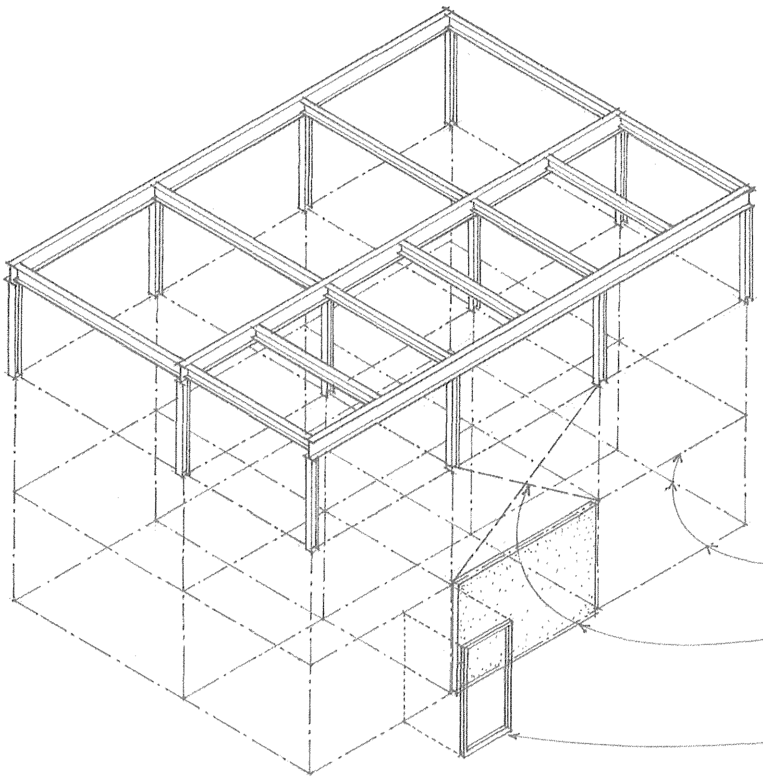
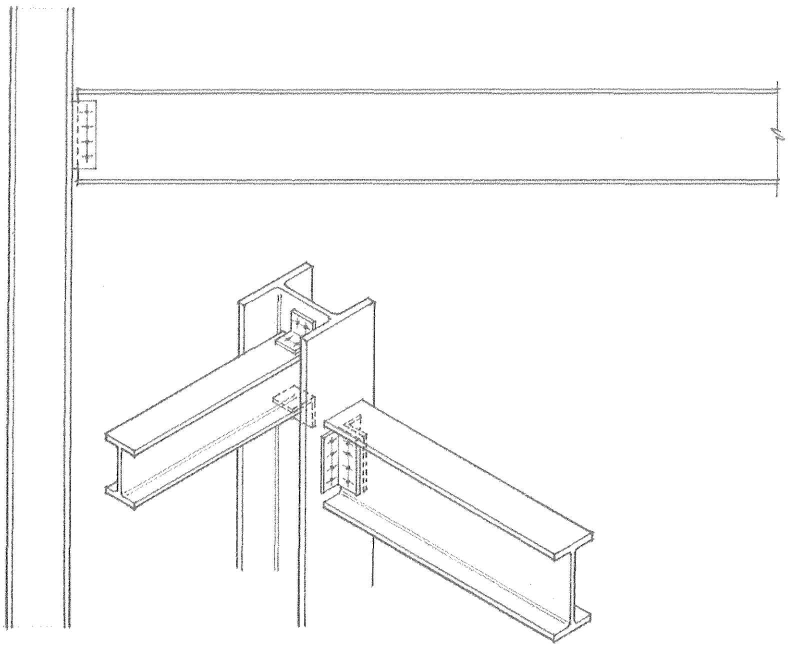
Structural steel girders, beams, and columns are used to construct a skeleton frame for structures ranging in size from one-story buildings to skyscrapers. Because structural steel is difficult to work on-site, it is normally cut, shaped, and drilled in a fabrication shop according to design specifications; this can result in relatively fast, precise construction of a structural frame. Structural steel may be left exposed in unprotected noncombustible construction, but because steel can lose strength rapidly in a fire, fire-rated assemblies or coatings are required to qualify as fire-resistive construction. In exposed conditions, corrosion resistance is also required. See 12.08 for a discussion of steel as a construction material; see the Appendix for fire-rated steel assemblies.

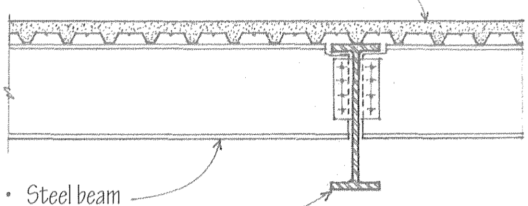


- Steel framing is most efficient when the girder and beam supports are laid out along a regular grid.
- Resistance to lateral wind or earthquake forces requires the use of shear walls, diagonal bracing, or rigid framing with moment-resisting connections.
- For nonbearing or curtain wall options, see 7.24.

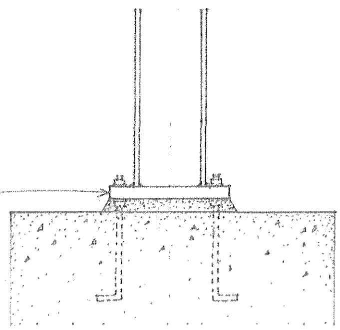


- Connections usually use transitional elements, such as steel angles, tees, or plates. The actual connections may be riveted but are more often bolted or welded.

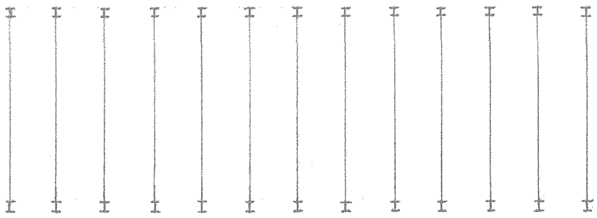
- Metal floor deck w/ concrete fill; see 4.22



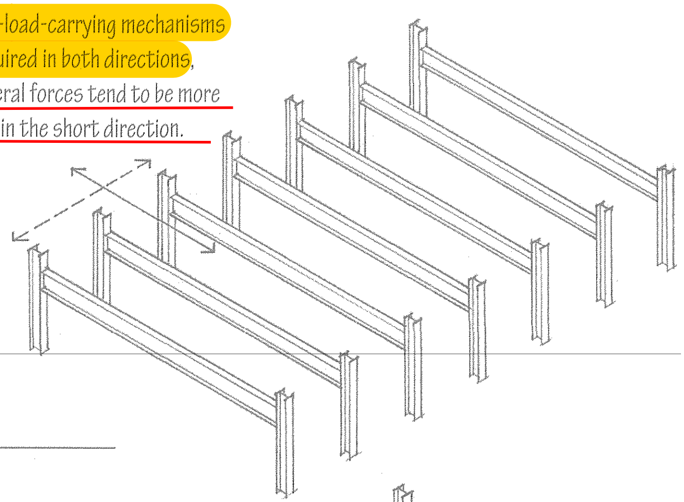
- Steel beam
- Steel girder



- When bearing on concrete or masonry, steel bearing plates are required to distribute the concentrated load imposed by a column or beam so that the resultant unit bearing pressure does not exceed the allowable unit stress for the supporting material.

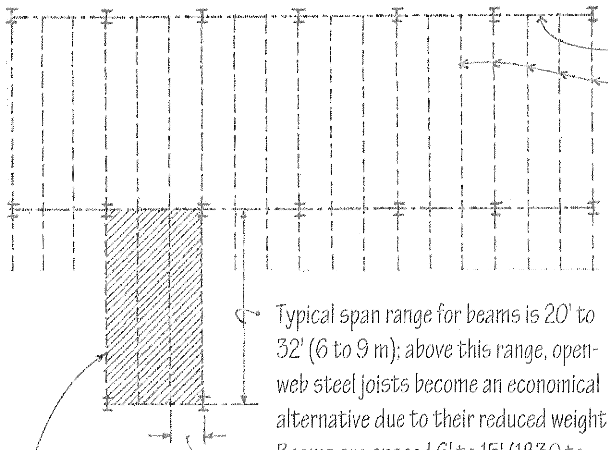


- Lateral-load-carrying mechanisms are required in both directions, but lateral forces tend to be more critical in the short direction.

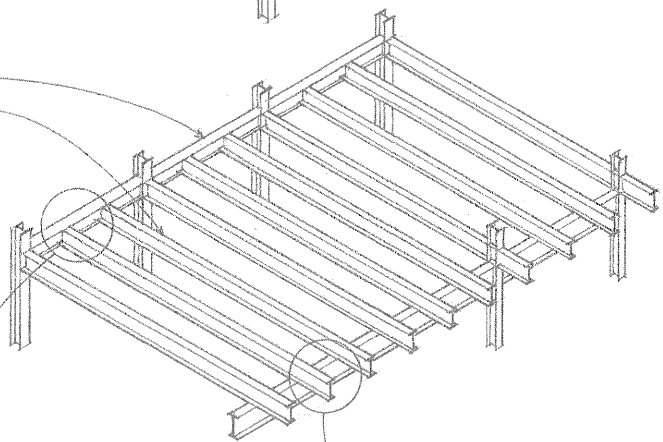


- Each pair of external columns supports a long-spanning beam or girder. This system is suitable for long, narrow buildings, especially when a column-free space is desired.

One-Way Beam System

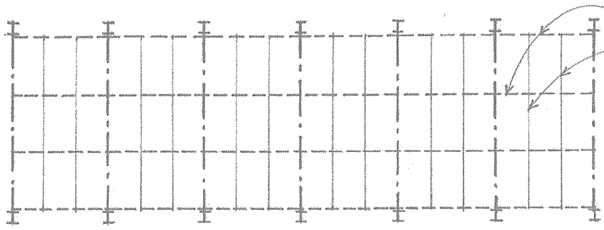


Girder
Beams

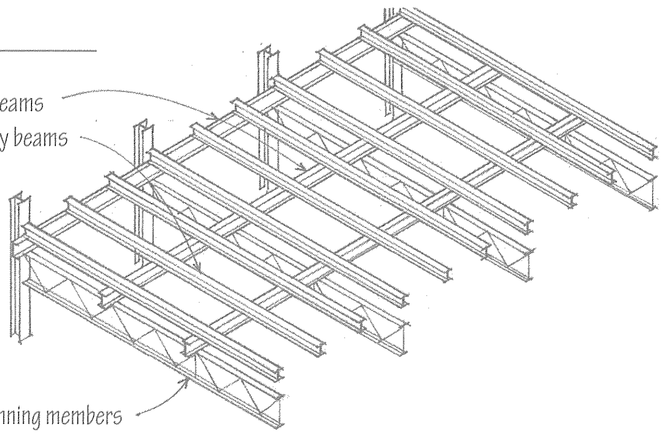


- Typical span range for beams is 20' to 32' (6 to 9 m); above this range, open-web steel joists become an economical alternative due to their reduced weight.
- Beams are spaced 6' to 15' (1830 to 4570), depending on magnitude of the applied load and spanning capability of the floor deck.
- Framing beams into girders minimizes floor depth; some mechanical services can pass through holes cut into the beam webs, but large lines may have to accommodated in a suspended ceiling space below.
- Two-layer system increases floor depth considerably but provides more space for mechanical services.
- Girders spanning the short axis of a building can contribute to the lateral stability of the structure.
- Steel framing should utilize rectangular bay units, with comparatively lightly loaded beams spanning farther than more heavily loaded girders.

Two-Way Beam System

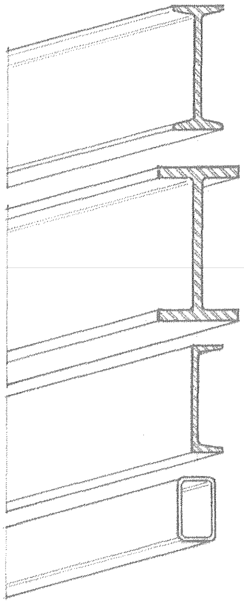


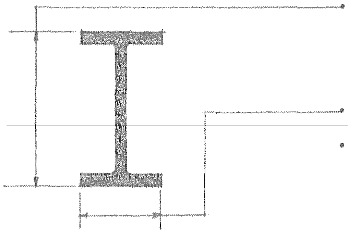
Primary beams
Secondary beams



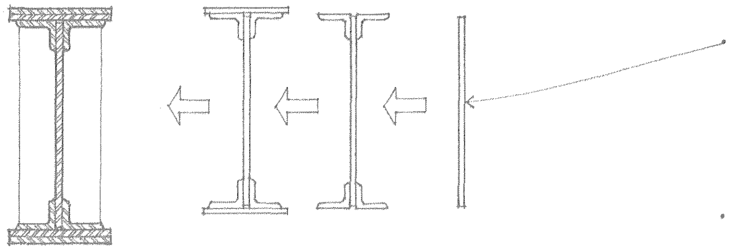
- Long-spanning members
- When a large, column-free space is required, long-spanning plate girders or trusses can be used to carry the primary beam, which in turn support a layer of secondary beams.

Triple Beam System

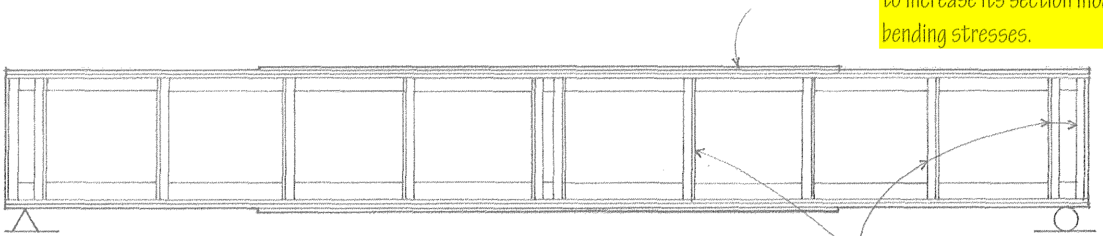




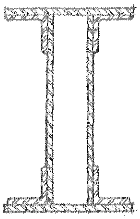
- More structurally efficient wide-flange (W) shapes have largely superseded the classic I-beam (S) shapes. Beams may also be in the form of channel (C) sections, structural tubing, or composite sections.
- Rules of thumb for estimating depth:
  beams: span/20
  girders: span/15
- Width = 1/3 to 1/2 of depth
- The general objective is to use the lightest steel section that will resist bending and shear forces within allowable limits of stress and without excessive deflection for intended use.
- In addition to material costs, also consider the labor costs required for erection.

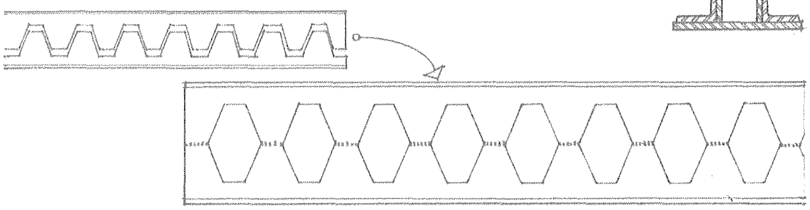


- Plate girders are built up from plates or shapes that are welded or riveted together. A web plate forms the web of a plate girder, while flange angles form the top and bottom flanges. Shear plates may be fastened to the web of the girder to increase its resistance to shearing stresses.
- Cover plates are fastened to the flanges of a plate girder to increase its section modulus in areas subject to high bending stresses.



- Stiffener angles are fastened to each side of a web plate to stiffen it against buckling; bearing stiffeners are placed at a point of support or under a concentrated load; intermediate stiffeners are placed between bearing stiffeners for increased resistance to diagonal compressive stresses.

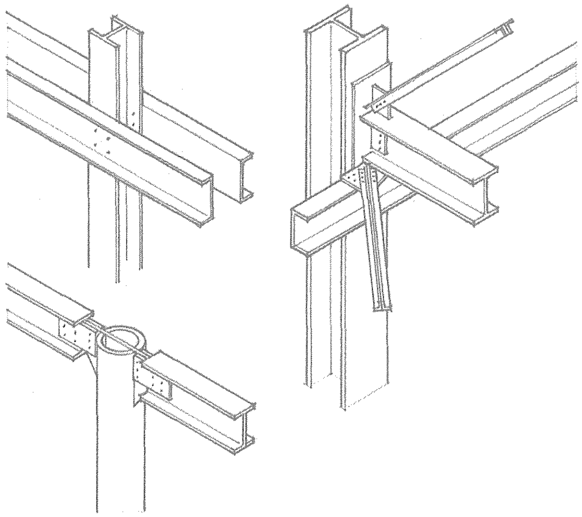


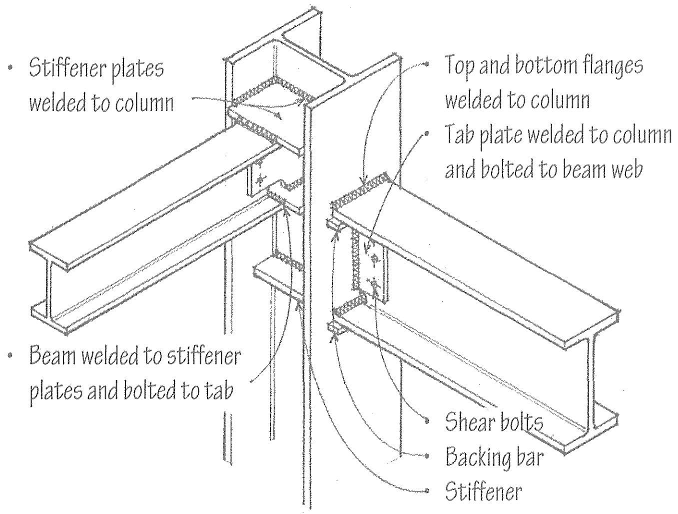


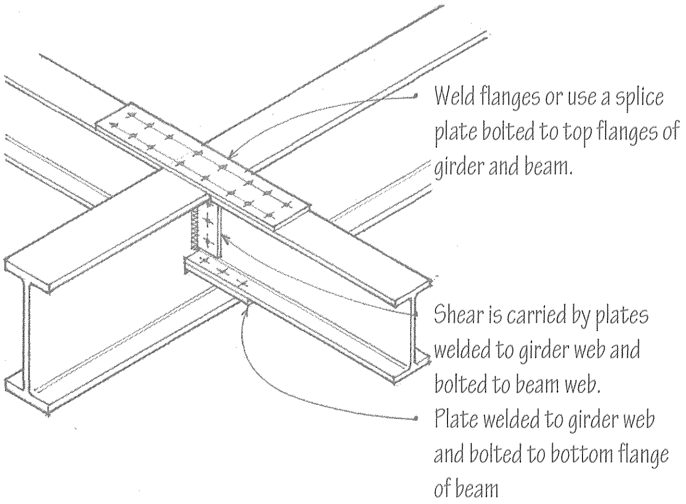
- Box girders are built up from shapes and have a hollow, rectangular cross section.
- Castellated beams are fabricated by dividing the web of a wide-flange section with a lengthwise zigzag cut, then welding both halves together at the peaks, thus increasing its depth without increasing its weight.

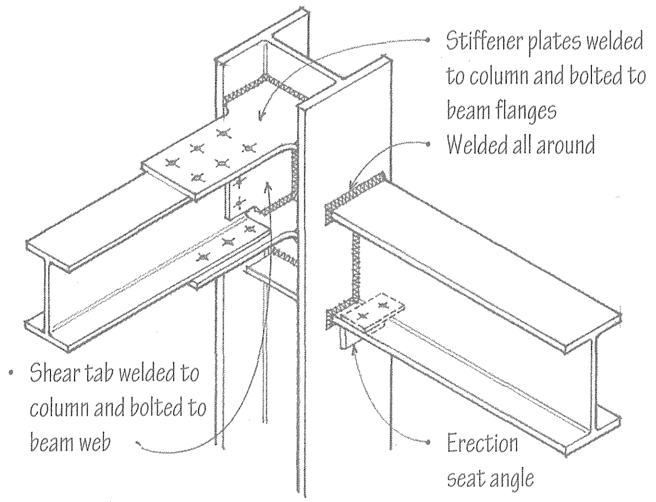
There are many ways in which steel connections can be made, using different types of connectors and various combinations of bolts and welds. Refer to the American Institute of Steel Construction's (AISC's) *Manual of Steel Construction* for steel section properties and dimensions, allowable load tables for beams and columns, and requirements for bolted and welded connections. In addition to strength and degree of rigidity, connections should be evaluated for economy of fabrication and erection, and for visual appearance if the structure is exposed to view.

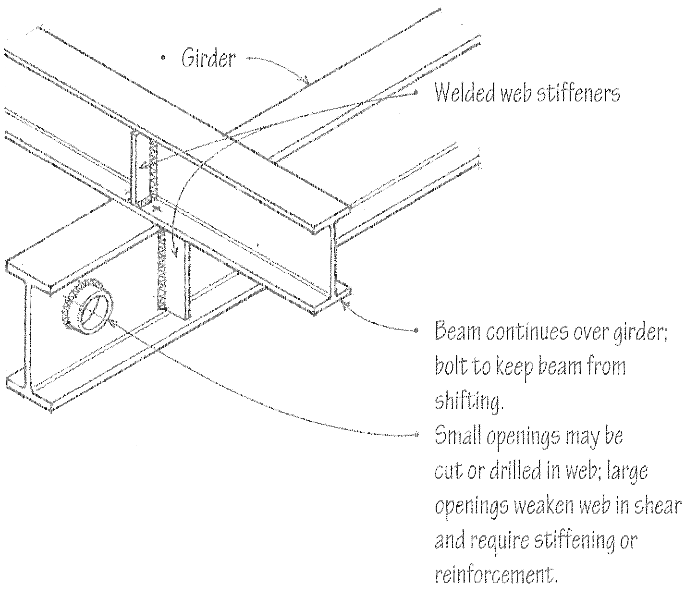
The strength of a connection depends on the sizes of the members and the connecting tees, angles, or plates, as well as the configuration of bolts or welds used. The AISC defines three types of steel framing that govern the sizes of members and the methods for their connections: moment connections, shear connections, and semi-rigid connections.









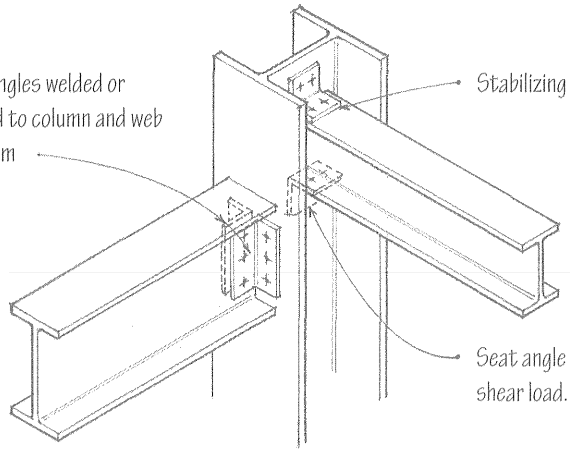


Moment Connections

AISC Type 1—Rigid Frame—connections are able to hold their original angle under loading by developing a specified resisting moment, usually by means of plates welded or bolted to the beam flanges and the supporting column.

- A framed connection is a shear-resisting steel connection made by welding or bolting the web of a beam to the supporting column or girder with two angles or a single tab plate.

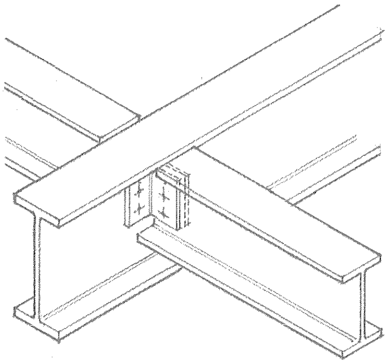
- Two angles welded or bolted to column and web of beam

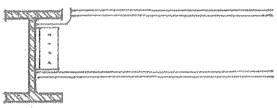


- Stabilizing angle
- Seat angle carries shear load.

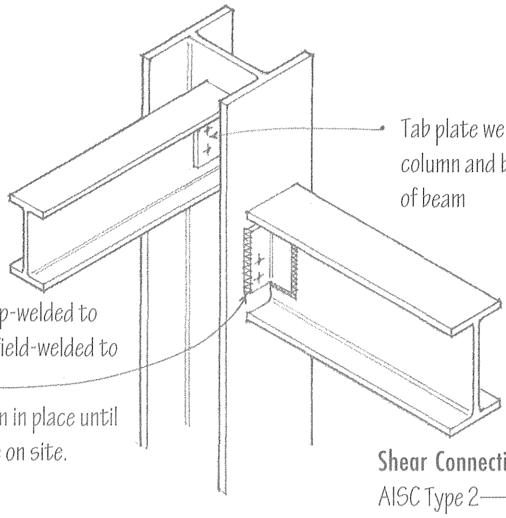
- A seated connection is a shear-resisting steel connection made by welding or bolting the flanges of a beam to the supporting column with a seat angle below and a stabilizing angle above.

- A seated connection may be stiffened to resist large beam reactions, usually by means of a vertical plate or pair of angles directly below the horizontal component of the seat angle.





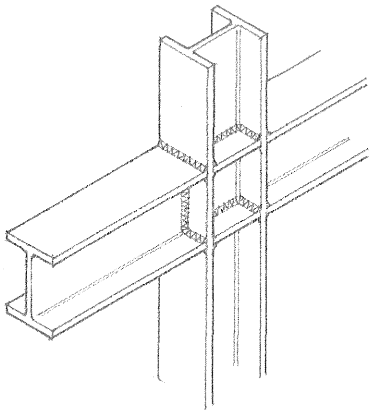
- Angles bolted or welded to webs of girder and beam; for the top of the beam to be flush w/ the top of the girder, the top flange of the beam is coped or cut away.



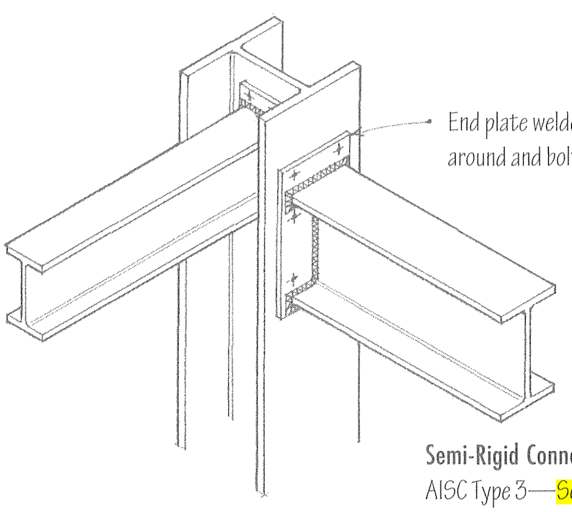
- Tab plate welded to column and bolted to web of beam
- Two angles shop-welded to beam web and field-welded to column
- Bolts hold beam in place until welds are made on site.

Shear Connections

AISC Type 2—Simple Frame—connections are made to resist only shear and are free to rotate under gravity loads. Shear walls or diagonal bracing is required for lateral stability of the structure.



- All-welded connections are aesthetically pleasing, especially when ground smooth, but they can be very expensive to fabricate.

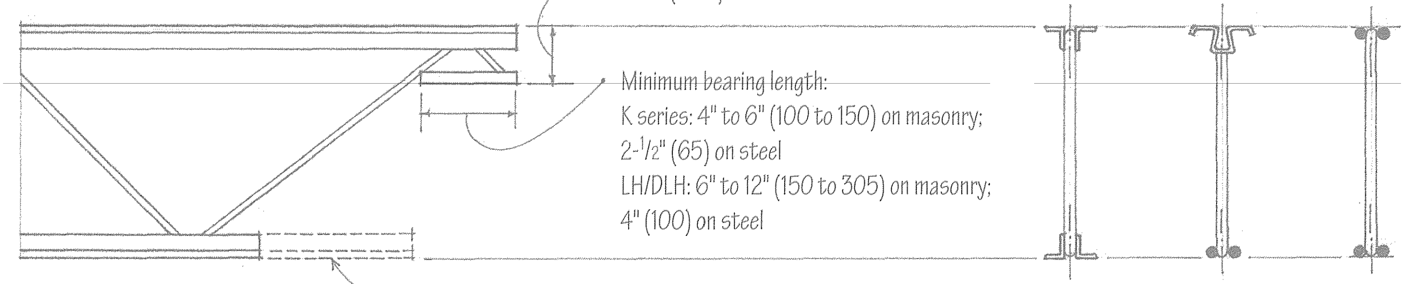


- End plate welded to beam all around and bolted to column

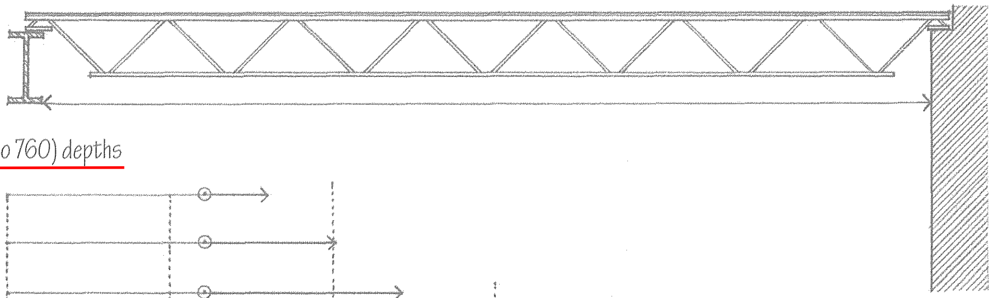
Semi-Rigid Connections

AISC Type 3—Semi-Rigid Frame—connections assume beam and girder connections possess a limited but known moment-resisting capacity.

Open-web joists are lightweight, shop-fabricated steel members having a trussed web. A K series joist has a web consisting of a single bent bar, running in a zigzag pattern between the upper and lower chords. LH and DLH series joists have heavier web and chord members for increased loads and spans.



- 2-1/2" (64) for K series; 5" (125) for LH/DLH series; 7-1/2" (1190) for DLH 18 and 19
- Minimum bearing length:
  K series: 4" to 6" (100 to 150) on masonry;
  2-1/2" (65) on steel
  LH/DLH: 6" to 12" (150 to 305) on masonry;
  4" (100) on steel
- Extension of bottom chord for direct attachment of ceiling; square-end joists are available.
- Profiles of open-web steel joists vary according to manufacturer.



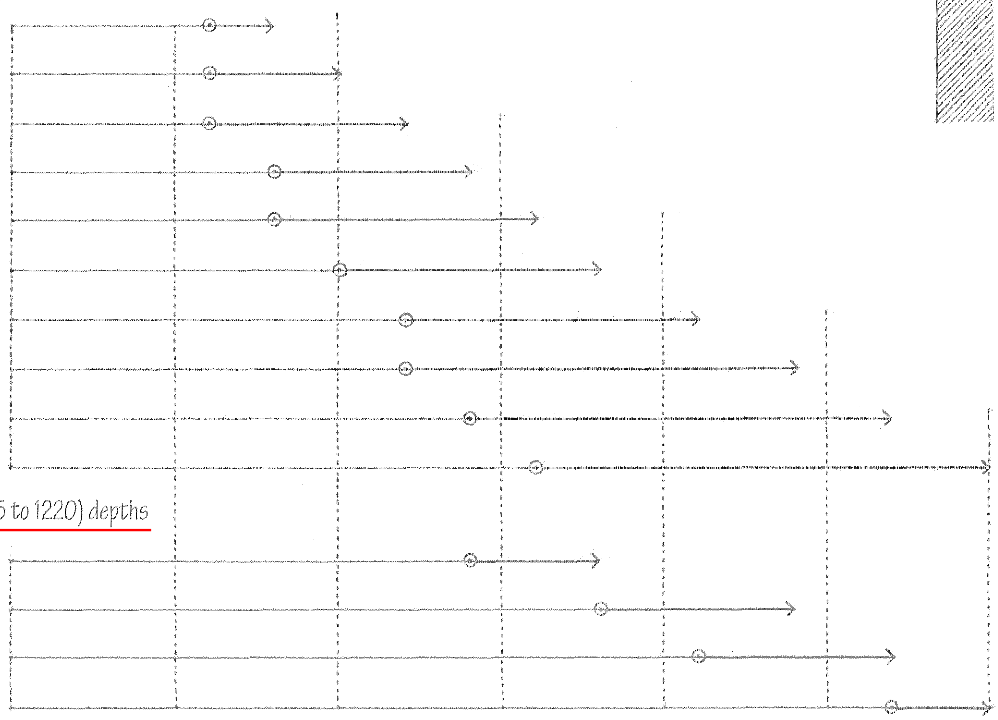
Span Ranges for Open-web Joists

- K series standard joists; 8" to 30" (205 to 760) depths

8K1	12' to 16'	(4 to 5 m)
10K1	12' to 20'	(4 to 6 m)
12K3	12' to 24'	(4 to 7 m)
14K4	16' to 28'	(5 to 8 m)
16K5	16' to 32'	(5 to 10 m)
18K6	20' to 36'	(6 to 11 m)
22K9	24' to 42'	(7 to 12 m)
24K9	24' to 48'	(7 to 14 m)
28K10	28' to 54'	(8 to 16 m)
30K12	32' to 60'	(10 to 18 m)

- LH series longspan joists; 18" to 48" (455 to 1220) depths

18LH5	28' to 36'	(8 to 11 m)
24LH7	36' to 48'	(11 to 14 m)
28LH9	42' to 54'	(12 to 16 m)
32LH10	54' to 60'	(16 to 18 m)



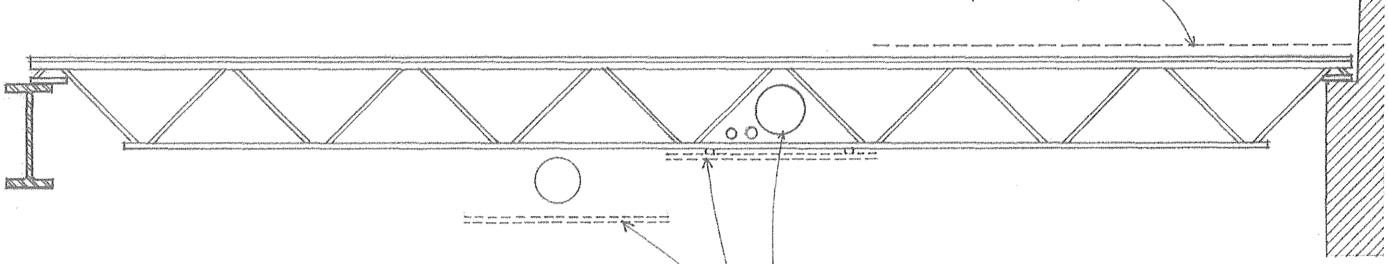
32LH10:
- Chord designation
- Joist series
- Nominal joist depth in inches

- Consult the Steel Joist Institute for specifications and complete load tables for all joist types.

- DLH series deep longspan joists are available in 52" to 72" (1320 to 1830) depths and can span up to 144' (44 m).

CSI MasterFormat 05 20 00 Metal Joists
CSI MasterFormat 05 21 00 Steel Joist Framing

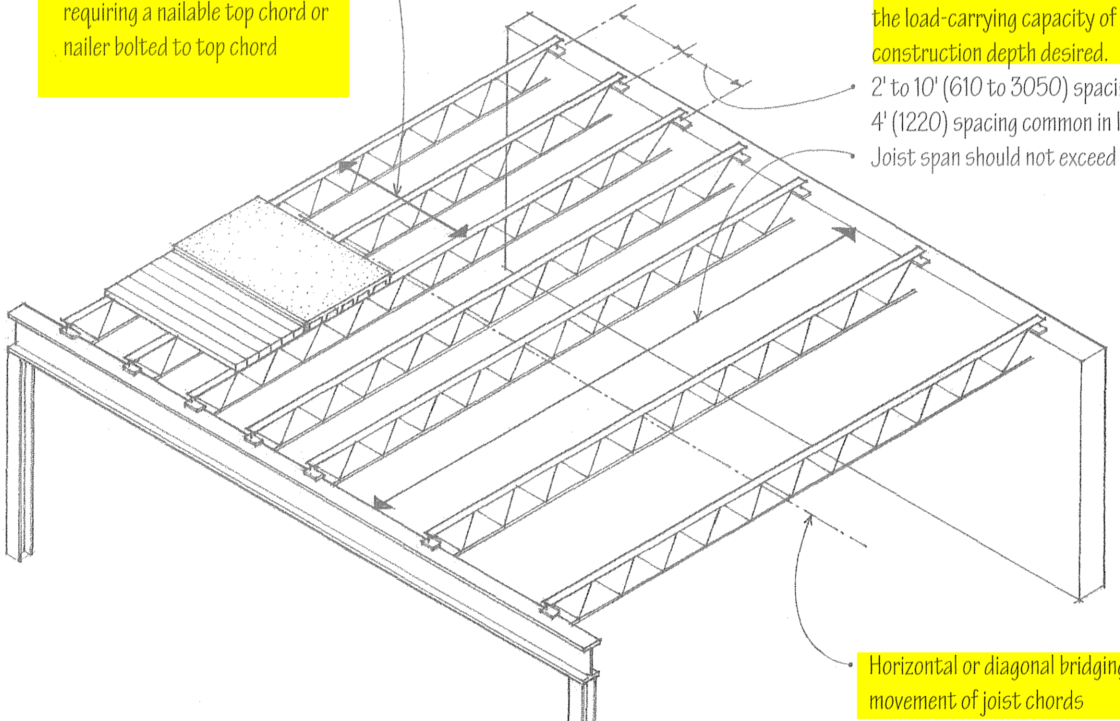
- Floor deck spans across joists.



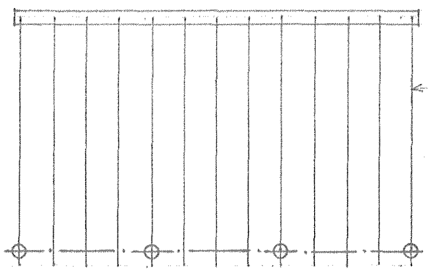
- Open-web steel joists may be supported by a bearing wall of masonry or reinforced concrete, or by steel beams or joist girders, which are heavier versions of open-web joists.
- Open webs permit the passage of mechanical services.
- Ceiling may be attached to bottom chords or be suspended if additional space for services is required; ceiling may also be omitted to expose joists and floor deck.
- Fire-resistance rating depends on the fire rating of the floor and ceiling assemblies; see Appendix.

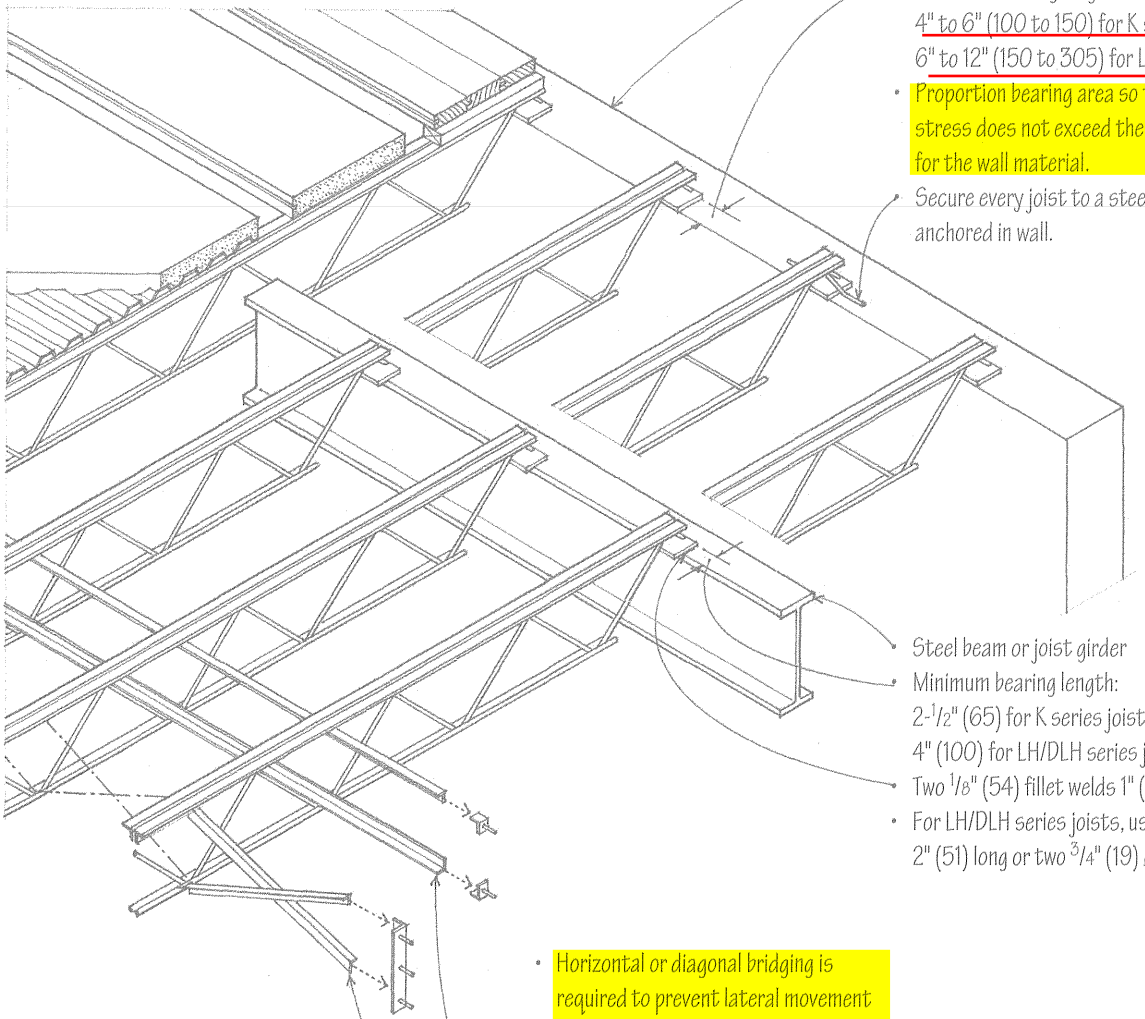
- Floor deck spans joist spaces.
- Floor deck may consist of:
  - Metal decking w/concrete fill
  - Precast concrete planks
  - Plywood panels or wood planking, requiring a nailable top chord or nailer bolted to top chord

- Spacing of joists is related to the magnitude of floor load, the spanning capability of the decking material, the load-carrying capacity of the joists, and the floor construction depth desired.
- 2' to 10' (610 to 3050) spacing; 4' (1220) spacing common in large buildings
- Joist span should not exceed 24 x joist depth.



- Horizontal or diagonal bridging to prevent lateral movement of joist chords
- The relatively lightweight construction is analogous to wood joist framing.
- Because of their standard depths and manufactured lengths, open-web joists should span rectangular bays.
- The framing works most efficiently when the joists carry uniformly distributed loads.
- If properly engineered, concentrated loads may bear over the panel points of the joists.

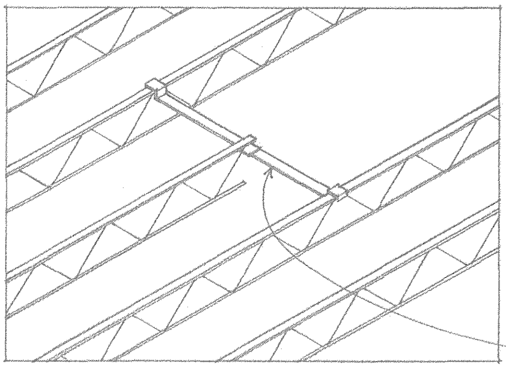




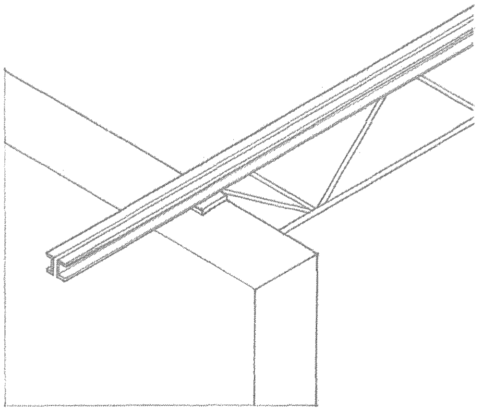
- Reinforced concrete or masonry bearing wall
- Minimum bearing length:
  4" to 6" (100 to 150) for K series joists;
  6" to 12" (150 to 305) for LH/DLH series joists
- Proportion bearing area so that unit bearing stress does not exceed the allowable unit stress for the wall material.
- Secure every joist to a steel bearing plate anchored in wall.

- Steel beam or joist girder
- Minimum bearing length:
  2-1/2" (65) for K series joists;
  4" (100) for LH/DLH series joists
- Two 1/8" (54) fillet welds 1" (25) long or 1/2" (13) ø bolt
- For LH/DLH series joists, use two 1/4" (57) fillet welds 2" (51) long or two 3/4" (19) ø bolts.

- Horizontal or diagonal bridging is required to prevent lateral movement of joist chords.
- Bridging is spaced from 10' to 20' (3050 to 6095) o.c., depending on joist span and chord size.
- Horizontal bridging angles are welded to top and bottom chords.
- Use diagonal bridging angles for LH/DLH series joists.
- Weld or bolt bridging to clip angles secured to masonry wall or steel edge beam.

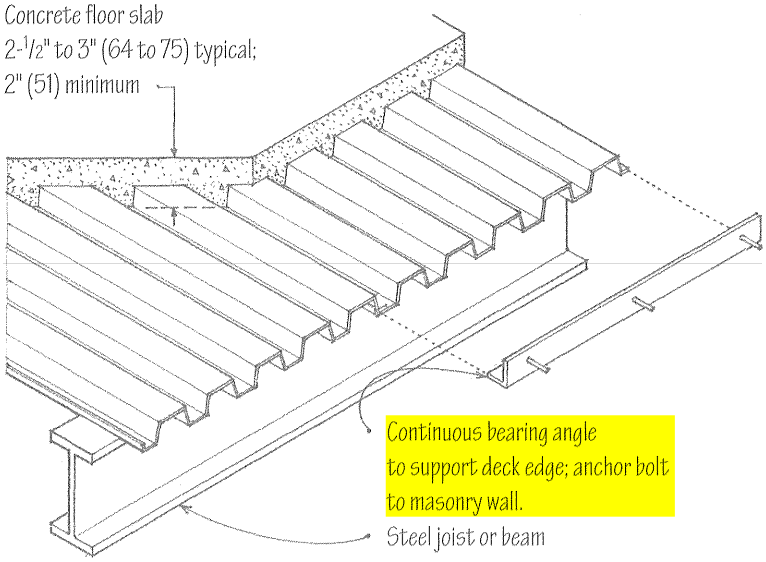


- Small openings may be framed with steel angle headers supported by trimmer joists. Large openings require structural steel framing.
- Header to support tail joist



- Limited overhangs are possible by extending the top chords.
- Extended ends of steel angles or channel sections are available for short overhangs. For K series joists, the overhang may extend 5'-6" (1675), with an allowable load of 300 psf (1 psf = 0.479 kPa).

Metal decking is corrugated to increase its stiffness and spanning capability. The floor deck serves as a working platform during construction and as formwork for a sitecast concrete slab.

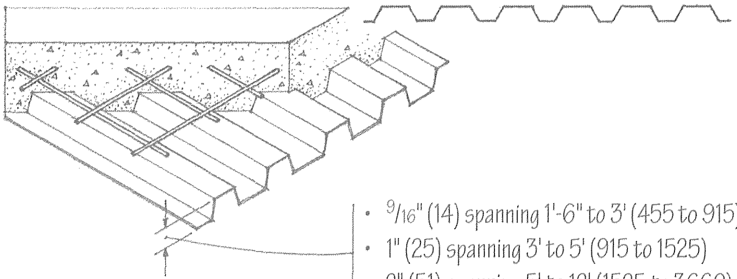


- The decking panels are secured with puddle-welds or shear studs welded through the decking to the supporting steel joists or beams.
- The panels are fastened to each other along their sides with screws, welds, or button punching standing seams.
- If the deck is to serve as a structural diaphragm and transfer lateral loads to shear walls, its entire perimeter must be welded to steel supports. In addition, more stringent requirements for support and side lap fastening may apply.

There are three major types of metal decking.

Form Decking

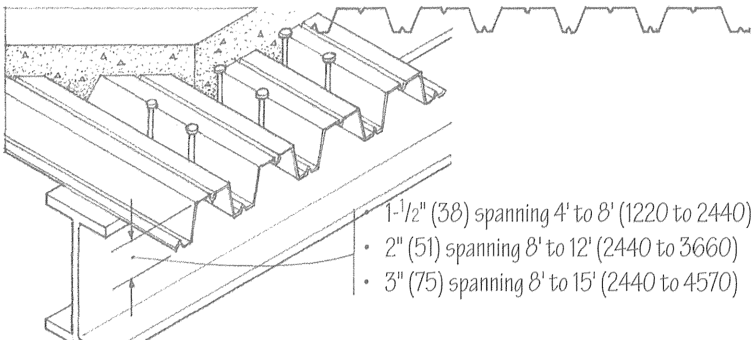
- Form decking serves as permanent formwork for a reinforced concrete slab until the slab can support itself and its live load.



- 9/16" (14) spanning 1'-6" to 3' (455 to 915)
- 1" (25) spanning 3' to 5' (915 to 1525)
- 2" (51) spanning 5' to 12' (1525 to 3660)

Composite Decking

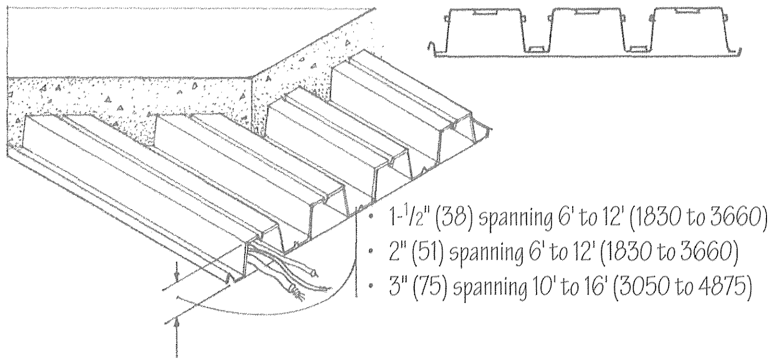
- Composite decking serves as tensile reinforcement for the concrete slab to which it is bonded with embossed rib patterns. Composite action between the concrete slab and the floor beams or joists can be achieved by welding shear studs through the decking to the supporting beam below.



- 1-1/2" (38) spanning 4' to 8' (1220 to 2440)
- 2" (51) spanning 8' to 12' (2440 to 3660)
- 3" (75) spanning 8' to 15' (2440 to 4570)

Cellular Decking

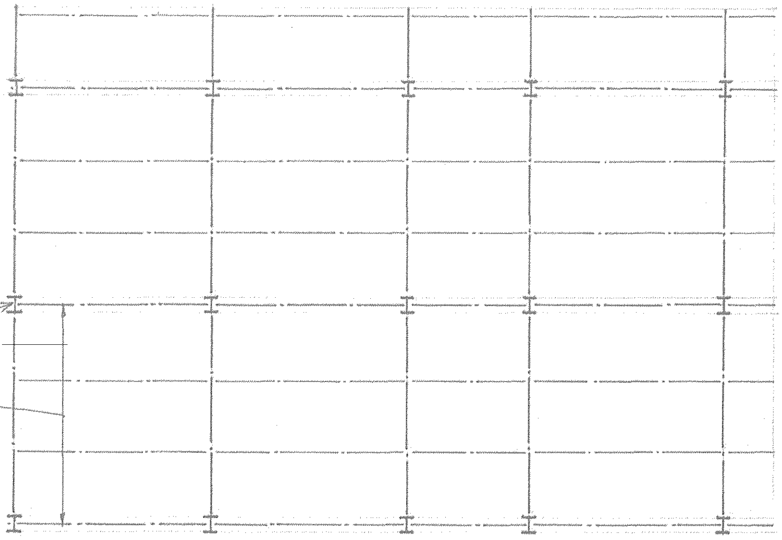
- Cellular decking is manufactured by welding a corrugated sheet to a flat steel sheet, forming a series of spaces or raceways for electrical and communications wiring; special cutouts are available for floor outlets. The decking may serve as an acoustic ceiling when the perforated cells are filled with glass fiber.



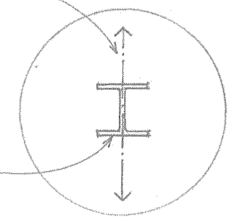
- 1-1/2" (38) spanning 6' to 12' (1830 to 3660)
- 2" (51) spanning 6' to 12' (1830 to 3660)
- 3" (75) spanning 10' to 16' (3050 to 4875)

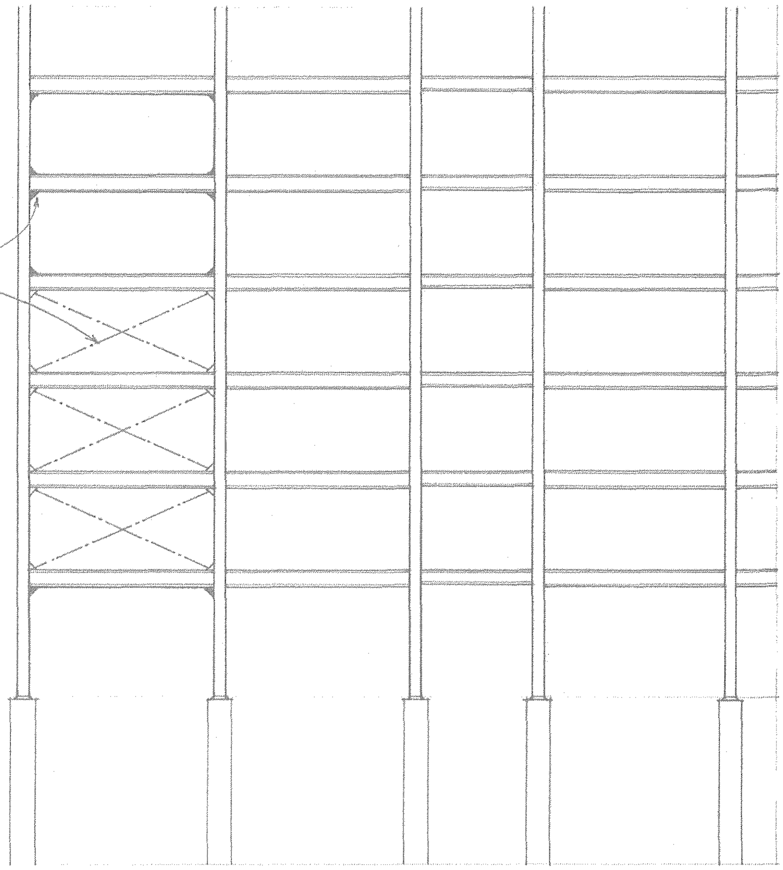
- Rule of thumb for overall depth: span/24
- Consult the manufacturer for patterns, widths, lengths, gauges, finishes, and allowable spans.

Conventional steel-framed structures are constructed of hot-rolled beams and columns, open-web joists, and metal decking. Since structural steel is difficult to work on site, it is normally cut, shaped, and drilled in a fabrication shop according to design specifications; this can result in relatively fast, precise construction.

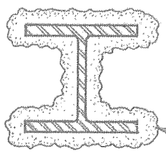


- Steel framing is most efficient when columns are laid out to support a regular grid of girders, beams, and joists.
- Column spacing = beam or girder spans
- Orient the webs of columns parallel to the short axis of the structural frame or the direction along which the structure is most susceptible to lateral forces.
- Orient the flanges on perimeter columns to the outside to facilitate attachment of curtain walls to the structural frame.

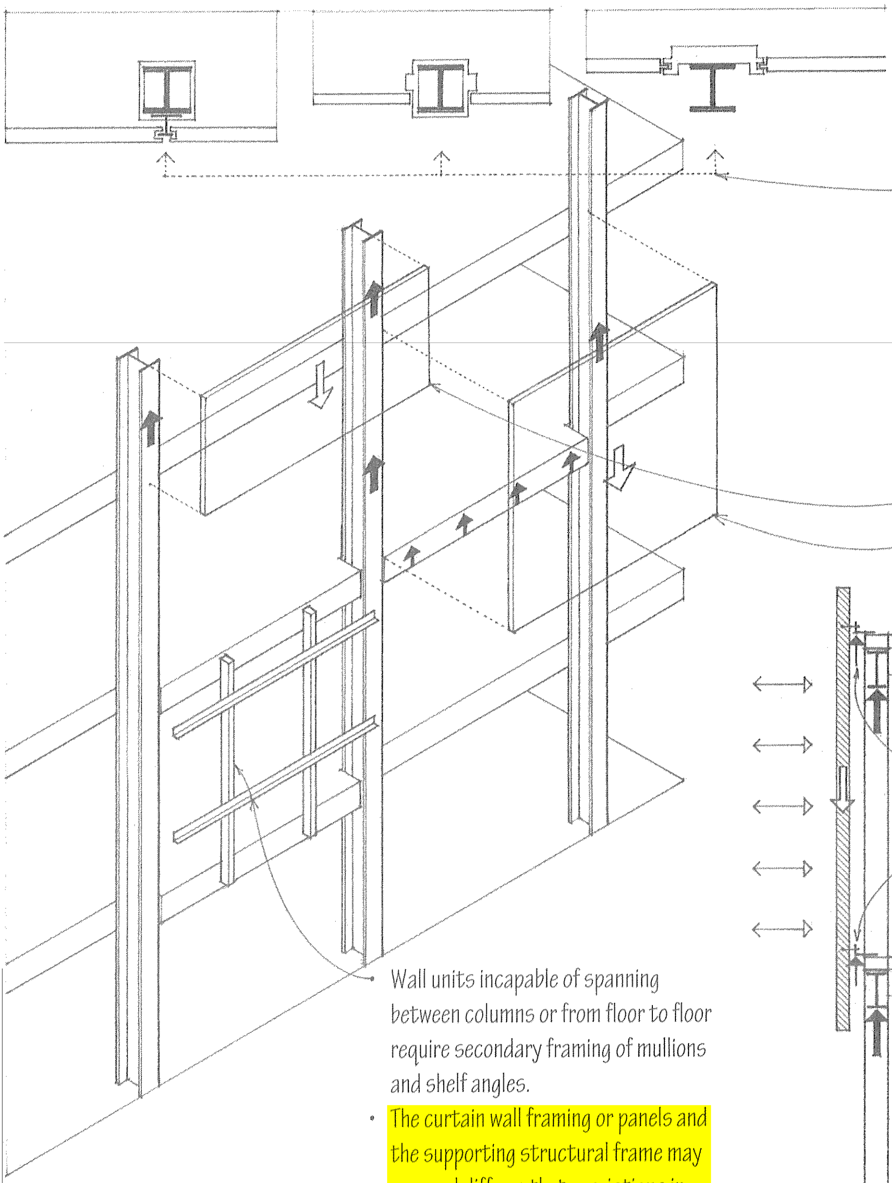




- Resistance to lateral wind and seismic forces requires the use of shear planes, diagonal bracing, or rigid framing with moment-resisting connections.



- Because steel can lose strength rapidly in a fire, fire-resistive assemblies or coatings are required; see A.12. In unprotected noncombustible construction, steel framing may be left exposed.
- See 4.14 for steel beams and floor framing systems.
- See 12.08 for a discussion of steel as a construction material.



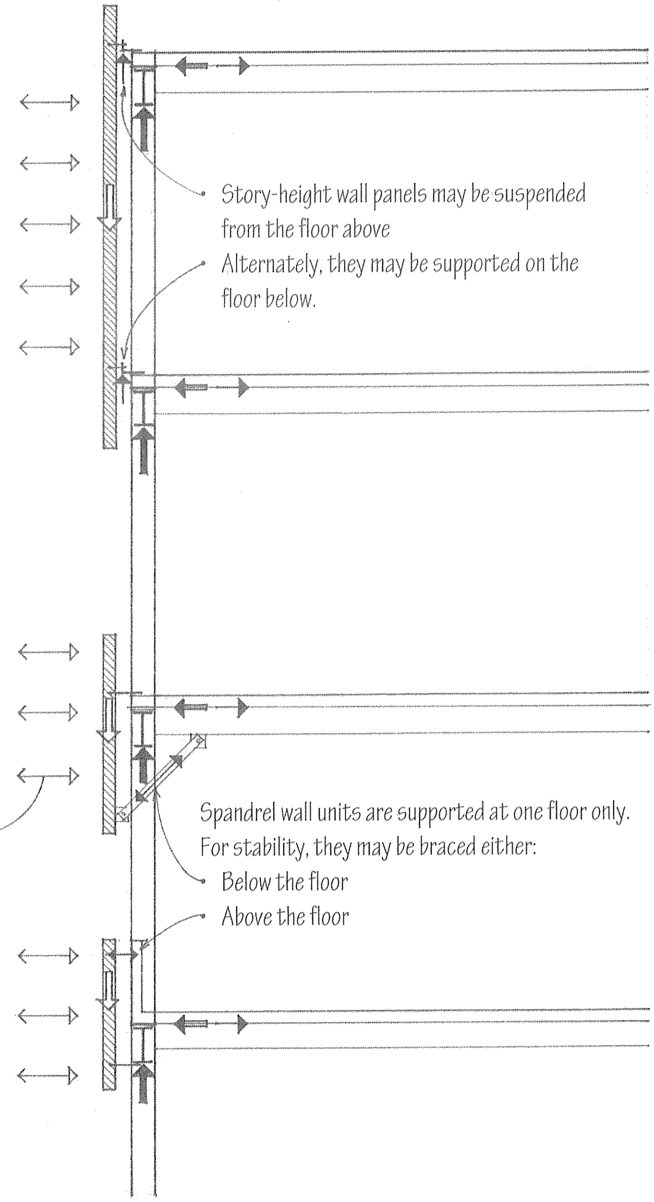
Because the columns in a steel frame structure transfer the gravity and lateral loads down to the foundation system, the exterior walls are essentially nonloadbearing curtain walls.

There are three basic relationships that may be established between a structural steel frame and the curtain wall or cladding it supports.

- Column in front of the wall plane
- Column within the wall plane
- Column behind the wall plane

The framing or panels of a curtain wall may be supported in one of two ways:

- By the columns alone
- By the columns as well as by spandrel beams or the edges of floor slabs

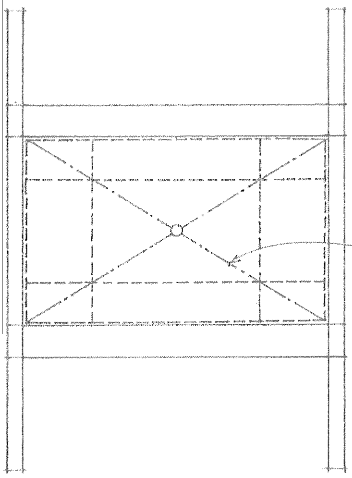


- Story-height wall panels may be suspended from the floor above
- Alternately, they may be supported on the floor below.

Spandrel wall units are supported at one floor only. For stability, they may be braced either:

- Below the floor
- Above the floor

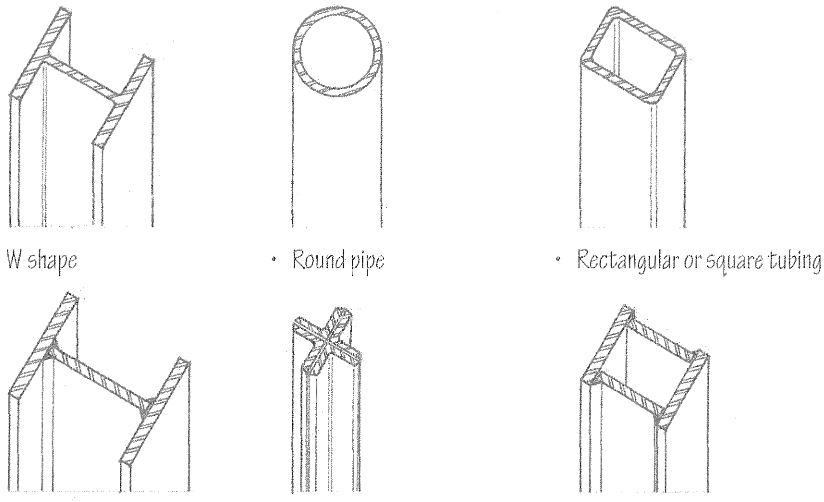
- Wall units incapable of spanning between columns or from floor to floor require secondary framing of mullions and shelf angles.
- The curtain wall framing or panels and the supporting structural frame may respond differently to variations in temperature and to gravity or wind loads. Connection details should allow for the differential movement between the wall and structural frame, as well as between the wall units themselves.
- The wall may be subject to both wind pressure and suction.



- If diagonals are used to brace the structural frame, they will affect the design of the wall units.

- For general information on curtain wall systems, see 7.24–7.26.
- For glazed curtain walls, see 8.31.

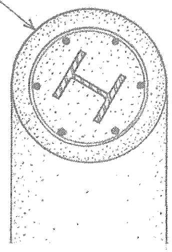
The most frequently used section for columns is the wide-flange (W) shape. It is suitable for connections to beams in two directions, and all of its surfaces are accessible for making bolted or welded connections. Other steel shapes used for columns are round pipes and square or rectangular tubing. Column sections may also be fabricated from a number of shapes or plates to fit the desired end-use of a column.



- W shape
- Round pipe
- Rectangular or square tubing
- Welded plates
- Cruciform (4 angles)
- Welded plates

Column Shapes

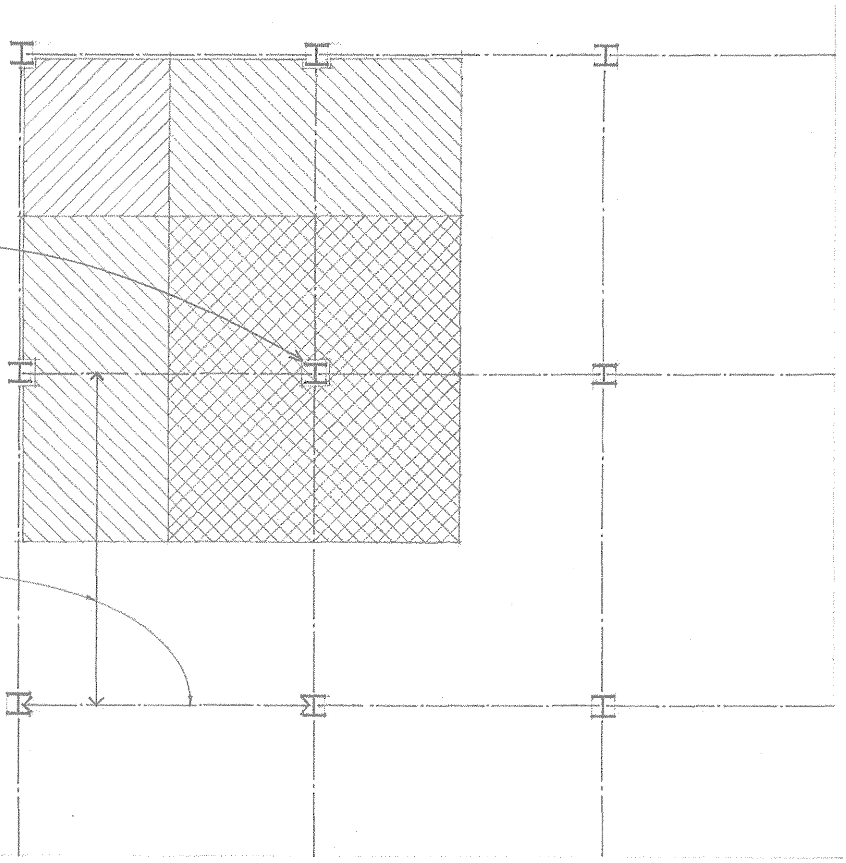
- Compound columns are structural steel columns encased in concrete at least 2-1/2" (64 mm) thick, reinforced with wire mesh.
- Composite columns are structural steel sections thoroughly encased in concrete reinforced with both vertical and spiral reinforcement.



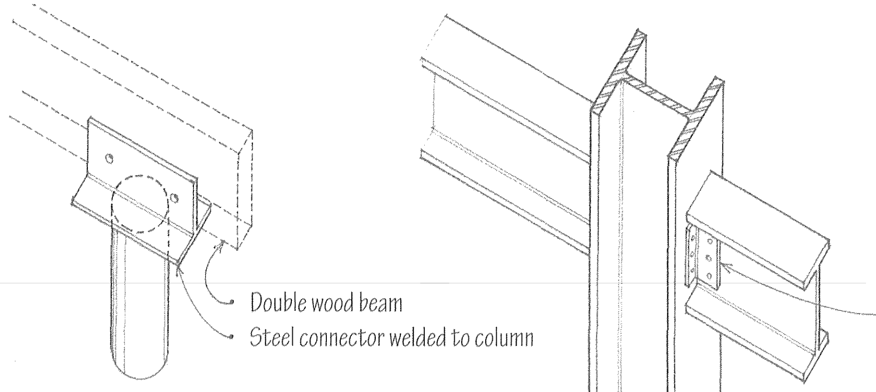
The allowable load on a steel column depends on its cross-sectional area and its slenderness ratio (L/r), where (L) is the unsupported length of the column in inches and (r) is the least radius of gyration for the cross section of the column.

Estimating Guidelines for Steel Columns

- 4x4 steel tube column may support up to 750 sf (70 m^2) of floor and roof area.
- 6x6 steel tube column may support up to 2400 sf (223 m^2) of floor and roof area.
- W6x6 may support up to 750 sf (70 m^2) of floor and roof area.
- W8x8 may support up to 3000 sf (279 m^2) of floor and roof area.
- W10x10 may support up to 4500 sf (418 m^2) of floor and roof area.
- W12x12 may support up to 6000 sf (557 m^2) of floor and roof area.
- W14x14 may support up to 12,000 sf (1115 m^2) of floor and roof area.

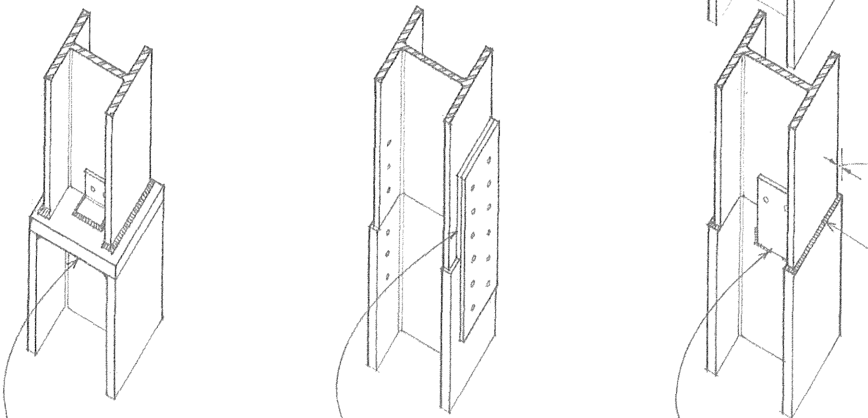


- Column spacing = beam span; see 4.16.
- Columns are assumed to have an effective length of 12' (3660).
- Increased sizes or weights are required for columns supporting heavy loads, rising to greater heights, or contributing to the lateral stability of a structure.
- Consult a structural engineer for final design requirements.



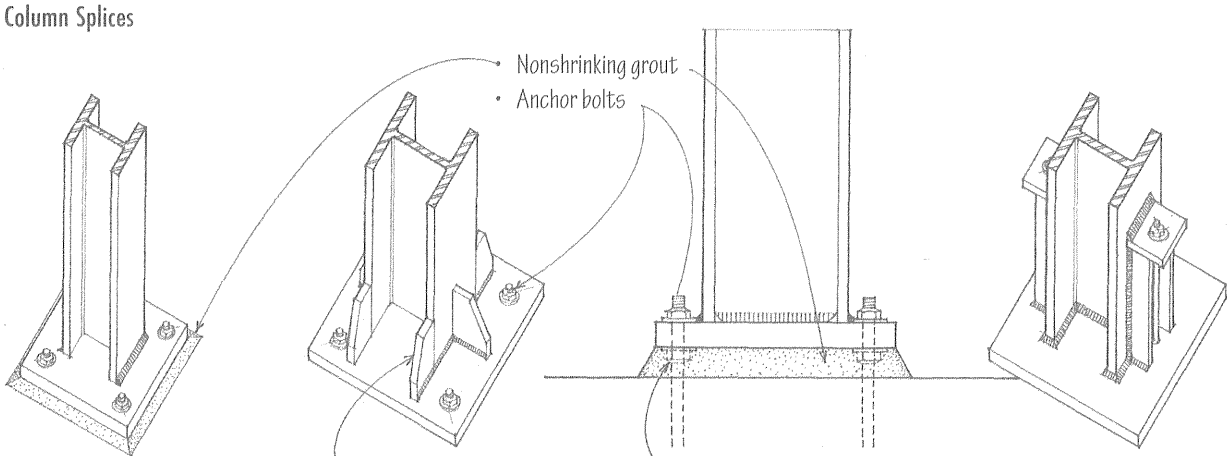
- Double wood beam
- Steel connector welded to column
- For steel beam connections, see 4.17–4.18.

Beam Connections



- As the load on a column diminishes, different flange thicknesses may be used at a column-to-column connection.
- When a change in the nominal size of a column occurs, a thick butt plate welded to both column sections is used to transfer the load.
- A backer plate can make up the difference in flange thicknesses at a bolted connection.
- Plate to keep columns aligned until welds are formed
- Welded butt connection

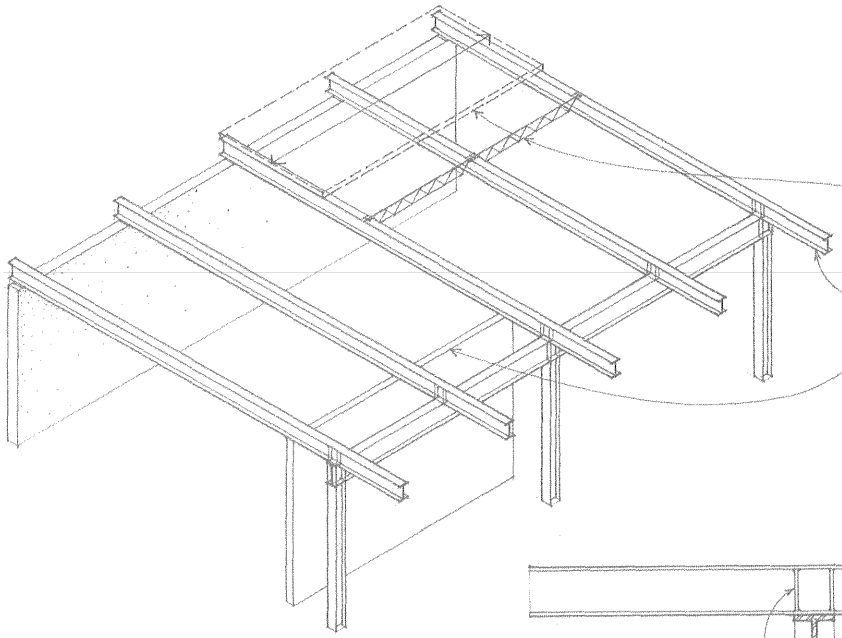
Column Splices



- Nonshrinking grout
- Anchor bolts
- Column is welded to its steel base plate after the plate is leveled on a bed of nonshrinking grout.
- Stiffeners may be required when a column bears on a thin base plate.
- Base plates for large columns are set on leveling nuts before grouting.
- A seismic foundation connection utilizes stiffener plates and anchor bolts set into a concrete foundation.

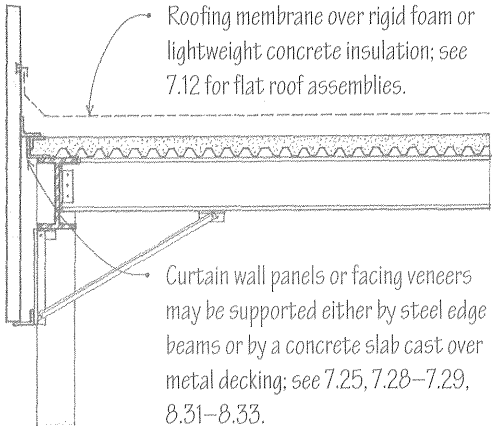
Column Bases

- A steel base plate is required to distribute the concentrated load from a column to the concrete foundation to ensure that the allowable stresses in the concrete are not exceeded.

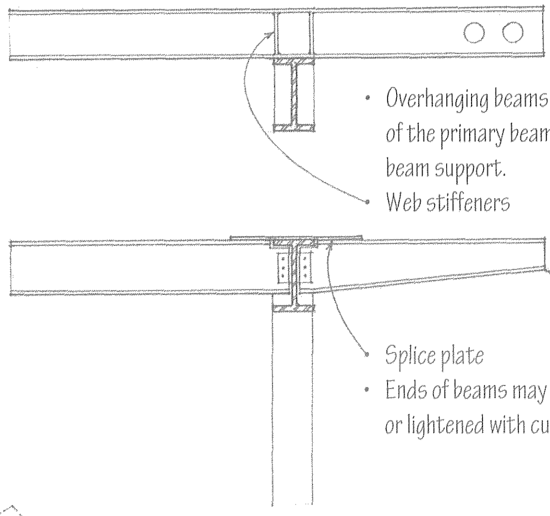


A flat roof structure may be framed with structural steel members similar to the way steel floors are framed. See 4.14–4.15.

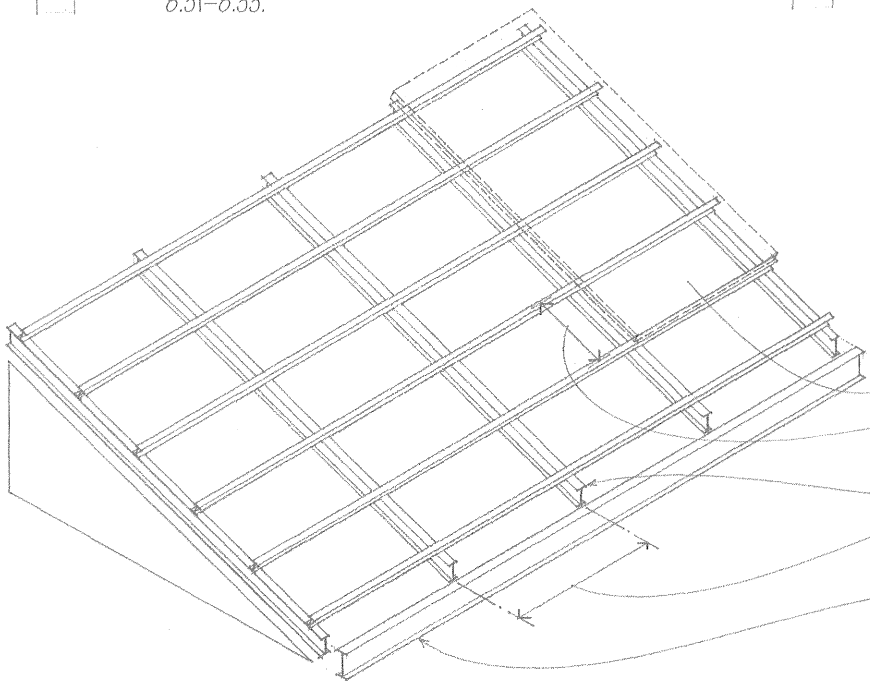
- The primary and secondary roof beams may support open-web steel joists, metal roof decking, a sitecast concrete slab, or precast concrete units.
- Roof overhangs may be achieved by extending the secondary roof beams over their supports or by recessing the exterior wall construction.



- Roofing membrane over rigid foam or lightweight concrete insulation; see 7.12 for flat roof assemblies.
- Curtain wall panels or facing veneers may be supported either by steel edge beams or by a concrete slab cast over metal decking; see 7.25, 7.28–7.29, 8.31–8.33.



- Overhanging beams may be framed within the depth of the primary beam or be continuous over the main beam support.
- Web stiffeners
- Splice plate
- Ends of beams may be tapered or lightened with cutouts.

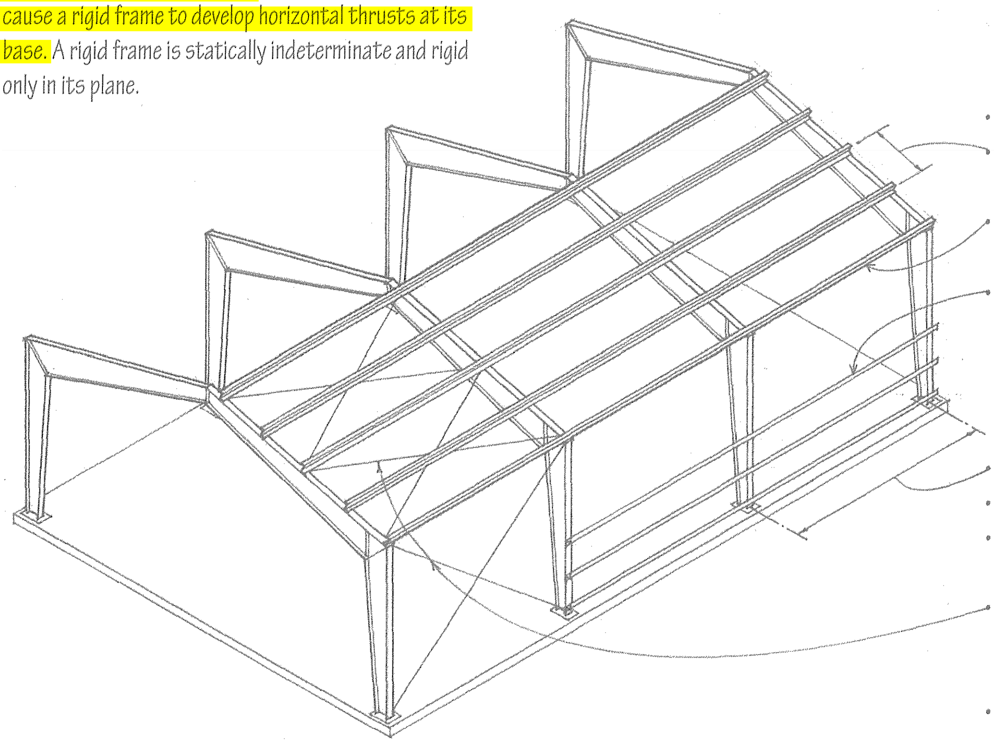


Structural steel can also be used to frame sloping roofs.

- Metal or cementitious roof decking
- Purlin spacing = decking span
- Sloping roof beams support purlins.
- Beam spacing = purlin span
- Girders support roof beams at ridge and eaves.

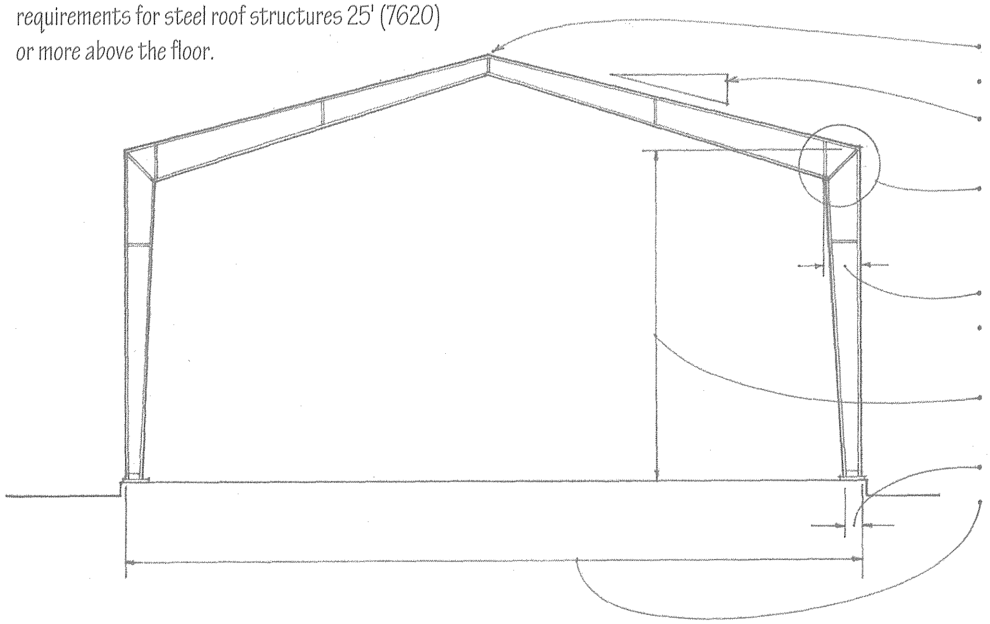
Rigid frames consist of two columns and a beam or girder that are rigidly connected at their joints. Applied loads produce axial, bending, and shear forces in all members of the frame since the rigid joints restrain the ends of the members from rotating freely. In addition, vertical loads cause a rigid frame to develop horizontal thrusts at its base. A rigid frame is statically indeterminate and rigid only in its plane.

- Various shapes of rigid frames can be fabricated of steel to span from 30' to 120' (9 to 36 m).
- Rigid frames typically form one-story structures used for light-industrial buildings, warehouses, and recreational facilities.



- Channel or Z-shape purlins
- Purlin spacing = span of roof decking; 4' to 5' (1220 to 1525) o.c.
- Eave strut
- Channel or Z-shape girts
- Frames spaced 20' to 24' (6100 to 7315) o.c.
- Frame spacing = span of purlins
- Frame spacing = span of girts
- Rigid frames provide resistance to lateral forces in their planes; they must be braced in a direction perpendicular to the frames.
- Framing is typically clad with corrugated metal roofing and siding.

- Steel frames may be left exposed in unprotected noncombustible construction.
- See A.12 for fireproofing of steel structures.
- Some building codes reduce the fire-protection requirements for steel roof structures 25' (7620) or more above the floor.



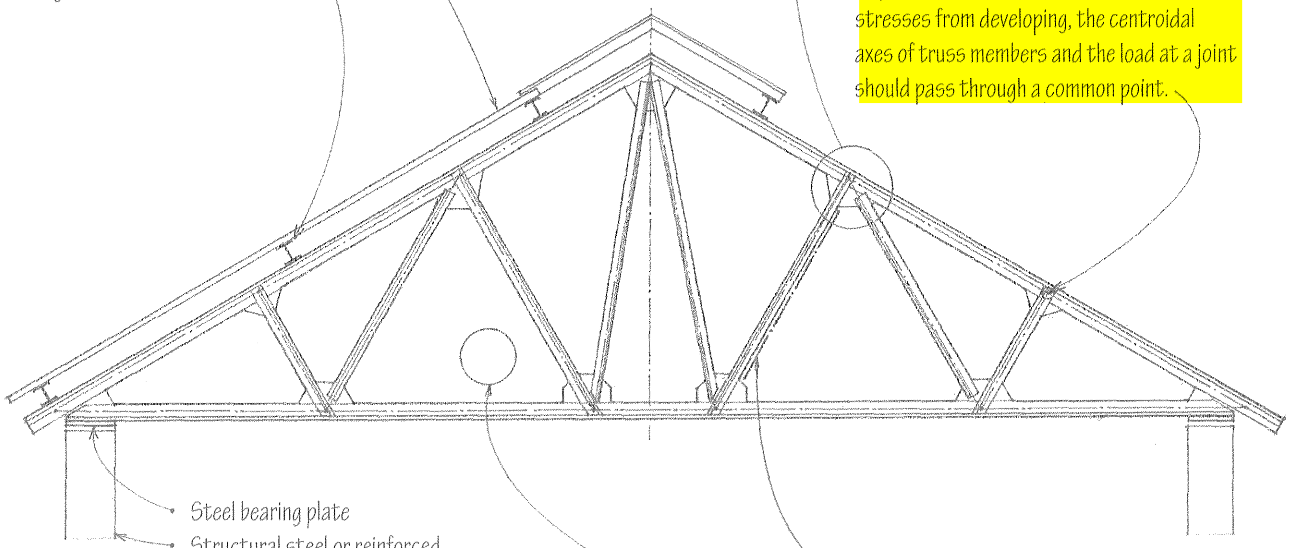
- Crown
- Rule of thumb for crown depth: span/40
- Pitch: 1:12 to 4:12
- Connection bolted or welded to resist moments
- Shoulder
- Rule of thumb for shoulder depth: span/25
- Wall height: 8' to 30' (2440 to 9145)
- Base: 8" to 20" (205 to 510)
- Typical span: 30' to 120' (9 to 36 m)

- See 2.16 for more information on trusses.

Steel trusses are generally fabricated by welding or bolting structural angles and tees together to form the triangulated framework. Because of the slenderness of these truss members, connections usually require the use of steel gusset plates. Heavier steel trusses may utilize wide-flange shapes and structural tubing.

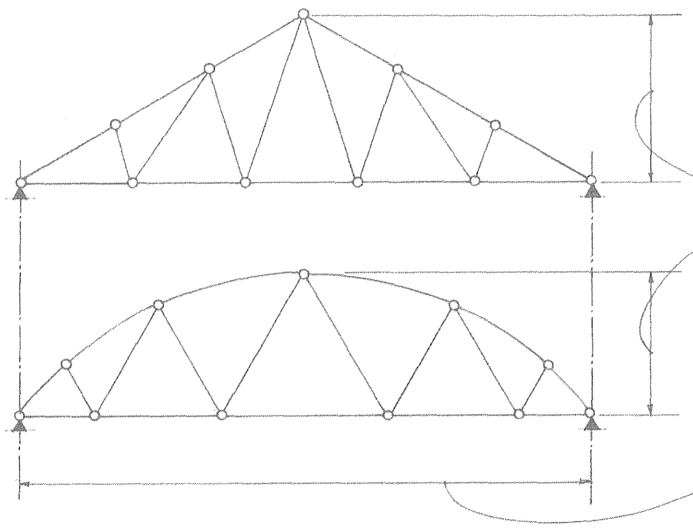
- Metal or cementitious roof decking or panels span purlin spaces.
- Channel or W-shape purlins span the truss spacing.
- If not bearing at a panel point, purlins subject top chord to local bending.

- Members are bolted or welded with gusset plate connectors.
- To prevent secondary shear and bending stresses from developing, the centroidal axes of truss members and the load at a joint should pass through a common point.

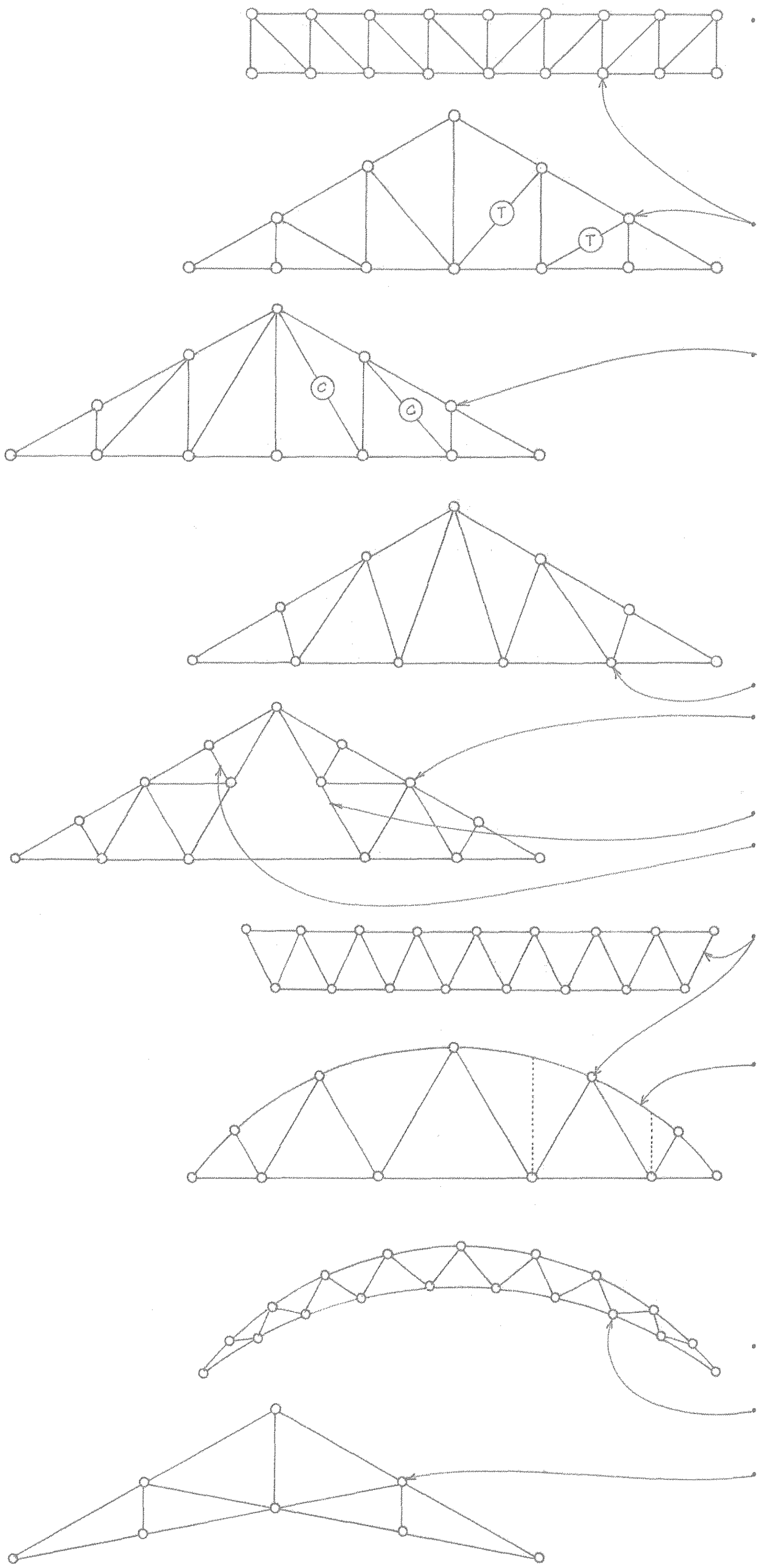


- Steel bearing plate
- Structural steel or reinforced concrete column support

- Trusses require lateral bracing in a direction perpendicular to their planes.
- Mechanical services such as piping, conduit, and ductwork may pass through the web spaces.
- Noncombustible steel construction may be left exposed if at least 20' (6095) above the finish floor; consult the building code for requirements.

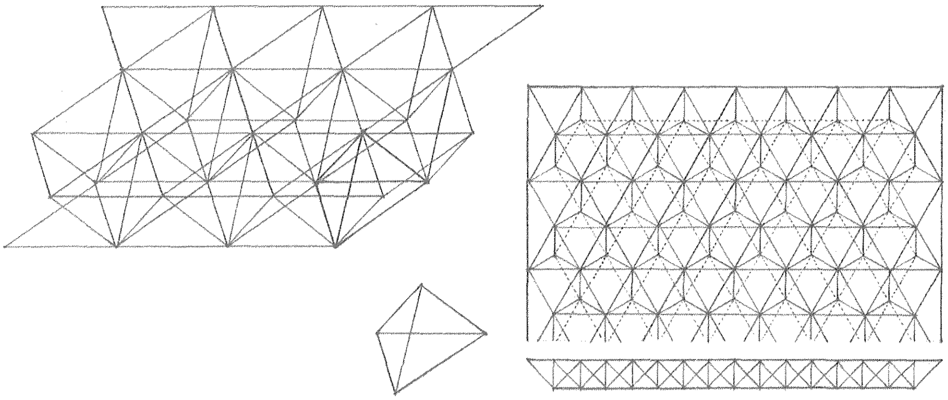


- Depth range for pitched trusses: span/4 to span/5
- Depth range for bowstring trusses: span/6 to span/8
- The increased depth of trusses allows them to span greater distances than steel beams and girders.
- Span range: 25' to 120' (7 to 36 m)

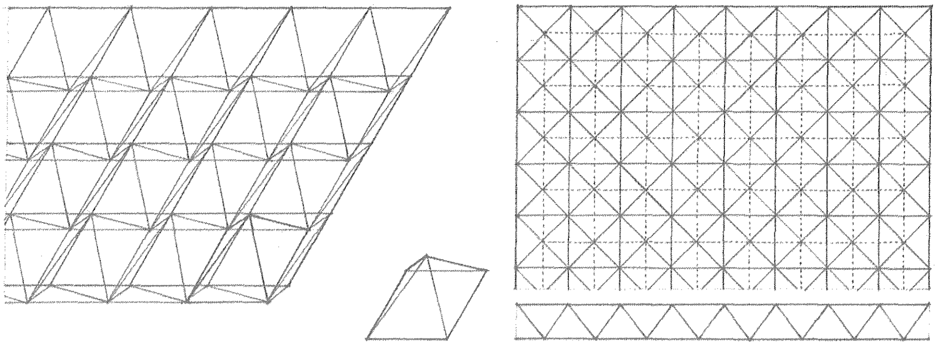


- Flat trusses have parallel top and bottom chords. Flat trusses are generally not as efficient as pitched or bowstring trusses.
- Pratt trusses have vertical web members in compression and diagonal web members in tension. It is generally more efficient to use a truss type in which the longer web members are loaded in tension.
- Howe trusses have vertical web members in tension and diagonal web members in compression.
- Belgian trusses have only inclined web members.
- Fink trusses are Belgian trusses having subdiagonals to reduce the length of compression web members toward the centerline of the span.
- Diagonals connect a top to a bottom chord.
- Subdiagonals join a chord with a main diagonal.
- Warren trusses have inclined web members forming a series of equilateral triangles. Vertical web members are sometimes introduced to reduce the panel lengths of the top chord, which is in compression.
- Bowstring trusses have a curved top chord meeting a straight bottom chord at each end.
- Raised-chord trusses have a bottom chord raised substantially above the level of the supports.
- Crescent trusses have both top and bottom chords curving upward from a common point at each side.
- Scissors trusses have tension members extending from the foot of each top chord to an intermediate point on the opposite top chord.

A space frame is a long-spanning three-dimensional plate structure based on the rigidity of the triangle and composed of linear elements subject only to axial tension or compression. The simplest spatial unit of a space frame is a tetrahedron having four joints and six structural members.

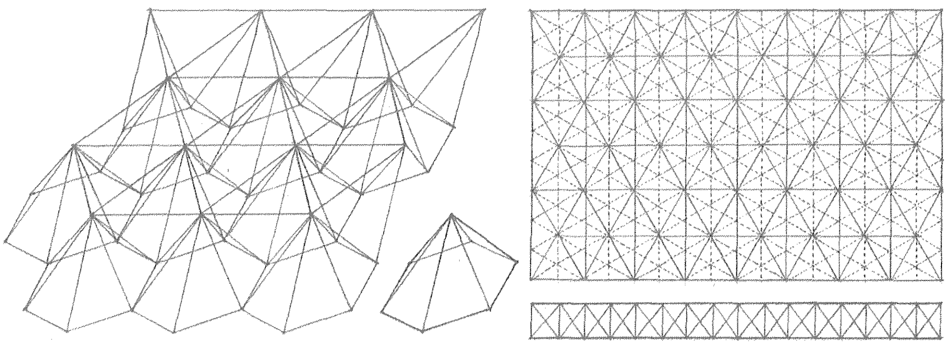


Triangular Grid



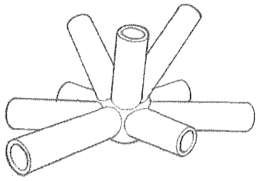
Square Grid

- Illustrated are three of the many patterns available.
- Typical modules: 4', 5', 8', 12' (1220, 1525, 2440, 3660)

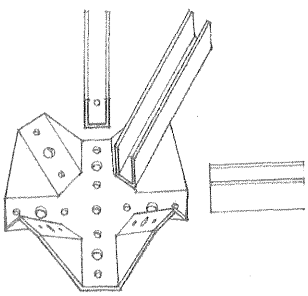


Hexagonal Grid

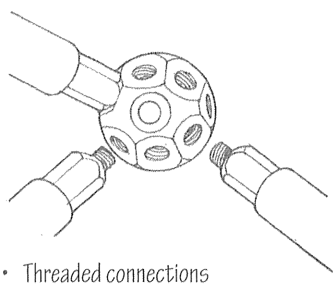
- Space frames may be constructed of structural steel pipe, tubing, channels, tees, or W-shapes.



- Welded connection



- Bolted connection

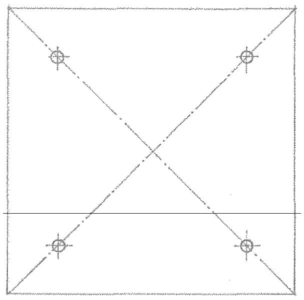


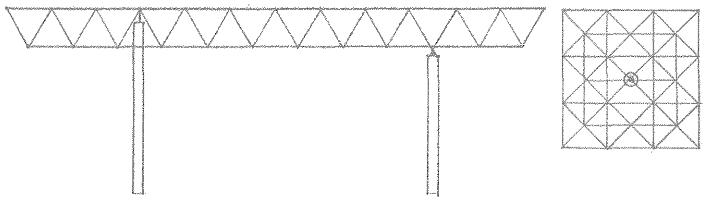
- Threaded connections

- Fabricated connectors join the members.
- Consult manufacturer for details, module size, and allowable spans.

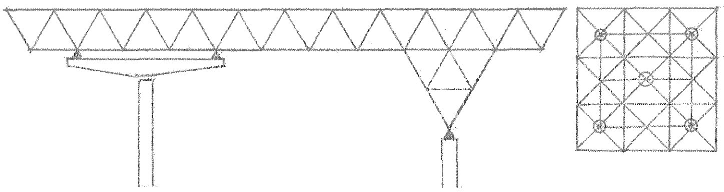
CSI MasterFormat 13 32 13 Metal Space Frames

- As with other constant-depth plate structures, the supporting bay for a space frame should be square or nearly square to ensure that it acts as a two-way structure.

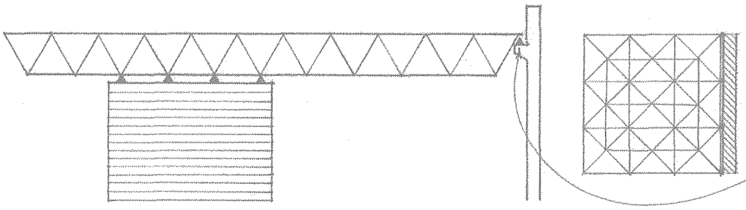




- Top-chord supported
- Bottom-chord supported
- A space frame should always be supported at a panel point.

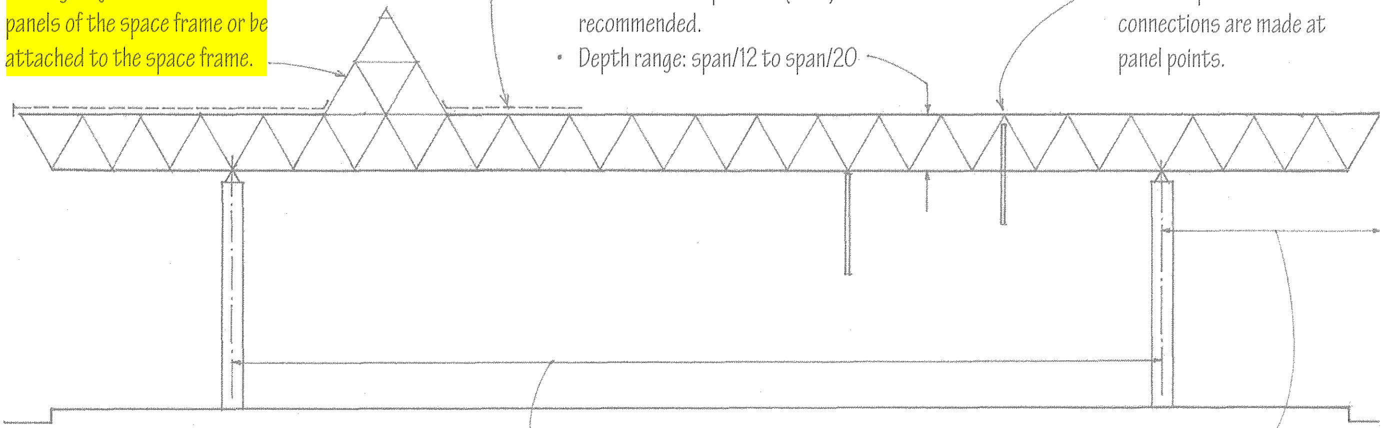


- Four-point cruciform
- Frame capital
- Increasing the bearing area of the supports increases the number of members into which shear is transferred and reduces the forces in the members.



- Interior wall
- Exterior wall
- A reinforced concrete or masonry bearing wall distributes its support points along a line.
- Steel bearing plates anchored into concrete or bond beam

- Glazing may occur within the panels of the space frame or be attached to the space frame.
- Wood panel sheathing, metal roof decking, or cementitious roof planks
- Slope or camber frame for drainage; minimum of 1/4" per foot (1:50) recommended.
- Depth range: span/12 to span/20
- Roof and partition connections are made at panel points.



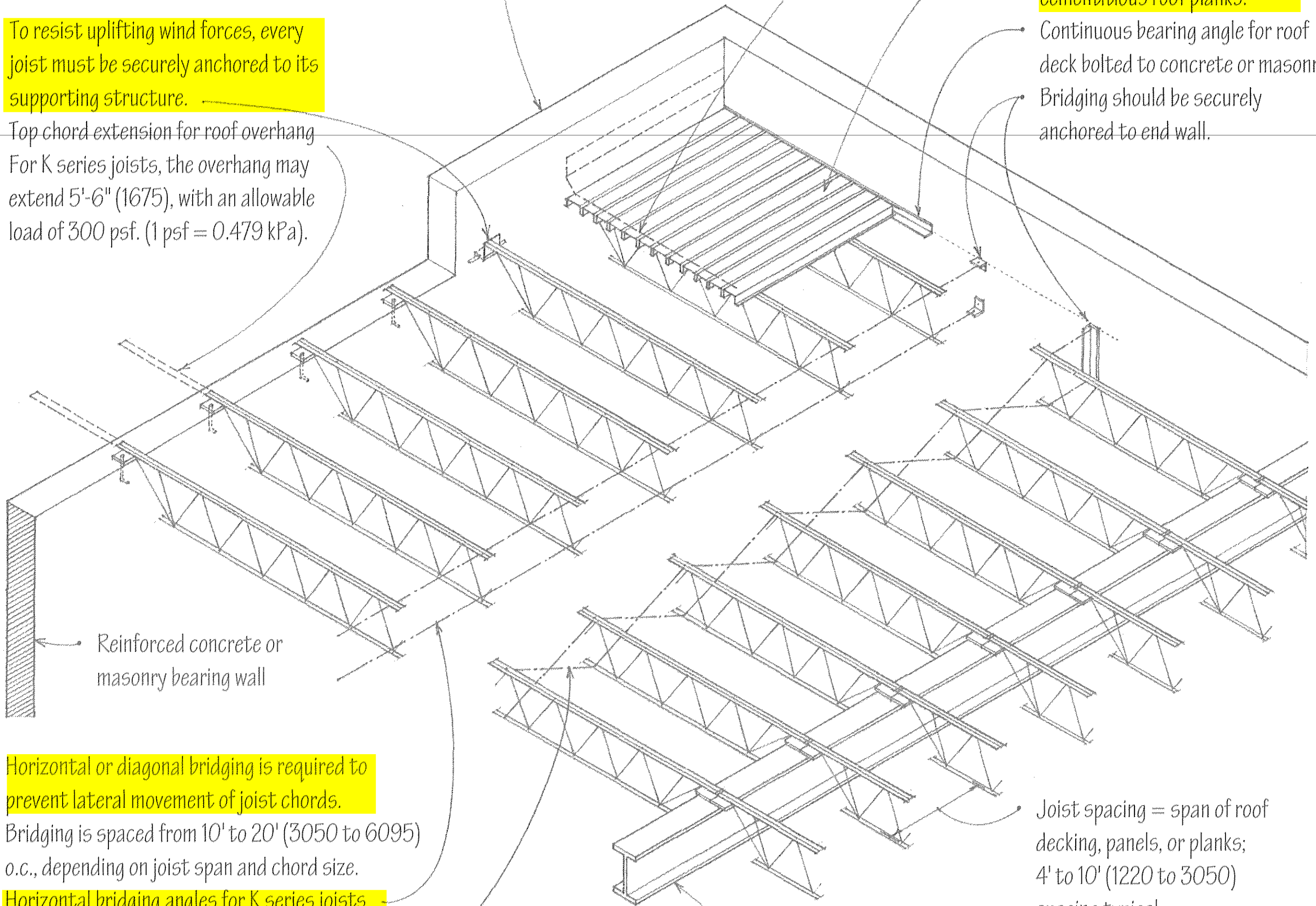
- Mechanical services such as piping, conduit, and ductwork may pass through the web spaces.
- Noncombustible steel construction may be left exposed if at least 20' (6095) above the finish floor; consult the building code for requirements.
- Span: 6 to 36 modules
- Span range for column-supported space frames: 30' to 80' (9 to 24 m)
- Span range for wall-supported space frames: 30' to 130' (9 to 39 m)
- Overhangs: 15% to 30% of span

Roof systems utilizing open-web steel joists are similar in layout and construction to steel joist floor systems. For joist sizes and span ranges, refer to 4.19–4.21.

- To resist uplifting wind forces, every joist must be securely anchored to its supporting structure.
- Top chord extension for roof overhang
- For K series joists, the overhang may extend 5'-6" (1675), with an allowable load of 300 psf. (1 psf = 0.479 kPa).

Joists may frame into a bearing wall rising to form a parapet or bear on the wall to form a flush or overhanging roof edge.

- Roofing membrane over rigid foam or lightweight concrete insulation; see 7.12 for flat roof assemblies.
- Roof deck may consist of metal roof decking, plywood panels, cementitious roof planks.
- Continuous bearing angle for roof deck bolted to concrete or masonry
- Bridging should be securely anchored to end wall.



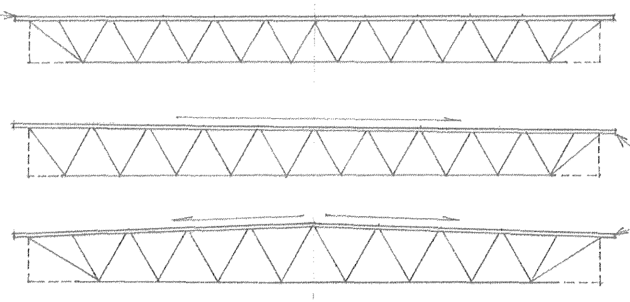
- Reinforced concrete or masonry bearing wall

- Horizontal or diagonal bridging is required to prevent lateral movement of joist chords.
- Bridging is spaced from 10' to 20' (3050 to 6095) o.c., depending on joist span and chord size.
- Horizontal bridging angles for K series joists are welded to top and bottom chords.
- Diagonal bridging angles for LH/DLH series joists; weld or bolt bridging to clip angles secured to masonry wall or steel edge beam.

- Joist spacing = span of roof decking, panels, or planks; 4' to 10' (1220 to 3050) spacing typical
- Joist span should not exceed 24 x joist depth

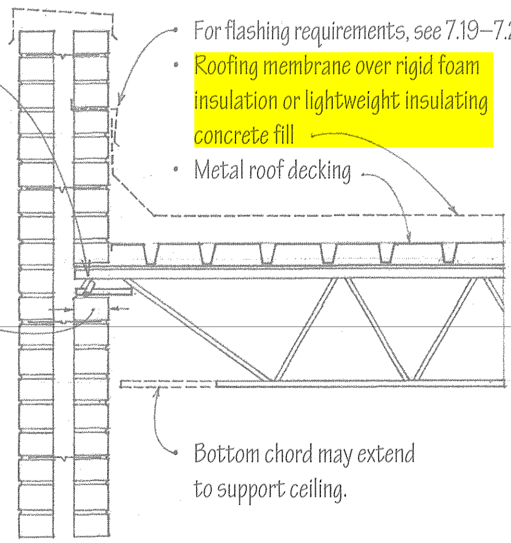
- Steel beam or joist girders

- Top and bottom chords parallel; required roof slope may be achieved by shortening some of the joist supports and sloping the joists, or by tapering the insulating layer of the roof deck.



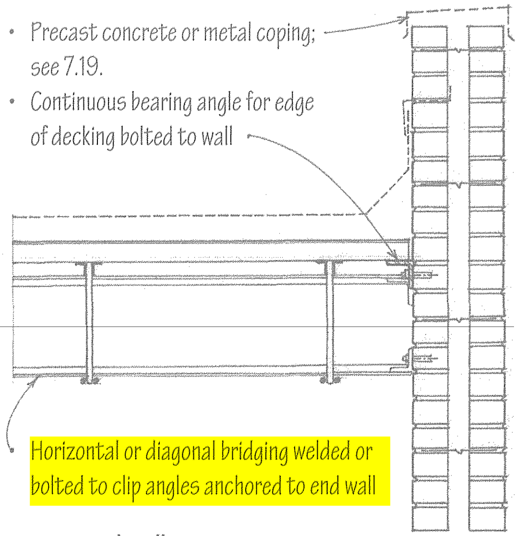
- LH/DLH series LH and DLH joists are available with single or double pitch top chords.
- Top chord pitched one way
- Top chord pitched two ways
- Standard slope is 1/8" per foot (1:100).

- Secure every roof joist to a steel bearing plate with anchors embedded in wall.
- 3/8" (10) ø steel bar 8" (205) long; for LH/DLH series joists, anchor w/ 3/4" (19) ø steel bar 12" (305) long.
- Minimum bearing length: 4" to 6" (100 to 150) for K series joists; 6" to 12" (150 to 305) for LH/DLH series joists
- For flashing requirements, see 7.19–7.20.
- Roofing membrane over rigid foam insulation or lightweight insulating concrete fill
- Metal roof decking
- Bottom chord may extend to support ceiling.



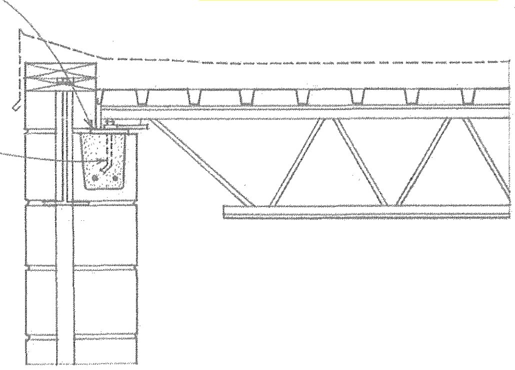
Parapet: Bearing Wall

- Precast concrete or metal coping; see 7.19.
- Continuous bearing angle for edge of decking bolted to wall
- Horizontal or diagonal bridging welded or bolted to clip angles anchored to end wall



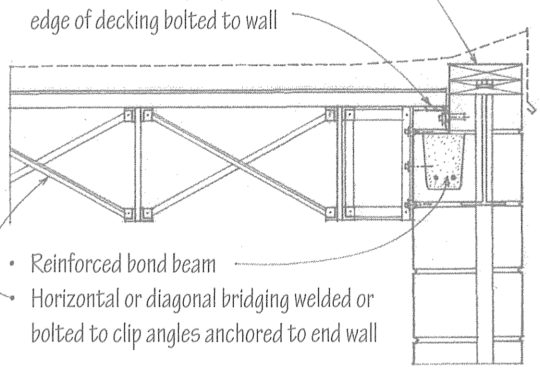
Parapet: End Wall

- Secure every roof joist to a steel bearing plate anchored in a continuous reinforced bond beam.
- Two 1/2" (13) ø anchor bolts; for LH/DLH series joists, use two 3/4" (19) ø anchor bolts.
- Metal gravel stop and fascia
- Metal roof decking is secured to all supports with puddle welds or mechanical fasteners.



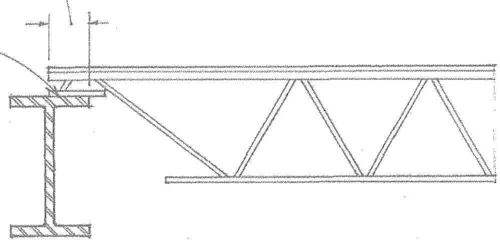
Flush Edge: Bearing Wall

- Double treated wood plate; secure w/ 1/2" (13) ø anchor bolts @ 6' (1830) o.c. maximum
- Continuous bearing angle for edge of decking bolted to wall
- Reinforced bond beam
- Horizontal or diagonal bridging welded or bolted to clip angles anchored to end wall



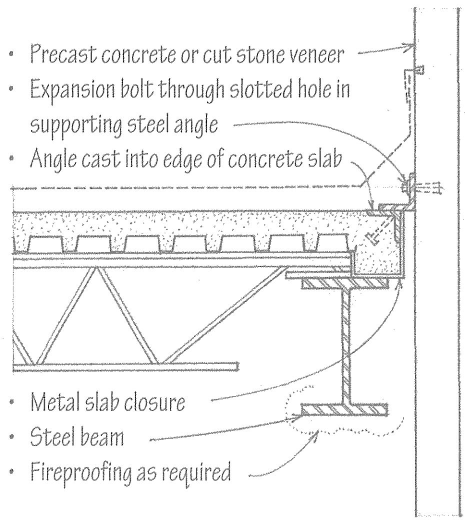
Flush Edge: End Wall

- Minimum bearing length: 2-1/2" (65) for K series joists; 4" (100) for LH/DLH series joists
- Two 1/8" (54) fillet welds 1" (25) long or 1/2" (13) ø bolt
- For LH/DLH series joists, two 1/4" (57) fillet welds 2" (51) long or two 3/4" (19) ø bolts

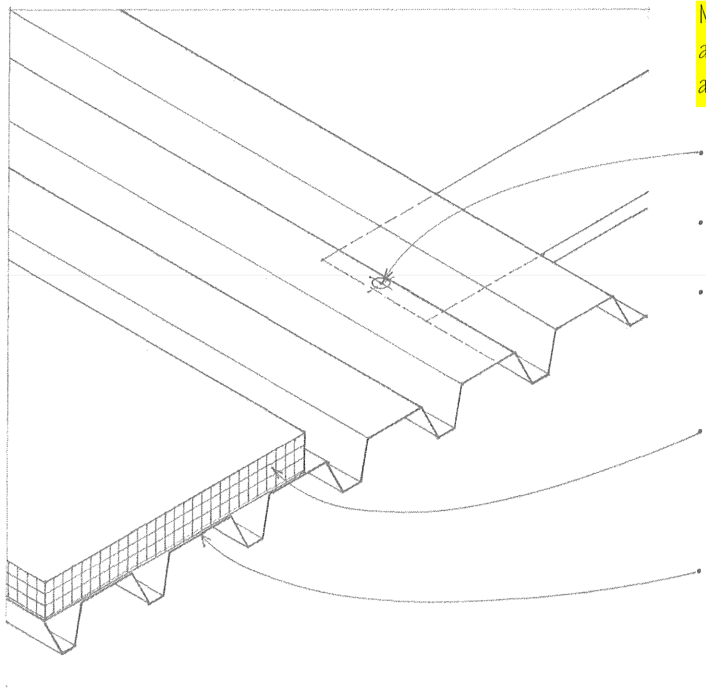


Structural Steel Frame

- Precast concrete or cut stone veneer
- Expansion bolt through slotted hole in supporting steel angle
- Angle cast into edge of concrete slab
- Metal slab closure
- Steel beam
- Fireproofing as required

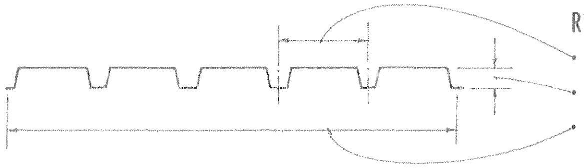


Parapet Wall

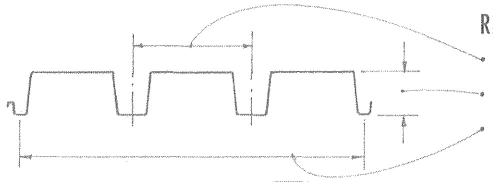


Metal roof decking is corrugated to increase its stiffness and ability to span across open-web steel joists or more widely spaced steel beams and to serve as a base for thermal insulation and membrane roofing.

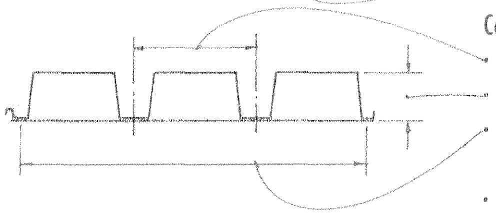
- The decking panels are puddle-welded or mechanically fastened to the supporting steel joists or beams.
- The panels are fastened to each other along their sides with screws, welds, or button punching standing seams.
- If the deck is to serve as a structural diaphragm and transfer lateral loads to shear walls, its entire perimeter must be welded to steel supports. In addition, more stringent requirements for support and side lap fastening may apply.
- Metal roof decking is commonly used without a concrete topping, requiring structural wood or cementitious panels or rigid foam insulation panels to bridge the gaps in the corrugation and provide a smooth, firm surface for the thermal insulation and membrane roofing.
- To provide maximum surface area for the effective adhesion of rigid foam insulation, the top flange should be wide and flat. If the decking has stiffening grooves, the insulation layer may have to be mechanically fastened.
- Metal decking has low-vapor permeance but because of the many discontinuities between the panels, it is not airtight. If an air barrier is required to prevent the migration of moisture vapor into the roofing assembly, a concrete topping can be used. When a lightweight insulating concrete fill is used, the decking may have perforated vents for the release of latent moisture and vapor pressure.



Ribbed Roof Decking
- 6" (150)
- 1-1/2" (38) depth spans 4' to 9' (1220 to 2745)
- 24", 30", 36" (610, 760, 915)



Ribbed Roof Decking
- 8" (205)
- 3" and 4-1/2" (75 and 115) depths span 8' to 16' (2440 to 4875)
- 12", 24" (305, 610)



Cellular Roof Decking
- 6" (150)
- 3" (75) depth spans 10' to 20' (3050 to 6095)
- 24" (610)

- Acoustic roof decking used as a sound-absorbing ceiling contains glass fiber between the perforated webs of ribbed decking or in the perforated cells of cellular decking.
- Decking profiles vary. Consult manufacturer for available profiles, lengths, gauges, allowable spans, and installation details.