Steel Construction – Rules of Thumb

Floors (Beams and Girders)

To calculate the necessary depth of a beam, divide the span (in inches) by 20. For example, a 25’ span would be 25x12 / 20 = 15”. The width of this beam would be between 1/3 and ½ the depth. The dimensions of a girder would be the same, but the flange would be thicker.

A beam overhang can be a maximum of 3/8 of the supported span.

Floors (Decking and Joists)

Metal decking with shear studs, 2” deep spans 10’, 3” spans 15’ in the direction of the decking ribs. In addition to the decking depth, a concrete floor of 2-3” must be poured on top of the floor. Be sure to properly draw the corrugation of the decking, as its proper dimensions assure its rigidity.

Light Gauge steel joists or trusses 6” deep span 10’. For each additional 2” of depth, add 2’ of span up to 12” deep. After 12” of depth, every additional 3” of depth add 2’ of span.

Roofs must slope ¼” / foot for proper drainage

Columns

A column size depends on the floor area it is supporting; this floor area is calculated by subdividing the distance between the column and all adjacent columns. This area is cumulative from floor to floor.

A 6x6 column can support 750 sq.ft; a 8x8 column can support 3000 sq.ft, and a 12x12 column 6000 sq.ft. each additional 2” can add 1500 sq.ft. of supported area.

Example: a two-story building made up of 4 25’x25’ bays. The column at the center of the plan supports an area 25’x25’x2 stories = 1250 sq.ft. – so an 8x8 column would be large enough.

General Note

Using each of the methods above will most likely generate steel element sizes that do not coordinate with one another, for example an 8” interior column with a 6” exterior column with a 12” beam. It is necessary for you to coordinate dimensions in an efficient way to make the construction as efficient as possible.
COLUMN LAYOUT

All columns at the perimeter of a building should be oriented with their flanges facing outward to facilitate the attachment of cladding to the structural frame of the building. Elsewhere, columns should be oriented with their webs parallel to the short axis of a building whenever possible. This permits the maximum contribution from the columns to the stability of the building in the direction in which the building is most susceptible to lateral forces.

Columns above and below each other at the perimeter of a multistory building are also often aligned on their outer faces. Despite the misalignment of column centers that occurs as the column size reduces on upper floors, this arrangement is desirable for the consistent curtain-wall fastening detail that it produces.

See pages 96–97 for additional information on the sizing of column bays.

FINISH DIMENSIONS OF STEEL COLUMNS

The finish dimension of a steel column must be increased from the actual size of the section to account for applied fireproofing, protective cover or other finishes, and the added depth of connecting plates and protruding bolt heads where column sections are joined. The total finish dimension may range from 2 to 8 in. (50 to 200 mm) greater than the actual column size.

FIRE-RESISTANCE RATINGS FOR STEEL COLUMNS

Exposed steel columns may be used in Unprotected Noncombustible construction. Fire-resistance ratings of up to 4 hours are easily achieved with applied fireproofing.
The top chart is for steel wide flange section columns up to 12 ft (3.7 m) tall between floors. The open areas indicated are for high-strength (50 ksi or 345 MPa) steel only.

- For light loads, read toward the top in the indicated areas. For heavy loads, read toward the bottom.
- Approximate actual column sizes are shown in inches and millimeters to the sides of the data bars.
- Columns that contribute to the lateral stability of a building may be larger in size than shown on this chart.
- W14 sections are the largest standard rolled sizes commonly used as columns. Larger built-up sections capable of carrying greater loads may be shop fabricated.
- Total tributary area is the total area of roofs and floors supported by the column.

For columns taller than 12 ft (3.7 m) between floors, read both charts on this page. Use the larger of the two sizes indicated. Nominal and approximate actual column sizes are shown on the chart. Column size may increase for heavy loads.

- Column size will increase for columns that contribute to the lateral stability of a building, particularly with taller columns.
- Column height may be increased with the use of intermediate bracing.
STEEL TUBE COLUMNS

STRUCTURAL STEEL TUBING

Standard shapes for structural steel tubing include square tubes, rectangular tubes, and round pipes. Compared to wide flange sections or other shapes of similar size, tubes and pipes are more resistant to buckling forces, making them good choices for columns and compressive struts in all types of steel systems. They are employed as columns in long-span steel structures for their greater efficiency, and because they are available in lighter weights than other standard shapes, they are frequently used in one- or two-story steel structures as well. Tube and pipe sections are popular choices for use in the fabrication of steel trusses and space frames, and their high torsional resistance makes them excellent choices for single post supports such as for signs or platforms.

The simple profiles and clean appearance of steel tubes and pipes also make them popular for use where the steel may remain visible in the finished structure, or for structures exposed to the weather where the absence of moisture- and dirt-trapping profiles and ease of maintenance are desirable characteristics.

SIZES FOR STEEL TUBES ANDPIPES

Tubes and pipes are generally available in whole-inch (25-mm) sizes up to 6 or 8 in. (152 or 203 mm). Greater sizes are available in even-inch (51-mm) increments.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Width of Tube or Diameter of Pipe</th>
<th>Thickness of Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square tubes</td>
<td>3&quot; × 3&quot; - 16&quot; × 16&quot; (76 × 76 mm - 406 × 406 mm)</td>
<td>.188&quot; - .625&quot; (5 - 16 mm)</td>
</tr>
<tr>
<td>Rectangular tubes</td>
<td>3&quot; × 2&quot; - 16&quot; × 12&quot; (76 × 51 mm - 406 × 305 mm)</td>
<td>.188&quot; - .625&quot; (5 - 16 mm)</td>
</tr>
<tr>
<td>Pipes</td>
<td>3&quot; - 12&quot; (76 - 305 mm)</td>
<td>.216&quot; - .675&quot; (5 - 22 mm)</td>
</tr>
</tbody>
</table>

FINISH DIMENSIONS OF STEEL COLUMNS

The finish dimension of a steel column must be increased from the actual size of the section to account for applied fireproofing, protective cover or other finishes, and the added depth of connecting plates and protruding bolt heads where column sections are joined. The total finish dimension may range from 2 to 8 in. (50 to 200 mm) greater than the actual column size.
This chart is for square tube steel columns. Column size may increase with heavy loads, or where columns contribute to the lateral stability of a building, particularly with taller columns.

☐ Actual column size is equal to nominal size.
☐ Total tributary area is the total area of roofs and floors supported by the column.

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**FIRE-RESISTANCE RATINGS FOR STEEL TUBE AND PIPE COLUMNS**

Exposed steel columns or other framing elements may be used in Unprotected Noncombustible construction. Fire-resistance ratings of up to 4 hours are easily achieved with applied fireproofing. When used in roof framing systems, some building codes allow reduced fire protection of exposed steel for structures that are 15 to 25 ft (4.6 to 7.6 m) or more above the floor.
STEEL FLOOR AND ROOF DECKING

STEEL FLOOR DECKING
Corrugated steel floor decking with a sitecast concrete topping is the slab system most commonly used over structural steel framing. Typical span ranges for steel floor decking when used with structural steel framing are from 6 to 15 ft (1.8 to 4.6 m). Longer spans or shallower depths than those indicated on the chart on the facing page may be possible, although increased construction costs may result from the need for additional temporary shoring of the decking during erection.

CELLULAR FLOOR DECKING
The use of cellular decking to provide protected spaces within the floor slab for the running of electrical and communications wiring may influence the overall framing plan for the building. The layout of such a distribution system can determine the direction in which the decking cells will run in various areas of the building plan. The orientation of the beams or joists carrying the decking will be determined from this in turn, as in all cases these elements must run perpendicular to the cells in the decking. See page 181 for additional information on the planning of such systems. When reading from the chart for cellular deck on the facing page, read toward the bottom in the indicated area.

STEEL ROOF DECKING
Steel roof decking may have a sitecast concrete or gypsum topping or may be covered directly with a variety of board or roofing products. A common and economical configuration for roof decking is 1½ in. (38-mm) decking spanning up to approximately 8 ft (2.4 m). Many proprietary metal roof decking systems, with a wide variety of performance characteristics, are also available. For information on such systems, consult individual manufacturers.

FIRE-RESISTANCE RATINGS FOR STEEL DECKING
Steel roof decking without a concrete topping may be used in Unprotected Noncombustible construction.

The fire resistance of roof or floor decking with a concrete topping varies with the configuration of the decking and the thickness of the topping. Though resistance ratings of as high as 3 hours may be possible, for preliminary design, assume that decking must be protected with applied fireproofing or an appropriately fire-resistive ceiling to achieve ratings of more than 1 hour.
The top chart is for corrugated or cellular steel floor decking with concrete slab topping. For light loads, read toward the bottom in the indicated areas. For heavy loads, read toward the top.

- **Total depth of slab** is the depth of the decking and the concrete topping. Approximate sizes for the steel decking alone are shown within the chart.
- Deeper deck sections with spans of up to approximately 25 ft (7.6 m) may be available from some manufacturers.

The bottom chart is for corrugated steel roof decking. For light loads, read toward the right in the indicated areas. For heavy loads, read toward the left.

- Deeper deck sections with spans of up to approximately 25 ft (7.6 m) may be available from some manufacturers.
STEEL BEAMS AND GIRDERS

Structural steel is a versatile building material. Though it can be used in a great variety of ways, the following guidelines may be used for preliminary design.

FLOOR AND ROOF FRAMING

The most economical span range for conventional steel floor and roof framing is from 20 to 32 ft (6 to 10 m). Above spans of 32 to 40 ft (10 to 12 m), open-web steel joists become an increasingly economical alternative for both floor and roof framing due to their lighter weight. See pages 98–99 for the sizing and spacing of open-web steel joists.

The spacing of beams depends on the applied loads and the decking system. Spacings of from 6 to 15 ft (1.8 to 4.6 m) are common with corrugated steel floor decking. Spacings of up to approximately 8 ft (2.4 m) are typical for roof decking systems.

BEAM AND GIRDERS CONFIGURATION

The orientation of beams and girders in a floor or roof framing system may depend on a variety of factors. When possible, girders should run parallel to the short axis of the building. This permits any contribution that these heavier members can make to lateral stability to be utilized in the direction along which the structure is most susceptible to lateral forces.

Beam and girder placement is also related to the arrangement of the column bays. In a rectangular bay, it is usually more economical to run the girders in the longer direction. When combined with open web steel joists, however, structural steel girders most often run along the short direction of the bay, allowing the joists to span the greater distance. Furthermore, when a floor system utilizes cellular decking as part of a communications or wiring system, the preferred direction for the cells of the decking may determine beam and girder orientations, because beams must run perpendicular to the corrugations of any steel decking.

COMPOSITE BEAMS

Composite construction, in which shear studs are used to cause the concrete deck and the steel beams to act as a unified structural element, can reduce beam depths, or increase their span and load capacity. Composite beams are almost always an economical alternative to simple beams. However, their use may be limited with electrified deck systems because of the trench headers in the slabs used with these systems. Composite beams are often spaced farther than simple beams to gain maximum advantage from the interaction of the beam and the section of concrete slab above.
STEEL BEAMS AND GIRDER

This chart is for steel wide-flange sections. For heavy loads, read toward the left in the solid area. For light loads, read toward the right.

- For girders, read in the open area indicated. For composite beams, read along the line indicated. (For more information on girders or composite beams, see the facing page.)
- Beams or girders also acting to resist lateral loads may be deeper than indicated on this chart.
- Economical widths of beams and girders range from approximately one-third to one-half the depth of the beam. Heavy sections may be wider.
- Depths of up to 36 in. (914 mm) are available as standard rolled sections. Greater depth beams capable of longer spans may be shop fabricated.

FIRE-RESISTANCE RATINGS FOR STEEL BEAMS AND GIRDER

Exposed steel beams and girders may be used in Unprotected Noncombustible construction. Fire-resistance ratings of as high as 4 hours are easily achieved with applied fireproofing or an appropriately fire resistant ceiling. Some building codes also allow reduced fire protection or exposed steel for roof structures that are 15 to 25 ft (4.6 to 7.6 m) or more above the floor.
WEB STEEL JOISTS

RATINGS FOR OPEN-WEB JOISTS

FIRE-RESISTANCE

Sometimes encountered with long-span joist systems, systems are particularly effective at overcoming the excessive flexibity of steel joists. See pages 96-97 for structural steel beams and girders and pages 102-103 for heavy I-joists. For greater spans, heavier steel joists may be used with open-web joists. Where significant concentrated loads exist, alternate to conventional structural steel members for spans greater than 30 to 40 ft (9 to 12 m). Where significant concentrated loads exist, alternative to conventional structural steel members for spans greater than 30 to 40 ft (9 to 12 m).
Structures that are 15 to 25 ft (4.5 to 7.6 m) or more above the floor:

Exposed steel trusses also allow reduced fire protection on exposed steel for building codes. Some fire-tested designs are used in non-protected environments or where fire protection is not required.

**TRUSSES**

**RATING FOR STEEL**

**FIRE-RESISTANCE**

Trusses spanning 300 ft (90 m) or more may be fabricated on site. Chord trusses are most economical for spans of up to 120 ft (37 m). Trusses spanning greater than 12 ft (3.7 m) deep, triangular and bowstring trusses can be shipped.

**ECONOMICAL SPAN**

**PARALLEL RANGES FOR PARALLEL CHORD TRUSSES**
This chart is for steel trusses fabricated from structural steel members. Because these trusses are custom designed and fabricated, a great variety of shapes and configurations are possible.