CHEVRON BRACING IN LOW-RISE BUILDINGS

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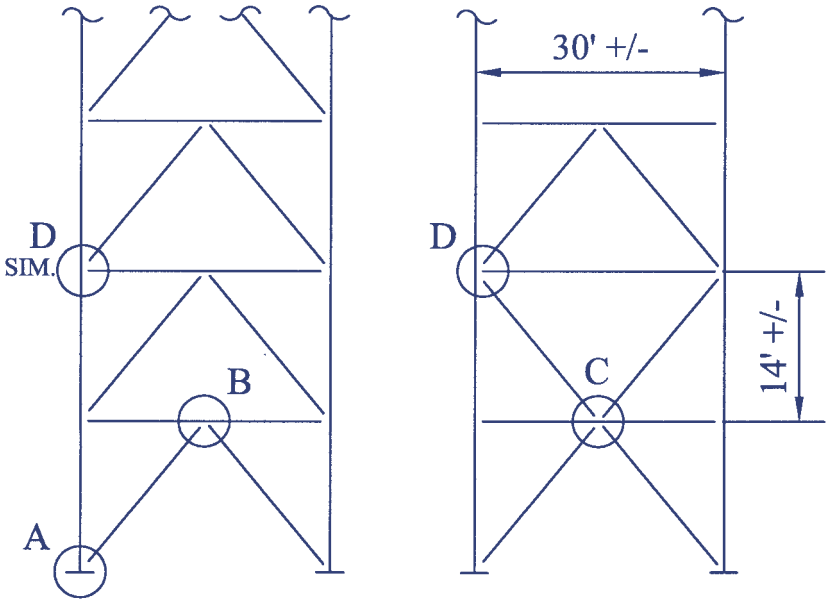
Estimating member sizes for chevron bracing in low-rise steel-framed construction is easier than ever with this handy design aid.



Schematic of typical chevron brace configurations. The details circled are highlighted in later figures in this article.

Chevron braces are a common configuration for providing lateral-load resistance in steel-framed buildings. This handy chart will help you quickly estimate the brace size and connection material required for a given force in chevron bracing designed to resist lateral forces due to gravity, wind and low-seismic loads.[1] These rules of thumb don't cover all situations, but they will provide a reasonable starting point for the preliminary brace and connection design or cost estimating.

Estimated brace sizes, gusset plate thicknesses, and required number of bolts or size and length of the welds are tabulated for a practical range of *unfactored* brace forces (tensile and compressive). The bolts and welds indicated are for the connection of the brace to the gusset plate. A 3" center-to-center bolt spacing and a 1½" edge distance were assumed in the connection design. Suggested details for the various connections involved in chevron bracing are also included for each of the bracing types: HSS, W-shapes, WT-shapes and double angles.

The connection(s) of the gusset plate to the beam and / or column are not addressed in the table. Also, drift control issues must be considered separately.

The minimum length of the welds for the connection of the HSS to the gusset is 1.3 times the diameter of the round HSS or 1.3 times the side of the square HSS. Rectangular HSS are not included. This minimum length allows the welds to be designed with a shear lag coefficient $U = 1$ in the HSS.[2] A smaller weld length may be acceptable, provided the effects of shear lag are considered.

Thanks to Victor Shneur, P.E., of Lejeune Steel Company in Minneapolis, MN, for laying the groundwork for this feature.

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Chevron Bracing in Low-Rise Buildings

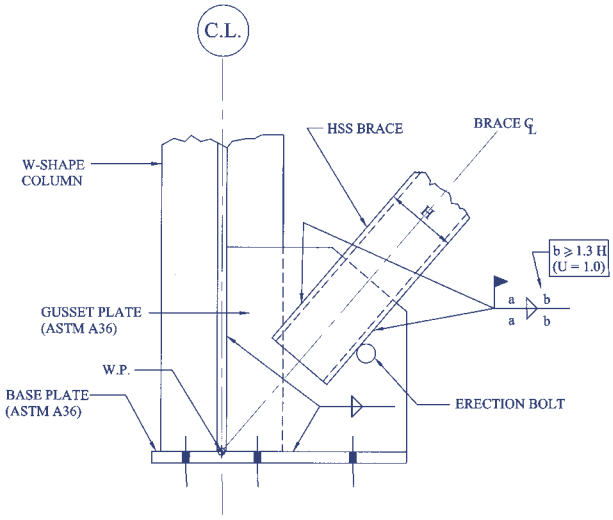
Unfactored Loads (Kips)			30	50	75	100	150	200
Gusset Plate ASTM A36			PL 3/8"	PL 3/8"	PL 1/2"	PL 1/2"	PL 3/4"	PL 3/4"
Double Angles	**Double Angles ASTM A36**		2L5x5x5/16 (21 lb/ft)	2L6x6x3/8 (30 lb/ft)	2L6x6x3/8 (30 lb/ft)	2L6x6x1/2 (39 lb/ft)	2L8x8x1/2 (53 lb/ft)	2L8x8x1/2 (53 lb/ft)
	Bolts	**3/4" Bolts / row ASTM A325**	3	4	6	6	6	8
		7/8" Bolts / row ASTM A325	3	4	4	6	5	6
		No. of Rows	1	1	1	1	2	2
HSS	**Round HSS ASTM A500, Gr. B**		HSS 5.000x0.375 (18.5 lb/ft)	HSS 6.000x0.312 (19.0 lb/ft)	HSS 6.000x0.500 (29.4 lb/ft)	HSS 6.875x0.500 (34.1 lb/ft)	HSS 8.625x0.500 (43.4 lb/ft)	HSS 9.625x0.500 (48.8 lb/ft)
	Square HSS ASTM A500, Gr. B		HSS5x5x1/4 (16 lb/ft)	HSS6x6x1/4 (19 lb/ft)	HSS6x6x1/4 (19 lb/ft)	HSS7x7x1/4 (22 lb/ft)	HSS8x8x5/16 (32 lb/ft)	HSS8x8x3/8 (38 lb/ft)
	Weld	**"a" (in) [See Details]**	3/16	3/16	1/4	1/4	5/16	5/16
		"b" (in) ** [See Details]	7	8	8	9 (Round) 10 (Square)	12 (Round) 11 (Square)	13 (Round) 11 (Square)
W-Shape	**W-Shape ASTM A992**		W6x20	W8x28	W8x31	W8x35	W8x48	W10x49
	Web	**Web Plates ASTM A36**	(2) PL 3/8"	(2) PL 3/8"	(2) PL 3/8"	(2) PL 3/8"	(2) PL 3/8"	(2) PL 3/8"
		3/4" or 7/8" ASTM A325 Bolts	4 - Gusset 4 - Web	4 - Gusset 4 - Web	4 - Gusset 4 - Web	4 - Gusset 4 - Web	4 - Gusset 4 - Web	4 - Gusset 4 - Web
	Flange	**Angles ASTM A36**	4 L4x4x5/16	4 L4x4x5/16	4 L4x4x5/16	4 L4x4x5/16	4 L4x4x5/16	4 L4x4x5/16
		3/4" or 7/8" ASTM A325 Bolts	4 - Gusset 8 - Flange	4 - Gusset 8 - Flange	4 - Gusset 8 - Flange	4 - Gusset 8 - Flange	6 - Gusset 12 - Flange	8 - Gusset 16 - Flange
WT-Shape (Flange Connection)	**WT-Shape ASTM A992**		WT6x13	WT6x25	WT6x43.5	WT7x45	WT8x38.5	WT13.5x73
	Bolts	**3/4" Bolts ASTM A325**	4	4	4	6	6	8
		7/8" Bolts ASTM A325	4	4	4	6	6	8

** Weld lengths are based on 1.3*H*, where *H* is the outside diameter of a round HSS or leg dimension of a square HSS.

REFERENCES

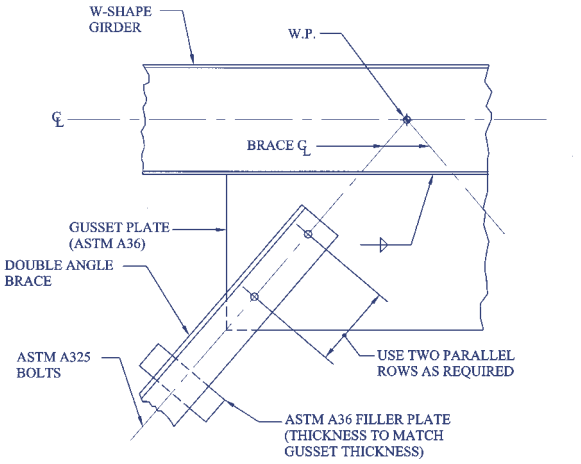
1. Low-seismic loads are those for applications in which the seismic response modification factor *R* is taken equal to or less than 3. Structural elements and connections in such applications are designed to meet the requirements in the AISC *Load and Resistance Factor Design (LRFD) Specification* with no special seismic detailing.
2. Kulak, Geoffrey L., and J. J. Roger Cheng, 2000, "Gusset Plate Connection to Round HSS Tension Members." *Engineering Journal* Vol. 37 No. 4 (Fourth Quarter): 133-139.

Turn page for typical details



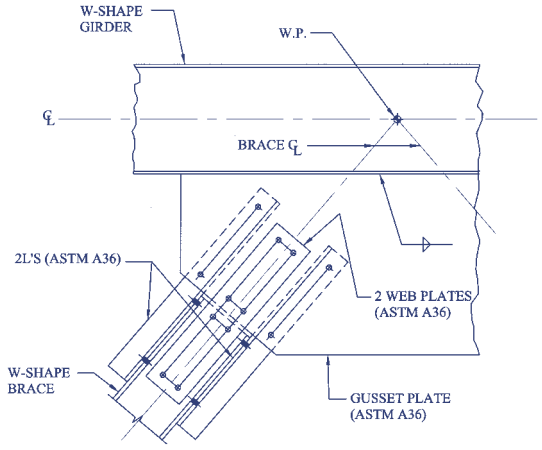
A HSS-BRACE CONNECTION AT COLUMN BASE

NOTES:
1. "a" = FILLET WELD SIZE
"b" = FILLET WELD LENGTH
2. PER AWS D1.1 SECTION 5.22.1 INCREASE WELD SIZE IF FIT-UP GAP EXCEEDS 1/16-IN.
3. U = REDUCTION COEFFICIENT, REFER TO AISC SPECIFICATION SECTION B3.



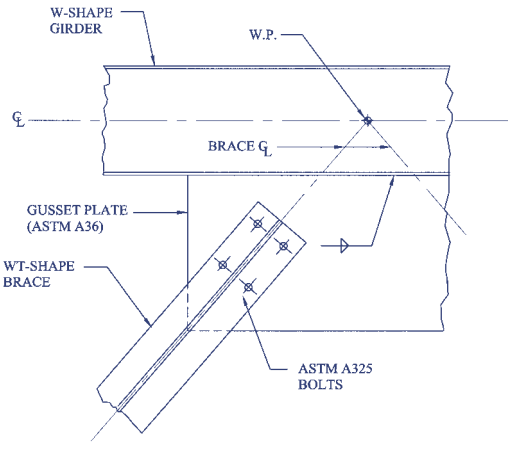
B1 DOUBLE-ANGLE BRACE CONNECTION AT MIDSPAN

NOTES:
1. BEAM STABILITY MUST BE ADDRESSED PER LRFD SPECIFICATION SECTION C3. THIS IS COMMONLY ASSURED WITH AN INFILL BEAM, KICKER OR A PAIR OF STIFFENERS AT THE WORK POINT.
2. SEE AISC SPECIFICATION SECTION E4 FOR DESIGN OF BUILT-UP COMPRESSION MEMBERS, INCLUDING FILLER SPACING REQUIREMENTS.



B2 W-BRACE CONNECTION AT MIDSPAN

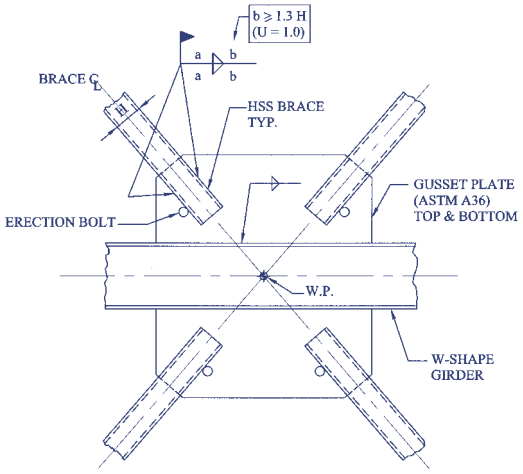
NOTES:
1. BEAM STABILITY MUST BE ADDRESSED PER LRFD SPECIFICATION SECTION C3. THIS IS COMMONLY ASSURED WITH AN INFILL BEAM, KICKER OR A PAIR OF STIFFENERS AT THE WORK POINT.



B3 WT-FLANGE CONNECTION AT MIDSPAN

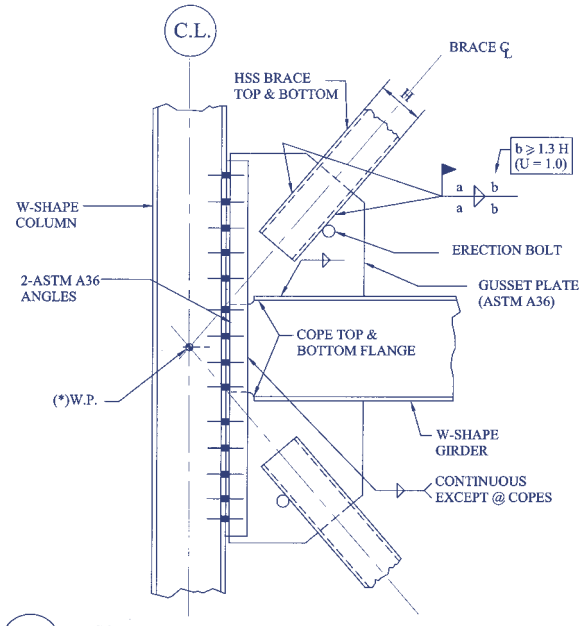
NOTES:
1. BEAM STABILITY MUST BE ADDRESSED PER LRFD SPECIFICATION SECTION C3. THIS IS COMMONLY ASSURED WITH AN INFILL BEAM, KICKER OR A PAIR OF STIFFENERS AT THE WORK POINT.

SUGGESTED DETAILS FOR CHEVRON BRACING



C HSS-BRACE CONNECTION AT MIDSPAN

NOTES:
1. BEAM STABILITY MUST BE ADDRESSED PER LRFD SPECIFICATION SECTION C3. THIS IS COMMONLY ASSURED WITH AN INFILL BEAM, A KICKER, OR A PAIR OF STIFFENERS AT THE WORK POINT.
2. a = FILLET WELD SIZE
   b = FILLET WELD LENGTH
3. PER AWS D1.1 SECTION 5.22.1 INCREASE WELD SIZE IF FIT-UP GAP EXCEEDS 1/16-IN.
4. U = REDUCTION COEFFICIENT, REFER TO AISC SPECIFICATION SECTION B3.



D HSS-BRACE CONNECTION AT COLUMN

NOTES:
1. a = FILLET WELD SIZE
   b = FILLET WELD LENGTH
2. PER AWS D1.1 SECTION 5.22.1 INCREASE WELD SIZE IF FIT-UP GAP EXCEEDS 1/16-IN.
3. (*) THIS W.P. LOCATION REDUCES CONNECTION ANGLES AND GUSSET PLATES SIZE BUT ADDS MOMENT TO COLUMN AND GIRDER (REFER TO AISC'S LRFD MANUAL, 3RD EDITION, PAGE 13-4 FOR THE UNIFORM FORCE METHOD).

SUGGESTED DETAILS FOR CHEVRON BRACING