GUIDE TO USING THE PRELIMINARY BEAM, GIRDER AND COLUMN SIZE TABLES

During the early stages of a project, before a structural engineer is engaged, architects frequently need to get a sense of the required column sizes and beam/girder depths that might ultimately be required for their projects. While this tool is not a substitute for structural engineering services, the American Institute of Steel Construction (AISC) has developed a series of tables to aid the architect in determining approximate column sizes and floor and roof system depths (Table sets A, B, C, D, E, F and G). Each set of tables represents a distinct set of floor and roof system parameters. Three different "live load" (example: people and non-permanent load) conditions for each range of beam and girder spans have been presented. The tables present nominal member depth ranges (example: W24 beams have a nominal depth of 24") for beam spans of 15 feet to 45 feet, as well as girder spans from 15 feet to 45 feet. Preliminary beam and girder depths can quickly be determined from the tables for square and rectangular bay sizes ranging from 15'x15' to 45'x45'.

The beam and girder depths indicated in the tables represent a range of depths for a particular span. It must be brought to the user's attention that a shallower member depth generally results in an increase in member weight, and therefore increased cost. As a general "rule-of-thumb" a 25 percent increase in member weight will occur with each size of depth reduction. For example, if the reported range is W18 – W24 there will be an approximate 25 percent increase in weight for a W21 member to meet the same design criteria as a W24. A W18 member will have an approximate 25 percent increase in weight if selected in place of a W21. Should a W18 member be selected in place of a W24, the minimum increase in member weight will be approximately 60 percent (1.25 x 1.25).

As with any design problem there are many solutions. Each project will have a unique set of loading and serviceability (deflection and vibration) parameters. The design information and example have been prepared accurately and consistently with current structural design practice for multiple load cases. The information presented in this publication has been prepared in accordance with recognized engineering principles and is for general information only. While it is believed to be accurate, this information should not be used or relied upon without competent professional examination and verification of its accuracy, suitability, and applicability by a licensed professional engineer or architect.

Design Parameters and Limitations

Many specific parameters and limitations go into the design of any structural member. Loads imposed by earthquake, wind, snow, rain, construction methods, etc., vary across the country. Live loads are generally specified in the applicable building codes. Dead loads are much more variable and require special attention in their computation.

Specific requirements for strength, serviceability, lateral stability of individual elements, and the lateral resistance of the overall building all contribute to the design of a safe and efficient building. The information presented in the following tables is intended for use in establishing preliminary floor and roof framing member depths only, without regard to earthquake loading or contributing to lateral resistance of the building.

Beam spans in these tables range from 15-feet to 45-feet, in 5-foot increments. Girder spans also range from 15 feet to 45 feet in 5-foot increments for each of the beam spans noted. Therefore, beam/girder depths tabulated cover 28 different bay sizes for each of three load cases. Dead loads address the self-weight of the floor/roof framing system. Different topping-slab thicknesses, concrete densities, and beam spacings options have been presented to address varying preferences around the country to address required floor/roof fire rating requirements as well as local availability of concrete aggregate.

The following girder and floor beam sizing tables are based on the following parameters:

- Load and Resistance Factor Design Specification, American Institute of Steel Construction, 2017
- Live and dead loads are uniformly distributed over the entire bay area
- Full live load has been applied to a full bay; no live load reduction has been taken into account
- No analyses have been made for floor vibration/vibration susceptibility
- A construction live load of 20 psf has been applied for composite member design
- Beam and girder depths represent designs for composite beams and girders (non-composite beams/girders would likely be slightly deeper)
- Live load deflection has been limited to 1/360 of the individual member span
- Shear connectors for composite type metal decking
- Normal weight concrete unit weight used in the designs is 145 pcf; Lightweight concrete unit weight used in the designs is 110 pcf
- Beams and girders have been selected assuming that cambering will be considered by the structural engineer of record for the placement of "level" floors
- Connection designs have not been considered
- 50 ksi steel yield strength and 3000 psi concrete strength
- Actual member depths may vary from the nominal depths tabulated. For actual member depths refer to the properties tables found in the ?? Section of this Guide.

Selection Example for Girder and Floor Beam Sizing Tables

Known Design Criteria:

- Dead load equals system self-weight (slab + steel)
- Superimposed dead load = 25 psf (partitions + MEP)
- Live Load = 100 psf (loads are uniformly distributed over the entire bay area)
- 4¼" Lightweight concrete topping
- 2" metal decking (composite)
- Fy=50 ksi
- Floor system requiring a 3-hour fire rating (floor assembly, unprotected metal deck)
- Bay size is 30-feet x 35-feet (girder span x beam span)
- Beam spacing is 10-foot max.

Solution:

Beam depth selection:

Enter "Table C, Beam Sizes", which is located directly below the illustrative floor diagram

Find the required 100 psf Live Load criteria along the left side of the table.

Slide over to the fifth column of the table to find the typical beam depth range for a 35-foot beam span. The range of beam depths is shown as W16-W18. Therefore, the table indicates that the nominal wide-flange beam depth for a 35-foot beam (10-foot max. spacing and supporting 100 psf live load) could be as shallow as 16-inches (indicated by W16) or as deep as 18-inches (indicated by W18).

Girder depth selection:

Along the left side of "Table C, Girder Sizes" (located directly under the "Beam Sizes" table), find the row for a 30-foot girder and a 100 psf live load.

Across the top of the table, find the column for a 35-feet beam.

At the intersection of the 30-foot girder row (100 psf live load) and the 35-foot beam, find that the range of girder depths to support the 35-beams spaced at 10-foot max. as W21-W24. This table indicates that the 30-foot long girder could be a wide-flange girder with a nominal depth as shallow as 21-inches (W21) or as deep as 24-inches (W24).

Summary:

35-foot beam span: W16-W18 (*Note that actual depths will vary*).

30-foot girder span: W21-W24 (*Note that actual depths will vary*).

Member cambers may be required (*Consult a structural engineer for specifics*).

TABLE E
Span Ranges

Representative Span Ranges of Different Structural Steel Components	
Component	**Span Range, feet** (10 20 40 60 80 100)
Roof Framing	
1½" Metal Deck	
3" Metal Deck	
6" Metal Deck	
Beams (See Tables)	
Girders (See Tables)	
Joists	
K Series	
LH Series	
Floor Framing	
Composite Slab	
Non-composite Slab	
Beams (See Tables)	
Girders (See Tables)	
Long Spans	
Plate Girders – Fabricated Beams	
Trusses – Fabricated	
Joists "DLH/SLH" Series	
Space Frames	

DETERMINING INTERIOR COLUMN SIZES

Determining preliminary column dimensions during the early planning phases of a project can greatly assist the architectural and interior design teams. Column dimensions influence the overall column enclosure sizes required, which is useful information to have for preliminary space planning, and when assessing perimeter slab edge dimensions from column centerlines. The column enclosures are not only a function of the column dimensions, but also any utility services (i.e. plumbing, electrical) that may be running vertically, immediately adjacent to the columns. In addition, the column base plate dimensions may be a factor in the required column enclosure size at the base of the building if the column base plate or its associated anchor rods are located above the finished floor.

Column sizes are usually determined by the structural engineer. Columns typically support gravity loads or a combination of gravity and lateral loads, depending on the lateral load resisting system selected for the project. In this Guide, preliminary column dimensions have been tabulated for typical buildings ranging from one story to six stories. The tables have considered two (2) different commonly used floor loading conditions, 50psf and 100psf. A roof load of 40psf was selected for use with each of the floor loading options. While roof loads can vary significantly based on the type of roofing system used, the selection of a single roof live load was found to have a very minimal effect on the overall column size selection. For the purposes of these tables, columns are considered to be "interior columns" and are assumed not to contribute to the lateral load resisting system for the building. The tables presented indicate representative interior column dimensions for square and rectangular bay sizes ranging from 20'x20' to 40'x40'. Each set of tables represents a different floor construction type meeting a two-hour fire rated floor system.

Exterior columns have not been considered in the formulation of the column size tables for two reasons. First, exterior columns are commonly engaged as part of the lateral load resisting system, particularly in the case of moment resistant lateral frames. Secondly, exterior beams and girders often transfer exterior wall loads to the exterior columns. Façade types as well as façade loads can vary significantly. As a result it would be difficult to formulate a concise set of generalized tables to account for these conditions. As a general "rule of thumb" exterior columns can be approximated to be the same size as interior columns.

As with any design problem there are many solutions. Each project will have a unique set of loading parameters. The design information and example have been prepared consistently with current structural design practice for several different load cases. The information presented in this publication has been prepared in accordance with recognized engineering principles and is for general information only. While it is believed to be accurate, this information should not be used or relied upon without

competent professional examination and verification of its accuracy, suitability, and applicability by a licensed professional engineer, or architect.

DESIGN PARAMETERS AND LIMITATIONS

Many specific parameters and limitations go into the design of any structural member. Imposed loadings caused by earthquake, wind, snow, rain, construction methods, etc. vary across the country. Live loads (transient loads) are specified in the applicable building codes. Dead loads (permanent loads) are much more variable and require special attention in their computation. Specific requirements for serviceability, strength, lateral stability of individual elements, and the lateral resistance of the building all contribute to the design of a safe and efficient building. The information presented in the following tables is intended for use establishing preliminary interior column dimensions only without regard to earthquake loading or contributing to lateral resistance of the building.

Column dimensions have been selected based on properties for rolled wide flange shapes, as well as hollow structural section and pipe column shapes. Bay sizes range form 20' by 20' to 40' by 40' in 5' increments. Both square and rectangular bays have been accounted for. As a result, 15 different bay sizes for each of two load cases have been tabulated for three different slab construction types.

Interior column sizing tables are based on the following parameters:

- Load and Resistance Factor Design Specification, 2017
- Live and dead loads are uniformly distributed over the bay area
- Full live load has been applied to the entire bay: No live load reduction has been considered
- Maximum floor-to-floor height is 15 feet
- Column sizes tabulated are based on gravity load only. Additional column forces associated with a column's contribution to the building's lateral system is not considered.
- All connections to the columns considered are to be "simple" connection – No moment transfer from beam/girder to column has been considered
- Normal weight concrete unit weight used in the designs is 145 pcf; Lightweight concrete unit weight used in the designs is 110 pcf
- A maximum 40 psf roof live load has been considered for all column designs
- 46 ksi steel yield has been used for hollow structural section columns
- 50 ksi steel yield has been used for rolled wide flange columns
- Only square hollow structural sections have been used in the tabulated dimensions. Consult a structural engineer if rectangular sections are desired.

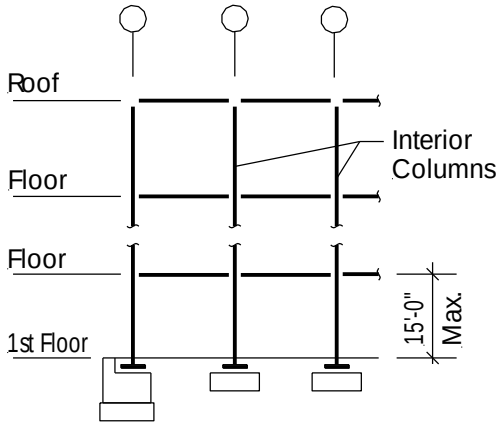
- Actual dimensions have been tabulated. The involvement of a qualified structural engineer shall determine actual pipe, hollow structural section, or rolled wide flange section designation required for any specific project and loading condition.

Interior Column Sizing Table F1

Floor Framing Design Criteria

- 3¼" lightweight topping (2 hr. floor rating)
- 2" metal decking
- Floor LL = **50psf**
- Roof LL = 40psf

Building Section



Multi-story Building

Table F1
Typical Interior Column Size (Depth x Width)

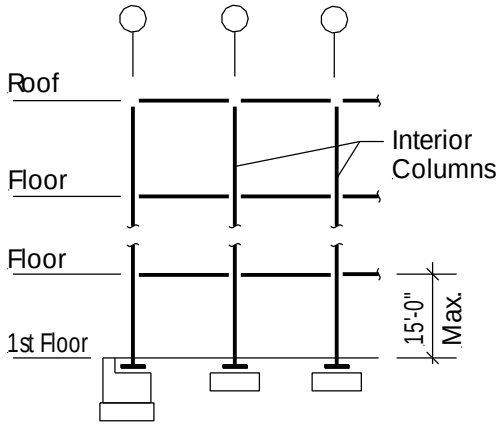
	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	6 X 6	10 X 10	12 X 10	14 X 10	14¼ X 10¼
20 X 25	4 X 4	8 X 8	10 X 10	12 X 10	14 X 10	14¼ X 10¼
20 X 30	5 X 5	8 X 8	10 X 10	12 X 10	14 X 10	14¼ X 10¼
20 X 35	5 X 5	10 X 8	10¼ X 10	12¼ X 12	14¼ X 10¼	14 X 14½
20 X 40	6 X 6	10 X 8	10¼ X 10	12¼ X 12	14¼ X 10¼	14 X 14½
25 X 25	4 X 4	7 X 7	10 X 10	12 X 10	14¼ X 10¼	14¼ X 10¼
25 X 30	5 X 5	7 X 7	10¼ X 10	12¼ X 12	14¼ X 10¼	14 X 14½
25 X 35	5 X 5	8½ X 8½	12¼ X 10	12¼ X 12¼	14 X 14½	14¼ X 14¾
25 X 40	5 X 5	8½ X 8½	12¼ X 10	12¼ X 12¼	14 X 14½	14¼ X 14¾
30 X 30	5 X 5	8½ X 8½	12¼ X 10	12¼ X 12¼	14 X 14½	14¼ X 14¾
30 X 35	5 X 5	8½ X 8½	12¼ X 12	14 X 14½	14¼ X 14¾	14½ X 14¾
30 X 40	5 X 5	10¼ X 10¼	12¼ X 12	14 X 14½	14¼ X 14¾	14½ X 14¾
35 X 35	6 X 6	10¼ X 10¼	12¼ X 12	14 X 14½	14¼ X 14¾	14½ X 14¾
35 X 40	6 X 6	10¼ X 10¼	12½ X 12¼	14¼ X 14¾	14½ X 14¾	15 X 15¾
40 X 40	8 X 8	12¼ X 10	12½ X 12¼	14¼ X 14¾	14½ X 14¾	15 X 15¾

Interior Column Sizing Table F2

Floor Framing Design Criteria

- 3¼" lightweight topping (2 hr. floor rating)
- 2" metal decking
- Floor LL = **100psf**
- Roof LL = 40psf

Building Section



Multi-story Building

Table F2
Typical Interior Column Size (Depth x Width)

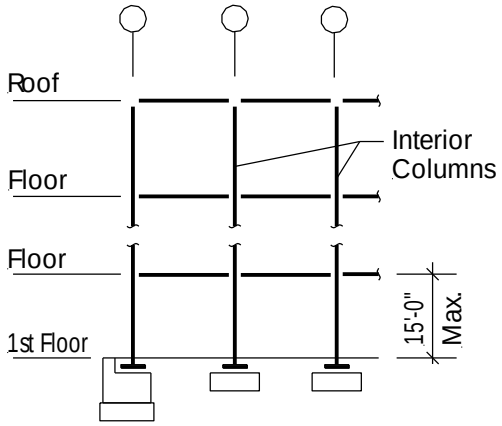
	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	6 X 6	10 X 10	12¼ X 12	12¼ X 12	12½ X12¼
20 X 25	4 X 4	6 X 6	10 X 10	12¼ X 12	12¼ X 12	12½ X12¼
20 X 30	5 X 5	6 X 6	10 X 10	12¼ X 12	12¼ X 12	12½ X12¼
20 X 35	5 X 5	8 X 8	1O¼ X 10¼	12¼ X 12	12¾ X 12¼	13 X 12¼
20 X 40	6 X 6	8 X 8	1O¼ X 10¼	12¼ X 12	12¾ X 12¼	13 X 12¼
25 X 25	4 X 4	6 X 6	10 X 10	12¼ X 12	12½ X12	12½ X12¼
25 X 30	5 X 5	7 X 7	12¼ X 12	12¾ X12¼	13¼ X 12½	13½ X 12½
25 X 35	5 X 5	8 X 8	12¼ X 12	12¾ X12¼	13¼ X 12½	13½ X 12½
25 X 40	5 X 5	8 X 8	12¼ X 12	12¾ X12¼	13¼ X 12½	13½ X 12½
30 X 30	5 X 5	8 X 8	1O¼ X 10¼	12¾ X12¼	13¼ X 12½	13½ X 12½
30 X 35	5 X 5	10¼ X 10	12½ X12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
30 X 40	5 X 5	10¼ X 10	12½ X12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
35 X 35	6 X 6	10¼ X 10	12½ X12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
35 X 40	6 X 6	10½ X 10¼	13 X 12¼	14½ X 14¾	15¼ X 15¾	15¾ X 15¾
40 X 40	8 X 8	10½ X 10¼	13 X 12¼	14¾ X 14¾	15¼ X 15¾	15¾ X 15¾

Interior Column Sizing Table G1

Floor Framing Design Criteria

- 4½" normal weight topping (2 hr. floor rating)
- 2" metal decking
- Floor LL = **50psf**
- Roof LL = 40psf

Building Section



Multi-story Building

Table G1
Typical Interior Column Size (Depth x Width)

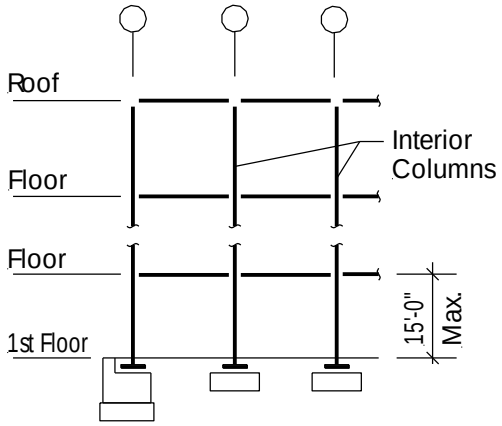
	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 25	4 X 4	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 30	5 X 5	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 35	5 X 5	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
20 X 40	6 X 6	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
25 X 25	4 X 4	8 X8	8½ X 8¼	10¼ X 10¼	12¼ X12	12½ X12¼
25 X 30	5 X 5	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
25 X 35	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X 12¼	12¾ X 12¼	13 X 12½
25 X 40	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X12¼	12¾ X 12¼	13 X 12½
30 X 30	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X12¼	12¾ X 12¼	13 X 12½
30 X 35	5 X 5	8½ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
30 X 40	5 X 5	8¾ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
35 X 35	6 X 6	8¾ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
35 X 40	6 X 6	10¼ X 10¼	12½ X 12¼	14½ X 14¼	14¾ X 15½	15¼ X 15¾
40 X 40	8 X 8	10¼ X 10¼	12½ X 12¼	14½ X 14¼	14¾ X 15½	15¼ X 15¾

Interior Column Sizing Table G2

Floor Framing Design Criteria

- 4½" normal weight topping (2 hr. floor rating)
- 2" metal decking
- Floor LL = 100psf
- Roof LL = 40psf

Building Section



Multi-story Building

Table G2
Typical Interior Column Size (Depth x Width)

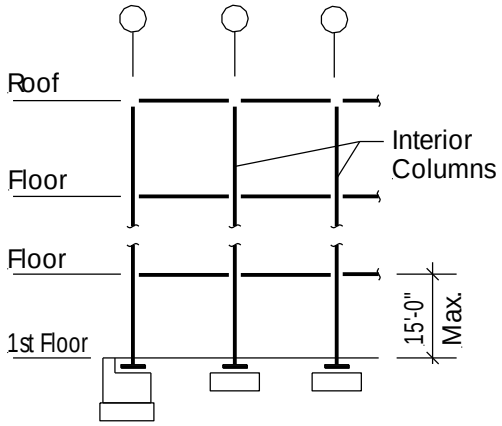
	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 25	4 X 4	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 30	5 X 5	8 X 8	8½ x 8¼	10¼ X 10¼	12¼ X 12	12½ X12¼
20 X 35	5 X 5	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
20 X 40	6 X 6	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
25 X 25	4 X 4	8 X 8	8½ X 8¼	10¼ X 10¼	12¼ X12	12½ X12¼
25 X 30	5 X 5	8¼ X 8¼	8¾ X 8¼	12¼ X 12	12½ X 12¼	12¾ X 12¼
25 X 35	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X12¼	12¾ X 12¼	13 X 12½
25 X 40	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X12¼	12¾ X 12¼	13 X 12½
30 X 30	5 X 5	8½ X 8¼	10¼ X 10¼	12½ X12¼	12¾ X 12¼	13 X 12½
30 X 35	5 X 5	8½ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
30 X 40	5 X 5	8¾ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
35 X 35	6 X 6	8¾ X 8¼	12¼ X 12	14 X 14½	14½ X 14¾	14¾ X 14¾
35 X 40	6 X 6	10¼ X 10¼	12½ X 12¼	14½ X 14¼	14¾ X 15½	15¼ X 15¾
40 X 40	8 X 8	10¼ X 10¼	12½ X 12¼	14½ X 14¼	14¾ X 15½	15¼ X 15¾

Interior Column Sizing Table H1

Floor Framing Design Criteria

- 4¼" lightweight topping (3 hr. floor rating)
- 2" metal decking
- Floor LL = **50psf**
- Roof LL = 40psf

Building Section



Multi-story Building

Table H1
Typical Interior Column Size (Depth x Width)

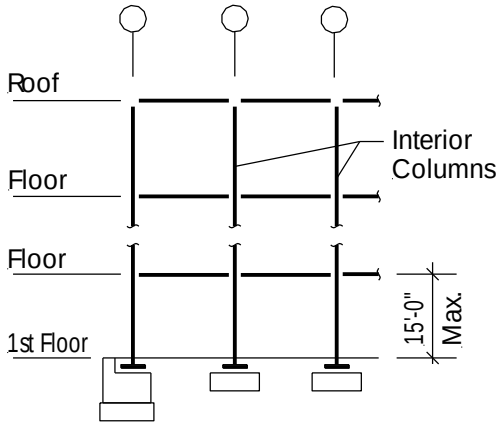
	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	6 X 6	10¼ X 8	12 X 10	14 X 10	12¼ X 12
20 X 25	4 X 4	8 X 8	10¼ X 8	12 X 10	14 X 10	12¼ X 12
20 X 30	5 X 5	8 X 8	10¼ X 8	12 X 10	14 X 10	12¼ X 12
20 X 35	5 X 5	10 X 8	10¼ X 10	12¼ X 12	12¼ X 12	12½ X 12¼
20 X 40	6 X 6	10 X 8	10¼ X 10	12¼ X 12	12¼ X 12	12½ X 12¼
25 X 25	4 X 4	7 X 7	10¼ X 8	12 X 10	14¼ X10¼	14¼ X 10¼
25 X 30	5 X 5	10 X 8	10¼ X 10	12¼ x 12	12¼ X 12	12½ X 12¼
25 X 35	5 X 5	8½ X 8½	12¼ X 10	12¼ X12¼	14 x 14½	14¼ X 14¾
25 X 40	5 X 5	8½ X 8½	12¼ X 10	12¼ X12¼	14 x 14½	14¼ X 14¾
30 X 30	5 X 5	8½ X 8½	12¼ X 10	12¼ X12¼	14 x 14½	14¼ X 14¾
30 X 35	5 X 5	8½ X 8½	12¼ X 12	12½ X 12¼	14¼ X 14¾	14½ X 14¾
30 X 40	5 X 5	10¼ X 10¼	12¼ X 12	12½ X 12¼	14¼ X 14¾	14½ X 14¾
35 X 35	6 X 6	10¼ X 10¼	12¼ X 12	12½ X 12¼	14¼ X 14¾	14½ X 14¾
35 X 40	6 X 6	10¼ X 10¼	12½ X 12¼	14¼ X 14¾	14½ X 14¾	15 X 15¾
40 X 40	8 X 8	12¼ X 10	12½ X 12¼	14¼ X 14¾	14½ X 14¾	15 X 15¾

Interior Column Sizing Table H2

Floor Framing Design Criteria

- 4¼" lightweight topping **(3 hr. floor rating)**
- 2" metal decking
- Floor LL = **100psf**
- Roof LL = 40psf

Building Section



Multi-story Building

Table H2
Typical Interior Column Size (Depth x Width)

	NUMBER OF STORIES					
BAY SPACING	1	2	3	4	5	6
20 X 20	4 X 4	6 X 6	10 X 10	10½ X 10¼	12½ X 12¼	12¾ X 12¼
20 X 25	4 X 4	6 X 6	10 X 10	10½ X 10¼	12½ X 12¼	12¾ X 12¼
20 X 30	5 X 5	6 X 6	10 X 10	10½ X 10¼	12½ X 12¼	12¾ X 12¼
20 X 35	5 X 5	8 X 8	10¼ X 10¼	12½ X 12¼	12¾ X12¼	14½ X 14¾
20 X 40	6 X 6	8 X 8	10¼ X 10¼	12½ X 12¼	12¾ X12¼	14½ X 14¾
25 X 25	4 X 4	6 X 6	10 X 10	10½ X 10¼	12½ X 12¼	12¾ X 12¼
25 X 30	5 X 5	7 X 7	12¼ X 12	12½ X12¼	13¼ X 12½	14½ X 14¾
25 X 35	5 X 5	8 X 8	12¼ X 12	12¾ X12¼	13¼ X 12½	14¾ X 15½
25 X 40	5 X 5	8 X 8	12¼ X 12	12¾ X12¼	13¼ X 12½	14¾ X 15½
30 X 30	5 X 5	8 X 8	10¼ X 10¼	12¾ X12¼	13¼ X 12½	14¾ X 15½
30 X 35	5 X 5	10¼ X 10	12½ X 12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
30 X 40	5 X 5	10¼ X 10	12½ X 12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
35 X 35	6 X 6	10¼ X 10	12½ X 12¼	14½ X 14¾	14¾ X 14¾	15 X 15¾
35 X 40	6 X 6	10½ X 10¼	13 X 12¼	14¾ X 15½	15¼ X 15¾	15¾ X 15¾
40 X 40	8 X 8	10½ X 10¼	13 X 12¼	14¾ X 15½	15¼ X 15¾	15¾ X 15¾