–11⅝	2–1⅛	
SJ 124	424	423	12	½	13⅝	1– 7⅛	1– 8⅝	1–10⅛	1–11⅝	2–1⅛	
SJ 125	425	424	12	½	13⅝	1– 7⅛	1– 8⅝	1–10⅛	1–11⅝	2–1⅛	
SJ 126	426	425	12	9/16	13⅜	1– 6⅞	1– 8⅜	1– 9⅞	1–11⅜	2–0⅞	
SJ 145	425	424	14	9/16	15¾	1– 9¼	1–10¾	2– 0¼	2– 1¾	2–3¼	2–4¾
SJ 146	426	425	14	9/16	15¾	1– 9¼	1–10¾	2– 0¼	2– 1¾	2–3¼	2–4¾
SJ 147	427	426	14	⅝	15¼	1– 8¾	1–10¼	1–11¾	2– 1¼	2–2¾	
SJ 166	426	425	16	⅝	17⅞	1–11⅜	2– 0⅞	2– 2⅜	2– 3⅞	2–5⅜	2–6⅞
SJ 167	427	426	16	⅝	17⅞	1–11⅜	2– 0⅞	2– 2⅜	2– 3⅞	2–5⅜	2–6⅞

The design of the Truscon Steel Joist is that of a Warren truss. The top and bottom chords consist of hot rolled special tee bars, except for light trusses, having a depth of ten inches or less, where cold rolled sections 421 and 422 are used. Web members are round bars.

Joists are assembled by means of electric forging.

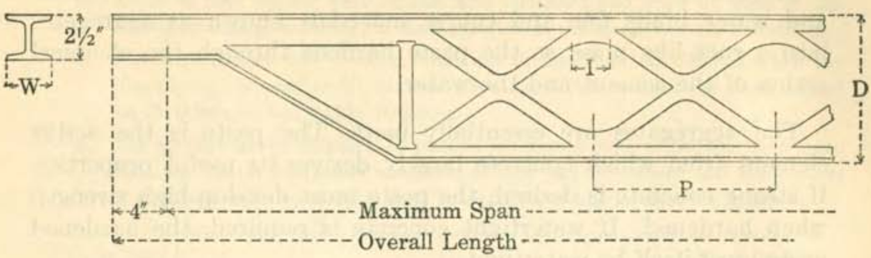
Joist lengths can be made to suit any span with the combinations of panels shown in above table.

The complete designation of a joist is shown by combining the "Joist Type," the number of interior, or N, panels, and the proper suffix letter to indicate length of the exterior panel, M.

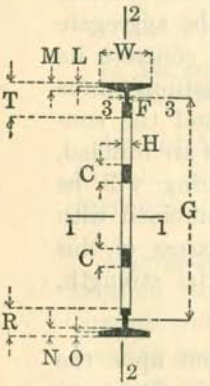
Example: 125-08 C represents a joist, type 125, with 8 interior panels and exterior panels of length, C, making an overall dimension of 12′-9¼″.

BATES-X OPEN WEB STEEL JOISTS

Manufactured by Bates Expanded Steel Corporation



PROPERTIES OF BATES JOISTS



JOIST TYPE	D	Top Chord Area	Top Chord Axis 3-3 S	Top Chord Axis 3-3 r	Bottom Chord Area	Web Area	Web r_{2-2}	Strut Area	Strut r_{2-2}
	In.	In.^{2}	In.^{3}	In.	In.^{2}	In.^{2}	In.	In.^{2}	In.
SJ 82	8	.5053	.105	.448	.443	.16	.072	.3068	.156
SJ 102	10	.5053	.105	.448	.443	.16	.072	.3068	.156
SJ 103	10	.602	.132	.45	.522	.20	.092	.3068	.156
SJ 104	10	.727	.126	.41	.621	.18	.084	.3068	.156
SJ 123	12	.562	.109	.41	.482	.24	.092	.3068	.156
SJ 124	12	.727	.126	.41	.621	.22	.084	.3068	.156
SJ 125	12	.85	.161	.422	.722	.24	.109	.3068	.156
SJ 145	14	.80	.148	.403	.674	.29	.109	.3068	.156
SJ 146	14	1.13	.159	.36	1.05	.29	.098	.3068	.156
SJ 166	16	1.13	.159	.36	1.05	.29	.098	.3068	.156

JOIST TYPE	D	W	G	T	R	C	H	F	L	M	O	N	P	I
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
SJ 82	8	1.50	7.25	1⅜	1⅛	⅝	.25	.15	.15	.206	.15	.206	12⅛	2⅛
SJ 102	10	1.50	9.25	1⅜	1⅛	⅝	.25	.15	.15	.206	.15	.206	17¼	2½
SJ 103	10	1.57	9.17	1⅜	1⅛	⅝	.32	.22	.15	.206	.15	.206	17¼	2½
SJ 104	10	1.83	9.27	1⅜	1⅛	⅝	.29	.23	.20	.266	.17	.236	17¼	2½
SJ 123	12	1.57	11.29	1¼	1	¾	.32	.22	.15	.206	.15	.206	22⅛	2½
SJ 124	12	1.83	11.38	1¼	1	¾	.29	.23	.20	.266	.17	.236	22⅛	2½
SJ 125	12	1.92	11.19	1⅜	1⅛	⅝	.38	.32	.20	.266	.17	.236	22⅛	2½
SJ 145	14	1.92	13.30	1¼	1	¾	.38	.32	.20	.266	.17	.236	25½	2½
SJ 146	14	2.80	13.42	1¼	1	⅞	.33	.33	.19	.396	.19	.396	25½	2½
SJ 166	16	2.80	15.42	1¼	1	⅞	.33	.33	.19	.396	.19	.396	29½	2½

The Bates One-piece Expanded Steel Joist is a continuous double lattice truss formed by slitting the webs of special rolled shapes, heating and expanding to the desired depth.

The ends are formed by bending up the bottom chord. Vertical struts are inserted and the bottom chord is secured to the upper portion of the web to give additional strength to the ends of the joist and so that the lower flange operates as the bearing member.

Its strength is uniform. The process of manufacture automatically tests every joist for any possible defect in either material or workmanship.

Its properties may be determined readily by standard formulae.

CONCRETE AND REINFORCED CONCRETE

CONCRETE is a mixture in which a paste of portland cement and water binds fine and course materials known as aggregates into a rock-like mass as the paste hardens through the chemical action of the cement and the water.

The aggregates are essentially inert. The paste is the active element from which concrete largely derives its useful properties. If strong concrete is desired, the paste must develop high strength when hardened. If watertight concrete is required, the hardened paste must itself be watertight.

When portland cement is mixed with enough water to form a paste, the compounds of the cement react with the water to form new compounds which adhere.to each other and to the aggregate particles to form the binding medium which gives concrete its useful properties. To complete these chemical reactions three things are required: time, favorable temperatures and the continued presence of water. When these three conditions are fulfilled, the concrete will cure properly; otherwise the curing will be deficient. Only a certain amount of water can be combined with the compounds of the cement and any water in excess of this amount dilutes the mixture and reduces its potential strength, watertightness and durability.

Properties of the hardened paste are also dependent upon the characteristics of the cement, the relative proportions of cement and water and the completeness of the chemical combination between the cement and water.

When the aggregates and cement paste are mixed to form concrete, the space between the aggregate particles must be completely filled with the paste. Further, as a practical matter, the paste must be of such consistency that the mixture is plastic and remains homogeneous during transporting, placing and the hardening period.

PORTLAND CEMENT is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

The chemical properties of portland cement should not exceed the following limits:

Loss on ignition	4.00 per cent
Insoluble residue	0.85 per cent
Sulphuric anhydride (SO_3)	2.00 per cent
Magnesia (MgO)	5.00 per cent

Physical properties should conform to the following:

a. The residue on a standard No. 200 sieve shall not exceed 22 per cent by weight.

b. A pat of neat cement shall remain firm and hard and show no signs of distortion, cracking, checking, or disintegration in the steam test for soundness.

c. The cement shall not develop initial set in less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours.

d. The average tensile strength, in pounds per square inch, of not less than three standard mortar briquettes composed of one part of cement and three parts of standard sand, by weight, shall be equal to or higher than the following:

Age at Test, Days	Storage of Briquettes	Tensile Strength Pound Per Square Inch
7	1 day in moist air, 6 days in water...............	275
28	1 day in moist air, 27 days in water................	350

e. The average tensile strength of standard mortar at 28 days shall be higher than the strength at 7 days.

For further requirements see Standard Specifications for Portland Cement, American Society for Testing Materials, C9, and Standard Methods of Testing Cement, A. S. T. M. C77.

Aggregate. Aggregate consists of sand, pebbles, gravel, crushed stone, blast furnace slag, or similar materials. If they contain soft, friable, thin, flaky, elongated or laminated particles totaling more than 3 per cent or contain shale in excess of 1½ per cent or silt and crusher dust finer than the No. 100 standard sieve in excess of 2 per cent, they shall not be used. These percentages shall be based on the weight of the combined aggregate and if all three groups of these deleterious materials are present, their combined amount shall not exceed 5 per cent, by weight, of the total aggregate.

Aggregates shall not contain strong alkali or organic material which gives a color darker than the standard color when tested in accordance with the Standard Method of Test for Organic Impurities in Sands for Concrete, A. S. T. M., C40.

The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms of the member for which the concrete is to be used, nor larger than three-fourths of the minimum clear spacing between reinforcing bars. By maximum size of aggregate is meant the clear space between the sides of the smallest square opening through which 95 per cent by weight of the material can be passed.

Water. Water used in mixing concrete shall be clean and free from strong acids, alkalis, or organic materials.

Metal Reinforcement. Metal reinforcement shall conform to the requirements of the Standard Specifications for Billet-Steel Concrete Reinforcement Bars of Intermediate Grade, A. S. T. M., A 15. The provision in these specifications for machining deformed bars before testing shall be eliminated.

Wire for concrete reinforcement shall conform to the requirements of the Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, A. S. T. M., A 82.

Structural steel shall conform to the requirements of the Standard Specifications for Structural Steel for Buildings, A. S. T. M., A 9.

Cast-iron sections for composite or combination columns shall conform to Standard Specifications for Cast-Iron Pipe and Special Castings, A. S. T. M., A 44.

Water-Cement Ratio. This is the ratio of the total quantity of water in the mixture, including the surface water carried by the aggregate, to the quantity of cement. The ratio is expressed in U. S. gallons, 8⅓ pounds to the gallon, per 94 pound sack of cement.

When no tests of the materials have been made to determine the ratios, they should not exceed those given in Table 1. These values are approximate and may need adjustment for proper workability.

TABLE 1

ASSUMED STRENGTH OF CONCRETE MIXTURES

Ratio of Water-Cement, U. S. Gallons to 94 Pound Sack of Cement	Approximate Mix by Volume of Portland Cement to Total Aggregate, Measured Dry	Assumed Compressive Strength at 28 Days, Pounds per Square Inch
PLASTIC CONCRETE		
8¼	1 : 7	1,500
7½	1 : 6	2,000
6¾	1 : 5¼	2,500
6	1 : 4½	3,000
MODERATELY WET CONCRETE		
8¼	1 : 6½	1,500
7½	1 : 5½	2,000
6¾	1 : 4¾	2,500
6	1 : 4	3,000

NOTE:—In interpreting above table, surface water contained in the aggregate must be included as part of the mixing water in computing the water-cement ratio.

Table 2 gives recommended water-cement ratios for concrete to meet different degrees of exposure.

TABLE 2

These requirements are predicated on the use of concrete mixtures in which the cement meets the present standard specifications of the A. S. T. M. and to which an early curing is given that will be equivalent to that obtained when protected from the loss of moisture for at least ten days at a temperature of 70 deg. F. For less favorable curing conditions, correspondingly lower water-cement ratios should be used. The values are also based on the assumption that the concrete is of such consistency and is so placed that the space between the aggregate particles is completely filled with cement paste of the given water ratio.

Exposure	Reinforced Structures		
	Piles, Thin Walls, Light Structural Members, Exterior Columns and Beams in Buildings	Reservoirs, Water Tanks, Pressure Pipes, Sewers, Canal Linings, Dams of Thin Sections	Heavy Walls, Piers, Foundations, Dams of Heavy Sections
	Water-Cement Ratio, U. S. Gallons per Sack*		
Extreme. In severe climates as in northern U. S. Exposure to alternate wetting and drying, freezing and thawing, as at the water line in hydraulic structures. Exposure to sea and strong sulphate waters in both severe and moderate climates.	5½	5½	6
Severe. In severe climates as in northern U. S. Exposure to rain and snow, and freezing and thawing, but not continuously in contact with water. In moderate climates as in southern U. S. Exposure to alternate wetting and drying, as at water line in hydraulic structures.	6	6	6¾
Moderate. In moderate climates as in southern U. S. Exposure to ordinary weather, but not continuously in contact with water. Concrete completely submerged, but protected from freezing.	6¾	6	7½
Protected. Ordinary enclosed structural members. Concrete below the ground and not subject to action of corrosive groundwaters or freezing and thawing.	7½	6	8¼

*Surface water or moisture carried by the aggregate must be included as part of the mixing water.

To design a concrete mix for any project select the water-cement ratio which will produce concrete of the desired strength and resistance to exposure, and find the most suitable combination of aggregates which will give the necessary workability when combined with cement and water in this ratio.

The design of a concrete mixture involves several steps as follows:

1. Selection of Water-Cement Ratio. Knowing the degree of exposure to which the concrete will be subjected and also the required strength, the amount of mixing water to be used per sack of cement can be selected by reference to Tables 1 and 2.

2. Consistency. The amount of aggregate which can be added to the quantity of mixing water selected per sack of cement is limited by the consistency required for proper placing. A measure of this consistency is the slump test described under Tentative Method of Test for Consistency of Concrete, A. S. T. M., D138-26T. Recommended slumps for different types of structures are as follows:

TABLE 3

RECOMMENDED SLUMPS FOR CONCRETE

Type of Structure	Slump in Inches	
	Minimum	Maximum
Massive sections, pavements and floors laid on ground	1	4
Heavy slabs, beams or walls	3	6
Thin walls and columns, ordinary slabs or beams	4	8

3. Aggregate Proportions. Table 4 indicates the usual limits in the proportions of fine and coarse aggregates for several sizes, using water-cement ratios of $7\frac{1}{2}$ gallons or less per sack of cement, with plastic and workable mixes.

TABLE 4

RECOMMENDED PROPORTIONS OF AGGREGATES

Maximum Size of Coarse Aggregate, Inches	Ratio of fine* to total aggregate on basis of dry, compact volumes, measured separately	
	Minimum	Maximum
$\frac{3}{8}$	0.55	0.70
$\frac{3}{4}$	0.40	0.60
1 and over	0.30	0.50

*The finer the sand, the lower will be the percentage required.

By making a few small trial batches, employing about 1/10 sack of cement, the proper mixture can be determined without difficulty. A given quantity of each aggregate (saturated and surface dried) is measured either by volume or by weight. A paste is then prepared consisting of cement and water in the ratio selected, and the aggregates added to the paste until the batch has stiffened to the desired consistency. Several trial batches should be made to find the combination of materials which will give the best workability and produce an economical yield. Table 5 may be used as a guide in selecting a trial mix.

TABLE 5

TRIAL MIXTURES FOR VARIOUS WATER-CEMENT RATIOS

Water-Cement Ratio, Gallons per Sack	Slump, Inches	Trial Mix, Dry Compact Volumes	
		Maximum Size of Aggregate, 1 Inch	Maximum Size of Aggregate, 2 Inches
5½	½ to 1 3 to 4 5 to 7	1 : 2 : 3 1 : 1¾ : 2½ 1 : 1½ : 2	1 : 2 : 3½ 1 : 1¾ : 3 1 : 1½ : 2½
6	½ to 1 3 to 4 5 to 7	1 : 2¼ : 3¼ 1 : 2 : 3 1 : 1¾ : 2½	1 : 2¼ : 4 1 : 2 : 3½ 1 : 1¾ : 3
6¾	½ to 1 3 to 4 5 to 7	1 : 2½ : 3½ 1 : 2¼ : 3¼ 1 : 2 : 3	1 : 2½ : 4 1 : 2¼ : 3¾ 1 : 2 : 3½
7½	½ to 1 3 to 4 5 to 7	1 : 3 : 4 1 : 2½ : 3¾ 1 : 2¼ : 3½	1 : 3 : 4¾ 1 : 2½ : 4¼ 1 : 2¼ : 3¾

Water-cement ratios indicated include moisture contained in the aggregate.

Proportions are given by volume, aggregate dry and compact. Thus 1:2:3½ indicates 1 volume of cement, 2 volumes of sand and 3½ volumes of coarse aggregate.

If the aggregates are to be measured in the damp and loose condition, they will occupy greater volume than when dry and compact. Amount should be determined by test. Approximate average moisture content for sand, 20 per cent; for coarse aggregate, 6 per cent.

For approximate proportions by weight, add 15 per cent to proportions of aggregate shown in the table.

The mixes are given as a guide only. The first batch should be made with measured water content and the proportions thereafter adjusted to give the desired workability, maintaining the specified water-cement ratio.

4. Determination of Moisture in Aggregates. If the aggregates used in the trial batch were surface-dried, while those used under job conditions contain moisture, then allowance must be made for this factor when adding the mixing water.

An accurate method of finding this is to take the weight of a small measured amount of aggregate, heat the same until the moisture is evaporated, then weigh again; the difference between the two weights is the amount of surface water in the test batch, which amount should be reduced to pounds and then converted to gallons per cubic foot.

If the above method is not used, the approximate quantity of moisture can be estimated from the values given in Table 6.

TABLE 6

APPROXIMATE QUANTITY OF SURFACE WATER CARRIED BY AVERAGE AGGREGATES*

Very wet sand	¾ to 1 gallon per cubic foot
Moderately wet sand	about ½ gallon per cubic foot
Moist sand	about ¼ gallon per cubic foot
Moist gravel or crushed rock	about ¼ gallon per cubic foot

*The coarser the aggregate, the less free water it will carry.

When very dry aggregates are used, allowance may be made for the absorption which takes place in the aggregate during the period of mixing and handling. For this purpose the absorption during a period of 30 minutes may be used. Tests for absorption may be made or, in the absence of tests, average quantities given in Table 7 may be used as a basis.

TABLE 7

APPROXIMATE ABSORPTION OF AGGREGATES

Average sand	1.0 per cent by weight
Pebbles and crushed limestone	1.0 per cent by weight
Trap rock and granite	0.5 per cent by weight
Porous sandstone	7.0 per cent by weight

Very light and porous aggregate may be as high as 25 per cent by weight.

Most aggregates as used on the job are damp and contain more moisture than the equivalent of the absorption. The amount of free moisture is found by substracting the absorption from the total amount of moisture as determined by test. Thus, if moist sand is found to contain 5 pounds of water per cubic foot and has absorption of 1 pound per cubic foot, the effective quantity of water which becomes part of the mixing water is 4 pounds per cubic foot.

5. Determination of Quantity of Mixing Water. The quantity of mixing water to be added for each sack of cement is obtained by subtracting the amount of water carried by the aggregates from the amount required for the selected water-cement ratio, or if aggregates are dry, by adding the amount of water allowed for absorption to that ratio.

Example: By trial the proportion of volumes determined is 1:2 :3 for a water-cement ratio of 6 gallons to the sack of cement. The 5 cubic feet of aggregates (at the job site*) will carry about 1¾ gallons of water (from Table 6); then the amount of mixing water to be added is 6–1¾ or 4¼ gallons.

Example: Use a mix of 1:2:3 and water-cement ratio of 6 gallons. To find the amount of mixing water when dry aggregates are used. If the aggregates weigh 100 pounds per cubic foot, then the water absorbed on the basis of 1 per cent by weight is 100 x 5 x .01 = 5 pounds or ⅝ gallon. This must be added to the required 6 gallons per sack of cement, making a total of 6⅝ gallons of mixing water.

*To allow for bulking or increase in volume due to moisture in the aggregates, see Table 5.

REINFORCED CONCRETE DESIGN

While the design of reinforced concrete structures is based upon the general principles of structural design, the numerous problems involved cannot be discussed in a general outline. For a complete analysis of the stresses occurring in reinforced concrete structures and for other practical considerations, reference should be made to special treatises dealing with the theory and practice pertaining to reinforced concrete structures.

General Assumptions

The design of reinforced concrete members is usually based on the following assumptions:

a. Calculations are made with reference to working stresses and safe loads rather than with reference to ultimate strength and ultimate loads.

b. A plane section before bending remains plane after bending, shearing distortions being neglected.

c. The modulus of elasticity of concrete in compression is constant within the limits of working stresses and the distribution of compressive stresses in beams is rectilinear.

d. The moduli of elasticity of concrete in computations for the position of the neutral axis, for the resisting moment of beams, and for compression of concrete in columns, are as follows:

   (1) $\frac{1}{15}$ that of steel. when the compressive strength of the concrete at 28 days exceeds 1500 and does not exceed 2200 pounds per square inch.

   (2) $\frac{1}{12}$ that of steel, when the compressive strength of the concrete at 28 days exceeds 2200 and does not exceed 2900 pounds per square inch.

   (3) $\frac{1}{10}$ that of steel, when the compressive strength of the concrete at 28 days is greater than 2900 pounds per square inch.

e. In calculating the moment of resistance of reinforced concrete beams and slabs, the tensile resistance of the concrete is neglected.

f. The bond between the concrete and the metal reinforcement remains unbroken throughout the range of working stresses. Under compression the two materials are therefore stressed in proportion of their moduli of elasticity.

g. Initial stress in the reinforcement, due to contraction or expansion of the concrete, is neglected except in the design of reinforced concrete columns.

NOTATION USED IN FORMULAS

Rectangular Beams Reinforced for Tension Only.

A_s = effective cross-sectional area of metal reinforcement in tension in beams or in compression in columns, in square inches.

b = width of rectangular beams, in inches.

d = depth from compression surface of beam or slab to center of longitudinal tension reinforcement, in inches.

E_c = modulus of elasticity of concrete in compression.

E_s = modulus of elasticity of steel in tension or compression = 30,000,000 pounds per square inch.

f_c = unit compressive stress in extreme fiber of concrete, in pounds per square inch.

f'_c = ultimate compressive strength of concrete at age of 28 days, in pounds per square inch.

f_s = unit tensile stress in longitudinal reinforcement, in pounds per square inch.

I = moment of inertia of a section about the neutral axis for bending, in inches^4.

j = ratio of lever arm of resisting couple to depth d.

k = ratio of depth of neutral axis to depth d.

l = span length of beam or slab, in inches. (See paragraph following on Span Length.)

M = bending moment or moment of resistance in general.

n = E_s/E_c = ratio of modulus of elasticity of steel to that of concrete.

p = A_s/bd = ratio of effective area of tension reinforcement to effective area of concrete in beams.

w = uniformly distributed load per unit of length of beam or slab, in pounds.

W = total dead and live load uniformly distributed, in pounds.

z = depth from compression surface of beam or slab to resultant of compressive stresses, in inches.

T-Beams Reinforced for Tension Only.

b = width of flange, in inches.

b′ = width of web or stem, in inches.

t = thickness of flange, in inches.

(Other notation same as that for rectangular beams reinforced for tension only.)

Rectangular Beam Reinforced for Tension and Compression.

A'_s = effective cross-sectional area of compressive reinforcement, in square inches.

C = total compressive stress in concrete, in pounds.

C′ = total stress in compressive reinforcement, in pounds.

d′ = depth from compression surface of beam or slab to center of compression reinforcement, in inches.

f'_s = unit compressive stress in longitudinal reinforcement, in pounds per square inch.

p′ = ratio of effective area of compression reinforcement to effective area of concrete in beams.

z = depth from compression surface of beam or slab to a resultant of compressive stresses, in inches.

Bond and Shear.

α = angle between inclined web bars and axis of beam.

A_v = total area of web reinforcement in tension within a distance of s (measured perpendicular to the direction of the web reinforcement bar), or the total area of all bars bent up in any one plane, in square inches.

f_v = unit tensile stress in web reinforcement, in pounds per square inch.

Σ_0 = sum of perimeters of bars in one set, in inches.

s = spacing of web bars or stirrups measured at the plane of the lower reinforcement and in the direction of the longitudinal axis of the beam, in inches.

T = total tensile stress in web reinforcement, in pounds.

u = bond stress per unit of area of surface of bar, in pounds.

v = unit shearing stress, in pounds per square inch.

v_c = unit shearing stress permitted on the concrete of the web; the value depending on the anchorage of the longitudinal reinforcement, in pounds per square inch.

V = total shear, in pounds.

V′ = total shear producing stress in reinforcement = excess of the total shear over that permitted on the concrete.

Footings.

a = width of face of column or pedestal.

c = projection of footing from face of column or pedestal.

r_a = permissible unit working stress in concrete over the loaded area of a pedestal, pier or footing.

p_a = permissible unit stress on pedestal, pier or footing when the full area is loaded.

p′ = ratio of effective area of compressive reinforcement to effective area of concrete in compression.

A = total area of top of pedestal, pier or footing.

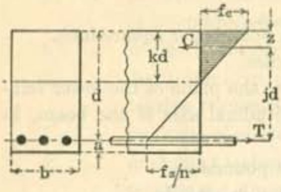
A′ = loaded area of pedestal, pier or footing at the column base.

SPAN LENGTH

The span length, *l*, of freely supported beams and slabs, is generally taken as the distance between centers of the supports, but should not exceed the clear span plus the depth of beam or slab. The span length for continuous or restrained beams, built to act integrally with supports, is taken as the clear distance between faces of supports. Where brackets, having a width not less than the width of the beam and making an angle of 45 degrees or more with the horizontal axis of a restrained beam, are built to act integrally with the beam and support, the span should be measured from the section where the combined depth of the beam and bracket is at least one-third more than the depth of the beam, but no portion of such a bracket shall be considered as adding to the effective depth of the beam. Maximum negative moments are to be considered as existing at the ends of the span, as defined above.

REINFORCED CONCRETE BEAMS—FORMULAS

Rectangular Beams, Reinforced for Tension only.



$$k = \sqrt{2pn + (pn)^2} - pn$$

$$z = \frac{1}{3}kd \qquad j = 1 - \frac{k}{3}$$

$$M = f_s A_s jd = f_s pjbd^2$$

$$M = \frac{1}{2} f_c kjbd^2$$

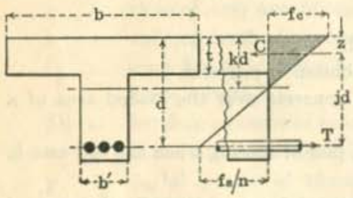
$$f_s = \frac{M}{A_s jd} = \frac{M}{pjbd^2}$$

$$f_c = \frac{2M}{jkbd^2} = \frac{2pf_s}{k}$$

Balanced Reinforcement:

Steel ratio, $p = \dfrac{1}{\dfrac{2f_s}{f_c}\left[\dfrac{f_s}{nf_c} + 1\right]}$ $\qquad bd^2 = \dfrac{M}{f_s pj} = \dfrac{M}{\frac{1}{2}f_c kj}$

Tee Beams, Reinforced for Tension only.



Neutral axis in flange—
(use formulas for rectangular beams)
Neutral axis below the flange, neglecting compression in web.

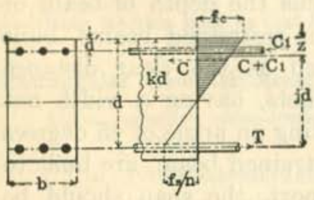
$$kd = \frac{2nd\,A_s + bt^2}{2n\,A_s + 2bt}$$

$$z = \frac{t\,(3kd - 2t)}{3\,(2kd - t)} \qquad jd = (d - z)$$

$$M = f_s A_s jd \qquad f_s = \frac{M}{A_s jd} = \frac{f_c n\,(1 - k)}{k}$$

$$M = \frac{f_c bt\,(kd - \frac{1}{2}t)\,jd}{kd} \qquad f_c = \frac{Mkd}{bt\,(kd - \frac{1}{2}t)\,jd} = \frac{f_s k}{n\,(1 - k)}$$

Rectangular Beams, Reinforced for Tension and Compression.



$$k = \sqrt{2n\,(p + p'\frac{d'}{d}) + n^2\,(p + p')^2} - n\,(p + p')$$

$$z = \frac{\frac{1}{3}k^3 d + 2p'nd'\,(k - \frac{d'}{d})}{k^2 + 2p'n\,(k - \frac{d'}{d})} \qquad jd = (d - z)$$

$$f_s = \frac{M}{pjbd^2} = \frac{nf_c\,(1 - k)}{k}$$

$$f'_s = \frac{nf_c\,(k - \frac{d'}{d})}{k}$$

$$f_c = \frac{6M}{bd^2\left[3k - k^2 + \frac{6p'n}{k}\,(k - \frac{d'}{d})\,(1 - \frac{d'}{d})\right]}$$

Bond and Shear.

Rectangular Beams $\quad v = \dfrac{V}{bjd} \qquad T = \dfrac{V's}{jd} \qquad u = \dfrac{V}{jd\Sigma o}$

T Beams $\quad v = \dfrac{V}{b'jd} \qquad T = \dfrac{V's}{jd} \qquad u = \dfrac{V}{jd\Sigma o}$

CONSTANT VALUES FOR RECTANGULAR BEAMS—BALANCED TENSION REINFORCEMENT

n = 15

f_c	f_s	p	k	j	pj	kj	f_sj In.-Lb.	f_sj Ft.-Lb.	$f_spj=\frac{1}{2}f_ckj$ In.-Lb.	$f_spj=\frac{1}{2}f_ckj$ Ft.-Lb.
600	18000	.00556	.3333	.8889	.00494	.2963	16000	1333.3	88.89	7.407
	20000	.00466	.3103	.8965	.00417	.2782	17930	1494.2	83.47	6.956
650	18000	.00634	.3514	.8829	.00560	.3102	15892	1324.3	100.82	8.401
	20000	.00533	.3277	.8908	.00474	.2919	17815	1484.6	94.88	7.906
700	18000	.00716	.3684	.8772	.00628	.3232	15789	1315.8	113.11	9.426
	20000	.00602	.3443	.8852	.00533	.3048	17705	1475.4	106.67	8.889
750	18000	.00801	.3846	.8718	.00699	.3353	15692	1307.7	125.74	10.478
	20000	.00675	.3600	.8800	.00594	.3168	17600	1466.7	118.80	9.900
800	18000	.00889	.4000	.8667	.00770	.3467	15600	1300.0	138.69	11.558
	20000	.00750	.3750	.8750	.00656	.3281	17500	1458.3	131.25	10.938

Application of Tables. Rectangular beams reinforced for tension:

$M = f_sA_sjd = f_spjbd^2 = \frac{1}{2}f_ckjbd^2 = \frac{1}{2}f_cbd^2(k-\frac{1}{3}k^2)$.

$f_s = M \div A_sjd \qquad f_c = 2pf_s \div k \qquad A_s = M \div f_sjd \qquad d = \sqrt{M \div f_spjb}$

$k = \sqrt{2pn + (pn)^2} - pn \qquad p = k^2 \div 2n(1-k)$.

In above table values are given for k, j, pj, kj, f_sj, and $f_spj = \frac{1}{2}f_ckj$, corresponding to various unit stresses for steel and concrete; while these values are strictly correct only for rectangular beams with balanced reinforcement, they may also be applied for approximate calculations when steel is stressed to full capacity or nearly so, and generally, for preliminary designs, value of $j = \frac{7}{8}$.

In the three examples, the following values are assumed:

$f_s = 18{,}000 \qquad f_c = 800 \qquad n = 15 \qquad M = 480{,}000$ inch-pounds.

EXAMPLE 1. **Balanced reinforcement, concrete and steel stressed to full capacity. From tables for values of 18,000 and 800: $f_spj = 138.69$ $f_sj = 15{,}600$ $p = .00889$.**

$d = \sqrt{M \div f_spjb} = \sqrt{480{,}000 \div 138.69 \times b}$; assuming $b = 12$, then $d = 16.98$ inches.

$A_s = M \div f_sjd = 480{,}000 \div (15{,}600 \times 16.98) = 1.81$ sq. in., or

$A_s = pbd = .00889 \times 12 \times 16.98 = 1.81$ sq. in.

EXAMPLE 2. **Depth, d, reduced, concrete stressed to full capacity and steel understressed. Assuming depth d = 16 inches, then**

$M = \frac{1}{2}f_ckjbd^2 = \frac{1}{2}f_c\,bd^2\,(k - \frac{1}{3}k^2) \qquad M \div \frac{1}{2}f_c\,bd^2 = k - \frac{1}{3}k^2$

$M = 480{,}000 = \frac{1}{2}\,(800 \times 12 \times 16^2)\,(k - \frac{1}{3}k^2) \qquad k - \frac{1}{3}k^2 = .3906$

$k = .4616 \qquad j = (1 - \frac{1}{3}k) = .8461 \qquad jd = 13.538$ inches

$p = k^2 \div 2n\,(1-k) = .4616^2 \div [2 \times 15\,(1 - .4616)] = .0132$

$A_s = pbd = .0132 \times 12 \times 16 = 2.534$ sq. in.

$f_s = M \div A_sjd = 13{,}992$ lbs. per sq. in. $\qquad f_c = 2\,pf_s \div k = 800$ lb. per sq. in.

EXAMPLE 3. **Depth, d, increased, steel stressed to full capacity and concrete understressed. Assuming depth, d = 18 inches and value of $f_sj = 15{,}600$, approximately:**

$A_s = M \div f_sjd = 480{,}000 \div (15{,}600 \times 18) = 1.709$ sq. in.

$p = A_s \div bd = 1.709 \div (12 \times 18) = .00791$

$k = \sqrt{2\,pn + (pn)^2} - pn = .3827 \qquad j = (1 - \frac{1}{3}k) = .8724 \qquad jd = 15.703$ inches.

$f_s = M \div A_sjd = 17{,}886$ lbs. per sq. in. $\qquad f_c = 2pf_s \div k = 744$ lbs. per sq. in.

DEPTH OF BEAM OR SLAB

The depth of the beam or slab should be taken as the distance from the center line of the tensile reinforcement to the top surface of the structural slab. Any floor finish not placed monolithic with the floor slab should not be included as a part of the structural member. When the finish is placed monolithic with the structural slab in buildings of the warehouse or industrial class where the finish is subjected to unusual wear from trucking or other causes, there should be placed an additional depth of ½ inch over that used in the design of the member.

POINT OF INFLECTION

For the purpose of these regulations, the point of inflection in beams and slabs of equal spans symmetrically loaded should be assumed to be located at the fifth point of the span as defined under "Span Length."

DISTANCE BETWEEN LATERAL SUPPORTS

The clear distance between lateral supports of a beam should not exceed 32 times the least width of compression flange.

REQUIREMENTS FOR T-BEAMS

1. In T-beam construction the slab should be built integrally with the beam. The effective flange width to be used in the design of symmetrical T-beams should not exceed one-fourth of the span length of the beam, and its overhanging width on either side of the web should not exceed eight times the thickness of the slab nor one-half the clear distance to the next beam.

2. For beams having a flange on one side only, the effective overhanging flange width should not exceed one-twelfth of the span length of the beam, nor six times the thickness of the slab, nor one-half the clear distance to the next beam.

3. Where the principal reinforcement in a slab which is considered as the flange of a T-beam (not a rib in ribbed floors) is parallel to the beam, transverse reinforcement should be provided in the top of the slab. This reinforcement should be designed to carry the load on the portion of the slab assumed as the flange of the T-beam. The spacing of the bars should not exceed five times the thickness of the flange, or in any case 18 inches.

4. Provision should be made for the compressive stress at the support in continuous T-beam construction, care being taken to

observe proper spacing of bars. In no case should the area of steel in compression at any cross-section adjacent to the support exceed 2 per cent of the cross-sectional area of the stem of the beam in that section.

5. The overhanging portion of the flange of the beam should not be considered as effective in computing the shear and diagonal tension resistance of T-beams.

6. Isolated beams in which the T-form is used only for purpose of providing additional compression area, should have a flange thickness not less than one-half the width of the web and a total flange width not more than four times the web thickness.

PLACING REINFORCEMENT

The minimum center to center distance between parallel bars should be 2½ times the diameter for round bars or 3 times the side dimension for square bars. If the ends of bars are especially anchored, the center to center spacing may be made equal to 2 diameters for round bars or to 2½ times the side dimension for square bars, but in no case should the clear spacing between bars be less than 1 inch nor less than 1⅓ times the maximum size of the coarse aggregate. Bars at the upper face of any member shall be embedded a clear distance of not less than one diameter nor less than 1 inch.

PROTECTIVE COVERING OF CONCRETE FOR REINFORCEMENT

1. At those surfaces of footings and other principal structural members in which the concrete is deposited directly against the ground, metal reinforcement should have a minimum covering of 3 inches of concrete. At other surfaces of concrete exposed to the ground or weather, metal reinforcement should be protected by not less than 2 inches of concrete.

2. In fire-resistive construction, metal reinforcement should be protected by not less than 1 inch of concrete in slabs and walls, and not less than 1½ inches in beams, girders, and columns, provided coarse aggregate is used, which is free from disruptive action under high temperatures, as, for example, limestone or trap rock. When impracticable to obtain aggregate of this grade, the protective covering should be ½ inch thicker and should be reinforced with metal mesh having openings not exceeding 3 inches placed 1 inch from the finished surface. In similar structures where the fire hazard is limited, the metal reinforcement should not be placed nearer the exposed surface than ¾ inch in slabs and walls, or 1 inch in beams, girders, and columns.

3. Cement or gypsum plaster, ¾ inch or more in thickness (on metal lath weighing not less than 2½ pounds per square yard when used vertically, nor less than 3 pounds per square yard when used horizontally), may be substituted for a part of the protective covering of concrete, provided that only two-thirds of the thickness of the plaster be considered effective. The concrete protection should in no case be reduced to less than ¾ inch.

BENDING MOMENTS

1. Beams and slabs of equal spans freely supported or built to act integrally with beams, girders, or other slightly restraining supports and carrying uniformly distributed loads, shall be designed for the following moments at critical sections:

(a) Beams and slabs of one span:

(1) Maximum positive moment near center, $M = \frac{wl^2}{8}$.

(b) Beams and slabs continuous for two spans only:

(1) Maximum positive moment near center, $M = \frac{wl^2}{10}$.

(2) Negative moment over interior support, $M = \frac{wl^2}{8}$.

(c) Beams and slabs continuous for more than two spans:

(1) Maximum positive moment near center and negative moment at support of interior spans, $M = \frac{wl^2}{12}$.

(2) Maximum positive moment near centers of end spans and negative moment at first interior support, $M = \frac{wl^2}{10}$.

(d) Negative moment at end supports for cases, (a), (b), (c), $M = \text{not less than } \frac{wl^2}{16}$.

2. Beams and slabs, built into brick or masonry walls in a manner which develops partial end restraint, shall be designed for a negative moment at the support of

$$M = \text{not less than } \frac{wl^2}{16}.$$

3. Beams and slabs of equal spans freely supported and assumed to carry uniformly distributed loads, shall be designed for the moments specified in paragraph 1, except that no reinforcement for negative moment need be provided at end supports where effective measures are taken to prevent end restraint.

4. Beams and slabs of equal span built to act integrally with columns, walls, or other restraining supports and assumed to carry uniformly distributed loads, shall (except as provided in paragraph (1) be designed for the following moments at critical sections:

(a) Interior spans:

(1) Negative moment at interior supports except the first, $M = \frac{wl^2}{12}$.

(2) Maximum positive moment near centers of interior spans, $M = \frac{wl^2}{16}$.

(b) End spans of continuous beams and beams of one span in which I/l is less than twice the sum of the values of I/h* for the exterior columns, above and below, which are built into the beams:

(1) Maximum positive moment near center of span and negative moment at first interior supports, $M = \frac{wl^2}{12}$.

(2) Negative moment at exterior supports, $M = \frac{wl^2}{12}$.

(c) End spans of continuous beams, and beams of one span, in which I/l is equal to or greater than twice the sum of the values of I/h for the exterior columns, above and below, which are built into the beams:

(1) Maximum positive moment near center of span and negative moment at first interior support, $M = \frac{wl^2}{10}$.

(2) Negative moment at exterior support, $M = \frac{wl^2}{16}$.

5. Continuous beams with unequal spans, or with other than uniformly distributed loading, whether freely supported or restrained, shall be designed for the actual moments under the conditions of loading and restraint.

Provision shall be made where necessary for negative moment near the center of short spans which are adjacent to long spans, and for the negative moment at the end supports, if restrained.

*h = unsupported length of column.

SHEAR AND DIAGONAL TENSION

A beam transversely loaded is subjected to an external shearing force producing secondary stresses, principally due to horizontal shear which may cause failure by tension along diagonal planes on account of the low resistance of concrete to tensile stresses.

1. The unit shearing stress, v, in reinforced concrete beams may be computed by the formula

$$v = \frac{V}{bjd} = \frac{8\,V}{7\,bd}.$$

When the value of the unit shearing stress computed by this formula exceeds the unit shearing stress, v_c, permitted on the concrete of the web, web reinforcement should be provided to carry the excess. For beams of I or T section, b′ should be substituted for b in this formula. In tile and joist construction, b may be taken as a width equal to the thickness of the concrete web plus the thickness of the vertical webs of the concrete or clay tile in contact with the joist.

2. Web reinforcement may consist of:
   a. Vertical stirrups or web reinforcing bars.
   b. Inclined stirrups or web reinforcing bars forming an angle of 30 degrees or more with the axis of the beam.
   c. Longitudinal bars bent up at an angle of 15 degrees or more with the axis of the beam.

Stirrups or bent up bars, to be considered effective as web reinforcement, should be anchored at both ends.

3. The area of steel required in stirrup should be computed by the formula $A_v = \frac{V'_s}{14{,}000d}$.

Where the shearing stress is not greater than $0.06f'_c$ the distance s between two successive stirrups measured perpendicular to the direction of the stirrup should not exceed $\frac{3}{4}$ d, and where unit shearing stress exceeds $0.06f'_c$, the distance should not be greater than $\frac{3}{8}$ d.

4. Where there is a series of parallel bent-up bars at varying distances from the support, they should be considered as inclined stirrups and the area required determined from the formula given in paragraph 3. Where bent-up bars in a single plane are used for web reinforcement, the required area of the bar should be computed by the formula $A_v = \frac{V'}{16{,}000 \sin \alpha}$.

V′ should not exceed $0.035f'_c$ bd and α should not be less than 15 degrees. Only the center three-fourths of the inclined portion of such bar or group of bars should be considered effective in resisting shear. Between the face of the support and the area reinforced by the bent-up bar, other web reinforcement should be provided, except that when the distance is less than ½d and the beam is designed for uniform load only, such additional reinforcement need not be provided.

5. Where two or more types of web reinforcement are used in conjunction, the total shearing resistance of the beam should be assumed as the sum of the shearing resistances computed for the various types separately. In such computations the shearing resistance of the concrete should be included only once.

BOND AND ANCHORAGE

1. Where bar reinforcement is used to resist tensile stresses developed by beam action, the bond stress should be taken as not less than that computed by the formula

$$u = \frac{V}{\Sigma o j d} = \frac{8\,V}{7\,\Sigma o d}.$$

For continuous or restrained members, the critical section for bond for the positive reinforcement should be assumed to be at the point of inflection, that for the negative reinforcement should be assumed to be at the face of the support, and at the point of inflection. For simple beams, or at the outer ends of freely supported end spans of continuous beams, the critical section for bond should be assumed to be at the face of the support.

Bent-up longitudinal bars which, at the critical section, are within a distance ⅓ d from horizontal reinforcement under consideration may be included with the straight bars in computing Σo.

2. Tensile negative reinforcement in any span of a continuous, restrained, or cantilever beam, or in any member of a rigid frame, should have a length of anchorage beyond the face of the supporting member sufficient to develop the full maximum tension at an average bond stress not greater than $0.04f'_c$, for plain bars, or $0.05f'_c$ for deformed bars. Within any such span, not less than one-third of the negative reinforcements should extend along the tension side of the beam at least to or beyond the point of inflection, and any bars not so extended should be bent down at an angle of not more than 45 degrees with the axis of the member and made continuous with the positive reinforcement or anchored in a region of compression.

Of the positive reinforcement in continuous beams, not less than one-fourth the area should extend at the same face of the beam into the support to provide an embedment of ten or more bar diameters beyond the face of the support.

For non-continuous beams not less than one-half the area of positive reinforcement should extend at the same face of the beam into the support to provide an embedment of ten or more bar diameters.

3. Web bars should be anchored at both ends by one of the following methods:

a. Providing continuity with the longitudinal reinforcement.

b. Bending around the longitudinal bar.

c. A semi-circular hook which has a radius not less than four times the diameter of the web bar.

Stirrup anchorage should be so provided in the compression and tension regions of a beam as to permit the development of safe working tensile stress in the stirrup at a point 0.3d from either face. Generally a properly anchored stirrup whose diameter does not exceed 1/50 of the depth of the beam will meet these requirements.

The end anchorage of a web member not in bearing on the longitudinal reinforcement should be such as to engage an amount of concrete sufficient to prevent the bar from pulling out. In all cases the stirrup should be carried as close to the upper and lower surfaces as fireproofing requirements permit.

SHRINKAGE AND TEMPERATURE REINFORCEMENT

Reinforcement for shrinkage and temperature stresses normal to the principal reinforcement should be provided in floor and roof slabs where the principal reinforcement extends in one direction only. Such reinforcement should provide for the following minimum ratios of reinforcement area to concrete area, but in no case should such reinforcing bars be placed farther apart than five times the slab thickness nor more than 18 inches:

Floor slabs where plain bars are used	0.0025
Floor slabs where deformed bars are used	0.002
Floor slabs where wire fabric is used, having welded intersections not farther apart in the direction of stress than 12 inches	0.0018
Roof slabs where plain bars are used	0.003
Roof slabs where deformed bars are used	0.0025
Roof slabs where wire fabric is used, having welded intersections not farther apart in the direction of stress than 12 inches	0.0022

FLOOR SLABS

Reinforcement may be of small rods, wires or metal fabric, the latter especially on short spans. Cross reinforcement of small rods or wires about 2 feet apart laid parallel to the beam supporting the slab should be used to prevent cracks, shrinkage, etc. If the length of the slab exceeds $1\frac{1}{2}$ times its width, the entire load should be carried by transverse reinforcement. For rectangular slabs, the length of which does not exceed $1\frac{1}{2}$ times the width and which are supported on four sides and reinforced in both directions, the proportion of the load assumed to be supported in the short direction is determined by the formula: $R = (l \div b) - 0.5$, where R is the ratio of the load, l the length and b the width of the slab. The remainder of the load is assumed to be supported by the slab in the long direction. An effective bond should be provided at the junction of beam and slab, and if the principal reinforcement of the slab is parallel to the beam, transverse reinforcement, extending over the beam and well into the slab, should be used.

COLUMNS

1. Unless designed as long columns (see paragraph 6), reinforced concrete columns should not be longer than eleven times the least lateral dimension. Principal columns in buildings should have a minimum diameter or thickness of 12 inches. Posts that are not continuous from story to story shall have a minimum diameter or thickness of 6 inches.

2. The unsupported length of reinforced concrete columns should be taken as:

a. In flat-slab construction, the clear distance between the floor and under side of the capital.

b. In beam-and slab construction, the clear distance between the floor and the under side of the shallowest beam framing into the column at the next higher floor level.

c. In floor construction with beams in one direction only, the clear distance between floor slabs.

d. In columns supported laterally by struts or beams only, the clear distance between consecutive pairs (or groups) of struts or beams, provided that, to be considered an adequate support, two such struts or beams shall meet the column at approximately the same level, and the angle between the two planes formed by the axis of the column and the axis of each strut respectively is not less than 75 degrees nor more than 105 degrees.

When reinforced concrete brackets are used at the junction of beams or struts with columns, the clear distance between supports may be considered as reduced by the depth of the bracket, provided the width of the bracket is at least equal to that of the beam and not less than one-half that of the column.

3. The permissible axial load on columns, reinforced with longitudinal bars and closely spaced spirals enclosing a circular core, should not be greater than that determined by the formula

$$P = A_c\,[1 + (n - 1)\,p]\,f_c$$

in which A_c is the area within the outer circumference of the spiral hooping and the values of f_c are as given in Table 8, or as may be found for intermediate values of p by interpolation or, in general, by the formula

$$f_c = [300 + (0.10 + 4p)\,f'_c].$$

The longitudinal reinforcement should consist of at least six bars of minimum diameter of ½ inch and of an effective cross-sectional area not less than 0.01, nor more than 0.06 of that of the core. The number of longitudinal bars concentrated in the ring at the periphery of the core should be governed by the spacing requirements. If all the bars cannot be placed at the periphery of the core, the bars within shall be stayed at intervals of 24 inches and shall not be nearer to the outer ring than 0.2 of the core diameter. When the ratio of reinforcement in a spirally reinforced column is greater than 0.04, special placing drawings illustrating the proper distribution of steel should be submitted with the detail plans. Splices in longitudinal reinforcement should provide a lap of at least 24 bar diameters for deformed bars, and 30 diameters for plain bars.

The ratio of the spiral reinforcement should be not less than one-fourth the ratio of the longitudinal reinforcement. Spiral reinforcement should consist of evenly spaced continuous spirals held firmly in place and true to line by at least three vertical spacer bars. At the ends of all spirals and at points of splice, the outside diameter should be maintained. The spacing of the spirals should not be greater than one-sixth of the diameter of the core and in no case more than 3 inches.

Reinforcement should be protected everywhere by a covering of concrete cast monolithic with the core and having a minimum thickness of 1½ inches.

4. The permissible axial load on columns reinforced with longitudinal bars and separate lateral ties should not be greater than that determined by formula

$$P = 0.225f'_c\,A_g\,[1 + (n - 1)\,p],$$

where A_g = gross area of tied columns with lateral ties.

The ratio of longitudinal reinforcement should not be less than 0.005 nor should the ratio considered in the calculations be more than 0.02 of the total area of the column. The longitudinal reinforcement should consist of not less than four bars of minimum diameter of ⅝ inch placed with clear distance from the face of the column not less than 2 inches nor more than 3 inches. Splices in longitudinal reinforcement should provide a lap of at least 24 bar diameters for deformed bars, and 30 diameters for plain bars.

Lateral ties should be at least ¼ inch in diameter spaced not more than 12 inches apart. In columns of rectangular section, cross ties should be arranged to afford support to the vertical bars at intervals not greater than the shorter side of the section, but such intervals need not be less than 12 inches in any case.

5. The bending moments in interior and exterior columns should be determined on the basis of loading conditions and end restraint, and should be provided for in the design.

In flat-slab construction, the least dimension of the column should be not less than one-fifteenth of the average center to center span, nor less than 16 inches. For known eccentric loads or unequal spacing of columns, computations of moments should be made accordingly. Wall columns in flat-slab construction should be designed to resist a bending moment of $Wl/35$. Any counter moment due to the weight of the structure that projects beyond the column center line may be deducted from the moment computed as just described. Resistance to the bending moments should be divided between the columns immediately above and below in direct proportion to the values of their ratios of I/h.

The recognized methods should be followed in calculating the stresses due to combined axial load and bending. The column section should not be less than that required where axial load alone is considered. The limiting combined unit stresses should be as follows:

a. Columns with spiral reinforcement,
   $[300 + (0.10 + 4p)\,f'_c] + 0.15f'_c$.

b. Columns with lateral ties, $0.3f'_c$. The total amount of reinforcement considered in the computations should not be more than 4 per cent of the total area of the column.

c. Tension in longitudinal reinforcement due to bending on the column should not exceed 16,000 pounds per square inch.

Where the allowable unit stress in columns is increased (to provide for combined axial load and bending) and wind loads are also added, the total should still be within the allowable values for wind loads.

6. The permissible working load on the core in axially loaded spiral or composite columns, which have a length greater than 50 times the least radius of gyration of the column core (50r), should not be greater than that determined by the formula

$$\frac{P'}{P} = 1.50 - \frac{h}{100\,r}.$$

The permissible working load on axially-loaded tied columns, which have a length greater than 40 times the least radius of gyration of the column section (40r), shall not be greater than that determined by the formula

$$\frac{P'}{P} = 1.33 - \frac{h}{120\,r}.$$

The radius of gyration of a column should be computed from the concrete area used in design and the transformed section of the longitudinal steel area; that is, n times the actual area of steel.

P = total safe axial load on column whose length does not exceed 11 times its least cross-sectional dimension.
P′ = total safe axial load on long column.
h = unsupported length of column.
r = least radius of gyration of a section.

FOOTINGS

Loads. Footings resting directly on soil or on piles shall be proportioned as to area or number of piles on the basis of the total column load plus the weight of the footing. For computations of moments and shears, an upward reaction per unit area or per pile shall be based on the total column load (not including the weight of the footing) divided by the area or by the number of piles.

Sloped or Stepped Footings. Footings in which the thickness has been determined by the requirements for shear, may be sloped or stepped between the critical section and the edge of the footing, provided that the shear on no section outside the critical section exceeds the value specified, and provided also that the thickness of the footing above the reinforcement at the edge shall not be less than 6 inches for footings on soil, nor less than 12 inches for footings on piles. These footings shall be cast as a unit.

Bending in Footings. The critical section for bending when footing supports a concrete column or pedestal, is at the face of column or pedestal. Where steel or cast-iron column bases are used, the moment in the footing is computed at the middle and at the edge of the base; the load is considered as uniformly distributed over the column or pedestal base.

The bending moment at the critical section in a square footing supporting a concentric square column, is computed from the load on the trapezoid bounded by one face of the column, the corresponding outside edge of the footing, and the portions of the two diagonals. The load on the two corner triangles of this trapezoid is considered as applied at a distance from the face equal to six-tenths of the projection of the footing from the face of the column. The load on the rectangular portion of the trapezoid is considered as applied at its center of gravity. The bending moment is expressed by the formula

$$M = \frac{w}{2}\,(a + 1.2c)\,c^2$$

For a round or octagonal column, the distance a shall be taken as equal to the side of a square of an area equal to the area enclosed within the perimeter of the column.

Transfer of Stress at Base of Column. The compressive stress in longitudinal reinforcement at the base of a column shall be transferred to the pedestal or footing by dowels. There shall be at least one dowel for each column bar, and the total sectional area of the dowels shall not be less than the sectional area of the longitudinal reinforcement in the column. The dowels shall extend into the column and into the pedestal or footing not less than 30 diameters of the dowel bars for plain bars, or 24 diameters for deformed bars.

The permissible compressive unit stress on top of the pedestal or footing directly under the column shall not be greater than that determined by formula

$$r_a = p_a \sqrt[3]{\frac{A}{A'}}$$

The value of p_a shall not exceed 0.25 f'_c for plain concrete. When lateral reinforcement in the form of spiral or hoops is provided, the value of p_a for the area within the spiral may be increased $(1 + 2.5np')$ times that for plain concrete, but no area outside the outer face of the spiral shall be considered. Where piers are designed as columns, the value of p_a shall be computed by the proper column design formula.

The total load computed by above formula shall not be taken as greater than the load computed, using a stress equal to p_a, on the gross area of the pedestal, pier, or footing at a point below special reinforcing provided at the top.

Where the loaded area is not central on the top of the pedestal pier, or footing, the total area A shall not be taken as greater than the area of the largest circle that can be drawn about the load as a center and lying entirely within the top of the pedestal, pier, or footing.

Where lateral reinforcement is provided to increase the value of p_a, it shall extend to within 3 inches of the top of the pedestal, pier, or footing and to a depth equal to the diameter of the spiral, and the loaded area shall lie at the center of the spiral or hoops. The pitch of the spiral or the spacing of the hoops, in the clear, shall not be less than 2 inches, nor more than 5 inches. The designed pitch shall be maintained by at least four spacers securely fastened to each spiral turn or hoop. The ratio of lateral reinforcement shall not exceed 0.015.

In sloped or stepped footings, A may be the area of the top horizontal surface of the footing or the area of the lower base of the largest frustum of a pyramid or cone contained wholly within the footing, having for its upper base the loaded area A′, with side slopes of 1 vertical to 2 horizontal.

Pedestals without Reinforcement. The allowable compressive unit stress on the gross area of a concentrically loaded pedestal or on the minimum area of a pedestal footing shall not exceed $0.25f'_c$, unless reinforcement is provided and the member designed as a reinforced-concrete column.

The depth of a pedestal or pedestal footing shall not be greater than three times its least width and the projection on any side from the face of the supported member shall not be greater than one-half the depth. The depth of a pedestal whose sides are sloped or stepped shall not exceed three times the least width or diameter of the section midway between the top and bottom. A pedestal footing supported directly on piles shall have a mat of reinforcing bars having a cross-sectional area of not less than 0.20 square inches per foot in each direction, placed 3 inches above the top of the piles.

Explanation of Tables. Reinforced Concrete Slabs: The tables on page 414 are based upon the preceding formulas for rectangular beams reinforced for tension only. The unit stresses in pounds per square inch are 800 for concrete, 18,000 for steel bar reinforcement (see upper table) and 20,000 for steel wire reinforcement (see lower table). The elasticity ratio, $n = 15$.

The first column gives the total thickness of slab, the second, the distance from the center of the steel to the top of slab, and the third, the approximate weight of slabs one foot square.

EXAMPLE: Find the reinforcement for a slab 5 inches thick continuous at both ends to carry a superimposed load of 150 pounds per square foot over a clear span of 8 feet.

From the table, the weight of a 5-inch slab is found to be 62.5 pounds per square foot and the total weight, W, for a span of 8 feet is $(62.5 + 150) \times 8 = 1{,}700$ pounds.

$$M = WL \div 12 = (1{,}700 \times 8) \div 12 = 1{,}133 \text{ foot-pounds.}$$

For medium structural steel bars, the required area, from upper table, page 414 is, by interpolation, 0.21 square inches; the sizes may be taken from page 116.

For triangle mesh, the steel area required by lower table, page 414, is, by interpolation, 0.188 square inches, requiring by table, page 415, triangle mesh style number 208.

WORKING STRESSES—TABLE 8

The allowable unit stresses in concrete in pounds per square inch on the concrete to be used in the design shall not exceed the following values, where f'_c equals the minimum ultimate strength at 28 days.

DESCRIPTION	ALLOWABLE UNIT STRESSES: For any Strength of Concrete as Fixed by Test (Water-Cement Ratio) $n = \frac{30,000}{f'_c}$	When Strength of Concrete is Fixed by the Water-Cement Ratio Method: $f'_c = 2,000$ lbs. $n = 15$	$f'_c = 2,500$ lbs. $n = 12$	$f'_c = 3,000$ lbs. $n = 10$
Flexure, f_c:				
Extreme unit stress in compression, f_c	$0.40f'_c$	800	1000	1200
Extreme unit stress in compression adjacent to supports of continuous or fixed beams or of rigid frames, f_c	$0.45f'_c$	900	1125	1350
Shear, v:				
Beams with no web reinforcement and without special anchorage of longitudinal steel, v_c	$0.02f'_c$	40	50	60
Beams with no web reinforcement, but with special anchorage of longitudinal steel, v_c	$0.03f'_c$	60	75	90
Beams with properly designed web reinforcement, but without special anchorage of longitudinal steel, v	$0.06f'_c$	120	150	180
Beams with properly designed web reinforcement and with special anchorage of longitudinal steel, v	$0.09f'_c$	180	225	270
Flat slabs at distance d from edge of column cap or drop panel, v_c	$0.03f'_c$	60	75	90
Footings where longitudinal bars have no special anchorage, v_c	$0.02f'_c$	40	50	60
Footings where longitudinal bars have special anchorage, v_c	$0.03f'_c$	60	75	90
Bond, u:				
In beams and slabs and one-way footings:				
Plain bars, u	$0.04f'_c$	80	100	120
Deformed bars, u	$0.05f'_c$	100	125	150
In two-way footings:				
Plain bars, u	$0.03f'_c$	60	75	90
Deformed bars, u	$0.0375f'_c$	75	94	112
(Where special anchorage is provided these values in bond may be increased.)				
Bearing, f_c:				
Where a concrete member has an area at least twice the area in bearing, f_c	$0.25f'_c$	500	625	750
Axial Compression, f_c:				
In columns with lateral ties, f_c	$0.225f'_c$	450	563	675
*In columns with continuous spirals enclosing a circular core.				
Ratio of longitudinal reinforcement, p = 0.01	$300 + 0.14f'_c$	580	650	720
0.02	$300 + 0.18f'_c$	660	750	840
0.03	$300 + 0.22f'_c$	740	850	960
0.04	$300 + 0.26f'_c$	820	950	1080
0.05	$300 + 0.30f'_c$	900	1050	1200
0.06	$300 + 0.34f'_c$	980	1150	1320

*Unit stress in spirally reinforced columns $= 300 + (0.10 + 4p) f'_c$.

Spiral reinforcement should not be less than one-fourth the longitudinal.

The following allowable unit stresses in reinforcing steel should not be exceeded:

Tension:

Intermediate grade billet steel, f_s .... = 20,000 pounds per square inch
Rail steel bars, f_s .... = 20,000 pounds per square inch
Web reinforcement, f_v .... = 16,000 pounds per square inch
Structural steel shapes, f_s .... = 18,000 pounds per square inch
Other steel reinforcement 50 per cent of the yield point stress, but not to exceed, f_s .... = 20,000 pounds per square inch

Compression:

Bars .... $= nf_c$
Structural Steel section in composite columns ..... = 15,000 pounds per square inch
Cast Iron section in composite columns .... = 9,000 pounds per square inch

REINFORCED CONCRETE SLABS

Bending Moments in Foot-Pounds per Foot of Width

Allowable Unit Stress: Steel, 18,000 and Concrete 800 Pounds per Sq. Inch. n = 15

Slab			STEEL BAR REINFORCEMENT												
			Area of Steel Reinforcement in Square Inches per Foot of Width												
Thickness, In.	Effective Depth, d, In.	Weight, Lbs. per Sq. Ft.	.10	.20	.30	.40	.50	.60	.70	.80	.90	1.00	1.10	1.25	1.50
2½	1¾	31.25	230	434											
3	2¼	37.50	306	591	752										
3½	2¾	43.75	377	730	1056										
4	3¼	50.00	448	870	1278	1531									
4½	3¾	56.25	520	1011	1486	1950									
5	4	62.50	556	1081	1590	2088	2331								
5½	4½	68.75	628	1223	1800	2364	2844								
6	5	75.00	700	1365	2010	2642	3262	3597							
6½	5½	81.25	772	1507	2222	2921	3607	4225							
7	6	87.50	845	1650	2433	3200	3954	4697	5134						
7½	6¼	93.75	881	1722	2539	3340	4128	4904	5501						
8	6¾	100.00	.....	1865	2747	3621	4476	5319	6152	6530	6769	6983			
8½	7¼	106.25	.....	2008	2952	3903	4825	5736	6635	7367	7641	7888			
9	7½	112.50	.....	2080	3071	4043	5003	5943	6876	7799	8093	8356			
9½	8	118.75	.....	2223	3285	4326	5350	6362	7362	8350	9025	9324			
10	8½	125.00	.....	2368	3496	4609	5702	6780	7847	8903	9950	10331			
10½	8¾	131.25	.....	.....	3605	4751	5877	6990	8091	9179	10258	10850	11173	11610	12234
11	9¼	137.50	.....	.....	3820	5034	6230	7410	8577	9733	10879	11915	12276	12762	13460
11½	9¾	143.75	.....	.....	4034	5318	6583	7831	9066	10289	11505	12704	13417	13956	14730
12	10	150.00	.....	.....	4142	5459	6759	8042	9310	10567	11812	13048	14002	14569	15382

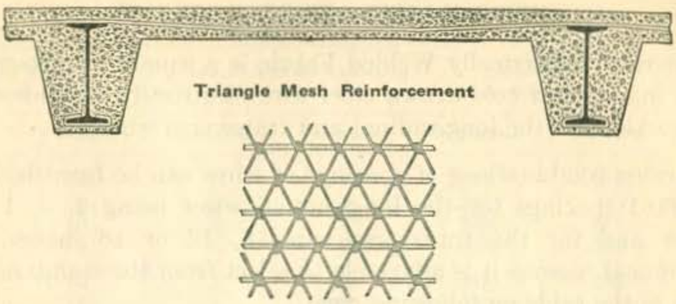
Allowable Unit Stress: Steel, 20,000 and Concrete 800 Pounds per Sq. Inch. n = 15

Slab			TRIANGLE MESH REINFORCEMENT														
			Area of Steel Reinforcement in Square Inches per Foot of Width														
Thickness, In.	Effective Depth, d, In.	Weight, Lbs. per Sq. Ft.	.04	.06	.08	.10	.12	.14	.16	.18	.20	.25	.30	.35	.40	.45	.50
2½	1¾	31.25	108	160	211	261	311	360	404	420	434	464					
3	2¼	37.50	140	208	274	340	404	468	532	594	657	711	752				
3½	2¾	43.75	173	256	338	419	499	578	656	734	811	996	1056	1108			
4	3¼	50.00	205	304	402	498	593	688	782	874	967	1200	1398	1469	1531		
4½	3¾	56.25	237	352	466	578	689	798	908	1016	1123	1389	1651	1882	1950	2023	
5	4	62.50	....	377	498	618	736	854	971	1086	1202	1486	1767	2045	2173	2256	2331
5½	4½	68.75	....	425	562	698	832	965	1097	1228	1359	1682	2000	2315	2627	2751	2844
6	5	75.00	....	....	626	778	928	1076	1224	1371	1516	1878	2234	2586	2935	3281	3396
6½	5½	81.25	....	....	691	858	1024	1188	1351	1513	1675	2074	2468	2858	3245	3628	3984
7	6	87.50	....	....	....	939	1120	1300	1479	1657	1833	2271	2704	3131	3556	3976	4393
7½	6¼	93.75	....	....	....	979	1168	1356	1543	1728	1913	2369	2821	3269	3711	4150	4587
8	6¾	100.00	....	....	....	....	1264	1468	1670	1872	2072	2567	3058	3542	4023	4500	4973
8½	7¼	106.25	....	....	....	....	1361	1580	1799	2016	2231	2766	3294	3817	4336	4850	5361
9	7½	112.50	....	....	....	....	....	1637	1863	2087	2311	2864	3412	3955	4492	5026	5556
9½	8	118.75	....	....	....	....	....	1749	1991	2231	2470	3063	3649	4230	4807	5378	5945
10	8½	125.00	....	....	....	....	....	....	2120	2376	2631	3262	3884	4506	5121	5730	6335

Loads above the heavy lines are maximum loads for the concrete.
Loads below the heavy lines are maximum loads for the steel.
See page 412 for explanation of tables.

TRIANGLE MESH CONCRETE REINFORCEMENT

American Steel and Wire Company



Triangle Mesh is a woven fabric of cold drawn steel wire, providing a continuous reinforcement, an even distribution of metal and a perfect bond.

Made with both single and stranded tension members in lengths up to 300 feet and in widths up to 56 inches.

TRIANGLE MESH—STYLES, AREAS, AND WEIGHTS

Longitudinal and Cross Wires (No. 14 A. S. & W. Co. Gage), Spaced 4 Inches.

Triangle Mesh Style Number	Longitudinal Wire			Triangle Mesh	
	Number of Strands	Thickness, A. S. & W. Co. Wire Gage	Net Area per Foot of Width, Square Inches	Total Area per Foot of Width, Square Inches	Approx. Weight per 100 Sq. Ft., Pounds
032	1	No. 12	.026	.032	22
040	1	" 11	.034	.040	25
049	1	" 10	.043	.049	28
058	1	" 9	.052	.058	32
068	1	" 8	.062	.068	35
080	1	" 7	.074	.080	40
093	1	" 6	.087	.093	45
107	1	" 5	.101	.107	50
126	1	" 4	.120	.126	57
146	1	" 3	.140	.146	65
153	1	¼"	.147	.153	68
168	1	No. 2	.162	.168	74
180	2	" 6	.174	.180	78
208	2	" 5	.202	.208	89
245	2	" 4	.239	.245	103
267	3	" 6	.261	.267	111
287	3	" 5½	.281	.287	119
309	3	" 5	.303	.309	128
336	3	" 4½	.330	.336	138
365	3	" 4	.359	.365	149
395	3	" 3½	.389	.395	160

Length of Rolls: 150, 200 and 300 feet.

Width of Rolls: 16, 20, 24, 28, 32, 36, 40, 44, 48, 52 and 56 inches, approximately.

Triangle Mesh is furnished either with or without galvanizing; unless otherwise specified material will be shipped not galvanized.

AMERICAN ELECTRICALLY WELDED FABRIC REINFORCEMENT

AMERICAN STEEL AND WIRE COMPANY

American Electrically Welded Fabric is a square or rectangular mesh made from cold-drawn steel wire electrically welded at the intersections of the longitudinal and transverse wires.

Various combinations of spacings of wires can be furnished, the standard spacings for the longitudinal wires being 2, 3, 4 or 6 inches and for the transverse wires 8, 12 or 16 inches. For economical reasons it is advisable to select from the standard sizes given in the table on following page.

In ordinary American Welded Fabric, the spacings of the wires should be specified first, followed by the size or gage of the wires, giving first the size of the longitudinal and last the size of the transverse wires.

EXAMPLE: For No. 6 Gage longitudinal wires spaced 4 inches and No. 10 Gage transverse wires spaced 12 inches, the specifications should read:

American Welded Fabric, 4″ x 12″ mesh, No. 6 x No. 10 wires.

Widths. Widths are multiples of the spacing of longitudinal wires up to a maximum width which varies with the size and spacing of the longitudinals. Approximate maximums: 56 to 72 inches for 2-inch spacing, 84 to 120 inches for 3-or 4-inch spacing, and 96 to 126 inches for 6-inch spacing.

All widths are measured center to center of selvage longitudinals.

The transverse wires extend 1 inch beyond the outside longitudinal wires. Square footage or square yardage will be figured exclusive of these projections. An extra charge is made for widths narrower than 40 inches.

Length—Rolls. Styles having longitudinals No. 3 gage or smaller are made regularly in standard lengths 150, 200 and 300 feet. Flat sheets can be furnished when desired. Styles having longitudinals larger than No. 0 gage, made regularly in straightened and cut sheets only.

Width and length of rolls should be shown; if rolls are ordered without stating any preference as to widths or lengths, the total number of square feet should be specified with the statement that any standard width and length of rolls will be satisfactory.

Weights. All weights of styles shown on following page are based on a width of 60 inches measured from center to center of the outside or selvage longitudinal wires.

AMERICAN ELECTRICALLY WELDED FABRIC REINFORCEMENT

American Steel and Wire Company

Spacing of Wires, Inches		American Steel & Wire Co. Steel Wire Gage Number		Sectional Area, Square Inches per Foot		Weight, Pounds per 100 Square Feet
Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse	
2	16	1	7	.377	.018	139
2	16	2	8	.325	.015	119
2	16	3	8	.280	.015	104
2	16	4	9	.239	.013	89
3	16	2	8	.216	.016	83
2	16	5	10	.202	.011	75
3	16	3	8	.187	.015	72
2	16	6	10	.174	.011	65
3	16	4	9	.159	.013	61
4	16	3	8	.140	.015	56
3	16	5	10	.135	.011	52
4	16	4	9	.120	.013	48
3	16	6	10	.116	.011	45
4	16	5	10	.101	.011	40
3	16	7	11	.098	.009	38
4	16	6	10	.087	.011	35
3	16	8	12	.082	.007	32
4	16	7	11	.074	.009	30
4	12	8	12	.062	.009	26
4	12	9	12	.052	.009	22
4	12	10	12	.043	.009	19
4	12	12	12	.026	.009	13
6	12	0	6	.148	.029	65
6	12	2	2	.108	.054	59
6	12	3	3	.093	.047	51
6	12	4	4	.080	.040	44
6	12	5	5	.067	.034	37
6	12	6	6	.058	.029	32
6	12	7	7	.049	.025	27
6	6	3	3	.093	.093	68
6	6	4	4	.080	.080	58
6	6	5	5	.067	.067	49
6	6	6	6	.058	.058	42
6	6	7	7	.049	.049	36
6	6	8	8	.041	.041	30
6	6	9	9	.035	.035	25
6	6	10	10	.029	.029	21
4	4	4	4	.120	.120	85
4	4	6	6	.087	.087	62
4	4	8	8	.062	.062	44
4	4	10	10	.043	.043	31
4	4	12	12	.026	.026	19
4	4	14	14	.015	.015	11
3	3	10	10	.057	.057	41
2	2	10	10	.086	.086	60
2	2	12	12	.052	.052	37
2	2	14	14	.030	.030	21
2	2	16	16	.018	.018	13

ROOFS AND ROOF LOADS

The design of roofs and the selection of suitable roofing materials depend on the character of the building, whether monumental, public, residence, mill or shop; permanent or temporary; geographical location as regards allowance for snow and wind loads, and also availability of materials and familiarity of workmen with the construction; atmospheric conditions as concerns presence of industrial or other plants producing deleterious gases; water-tightness or resistance of the roof layers to penetration of water, snow or ice under storm and long continued exposure; wind resistance or the strength of materials to resist displacement of the entire surface or disruption between points of support; type and pitch of roof, whether self-supporting on wide spans or requiring the use of sheathing, and whether materials can be laid safely on steep surfaces.

A good roof on a permanent structure should be fireproof from within as well as without, made of refractory materials supported by equally fireproof framing. It should last without repair as long as the building stands without repair. Its maintenance cost should be low and its materials purchased on the probable life and service of the structure.

Snow Loads. The snow loads on roofs vary with the geographical location, the altitude and humidity of the place, and with the slope of the roof. Where snow is likely to occur, the minimum load per horizontal square foot of roof should be taken at 25 pounds for all slopes up to 20 degrees, this load to be reduced one pound for each degree of increase in slope up to 45 degrees, above which no snow load need be considered. In severe climates these loads should be increased in accordance with actual conditions. Regard should also be given to the possibility of partial snow load with local concentration.

Wind Loads. These vary also with the geographical location and the slope of the roof and, when not fixed by building laws, are usually taken as acting horizontally at 40 pounds per square foot on vertical surfaces of the most exposed structures, and 30 pounds on less exposed structures. On inclined surfaces only the normal components of the wind pressure need be considered. The following normal pressures are based on the formula given by Duchemin: $P = P_1 \frac{2 \sin a}{1 + \sin^2 a}$, where P_1 is the direct horizontal pressure assumed at 30 pounds per square foot on the vertical surface and P the normal pressure on a unit of surface, sloping at angle a with the horizontal.

NORMAL WIND PRESSURE, IN POUNDS PER SQUARE FOOT

Slope $a°$	Pressure per Sq. Foot, Pounds	Slope $a°$	Pressure per Sq. Foot, Pounds	Slope $a°$	Pressure per Sq. Foot, Pounds	Slope $a°$	Pressure per Sq. Foot, Pounds
5	5.19	20	18.37	35	25.90	50	28.97
10	10.11	25	21.51	40	27.29	55	29.41
15	14.55	30	24.00	45	28.28	60	29.69

For pressures other than 30 pounds per square foot, the values given above change in proportion. For slopes over 60° the values assumed for horizontal pressure are applied.

Combined Roof Loads. In climates corresponding to that of Pittsburgh, and where the roof loads are not fixed by building laws, ordinary roofs with spans up to 80 feet should carry the following minimum loads per square foot of exposed surface, applied vertically, to provide for dead, wind and snow loads combined.

Roof Covering		Roof Load per Square Foot, Pounds
Gravel or Composition Roofing	on boards, flat slope, 1 to 6 or less	50
	on boards, steep slope, more than 1 to 6	45
	on 3-inch flat tile or cinder concrete	60
Corrugated sheeting on boards or purlins		40
Slate	on boards or purlins	50
	on 3-inch flat tile or cinder concrete	65
Tile on steel purlins		55
Glass		45

For roofs in climates where no snow is likely to occur, reduce these loads by 10 pounds per square foot, but no roof or any part thereof should be designed for a total live and dead load less than 40 pounds per square foot.

Roof Covering. As stated above, suitable protection of a building against rain, snow, etc., depends on the character and location of the building, and the slope or pitch of the roof. Tin, tar, gravel, asphalt roofings and similar compositions are used for flat roofs; slate, tiles, and tin are used for slant roofs of public buildings and residences, shingles for smaller dwelling houses, and corrugated sheeting for shops and warehouses. Slate, tile, tin, or shingles are usually attached to a layer of planking, called sheathing, which is supported either by rafters, or else placed directly on the roof purlins.

Approximate Weight of Roofing Material

Roofing Material	Approximate Weight per Square Foot, Pounds
Copper, No. 22 B. & S. Gage	1¼
*Corrugated galvanized iron, No. 20 G. S. G.	2¼
*Corrugated galvanized iron, No. 22 G. S. G.	1¾
Felt, 2 layers	½
Felt and asphalt or coal-tar	2
Glass, ⅛ inch thick	1¾
Lath and plaster ceiling	6–8
Lead, ⅛ inch thick	7½
Sheathing, hemlock, 1 inch thick	2½
Sheathing, white pine, spruce, 1 inch thick	2¼–2½
Sheathing, yellow pine, 1 inch thick	3½
Shingles, 6″x18″, with 6 inches to weather	2
Skylight, including frame; glass 3/16 to ½ inch	4–10
Slag roof, 4-ply, with cement and sand	4
Slate, ⅛ inch thick, 3-inch double lap	4½
Slate, 3/16 inch thick, 3-inch double lap	6¾
Terne plate, IC	⅝
Terne plate, IX	¾
Tiles (plain), 10½″x6¼″x⅝″, with 5¼ inches to weather	18
Tiles (Spanish), 14½″x10½″, with 7¼ inches to weather	8½
Zinc, No. 20 B. & S. Gage	1¼

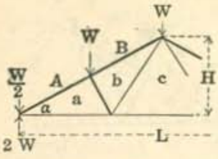
*For additional information on Corrugated Sheets, see page 425.

Roof Trusses. Trusses are used where wide roof openings are to be spanned; they form a structure of compression and tension members and produce vertical reactions under vertical loads; the total load of the roof, that is, the weight of the truss, purlins, roof covering, ceiling, and often also the snow and wind load, is usually considered a uniformly distributed load, equally divided between the two supports and producing equal vertical end reactions.

The purlins usually rest on the upper chord of the truss, transmitting to the latter the load of the roof covering, the wind and snow load, and are often so arranged as to carry the dead load directly to the truss joints or panel points to avoid transverse stresses. The distance between two consecutive joints of the top chord is the panel length; the distance between two adjacent trusses is the bay length.

The transverse strength of the sheathing or of the corrugated iron used for the roof covering generally determines the spaces between the jack rafters or the purlins. These purlins or rafters are small steel shapes, such as beams, channels and angles, or wooden beams if the roof is not of fireproof construction.

TRUSSES—LENGTHS AND STRESSES OF MEMBERS

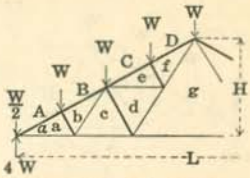


SIMPLE FINK

Compression members are indicated by heavy lines.

$$\text{Pitch of truss} = \frac{\text{Height, H}}{\text{Length, L}}$$

$$n = \frac{L}{H} = 2 \cot a$$



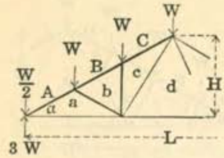
COMPOUND FINK

Member	Length	Stress = W x Formula:	Coefficients of Stress (Stress = W x Coefficient) For Values of n = 3	24/7	2 cot 30°	4	24/5	5	6
		SIMPLE FINK TRUSS							
Aa	$\frac{1}{4}$ L sec a	$\frac{3}{4}\sqrt{n^2+4}$	2.70	2.98	3.00	3.35	3.90	4.04	4.74
Bb	$\frac{1}{4}$ L sec a	$\frac{1}{\sqrt{n^2+4}}(\frac{3}{4}n^2+1)$	2.15	2.47	2.50	2.91	3.52	3.67	4.43
La	$\frac{1}{4}$ L sec² a	$\frac{3}{4}$ n	2.25	2.57	2.60	3.00	3.60	3.75	4.50
Lc	L (1 − $\frac{1}{2}$ sec² a)	$\frac{1}{2}$ n	1.50	1.71	1.73	2.00	2.40	2.50	3.00
ab	$\frac{1}{4}$ L sec a tan a	$\frac{n}{\sqrt{n^2+4}}$	0.83	0.86	0.87	0.89	0.92	0.93	0.95
bc	$\frac{1}{4}$ L sec² a	$\frac{1}{4}$ n	0.75	0.86	0.87	1.00	1.20	1.25	1.50
		COMPOUND FINK TRUSS							
Aa	$\frac{1}{8}$ L sec a	$\frac{7}{4}\sqrt{n^2+4}$	6.31	6.95	7.00	7.83	9.10	9.42	11.07
Bb	$\frac{1}{8}$ L sec a	$\frac{1}{\sqrt{n^2+4}}(\frac{7}{4}n^2+5)$	5.76	6.44	6.50	7.38	8.72	9.05	10.75
Ce	$\frac{1}{8}$ L sec a	$\frac{1}{\sqrt{n^2+4}}(\frac{7}{4}n^2+3)$	5.20	5.94	6.00	6.93	8.33	8.68	10.43
Df	$\frac{1}{8}$ L sec a	$\frac{1}{\sqrt{n^2+4}}(\frac{7}{4}n^2+1)$	4.65	5.43	5.50	6.48	7.95	8.31	10.12
La	$\frac{1}{8}$ L sec² a	$\frac{7}{4}$ n	5.25	6.00	6.07	7.00	8.40	8.75	10.50
Lc	$\frac{1}{8}$ L sec² a	$\frac{3}{2}$ n	4.50	5.14	5.20	6.00	7.20	7.50	9.00
Lg	L (1 − $\frac{1}{2}$ sec² a)	n	3.00	3.43	3.46	4.00	4.80	5.00	6.00
ab, ef	$\frac{1}{8}$ L sec a tan a	$\frac{n}{\sqrt{n^2+4}}$	0.83	0.86	0.87	0.89	0.92	0.93	0.95
cd	$\frac{1}{4}$ L sec a tan a	$\frac{2n}{\sqrt{n^2+4}}$	1.66	1.73	1.73	1.79	1.85	1.86	1.90
bc, de	$\frac{1}{8}$ L sec² a	$\frac{1}{4}$ n	0.75	0.86	0.87	1.00	1.20	1.25	1.50
dg	$\frac{1}{8}$ L sec² a	$\frac{1}{2}$ n	1.50	1.71	1.73	2.00	2.40	2.50	3.00
fg	$\frac{1}{8}$ L sec² a	$\frac{3}{4}$ n	2.25	2.57	2.60	3.00	3.60	3.75	4.50

Equivalents for Use in Length Formulas

Values of n	3	24/7	2 cot 30°	4	24/5	5	6
Values of a	33°41′24″	30°15′23″	30°	26°33′54″	22°37′12″	21°48′5″	18°26′6″
sec a	1.2018	1.1577	1.1547	1.1180	1.0833	1.0770	1.0541
sec² a	1.4444	1.3403	1.3333	1.2500	1.1736	1.1600	1.1111
sec a tan a	0.8012	0.6753	0.6667	0.5590	0.4514	0.4308	0.3514
$\sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$	0.8958	0.7778	0.7698	0.6718	0.5781	0.5608	0.4969

TRUSSES—LENGTHS AND STRESSES OF MEMBERS

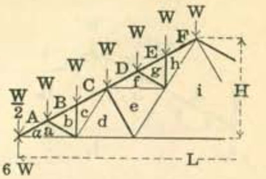


SIMPLE FAN

Compression members are indicated by heavy lines.

$$\text{Pitch of truss} = \frac{\text{Height, H}}{\text{Length, L}}$$

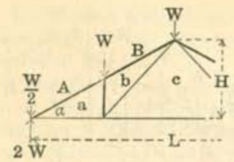
$$n = \frac{L}{H} = 2 \cot \alpha$$



COMPOUND FAN

Member	Length	Stress = W x Formula:	Coefficients of Stress (Stress = W x Coefficient) For Values of n = 3	24/7	2 cot 30°	4	24/5	5	6
		SIMPLE FAN TRUSS							
Aa	$\frac{1}{6} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(\frac{5}{4} n^2 + 5)$	4.51	4.98	5.00	5.59	6.50	6.73	7.91
Bb	$\frac{1}{6} L \sec a$	$\frac{1}{2\sqrt{n^2+4}}(\frac{13}{8} n^2 + 6)$	3.54	3.96	4.00	4.55	5.38	5.59	6.64
Cc	$\frac{1}{6} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(\frac{5}{4} n^2 + 1)$	3.40	3.95	4.00	4.70	5.73	5.99	7.27
La	$\frac{1}{4} L \sec^2 a$	$\frac{5}{4} n$	3.75	4.30	4.33	5.00	6.00	6.25	7.50
Ld	$L(1 - \frac{1}{2}\sec^2 a)$	$\frac{3}{4} n$	2.25	2.57	2.60	3.00	3.60	3.75	4.50
ab, bc	$\frac{1}{4} L \sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$	$\frac{n\sqrt{n^4 + 40n^2 + 144}}{6(n^2+4)}$	0.93	0.99	1.00	1.08	1.18	1.21	1.34
cd	$\frac{1}{4} L \sec^2 a$	$\frac{1}{2} n$	1.50	1.71	1.73	2.00	2.40	2.50	3.00
		COMPOUND FAN TRUSS							
Aa	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(1\frac{1}{4} n^2 + 11)$	9.92	10.91	11.00	12.30	14.30	14.81	17.39
Bb	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(\frac{81}{12} n^2 + 9)$	8.95	9.91	10.00	11.25	13.18	13.66	16.13
Cc	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(1\frac{1}{4} n^2 + 7)$	8.81	9.91	10.00	11.40	13.53	14.07	16.76
Df	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(1\frac{1}{4} n^2 + 5)$	8.25	9.40	9.50	10.96	13.15	13.70	16.44
Eg	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(\frac{31}{12} n^2 + 3)$	7.28	8.41	8.50	9.91	12.02	12.55	15.18
Fh	$\frac{1}{12} L \sec a$	$\frac{1}{\sqrt{n^2+4}}(1\frac{1}{4} n^2 + 1)$	7.14	8.40	8.50	10.06	12.38	12.95	15.93
La	$\frac{1}{8} L \sec^2 a$	$\frac{11}{4} n$	8.25	9.43	9.53	11.00	13.20	13.75	16.50
Ld	$\frac{1}{8} L \sec^2 a$	$\frac{9}{4} n$	6.75	7.71	7.79	9.00	10.80	11.25	13.50
Li	$L(1 - \frac{1}{2}\sec^2 a)$	$\frac{3}{2} n$	4.50	5.14	5.20	6.00	7.20	7.50	9.00
ab, bc, fg, gh	$\frac{1}{8} L \sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$	$\frac{n\sqrt{n^4 + 40n^2 + 144}}{6(n^2+4)}$	0.93	0.99	1.00	1.08	1.18	1.21	1.34
de	$\frac{1}{4} L \sec a \tan a$	$\frac{3n}{\sqrt{n^2+4}}$	2.50	2.59	2.60	2.68	2.77	2.79	2.85
cd, ef	$\frac{1}{8} L \sec^2 a$	$\frac{1}{2} n$	1.50	1.71	1.73	2.00	2.40	2.50	3.00
ei	$\frac{1}{8} L \sec^2 a$	$\frac{3}{4} n$	2.25	2.57	2.60	3.00	3.60	3.75	4.50
hi	$\frac{1}{8} L \sec^2 a$	$\frac{5}{4} n$	3.75	4.29	4.33	5.00	6.00	6.25	7.50

TRUSSES—LENGTHS AND STRESSES OF MEMBERS

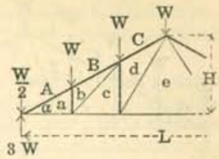


PRATT—4 PANELS

Compression members are indicated by heavy lines.

$$\text{Pitch of truss} = \frac{\text{Height, H}}{\text{Length, L}}$$

$$n = \frac{L}{H} = 2 \cot \alpha$$



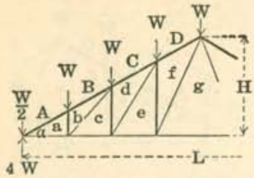
PRATT—6 PANELS

Member	Length	Stress = W x Formula:	Coefficient of Stress (Stress = W x Coefficient) For Values of n = 3	24/7	2 cot 30°	4	24/5	5	6
PRATT TRUSS 4 PANELS									
Aa, Bb	$\frac{1}{4}$ L sec α	$\frac{3}{4}\sqrt{n^2+4}$	2.70	2.98	3.00	3.35	3.90	4.04	4.74
La	$\frac{1}{4}$ L	$\frac{3}{4}$ n	2.25	2.57	2.60	3.00	3.60	3.75	4.50
Lc	$\frac{1}{2}$ L	$\frac{1}{2}$ n	1.50	1.71	1.73	2.00	2.40	2.50	3.00
ab	$\frac{1}{2}$ H	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
bc	$\frac{1}{4}\sqrt{L^2+16h^2}$	$\frac{1}{4}\sqrt{n^2+16}$	1.25	1.32	1.32	1.41	1.56	1.60	1.80
PRATT TRUSS—6 PANELS									
Aa, Bb	$\frac{1}{6}$ L sec α	$\frac{5}{4}\sqrt{n^2+4}$	4.51	4.96	5.00	5.59	6.50	6.73	7.91
Cd	$\frac{1}{6}$ L sec α	$\sqrt{n^2+4}$	3.61	3.97	4.00	4.47	5.20	5.39	6.32
La	$\frac{1}{6}$ L	$\frac{5}{4}$ n	3.75	4.29	4.33	5.00	6.00	6.25	7.50
Lc	$\frac{1}{6}$ L	n	3.00	3.43	3.46	4.00	4.80	5.00	6.00
Le	$\frac{1}{3}$ L	$\frac{3}{4}$ n	2.25	2.57	2.60	3.00	3.60	3.75	4.50
ab	$\frac{1}{3}$ H	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
cd	$\frac{2}{3}$ H	$\frac{3}{2}$	1.50	1.50	1.50	1.50	1.50	1.50	1.50
bc	$\frac{1}{6}\sqrt{L^2+16h^2}$	$\frac{1}{4}\sqrt{n^2+16}$	1.25	1.32	1.32	1.41	1.56	1.60	1.80
de	$\frac{1}{6}\sqrt{L^2+36h^2}$	$\frac{1}{4}\sqrt{n^2+36}$	1.68	1.73	1.73	1.80	1.92	1.95	2.12

Equivalents for use in Length Formulas

Values of n	3	24/7	2 cot 30°	4	24/5	5	6
Values of α	33°41′24″	30°15′23″	30°	26°33′54″	22°37′12″	21° 48′ 5″	18° 26′ 6″
sec α	1.2018	1.1577	1.1547	1.1180	1.0833	1.0770	1.0541

TRUSSES—LENGTHS AND STRESSES OF MEMBERS

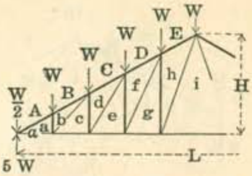


PRATT—8 PANELS

Compression members are indicated by heavy lines.

Pitch of truss $= \dfrac{\text{Height, H}}{\text{Length, L}}$

$$n = \frac{L}{H} = 2 \cot a$$



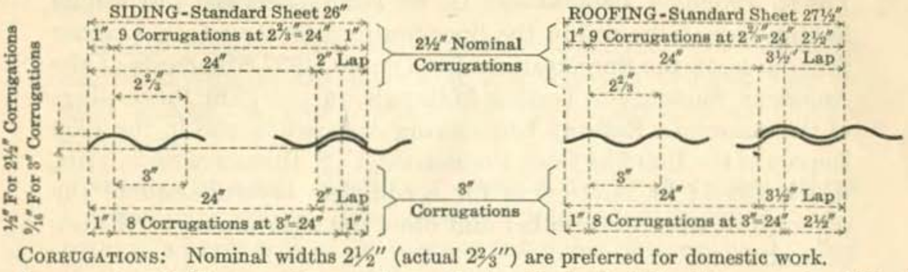
PRATT—10 PANELS

Member	Length	Stress = W x Formula:	Coefficient of Stress (Stress = W x Coefficient) For Values of n = 3	24/7	2 cot 30°	4	24/5	5	6
PRATT TRUSS—8 PANELS									
Aa, Bb	$\frac{1}{8} L \sec a$	$\frac{7}{4}\sqrt{n^2+4}$	6.31	6.95	7.00	7.83	9.10	9.42	11.07
Cd	$\frac{1}{8} L \sec a$	$\frac{3}{2}\sqrt{n^2+4}$	5.41	5.95	6.00	6.71	7.80	8.08	9.49
Df	$\frac{1}{8} L \sec a$	$\frac{5}{4}\sqrt{n^2+4}$	4.51	4.97	5.00	5.59	6.50	6.73	7.91
La	$\frac{1}{8} L$	$\frac{7}{4} n$	5.25	6.00	6.06	7.00	8.40	8.75	10.50
Lc	$\frac{1}{8} L$	$\frac{3}{2} n$	4.50	5.14	5.20	6.00	7.20	7.50	9.00
Le	$\frac{1}{8} L$	$\frac{5}{4} n$	3.75	4.29	4.33	5.00	6.00	6.25	7.50
Lg	$\frac{1}{4} L$	n	3.00	3.43	3.46	4.00	4.80	5.00	6.00
ab	$\frac{1}{4} H$	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
cd	$\frac{1}{2} H$	$\frac{3}{2}$	1.50	1.50	1.50	1.50	1.50	1.50	1.50
ef	$\frac{3}{4} H$	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00
bc	$\frac{1}{8}\sqrt{L^2+16h^2}$	$\frac{1}{4}\sqrt{n^2+16}$	1.25	1.32	1.32	1.41	1.56	1.60	1.80
de	$\frac{1}{8}\sqrt{L^2+36h^2}$	$\frac{1}{4}\sqrt{n^2+36}$	1.68	1.73	1.73	1.80	1.92	1.95	2.12
fg	$\frac{1}{8}\sqrt{L^2+64h^2}$	$\frac{1}{4}\sqrt{n^2+64}$	2.14	2.18	2.18	2.24	2.33	2.36	2.50
PRATT TRUSS—10 PANELS									
Aa, Bb	$\frac{1}{10} L \sec a$	$\frac{9}{4}\sqrt{n^2+4}$	8.11	8.93	9.00	10.06	11.70	12.12	14.23
Cd	$\frac{1}{10} L \sec a$	$2\sqrt{n^2+4}$	7.21	7.94	8.00	8.94	10.40	10.77	12.65
Df	$\frac{1}{10} L \sec a$	$\frac{7}{4}\sqrt{n^2+4}$	6.31	6.95	7.00	7.83	9.10	9.42	11.07
Eh	$\frac{1}{10} L \sec a$	$\frac{3}{2}\sqrt{n^2+4}$	5.41	5.95	6.00	6.71	7.80	8.08	9.49
La	$\frac{1}{10} L$	$\frac{9}{4} n$	6.75	7.71	7.79	9.00	10.80	11.25	13.50
Lc	$\frac{1}{10} L$	$2 n$	6.00	6.86	6.93	8.00	9.60	10.00	12.00
Le	$\frac{1}{10} L$	$\frac{7}{4} n$	5.25	6.00	6.06	7.00	8.40	8.75	10.50
Lg	$\frac{1}{10} L$	$\frac{3}{2} n$	4.50	5.14	5.20	6.00	7.20	7.50	9.00
Li	$\frac{1}{5} L$	$\frac{5}{4} n$	3.75	4.29	4.33	5.00	6.00	6.25	7.50
ab	$\frac{1}{5} H$	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
cd	$\frac{2}{5} H$	$\frac{3}{2}$	1.50	1.50	1.50	1.50	1.50	1.50	1.50
ef	$\frac{3}{5} H$	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00
gh	$\frac{4}{5} H$	$\frac{5}{2}$	2.50	2.50	2.50	2.50	2.50	2.50	2.50
bc	$\frac{1}{10}\sqrt{L^2+16h^2}$	$\frac{1}{4}\sqrt{n^2+16}$	1.25	1.32	1.32	1.41	1.56	1.60	1.80
de	$\frac{1}{10}\sqrt{L^2+36h^2}$	$\frac{1}{4}\sqrt{n^2+36}$	1.68	1.73	1.73	1.80	1.92	1.95	2.12
fg	$\frac{1}{10}\sqrt{L^2+64h^2}$	$\frac{1}{4}\sqrt{n^2+64}$	2.14	2.18	2.18	2.24	2.33	2.36	2.50
hi	$\frac{1}{10}\sqrt{L^2+100h^2}$	$\frac{1}{4}\sqrt{n^2+100}$	2.61	2.64	2.65	2.69	2.77	2.80	2.92

CORRUGATED SHEET METAL CONSTRUCTION

Corrugated steel, in addition to its extensive application as roofing and siding for buildings, is adaptable to other uses such as lining of shafts, supports and forms for floor arches, partitions, enclosures and culverts.

Corrugated sheets are available in steel of regular analysis or in rust-resisting alloys, usually copper bearing steel, either black (unpainted mill finish), painted or galvanized. Although the mills offer a wide choice in types and widths of corrugations, the curved type is generally used. Standard lengths range from 60″ to a maximum of 144″ varying by 12″; other lengths are subject to an extra charge.



CORRUGATIONS: Nominal widths 2½″ (actual 2⅔″) are preferred for domestic work.

For export work 3″ corrugations are frequently furnished with 32″ widths, covering 27″ net when laid with 2 corrugations side lap, and 30″ net with one corrugation side lap.

Roofing sheet is 27½″ wide after corrugating and has one edge turned up and the other down. It is laid with a side lap of 1½ corrugations (covering approximately 24″ net width) and a minimum end lap of 6″ for roof pitch of 4 in 12 or over. For roofs of less pitch the minimum end lap should be 8″. Corrugated steel roofing is seldom used for roof pitch under 3 in 12.

Siding sheet is 26″ wide after corrugating with both edges of sheet turned the same way. It is laid with side lap of one corrugation (approximately 24″ net width) and minimum end lap of 4″.

Sheet steel flashing must be provided at roof ridge, eaves, windows and wherever necessary to insure watertight results.

U. S. Std. Gage	Thickness in Inches	Permissible Variation + or — % of Wt.	FLAT SHEETS Pounds per Sq. Ft.		2½″ AND 3″ CORRUGATIONS					
					26″ Sheets Pounds per Sq. Ft.		27½″ Sheets Pounds per Sq. Ft.		Maximum Span Between Supports	
			Galvanized	Black	Galvanized	Black	Galvanized	Black	Roofing	Siding
12	.107	5.0	4.53	4.38	4.88	4.71	4.94	4.77	5′—9″	5′—10″
14	.077	5.0	3.28	3.13	3.53	3.37	3.58	3.41	5′—9″	5′—10″
16	.061	5.0	2.66	2.50	2.86	2.69	2.90	2.73	5′—9″	5′—10″
18	.049	3.5	2.16	2.00	2.32	2.15	2.35	2.18	5′—9″	5′—10″
20	.037	3.5	1.66	1.50	1.78	1.62	1.81	1.64	5′—9″	5′—10″
21	.034	3.5	1.53	1.38	1.65	1.48	1.67	1.50	5′—9″	5′—10″
22	.031	3.5	1.41	1.25	1.51	1.35	1.53	1.36	4′—9″	5′—10″
23	.028	2.5	1.28	1.13	1.38	1.21	1.40	1.23	4′—9″	5′—10″
24	.025	2.5	1.16	1.00	1.25	1.08	1.26	1.09	3′—9″	4′—10″
25	.021	2.5	1.03	.88	1.11	.94	1.13	.96	3′—9″	4′—10″
26	.018	2.5	.91	.75	.98	.81	.99	.82	2′—9″	3′—10″
28	.015	2.5	.78	.63	.84	.67	.85	.68	2′—9″	3′—10″

To obtain the weights of Black Painted Sheets, add 0.015 Lbs. per Sq. Ft. to weights of Black Sheets.

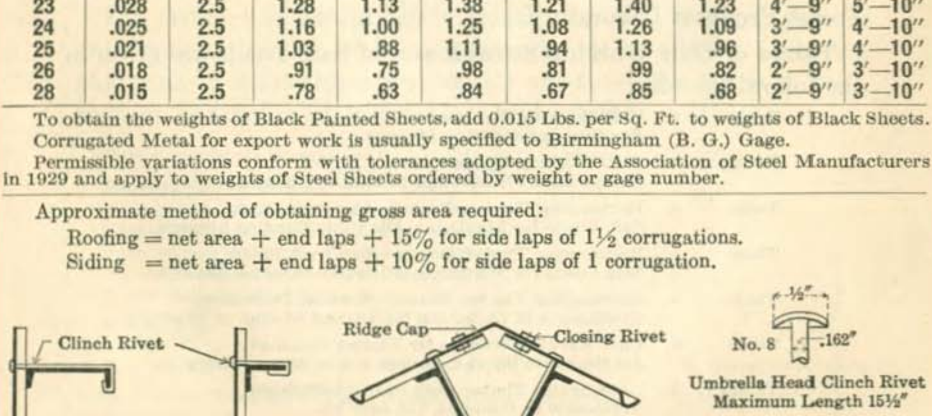
Corrugated Metal for export work is usually specified to Birmingham (B. G.) Gage.

Permissible variations conform with tolerances adopted by the Association of Steel Manufacturers in 1929 and apply to weights of Steel Sheets ordered by weight or gage number.

Approximate method of obtaining gross area required:

Roofing = net area + end laps + 15% for side laps of 1½ corrugations.

Siding = net area + end laps + 10% for side laps of 1 corrugation.



FASTENINGS FOR CORRUGATED STEEL

STRUCTURAL TIMBER

The strength of structural timbers depends upon a number of factors: the species of wood and its age, seasoning and therewith the moisture content, influence of defects and variation in strength due to conditions of load and service.

The most recent studies in this direction have been made by the Forest Products Laboratory, U. S. Forest Service, the results having been embodied in the Specifications for American Lumber Standards, in the Specifications for Timber, 1927 Standards of the American Society for Testing Materials, in the 1929 Proceedings of the American Railway Engineering Association and in the 1926 Report of the Building Code Committee, U. S. Bureau of Standards, which should be referred to for a complete investigation of the strength of structural timber and other data pertaining to the use of timber.

In accordance with these specifications the working stresses are given for two grades, select and common, each for three conditions of exposure during use:

a. Continuously Dry. Timber continuously dry; when restricted to use in interior or protected constructions and not subject to conditions of dampness or humidity.

b. Occasionally Wet. Timber occasionally wet but quickly dried; when used in exterior structures such as bridges, trestles, or other exposed frame work.

c. Usually Wet. Timber more or less continuously damp or wet; when exposed to water or when in contact with earth, or when used in structures that are more or less continuously wet.

Tables for Working Stresses and Safe Loads

Values given in Tables 1 and 2 are those recommended by the Forest Products Laboratory.

Tables of Unit Working Stresses and of Safe Loads are given in the following order:

Table 1.	Unit Working Stresses; Bending and Shearing Stresses.
Table 2.	Unit Working Stresses; Compressive Stresses and Moduli of Elasticity.
Table 3.	Rectangular Timber Beams—One Inch Thick; Safe Loads for Maximum Allowable Bending Stresses.
Table 4.	Rectangular Timber Beams—One Inch Thick; Safe Loads for Maximum Allowable Shearing Stresses.
Table 5.	Rectangular Timber Beams—Vertical Deflection; Coefficients of Deflection for Various Moduli of Elasticity.
Table 6.	Unit Working Stresses for Timber Columns; Applicable to Short Columns, $l/d = 10$ and under.
Tables 7, 8.	Rectangular Timber Columns—Coefficients; Applicable to Columns, l/d over 10.
Tables 9, 10.	Rectangular Timber Columns—Safe Loads; Applicable to Columns, l/d over 10.

UNIT WORKING STRESSES

Rectangular Timber Beams

Bending Stresses. The factor of safety at a given working stress varies materially with the duration of the stress; at the recommended working stresses the average timber in buildings has a factor of safety of 6 for momentarily applied loads but a factor of safety of only 2¼ for permanent loads.

Tensile Stresses. For members in direct tension, such as bottom chords of trusses, the allowable unit stress in bending may be used, except at joints, where full tensile strength cannot be developed.

Shearing Stresses. Working stresses given for horizontal shear are maximum values. The maximum unit horizontal shear at any point in a beam is 3/2 of the average unit shear obtained by dividing the total shear at that point by the area of the cross section.

Modulus of Elasticity. The stresses given are averages for species and are used for computing the approximate initial deflection of a timber beam. The tabular values give the initial deflection for a load temporarily applied; for a beam supporting a permanent load, only one-half the tabular values should be used to prevent sag.

The approximate ratio of the modulus of elasticity to the bending stress is 1100 : 1 for the select grade of building timber.

Rectangular Timber Columns

Compressive Stresses. The unit working stresses given for compression parallel to grain are used for short columns up to a length where the ratio of unsupported length to least dimension does not exceed 10.

For columns of intermediate length, the unit working stresses are obtained from the following formula, up to a point where the reduction in allowable stress equals one-third the stress in compression parallel to grain used for short columns.

Unit Compressive Stress $\frac{P}{A} = f_c\left[1 - \frac{1}{3}\left(\frac{l}{Kd}\right)\right]$, where

P = total load in pounds.
A = cross sectional area, in square inches.
f_c = unit compressive stress parallel to grain.
l = unsupported length of column, in inches.
d = least dimension of column, in inches.
E = Modulus of Elasticity.

$K = \frac{\pi}{2}\sqrt{\frac{E}{6f_c}}$

For columns of a length where the value of $K = l/d$ and $\frac{P}{A} = \frac{2}{3} f_c$, the curve becomes tangent to the Euler curve which is used for long columns up to $l/d = 50$, with a factor of safety of 3.

Unit Compressive Stress $\frac{P}{A} = \frac{\pi^2 E}{36\,(l/d)^2}$

1. STRUCTURAL TIMBER—UNIT WORKING STRESSES

Bending and Shearing Stresses, in Pounds per Square Inch

Species of Timber	Transverse Bending Stresses										Horizontal Shearing Stress	
	All Sizes		Thickness, 5 Inches and Over				Thickness, 4 Inches and Under					
	Continuously Dry		Occasionally Wet		Usually Wet		Occasionally Wet		Usually Wet		Dry or Wet	
	Select	Common	Select	Common	Select	Common	Select	Common	Select	Common	Select	Common
Ash, White, commercial	1400	1120	1200	960	1000	800	1070	910	890	760	125	100
Beech and Birch, Yellow	1500	1200	1300	1040	1000	800	1150	980	890	760	125	100
Cedar, Port Orford and Alaska	1100	880	1000	800	900	720	890	760	800	680	90	72
" Western Red	900	720	800	640	750	600	710	600	670	570	80	64
" Northern and Southern White	750	600	650	520	600	480	580	490	530	450	70	56
Chestnut	950	760	850	680	700	560	760	650	620	530	90	72
Cypress, Southern	1300	1040	1100	880	900	720	980	830	800	680	100	80
Douglas Fir, Coast Region	1600	1200	1385	1040	1065	800	1235	985	950	755	90	72
" " " " Dense	1750	1400	1515	1215	1165	935	1350	1150	1035	880	105	84
" " Rocky Mountain	1100	880	900	720	700	560	800	680	620	530	85	68
Fir, White, commercial	1100	880	900	720	800	640	800	680	710	600	70	56
" Balsam	900	720	750	600	600	480	670	570	530	450	70	56
Hemlock, Western	1300	1040	1100	880	900	720	980	830	800	680	75	60
" Eastern	1100	880	900	720	800	640	800	680	710	600	70	56
Hickory	1900	1520	1500	1200	1200	960	1330	1130	1070	910	140	112
Larch, Western	1200	960	1100	880	900	720	980	830	800	680	100	80
Maple, Sugar and Black	1500	1200	1300	1040	1000	800	1150	980	890	760	125	100
" Red and Silver	1000	800	900	720	700	560	800	680	620	530	100	80
Oak, Red and White, commercial	1400	1120	1200	960	1000	800	1070	910	890	760	125	100
Pine, Southern Yellow	....	1200	....	1040	....	800	....	985	....	755	....	88
" " " Dense	1750	1400	1515	1215	1165	935	1350	1145	1035	880	128	103
" White, Yellow and Sugar	900	720	800	640	750	600	710	600	670	570	85	68
" Norway	1100	880	1000	800	800	640	890	760	710	600	85	68
Poplar, Yellow	1000	800	900	720	800	640	800	680	710	600	80	64
Redwood	1200	960	1000	800	800	640	890	760	710	600	70	56
Spruce, Red, White and Sitka	1100	880	900	720	800	640	800	680	710	600	85	68
" Engelmann	750	600	650	520	500	400	580	490	440	370	70	56
Tamarack	1200	960	1100	880	900	720	980	830	800	680	95	76

2. STRUCTURAL TIMBER—UNIT WORKING STRESSES

Compressive Stresses and Elastic Moduli, in Pounds per Square Inch

Species of Timber	Compressive Stresses									Average Modulus of Elasticity
	Perpendicular to Grain			Parallel with Grain						
	Continuously Dry	Occasionally Wet	Usually Wet	Continuously Dry		Occasionally Wet		Usually Wet		
	Select or Common			Select	Common	Select	Common	Select	Common	All Classes
Ash, White, commercial	500	375	300	1100	880	1000	800	900	720	1,500,000
Beech and Birch, Yellow	500	375	300	1200	960	1100	880	900	720	1,600,000
Cedar, Alaska	250	200	150	800	640	750	600	650	520	1,200,000
Cedar, Port Orford	250	200	150	900	720	825	660	750	600	1,200,000
" Western Red	200	150	125	700	560	700	560	650	520	1,000,000
" Northern and Southern White	175	140	100	550	440	500	400	450	360	800,000
Chestnut	300	200	150	800	640	700	560	600	480	1,000,000
Cypress, Southern	300	225	200	1100	880	1000	800	800	640	1,200,000
Douglas Fir, Coast Region	345	240	215	1175	880	1065	800	905	680	1,600,000
" " " " Dense	380	260	235	1285	1025	1165	935	990	795	1,600,000
" " Rocky Mountain	275	225	200	800	640	800	640	700	560	1,200,000
Fir, White, commercial	300	225	200	700	560	700	560	600	480	1,100,000
" Balsam	150	125	100	700	560	600	480	500	400	1,000,000
Hemlock, Western	300	225	200	900	720	900	720	800	640	1,400,000
" Eastern	300	225	200	700	560	700	560	600	480	1,100,000
Hickory	600	400	350	1500	1200	1200	960	1000	800	1,800,000
Larch, Western	325	225	200	1100	880	1000	800	800	640	1,300,000
Maple, Sugar and Black	500	375	300	1200	960	1100	880	900	720	1,600,000
" Red and Silver	350	250	200	800	640	700	560	600	480	1,100,000
Oak, Red and White, commercial	500	375	300	1000	800	900	720	800	640	1,500,000
Pine, Southern Yellow	...	...	...	....	880	....	800	...	680	1,600,000
" " " Dense	380	260	235	1285	1025	1165	935	990	795	1,600,000
" White, Yellow and Sugar	250	150	125	750	600	750	600	650	520	1,000,000
" Norway	300	175	150	800	640	800	640	700	560	1,200,000
Poplar, Yellow	250	150	125	800	640	700	560	600	480	1,100,000
Redwood	250	150	125	1000	800	900	720	750	600	1,200,000
Spruce, Red, White and Sitka	250	150	125	800	640	750	600	650	520	1,200,000
" Engelmann	175	140	100	600	480	550	440	450	360	800,000
Tamarack	300	225	200	1000	800	900	720	800	640	1,300,000

3. RECTANGULAR TIMBER BEAMS

ELEMENTS FOR AMERICAN STANDARD DRESSED SIZES

Nominal Size	American Standard Dressed Size	Area of Section	Weight per Foot	Moment of Inertia	Section Modulus
In.	In.	In.^{2}	Lb.	In.^{4}	In.^{3}
2 x 4	1⅝ x 3⅝	5.89	1.64	6.45	3.56
6	5⅝	9.14	2.54	24.1	8.57
8	7½	12.2	3.39	57.1	15.3
10	9½	15.4	4.29	116	24.4
12	11½	18.7	5.19	206	35.8
14	13½	21.9	6.09	333	49.4
16	15½	25.2	6.99	504	65.1
18	17½	28.4	7.90	726	82.9
3 x 4	2⅝ x 3⅝	9.52	2.64	10.4	5.75
6	5⅝	14.8	4.10	38.9	13.8
8	7½	19.7	5.47	92.3	24.6
10	9½	24.9	6.93	188	39.5
12	11½	30.2	8.39	333	57.9
14	13½	35.4	9.84	538	79.7
16	15½	40.7	11.3	815	105
18	17½	45.9	12.8	1172	134
4 x 4	3⅝ x 3⅝	13.1	3.65	14.4	7.94
6	5⅝	20.4	5.66	53.8	19.1
8	7½	27.2	7.55	127	34.0
10	9½	34.4	9.57	259	54.5
12	11½	41.7	11.6	459	79.9
14	13½	48.9	13.6	743	110
16	15½	56.2	15.6	1125	145
18	17½	63.4	17.6	1619	185
6 x 6	5½ x 5½	30.3	8.40	76.3	27.7
8	7½	41.3	11.4	193	51.6
10	9½	52.3	14.5	330	82.7
12	11½	63.3	17.5	697	121
14	13½	74.3	20.6	1128	167
16	15½	85.3	23.6	1707	220
18	17½	96.3	26.7	2456	281
20	19½	107.3	29.8	3398	349
8 x 8	7½ x 7½	56.3	15.6	264	70.3
10	9½	71.3	19.8	536	113
12	11½	86.3	23.9	951	165
14	13½	101.3	28.0	1538	228
16	15½	116.3	32.0	2327	300
18	17½	131.3	36.4	3350	383
20	19½	146.3	40.6	4634	475
22	21½	161.3	44.8	6211	578

Nominal Size	American Standard Dressed Size	Area of Section	Weight per Foot	Moment of Inertia	Section Modulus
In.	In.	In.^{2}	Lb.	In.^{4}	In.^{3}
10 x 10	9½ x 9½	90.3	25.0	679	143
12	11½	109	30.3	1204	209
14	13½	128	35.6	1948	289
16	15½	147	40.9	2948	380
18	17½	166	46.1	4243	485
20	19½	185	51.4	5870	602
22	21½	204	56.7	7868	732
24	23½	223	62.0	10274	874
12 x 12	11½ x 11½	132	36.7	1458	253
14	13½	155	43.1	2358	349
16	15½	178	49.5	3569	460
18	17½	201	55.9	5136	587
20	19½	224	62.3	7106	729
22	21½	247	68.7	9524	886
24	23½	270	75.0	12437	1058
14 x 14	13½ x 13½	182	50.6	2768	410
16	15½	209	58.1	4189	541
18	17½	236	65.6	6029	689
20	19½	263	73.1	8342	856
22	21½	290	80.6	11181	1040
24	23½	317	88.1	14600	1243
16 x 16	15½ x 15½	240	66.7	4810	621
18	17½	271	75.3	6923	791
20	19½	302	83.9	9578	982
22	21½	333	92.5	12837	1194
24	23½	364	101	16763	1427
18 x 18	17½ x 17½	306	85.0	7816	893
20	19½	341	94.8	10813	1109
22	21½	376	105	14493	1348
24	23½	411	114	18926	1611
26	25½	446	124	24181	1897
20 x 20	19½ x 19½	380	106	12049	1236
22	21½	419	116	16150	1502
24	23½	458	127	21089	1795
26	25½	497	138	26945	2113
28	27½	536	149	33795	2458
24 x 24	23½ x 23½	552	153	25415	2163
26	25½	599	166	32472	2547
28	27½	646	180	40727	2962
30	29½	693	193	50275	3408

All properties and weights given are for dressed size only.
The weights given above are based on assumed average weight of 40 pounds per cubic foot.

4. COEFFICIENTS OF DEFLECTION

Maximum Bending Stress, 1000 Pounds per Square Inch

Span in Feet	Modulus of Elasticity, Pounds per Square Inch									
	1 800 000	1 600 000	1 500 000	1 400 000	1 300 000	1 200 000	1 100 000	1 000 000	900 000	800 000
1	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
2	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.15
3	0.15	0.17	0.18	0.19	0.21	0.23	0.25	0.27	0.30	0.34
4	0.27	0.30	0.32	0.34	0.37	0.40	0.44	0.48	0.53	0.60
5	0.42	0.47	0.50	0.54	0.58	0.63	0.68	0.75	0.83	0.94
6	0.60	0.68	0.72	0.77	0.83	0.90	0.98	1.08	1.20	1.35
7	0.82	0.92	0.98	1.05	1.13	1.23	1.34	1.47	1.63	1.84
8	1.07	1.20	1.28	1.37	1.48	1.60	1.75	1.92	2.13	2.40
9	1.35	1.52	1.62	1.74	1.87	2.03	2.21	2.43	2.70	3.04
10	1.67	1.88	2.00	2.14	2.31	2.50	2.73	3.00	3.33	3.75
11	2.02	2.27	2.42	2.59	2.79	3.03	3.30	3.63	4.03	4.54
12	2.40	2.70	2.88	3.09	3.32	3.60	3.93	4.32	4.80	5.40
13	2.82	3.17	3.38	3.62	3.90	4.23	4.61	5.07	5.63	6.34
14	3.27	3.68	3.92	4.20	4.52	4.90	5.35	5.88	6.53	7.35
15	3.75	4.22	4.50	4.82	5.19	5.63	6.14	6.75	7.50	8.44
16	4.27	4.80	5.12	5.49	5.91	6.40	6.98	7.68	8.53	9.60
17	4.82	5.42	5.78	6.19	6.67	7.23	7.88	8.67	9.63	10.84
18	5.40	6.08	6.48	6.94	7.48	8.10	8.84	9.72	10.80	12.15
19	6.01	6.76	7.21	7.73	8.32	9.02	9.84	10.82	12.02	13.53
20	6.67	7.50	8.00	8.57	9.23	10.00	10.91	12.00	13.33	15.00
21	7.35	8.27	8.82	9.45	10.18	11.03	12.03	13.23	14.70	16.54
22	8.07	9.08	9.68	10.37	11.17	12.10	13.20	14.52	16.13	18.15
23	8.82	9.92	10.58	11.34	12.21	13.23	14.43	15.87	17.63	19.84
24	9.60	10.80	11.52	12.34	13.29	14.40	15.71	17.28	19.20	21.60
25	10.42	11.72	12.50	13.39	14.42	15.63	17.05	18.75	20.83	23.44
26	11.27	12.68	13.52	14.49	15.60	16.90	18.44	20.28	22.53	25.35
27	12.15	13.67	14.58	15.62	16.82	18.23	19.88	21.87	24.30	27.33
28	13.07	14.70	15.68	16.80	18.09	19.60	21.38	23.52	26.13	29.40
29	14.02	15.76	16.82	18.02	19.41	21.03	22.94	25.23	28.03	31.54
30	15.00	16.88	18.00	19.29	20.77	22.50	24.55	27.00	30.00	33.75
31	16.02	18.02	19.22	20.59	22.18	24.03	26.21	28.83	32.03	36.04
32	17.07	19.20	20.48	21.94	23.63	25.60	27.93	30.72	34.13	38.40
33	18.15	20.42	21.78	23.34	25.13	27.23	29.70	32.67	36.30	40.84
34	19.27	21.68	23.12	24.77	26.68	28.90	31.53	34.68	38.53	43.35
35	20.42	22.97	24.50	26.25	28.27	30.63	33.41	36.75	40.83	45.94

Coefficients of Deflection for Bending Stresses other than 1,000 pounds are obtained by multiplying the values given in table by the ratio of the given stress to 1,000.

Deflection in inches is obtained by dividing the coefficient of Deflection corresponding to given span and unit stress by the depth of beam in inches.

For beams under permanent loading twice the tabular values should be used, to prevent sagging of beam.

For select building material the ratio of modulus of elasticity to bending stress is about 1100 to 1. If the deflection is not to exceed $\frac{1}{360}$ of span, the permissible span in feet is approximately $1\frac{1}{4}$ × depth of beam in inches.

5. RECTANGULAR TIMBER BEAMS—ONE INCH IN WIDTH

ALLOWABLE UNIFORM LOAD IN POUNDS FOR BENDING

Maximum Stress 1000 Pounds per Square Inch

Span in Feet	Depth of Beam—Dressed Sizes—in Inches											
	$\frac{3}{4}$	$1\frac{5}{8}$	$2\frac{5}{8}$	$3\frac{5}{8}$	$5\frac{5}{8}$	$7\frac{1}{2}$	$9\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$	$15\frac{1}{2}$	$17\frac{1}{2}$	$19\frac{1}{2}$
6	10	49	128	243	586	1042	1671	2449	3375	4449	5671	7042
7	....	42	109	209	502	893	1433	2099	2893	3813	4861	6036
8	....	37	96	183	440	781	1254	1837	2531	3337	4254	5281
9	....	....	85	162	391	694	1114	1633	2250	2966	3781	4694
10	....	....	77	146	352	625	1003	1469	2025	2669	3403	4225
11	....	....	....	133	320	568	912	1336	1841	2427	3093	3841
12	....	....	....	122	293	521	836	1224	1687	2224	2836	3521
13	....	....	....	....	270	481	771	1130	1558	2053	2618	3250
14	....	....	....	....	251	446	716	1050	1446	1907	2431	3018
15	....	....	....	....	234	417	669	980	1350	1780	2269	2817
16	....	....	....	....	....	391	627	918	1266	1668	2127	2641
17	....	....	....	....	....	368	590	864	1191	1570	2002	2485
18	....	....	....	....	....	347	557	816	1125	1483	1890	2347
19	....	....	....	....	....	329	528	773	1066	1405	1791	2224
20	....	....	....	....	....	313	501	735	1013	1335	1701	2113
21	....	....	....	....	....	....	478	700	964	1271	1620	2012
22	....	....	....	....	....	....	456	668	920	1213	1547	1920
23	....	....	....	....	....	....	436	639	880	1161	1479	1837
24	....	....	....	....	....	....	418	612	844	1112	1418	1760
25	....	....	....	....	....	....	401	588	810	1068	1361	1690
Coefficient of Strength	62	293	766	1460	3516	6250	10028	14694	20250	26694	34028	42250

5A. RECTANGULAR TIMBER BEAMS—ONE INCH IN WIDTH

ALLOWABLE UNIFORM LOAD IN POUNDS

Maximum Horizontal Shearing Stresses

Shearing Stress, Lbs. per Sq. In.	Depth of Beam—Dressed Sizes—in Inches											
	$\frac{3}{4}$	$1\frac{5}{8}$	$2\frac{5}{8}$	$3\frac{5}{8}$	$5\frac{5}{8}$	$7\frac{1}{2}$	$9\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$	$15\frac{1}{2}$	$17\frac{1}{2}$	$19\frac{1}{2}$
140	140	303	490	677	1050	1400	1773	2147	2520	2893	3267	3640
125	125	270	438	604	938	1250	1583	1917	2250	2583	2917	3250
110	110	238	385	532	825	1100	1393	1687	1980	2273	2567	2860
105	105	228	368	508	788	1050	1330	1610	1890	2170	2450	2730
100	100	217	350	483	750	1000	1267	1533	1800	2067	2333	2600
95	95	206	333	459	713	950	1203	1457	1710	1983	2217	2470
90	90	195	315	435	675	900	1140	1380	1620	1860	2100	2340
85	85	184	298	411	638	850	1077	1303	1530	1757	1983	2210
80	80	173	280	387	600	800	1013	1227	1440	1653	1867	2080
75	75	163	263	363	563	750	950	1150	1350	1550	1750	1950
70	70	152	245	338	525	700	887	1073	1260	1447	1633	1820
65	65	141	228	314	488	650	823	997	1170	1343	1517	1690
60	60	130	210	290	450	600	760	920	1080	1240	1400	1560
55	55	119	193	266	413	550	697	843	990	1137	1283	1430
50	50	108	175	242	375	500	633	767	900	1033	1167	1300
Coefficient Minimum Span	.063	.135	.219	.302	.469	.625	.792	.958	1.125	1.292	1.458	1.625

Tabular safe loads include the weight of the beam and are applicable only when beams are sufficiently braced against lateral deflection.

Bending Safe Loads. Table 5 gives the uniformly distributed safe loads for rectangular sections, one inch in width, and for a unit stress of 1,000 pounds per square inch. The safe load for a beam of greater width is obtained by multiplying the tabular value by the width of the beam in inches.

For a unit stress other than 1,000 pounds, multiply tabular safe load by the ratio of the given stress to 1,000.

The allowable uniform load for bending stress must not exceed the maximum load for horizontal shearing stress for corresponding depth of beam, given in Table 5A, to avoid failure of beam in horizontal direction of the grain of the wood.

Shearing Stresses. Table 5A gives the allowable uniform loads for rectangular sections, one inch in width, for various unit horizontal shearing stresses. These loads are limited by the allowable shearing stresses along the horizontal axis of the beam, as calculated from formula:

Maximum Safe Load = $\frac{4}{3}$ Area of Section $\times$ Unit Shearing Stress.

The limit of allowable uniform loads on short spans, depending upon the maximum allowable horizontal shear, is obtained by multiplying the corresponding coefficient for minimum span, Table 5A, by the ratio of allowable bending stress and shearing stress.

These limits must not be exceeded to avoid failure of beam in horizontal direction of the grain of the wood.

Vertical Deflection. Table 4 gives the coefficient of deflection in center of span for uniformly distributed loads; the deflection in inches is obtained by dividing the coefficient by the depth of the beam in inches.

In building construction, the maximum span in inches of a beam uniformly loaded to capacity is generally limited to 360 $\times$ deflection in inches; for select building timber, the maximum span in feet is about 1.22 $\times$ depth of beam in inches, while for the reduced unit stress and safe loads permissible for the common grades, the maximum span may be taken at $1\frac{1}{2}$ $\times$ depth of beam.

This deflection is for a load temporarily applied and will increase to about twice theoretical value when beam is permanently loaded.

Beams Not Uniformly Loaded. For loads concentrated in the center of the span, one-half of the values for tabular safe loads for bending and four-fifths of the coefficient of deflection are used.

For other conditions of loading, reference must be made to formulas given for those conditions.

EXAMPLES OF TIMBER BEAM DESIGN

EXAMPLE 1. Find the load and deflection of a beam, actual size 5⅝″ x 13½″ white oak, select grade, continuously dry, laterally braced. Span 13 feet.

Stresses in pounds per square inch:

Bending, 1,400; Shearing, 125; Modulus of Elasticity, 1,500,000.

From table 5, allowable load for bending for 1 inch width at 1,000 pounds stress is 1,558 pounds. Maximum load for bending is 1,558 × 1.4 × 5⅝ or 12,200 pounds.

Maximum allowable load for shear is 2,250 × 5⅝ or 12,600 pounds.

Deflection is (3.38 × 1.4) ÷ 13.5 or .351″ initial and .702″ permanent.

EXAMPLE 2. Required the thickness of a 12″ nominal depth joist western hemlock, common grade, occasionally wet. Span 15 feet.

Stresses in pounds per square inch:

Bending, 830; Shearing, 60; Modulus of Elasticity, 1,400,000.

Uniformly distributed load 2,900 pounds.

Thickness of joist is 2900 ÷ (980 × .83) or 3.56 inches. Use 3⅝″.

Allowable load for horizontal shear is 920 × 3⅝ or 3,340 pounds.

Deflection is (4.82 × .83) ÷ 11½ or .348″ initial and .696″ permanent.

EXAMPLE 3. For a load of 11,000 pounds concentrated at the center of a 24 foot span, what size beam is required?

Assume white oak, select grade, continuously dry.

Stresses in pounds per square inch:

Bending, 1,400; Shearing, 125; Modulus of Elasticity, 1,500,000.

Selecting a depth of 19½″, each inch of width is good for a uniformly distributed load of 1,760 pounds at a unit stress of 1,000 pounds, or 2,464 pounds at 1,400 pounds, which is equivalent to 1,232 pounds concentrated at the center. 11,000 ÷ 1,232 = 8.93 inches.

The weight of a 9½″ x 19½″ timber at 40 pounds per cubic foot is 1,234 pounds; this will require a width of 1,234 ÷ 1,760 or .701 inch at 1,000 pounds or .50 inch of width at 1,400 pounds.

8.93 inches for load + .50 inch for beam weight = 9.43 inches. Use a beam 9½″ wide.

Allowable load for shear is 3,250 × 9½ or 30,875 pounds.

Deflection for load concentrated at center is .8 of that for an equivalent uniformly distributed load, so .8 × 11.52 × 1.4 ÷ 19.5 gives .662″ initial and 1.324″ for permanent loading.

EXAMPLE 4. Same as Example No. 3.

The required section modulus is determined as follows:

$Wl \div 4 = fS$; then $S = (11{,}000 \times 24 \times 12) \div (4 \times 1{,}400) = 565.7$.

In table No. 3, for section modulus, we find 7½″ x 19½″ is not large enough; the next size 9½″ x 19½″ has a section modulus of 602. This beam weighs 51.4 pounds per foot or a total of 1,234 pounds and the additional section modulus required is (1,234 × 24 × 12) ÷ (8 × 1,400) or 31.7. Total S required is 565.7 + 31.7 or 597.4, hence the 9½″ x 19½″ beam is satisfactory, see table 3.

Deflection and shear are figured the same as for Example 3.

For problems where the span is not given in table 5, divide the coefficient of strength by the span of the beam in feet. The quotient is the allowable uniform load in pounds at 1,000 pounds unit stress for each inch of beam width.

EXAMPLE 5. Depth of beam 19½″. Span 30′—6″.

Coefficient of strength 42,250 ÷ 30.5 = 1,385 pounds, the allowable uniformly distributed load for each inch of width of the beam at 1,000 pounds unit stress.

For problems outside of the range of the foregoing tables, for uniformly distributed loads use the following:

$W = 8\,fS \div l$; since $S = bd^2 \div 6$, then $W = 4\,fbd^2 \div 3l$.

For load concentrated in center use one-half of this value.

6. SHORT TIMBER COLUMNS

UNIT COMPRESSIVE STRESSES, f_c

Stresses parallel to Grain, in Pounds per Square Inch

Species of Timber	Continuously Dry		Occasionally Wet		Usually Wet		Modulus of Elasticity
	Select	Common	Select	Common	Select	Common	
Cedar, Western Red	700	560	700	560	650	520	1,000,000
" Port Orford	900	720	825	660	750	600	1,200,000
Douglas Fir, Coast Region	1175	880	1065	800	905	680	1,600,000
" " " " Dense	1285	1025	1165	935	990	795	1,600,000
" " Rocky Mountain	800	640	800	640	700	560	1,200,000
Hemlock, Western	900	720	900	720	800	640	1,400,000
Larch, Western	1100	880	1000	800	800	640	1,300,000
Oak, Red and White	1000	800	900	720	800	640	1,500,000
Pine, Southern Yellow	....	880	....	800	....	680	1,600,000
" " " Dense	1285	1025	1165	935	990	795	1,600,000
Redwood	1000	800	900	720	750	600	1,200,000
Spruce, Red, White, Sitka	800	640	750	600	650	520	1,200,000

7. TIMBER COLUMNS OF INTERMEDIATE LENGTH

VALUES OF $K = \frac{\pi}{2}\sqrt{\frac{E}{6f_c}}$

Species of Timber	Continuously Dry		Occasionally Wet		Usually Wet	
	Select	Common	Select	Common	Select	Common
Cedar, Western Red	24.2	27.1	24.2	27.1	25.1	28.1
" Port Orford	23.4	26.2	24.5	27.4	25.6	28.7
Douglas Fir, Coast Region	23.7	27.3	24.9	28.6	27.0	31.1
" " " " Dense	22.6	25.3	23.8	26.5	25.8	28.8
" " Rocky Mountain	24.8	27.8	24.8	27.8	26.5	29.7
Hemlock, Western	25.3	28.3	25.3	28.3	26.8	30.0
Larch, Western	22.0	24.6	23.1	25.8	25.8	28.8
Oak, Red and White	24.8	27.8	26.1	29.3	27.7	31.1
Pine, Southern Yellow	....	27.3	....	28.6	....	31.1
" " " Dense	22.6	25.3	23.8	26.5	25.8	28.8
Redwood	22.2	24.8	23.4	26.1	25.6	28.6
Spruce, Red, White, Sitka	24.8	27.8	25.6	28.7	27.5	30.8

8. TIMBER COLUMNS OF INTERMEDIATE LENGTH

VALUES OF $\left[1 - \frac{1}{3}\left(\frac{l}{Kd}\right)^4\right]$

Percentage of Strength with reference to Short Columns

K	Ratio of Length to Least Dimension of Rectangular Sections																					
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
22		98	97	96	95	93	91	88	85	81	77	72	67	67								
23		98	98	97	95	94	92	90	87	84	81	77	72	67	67							
24		99	98	97	96	95	93	92	89	87	84	80	76	72	67	67						
25		99	98	98	97	96	94	93	91	89	86	83	80	76	72	67	67					
26	100%	99	99	98	97	96	95	93	92	91	89	86	83	80	76	72	67	67				
27		99	99	98	98	97	96	95	93	92	90	88	85	82	79	74	71	67	67			
28		99	99	98	98	97	96	95	94	93	91	89	87	85	82	79	75	71	67	67		
29		99	99	99	98	98	97	96	95	94	92	91	89	87	84	82	79	75	71	67	67	
30		99	99	99	98	98	97	97	96	95	94	92	90	88	86	84	81	78	75	71	67	67
31		100	99	99	99	98	98	97	96	95	94	93	92	90	88	86	84	81	78	75	71	67

9. RECTANGULAR TIMBER COLUMNS

UNIT COMPRESSIVE STRESSES, f_c

Timbers 6″ x 6″ and Larger

SELECT GRADE

Stresses Parallel to Grain, in Pounds per Square Inch

Species of Timber	Ratio of Length to Least Dimension l/d										
	10	12	14	16	18	20	25	30	35	40	50
	Continuously Dry										
Cedar, Western Red	700	686	674	656	629	592	438	304	224	171	110
" Port Orford	900	878	861	834	795	740	526	365	268	206	132
Douglas Fir, Coast Region	1175	1149	1127	1093	1045	975	702	487	358	274	175
" " " " Dense	1285	1251	1222	1176	1112	1022	702	487	358	274	175
" " Rocky Mountain	800	786	774	753	726	688	526	365	268	206	132
Hemlock, Western	900	885	872	852	823	783	614	426	313	240	153
Larch, Western	1100	1068	1041	999	937	851	570	396	291	223	142
Oak, Red and White	1000	982	966	942	907	859	658	457	336	257	164
Pine, Southern Yellow, Dense	1285	1251	1222	1176	1112	1022	702	487	358	274	175
Redwood	1000	972	947	910	856	781	526	365	268	206	132
Spruce, Red, White, Sitka	800	786	774	753	726	688	526	365	268	206	132
	Occasionally Wet										
Cedar, Western Red	700	686	673	654	628	591	438	304	224	171	110
" Port Orford	825	809	796	775	744	703	526	365	268	206	132
Douglas Fir, Coast Region	1065	1045	1028	1003	968	915	702	487	358	274	175
" " " " Dense	1165	1139	1118	1083	1036	971	702	487	358	274	175
" " Rocky Mountain	800	785	772	753	728	688	526	365	268	206	132
Hemlock, Western	900	885	871	851	824	783	612	426	313	240	153
Larch, Western	1000	976	955	922	877	810	570	396	291	223	142
Oak, Red and White	900	886	875	858	832	797	648	457	336	257	164
Pine, Southern Yellow, Dense	1165	1139	1118	1083	1036	971	702	487	358	274	175
Redwood	900	879	861	834	794	738	526	365	268	206	132
Spruce, Red, White, Sitka	750	738	728	712	690	657	525	365	268	206	132
	Usually Wet										
Cedar, Western Red	650	638	629	614	594	565	437	304	224	171	110
" Port Orford	750	738	728	712	689	657	523	365	268	206	132
Douglas Fir, Coast Region	905	893	883	867	846	814	683	487	358	274	175
" " " " Dense	990	974	961	940	910	871	698	487	358	274	175
" " Rocky Mountain	700	690	681	669	651	623	514	365	268	206	132
Hemlock, Western	800	789	780	766	745	717	600	426	313	240	153
Larch, Western	800	787	776	760	736	704	565	396	291	223	142
Oak, Red and White	800	791	783	770	752	727	623	457	336	257	164
Pine, Southern Yellow, Dense	990	974	961	940	910	871	698	487	358	274	175
Redwood	750	737	727	712	690	657	525	365	268	206	132
Spruce, Red, White, Sitka	650	642	635	625	611	589	500	365	268	206	132

10. RECTANGULAR TIMBER COLUMNS

UNIT COMPRESSIVE STRESSES, f_c

Timbers 6″ x 6″ and Larger

COMMON GRADE

Stresses Parallel to Grain, in Pounds per Square Inch

Species of Timber	Ratio of Length to Least Dimension, l/d										
	10	12	14	16	18	20	25	30	35	40	50
	Continuously Dry										
Cedar, Western Red	560	553	547	538	524	505	425	304	224	171	110
" Port Orford	720	707	700	687	667	639	521	365	268	206	132
Douglas Fir, Coast Region	880	870	861	847	826	796	675	487	358	274	175
" " " " Dense	1025	1008	994	971	938	891	700	487	358	274	175
" " Rocky Mountain	640	632	627	617	602	582	500	365	268	206	132
Hemlock, Western	720	712	706	696	680	660	573	426	313	240	153
Larch, Western	880	863	849	828	798	752	570	396	291	223	142
Oak, Red and White	800	791	783	771	753	729	626	457	336	257	164
Pine, Southern Yellow	880	870	861	847	826	796	675	487	358	274	175
" " " Dense	1025	1008	994	971	938	891	700	487	358	274	175
Redwood	800	786	773	754	726	688	526	365	268	206	132
Spruce, Red, White, Sitka	640	632	627	617	602	582	500	365	268	206	132
	Occasionally Wet										
Cedar, Western Red	560	552	546	537	523	504	425	304	224	171	110
" Port Orford	660	652	645	635	619	598	508	365	268	206	132
Douglas Fir, Coast Region	800	792	784	773	758	736	644	487	358	274	175
" " " " Dense	935	922	911	893	869	834	688	487	358	274	175
" " Rocky Mountain	640	632	625	616	602	582	502	365	268	206	132
Hemlock, Western	720	712	705	695	681	659	572	426	313	240	153
Larch, Western	800	787	777	760	736	704	564	396	291	223	142
Oak, Red and White	720	713	708	699	686	668	593	457	336	257	164
Pine, Southern Yellow	800	792	784	773	758	736	644	487	358	274	175
" " " Dense	935	922	911	893	869	834	688	487	358	274	175
Redwood	720	709	700	685	666	637	518	365	268	206	132
Spruce, Red, White, Sitka	600	594	588	580	568	552	485	365	268	206	132
	Usually Wet										
Cedar, Western Red	520	514	509	502	491	475	413	304	224	171	110
" Port Orford	600	594	589	581	569	553	485	365	268	206	132
Douglas Fir, Coast Region	680	675	670	664	655	641	588	482	358	274	175
" " " " Dense	795	787	780	770	755	734	645	487	358	274	175
" " Rocky Mountain	560	554	551	544	535	521	465	365	268	206	132
Hemlock, Western	640	634	629	622	612	598	537	426	313	240	153
Larch, Western	640	633	627	618	606	588	519	396	291	223	142
Oak, Red and White	640	635	631	625	616	604	551	455	336	257	164
Pine, Southern Yellow	680	675	670	664	655	641	588	482	358	274	175
" " " Dense	795	787	780	770	755	734	645	487	358	274	175
Redwood	600	594	588	580	568	552	483	365	268	206	132
Spruce, Red, White, Sitka	520	515	512	507	500	489	446	365	268	206	132

USE OF COLUMN SAFE LOAD TABLES

Rectangular Columns

To determine the required rectangular dimensions of a specified wooden column of a given length, to support a certain load, it is necessary to:

1. Determine the cross section of a square timber necessary to support the load, assuming corresponding safe unit stress, f_c, for short columns, from Table 6.
2. Determine from Table 7 the corresponding value of K.
3. Determine the cross sectional area and side, d, of square trial column, from $P \div f_c$, and obtain the square root of the quotient.
4. Determine the slenderness ratio, l/d, of trial column.
5. Determine from Table 8 the nearest percentage value corresponding to values of K and l/d.
6. Determine net cross sectional area by dividing the cross sectional area of square trial column by percentage value.
7. Determine the other dimension, b, of the rectangular column by dividing the net cross sectional area by the width, d.

Example: Required the size of a rectangular column, 14′–9″ long, White Oak, common grade, continuously dry, to support a load of 44,000 pounds.

1. Table 6. Corresponding value of f_c = 800 pounds.
2. Table 7. Corresponding value of K = 27.8.
3. Area of square trial column: $44{,}000 \div 800 = 55.0$ square inches.
   Side of square trial column: $\sqrt{55.0} = 7.42$ inches.
4. Slenderness ratio: $(14.75 \times 12) \div 7.42 = 24.0$.
5. Table 8. Percentage value when K = 27.8 and l/d = 24.0: 82%.
6. Actual net area required: $55.0 \div 0.82 = 67.1$ square inches.
7. Dimension, b, of rectangular column: $67.1 \div 7.42 = 9.04$ inches.

The theoretical size is 7.42″ x 9.04″ but the actual size to use is 7½″ x 9″.

Tables 9 and 10 can be used to determine directly the safe loads for a specified column of given size and length.

Example: Checking the results obtained in the foregoing example, assuming actual dimensions of column to be 7½″ x 9″.

Slenderness ratio: $(14.75 \times 12) \div 7.5 = 23.6$.

Table 10. Net safe unit stress:

Interpolating, for l/d = 23.6: f_c = 654 pounds per square inch.

Total safe load: $7\frac{1}{2} \times 9 \times 654 = 44{,}000$ pounds.

Round Columns

The tables used for the calculation of rectangular wooden columns can also be applied to columns not rectangular, by expressing the value of least side of rectangle in terms of corresponding radius of gyration, that is, when d is the least side of rectangle:

$$d = r \times \sqrt{12} \quad \text{or} \quad r = d \div \sqrt{12} = 0.2887\ d$$

For a circular section, when d is the diameter:

$$d = 4\ r \quad \text{or} \quad r = d \div 4 \quad = 0.25\ d$$

The ratio of diameter, d, of circle and the least side, d, of rectangle is, therefore:

$$0.2887 \div 0.25 = 1.155$$

and the ratio of slenderness applicable to rectangular sections must be multiplied by 1.155, or about 7/6, to obtain the equivalent ratio of slenderness for circular sections of corresponding dimension, d.

The unit safe loads found for this increased ratio of slenderness, l/d, are multiplied by the corresponding area of the circular section to obtain the net safe load of the round column.

Example: Required the safe load of a round column, Hemlock, common grade, usually wet, 10″ diameter, 12′-4″ long.

Slenderness ratio: $(12.33 \times 12) \div 10 \times 1.155 = 17.1$.

Table 10. Net safe unit stress:
Interpolating, for $l/d = 17.1$: $f_c = 616$ pounds per square inch.

Total safe load for 10″ dia. column: area = 78.54 square inches, then
$78.54 \times 616 = 48{,}380$ pounds.

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Lbs. per Cu. Ft.	Substance	Specific Gravity	Weight, Lbs. per Cu. Ft.
Metals, Alloys, Ores			**Timber, U. S. Seasoned**		
Aluminum, cast-hammered	2.55–2.75	165	Ash, White	0.65	41
" bronze	7.7	481	Beech	0.70	44
Antimony	6.62–6.72	416	Birch, Yellow	0.68	43
Arsenic	5.73	358	Cedar, Port Orford	0.47	29
Bismuth	9.70–9.78	608	" white, red	0.35–0.37	22–23
Brass, cast-rolled	8.4–8.7	534	Chestnut	0.48	30
Bronze (gun metal)—copper 88, tin 10, zinc 2%	8.7	544	Cypress, southern	0.51	32
Bronze (Phosphor)—copper 80, tin 10, lead 10%	9.0	562	Douglas Fir, coast type	0.54	34
			" " mountain	0.48	30
Chromium	6.80–6.92	428	Elm, American	0.56	35
Cobalt	8.72–8.95	552	Hemlock, eastern, western	0.45	28
Copper, cast-rolled	8.8–9.0	556	Hickory, bigleaf	0.77	48
" ore, pyrites	4.1–4.3	262	" pignut	0.85	53
Gold, cast-hammered	19.25–19.35	1205	Larch, western	0.58	36
Iron, cast, pig	7.2	450	Maple, red, black	0.61–0.64	38–40
" wrought	7.6–7.9	485	" silver	0.53	33
" Spiegel-eisen	7.5	468	Oak, Oregon white	0.82	51
" ferro-silicon	6.7–7.3	437	" red	0.71	44
" ore, hematite	5.2	325	Pine, red	0.53	33
" " " in bank	....	160-180	" yellow—long leaf	0.70	44
" " " loose	....	130-160	" " —short leaf	0.61	38
" " limonite	3.6–4.0	237	" white, western	0.43–0.45	27–28
" " magnetite	4.9–5.2	315	Poplar, yellow	0.45	28
" slag	2.5–3.0	172	Redwood	0.48	30
Lead	11.28–11.35	706	Spruce, black, red	0.45	28
" ore, galena	7.3–7.6	465	" Engelmann	0.37	23
Magnesium	1.74	109	Tamarack	0.60	37
Manganese	7.20–7.42	456	Walnut	0.63–0.64	39–40
" ore, pyrolusite	3.7–4.6	259	Moisture Contents:		
Mercury	13.59	848	Seasoned timber 12%	....	......
Molybdenum	9.01	562	Green timber up to 50%	....	......
Nickel	8.57–8.90	545			
" monel metal	8.8–9.0	556	**Various Liquids**		
Platinum, cast-hammered	21.1–21.5	1330	Alcohol, 100%	0.79	49
Silver, cast-hammered	10.4–10.6	656	Acids, Muriatic 40%	1.20	75
Steel	7.8–7.9	490	" nitric 91%	1.50	94
Tin, cast-hammered	7.2–7.5	459	" sulphuric 87%	1.80	112
" babbitt metal	7.1	443	Lye, soda 66%	1.70	106
" ore, cassiterite	6.4–7.0	418	Oils, vegetable	0.91–0.94	58
Tungsten	18.7–19.1	1180	" mineral, lubricants	0.90–0.93	57
Vanadium	5.5–5.7	350	Petroleum	0.88	55
Zinc, cast-rolled	6.9–7.2	440	Gasoline	0.66–0.69	42
" ore, blende	3.9–4.2	253	Water, 4°C, max. density	1.0	62.428
			" 100°C	0.9584	59.830
Various Solids			" ice	0.88–0.92	56
Cork	0.24	15	" snow, fresh fallen	.125	8
Ebony	1.22	76	" sea water	1.02–1.03	64
Fats	0.92–0.94	58			
Glass, common, plate	2.40–2.72	160	**Gases**		
" crystal	2.90–3.00	184	Air, 0°C, 760 mm	1.0	.08071
" flint	3.15–3.90	220	Ammonia	0.5920	.0478
Phosphorus, white	1.83	114	Carbon dioxide	1.5291	.1234
Porcelain, china	2.30–2.50	150	Carbon monoxide	0.9673	.0781
Resins, Rosin, Amber	1.07	67	Gas, illuminating	0.35–0.45	.028-.036
Rubber, caoutchouc	0.93	58	" natural	0.47–0.48	.038-.039
Silicon	2.49	155	Hydrogen	0.0693	.00559
Sulphur, Amorphous	2.05	128	Nitrogen	0.9714	.0784
Wax	0.95–0.98	60	Oxygen	1.1056	.0892

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Lbs. per Cu. Ft.
Minerals		
Asbestos	2.1–2.8	153
Barytes	4.50	281
Basalt	2.7–3.2	184
Bauxite	2.55	159
Borax	1.7–1.8	109
Chalk	1.8–2.6	137
Clay, marl	1.8–2.6	137
Dolomite	2.9	181
Feldspar, orthoclase	2.5–2.6	159
Granite, gneiss	2.6–2.9	172
Greenstone, trap	2.8–3.2	187
Gypsum, alabaster	2.3–2.8	159
Hornblende	3.0	187
Limestone, crystalline	2.4–2.7	160
" oolitic	2.3	144
Magnesite	3.0	187
Marble	2.7–2.8	168
Phosphate rock, apatite	3.2	200
Porphyry	2.6–2.9	172
Pumice, natural	0.37–0.90	40
Quartz, flint	2.5–2.8	165
Sandstone, bluestone	2.2–2.5	147
Slate, shale	2.7–2.8	172
Soapstone, talc	2.6–2.8	169
Stone, Quarried, Piled		
Basalt, granite, gneiss	....	96
Limestone, marble, quartz	....	95
Sandstone	....	82
Shale	....	92
Greenstone, hornblende	....	107
Bituminous Substances		
Asphaltum	1.1–1.5	81
Coal, anthracite	1.4–1.7	97
" bituminous	1.2–1.5	84
" lignite	1.1–1.4	78
" peat, turf, dry	0.65–0.85	47
" charcoal, pine	0.28–0.44	23
" " oak	0.47–0.57	33
" coke	1.0–1.4	75
Graphite	1.9–2.3	131
Paraffine	0.87–0.91	56
Petroleum, crude	0.88	55
" refined	0.79–0.82	50
" benzine	0.73–0.75	46
" gasoline	0.66–0.69	42
Pitch	1.07–1.15	69
Tar, bituminous	1.20	75
Coal and Coke, Piled		
Coal, anthracite	....	47–58
" bituminous, lignite	....	40–54
" peat, turf	....	20–26
" charcoal	....	10–14
" coke	....	23–32

Substance	Specific Gravity	Weight, Lbs. per Cu. Ft.
Ashlar Masonry		
Granite, gneiss	2.6–2.9	172
Limestone, crystalline	2.4–2.7	160
" oolitic	2.3	144
Marble	2.6–2.8	168
Sandstone, bluestone	2.2–2.5	147
Mortar Rubble Masonry		
Granite, gneiss	2.5–2.8	165
Limestone, crystalline	2.3–2.6	156
" oolitic	2.2	138
Marble	2.5–2.7	162
Sandstone, bluestone	2.1–2.4	140
Brick Masonry		
Pressed brick	2.2–2.3	140
Common brick	1.8–2.0	120
Soft brick	1.5–1.7	100
Concrete		
Cement, stone, sand	2.2–2.4	144
" slag, etc.	1.9–2.3	130
" cinder, etc.	1.5–1.7	100
Various Building Material		
Ashes, cinders	....	40–45
Cement, Portland, loose	....	90
" " set	2.7–3.2	183
Lime, gypsum, loose	....	65–75
Mortar, set	1.4–1.9	103
Slags, bank slag	....	67–72
" " screenings	....	98–117
" machine slag	....	96
" slag sand	....	49–55
Earth, etc., Excavated		
Clay, dry	....	63
" damp, plastic	....	110
Clay and gravel, dry	....	100
Earth, dry, loose	....	76
" " packed	....	95
" moist, loose	....	78
" " packed	....	96
" mud, flowing	....	108
" " packed	....	115
Riprap, limestone	....	80–85
" sandstone	....	90
" shale	....	105
Sand, gravel, dry, loose	....	90–105
" " " packed	....	100–120
" " wet	....	118–120
Excavations in Water		
Sand or gravel	....	60
" " " and clay	....	65
Clay	....	80
River mud	....	90
Soil	....	70
Stone riprap	....	65

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

STRENGTH OF MATERIALS

STRESSES PER SQUARE INCH

Metals and Alloys	Stresses in Kips					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate		
Aluminum, cast	15	6.5	12	....	12	11,000,000	....
" bars, sheets	24–28	12–14	....	....	....	....	....
" wire, hard	30–65	16–30	....	....	....	....	....
" " annealed	20–35	14	....	....	....	....	....
" 2% to 7% Ni, Cu, Fe, etc.	40–50	25	....	....	....	....	....
Aluminum Bronze, 5% to 7½% Al	75	40	120	....	....	....	....
" " 10% Al	85–100	60	....	....	....	....	....
Copper, cast	25	6	40	22	30	10,000,000	....
" plates, rods, bolts	32–35	10	32	....	....	....	....
" wire, hard	55–65	....	....	....	....	18,000,000	....
" wire, annealed	36	10	....	....	....	15,000,000	....
Brass, 17% Zn	32.6	8.2	....	23.2	....	....	26.7
" 23% "	....	7.6	42	22.3	....	....	35.8
" 30% "	28.1	8.6	....	26.9	....	....	20.7
" 39% "	41.1	17.4	75	39	....	....	20.7
" 50% "	31	17.9	117	33.5	....	....	5.0
" cast, common	18–24	6	30	20	36	9,000,000	....
" wire, hard	80	....	....	....	....	....	....
" " annealed	50	16	....	....	....	14,000,000	....
Bronze 8% Sn	28.5	19	42	43.7	....	10,000,000	5.5
" 13% "	29.4	20	53	34.5	....	....	3.3
" 20% "	33	....	78	56.7	....	....	0.04
" 24% "	22	22	114	32	....	....	0
" 30% "	5.6	5.6	147	12.1	....	....	0
" gun metal, 9 Cu, 1 Sn	25–55	10	....	52	....	10,000,000	....
" Manganese, cast } 10% Sn	60	30	125	....	....	....	....
" " rolled } 2% Mn	100	80	....	....	....	....	....
" Phosphorus, cast } 9% Sn	50	24	....	....	....	....	....
" " wire } 1% P	100	....	....	....	....	....	....
" Silicon, cast, 3% Si	55	....	....	....	....	....	....
" " " 5% Si	75	....	....	....	....	....	....
" " wire	108	....	....	....	....	....	....
" Tobin, cast } 38% Zn	66	....	....	....	....	....	....
" " rolled } 1½% Sn	80	40	....	....	....	4,500,000	....
" " cold rolled } ⅓% Pb	100	....	....	....	....	....	....
Delta Metal, cast } 55% to 60% Cu	45	....	....	....	....	....	....
" " plates } 38% to 40% Zn	68	....	....	....	....	....	....
" " bars } 2% to 4% Fe	85	....	....	....	....	....	....
" " wire } 1% to 2% Sn	100	....	....	....	....	....	....
German Silver, 25% Zn, 20% Ni	....	....	....	....	....	....	....
Iron, see next page	....	....	....	....	....	....	....
Gold, cast	20	4	....	....	....	8,000,000	....
" wire	30	....	....	....	....	....	....
" copper, 5 Au, 1 Cu	50	....	....	....	....	....	....
Lead, cast	1.8	....	....	....	....	1,000,000	....
" pipe, wire	2.2–2.5	....	....	....	....	1,000,000	....
" rolled sheets	3.3	....	....	....	....	720,000	....
Platinum, wire, unannealed	53	....	....	....	....	....	....
" " annealed	32	....	....	....	....	....	....
Silver, cast	40	....	....	....	....	....	....
Steel, see next page	....	....	....	....	....	....	....
Tin, cast	3.5–4.6	1.5–1.8	6	4	....	4,000,000	....
" antimony, 10 Sn, 1 Sb	11	....	....	....	....	....	....
Zinc, cast	4–6	4	18	7	....	13,000,000	....
" rolled sheets	7–16	....	....	....	....	....	....

STRENGTH OF MATERIALS

STRESSES PER SQUARE INCH

Metals and Alloys	Stresses in Kips					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate		
Steel							
Shapes, Plates, Bars*							
" bridges	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27.3–23.1
" buildings	55–65	"	"	"	"	29,000,000	25.5–21.5
" cars	50–65	"	"	"	"	29,000,000	30.0–23.1
" locomotives	55–65	"	"	"	"	29,000,000	27.3–23.1
" ships	60–72	"	"	"	"	29,000,000	25.0–21.1
Boiler Plates*							
" " flange plates	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27.3–23.1
" " fire box	52–62	"	"	"	"	29,000,000	28.8–24.2
Rivets*							
" boilers	45–55	½ tens.	tensile	tensile	¾ tens.	29,000,000	33.3–27.3
" bridges	52–62	"	"	"	"	29,000,000	28.8–24.2
" buildings	52–62	"	"	"	"	29,000,000	28.8–24.2
" cars	52–62	"	"	"	"	29,000,000	28.8–24.2
" ships	55–65	"	"	"	"	29,000,000	27.3–23.0
Concrete Bars*							
" plain, structural grade	55–70	33	tensile	tensile	¾ tens.	29,000,000	25.5–20.0
" " intermediate	70–90	40	"	"	"	29,000,000	18.6–14.3
" " hard	80	50	"	"	"	29,000,000	15.0
" deformed, struct'l grade	55–70	33	"	"	"	29,000,000	22.7–17.9
" " intermediate	70–90	40	"	"	"	29,000,000	16.1–11.3
" " hard	80	50	"	"	"	29,000,000	12.5
" cold twisted	.....	55	"	"	"	29,000,000	5.0
Castings*							
" soft	60	30	tensile	tensile	¾ tens.	29,000,000	26
" medium	70	38	"	"	"	29,000,000	24
" hard	80	43	"	"	"	29,000,000	17
Forgings*	.....	.....	.....	.....	.....	....	....
Steel Alloys							
Nickel Steel,* 3.25% Ni.							
" shapes, plates, bars	85–100	50	tensile	tensile	¾ tens.	29,000,000	17.6–15.0
" rivets	70–80	45	"	"	"	29,000,000	21.4–18.8
" eye bars, unannealed	95–110	55	"	"	"	29,000,000	15.8–13.6
" " " annealed	90–105	52	"	"	"	29,000,000	20.0
Steel Springs and Wire							
Springs, untempered	65–110	40–70	.....	.....	.....	....	....
Wire, unannealed	120	60	.....	.....	.....	....	....
" annealed	80	40	.....	.....	.....	....	....
" bridge cable	200	95	.....	.....	.....	....	....
Wrought Iron							
Shapes	48	26	tensile	tensile	⅚ tens.	28,000,000	....
Bars	50	27	"	"	"	28,000,000	....
Wire, unannealed	80	.....	.....	.....	.....	15,000,000	....
" annealed	60	27	.....	.....	.....	25,000,000	....
Cast Iron							
Common	15–18	6	80	30	18–20	12,000,000	....
Gray	18–24	.....	.....	25–33	.....	....	....
Malleable	27–35	15–20	46	30	40	....	....

*See Specifications of the American Society for Testing Materials.

STRENGTH OF MATERIALS

STRESSES IN POUNDS PER SQUARE INCH

Building Materials	Ultimate Average Stresses			Modulus of Elasticity	Safe Working Stresses		
	Compress.	Tension	Bending		Compress.	Bearing	Shearing
Stone							
Granite, gneiss, bluestone.....	12,000	1,200	1,600	7,000,000	1,200	1,200	200
Limestone, marble...........	8,000	800	1,500	7,000,000	800	800	150
Sandstone.................	5,000	150	1,200	3,000,000	500	500	150
Slate.....................	10,000	3,000	5,000	14,000,000	1,000	1,000	175
Masonry							
Granite..................	......	......	......	....	420	600	......
Limestone, bluestone.........	......	......	......	....	350	500	......
Sandstone.................	......	......	......	....	280	400	......
Rubble....................	......	......	......	....	140	250	......
" coursed............	......	......	......	....	170	250	......
Brick, medium burned.......	10,000	......	......	....	170	300	......
" hard burned..........	15,000	......	......	....	210	300	......
" pressed, paving brick...	6,000	......	......	....	......	......	......
Terra Cotta................	5,000	......	......	....	......	......	......
Cement, Portland							
Neat, 28 days............	7,040	740	......	....	......	......	......
" 90 days............	7,350	740	......	....	......	......	......
1:3 sand, 28 days............	1,290	320	......	....	......	......	......
" 90 days............	1,490	340	......	....	......	......	......
Concrete, P. C.							
1:1:2 Granite, trap rock........	3,300						
1:1:2 Furnace Slag............	3,000						
1:1:2 Lime and Sandstone, hard.	3,000						
1:1:2 Lime and Sandstone, soft..	2,200						
1:1:2 Cinders................	800						
1:1½:3 Granite, trap rock........	2,800						
1:1½:3 Furnace Slag............	2,500						
1:1½:3 Lime and Sandstone, hard.	2,500						
1:1½:3 Lime and Sandstone, soft..	1,800						
1:1½:3 Cinders................	700						
1:2:4 Granite, trap rock........	2,200						
1:2:4 Furnace Slag............	2,000						
1:2:4 Lime and Sandstone, hard.	2,000						
1:2:4 Lime and Sandstone, soft..	1,500						
1:2:4 Cinders................	600						
1:2½:5 Granite, trap rock........	1,800						
1:2½:5 Furnace Slag............	1,600						
1:2½:5 Lime and Sandstone, hard.	1,600						
1:2½:5 Lime and Sandstone, soft..	1,200						
1:2½:5 Cinders................	500						
1:3:6 Granite, trap rock........	1,400						
1:3:6 Furnace Slag............	1,300						
1:3:6 Lime and Sandstone, hard.	1,300						
1:3:6 Lime and Sandstone, soft..	1,000						
1:3:6 Cinders................	400						
Miscellaneous							
Glass, common...............	30,000	3,000	......	....	......	......	......
Plaster....................	700	70	3,000	8,000,000	......	......	......

Reinforced Concrete

Modulus of Elasticity	3,000,000 for ult. compression over 2,900. 2,500,000 for ult. compression up to 2,900. 2,000,000 for ult. compression up to 2,200. 750,000 for ult. compression under 800.

Safe Working Stresses in Percent of Ultimate Compression

Compression	Plain Concrete Piers, length 4 dia. 22.5% Reinforced Columns, " 12 " 22.5% Reinforced Beams, 32.5%
Bearing	Surface twice the loaded area......35.0%
Shear and Diag. Tension	HorizontalBars,nowebreinforcement 2.0% " " vertical stirrups... 4.5% Bent Bars and vertical stirrups..... 5.0% Same, securely attached........... 6.0%
Bond Stress	Drawn Wire..................... 2.0% Plain reinforcing bars............. 4.0% Deformed Bars, best type......... 5.0%

For complete data see Transactions of the American Society of Civil Engineers, Vol. LXXXI–No.1398, Dec. 1917

For working stresses of Structural Timber, see pages 428, 429.

EXPANSION AND CONTRACTION OF BODIES BY CHANGES IN TEMPERATURE

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with a change of one degree of temperature; the square surface coefficient of expansion is, approximately, two times, and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length $= l$tn, where l is the length of the bar in inches, t the change in temperature in degrees, n the corresponding linear coefficient; if fixed at both ends, the internal stress per unit of area = tnE pounds per square inch, where E is the modulus of elasticity, and the total temperature stress = AtnE pounds, where A is the area of the cross section of the bar in square inches.

To find the change in length of a bar, due to a change in temperature, multiply the length of the bar by that change in degrees and by the coefficient for one degree.

LINEAR COEFFICIENTS OF EXPANSION FOR ONE DEGREE

Substance	Coefficient, n		Substance	Coefficient, n	
	Centigrade	Fahrenheit		Centigrade	Fahrenheit
Metals and Alloys			**Stone and Masonry**		
Aluminum, wrought	.0000231	.0000128	Ashlar masonry	.0000063	.0000035
Brass	.0000188	.0000104	Brick masonry	.0000055	.0000031
" wire	.0000193	.0000107	Cement, Portland	.0000107	.0000059
Bronze	.0000181	.0000101	Concrete	.0000143	.0000079
Copper	.0000168	.0000093	" masonry	.0000120	.0000067
German Silver	.0000183	.0000102	Granite	.0000084	.0000047
Gold	.0000150	.0000083	Limestone	.0000080	.0000044
Iron, cast, gray	.0000106	.0000059	Marble	.0000100	.0000056
" wrought	.0000120	.0000067	Plaster	.0000166	.0000092
" wire	.0000124	.0000069	Rubble masonry	.0000063	.0000035
Lead	.0000286	.0000159	Sandstone	.0000110	.0000061
Nickel	.0000126	.0000070	Slate	.0000104	.0000058
Platinum	.0000090	.0000050	**Timber**		
Platinum-Iridium, 15% Ir.	.0000081	.0000045	Fir, parallel to fiber	.0000037	.0000021
Silver	.0000192	.0000107	Maple, parallel to fiber	.0000064	.0000036
Steel, cast	.0000110	.0000061	Oak, parallel to fiber	.0000049	.0000027
" hard	.0000132	.0000073	Pine, parallel to fiber	.0000054	.0000030
" medium	.0000120	.0000067	Fir, perpendicular to fiber	.000058	.000032
" soft	.0000110	.0000061	Maple, perpendicular to fiber	.000048	.000027
Tin	.0000210	.0000117	Oak, perpendicular to fiber	.000054	.000030
Zinc, rolled	.0000311	.0000173	Pine, perpendicular to fiber	.000034	.000019
Miscellaneous Solids			**Liquid Substances**	Volumetric Expan.	
Glass	.0000085	.0000047	Alcohol	.00104	.00058
Graphite	.0000079	.0000044	Acid, nitric	.00110	.00061
Gutta-percha	.0005980	.0003322	" sulphuric	.00063	.00035
Paraffin	.0002785	.0001547	Mercury	.00018	.00010
Porcelain	.0000036	.0000020	Oil, turpentine	.00090	.00050

EXPANSION OF WATER, MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

EQUIVALENTS OF MEASURE

LENGTHS

1 meter (m) = 10 decimeters (dm) = 100 centimeters (cm) = 1000 millimeters (mm).
1 meter (m) = 0.1 decameter (dkm) = 0.01 hectometer (hm) = 0.001 kilometer (km).
1 meter (m) = 39.37 inches, U. S. Standard = 39.370113 inches, British Standard.
1 millimeter (mm) = 1000 microns (μ) = 0.03937 inch = 39.37 mils.

Meters, m	Inches, in.	Feet, ft.	Yard, yd.	Rods, r.	Chains, ch.	Miles, U. S.		Kilometers, km
						Statute	Nautical	
1	39.37	3.28083	1.09361	0.19884	0.04971	$0.\overset{3}{0}6214$	$0.\overset{3}{0}5396$	0.001
0.02540	1	0.08333	0.02778	$0.\overset{2}{0}5051$	$0.\overset{2}{0}1263$	$0.\overset{4}{0}1578$	$0.\overset{4}{0}1371$	$0.\overset{4}{0}2540$
0.30480	12	1	0.33333	0.06061	0.01515	$0.\overset{3}{0}1894$	$0.\overset{3}{0}1645$	$0.\overset{3}{0}3048$
0.91440	36	3	1	0.18182	0.04545	$0.\overset{3}{0}5682$	$0.\overset{3}{0}4934$	$0.\overset{3}{0}9144$
5.02921	198	16.5	5.5	1	0.25	$0.\overset{2}{0}3125$	$0.\overset{2}{0}2714$	$0.\overset{2}{0}5029$
20.1168	792	66	22	4	1	0.01250	0.01085	0.02012
1609.35	63360	5280	1760	320	80	1	0.86839	1.60935
1853.25	72962.5	6080.20	2026.73	368.497	92.1243	1.15155	1	1.85325
1000	39370	3280.83	1093.61	198.838	49.7096	0.62137	0.53959	1

1 yard, U. S. = 1.0000029 yards, British. 1 yard, British = 0.9999971 yard, U. S.
1 chain, Gunter's = 100 links. 1 link = 7.92 inches.
1 cable length, U. S. = 120 fathoms = 960 spans = 720 feet = 219.457 meters.
1 league, U. S. = 3 statute miles = 24 furlongs.
1 international geographical mile = 1/15° at equator = 7422 m = 4.611808 U. S. statute miles.
1 international nautical mile = 1/60° at meridian = 1852 m = 0.999326 U. S. nautical miles.
1 U. S. nautical mile = 1/60° of circumference of sphere whose surface equals that of the earth = 6080.27 feet = 1.15155 statute miles = 1853.27 meters.
1 British nautical mile = 6080.00 feet = 1.15152 statute miles = 1853.19 meters.

SURFACES AND AREAS

1 sq. meter (m^2) = 100 sq. decimeters (dm^2) = 10000 sq. centimeters (cm^2).
1 sq. meter (m^2) = 0.01 are (a) = 0.0001 hectare (ha).
1 sq. millimeter (mm^2) = 0.01 cm^2 = 0.00155 sq. inch = 1973.5 circular mils.
1 are (a) = 1 sq. decameter (dkm) = 0.0247104 acre.

Sq. Meters, m^2	Sq. Inches, sq. in.	Sq. Feet, sq. ft.	Sq. Yards, sq. yd.	Sq. Rods, sq. r.	Acres, A	Hectares, ha.	Sq. Miles, Statute	Sq. Kilometers, km^2
1	1550.00	10.7639	1.19599	0.03954	$0.\overset{3}{0}2471$	0.0001	$0.\overset{6}{0}3861$	$0.\overset{5}{0}1$
$0.\overset{3}{0}6452$	1	$0.\overset{2}{0}6944$	$0.\overset{3}{0}7716$	$0.\overset{4}{0}2551$	$0.\overset{6}{0}1594$	$0.\overset{7}{0}6452$	$0.\overset{9}{0}2491$	$0.\overset{9}{0}6452$
0.09290	144	1	0.11111	$0.\overset{2}{0}3673$	$0.\overset{4}{0}2296$	$0.\overset{5}{0}9290$	$0.\overset{7}{0}3587$	$0.\overset{7}{0}9290$
0.83613	1296	9	1	0.03306	$0.\overset{3}{0}2066$	$0.\overset{4}{0}8361$	$0.\overset{6}{0}3228$	$0.\overset{6}{0}8361$
25.2930	39204	272.25	30.25	1	0.00625	$0.\overset{2}{0}2529$	$0.\overset{5}{0}9766$	$0.\overset{4}{0}2529$
4046.87	6272640	43560	4840	160	1	0.40469	$0.\overset{2}{0}1563$	$0.\overset{2}{0}4047$
10000	15499969	107639	11959.9	395.366	2.47104	1	$0.\overset{2}{0}3861$	0.01
2589999	....	27878400	3097600	102400	640	259.000	1	2.59000
1000000	....	10763867	1195985	39536.6	247.104	100	0.38610	1

1 sq. rod, sq. pole, or sq. perch = 625 sq. links = 1/160 acre.
1 sq. chain, Gunter's = 16 sq. rods = 1/10 acre.
1 acre = 4 roods = 160 sq. rods. Square of 1 acre = 208.7103 feet square.

Notations $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., indicate that the $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.
EXAMPLE. 1 sq. rod = $0.\overset{5}{0}9766$ = 0.000009766 sq. miles.

EQUIVALENTS OF MEASURE

VOLUME AND CAPACITY

1 cu. meter (m^3) = 1000 cu. decimeter (dm^3) = 1000000 cu. centimeters (cm^3).
1 liter (l) = 10 deciliters (dl) = 100 centiliters (cl) = 1000 milliliters (ml) = 1000 cu. centimeters, (cm^3 or c.c.)
1 liter (l) = 0.1 decaliter (dkl) = 0.01 hectoliter (hl) = 1 cu. decimeter (dm^3).

Cubic Decimeters, dm^3 or Liters, l	Cubic Inches, cu. in.	Cubic Feet, cu. ft.	Cubic Yards, cu. yd.	U. S. Quarts		U. S. Gallons		U. S. Bushels, bu.
				Liquid, l. qt.	Dry, d. qt.	Liquid, l. gal.	Dry, d. gal.	
1	61.0234	0.03531	$0.{}^{2}_{0}1308$	1.05668	0.90808	0.26417	0.22702	0.02838
0.01639	1	$0.{}^{3}_{0}5787$	$0.{}^{4}_{0}2143$	0.01732	0.01488	$0.{}^{2}_{0}4329$	$0.{}^{2}_{0}3720$	$0.{}^{3}_{0}4650$
28.3170	1728	1	0.03704	29.9221	25.7140	7.48055	6.42851	0.80356
764.559	46656	27	1	807.896	694.279	201.974	173.570	21.6962
0.94636	57.75	0.03342	$0.{}^{2}_{0}1238$	1	0.85937	0.25	0.21484	0.02686
1.10123	67.2006	0.03889	$0.{}^{2}_{0}1440$	1.16365	1	0.29091	0.25	0.03125
3.78543	231	0.13368	$0.{}^{2}_{0}4951$	4	3.43747	1	0.85937	0.10742
4.40492	268.803	0.15556	$0.{}^{2}_{0}5761$	4.65460	4	1.16365	1	0.125
35.2393	2150.42	1.24446	0.04609	37.2368	32	9.30920	8	1

U. S. Dry Measure: 1 bushel = 4 pecks = 8 gallons = 32 quarts = 64 pints.
U. S. Liquid Measure: 1 gallon = 4 quarts = 8 pints = 32 gills = 128 fluid ounces.
U. S. Apoth. Measure: 1 fl. ounce (f ℥) = 8 fl. drams (f ʒ) = 480 minims (♏) = 29.574 cm^3.
British Imperial gallon dry and liquid measure = 1.03202 U. S. dry gal. = 1.20091 U. S. liquid gal.
British Imperial gallon = 277.410 cu. in. = 4545.9631 cm^3.
Weight of water at maximum density, 4°C, 45° Lat., at sea level.
1 cu. ft. = 62.4283 lbs. av. = 28.3170 kg. 1 cu. in. = 0.57804 oz. av. = 16.3872 g.
1 gal., U. S. liquid = 8.34545 lbs. = 3.78543 kg.
1 gal., British Imperial = 10.0221 lbs. = 4.5459631 kg.

MASSES AND WEIGHTS

1 gram (g) = 10 decigrams (dg) = 100 centigrams (cg) = 1000 milligrams (mg).
1 gram (g) = 0.1 decagram (dkg) = 0.01 hectogram (hg) = 0.001 kilogram (kg).
1 kilogram (kg) = 1 liter of water, (4°C, 45° Lat. at sea level) = 15432.35639 grains, U. S. and British Standard.

Kilograms, kg	Grains, gr.	Ounces		Pounds		Tons		
		Troy, oz. t.	Avoir., oz. av.	Troy, lb. t.	Avoir., lb. av.	Net, (Short), 2000 lbs.	Gross, (Long), 2240 lbs.	Metric, 1000 kg
1	15432.4	32.1507	35.2740	2.67923	2.20462	$0.{}^{2}_{0}1102$	$0.{}^{3}_{0}9842$	0.001
$0.{}^{4}_{0}6480$	1	$0.{}^{2}_{0}2083$	$0.{}^{2}_{0}2286$	$0.{}^{3}_{0}1736$	$0.{}^{3}_{0}1429$	$0.{}^{7}_{0}7143$	$0.{}^{7}_{0}6378$	$0.{}^{7}_{0}6480$
0.03110	480	1	1.09714	0.08333	0.06857	$0.{}^{4}_{0}3429$	$0.{}^{4}_{0}3061$	$0.{}^{4}_{0}3110$
0.02835	437.5	0.91146	1	0.07595	0.06250	$0.{}^{4}_{0}3125$	$0.{}^{4}_{0}2790$	$0.{}^{4}_{0}2835$
0.37324	5760	12	13.1657	1	0.82286	$0.{}^{3}_{0}4114$	$0.{}^{3}_{0}3674$	$0.{}^{3}_{0}3732$
0.45359	7000	14.5833	16	1.21528	1	0.00050	$0.{}^{3}_{0}4464$	$0.{}^{3}_{0}4536$
907.185	14000000	29166.7	32000	2430.56	2000	1	0.89286	0.90719
1016.05	15680000	32666.7	35840	2722.22	2240	1.12	1	1.01605
1000	15432356	32150.7	35274.0	2679.23	2204.62	1.10231	0.98421	1

1 ounce avoir. = 16 drams, avoir. 1 ounce troy = 20 pennyweight (dwt).
1 ounce apoth. (℥) = 8 drams (ʒ) = 24 scruples (℈) = 480 grains (gr) = 31.1035 g.
1 long hundredweight (l cwt.) = 1/20 long ton = 4 quarters = 8 stone = 112 lbs. = 50.8024 kg.

Notations ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., indicate that the ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.
EXAMPLE. 1 grain = $0.{}^{2}_{0}2083$ = 0.002083 oz. t. 1 grain = $0.{}^{4}_{0}6480$ = 0.00006480 kg.

EQUIVALENTS OF MEASURE

FORCES OR WEIGHTS PER UNITS OF LENGTH (LINEAR WEIGHTS)

1 dyne per centimeter = 0.00101979 g/cm = 0.000183719 poundal/in.
1 gram per centimeter = 980.5966 dynes/cm = 0.180154 poundal/in.
1 poundal per inch = 5443.11 dynes/cm = 5.55081 g/cm = 0.0310832 pound/in.

Grams per Centimeter, g/cm	Grains per Inch, gr./in.	Pounds per Inch, lb./in.	Pounds per Foot, lb./ft.	Pounds per Yard, lb./yd.	Kilograms per Meter, kg/m	Net Tons, (2000 lbs.), per Mile	Gross Tons, (2240 lbs.), per Mile	Metric Tons, (1000 kg, per Kilometer
1	39.1983	$0.{}^{2}_{0}5600$	0.06720	0.20159	0.10	0.17740	0.15839	0.10
0.02551	1	$0.{}^{3}_{0}1429$	$0.{}^{2}_{0}1714$	$0.{}^{2}_{0}5143$	$0.{}^{2}_{0}2551$	$0.{}^{2}_{0}4526$	$0.{}^{2}_{0}4041$	$0.{}^{2}_{0}2551$
178.579	7000	1	12	36	17.8579	31.6800	28.2857	17.8579
14.8816	583.333	0.08333	1	3	1.48816	2.64000	2.35714	1.48816
4.96054	194.444	0.02778	0.33333	1	0.49605	0.88000	0.78571	0.49605
10	391.983	0.05600	0.67197	2.01591	1	1.77400	1.58393	1
5.63698	220.960	0.03157	0.37879	1.13636	0.56370	1	0.89286	0.56370
6.31342	247.475	0.03535	0.42424	1.27273	0.63134	1.12	1	0.63134

FORCES OR WEIGHTS PER UNITS OF AREA (PRESSURE)

1 dyne per sq. centimeter = 0.00101979 g/cm² = 0.000466646 poundals/in².
1 gram per sq. centimeter = 980.5966 dynes/cm² = 0.457592 poundals/in².
1 poundal per sq. inch = 2142.95 dynes/cm² = 2.18536 g/cm² = 0.0310832 pound/in².

Kilograms per Sq. Centimeter, kg/cm²	Pounds per Sq. Inch, lb./in.²	Pounds per Sq. Foot, lb./ft.²	Net Tons, (2000 lbs.), per Sq. Foot	Atmospheres, Standard, 760 mm	Columns of Mercury, (Hg) 13.59593 Sp. G.		Columns of Water, Max. Density 4° C	
					Millimeters	Inches	Meters	Feet
1	14.2234	2048.17	1.02408	0.96778	735.514	28.9572	10	32.8083
0.07031	1	144	0.07200	0.06804	51.7116	2.03588	0.70307	2.30665
$0.{}^{3}_{0}4882$	$0.{}^{2}_{0}6944$	1	0.00050	$0.{}^{3}_{0}4725$	0.35911	0.01414	$0.{}^{2}_{0}4882$	0.01602
0.97648	13.8889	2000	1	0.94502	718.216	28.2762	9.76482	32.0367
1.03329	14.6969	2116.35	1.05818	1	760	29.9212	10.3329	33.9006
$0.{}^{2}_{0}1360$	0.01934	2.78468	$1.{}^{2}_{0}1392$	$0.{}^{2}_{0}1316$	1	0.03937	0.01360	0.04461
0.03453	0.49119	70.7310	0.03537	0.03342	25.4001	1	0.34534	1.13299
0.10	1.42234	204.817	0.10241	0.09678	73.5514	2.89572	1	3.28083
0.03048	0.43353	62.4283	0.03121	0.02950	22.4185	0.88262	0.30480	1

FORCES OR WEIGHTS PER UNITS OF VOLUME (DENSITY)

1 dyne per cu. centimeter = 0.00101979 gram/cm³ = 0.00118528 poundals/in³.
1 gram per cu. centimeter = 980.5966 dynes/cm³ = 1.162283 poundals/in³.
1 poundal per cu. inch = 843.683 dynes/cm³ = 0.860378 g/cm³ = 0.0310832 pound/in³.

Grams per Cu. Centimeter, g/cm³	Pounds per Cu. Inch, lb./in.³	Pounds per Cu. Foot, lb./ft.³	Pounds per Cu. Yard, lb./yd.³	Kilograms per Cu. Meter, kg/m³	Pounds per Bushel, U. S.	Pounds per Gallon, Dry, U. S.	Pounds per Gallon, Liquid, U. S.	Kilograms per Hectoliter kg/hl
1	0.03613	62.4283	1685.56	1000	77.6893	9.71116	8.34545	100
27.6797	1	1728	46656	27679.7	2150.42	268.803	231	2767.97
0.01602	$0.{}^{3}_{0}5787$	1	27	16.0184	1.24446	0.15556	0.13368	1.60184
$0.{}^{3}_{0}5933$	$0.{}^{4}_{0}2143$	0.03704	1	0.59327	0.04609	$0.{}^{2}_{0}5762$	$0.{}^{2}_{0}4951$	0.05933
0.001	$0.{}^{4}_{0}3613$	0.06243	1.68556	1	0.07769	$0.{}^{2}_{0}9711$	$0.{}^{2}_{0}8345$	0.10
0.01287	$0.{}^{3}_{0}4650$	0.80356	21.6962	12.8718	1	0.125	0.10742	1.28718
0.10297	$0.{}^{2}_{0}3720$	6.42851	173.570	102.974	8	1	0.85937	10.2974
0.11983	$0.{}^{2}_{0}4329$	7.48052	201.974	119.826	9.30920	1.16365	1	11.9826
0.01	$0.{}^{3}_{0}3613$	0.62428	16.8557	10	0.77689	0.09711	0.08345	1

Notations ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., indicate that the ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.
Example. 1 kg/m³ = $0.{}^{4}_{0}3613$ = 0.00003613 lb./in³.

EQUIVALENTS OF MEASURE

ENERGY, WORK, HEAT

1 dyne-centimeter = 1 erg = 0.00101979 gram-centimeter = $0.{}^{7}_{0}737612$ foot-pound.
1 gram-centimeter = 980.5966 ergs = $0.{}^{4}_{0}7233$ foot-pound.
1 foot-pound = 13557300 ergs = 13825.5 gram-centimeters.

Kilogram-meters, kg-m	Foot-Pounds, ft.-lbs.	Horsepower-hour		Poncelet-hours, 100 kg-m-h	Kilowatt-hours, kw-h	Joules, 10^7 ergs, J	Thermal Units	
		U. S., H. P.-h	Metric, 75 kg-m-h				B. T. U.	Calories, kg-cal
1	7.23300	$0.{}^{5}_{0}3653$	$0.{}^{5}_{0}3704$	$0.{}^{5}_{0}2778$	$0.{}^{5}_{0}2724$	9.80597	$0.{}^{2}_{0}9296$	$0.{}^{2}_{0}2342$
0.13826	1	$0.{}^{6}_{0}5051$	$0.{}^{6}_{0}5121$	$0.{}^{6}_{0}3840$	$0.{}^{6}_{0}3766$	1.35573	$0.{}^{2}_{0}1285$	$0.{}^{3}_{0}3239$
273745	1980000	1	1.01387	0.76040	0.74565	2684340	2544.65	641.240
270000	1952910	0.98632	1	0.75	0.73545	2647610	2509.83	632.467
360000	2603880	1.31509	1.33333	1	0.98060	3530147	3346.44	843.289
367123	2655403	1.34111	1.35972	1.01979	1	3600000	3412.66	859.975
0.10198	0.73761	$0.{}^{6}_{0}3725$	$0.{}^{6}_{0}3777$	$0.{}^{6}_{0}2833$	$0.{}^{6}_{0}2778$	1	$0.{}^{3}_{0}9480$	$0.{}^{3}_{0}2389$
107.577	778.104	$0.{}^{3}_{0}3930$	$0.{}^{3}_{0}3984$	$0.{}^{3}_{0}2988$	$0.{}^{3}_{0}2930$	1054.90	1	0.25200
426.900	3087.77	$0.{}^{2}_{0}1559$	$0.{}^{2}_{0}1581$	$0.{}^{2}_{0}1186$	$0.{}^{2}_{0}1163$	4186.17	3.96832	1

POWER, RATE OF ENERGY AND HEAT

1 erg per sec. = 1 dyne-cm/sec. = 0.00101979 gram-cm/sec. = $0.{}^{7}_{0}737612$ foot-pound/sec.
1 gram-centimeter per second = 980.5966 ergs/sec. = $0.{}^{4}_{0}7233$ foot-pound/sec.
1 foot-pound per second = 13557300 ergs/sec = 13825.5 gram-cm/sec.

Kilogram-meters per Second, kg-m/sec.	Foot-pounds per Second, ft.-lbs./sec.	Horsepower		Poncelet, 100 kg-m/sec.	Kilowatt, kw.	Watts, 10^7 ergs/sec.	Thermal Units per Sec.	
		U. S., 550 ft.-lbs./sec.	Metric, 75 kg-m/sec.				B. T. U., B.T.U./sec.	Calorie, kg-cal/sec.
1	7.23300	0.01315	0.01333	0.01	$0.{}^{2}_{0}9806$	9.80597	$0.{}^{2}_{0}9296$	$0.{}^{2}_{0}2342$
0.13826	1	$0.{}^{2}_{0}1818$	$0.{}^{2}_{0}1843$	$0.{}^{2}_{0}1383$	$0.{}^{2}_{0}1356$	1.35573	$0.{}^{2}_{0}1285$	$0.{}^{3}_{0}3237$
76.0404	550	1	1.01387	0.76040	0.74565	745.650	0.70685	0.17812
75	542.475	0.98632	1	0.75	0.73545	735.448	0.69718	0.17569
100	723.300	1.31509	1.33333	1	0.98060	980.597	0.92957	0.23425
101.979	737.612	1.34111	1.35972	1.01979	1	1000	0.94796	0.23888
0.10198	0.73761	$0.{}^{2}_{0}1341$	$0.{}^{2}_{0}1360$	$0.{}^{2}_{0}1020$	0.001	1	$0.{}^{3}_{0}9480$	$0.{}^{3}_{0}2389$
107.577	778.104	1.41474	1.43436	1.07577	1.05490	1054.90	1	0.25200
426.900	3087.77	5.61412	5.69200	4.26900	4.18617	4186.17	3.96832	1

VELOCITIES AND ACCELERATIONS

1 kine = 1 centimeter per second = 0.0328083 foot per second.
1 radian per second = 57.2958 degrees per sec. = 0.159155 revolutions per sec.
1 gravity = 980.5966 centimeters per sec. per sec. = 32.1717 feet per sec. per sec.

Meters per Second, m/sec.	Feet per Second, ft./sec.	Miles per Hour, M/h	Knots per Hour, U. S.	Kilometers per Hour, km/h	Meter per Sec. per Sec. m/sec./sec.	Feet per Sec. per Sec. ft./sec./sec.	Miles per Hour per Sec. M/h/sec.	Kilometers per Hour per Sec. km/h/sec.
1	3.28083	2.23693	1.94254	3.6	....	....	....	....
0.30480	1	0.68182	0.59209	1.09728	....	....	....	....
0.44704	1.46667	1	0.86839	1.60935	....	....	....	....
0.51479	1.68894	1.15155	1	1.85325	....	....	....	....
0.27778	0.91134	0.62137	0.53959	1	....	....	....	....
....	....	....	....	....	1	3.28083	2.23693	3.6
....	....	....	....	....	0.30480	1	0.68182	1.09728
....	....	....	....	....	0.44704	1.46667	1	1.60935
....	....	....	....	....	0.27778	0.91134	0.62137	1

Notations ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., indicate that the ${}^{2}_{0}$, ${}^{3}_{0}$, ${}^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.
EXAMPLE. 1 Calorie = $0.{}^{2}_{0}1163$ = 0.001163 kilowatt-hours.

METRIC CONVERSION TABLE

INCHES AND FRACTIONS OF AN INCH TO MILLIMETERS

39.37 Inches, U. S. Standard = 1 Meter = 100 Centimeters = 1000 Millimeters

Fractions	Inches											Fractions
	0	1	2	3	4	5	6	7	8	9	10	
0	0.00	25.40	50.80	76.20	101.60	127.00	152.40	177.80	203.20	228.60	254.00	0
1/64	0.40	25.80	51.20	76.60	102.00	127.40	152.80	178.20	203.60	229.00	254.40	1/64
1/32	0.79	26.19	51.59	76.99	102.39	127.79	153.19	178.59	203.99	229.39	254.79	1/32
3/64	1.19	26.59	51.99	77.39	102.79	128.19	153.59	178.99	204.39	229.79	255.19	3/64
1/16	1.59	26.99	52.39	77.79	103.19	128.59	153.99	179.39	204.79	230.19	255.59	1/16
5/64	1.98	27.38	52.79	78.18	103.58	128.98	154.38	179.78	205.18	230.58	255.99	5/64
3/32	2.38	27.78	53.18	78.58	103.98	129.38	154.78	180.18	205.58	230.98	256.38	3/32
7/64	2.78	28.18	53.58	78.98	104.38	129.78	155.18	180.58	205.98	231.38	256.78	7/64
1/8	3.18	28.58	53.98	79.38	104.78	130.18	155.58	180.98	206.38	231.78	257.18	1/8
9/64	3.57	28.97	54.37	79.77	105.17	130.57	155.97	181.37	206.77	232.17	257.57	9/64
5/32	3.97	29.37	54.77	80.17	105.57	130.97	156.37	181.77	207.17	232.57	257.97	5/32
11/64	4.37	29.77	55.17	80.57	105.97	131.37	156.77	182.17	207.57	232.97	258.37	11/64
3/16	4.76	30.16	55.56	80.96	106.36	131.76	157.16	182.56	207.96	233.36	258.76	3/16
13/64	5.16	30.56	55.96	81.36	106.76	132.16	157.56	182.96	208.36	233.76	259.16	13/64
7/32	5.56	30.96	56.36	81.76	107.16	132.56	157.96	183.36	208.76	234.16	259.56	7/32
15/64	5.95	31.35	56.75	82.15	107.55	132.95	158.35	183.75	209.15	234.55	259.95	15/64
1/4	6.35	31.75	57.15	82.55	107.95	133.35	158.75	184.15	209.55	234.95	260.35	1/4
17/64	6.75	32.15	57.55	82.95	108.35	133.75	159.15	184.55	209.95	235.35	260.75	17/64
9/32	7.14	32.54	57.94	83.34	108.74	134.14	159.54	184.94	210.34	235.74	261.14	9/32
19/64	7.54	32.94	58.34	83.74	109.14	134.54	159.94	185.34	210.74	236.14	261.54	19/64
5/16	7.94	33.34	58.74	84.14	109.54	134.94	160.34	185.74	211.14	236.54	261.94	5/16
21/64	8.33	33.73	59.13	84.53	109.93	135.33	160.73	186.13	211.53	236.93	262.34	21/64
11/32	8.73	34.13	59.53	84.93	110.33	135.73	161.13	186.53	211.93	237.33	262.73	11/32
23/64	9.13	34.53	59.93	85.33	110.73	136.13	161.53	186.93	212.33	237.73	263.13	23/64
3/8	9.53	34.93	60.33	85.73	111.13	136.53	161.93	187.33	212.73	238.13	263.53	3/8
25/64	9.92	35.32	60.72	86.12	111.52	136.92	162.32	187.72	213.12	238.52	263.92	25/64
13/32	10.32	35.72	61.12	86.52	111.92	137.32	162.72	188.12	213.52	238.92	264.32	13/32
27/64	10.72	36.12	61.52	86.92	112.32	137.72	163.12	188.52	213.92	239.32	264.72	27/64
7/16	11.11	36.51	61.91	87.31	112.71	138.11	163.51	188.91	214.31	239.71	265.11	7/16
29/64	11.51	36.91	62.31	87.71	113.11	138.51	163.91	189.31	214.71	240.11	265.51	29/64
15/32	11.91	37.31	62.71	88.11	113.51	138.91	164.31	189.71	215.11	240.51	265.91	15/32
31/64	12.30	37.70	63.10	88.50	113.90	139.30	164.70	190.10	215.50	240.90	266.30	31/64
1/2	12.70	38.10	63.50	88.90	114.30	139.70	165.10	190.50	215.90	241.30	266.70	1/2
33/64	13.10	38.50	63.90	89.30	114.70	140.10	165.50	190.90	216.30	241.70	267.10	33/64
17/32	13.49	38.89	64.29	89.69	115.09	140.49	165.89	191.29	216.69	242.09	267.49	17/32
35/64	13.89	39.29	64.69	90.09	115.49	140.89	166.29	191.69	217.09	242.49	267.89	35/64
9/16	14.29	39.69	65.09	90.49	115.89	141.29	166.69	192.09	217.49	242.89	268.29	9/16
37/64	14.68	40.08	65.48	90.88	116.28	141.68	167.08	192.48	217.88	243.28	268.69	37/64
19/32	15.08	40.48	65.88	91.28	116.68	142.08	167.48	192.88	218.28	243.68	269.08	19/32
39/64	15.48	40.88	66.28	91.68	117.08	142.48	167.88	193.28	218.68	244.08	269.48	39/64
5/8	15.88	41.28	66.68	92.08	117.48	142.88	168.28	193.68	219.08	244.48	269.88	5/8
41/64	16.27	41.67	67.07	92.47	117.87	143.27	168.67	194.07	219.47	244.87	270.27	41/64
21/32	16.67	42.07	67.47	92.87	118.27	143.67	169.07	194.47	219.87	245.27	270.67	21/32
43/64	17.07	42.47	67.87	93.27	118.67	144.07	169.47	194.87	220.27	245.67	271.07	43/64
11/16	17.46	42.86	68.26	93.66	119.06	144.46	169.86	195.26	220.66	246.06	271.46	11/16
45/64	17.86	43.26	68.66	94.06	119.46	144.86	170.26	195.66	221.06	246.46	271.86	45/64
23/32	18.26	43.66	69.06	94.46	119.86	145.26	170.66	196.06	221.46	246.86	272.26	23/32
47/64	18.65	44.05	69.45	94.85	120.25	145.65	171.05	196.45	221.85	247.25	272.65	47/64
3/4	19.05	44.45	69.85	95.25	120.65	146.05	171.45	196.85	222.25	247.65	273.05	3/4
49/64	19.45	44.85	70.25	95.65	121.05	146.45	171.85	197.25	222.65	248.05	273.45	49/64
25/32	19.84	45.24	70.64	96.04	121.44	146.85	172.24	197.64	223.04	248.44	273.84	25/32
51/64	20.24	45.64	71.04	96.44	121.84	147.24	172.64	198.04	223.44	248.84	274.24	51/64
13/16	20.64	46.04	71.44	96.84	122.24	147.64	173.04	198.44	223.84	249.24	274.64	13/16
53/64	21.03	46.43	71.83	97.23	122.63	148.03	173.43	198.83	224.23	249.64	275.04	53/64
27/32	21.43	46.83	72.23	97.63	123.03	148.43	173.83	199.23	224.63	250.03	275.43	27/32
55/64	21.83	47.23	72.63	98.03	123.43	148.83	174.23	199.63	225.03	250.43	275.83	55/64
7/8	22.23	47.63	73.03	98.43	123.83	149.23	174.63	200.03	225.43	250.83	276.23	7/8
57/64	22.62	48.02	73.42	98.82	124.22	149.62	175.02	200.42	225.82	251.22	276.62	57/64
29/32	23.02	48.42	73.82	99.22	124.62	150.02	175.42	200.82	226.22	251.62	277.02	29/32
59/64	23.42	48.82	74.22	99.62	125.02	150.42	175.82	201.22	226.62	252.02	277.42	59/64
15/16	23.81	49.21	74.61	100.01	125.41	150.81	176.21	201.61	227.01	252.41	277.81	15/16
61/64	24.21	49.61	75.01	100.41	125.81	151.21	176.61	202.01	227.41	252.81	278.21	61/64
31/32	24.61	50.01	75.41	100.81	126.21	151.61	177.01	202.41	227.81	253.21	278.61	31/32
63/64	25.00	50.40	75.80	101.20	126.60	152.00	177.40	202.80	228.20	253.60	279.00	63/64

METRIC CONVERSION TABLE

INCHES AND FRACTIONS OF AN INCH TO MILLIMETERS

39.37 Inches, U. S. Standard = 1 Meter = 100 Centimeters = 1000 Millimeters

Fractions	Inches										Fractions
	11	12	13	14	15	16	17	18	19	20	
0	279.40	304.80	330.20	355.60	381.00	406.40	431.80	457.20	482.60	508.00	0
1/64	279.80	305.20	330.60	356.00	381.40	406.80	432.20	457.60	483.00	508.40	1/64
1/32	280.19	305.59	330.99	356.39	381.79	407.19	432.59	457.99	483.39	508.80	1/32
3/64	280.59	305.99	331.39	356.79	382.19	407.59	432.99	458.39	483.79	509.19	3/64
1/16	280.99	306.39	331.79	357.19	382.59	407.99	433.39	458.79	484.19	509.59	1/16
5/64	281.39	306.79	332.19	357.59	382.99	408.39	433.79	459.19	484.59	509.99	5/64
3/32	281.78	307.18	332.58	357.98	383.38	408.78	434.18	459.58	484.98	510.38	3/32
7/64	282.18	307.58	332.98	358.38	383.78	409.18	434.58	459.98	485.38	510.78	7/64
1/8	282.58	307.98	333.38	358.78	384.18	409.58	434.98	460.38	485.78	511.18	1/8
9/64	282.97	308.37	333.77	359.17	384.57	409.97	435.37	460.77	486.17	511.57	9/64
5/32	283.37	308.77	334.17	359.57	384.97	410.37	435.77	461.17	486.57	511.97	5/32
11/64	283.77	309.17	334.57	359.97	385.37	410.77	436.17	461.57	486.97	512.37	11/64
3/16	284.16	309.56	334.96	360.36	385.76	411.16	436.56	461.96	487.36	512.76	3/16
13/64	284.56	309.96	335.36	360.76	386.16	411.56	436.96	462.36	487.76	513.16	13/64
7/32	284.96	310.36	335.76	361.16	386.56	411.96	437.36	462.76	488.16	513.56	7/32
15/64	285.35	310.75	336.15	361.55	386.95	412.35	437.75	463.15	488.55	513.95	15/64
1/4	285.75	311.15	336.55	361.95	387.35	412.75	438.15	463.55	488.95	514.35	1/4
17/64	286.15	311.55	336.95	362.35	387.75	413.15	438.55	463.95	489.35	514.75	17/64
9/32	286.54	311.94	337.34	362.74	388.14	413.54	438.95	464.34	489.74	515.15	9/32
19/64	286.94	312.34	337.74	363.14	388.54	413.94	439.34	464.74	490.14	515.54	19/64
5/16	287.34	312.74	338.14	363.54	388.94	414.34	439.74	465.14	490.54	515.94	5/16
21/64	287.74	313.14	338.54	363.94	389.34	414.74	440.14	465.54	490.94	516.34	21/64
11/32	288.13	313.53	338.93	364.33	389.73	415.13	440.53	465.93	491.33	516.73	11/32
23/64	288.53	313.93	339.33	364.73	390.13	415.53	440.93	466.33	491.73	517.13	23/64
3/8	288.93	314.33	339.73	365.13	390.53	415.93	441.33	466.73	492.13	517.53	3/8
25/64	289.32	314.72	340.12	365.52	390.92	416.32	441.72	467.12	492.52	517.92	25/64
13/32	289.72	315.12	340.52	365.92	391.32	416.72	442.12	467.52	492.92	518.32	13/32
27/64	290.12	315.52	340.92	366.32	391.72	417.12	442.52	467.92	493.32	518.72	27/64
7/16	290.51	315.91	341.31	366.71	392.11	417.51	442.91	468.31	493.71	519.11	7/16
29/64	290.91	316.31	341.71	367.11	392.51	417.91	443.31	468.71	494.11	519.51	29/64
15/32	291.31	316.71	342.11	367.51	392.91	418.31	443.71	469.11	494.51	519.91	15/32
31/64	291.70	317.10	342.50	367.90	393.30	418.70	444.10	469.50	494.90	520.30	31/64
1/2	292.10	317.50	342.90	368.30	393.70	419.10	444.50	469.90	495.30	520.70	1/2
33/64	292.50	317.90	343.30	368.70	394.10	419.50	444.90	470.30	495.70	521.10	33/64
17/32	292.89	318.29	343.70	369.09	394.50	419.89	445.29	470.69	496.10	521.50	17/32
35/64	293.29	318.69	344.09	369.49	394.89	420.29	445.69	471.09	496.49	521.89	35/64
9/16	293.69	319.09	344.49	369.89	395.29	420.69	446.09	471.49	496.89	522.29	9/16
37/64	294.09	319.49	344.89	370.29	395.69	421.09	446.49	471.89	497.29	522.69	37/64
19/32	294.48	319.88	345.28	370.68	396.08	421.48	446.88	472.28	497.68	523.08	19/32
39/64	294.88	320.28	345.68	371.08	396.48	421.88	447.28	472.68	498.08	523.48	39/64
5/8	295.28	320.68	346.08	371.48	396.88	422.28	447.68	473.08	498.48	523.88	5/8
41/64	295.67	321.07	346.47	371.87	397.27	422.67	448.07	473.47	498.87	524.27	41/64
21/32	296.07	321.47	346.87	372.27	397.67	423.07	448.47	473.87	499.27	524.67	21/32
43/64	296.47	321.87	347.27	372.67	398.07	423.47	448.87	474.27	499.67	525.07	43/64
11/16	296.86	322.26	347.66	373.06	398.46	423.86	449.26	474.66	500.06	525.46	11/16
45/64	297.26	322.66	348.06	373.46	398.86	424.26	449.66	475.06	500.46	525.86	45/64
23/32	297.66	323.06	348.46	373.86	399.26	424.66	450.06	475.46	500.86	526.26	23/32
47/64	298.05	323.45	348.85	374.25	399.65	425.06	450.45	475.85	501.25	526.65	47/64
3/4	298.45	323.85	349.25	374.65	400.05	425.45	450.85	476.25	501.65	527.05	3/4
49/64	298.85	324.25	349.65	375.05	400.45	425.85	451.25	476.65	502.05	527.45	49/64
25/32	299.24	324.64	350.04	375.44	400.84	426.25	451.64	477.04	502.45	527.85	25/32
51/64	299.64	325.04	350.44	375.84	401.24	426.64	452.04	477.44	502.84	528.24	51/64
13/16	300.04	325.44	350.84	376.24	401.64	427.04	452.44	477.84	503.24	528.64	13/16
53/64	300.44	325.84	351.24	376.64	402.04	427.44	452.84	478.24	503.64	529.04	53/64
27/32	300.83	326.23	351.63	377.03	402.43	427.83	453.23	478.63	504.03	529.43	27/32
55/64	301.23	326.63	352.03	377.43	402.83	428.23	453.63	479.03	504.43	529.83	55/64
7/8	301.63	327.03	352.43	377.83	403.23	428.63	454.03	479.43	504.83	530.23	7/8
57/64	302.02	327.42	352.82	378.22	403.62	429.02	454.42	479.82	505.22	530.62	57/64
29/32	302.42	327.82	353.22	378.62	404.02	429.42	454.82	480.22	505.62	531.02	29/32
59/64	302.82	328.22	353.62	379.02	404.42	429.82	455.22	480.62	506.02	531.42	59/64
15/16	303.21	328.61	354.01	379.41	404.81	430.21	455.61	481.01	506.41	531.81	15/16
61/64	303.61	329.01	354.41	379.81	405.21	430.61	456.01	481.41	506.81	532.21	61/64
31/32	304.01	329.41	354.81	380.21	405.61	431.01	456.41	481.81	507.21	532.61	31/32
63/64	304.40	329.80	355.20	380.60	406.00	431.40	456.80	482.20	507.60	533.00	63/64

METRIC CONVERSION TABLE

INCHES AND FRACTIONS OF AN INCH TO MILLIMETERS

39.37 Inches, U. S. Standard = 1 Meter = 100 Centimeters = 1000 Millimeters

Fractions	Inches										Fractions
	21	22	23	24	25	26	27	28	29	30	
0	533.40	558.80	584.20	609.60	635.00	660.40	685.80	711.20	736.60	762.00	0
1/64	533.80	559.20	584.60	610.00	635.40	660.80	686.20	711.60	737.00	762.40	1/64
1/32	534.20	559.60	585.00	610.40	635.80	661.20	686.60	712.00	737.40	762.80	1/32
3/64	534.59	559.99	585.39	610.79	636.19	661.59	686.99	712.39	737.79	763.19	3/64
1/16	534.99	560.39	585.79	611.19	636.59	661.99	687.39	712.79	738.19	763.59	1/16
5/64	535.39	560.79	586.19	611.59	636.99	662.39	687.79	713.19	738.59	763.99	5/64
3/32	535.78	561.18	586.58	611.98	637.38	662.78	688.18	713.58	738.98	764.38	3/32
7/64	536.18	561.58	586.98	612.38	637.78	663.18	688.58	713.98	739.38	764.78	7/64
1/8	536.58	561.98	587.38	612.78	638.18	663.58	688.98	714.38	739.78	765.18	1/8
9/64	536.97	562.37	587.77	613.17	638.57	663.97	689.37	714.77	740.17	765.57	9/64
5/32	537.37	562.77	588.17	613.57	638.97	664.37	689.77	715.17	740.57	765.97	5/32
11/64	537.77	563.17	588.57	613.97	639.37	664.77	690.17	715.57	740.97	766.37	11/64
3/16	538.16	563.56	588.96	614.36	639.76	665.16	690.56	715.96	741.36	766.76	3/16
13/64	538.56	563.96	589.36	614.76	640.16	665.56	690.96	716.36	741.76	767.16	13/64
7/32	538.96	564.36	589.76	615.16	640.56	665.96	691.36	716.76	742.16	767.56	7/32
15/64	539.35	564.75	590.15	615.55	640.95	666.35	691.75	717.15	742.55	767.96	15/64
1/4	539.75	565.15	590.55	615.95	641.35	666.75	692.15	717.55	742.95	768.35	1/4
17/64	540.15	565.55	590.95	616.35	641.75	667.15	692.55	717.95	743.35	768.75	17/64
9/32	540.55	565.95	591.35	616.75	642.15	667.55	692.95	718.35	743.75	769.15	9/32
19/64	540.94	566.34	591.74	617.14	642.54	667.94	693.34	718.74	744.14	769.54	19/64
5/16	541.34	566.74	592.14	617.54	642.94	668.34	693.74	719.14	744.54	769.94	5/16
21/64	541.74	567.14	592.54	617.94	643.34	668.74	694.14	719.54	744.94	770.34	21/64
11/32	542.13	567.53	592.93	618.33	643.73	669.13	694.53	719.93	745.33	770.73	11/32
23/64	542.53	567.93	593.33	618.73	644.13	669.53	694.93	720.33	745.73	771.13	23/64
3/8	542.93	568.33	593.73	619.13	644.53	669.93	695.33	720.73	746.13	771.53	3/8
25/64	543.32	568.72	594.12	619.52	644.92	670.32	695.72	721.12	746.52	771.92	25/64
13/32	543.72	569.12	594.52	619.92	645.32	670.72	696.12	721.52	746.92	772.32	13/32
27/64	544.12	569.52	594.92	620.32	645.72	671.12	696.52	721.92	747.32	772.72	27/64
7/16	544.51	569.91	595.31	620.71	646.11	671.51	696.91	722.31	747.71	773.11	7/16
29/64	544.91	570.31	595.71	621.11	646.51	671.91	697.31	722.71	748.11	773.51	29/64
15/32	545.31	570.71	596.11	621.51	646.91	672.31	697.71	723.11	748.51	773.91	15/32
31/64	545.70	571.10	596.50	621.90	647.30	672.70	698.10	723.50	748.91	774.31	31/64
1/2	546.10	571.50	596.90	622.30	647.70	673.10	698.50	723.90	749.30	774.70	1/2
33/64	546.50	571.90	597.30	622.70	648.10	673.50	698.90	724.30	749.70	775.10	33/64
17/32	546.90	572.30	597.70	623.10	648.50	673.90	699.30	724.70	750.10	775.50	17/32
35/64	547.29	572.69	598.09	623.49	648.89	674.29	699.69	725.09	750.49	775.89	35/64
9/16	547.69	573.09	598.49	623.89	649.29	674.69	700.09	725.49	750.89	776.29	9/16
37/64	548.09	573.49	598.89	624.29	649.69	675.09	700.49	725.89	751.29	776.69	37/64
19/32	548.48	573.88	599.28	624.68	650.08	675.48	700.88	726.28	751.68	777.08	19/32
39/64	548.88	574.28	599.68	625.08	650.48	675.88	701.28	726.68	752.08	777.48	39/64
5/8	549.28	574.68	600.08	625.48	650.88	676.28	701.68	727.08	752.48	777.88	5/8
41/64	549.67	575.07	600.47	625.87	651.27	676.67	702.07	727.47	752.87	778.27	41/64
21/32	550.07	575.47	600.87	626.27	651.67	677.07	702.47	727.87	753.27	778.67	21/32
43/64	550.47	575.87	601.27	626.67	652.07	677.47	702.87	728.27	753.67	779.07	43/64
11/16	550.86	576.26	601.66	627.06	652.46	677.86	703.26	728.66	754.06	779.46	11/16
45/64	551.26	576.66	602.06	627.46	652.86	678.26	703.66	729.06	754.46	779.86	45/64
23/32	551.66	577.06	602.46	627.86	653.26	678.66	704.06	729.46	754.86	780.26	23/32
47/64	552.05	577.45	602.85	628.25	653.65	679.05	704.45	729.85	755.26	780.66	47/64
3/4	552.45	577.85	603.25	628.65	654.05	679.45	704.85	730.25	755.65	781.05	3/4
49/64	552.85	578.25	603.65	629.05	654.45	679.85	705.25	730.65	756.05	781.45	49/64
25/32	553.25	578.65	604.05	629.45	654.85	680.25	705.65	731.05	756.45	781.85	25/32
51/64	553.64	579.04	604.44	629.84	655.24	680.64	706.04	731.44	756.84	782.24	51/64
13/16	554.04	579.44	604.84	630.24	655.64	681.04	706.44	731.84	757.24	782.64	13/16
53/64	554.44	579.84	605.24	630.64	656.04	681.44	706.84	732.24	757.64	783.04	53/64
27/32	554.83	580.23	605.63	631.03	656.43	681.83	707.23	732.63	758.03	783.43	27/32
55/64	555.23	580.63	606.03	631.43	656.83	682.23	707.63	733.03	758.43	783.83	55/64
7/8	555.63	581.03	606.43	631.83	657.23	682.63	708.03	733.43	758.83	784.23	7/8
57/64	556.02	581.42	606.82	632.22	657.62	683.02	708.42	733.82	759.22	784.62	57/64
29/32	556.42	581.82	607.22	632.62	658.02	683.42	708.82	734.22	759.62	785.02	29/32
59/64	556.82	582.22	607.62	633.02	658.42	683.82	709.22	734.62	760.02	785.42	59/64
15/16	557.21	582.61	608.01	633.41	658.81	684.21	709.61	735.01	760.41	785.81	15/16
61/64	557.61	583.01	608.41	633.81	659.21	684.61	710.01	735.41	760.81	786.21	61/64
31/32	558.01	583.41	608.81	634.21	659.61	685.01	710.41	735.81	761.21	786.61	31/32
63/64	558.40	583.80	609.20	634.60	660.00	685.40	710.80	736.20	761.61	787.01	63/64

METRIC CONVERSION TABLE

INCHES AND FRACTIONS OF AN INCH TO MILLIMETERS

39.37 Inches, U. S. Standard = 1 Meter = 100 Centimeters = 1000 Millimeters

Fractions	Inches										Fractions
	31	32	33	34	35	36	37	38	39	40	
0	787.40	812.80	838.20	863.60	889.00	914.40	939.80	965.20	990.60	1016.00	0
1/64	787.80	813.20	838.60	864.00	889.40	914.80	940.20	965.60	991.00	1016.40	1/64
1/32	788.20	813.60	839.00	864.40	889.80	915.20	940.60	966.00	991.40	1016.80	1/32
3/64	788.59	813.99	839.39	864.79	890.19	915.59	940.99	966.39	991.79	1017.19	3/64
1/16	788.99	814.39	839.79	865.19	890.59	915.99	941.39	966.79	992.19	1017.59	1/16
5/64	789.39	814.79	840.19	865.59	890.99	916.39	941.79	967.19	992.59	1017.99	5/64
3/32	789.78	815.18	840.58	865.98	891.38	916.78	942.18	967.58	992.98	1018.38	3/32
7/64	790.18	815.58	840.98	866.38	891.78	917.18	942.58	967.98	993.38	1018.78	7/64
1/8	790.58	815.98	841.38	866.78	892.18	917.58	942.98	968.38	993.78	1019.18	1/8
9/64	790.97	816.37	841.77	867.17	892.57	917.97	943.37	968.77	994.17	1019.57	9/64
5/32	791.37	816.77	842.17	867.57	892.97	918.37	943.77	969.17	994.57	1019.97	5/32
11/64	791.77	817.17	842.57	867.97	893.37	918.77	944.17	969.57	994.97	1020.37	11/64
3/16	792.16	817.56	842.96	868.36	893.76	919.16	944.56	969.96	995.37	1020.77	3/16
13/64	792.56	817.96	843.36	868.76	894.16	919.56	944.96	970.36	995.76	1021.16	13/64
7/32	792.96	818.36	843.76	869.16	894.56	919.96	945.36	970.76	996.16	1021.56	7/32
15/64	793.36	818.76	844.16	869.56	894.96	920.36	945.76	971.16	996.56	1021.96	15/64
1/4	793.75	819.15	844.55	869.95	895.35	920.75	946.15	971.55	996.95	1022.35	1/4
17/64	794.15	819.55	844.95	870.35	895.75	921.15	946.55	971.95	997.35	1022.75	17/64
9/32	794.55	819.95	845.35	870.75	896.15	921.55	946.95	972.35	997.75	1023.15	9/32
19/64	794.94	820.34	845.74	871.14	896.54	921.94	947.34	972.74	998.14	1023.54	19/64
5/16	795.34	820.74	846.14	871.54	896.94	922.34	947.74	973.14	998.54	1023.94	5/16
21/64	795.74	821.14	846.54	871.94	897.34	922.74	948.14	973.54	998.94	1024.34	21/64
11/32	796.13	821.53	846.93	872.33	897.73	923.13	948.53	973.93	999.33	1024.73	11/32
23/64	796.53	821.93	847.33	872.73	898.13	923.53	948.93	974.33	999.73	1025.13	23/64
3/8	796.93	822.33	847.73	873.13	898.53	923.93	949.33	974.73	1000.13	1025.53	3/8
25/64	797.32	822.72	848.12	873.52	898.92	924.32	949.72	975.12	1000.52	1025.92	25/64
13/32	797.72	823.12	848.52	873.92	899.32	924.72	950.12	975.52	1000.92	1026.32	13/32
27/64	798.12	823.52	848.92	874.32	899.72	925.12	950.52	975.92	1001.32	1026.72	27/64
7/16	798.51	823.91	849.31	874.71	900.11	925.51	950.91	976.31	1001.72	1027.12	7/16
29/64	798.91	824.31	849.71	875.11	900.51	925.91	951.31	976.71	1002.11	1027.51	29/64
15/32	799.31	824.71	850.11	875.51	900.91	926.31	951.71	977.11	1002.51	1027.91	15/32
31/64	799.71	825.11	850.51	875.91	901.31	926.71	952.11	977.51	1002.91	1028.31	31/64
1/2	800.10	825.50	850.90	876.30	901.70	927.10	952.50	977.90	1003.30	1028.70	1/2
33/64	800.50	825.90	851.30	876.70	902.10	927.50	952.90	978.30	1003.70	1029.10	33/64
17/32	800.90	826.30	851.70	877.10	902.50	927.90	953.30	978.70	1004.10	1029.50	17/32
35/64	801.29	826.69	852.09	877.49	902.89	928.29	953.69	979.09	1004.49	1029.89	35/64
9/16	801.69	827.09	852.49	877.89	903.29	928.69	954.09	979.49	1004.89	1030.29	9/16
37/64	802.09	827.49	852.89	878.29	903.69	929.09	954.49	979.89	1005.29	1030.69	37/64
19/32	802.48	827.88	853.28	878.68	904.08	929.48	954.88	980.28	1005.68	1031.08	19/32
39/64	802.88	828.28	853.68	879.08	904.48	929.88	955.28	980.68	1006.08	1031.48	39/64
5/8	803.28	828.68	854.08	879.48	904.88	930.28	955.68	981.08	1006.48	1031.88	5/8
41/64	803.67	829.07	854.47	879.87	905.27	930.67	956.07	981.47	1006.87	1032.27	41/64
21/32	804.07	829.47	854.87	880.27	905.67	931.07	956.47	981.87	1007.27	1032.67	21/32
43/64	804.47	829.87	855.27	880.67	906.07	931.47	956.87	982.27	1007.67	1033.07	43/64
11/16	804.86	830.26	855.66	881.06	906.46	931.86	957.26	982.66	1008.07	1033.47	11/16
45/64	805.26	830.66	856.06	881.46	906.86	932.26	957.66	983.06	1008.46	1033.86	45/64
23/32	805.66	831.06	856.46	881.86	907.26	932.66	958.06	983.46	1008.86	1034.26	23/32
47/64	806.06	831.46	856.86	882.26	907.66	933.06	958.46	983.86	1009.26	1034.66	47/64
3/4	806.45	831.85	857.25	882.65	908.05	933.45	958.85	984.25	1009.65	1035.05	3/4
49/64	806.85	832.25	857.65	883.05	908.45	933.85	959.25	984.65	1010.05	1035.45	49/64
25/32	807.25	832.65	858.05	883.45	908.85	934.25	959.65	985.05	1010.45	1035.85	25/32
51/64	807.64	833.04	858.44	883.84	909.24	934.64	960.04	985.44	1010.84	1036.24	51/64
13/16	808.04	833.44	858.84	884.24	909.64	935.04	960.44	985.84	1011.24	1036.64	13/16
53/64	808.44	833.84	859.24	884.64	910.04	935.44	960.84	986.24	1011.64	1037.04	53/64
27/32	808.83	834.23	859.63	885.03	910.43	935.83	961.23	986.63	1012.03	1037.43	27/32
55/64	809.23	834.63	860.03	885.43	910.83	936.23	961.63	987.03	1012.43	1037.83	55/64
7/8	809.63	835.03	860.43	885.83	911.23	936.63	962.03	987.43	1012.83	1038.23	7/8
57/64	810.02	835.42	860.82	886.22	911.62	937.02	962.42	987.82	1013.22	1038.62	57/64
29/32	810.42	835.82	861.22	886.62	912.02	937.42	962.82	988.22	1013.62	1039.02	29/32
59/64	810.82	836.22	861.62	887.02	912.42	937.82	963.22	988.62	1014.02	1039.42	59/64
15/16	811.21	836.61	862.01	887.41	912.81	938.21	963.61	989.01	1014.42	1039.82	15/16
61/64	811.61	837.01	862.41	887.81	913.21	938.61	964.01	989.41	1014.81	1040.21	61/64
31/32	812.01	837.41	862.81	888.21	913.61	939.01	964.41	989.81	1015.21	1040.61	31/32
63/64	812.41	837.81	863.21	888.61	914.01	939.41	964.81	990.21	1015.61	1041.01	63/64

METRIC CONVERSION TABLE

MILLIMETERS TO FEET AND INCHES

0 to 399 mm

mm	Ft.	In.	mm, Units									
Tens			0	1	2	3	4	5	6	7	8	9
			Fractions of an Inch									
0	0	0	.....	3/64	5/64	1/8	5/32	13/64	15/64	9/32	5/16	23/64
1			25/64	7/16	15/32	33/64	35/64	19/32	5/8	43/64	45/64	3/4
2			25/32	53/64	55/64	29/32	15/16	63/64	.....	.....	.....	.....
	0	1	.....	.....	.....	.....	.....	.....	1/32	1/16	7/64	9/64
3			3/16	7/32	17/64	19/64	11/32	3/8	27/64	29/64	1/2	17/32
4			37/64	39/64	21/32	11/16	47/64	49/64	13/16	27/32	57/64	59/64
5			31/32	.....	.....	.....	.....	.....	.....	.....	.....	.....
	0	2	.....	1/64	3/64	3/32	1/8	11/64	13/64	1/4	9/32	21/64
6			23/64	13/32	7/16	31/64	33/64	9/16	19/32	41/64	43/64	23/32
7			3/4	51/64	53/64	7/8	29/32	61/64	63/64	.....	.....	.....
	0	3	.....	.....	.....	.....	.....	.....	.....	1/32	5/64	7/64
8			5/32	3/16	15/64	17/64	5/16	11/32	25/64	27/64	15/32	1/2
9			35/64	37/64	5/8	21/32	45/64	47/64	25/32	13/16	55/64	57/64
10			15/16	31/32	.....	.....	.....	.....	.....	.....	.....	.....
	0	4	.....	.....	1/64	1/16	3/32	9/64	11/64	7/32	1/4	19/64
11			21/64	3/8	13/32	29/64	31/64	17/32	9/16	39/64	41/64	11/16
12			23/32	49/64	51/64	27/32	7/8	59/64	61/64	.....	.....	.....
	0	5	.....	.....	.....	.....	.....	.....	.....	0	3/64	5/64
13			1/8	5/32	13/64	15/64	9/32	5/16	23/64	25/64	7/16	15/32
14			33/64	35/64	19/32	5/8	43/64	45/64	3/4	25/32	53/64	55/64
15			29/32	15/16	63/64	.....	.....	.....	.....	.....	.....	.....
	0	6	.....	.....	.....	1/32	1/16	7/64	9/64	3/16	7/32	17/64
16			19/64	11/32	3/8	27/64	29/64	1/2	17/32	37/64	39/64	21/32
17			11/16	47/64	49/64	13/16	27/32	57/64	59/64	31/32	.....	.....
	0	7	.....	.....	.....	.....	.....	.....	.....	.....	1/64	3/64
18			3/32	1/8	11/64	13/64	1/4	9/32	21/64	23/64	13/32	7/16
19			31/64	33/64	9/16	19/32	41/64	43/64	23/32	3/4	51/64	53/64
20			7/8	29/32	61/64	63/64	.....	.....	.....	.....	.....	.....
	0	8	.....	.....	.....	.....	1/32	5/64	7/64	5/32	3/16	15/64
21			17/64	5/16	11/32	25/64	27/64	15/32	1/2	35/64	37/64	5/8
22			21/32	45/64	47/64	25/32	13/16	55/64	57/64	15/16	31/32	.....
	0	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/64
23			1/16	3/32	9/64	11/64	7/32	1/4	19/64	21/64	3/8	13/32
24			29/64	31/64	17/32	9/16	39/64	41/64	11/16	23/32	49/64	51/64
25			27/32	7/8	59/64	61/64	.....	.....	.....	.....	.....	.....
	0	10	.....	.....	.....	.....	0	3/64	5/64	1/8	5/32	13/64
26			15/64	9/32	5/16	23/64	25/64	7/16	15/32	33/64	35/64	19/32
27			5/8	43/64	45/64	3/4	25/32	53/64	55/64	29/32	15/16	63/64
28	0	11	1/32	1/16	7/64	9/64	3/16	7/32	17/64	19/64	11/32	3/8
29			27/64	29/64	1/2	17/32	37/64	39/64	21/32	11/16	47/64	49/64
30			13/16	27/32	57/64	59/64	31/32	.....	.....	.....	.....	.....
	1	0	.....	.....	.....	.....	.....	1/64	3/64	3/32	1/8	11/64
31			13/64	1/4	9/32	21/64	23/64	13/32	7/16	31/64	33/64	9/16
32			19/32	41/64	43/64	23/32	3/4	51/64	53/64	7/8	29/32	61/64
33			63/64	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1	1	.....	1/32	5/64	7/64	5/32	3/16	15/64	17/64	5/16	11/32
34			25/64	27/64	15/32	1/2	35/64	37/64	5/8	21/32	45/64	47/64
35			25/32	13/16	55/64	57/64	15/16	31/32	.....	.....	.....	.....
	1	2	.....	.....	.....	.....	.....	.....	1/64	1/16	3/32	9/64
36			11/64	7/32	1/4	19/64	21/64	3/8	13/32	29/64	31/64	17/32
37			9/16	39/64	41/64	11/16	23/32	49/64	51/64	27/32	7/8	59/64
38			61/64	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1	3	.....	0	3/64	5/64	1/8	5/32	13/64	15/64	9/32	5/16
39			23/64	25/64	7/16	15/32	33/64	35/64	19/32	5/8	43/64	45/64

METRIC CONVERSION TABLE

MILLIMETERS TO FEET AND INCHES

400 to 799 mm

mm Tens	Ft.	In.	0	1	2	3	4	5	6	7	8	9
			mm, Units — Fractions of an Inch									
40	1	3	3/4	25/32	53/64	55/64	29/32	15/16	63/64	.....	.....	.....
	1	4	.....	.....	.....	.....	.....	.....	.....	1/32	1/16	7/64
41			9/64	3/16	7/32	17/64	19/64	11/32	3/8	27/64	29/64	1/2
42			17/32	37/64	39/64	21/32	11/16	47/64	49/64	13/16	27/32	57/64
43			59/64	31/32	.....	.....	.....	.....	.....	.....	.....	.....
	1	5	.....	.....	1/64	3/64	3/32	1/8	11/64	13/64	1/4	9/32
44			21/64	23/64	13/32	7/16	31/64	33/64	9/16	19/32	41/64	43/64
45			23/32	3/4	51/64	53/64	7/8	29/32	61/64	63/64	.....	.....
	1	6	.....	.....	.....	.....	.....	.....	.....	.....	1/32	5/64
46			7/64	5/32	3/16	15/64	17/64	5/16	11/32	25/64	27/64	15/32
47			1/2	35/64	37/64	5/8	21/32	45/64	47/64	25/32	13/16	55/64
48			57/64	15/16	31/32	.....	.....	.....	.....	.....	.....	.....
	1	7	.....	.....	.....	1/64	1/16	3/32	9/64	11/64	7/32	1/4
49			19/64	21/64	3/8	13/32	29/64	31/64	17/32	9/16	39/64	41/64
50			11/16	23/32	49/64	51/64	27/32	7/8	59/64	61/64	.....	.....
	1	8	.....	.....	.....	.....	.....	.....	.....	.....	0	3/64
51			5/64	1/8	5/32	13/64	15/64	9/32	5/16	23/64	25/64	7/16
52			15/32	33/64	35/64	19/32	5/8	43/64	45/64	3/4	25/32	53/64
53			55/64	29/32	15/16	63/64	.....	.....	.....	.....	.....	.....
	1	9	.....	.....	.....	.....	1/32	1/16	7/64	9/64	3/16	7/32
54			17/64	19/64	11/32	3/8	27/64	29/64	1/2	17/32	37/64	39/64
55			21/32	11/16	47/64	49/64	13/16	27/32	57/64	59/64	31/32	.....
	1	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/64
56			3/64	3/32	1/8	11/64	13/64	1/4	9/32	21/64	23/64	13/32
57			7/16	31/64	33/64	9/16	19/32	41/64	43/64	23/32	3/4	51/64
58			53/64	7/8	29/32	61/64	63/64	.....	.....	.....	.....	.....
	1	11	.....	.....	.....	.....	.....	1/32	5/64	7/64	5/32	3/16
59			15/64	17/64	5/16	11/32	25/64	27/64	15/32	1/2	35/64	37/64
60			5/8	21/32	45/64	47/64	25/32	13/16	55/64	57/64	15/16	31/32
61	2	0	1/64	1/16	3/32	9/64	11/64	7/32	1/4	19/64	21/64	3/8
62			13/32	29/64	31/64	17/32	9/16	39/64	41/64	11/16	23/32	49/64
63			51/64	27/32	7/8	59/64	61/64	.....	.....	.....	.....	.....
	2	1	.....	.....	.....	.....	.....	0	3/64	5/64	1/8	5/32
64			13/64	15/64	9/32	5/16	23/64	25/64	7/16	15/32	33/64	35/64
65			19/32	5/8	43/64	45/64	3/4	25/32	53/64	55/64	29/32	15/16
66			63/64	.....	.....	.....	.....	.....	.....	.....	.....	.....
	2	2	.....	1/32	1/16	7/64	9/64	3/16	7/32	17/64	19/64	11/32
67			3/8	27/64	29/64	1/2	17/32	37/64	39/64	21/32	11/16	47/64
68			49/64	13/16	27/32	57/64	59/64	31/32	.....	.....	.....	.....
	2	3	.....	.....	.....	.....	.....	.....	1/64	3/64	3/32	1/8
69			11/64	13/64	1/4	9/32	21/64	23/64	13/32	7/16	31/64	33/64
70			9/16	19/32	41/64	43/64	23/32	3/4	51/64	53/64	7/8	29/32
71			61/64	63/64	.....	.....	.....	.....	.....	.....	.....	.....
	2	4	.....	.....	1/32	5/64	7/64	5/32	3/16	15/64	17/64	5/16
72			11/32	25/64	27/64	15/32	1/2	35/64	37/64	5/8	21/32	45/64
73			47/64	25/32	13/16	55/64	57/64	15/16	31/32	.....	.....	.....
	2	5	.....	.....	.....	.....	.....	.....	.....	1/64	1/16	3/32
74			9/64	11/64	7/32	1/4	19/64	21/64	3/8	13/32	29/64	31/64
75			17/32	9/16	39/64	41/64	11/16	23/32	49/64	51/64	27/32	7/8
76			59/64	61/64	.....	.....	.....	.....	.....	.....	.....	.....
	2	6	.....	.....	0	3/64	5/64	1/8	5/32	13/64	15/64	9/32
77			5/16	23/64	25/64	7/16	15/32	33/64	35/64	19/32	5/8	43/64
78			45/64	3/4	25/32	53/64	55/64	29/32	15/16	63/64	.....	.....
	2	7	.....	.....	.....	.....	.....	.....	.....	.....	1/32	1/16
79			7/64	9/64	3/16	7/32	17/64	19/64	11/32	3/8	27/64	29/64

METRIC CONVERSION TABLE

MILLIMETERS TO FEET AND INCHES

800 to 1199 mm

mm Tens	Ft.	In.	0	1	2	3	4	5	6	7	8	9
			Fractions of an Inch									
80	2	7	1/2	17/32	37/64	39/64	21/32	11/16	47/64	49/64	13/16	27/32
81			57/64	59/64	31/32							
	2	8	.....	.....	.....	1/64	3/64	3/32	1/8	11/64	13/64	1/4
82			9/32	21/64	23/64	13/32	7/16	31/64	33/64	9/16	19/32	41/64
83			43/64	23/32	3/4	51/64	53/64	7/8	29/32	61/64	63/64	
	2	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/32
84			5/64	7/64	5/32	3/16	15/64	17/64	5/16	11/32	25/64	27/64
85			15/32	1/2	35/64	37/64	5/8	21/32	45/64	47/64	25/32	13/16
86			55/64	57/64	15/16	31/32						
	2	10	.....	.....	.....	.....	1/64	1/16	3/32	9/64	11/64	7/32
87			1/4	19/64	21/64	3/8	13/32	29/64	31/64	17/32	9/16	39/64
88			41/64	11/16	23/32	49/64	51/64	27/32	7/8	59/64	61/64	
	2	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	0
89			3/64	5/64	1/8	5/32	13/64	15/64	9/32	5/16	23/64	25/64
90			7/16	15/32	33/64	35/64	19/32	5/8	43/64	45/64	3/4	25/32
91			53/64	55/64	29/32	15/16	63/64					
	3	0	.....	.....	.....	.....	.....	1/32	1/16	7/64	9/64	3/16
92			7/32	17/64	19/64	11/32	3/8	27/64	29/64	1/2	17/32	37/64
93			39/64	21/32	11/16	47/64	49/64	13/16	27/32	57/64	59/64	31/32
94	3	1	1/64	3/64	3/32	1/8	11/64	13/64	1/4	9/32	21/64	23/64
95			13/32	7/16	31/64	33/64	9/16	19/32	41/64	43/64	23/32	3/4
96			51/64	53/64	7/8	29/32	61/64	63/64				
	3	2	.....	.....	.....	.....	.....	.....	1/32	5/64	7/64	5/32
97			3/16	15/64	17/64	5/16	11/32	25/64	27/64	15/32	1/2	35/64
98			37/64	5/8	21/32	45/64	47/64	25/32	13/16	55/64	57/64	15/16
99			31/32									
	3	3	.....	1/64	1/16	3/32	9/64	11/64	7/32	1/4	19/64	21/64
100			3/8	13/32	29/64	31/64	17/32	9/16	39/64	41/64	11/16	23/32
101			49/64	51/64	27/32	7/8	59/64	61/64				
	3	4	.....	.....	.....	.....	.....	.....	0	3/64	5/64	1/8
102			5/32	13/64	15/64	9/32	5/16	23/64	25/64	7/16	15/32	33/64
103			35/64	19/32	5/8	43/64	45/64	3/4	25/32	53/64	55/64	29/32
104			15/16	63/64								
	3	5	.....	.....	1/32	1/16	7/64	9/64	3/16	7/32	17/64	19/64
105			11/32	3/8	27/64	29/64	1/2	17/32	37/64	39/64	21/32	11/16
106			47/64	49/64	13/16	27/32	57/64	59/64	31/32			
	3	6	.....	.....	.....	.....	.....	.....	.....	1/64	3/64	3/32
107			1/8	11/64	13/64	1/4	9/32	21/64	23/64	13/32	7/16	31/64
108			33/64	9/16	19/32	41/64	43/64	23/32	3/4	51/64	53/64	7/8
109			29/32	61/64	63/64							
	3	7	.....	.....	.....	1/32	5/64	7/64	5/32	3/16	15/64	17/64
110			5/16	11/32	25/64	27/64	15/32	1/2	35/64	37/64	5/8	21/32
111			45/64	47/64	25/32	13/16	55/64	57/64	15/16	31/32		
	3	8	.....	.....	.....	.....	.....	.....	.....	.....	1/64	1/16
112			3/32	9/64	11/64	7/32	1/4	19/64	21/64	3/8	13/32	29/64
113			31/64	17/32	9/16	39/64	41/64	11/16	23/32	49/64	51/64	27/32
114			7/8	59/64	61/64							
	3	9	.....	.....	.....	0	3/64	5/64	1/8	5/32	13/64	15/64
115			9/32	5/16	23/64	25/64	7/16	15/32	33/64	35/64	19/32	5/8
116			43/64	45/64	3/4	25/32	53/64	55/64	29/32	15/16	63/64	
	3	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/32
117			1/16	7/64	9/64	3/16	7/32	17/64	19/64	11/32	3/8	27/64
118			29/64	1/2	17/32	37/64	39/64	21/32	11/16	47/64	49/64	13/16
119			27/32	57/64	59/64	31/32						
	3	11	.....	.....	.....	.....	1/64	3/64	3/32	1/8	11/64	13/64

METRIC CONVERSION TABLE

MILLIMETERS TO FEET AND INCHES

1200 to 1599 mm

mm	Ft.	In.	mm, Units									
			0	1	2	3	4	5	6	7	8	9
Tens			Fractions of an Inch									
120	3	11	1/4	9/32	21/64	23/64	13/32	7/16	31/64	33/64	9/16	19/32
121			41/64	43/64	23/32	3/4	51/64	53/64	7/8	29/32	61/64	63/64
122	4	0	1/32	5/64	7/64	5/32	3/16	15/64	17/64	5/16	11/32	25/64
123			27/64	15/32	1/2	35/64	37/64	5/8	21/32	45/64	47/64	25/32
124			13/16	55/64	57/64	15/16	31/32	.....	.....	.....	.....	.....
	4	1	.....	.....	.....	.....	.....	1/64	1/16	3/32	9/64	11/64
125			7/32	1/4	19/64	21/64	3/8	13/32	29/64	31/64	17/32	9/16
126			39/64	41/64	11/16	23/32	49/64	51/64	27/32	7/8	59/64	61/64
127	4	2	0	3/64	5/64	1/8	5/32	13/64	15/64	9/32	5/16	23/64
128			25/64	7/16	15/32	33/64	35/64	19/32	5/8	43/64	45/64	3/4
129			25/32	53/64	55/64	29/32	15/16	63/64	.....	.....	.....	.....
	4	3	.....	.....	.....	.....	.....	.....	1/32	1/16	7/64	9/64
130			3/16	7/32	17/64	19/64	11/32	3/8	27/64	29/64	1/2	17/32
131			37/64	39/64	21/32	11/16	47/64	49/64	13/16	27/32	57/64	59/64
132			31/32	.....	.....	.....	.....	.....	.....	.....	.....	.....
	4	4	.....	1/64	3/64	3/32	1/8	11/64	13/64	1/4	9/32	21/64
133			23/64	13/32	7/16	31/64	33/64	9/16	19/32	41/64	43/64	23/32
134			3/4	51/64	53/64	7/8	29/32	61/64	63/64	.....	.....	.....
	4	5	.....	.....	.....	.....	.....	.....	.....	1/32	5/64	7/64
135			5/32	3/16	15/64	17/64	5/16	11/32	25/64	27/64	15/32	1/2
136			35/64	37/64	5/8	21/32	45/64	47/64	25/32	13/16	55/64	57/64
137			15/16	31/32	.....	.....	.....	.....	.....	.....	.....	.....
	4	6	.....	.....	1/64	1/16	3/32	9/64	11/64	7/32	1/4	19/64
138			21/64	3/8	13/32	29/64	31/64	17/32	9/16	39/64	41/64	11/16
139			23/32	49/64	51/64	27/32	7/8	59/64	61/64	.....	.....	.....
	4	7	.....	.....	.....	.....	.....	.....	.....	0	3/64	5/64
140			1/8	5/32	13/64	15/64	9/32	5/16	23/64	25/64	7/16	15/32
141			33/64	35/64	19/32	5/8	43/64	45/64	3/4	25/32	53/64	55/64
142			29/32	15/16	63/64	.....	.....	.....	.....	.....	.....	.....
	4	8	.....	.....	.....	1/32	1/16	7/64	9/64	3/16	7/32	17/64
143			19/64	11/32	3/8	27/64	29/64	1/2	17/32	37/64	39/64	21/32
144			11/16	47/64	49/64	13/16	27/32	57/64	59/64	31/32	.....	.....
	4	9	.....	.....	.....	.....	.....	.....	.....	.....	1/64	3/64
145			3/32	1/8	11/64	13/64	1/4	9/32	21/64	23/64	13/32	7/16
146			31/64	33/64	9/16	19/32	41/64	43/64	23/32	3/4	51/64	53/64
147			7/8	29/32	61/64	63/64	.....	.....	.....	.....	.....	.....
	4	10	.....	.....	.....	.....	1/32	5/64	7/64	5/32	3/16	15/64
148			17/64	5/16	11/32	25/64	27/64	15/32	1/2	35/64	37/64	5/8
149			21/32	45/64	47/64	25/32	13/16	55/64	57/64	15/16	31/32	.....
	4	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/64
150			1/16	3/32	9/64	11/64	7/32	1/4	19/64	21/64	3/8	13/32
151			29/64	31/64	17/32	9/16	39/64	41/64	11/16	23/32	49/64	51/64
152			27/32	7/8	59/64	61/64	.....	.....	.....	.....	.....	.....
	5	0	.....	.....	.....	.....	0	3/64	5/64	1/8	5/32	13/64
153			15/64	9/32	5/16	23/64	25/64	7/16	15/32	33/64	35/64	19/32
154			5/8	43/64	45/64	3/4	25/32	53/64	55/64	29/32	15/16	63/64
155	5	1	1/32	1/16	7/64	9/64	3/16	7/32	17/64	19/64	11/32	3/8
156			27/64	29/64	1/2	17/32	37/64	39/64	21/32	11/16	47/64	49/64
157			13/16	27/32	57/64	59/64	31/32	.....	.....	.....	.....	.....
	5	2	.....	.....	.....	.....	.....	1/64	3/64	3/32	1/8	11/64
158			13/64	1/4	9/32	21/64	23/64	13/32	7/16	31/64	33/64	9/16
159			19/32	41/64	43/64	23/32	3/4	51/64	53/64	7/8	29/32	61/64

METRIC CONVERSION TABLES

INCHES TO CENTIMETERS—1 in. = 2.540005 cm

In.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	2.540	5.080	7.620	10.160	12.700	15.240	17.780	20.320	22.860
1	25.400	27.940	30.480	33.020	35.560	38.100	40.640	43.180	45.720	48.260
2	50.800	53.340	55.880	58.420	60.960	63.500	66.040	68.580	71.120	73.660
3	76.200	78.740	81.280	83.820	86.360	88.900	91.440	93.980	96.520	99.060
4	101.600	104.140	106.680	109.220	111.760	114.300	116.840	119.380	121.920	124.460
5	127.000	129.540	132.080	134.620	137.160	139.700	142.240	144.780	147.320	149.860
6	152.400	154.940	157.480	160.020	162.560	165.100	167.640	170.180	172.720	175.260
7	177.800	180.340	182.880	185.420	187.960	190.500	193.040	195.580	198.120	200.660
8	203.200	205.740	208.280	210.820	213.360	215.900	218.440	220.980	223.520	226.060
9	228.600	231.140	233.680	236.220	238.760	241.300	243.840	246.380	248.920	251.460

INCHES^2 TO CENTIMETERS^2—1 in.^{2} = 6.451625 cm^2

In.^{2}	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	6.452	12.903	19.355	25.807	32.258	38.710	45.161	51.613	58.065
1	64.516	70.968	77.420	83.871	90.323	96.774	103.226	109.678	116.129	122.581
2	129.033	135.484	141.936	148.387	154.839	161.291	167.742	174.194	180.646	187.097
3	193.549	200.000	206.452	212.904	219.355	225.807	232.259	238.710	245.162	251.613
4	258.065	264.517	270.968	277.420	283.872	290.323	296.775	303.226	309.678	316.130
5	322.581	329.033	335.485	341.936	348.388	354.839	361.291	367.743	374.194	380.646
6	387.098	393.549	400.001	406.452	412.904	419.356	425.807	432.259	438.711	445.162
7	451.614	458.065	464.517	470.969	477.420	483.872	490.324	496.775	503.227	509.678
8	516.130	522.582	529.033	535.485	541.937	548.388	554.840	561.291	567.743	574.195
9	580.646	587.098	593.550	600.001	606.453	612.904	619.356	625.808	632.259	638.711

INCHES^3 TO CENTIMETERS^3—1 in.^{3} = 16.38716 cm^3

In.^{3}	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	16.39	32.77	49.16	65.55	81.94	98.32	114.71	131.10	147.48
1	163.87	180.26	196.65	213.03	229.42	245.81	262.19	278.58	294.97	311.36
2	327.74	344.13	360.52	376.90	393.29	409.68	426.07	442.45	458.84	475.23
3	491.61	508.00	524.39	540.78	557.16	573.55	589.94	606.32	622.71	639.10
4	655.49	671.87	688.26	704.65	721.04	737.42	753.81	770.20	786.58	802.97
5	819.36	835.75	852.13	868.52	884.91	901.29	917.68	934.07	950.46	966.84
6	983.23	999.62	1016.00	1032.39	1048.78	1065.17	1081.55	1097.94	1114.33	1130.71
7	1147.10	1163.49	1179.88	1196.26	1212.65	1229.04	1245.42	1261.81	1278.20	1294.59
8	1310.97	1327.36	1343.75	1360.13	1376.52	1392.91	1409.30	1425.68	1442.07	1458.46
9	1474.84	1491.23	1507.62	1524.01	1540.39	1556.78	1573.17	1589.55	1605.94	1622.33

INCHES^4 TO CENTIMETERS^4—1 in.^{4} = 41.62347 cm^4

In.^{4}	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	41.62	83.25	124.87	166.49	208.12	249.74	291.36	332.99	374.61
1	416.23	457.86	499.48	541.11	582.73	624.35	665.98	707.60	749.22	790.85
2	832.47	874.09	915.72	957.34	998.96	1040.59	1082.21	1123.83	1165.46	1207.08
3	1248.70	1290.33	1331.95	1373.57	1415.20	1456.82	1498.44	1540.07	1581.69	1623.32
4	1664.94	1706.56	1748.19	1789.81	1831.43	1873.06	1914.68	1956.30	1997.93	2039.55
5	2081.17	2122.80	2164.42	2206.04	2247.67	2289.29	2330.91	2372.54	2414.16	2455.78
6	2497.41	2539.03	2580.66	2622.28	2663.90	2705.53	2747.15	2788.77	2830.40	2872.02
7	2913.64	2955.27	2996.89	3038.51	3080.14	3121.76	3163.38	3205.01	3246.63	3288.25
8	3329.88	3371.50	3413.12	3454.75	3496.37	3537.99	3579.62	3621.24	3662.87	3704.49
9	3746.11	3787.74	3829.36	3870.98	3912.61	3954.23	3995.85	4037.48	4079.10	4120.72

METRIC CONVERSION TABLES

CENTIMETERS TO INCHES—1 cm = 0.3937 in.

cm Tens	Units 0	1	2	3	4	5	6	7	8	9
0	....	0.3937	0.7874	1.1811	1.5748	1.9685	2.3622	2.7559	3.1496	3.5433
1	3.9370	4.3307	4.7244	5.1181	5.5118	5.9055	6.2992	6.6929	7.0866	7.4803
2	7.8740	8.2677	8.6614	9.0551	9.4488	9.8425	10.2362	10.6299	11.0236	11.4173
3	11.8110	12.2047	12.5984	12.9921	13.3858	13.7795	14.1732	14.5669	14.9606	15.3543
4	15.7480	16.1417	16.5354	16.9291	17.3228	17.7165	18.1102	18.5039	18.8976	19.2913
5	19.6850	20.0787	20.4724	20.8661	21.2598	21.6535	22.0472	22.4409	22.8346	23.2283
6	23.6220	24.0157	24.4094	24.8031	25.1968	25.5905	25.9842	26.3779	26.7716	27.1653
7	27.5590	27.9527	28.3464	28.7401	29.1338	29.5275	29.9212	30.3149	30.7086	31.1023
8	31.4960	31.8897	32.2834	32.6771	33.0708	33.4645	33.8582	34.2519	34.6456	35.0393
9	35.4330	35.8267	36.2204	36.6141	37.0078	37.4015	37.7952	38.1889	38.5826	38.9763

CENTIMETERS² TO INCHES²—1 cm² = 0.15499969 in.²

cm² Tens	Units 0	1	2	3	4	5	6	7	8	9
0	....	0.1550	0.3100	0.4650	0.6200	0.7750	0.9300	1.0850	1.2400	1.3950
1	1.5500	1.7050	1.8600	2.0150	2.1700	2.3250	2.4800	2.6350	2.7900	2.9450
2	3.1000	3.2550	3.4100	3.5650	3.7200	3.8750	4.0300	4.1850	4.3400	4.4950
3	4.6500	4.8050	4.9600	5.1150	5.2700	5.4250	5.5800	5.7350	5.8900	6.0450
4	6.2000	6.3550	6.5100	6.6650	6.8200	6.9750	7.1300	7.2850	7.4400	7.5950
5	7.7500	7.9050	8.0600	8.2150	8.3700	8.5250	8.6800	8.8350	8.9900	9.1450
6	9.3000	9.4550	9.6100	9.7650	9.9200	10.0750	10.2300	10.3850	10.5400	10.6950
7	10.8500	11.0050	11.1600	11.3150	11.4700	11.6250	11.7800	11.9350	12.0900	12.2450
8	12.4000	12.5550	12.7100	12.8650	13.0200	13.1750	13.3300	13.4850	13.6400	13.7950
9	13.9500	14.1050	14.2600	14.4150	14.5700	14.7250	14.8800	15.0350	15.1900	15.3450

CENTIMETERS³ TO INCHES³—1 cm³ = 0.0610234 in.³

cm³ Tens	Units 0	1	2	3	4	5	6	7	8	9
0	....	0.06102	0.12205	0.18307	0.24409	0.30512	0.36614	0.42716	0.48819	0.54921
1	0.61023	0.67126	0.73228	0.79330	0.85433	0.91535	0.97637	1.03740	1.09842	1.15944
2	1.22047	1.28149	1.34251	1.40354	1.46456	1.52559	1.58661	1.64763	1.70866	1.76968
3	1.83070	1.89173	1.95275	2.01377	2.07480	2.13582	2.19684	2.25787	2.31889	2.37991
4	2.44094	2.50196	2.56298	2.62401	2.68503	2.74605	2.80708	2.86810	2.92912	2.99015
5	3.05117	3.11219	3.17322	3.23424	3.29526	3.35629	3.41731	3.47833	3.53936	3.60038
6	3.66140	3.72243	3.78345	3.84447	3.90550	3.96652	4.02754	4.08857	4.14959	4.21061
7	4.27164	4.33266	4.39368	4.45471	4.51573	4.57675	4.63778	4.69880	4.75983	4.82085
8	4.88187	4.94290	5.00392	5.06494	5.12597	5.18699	5.24801	5.30904	5.37006	5.43108
9	5.49211	5.55313	5.61415	5.67518	5.73620	5.79722	5.85825	5.91927	5.98029	6.04132

CENTIMETERS⁴ TO INCHES⁴—1 cm⁴ = 0.0240249 in.⁴

cm⁴ Tens	Units 0	1	2	3	4	5	6	7	8	9
0	....	0.02402	0.04805	0.07207	0.09610	0.12012	0.14415	0.16817	0.19220	0.21622
1	0.24025	0.26427	0.28830	0.31232	0.33635	0.36037	0.38440	0.40842	0.43245	0.45647
2	0.48050	0.50452	0.52855	0.55257	0.57660	0.60062	0.62465	0.64867	0.67270	0.69672
3	0.72075	0.74477	0.76880	0.79282	0.81685	0.84087	0.86490	0.88892	0.91295	0.93697
4	0.96100	0.98502	1.00905	1.03307	1.05710	1.08112	1.10515	1.12917	1.15320	1.17722
5	1.20125	1.22527	1.24930	1.27332	1.29734	1.32137	1.34539	1.36942	1.39344	1.41747
6	1.44149	1.46552	1.48954	1.51357	1.53759	1.56162	1.58564	1.60967	1.63369	1.65772
7	1.68174	1.70577	1.72979	1.75382	1.77784	1.80187	1.82589	1.84992	1.87394	1.89797
8	1.92199	1.94602	1.97004	1.99407	2.01809	2.04212	2.06614	2.09017	2.11419	2.13822
9	2.16224	2.18627	2.21029	2.23432	2.25834	2.28237	2.30639	2.33042	2.35444	2.37847

METRIC CONVERSION TABLES

FEET TO METERS—1 ft. = 0.3048006 m

Ft.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.3048	0.6096	0.9144	1.2192	1.5240	1.8288	2.1336	2.4384	2.7432
1	3.0480	3.3528	3.6576	3.9624	4.2672	4.5720	4.8768	5.1816	5.4864	5.7912
2	6.0960	6.4008	6.7056	7.0104	7.3152	7.6200	7.9248	8.2296	8.5344	8.8392
3	9.1440	9.4488	9.7536	10.0584	10.3632	10.6680	10.9728	11.2776	11.5824	11.8872
4	12.1920	12.4968	12.8016	13.1064	13.4112	13.7160	14.0208	14.3256	14.6304	14.9352
5	15.2400	15.5448	15.8496	16.1544	16.4592	16.7640	17.0688	17.3736	17.6784	17.9832
6	18.2880	18.5928	18.8976	19.2024	19.5072	19.8120	20.1168	20.4216	20.7264	21.0312
7	21.3360	21.6408	21.9456	22.2504	22.5552	22.8600	23.1648	23.4696	23.7744	24.0792
8	24.3840	24.6888	24.9936	25.2984	25.6033	25.9081	26.2129	26.5177	26.8225	27.1273
9	27.4321	27.7369	28.0417	28.3465	28.6513	28.9561	29.2609	29.5657	29.8705	30.1753

YARDS TO METERS—1 yd. = 0.9144018 m

Yds.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.9144	1.8288	2.7432	3.6576	4.5720	5.4864	6.4008	7.3152	8.2296
1	9.1440	10.0584	10.9728	11.8872	12.8016	13.7160	14.6304	15.5448	16.4592	17.3736
2	18.2880	19.2024	20.1168	21.0312	21.9456	22.8600	23.7744	24.6888	25.6033	26.5177
3	27.4321	28.3465	29.2609	30.1753	31.0897	32.0041	32.9185	33.8329	34.7473	35.6617
4	36.5761	37.4905	38.4049	39.3193	40.2337	41.1481	42.0625	42.9769	43.8913	44.8057
5	45.7201	46.6345	47.5489	48.4633	49.3777	50.2921	51.2065	52.1209	53.0353	53.9497
6	54.8641	55.7785	56.6929	57.6073	58.5217	59.4361	60.3505	61.2649	62.1793	63.0937
7	64.0081	64.9225	65.8369	66.7513	67.6657	68.5801	69.4945	70.4089	71.3233	72.2377
8	73.1521	74.0665	74.9809	75.8953	76.8098	77.7242	78.6386	79.5530	80.4674	81.3818
9	82.2962	83.2106	84.1250	85.0394	85.9538	86.8682	87.7826	88.6970	89.6114	90.5258

POUNDS PER FOOT TO KILOGRAMS PER METER—1 lb./ft. = 1.488161 kg/m

Lb./Ft.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	1.488	2.976	4.464	5.953	7.441	8.929	10.417	11.905	13.393
1	14.882	16.370	17.858	19.346	20.834	22.322	23.811	25.299	26.787	28.275
2	29.763	31.251	32.740	34.228	35.716	37.204	38.692	40.180	41.669	43.157
3	44.645	46.133	47.621	49.109	50.597	52.086	53.574	55.062	56.550	58.038
4	59.526	61.015	62.503	63.991	65.479	66.967	68.455	69.944	71.432	72.920
5	74.408	75.896	77.384	78.873	80.361	81.849	83.337	84.825	86.313	87.801
6	89.290	90.778	92.266	93.754	95.242	96.730	98.219	99.707	101.195	102.683
7	104.171	105.659	107.148	108.636	110.124	111.612	113.100	114.588	116.077	117.565
8	119.053	120.541	122.029	123.517	125.006	126.494	127.982	129.470	130.958	132.446
9	133.934	135.423	136.911	138.399	139.887	141.375	142.863	144.352	145.840	147.328

POUNDS PER YARD TO KILOGRAMS PER METER—1 lb./yd. = 0.496053 kg/m

Lb./Ft.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.4961	0.9921	1.4882	1.9842	2.4803	2.9763	3.4724	3.9684	4.4645
1	4.9605	5.4566	5.9526	6.4487	6.9447	7.4408	7.9368	8.4329	8.9290	9.4250
2	9.9211	10.4171	10.9132	11.4092	11.9053	12.4013	12.8974	13.3934	13.8895	14.3855
3	14.8816	15.3776	15.8737	16.3697	16.8658	17.3619	17.8579	18.3540	18.8500	19.3461
4	19.8421	20.3382	20.8342	21.3303	21.8263	22.3224	22.8184	23.3145	23.8105	24.3066
5	24.8027	25.2987	25.7948	26.2908	26.7869	27.2829	27.7790	28.2750	28.7711	29.2671
6	29.7632	30.2592	30.7553	31.2513	31.7474	32.2434	32.7395	33.2356	33.7316	34.2277
7	34.7237	35.2198	35.7158	36.2119	36.7079	37.2040	37.7000	38.1961	38.6921	39.1882
8	39.6842	40.1803	40.6763	41.1724	41.6685	42.1645	42.6606	43.1566	43.6527	44.1487
9	44.6448	45.1408	45.6369	46.1329	46.6290	47.1250	47.6211	48.1171	48.6132	49.1092

METRIC CONVERSION TABLES

METERS TO FEET—1 m = 3.2808333 ft.

m	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	3.281	6.562	9.843	13.123	16.404	19.685	22.966	26.247	29.528
1	32.808	36.089	39.370	42.651	45.932	49.213	52.493	55.774	59.055	62.336
2	65.617	68.898	72.178	75.459	78.740	82.021	85.302	88.583	91.863	95.144
3	98.425	101.706	104.987	108.268	111.548	114.829	118.110	121.391	124.672	127.953
4	131.233	134.514	137.795	141.076	144.357	147.638	150.918	154.199	157.480	160.761
5	164.042	167.323	170.603	173.884	177.165	180.446	183.727	187.008	190.288	193.569
6	196.850	200.131	203.412	206.693	209.973	213.254	216.535	219.816	223.097	226.378
7	229.658	232.939	236.220	239.501	242.782	246.063	249.343	252.624	255.905	259.186
8	262.467	265.748	269.028	272.309	275.590	278.871	282.152	285.433	288.713	291.994
9	295.275	298.556	301.837	305.118	308.398	311.679	314.960	318.241	321.522	324.803

METERS TO YARDS—1 m = 1.0936111 yd.

m	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	1.094	2.187	3.281	4.374	5.468	6.562	7.655	8.749	9.842
1	10.936	12.030	13.123	14.217	15.311	16.404	17.498	18.591	19.685	20.779
2	21.872	22.966	24.059	25.153	26.247	27.340	28.434	29.527	30.621	31.715
3	32.808	33.902	34.996	36.089	37.183	38.276	39.370	40.464	41.557	42.651
4	43.744	44.838	45.932	47.025	48.119	49.212	50.306	51.400	52.493	53.587
5	54.681	55.774	56.868	57.961	59.055	60.149	61.242	62.336	63.429	64.523
6	65.617	66.710	67.804	68.897	69.991	71.085	72.178	73.272	74.366	75.459
7	76.553	77.646	78.740	79.834	80.927	82.021	83.114	84.208	85.302	86.395
8	87.489	88.582	89.676	90.770	91.863	92.957	94.051	95.144	96.238	97.331
9	98.425	99.519	100.612	101.706	102.799	103.893	104.987	106.080	107.174	108.267

KILOGRAMS PER METER TO POUNDS PER FOOT—1 kg/m = 0.67197 lb./ft.

kg/m	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.6720	1.3439	2.0159	2.6879	3.3599	4.0318	4.7038	5.3758	6.0477
1	6.7197	7.3917	8.0636	8.7356	9.4076	10.0796	10.7515	11.4235	12.0955	12.7674
2	13.4394	14.1114	14.7833	15.4553	16.1273	16.7993	17.4712	18.1432	18.8152	19.4871
3	20.1591	20.8311	21.5030	22.1750	22.8470	23.5190	24.1909	24.8629	25.5349	26.2068
4	26.8788	27.5508	28.2227	28.8947	29.5667	30.2387	30.9106	31.5826	32.2546	32.9265
5	33.5985	34.2705	34.9424	35.6144	36.2864	36.9584	37.6303	38.3023	38.9743	39.6462
6	40.3182	40.9902	41.6621	42.3341	43.0061	43.6781	44.3500	45.0220	45.6940	46.3659
7	47.0379	47.7099	48.3818	49.0538	49.7258	50.3978	51.0697	51.7417	52.4137	53.0856
8	53.7576	54.4296	55.1015	57.7735	56.4455	57.1175	57.7894	58.4614	59.1334	59.8053
9	60.4773	61.1493	61.8212,	62.4932	63.1652	63.8372	64.5091	65.1811	65.8531	66.5250

KILOGRAMS PER METER TO POUNDS PER YARD—1 kg/m = 2.015913 lb./yd.

kg/m	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	2.016	4.032	6.048	8.064	10.080	12.095	14.111	16.127	18.143
1	20.159	22.175	24.191	26.207	28.223	30.239	32.255	34.271	36.286	38.302
2	40.318	42.334	44.350	46.366	48.382	50.398	52.414	54.430	56.446	58.461
3	60.477	62.493	64.509	66.525	68.541	70.557	72.573	74.589	76.605	78.621
4	80.637	82.652	84.668	86.684	88.700	90.716	92.732	94.748	96.764	98.780
5	100.796	102.812	104.827	106.843	108.859	110.875	112.891	114.907	116.923	118.939
6	120.955	122.971	124.987	127.003	129.018	131.034	133.050	135.066	137.082	139.098
7	141.114	143.130	145.146	147.162	149.178	151.193	153.209	155.225	157.241	159.257
8	161.273	163.289	165.305	167.321	169.337	171.353	173.369	175.384	177.400	179.416
9	181.432	183.448	185.464	187.480	189.496	191.512	193.528	195.544	197.559	199.575

METRIC CONVERSION TABLES

POUNDS PER SQ. IN. TO KG PER SQ. CM—1 lb./in.^{2}=0.0703067 kg/cm^2

Lb./In.^{2}	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.07031	0.14061	0.21092	0.28123	0.35153	0.42184	0.49215	0.56245	0.63276
1	0.70307	0.77337	0.84368	0.91399	0.98429	1.05460	1.12491	1.19521	1.26552	1.33583
2	1.40613	1.47644	1.54675	1.61705	1.68736	1.75767	1.82797	1.89828	1.96859	2.03889
3	2.10920	2.17951	2.24981	2.32012	2.39043	2.46073	2.53104	2.60135	2.67165	2.74196
4	2.81227	2.88257	2.95288	3.02319	3.09349	3.16380	3.23411	3.30441	3.37472	3.44503
5	3.51534	3.58564	3.65595	3.72626	3.79656	3.86687	3.93718	4.00748	4.07779	4.14810
6	4.21840	4.28871	4.35902	4.42932	4.49963	4.56994	4.64024	4.71055	4.78086	4.85116
7	4.92147	4.99178	5.06208	5.13239	5.20270	5.27300	5.34331	5.41362	5.48392	5.55423
8	5.62454	5.69484	5.76515	5.83546	5.90576	5.97607	6.04638	6.11668	6.18699	6.25730
9	6.32760	6.39791	6.46822	6.53852	6.60883	6.67914	6.74944	6.81975	6.89006	6.96036

KG PER SQ. CM TO POUNDS PER SQ. IN.—1 kg/cm^2=14.2234 lbs./in.^{2}

kg/cm2	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.79	128.01
1	142.23	156.46	170.68	184.90	199.13	213.35	227.57	241.80	256.02	270.24
2	284.47	298.69	312.91	327.14	341.36	355.59	369.81	384.03	398.26	412.48
3	426.70	440.93	455.15	469.37	483.60	497.82	512.04	526.27	540.49	554.71
4	568.94	583.16	597.38	611.61	625.83	640.05	654.28	668.50	682.72	696.95
5	711.17	725.39	739.62	753.84	768.06	782.29	796.51	810.73	824.96	839.18
6	853.40	867.63	881.85	896.07	910.30	924.52	938.74	952.97	967.19	981.41
7	995.64	1009.86	1024.08	1038.31	1052.53	1066.76	1080.98	1095.20	1109.43	1123.65
8	1137.87	1152.10	1166.32	1180.54	1194.77	1208.99	1223.21	1237.44	1251.66	1265.88
9	1280.11	1294.33	1308.55	1322.78	1337.00	1351.22	1365.45	1379.67	1393.89	1408.12

INCH-POUNDS TO KILOGRAM-CENTIMETERS—1 in.-lb.=1.152127 kg-cm

In.-Lbs.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	1.152	2.304	3.456	4.609	5.761	6.913	8.065	9.217	10.369
1	11.521	12.673	13.826	14.978	16.130	17.282	18.434	19.586	20.738	21.890
2	23.043	24.195	25.347	26.499	27.651	28.803	29.955	31.107	32.260	33.412
3	34.564	35.716	36.868	38.020	39.172	40.324	41.477	42.629	43.781	44.933
4	46.085	47.237	48.389	49.541	50.694	51.846	52.998	54.150	55.302	56.454
5	57.606	58.758	59.911	61.063	62.215	63.367	64.519	65.671	66.823	67.975
6	69.128	70.280	71.432	72.584	73.736	74.888	76.040	77.193	78.345	79.497
7	80.649	81.801	82.953	84.105	85.257	86.410	87.562	88.714	89.866	91.018
8	92.170	93.322	94.474	95.627	96.779	97.931	99.083	100.235	101.387	102.539
9	103.691	104.844	105.996	107.148	108.300	109.452	110.604	111.756	112.908	114.061

KILOGRAM-CENTIMETERS TO INCH-POUNDS—1 kg-cm=0.86796 in.-lb.

kg-cm	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.8680	1.7359	2.6039	3.4718	4.3398	5.2078	6.0757	6.9437	7.8116
1	8.6796	9.5476	10.4155	11.2835	12.1514	13.0194	13.8874	14.7553	15.6233	16.4912
2	17.3592	18.2272	19.0951	19.9631	20.8310	21.6990	22.5670	23.4349	24.3029	25.1708
3	26.0388	26.9068	27.7747	28.6427	29.5106	30.3786	31.2466	32.1145	32.9825	33.8504
4	34.7184	35.5864	36.4543	37.3223	38.1902	39.0582	39.9262	40.7941	41.6621	42.5300
5	43.3980	44.2660	45.1339	46.0019	46.8698	47.7378	48.6058	49.4737	50.3417	51.2096
6	52.0776	52.9456	53.8135	54.6815	55.5494	56.4174	57.2854	58.1533	59.0213	59.8892
7	60.7572	61.6252	62.4931	63.3611	64.2290	65.0970	65.9650	66.8329	67.7009	68.5688
8	69.4368	70.3048	71.1727	72.0407	72.9086	73.7766	74.6446	75.5125	76.3805	77.2484
9	78.1164	78.9844	79.8523	80.7203	81.5882	82.4562	83.3242	84.1921	85.0601	85.9280

METRIC CONVERSION TABLES

POUNDS PER SQ. FOOT TO KILOGRAMS PER SQ. METER

1 lb./ft.^{2} = 4.882407 kg/m^2

Lb./Ft.^{2}	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	4.882	9.765	14.647	19.530	24.412	29.294	34.177	39.059	43.942
1	48.824	53.706	58.589	63.471	68.354	73.236	78.119	83.001	87.883	92.766
2	97.648	102.531	107.413	112.295	117.178	122.060	126.943	131.825	136.707	141.590
3	146.472	151.355	156.237	161.119	166.002	170.884	175.767	180.649	185.531	190.414
4	195.296	200.179	205.061	209.944	214.826	219.708	224.591	229.473	234.356	239.238
5	244.120	249.003	253.885	258.768	263.650	268.532	273.415	278.297	283.180	288.062
6	292.944	297.827	302.709	307.592	312.474	317.356	322.239	327.121	332.004	336.886
7	341.768	346.651	351.533	356.416	361.298	366.181	371.063	375.945	380.828	385.710
8	390.593	395.475	400.357	405.240	410.122	415.005	419.887	424.769	429.652	434.534
9	439.417	444.299	449.181	454.064	458.946	463.829	468.711	473.593	478.476	483.358

KILOGRAMS PER SQ. METER TO POUNDS PER SQ. FOOT

1 kg/m^2 = 0.204817 lb./ft.^{2}

kg/m^2	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	....	0.2048	0.4096	0.6145	0.8193	1.0241	1.2289	1.4337	1.6385	1.8434
1	2.0482	2.2530	2.4578	2.6626	2.8674	3.0723	3.2771	3.4819	3.6867	3.8915
2	4.0963	4.3012	4.5060	4.7108	4.9156	5.1204	5.3252	5.5301	5.7349	5.9397
3	6.1445	6.3493	6.5541	6.7590	6.9638	7.1686	7.3734	7.5782	7.7830	7.9879
4	8.1927	8.3975	8.6023	8.8071	9.0119	9.2168	9.4216	9.6264	9.8312	10.0360
5	10.2409	10.4457	10.6505	10.8553	11.0601	11.2649	11.4698	11.6746	11.8794	12.0842
6	12.2890	12.4938	12.6987	12.9035	13.1083	13.3131	13.5179	13.7227	13.9276	14.1324
7	14.3372	14.5420	14.7468	14.9516	15.1565	15.3613	15.5661	15.7709	15.9757	16.1805
8	16.3854	16.5902	16.7950	16.9998	17.2046	17.4094	17.6143	17.8191	18.0239	18.2287
9	18.4335	18.6383	18.8432	19.0480	19.2528	19.4576	19.6624	19.8672	20.0721	20.2769
10	20.4817	20.6865	20.8913	21.0962	21.3010	21.5058	21.7106	21.9154	22.1202	22.3251
11	22.5299	22.7347	22.9395	23.1443	23.3491	23.5540	23.7588	23.9636	24.1684	24.3732
12	24.5780	24.7829	24.9877	25.1925	25.3973	25.6021	25.8069	26.0118	26.2166	26.4214
13	26.6262	26.8310	27.0358	27.2407	27.4455	27.6503	27.8551	28.0599	28.2647	28.4696
14	28.6744	28.8792	29.0840	29.2888	29.4936	29.6985	29.9033	30.1081	30.3129	30.5177
15	30.7226	30.9274	31.1322	31.3370	31.5418	31.7466	31.9515	32.1563	32.3611	32.5659
16	32.7707	32.9755	33.1804	33.3852	33.5900	33.7948	33.9996	34.2044	34.4093	34.6141
17	34.8189	35.0237	35.2285	35.4333	35.6382	35.8430	36.0478	36.2526	36.4574	36.6622
18	36.8671	37.0719	37.2767	37.4815	37.6863	37.8911	38.0960	38.3008	38.5056	38.7104
19	38.9152	39.1200	39.3249	39.5297	39.7345	39.9393	40.1441	40.3489	40.5538	40.7586
20	40.9634	41.1682	41.3730	41.5779	41.7827	41.9875	42.1923	42.3971	42.6019	42.8068
21	43.0116	43.2164	43.4212	43.6260	43.8308	44.0357	44.2405	44.4453	44.6501	44.8549
22	45.0597	45.2646	45.4694	45.6742	45.8790	46.0838	46.2886	46.4935	46.6983	46.9031
23	47.1079	47.3127	47.5175	47.7224	47.9272	48.1320	48.3368	48.5416	48.7464	48.9513
24	49.1561	49.3609	49.5657	49.7705	49.9753	50.1802	50.3850	50.5898	50.7946	50.9994
25	51.2043	51.4091	51.6139	51.8187	52.0235	52.2283	52.4332	52.6380	52.8428	53.0476
26	53.2524	53.4572	53.6621	53.8669	54.0717	54.2765	54.4813	54.6861	54.8910	55.0958
27	55.3006	55.5054	55.7102	55.9150	56.1199	56.3247	56.5295	56.7343	56.9391	57.1439
28	57.3488	57.5536	57.7584	57.9632	58.1680	58.3728	58.5777	58.7825	58.9873	59.1921
29	59.3969	59.6017	59.8066	60.0114	60.2162	60.4210	60.6258	60.8306	61.0355	61.2403
30	61.4451	61.6499	61.8547	62.0596	62.2644	62.4692	62.6740	62.8788	63.0836	63.2885
31	63.4933	63.6981	63.9029	64.1077	64.3125	64.5174	64.7222	64.9270	65.1318	65.3366
32	65.5414	65.7463	65.9511	66.1559	66.3607	66.5655	66.7703	66.9752	67.1800	67.3848
33	67.5896	67.7944	67.9992	68.2041	68.4089	68.6137	68.8185	69.0233	69.2281	69.4330
34	69.6378	69.8426	70.0474	70.2522	70.4570	70.6619	70.8667	71.0715	71.2763	71.4811
35	71.6860	71.8908	72.0956	72.3004	72.5052	72.7100	72.9149	73.1197	73.3245	73.5293
36	73.7341	73.9389	74.1438	74.3486	74.5534	74.7582	74.9630	75.1678	75.3727	75.5775
37	75.7823	75.9871	76.1919	76.3967	76.6016	76.8064	77.0112	77.2160	77.4208	77.6256
38	77.8305	78.0353	78.2401	78.4449	78.6497	78.8545	79.0594	79.2642	79.4690	79.6738
39	79.8786	80.0834	80.2883	80.4931	80.6979	80.9027	81.1075	81.3123	81.5172	81.7220

METRIC CONVERSION TABLE

POUNDS AVOIRDUPOIS TO KILOGRAMS

1 Pound = 0.45359 Kilograms

Lbs.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	......	0.45	0.91	1.36	1.81	2.27	2.72	3.18	3.63	4.08
1	4.54	4.99	5.44	5.90	6.35	6.80	7.26	7.71	8.16	8.62
2	9.07	9.53	9.98	10.43	10.89	11.34	11.79	12.25	12.70	13.15
3	13.61	14.06	14.51	14.97	15.42	15.88	16.33	16.78	17.24	17.69
4	18.14	18.60	19.05	19.50	19.96	20.41	20.87	21.32	21.77	22.23
5	22.68	23.13	23.59	24.04	24.49	24.95	25.40	25.85	26.31	26.76
6	27.22	27.67	28.12	28.58	29.03	29.48	29.94	30.39	30.84	31.30
7	31.75	32.21	32.66	33.11	33.57	34.02	34.47	34.93	35.38	35.83
8	36.29	36.74	37.19	37.65	38.10	38.56	39.01	39.46	39.92	40.37
9	40.82	41.28	41.73	42.18	42.64	43.09	43.54	44.00	44.45	44.91
10	45.36	45.81	46.27	46.72	47.17	47.63	48.08	48.53	48.99	49.44
11	49.90	50.35	50.80	51.26	51.71	52.16	52.62	53.07	53.52	53.98
12	54.43	54.88	55.34	55.79	56.25	56.70	57.15	57.61	58.06	58.51
13	58.97	59.42	59.87	60.33	60.78	61.23	61.69	62.14	62.60	63.05
14	63.50	63.96	64.41	64.86	65.32	65.77	66.22	66.68	67.13	67.59
15	68.04	68.49	68.95	69.40	69.85	70.31	70.76	71.21	71.67	72.12
16	72.57	73.03	73.48	73.94	74.39	74.84	75.30	75.75	76.20	76.66
17	77.11	77.56	78.02	78.47	78.93	79.38	79.83	80.29	80.74	81.19
18	81.65	82.10	82.55	83.01	83.46	83.91	84.37	84.82	85.28	85.73
19	86.18	86.64	87.09	87.54	88.00	88.45	88.90	89.36	89.81	90.26
20	90.72	91.17	91.63	92.08	92.53	92.99	93.44	93.89	94.35	94.80
21	95.25	95.71	96.16	96.62	97.07	97.52	97.98	98.43	98.88	99.34
22	99.79	100.24	100.70	101.15	101.60	102.06	102.51	102.97	103.42	103.87
23	104.33	104.78	105.23	105.69	106.14	106.59	107.05	107.50	107.96	108.41
24	108.86	109.32	109.77	110.22	110.68	111.13	111.58	112.04	112.49	112.94
25	113.40	113.85	114.31	114.76	115.21	115.67	116.12	116.57	117.03	117.48
26	117.93	118.39	118.84	119.29	119.75	120.20	120.66	121.11	121.56	122.02
27	122.47	122.92	123.38	123.83	124.28	124.74	125.19	125.65	126.10	126.55
28	127.01	127.46	127.91	128.37	128.82	129.27	129.73	130.18	130.63	131.09
29	131.54	132.00	132.45	132.90	133.36	133.81	134.26	134.72	135.17	135.62
30	136.08	136.53	136.98	137.44	137.89	138.35	138.80	139.25	139.71	140.16
31	140.61	141.07	141.52	141.97	142.43	142.88	143.34	143.79	144.24	144.70
32	145.15	145.60	146.06	146.51	146.96	147.42	147.87	148.32	148.78	149.23
33	149.69	150.14	150.59	151.05	151.50	151.95	152.41	152.86	153.31	153.77
34	154.22	154.68	155.13	155.58	156.04	156.49	156.94	157.40	157.85	158.30
35	158.76	159.21	159.66	160.12	160.57	161.03	161.48	161.93	162.39	162.84
36	163.29	163.75	164.20	164.65	165.11	165.56	166.01	166.47	166.92	167.38
37	167.83	168.28	168.74	169.19	169.64	170.10	170.55	171.00	171.46	171.91
38	172.37	172.82	173.27	173.73	174.18	174.63	175.09	175.54	175.99	176.45
39	176.90	177.35	177.81	178.26	178.72	179.17	179.62	180.08	180.53	180.98
40	181.44	181.89	182.34	182.80	183.25	183.70	184.16	184.61	185.07	185.52
41	185.97	186.43	186.88	187.33	187.79	188.24	188.69	189.15	189.60	190.06
42	190.51	190.96	191.42	191.87	192.32	192.78	193.23	193.68	194.14	194.59
43	195.04	195.50	195.95	196.41	196.86	197.31	197.77	198.22	198.67	199.13
44	199.58	200.03	200.49	200.94	201.40	201.85	202.30	202.76	203.21	203.66
45	204.12	204.57	205.02	205.48	205.93	206.38	206.84	207.29	207.75	208.20
46	208.65	209.11	209.56	210.01	210.47	210.92	211.37	211.83	212.28	212.73
47	213.19	213.64	214.10	214.55	215.00	215.46	215.91	216.36	216.82	217.27
48	217.72	218.18	218.63	219.09	219.54	219.99	220.45	220.90	221.35	221.81
49	222.26	222.71	223.17	223.62	224.07	224.53	224.98	225.44	225.89	226.34

METRIC CONVERSION TABLE

POUNDS AVOIRDUPOIS TO KILOGRAMS

1 Pound = 0.45359 Kilograms

Lbs.	Units									
Tens	0	1	2	3	4	5	6	7	8	9
50	226.80	227.25	227.70	228.16	228.61	229.06	229.52	229.97	230.42	230.88
51	231.33	231.79	232.24	232.69	233.15	233.60	234.05	234.51	234.96	235.41
52	235.87	236.32	236.78	237.23	237.68	238.14	238.59	239.04	239.50	239.95
53	240.40	240.86	241.31	241.76	242.22	242.67	243.13	243.58	244.03	244.49
54	244.94	245.39	245.85	246.30	246.75	247.21	247.66	248.12	248.57	249.02
55	249.48	249.93	250.38	250.84	251.29	251.74	252.20	252.65	253.10	253.56
56	254.01	254.47	254.92	255.37	255.83	256.28	256.73	257.19	257.64	258.09
57	258.55	259.00	259.45	259.91	260.36	260.82	261.27	261.72	262.18	262.63
58	263.08	263.54	263.99	264.44	264.90	265.35	265.81	266.26	266.71	267.17
59	267.62	268.07	268.53	268.98	269.43	269.89	270.34	270.99	271.25	271.70
60	272.16	272.61	273.06	273.52	273.97	274.42	274.88	275.33	275.78	276.24
61	276.69	277.14	277.60	278.05	278.51	278.96	279.41	279.87	280.32	280.77
62	281.23	281.68	282.13	282.59	283.04	283.50	283.95	284.40	284.86	285.31
63	285.76	286.22	286.67	287.12	287.58	288.03	288.48	288.94	289.39	289.85
64	290.30	290.75	291.21	291.66	292.11	292.57	293.02	293.47	293.93	294.38
65	294.84	295.29	295.74	296.20	296.65	297.10	297.56	298.01	298.46	298.92
66	299.37	299.82	300.28	300.73	301.19	301.64	302.09	302.55	303.00	303.45
67	303.91	304.36	304.81	305.27	305.72	306.17	306.63	307.08	307.54	307.99
68	308.44	308.90	309.35	309.80	310.26	310.71	311.16	311.62	312.07	312.53
69	312.98	313.43	313.89	314.34	314.79	315.25	315.70	316.15	316.61	317.06
70	317.51	317.97	318.42	318.88	319.33	319.78	320.24	320.69	321.14	321.60
71	322.05	322.50	322.96	323.41	323.86	324.32	324.77	325.23	325.68	326.13
72	326.59	327.04	327.49	327.95	328.40	328.85	329.31	329.76	330.22	330.67
73	331.12	331.58	332.03	332.48	332.94	333.39	333.84	334.30	334.75	335.20
74	335.66	336.11	336.57	337.02	337.47	337.93	338.38	338.83	339.29	339.74
75	340.19	340.65	341.10	341.56	342.01	342.46	342.92	343.37	343.82	344.28
76	344.73	345.18	345.64	346.09	346.54	347.00	347.45	347.91	348.36	348.81
77	349.27	349.72	350.17	350.63	351.08	351.53	351.99	352.44	352.89	353.35
78	353.80	354.26	354.71	355.16	355.62	356.07	356.52	356.98	357.43	357.88
79	358.34	358.79	359.25	359.70	360.15	360.61	361.06	361.51	361.97	362.42
80	362.87	363.33	363.78	364.23	364.69	365.14	365.60	366.05	366.50	366.96
81	367.41	367.86	368.32	368.77	369.22	369.68	370.13	370.59	371.04	371.49
82	371.95	372.40	372.85	373.31	373.76	374.21	374.67	375.12	375.57	376.03
83	376.48	376.94	377.39	377.84	378.30	378.75	379.20	379.66	380.11	380.56
84	381.02	381.47	381.92	382.33	382.83	383.29	383.74	384.19	384.65	385.10
85	385.55	386.01	386.46	386.91	387.37	387.82	388.28	388.73	389.18	389.64
86	390.09	390.54	391.00	391.45	391.90	392.36	392.81	393.26	393.72	394.17
87	394.63	395.08	395.53	395.99	396.44	396.89	397.35	397.80	398.25	398.71
88	399.16	399.61	400.07	400.52	400.98	401.43	401.88	402.34	402.79	403.24
89	403.78	404.15	404.60	405.06	405.51	405.97	406.42	406.87	407.33	407.78
90	408.23	408.69	409.14	409.59	410.05	410.50	410.95	411.41	411.86	412.32
91	412.77	413.22	413.68	414.13	414.58	415.14	415.49	415.94	416.40	416.85
92	417.31	417.76	418.21	418.67	419.12	419.57	420.03	420.48	420.93	421.39
93	421.84	422.29	422.75	423.20	423.66	424.11	424.56	425.02	425.47	425.92
94	426.38	426.83	427.28	427.74	428.19	428.64	429.10	429.55	430.01	430.46
95	430.91	431.37	431.82	432.27	432.73	433.18	433.63	434.09	434.54	435.00
96	435.45	435.90	436.36	436.81	437.26	437.72	438.17	438.62	439.08	439.53
97	439.98	440.44	440.89	441.35	441.80	442.25	442.71	443.16	443.61	444.07
98	444.52	444.97	445.43	445.88	446.33	446.79	447.24	447.70	448.15	448.60
99	449.06	449.51	449.96	450.42	450.87	451.32	451.78	452.23	452.69	453.14

METRIC CONVERSION TABLE

KILOGRAMS TO POUNDS AVOIRDUPOIS

1 kilogram = 2.204622341 pounds

kg	Units									
Tens	0	1	2	3	4	5	6	7	8	9
0	......	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8
1	22.0	24.3	26.5	28.7	30.9	33.1	35.3	37.5	39.7	41.9
2	44.1	46.3	48.5	50.7	52.9	55.1	57.3	59.5	61.7	63.9
3	66.1	68.3	70.5	72.8	75.0	77.2	79.4	81.6	83.8	86.0
4	88.2	90.4	92.6	94.8	97.0	99.2	101.4	103.6	105.8	108.0
5	110.2	112.4	114.6	116.8	119.0	121.3	123.5	125.7	127.9	130.1
6	132.4	134.5	136.7	138.9	141.1	143.3	145.5	147.7	149.9	152.1
7	154.3	156.5	158.7	160.9	163.1	165.3	167.6	169.8	172.0	174.2
8	176.4	178.6	180.8	183.0	185.2	187.4	189.6	191.8	194.0	196.2
9	198.4	200.6	202.8	205.0	207.2	209.4	211.6	213.8	216.1	218.3
10	220.5	222.7	224.9	227.1	229.3	231.5	233.7	235.9	238.1	240.3
11	242.5	244.7	246.9	249.1	251.3	253.5	255.7	257.9	260.1	262.4
12	264.6	266.8	269.0	271.2	273.4	275.6	277.8	280.0	282.2	284.4
13	286.6	288.8	291.0	293.2	295.4	297.6	299.8	302.0	304.2	306.4
14	308.6	310.9	313.1	315.3	317.5	319.7	321.9	324.1	326.3	328.5
15	330.7	332.9	335.1	337.3	339.5	341.7	343.9	346.1	348.3	350.5
16	352.7	354.9	357.1	359.4	361.6	363.8	366.0	368.2	370.4	372.6
17	374.8	377.0	379.2	381.4	383.6	385.8	388.0	390.2	392.4	394.6
18	396.8	399.0	401.2	403.4	405.7	407.9	410.1	412.3	414.5	416.7
19	418.9	421.1	423.3	425.5	427.7	429.9	432.1	434.3	436.5	438.7
20	440.9	443.1	445.3	447.5	449.7	451.9	454.2	456.4	458.6	460.8
21	463.0	465.2	467.4	469.6	471.8	474.0	476.2	478.4	480.6	482.8
22	485.0	487.2	489.4	491.6	493.8	496.0	498.2	500.4	502.7	504.9
23	507.1	509.3	511.5	513.7	515.9	518.1	520.3	522.5	524.7	526.9
24	529.1	531.3	533.5	535.7	537.9	540.1	542.3	544.5	546.7	549.0
25	551.2	553.4	555.6	557.8	560.0	562.2	564.4	566.6	568.8	571.0
26	573.2	575.4	577.6	579.8	582.0	584.2	586.4	588.6	590.8	593.0
27	595.2	597.5	599.7	601.9	604.1	606.3	608.5	610.7	612.9	615.1
28	617.3	619.5	621.7	623.9	626.1	628.3	630.5	632.7	634.9	637.1
29	639.3	641.5	643.7	646.0	648.2	650.4	652.6	654.8	657.0	659.2
30	661.4	663.6	665.8	668.0	670.2	672.4	674.6	676.8	679.0	681.2
31	683.4	685.6	687.8	690.0	692.3	694.5	696.7	698.9	701.1	703.3
32	705.5	707.7	709.9	712.1	714.3	716.5	718.7	720.9	723.1	725.3
33	727.5	729.7	731.9	734.1	736.3	738.5	740.8	743.0	745.2	747.4
34	749.6	751.8	754.0	756.2	758.4	760.6	762.8	765.0	767.2	769.4
35	771.6	773.8	776.0	778.2	780.4	782.6	784.8	787.1	789.3	791.5
36	793.7	795.9	798.1	800.3	802.5	804.7	806.9	809.1	811.3	813.5
37	815.7	817.9	820.1	822.3	824.5	826.7	828.9	831.1	833.3	835.6
38	837.8	840.0	842.2	844.4	846.6	848.8	851.0	853.2	855.4	857.6
39	859.8	862.0	864.2	866.4	868.6	870.8	873.0	875.2	877.4	879.6
40	881.8	884.1	886.3	888.5	890.7	892.9	895.1	897.3	899.5	901.7
41	903.9	906.1	908.3	910.5	912.7	914.9	917.1	919.3	921.5	923.7
42	925.9	928.1	930.4	932.6	934.8	937.0	939.2	941.4	943.6	945.8
43	948.0	950.2	952.4	954.6	956.8	959.0	961.2	963.4	965.6	967.8
44	970.0	972.2	974.4	976.6	978.9	981.1	983.3	985.5	987.7	989.9
45	992.1	994.3	996.5	998.7	1000.9	1003.1	1005.3	1007.5	1009.7	1011.9
46	1014.1	1016.3	1018.5	1020.7	1022.9	1025.1	1027.4	1029.6	1031.8	1034.0
47	1036.2	1038.4	1040.6	1042.8	1045.0	1047.2	1049.4	1051.6	1053.8	1056.0
48	1058.2	1060.4	1062.6	1064.8	1067.0	1069.2	1071.4	1073.7	1075.9	1078.1
49	1080.3	1082.5	1084.7	1086.9	1089.1	1091.3	1093.5	1095.7	1097.9	1100.1

METRIC CONVERSION TABLE

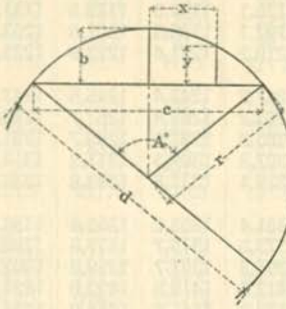
KILOGRAMS TO POUNDS AVOIRDUPOIS

1 kilogram = 2.204622341 pounds

kg	Units									
Tens	0	1	2	3	4	5	6	7	8	9
50	1102.3	1104.5	1106.7	1108.9	1111.1	1113.3	1115.5	1117.7	1119.9	1122.2
51	1124.4	1126.6	1128.8	1131.0	1133.2	1135.4	1137.6	1139.8	1142.0	1144.2
52	1146.4	1148.6	1150.8	1153.0	1155.2	1157.4	1159.6	1161.8	1164.0	1166.2
53	1168.4	1170.7	1172.9	1175.1	1177.3	1179.5	1181.7	1183.9	1186.1	1188.3
54	1190.5	1192.7	1194.9	1197.1	1199.3	1201.5	1203.7	1205.9	1208.1	1210.3
55	1212.5	1214.7	1217.0	1219.2	1221.4	1223.6	1225.8	1228.0	1230.2	1232.4
56	1234.6	1236.8	1239.0	1241.2	1243.4	1245.6	1247.8	1250.0	1252.2	1254.4
57	1256.6	1258.8	1261.0	1263.2	1265.5	1267.7	1269.9	1272.1	1274.3	1276.5
58	1278.7	1280.9	1283.1	1285.3	1287.5	1289.7	1291.9	1294.1	1296.3	1298.5
59	1300.7	1302.9	1305.1	1307.3	1309.5	1311.8	1314.0	1316.2	1318.4	1320.6
60	1322.8	1325.0	1327.2	1329.4	1331.6	1333.8	1336.0	1338.2	1340.4	1342.6
61	1344.8	1347.0	1349.2	1351.4	1353.6	1355.8	1358.0	1360.3	1362.5	1364.7
62	1366.9	1369.1	1371.3	1373.5	1375.7	1377.9	1380.1	1382.3	1384.5	1386.7
63	1388.9	1391.1	1393.3	1395.5	1397.7	1399.9	1402.1	1404.3	1406.5	1408.8
64	1411.0	1413.2	1415.4	1417.6	1419.8	1422.0	1424.2	1426.4	1428.6	1430.8
65	1433.0	1435.2	1437.4	1439.6	1441.8	1444.0	1446.2	1448.4	1450.6	1452.8
66	1455.1	1457.3	1459.5	1461.7	1463.9	1466.1	1468.3	1470.5	1472.7	1474.9
67	1477.1	1479.3	1481.5	1483.7	1485.9	1488.1	1490.3	1492.5	1494.7	1496.9
68	1499.1	1501.3	1503.6	1505.8	1508.0	1510.2	1512.4	1514.6	1516.8	1519.0
69	1521.2	1523.4	1525.6	1527.8	1530.0	1532.2	1534.4	1536.6	1538.8	1541.0
70	1543.2	1545.4	1547.6	1549.8	1552.1	1554.3	1556.5	1558.7	1560.9	1563.1
71	1565.3	1567.5	1569.7	1571.9	1574.1	1576.3	1578.5	1580.7	1582.9	1585.1
72	1587.3	1589.5	1591.7	1593.9	1596.1	1598.4	1600.6	1602.8	1605.0	1607.2
73	1609.4	1611.6	1613.8	1616.0	1618.2	1620.4	1622.6	1624.8	1627.0	1629.2
74	1631.4	1633.6	1635.8	1638.0	1640.2	1642.4	1644.6	1646.9	1649.1	1651.3
75	1653.5	1655.7	1657.9	1660.1	1662.3	1664.5	1666.7	1668.9	1671.1	1673.3
76	1675.5	1677.7	1679.9	1682.1	1684.3	1686.5	1688.7	1690.9	1693.2	1695.4
77	1697.6	1699.8	1702.0	1704.2	1706.4	1708.6	1710.8	1713.0	1715.2	1717.4
78	1719.6	1721.8	1724.0	1726.2	1728.4	1730.6	1732.8	1735.0	1737.2	1739.4
79	1741.7	1743.9	1746.1	1748.3	1750.5	1752.7	1754.9	1757.1	1759.3	1761.5
80	1763.7	1765.9	1768.1	1770.3	1772.5	1774.7	1776.9	1779.1	1781.3	1783.5
81	1785.7	1787.9	1790.2	1792.4	1794.6	1796.8	1799.0	1801.2	1803.4	1805.6
82	1807.8	1810.0	1812.2	1814.4	1816.6	1818.8	1821.0	1823.2	1825.4	1827.6
83	1829.8	1832.0	1834.2	1836.5	1838.7	1840.9	1843.1	1845.3	1847.5	1849.7
84	1851.9	1854.1	1856.3	1858.5	1860.7	1862.9	1865.1	1867.3	1869.5	1871.7
85	1873.9	1876.1	1878.3	1880.5	1882.7	1885.0	1887.2	1889.4	1891.6	1893.8
86	1896.0	1898.2	1900.4	1902.6	1904.8	1907.0	1909.2	1911.4	1913.6	1915.8
87	1918.0	1920.2	1922.4	1924.6	1926.8	1929.0	1931.2	1933.5	1935.7	1937.9
88	1940.1	1942.3	1944.5	1946.7	1948.9	1951.1	1953.3	1955.5	1957.7	1959.9
89	1962.1	1964.3	1966.5	1968.7	1970.9	1973.1	1975.3	1977.5	1979.8	1982.0
90	1984.2	1986.4	1988.6	1990.8	1993.0	1995.2	1997.4	1999.6	2001.8	2004.0
91	2006.2	2008.4	2010.6	2012.8	2015.0	2017.2	2019.4	2021.6	2023.8	2026.0
92	2028.3	2030.5	2032.7	2034.9	2037.1	2039.3	2041.5	2043.7	2045.9	2048.1
93	2050.3	2052.5	2054.7	2056.9	2059.1	2061.3	2063.5	2065.7	2067.9	2070.1
94	2072.3	2074.5	2076.8	2079.0	2081.2	2083.4	2085.6	2087.8	2090.0	2092.2
95	2094.4	2096.6	2098.8	2101.0	2103.2	2105.4	2107.6	2109.8	2112.0	2114.2
96	2116.4	2118.6	2120.8	2123.1	2125.3	2127.5	2129.7	2131.9	2134.1	2136.3
97	2138.5	2140.7	2142.9	2145.1	2147.3	2149.5	2151.7	2153.9	2156.1	2158.3
98	2160.5	2162.7	2164.9	2167.1	2169.3	2171.6	2173.8	2176.0	2178.2	2180.4
99	2182.6	2184.8	2187.0	2189.2	2191.4	2193.6	2195.8	2198.0	2200.2	2202.4

PROPERTIES OF THE CIRCLE

Circumference of Circle of Diameter $1 = \pi = 3.14159265$
Circumference of Circle $= 2\pi r$
Diameter of Circle = Circumference x 0.31831
Diameter of Circle of equal periphery as square = side x 1.27324
Side of Square of equal periphery as circle = diameter x 0.78540
Diameter of Circle circumscribed about square = side x 1.41421
Side of Square inscribed in Circle = diameter x 0.70711



Arc, $a = \frac{\pi r A^\circ}{180} = 0.017453\, r\, A^\circ$

Angle, $A = \frac{180^\circ a}{\pi r} = 57.29578 \frac{a}{r}$

Radius, $r = \frac{4b^2 + c^2}{8b}$ Diameter, $d = \frac{4b^2 + c^2}{4b}$

Chord, $c = 2\sqrt{2br - b^2} = 2r\sin\frac{A^\circ}{2}$

Rise, $b = r - \frac{1}{2}\sqrt{4r^2 - c^2} = \frac{c}{2}\tan\frac{A^\circ}{4} = 2r\sin^2\frac{A}{4}$

Rise, $b = r + y - \sqrt{r^2 - x^2}$, $y = b - r + \sqrt{r^2 - x^2}$, $x = \sqrt{r^2 - (r + y - b)^2}$

$\pi = 3.14159265$, $\log = 0.4971499$

$\frac{1}{\pi} = 0.3183099$, $\log = 9.5028501-10$

$\pi^2 = 9.8696044$, $\log = 0.9942997$

$\frac{1}{\pi^2} = 0.1013212$, $\log = 9.0057003-10$

$\sqrt{\pi} = 1.7724539$, $\log = 0.2485749$

$\sqrt{\frac{1}{\pi}} = 0.5641896$, $\log = 9.7514251-10$

$\frac{\pi}{180} = 0.0174533$, $\log = 8.2418774-10$

$\frac{180}{\pi} = 57.2957795$, $\log = 1.7581226$

AREA OF PLANE FIGURES

Triangle: Base × ½ perpendicular height.

$\sqrt{s(s-a)\ (s-b)\ (s-c)}$,
where $s = \frac{1}{2}$ sum of the three sides a, b and c.

Trapezium: Sum of areas of the two triangles.

Trapezoid: ½ sum of parallel sides × perpendicular height.

Parallelogram: Base × perpendicular height.

Regular Polygon: ½ sum of sides × inside radius.

Circle: $\pi r^2 = .7854 \times \text{diameter}^2 = .07958 \times \text{circumference}^2$.

Sector of Circle: $\frac{\pi r^2 A^\circ}{360} = .0087266\, r^2 A^\circ = \text{arc} \times \frac{1}{2}\text{radius}$.

Segment of Circle: $\frac{r^2}{2}\left(\frac{\pi A^\circ}{180} - \sin A^\circ\right)$

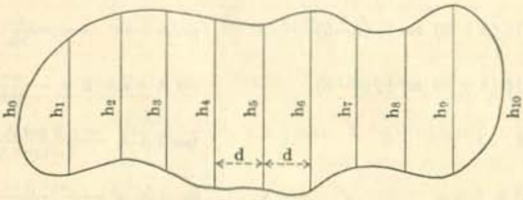
Circle of same area as square: diameter = side × 1.12838.

Square of same area as circle: side = diameter × .88623.

Ellipse: Long diameter × short diameter × .7854.

Parabola: Base × ⅔ perpendicular height.

IRREGULAR PLANE SURFACE



Divide the plane surface into an even number of parallel strips of equal width.

The given figure has been divided into ten strips of width, d; the ordinates are h_0 to h_{10}.

When the ends are curved, h_0 and h_{10} are zero and cancel out of formulas.

Simpson's Rule:

$$\text{Area} = \frac{d}{3}\left[h_0 + h_{10} + 4\,(h_1 + h_3 + h_5 + h_7 + h_9) + 2\,(h_2 + h_4 + h_6 + h_8)\right].$$

Durand's Rule:

$$\text{Area} = d\ \left[0.4\,(h_0 + h_{10}) + 1.1\,(h_1 + h_9) + h_2 + h_3 + h_4 + h_5 + h_6 + h_7 + h_8\right].$$

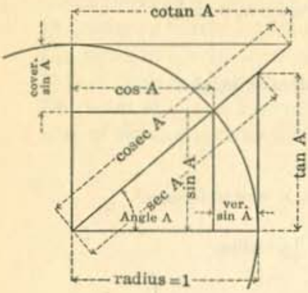
Trapezoidal Rule:

$$\text{Area} = d\ \left[\tfrac{1}{2}\,(h_0 + h_{10}) + h_1 + h_2 + h_3 + h_4 + h_5 + h_6 + h_7 + h_8 + h_9\right].$$

When the ends are not curved, but are the straight lines h_1 and h_9 then,

$$\text{Area} = d\ \left[\tfrac{1}{2}\,(h_1 + h_9) + h_2 + h_3 + h_4 + h_5 + h_6 + h_7 + h_8\right].$$

TRIGONOMETRIC FORMULAS



Radius, $1 = \sin^2 A + \cos^2 A$

$= \sin A \operatorname{cosec} A = \cos A \sec A = \tan A \cot A$

Sine $A = \dfrac{\cos A}{\cot A} = \dfrac{1}{\operatorname{cosec} A} = \cos A \tan A = \sqrt{1 - \cos^2 A}$

Cosine $A = \dfrac{\sin A}{\tan A} = \dfrac{1}{\sec A} = \sin A \cot A = \sqrt{1 - \sin^2 A}$

Tangent $A = \dfrac{\sin A}{\cos A} = \dfrac{1}{\cot A} = \sin A \sec A$

Cotangent $A = \dfrac{\cos A}{\sin A} = \dfrac{1}{\tan A} = \cos A \operatorname{cosec} A$

Secant $A = \dfrac{\tan A}{\sin A} = \dfrac{1}{\cos A}$

Cosecant $A = \dfrac{\cot A}{\cos A} = \dfrac{1}{\sin A}$

$\sin (A \pm B) = \sin A \cos B \pm \cos A \sin B$

$\tan (A \pm B) = \dfrac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

$\cos (A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\cot (A \pm B) = \dfrac{\cot A \cot B \mp 1}{\cot B \pm \cot A}$

$\sin A + \sin B = 2 \sin \tfrac{1}{2}(A + B) \cos \tfrac{1}{2}(A - B)$

$\tan A + \tan B = \dfrac{\sin (A + B)}{\cos A \cos B}$

$\sin A - \sin B = 2 \cos \tfrac{1}{2}(A + B) \sin \tfrac{1}{2}(A - B)$

$\tan A - \tan B = \dfrac{\sin (A - B)}{\cos A \cos B}$

$\cos A + \cos B = 2 \cos \tfrac{1}{2}(A + B) \cos \tfrac{1}{2}(A - B)$

$\cot A + \cot B = \dfrac{\sin (B + A)}{\sin A \sin B}$

$\cos B - \cos A = 2 \sin \tfrac{1}{2}(A + B) \sin \tfrac{1}{2}(A - B)$

$\cot A - \cot B = \dfrac{\sin (B - A)}{\sin A \sin B}$

$\sin 2A = 2 \sin A \cos A$

$\tan 2A = \dfrac{2 \tan A}{1 - \tan^2 A}$

$\cos 2A = \cos^2 A - \sin^2 A$

$\cot 2A = \dfrac{\cot^2 A - 1}{2 \cot A}$

$\sin \tfrac{1}{2} A = \sqrt{\dfrac{1 - \cos A}{2}}$ $\quad \cos \tfrac{1}{2} A = \sqrt{\dfrac{1 + \cos A}{2}}$ $\quad \tan \tfrac{1}{2} A = \dfrac{\sin A}{1 + \cos A}$ $\quad \cot \tfrac{1}{2} A = \dfrac{\sin A}{1 - \cos A}$

$\sin^2 A = \dfrac{1 - \cos 2A}{2}$ $\quad \cos^2 A = \dfrac{1 + \cos 2A}{2}$ $\quad \tan^2 A = \dfrac{1 - \cos 2A}{1 + \cos 2A}$ $\quad \cot^2 A = \dfrac{1 + \cos 2A}{1 - \cos 2A}$

$\sin^2 A - \sin^2 B = \sin (A + B) \sin (A - B)$

$\cos^2 A - \sin^2 B = \cos (A + B) \cos (A - B)$

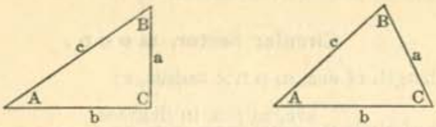
$\dfrac{\sin A \pm \sin B}{\cos A + \cos B} = \tan \tfrac{1}{2}(A \pm B)$

$\dfrac{\sin A \pm \sin B}{\cos B - \cos A} = \cot \tfrac{1}{2}(A \mp B)$

Quadrant	I	II	III	IV	Angle		
Angles	0° to 90°	90° to 180°	180° to 270°	270° to 360°	30°	45°	60°
Functions	Values vary from				Equivalent values		
sin	+0 to +1	+1 to +0	−0 to −1	−1 to −0	$\tfrac{1}{2}$	$\tfrac{1}{2}\sqrt{2}$	$\tfrac{1}{2}\sqrt{3}$
cos	+1 to +0	−0 to −1	−1 to −0	+0 to +1	$\tfrac{1}{2}\sqrt{3}$	$\tfrac{1}{2}\sqrt{2}$	$\tfrac{1}{2}$
tan	+0 to +∞	−∞ to −0	+0 to +∞	−∞ to −0	$\tfrac{1}{3}\sqrt{3}$	1	$\sqrt{3}$
cot	+∞ to +0	−0 to −∞	+∞ to +0	−0 to −∞	$\sqrt{3}$	1	$\tfrac{1}{3}\sqrt{3}$

Angle a° < 90°				
Angle	sin	cos	tan	cot
φ°	φ°	φ°	φ°	φ°
$0° \pm a$	$\pm \sin a$	$+\cos a$	$\pm \tan a$	$\pm \cot a$
$90° \pm a$	$+\cos a$	$\mp \sin a$	$\mp \cot a$	$\mp \tan a$
$180° \pm a$	$\mp \sin a$	$-\cos a$	$\pm \tan a$	$\pm \cot a$
$270° \pm a$	$-\cos a$	$\pm \sin a$	$\mp \cot a$	$\mp \tan a$

TRIGONOMETRIC SOLUTION OF TRIANGLES

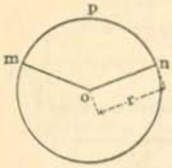


$$S = \frac{a+b+c}{2}$$

Given	Sought	Formulae
		RIGHT-ANGLED TRIANGLES
a, c	A, B, b	$\sin A = \frac{a}{c}$, $\cos B = \frac{a}{c}$, $b = \sqrt{c^2 - a^2}$
	Area	$\text{Area} = \frac{a}{2}\sqrt{c^2 - a^2}$
a, b	A, B, c	$\tan A = \frac{a}{b}$, $\tan B = \frac{b}{a}$, $c = \sqrt{a^2 + b^2}$
	Area	$\text{Area} = \frac{a\,b}{2}$
A, a	B, b, c	$B = 90° - A$, $b = a \cot A$, $c = \frac{a}{\sin A}$
	Area	$\text{Area} = \frac{a^2 \cot A}{2}$
A, b	B, a, c	$B = 90° - A$, $a = b \tan A$, $c = \frac{b}{\cos A}$
	Area	$\text{Area} = \frac{b^2 \tan A}{2}$
A, c	B, a, b	$B = 90° - A$, $a = c \sin A$, $b = c \cos A$
	Area	$\text{Area} = \frac{c^2 \sin A \cos A}{2} = \frac{c^2 \sin 2A}{4}$
		OBLIQUE-ANGLED TRIANGLES
a, b, c	A	$\sin \frac{1}{2} A = \sqrt{\frac{(s-b)\,(s-c)}{b\,c}}$, $\cos \frac{1}{2} A = \sqrt{\frac{s\,(s-a)}{b\,c}}$, $\tan \frac{1}{2} A = \sqrt{\frac{(s-b)\,(s-c)}{s\,(s-a)}}$
	B	$\sin \frac{1}{2} B = \sqrt{\frac{(s-a)\,(s-c)}{a\,c}}$, $\cos \frac{1}{2} B = \sqrt{\frac{s\,(s-b)}{a\,c}}$, $\tan \frac{1}{2} B = \sqrt{\frac{(s-a)\,(s-c)}{s\,(s-b)}}$
	C	$\sin \frac{1}{2} C = \sqrt{\frac{(s-a)\,(s-b)}{a\,b}}$, $\cos \frac{1}{2} C = \sqrt{\frac{s\,(s-c)}{a\,b}}$, $\tan \frac{1}{2} C = \sqrt{\frac{(s-a)\,(s-b)}{s\,(s-c)}}$
	Area	$\text{Area} = \sqrt{s\,(s-a)\,(s-b)\,(s-c)}$
a, A, B	b, c	$b = \frac{a \sin B}{\sin A}$, $c = \frac{a \sin C}{\sin A} = \frac{a \sin (A+B)}{\sin A}$
	Area	$\text{Area} = \frac{1}{2} a\,b \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$
a, b, A	B	$\sin B = \frac{b \sin A}{a}$
	c	$c = \frac{a \sin C}{\sin A} = \frac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2\,ab \cos C}$
	Area	$\text{Area} = \frac{1}{2} a\,b \sin C$
a, b, C	A	$\tan A = \frac{a \sin C}{b - a \cos C}$, $\tan \frac{1}{2} (A-B) = \frac{a-b}{a+b} \cot \frac{1}{2} C$
	c	$c = \sqrt{a^2 + b^2 - 2\,ab \cos C} = \frac{a \sin C}{\sin A}$
	Area	$\text{Area} = \frac{1}{2}\,ab \sin C$

$a^2 = b^2 + c^2 - 2bc \cos A$, $b^2 = a^2 + c^2 - 2\,a\,c \cos B$, $c^2 = a^2 + b^2 - 2\,ab \cos C$

AREA OF CIRCULAR SECTIONS

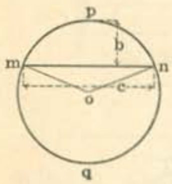


Circular Sector, m o n p.

Area $= \frac{1}{2}$ (length of arc, m p n $\times$ radius, r)

$= \text{area of circle} \times \dfrac{\text{arc, m p n, in degrees}}{360}$

$= 0.0087266 \times$ square of radius, $r^2 \times$ angle of arc, m p n, in degrees.



Circular Segment, m p n, less than half circle.

Area = area of sector, m o n p — area of triangle, m o n

$= \dfrac{(\text{length of arc, m p n} \times \text{radius, r}) - (\text{radius, r} - \text{rise, b}) \times \text{chord, c.}}{2}$

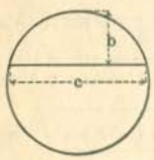
Circular Segment, m q n, greater than half circle.

Area = area of circle − area of segment, m n p.

Circular Segment, from Table, page 473

Given: rise, b, and chord, c.

Area = rise, b $\times$ chord, c $\times$ coefficient for $\dfrac{b}{c}$.



EXAMPLE. Given: rise = 2.10 and chord = 5.65.

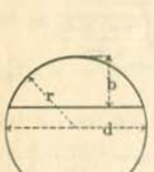
$\dfrac{b}{c} = \dfrac{2.10}{5.65} = 0.3717.$

Coefficient by interpolation = 0.7354.

Area $= b \times c \times$ coeff. $= 2.10 \times 5.65 \times 0.7354 = 8.7255.$

Circular Segment, from Table, pages 474 and 475

Given: rise, b, and diameter, d.



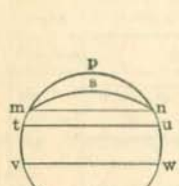
Area = square of diameter, $d^2 \times$ coefficient for $\dfrac{b}{d}$.

EXAMPLE. Given: rise $= 2\frac{7}{16}$ and diameter $= 5\frac{3}{32}$.

$\dfrac{b}{d} = 2\frac{7}{16} \div 5\frac{3}{32} = 0.478528.$

Coefficient by interpolation = 0.371233.

Area $= d^2 \times$ coefficient $= 25.94629 \times 0.371233 = 9.6321.$



Circular Zone, t u w v.

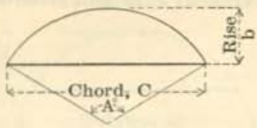
Area = area of circle — sum of areas of segments, t p u and v q w.

Circular Lune, m p n s.

Area = area of segment, m p n — area of segment, m s n.

AREAS OF CIRCULAR SEGMENTS

For Ratios of Rise and Chord

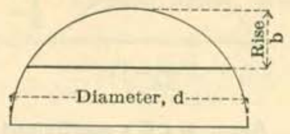


Area = b x C x coefficient

A°	Coefficient	b/C	A°	Coefficient	b/C	A°	Coefficient	b/C	A°	Coefficient	b/C
1	.6667	.0022	46	.6722	.1017	91	.6895	.2097	136	.7239	.3373
2	.6667	.0044	47	.6724	.1040	92	.6901	.2122	137	.7249	.3404
3	.6667	.0066	48	.6727	.1063	93	.6906	.2148	138	.7260	.3436
4	.6667	.0087	49	.6729	.1086	94	.6912	.2174	139	.7270	.3469
5	.6667	.0109	50	.6732	.1109	95	.6918	.2200	140	.7281	.3501
6	.6667	.0131	51	.6734	.1131	96	.6924	.2226	141	.7292	.3534
7	.6668	.0153	52	.6737	.1154	97	.6930	.2252	142	.7303	.3567
8	.6668	.0175	53	.6740	.1177	98	.6936	.2279	143	.7314	.3600
9	.6669	.0197	54	.6743	.1200	99	.6942	.2305	144	.7325	.3633
10	.6670	.0218	55	.6746	.1224	100	.6948	.2332	145	.7336	.3666
11	.6670	.0240	56	.6749	.1247	101	.6954	.2358	146	.7348	.3700
12	.6671	.0262	57	.6752	.1270	102	.6961	.2385	147	.7360	.3734
13	.6672	.0284	58	.6755	.1293	103	.6967	.2412	148	.7372	.3768
14	.6672	.0306	59	.6758	.1316	104	.6974	.2439	149	.7384	.3802
15	.6673	.0328	60	.6761	.1340	105	.6980	.2466	150	.7396	.3837
16	.6674	.0350	61	.6764	.1363	106	.6987	.2493	151	.7408	.3871
17	.6674	.0372	62	.6768	.1387	107	.6994	.2520	152	.7421	.3906
18	.6675	.0394	63	.6771	.1410	108	.7001	.2548	153	.7434	.3942
19	.6676	.0416	64	.6775	.1434	109	.7008	.2575	154	.7447	.3977
20	.6677	.0437	65	.6779	.1457	110	.7015	.2603	155	.7460	.4013
21	.6678	.0459	66	.6782	.1481	111	.7022	.2631	156	.7473	.4049
22	.6679	.0481	67	.6786	.1505	112	.7030	.2659	157	.7486	.4085
23	.6680	.0504	68	.6790	.1529	113	.7037	.2687	158	.7500	.4122
24	.6681	.0526	69	.6794	.1553	114	.7045	.2715	159	.7514	.4159
25	.6682	.0548	70	.6797	.1577	115	.7052	.2743	160	.7528	.4196
26	.6684	.0570	71	.6801	.1601	116	.7060	.2772	161	.7542	.4233
27	.6685	.0592	72	.6805	.1625	117	.7068	.2800	162	.7557	.4270
28	.6687	.0614	73	.6809	.1649	118	.7076	.2829	163	.7571	.4308
29	.6688	.0636	74	.6814	.1673	119	.7084	.2858	164	.7586	.4346
30	.6690	.0658	75	.6818	.1697	120	.7092	.2887	165	.7601	.4385
31	.6691	.0681	76	.6822	.1722	121	.7100	.2916	166	.7616	.4424
32	.6693	.0703	77	.6826	.1746	122	.7109	.2945	167	.7632	.4463
33	.6694	.0725	78	.6831	.1771	123	.7117	.2975	168	.7648	.4502
34	.6696	.0747	79	.6835	.1795	124	.7126	.3004	169	.7664	.4542
35	.6698	.0770	80	.6840	.1820	125	.7134	.3034	170	.7680	.4582
36	.6700	.0792	81	.6844	.1845	126	.7143	.3064	171	.7696	.4622
37	.6702	.0814	82	.6849	.1869	127	.7152	.3094	172	.7712	.4663
38	.6704	.0837	83	.6854	.1894	128	.7161	.3124	173	.7729	.4704
39	.6706	.0859	84	.6859	.1919	129	.7170	.3155	174	.7746	.4745
40	.6708	.0882	85	.6864	.1944	130	.7180	.3185	175	.7763	.4787
41	.6710	.0904	86	.6869	.1970	131	.7189	.3216	176	.7781	.4828
42	.6712	.0927	87	.6874	.1995	132	.7199	.3247	177	.7799	.4871
43	.6714	.0949	88	.6879	.2020	133	.7209	.3278	178	.7817	.4914
44	.6717	.0972	89	.6884	.2046	134	.7219	.3309	179	.7835	.4957
45	.6719	.0995	90	.6890	.2071	135	.7229	.3341	180	.7854	.5000

AREAS OF CIRCULAR SEGMENTS

For Ratios of Rise and Diameter

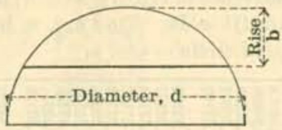


Area = d^2 x Coefficient

$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient
.001	.000042	.051	.015119	.101	.041477	.151	.074590	.201	.112625
.002	.000119	.052	.015561	.102	.042081	.152	.075307	.202	.113427
.003	.000219	.053	.016008	.103	.042687	.153	.076026	.203	.114231
.004	.000337	.054	.016458	.104	.043296	.154	.076747	.204	.115036
.005	.000471	.055	.016912	.105	.043908	.155	.077470	.205	.115842
.006	.000619	.056	.017369	.106	.044523	.156	.078194	.206	.116651
.007	.000779	.057	.017831	.107	.045140	.157	.078921	.207	.117460
.008	.000952	.058	.018297	.108	.045759	.158	.079650	.208	.118271
.009	.001135	.059	.018766	.109	.046381	.159	.080380	.209	.119084
.010	.001329	.060	.019239	.110	.047006	.160	.081112	.210	.119898
.011	.001533	.061	.019716	.111	.047633	.161	.081847	.211	.120713
.012	.001746	.062	.020197	.112	.048262	.162	.082582	.212	.121530
.013	.001969	.063	.020681	.113	.048894	.163	.083320	.213	.122348
.014	.002199	.064	.021168	.114	.049529	.164	.084060	.214	.123167
.015	.002438	.065	.021660	.115	.050165	.165	.084801	.215	.123988
.016	.002685	.066	.022155	.116	.050805	.166	.085545	.216	.124811
.017	.002940	.067	.022653	.117	.051446	.167	.086290	.217	.125634
.018	.003202	.068	.023155	.118	.052090	.168	.087037	.218	.126459
.019	.003472	.069	.023660	.119	.052737	.169	.087785	.219	.127286
.020	.003749	.070	.024168	.120	.053385	.170	.088536	.220	.128114
.021	.004032	.071	.024680	.121	.054037	.171	.089288	.221	.128943
.022	.004322	.072	.025196	.122	.054690	.172	.090042	.222	.129773
.023	.004619	.073	.025714	.123	.055346	.173	.090797	.223	.130605
.024	.004922	.074	.026236	.124	.056004	.174	.091555	.224	.131438
.025	.005231	.075	.026761	.125	.056664	.175	.092314	.225	.132273
.026	.005546	.076	.027290	.126	.057327	.176	.093074	.226	.133109
.027	.005867	.077	.027821	.127	.057991	.177	.093837	.227	.133946
.028	.006194	.078	.028356	.128	.058658	.178	.094601	.228	.134784
.029	.006527	.079	.028894	.129	.059328	.179	.095367	.229	.135624
.030	.006866	.080	.029435	.130	.059999	.180	.096135	.230	.136465
.031	.007209	.081	.029979	.131	.060673	.181	.096904	.231	.137307
.032	.007559	.082	.030526	.132	.061349	.182	.097675	.232	.138151
.033	.007913	.083	.031077	.133	.062027	.183	.098447	.233	.138996
.034	.008273	.084	.031630	.134	.062707	.184	.099221	.234	.139842
.035	.008638	.085	.032186	.135	.063389	.185	.099997	.235	.140689
.036	.009008	.086	.032746	.136	.064074	.186	.100774	.236	.141538
.037	.009383	.087	.033308	.137	.064761	.187	.101553	.237	.142388
.038	.009764	.088	.033873	.138	.065449	.188	.102334	.238	.143239
.039	.010148	.089	.034441	.139	.066140	.189	.103116	.239	.144091
.040	.010538	.090	.035012	.140	.066833	.190	.103900	.240	.144945
.041	.010932	.091	.035586	.141	.067528	.191	.104686	.241	.145800
.042	.011331	.092	.036162	.142	.068225	.192	.105472	.242	.146656
.043	.011734	.093	.036742	.143	.068924	.193	.106261	.243	.147513
.044	.012142	.094	.037324	.144	.069626	.194	.107051	.244	.148371
.045	.012555	.095	.037909	.145	.070329	.195	.107843	.245	.149231
.046	.012971	.096	.038497	.146	.071034	.196	.108636	.246	.150091
.047	.013393	.097	.039087	.147	.071741	.197	.109431	.247	.150953
.048	.013818	.098	.039681	.148	.072450	.198	.110227	.248	.151816
.049	.014248	.099	.040277	.149	.073162	.199	.111025	.249	.152681
.050	.014681	.100	.040875	.150	.073875	.200	.111824	.250	.153546

AREAS OF CIRCULAR SEGMENTS

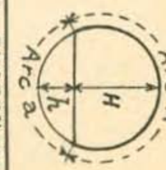
For Ratios of Rise and Diameter—Concluded



Area $= d^2 \times$ Coefficient

$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient
.251	.154413	.301	.199085	.351	.245935	.401	.294350	.451	.343778
.252	.155281	.302	.200003	.352	.246890	.402	.295330	.452	.344773
.253	.156149	.303	.200922	.353	.247845	.403	.296311	.453	.345768
.254	.157019	.304	.201841	.354	.248801	.404	.297292	.454	.346764
.255	.157891	.305	.202762	.355	.249758	.405	.298274	.455	.347760
.256	.158763	.306	.203683	.356	.250715	.406	.299256	.456	.348756
.257	.159636	.307	.204605	.357	.251673	.407	.300238	.457	.349752
.258	.160511	.308	.205528	.358	.252632	.408	.301221	.458	.350749
.259	.161386	.309	.206452	.359	.253591	.409	.302204	.459	.351745
.260	.162263	.310	.207376	.360	.254551	.410	.303187	.460	.352742
.261	.163141	.311	.208302	.361	.255511	.411	.304171	.461	.353739
.262	.164020	.312	.209228	.362	.256472	.412	.305156	.462	.354736
.263	.164900	.313	.210155	.363	.257433	.413	.306140	.463	.355733
.264	.165781	.314	.211083	.364	.258395	.414	.307125	.464	.356730
.265	.166663	.315	.212011	.365	.259358	.415	.308110	.465	.357728
.266	.167546	.316	.212941	.366	.260321	.416	.309096	.466	.358725
.267	.168431	.317	.213871	.367	.261285	.417	.310082	.467	.359723
.268	.169316	.318	.214802	.368	.262249	.418	.311068	.468	.360721
.269	.170202	.319	.215734	.369	.263214	.419	.312055	.469	.361719
.270	.171090	.320	.216666	.370	.264179	.420	.313042	.470	.362717
.271	.171978	.321	.217600	.371	.265145	.421	.314029	.471	.363715
.272	.172868	.322	.218534	.372	.266111	.422	.315017	.472	.364714
.273	.173758	.323	.219469	.373	.267078	.423	.316005	.473	.365712
.274	.174650	.324	.220404	.374	.268046	.424	.316993	.474	.366711
.275	.175542	.325	.221341	.375	.269014	.425	.317981	.475	.367710
.276	.176436	.326	.222278	.376	.269982	.426	.318970	.476	.368708
.277	.177330	.327	.223216	.377	.270951	.427	.319959	.477	.369707
.278	.178226	.328	.224154	.378	.271921	.428	.320949	.478	.370706
.279	.179122	.329	.225094	.379	.272891	.429	.321938	.479	.371705
.280	.180020	.330	.226034	.380	.273861	.430	.322928	.480	.372704
.281	.180918	.331	.226974	.381	.274832	.431	.323919	.481	.373704
.282	.181818	.332	.227916	.382	.275804	.432	.324909	.482	.374703
.283	.182718	.333	.228858	.383	.276776	.433	.325900	.483	.375702
.284	.183619	.334	.229801	.384	.277748	.434	.326891	.484	.376702
.285	.184522	.335	.230745	.385	.278721	.435	.327883	.485	.377701
.286	.185425	.336	.231689	.386	.279695	.436	.328874	.486	.378701
.287	.186329	.337	.232634	.387	.280669	.437	.329866	.487	.379701
.288	.187235	.338	.233580	.388	.281643	.438	.330858	.488	.380700
.289	.188141	.339	.234526	.389	.282618	.439	.331851	.489	.381700
.290	.189048	.340	.235473	.390	.283593	.440	.332843	.490	.382700
.291	.189956	.341	.236421	.391	.284569	.441	.333836	.491	.383700
.292	.190865	.342	.237369	.392	.285545	.442	.334829	.492	.384699
.293	.191774	.343	.238319	.393	.286521	.443	.335823	.493	.385699
.294	.192685	.344	.239268	.394	.287499	.444	.336816	.494	.386699
.295	.193597	.345	.240219	.395	.288476	.445	.337810	.495	.387699
.296	.194509	.346	.241170	.396	.289454	.446	.338804	.496	.388699
.297	.195423	.347	.242122	.397	.290432	.447	.339799	.497	.389699
.298	.196337	.348	.243074	.398	.291411	.448	.340793	.498	.390699
.299	.197252	.349	.244027	.399	.292390	.449	.341788	.499	.391699
.300	.198168	.350	.244980	.400	.293370	.450	.342783	.500	.392699

TABLE OF CIRCULAR ARCS



When the arc, A, is greater than a semi-circle, let rise = H.
Now smaller arc, a = circumference of circle − arc, A; let rise = h.
Rise, h, of arc, a = (half-chord)² ÷ H. Find arc, a, by table.
Then arc, A = circumference of circle − arc, a.

Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord	Rise / Chord	Arc / Chord
.001	1.00002	.051	1.00692	.101	1.02698	.151	1.05973	.201	1.10447	.251	1.16034	.301	1.22636	.351	1.30156	.401	1.38496	.451	1.47565
.002	1.00002	.052	1.00720	.102	1.02752	.152	1.06051	.202	1.10548	.252	1.16156	.302	1.22778	.352	1.30315	.402	1.38671	.452	1.47753
.003	1.00003	.053	1.00748	.103	1.02806	.153	1.06130	.203	1.10650	.253	1.16279	.303	1.22920	.353	1.30474	.403	1.38846	.453	1.47942
.004	1.00004	.054	1.00776	.104	1.02860	.154	1.06209	.204	1.10752	.254	1.16402	.304	1.23063	.354	1.30634	.404	1.39021	.454	1.48131
.005	1.00007	.055	1.00805	.105	1.02914	.155	1.06288	.205	1.10855	.255	1.16526	.205	1.23206	.355	1.30794	.405	1.39196	.455	1.48320
.006	1.00010	.056	1.00834	.106	1.02970	.156	1.06368	.206	1.10958	.256	1.16650	.306	1.23349	.356	1.30954	.406	1.39372	.456	1.48509
.007	1.00013	.057	1.00864	.107	1.03026	.157	1.06449	.207	1.11062	.257	1.16774	.307	1.23492	.357	1.31115	.407	1.39548	.457	1.48699
.008	1.00017	.058	1.00895	.108	1.03082	.158	1.06530	.208	1.11165	.258	1.16899	.308	1.23636	.358	1.31276	.408	1.39724	.458	1.48889
.009	1.00022	.059	1.00926	.109	1.03139	.159	1.06611	.209	1.11269	.259	1.17024	.309	1.23781	.359	1.31437	.409	1.39900	.459	1.49079
.010	1.00027	.060	1.00957	.110	1.03196	.160	1.06693	.210	1.11374	.260	1.17150	.310	1.23926	.360	1.31599	.410	1.40077	.460	1.49269
.011	1.00032	.061	1.00989	.111	1.03254	.161	1.06775	.211	1.11479	.261	1.17276	.311	1.24070	.361	1.31761	.411	1.40254	.461	1.49460
.012	1.00038	.062	1.01021	.112	1.03312	.162	1.06858	.212	1.11584	.262	1.17403	.312	1.24216	.362	1.31923	.412	1.40432	.462	1.49651
.013	1.00045	.063	1.01054	.113	1.03371	.163	1.06941	.213	1.11690	.263	1.17530	.313	1.24361	.363	1.32086	.413	1.40610	.463	1.49842
.014	1.00053	.064	1.01088	.114	1.03430	.164	1.07025	.214	1.11796	.264	1.17657	.314	1.24507	.364	1.32249	.414	1.40788	.464	1.50033
.015	1.00061	.065	1.01123	.115	1.03490	.165	1.07109	.215	1.11904	.265	1.17784	.315	1.24654	.365	1.32413	.415	1.40966	.465	1.50224
.016	1.00069	.066	1.01158	.116	1.03551	.166	1.07194	.216	1.12011	.266	1.17912	.316	1.24801	.366	1.32577	.416	1.41145	.466	1.50416
.017	1.00078	.067	1.01193	.117	1.03611	.167	1.07279	.217	1.12118	.267	1.18040	.317	1.24948	.367	1.32741	.417	1.41324	.467	1.50608
.018	1.00087	.068	1.01228	.118	1.03672	.168	1.07365	.218	1.12225	.268	1.18169	.318	1.25095	.368	1.32905	.418	1.41503	.468	1.50800
.019	1.00097	.069	1.01264	.119	1.03734	.169	1.07451	.219	1.12334	.269	1.18299	.319	1.25243	.369	1.33069	.419	1.41682	.469	1.50992
.020	1.00107	.070	1.01302	.120	1.03797	.170	1.07537	.220	1.12444	.270	1.18429	.320	1.25391	.370	1.33234	.420	1.41861	.470	1.51185
.021	1.00117	.071	1.01338	.121	1.03860	.171	1.07624	.221	1.12554	.271	1.18559	.321	1.25540	.371	1.33399	.421	1.42041	.471	1.51378
.022	1.00128	.072	1.01376	.122	1.03923	.172	1.07711	.222	1.12664	.272	1.18689	.322	1.25689	.372	1.33564	.422	1.42221	.472	1.51571
.023	1.00140	.073	1.01414	.123	1.03987	.173	1.07799	.223	1.12774	.273	1.18820	.323	1.25838	.373	1.33730	.423	1.42402	.473	1.51764
.024	1.00153	.074	1.01453	.124	1.04051	.174	1.07888	.224	1.12885	.274	1.18951	.324	1.25988	.374	1.33896	.424	1.42583	.474	1.51958
.025	1.00167	.075	1.01493	.125	1.04116	.175	1.07977	.225	1.12997	.275	1.19082	.325	1.26138	.375	1.34063	.425	1.42764	.475	1.52152
.026	1.00182	.076	1.01533	.126	1.04181	.176	1.08066	.226	1.13108	.276	1.19214	.326	1.26288	.376	1.34229	.426	1.42945	.476	1.52346
.027	1.00196	.077	1.01573	.127	1.04247	.177	1.08156	.227	1.13219	.277	1.19346	.327	1.26437	.377	1.34396	.427	1.43127	.477	1.52541
.028	1.00210	.078	1.01614	.128	1.04313	.178	1.08246	.228	1.13331	.278	1.19479	.328	1.26588	.378	1.34563	.428	1.43309	.478	1.52736
.029	1.00225	.079	1.01656	.129	1.04380	.179	1.08337	.229	1.13444	.279	1.19612	.329	1.26740	.379	1.34731	.429	1.43491	.479	1.52931
.030	1.00240	.080	1.01698	.130	1.04447	.180	1.08428	.230	1.13557	.280	1.19746	.330	1.26892	.380	1.34899	.430	1.43673	.480	1.53126
.031	1.00256	.081	1.01741	.131	1.04515	.181	1.08519	.231	1.13671	.281	1.19880	.331	1.27044	.381	1.35068	.431	1.43856	.481	1.53322
.032	1.00272	.082	1.01784	.132	1.04584	.182	1.08611	.232	1.13785	.282	1.20014	.332	1.27196	.382	1.35237	.432	1.44039	.482	1.53518
.033	1.00289	.083	1.01828	.133	1.04652	.183	1.08704	.233	1.13900	.283	1.20149	.333	1.27349	.383	1.35406	.433	1.44222	.483	1.53714
.034	1.00307	.084	1.01872	.134	1.04722	.184	1.08797	.234	1.14015	.284	1.20284	.334	1.27502	.384	1.35575	.434	1.44405	.484	1.53910
.035	1.00327	.085	1.01916	.135	1.04792	.185	1.08890	.235	1.14131	.285	1.20419	.335	1.27656	.385	1.35744	.435	1.44589	.485	1.54106
.036	1.00345	.086	1.01961	.136	1.04862	.186	1.08984	.236	1.14247	.286	1.20555	.336	1.27810	.386	1.35914	.436	1.44773	.486	1.54302
.037	1.00364	.087	1.02006	.137	1.04932	.187	1.09079	.237	1.14363	.287	1.20691	.337	1.27964	.387	1.36084	.437	1.44957	.487	1.54499
.038	1.00384	.088	1.02052	.138	1.05003	.188	1.09174	.238	1.14480	.288	1.20827	.338	1.28118	.388	1.36254	.438	1.45142	.488	1.54696
.039	1.00405	.089	1.02098	.139	1.05075	.189	1.09269	.239	1.14597	.289	1.20964	.339	1.28273	.389	1.36425	.439	1.45327	.489	1.54893
.040	1.00426	.090	1.02146	.140	1.05147	.190	1.09365	.240	1.14714	.290	1.21102	.340	1.28428	.390	1.36596	.440	1.45512	.490	1.55091
.041	1.00447	.091	1.02192	.141	1.05220	.191	1.09461	.241	1.14832	.291	1.21239	.341	1.28583	.391	1.36767	.441	1.45697	.491	1.55289
.042	1.00469	.092	1.02240	.142	1.05293	.192	1.09557	.242	1.14951	.292	1.21377	.342	1.28739	.392	1.36939	.442	1.45883	.492	1.55487
.043	1.00492	.093	1.02289	.143	1.05367	.193	1.09654	.243	1.15070	.293	1.21515	.343	1.28895	.393	1.37111	.443	1.46069	.493	1.55685
.044	1.00515	.094	1.02339	.144	1.05441	.194	1.09752	.244	1.15189	.294	1.21654	.344	1.29052	.394	1.37283	.444	1.46255	.494	1.55884
.045	1.00539	.095	1.02389	.145	1.05516	.195	1.09850	.245	1.15308	.295	1.21794	.345	1.29209	.395	1.37455	.445	1.46441	.495	1.56083
.046	1.00563	.096	1.02440	.146	1.05591	.196	1.09949	.246	1.15428	.296	1.21933	.346	1.29366	.396	1.37628	.446	1.46628	.496	1.56282
.047	1.00587	.097	1.02491	.147	1.05667	.197	1.10048	.247	1.15549	.297	1.22073	.347	1.29523	.397	1.37801	.447	1.46815	.497	1.56481
.048	1.00612	.098	1.02542	.148	1.05743	.198	1.10147	.248	1.15670	.298	1.22213	.348	1.29681	.398	1.37974	.448	1.47002	.498	1.56681
.049	1.00638	.099	1.02593	.149	1.05819	.199	1.10247	.249	1.15791	.299	1.22354	.349	1.29839	.399	1.38148	.449	1.47189	.499	1.56881
.050	1.00665	.100	1.02646	.150	1.05896	.200	1.10347	.250	1.15912	.300	1.22495	.350	1.29997	.400	1.38322	.450	1.47377	.500	1.57080

AREAS AND WEIGHTS OF 90° FILLETS OR ROUNDINGS

Radius R, In.	Area, Sq. In. One	Area, Sq. In. Four	Weight, Lb. per Ft. One	Weight, Lb. per Ft. Four	Radius R, In.	Area, Sq. In. One	Area, Sq. In. Four	Weight, Lb. per Ft. One	Weight, Lb. per Ft. Four
1/64	.00005	.00021	.00018	.00071	33/64	.05705	.22822	.19399	.77595
1/32	.00021	.00084	.00071	.00285	17/32	.06057	.24226	.20592	.82369
3/64	.00047	.00189	.00160	.00641	35/64	.06418	.25672	.21821	.87285
1/16	.00084	.00335	.00285	.01140	9/16	.06790	.27160	.23086	.92344
5/64	.00131	.00524	.00445	.01781	37/64	.07172	.28690	.24386	.97546
3/32	.00189	.00754	.00641	.02565	19/32	.07565	.30262	.25722	1.0289
7/64	.00257	.01027	.00873	.03491	39/64	.07969	.31875	.27094	1.0838
1/8	.00335	.01341	.01140	.04560	5/8	.08383	.33531	.28501	1.1400
9/64	.00424	.01698	.01443	.05772	41/64	.08807	.35228	.29944	1.1978
5/32	.00524	.02096	.01781	.07125	21/32	.09242	.36968	.31423	1.2569
11/64	.00634	.02536	.02155	.08622	43/64	.09687	.38749	.32937	1.3175
3/16	.00754	.03018	.02565	.10260	11/16	.10143	.40572	.34487	1.3795
13/64	.00885	.03542	.03010	.12042	45/64	.10609	.42438	.36072	1.4429
7/32	.01027	.04108	.03491	.13966	23/32	.11086	.44345	.37693	1.5077
15/64	.01179	.04715	.04008	.16032	47/64	.11573	.46294	.39350	1.5740
1/4	.01341	.05365	.04560	.18241	3/4	.12071	.48284	.41042	1.6417
17/64	.01514	.06057	.05148	.20592	49/64	.12579	.50317	.42770	1.7108
9/32	.01698	.06790	.05772	.23086	25/32	.13098	.52392	.44533	1.7813
19/64	.01891	.07565	.06431	.25722	51/64	.13627	.54509	.46332	1.8533
5/16	.02096	.08383	.07125	.28501	13/16	.14167	.56667	.48167	1.9267
21/64	.02310	.09242	.07856	.31423	53/64	.14717	.58868	.50038	2.0015
11/32	.02536	.10143	.08622	.34487	27/32	.15278	.61110	.51944	2.0777
23/64	.02772	.11086	.09423	.37693	55/64	.15849	.63394	.53885	2.1554
3/8	.03018	.12071	.10260	.41042	7/8	.16430	.65721	.55862	2.2345
25/64	.03275	.13098	.11133	.44533	57/64	.17022	.68089	.57875	2.3150
13/32	.03542	.14167	.12042	.48167	29/32	.17625	.70499	.59924	2.3970
27/64	.03819	.15278	.12986	.51944	59/64	.18238	.72951	.62008	2.4803
7/16	.04108	.16430	.13966	.55862	15/16	.18861	.75444	.64128	2.5651
29/64	.04406	.17625	.14981	.59924	61/64	.19495	.77980	.66283	2.6513
15/32	.04715	.18861	.16032	.64128	31/32	.20139	.80558	.68474	2.7390
31/64	.05035	.20139	.17119	.68474	63/64	.20794	.83178	.70701	2.8280
1/2	.05365	.21460	.18241	.72963	1	.21460	.85839	.72963	2.9185

Coefficients of Values of 90° Fillets to obtain Values of Oblique Angle Fillets

Angle θ	5°	10°	15°	20°	30°	40°	50°	60°	70°	80°
Coefficient	99.611	46.349	28.685	19.921	11.291	7.1097	4.7066	3.1913	2.1818	1.4869

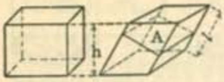
Angle θ	90°	100°	110°	120°	130°	140°	150°	160°	170°
Coefficient	1.0000	.6569	.4163	.2505	.1397	.0694	.0287	.0084	.0010

To obtain area or weight of an oblique angle fillet of any radius, multiply the value for a 90° fillet of same radius by the coefficient given for the angle.

SURFACE AND VOLUME OF SOLIDS

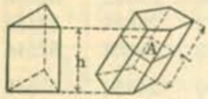
S=LATERAL OR CONVEX SURFACE. V=VOLUME

Parallelopiped



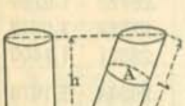
$S = Pl.$ P is perimeter perp. to sides; l is lateral length.
$V = Bh.$ B is area of base; h is perpendicular height.
$V = Al.$ A is area of section perp. to sides; l is lateral length.

Prism, Right or Oblique, Regular or Irregular



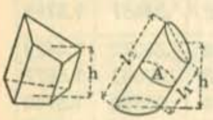
$S = Pl.$ P is perimeter perp. to sides; l is lateral length.
$V = Bh.$ B is area of base; h is perpendicular height.
$V = Al.$ A is area of section perp. to sides; l is lateral length.

Cylinder, Right or Oblique, Circular or Elliptic, etc.



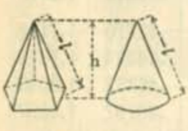
$S = Ph.$ P is perimeter of base; h is perp. height.
$S = P_1l.$ P_1 is perimeter perp. to sides; l is lateral length.
$V = Bh.$ B is area of base; h is perpendicular height.
$V = Al.$ A is area of section perp. to sides; l is lateral length.

Frustum of any Prism or Cylinder



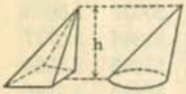
$V = Bh.$ B is area of base; h is perp. height from base to center of gravity of top.
$V = \frac{1}{2} A (l_1 + l_2)$, for cylinder.

Pyramid or Cone, Right and Regular



$S = \frac{1}{2} Pl.$ P is perimeter of base; l is slant height.
$V = \frac{1}{3} Bh.$ B is area of base; h is perpendicular height.

Pyramid or Cone, Right or Oblique, Regular or Irregular

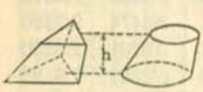


$V = \frac{1}{3} Bh.$ B is area of base; h is perpendicular height.
$V = \frac{1}{3}$ volume of prism or cylinder of same base and perpendicular height.
$V = \frac{1}{2}$ volume of hemisphere of same base and perpendicular height.

Frustum of Pyramid or Cone, Right and Regular, Parallel Ends

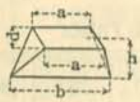
$S = \frac{1}{2} l (P + p).$ P and p are perimeters of base and top; l is slant height.
$V = \frac{1}{3} h (B + b + \sqrt{Bb}).$ B and b are areas of base and top; h is perpendicular height.

Frustum of any Pyramid or Cone, Parallel Ends



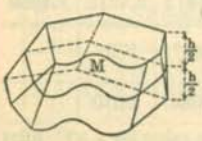
$V = \frac{1}{3} h (B + b + \sqrt{Bb}).$ B and b are areas of base and top; h is perpendicular height.

Wedge, Parallelogram Face



$V = \frac{1}{6} d h (2a + b).$ a, b, a are the lengths of the three edges; h is perpendicular height; d is perpendicular width.

Prismatoid

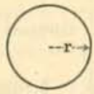


$V = \frac{1}{6} h (B + b + 4M).$ B and b are areas of base and top; h is perpendicular height; M is area of section parallel to bases, midway between them.

The Prismatoid formula applies also to any of the foregoing solids with parallel bases, to pyramids, cones, spherical sections, and to many solids with irregular surfaces.

SURFACE AND VOLUME OF SOLIDS

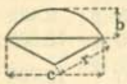
S = LATERAL OR CONVEX SURFACE. V = VOLUME



Sphere

$S = 4\,\pi\, r^2 = \pi\, d^2 = 3.14159265\, d^2$

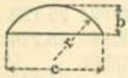
$V = \frac{4}{3}\pi\, r^3 = \frac{1}{6}\pi\, d^3 = 0.52359878\, d^3$



Spherical Sector

$S = \frac{1}{2}\pi\, r\,(4\,b + c)$

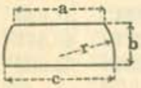
$V = \frac{2}{3}\pi\, r^2\, b$



Spherical Segment

$S = 2\,\pi\, r\, b = \frac{1}{4}\pi\,(4\,b^2 + c^2)$

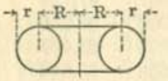
$V = \frac{1}{3}\pi\, b^2\,(3\,r - b) = \frac{1}{24}\pi\, b\,(3\,c^2 + 4\,b^2)$



Spherical Zone

$S = 2\,\pi\, r\, b$

$V = \frac{1}{24}\pi\, b\,(3\,a^2 + 3\,c^2 + 4\,b^2)$

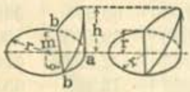


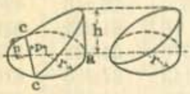
Circular Ring

$S = 4\,\pi^2\, R\, r$

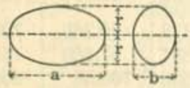
$V = 2\,\pi^2\, R\, r^2$

Ungula of Right, Regular Cylinder



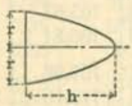


Base = Segment b a b	Base = Half Circle
$S = (2\,r\,m - o \times \text{arc, b a b})\ \frac{h}{r-o}$	$S = 2\,r\,h$
$V = (\frac{2}{3}\,m^3 - o \times \text{area, b a b})\ \frac{h}{r-o}$	$V = \frac{2}{3}\,r^2\,h$
Base = Segment, c a c	**Base = Circle**
$S = (2\,r\,n + p \times \text{arc, c a c})\ \frac{h}{r+p}$	$S = \pi\,r\,h$
$V = (\frac{2}{3}\,n^3 + p \times \text{area, c a c})\ \frac{h}{r+p}$	$V = \frac{1}{2}\pi\,r^2\,h$



Ellipsoid

$V = \frac{1}{3}\pi\, r\, a\, b$

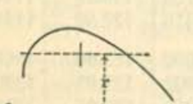


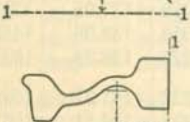
Paraboloid

$V = \frac{1}{2}\pi\, r^2\, h$

Ratio of corresponding volumes of a Cone, Paraboloid, Sphere, and Cylinder of equal height: $\frac{1}{3} : \frac{1}{2} : \frac{2}{3} : 1$.

Bodies Generated by Partial or Complete Revolution





l = length of a curve, A = area of a plane, rotating about an axis 1-1 on one side and in plane of axis.

r = distance of center of gravity of line or plane from axis 1-1 and for any angle of revolution, a°.

$\frac{2\,\pi\, r\, a^\circ}{360}$ = length of arc described by center of gravity.

S = length of curve × length of arc about axis 1-1

$= l\,\frac{2\,\pi\, r\, a^\circ}{360}$. For complete revolution $S = 2\,\pi\, r\, l$.

V = area of plane × length of arc about axis 1-1

$= A\,\frac{2\,\pi\, r\, a^\circ}{360}$. For complete revolution $V = 2\,\pi\, r\, A$.

FUNCTIONS OF NUMBERS, 1 to 49

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
1	1	1	1.0000	1.0000	0.00000	1000.000	3.142	0.7854
2	4	8	1.4142	1.2599	0.30103	500.000	6.283	3.1416
3	9	27	1.7321	1.4422	0.47712	333.333	9.425	7.0686
4	16	64	2.0000	1.5874	0.60206	250.000	12.566	12.5664
5	25	125	2.2361	1.7100	0.69897	200.000	15.708	19.6350
6	36	216	2.4495	1.8171	0.77815	166.667	18.850	28.2743
7	49	343	2.6458	1.9129	0.84510	142.857	21.991	38.4845
8	64	512	2.8284	2.0000	0.90309	125.000	25.133	50.2655
9	81	729	3.0000	2.0801	0.95424	111.111	28.274	63.6173
10	100	1000	3.1623	2.1544	1.00000	100.000	31.416	78.5398
11	121	1331	3.3166	2.2240	1.04139	90.9091	34.558	95.0332
12	144	1728	3.4641	2.2894	1.07918	83.3333	37.699	113.097
13	169	2197	3.6056	2.3513	1.11394	76.9231	40.841	132.732
14	196	2744	3.7417	2.4101	1.14613	71.4286	43.982	153.938
15	225	3375	3.8730	2.4662	1.17609	66.6667	47.124	176.715
16	256	4096	4.0000	2.5198	1.20412	62.5000	50.265	201.062
17	289	4913	4.1231	2.5713	1.23045	58.8235	53.407	226.980
18	324	5832	4.2426	2.6207	1.25527	55.5556	56.549	254.469
19	361	6859	4.3589	2.6684	1.27875	52.6316	59.690	283.529
20	400	8000	4.4721	2.7144	1.30103	50.0000	62.832	314.159
21	441	9261	4.5826	2.7589	1.32222	47.6190	65.973	346.361
22	484	10648	4.6904	2.8020	1.34242	45.4545	69.115	380.133
23	529	12167	4.7958	2.8439	1.36173	43.4783	72.257	415.476
24	576	13824	4.8990	2.8845	1.38021	41.6667	75.398	452.389
25	625	15625	5.0000	2.9240	1.39794	40.0000	78.540	490.874
26	676	17576	5.0990	2.9625	1.41497	38.4615	81.681	530.929
27	729	19683	5.1962	3.0000	1.43136	37.0370	84.823	572.555
28	784	21952	5.2915	3.0366	1.44716	35.7143	87.965	615.752
29	841	24389	5.3852	3.0723	1.46240	34.4828	91.106	660.520
30	900	27000	5.4772	3.1072	1.47712	33.3333	94.248	706.858
31	961	29791	5.5678	3.1414	1.49136	32.2581	97.389	754.768
32	1024	32768	5.6569	3.1748	1.50515	31.2500	100.53	804.248
33	1089	35937	5.7446	3.2075	1.51851	30.3030	103.67	855.299
34	1156	39304	5.8310	3.2396	1.53148	29.4118	106.81	907.920
35	1225	42875	5.9161	3.2711	1.54407	28.5714	109.96	962.113
36	1296	46656	6.0000	3.3019	1.55630	27.7778	113.10	1017.88
37	1369	50653	6.0828	3.3322	1.56820	27.0270	116.24	1075.21
38	1444	54872	6.1644	3.3620	1.57978	26.3158	119.38	1134.11
39	1521	59319	6.2450	3.3912	1.59106	25.6410	122.52	1194.59
40	1600	64000	6.3246	3.4200	1.60206	25.0000	125.66	1256.64
41	1681	68921	6.4031	3.4482	1.61278	24.3902	128.81	1320.25
42	1764	74088	6.4807	3.4760	1.62325	23.8095	131.95	1385.44
43	1849	79507	6.5574	3.5034	1.63347	23.2558	135.09	1452.20
44	1936	85184	6.6332	3.5303	1.64345	22.7273	138.23	1520.53
45	2025	91125	6.7082	3.5569	1.65321	22.2222	141.37	1590.43
46	2116	97336	6.7823	3.5830	1.66276	21.7391	144.51	1661.90
47	2209	103823	6.8557	3.6088	1.67210	21.2766	147.65	1734.94
48	2304	110592	6.9282	3.6342	1.68124	20.8333	150.80	1809.56
49	2401	117649	7.0000	3.6593	1.69020	20.4082	153.94	1885.74

FUNCTIONS OF NUMBERS, 50 to 99

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
50	2500	125000	7.0711	3.6840	1.69897	20.0000	157.08	1963.50
51	2601	132651	7.1414	3.7084	1.70757	19.6078	160.22	2042.82
52	2704	140608	7.2111	3.7325	1.71600	19.2308	163.36	2123.72
53	2809	148877	7.2801	3.7563	1.72428	18.8679	166.50	2206.18
54	2916	157464	7.3485	3.7798	1.73239	18.5185	169.65	2290.22
55	3025	166375	7.4162	3.8030	1.74036	18.1818	172.79	2375.83
56	3136	175616	7.4833	3.8259	1.74819	17.8571	175.93	2463.01
57	3249	185193	7.5498	3.8485	1.75587	17.5439	179.07	2551.76
58	3364	195112	7.6158	3.8709	1.76343	17.2414	182.21	2642.08
59	3481	205379	7.6811	3.8930	1.77085	16.9492	185.35	2733.97
60	3600	216000	7.7460	3.9149	1.77815	16.6667	188.50	2827.43
61	3721	226981	7.8102	3.9365	1.78533	16.3934	191.64	2922.47
62	3844	238328	7.8740	3.9579	1.79239	16.1290	194.78	3019.07
63	3969	250047	7.9373	3.9791	1.79934	15.8730	197.92	3117.25
64	4096	262144	8.0000	4.0000	1.80618	15.6250	201.06	3216.99
65	4225	274625	8.0623	4.0207	1.81291	15.3846	204.20	3318.31
66	4356	287496	8.1240	4.0412	1.81954	15.1515	207.35	3421.19
67	4489	300763	8.1854	4.0615	1.82607	14.9254	210.49	3525.65
68	4624	314432	8.2462	4.0817	1.83251	14.7059	213.63	3631.68
69	4761	328509	8.3066	4.1016	1.83885	14.4928	216.77	3739.28
70	4900	343000	8.3666	4.1213	1.84510	14.2857	219.91	3848.45
71	5041	357911	8.4261	4.1408	1.85126	14.0845	223.05	3959.19
72	5184	373248	8.4853	4.1602	1.85733	13.8889	226.19	4071.50
73	5329	389017	8.5440	4.1793	1.86332	13.6986	229.34	4185.39
74	5476	405224	8.6023	4.1983	1.86923	13.5135	232.48	4300.84
75	5625	421875	8.6603	4.2172	1.87506	13.3333	235.62	4417.86
76	5776	438976	8.7178	4.2358	1.88081	13.1579	238.76	4536.46
77	5929	456533	8.7750	4.2543	1.88649	12.9870	241.90	4656.63
78	6084	474552	8.8318	4.2727	1.89209	12.8205	245.04	4778.36
79	6241	493039	8.8882	4.2908	1.89763	12.6582	248.19	4901.67
80	6400	512000	8.9443	4.3089	1.90309	12.5000	251.33	5026.55
81	6561	531441	9.0000	4.3267	1.90849	12.3457	254.47	5153.00
82	6724	551368	9.0554	4.3445	1.91381	12.1951	257.61	5281.02
83	6889	571787	9.1104	4.3621	1.91908	12.0482	260.75	5410.61
84	7056	592704	9.1652	4.3795	1.92428	11.9048	263.89	5541.77
85	7225	614125	9.2195	4.3968	1.92942	11.7647	267.04	5674.50
86	7396	636056	9.2736	4.4140	1.93450	11.6279	270.18	5808.80
87	7569	658503	9.3274	4.4310	1.93952	11.4943	273.32	5944.68
88	7744	681472	9.3808	4.4480	1.94448	11.3636	276.46	6082.12
89	7921	704969	9.4340	4.4647	1.94939	11.2360	279.60	6221.14
90	8100	729000	9.4868	4.4814	1.95424	11.1111	282.74	6361.73
91	8281	753571	9.5394	4.4979	1.95904	10.9890	285.88	6503.88
92	8464	778688	9.5917	4.5144	1.96379	10.8696	289.03	6647.61
93	8649	804357	9.6437	4.5307	1.96848	10.7527	292.17	6792.91
94	8836	830584	9.6954	4.5468	1.97313	10.6383	295.31	6939.78
95	9025	857375	9.7468	4.5629	1.97772	10.5263	298.45	7088.22
96	9216	884736	9.7980	4.5789	1.98227	10.4167	301.59	7238.23
97	9409	912673	9.8489	4.5947	1.98677	10.3093	304.73	7389.81
98	9604	941192	9.8995	4.6104	1.99123	10.2041	307.88	7542.96
99	9801	970299	9.9499	4.6261	1.99564	10.1010	311.02	7697.69

FUNCTIONS OF NUMBERS, 100 to 149

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
100	10000	1000000	10.0000	4.6416	2.00000	10.00000	314.16	7853.98
101	10201	1030301	10.0499	4.6570	2.00432	9.90099	317.30	8011.85
102	10404	1061208	10.0995	4.6723	2.00860	9.80392	320.44	8171.28
103	10609	1092727	10.1489	4.6875	2.01284	9.70874	323.58	8332.29
104	10816	1124864	10.1980	4.7027	2.01703	9.61538	326.73	8494.87
105	11025	1157625	10.2470	4.7177	2.02119	9.52381	329.87	8659.01
106	11236	1191016	10.2956	4.7326	2.02531	9.43396	333.01	8824.73
107	11449	1225043	10.3441	4.7475	2.02938	9.34579	336.15	8992.02
108	11664	1259712	10.3923	4.7622	2.03342	9.25926	339.29	9160.88
109	11881	1295029	10.4403	4.7769	2.03743	9.17431	342.43	9331.32
110	12100	1331000	10.4881	4.7914	2.04139	9.09091	345.58	9503.32
111	12321	1367631	10.5357	4.8059	2.04532	9.00901	348.72	9676.89
112	12544	1404928	10.5830	4.8203	2.04922	8.92857	351.86	9852.03
113	12769	1442897	10.6301	4.8346	2.05308	8.84956	355.00	10028.7
114	12996	1481544	10.6771	4.8488	2.05690	8.77193	358.14	10207.0
115	13225	1520875	10.7238	4.8629	2.06070	8.69565	361.28	10386.9
116	13456	1560896	10.7703	4.8770	2.06446	8.62069	364.42	10568.3
117	13689	1601613	10.8167	4.8910	2.06819	8.54701	367.57	10751.3
118	13924	1643032	10.8628	4.9049	2.07188	8.47458	370.71	10935.9
119	14161	1685159	10.9087	4.9187	2.07555	8.40336	373.85	11122.0
120	14400	1728000	10.9545	4.9324	2.07918	8.33333	376.99	11309.7
121	14641	1771561	11.0000	4.9461	2.08279	8.26446	380.13	11499.0
122	14884	1815848	11.0454	4.9597	2.08636	8.19672	383.27	11689.9
123	15129	1860867	11.0905	4.9732	2.08991	8.13008	386.42	11882.3
124	15376	1906624	11.1355	4.9866	2.09342	8.06452	389.56	12076.3
125	15625	1953125	11.1803	5.0000	2.09691	8.00000	392.70	12271.8
126	15876	2000376	11.2250	5.0133	2.10037	7.93651	395.84	12469.0
127	16129	2048383	11.2694	5.0265	2.10380	7.87402	398.98	12667.7
128	16384	2097152	11.3137	5.0397	2.10721	7.81250	402.12	12868.0
129	16641	2146689	11.3578	5.0528	2.11059	7.75194	405.27	13069.8
130	16900	2197000	11.4018	5.0658	2.11394	7.69231	408.41	13273.2
131	17161	2248091	11.4455	5.0788	2.11727	7.63359	411.55	13478.2
132	17424	2299968	11.4891	5.0916	2.12057	7.57576	414.69	13684.8
133	17689	2352637	11.5326	5.1045	2.12385	7.51880	417.83	13892.9
134	17956	2406104	11.5758	5.1172	2.12710	7.46269	420.97	14102.6
135	18225	2460375	11.6190	5.1299	2.13033	7.40741	424.12	14313.9
136	18496	2515456	11.6619	5.1426	2.13354	7.35294	427.26	14526.7
137	18769	2571353	11.7047	5.1551	2.13672	7.29927	430.40	14741.1
138	19044	2628072	11.7473	5.1676	2.13988	7.24638	433.54	14957.1
139	19321	2685619	11.7898	5.1801	2.14301	7.19424	436.68	15174.7
140	19600	2744000	11.8322	5.1925	2.14613	7.14286	439.82	15393.8
141	19881	2803221	11.8743	5.2048	2.14922	7.09220	442.96	15614.5
142	20164	2863288	11.9164	5.2171	2.15229	7.04225	446.11	15836.8
143	20449	2924207	11.9583	5.2293	2.15534	6.99301	449.25	16060.6
144	20736	2985984	12.0000	5.2415	2.15836	6.94444	452.39	16286.0
145	21025	3048625	12.0416	5.2536	2.16137	6.89655	455.53	16513.0
146	21316	3112136	12.0830	5.2656	2.16435	6.84932	458.67	16741.5
147	21609	3176523	12.1244	5.2776	2.16732	6.80272	461.81	16971.7
148	21904	3241792	12.1655	5.2896	2.17026	6.75676	464.96	17203.4
149	22201	3307949	12.2066	5.3015	2.17319	6.71141	468.10	17436.6

FUNCTIONS OF NUMBERS, 150 to 199

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
150	22500	3375000	12.2474	5.3133	2.17609	6.66667	471.24	17671.5
151	22801	3442951	12.2882	5.3251	2.17898	6.62252	474.38	17907.9
152	23104	3511808	12.3288	5.3368	2.18184	6.57895	477.52	18145.8
153	23409	3581577	12.3693	5.3485	2.18469	6.53595	480.66	18385.4
154	23716	3652264	12.4097	5.3601	2.18752	6.49351	483.81	18626.5
155	24025	3723875	12.4499	5.3717	2.19033	6.45161	486.95	18869.2
156	24336	3796416	12.4900	5.3832	2.19312	6.41026	490.09	19113.4
157	24649	3869893	12.5300	5.3947	2.19590	6.36943	493.23	19359.3
158	24964	3944312	12.5698	5.4061	2.19866	6.32911	496.37	19606.7
159	25281	4019679	12.6095	5.4175	2.20140	6.28931	499.51	19855.7
160	25600	4096000	12.6491	5.4288	2.20412	6.25000	502.65	20106.2
161	25921	4173281	12.6886	5.4401	2.20683	6.21118	505.80	20358.3
162	26244	4251528	12.7279	5.4514	2.20952	6.17284	508.94	20612.0
163	26569	4330747	12.7671	5.4626	2.21219	6.13497	512.08	20867.2
164	26896	4410944	12.8062	5.4737	2.21484	6.09756	515.22	21124.1
165	27225	4492125	12.8452	5.4848	2.21748	6.06061	518.36	21382.5
166	27556	4574296	12.8841	5.4959	2.22011	6.02410	521.50	21642.4
167	27889	4657463	12.9228	5.5069	2.22272	5.98802	524.65	21904.0
168	28224	4741632	12.9615	5.5178	2.22531	5.95238	527.79	22167.1
169	28561	4826809	13.0000	5.5288	2.22789	5.91716	530.93	22431.8
170	28900	4913000	13.0384	5.5397	2.23045	5.88235	534.07	22698.0
171	29241	5000211	13.0767	5.5505	2.23300	5.84795	537.21	22965.8
172	29584	5088448	13.1149	5.5613	2.23553	5.81395	540.35	23235.2
173	29929	5177717	13.1529	5.5721	2.23805	5.78035	543.50	23506.2
174	30276	5268024	13.1909	5.5828	2.24055	5.74713	546.64	23778.7
175	30625	5359375	13.2288	5.5934	2.24304	5.71429	549.78	24052.8
176	30976	5451776	13.2665	5.6041	2.24551	5.68182	552.92	24328.5
177	31329	5545233	13.3041	5.6147	2.24797	5.64972	556.06	24605.7
178	31684	5639752	13.3417	5.6252	2.25042	5.61798	559.20	24884.6
179	32041	5735339	13.3791	5.6357	2.25285	5.58659	562.35	25164.9
180	32400	5832000	13.4164	5.6462	2.25527	5.55556	565.49	25446.9
181	32761	5929741	13.4536	5.6567	2.25768	5.52486	568.63	25730.4
182	33124	6028568	13.4907	5.6671	2.26007	5.49451	571.77	26015.5
183	33489	6128487	13.5277	5.6774	2.26245	5.46448	574.91	26302.2
184	33856	6229504	13.5647	5.6877	2.26482	5.43478	578.05	26590.4
185	34225	6331625	13.6015	5.6980	2.26717	5.40541	581.19	26880.3
186	34596	6434856	13.6382	5.7083	2.26951	5.37634	584.34	27171.6
187	34969	6539203	13.6748	5.7185	2.27184	5.34759	587.48	27464.6
188	35344	6644672	13.7113	5.7287	2.27416	5.31915	590.62	27759.1
189	35721	6751269	13.7477	5.7388	2.27646	5.29101	593.76	28055.2
190	36100	6859000	13.7840	5.7489	2.27875	5.26316	596.90	28352.9
191	36481	6967871	13.8203	5.7590	2.28103	5.23560	600.04	28652.1
192	36864	7077888	13.8564	5.7690	2.28330	5.20833	603.19	28952.9
193	37249	7189057	13.8924	5.7790	2.28556	5.18135	606.33	29255.3
194	37636	7301384	13.9284	5.7890	2.28780	5.15464	609.47	29559.2
195	38025	7414875	13.9642	5.7989	2.29003	5.12821	612.61	29864.8
196	38416	7529536	14.0000	5.8088	2.29226	5.10204	615.75	30171.9
197	38809	7645373	14.0357	5.8186	2.29447	5.07614	618.89	30480.5
198	39204	7762392	14.0712	5.8285	2.29667	5.05051	622.04	30790.7
199	39601	7880599	14.1067	5.8383	2.29885	5.02513	625.18	31102.6

FUNCTIONS OF NUMBERS, 200 to 249

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
200	40000	8000000	14.1421	5.8480	2.30103	5.00000	628.32	31415.9
201	40401	8120601	14.1774	5.8578	2.30320	4.97512	631.46	31730.9
202	40804	8242408	14.2127	5.8675	2.30535	4.95050	634.60	32047.4
203	41209	8365427	14.2478	5.8771	2.30750	4.92611	637.74	32365.5
204	41616	8489664	14.2829	5.8868	2.30963	4.90196	640.88	32685.1
205	42025	8615125	14.3178	5.8964	2.31175	4.87805	644.03	33006.4
206	42436	8741816	14.3527	5.9059	2.31387	4.85437	647.17	33329.2
207	42849	8869743	14.3875	5.9155	2.31597	4.83092	650.31	33653.5
208	43264	8998912	14.4222	5.9250	2.31806	4.80769	653.45	33979.5
209	43681	9129329	14.4568	5.9345	2.32015	4.78469	656.59	34307.0
210	44100	9261000	14.4914	5.9439	2.32222	4.76190	659.73	34636.1
211	44521	9393931	14.5258	5.9533	2.32428	4.73934	662.88	34966.7
212	44944	9528128	14.5602	5.9627	2.32634	4.71698	666.02	35298.9
213	45369	9663597	14.5945	5.9721	2.32838	4.69484	669.16	35632.7
214	45796	9800344	14.6287	5.9814	2.33041	4.67290	672.30	35968.1
215	46225	9938375	14.6629	5.9907	2.33244	4.65116	675.44	36305.0
216	46656	10077696	14.6969	6.0000	2.33445	4.62963	678.58	36643.5
217	47089	10218313	14.7309	6.0092	2.33646	4.60829	681.73	36983.6
218	47524	10360232	14.7648	6.0185	2.33846	4.58716	684.87	37325.3
219	47961	10503459	14.7986	6.0277	2.34044	4.56621	688.01	37668.5
220	48400	10648000	14.8324	6.0368	2.34242	4.54545	691.15	38013.3
221	48841	10793861	14.8661	6.0459	2.34439	4.52489	694.29	38359.6
222	49284	10941048	14.8997	6.0550	2.34635	4.50450	697.43	38707.6
223	49729	11089567	14.9332	6.0641	2.34830	4.48430	700.58	39057.1
224	50176	11239424	14.9666	6.0732	2.35025	4.46429	703.72	39408.1
225	50625	11390625	15.0000	6.0822	2.35218	4.44444	706.86	39760.8
226	51076	11543176	15.0333	6.0912	2.35411	4.42478	710.00	40115.0
227	51529	11697083	15.0665	6.1002	2.35603	4.40529	713.14	40470.8
228	51984	11852352	15.0997	6.1091	2.35793	4.38596	716.28	40828.1
229	52441	12008989	15.1327	6.1180	2.35984	4.36681	719.42	41187.1
230	52900	12167000	15.1658	6.1269	2.36173	4.34783	722.57	41547.6
231	53361	12326391	15.1987	6.1358	2.36361	4.32900	725.71	41909.6
232	53824	12487168	15.2315	6.1446	2.36549	4.31034	728.85	42273.3
233	54289	12649337	15.2643	6.1534	2.36736	4.29185	731.99	42638.5
234	54756	12812904	15.2971	6.1622	2.36922	4.27350	735.13	43005.3
235	55225	12977875	15.3297	6.1710	2.37107	4.25532	738.27	43373.6
236	55696	13144256	15.3623	6.1797	2.37291	4.23729	741.42	43743.5
237	56169	13312053	15.3948	6.1885	2.37475	4.21941	744.56	44115.0
238	56644	13481272	15.4272	6.1972	2.37658	4.20168	747.70	44488.1
239	57121	13651919	15.4596	6.2058	2.37840	4.18410	750.84	44862.7
240	57600	13824000	15.4919	6.2145	2.38021	4.16667	753.98	45238.9
241	58081	13997521	15.5242	6.2231	2.38202	4.14938	757.12	45616.7
242	58564	14172488	15.5563	6.2317	2.38382	4.13223	760.27	45996.1
243	59049	14348907	15.5885	6.2403	2.38561	4.11523	763.41	46377.0
244	59536	14526784	15.6205	6.2488	2.38739	4.09836	766.55	46759.5
245	60025	14706125	15.6525	6.2573	2.38917	4.08163	769.69	47143.5
246	60516	14886936	15.6844	6.2658	2.39094	4.06504	772.83	47529.2
247	61009	15069223	15.7162	6.2743	2.39270	4.04858	775.97	47916.4
248	61504	15252992	15.7480	6.2828	2.39445	4.03226	779.12	48305.1
249	62001	15438249	15.7797	6.2912	2.39620	4.01606	782.26	48695.5

FUNCTIONS OF NUMBERS, 250 to 299

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
250	62500	15625000	15.8114	6.2996	2.39794	4.00000	785.40	49087.4
251	63001	15813251	15.8430	6.3080	2.39967	3.98406	788.54	49480.9
252	63504	16003008	15.8745	6.3164	2.40140	3.96825	791.68	49875.9
253	64009	16194277	15.9060	6.3247	2.40312	3.95257	794.82	50272.6
254	64516	16387064	15.9374	6.3330	2.40483	3.93701	797.96	50670.7
255	65025	16581375	15.9687	6.3413	2.40654	3.92157	801.11	51070.5
256	65536	16777216	16.0000	6.3496	2.40824	3.90625	804.25	51471.9
257	66049	16974593	16.0312	6.3579	2.40993	3.89105	807.39	51874.8
258	66564	17173512	16.0624	6.3661	2.41162	3.87597	810.53	52279.2
259	67081	17373979	16.0935	6.3743	2.41330	3.86100	813.67	52685.3
260	67600	17576000	16.1245	6.3825	2.41497	3.84615	816.81	53092.9
261	68121	17779581	16.1555	6.3907	2.41664	3.83142	819.96	53502.1
262	68644	17984728	16.1864	6.3988	2.41830	3.81679	823.10	53912.9
263	69169	18191447	16.2173	6.4070	2.41996	3.80228	826.24	54325.2
264	69696	18399744	16.2481	6.4151	2.42160	3.78788	829.38	54739.1
265	70225	18609625	16.2788	6.4232	2.42325	3.77358	832.52	55154.6
266	70756	18821096	16.3095	6.4312	2.42488	3.75940	835.66	55571.6
267	71289	19034163	16.3401	6.4393	2.42651	3.74532	838.81	55990.2
268	71824	19248832	16.3707	6.4473	2.42813	3.73134	841.95	56410.4
269	72361	19465109	16.4012	6.4553	2.42975	3.71747	845.09	56832.2
270	72900	19683000	16.4317	6.4633	2.43136	3.70370	848.23	57255.5
271	73441	19902511	16.4621	6.4713	2.43297	3.69004	851.37	57680.4
272	73984	20123648	16.4924	6.4792	2.43457	3.67647	854.51	58106.9
273	74529	20346417	16.5227	6.4872	2.43616	3.66300	857.65	58534.9
274	75076	20570824	16.5529	6.4951	2.43775	3.64964	860.80	58964.6
275	75625	20796875	16.5831	6.5030	2.43933	3.63636	863.94	59395.7
276	76176	21024576	16.6132	6.5108	2.44091	3.62319	867.08	59828.5
277	76729	21253933	16.6433	6.5187	2.44248	3.61011	870.22	60262.8
278	77284	21484952	16.6733	6.5265	2.44404	3.59712	873.36	60698.7
279	77841	21717639	16.7033	6.5343	2.44560	3.58423	876.50	61136.2
280	78400	21952000	16.7332	6.5421	2.44716	3.57143	879.65	61575.2
281	78961	22188041	16.7631	6.5499	2.44871	3.55872	882.79	62015.8
282	79524	22425768	16.7929	6.5577	2.45025	3.54610	885.93	62458.0
283	80089	22665187	16.8226	6.5654	2.45179	3.53357	889.07	62901.8
284	80656	22906304	16.8523	6.5731	2.45332	3.52113	892.21	63347.1
285	81225	23149125	16.8819	6.5808	2.45484	3.50877	895.35	63794.0
286	81796	23393656	16.9115	6.5885	2.45637	3.49650	898.50	64242.4
287	82369	23639903	16.9411	6.5962	2.45788	3.48432	901.64	64692.5
288	82944	23887872	16.9706	6.6039	2.45939	3.47222	904.78	65144.1
289	83521	24137569	17.0000	6.6115	2.46090	3.46021	907.92	65597.2
290	84100	24389000	17.0294	6.6191	2.46240	3.44828	911.06	66052.0
291	84681	24642171	17.0587	6.6267	2.46389	3.43643	914.20	66508.3
292	85264	24897088	17.0880	6.6343	2.46538	3.42466	917.35	66966.2
293	85849	25153757	17.1172	6.6419	2.46687	3.41297	920.49	67425.6
294	86436	25412184	17.1464	6.6494	2.46835	3.40136	923.63	67886.7
295	87025	25672375	17.1756	6.6569	2.46982	3.38983	926.77	68349.3
296	87616	25934336	17.2047	6.6644	2.47129	3.37838	929.91	68813.4
297	88209	26198073	17.2337	6.6719	2.47276	3.36700	933.05	69279.2
298	88804	26463592	17.2627	6.6794	2.47422	3.35570	936.19	69746.5
299	89401	26730899	17.2916	6.6869	2.47567	3.34448	939.34	70215.4

FUNCTIONS OF NUMBERS, 300 to 349

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
300	90000	27000000	17.3205	6.6943	2.47712	3.33333	942.48	70685.8
301	90601	27270901	17.3494	6.7018	2.47857	3.32226	945.62	71157.9
302	91204	27543608	17.3781	6.7092	2.48001	3.31126	948.76	71631.5
303	91809	27818127	17.4069	6.7166	2.48144	3.30033	951.90	72106.6
304	92416	28094464	17.4356	6.7240	2.48287	3.28947	955.04	72583.4
305	93025	28372625	17.4642	6.7313	2.48430	3.27869	958.19	73061.7
306	93636	28652616	17.4929	6.7387	2.48572	3.26797	961.33	73541.5
307	94249	28934443	17.5214	6.7460	2.48714	3.25733	964.47	74023.0
308	94864	29218112	17.5499	6.7533	2.48855	3.24675	967.61	74506.0
309	95481	29503629	17.5784	6.7606	2.48996	3.23625	970.75	74990.6
310	96100	29791000	17.6068	6.7679	2.49136	3.22581	973.89	75476.8
311	96721	30080231	17.6352	6.7752	2.49276	3.21543	977.04	75964.5
312	97344	30371328	17.6635	6.7824	2.49415	3.20513	980.18	76453.8
313	97969	30664297	17.6918	6.7897	2.49554	3.19489	983.32	76944.7
314	98596	30959144	17.7200	6.7969	2.49693	3.18471	986.46	77437.1
315	99225	31255875	17.7482	6.8041	2.49831	3.17460	989.60	77931.1
316	99856	31554496	17.7764	6.8113	2.49969	3.16456	992.74	78426.7
317	100489	31855013	17.8045	6.8185	2.50106	3.15457	995.88	78923.9
318	101124	32157432	17.8326	6.8256	2.50243	3.14465	999.03	79422.6
319	101761	32461759	17.8606	6.8328	2.50379	3.13480	1002.2	79922.9
320	102400	32768000	17.8885	6.8399	2.50515	3.12500	1005.3	80424.8
321	103041	33076161	17.9165	6.8470	2.50651	3.11526	1008.5	80928.2
322	103684	33386248	17.9444	6.8541	2.50786	3.10559	1011.6	81433.2
323	104329	33698267	17.9722	6.8612	2.50920	3.09598	1014.7	81939.8
324	104976	34012224	18.0000	6.8683	2.51055	3.08642	1017.9	82448.0
325	105625	34328125	18.0278	6.8753	2.51188	3.07692	1021.0	82957.7
326	106276	34645976	18.0555	6.8824	2.51322	3.06749	1024.2	83469.0
327	106929	34965783	18.0831	6.8894	2.51455	3.05810	1027.3	83981.8
328	107584	35287552	18.1108	6.8964	2.51587	3.04878	1030.4	84496.3
329	108241	35611289	18.1384	6.9034	2.51720	3.03951	1033.6	85012.3
330	108900	35937000	18.1659	6.9104	2.51851	3.03030	1036.7	85529.9
331	109561	36264691	18.1934	6.9174	2.51983	3.02115	1039.9	86049.0
332	110224	36594368	18.2209	6.9244	2.52114	3.01205	1043.0	86569.7
333	110889	36926037	18.2483	6.9313	2.52244	3.00300	1046.2	87092.0
334	111556	37259704	18.2757	6.9382	2.52375	2.99401	1049.3	87615.9
335	112225	37595375	18.3030	6.9451	2.52504	2.98507	1052.4	88141.3
336	112896	37933056	18.3303	6.9521	2.52634	2.97619	1055.6	88668.3
337	113569	38272753	18.3576	6.9589	2.52763	2.96736	1058.7	89196.9
338	114244	38614472	18.3848	6.9658	2.52892	2.95858	1061.9	89727.0
339	114921	38958219	18.4120	6.9727	2.53020	2.94985	1065.0	90258.7
340	115600	39304000	18.4391	6.9795	2.53148	2.94118	1068.1	90792.0
341	116281	39651821	18.4662	6.9864	2.53275	2.93255	1071.3	91326.9
342	116964	40001688	18.4932	6.9932	2.53403	2.92398	1074.4	91863.3
343	117649	40353607	18.5203	7.0000	2.53529	2.91545	1077.6	92401.3
344	118336	40707584	18.5472	7.0068	2.53656	2.90698	1080.7	92940.9
345	119025	41063625	18.5742	7.0136	2.53782	2.89855	1083.8	93482.0
346	119716	41421736	18.6011	7.0203	2.53908	2.89017	1087.0	94024.7
347	120409	41781923	18.6279	7.0271	2.54033	2.88184	1090.1	94569.0
348	121104	42144192	18.6548	7.0338	2.54158	2.87356	1093.3	95114.9
349	121801	42508549	18.6815	7.0406	2.54283	2.86533	1096.4	95662.3

FUNCTIONS OF NUMBERS, 350 to 399

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
350	122500	42875000	18.7083	7.0473	2.54407	2.85714	1099.6	96211.3
351	123201	43243551	18.7350	7.0540	2.54531	2.84900	1102.7	96761.8
352	123904	43614208	18.7617	7.0607	2.54654	2.84091	1105.8	97314.0
353	124609	43986977	18.7883	7.0674	2.54777	2.83286	1109.0	97867.7
354	125316	44361864	18.8149	7.0740	2.54900	2.82486	1112.1	98423.0
355	126025	44738875	18.8414	7.0807	2.55023	2.81690	1115.3	98979.8
356	126736	45118016	18.8680	7.0873	2.55145	2.80899	1118.4	99538.2
357	127449	45499293	18.8944	7.0940	2.55267	2.80112	1121.5	100098
358	128164	45882712	18.9209	7.1006	2.55388	2.79330	1124.7	100660
359	128881	46268279	18.9473	7.1072	2.55509	2.78552	1127.8	101223
360	129600	46656000	18.9737	7.1138	2.55630	2.77778	1131.0	101788
361	130321	47045881	19.0000	7.1204	2.55751	2.77008	1134.1	102354
362	131044	47437928	19.0263	7.1269	2.55871	2.76243	1137.3	102922
363	131769	47832147	19.0526	7.1335	2.55991	2.75482	1140.4	103491
364	132496	48228544	19.0788	7.1400	2.56110	2.74725	1143.5	104062
365	133225	48627125	19.1050	7.1466	2.56229	2.73973	1146.7	104635
366	133956	49027896	19.1311	7.1531	2.56348	2.73224	1149.8	105209
367	134689	49430863	19.1572	7.1596	2.56467	2.72480	1153.0	105785
368	135424	49836032	19.1833	7.1661	2.56585	2.71739	1156.1	106362
369	136161	50243409	19.2094	7.1726	2.56703	2.71003	1159.2	106941
370	136900	50653000	19.2354	7.1791	2.56820	2.70270	1162.4	107521
371	137641	51064811	19.2614	7.1855	2.56937	2.69542	1165.5	108103
372	138384	51478848	19.2873	7.1920	2.57054	2.68817	1168.7	108687
373	139129	51895117	19.3132	7.1984	2.57171	2.68097	1171.8	109272
374	139876	52313624	19.3391	7.2048	2.57287	2.67380	1175.0	109858
375	140625	52734375	19.3649	7.2112	2.57403	2.66667	1178.1	110447
376	141376	53157376	19.3907	7.2177	2.57519	2.65957	1181.2	111036
377	142129	53582633	19.4165	7.2240	2.57634	2.65252	1184.4	111628
378	142884	54010152	19.4422	7.2304	2.57749	2.64550	1187.5	112221
379	143641	54439939	19.4679	7.2368	2.57864	2.63852	1190.7	112815
380	144400	54872000	19.4936	7.2432	2.57978	2.63158	1193.8	113411
381	145161	55306341	19.5192	7.2495	2.58093	2.62467	1196.9	114009
382	145924	55742968	19.5448	7.2558	2.58206	2.61780	1200.1	114608
383	146689	56181887	19.5704	7.2622	2.58320	2.61097	1203.2	115209
384	147456	56623104	19.5959	7.2685	2.58433	2.60417	1206.4	115812
385	148225	57066625	19.6214	7.2748	2.58546	2.59740	1209.5	116416
386	148996	57512456	19.6469	7.2811	2.58659	2.59067	1212.7	117021
387	149769	57960603	19.6723	7.2874	2.58771	2.58398	1215.8	117628
388	150544	58411072	19.6977	7.2936	2.58883	2.57732	1218.9	118237
389	151321	58863869	19.7231	7.2999	2.58995	2.57069	1222.1	118847
390	152100	59319000	19.7484	7.3061	2.59106	2.56410	1225.2	119459
391	152881	59776471	19.7737	7.3124	2.59218	2.55754	1228.4	120072
392	153664	60236288	19.7990	7.3186	2.59329	2.55102	1231.5	120687
393	154449	60698457	19.8242	7.3248	2.59439	2.54453	1234.6	121304
394	155236	61162984	19.8494	7.3310	2.59550	2.53807	1237.8	121922
395	156025	61629875	19.8746	7.3372	2.59660	2.53165	1240.9	122542
396	156816	62099136	19.8997	7.3434	2.59770	2.52525	1244.1	123163
397	157609	62570773	19.9249	7.3496	2.59879	2.51889	1247.2	123786
398	158404	63044792	19.9499	7.3558	2.59988	2.51256	1250.4	124410
399	159201	63521199	19.9750	7.3619	2.60097	2.50627	1253.5	125036

FUNCTIONS OF NUMBERS, 400 to 449

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
400	160000	64000000	20.0000	7.3681	2.60206	2.50000	1256.6	125664
401	160801	64481201	20.0250	7.3742	2.60314	2.49377	1259.8	126293
402	161604	64964808	20.0499	7.3803	2.60423	2.48756	1262.9	126923
403	162409	65450827	20.0749	7.3864	2.60531	2.48139	1266.1	127556
404	163216	65939264	20.0998	7.3925	2.60638	2.47525	1269.2	128190
405	164025	66430125	20.1246	7.3986	2.60746	2.46914	1272.3	128825
406	164836	66923416	20.1494	7.4047	2.60853	2.46305	1275.5	129462
407	165649	67419143	20.1742	7.4108	2.60959	2.45700	1278.6	130100
408	166464	67917312	20.1990	7.4169	2.61066	2.45098	1281.8	130741
409	167281	68417929	20.2237	7.4229	2.61172	2.44499	1284.9	131382
410	168100	68921000	20.2485	7.4290	2.61278	2.43902	1288.1	132025
411	168921	69426531	20.2731	7.4350	2.61384	2.43309	1291.2	132670
412	169744	69934528	20.2978	7.4410	2.61490	2.42718	1294.3	133317
413	170569	70444997	20.3224	7.4470	2.61595	2.42131	1297.5	133965
414	171396	70957944	20.3470	7.4530	2.61700	2.41546	1300.6	134614
415	172225	71473375	20.3715	7.4590	2.61805	2.40964	1303.8	135265
416	173056	71991296	20.3961	7.4650	2.61909	2.40385	1306.9	135918
417	173889	72511713	20.4206	7.4710	2.62014	2.39808	1310.0	136572
418	174724	73034632	20.4450	7.4770	2.62118	2.39234	1313.2	137228
419	175561	73560059	20.4695	7.4829	2.62221	2.38663	1316.3	137885
420	176400	74088000	20.4939	7.4889	2.62325	2.38095	1319.5	138544
421	177241	74618461	20.5183	7.4948	2.62428	2.37530	1322.6	139205
422	178084	75151448	20.5426	7.5007	2.62531	2.36967	1325.8	139867
423	178929	75686967	20.5670	7.5067	2.62634	2.36407	1328.9	140531
424	179776	76225024	20.5913	7.5126	2.62737	2.35849	1332.0	141196
425	180625	76765625	20.6155	7.5185	2.62839	2.35294	1335.2	141863
426	181476	77308776	20.6398	7.5244	2.62941	2.34742	1338.3	142531
427	182329	77854483	20.6640	7.5302	2.63043	2.34192	1341.5	143201
428	183184	78402752	20.6882	7.5361	2.63144	2.33645	1344.6	143872
429	184041	78953589	20.7123	7.5420	2.63246	2.33100	1347.7	144545
430	184900	79507000	20.7364	7.5478	2.63347	2.32558	1350.9	145220
431	185761	80062991	20.7605	7.5537	2.63448	2.32019	1354.0	145896
432	186624	80621568	20.7846	7.5595	2.63548	2.31481	1357.2	146574
433	187489	81182737	20.8087	7.5654	2.63649	2.30947	1360.3	147254
434	188356	81746504	20.8327	7.5712	2.63749	2.30415	1363.5	147934
435	189225	82312875	20.8567	7.5770	2.63849	2.29885	1366.6	148617
436	190096	82881856	20.8806	7.5828	2.63949	2.29358	1369.7	149301
437	190969	83453453	20.9045	7.5886	2.64048	2.28833	1372.9	149987
438	191844	84027672	20.9284	7.5944	2.64147	2.28311	1376.0	150674
439	192721	84604519	20.9523	7.6001	2.64246	2.27790	1379.2	151363
440	193600	85184000	20.9762	7.6059	2.64345	2.27273	1382.3	152053
441	194481	85766121	21.0000	7.6117	2.64444	2.26757	1385.4	152745
442	195364	86350888	21.0238	7.6174	2.64542	2.26244	1388.6	153439
443	196249	86938307	21.0476	7.6232	2.64640	2.25734	1391.7	154134
444	197136	87528384	21.0713	7.6289	2.64738	2.25225	1394.9	154830
445	198025	88121125	21.0950	7.6346	2.64836	2.24719	1398.0	155528
446	198916	88716536	21.1187	7.6403	2.64933	2.24215	1401.2	156228
447	199809	89314623	21.1424	7.6460	2.65031	2.23714	1404.3	156930
448	200704	89915392	21.1660	7.6517	2.65128	2.23214	1407.4	157633
449	201601	90518849	21.1896	7.6574	2.65225	2.22717	1410.6	158337

FUNCTIONS OF NUMBERS, 450 to 499

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
450	202500	91125000	21.2132	7.6631	2.65321	2.22222	1413.7	159043
451	203401	91733851	21.2368	7.6688	2.65418	2.21729	1416.9	159751
452	204304	92345408	21.2603	7.6744	2.65514	2.21239	1420.0	160460
453	205209	92959677	21.2838	7.6801	2.65610	2.20751	1423.1	161171
454	206116	93576664	21.3073	7.6857	2.65706	2.20264	1426.3	161883
455	207025	94196375	21.3307	7.6914	2.65801	2.19780	1429.4	162597
456	207936	94818816	21.3542	7.6970	2.65896	2.19298	1432.6	163313
457	208849	95443993	21.3776	7.7026	2.65992	2.18818	1435.7	164030
458	209764	96071912	21.4009	7.7082	2.66087	2.18341	1438.8	164748
459	210681	96702579	21.4243	7.7138	2.66181	2.17865	1442.0	165468
460	211600	97336000	21.4476	7.7194	2.66276	2.17391	1445.1	166190
461	212521	97972181	21.4709	7.7250	2.66370	2.16920	1448.3	166914
462	213444	98611128	21.4942	7.7306	2.66464	2.16450	1451.4	167639
463	214369	99252847	21.5174	7.7362	2.66558	2.15983	1454.6	168365
464	215296	99897344	21.5407	7.7418	2.66652	2.15517	1457.7	169093
465	216225	100544625	21.5639	7.7473	2.66745	2.15054	1460.8	169823
466	217156	101194696	21.5870	7.7529	2.66839	2.14592	1464.0	170554
467	218089	101847563	21.6102	7.7584	2.66932	2.14133	1467.1	171287
468	219024	102503232	21.6333	7.7639	2.67025	2.13675	1470.3	172021
469	219961	103161709	21.6564	7.7695	2.67117	2.13220	1473.4	172757
470	220900	103823000	21.6795	7.7750	2.67210	2.12766	1476.5	173494
471	221841	104487111	21.7025	7.7805	2.67302	2.12314	1479.7	174234
472	222784	105154048	21.7256	7.7860	2.67394	2.11864	1482.8	174974
473	223729	105823817	21.7486	7.7915	2.67486	2.11416	1486.0	175716
474	224676	106496424	21.7715	7.7970	2.67578	2.10970	1489.1	176460
475	225625	107171875	21.7945	7.8025	2.67669	2.10526	1492.3	177205
476	226576	107850176	21.8174	7.8079	2.67761	2.10084	1495.4	177952
477	227529	108531333	21.8403	7.8134	2.67852	2.09644	1498.5	178701
478	228484	109215352	21.8632	7.8188	2.67943	2.09205	1501.7	179451
479	229441	109902239	21.8861	7.8243	2.68034	2.08768	1504.8	180203
480	230400	110592000	21.9089	7.8297	2.68124	2.08333	1508.0	180956
481	231361	111284641	21.9317	7.8352	2.68215	2.07900	1511.1	181711
482	232324	111980168	21.9545	7.8406	2.68305	2.07469	1514.2	182467
483	233289	112678587	21.9773	7.8460	2.68395	2.07039	1517.4	183225
484	234256	113379904	22.0000	7.8514	2.68485	2.06612	1520.5	183984
485	235225	114084125	22.0227	7.8568	2.68574	2.06186	1523.7	184745
486	236196	114791256	22.0454	7.8622	2.68664	2.05761	1526.8	185508
487	237169	115501303	22.0681	7.8676	2.68753	2.05339	1530.0	186272
488	238144	116214272	22.0907	7.8730	2.68842	2.04918	1533.1	187038
489	239121	116930169	22.1133	7.8784	2.68931	2.04499	1536.2	187805
490	240100	117649000	22.1359	7.8837	2.69020	2.04082	1539.4	188574
491	241081	118370771	22.1585	7.8891	2.69108	2.03666	1542.5	189345
492	242064	119095488	22.1811	7.8944	2.69197	2.03252	1545.7	190117
493	243049	119823157	22.2036	7.8998	2.69285	2.02840	1548.8	190890
494	244036	120553784	22.2261	7.9051	2.69373	2.02429	1551.9	191665
495	245025	121287375	22.2486	7.9105	2.69461	2.02020	1555.1	192442
496	246016	122023936	22.2711	7.9158	2.69548	2.01613	1558.2	193221
497	247009	122763473	22.2935	7.9211	2.69636	2.01207	1561.4	194000
498	248004	123505992	22.3159	7.9264	2.69723	2.00803	1564.5	194782
499	249001	124251499	22.3383	7.9317	2.69810	2.00401	1567.7	195565

FUNCTIONS OF NUMBERS, 500 to 549

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
500	250000	125000000	22.3607	7.9370	2.69897	2.00000	1570.8	196350
501	251001	125751501	22.3830	7.9423	2.69984	1.99601	1573.9	197136
502	252004	126506008	22.4054	7.9476	2.70070	1.99203	1577.1	197923
503	253009	127263527	22.4277	7.9528	2.70157	1.98807	1580.2	198713
504	254016	128024064	22.4499	7.9581	2.70243	1.98413	1583.4	199504
505	255025	128787625	22.4722	7.9634	2.70329	1.98020	1586.5	200296
506	256036	129554216	22.4944	7.9686	2.70415	1.97628	1589.6	201090
507	257049	130323843	22.5167	7.9739	2.70501	1.97239	1592.8	201886
508	258064	131096512	22.5389	7.9791	2.70586	1.96850	1595.9	202683
509	259081	131872229	22.5610	7.9843	2.70672	1.96464	1599.1	203482
510	260100	132651000	22.5832	7.9896	2.70757	1.96078	1602.2	204282
511	261121	133432831	22.6053	7.9948	2.70842	1.95695	1605.4	205084
512	262144	134217728	22.6274	8.0000	2.70927	1.95312	1608.5	205887
513	263169	135005697	22.6495	8.0052	2.71012	1.94932	1611.6	206692
514	264196	135796744	22.6716	8.0104	2.71096	1.94553	1614.8	207499
515	265225	136590875	22.6936	8.0156	2.71181	1.94175	1617.9	208307
516	266256	137388096	22.7156	8.0208	2.71265	1.93798	1621.1	209117
517	267289	138188413	22.7376	8.0260	2.71349	1.93424	1624.2	209928
518	268324	138991832	22.7596	8.0311	2.71433	1.93050	1627.3	210741
519	269361	139798359	22.7816	8.0363	2.71517	1.92678	1630.5	211556
520	270400	140608000	22.8035	8.0415	2.71600	1.92308	1633.6	212372
521	271441	141420761	22.8254	8.0466	2.71684	1.91939	1636.8	213189
522	272484	142236648	22.8473	8.0517	2.71767	1.91571	1639.9	214008
523	273529	143055667	22.8692	8.0569	2.71850	1.91205	1643.1	214829
524	274576	143877824	22.8910	8.0620	2.71933	1.90840	1646.2	215651
525	275625	144703125	22.9129	8.0671	2.72016	1.90476	1649.3	216475
526	276676	145531576	22.9347	8.0723	2.72099	1.90114	1652.5	217301
527	277729	146363183	22.9565	8.0774	2.72181	1.89753	1655.6	218128
528	278784	147197952	22.9783	8.0825	2.72263	1.89394	1658.8	218956
529	279841	148035889	23.0000	8.0876	2.72346	1.89036	1661.9	219787
530	280900	148877000	23.0217	8.0927	2.72428	1.88679	1665.0	220618
531	281961	149721291	23.0434	8.0978	2.72509	1.88324	1668.2	221452
532	283024	150568768	23.0651	8.1028	2.72591	1.87970	1671.3	222287
533	284089	151419437	23.0868	8.1079	2.72673	1.87617	1674.5	223123
534	285156	152273304	23.1084	8.1130	2.72754	1.87266	1677.6	223961
535	286225	153130375	23.1301	8.1180	2.72835	1.86916	1680.8	224801
536	287296	153990656	23.1517	8.1231	2.72916	1.86567	1683.9	225642
537	288369	154854153	23.1733	8.1281	2.72997	1.86220	1687.0	226484
538	289444	155720872	23.1948	8.1332	2.73078	1.85874	1690.2	227329
539	290521	156590819	23.2164	8.1382	2.73159	1.85529	1693.3	228175
540	291600	157464000	23.2379	8.1433	2.73239	1.85185	1696.5	229022
541	292681	158340421	23.2594	8.1483	2.73320	1.84843	1699.6	229871
542	293764	159220088	23.2809	8.1533	2.73400	1.84502	1702.7	230722
543	294849	160103007	23.3024	8.1583	2.73480	1.84162	1705.9	231574
544	295936	160989184	23.3238	8.1633	2.73560	1.83824	1709.0	232428
545	297025	161878625	23.3452	8.1683	2.73640	1.83486	1712.2	233283
546	298116	162771336	23.3666	8.1733	2.73719	1.83150	1715.3	234140
547	299209	163667323	23.3880	8.1783	2.73799	1.82815	1718.5	234998
548	300304	164566592	23.4094	8.1833	2.73878	1.82482	1721.6	235858
549	301401	165469149	23.4307	8.1882	2.73957	1.82149	1724.7	236720

FUNCTIONS OF NUMBERS, 550 to 599

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
550	302500	166375000	23.4521	8.1932	2.74036	1.81818	1727.9	237583
551	303601	167284151	23.4734	8.1982	2.74115	1.81488	1731.0	238448
552	304704	168196608	23.4947	8.2031	2.74194	1.81159	1734.2	239314
553	305809	169112377	23.5160	8.2081	2.74273	1.80832	1737.3	240182
554	306916	170031464	23.5372	8.2130	2.74351	1.80505	1740.4	241051
555	308025	170953875	23.5584	8.2180	2.74429	1.80180	1743.6	241922
556	309136	171879616	23.5797	8.2229	2.74507	1.79856	1746.7	242795
557	310249	172808693	23.6008	8.2278	2.74586	1.79533	1749.9	243669
558	311364	173741112	23.6220	8.2327	2.74663	1.79211	1753.0	244545
559	312481	174676879	23.6432	8.2377	2.74741	1.78891	1756.2	245422
560	313600	175616000	23.6643	8.2426	2.74819	1.78571	1759.3	246301
561	314721	176558481	23.6854	8.2475	2.74896	1.78253	1762.4	247181
562	315844	177504328	23.7065	8.2524	2.74974	1.77936	1765.6	248063
563	316969	178453547	23.7276	8.2573	2.75051	1.77620	1768.7	248947
564	318096	179406144	23.7487	8.2621	2.75128	1.77305	1771.9	249832
565	319225	180362125	23.7697	8.2670	2.75205	1.76991	1775.0	250719
566	320356	181321496	23.7908	8.2719	2.75282	1.76678	1778.1	251607
567	321489	182284263	23.8118	8.2768	2.75358	1.76367	1781.3	252497
568	322624	183250432	23.8328	8.2816	2.75435	1.76056	1784.4	253388
569	323761	184220009	23.8537	8.2865	2.75511	1.75747	1787.6	254281
570	324900	185193000	23.8747	8.2913	2.75587	1.75439	1790.7	255176
571	326041	186169411	23.8956	8.2962	2.75664	1.75131	1793.8	256072
572	327184	187149248	23.9165	8.3010	2.75740	1.74825	1797.0	256970
573	328329	188132517	23.9374	8.3059	2.75815	1.74520	1800.1	257869
574	329476	189119224	23.9583	8.3107	2.75891	1.74216	1803.3	258770
575	330625	190109375	23.9792	8.3155	2.75967	1.73913	1806.4	259672
576	331776	191102976	24.0000	8.3203	2.76042	1.73611	1809.6	260576
577	332929	192100033	24.0208	8.3251	2.76118	1.73310	1812.7	261482
578	334084	193100552	24.0416	8.3300	2.76193	1.73010	1815.8	262389
579	335241	194104539	24.0624	8.3348	2.76268	1.72712	1819.0	263298
580	336400	195112000	24.0832	8.3396	2.76343	1.72414	1822.1	264208
581	337561	196122941	24.1039	8.3443	2.76418	1.72117	1825.3	265120
582	338724	197137368	24.1247	8.3491	2.76492	1.71821	1828.4	266033
583	339889	198155287	24.1454	8.3539	2.76567	1.71527	1831.6	266948
584	341056	199176704	24.1661	8.3587	2.76641	1.71233	1834.7	267865
585	342225	200201625	24.1868	8.3634	2.76716	1.70940	1837.8	268783
586	343396	201230056	24.2074	8.3682	2.76790	1.70648	1841.0	269703
587	344569	202262003	24.2281	8.3730	2.76864	1.70358	1844.1	270624
588	345744	203297472	24.2487	8.3777	2.76938	1.70068	1847.3	271547
589	346921	204336469	24.2693	8.3825	2.77012	1.69779	1850.4	272471
590	348100	205379000	24.2899	8.3872	2.77085	1.69492	1853.5	273397
591	349281	206425071	24.3105	8.3919	2.77159	1.69205	1856.7	274325
592	350464	207474688	24.3311	8.3967	2.77232	1.68919	1859.8	275254
593	351649	208527857	24.3516	8.4014	2.77305	1.68634	1863.0	276184
594	352836	209584584	24.3721	8.4061	2,77379	1.68350	1866.1	277117
595	354025	210644875	24.3926	8.4108	2.77452	1.68067	1869.2	278051
596	355216	211708736	24.4131	8.4155	2.77525	1.67785	1872.4	278986
597	356409	212776173	24.4336	8.4202	2.77597	1.67504	1875.5	279923
598	357604	213847192	24.4540	8.4249	2.77670	1.67224	1878.7	280862
599	358801	214921799	24.4745	8.4296	2.77743	1.66945	1881.8	281802

FUNCTIONS OF NUMBERS, 600 to 649

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
600	360000	216000000	24.4949	8.4343	2.77815	1.66667	1885.0	282743
601	361201	217081801	24.5153	8.4390	2.77887	1.66389	1888.1	283687
602	362404	218167208	24.5357	8.4437	2.77960	1.66113	1891.2	284631
603	363609	219256227	24.5561	8.4484	2.78032	1.65837	1894.4	285578
604	364816	220348864	24.5764	8.4530	2.78104	1.65563	1897.5	286526
605	366025	221445125	24.5967	8.4577	2.78176	1.65289	1900.7	287475
606	367236	222545016	24.6171	8.4623	2.78247	1.65017	1903.8	288426
607	368449	223648543	24.6374	8.4670	2.78319	1.64745	1906.9	289379
608	369664	224755712	24.6577	8.4716	2.78390	1.64474	1910.1	290333
609	370881	225866529	24.6779	8.4763	2.78462	1.64204	1913.2	291289
610	372100	226981000	24.6982	8.4809	2.78533	1.63934	1916.4	292247
611	373321	228099131	24.7184	8.4856	2.78604	1.63666	1919.5	293206
612	374544	229220928	24.7386	8.4902	2.78675	1.63399	1922.7	294166
613	375769	230346397	24.7588	8.4948	2.78746	1.63132	1925.8	295128
614	376996	231475544	24.7790	8.4994	2.78817	1.62866	1928.9	296092
615	378225	232608375	24.7992	8.5040	2.78888	1.62602	1932.1	297057
616	379456	233744896	24.8193	8.5086	2.78958	1.62338	1935.2	298024
617	380689	234885113	24.8395	8.5132	2.79029	1.62075	1938.4	298992
618	381924	236029032	24.8596	8.5178	2.79099	1.61812	1941.5	299962
619	383161	237176659	24.8797	8.5224	2.79169	1.61551	1944.6	300934
620	384400	238328000	24.8998	8.5270	2.79239	1.61290	1947.8	301907
621	385641	239483061	24.9199	8.5316	2.79309	1.61031	1950.9	302882
622	386884	240641848	24.9399	8.5362	2.79379	1.60772	1954.1	303858
623	388129	241804367	24.9600	8.5408	2.79449	1.60514	1957.2	304836
624	389376	242970624	24.9800	8.5453	2.79518	1.60256	1960.4	305815
625	390625	244140625	25.0000	8.5499	2.79588	1.60000	1963.5	306796
626	391876	245314376	25.0200	8.5544	2.79657	1.59744	1966.6	307779
627	393129	246491883	25.0400	8.5590	2.79727	1.59490	1969.8	308763
628	394384	247673152	25.0599	8.5635	2.79796	1.59236	1972.9	309748
629	395641	248858189	25.0799	8.5681	2.79865	1.58983	1976.1	310736
630	396900	250047000	25.0998	8.5726	2.79934	1.58730	1979.2	311725
631	398161	251239591	25.1197	8.5772	2.80003	1.58479	1982.3	312715
632	399424	252435968	25.1396	8.5817	2.80072	1.58228	1985.5	313707
633	400689	253636137	25.1595	8.5862	2.80140	1.57978	1988.6	314700
634	401956	254840104	25.1794	8.5907	2.80209	1.57729	1991.8	315696
635	403225	256047875	25.1992	8.5952	2.80277	1.57480	1994.9	316692
636	404496	257259456	25.2190	8.5997	2.80346	1.57233	1998.1	317690
637	405769	258474853	25.2389	8.6043	2.80414	1.56986	2001.2	318690
638	407044	259694072	25.2587	8.6088	2.80482	1.56740	2004.3	319692
639	408321	260917119	25.2784	8.6132	2.80550	1.56495	2007.5	320695
640	409600	262144000	25.2982	8.6177	2.80618	1.56250	2010.6	321699
641	410881	263374721	25.3180	8.6222	2.80686	1.56006	2013.8	322705
642	412164	264609288	25.3377	8.6267	2.80754	1.55763	2016.9	323713
643	413449	265847707	25.3574	8.6312	2.80821	1.55521	2020.0	324722
644	414736	267089984	25.3772	8.6357	2.80889	1.55280	2023.2	325733
645	416025	268336125	25.3969	8.6401	2.80956	1.55039	2026.3	326745
646	417316	269586136	25.4165	8.6446	2.81023	1.54799	2029.5	327759
647	418609	270840023	25.4362	8.6490	2.81090	1.54560	2032.6	328775
648	419904	272097792	25.4558	8.6535	2.81158	1.54321	2035.8	329792
649	421201	273359449	25.4755	8.6579	2.81224	1.54083	2038.9	330810

FUNCTIONS OF NUMBERS, 650 to 699

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
650	422500	274625000	25.4951	8.6624	2.81291	1.53846	2042.0	331831
651	423801	275894451	25.5147	8.6668	2.81358	1.53610	2045.2	332853
652	425104	277167808	25.5343	8.6713	2.81425	1.53374	2048.3	333876
653	426409	278445077	25.5539	8.6757	2.81491	1.53139	2051.5	334901
654	427716	279726264	25.5734	8.6801	2.81558	1.52905	2054.6	335927
655	429025	281011375	25.5930	8.6845	2.81624	1.52672	2057.7	336955
656	430336	282300416	25.6125	8.6890	2.81690	1.52439	2060.9	337985
657	431649	283593393	25.6320	8.6934	2.81757	1.52207	2064.0	339016
658	432964	284890312	25.6515	8.6978	2.81823	1.51976	2067.2	340049
659	434281	286191179	25.6710	8.7022	2.81889	1.51745	2070.3	341084
660	435600	287496000	25.6905	8.7066	2.81954	1.51515	2073.5	342119
661	436921	288804781	25.7099	8.7110	2.82020	1.51286	2076.6	343157
662	438244	290117528	25.7294	8.7154	2.82086	1.51057	2079.7	344196
663	439569	291434247	25.7488	8.7198	2.82151	1.50830	2082.9	345237
664	440896	292754944	25.7682	8.7241	2.82217	1.50602	2086.0	346279
665	442225	294079625	25.7876	8.7285	2.82282	1.50376	2089.2	347323
666	443556	295408296	25.8070	8.7329	2.82347	1.50150	2092.3	348368
667	444889	296740963	25.8263	8.7373	2.82413	1.49925	2095.4	349415
668	446224	298077632	25.8457	8.7416	2.82478	1.49701	2098.6	350464
669	447561	299418309	25.8650	8.7460	2.82543	1.49477	2101.7	351514
670	448900	300763000	25.8844	8.7503	2.82607	1.49254	2104.9	352565
671	450241	302111711	25.9037	8.7547	2.82672	1.49031	2108.0	353618
672	451584	303464448	25.9230	8.7590	2.82737	1.48810	2111.2	354673
673	452929	304821217	25.9422	8.7634	2.82802	1.48588	2114.3	355730
674	454276	306182024	25.9615	8.7677	2.82866	1.48368	2117.4	356788
675	455625	307546875	25.9808	8.7721	2.82930	1.48148	2120.6	357847
676	456976	308915776	26.0000	8.7764	2.82995	1.47929	2123.7	358908
677	458329	310288733	26.0192	8.7807	2.83059	1.47710	2126.9	359971
678	459684	311665752	26.0384	8.7850	2.83123	1.47493	2130.0	361035
679	461041	313046839	26.0576	8.7893	2.83187	1.47275	2133.1	362101
680	462400	314432000	26.0768	8.7937	2.83251	1.47059	2136.3	363168
681	463761	315821241	26.0960	8.7980	2.83315	1.46843	2139.4	364237
682	465124	317214568	26.1151	8.8023	2.83378	1.46628	2142.6	365308
683	466489	318611987	26.1343	8.8066	2.83442	1.46413	2145.7	366380
684	467856	320013504	26.1534	8.8109	2.83506	1.46199	2148.8	367453
685	469225	321419125	26.1725	8.8152	2.83569	1.45985	2152.0	368528
686	470596	322828856	26.1916	8.8194	2.83632	1.45773	2155.1	369605
687	471969	324242703	26.2107	8.8237	2.83696	1.45560	2158.3	370684
688	473344	325660672	26.2298	8.8280	2.83759	1.45349	2161.4	371764
689	474721	327082769	26.2488	8.8323	2.83822	1.45138	2164.6	372845
690	476100	328509000	26.2679	8.8366	2.83885	1.44928	2167.7	373928
691	477481	329939371	26.2869	8.8408	2.83948	1.44718	2170.8	375013
692	478864	331373888	26.3059	8.8451	2.84011	1.44509	2174.0	376099
693	480249	332812557	26.3249	8.8493	2.84073	1.44300	2177.1	377187
694	481636	334255384	26.3439	8.8536	2.84136	1.44092	2180.3	378276
695	483025	335702375	26.3629	8.8578	2.84198	1.43885	2183.4	379367
696	484416	337153536	26.3818	8.8621	2.84261	1.43678	2186.5	380459
697	485809	338608873	26.4008	8.8663	2.84323	1.43472	2189.7	381553
698	487204	340068392	26.4197	8.8706	2.84386	1.43266	2192.8	382649
699	488601	341532099	26.4386	8.8748	2.84448	1.43062	2196.0	383746

FUNCTIONS OF NUMBERS, 700 to 749

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
700	490000	343000000	26.4575	8.8790	2.84510	1.42857	2199.1	384845
701	491401	344472101	26.4764	8.8833	2.84572	1.42653	2202.3	385945
702	492804	345948408	26.4953	8.8875	2.84634	1.42450	2205.4	387047
703	494209	347428927	26.5141	8.8917	2.84696	1.42248	2208.5	388151
704	495616	348913664	26.5330	8.8959	2.84757	1.42045	2211.7	389256
705	497025	350402625	26.5518	8.9001	2.84819	1.41844	2214.8	390363
706	498436	351895816	26.5707	8.9043	2.84880	1.41643	2218.0	391471
707	499849	353393243	26.5895	8.9085	2.84942	1.41443	2221.1	392580
708	501264	354894912	26.6083	8.9127	2.85003	1.41243	2224.2	393692
709	502681	356400829	26.6271	8.9169	2.85065	1.41044	2227.4	394805
710	504100	357911000	26.6458	8.9211	2.85126	1.40845	2230.5	395919
711	505521	359425431	26.6646	8.9253	2.85187	1.40647	2233.7	397035
712	506944	360944128	26.6833	8.9295	2.85248	1.40449	2236.8	398153
713	508369	362467097	26.7021	8.9337	2.85309	1.40252	2240.0	399272
714	509796	363994344	26.7208	8.9378	2.85370	1.40056	2243.1	400393
715	511225	365525875	26.7395	8.9420	2.85431	1.39860	2246.2	401515
716	512656	367061696	26.7582	8.9462	2.85491	1.39665	2249.4	402639
717	514089	368601813	26.7769	8.9503	2.85552	1.39470	2252.5	403765
718	515524	370146232	26.7955	8.9545	2.85612	1.39276	2255.7	404892
719	516961	371694959	26.8142	8.9587	2.85673	1.39082	2258.8	406020
720	518400	373248000	26.8328	8.9628	2.85733	1.38889	2261.9	407150
721	519841	374805361	26.8514	8.9670	2.85794	1.38696	2265.1	408282
722	521284	376367048	26.8701	8.9711	2.85854	1.38504	2268.2	409415
723	522729	377933067	26.8887	8.9752	2.85914	1.38313	2271.4	410550
724	524176	379503424	26.9072	8.9794	2.85974	1.38122	2274.5	411687
725	525625	381078125	26.9258	8.9835	2.86034	1.37931	2277.7	412825
726	527076	382657176	26.9444	8.9876	2.86094	1.37741	2280.8	413965
727	528529	384240583	26.9629	8.9918	2.86153	1.37552	2283.9	415106
728	529984	385828352	26.9815	8.9959	2.86213	1.37363	2287.1	416248
729	531441	387420489	27.0000	9.0000	2.86273	1.37174	2290.2	417393
730	532900	389017000	27.0185	9.0041	2.86332	1.36986	2293.4	418539
731	534361	390617891	27.0370	9.0082	2.86392	1.36799	2296.5	419686
732	535824	392223168	27.0555	9.0123	2.86451	1.36612	2299.6	420835
733	537289	393832837	27.0740	9.0164	2.86510	1.36426	2302.8	421986
734	538756	395446904	27.0924	9.0205	2.86570	1.36240	2305.9	423138
735	540225	397065375	27.1109	9.0246	2.86629	1.36054	2309.1	424293
736	541696	398688256	27.1293	9.0287	2.86688	1.35870	2312.2	425447
737	543169	400315553	27.1477	9.0328	2.86747	1.35685	2315.4	426604
738	544644	401947272	27.1662	9.0369	2.86806	1.35501	2318.5	427762
739	546121	403583419	27.1846	9.0410	2.86864	1.35318	2321.6	428922
740	547600	405224000	27.2029	9.0450	2.86923	1.35135	2324.8	430084
741	549081	406869021	27.2213	9.0491	2.86982	1.34953	2327.9	431247
742	550564	408518488	27.2397	9.0532	2.87040	1.34771	2331.1	432412
743	552049	410172407	27.2580	9.0572	2.87099	1.34590	2334.2	433578
744	553536	411830784	27.2764	9.0613	2.87157	1.34409	2337.3	434746
745	555025	413493625	27.2947	9.0654	2.87216	1.34228	2340.5	435916
746	556516	415160936	27.3130	9.0694	2.87274	1.34048	2343.6	437087
747	558009	416832723	27.3313	9.0735	2.87332	1.33869	2346.8	438259
748	559504	418508992	27.3496	9.0775	2.87390	1.33690	2349.9	439433
749	561001	420189749	27.3679	9.0816	2.87448	1.33511	2353.1	440609

FUNCTIONS OF NUMBERS, 750 to 799

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
750	562500	421875000	27.3861	9.0856	2.87506	1.33333	2356.2	441786
751	564001	423564751	27.4044	9.0896	2.87564	1.33156	2359.3	442965
752	565504	425259008	27.4226	9.0937	2.87622	1.32979	2362.5	444146
753	567009	426957777	27.4408	9.0977	2.87680	1.32802	2365.6	445328
754	568516	428661064	27.4591	9.1017	2.87737	1.32626	2368.8	446511
755	570025	430368875	27.4773	9.1057	2.87795	1.32450	2371.9	447697
756	571536	432081216	27.4955	9.1098	2.87852	1.32275	2375.0	448883
757	573049	433798093	27.5136	9.1138	2.87910	1.32100	2378.2	450072
758	574564	435519512	27.5318	9.1178	2.87967	1.31926	2381.3	451262
759	576081	437245479	27.5500	9.1218	2.88024	1.31752	2384.5	452453
760	577600	438976000	27.5681	9.1258	2.88081	1.31579	2387.6	453646
761	579121	440711081	27.5862	9.1298	2.88138	1.31406	2390.8	454841
762	580644	442450728	27.6043	9.1338	2.88196	1.31234	2393.9	456037
763	582169	444194947	27.6225	9.1378	2.88252	1.31062	2397.0	457234
764	583696	445943744	27.6405	9.1418	2.88309	1.30890	2400.2	458434
765	585225	447697125	27.6586	9.1458	2.88366	1.30719	2403.3	459635
766	586756	449455096	27.6767	9.1498	2.88423	1.30548	2406.5	460837
767	588289	451217663	27.6948	9.1537	2.88480	1.30378	2409.6	462041
768	589824	452984832	27.7128	9.1577	2.88536	1.30208	2412.7	463247
769	591361	454756609	27.7308	9.1617	2.88593	1.30039	2415.9	464454
770	592900	456533000	27.7489	9.1657	2.88649	1.29870	2419.0	465663
771	594441	458314011	27.7669	9.1696	2.88705	1.29702	2422.2	466873
772	595984	460099648	27.7849	9.1736	2.88762	1.29534	2425.3	468085
773	597529	461889917	27.8029	9.1775	2.88818	1.29366	2428.5	469298
774	599076	463684824	27.8209	9.1815	2.88874	1.29199	2431.6	470513
775	600625	465484375	27.8388	9.1855	2.88930	1.29032	2434.7	471730
776	602176	467288576	27.8568	9.1894	2.88986	1.28866	2437.9	472948
777	603729	469097433	27.8747	9.1933	2.89042	1.28700	2441.0	474168
778	605284	470910952	27.8927	9.1973	2.89098	1.28535	2444.2	475389
779	606841	472729139	27.9106	9.2012	2.89154	1.28370	2447.3	476612
780	608400	474552000	27.9285	9.2052	2.89209	1.28205	2450.4	477836
781	609961	476379541	27.9464	9.2091	2.89265	1.28041	2453.6	479062
782	611524	478211768	27.9643	9.2130	2.89321	1.27877	2456.7	480290
783	613089	480048687	27.9821	9.2170	2.89376	1.27714	2459.9	481519
784	614656	481890304	28.0000	9.2209	2.89432	1.27551	2463.0	482750
785	616225	483736625	28.0179	9.2248	2.89487	1.27389	2466.2	483982
786	617796	485587656	28.0357	9.2287	2.89542	1.27226	2469.3	485216
787	619369	487443403	28.0535	9.2326	2.89597	1.27065	2472.4	486451
788	620944	489303872	28.0713	9.2365	2.89653	1.26904	2475.6	487688
789	622521	491169069	28.0891	9.2404	2.89708	1.26743	2478.7	488927
790	624100	493039000	28.1069	9.2443	2.89763	1.26582	2481.9	490167
791	625681	494913671	28.1247	9.2482	2.89818	1.26422	2485.0	491409
792	627264	496793088	28.1425	9.2521	2.89873	1.26263	2488.1	492652
793	628849	498677257	28.1603	9.2560	2.89927	1.26103	2491.3	493897
794	630436	500566184	28.1780	9.2599	2.89982	1.25945	2494.4	495143
795	632025	502459875	28.1957	9.2638	2.90037	1.25786	2497.6	496391
796	633616	504358336	28.2135	9.2677	2.90091	1.25628	2500.7	497641
797	635209	506261573	23.2312	9.2716	2.90146	1.25471	2503.8	498892
798	636804	508169592	28.2489	9.2754	2.90200	1.25313	2507.0	500145
799	638401	510082399	28.2666	9.2793	2.90255	1.25156	2510.1	501399

FUNCTIONS OF NUMBERS, 800 to 849

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
800	640000	512000000	28.2843	9.2832	2.90309	1.25000	2513.3	502655
801	641601	513922401	28.3019	9.2870	2.90363	1.24844	2516.4	503912
802	643204	515849608	28.3196	9.2909	2.90417	1.24688	2519.6	505171
803	644809	517781627	28.3373	9.2948	2.90472	1.24533	2522.7	506432
804	646416	519718464	28.3549	9.2986	2.90526	1.24378	2525.8	507694
805	648025	521660125	28.3725	9.3025	2.90580	1.24224	2529.0	508958
806	649636	523606616	28.3901	9.3063	2.90634	1.24069	2532.1	510223
807	651249	525557943	28.4077	9.3102	2.90687	1.23916	2535.3	511490
808	652864	527514112	28.4253	9.3140	2.90741	1.23762	2538.4	512758
809	654481	529475129	28.4429	9.3179	2.90795	1.23609	2541.5	514028
810	656100	531441000	28.4605	9.3217	2.90849	1.23457	2544.7	515300
811	657721	533411731	28.4781	9.3255	2.90902	1.23305	2547.8	516573
812	659344	535387328	28.4956	9.3294	2.90956	1.23153	2551.0	517848
813	660969	537367797	28.5132	9.3332	2.91009	1.23001	2554.1	519124
814	662596	539353144	28.5307	9.3370	2.91062	1.22850	2557.3	520402
815	664225	541343375	28.5482	9.3408	2.91116	1.22699	2560.4	521681
816	665856	543338496	28.5657	9.3447	2.91169	1.22549	2563.5	522962
817	667489	545338513	28.5832	9.3485	2.91222	1.22399	2566.7	524245
818	669124	547343432	28.6007	9.3523	2.91275	1.22249	2569.8	525529
819	670761	549353259	28.6182	9.3561	2.91328	1.22100	2573.0	526814
820	672400	551368000	28.6356	9.3599	2.91381	1.21951	2576.1	528102
821	674041	553387661	28.6531	9.3637	2.91434	1.21803	2579.2	529391
822	675684	555412248	28.6705	9.3675	2.91487	1.21655	2582.4	530681
823	677329	557441767	28.6880	9.3713	2.91540	1.21507	2585.5	531973
824	678976	559476224	28.7054	9.3751	2.91593	1.21359	2588.7	533267
825	680625	561515625	28.7228	9.3789	2.91645	1.21212	2591.8	534562
826	682276	563559976	28.7402	9.3827	2.91698	1.21065	2595.0	535858
827	683929	565609283	28.7576	9.3865	2.91751	1.20919	2598.1	537157
828	685584	567663552	28.7750	9.3902	2.91803	1.20773	2601.2	538456
829	687241	569722789	28.7924	9.3940	2.91855	1.20627	2604.4	539758
830	688900	571787000	28.8097	9.3978	2.91908	1.20482	2607.5	541061
831	690561	573856191	28.8271	9.4016	2.91960	1.20337	2610.7	542365
832	692224	575930368	28.8444	9.4053	2.92012	1.20192	2613.8	543671
833	693889	578009537	28.8617	9.4091	2.92065	1.20048	2616.9	544979
834	695556	580093704	28.8791	9.4129	2.92117	1.19904	2620.1	546288
835	697225	582182875	28.8964	9.4166	2.92169	1.19760	2623.2	547599
836	698896	584277056	28.9137	9.4204	2.92221	1.19617	2626.4	548912
837	700569	586376253	28.9310	9.4241	2.92273	1.19474	2629.5	550226
838	702244	588480472	28.9482	9.4279	2.92324	1.19332	2632.7	551541
839	703921	590589719	28.9655	9.4316	2.92376	1.19190	2635.8	552858
840	705600	592704000	28.9828	9.4354	2.92428	1.19048	2638.9	554177
841	707281	594823321	29.0000	9.4391	2.92480	1.18906	2642.1	555497
842	708964	596947688	29.0172	9.4429	2.92531	1.18765	2645.2	556819
843	710649	599077107	29.0345	9.4466	2.92583	1.18624	2648.4	558142
844	712336	601211584	29.0517	9.4503	2.92634	1.18483	2651.5	559467
845	714025	603351125	29.0689	9.4541	2.92686	1.18343	2654.6	560794
846	715716	605495736	29.0861	9.4578	2.92737	1.18203	2657.8	562122
847	717409	607645423	29.1033	9.4615	2.92788	1.18064	2660.9	563452
848	719104	609800192	29.1204	9.4652	2.92840	1.17925	2664.1	564783
849	720801	611960049	29.1376	9.4690	2.92891	1.17786	2667.2	566116

FUNCTIONS OF NUMBERS, 850 to 899

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	Area
850	722500	614125000	29.1548	9.4727	2.92942	1.17647	2670.4	567450
851	724201	616295051	29.1719	9.4764	2.92993	1.17509	2673.5	568786
852	725904	618470208	29.1890	9.4801	2.93044	1.17371	2676.6	570124
853	727609	620650477	29.2062	9.4838	2.93095	1.17233	2679.8	571463
854	729316	622835864	29.2233	9.4875	2.93146	1.17096	2682.9	572803
855	731025	625026375	29.2404	9.4912	2.93197	1.16959	2686.1	574146
856	732736	627222016	29.2575	9.4949	2.93247	1.16822	2689.2	575490
857	734449	629422793	29.2746	9.4986	2.93298	1.16686	2692.3	576835
858	736164	631628712	29.2916	9.5023	2.93349	1.16550	2695.5	578182
859	737881	633839779	29.3087	9.5060	2.93399	1.16414	2698.6	579530
860	739600	636056000	29.3258	9.5097	2.93450	1.16279	2701.8	580880
861	741321	638277381	29.3428	9.5134	2.93500	1.16144	2704.9	582232
862	743044	640503928	29.3598	9.5171	2.93551	1.16009	2708.1	583585
863	744769	642735647	29.3769	9.5207	2.93601	1.15875	2711.2	584940
864	746496	644972544	29.3939	9.5244	2.93651	1.15741	2714.3	586297
865	748225	647214625	29.4109	9.5281	2.93702	1.15607	2717.5	587655
866	749956	649461896	29.4279	9.5317	2.93752	1.15473	2720.6	589014
867	751689	651714363	29.4449	9.5354	2.93802	1.15340	2723.8	590375
868	753424	653972032	29.4618	9.5391	2.93852	1.15207	2726.9	591738
869	755161	656234909	29.4788	9.5427	2.93902	1.15075	2730.0	593102
870	756900	658503000	29.4958	9.5464	2.93952	1.14943	2733.2	594468
871	758641	660776311	29.5127	9.5501	2.94002	1.14811	2736.3	595835
872	760384	663054848	29.5296	9.5537	2.94052	1.14679	2739.5	597204
873	762129	665338617	29.5466	9.5574	2.94101	1.14548	2742.6	598575
874	763876	667627624	29.5635	9.5610	2.94151	1.14416	2745.8	599947
875	765625	669921875	29.5804	9.5647	2.94201	1.14286	2748.9	601320
876	767376	672221376	29.5973	9.5683	2.94250	1.14155	2752.0	602696
877	769129	674526133	29.6142	9.5719	2.94300	1.14025	2755.2	604073
878	770884	676836152	29.6311	9.5756	2.94349	1.13895	2758.3	605451
879	772641	679151439	29.6479	9.5792	2.94399	1.13766	2761.5	606831
880	774400	681472000	29.6648	9.5828	2.94448	1.13636	2764.6	608212
881	776161	683797841	29.6816	9.5865	2.94498	1.13507	2767.7	609595
882	777924	686128968	29.6985	9.5901	2.94547	1.13379	2770.9	610980
883	779689	688465387	29.7153	9.5937	2.94596	1.13250	2774.0	612366
884	781456	690807104	29.7321	9.5973	2.94645	1.13122	2777.2	613754
885	783225	693154125	29.7489	9.6010	2.94694	1.12994	2780.3	615143
886	784996	695506456	29.7658	9.6046	2.94743	1.12867	2783.5	616534
887	786769	697864103	29.7825	9.6082	2.94792	1.12740	2786.6	617927
888	788544	700227072	29.7993	9.6118	2.94841	1.12613	2789.7	619321
889	790321	702595369	29.8161	9.6154	2.94890	1.12486	2792.9	620717
890	792100	704969000	29.8329	9.6190	2.94939	1.12360	2796.0	622114
891	793881	707347971	29.8496	9.6226	2.94988	1.12233	2799.2	623513
892	795664	709732288	29.8664	9.6262	2.95036	1.12108	2802.3	624913
893	797449	712121957	29.8831	9.6298	2.95085	1.11982	2805.4	626315
894	799236	714516984	29.8998	9.6334	2.95134	1.11857	2808.6	627718
895	801025	716917375	29.9166	9.6370	2.95182	1.11732	2811.7	629124
896	802816	719323136	29.9333	9.6406	2.95231	1.11607	2814.9	630530
897	804609	721734273	29.9500	9.6442	2.95279	1.11483	2818.0	631938
898	806404	724150792	29.9666	9.6477	2.95328	1.11359	2821.2	633348
899	808201	726572699	29.9833	9.6513	2.95376	1.11235	2824.3	634760

FUNCTIONS OF NUMBERS, 900 to 949

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
900	810000	729000000	30.0000	9.6549	2.95424	1.11111	2827.4	636173
901	811801	731432701	30.0167	9.6585	2.95472	1.10988	2830.6	637587
902	813604	733870808	30.0333	9.6620	2.95521	1.10865	2833.7	639003
903	815409	736314327	30.0500	9.6656	2.95569	1.10742	2836.9	640421
904	817216	738763264	30.0666	9.6692	2.95617	1.10619	2840.0	641840
905	819025	741217625	30.0832	9.6727	2.95665	1.10497	2843.1	643261
906	820836	743677416	30.0998	9.6763	2.95713	1.10375	2846.3	644683
907	822649	746142643	30.1164	9.6799	2.95761	1.10254	2849.4	646107
908	824464	748613312	30.1330	9.6834	2.95809	1.10132	2852.6	647533
909	826281	751089429	30.1496	9.6870	2.95856	1.10011	2855.7	648960
910	828100	753571000	30.1662	9.6905	2.95904	1.09890	2858.8	650388
911	829921	756058031	30.1828	9.6941	2.95952	1.09769	2862.0	651818
912	831744	758550528	30.1993	9.6976	2.95999	1.09649	2865.1	653250
913	833569	761048497	30.2159	9.7012	2.96047	1.09529	2868.3	654684
914	835396	763551944	30.2324	9.7047	2.96095	1.09409	2871.4	656118
915	837225	766060875	30.2490	9.7082	2.96142	1.09290	2874.6	657555
916	839056	768575296	30.2655	9.7118	2.96190	1.09170	2877.7	658993
917	840889	771095213	30.2820	9.7153	2.96237	1.09051	2880.8	660433
918	842724	773620632	30.2985	9.7188	2.96284	1.08932	2884.0	661874
919	844561	776151559	30.3150	9.7224	2.96332	1.08814	2887.1	663317
920	846400	778688000	30.3315	9.7259	2.96379	1.08696	2890.3	664761
921	848241	781229961	30.3480	9.7294	2.96426	1.08578	2893.4	666207
922	850084	783777448	30.3645	9.7329	2.96473	1.08460	2896.5	667654
923	851929	786330467	30.3809	9.7364	2.96520	1.08342	2899.7	669103
924	853776	788889024	30.3974	9.7400	2.96567	1.08225	2902.8	670554
925	855625	791453125	30.4138	9.7435	2.96614	1.08108	2906.0	672006
926	857476	794022776	30.4302	9.7470	2.96661	1.07991	2909.1	673460
927	859329	796597983	30.4467	9.7505	2.96708	1.07875	2912.3	674915
928	861184	799178752	30.4631	9.7540	2.96755	1.07759	2915.4	676372
929	863041	801765089	30.4795	9.7575	2.96802	1.07643	2918.5	677831
930	864900	804357000	30.4959	9.7610	2.96848	1.07527	2921.7	679291
931	866761	806954491	30.5123	9.7645	2.96895	1.07411	2924.8	680752
932	868624	809557568	30.5287	9.7680	2.96942	1.07296	2928.0	682216
933	870489	812166237	30.5450	9.7715	2.96988	1.07181	2931.1	683680
934	872356	814780504	30.5614	9.7750	2.97035	1.07066	2934.2	685147
935	874225	817400375	30.5778	9.7785	2.97081	1.06952	2937.4	686615
936	876096	820025856	30.5941	9.7819	2.97128	1.06838	2940.5	688084
937	877969	822656953	30.6105	9.7854	2.97174	1.06724	2943.7	689555
938	879844	825293672	30.6268	9.7889	2.97220	1.06610	2946.8	691028
939	881721	827936019	30.6431	9.7924	2.97267	1.06496	2950.0	692502
940	883600	830584000	30.6594	9.7959	2.97313	1.06383	2953.1	693978
941	885481	833237621	30.6757	9.7993	2.97359	1.06270	2956.2	695455
942	887364	835896888	30.6920	9.8028	2.97405	1.06157	2959.4	696934
943	889249	838561807	30.7083	9.8063	2.97451	1.06045	2962.5	698415
944	891136	841232384	30.7246	9.8097	2.97497	1.05932	2965.7	699897
945	893025	843908625	30.7409	9.8132	2.97543	1.05820	2968.8	701380
946	894916	846590536	30.7571	9.8167	2.97589	1.05708	2971.9	702865
947	896809	849278123	30.7734	9.8201	2.97635	1.05597	2975.1	704352
948	898704	851971392	30.7896	9.8236	2.97681	1.05485	2978.2	705840
949	900601	854670349	30.8058	9.8270	2.97727	1.05374	2981.4	707330

FUNCTIONS OF NUMBERS, 950 to 999

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 x Reciprocal	No. = Diameter Circum.	No. = Diameter Area
950	902500	857375000	30.8221	9.8305	2.97772	1.05263	2984.5	708822
951	904401	860085351	30.8383	9.8339	2.97818	1.05152	2987.7	710315
952	906304	862801408	30.8545	9.8374	2.97864	1.05042	2990.8	711809
953	908209	865523177	30.8707	9.8408	2.97909	1.04932	2993.9	713306
954	910116	868250664	30.8869	9.8443	2.97955	1.04822	2997.1	714803
955	912025	870983875	30.9031	9.8477	2.98000	1.04712	3000.2	716303
956	913936	873722816	30.9192	9.8511	2.98046	1.04603	3003.4	717804
957	915849	876467493	30.9354	9.8546	2.98091	1.04493	3006.5	719306
958	917764	879217912	30.9516	9.8580	2.98137	1.04384	3009.6	720810
959	919681	881974079	30.9677	9.8614	2.98182	1.04275	3012.8	722316
960	921600	884736000	30.9839	9.8648	2.98227	1.04167	3015.9	723823
961	923521	887503681	31.0000	9.8683	2.98272	1.04058	3019.1	725332
962	925444	890277128	31.0161	9.8717	2.98318	1.03950	3022.2	726842
963	927369	893056347	31.0322	9.8751	2.98363	1.03842	3025.4	728354
964	929296	895841344	31.0483	9.8785	2.98408	1.03734	3028.5	729867
965	931225	898632125	31.0644	9.8819	2.98453	1.03627	3031.6	731382
966	933156	901428696	31.0805	9.8854	2.98498	1.03520	3034.8	732899
967	935089	904231063	31.0966	9.8888	2.98543	1.03413	3037.9	734417
968	937024	907039232	31.1127	9.8922	2.98588	1.03306	3041.1	735937
969	938961	909853209	31.1288	9.8956	2.98632	1.03199	3044.2	737458
970	940900	912673000	31.1448	9.8990	2.98677	1.03093	3047.3	738981
971	942841	915498611	31.1609	9.9024	2.98722	1.02987	3050.5	740506
972	944784	918330048	31.1769	9.9058	2.98767	1.02881	3053.6	742032
973	946729	921167317	31.1929	9.9092	2.98811	1.02775	3056.8	743559
974	948676	924010424	31.2090	9.9126	2.98856	1.02669	3059.9	745088
975	950625	926859375	31.2250	9.9160	2.98900	1.02564	3063.1	746619
976	952576	929714176	31.2410	9.9194	2.98945	1.02459	3066.2	748151
977	954529	932574833	31.2570	9.9227	2.98989	1.02354	3069.3	749685
978	956484	935441352	31.2730	9.9261	2.99034	1.02249	3072.5	751221
979	958441	938313739	31.2890	9.9295	2.99078	1.02145	3075.6	752758
980	960400	941192000	31.3050	9.9329	2.99123	1.02041	3078.8	754296
981	962361	944076141	31.3209	9.9363	2.99167	1.01937	3081.9	755837
982	964324	946966168	31.3369	9.9396	2.99211	1.01833	3085.0	757378
983	966289	949862087	31.3528	9.9430	2.99255	1.01729	3088.2	758922
984	968256	952763904	31.3688	9.9464	2.99300	1.01626	3091.3	760466
985	970225	955671625	31.3847	9.9497	2.99344	1.01523	3094.5	762013
986	972196	958585256	31.4006	9.9531	2.99388	1.01420	3097.6	763561
987	974169	961504803	31.4166	9.9565	2.99432	1.01317	3100.8	765111
988	976144	964430272	31.4325	9.9598	2.99476	1.01215	3103.9	766662
989	978121	967361669	31.4484	9.9632	2.99520	1.01112	3107.0	768214
990	980100	970299000	31.4643	9.9666	2.99564	1.01010	3110.2	769769
991	982081	973242271	31.4802	9.9699	2.99607	1.00908	3113.3	771325
992	984064	976191488	31.4960	9.9733	2.99651	1.00806	3116.5	772882
993	986049	979146657	31.5119	9.9766	2.99695	1.00705	3119.6	774441
994	988036	982107784	31.5278	9.9800	2.99739	1.00604	3122.7	776002
995	990025	985074875	31.5436	9.9833	2.99782	1.00503	3125.9	777564
996	992016	988047936	31.5595	9.9866	2.99826	1.00402	3129.0	779128
997	994009	991026973	31.5753	9.9900	2.99870	1.00301	3132.2	780693
998	996004	994011992	31.5911	9.9933	2.99913	1.00200	3135.3	782260
999	998001	997002999	31.6070	9.9967	2.99957	1.00100	3138.5	783828

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	SINES 0′	10′	20′	30′	40′	50′	60′	Cosines
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01454	0.01745	89
1	0.01745	0.02036	0.02327	0.02618	0.02908	0.03199	0.03490	88
2	0.03490	0.03781	0.04071	0.04362	0.04653	0.04943	0.05234	87
3	0.05234	0.05524	0.05814	0.06105	0.06395	0.06685	0.06976	86
4	0.06976	0.07266	0.07556	0.07846	0.08136	0.08426	0.08716	85
5	0.08716	0.09005	0.09295	0.09585	0.09874	0.10164	0.10453	84
6	0.10453	0.10742	0.11031	0.11320	0.11609	0.11898	0.12187	83
7	0.12187	0.12476	0.12764	0.13053	0.13341	0.13629	0.13917	82
8	0.13917	0.14205	0.14493	0.14781	0.15069	0.15356	0.15643	81
9	0.15643	0.15931	0.16218	0.16505	0.16792	0.17078	0.17365	80
10	0.17365	0.17651	0.17937	0.18224	0.18509	0.18795	0.19081	79
11	0.19081	0.19366	0.19652	0.19937	0.20222	0.20507	0.20791	78
12	0.20791	0.21076	0.21360	0.21644	0.21928	0.22212	0.22495	77
13	0.22495	0.22778	0.23062	0.23345	0.23627	0.23910	0.24192	76
14	0.24192	0.24474	0.24756	0.25038	0.25320	0.25601	0.25882	75
15	0.25882	0.26163	0.26443	0.26724	0.27004	0.27284	0.27564	74
16	0.27564	0.27843	0.28123	0.28402	0.28680	0.28959	0.29237	73
17	0.29237	0.29515	0.29793	0.30071	0.30348	0.30625	0.30902	72
18	0.30902	0.31178	0.31454	0.31730	0.32006	0.32282	0.32557	71
19	0.32557	0.32832	0.33106	0.33381	0.33655	0.33929	0.34202	70
20	0.34202	0.34475	0.34748	0.35021	0.35293	0.35565	0.35837	69
21	0.35837	0.36108	0.36379	0.36650	0.36921	0.37191	0.37461	68
22	0.37461	0.37730	0.37999	0.38268	0.38537	0.38805	0.39073	67
23	0.39073	0.39341	0.39608	0.39875	0.40142	0.40408	0.40674	66
24	0.40674	0.40939	0.41204	0.41469	0.41734	0.41998	0.42262	65
25	0.42262	0.42525	0.42788	0.43051	0.43313	0.43575	0.43837	64
26	0.43837	0.44098	0.44359	0.44620	0.44880	0.45140	0.45399	63
27	0.45399	0.45658	0.45917	0.46175	0.46433	0.46690	0.46947	62
28	0.46947	0.47204	0.47460	0.47716	0.47971	0.48226	0.48481	61
29	0.48481	0.48735	0.48989	0.49242	0.49495	0.49748	0.50000	60
30	0.50000	0.50252	0.50503	0.50754	0.51004	0.51254	0.51504	59
31	0.51504	0.51753	0.52002	0.52250	0.52498	0.52745	0.52992	58
32	0.52992	0.53238	0.53484	0.53730	0.53975	0.54220	0.54464	57
33	0.54464	0.54708	0.54951	0.55194	0.55436	0.55678	0.55919	56
34	0.55919	0.56160	0.56401	0.56641	0.56880	0.57119	0.57358	55
35	0.57358	0.57596	0.57833	0.58070	0.58307	0.58543	0.58779	54
36	0.58779	0.59014	0.59248	0.59482	0.59716	0.59949	0.60182	53
37	0.60182	0.60414	0.60645	0.60876	0.61107	0.61337	0.61566	52
38	0.61566	0.61795	0.62024	0.62251	0.62479	0.62706	0.62932	51
39	0.62932	0.63158	0.63383	0.63608	0.63832	0.64056	0.64279	50
40	0.64279	0.64501	0.64723	0.64945	0.65166	0.65386	0.65606	49
41	0.65606	0.65825	0.66044	0.66262	0.66480	0.66697	0.66913	48
42	0.66913	0.67129	0.67344	0.67559	0.67773	0.67987	0.68200	47
43	0.68200	0.68412	0.68624	0.68835	0.69046	0.69256	0.69466	46
44	0.69466	0.69675	0.69883	0.70091	0.70298	0.70505	0.70711	45
Sines	60′	50′	40′	30′ COSINES	20′	10′	0′	Degrees

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	COSINES							Sines
	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00000	0.99998	0.99996	0.99993	0.99989	0.99985	89
1	0.99985	0.99979	0.99973	0.99966	0.99958	0.99949	0.99939	88
2	0.99939	0.99929	0.99917	0.99905	0.99892	0.99878	0.99863	87
3	0.99863	0.99847	0.99831	0.99813	0.99795	0.99776	0.99756	86
4	0.99756	0.99736	0.99714	0.99692	0.99668	0.99644	0.99619	85
5	0.99619	0.99594	0.99567	0.99540	0.99511	0.99482	0.99452	84
6	0.99452	0.99421	0.99390	0.99357	0.99324	0.99290	0.99255	83
7	0.99255	0.99219	0.99182	0.99144	0.99106	0.99067	0.99027	82
8	0.99027	0.98986	0.98944	0.98902	0.98858	0.98814	0.98769	81
9	0.98769	0.98723	0.98676	0.98629	0.98580	0.98531	0.98481	80
10	0.98481	0.98430	0.98378	0.98325	0.98272	0.98218	0.98163	79
11	0.98163	0.98107	0.98050	0.97992	0.97934	0.97875	0.97815	78
12	0.97815	0.97754	0.97692	0.97630	0.97566	0.97502	0.97437	77
13	0.97437	0.97371	0.97304	0.97237	0.97169	0.97100	0.97030	76
14	0.97030	0.96959	0.96887	0.96815	0.96742	0.96667	0.96593	75
15	0.96593	0.96517	0.96440	0.96363	0.96285	0.96206	0.96126	74
16	0.96126	0.96046	0.95964	0.95882	0.95799	0.95715	0.95630	73
17	0.95630	0.95545	0.95459	0.95372	0.95284	0.95195	0.95106	72
18	0.95106	0.95015	0.94924	0.94832	0.94740	0.94646	0.94552	71
19	0.94552	0.94457	0.94361	0.94264	0.94167	0.94068	0.93969	70
20	0.93969	0.93869	0.93769	0.93667	0.93565	0.93462	0.93358	69
21	0.93358	0.93253	0.93148	0.93042	0.92935	0.92827	0.92718	68
22	0.92718	0.92609	0.92499	0.92388	0.92276	0.92164	0.92050	67
23	0.92050	0.91936	0.91822	0.91706	0.91590	0.91472	0.91355	66
24	0.91355	0.91236	0.91116	0.90996	0.90875	0.90753	0.90631	65
25	0.90631	0.90507	0.90383	0.90259	0.90133	0.90007	0.89879	64
26	0.89879	0.89752	0.89623	0.89493	0.89363	0.89232	0.89101	63
27	0.89101	0.88968	0.88835	0.88701	0.88566	0.88431	0.88295	62
28	0.88295	0.88158	0.88020	0.87882	0.87743	0.87603	0.87462	61
29	0.87462	0.87321	0.87178	0.87036	0.86892	0.86748	0.86603	60
30	0.86603	0.86457	0.86310	0.86163	0.86015	0.85866	0.85717	59
31	0.85717	0.85567	0.85416	0.85264	0.85112	0.84959	0.84805	58
32	0.84805	0.84650	0.84495	0.84339	0.84182	0.84025	0.83867	57
33	0.83867	0.83708	0.83549	0.83389	0.83228	0.83066	0.82904	56
34	0.82904	0.82741	0.82577	0.82413	0.82248	0.82082	0.81915	55
35	0.81915	0.81748	0.81580	0.81412	0.81242	0.81072	0.80902	54
36	0.80902	0.80730	0.80558	0.80386	0.80212	0.80038	0.79864	53
37	0.79864	0.79688	0.79512	0.79335	0.79158	0.78980	0.78801	52
38	0.78801	0.78622	0.78442	0.78261	0.78079	0.77897	0.77715	51
39	0.77715	0.77531	0.77347	0.77162	0.76977	0.76791	0.76604	50
40	0.76604	0.76417	0.76229	0.76041	0.75851	0.75661	0.75471	49
41	0.75471	0.75280	0.75088	0.74896	0.74703	0.74509	0.74314	48
42	0.74314	0.74120	0.73924	0.73728	0.73531	0.73333	0.73135	47
43	0.73135	0.72937	0.72737	0.72537	0.72337	0.72136	0.71934	46
44	0.71934	0.71732	0.71529	0.71325	0.71121	0.70916	0.70711	45
Cosines	60′	50′	40′	30′	20′	10′	0′	Degrees
	SINES							

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	TANGENTS							Cotangents
	0′	10′	20′	30′	40′	50′	60′	
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01455	0.01746	89
1	0.01746	0.02036	0.02328	0.02619	0.02910	0.03201	0.03492	88
2	0.03492	0.03783	0.04075	0.04366	0.04658	0.04949	0.05241	87
3	0.05241	0.05533	0.05824	0.06116	0.06408	0.06700	0.06993	86
4	0.06993	0.07285	0.07578	0.07870	0.08163	0.08456	0.08749	85
5	0.08749	0.09042	0.09335	0.09629	0.09923	0.10216	0.10510	84
6	0.10510	0.10805	0.11099	0.11394	0.11688	0.11983	0.12278	83
7	0.12278	0.12574	0.12869	0.13165	0.13461	0.13758	0.14054	82
8	0.14054	0.14351	0.14648	0.14945	0.15243	0.15540	0.15838	81
9	0.15838	0.16137	0.16435	0.16734	0.17033	0.17333	0.17633	80
10	0.17633	0.17933	0.18233	0.18534	0.18835	0.19136	0.19438	79
11	0.19438	0.19740	0.20042	0.20345	0.20648	0.20952	0.21256	78
12	0.21256	0.21560	0.21864	0.22169	0.22475	0.22781	0.23087	77
13	0.23087	0.23393	0.23700	0.24008	0.24316	0.24624	0.24933	76
14	0.24933	0.25242	0.25552	0.25862	0.26172	0.26483	0.26795	75
15	0.26795	0.27107	0.27419	0.27732	0.28046	0.28360	0.28675	74
16	0.28675	0.28990	0.29305	0.29621	0.29938	0.30255	0.30573	73
17	0.30573	0.30891	0.31210	0.31530	0.31850	0.32171	0.32492	72
18	0.32492	0.32814	0.33136	0.33460	0.33783	0.34108	0.34433	71
19	0.34433	0.34758	0.35085	0.35412	0.35740	0.36068	0.36397	70
20	0.36397	0.36727	0.37057	0.37388	0.37720	0.38053	0.38386	69
21	0.38386	0.38721	0.39055	0.39391	0.39727	0.40065	0.40403	68
22	0.40403	0.40741	0.41081	0.41421	0.41763	0.42105	0.42447	67
23	0.42447	0.42791	0.43136	0.43481	0.43828	0.44175	0.44523	66
24	0.44523	0.44872	0.45222	0.45573	0.45924	0.46277	0.46631	65
25	0.46631	0.46985	0.47341	0.47698	0.48055	0.48414	0.48773	64
26	0.48773	0.49134	0.49495	0.49858	0.50222	0.50587	0.50953	63
27	0.50953	0.51320	0.51688	0.52057	0.52427	0.52798	0.53171	62
28	0.53171	0.53545	0.53920	0.54296	0.54674	0.55051	0.55431	61
29	0.55431	0.55812	0.56194	0.56577	0.56962	0.57348	0.57735	60
30	0.57735	0.58124	0.58513	0.58905	0.59297	0.59691	0.60086	59
31	0.60086	0.60483	0.60881	0.61280	0.61681	0.62083	0.62487	58
32	0.62487	0.62892	0.63299	0.63707	0.64117	0.64528	0.64941	57
33	0.64941	0.65355	0.65771	0.66189	0.66608	0.67028	0.67451	56
34	0.67451	0.67875	0.68301	0.68728	0.69157	0.69588	0.70021	55
35	0.70021	0.70455	0.70891	0.71329	0.71769	0.72211	0.72654	54
36	0.72654	0.73100	0.73547	0.73996	0.74447	0.74900	0.75355	53
37	0.75355	0.75812	0.76272	0.76733	0.77196	0.77661	0.78129	52
38	0.78129	0.78598	0.79070	0.79544	0.80020	0.80498	0.80978	51
39	0.80978	0.81461	0.81946	0.82434	0.82923	0.83415	0.83910	50
40	0.83910	0.84407	0.84906	0.85408	0.85912	0.86419	0.86929	49
41	0.86929	0.87441	0.87955	0.88473	0.88992	0.89515	0.90040	48
42	0.90040	0.90569	0.91099	0.91633	0.92170	0.92709	0.93252	47
43	0.93252	0.93797	0.94345	0.94896	0.95451	0.96008	0.96569	46
44	0.96569	0.97133	0.97700	0.98270	0.98843	0.99420	1.00000	45
Tangents	60′	50′	40′	30′	20′	10′	0′	Degrees
	COTANGENTS							

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	COTANGENTS							Tangents
	0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77371	171.88540	114.58865	85.93979	68.75009	57.28996	89
1	57.28996	49.10388	42.96408	38.18846	34.36777	31.24158	28.63625	88
2	28.63625	26.43160	24.54176	22.90377	21.47040	20.20555	19.08114	87
3	19.08114	18.07498	17.16934	16.34986	15.60478	14.92442	14.30067	86
4	14.30067	13.72674	13.19688	12.70621	12.25051	11.82617	11.43005	85
5	11.43005	11.05943	10.71191	10.38540	10.07803	9.78817	9.51436	84
6	9.51436	9.25530	9.00983	8.77689	8.55555	8.34496	8.14435	83
7	8.14435	7.95302	7.77035	7.59575	7.42871	7.26873	7.11537	82
8	7.11537	6.96823	6.82694	6.69116	6.56055	6.43484	6.31375	81
9	6.31375	6.19703	6.08444	5.97576	5.87080	5.76937	5.67128	80
10	5.67128	5.57638	5.48451	5.39552	5.30928	5.22566	5.14455	79
11	5.14455	5.06584	4.98940	4.91516	4.84300	4.77286	4.70463	78
12	4.70463	4.63825	4.57363	4.51071	4.44942	4.38969	4.33148	77
13	4.33148	4.27471	4.21933	4.16530	4.11256	4.06107	4.01078	76
14	4.01078	3.96165	3.91364	3.86671	3.82083	3.77595	3.73205	75
15	3.73205	3.68909	3.64705	3.60588	3.56557	3.52609	3.48741	74
16	3.48741	3.44951	3.41236	3.37594	3.34023	3.30521	3.27085	73
17	3.27085	3.23714	3.20406	3.17159	3.13972	3.10842	3.07768	72
18	3.07768	3.04749	3.01783	2.98869	2.96004	2.93189	2.90421	71
19	2.90421	2.87700	2.85023	2.82391	2.79802	2.77254	2.74748	70
20	2.74748	2.72281	2.69853	2.67462	2.65109	2.62791	2.60509	69
21	2.60509	2.58261	2.56046	2.53865	2.51715	2.49597	2.47509	68
22	2.47509	2.45451	2.43422	2.41421	2.39449	2.37504	2.35585	67
23	2.35585	2.33693	2.31826	2.29984	2.28167	2.26374	2.24604	66
24	2.24604	2.22857	2.21132	2.19430	2.17749	2.16090	2.14451	65
25	2.14451	2.12832	2.11233	2.09654	2.08094	2.06553	2.05030	64
26	2.05030	2.03526	2.02039	2.00569	1.99116	1.97680	1.96261	63
27	1.96261	1.94858	1.93470	1.92098	1.90741	1.89400	1.88073	62
28	1.88073	1.86760	1.85462	1.84177	1.82907	1.81649	1.80405	61
29	1.80405	1.79174	1.77955	1.76749	1.75556	1.74375	1.73205	60
30	1.73205	1.72047	1.70901	1.69766	1.68643	1.67530	1.66428	59
31	1.66428	1.65337	1.64256	1.63185	1.62125	1.61074	1.60033	58
32	1.60033	1.59002	1.57981	1.56969	1.55966	1.54972	1.53987	57
33	1.53987	1.53010	1.52043	1.51084	1.50133	1.49190	1.48256	56
34	1.48256	1.47330	1.46411	1.45501	1.44598	1.43703	1.42815	55
35	1.42815	1.41934	1.41061	1.40195	1.39336	1.38484	1.37638	54
36	1.37638	1.36800	1.35968	1.35142	1.34323	1.33511	1.32704	53
37	1.32704	1.31904	1.31110	1.30323	1.29541	1.28764	1.27994	52
38	1.27994	1.27230	1.26471	1.25717	1.24969	1.24227	1.23490	51
39	1.23490	1.22758	1.22031	1.21310	1.20593	1.19882	1.19175	50
40	1.19175	1.18474	1.17777	1.17085	1.16398	1.15715	1.15037	49
41	1.15037	1.14363	1.13694	1.13029	1.12369	1.11713	1.11061	48
42	1.11061	1.10414	1.09770	1.09131	1.08496	1.07864	1.07237	47
43	1.07237	1.06613	1.05994	1.05378	1.04766	1.04158	1.03553	46
44	1.03553	1.02952	1.02355	1.01761	1.01170	1.00583	1.00000	45
Cotangents	60′	50′	40′	30′	20′	10′	0′	Degrees
	TANGENTS							

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	SECANTS							Cosecants
	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00000	1.00002	1.00004	1.00007	1.00011	1.00015	89
1	1.00015	1.00021	1.00027	1.00034	1.00042	1.00051	1.00061	88
2	1.00061	1.00072	1.00083	1.00095	1.00108	1.00122	1.00137	87
3	1.00137	1.00153	1.00169	1.00187	1.00205	1.00224	1.00244	86
4	1.00244	1.00265	1.00287	1.00309	1.00333	1.00357	1.00382	85
5	1.00382	1.00408	1.00435	1.00463	1.00491	1.00521	1.00551	84
6	1.00551	1.00582	1.00614	1.00647	1.00681	1.00715	1.00751	83
7	1.00751	1.00787	1.00825	1.00863	1.00902	1.00942	1.00983	82
8	1.00983	1.01024	1.01067	1.01111	1.01155	1.01200	1.01247	81
9	1.01247	1.01294	1.01342	1.01391	1.01440	1.01491	1.01543	80
10	1.01543	1.01595	1.01649	1.01703	1.01758	1.01815	1.01872	79
11	1.01872	1.01930	1.01989	1.02049	1.02110	1.02171	1.02234	78
12	1.02234	1.02298	1.02362	1.02428	1.02494	1.02562	1.02630	77
13	1.02630	1.02700	1.02770	1.02842	1.02914	1.02987	1.03061	76
14	1.03061	1.03137	1.03213	1.03290	1.03368	1.03447	1.03528	75
15	1.03528	1.03609	1.03691	1.03774	1.03858	1.03944	1.04030	74
16	1.04030	1.04117	1.04206	1.04295	1.04385	1.04477	1.04569	73
17	1.04569	1.04663	1.04757	1.04853	1.04950	1.05047	1.05146	72
18	1.05146	1.05246	1.05347	1.05449	1.05552	1.05657	1.05762	71
19	1.05762	1.05869	1.05976	1.06085	1.06195	1.06306	1.06418	70
20	1.06418	1.06531	1.06645	1.06761	1.06878	1.06995	1.07115	69
21	1.07115	1.07235	1.07356	1.07479	1.07602	1.07727	1.07853	68
22	1.07853	1.07981	1.08109	1.08239	1.08370	1.08503	1.08636	67
23	1.08636	1.08771	1.08907	1.09044	1.09183	1.09323	1.09464	66
24	1.09464	1.09606	1.09750	1.09895	1.10041	1.10189	1.10338	65
25	1.10338	1.10488	1.10640	1.10793	1.10947	1.11103	1.11260	64
26	1.11260	1.11419	1.11579	1.11740	1.11903	1.12067	1.12233	63
27	1.12233	1.12400	1.12568	1.12738	1.12910	1.13083	1.13257	62
28	1.13257	1.13433	1.13610	1.13789	1.13970	1.14152	1.14335	61
29	1.14335	1.14521	1.14707	1.14896	1.15085	1.15277	1.15470	60
30	1.15470	1.15665	1.15861	1.16059	1.16259	1.16460	1.16663	59
31	1.16663	1.16868	1.17075	1.17283	1.17493	1.17704	1.17918	58
32	1.17918	1.18133	1.18350	1.18569	1.18790	1.19012	1.19236	57
33	1.19236	1.19463	1.19691	1.19920	1.20152	1.20386	1.20622	56
34	1.20622	1.20859	1.21099	1.21341	1.21584	1.21830	1.22077	55
35	1.22077	1.22327	1.22579	1.22833	1.23089	1.23347	1.23607	54
36	1.23607	1.23869	1.24134	1.24400	1.24669	1.24940	1.25214	53
37	1.25214	1.25489	1.25767	1.26047	1.26330	1.26615	1.26902	52
38	1.26902	1.27191	1.27483	1.27778	1.28075	1.28374	1.28676	51
39	1.28676	1.28980	1.29287	1.29597	1.29909	1.30223	1.30541	50
40	1.30541	1.30861	1.31183	1.31509	1.31837	1.32168	1.32501	49
41	1.32501	1.32838	1.33177	1.33519	1.33864	1.34212	1.34563	48
42	1.34563	1.34917	1.35274	1.35634	1.35997	1.36363	1.36733	47
43	1.36733	1.37105	1.37481	1.37860	1.38242	1.38628	1.39016	46
44	1.39016	1.39409	1.39804	1.40203	1.40606	1.41012	1.41421	45
Secants	60′	50′	40′	30′	20′	10′	0′	Degrees
	COSECANTS							

NATURAL TRIGONOMETRIC FUNCTIONS

Degrees	COSECANTS							Secants
	0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77516	171.88831	114.59301	85.94561	68.75736	57.29869	89
1	57.29869	49.11406	42.97571	38.20155	34.38232	31.25758	28.65371	88
2	28.65371	26.45051	24.56212	22.92559	21.49368	20.23028	19.10732	87
3	19.10732	18.10262	17.19843	16.38041	15.63679	14.95788	14.33559	86
4	14.33559	13.76312	13.23472	12.74550	12.29125	11.86837	11.47371	85
5	11.47371	11.10455	10.75849	10.43343	10.12752	9.83912	9.56677	84
6	9.56677	9.30917	9.06515	8.83367	8.61379	8.40466	8.20551	83
7	8.20551	8.01565	7.83443	7.66130	7.49571	7.33719	7.18530	82
8	7.18530	7.03962	6.89979	6.76547	6.63633	6.51208	6.39245	81
9	6.39245	6.27719	6.16607	6.05886	5.95536	5.85539	5.75877	80
10	5.75877	5.66533	5.57493	5.48740	5.40263	5.32049	5.24084	79
11	5.24084	5.16359	5.08863	5.01585	4.94517	4.87649	4.80973	78
12	4.80973	4.74482	4.68167	4.62023	4.56041	4.50216	4.44541	77
13	4.44541	4.39012	4.33622	4.28366	4.23239	4.18238	4.13357	76
14	4.13357	4.08591	4.03938	3.99393	3.94952	3.90613	3.86370	75
15	3.86370	3.82223	3.78166	3.74198	3.70315	3.66515	3.62796	74
16	3.62796	3.59154	3.55587	3.52094	3.48671	3.45317	3.42030	73
17	3.42030	3.38808	3.35649	3.32551	3.29512	3.26531	3.23607	72
18	3.23607	3.20737	3.17920	3.15155	3.12440	3.09774	3.07155	71
19	3.07155	3.04584	3.02057	2.99574	2.97135	2.94737	2.92380	70
20	2.92380	2.90063	2.87785	2.85545	2.83342	2.81175	2.79043	69
21	2.79043	2.76945	2.74881	2.72850	2.70851	2.68884	2.66947	68
22	2.66947	2.65040	2.63162	2.61313	2.59491	2.57698	2.55930	67
23	2.55930	2.54190	2.52474	2.50784	2.49119	2.47477	2.45859	66
24	2.45859	2.44264	2.42692	2.41142	2.39614	2.38107	2.36620	65
25	2.36620	2.35154	2.33708	2.32282	2.30875	2.29487	2.28117	64
26	2.28117	2.26766	2.25432	2.24116	2.22817	2.21535	2.20269	63
27	2.20269	2.19019	2.17786	2.16568	2.15366	2.14178	2.13005	62
28	2.13005	2.11847	2.10704	2.09574	2.08458	2.07356	2.06267	61
29	2.06267	2.05191	2.04128	2.03077	2.02039	2.01014	2.00000	60
30	2.00000	1.98998	1.98008	1.97029	1.96062	1.95106	1.94160	59
31	1.94160	1.93226	1.92302	1.91388	1.90485	1.89591	1.88709	58
32	1.88708	1.87834	1.86970	1.86116	1.85271	1.84435	1.83608	57
33	1.83608	1.82790	1.81981	1.81180	1.80388	1.79604	1.78829	56
34	1.78829	1.78062	1.77303	1.76552	1.75808	1.75073	1.74345	55
35	1.74345	1.73624	1.72911	1.72205	1.71506	1.70815	1.70130	54
36	1.70130	1.69452	1.68782	1.68117	1.67460	1.66809	1.66164	53
37	1.66164	1.65526	1.64894	1.64268	1.63648	1.63035	1.62427	52
38	1.62427	1.61825	1.61229	1.60639	1.60054	1.59475	1.58902	51
39	1.58902	1.58333	1.57771	1.57213	1.56661	1.56114	1.55572	50
40	1.55572	1.55036	1.54504	1.53977	1.53455	1.52938	1.52425	49
41	1.52425	1.51918	1.51415	1.50916	1.50422	1.49933	1.49448	48
42	1.49448	1.48967	1.48491	1.48019	1.47551	1.47087	1.46628	47
43	1.46628	1.46173	1.45721	1.45274	1.44831	1.44391	1.43956	46
44	1.43956	1.43524	1.43096	1.42672	1.42251	1.41835	1.41421	45
Cosecants	60′	50′	40′	30′	20′	10′	0′	Degrees
	SECANTS							

DECIMALS OF ONE DEGREE

′	0″	10″	20″	30″	40″	50″	′
0	......	.00278	.00556	.00833	.01111	.01389	0
1	.01667	.01944	.02222	.02500	.02778	.03056	1
2	.03333	.03611	.03889	.04167	.04444	.04722	2
3	.05000	.05278	.05556	.05833	.06111	.06389	3
4	.06667	.06944	.07222	.07500	.07778	.08056	4
5	.08333	.08611	.08889	.09167	.09444	.09722	5
6	.10000	.10278	.10556	.10833	.11111	.11389	6
7	.11667	.11944	.12222	.12500	.12778	.13056	7
8	.13333	.13611	.13889	.14167	.14444	.14722	8
9	.15000	.15278	.15556	.15833	.16111	.16389	9
10	.16667	.16944	.17222	.17500	.17778	.18056	10
11	.18333	.18611	.18889	.19167	.19444	.19722	11
12	.20000	.20278	.20556	.20833	.21111	.21389	12
13	.21667	.21944	.22222	.22500	.22778	.23056	13
14	.23333	.23611	.23889	.24167	.24444	.24722	14
15	.25000	.25278	.25556	.25833	.26111	.26389	15
16	.26667	.26944	.27222	.27500	.27778	.28056	16
17	.28333	.28611	.28889	.29167	.29444	.29722	17
18	.30000	.30278	.30556	.30833	.31111	.31389	18
19	.31667	.31944	.32222	.32500	.32778	.33056	19
20	.33333	.33611	.33889	.34167	.34444	.34722	20
21	.35000	.35270	.35556	.35833	.36111	.36389	21
22	.36667	.36944	.37222	.37500	.37778	.38056	22
23	.38333	.38611	.38889	.39167	.39444	.39722	23
24	.40000	.40278	.40556	.40833	.41111	.41389	24
25	.41667	.41944	.42222	.42500	.42778	.43056	25
26	.43333	.43611	.43889	.44167	.44444	.44722	26
27	.45000	.45278	.45556	.45833	.46111	.46389	27
28	.46667	.46944	.47222	.47500	.47778	.48056	28
29	.48333	.48611	.48889	.49167	.49444	.49722	29
30	.50000	.50278	.50556	.50833	.51111	.51389	30
31	.51667	.51944	.52222	.52500	.52778	.53056	31
32	.53333	.53611	.53889	.54167	.54444	.54722	32
33	.55000	.55278	.55556	.55833	.56111	.56389	33
34	.56667	.56944	.57222	.57500	.57778	.58056	34
35	.58333	.58611	.58889	.59167	.59444	.59722	35
36	.60000	.60278	.60556	.60833	.61111	.61389	36
37	.61667	.61944	.62222	.62500	.62778	.63056	37
38	.63333	.63611	.63889	.64167	.64444	.64722	38
39	.65000	.65278	.65556	.65833	.66111	.66389	39
40	.66667	.66944	.67222	.67500	.67778	.68056	40
41	.68333	.68611	.68889	.69167	.69444	.69722	41
42	.70000	.70278	.70556	.70833	.71111	.71389	42
43	.71667	.71944	.72222	.72500	.72778	.73056	43
44	.73333	.73611	.73889	.74167	.74444	.74722	44
45	.75000	.75278	.75556	.75833	.76111	.76389	45
46	.76667	.76944	.77222	.77500	.77778	.78056	46
47	.78333	.78611	.78889	.79167	.79444	.79722	47
48	.80000	.80278	.80556	.80833	.81111	.81389	48
49	.81667	.81944	.82222	.82500	.82778	.83056	49
50	.83333	.83611	.83889	.84167	.84444	.84722	50
51	.85000	.85278	.85556	.85833	.86111	.86389	51
52	.86667	.86944	.87222	.87500	.87778	.88056	52
53	.88333	.88611	.88889	.89167	.89444	.89722	53
54	.90000	.90278	.90556	.90833	.91111	.91389	54
55	.91667	.91944	.92222	.92500	.92778	.93056	55
56	.93333	.93611	.93889	.94167	.94444	.94722	56
57	.95000	.95278	.95556	.95833	.96111	.96389	57
58	.96667	.96944	.97222	.97500	.97778	.98056	58
59	.98333	.98611	.98889	.99167	.99444	.99722	59

″	
1	00028
2	00056
3	00083
4	00111
5	00139
6	00167
7	00194
8	00222
9	00250

DECIMAL OF AN INCH AND OF A FOOT

Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions
	.0052	1/16		.2552	3 1/16		.5052	6 1/16		.7552	9 1/16
	.0104	1/8		.2604	3 1/8		.5104	6 1/8		.7604	9 1/8
1/64	.015625	3/16	17/64	.265625	3 3/16	33/64	.515625	6 3/16	49/64	.765625	9 3/16
	.0208	1/4		.2708	3 1/4		.5208	6 1/4		.7708	9 1/4
	.0260	5/16		.2760	3 5/16		.5260	6 5/16		.7760	9 5/16
1/32	.03125	3/8	9/32	.28125	3 3/8	17/32	.53125	6 3/8	25/32	.78125	9 3/8
	.0365	7/16		.2865	3 7/16		.5365	6 7/16		.7865	9 7/16
	.0417	1/2		.2917	3 1/2		.5417	6 1/2		.7917	9 1/2
3/64	.046875	9/16	19/64	.296875	3 9/16	35/64	.546875	6 9/16	51/64	.796875	9 9/16
	.0521	5/8		.3021	3 5/8		.5521	6 5/8		.8021	9 5/8
	.0573	11/16		.3073	3 11/16		.5573	6 11/16		.8073	9 11/16
1/16	.0625	3/4	5/16	.3125	3 3/4	9/16	.5625	6 3/4	13/16	.8125	9 3/4
	.0677	13/16		.3177	3 13/16		.5677	6 13/16		.8177	9 13/16
	.0729	7/8		.3229	3 7/8		.5729	6 7/8		.8229	9 7/8
5/64	.078125	15/16	21/64	.328125	3 15/16	37/64	.578125	6 15/16	53/64	.828125	9 15/16
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	1 1/16		.3385	4 1/16		.5885	7 1/16		.8385	10 1/16
3/32	.09375	1 1/8	11/32	.34375	4 1/8	19/32	.59375	7 1/8	27/32	.84375	10 1/8
	.0990	1 3/16		.3490	4 3/16		.5990	7 3/16		.8490	10 3/16
	.1042	1 1/4		.3542	4 1/4		.6042	7 1/4		.8542	10 1/4
7/64	.109375	1 5/16	23/64	.359375	4 5/16	39/64	.609375	7 5/16	55/64	.859375	10 5/16
	.1146	1 3/8		.3646	4 3/8		.6146	7 3/8		.8646	10 3/8
	.1198	1 7/16		.3698	4 7/16		.6198	7 7/16		.8698	10 7/16
1/8	.1250	1 1/2	3/8	.3750	4 1/2	5/8	.6250	7 1/2	7/8	.8750	10 1/2
	.1302	1 9/16		.3802	4 9/16		.6302	7 9/16		.8802	10 9/16
	.1354	1 5/8		.3854	4 5/8		.6354	7 5/8		.8854	10 5/8
9/64	.140625	1 11/16	25/64	.390625	4 11/16	41/64	.640625	7 11/16	57/64	.890625	10 11/16
	.1458	1 3/4		.3958	4 3/4		.6458	7 3/4		.8958	10 3/4
	.1510	1 13/16		.4010	4 13/16		.6510	7 13/16		.9010	10 13/16
5/32	.15625	1 7/8	13/32	.40625	4 7/8	21/32	.65625	7 7/8	29/32	.90625	10 7/8
	.1615	1 15/16		.4115	4 15/16		.6615	7 15/16		.9115	10 15/16
	.1667	2		.4167	5		.6667	8		.9167	11
11/64	.171875	2 1/16	27/64	.421875	5 1/16	43/64	.671875	8 1/16	59/64	.921875	11 1/16
	.1771	2 1/8		.4271	5 1/8		.6771	8 1/8		.9271	11 1/8
	.1823	2 3/16		.4323	5 3/16		.6823	8 3/16		.9323	11 3/16
3/16	.1875	2 1/4	7/16	.4375	5 1/4	11/16	.6875	8 1/4	15/16	.9375	11 1/4
	.1927	2 5/16		.4427	5 5/16		.6927	8 5/16		.9427	11 5/16
	.1979	2 3/8		.4479	5 3/8		.6979	8 3/8		.9479	11 3/8
13/64	.203125	2 7/16	29/64	.453125	5 7/16	45/64	.703125	8 7/16	61/64	.953125	11 7/16
	.2083	2 1/2		.4583	5 1/2		.7083	8 1/2		.9583	11 1/2
	.2135	2 9/16		.4635	5 9/16		.7135	8 9/16		.9635	11 9/16
7/32	.21875	2 5/8	15/32	.46875	5 5/8	23/32	.71875	8 5/8	31/32	.96875	11 5/8
	.2240	2 11/16		.4740	5 11/16		.7240	8 11/16		.9740	11 11/16
	.2292	2 3/4		.4792	5 3/4		.7292	8 3/4		.9792	11 3/4
15/64	.234375	2 13/16	31/64	.484375	5 13/16	47/64	.734375	8 13/16	63/64	.984375	11 13/16
	.2396	2 7/8		.4896	5 7/8		.7396	8 7/8		.9896	11 7/8
	.2448	2 15/16		.4948	5 15/16		.7448	8 15/16		.9948	11 15/16
1/4	.2500	3	1/2	.5000	6	3/4	.7500	9	1	1.0000	12

BIRMINGHAM WIRE AND U. S. STANDARD GAGES

BIRMINGHAM WIRE

Gage Number	Thickness: Decimal Inches	Thickness: Nearest 1/64 Inch	Thickness: Millimeters
0000	.454	29/64	11.532
000	.425	27/64	10.795
00	.380	3/8	9.652
0	.340	11/32	8.636
1	.300	19/64	7.620
2	.284	9/32	7.214
3	.259	17/64	6.579
4	.238	15/64	6.045
5	.220	7/32	5.588
6	.203	13/64	5.156
7	.180	3/16	4.572
8	.165	11/64	4.191
9	.148	9/64	3.759
10	.134	9/64	3.404
11	.120	1/8	3.048
12	.109	7/64	2.769
13	.095	3/32	2.413
14	.083	5/64	2.108
15	.072	5/64	1.829
16	.065	1/16	1.651
17	.058	1/16	1.473
18	.049	3/64	1.245
19	.042	3/64	1.067
20	.035	1/32	.889
21	.032	1/32	.813
22	.028	1/32	.711
23	.025	1/32	.635
24	.022	1/64	.559
25	.020	1/64	.508
26	.018	1/64	.457
27	.016	1/64	.406
28	.014	...	.356
29	.013	...	.330
30	.012	...	.305
31	.010	...	.254
32	.009	...	.229
33	.008	...	.203
34	.007	...	.178
35	.005	...	.127
36	.004	...	.102

UNITED STATES STANDARD

Gage Number	Weight per Square Foot Pounds, Av.	Approx. Thickness, Inch: Steel	Approx. Thickness, Inch: Nearest 1/64 Inch
1	11.25	.2757	9/32
2	10.625	.2604	17/64
3	10.00	.2451	1/4
4	9.375	.2298	15/64
5	8.75	.2145	7/32
6	8.125	.1991	13/64
7	7.5	.1838	3/16
8	6.875	.1685	11/64
9	6.25	.1532	5/32
10	5.625	.1379	9/64
11	5.00	.1225	1/8
12	4.375	.1072	7/64
13	3.75	.0919	3/32
14	3.125	.0766	5/64
15	2.8125	.0689	1/16
16	2.50	.0613	1/16
17	2.25	.0551	1/16
18	2.00	.0490	3/64
19	1.75	.0429	3/64
20	1.50	.0368	1/32
21	1.375	.0337	1/32
22	1.25	.0306	1/32
23	1.125	.0276	1/32
24	1.00	.0245	1/32
25	.875	.0214	1/64
26	.75	.0184	1/64
27	.6875	.0169	1/64
28	.625	.0153	1/64
29	.5625	.0138	...
30	.50	.0123	...
31	.4375	.0107	...
32	.40625	.0100	...
33	.375	.0092	...
34	.34375	.0084	...
35	.3125	.0077	...
36	.28125	.0069	...
37	.265625	.0065	...
38	.25	.0061	...
39	.234375	.0057	...
40	.21875	.0054	...
41	.2109375	.0052	...
42	.203125	.0050	...
43	.1953125	.0048	...
44	.1875	.0046	...

Plates—Over 6" to 48" wide, 1/4" and thicker; Over 48" wide, 3/16" and thicker.
Sheets—24" to 48" wide, under 1/4" thick; Over 48" wide, under 3/16" thick.
Strip—23 15/16" and narrower, under 1/4" thick.

Birmingham Wire Gage is a dimension gage.

The United States Standard Gage is a weight gage based upon the weights per square foot, in ounces avoirdupois and approximate thicknesses based upon 489.6 pounds per cubic foot for steel and 480 pounds per cubic foot for iron.

It is desirable that decimal or fractional thicknesses be specified on orders for flat rolled products.

When gage numbers are specified, orders are produced as follows:
Plate and Strip—Birmingham Wire Gage decimal equivalent;
Sheets—U. S. Standard Plate Gage decimal equivalent for steel.

COMPARATIVE TABLE OF STANDARD GAGES

Gage Number	Thickness in Decimals of an Inch Birmingham Wire (B. W. G.) also known as Stubs Iron Wire	American Wire or Browne & Sharpe	United States Steel Wire formerly Washburn & Moen	Trenton Iron Company	British Imperial Standard Wire (S. W. G.)	Standard Birmingham Sheet and Hoop (B. G.)
0000000	...	......	.4900	....	.500	......
000000	...	.580000	.4615	....	.464	......
00000	...	.516500	.4305	.450	.432	......
0000	.454	.460000	.3938	.400	.400	......
000	.425	.409642	.3625	.360	.372	.5000
00	.380	.364796	.3310	.330	.348	.4452
0	.340	.324861	.3065	.305	.324	.3964
1	.300	.289297	.2830	.285	.300	.3532
2	.284	.257627	.2625	.265	.276	.3147
3	.259	.229423	.2437	.245	.252	.2804
4	.238	.204307	.2253	.225	.232	.2500
5	.220	.181940	.2070	.205	.212	.2225
6	.203	.162023	.1920	.190	.192	.1981
7	.180	.144285	.1770	.175	.176	.1764
8	.165	.128490	.1620	.160	.160	.1570
9	.148	.114423	.1483	.145	.144	.1398
10	.134	.101897	.1350	.130	.128	.1250
11	.120	.090742	.1205	.1175	.116	.1113
12	.109	.080808	.1055	.105	.104	.0991
13	.095	.071962	.0915	.0925	.092	.0882
14	.083	.064084	.0800	.0806	.080	.0785
15	.072	.057068	.0720	.070	.072	.0699
16	.065	.050821	.0625	.061	.064	.0625
17	.058	.045257	.0540	.0525	.056	.0556
18	.049	.040303	.0475	.045	.048	.0495
19	.042	.035890	.0410	.040	.040	.0440
20	.035	.031961	.0348	.035	.036	.0392
21	.032	.028462	.03175	.031	.032	.0349
22	.028	.025346	.0286	.028	.028	.03125
23	.025	.022572	.0258	.025	.024	.02782
24	.022	.020101	.0230	.0225	.022	.02476
25	.020	.017900	.0204	.020	.020	.02204
26	.018	.015941	.0181	.018	.018	.01961
27	.016	.014195	.0173	.017	.0164	.01745
28	.014	.012641	.0162	.016	.0148	.015625
29	.013	.011257	.0150	.015	.0136	.0139
30	.012	.010025	.0140	.014	.0124	.0123
31	.010	.008928	.0132	.013	.0116	.0110
32	.009	.007950	.0128	.012	.0108	.0098
33	.008	.007080	.0118	.011	.0100	.0087
34	.007	.006305	.0104	.010	.0092	.0077
35	.005	.005615	.0095	.0095	.0084	.0069
36	.004	.005000	.0090	.009	.0076	.0061
37	...	.004453	.0085	.0085	.0068	.0054
38	...	.003965	.0080	.008	.0060	.0048
39	...	.003531	.0075	.0075	.0052	.....
40	...	.003144	.0070	.007	.0048	.....

It is desirable that decimal or fractional thicknesses be specified on orders for flat rolled products. When gage numbers are specified, orders are produced as follows:

Plate and Strip—Birmingham Wire Gage decimal equivalent;
Sheets—U. S. Standard Plate Gage decimal equivalent for steel.

Acknowledgment is hereby given the American Bridge Company, Steel Joist Institute, Technical Bureau of the Universal Atlas Cement Company, Structural Clay Tile Association, U. S. Department of Agriculture, Forestry Service, and many others for their hearty co-operation in the preparation of this book.

SUBJECT INDEX

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES OF UNITED STATES STEEL CORPORATION

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh, Pa. Chicago, Ill.

ROLLED, FORGED, AND CAST STEEL PRODUCTS

C B Sections
Structural Shapes
Plates
Bars
Concrete Reinforcement Bars
Flats
Slack Barrel Hoop
Strip
Column Base Plates
Floor Plates
I-Beam-Lok Floor Construction
T-Tri-Lok Floor Construction
Steel Sheet Piling
CBP Bearing Piles
Steel Mine Timbers
Rails, Heavy and Light
GEO Track Material
Splice Bars
Tie Plates
Track Bolts
Track Spikes
Cross Ties
Axles and Forgings
Wheels, Car and Locomotive
Pig Iron
Billets
Ferro-Manganese
Coke
Coke By-Products
Alloy Steels
U S S Stainless and
Heat-Resisting Steels
U S S High Tensile Steels

SHEET AND TIN MILL PRODUCTS

Black Sheets—
Box Annealed
Blue Annealed
Cold Rolled
Strip Steel
Hot Rolled
Cold Rolled
Special Sheets
Electrical Sheets
Automobile Sheets
Metal Furniture
Vitreous Enameling
U S S Stainless and
Heat Resisting Steel Sheets
U S S High Tensile Steel Sheets
Blued Sheets—
Keystone-Wellsville Polished
Blued Stove Pipe Stock
Long Terne Sheets
American Galvannealed Sheets
Galvanized Sheets—
American Zinc Coated
Apollo Best Bloom
Apollo-Keystone
Corrugated Sheets
Formed Roofing and Siding Products
Bright Tin Plates—
American Cokes
American Charcoals
Terne Plates—
American Ternes
American Old Style Ternes
U. S. Eagle Ternes
Fire Door Ternes
Keystone Long and Short Ternes
Tin Mill Black

LORAIN DIVISION

Johnstown, Pa.

Special Track Work and Accessories
Girder Rails
Industrial and Mine Cars
Coal Conveyors
Mine Jacks
Forged Steel Grinding Balls
Cárbon Steel Castings
Manganese Steel Castings
Alloy Steel Castings
Grey Iron Castings

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES OF UNITED STATES STEEL CORPORATION—CONTINUED

COLUMBIA STEEL COMPANY

General Offices: Russ Building, San Francisco, Cal.

ROLLED AND CAST STEEL PRODUCTS

Structural Shapes
Bars and Small Shapes
Concrete Reinforcement Bars
Bands under ¼″
Tie Plates
Sheets—
- Black
- Blue Annealed
- Galvanized
- Cold Rolled

Wire—
- Manufacturers Wires
- Plain or Galvanized
- Barbed
- Spring

Wire Nails
Wire Fence
Wire Rope
Wire Rods
Steel Castings

Coal
Coke
Coke By-Products

Also distributors for Pacific Coast territory of products of all subsidiary manufacturing companies of United States Steel Corporation

TENNESSEE COAL, IRON AND RAILROAD COMPANY

General Offices: Brown-Marx Building, Birmingham, Ala.

ROLLED, FORGED AND DRAWN STEEL PRODUCTS

Structural Shapes
Plates
Bars
Small Shapes
Hot Rolled Strip
Cotton Ties

Axles
Forgings
Rails
Rail Accessories
Semi-Finished Material
Pig Iron

Sheets—
- Hot Rolled
- Hot Rolled Annealed
- Galvanized

Wire and Wire Products

AMERICAN BRIDGE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

STEEL STRUCTURES OF ALL CLASSES

Bridges
Buildings
Viaducts
Subway Structures
Ferry Aprons
Ore Docks

Dams
Crane Runways
Buckle Plates
Barges
Hulls
Turntables

Towers
Poles
Sub-Stations
Tanks
Eyebars
Electric Furnaces (Heroult)

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES OF UNITED STATES STEEL CORPORATION—Continued

AMERICAN STEEL AND WIRE COMPANY

General Offices: 208 South La Salle Street, Chicago, Ill.

WIRE AND WIRE PRODUCTS

Aerial Tramways
Bale Ties
Barbed Wire
Cold Rolled Strip Steel
Concrete Reinforcement
Electrical Wires
Flat Wire
Hoops
Manufacturing Wires
Nails
Netting
Piano Wire
Plain Wire
Rail Bonds
Screw Stock
Spikes
Springs
Steel Gates
Steel Posts
Strand
Tacks
Telegraph Wire
Telephone Wire
Trolley Wire
Welding Wire
Wire Fabric
Wire Fence
Wire Rope
Wire for Manufacturing Purposes
U S S Stainless and
Heat Resisting Steels

THE CANADIAN BRIDGE COMPANY, LTD.

General Offices: Walkerville, Ontario, Canada

STEEL STRUCTURES OF ALL CLASSES

Railway Bridges
Highway Bridges
Ferry Aprons
Mill Buildings
Office Buildings
Oil Storage Tanks
Poles, Galvanized
Radio Masts, Galvanized
Towers, Galvanized
Turntables

CYCLONE FENCE COMPANY

General Offices: Waukegan, Ill.

ORNAMENTAL AND PROTECTIVE FENCE

Chain Link Protective Fence
Chain Link Road Guard
Ornamental Iron Fence
Ornamental Lawn Fence
Chain Link Conveyor Belting
Screen Cloth
Hardware Cloth
Woven Wire Partitions
Wire Baskets (Rubbish Burners)

FEDERAL SHIPBUILDING AND DRY DOCK COMPANY

General Offices: Lincoln Highway, Kearny, N. J.

SHIPS AND STEEL FABRICATION

Builders and Repairers of—
Merchant Ships
Barges, Dredges, Lighters
Heavy Machine Work
Steel Fabrication

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES OF UNITED STATES STEEL CORPORATION—Concluded

NATIONAL TUBE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

WELDED AND SEAMLESS STEEL TUBULAR PRODUCTS

Standard Pipe
Copper Steel Pipe
Line Pipe, Casing
Oil Well Tubing
Drive Pipe
Rotary Drill Pipe
Galvanized Pipe
Special Dipped and Coated Pipe
Duroline (cement lined) Pipe
Boiler Tubes
Seamless Mechanical Tubing
Aircraft Tubing
Seamless Alloy Tubing
Trolley Poles, Line Poles
Cylinders, Seamless Couplings
U S S Stainless and Heat Resisting Pipes and Tubes

OIL WELL SUPPLY COMPANY

General Offices: Dallas, Texas

OIL FIELD DRILLING AND PUMPING MACHINERY AND AUXILIARY EQUIPMENT

"Oilwell", "Imperial", "Wilson-Snyder" and "Erie Ball" Products

General Machine Products
Drop and Light Hammer Forgings
Steel and Iron Castings
Erie Ball Steam Engines
Locomotive Type Boilers
Swaged Nipples and Bull Plugs
Special Fittings
Wilson-Snyder Pumping Machinery

UNIVERSAL ATLAS CEMENT COMPANY

General Offices: 208 South La Salle St., Chicago, Ill.

Atlas Portland Cement
Universal Portland Cement
Atlas White Portland Cement
Atlas Lumnite
Atlas Waterproofed White Portland Cement

CARNEGIE-ILLINOIS STEEL CORPORATION

General Offices, Pittsburgh, Pa. .... Carnegie Building

TENNESSEE COAL, IRON AND RAILROAD COMPANY

General Offices, Birmingham, Ala. .... Brown-Marx Building

DISTRICT AND SUB-OFFICES:

Birmingham .... Brown-Marx Building, 2000 First Avenue North
New Orleans, La. .... Maison Blanche, 921 Canal Street

Boston .... Statler Office Building, 20 Providence Street
Hartford, Conn. .... 31 Fairmont Street (Wethersfield)

Chicago .... 208 South La Salle Street

Cincinnati .... Union Trust Building, Fourth and Walnut Streets
Columbus, Ohio .... American Insurance Union Citadel, 50 West Broad St.
Lexington, Ky. .... 400 North Broadway
Louisville, Ky. .... 4528 West Broadway

Cleveland .... Rockefeller Building, 614 Superior Avenue, N. W.
Buffalo, N. Y. .... Liberty Bank Building, 424 Main Street

Denver .... First National Bank Building, 17th and Stout Streets

Detroit .... General Motors Building
Toledo, Ohio .... Toledo Club, 14th Street and Madison Avenue

Houston .... Petroleum Building
Dallas, Texas .... 703 Praetorian Building

Indianapolis .... Chamber of Commerce Bldg., 320 No. Meridian St.

Milwaukee .... Bankers Building, 208 East Wisconsin Avenue

New York .... 71 Broadway
Albany, N. Y. .... 90 State Street

Philadelphia .... Broad Street Station Building, 1617 Pennsylvania Blvd.

Pittsburgh .... Carnegie Building, 434 Fifth Avenue
Bluefield, W. Va. .... 2129 Jefferson Street
Parkersburg, W. Va. .... 1815 Washington Avenue
Warren, Pa. .... 208 Conewango Avenue
Youngstown, O. .... Union National Bank Building

St. Louis .... Mississippi Valley Trust Building, 506 Olive Street
Kansas City, Mo. .... 1410 Fidelity Bank Building
Tulsa, Okla. .... 1905 Philtower Building

St. Paul .... E 1308 First National Bank Building, 337 Robert Street
Duluth, Minn. .... Wolvin Building, 227 West First Street
Minneapolis, Minn. .... Security Building, 401-411 Second Avenue South

Washington .... 405 American Security Bldg., 15th St. & Pennsylvania Ave.

LORAIN DIVISION

Atlanta .... Trust Company of Georgia Building
Chicago .... 208 South La Salle Street
Cleveland .... Rockefeller Building, 614 Superior Avenue, N. W.
Philadelphia .... Broad Street Station Building, 1617 Pennsylvania Blvd.
Pittsburgh .... Frick Building
New York .... Empire State Building, 350 Fifth Avenue

COLUMBIA STEEL COMPANY

San Francisco .... Russ Building, 235 Montgomery Street
Los Angeles .... 2087 East Slauson Avenue
Portland .... 2345 N. W. Nicolai Street
Salt Lake City .... Walker Bank Building
Seattle .... Fourth Avenue South and Connecticut Street

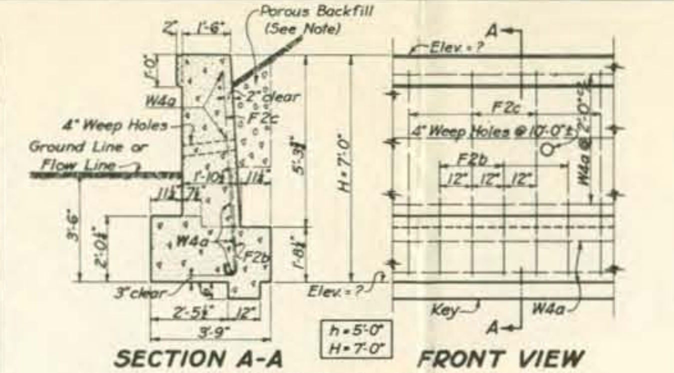
EXPORTERS OF THEIR PRODUCTS

UNITED STATES STEEL PRODUCTS COMPANY

New York .... Hudson Terminal Building, 30 Church Street

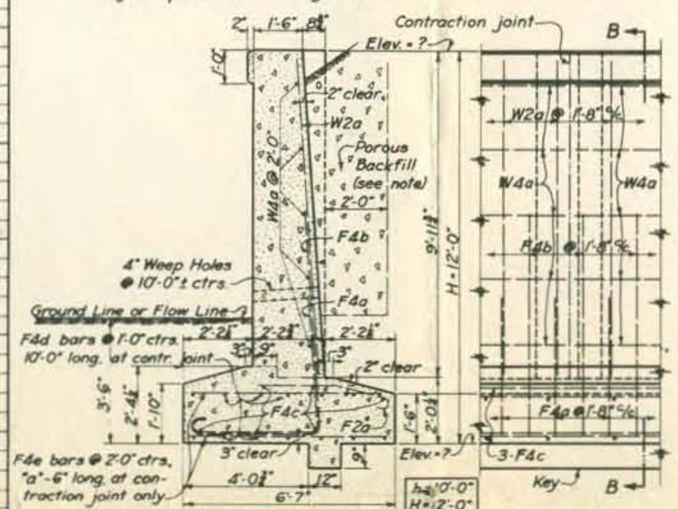
RETAINING WALL DIMENSIONS, STEEL DETAILS, AND QUANTITIES

Fill "h" (ft.)	H (ft.)	a	b	c	d	e	M-Bars Size	M-Bars f	M-Bars k	M-Bars Length	N-Bars Size	N-Bars g	N-Bars k	N-Bars Length	P-Bars Size	P-Bars m	P-Bars n	P-Bars Length	S-Bars Size	S-Bars Length	Spacing (M, N, P and S-Bars)	O-Bars Size	O-Bars Spcg.	O-Bars Length	R-Bars ⅝"φ No. in Wall	R-Bars ⅝"φ No. in Ftg.	Max. Footing Pressure (lb/sq ft) Toe	Max. Footing Pressure (lb/sq ft) Heel	Reinf. Steel/ft Wall & Ftg. Lbs.	Conc. per ft. Wall Cu.Yd.	Conc. per ft. Ftg. Cu.Yd.	H (ft.)
5	6	3'-3"	1'-7½"	1'-9½"	6"	12"	½"φ	5'-3"	—	6'-0"	½"φ	3'-2"	—	3'-11"	—	—	—	—	—	—	12"	Omit "O"			2	2	1500	300	8	.27	.23	6
	7	3'-9"	1'-8½"	1'-10½"	6"	12"	½"φ	6'-3"	—	7'-0"	½"φ	3'-3"	—	4'-0"	—	—	—	—	—	—	12"	bars here			3	2	1700	300	9	.33	.27	7
	8	4'-3"	1'-9"	1'-11½"	6"	12"	½"φ	7'-3"	—	8'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	and extend			3	2	1900	300	10	.40	.32	8
	9	4'-9"	1'-9½"	2'-0½"	6"	12"	½"φ	8'-3"	—	9'-0"	½"φ	3'-5"	—	4'-2"	—	—	—	—	—	—	12"	"M" bars to			4	2	2100	300	11	.47	.36	9
	10	5'-4"	1'-10½"	2'-1"	6"	12"	½"φ	9'-3"	—	10'-0"	½"φ	3'-5"	—	4'-2"	—	—	—	—	—	—	11"	top of wall.			4	2	2300	300	12	.54	.42	10
	11	5'-10"	1'-11½"	2'-2"	6"	12"	½"□	5'-6"	3'-3"	9'-9"	½"□	3'-6"	3'-3"	7'-9"	½"φ	2'-6"	1'-2"	4'-5"	—	—	12"	½"φ	24"	8'-9"	5	4	2500	300	23	.61	.47	11
	12	6'-4"	1'-11½"	2'-2½"	9"	12"	⅝"φ	6'-6"	3'-6"	11'-3"	⅝"φ	4'-0"	3'-6"	8'-9"	½"φ	2'-6"	1'-4"	4'-7"	—	—	12"	½"φ	24"	9'-9"	5	4	2700	300	27	.69	.50	12
	13	6'-10"	2'-0½"	2'-3½"	9"	12"	⅝"φ	6'-6"	3'-9"	11'-6"	⅝"φ	4'-0"	3'-9"	9'-0"	½"φ	2'-6"	1'-7"	4'-10"	—	—	10"	½"φ	20"	10'-9"	6	6	2800	300	34	.77	.55	13
	14	7'-4"	2'-1½"	2'-4½"	9"	12"	¾"φ	7'-7"	4'-0"	13'-1"	¾"φ	4'-7"	4'-0"	10'-1"	½"□	2'-6"	1'-10"	5'-1"	—	—	12"	½"φ	24"	11'-6"	6	6	2900	300	38	.85	.60	14
	15	7'-10"	2'-2½"	2'-5½"	9"	12"	¾"φ	7'-8"	4'-3"	13'-5"	¾"φ	4'-8"	4'-3"	10'-5"	½"□	2'-6"	2'-1"	5'-4"	—	—	10"	½"φ	20"	12'-6"	7	8	3000	300	48	.93	.65	15
	16	8'-5"	2'-2½"	2'-6"	12"	12"	⅞"φ	8'-7"	4'-6"	14'-10"	⅞"φ	5'-1"	4'-6"	11'-4"	⅝"φ	3'-0"	2'-3"	6'-2"	—	—	11½"	⅝"φ	23"	13'-6"	7	8	3200	300	57	1.02	.72	16
	17	8'-11"	2'-3½"	2'-6½"	12"	12"	⅞"φ	8'-8"	4'-9"	15'-2"	⅞"φ	5'-2"	4'-9"	11'-8"	¾"φ	3'-6"	2'-5"	6'-11"	—	—	10"	⅝"φ	20"	14'-6"	8	8	3400	200	71	1.11	.77	17
	18	9'-5"	2'-4½"	2'-7½"	15"	12"	1"φ	9'-8"	5'-0"	16'-7"	1"φ	5'-8"	5'-0"	12'-7"	¾"φ	3'-6"	2'-7"	7'-1"	—	—	10½"	⅝"φ	21"	15'-3"	8	8	3600	200	83	1.20	.82	18
	19	9'-11"	2'-5"	2'-8½"	15"	12"	1"□	9'-9"	5'-3"	16'-11"	1"□	5'-9"	5'-3"	12'-11"	⅞"φ	4'-0"	2'-9"	7'-11"	—	—	12"	⅝"φ	24"	16'-3"	9	8	3800	100	96	1.29	.87	19
	20	10'-5"	2'-5½"	2'-9½"	15"	12"	1"□	9'-10"	5'-7"	17'-4"	1"□	5'-10"	5'-7"	13'-4"	1"φ	4'-6"	2'-11"	8'-9"	½"φ	3'-3"	11"	¾"φ	22"	17'-3"	9	8	4000	100	117	1.38	.93	20
	21	10'-11"	2'-6½"	2'-10½"	18"	12"	1⅛"□	10'-10"	5'-8"	18'-8"	1⅛"□	6'-4"	5'-8"	14'-2"	1"□	4'-6"	3'-2"	9'-0"	½"φ	3'-6"	12"	¾"φ	24"	18'-3"	10	8	4200	0	137	1.49	1.00	21
	22	11'-5"	2'-7"	2'-11"	18"	12"	1⅛"□	10'-11"	6'-0"	19'-1"	1⅛"□	6'-5"	6'-0"	14'-7"	1"□	4'-6"	3'-5"	9'-3"	½"φ	3'-6"	11"	¾"φ	22"	19'-3"	10	8	4300	0	157	1.59	1.06	22
	23	12'-0"	2'-7½"	2'-11½"	21"	12"	1⅛"□	10'-11"	6'-4"	19'-5"	1⅛"□	6'-5"	6'-4"	14'-11"	1"□	4'-6"	3'-8"	9'-6"	⅝"φ	4'-3"	10"	1"φ	20"	20'-0"	11	10	4500	0	187	1.68	1.13	23
	24	12'-6"	2'-8½"	3'-0½"	21"	12"	1¼"□	11'-11"	6'-6"	20'-10"	1¼"□	6'-11"	6'-6"	15'-10"	1"□	4'-6"	3'-10"	9'-8"	⅝"φ	4'-3"	11"	1"φ	22"	21'-0"	11	10	4600	0	200	1.79	1.19	24
	25	13'-0"	2'-9½"	3'-1½"	24"	15"	1¼"□	12'-0"	6'-9"	21'-2"	1¼"□	7'-0"	6'-9"	16'-2"	1"□	4'-6"	4'-1"	9'-11"	¾"φ	4'-6"	9½"	1"φ	19"	22'-0"	12	10	4800	0	235	1.90	1.28	25
	26	13'-6"	2'-10"	3'-2½"	24"	15"	1¼"□	12'-1"	7'-1"	21'-7"	1¼"□	7'-1"	7'-1"	16'-7"	1"□	4'-6"	4'-4"	10'-2"	¾"φ	4'-6"	9"	1"□	18"	23'-0"	12	10	5000	0	263	2.00	1.34	26
10	6	3'-6"	1'-8"	1'-9½"	6"	12"	½"φ	5'-3"	—	6'-0"	½"φ	3'-3"	—	4'-0"	—	—	—	—	—	—	12"	Omit "O"			2	2	1400	400	8	.27	.25	6
	7	4'-0"	1'-8½"	1'-10½"	6"	12"	½"φ	6'-3"	—	7'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	bars here			3	2	1700	400	9	.33	.29	7
	8	4'-6"	1'-9½"	1'-11½"	6"	12"	½"φ	7'-3"	—	8'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	and extend			3	2	1900	400	10	.40	.34	8
	9	5'-0"	1'-10"	2'-0½"	6"	12"	½"φ	8'-3"	—	9'-0"	½"φ	3'-5"	—	4'-2"	—	—	—	—	—	—	12"	"M" bars to			4	2	2200	300	11	.47	.38	9
	10	5'-7"	1'-10½"	2'-1"	9"	12"	½"φ	9'-3"	—	10'-0"	½"φ	3'-6"	—	4'-3"	—	—	—	—	—	—	12"	top of wall.			4	2	2400	300	12	.54	.45	10
	11	6'-1"	1'-11½"	2'-2"	9"	12"	⅝"φ	6'-5"	3'-4"	11'-1"	⅝"φ	3'-11"	3'-4"	8'-7"	½"φ	2'-6"	1'-4"	4'-7"	—	—	12"	½"φ	24"	8'-9"	5	4	2600	300	26	.61	.51	11
	12	6'-7"	2'-0½"	2'-2½"	9"	12"	⅝"φ	6'-6"	3'-7"	11'-5"	⅝"φ	4'-0"	3'-7"	8'-11"	½"φ	2'-6"	1'-6"	4'-9"	—	—	10"	½"φ	20"	9'-9"	5	6	2800	300	32	.69	.53	12
	13	7'-1"	2'-1"	2'-3½"	12"	12"	¾"φ	7'-6"	3'-10"	12'-10"	¾"φ	4'-6"	3'-10"	9'-10"	⅝"φ	3'-0"	1'-8"	5'-7"	—	—	12"	½"φ	24"	10'-9"	6	6	3000	300	39	.77	.58	13
	14	7'-7"	2'-1½"	2'-4½"	12"	12"	¾"φ	7'-7"	4'-1"	13'-2"	¾"φ	4'-7"	4'-1"	10'-2"	⅝"φ	3'-0"	1'-11"	5'-10"	—	—	10"	½"φ	20"	11'-6"	6	8	3200	300	48	.85	.63	14
	15	8'-1"	2'-2½"	2'-5½"	12"	12"	⅞"φ	8'-7"	4'-3"	14'-7"	⅞"φ	5'-1"	4'-3"	11'-1"	¾"φ	3'-6"	2'-0"	6'-6"	—	—	11"	½"φ	22"	12'-6"	7	8	3400	300	60	.93	.69	15
	16	8'-8"	2'-3½"	2'-6"	15"	12"	1"φ	9'-7"	4'-6"	16'-0"	1"φ	5'-7"	4'-6"	12'-0"	¾"φ	3'-6"	2'-4"	6'-10"	—	—	12"	½"φ	24"	13'-6"	7	8	3500	300	68	1.01	.75	16
	17	9'-2"	2'-4"	2'-6½"	15"	12"	1"φ	9'-8"	4'-10"	16'-5"	1"φ	5'-8"	4'-10"	12'-5"	¾"φ	3'-6"	2'-6"	7'-0"	—	—	10"	⅝"φ	20"	14'-6"	8	8	3700	200	85	1.10	.80	17
	18	9'-8"	2'-4½"	2'-7½"	15"	12"	1"□	9'-9"	5'-1"	16'-9"	1"□	5'-9"	5'-1"	12'-9"	⅞"φ	4'-0"	2'-8"	7'-10"	½"φ	3'-3"	12"	⅝"φ	24"	15'-3"	8	8	3900	200	97	1.19	.86	18
	19	10'-2"	2'-5½"	2'-8½"	18"	12"	1"□	9'-9"	5'-4"	17'-0"	1"□	5'-9"	5'-4"	13'-0"	⅞"φ	4'-0"	2'-11"	8'-1"	½"φ	3'-6"	10½"	¾"φ	21"	16'-3"	9	8	4100	200	112	1.29	.91	19
	20	10'-8"	2'-6"	2'-9½"	18"	12"	1⅛"□	10'-10"	5'-7"	18'-7"	1⅛"□	6'-4"	5'-7"	14'-1"	1"φ	4'-6"	3'-1"	8'-11"	½"φ	3'-6"	12"	¾"φ	24"	17'-3"	9	8	4300	100	133	1.39	.97	20
	21	11'-2"	2'-6½"	2'-10"	18"	12"	1⅛"□	10'-10"	5'-10"	18'-10"	1⅛"□	6'-4"	5'-10"	14'-4"	1"φ	4'-6"	3'-4"	9'-2"	½"φ	3'-6"	10"	¾"φ	20"	18'-3"	10	10	4400	100	162	1.48	1.03	21
	22	11'-8"	2'-7½"	2'-11"	21"	12"	1¼"□	11'-10"	6'-0"	20'-3"	1¼"□	6'-10"	6'-0"	15'-3"	1"□	4'-6"	3'-6"	9'-4"	⅝"φ	4'-3"	11½"	¾"φ	23"	19'-0"	10	10	4500	100	178	1.58	1.09	22
	23	12'-3"	2'-8½"	2'-11½"	21"	12"	1¼"□	11'-11"	6'-4"	20'-8"	1¼"□	6'-11"	6'-4"	15'-8"	1"□	4'-6"	3'-9"	9'-7"	⅝"φ	4'-3"	10"	1"φ	20"	20'-0"	11	10	4600	100	215	1.68	1.16	23
	24	12'-9"	2'-9"	3'-0½"	24"	15"	1¼"□	12'-0"	6'-7"	21'-0"	1¼"□	7'-0"	6'-7"	16'-0"	1"□	4'-6"	4'-0"	9'-10"	¾"φ	4'-6"	9"	1"φ	18"	21'-0"	11	10	4800	100	242	1.79	1.25	24
	25	13'-3"	2'-9½"	3'-1½"	24"	15"	1¼"□	12'-0"	7'-0"	21'-5"	1¼"□	7'-0"	7'-0"	16'-5"	1"□	4'-6"	4'-2"	10'-0"	¾"φ	4'-6"	8½"	1"φ	17"	22'-0"	12	10	4900	100	262	1.90	1.31	25
	26	13'-9"	2'-10½"	3'-2½"	24"	15"	1¼"□	12'-1"	7'-3"	21'-9"	1¼"□	7'-1"	7'-3"	16'-9"	1"□	4'-6"	4'-5"	10'-3"	¾"φ	4'-6"	7½"	1"□	15"	22'-9"	12	10	5000	100	313	2.00	1.38	26
20	6	3'-8"	1'-8½"	1'-9½"	6"	12"	½"φ	5'-3"	—	6'-0"	½"φ	3'-3"	—	4'-0"	—	—	—	—	—	—	12"	Omit "O"			2	2	1400	500	8	.26	.27	6
	7	4'-3"	1'-9"	1'-10½"	6"	12"	½"φ	6'-3"	—	7'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	bars here			3	2	1700	500	9	.33	.32	7
	8	4'-10"	1'-9½"	1'-11½"	6"	12"	½"φ	7'-3"	—	8'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	and extend			3	2	2000	500	10	.40	.37	8
	9	5'-4"	1'-10½"	2'-0½"	9"	12"	½"φ	8'-3"	—	9'-0"	½"φ	3'-5"	—	4'-2"	—	—	—	—	—	—	12"	"M" bars to			4	2	2300	500	11	.46	.43	9
	10	5'-11"	1'-11½"	2'-1"	12"	12"	½"φ	9'-3"	—	10'-0"	½"φ	3'-6"	—	4'-3"	—	—	—	—	—	—	12"	top of wall.			4	2	2600	500	12	.53	.50	10
	11	6'-6"	2'-0½"	2'-1½"	12"	12"	⅝"φ	6'-6"	3'-7"	11'-5"	⅝"φ	4'-0"	3'-7"	8'-11"	½"φ	2'-6"	1'-6"	4'-9"	—	—	12"	½"φ	24"	8'-9"	5	6	2800	500	28	.60	.56	11
	12	7'-1"	2'-1"	2'-2½"	15"	12"	¾"φ	7'-6"	3'-9"	12'-9"	¾"φ	4'-6"	3'-9"	9'-9"	⅝"φ	2'-6"	1'-9"	5'-0"	—	—	12"	½"φ	24"	9'-9"	5	6	2900	500	36	.68	.59	12
	13	7'-8"	2'-1½"	2'-3½"	15"	12"	¾"φ	7'-7"	4'-1"	13'-2"	¾"φ	4'-7"	4'-1"	10'-2"	⅝"φ	3'-0"	2'-0"	5'-11"	—	—	11"	½"φ	22"	10'-6"	6	8	3100	500	45	.76	.64	13
	14	8'-2"	2'-2½"	2'-4½"	15"	12"	⅞"φ	8'-7"	4'-3"	14'-7"	⅞"φ	5'-1"	4'-3"	11'-1"	¾"φ	3'-6"	2'-2"	6'-8"	—	—	12"	½"φ	24"	11'-6"	6	8	3300	500	55	.84	.69	14
	15	8'-9"	2'-3½"	2'-5"	15"	12"	⅞"φ	8'-8"	4'-7"	15'-0"	⅞"φ	5'-2"	4'-7"	11'-6"	¾"φ	3'-6"	2'-5"	6'-11"	½"φ	3'-3"	10"	½"φ	20"	12'-6"	7	8	3400	600	69	.92	.75	15
	16	9'-4"	2'-4½"	2'-6"	18"	12"	1"φ	9'-8"	4'-10"	16'-5"	1"φ	5'-8"	4'-10"	12'-5"	⅞"φ	4'-0"	2'-7"	7'-9"	½"φ	3'-6"	11"	⅝"φ	22"	13'-3"	7	8	3600	600	83	1.01	.82	16
	17	9'-11"	2'-5"	2'-6½"	18"	12"	1"□	9'-9"	5'-2"	16'-10"	1"□	5'-9"	5'-2"	12'-10"	1"φ	4'-6"	2'-10"	8'-8"	½"φ	3'-6"	12"	⅝"φ	24"	14'-3"	8	8	3700	600	101	1.09	.89	17
	18	10'-6"	2'-6"	2'-7½"	21"	12"	1"□	9'-10"	5'-6"	17'-3"	1"□	5'-10"	5'-6"	13'-3"	1"□	4'-6"	3'-1"	8'-11"	½"φ	4'-3"	11"	⅝"φ	22"	15'-3"	8	8	3900	600	117	1.18	.96	18
	19	11'-0"	2'-6½"	2'-8½"	21"	12"	1⅛"□	10'-10"	5'-9"	18'-9"	1⅛"□	6'-4"	5'-9"	14'-3"	1"□	4'-6"	3'-4"	9'-2"	⅝"φ	4'-3"	11½"	¾"φ	23"	16'-3"	9	10	4000	700	144	1.28	1.03	19
	20	11'-7"	2'-7½"	2'-9½"	24"	15"	1⅛"□	10'-11"	6'-0"	19'-1"	1⅛"□	6'-5"	6'-0"	14'-7"	1"□	4'-6"	3'-7"	9'-5"	⅝"φ	4'-6"	10"	¾"φ	20"	17'-0"	9	10	4100	700	167	1.37	1.11	20
	21	12'-2"	2'-8½"	2'-10"	24"	15"	1¼"□	11'-11"	6'-3"	20'-7"	1¼"□	6'-11"	6'-3"	15'-7"	1"□	4'-6"	3'-10"	9'-8"	¾"φ	4'-6"	11"	¾"φ	22"	18'-0"	10	10	4300	700	187	1.47	1.18	21
	22	12'-9"	2'-9½"	2'-10½"	24"	15"	1¼"□	12'-0"	6'-7"	21'-0"	1¼"□	7'-0"	6'-7"	16'-0"	1"□	4'-6"	4'-1"	9'-11"	¾"φ	4'-6"	9½"	¾"φ	19"	19'-0"	10	10	4400	700	219	1.56	1.25	22
	23	13'-4"	2'-10"	2'-11½"	27"	15"	1¼"□	12'-1"	6'-11"	21'-5"	1¼"□	7'-1"	6'-11"	16'-5"	1"□	4'-6"	4'-4"	10'-2"	¾"φ	4'-9"	9"	⅞"φ	18"	20'-0"	11	10	4600	700	236	1.66	1.33	23
	24	13'-10"	2'-10½"	3'-0½"	27"	15"	1¼"□	12'-2"	7'-2"	21'-9"	1¼"□	7'-2"	7'-2"	16'-9"	1"□	4'-6"	4'-7"	10'-5"	¾"φ	4'-9"	8"	1"φ	16"	20'-9"	11	10	4700	700	278	1.76	1.40	24
	25	14'-5"	2'-11½"	3'-1"	27"	15"	1¼"□	12'-2"	7'-6"	22'-1"	1¼"□	7'-2"	7'-6"	17'-1"	1"□	4'-6"	4'-9"	10'-7"	¾"φ	4'-9"	7"	1"φ	14"	21'-9"	12	12	4800	700	325	1.86	1.47	25
	26	15'-0"	3'-0½"	3'-2"	30"	18"	1¼"□	12'-3"	7'-10"	22'-6"	1¼"□	7'-3"	7'-10"	17'-6"	1"□	4'-6"	5'-0"	10'-10"	¾"φ	5'-0"	6½"	1"φ	13"	22'-9"	12	12	5000	700	356	1.97	1.58	26
40	6	3'-9"	1'-8½"	1'-9½"	6"	12"	½"φ	5'-3"	—	6'-0"	½"φ	3'-3"	—	4'-0"	—	—	—	—	—	—	12"	Omit "O"			2	2	1500	500	8	.26	.28	6
	7	4'-4"	1'-9½"	1'-10½"	6"	12"	½"φ	6'-3"	—	7'-0"	½"φ	3'-4"	—	4'-1"	—	—	—	—	—	—	12"	bars here			3	2	1700	500	9	.33	.33	7
	8	5'-0"	1'-10½"	1'-11½"	9"	12"	½"φ	7'-3"	—	8'-0"	½"φ	3'-5"	—	4'-2"	—	—	—	—	—	—	12"	and extend			3	2	2000	500	10	.39	.40	8
	9	5'-7"	1'-11"	2'-0½"	9"	12"	½"φ	8'-3"	—	9'-0"	½"φ	3'-6"	—	4'-3"	—	—	—	—	—	—	12"	"M" bars to			4	2	2200	500	11	.46	.46	9
	10	6'-2"	1'-11½"	2'-1"	12"	12"	½"□	9'-3"	—	10'-0"	½"□	3'-6"	—	4'-3"	—	—	—	—	—	—	12"	top of wall.			4	2	2400	500	12	.53	.52	10
	11	6'-9"	2'-0½"	2'-1½"	12"	12"	⅝"φ	6'-7"	3'-8"	11'-7"	⅝"φ	4'-1"	3'-8"	9'-1"	½"□	2'-6"	1'-7"	4'-10"	—	—	12"	½"φ	24"	8'-9"	5	6	2600	500	30	.60	.59	11
	12	7'-4"	2'-1½"	2'-2½"	15"	12"	¾"φ	7'-7"	3'-11"	13'-0"	¾"φ	4'-7"	3'-11"	10'-0"	⅝"φ	3'-0"	1'-10"	5'-9"	—	—	12"	½"φ	24"	9'-6"	5	8	2800	600	40	.67	.61	12
	13	8'-0"	2'-2½"	2'-3½"	18"	12"	¾"φ	7'-8"	4'-4"	13'-6"	¾"φ	4'-8"	4'-4"	10'-6"	⅝"φ	3'-0"	2'-2"	6'-1"	½"φ	3'-6"	10"	½"φ	20"	10'-6"	6	8	3000	600	51	.77	.69	13
	14	8'-7"	2'-3½"	2'-4½"	18"	12"	⅞"φ	8'-8"	4'-6"	14'-11"	⅞"φ	5'-2"	4'-6"	11'-5"	¾"φ	3'-6"	2'-4"	6'-10"	½"φ	3'-6"	11"	⅝"φ	22"	11'-6"	6	8	3100	700	62	.83	.75	14
	15	9'-2"	2'-4½"	2'-5"	18"	12"	1"φ	9'-8"	4'-9"	16'-4"	1"φ	5'-8"	4'-9"	12'-4"	⅞"φ	4'-0"	2'-6"	7'-8"	⅝"φ	4'-0"	12"	⅝"φ	24"	12'-3"	7	8	3300	700	78	.92	.81	15
	16	9'-9"	2'-5"	2'-6"	21"	12"	1"φ	9'-9"	5'-0"	16'-8"	1"φ	5'-9"	5'-0"	12'-8"	⅞"φ	4'-0"	2'-9"	7'-11"	⅝"φ	4'-3"	10"	⅝"φ	20"	13'-3"	7	8	3500	800	93	1.00	.89	16
	17	10'-4"	2'-6"	2'-6½"	24"	15"	1"□	9'-10"	5'-4"	17'-1"	1"□	5'-10"	5'-4"	13'-1"	1"φ	4'-6"	3'-0"	8'-10"	⅝"φ	4'-6"	11"	¾"φ	22"	14'-3"	8	8	3700	800	112	1.09	.98	17
	18	11'-0"	2'-6½"	2'-7½"	27"	15"	1⅛"□	10'-10"	5'-7"	18'-7"	1⅛"□	6'-4"	5'-7"	14'-1"	1"□	4'-6"	3'-4"	9'-2"	¾"φ	5'-3"	12"	¾"φ	24"	15'-3"	8	10	3900	900	136	1.18	1.06	18
	19	11'-7"	2'-7½"	2'-8½"	27"	15"	1⅛"□	10'-11"	6'-0"	19'-1"	1⅛"□	6'-5"	6'-0"	14'-7"	1"□	4'-6"	3'-7"	9'-5"	¾"φ	5'-3"	11"	¾"φ	22"	16'-0"	9	10	4000	900	156	1.26	1.12	19
	20	12'-2"	2'-8½"	2'-9"	27"	15"	1¼"□	11'-11"	6'-3"	20'-7"	1¼"□	6'-11"	6'-3"	15'-7"	1"□	4'-6"	3'-10"	9'-8"	¾"φ	5'-3"	11½"	¾"φ	23"	17'-0"	9	10	4200	1000	177	1.36	1.19	20
	21	12'-9"	2'-9½"	2'-10"	27"	15"	1¼"□	12'-0"	6'-6"	20'-11"	1¼"□	7'-0"	6'-6"	15'-11"	1"□	4'-6"	4'-1"	9'-11"	¾"φ	5'-3"	10"	¾"φ	20"	18'-0"	10	10	4400	1000	206	1.46	1.27	21
	22	13'-4"	2'-10"	2'-10½"	27"	15"	1¼"□	12'-1"	6'-10"	21'-4"	1¼"□	7'-1"	6'-10"	16'-4"	1"□	4'-6"	4'-4"	10'-2"	¾"φ	5'-3"	9"	⅞"φ	18"	19'-0"	10	10	4500	1000	238	1.56	1.34	22
	23	14'-0"	2'-11"	2'-11½"	30"	18"	1¼"□	12'-2"	7'-3"	21'-10"	1¼"□	7'-2"	7'-3"	16'-10"	1"□	4'-6"	4'-8"	10'-6"	¾"φ	5'-6"	8"	⅞"φ	16"	19'-9"	11	12	4700	1000	275	1.65	1.45	23
	24	14'-7"	3'-0"	3'-0½"	30"	18"	1¼"□	12'-3"	7'-6"	22'-2"	1¼"□	7'-3"	7'-6"	17'-2"	1"□	4'-6"	4'-11"	10'-9"	⅞"φ	5'-0"	7"	1"φ	14"	20'-9"	11	12	4800	1000	323	1.75	1.54	24
	25	15'-2"	3'-1½"	3'-1"	30"	18"	1¼"□	12'-4"	7'-11"	22'-8"	1¼"□	7'-4"	7'-11"	17'-8"	1"□	4'-6"	5'-2"	11'-0"	⅞"φ	5'-0"	6½"	1"φ	13"	21'-6"	12	12	5000	1100	355	1.85	1.62	25
	26	15'-9"	3'-2½"	3'-1½"	33"	18"	1¼"□	12'-5"	8'-3"	23'-1"	1¼"□	7'-5"	8'-3"	18'-1"	1"□	4'-6"	5'-5"	11'-3"	⅞"φ	5'-9"	5½"	1"φ	11"	22'-6"	12	12	5100	1100	427	1.96	1.72	26



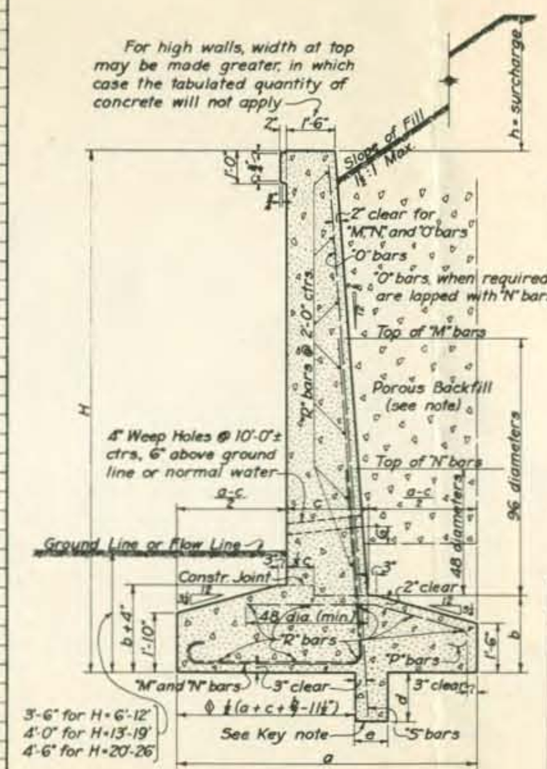
SECTION A-A FRONT VIEW

Sloped top of toe and heel of footing shall be eliminated for heights up to and including 11 feet.



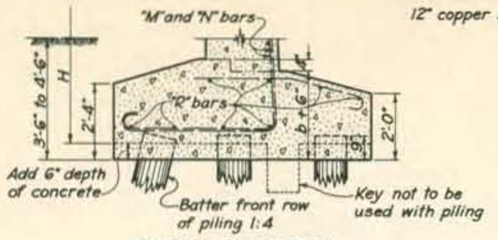
SECTION B-B FRONT VIEW

SHOWING CONTRACTION JOINT



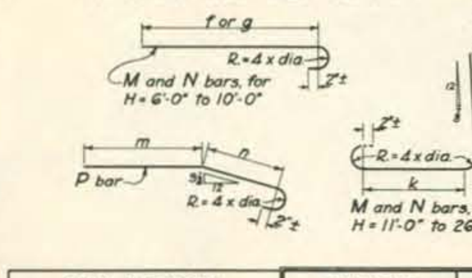
TYPICAL SECTION

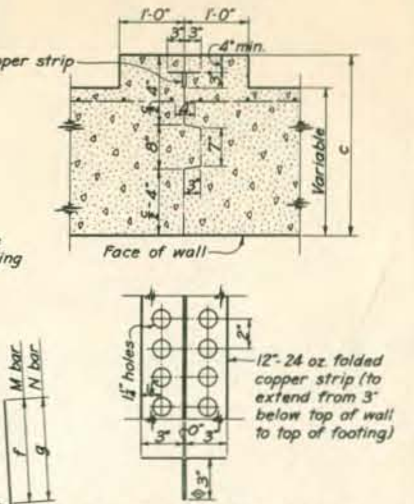
Sloped top of toe and heel of footing shall be eliminated where "H" is 11 feet or less.



PART SECTION

SHOWING ALTERATIONS REQUIRED IN FOOTING WHEN PILES ARE USED





CONTRACTION JOINT DETAILS

THIS DRAWING gives design data for reinforced concrete retaining walls where satisfactory subsoil conditions exist, for the pressures indicated.

SPECIAL CARE AND JUDGMENT should be exercised by the engineer in the use of data on this drawing, because retaining wall design is influenced by such features as: height of wall, height and slope of earth surcharge, weight and stability of retained material, live load surcharge, and the adequacy of foundation soil for resistance to both overturning and sliding. The design data on this drawing are based on a 1½:1 sloping surcharge; for steeper slopes or for saturated retained material, special design will be required. Familiarity with the pertinent provisions in "Specifications for Design of Highway Structures" is important. The adequacy of the subsoil and the need for piling should be carefully considered, although for a small height of wall, the footing pressures (as tabulated) are very low.

FOOTING WIDTH "a" may be reduced 10% to 20% where footing rests upon hard materials such as cemented gravel, shale, or rock.

CONTRACTION JOINTS, as shown, should be spaced not to exceed 30 feet apart. No allowance has been made in tabulated quantities per foot, for extra concrete at joints, or extra reinforcing steel in footings at joints.

KEYS on bottoms of footings may be omitted where the toe is placed against undisturbed hard materials or where piles are used.

PILING should be provided (or the footings increased in width) where the toe pressure tabulated hereon (or as computed in special cases) exceeds the safe bearing resistance (as estimated by the engineer) of the foundation soil. In streams where erosion is probable, piling should be used (if possible to drive) as protection against scour, even though the safe bearing resistance of the soil is adequate. The spacing of piles should take into account the varying intensity of pressure on the footing, so that loads on individual piles may be as nearly equal as possible, with a maximum load of 18 tons per pile. In case of high walls and high surcharge in conjunction with yielding foundation materials, resistance to horizontal thrust should be provided by the use of toe sheeting or battered piles, or both.

DIMENSIONS for intermediate heights of walls with varying surcharges may be interpolated from the tables.

WALLS having no earth surcharge but subject to any traffic type of surcharge shall be designed as a wall having a five foot earth surcharge.

POROUS BACKFILL is to be placed back of the wall, extending from an elevation 6 inches below weep holes to top of earth backfill, with a width at the bottom equal to the heel projection, except that where this heel projection is greater than 2 feet, the designer shall take into account both the suitability of material at the site for porous backfill purposes and the cost of shipped-in material; if material is available at the site, the porous backfill is to be carried out to the back of the footing regardless of the width of heel projection, but if shipped-in material of appreciable cost would be required, the width of the porous backfill is to be 2 feet unless the heel projection is less than 2 feet.

CONCRETE for retaining walls and footings shall be Class C.

REINFORCING BARS shown in "Typical Section" are marked with letters corresponding with bars shown in the table, but markings shown in Sections A-A and B-B are as to be used on plans for specific projects.

BAR LEGEND

Illustration of marking system to be used on plans for specific projects.

Location / Size / Mark: W5a, W5b, F4a

W = Walls, F = Footings

Sizes	
⅜"φ	1
½"φ	2
½"□	3
⅝"φ	4
¾"φ	5
⅞"φ	6
1"φ	7
1"□	8
1⅛"□	9
1¼"□	0

REVISIONS:
10/14/33 marked ◊
3/8/39 (Conc. Class)

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
BUREAU OF BRIDGES

DESIGN DATA FOR REINFORCED CONCRETE RETAINING WALLS

HEIGHTS 6 FT. TO 26 FT.

APPROVED: DATE 6-17-33 [signature] CHIEF ENGR. OF BRIDGES

DESIGNED: [initials] DRAWN: W.C.K. TRACED: R.B.K. CHECKED: [initials] REVIEWED: W.H.R.

DRAWING NUMBER RW-33

Old 27' Span Good for

83 ~~70#~~ '□' @ 1000 psi

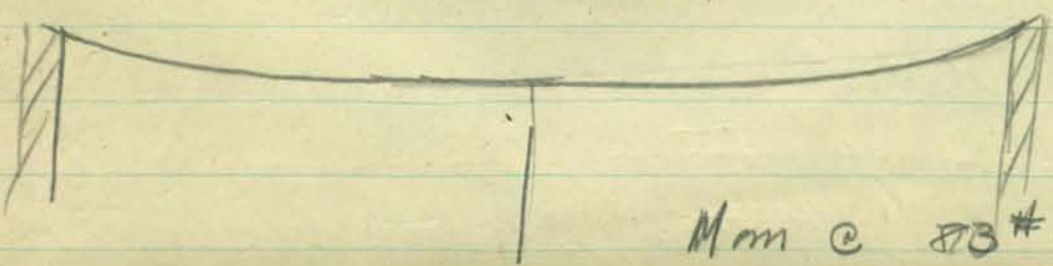
Mom = $M = \frac{S\,bd^2}{6} = \frac{1000 \times 2.5 \times 225}{6} = 94000$ ''#

Girder Good for 450 #'ft @ 1000 psi

For 83# / □' on Supported Joist

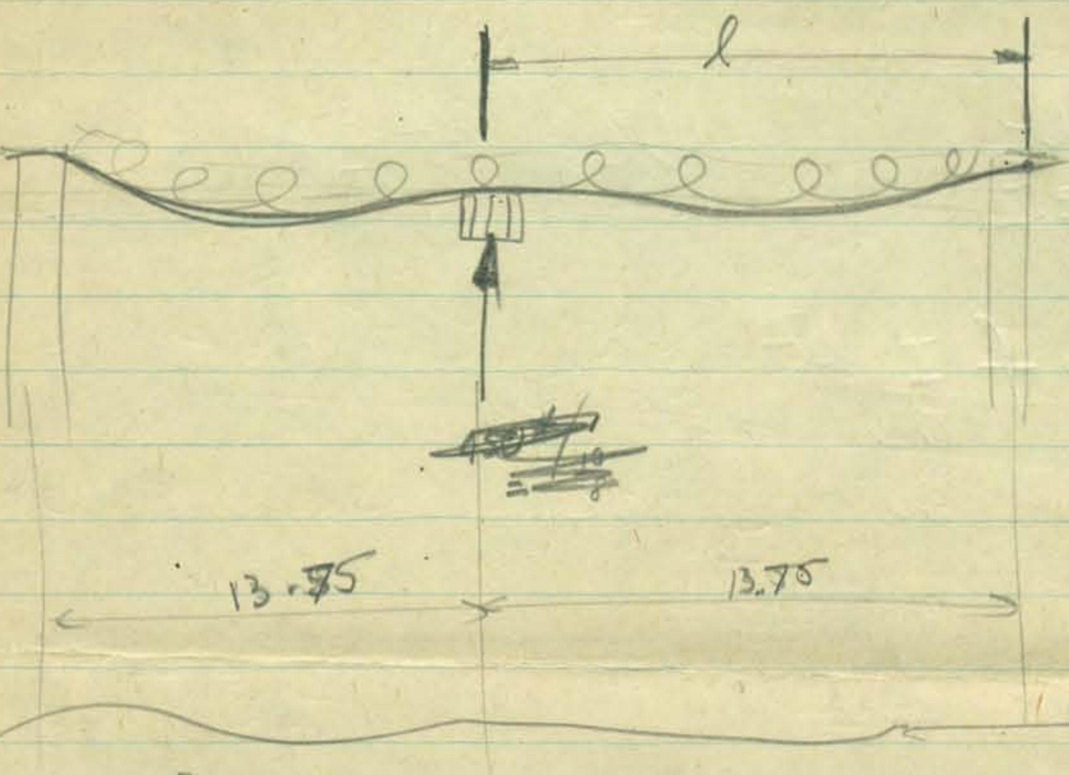
R @ ctr would be $83 \times 13.75 \times \frac{10}{8} = 1440$#

(or stress of 3200 psi In Girder)



Mom @ 83# = $\frac{83 \times 27.5 \times 27.5 \times 12}{8}$

= 94000 ''#



2 Span Continuous

$M = \frac{1}{8} w l^2$ @

$94000 = \frac{1}{8} w \cdot \overline{13.75}^2 \times 12$

$w = \frac{94000 \times 8}{13.75^2 \times 12}$

= 332#

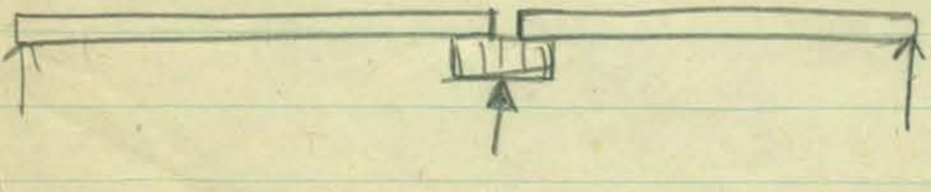
R @ center

$= 332 \times 13.75 \times \frac{10}{8} = 5710$#

R @ End

$332 \times 13.75 \times \frac{3}{8} = 1710$

Relieving Mom $13.5 \times 12 \times \frac{450}{2} = 36,400$ '#

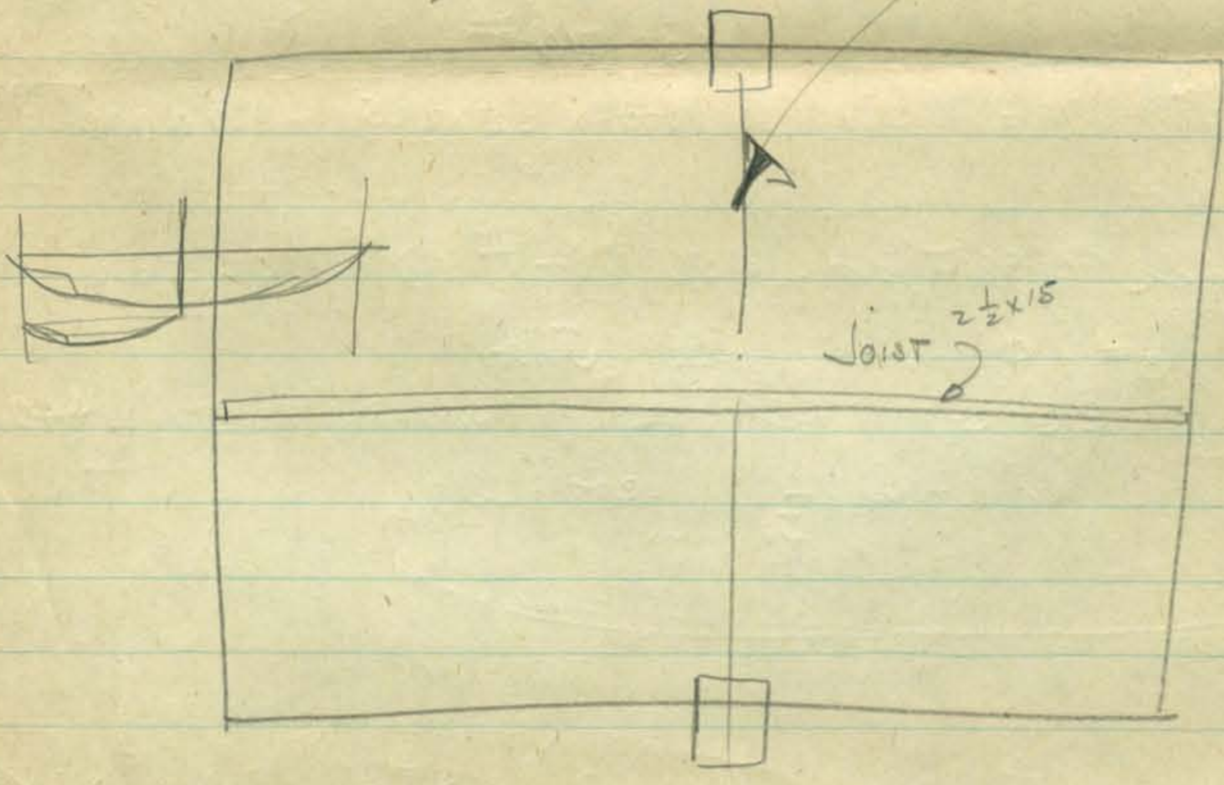


$$\begin{array}{r} 11\text{-}7 \\ 1\text{-}1 \\ \hline 12\text{-}8 \end{array}$$

$$\frac{Wl^2}{8} = \frac{SI}{\cancel{c}\,n}$$

4-2×12 Timbers

$Wl =$



Def. $\dfrac{5Wl^3}{384EI}$

$Wl = 8f\dfrac{I}{n}$

$\underline{40 \cdot f \dfrac{I}{n}\, l^2}$

30' Span 12"

F. C. MILLER