STANDARD SPECIFICATIONS
FOR OPEN WEB STEEL JOISTS, K-SERIES

Adopted by the Steel Joist Institute November 4, 1985
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SECTION 1.
SCOPE

This specification covers the design, manufacture and use of Open Web Steel Joists, **K**-Series. Load and Resistance Factor Design (LRFD) and Allowable Strength Design (ASD) are included in this specification.

SECTION 2.
DEFINITION

The term "Open Web Steel Joists **K**-Series," as used herein, refers to open web, parallel chord, load-carrying members suitable for the direct support of floors and roof decks in buildings, utilizing hot-rolled or cold-formed steel, including cold-formed steel whose yield strength* has been attained by cold working. **K**-Series Joists shall be designed in accordance with this specification to support the uniformly distributed loads given in the Standard Load Tables for Open Web Steel Joists, **K**-Series, attached hereto.

The KCS Joist is a **K**-Series Joist which is provided to address the problem faced by specifying professionals when trying to select joists to support uniform plus concentrated loads or other non-uniform loads.

The design of chord sections for **K**-Series Joists shall be based on a yield strength of 50 ksi (345 MPa). The design of web sections for **K**-Series Joists shall be based on a yield strength of either 36 ksi (250 MPa) or 50 ksi (345 MPa). Steel used for **K**-Series Joists chord or web sections shall have a minimum yield strength determined in accordance with one of the procedures specified in Section 3.2, which is equal to the yield strength assumed in the design.

* The term "Yield Strength" as used herein shall designate the yield level of a material as determined by the applicable method outlined in paragraph 13.1 "Yield Point", and in paragraph 13.2 "Yield Strength", of ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, or as specified in paragraph 3.2 of this specification.

SECTION 3.
MATERIALS

3.1 STEEL

The steel used in the manufacture of chord and web sections shall conform to one of the following ASTM Specifications:

- Carbon Structural Steel, ASTM A36/A36M.
- High-Strength, Low-Alloy Structural Steel, ASTM A242/A242M.
- High-Strength Carbon-Manganese Steel of Structural Quality, ASTM A529/A529M, Grade 50.
- High-Strength Low-Alloy Columbium-Vanadium Structural Steel, ASTM A572/A572M, Grade 42 and 50.
- High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inches (100 mm) Thick, ASTM A588/A588M.
- Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Corrosion Resistance, ASTM A606.
- Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1008/A1008M
- Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1011/A1011M

or shall be of suitable quality ordered or produced to other than the listed specifications, provided that such material in the state used for final assembly and manufacture is weldable and is proved by tests performed by the producer or manufacturer to have the properties specified in Section 3.2.

3.2 MECHANICAL PROPERTIES

The yield strength used as a basis for the design stresses prescribed in Section 4 shall be either 36 ksi (250 MPa) or 50 ksi (345 MPa). Evidence that the steel furnished meets or exceeds the design yield strength shall, if requested, be provided in the form of an affidavit or by witnessed or certified test reports.

For material used without consideration of increase in yield strength resulting from cold forming, the specimens shall be taken from as-rolled material. In the case of material, the mechanical properties of which conform to the requirements of one of the listed specifications, the test specimens and procedures shall conform to those of such specifications and to ASTM A370.

In the case of material, the mechanical properties of which do not conform to the requirements of one of the listed specifications, the test specimens and procedures shall conform to the applicable requirements of ASTM A370, and the specimens shall exhibit a yield strength equal to or exceeding the design yield strength and an elongation of not less than (a) 20 percent in 2 inches (51 millimeters) for sheet and strip, or (b) 18 percent in 8 inches (203 millimeters) for plates, shapes and bars with adjustments for thickness for plates, shapes and bars as prescribed in ASTM A36/A36M, A242/A242M, A529/A529M, A572/A572M, A588/A588M, whichever specification is applicable on the basis of design yield strength.

The number of tests shall be as prescribed in ASTM A6/A6M for plates, shapes, and bars; and ASTM A606, A1008/A1008M and A1011/A1011M for sheet and strip.

If as-formed strength is utilized, the test reports shall show the results of tests performed on full section specimens in accordance with the provisions of the AISI North American Specifications for the Design of Cold-Formed Steel Structural Members. They shall also indicate compliance with these provisions and with the following additional requirements:

a) The yield strength calculated from the test data shall equal or exceed the design yield strength.

b) Where tension tests are made for acceptance and control purposes, the tensile strength shall be at least 6 percent greater than the yield strength of the section.

c) Where compression tests are used for acceptance and control purposes, the specimen shall withstand a gross shortening of 2 percent of its original length without cracking. The length of the specimen shall be not greater than 20 times the least radius of gyration.

d) If any test specimen fails to pass the requirements of the subparagraphs (a), (b), or (c) above, as applicable, two retests shall be made of specimens from the same lot. Failure of one of the retest specimens to meet such requirements shall be the cause for rejection of the lot represented by the specimens.

3.3 PAINT

The standard shop paint is intended to protect the steel for only a short period of exposure in ordinary atmospheric conditions and shall be considered an impermanent and provisional coating.

When specified, the standard shop paint shall conform to one of the following:

a) Steel Structures Painting Council Specification, SSPC No. 15.

b) Or, shall be a shop paint which meets the minimum performance requirements of the above listed specification.

SECTION 4.
DESIGN AND MANUFACTURE

4.1 METHOD

Joists shall be designed in accordance with these specifications as simply supported, uniformly loaded trusses supporting a floor or roof deck so constructed as to brace the top chord of the joists against lateral buckling. Where any applicable design feature is not specifically covered herein, the design shall be in accordance with the following specifications:

a) Where the steel used consists of hot-rolled shapes, bars or plates, use the American Institute of Steel Construction, *Specification for Structural Steel Buildings*.

b) For members that are cold-formed from sheet or strip steel, use the American Iron and Steel Institute, *North American Specification for the Design of Cold-Formed Steel Structural Members*.

Design Basis:

Designs shall be made according to the provisions in this Specification for either Load and Resistance Factor Design (LRFD) or for Allowable Strength Design (ASD).

Load Combinations:

LRFD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed for the factored loads based on the factors and load combinations as follows:

1.4D

1.2D + 1.6 (L, or L_r, or S, or R)

ASD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed based on the load combinations as follows:

D

D + (L, or L_r, or S, or R)

Where:

D = dead load due to the weight of the structural elements and the permanent features of the structure

L = live load due to occupancy and movable equipment

L_r = roof live load

S = snow load

R = load due to initial rainwater or ice exclusive of the ponding contribution

When special loads are specified and the specifying professional does not provide the load combinations, the provisions of ASCE 7, *"Minimum Design Loads for Buildings and Other Structures"* shall be used for LRFD and ASD load combinations.

4.2 DESIGN AND ALLOWABLE STRESSES

Design Using Load and Resistance Factor Design (LRFD)

Joists shall have their components so proportioned that the required stresses, f_u, shall not exceed ϕF_n where,

f_u	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
ϕ	=	resistance factor	
ϕF_n	=	design stress	

Design Using Allowable Strength Design (ASD)

Joists shall have their components so proportioned that the required stresses, f, shall not exceed F_n / Ω where,

f	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
Ω	=	safety factor	
F_n/Ω	=	allowable stress	

Stresses:

(a) Tension: $\phi_t = 0.90$ (LRFD) $\Omega = 1.67$ (ASD)

For Chords: $F_y = 50$ ksi (345 MPa)

For Webs: $F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $0.9F_y$ (LRFD) (4.2-1)

Allowable Stress = $0.6F_y$ (ASD) (4.2-2)

(b) Compression: $\phi_c = 0.90$ (LRFD) $\Omega_c = 1.67$ (ASD)

For members with $\frac{\ell}{r} \le 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = Q\left[0.658^{\left(\frac{QF_y}{F_e}\right)}\right]F_y \qquad (4.2\text{-}3)$$

For members with $\frac{\ell}{r} > 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = 0.877F_e \qquad (4.2\text{-}4)$$

Where F_e = Elastic buckling stress determined in accordance with Equation 4.2-5.

$$F_e = \frac{\pi^2 E}{\left(\frac{\ell}{r}\right)^2} \qquad (4.2\text{-}5)$$

For hot-rolled sections, "Q" is the full reduction factor for slender compression elements.

Design Stress = $0.9F_{cr}$ (LRFD) (4.2-6)

Allowable Stress = $0.6F_{cr}$ (ASD) (4.2-7)

In the above equations, ℓ is taken as the distance in inches (millimeters) between panel points for the chord members and the appropriate length for web members, and r is the corresponding least radius of gyration of the member or any component thereof. E is equal to 29,000 ksi (200,000 MPa).

Use 1.2 ℓ/r_x for a crimped, first primary compression web member when a moment-resistant weld group is not used for this member; where r_x = member radius of gyration in the plane of the joist.

For cold-formed sections the method of calculating the nominal column strength is given in the AISI, *North American Specification for the Design of Cold-Formed Steel Structural Members.*

(c) Bending: $\phi_b = 0.90$ (LRFD) $\Omega_b = 1.67$ (ASD)

Bending calculations are to be based on using the elastic section modulus.

For chords and web members other than solid rounds:
$F_y = 50$ ksi (345 MPa)

Design Stress = $0.9F_y$ (LRFD) (4.2-8)

Allowable Stress = $0.6F_y$ (ASD) (4.2-9)

For web members of solid round cross section:
$F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $1.45F_y$ (LRFD) (4.2-10)

Allowable Stress = $0.95F_y$ (ASD) (4.2-11)

For bearing plates:
$F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $1.35F_y$ (LRFD) (4.2-12)

Allowable Stress = $0.90F_y$ (ASD) (4.2-13)

4.3 MAXIMUM SLENDERNESS RATIOS

The slenderness ratio, ℓ/r, where ℓ is as used in Section 4.2 (b) and r is the corresponding least radius of gyration, shall not exceed the following:

Top chord interior panels	90
Top chord end panels	120
Compression members other than top chord	200
Tension members	240

4.4 MEMBERS

(a) Chords

The bottom chord shall be designed as an axially loaded tension member.

The radius of gyration of the top chord about its vertical axis shall not be less than ℓ/145 where ℓ is the spacing in inches (millimeters) between lines of bridging as specified in Section 5.4(c).

The top chord shall be considered as stayed laterally by the floor slab or roof deck when attachments are in accordance with the requirements of Section 5.8(e) of these specifications.

The top chord shall be designed for only axial compressive stress when the panel length, ℓ, does not exceed 24 inches (609 mm). When the panel length exceeds 24 inches (609 mm), the top chord shall be designed as a continuous member subject to combined axial and bending stresses and shall be so proportioned that:

For LRFD:

at the panel point:

$$f_{au} + f_{bu} \le 0.9F_y \qquad (4.4\text{-}1)$$

at the mid panel: for $\frac{f_{au}}{\phi_c F_{cr}} \ge 0.2$,

$$\frac{f_{au}}{\phi_c F_{cr}} + \frac{8}{9}\left[\frac{C_m f_{bu}}{\left[1-\left(\frac{f_{au}}{\phi_c F_e}\right)\right] Q\phi_b F_y}\right] \le 1.0 \qquad (4.4\text{-}2)$$

for $\frac{f_{au}}{\phi_c F_{cr}} < 0.2$,

$$\left(\frac{f_{au}}{2\phi_c F_{cr}}\right) + \left[\frac{C_m f_{bu}}{\left[1-\left(\frac{f_{au}}{\phi_c F_e}\right)\right] Q\phi_b F_y}\right] \le 1.0 \qquad (4.4\text{-}3)$$

f_{au} = P_u/A = Required compressive stress, ksi (MPa)

P_u = Required axial strength using LRFD load combinations, kips (N)

f_{bu} = M_u/S = Required bending stress at the location under consideration, ksi (MPa)

M_u = Required flexural strength using LRFD load combinations, kip-in. (N-mm)

S = Elastic Section Modulus, in.^{3} (mm^3)

F_{cr} = Nominal axial compressive stress in ksi (MPa) based on ℓ/ r as defined in Section 4.2(b),

C_m = 1 - 0.3 $f_{au}/\phi F_e$ for end panels

C_m = 1 - 0.4 $f_{au}/\phi F_e$ for interior panels

F_y = Specified minimum yield strength, ksi (MPa)

$F_e = \dfrac{\pi^2 E}{\left(\ell / r_x\right)^2}$, ksi (MPa)

Where ℓ is the panel length, in inches (millimeters), as defined in Section 4.2(b) and r_x is the radius of gyration about the axis of bending.

Q = Form factor defined in Section 4.2(b)

A = Area of the top chord, in.^{2} (mm^2)

For ASD:

at the panel point:

$$f_a + f_b \le 0.6F_y \qquad (4.4\text{-}4)$$

at the mid panel: for $\frac{f_a}{F_a} \ge 0.2$,

$$\frac{f_a}{F_a} + \frac{8}{9}\left[\frac{C_m f_b}{\left[1-\left(\frac{1.67 f_a}{F_e}\right)\right] QF_b}\right] \le 1.0 \qquad (4.4\text{-}5)$$

for $\frac{f_a}{F_a} < 0.2$,

$$\left(\frac{f_a}{2F_a}\right) + \left[\frac{C_m f_b}{\left[1-\left(\frac{1.67 f_a}{F_e}\right)\right] QF_b}\right] \le 1.0 \qquad (4.4\text{-}6)$$

f_a = P/A = Required compressive stress, ksi (MPa)

P = Required axial strength using ASD load combinations, kips (N)

f_b = M/S = Required bending stress at the location under consideration, ksi (MPa)

M = Required flexural strength using ASD load combinations, kip-in. (N-mm)

S = Elastic Section Modulus, in.^{3} (mm^3)

F_a = Allowable axial compressive stress based on ℓ/r as defined in Section 4.2(b), ksi (MPa)

F_b = Allowable bending stress; $0.6F_y$, ksi (MPa)

C_m = 1 - 0.50 f_a/F_e for end panels

C_m = 1 - 0.67 f_a/F_e for interior panels

(b) Web

The vertical shears to be used in the design of the web members shall be determined from full uniform loading, but such vertical shears shall be not less than 25 percent of the end reaction. Due consideration shall be given to the effect of eccentricity. The effect of combined axial compression and bending may be investigated using the provisions of Section 4.4(a), letting C_m = 0.4 when bending due to eccentricity produces reversed curvature.

Interior vertical web members used in modified Warren type web systems shall be designed to resist the gravity loads supported by the member plus an additional axial load of 1/2 of 1.0 percent of the top chord axial force.

(c) Extended Ends

The magnitude and location of the loads to be supported, deflection requirements, and proper bracing of extended

top chords or full depth cantilever ends shall be clearly indicated on the structural drawings.

4.5 CONNECTIONS

(a) Methods

Joist connections and splices shall be made by attaching the members to one another by arc or resistance welding or other accredited methods.

(1) Welded Connections

a) Selected welds shall be inspected visually by the manufacturer. Prior to this inspection, weld slag shall be removed.

b) Cracks are not acceptable and shall be repaired.

c) Thorough fusion shall exist between weld and base metal for the required design length of the weld; such fusion shall be verified by visual inspection.

d) Unfilled weld craters shall not be included in the design length of the weld.

e) Undercut shall not exceed 1/16 inch (2 millimeters) for welds oriented parallel to the principal stress.

f) The sum of surface (piping) porosity diameters shall not exceed 1/16 inch (2 millimeters) in any 1 inch (25 millimeters) of design weld length.

g) Weld spatter that does not interfere with paint coverage is acceptable.

(2) Welding Program

Manufacturers shall have a program for establishing weld procedures and operator qualification, and for weld sampling and testing. (See Technical Digest #8 - Welding of Open Web Steel Joists.)

(3) Weld Inspection by Outside Agencies (See Section 5.12 of these specifications)

The agency shall arrange for visual inspection to determine that welds meet the acceptance standards of Section 4.5(a)(1) above. Ultrasonic, X-Ray, and magnetic particle testing are inappropriate for joists due to the configurations of the components and welds.

(b) Strength

(1) Joint Connections - Joint connections shall be capable of withstanding forces due to an ultimate load equal to at least 1.35 times the LRFD, or 2.0 times the ASD load shown in the applicable Standard Load Table.

(2) Shop Splices – Splices may occur at any point in chord or web members. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57 ksi (393 MPa) times the full design area of the chord or web. The term "member" shall be defined as all component parts comprising the chord or web, at the point of the splice.

(c) Eccentricity

Members connected at a joint shall have their centroidal axes meet at a point if practical. Otherwise, due consideration shall be given to the effect of eccentricity. In no case shall eccentricity of any web member at a joint exceed 3/4 of the over-all dimension, measured in the plane of the web, of the largest member connected. The eccentricity of any web member shall be the perpendicular distance from the centroidal axis of that web member to the point on the centroidal axis of the chord which is vertically above or below the intersection of the centroidal axes of the web members forming the joint. Ends of joists shall be proportioned to resist bending produced by eccentricity at the support.

4.6 CAMBER

Joists shall have approximate camber in accordance with the following:

TABLE 4.6-1

Top Chord Length		Approximate Camber	
20'-0"	(6096 mm)	1/4"	(6 mm)
30'-0"	(9144 mm)	3/8"	(10 mm)
40'-0"	(12192 mm)	5/8"	(16 mm)
50'-0"	(15240 mm)	1"	(25 mm)
60'-0"	(18288 mm)	1 1/2"	(38 mm)

The specifying professional shall give consideration to coordinating joist camber with adjacent framing.

4.7 VERIFICATION OF DESIGN AND MANUFACTURE

(a) Design Calculations

Companies manufacturing **K**-Series Joists shall submit design data to the Steel Joist Institute (or an independent agency approved by the Steel Joist Institute) for verification of compliance with the SJI Specifications. Design data shall be submitted in detail and in the format specified by the Institute.

(b) Tests of Chord and Web Members

Each manufacturer shall, at the time of design review by the Steel Joist Institute or other independent agency, verify by tests that the design, in accordance with Sections 4.1 through 4.5 of this specification, will provide the theoretical strength of critical members. Such tests shall be evaluated considering the actual yield strength of the members of the test joists.

Material tests for determining mechanical properties of component members shall be conducted.

(c) Tests of Joints and Connections

Each manufacturer shall verify by shear tests on representative joints of typical joists that connections will meet the provision of Section 4.5(b). Chord and web members may be reinforced for such tests.

(d) In-Plant Inspections

Each manufacturer shall verify their ability to manufacture **K**-Series Joists through periodic In-Plant Inspections. Inspections shall be performed by an independent agency approved by the Steel Joist Institute. The frequency, manner of inspection, and manner of reporting shall be determined by the Steel Joist Institute. The plant inspections are not a guarantee of the quality of any specific joists; this responsibility lies fully and solely with the individual manufacturer.

SECTION 5. APPLICATION

5.1 USAGE

These specifications shall apply to any type of structure where floors and roofs are to be supported directly by steel joists installed as hereinafter specified. Where joists are used other than on simple spans under uniformly distributed loading as prescribed in Section 4.1, they shall be investigated and modified if necessary to limit the required stresses to those listed in Section 4.2.

CAUTION: If a rigid connection of the bottom chord is to be made to the column or other support, it shall be made only after the application of the dead loads. The joist is then no longer simply supported, and the system must be investigated for continuous frame action by the specifying professional.

The designed detail of a rigid type connection and moment plates shall be shown on the structural drawings by the specifying professional. The moment plates shall be furnished by other than the joist manufacturer.

5.2 SPAN

The span of a joist shall not exceed 24 times its depth.

5.3 END SUPPORTS

(a) Masonry and Concrete

K-Series Joists supported by masonry or concrete are to bear on steel bearing plates and shall be designed as steel bearing. Due consideration of the end reactions and all other vertical or lateral forces shall be taken by the specifying professional in the design of the steel bearing plate and the masonry or concrete. The ends of **K**-Series Joists shall extend a distance of not less than 4 inches (102 millimeters) over the masonry or concrete support and be anchored to the steel bearing plate. The plate shall be located not more than 1/2 inch (13 millimeters) from the face of the wall and shall be not less than 6 inches (152 millimeters) wide perpendicular to the length of the joist. The plate is to be designed by the specifying professional and shall be furnished by other than the joist manufacturer.

Where it is deemed necessary to bear less than 4 inches (102 millimeters) over the masonry or concrete support, special consideration is to be given to the design of the steel bearing plate and the masonry or concrete by the specifying professional. The joists must bear a minimum of 2 1/2 inches (64 millimeters) on the steel bearing plate.

(b) Steel

Due consideration of the end reactions and all other vertical and lateral forces shall be taken by the specifying professional in the design of the steel support. The ends of **K**-Series Joists shall extend a distance of not less than 2 1/2 inches (64 millimeters) over the steel supports.

5.4 BRIDGING

Top and bottom chord bridging is required and shall consist of one or both of the following types.

(a) Horizontal

Horizontal bridging shall consist of continuous horizontal steel members. Attachments to the joist chords shall be made by welding or mechanical means and shall be capable of resisting a nominal (unfactored) horizontal force of not less than 700 pounds (3114 Newtons).

The ratio of unbraced length to least radius of gyration, ℓ/r, of the bridging member shall not exceed 300, where ℓ is the distance in inches (millimeters) between attachments and r is the least radius of gyration of the bridging member.

(b) Diagonal

Diagonal bridging shall consist of cross-bracing with a ℓ/r ratio of not more than 200, where ℓ is the distance in inches (millimeters) between connections and r is the least radius of gyration of the bracing member. Where cross-bracing members are connected at their point of intersection, the ℓ distance shall be taken as the distance in inches (millimeters) between connections at the point of intersection of the bracing members and the connections to the chord of the joists. Connections to the chords of steel joists shall be made by positive mechanical means or by welding.

(c) Quantity and Spacing

The number of rows of top chord bridging shall not be less than as shown in Bridging Tables 5.4-1 and 5.4-2 and the spacing shall meet the requirements of Section 4.4(a). The number of rows of bottom chord bridging, including bridging required per Section 5.11, shall not be less than the number of top chord rows. Rows of bottom chord bridging are permitted to be spaced independently of rows of top chord bridging. The spacing of rows of bottom chord bridging shall meet the slenderness requirement of Section 4.3 and any specified strength requirements.

(d) Bottom Chord Bearing Joists

Where bottom chord bearing joists are utilized, a row of diagonal bridging shall be provided near the support(s). This bridging shall be installed and anchored before the hoisting cable(s) is released.

TABLE 5.4-1

U. S. UNITS

NUMBER OF ROWS OF TOP CHORD BRIDGING**

Refer to the **K**-Series Load Table and Specification Section 6 for required bolted diagonal bridging.
Distances are Joist Span lengths in feet - See "Definition of Span" preceding Load Table.

*Section Number	One Row	Two Rows	Three Rows	Four Rows	Five Rows
#1	Up thru 16	Over 16 thru 24	Over 24 thru 28		
#2	Up thru 17	Over 17 thru 25	Over 25 thru 32		
#3	Up thru 18	Over 18 thru 28	Over 28 thru 38	Over 38 thru 40	
#4	Up thru 19	Over 19 thru 28	Over 28 thru 38	Over 38 thru 48	
#5	Up thru 19	Over 19 thru 29	Over 29 thru 39	Over 39 thru 50	Over 50 thru 52
#6	Up thru 19	Over 19 thru 29	Over 29 thru 39	Over 39 thru 51	Over 51 thru 56
#7	Up thru 20	Over 20 thru 33	Over 33 thru 45	Over 45 thru 58	Over 58 thru 60
#8	Up thru 20	Over 20 thru 33	Over 33 thru 45	Over 45 thru 58	Over 58 thru 60
#9	Up thru 20	Over 20 thru 33	Over 33 thru 46	Over 46 thru 59	Over 59 thru 60
#10	Up thru 20	Over 20 thru 37	Over 37 thru 51	Over 51 thru 60	
#11	Up thru 20	Over 20 thru 38	Over 38 thru 53	Over 53 thru 60	
#12	Up thru 20	Over 20 thru 39	Over 39 thru 53	Over 53 thru 60	

* Last digit(s) of joist designation shown in Load Table
** See Section 5.11 for additional bridging required for uplift design.

TABLE 5.4-2

METRIC UNITS

NUMBER OF ROWS OF TOP CHORD BRIDGING**

Refer to the **K**-Series Metric Load Table and Specification Section 6 for required bolted diagonal bridging.
Distances are Joist Span lengths in millimeters - See "Definition of Span" preceding Load Table.

*Section Number	One Row	Two Rows	Three Rows	Four Rows	Five Rows
#1	up thru 4877	Over 4877 thru 7315	Over 7315 thru 8534		
#2	up thru 5182	Over 5182 thru 7620	Over 7620 thru 9754		
#3	up thru 5486	Over 5486 thru 8534	Over 8534 thru 11582	Over 11582 thru 12192	
#4	up thru 5791	Over 5791 thru 8534	Over 8534 thru 11582	Over 11582 thru 14630	
#5	up thru 5791	Over 5791 thru 8839	Over 8839 thru 11887	Over 11887 thru 15240	Over 15240 thru 15850
#6	up thru 5791	Over 5791 thru 8839	Over 8839 thru 11887	Over 11887 thru 15545	Over 15545 thru 17069
#7	up thru 6096	Over 6096 thru 10058	Over 10058 thru 13716	Over 13716 thru 17678	Over 17678 thru 18288
#8	up thru 6096	Over 6096 thru 10058	Over 10058 thru 13716	Over 13716 thru 17678	Over 17678 thru 18288
#9	up thru 6096	Over 6096 thru 10058	Over 10058 thru 14021	Over 14021 thru 17983	Over 17983 thru 18288
#10	up thru 6096	Over 6096 thru 11278	Over 11278 thru 15545	Over 15545 thru 18288	
#11	up thru 6096	Over 6096 thru 11582	Over 11582 thru 16154	Over 16154 thru 18288	
#12	up thru 6096	Over 6096 thru 11887	Over 11887 thru 16154	Over 16154 thru 18288	

* Last digit(s) of joist designation shown in Load Table
** See Section 5.11 for additional bridging required for uplift design.

5.5 INSTALLATION OF BRIDGING

Bridging shall support the top and bottom chords against lateral movement during the construction period and shall hold the steel joists in the approximate position as shown on the joist placement plans.

The ends of all bridging lines terminating at walls or beams shall be anchored thereto.

5.6 END ANCHORAGE

(a) Masonry and Concrete

Ends of **K**-Series Joists resting on steel bearing plates on masonry or structural concrete shall be attached thereto with a minimum of two 1/8 inch (3 millimeters) fillet welds 1 inch (25 millimeters) long, or with two 1/2 inch (13 millimeters) ASTM A307 bolts, or the equivalent.

(b) Steel

Ends of **K**-Series Joists resting on steel supports shall be attached thereto with a minimum of two 1/8 inch (3 millimeters) fillet welds 1 inch (25 millimeters) long, or with two 1/2 inch (13 millimeters) ASTM A307 bolts, or the equivalent. When **K**-Series Joists are used to provide lateral stability to the supporting member, the final connection shall be made by welding or as designated by the specifying professional.

(c) Uplift

Where uplift forces are a design consideration, roof joists shall be anchored to resist such forces (Refer to Section 5.11 Uplift).

5.7 JOIST SPACING

Joists shall be spaced so that the loading on each joist does not exceed the design load (LRFD or ASD) for the particular joist designation and span as shown in the applicable load tables.

5.8 FLOOR AND ROOF DECKS

(a) Material

Floor and roof decks may consist of cast-in-place or precast concrete or gypsum, formed steel, wood, or other suitable material capable of supporting the required load at the specified joist spacing.

(b) Thickness

Cast-in-place slabs shall be not less than 2 inches (51 millimeters) thick.

(c) Centering

Centering for cast-in-place slabs may be ribbed metal lath, corrugated steel sheets, paper-backed welded wire fabric, removable centering or any other suitable material capable of supporting the slab at the designated joist spacing. Centering shall not cause lateral displacement or damage to the top chord of joists during installation or removal of the centering or placing of the concrete.

(d) Bearing

Slabs or decks shall bear uniformly along the top chords of the joists.

(e) Attachments

The spacing for slab or deck attachments along the joist top chord shall not exceed 36 inches (914 millimeters), and shall be capable of resisting a nominal (unfactored) lateral force of not less than 300 pounds (1335 Newtons), i.e., 100 plf (1.46 kN/m).

(f) Wood Nailers

Where wood nailers are used, such nailers in conjunction with deck or slab shall be attached to the top chords of the joists in conformance with Section 5.8(e).

(g) Joist With Standing Seam Roofing

The stiffness and strength of standing-seam roof clips varies from one manufacturer to another. Therefore, some roof systems cannot be counted on to provide lateral stability to the joists which support the roof. Sufficient stability must be provided to brace the joists laterally under the full design load. The compression chord must resist the chord axial design force in the plane of the joist (i.e., x-x axis buckling) and out of the plane of the joist (i.e., y-y axis buckling). Out-of-plane strength may be achieved by adjusting the bridging spacing and/or increasing the compression chord area, the joist depth, and the y-axis radius of gyration. The effective slenderness ratio in the y-direction equals 0.94 L/r_y; where L is the bridging spacing in inches (millimeters). The maximum bridging spacing may not exceed that specified in Section 5.4(c).

Horizontal bridging members attached to the compression chords and their anchorage's must be designed for a compressive axial force of 0.0025nP, where n is the number of joists between end anchors and P is the chord design force in kips (Newtons). The attachment force between the horizontal bridging member and the compression chord is 0.005P. Horizontal bridging attached to the tension chords shall be proportioned so that the slenderness ratio between attachments does not exceed 300. Diagonal bridging shall be proportioned so that the slenderness ratio between attachments does not exceed 200.

5.9 DEFLECTION

The deflection due to the design nominal live load shall not exceed the following:

Floors: 1/360 of span.

Roofs: 1/360 of span where a plaster ceiling is attached or suspended.
1/240 of span for all other cases.

The specifying professional shall give consideration to the effects of deflection and vibration* in the selection of joists.

* For further reference, refer to Steel Joist Institute Technical Digest #5, "Vibration of Steel Joist-Concrete Slab Floors" and the Institute's Computer Vibration Program.

5.10 PONDING*

The ponding investigation shall be performed by the specifying professional.

* For further reference, refer to Steel Joist Institute Technical Digest #3, "Structural Design of Steel Joist Roofs to Resist Ponding Loads" and AISC Specifications.

5.11 UPLIFT

Where uplift forces due to wind are a design requirement, these forces must be indicated on the contract drawings in terms of NET uplift in pounds per square foot (Pascals). The contract documents shall indicate if the net uplift is based upon LRFD or ASD. When these forces are specified, they must be considered in the design of joists and/or bridging. A single line of **bottom chord** bridging must be provided near the first bottom chord panel points whenever uplift due to wind forces is a design consideration.*

* For further reference, refer to Steel Joist Institute Technical Digest #6, "Structural Design of Steel Joist Roofs to Resist Uplift Loads".

5.12 INSPECTION

Joists shall be inspected by the manufacturer before shipment to verify compliance of materials and workmanship with the requirements of these specifications. If the purchaser wishes an inspection of the steel joists by someone other than the manufacturer's own inspectors, they may reserve the right to do so in their "Invitation to Bid" or the accompanying "Job Specifications".

Arrangements shall be made with the manufacturer for such inspection of the joists at the manufacturing shop by the purchaser's inspectors at purchaser's expense.

5.13 PARALLEL CHORD SLOPED JOISTS

The span of a parallel chord sloped joist shall be defined by the length along the slope. Minimum depth, load-carrying capacity, and bridging requirements shall be determined by the sloped definition of span. The Standard Load Table capacity shall be the component normal to the joist.

SECTION 6.*
ERECTION STABILITY AND HANDLING

When it is necessary for the erector to climb on the joists, extreme caution must be exercised since unbridged joists may exhibit some degree of instability under the erector's weight.

(a) Stability Requirements

1) Before an employee is allowed on the steel joist: BOTH ends of joists at columns (or joists designated as column joists) shall be attached to its supports. For all other joists a minimum of one end shall be attached before the employee is allowed on the joist. The attachment shall be in accordance with Section 5.6 – End Anchorage.

   When a bolted seat connection is used for erection purposes, as a minimum, the bolts must be snug tightened. The snug tight condition is defined as the tightness that exists when all plies of a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of an employee using an ordinary spud wrench.

2) On steel joists that do not require erection bridging as shown by the unshaded area of the Load Tables, only one employee shall be allowed on the steel joist unless all bridging is installed and anchored.

   * For a thorough coverage of this topic, refer to SJI Technical Digest #9, "Handling and Erection of Steel Joists and Joist Girders".

3) Where the span of the steel joist is within the Red shaded area of the Load Table, the following shall apply:

   a) The row of bridging nearest the mid span of the steel joists shall be bolted diagonal erection bridging; and

   b) Hoisting cables shall not be released until this bolted diagonal erection bridging is installed and anchored, unless an alternate method of stabilizing the joist has been provided; and

   c) No more than one employee shall be allowed on these spans until all other bridging is installed and anchored.

4) When permanent bridging terminus points cannot be used during erection, additional temporary bridging terminus points are required to provide stability.

5) In the case of bottom chord bearing joists, the ends of the joist must be restrained laterally per Section 5.4(d).

6) After the joist is straightened and plumbed, and all bridging is completely installed and anchored, the ends of the joists shall be fully connected to the supports in accordance with Section 5.6 End Anchorage.

(b) Landing and Placing Loads

1) Except as stated in paragraphs 6(b)(3) and 6(b)(4) of this section, no "construction loads"[1] are allowed on the steel joists until all bridging is installed and anchored, and all joist bearing ends are attached.

2) During the construction period, loads placed on the steel joists shall be distributed so as not to exceed the capacity of the steel joists.

3) The weight of a bundle of joist bridging shall not exceed a total of 1000 pounds (454 kilograms). The bundle of joist bridging shall be placed on a minimum of 3 steel joists that are secured at one end. The edge of the bridging bundle shall be positioned within 1 foot (0.30 m) of the secured end.

   [1] See Appendix E for definition of "construction load". A copy of the OSHA Steel Erection Standard §1926.757, Open Web Steel Joists, is included in Appendix E for reference purposes.

4) No bundle of deck may be placed on steel joists until all bridging has been installed and anchored and all joist bearing ends attached, unless the following conditions are met:

   a) The contractor has first determined from a *"qualified person"* [2] and documented in a site-specific erection plan that the structure or portion of the structure is capable of supporting the load;

   b) The bundle of decking is placed on a minimum of 3 steel joists;

   c) The joists supporting the bundle of decking are attached at both ends;

   d) At least one row of bridging is installed and anchored;

   e) The total weight of the decking does not exceed 4000 pounds (1816 kilograms); and

   f) The edge of the decking shall be placed within 1 foot (0.30 meters) of the bearing surface of the joist end.

   g) The edge of the construction load shall be placed within 1 foot (0.30 meters) of the bearing surface of the joist end.

(c) Field Welding

1) All field welding shall be performed in accordance with the contract documents. Field welding shall not damage the joists.

2) On cold-formed members whose yield strength has been attained by cold working, and whose as-formed strength is used in the design, the total length of weld at any one point shall not exceed 50 percent of the overall developed width of the cold-formed section.

(d) Handling

Care shall be exercised at all times to avoid damage to the joists and accessories.

(e) Fall Arrest Systems

Steel joists shall not be used as anchorage points for a fall arrest system unless written direction to do so is obtained from a *"qualified person"* [2].

[2] See Appendix E for OSHA definition of "qualified person".

KCS JOISTS

The KCS Joists:

1. Provide a versatile **K**-Series Joist that can be easily specified to support uniform loads plus concentrated and non-uniform loads.
2. Eliminate many repetitive load diagrams required on contract documents and allow some flexibility of load locations.

KCS joists are designed in accordance with the Standard Specification for **K**-Series Joists.

Standard **K**-Series Joists are designed for simple span uniform loading which results in a parabolic moment diagram for chord forces and a linearly sloped shear diagram for web forces. When non-uniform and/or concentrated loads are encountered the shear and moment diagrams required may be shaped quite differently and may not be covered by the shear and moment design envelopes of a standard **K**-Series Joist.

KCS Joist chords are designed for a flat positive moment envelope. The moment capacity is constant at all interior panels. The top chord end panel is designed for axial load based on the force in the first tension web, which is based on the specified shear. A uniform load of 825 plf (12030 N/m) LRFD or 550 plf (8020 N/m) ASD is used to check end panel bending.

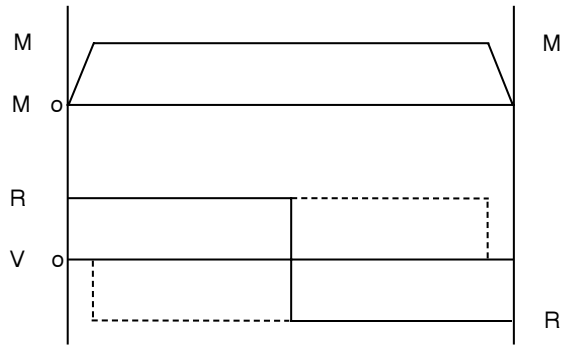
The web forces are determined based on a flat shear envelope. All webs are designed for a vertical shear equal to the specified shear capacity. Furthermore, all webs (except the first tension web which remains in tension under all simple span gravity loads) will be designed for 100% stress reversal.

Both LRFD and ASD KCS Joist load tables list the shear and moment capacity of each joist. The selection of a KCS Joist requires the specifying professional to calculate the maximum moment and shear imposed and select the appropriate KCS Joist. If a KCS Joist cannot be selected from the load table or if any uniform load exceeds 825 plf (12030 N/m) LRFD or 550 plf (8020 N/m) ASD or if the maximum concentrated load exceeds the shear capacity of the joist, use double KCS Joists or select an **LH**-Series Joist. For the **LH**-Series Joist, supply a load diagram. When net uplift loads, end moments or other external horizontal loads are a design consideration; these loads shall be provided to the joist manufacturer by the specifying professional.

As is the case with standard **K**-, **LH**- and **DLH**-Series Joists, chord bending due to concentrated loads must be addressed. In the case of concentrated loads, the specifying professional shall handle them in one of two ways: 1) specify on the structural drawings that an extra web must be field applied at all concentrated loads not occurring at joist panel points, or 2) provide exact locations of all concentrated loads for which the joist manufacturer shall provide necessary reinforcement.

Please reference SJI Technical Digest #9 "Handling and Erection of Steel Joists and Joist Girders" for further information.

NOTE: In the following examples joist selection is based on minimum depth and minimum weight (plf, kg/m). Other selections may be more suitable for specific job conditions.

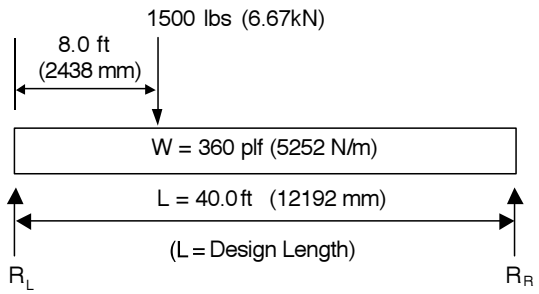


KCS JOIST
SHEAR AND MOMENT ENVELOPES

LRFD EXAMPLES

EXAMPLE 1

LRFD FACTORED LOADS



M = 938 in.-kip (105.9 kN-m)

R_L = 8400 lbs (37.37 kN), R_R = 7500 lbs (33.36 kN)

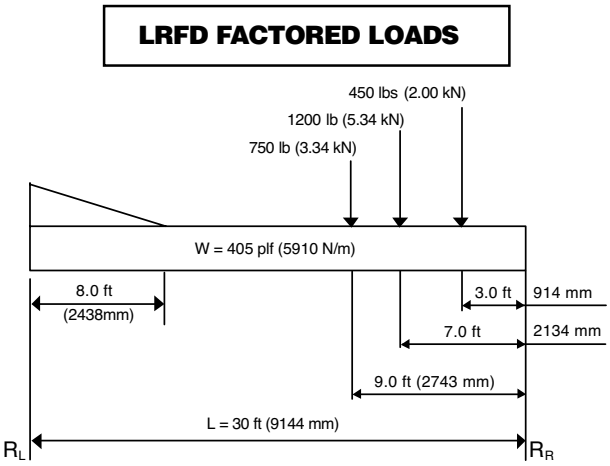
Select a 22KCS3, M = 987 in.-kip (111.5 kN-m)

R = 9900 lbs (44.0 kN)

Bridging section no. 9 for L = 40 ft. (12192 mm)
Use 22K9 to determine bridging and stability requirements.

Since a standard KCS Joist can be selected from the load table a load diagram is not required.

EXAMPLE 2



M = 664 in.-kip (75.03 kN-m)

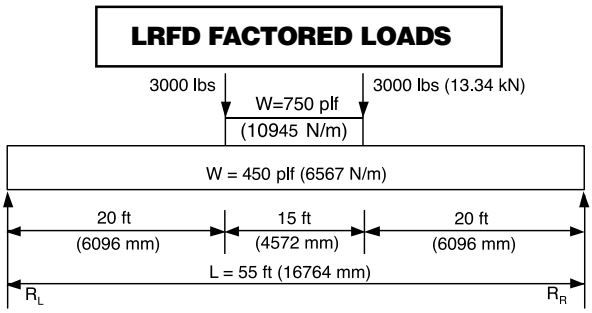
R_L = 7500 lbs (33.36 kN), R_R = 8010 lbs (35.63 kN)

Select a 22KCS2, M = 732 in.-kip (82.64 kN-m)
R = 8850 lbs (39.38 kN)

Bridging section no. 6 for L = 30 ft. (9144 mm)

Use 22K6 to determine bridging and stability requirements. Since the maximum *factored* uniform load of 639 plf (9318 N/m) (405 plf (5911 N/m) + 240 plf (3503 N/m)) does not exceed the maximum KCS Joist uniform load of 825 plf (12040 N/m) and a standard KCS Joist can be selected from the load table, a load diagram is not required.

EXAMPLE 3



M = 4365 in.-kip (492.81 kN-m)

$R_L = R_R$ = 21000 lbs (93.41 kN)

EXCEEDS CAPACITY OF 30KCS5 (MAXIMUM KCS JOIST AND EXCEEDS MAXIMUM *FACTORED* UNIFORM LOAD OF 825 plf (12040 N/m).

OPTION A: Use double joists each having a minimum M = 2183 in.-kip (246.65 kN-m) and R = 10500 lbs (46.71 kN) and a uniform load of 594 plf (8669 N/m).

Select two 28KCS5, M = 2556 in.-kip (288.7 kN-m), R = 13800 lbs (61.3 kN).

Bridging section no. 12 for L = 55 ft. (16764 mm) Use 28K12 to determine bridging and stability requirements.

OPTION B: Select an **LH**-Series Joist. Calculate an equivalent uniform load based on the maximum moment or shear:

$$W_M = \frac{8M}{L^2} = 962 \text{ plf (14.04 kN/m)}$$

$$W_V = \frac{2R}{L} = 764 \text{ plf (11.14 kN/m)}$$

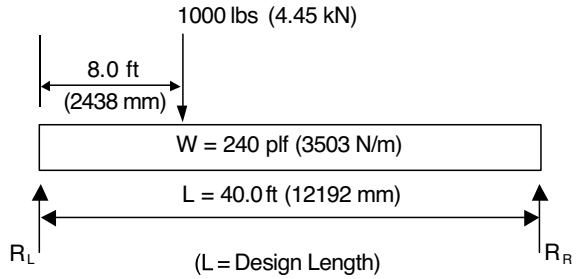
Use 962 plf (14.04 kN/m)

From the **LH**-Series LRFD Load Table select a 32LH13, W = 1035 plf (15.10 kN/m) for a 55 ft. (16764 mm) span. Specify a 32LH13SP and present a load diagram on the structural drawings with the following note:

JOIST MANUFACTURER SHALL DESIGN FOR THE LOADING SHOWN IN THE LOAD DIAGRAM.

ASD EXAMPLES

EXAMPLE 1



M = 625 in.-kip (70.6 kN-m)

R_L=5600 lbs (24.9 kN), R_R=5000 lbs (22.2 kN)

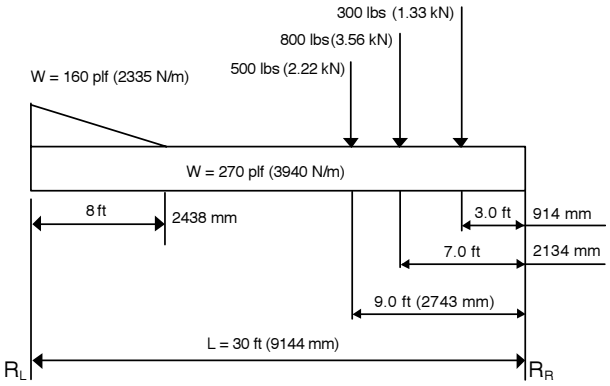
Select a 22KCS3, M = 658 in.-kip (74.3 kN-m)
R = 6600 lbs (29.3 kN)

Bridging section no. 9 for L = 40 ft. (12192 mm)

Use 22K9 to determine bridging and stability requirements.

Since a standard KCS Joist can be selected from the load table a load diagram is not required.

EXAMPLE 2



M = 443 in.-kip (50.1 kN-m)

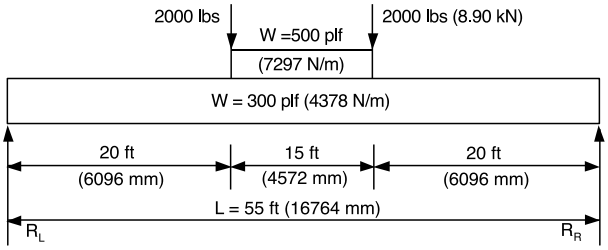
R_L = 5000 lbs (22.24 kN), R_R = 5340 lbs (23.75 kN)

Select a 22KCS2, M = 488 in.-kip (55.1 kN-m)
R = 5900 lbs (26.2 kN)

Bridging section no. 6 for L = 30 ft. (9144 mm)

Use 22K6 to determine bridging and stability requirements. Since the maximum uniform load of 430 plf [6275 N/m) (270 plf (3940 N/m) + 160 plf (2335 N/m)] does not exceed the maximum KCS Joist uniform load of 550 plf (8020 N/m) and a standard KCS Joist can be selected from the load table, a load diagram is not required.

EXAMPLE 3



M = 2910 in.-kip (328.5 kN-m)

$R_L = R_R$ = 14000 lbs (62.28 kN)

EXCEEDS CAPACITY OF 30KCS5 (MAXIMUM KCS JOIST) AND EXCEEDS MAXIMUM UNIFORM LOAD OF 550 plf (8027 N/m).

OPTION A: Use double joists each having a minimum M = 1455 in.-kip (164.3 kN-m) and R = 7000 lbs (31.14 kN) and a uniform load of 400 plf (5838 N/m).

Select two 28KCS5, M = 1704 in.-kip (192.5 kN-m), R = 9200 lbs (40.9 kN)

Bridging section no. 12 for L = 55 ft. (16764 mm) Use 28K12 to determine bridging and stability requirements.

OPTION B: Select an **LH**-Series Joist. Calculate an equivalent uniform load based on the maximum moment or shear:

$$W_M = \frac{8M}{L^2} = 641 \text{ plf } (9.35 \text{ kN/m})$$

$$W_V = \frac{2R}{L} = 509 \text{ plf } (7.43 \text{ kN/m})$$

Use 641 plf (9.35 kN/m)

From the **LH**-Series ASD Load Table select a 32LH13, W = 690 plf (10.06 kN/m) for a 55 ft. (16764 mm) span. Specify a **32LH13SP** and present a load diagram on the structural drawings with the following note:

JOIST MANUFACTURER SHALL DESIGN FOR THE LOADING SHOWN IN THE LOAD DIAGRAM.

STANDARD SPECIFICATIONS
FOR LONGSPAN STEEL JOISTS, LH-SERIES AND DEEP LONGSPAN STEEL JOISTS, DLH-SERIES

Adopted by the Steel Joist Institute February 15, 1978
Revised to November 10, 2003 - Effective March 01, 2005

SECTION 100.
SCOPE

This specification covers the design, manufacture and use of Longspan Steel Joists **LH**-Series, and Deep Longspan Steel Joists, **DLH**-Series. Load and Resistance Factor Design (LRFD) and Allowable Strength Design (ASD) are included in this specification.

SECTION 101.
DEFINITION

The term "Longspan Steel Joists **LH**-Series and Deep Longspan Steel Joists **DLH**-Series", as used herein, refers to open web, load-carrying members utilizing hot-rolled or cold-formed steel, including cold-formed steel whose yield strength* has been attained by cold working. **LH**-Series are suitable for the direct support of floors and roof decks in buildings, and **DLH**-Series are suitable for direct support of roof decks in buildings.

The design of **LH-** and **DLH**-Series joist chord and web sections shall be based on a yield strength of at least 36 ksi (250 MPa), but not greater than 50 ksi (345 MPa). Steel used for **LH-** and **DLH**-Series joist chord or web sections shall have a minimum yield strength determined in accordance with one of the procedures specified in Section 102.2, which is equal to the yield strength assumed in the design. **LH-** and **DLH**-Series Joists shall be designed in accordance with these specifications to support the loads given in the Standard Load Tables for Longspan and Deep Longspan Steel Joists, **LH-** and **DLH**-Series, attached hereto.

* The term "Yield Strength" as used herein shall designate the yield level of a material as determined by the applicable method outlined in paragraph 13.1, "Yield Point" and in paragraph 13.2, "Yield Strength", of ASTM Standard A370, "*Standard Test Methods and Definitions for Mechanical Testing of Steel Products*", or as specified in Section 102.2 of this Specification.

SECTION 102.
MATERIALS

102.1 STEEL

The steel used in the manufacture of chord and web sections shall conform to one of the following ASTM Specifications:

- Carbon Structural Steel, ASTM A36/A36M.
- High-Strength, Low-Alloy Structural Steel, ASTM A242/A242M.
- High-Strength Carbon-Manganese Steel of Structural Quality ASTM A529/A529M, Grade 50.
- High-Strength Low-Alloy Columbium-Vanadium Structural Steel, ASTM A572/A572M Grade 42 or 50.
- High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inches (100 mm) Thick, ASTM A588/A588M.
- Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Corrosion Resistance, ASTM A606.
- Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1008/A1008M
- Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1011/A1011M

or shall be of suitable quality ordered or produced to other than the listed specifications, provided that such material in the state used for final assembly and manufacture is weldable and is proved by tests performed by the producer or manufacturer to have the properties specified in Section 102.2.

102.2 MECHANICAL PROPERTIES

The yield strength used as a basis for the design stresses prescribed in Section 103 shall be at least 36 ksi (250 MPa), but shall not be greater than 50 ksi (345 MPa). Evidence that the steel furnished meets or exceeds the design yield strength shall, if requested, be provided in the form of an affidavit or by witnessed or certified test reports.

For material used without consideration of increase in yield strength resulting from cold forming, the specimens shall be taken from as-rolled material. In the case of material, the mechanical properties of which conform to the requirements of one of the listed specifications, the test specimens and

procedures shall conform to those of such specifications and to ASTM A370.

In the case of material, the mechanical properties of which do not conform to the requirements of one of the listed specifications, the test specimens and procedures shall conform to the applicable requirements of ASTM A370, and the specimens shall exhibit a yield strength equal to or exceeding the design yield strength and an elongation of not less than (a) 20 percent in 2 inches (51 millimeters) for sheet and strip, or (b) 18 percent in 8 inches (203 millimeters) for plates, shapes and bars with adjustments for thickness for plates, shapes and bars as prescribed in ASTM A36/A36M, A242/A242M, A529/A529M, A572/A572M, A588/A588M, whichever specification is applicable on the basis of design yield strength.

The number of tests shall be as prescribed in ASTM A6/A6M for plates, shapes, and bars; and ASTM A606, A1008/A1008M and A1011/A1011M for sheet and strip.

If as-formed strength is utilized, the test reports shall show the results of tests performed on full section specimens in accordance with the provisions of the AISI North American Specification for the Design of Cold-Formed Steel Structural Members. They shall also indicate compliance with these provisions and with the following additional requirements:

a) The yield strength calculated from the test data shall equal or exceed the design yield strength.

b) Where tension tests are made for acceptance and control purposes, the tensile strength shall be at least 6 percent greater than the yield strength of the section.

c) Where compression tests are used for acceptance and control purposes, the specimen shall withstand a gross shortening of 2 percent of its original length without cracking. The length of the specimen shall be not greater than 20 times its least radius of gyration.

d) If any test specimen fails to pass the requirements of subparagraphs (a), (b), or (c) above, as applicable, two retests shall be made of specimens from the same lot. Failure of one of the retest specimens to meet such requirements shall be the cause for rejection of the lot represented by the specimens.

102.3 WELDING ELECTRODES

The following electrodes shall be used for arc welding:

a) For connected members both having a specified yield strength greater than 36 ksi (250 MPa).

AWS A5.1: E70XX
AWS A5.5: E70XX-X
AWS A5.17: F7XX-EXXX, F7XX-ECXXX flux electrode combination
AWS A5.18: ER70S-X, E70C-XC, E70C-XM
AWS A5.20: E7XT-X, E7XT-XM
AWS A5.23: F7XX-EXXX-XX, F7XX-ECXXX-XX
AWS A5.28: ER70S-XXX, E70C-XXX
AWS A5.29: E7XTX-X, E7XTX-XM

b) For connected members both having a specified minimum yield strength of 36 ksi (250 MPa) or one having a specified minimum yield strength of 36 ksi (250 MPa), and the other having a specified minimum yield strength greater than 36 ksi (250 MPa).

AWS A5.1: E60XX
AWS A5.17: F6XX-EXXX, F6XX-ECXXX flux electrode combination
AWS A5.20: E6XT-X, E6XT-XM
AWS A5.29: E6XTX-X, E6XT-XM
or any of those listed in Section 102.3(a).

Other welding methods, providing equivalent strength as demonstrated by tests, may be used.

102.4 PAINT

The standard shop paint is intended to protect the steel for only a short period of exposure in ordinary atmospheric conditions and shall be considered an impermanent and provisional coating.

When specified, the standard shop paint shall conform to one of the following:

a) Steel Structures Painting Council Specification, SSPC No. 15

b) Or, shall be a shop paint which meets the minimum performance requirements of the above listed specification.

SECTION 103.
DESIGN AND MANUFACTURE

103.1 METHOD

Joists shall be designed in accordance with these specifications as simply supported, uniformly loaded trusses supporting a floor or roof deck so constructed as to brace the top chord of the joists against lateral buckling. Where any applicable design feature is not specifically covered herein, the design shall be in accordance with the following specifications:

a) Where the steel used consists of hot-rolled shapes, bars or plates, use the American Institute of Steel Construction, *Specification for Structural Steel Buildings*.

b) For members that are cold-formed from sheet or strip steel, use the American Iron and Steel Institute, *North American Specification for the Design of Cold-Formed Steel Structural Members*.

Design Basis:

Designs shall be made according to the provisions in this Specification for either Load and Resistance Factor Design (LRFD) or for Allowable Strength Design (ASD).

Load Combinations:

LRFD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed for the

factored loads based on the factors and load combinations as follows:

1.4D

1.2D + 1.6 (L, or L_r, or S, or R)

ASD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed based on the load combinations as follows:

D

D + (L, or L_r, or S, or R)

Where:

D = dead load due to the weight of the structural elements and the permanent features of the structure

L = live load due to occupancy and movable equipment

L_r = roof live load

S = snow load

R = load due to initial rainwater or ice exclusive of the ponding contribution

When special loads are specified and the specifying professional does not provide the load combinations, the provisions of ASCE 7, *"Minimum Design Loads for Buildings and Other Structures"* shall be used for LRFD and ASD load combinations.

103.2 DESIGN AND ALLOWABLE STRESSES

Design Using Load and Resistance Factor Design (LRFD)

Joists shall have their components so proportioned that the required stresses, f_u, shall not exceed ϕF_n where,

f_u	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
ϕ	=	resistance factor	
ϕF_n	=	design stress	

Design Using Allowable Strength Design (ASD)

Joists shall have their components so proportioned that the required stresses, f, shall not exceed F_n / Ω where,

f	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
Ω	=	safety factor	
F_n/Ω	=	allowable stress	

Stresses:

(a) Tension: $\phi_t = 0.90$ (LRFD) $\Omega_t = 1.67$ (ASD)

For Chords: $F_y = 50$ ksi (345 MPa)

For Webs: $F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $0.9F_y$ (LRFD) (103.2-1)

Allowable Stress = $0.6F_y$ (ASD) (103.2-2)

(b) Compression: $\phi_c = 0.90$ (LRFD) $\Omega_c = 1.67$ (ASD)

For members with $\frac{K\ell}{r} \le 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = Q\left[0.658^{\left(\frac{QF_y}{F_e}\right)}\right]F_y \qquad (103.2\text{-}3)$$

For members with $\frac{K\ell}{r} > 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = 0.877F_e \qquad (103.2\text{-}4)$$

Where, F_e = elastic buckling stress determined in accordance with Equation 103.2-5.

$$F_e = \frac{\pi^2 E}{\left(\frac{K\ell}{r}\right)^2} \qquad (103.2\text{-}5)$$

For hot-rolled sections, "Q" is the full reduction factor for slender compression elements.

Design Stress = $0.9F_{cr}$ (LRFD) (103.2-6)

Allowable Stress = $0.6F_{cr}$ (ASD) (103.2-7)

In the above equations, ℓ is taken as the distance in inches (millimeters) between panel points for the chord members and the appropriate length for web members, and r is the corresponding least radius of gyration of the member or any component thereof. E is equal to 29,000 ksi (200,000 MPa).

Use $1.2\,\ell/r_x$ for a crimped, first primary compression web member when a moment-resistant weld group is not used for this member; where = r_x member radius of gyration in the plane of the joist.

For cold-formed sections the method of calculating the nominal column strength is given in the AISI, *North American Specification for the Design of Cold-Formed Steel Structural Members*.

(c) Bending: $\phi_b = 0.90$ (LRFD) $\Omega_b = 1.67$ (ASD)

Bending calculations are to be based on using the elastic section modulus.

For chords and web members other than solid rounds: $F_y = 50$ ksi (345 MPa)

Design Stress = $0.9F_y$ (LRFD) (103.2-8)

Allowable Stress = $0.6F_y$ (ASD) (103.2-9)

For web members of solid round cross section: $F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $1.45F_y$ (LRFD) (103.2-10)

Allowable Stress = $0.95F_y$ (ASD) (103.2-11)

For bearing plates: $F_y = 50$ ksi (345MPa), or $F_y = 36$ ksi (250MPa)

Design Stress = $1.35F_y$ (LRFD) (103.2-12)

Allowable Stress = $0.9F_y$ (ASD) (103.2-13)

(d) Weld Strength:

Shear at throat of fillet welds:

Nominal Shear Stress = $F_{nw} = 0.6F_{exx}$ (103.2-14)

LRFD: $\phi_w = 0.75$

Design Shear Strength = $\phi R_n = \phi_w F_{nw} A = 0.45F_{exx} A$ (103.2-15)

ASD: $\Omega_w = 2.0$

Allowable Shear Strength = $R_n/\Omega_w = F_{nw}A/\Omega_w = 0.3F_{exx} A$ (103.2-16)

A = effective throat area

Made with E70 series electrodes or F7XX-EXXX flux-electrode combinations.....$F_{exx} = 70$ ksi (483 MPa)

Made with E60 series electrodes or F6XX-EXXX flux-electrode combinations.....$F_{exx} = 60$ ksi (414 MPa)

Tension or compression on groove or butt welds shall be the same as those specified for the connected material.

103.3 MAXIMUM SLENDERNESS RATIOS

The slenderness ratios, $1.0\,\ell/r$ and $1.0\,\ell_s/r$ of members as a whole or any component part shall not exceed the values given in Table 103.3-1, Parts A.

The effective slenderness ratio, $K\ell/r^*$, to be used in calculating the nominal stresses F_{cr} and F'_e, is the largest value as determined from Table 103.3-1, Parts B and C.

In compression members when fillers or ties are used, they shall be spaced so that the ℓ_s/r_z ratio of each component does not exceed the governing ℓ/r ratio of the member as a whole.

The terms used in Table 103.3-1 are defined as follows:

ℓ = Length center-to-center of panel points, except $\ell = 36$ in. (914 mm) for calculating ℓ/r_y of top chord member.

ℓ_s = maximum length center-to-center between panel . point and filler (tie), or between adjacent fillers (ties).

r_x = member radius of gyration in the plane of the joist.

r_y = member radius of gyration out of the plane of the joist.

r_z =least radius of gyration of a member component.

* See P.N. Chod and T. V. Galambos, Compression Chords Without Fillers in Longspan Steel Joists, Research Report No. 36, June 1975 Structural Division, Civil Engineering Department, Washington University, St. Louis, MO.

TABLE 103.3-1
MAXIMUM AND EFFECTIVE SLENDERNESS RATIOS

I TOP CHORD INTERIOR PANEL

A. The slenderness ratios, 1.0 ℓ/r and 1.0 ℓ_s/r, of members as a whole or any component part shall not exceed 90.

B. *The effective slenderness ratio to determine* "F_{cr}"

1. With fillers or ties	0.75 ℓ/r_x	1.0 ℓ/r_y		1.0 ℓ_s/r_z
2. Without fillers or ties			0.75 ℓ/r_z	
3. Single component members	0.75 ℓ/r_x	1.0 ℓ/r_y		

C. *The effective slenderness ratio to determine* "F'_e"

1. With fillers or ties	0.75 ℓ/r_x
2. Without fillers or ties	0.75 ℓ/r_x
3. Single component members	0.75 ℓ/r_x

II TOP CHORD END PANEL

A. The slenderness ratios, 1.0 ℓ/r and 1.0 ℓ_s/r, of members as a whole or any component part shall not exceed 120.

B. *The effective slenderness ratio to determine* "F_{cr}"

1. With fillers or ties	1.0 ℓ/r_x	1.0 ℓ/r_y		1.0 ℓ_s/r_z
2. Without fillers or ties			1.0 ℓ/r_z	
3. Single component members	1.0 ℓ/r_x	1.0 ℓ/r_y		

C. *The effective slenderness ratio to determine* "F'_e"

1. With fillers or ties	1.0 ℓ/r_x
2. Without fillers or ties	1.0 ℓ/r_x
3. Single component members	1.0 ℓ/r_x

III TENSION MEMBERS - CHORDS AND WEBS

A. The slenderness ratios, 1.0 ℓ/r and 1.0 ℓ_s/r, of members as a whole or any component part shall not exceed 240.

IV COMPRESSION WEB MEMBERS

A. The slenderness ratios, 1.0 ℓ/r and 1.0 ℓ_s/r, of members as a whole or any component part shall not exceed 200.

B. *The effective slenderness ratio to determine* "F_{cr}"

1. With fillers or ties	0.75 ℓ/r_x	1.0 ℓ/r_y		1.0 ℓ_s/r_z
2. Without fillers or ties			1.0 ℓ/r_z	
3. Single component members	0.75 ℓ/r_x*	1.0 ℓ/r_y		

* Use 1.2 ℓ/r_x for a crimped, first primary compression web member when a moment-resistant weld group is not used for this member.

103.4 MEMBERS

(a) Chords

The bottom chord shall be designed as an axially loaded tension member.

The radius of gyration of the top chord about its vertical axis shall not be less than $\ell/170$ where ℓ is the spacing in inches (millimeters) between lines of bridging as specified in Section 104.5(d)

The top chord shall be considered as stayed laterally by the floor slab or roof deck provided the requirements of Section 104.9(e) of this specification are met.

The top chord shall be designed as a continuous member subject to combined axial and bending stresses and shall be so proportioned that

For LRFD:

at the panel point:

$$f_{au} + f_{bu} \le 0.9F_y \qquad (103.4\text{-}1)$$

at the mid panel: for $\dfrac{f_{au}}{\phi_c F_{cr}} \ge 0.2$,

$$\frac{f_{au}}{\phi_c F_{cr}} + \frac{8}{9}\left[\frac{C_m f_{bu}}{\left[1-\left(\dfrac{f_{au}}{\phi_c F'_e}\right)\right] Q\phi_b F_y}\right] \le 1.0 \qquad (103.4\text{-}2)$$

for $\dfrac{f_{au}}{\phi_c F_{cr}} < 0.2$,

$$\left(\frac{f_{au}}{2\phi_c F_{cr}}\right) + \left[\frac{C_m f_{bu}}{\left[1-\left(\dfrac{f_{au}}{\phi_c F'_e}\right)\right] Q\phi_b F_y}\right] \le 1.0 \qquad (103.4\text{-}3)$$

f_{au} = P_u/A = Required compressive stress, ksi (MPa)

P_u = Required axial strength using LRFD load combinations, kips (N)

f_{bu} = M_u/S = Required bending stress at the location under consideration, ksi (MPa)

M_u = Required flexural strength using LRFD load combinations, kip-in. (N-mm)

S = Elastic Section Modulus, in.^{3} (mm^3)

F_{cr} = Nominal axial compressive stress in ksi (MPa) based on ℓ/r as defined in Section 103.2(b)

$C_m = 1 - 0.3\, f_{au}/\phi F'_e$ for end panels

$C_m = 1 - 0.4\, f_{au}/\phi F'_e$ for interior panels

F_y = Specified minimum yield strength, ksi (MPa)

$F'_e = \dfrac{\pi^2 E}{\left(K\ell/r_x\right)^2}$, ksi (MPa)

Where ℓ is the panel length,in inches (millimeters), as defined in Section 103.2(b) and r_x is the radius of gyration about the axis of bending.

Q = Form factor defined in Section 103.2(b)

A = Area of the top chord, in.^{2}, (mm^2)

For ASD:

at the panel point:

$$f_a + f_b \le 0.6F_y \qquad (103.4\text{-}4)$$

at the mid panel: for $\dfrac{f_a}{F_a} \ge 0.2$,

$$\frac{f_a}{F_a} + \frac{8}{9}\left[\frac{C_m f_b}{\left[1-\left(\dfrac{1.67f_a}{F'_e}\right)\right] QF_b}\right] \le 1.0 \qquad (103.4\text{-}5)$$

for $\dfrac{f_a}{F_a} < 0.2$,

$$\left(\frac{f_a}{2F_a}\right) + \left[\frac{C_m f_b}{\left[1-\left(\dfrac{1.67f_a}{F'_e}\right)\right] QF_b}\right] \le 1.0 \qquad (103.4\text{-}6)$$

f_a = P/A = Required compressive stress, ksi (MPa)

P = Required axial strength using ASD load combinations, kips (N)

f_b = M/S = Required bending stress at the location under consideration, ksi (MPa)

M = Required flexural strength using ASD load combinations, kip-in. (N-mm)

S = Elastic Section Modulus, in.^{3} (mm^3)

F_a = Allowable axial compressive stress, based on ℓ/r as defined in Section 103.2(b), ksi (MPa)

F_b = Allowable bending stress; $0.6F_y$, ksi (MPa)

$C_m = 1 - 0.50\, f_a/F'_e$ for end panels

$C_m = 1 - 0.67\, f_a/F'_e$ for interior panels

(b) Web

The vertical shears to be used in the design of the web members shall be determined from full uniform loading, but such vertical shears shall be not less than 25 percent of the end reaction.

Interior vertical web members used in modified Warren type web systems shall be designed to resist the gravity loads supported by the member plus an additional axial load of 1/2 of 1.0 percent of the top chord axial force.

(c) Depth

Joists may have either parallel chords or a top chord slope of 1/8 inch per foot (1:96). The depth, for the purpose of design, in all cases shall be the depth at mid-span.

(d) Eccentricity

Members connected at a joint shall have their center of gravity lines meet at a point, if practical. Eccentricity on either side of the neutral axis of chord members may be neglected when it does not exceed the distance between the neutral axis and the back of the chord. Otherwise, provision shall be made for the stresses due to eccentricity. Ends of joists shall be proportioned to resist bending produced by eccentricity at the support.

In those cases where a single angle compression member is attached to the outside of the stem of a tee or double angle chord, due consideration shall be given to eccentricity.

(e) Extended Ends

Extended top chords or full depth cantilever ends require the special attention of the specifying professional. The magnitude and location of the loads to be supported, deflection requirements, and proper bracing shall be clearly indicated on the structural drawings.

103.5 CONNECTIONS

(a) Methods

Joist connections and splices shall be made by attaching the members to one another by arc or resistance welding or other accredited methods.

(1) Welded Connections

a) Selected welds shall be inspected visually by the manufacturer. Prior to this inspection, weld slag shall be removed.

b) Cracks are not acceptable and shall be repaired.

c) Thorough fusion shall exist between layers of weld metal and between weld metal and base metal for the required design length of the weld; such fusion shall be verified by visual inspection.

d) Unfilled weld craters shall not be included in the design length of the weld.

e) Undercut shall not exceed 1/16 inch (2 millimeters) for welds oriented parallel to the principal stress.

f) The sum of surface (piping) porosity diameters shall not exceed 1/16 inch (2 millimeters) in any 1 inch (25 millimeters) of design weld length.

g) Weld spatter that does not interfere with paint coverage is acceptable.

(2) Welding Program

Manufacturers shall have a program for establishing weld procedures and operator qualification, and for weld sampling and testing.

(3) Weld Inspection by Outside Agencies (See Section 104.13 of this specification).

The agency shall arrange for visual inspection to determine that welds meet the acceptance standards of Section 103.5(a)(1). Ultrasonic, X-Ray, and magnetic particle testing are inappropriate for joists due to the configurations of the components and welds.

(b) Strength

(1) Joint Connections – Joint connections shall develop the maximum force due to any of the design loads, but not less than 50 percent of the strength of the member in tension or compression, whichever force is the controlling factor in the selection of the member.

(2) Shop Splices - Shop splices may occur at any point in chord or web members. Splices shall be designed for the member force but not less than 50 percent of the member strength. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57 ksi (393 MPa) times the full design area of the chord or web. The term "member" shall be defined as all component parts comprising the chord or web, at the point of splice.

(c) Field Splices

Field Splices shall be designed by the manufacturer and may be either bolted or welded. Splices shall be designed for the member force, but not less than 50 percent of the member strength.

103.6 CAMBER

Joists shall have approximate cambers in accordance with the following:

TABLE 103.6-1

Top Chord Length		Approximate Camber	
20'-0"	(6096 mm)	1/4"	(6 mm)
30'-0"	(9144 mm)	3/8"	(10 mm)
40'-0"	(12192 mm)	5/8"	(16 mm)
50'-0"	(15240 mm)	1"	(25 mm)
60'-0"	(18288 mm)	1 1/2"	(38 mm)
70'-0"	(21336 mm)	2"	(51 mm)
80'-0"	(24384 mm)	2 3/4"	(70 mm)
90'-0"	(27432 mm)	3 1/2"	(89 mm)
100'-0"	(30480 mm)	4 1/4"	(108 mm)
110'-0"	(33528 mm)	5"	(127 mm)
120'-0"	(36576 mm)	6"	(152 mm)
130'-0"	(39621 mm)	7"	(178 mm)
140'-0"	(42672 mm)	8"	(203 mm)
144'-0"	(43890 mm)	8 1/2"	(216 mm)

The specifying professional shall give consideration to coordinating joist camber with adjacent framing.

103.7 VERIFICATION OF DESIGN AND MANUFACTURE

(a) Design Calculations

Companies manufacturing any **LH-** or **DLH-**Series Joists shall submit design data to the Steel Joist Institute (or an independent agency approved by the Steel Joist Institute) for verification of compliance with the SJI Specifications.

(b) In-Plant Inspections

Each manufacturer shall verify their ability to manufacture **LH-** and **DLH-**Series Joists through periodic In-Plant Inspections. Inspections shall be performed by an independent agency approved by the Steel Joist Institute. The frequency, manner of inspection, and manner of reporting shall be determined by the Steel Joist Institute. The plant inspections are not a guarantee of the quality of any specific joists; this responsibility lies fully and solely with the individual manufacturer.

SECTION 104.
APPLICATION

104.1 USAGE

This specification shall apply to any type of structure where floors and roofs are to be supported directly by steel joists installed as hereinafter specified. Where joists are used other than on simple spans under uniformly distributed loading as prescribed in Section 103.1, they shall be investigated and modified if necessary to limit the required stresses to those listed in Section 103.2.

CAUTION: If a rigid connection of the bottom chord is to be made to a column or other support, it shall be made only after the application of the dead loads. The joist is then no longer simply supported, and the system must be investigated for continuous frame action by the specifying professional.

The designed detail of a rigid type connection and moment plates shall be shown on the structural drawings by the specifying professional. The moment plates shall be furnished by other than the joist manufacturer.

104.2 SPAN

The clear span of a joist shall not exceed 24 times its depth. The term "Span" as used herein is defined as the clear span plus 8 inches (203 millimeters).

104.3 DEPTH

The nominal depth of sloping chord joists shall be the depth at mid-span. The standard slope of the top chord shall be 1/8 inch per foot (1:96).

104.4 END SUPPORTS

(a) Masonry and Concrete

LH- and **DLH-**Series Joists supported by masonry or concrete are to bear on steel bearing plates and shall be designed as steel bearing. Due consideration of the end reactions and all other vertical and lateral forces shall be taken by the specifying professional in the design of the steel bearing plate and the masonry or concrete. The ends of **LH-** and **DLH-**Series Joists shall extend a distance of not less than 6 inches (152 millimeters) over the masonry or concrete support and be anchored to the steel bearing plate. The plate shall be located not more than 1/2 inch (13 millimeters) from the face of the wall and shall be not less than 9 inches (229 millimeters) wide perpendicular to the length of the joist. The plate is to be designed by the specifying professional and shall be furnished by other than the joist manufacturer.

Where it is deemed necessary to bear less than 6 inches (152 millimeters) over the masonry or concrete support, special consideration is to be given to the design of the steel bearing plate and the masonry or concrete by the specifying professional. The joists must bear a minimum 4 inches (102 millimeters) on the steel bearing plate.

(b) Steel

Due consideration of the end reactions and all other vertical and lateral forces shall be taken by the specifying professional in the design of the steel support.

The ends of **LH-** or **DLH-**Series Joists shall extend a distance of not less than 4 inches (102 millimeters) over the steel supports. Where it is deemed necessary to butt opposite joists over a narrow steel support with bearing less than that noted above, special ends must be specified, and such ends shall have positive attachment to the support, either by bolting or welding.

104.5 BRIDGING

Top and bottom chord bridging is required and shall consist of one or both of the following types.

(a) Horizontal

Horizontal bridging lines shall consist of continuous horizontal steel members. The ℓ/r of the bridging member shall not exceed 300, where ℓ is the distance in inches (millimeters) between attachments and r is the least radius of gyration of the bridging member.

(b) Diagonal

Diagonal bridging shall consist of cross-bracing with a ℓ/r ratio of not more than 200, where ℓ is the distance in inches (millimeters) between connections, and r is the least radius of gyration of the bridging member. Where cross-bracing members are connected at their point of intersection, the ℓ distance shall be taken as the distance in inches (millimeters) between connections at the point of intersection of the bridging members and the connections to the chord of the joists.

(c) Bridging Lines

For spans up through 60 feet (18288 mm), welded horizontal bridging may be used except where the row of bridging

nearest the center is required to be bolted diagonal bridging as indicated by the **Red** shaded area in the Load Table. For spans over 60 feet (18288 mm) bolted diagonal bridging shall be used as indicated by the **Blue** and **Gray** shaded areas of the Load Table.

(d) Quantity and Spacing

The maximum spacing of lines of top chord bridging shall not exceed the values in Table 104.5-1. The number of rows of bottom chord bridging, including bridging required per Section 104.12, shall not be less than the number of top chord rows. Rows of bottom chord bridging are permitted to be spaced independently of rows of top chord bridging. The spacing of rows of bottom chord bridging shall meet the slenderness requirement of Section 103.4(a) and any specified strength requirements.

Table 104.5-1

LH-DLH SECTION* NUMBER	MAX. SPACING OF LINES OF TOP CHORD BRIDGING	NOMINAL** HORIZONTAL BRACING FORCE	
		lbs	(N)
02,03,04	11'-0" (3352 mm)	400	(1779)
05,06	12'-0" (3657 mm)	500	(2224)
07,08	13'-0" (3962 mm)	650	(2891)
09,10	14'-0" (4267 mm)	800	(3558)
11,12	16'-0" (4876 mm)	1000	(4448)
13,14	16'-0" (4876 mm)	1200	(5337)
15,16	21'-0" (6400 mm)	1600	(7117)
17	21'-0" (6400 mm)	1800	(8006)
18,19	26'-0" (7924 mm)	2000	(8896)

Number of lines of bridging is based on joist clear span dimensions.
* Last two digits of joist designation shown in load table.
** Nominal bracing force is unfactored.

(e) Connections

Connections to the chords of the steel joists shall be made by positive mechanical means or by welding, and capable of resisting a horizontal force not less than that specified in Table 104.5-1.

(f) Bottom Chord Bearing Joists

Where bottom chord bearing joists are utilized, a row of diagonal bridging shall be provided near the support(s). This bridging shall be installed and anchored before the hoisting cable(s) is released.

104.6 INSTALLATION OF BRIDGING

Bridging shall support the top and bottom chords against lateral movement during the construction period and shall hold the steel joists in the approximate position as shown on the joist placement plans.

The ends of all bridging lines terminating at walls or beams shall be anchored to resist the nominal force shown in Table 104.5-1.

104.7 END ANCHORAGE

(a) Masonry and Concrete

Ends of **LH-** and **DLH-**Series Joists resting on steel bearing plates on masonry or structural concrete shall be attached thereto with a minimum of two 1/4 inch (6 millimeters) fillet welds 2 inches (51 millimeters) long, or with two 3/4 inch (19 millimeters) ASTM A307 bolts (minimum), or the equivalent.

(b) Steel

Ends of **LH-** and **DLH-**Series Joists resting on steel supports shall be attached thereto with a minimum of two 1/4 inch (6 millimeters) fillet welds 2 inches (51 millimeters) long, or with two 3/4 inch (19 millimeters) ASTM A307 bolts, or the equivalent. When LH/DLH series joists are used to provide lateral stability to the supporting member, the final connection shall be made by welding or as designated by the specifying professional.

(c) Uplift

Where uplift forces are a design consideration, roof joists shall be anchored to resist such forces (Refer to Section 104.12).

104.8 JOIST SPACING

Joists shall be spaced so that the loading on each joist does not exceed the design load (LRFD or ASD) for the particular joist designation and span as shown in the applicable load tables.

104.9 FLOOR AND ROOF DECKS

(a) Material

Floor and roof decks may consist of cast-in-place or precast concrete or gypsum, formed steel, wood, or other suitable material capable of supporting the required load at the specified joist spacing.

(b) Thickness

Cast-in-place slabs shall be not less than 2 inches (51 millimeters) thick.

(c) Centering

Centering for structural slabs may be ribbed metal lath, corrugated steel sheets, paper-backed welded wire fabric, removable centering or any other suitable material capable of supporting the slab at the designated joist spacing. Centering shall not cause lateral displacement or damage to the top chord of joists during installation or removal of the centering or placing of the concrete.

(d) Bearing

Slabs or decks shall bear uniformly along the top chords of the joists.

(e) Attachments

The spacing of attachments along the top chord shall not exceed 36 inches (914 millimeters). Such attachments of the slab or deck to the top chords of joists shall be capable of resisting the following forces:

Table 104.9-1

SECTION* NUMBER	NOMINAL** FORCE REQUIRED
02 to 04 incl.	120 lbs/ft (1.75 kN/m)
05 to 09 incl.	150 lbs/ft (2.19 kN/m)
10 to 17 incl.	200 lbs/ft (2.92 kN/m)
18 and 19	250 lbs/ft (3.65 kN/m)

* Last two digits of joist designation shown in the load table.
** Nominal force is unfactored.

(f) Wood Nailers

Where wood nailers are used, such nailers in conjunction with deck or slab shall be firmly attached to the top chords of the joists in conformance with Section 104.9(e).

(g) Joist with Standing Seam Roofing

The stiffness and strength of standing-seam roof clips varies from one manufacturer to another. Therefore, some roof systems cannot be counted on to provide lateral stability to the joists which support the roof. Sufficient stability must be provided to brace the joists laterally under the full design load. The compression chord must resist the chord axial design force in the plane of the joist (i.e., x-x axis buckling) and out of the plane of the joist (i.e., y-y axis buckling). Out of plane strength may be achieved by adjusting the bridging spacing and/or increasing the compression chord area, the joist depth, and the y-axis radius of gyration. The effective slenderness ratio in the y-direction equals 0.94 L/r_y; where L is the bridging spacing in inches (millimeters). The maximum bridging spacing may not exceed that specified in Section 104.5(d).

Horizontal bridging members attached to the compression chords and their anchorages must be designed for a compressive axial force of 0.0025nP, where n is the number of joists between end anchors and P is the chord design force in kips (Newtons). The attachment force between the horizontal bridging member and the compression chord is 0.005P. Horizontal bridging attached to the tension chords shall be proportioned so that the slenderness ratio between attachments does not exceed 300. Diagonal bridging shall be proportioned so that the slenderness ratio between attachments does not exceed 200.

104.10 DEFLECTION

The deflection due to the design live load shall not exceed the following:

Floors: 1/360 of span.

Roofs: 1/360 of span where a plaster ceiling is attached or suspended.

1/240 of span for all other cases.

The specifying professional shall give consideration to the effects of deflection and vibration* in the selection of joists.

* For further reference, refer to Steel Joist Institute Technical Digest #5, "Vibration of Steel Joist-Concrete Slab Floors" and the Institute's Computer Vibration Program.

104.11 PONDING*

The ponding investigation shall be performed by the specifying professional.

* For further reference, refer to Steel Joist Institute Technical Digest #3, "Structural Design of Steel Joist Roofs to Resist Ponding Loads" and AISC Specifications.

104.12 UPLIFT

Where uplift forces due to wind are a design requirement, these forces must be indicated on the contract drawings in terms of NET uplift in pounds per square foot (Pascals). The contract documents shall indicate if the net uplift is based on ASD or LRFD. When these forces are specified, they must be considered in the design of joists and/or bridging. A single line of **bottom chord** bridging must be provided near the first bottom chord panel points whenever uplift due to wind forces is a design consideration.*

* For further reference, refer to Steel Joist Institute Technical Digest #6, "Structural Design of Steel Joist Roofs to Resist Uplift Loads".

104.13 INSPECTION

Joists shall be inspected by the manufacturer before shipment to verify compliance of materials and workmanship with the requirements of these specifications. If the purchaser wishes an inspection of the steel joists by someone other than the manufacturer's own inspectors, they may reserve the right to do so in their "Invitation to Bid" or the accompanying "Job Specifications".

Arrangements shall be made with the manufacturer for such shop inspection of the joists at the manufacturing shop by the purchaser's inspectors at purchaser's expense.

104.14 PARALLEL CHORD SLOPED JOISTS

The span of a parallel chord sloped joist shall be defined by the length along the slope. Minimum depth, load-carrying capacity, and bridging requirements shall be determined by the sloped definition of span. The Load Table capacity shall be the component normal to the joist.

SECTION 105.*

ERECTION STABILITY AND HANDLING

When it is necessary for the erector to climb on the joists, extreme caution must be exercised since unbridged joists may exhibit some degree of instability under the erector's weight.

(a) Stability Requirements

1) Before an employee is allowed on the steel joist: BOTH ends of joists at columns (or joists designated as column joists) shall be attached to its supports. For all other joists a minimum of one end shall be attached before the employee is allowed on the joist. The attachment shall be in accordance with Section 104.7 – End Anchorage.

   When a bolted seat connection is used for erection purposes, as a minimum, the bolts must be snug tightened. The snug tight condition is defined as the tightness that exists when all plies of a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of an employee using an ordinary spud wrench.

2) On steel joists that do not require erection bridging as shown by the unshaded area of the Load Table, only one employee shall be allowed on the joist unless all bridging is installed and anchored.

   * For a thorough coverage of this topic, refer to SJI Technical Digest #9, "Handling and Erection of Steel Joists and Joist Girders".

3) Where the span of the steel joist is within the Red shaded area of the Load Table, the following shall apply:

   a) The row of bridging nearest the mid span of the steel joist shall be bolted diagonal erection bridging; and

   b) Hoisting cables shall not be released until this bolted diagonal erection bridging is installed and anchored, unless an alternate method of stabilizing the joist has been provided; and

   c) No more than one employee shall be allowed on these spans until all other bridging is installed and anchored.

4) Where the span of the steel joist is within the Blue shaded area of the Load Table, the following shall apply:

   a) All rows of bridging shall be bolted diagonal bridging; and

   b) Hoisting cables shall not be released until the two rows of bolted diagonal erection bridging nearest the third points of the steel joist are installed and anchored; and

   c) No more than two employees shall be allowed on these spans until all other bridging is installed and anchored.

5) Where the span of the steel joist is in the Gray shaded area of the Load Table, the following shall apply:

   a) All rows of bridging shall be bolted diagonal bridging; and

   b) Hoisting cables shall not be released until all bridging is installed and anchored; and

   c) No more than two employees shall be allowed on these spans until all other bridging is installed and anchored.

6) When permanent bridging terminus points cannot be used during erection, additional temporary bridging terminus points are required to provide lateral stability.

7) In the case of bottom chord bearing joists, the ends of the joist must be restrained laterally per Section 104.5(f) before releasing the hoisting cables.

8) After the joist is straightened and plumbed, and all bridging is completely installed and anchored, the ends of the joists shall be fully connected to the supports in accordance with Section 104.7- End Anchorage.

(b) Landing and Placing Loads

1) Except as stated in paragraph 105(b)(3) of this section, no "construction loads"(1) are allowed on the steel joists until all bridging is installed and anchored, and all joist bearing ends are attached.

2) During the construction period, loads placed on the joists shall be distributed so as not to exceed the capacity of the joists.

3) No bundle of deck may be placed on steel joists until all bridging has been installed and anchored and all joist bearing ends attached, unless the following conditions are met:

   a) The contractor has first determined from a *"qualified person"* (2) and documented in a site specific erection plan that the structure or portion of structure is capable of supporting the load;

   b) The bundle of decking is placed on a minimum of 3 steel joists;

   c) The joists supporting the bundle of decking are attached at both ends;

   d) At least one row of bridging is installed and anchored;

   e) The total weight of the decking does not exceed 4000 pounds (1816 kilograms); and

   f) The edge of the bundle of decking shall be placed within 1 foot (0.30 meters) of the bearing surface of the joist end.

g) The edge of the construction load shall be placed within 1 foot (0.30 meters) of the bearing surface of the joist end.

(c) Field Welding

1) All field welding shall be performed in accordance with contract documents. Field welding shall not damage the joists.

2) On cold-formed members whose yield strength has been attained by cold working, and whose as-formed strength is used in the design, the total length of weld at any one point shall not exceed 50 percent of the overall developed width of the cold-formed section.

(1) See Appendix E for definition of "construction load". A copy of the OSHA Steel Erection Standard §1926.757, Open Web Steel Joists, is included in Appendix E for reference purposes.

(d) Handling

Particular attention should be paid to the erection of Longspan and Deep Longspan Steel Joists. Care shall be exercised at all times to avoid damage to the joists and accessories.

Each joist shall be adequately braced laterally before any loads are applied. If lateral support is provided by bridging, the bridging lines as defined in Section 105(a), paragraphs 2, 3, 4 and 5, must be anchored to prevent lateral movement.

(e) Fall Arrest Systems

Steel joists shall not be used as anchorage points for a fall arrest system unless written approval to do so is obtained from a "qualified person" (2).

(2) See Appendix E for OSHA definition of "qualified person".

STANDARD SPECIFICATIONS
FOR JOIST GIRDERS

Adopted by the Steel Joist Institute November 4, 1985
Revised to November 10, 2003 - Effective March 01, 2005

SECTION 1000.
SCOPE

This specification covers the design, manufacture and use of Joist Girders. Load and Resistance Factor Design (LRFD) and Allowable Strength Design (ASD) are included in this specification.

SECTION 1001.
DEFINITION

The term "Joist Girders", as used herein, refers to open web, load-carrying members utilizing hot-rolled or cold-formed steel, including cold-formed steel whose yield strength* has been attained by cold working.

The design of Joist Girder chord and web sections shall be based on a yield strength of at least 36 ksi (250 MPa), but not greater than 50 ksi (345 MPa). Steel used for Joist Girder chord or web sections shall have a minimum yield strength determined in accordance with one of the procedures specified in Section 1002.2, which is equal to the yield strength assumed in the design. Joist Girders shall be designed in accordance with this specification to support panel point loadings.

* The term "Yield Strength" as used herein shall designate the yield level of a material as determined by the applicable method outlined in paragraph 13.1, "Yield Point" and in paragraph 13.2, "Yield Strength", of ASTM Standard A370, "Standard Test Methods and Definitions for Mechanical Testing of Steel Products", or as specified in Section 1002.2 of this Specification.

SECTION 1002.
MATERIALS

1002.1 STEEL

The steel used in the manufacture of chord and web sections shall conform to one of the following ASTM Specifications:

- Carbon Structural Steel, ASTM A36/A36M.
- High-Strength, Low-Alloy Structural Steel, ASTM A242/A242M.
- High-Strength Carbon-Manganese Steel of Structural Quality ASTM A529/A529M, Grade 50.
- High-Strength Low-Alloy Columbium-Vanadium Structural Steel, ASTM A572/A572M Grade 42 and 50.
- High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inches (100 mm) Thick, ASTM A588/A588M.
- Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Corrosion Resistance, ASTM A606.
- Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1008/A1008M.
- Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1011/A1011M.

or shall be of suitable quality ordered or produced to other than the listed specifications, provided that such material in the state used for final assembly and manufacture is weldable and is proved by tests performed by the producer or manufacturer to have the properties specified in Section 1002.2.

1002.2 MECHANICAL PROPERTIES

The yield strength used as a basis for the design stresses prescribed in Section 1003 shall be at least 36 ksi (250 MPa), but shall not be greater than 50 ksi (345 MPa). Evidence that the steel furnished meets or exceeds the design yield strength shall, if requested, be provided in the form of an affidavit or by witnessed or certified test reports.

For material used without consideration of increase in yield strength resulting from cold forming, the specimens shall be taken from as-rolled material. In the case of material properties of which conform to the requirements of one of the listed specifications, the test specimens and procedures shall conform to those of such specifications and to ASTM A370.

In the case of material the mechanical properties of which do not conform to the requirements of one of the listed specifications, the test specimens and procedures shall conform to the applicable requirements of ASTM A370 and the specimens shall exhibit a yield strength equal to or exceeding the design yield strength and an elongation of not less than (a) 20 percent in 2 inches (51 millimeters) for sheet and strip, or (b) 18 percent in 8 inches (203 millimeters) for plates, shapes and bars with adjustments for thickness for plates, shapes and bars as prescribed in ASTM A36/A36M, A242/A242M, A529/A529M, A572/A572M, A588/A588M, whichever specification is applicable on the basis of design yield strength.

The number of tests shall be as prescribed in ASTM A6/A6M for plates, shapes, and bars; and ASTM A606, A1008/A1008M and A1011/A1011M for sheet and strip.

If as-formed strength is utilized, the test reports shall show the results of tests performed on full section specimens in accordance with the provisions of the AISI Specifications for the Design of Cold-Formed Steel Structural Members and shall indicate compliance with these provisions and with the following additional requirements:

a) The yield strength calculated from the test data shall equal or exceed the design yield strength.

b) Where tension tests are made for acceptance and control purposes, the tensile strength shall be at least 6 percent greater than the yield strength of the section.

c) Where compression tests are used for acceptance and control purposes, the specimen shall withstand a gross shortening of 2 percent of its original length without cracking. The length of the specimen shall not be greater than 20 times its least radius of gyration.

d) If any test specimen fails to pass the requirements of the subparagraphs (a), (b), or (c) above, as applicable, two retests shall be made of specimens from the same lot. Failure of one of the retest specimens to meet such requirements shall be the cause for rejection of the lot represented by the specimens.

1002.3 WELDING ELECTRODES

The following electrodes shall be used for arc welding:

a) For connected members both having a specified yield strength greater than 36 ksi (250 MPa).

AWS A5.1: E70XX
AWS A5.5: E70XX-X
AWS A5.17: F7XX-EXXX, F7XX-ECXXX flux electrode combination
AWS A5.18: ER70S-X, E70C-XC, E70C-XM
AWS A5.20: E7XT-X, E7XT-XM
AWS A5.23: F7XX-EXXX-XX, F7XX-ECXXX-XX
AWS A5.28: ER70S-XXX, E70C-XXX
AWS A5.29: E7XTX-X, E7XTX-XM

b) For connected members both having a specified minimum yield strength of 36 ksi (250 MPa) or one having a specified minimum yield strength of 36 ksi (250 MPa), and the other having a specified minimum yield strength greater than 36 ksi (250 MPa).

AWS A5.1: E60XX
AWS A5.17: F6XX-EXXX, F6XX-ECXXX flux electrode combination
AWS A5.20: E6XT-X, E6XT-XM
AWS A5.29: E6XTX-X, E6XT-XM
or any of those listed in Section 1002.3(a).

Other welding methods, providing equivalent strength as demonstrated by tests, may be used.

1002.4 PAINT

The standard shop paint is intended to protect the steel for only a short period of exposure in ordinary atmospheric conditions and shall be considered an impermanent and provisional coating.

When specified, the standard shop paint shall conform to one of the following:

a) Steel Structures Painting Council Specification, SSPC No. 15

b) Or, shall be a shop paint which meets the minimum performance requirements of the above listed specification.

SECTION 1003.
DESIGN AND MANUFACTURE

1003.1 METHOD

Joist Girders shall be designed in accordance with this specification as simply supported primary members. All loads shall be applied through steel joists, and will be equal in magnitude and evenly spaced along the joist girder top chord. Where any applicable design feature is not specifically covered herein, the design shall be in accordance with the following specifications:

a) Where the steel used consists of hot-rolled shapes, bars or plates, use the American Institute of Steel Construction, *Specification for Structural Steel Buildings*.

b) For members that are cold-formed from sheet or strip steel, use the American Iron and Steel Institute, *North American Specification for the Design of Cold-Formed Steel Structural Members*.

Design Basis:

Designs shall be made according to the provisions in this Specification for either Load and Resistance Factor Design (LRFD) or for Allowable Strength Design (ASD).

Load Combinations:

LRFD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed for the factored loads based on the factors and load combinations as follows:

1.4D

1.2D + 1.6 (L, or L_r, or S, or R)

ASD:

When load combinations are not specified to the joist manufacturer, the required stress shall be computed based on the load combinations as follows:

D

D + (L, or L_r, or S, or R)

Where:

D = dead load due to the weight of the structural elements and the permanent features of the structure

L = live load due to occupancy and movable equipment

L_r = roof live load

S = snow load

R = load due to initial rainwater or ice exclusive of the ponding contribution

When special loads are specified and the specifying professional does not provide the load combinations, the provisions of ASCE 7, *"Minimum Design Loads for Buildings and Other Structures"* shall be used for LRFD and ASD load combinations.

1003.2 DESIGN AND ALLOWABLE STRESSES

Design Using Load and Resistance Factor Design (LRFD)

Joist Girders shall have their components so proportioned that the required stresses, f_u, shall not exceed ϕF_n where,

f_u	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
ϕ	=	resistance factor	
ϕF_n	=	design stress	

Design Using Allowable Strength Design (ASD)

Joist Girders shall have their components so proportioned that the required stresses, *f*, shall not exceed F_n/Ω where,

f	=	required stress	ksi (MPa)
F_n	=	nominal stress	ksi (MPa)
Ω	=	safety factor	
F_n/Ω	=	allowable stress	

Stresses:

(a) Tension: $\phi_t = 0.90$ (LRFD) $\Omega_t = 1.67$ (ASD)

For Chords: $F_y = 50$ ksi (345 MPa)

For Webs: $F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $0.9F_y$ (LRFD) (1003.2-1)

Allowable Stress = $0.6F_y$ (ASD) (1003.2-2)

(b) Compression: $\phi_c = 0.90$ (LRFD) $\Omega_c = 1.67$ (ASD)

For members with $\frac{\ell}{r} \le 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = Q\left[0.658^{\left(\frac{QF_y}{F_e}\right)}\right]F_y \qquad (1003.2\text{-}3)$$

For members with $\frac{\ell}{r} > 4.71\sqrt{\frac{E}{QF_y}}$

$$F_{cr} = 0.877F_e \qquad (1003.2\text{-}4)$$

Where F_e = Elastic bucking stress determined in accordance with Equation 1003.2-5.

$$F_e = \frac{\pi^2 E}{\left(\frac{\ell}{r}\right)^2} \qquad (1003.2\text{-}5)$$

For hot-rolled sections, "Q" is the full reduction factor for slender compression elements.

Design Stress = $0.9F_{cr}$ (LRFD) (1003.2-6)

Allowable Stress = $0.6F_{cr}$ (ASD) (1003.2-7)

In the above equations, ℓ is taken as the distance, in inches (millimeters), between panel points for the chord members and the appropriate length for web members, and *r* is the corresponding least radius of gyration of the member or any component thereof. *E* is equal to 29,000 ksi (200,000 MPa).

Use 1.2 ℓ/r_x for a crimped, first primary compression web member when a moment-resistant weld group is not used for this member; where r_x = member radius of gyration in the plane of the joist.

For cold-formed sections, the method of calculating the nominal column strength is given in the AISI, *North American Specification for the Design of Cold-Formed Steel Structural Members.*

(c) Bending: $\phi_b = 0.90$ (LRFD) $\Omega_b = 1.67$ (ASD)

Bending calculations are to be based on using the elastic section modulus.

For chords and web members other than solid rounds:
$F_y = 50$ ksi (345 MPa)

Design Stress = $0.90F_y$ (LRFD) (1003.2-8)

Allowable Stress = $0.60F_y$ (ASD) (1003.2-9)

For web members of solid round cross section:
$F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $1.45F_y$ (LRFD) (1003.2-10)

Allowable Stress = $0.95F_y$ (ASD) (1003.2-11)

For bearing plates:
$F_y = 50$ ksi (345 MPa), or $F_y = 36$ ksi (250 MPa)

Design Stress = $1.35F_y$ (LRFD) (1003.2-12)

Allowable Stress = $0.90F_y$ (ASD) (1003.2-13)

(d) Weld Strength:

Shear at throat of fillet welds:

Nominal Shear Stress = $F_{nw} = 0.6F_{exx}$ (1003.2-14)

LRFD: $\phi_w = 0.75$

Design Shear Strength =
$\phi R_n = \phi_w F_{nw} A = 0.45F_{exx} A$ (1003.2-15)

ASD: $\Omega_w = 2.0$

Allowable Shear Strength = (1003.2-16)
$R_n/\Omega_w = F_{nw} A/\Omega_w = 0.3F_{exx} A$

A = effective throat area

Made with E70 series electrodes or F7XX-EXXX flux-electrode combinations .....$F_{exx} = 70$ ksi (483 MPa)

Made with E60 series electrodes or F6XX-EXXX flux-electrode combinations .....$F_{exx} = 60$ ksi (414 MPa)

Tension or compression on groove or butt welds shall be the same as those specified for the connected material.

1003.3 MAXIMUM SLENDERNESS RATIOS

The slenderness ratio ℓ/r, where ℓ is the length center-to-center of support points and r is the corresponding least radius of gyration, shall not exceed the following:

Top chord end panels 120

Top chord interior panels 90

Compression members other than top chord 200

Tension members 240

1003.4 MEMBERS

(a) Chords

The bottom chord shall be designed as an axially loaded tension member. The radius of gyration of the bottom chord about its vertical axis shall not be less than $\ell/240$ where ℓ is the distance between lines of bracing.

The top chord shall be designed as an axial loaded compression member. The radius of gyration of the top chord about the vertical axis shall not be less than Span/575.

The top chord shall be considered as stayed laterally by the steel joists provided positive attachment is made.

(b) Web

The vertical shears to be used in the design of the web members shall be determined from full loading, but such vertical shear shall be not less than 25 percent of the end reaction.

Interior vertical web members used in modified Warren type web systems that do not support the direct loads through steel joists shall be designed to resist an axial load of 2 percent of the top chord axial force.

Tension members shall be designed to resist at least 25 percent of their axial force in compression.

(c) Fillers and Ties

In compression members composed of two components, when fillers, ties or welds are used, they shall be spaced so the ℓ/r ratio for each component does not exceed the ℓ/r ratio of the member as a whole. In tension members composed of two components, when fillers, ties or welds are used, they shall be spaced so that the ℓ/r ratio of each component does not exceed 240. The least radius of gyration shall be used in computing the ℓ/r ratio of a component.

(d) Eccentricity

Members connected at a joint shall have their center of gravity lines meet at a point, if practical. Eccentricity on either side of the centroid of chord members may be neglected when it does not exceed the distance between the centroid and the back of the chord. Otherwise, provision shall be made for the stresses due to eccentricity. Ends of Joist Girders shall be proportioned to resist bending produced by eccentricity at the support.

In those cases where a single angle compression member is attached to the outside of the stem of a tee or double angle chord, due consideration shall be given to eccentricity.

(e) Extended Ends

Extended top chords or full depth cantilever ends require the special attention of the specifying professional. The magnitude and location of the loads to be supported, deflection requirements, and proper bracing shall be clearly indicated on the structural drawings.

1003.5 CONNECTIONS

(a) Methods

Joint connections and splices shall be made by attaching the members to one another by arc or resistance welding or other accredited methods.

(1) Welded Connections

a) Selected welds shall be inspected visually by the manufacturer. Prior to this inspection, weld slag shall be removed.

b) Cracks are not acceptable and shall be repaired.

c) Thorough fusion shall exist between layers of weld metal and between weld metal and base metal for the required design length of the weld; such fusion shall be verified by visual inspection.

d) Unfilled weld craters shall not be included in the design length of the weld.

e) Undercut shall not exceed 1/16 inch (2 millimeters) for welds oriented parallel to the principal stress.

f) The sum of surface (piping) porosity diameters shall not exceed 1/16 inch (2 millimeters) in any 1 inch (25 millimeters) of design weld length.

g) Weld spatter that does not interfere with paint coverage is acceptable.

(2) Welding Program

Manufacturers shall have a program for establishing weld procedures and operator qualification, and for weld sampling and testing.

(3) Weld Inspection by Outside Agencies (See Section 1004.10 of this specification).

The agency shall arrange for visual inspection to determine that welds meet the acceptance standards of Section 1003.5(a)(1). Ultrasonic, X-Ray, and magnetic particle testing are inappropriate for Joists Girders due to the configurations of the components and welds.

(b) Strength

(1) Joint Connections – Joint connections shall develop the maximum force due to any of the design loads, but not less than 50 percent of the strength of the member in tension or compression, whichever force is the controlling factor in the selection of the member.

(2) Shop Splices - Shop splices may occur at any point in chord or web members. Splices shall be designed for the member force but not less than 50 percent of the member strength. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57 ksi (393 MPa) times the full design area of the chord or web. The term "member" shall be defined as all component parts comprising the chord or web, at the point of splice.

(c) Field Splices

Field Splices shall be designed by the manufacturer and may be either bolted or welded. Splices shall be designed for the member force, but not less than 50 percent of the member strength.

1003.6 CAMBER

Joist Girders shall have approximate cambers in accordance with the following:

TABLE 1003.6-1

Top Chord Length		Approximate Camber	
20'-0"	(6096 mm)	1/4"	(6 mm)
30'-0"	(9144 mm)	3/8"	(10 mm)
40'-0"	(12192 mm)	5/8"	(16 mm)
50'-0"	(15240 mm)	1"	(25 mm)
60'-0"	(18288 mm)	1 1/2"	(38 mm)
70'-0"	(21336 mm)	2"	(51 mm)
80'-0"	(24384 mm)	2 3/4"	(70 mm)
90'-0"	(27342 mm)	3 1/2"	(89 mm)
100'-0"	(30480 mm)	4 1/4"	(108 mm)
110'-0"	(33528 mm)	5"	(127 mm)
120'-0"	(36576 mm)	6"	(152 mm)

The specifying professional shall give consideration to coordinating Joist Girder camber with adjacent framing.

1003.7 VERIFICATION OF DESIGN AND MANUFACTURE

(a) Design Calculations

Companies manufacturing Joist Girders shall submit design data to the Steel Joist Institute (or an independent agency approved by the Steel Joist Institute) for verification of compliance with the SJI Specifications.

(b) In-Plant Inspections

Each manufacturer shall verify their ability to manufacture Joist Girders through periodic In-Plant Inspections. Inspections shall be performed by an independent agency approved by the Steel Joist Institute. The frequency, manner of inspection, and manner of reporting shall be determined by the Steel Joist Institute. The In-Plant Inspections are not a guarantee of the quality of any specific Joist Girder; this responsibility lies fully and solely with the individual manufacturer.

SECTION 1004.
APPLICATION

1004.1 USAGE

This specification shall apply to any type of structure where steel joists are to be supported directly by Joist Girders installed as hereinafter specified. Where Joist Girders are used other than on simple spans under equal concentrated gravity loading, as prescribed in Section 1003.1, they shall be investigated and modified if necessary to limit the unit stresses to those listed in Section 1003.2. The magnitude and location of all loads and forces, other than equal concentrated gravity loading, shall be provided on the structural drawings. The specifying professional shall design the supporting structure, including the design of columns, connections, and moment plates*. This design shall account for the stresses caused by lateral forces and the stresses due to connecting the bottom chord to the column or other support.

The designed detail of a rigid type connection and moment plates shall be shown on the structural drawings by the specifying professional. The moment plates shall be furnished by other than the joist manufacturer.

* For further reference, refer to Steel Joist Institute Technical Digest #11, "Design of Joist-Girder Frames"

1004.2 SPAN

The span of a Joist Girder shall not exceed 24 times its depth.

1004.3 DEPTH

Joist Girders may have either parallel top chords or a top chord slope of 1/8 inch per foot (1:96). The nominal depth of sloping chord Joist Girders shall be the depth at mid-span.

1004.4 END SUPPORTS

(a) Masonry and Concrete

Joist Girders supported by masonry or concrete are to bear on steel bearing plates and shall be designed as steel bearing. Due consideration of the end reactions and all other vertical and lateral forces shall be taken by the specifying professional in the design of the steel bearing plate and the masonry or concrete. The ends of Joist Girders shall extend a distance of not less than 6 inches (152 millimeters) over the masonry or concrete support and be anchored to the steel bearing plate. The plate shall be located not more than 1/2 inch (13 millimeters) from the face of the wall and shall be not less than 9 inches (229 millimeters) wide perpendicular to the length of the girder. The plate is to be designed by the specifying professional and shall be furnished by other than the joist manufacturer.

Where it is deemed necessary to bear less than 6 inches (152 millimeters) over the masonry or concrete support, special consideration is to be given to the design of the steel bearing plate and the masonry or concrete by the specifying professional. The girders must bear a minimum of 4 inches (102 millimeters) on the steel bearing plate.

(b) Steel

Due consideration of the end reactions and all other vertical and lateral forces shall be taken by the specifying professional in the design of the steel support. The ends of Joist Girders shall extend a distance of not less than 4 inches (102 millimeters) over the steel supports and shall have positive attachment to the support, either by bolting or welding.

1004.5 BRACING

Joist Girders shall be proportioned such that they can be erected without bridging (See Section 1004.9 for bracing required for uplift forces). Therefore, the following requirements must be met:

a) The ends of the bottom chord are restrained from lateral movement to brace the girder from overturning. For Joist Girders at columns in steel frames, restraint shall be provided by a stabilizer plate on the column.

b) No other loads shall be placed on the Joist Girder until the steel joists bearing on the girder are in place and welded to the girder.

1004.6 END ANCHORAGE

(a) Masonry and Concrete

Ends of Joist Girders resting on steel bearing plates on masonry or structural concrete shall be attached thereto with a minimum of two 1/4 inch (6 millimeters) fillet welds 2 inches (51 millimeters) long, or with two 3/4 inch (19 millimeters) bolts, or the equivalent.

(b) Steel

Ends of Joist Girders resting on steel supports shall be attached thereto with a minimum of two 1/4 inch (6 millimeters) fillet welds 2 inches (51 millimeters) long, or with two 3/4 inch (19 millimeters) bolts, or the equivalent. In steel frames, bearing seats for Joist Girders shall be fabricated to allow for field bolting.

(c) Uplift

Where uplift forces are a design consideration, roof Joist Girders shall be anchored to resist such forces (Refer to Section 1004.9).

1004.7 DEFLECTION

The deflections due to the design live load shall not exceed the following:

Floors: 1/360 of span.

Roofs: 1/360 of span where a plaster ceiling is attached or suspended.

1/240 of span for all other cases.

The specifying professional shall give consideration to the

effects of deflection and vibration* in the selection of Joist Girders.

* For further reference, refer to Steel Joist Institute Technical Digest #5, "Vibration of Steel Joist-Concrete Slab Floors" and the Institute's Computer Vibration Program.

1004.8 PONDING*

The ponding investigation shall be performed by the specifying professional.

* For further reference, refer to Steel Joist Institute Technical Digest #3, "Structural Design of Steel Joist Roofs to Resist Ponding Loads" and AISC Specifications.

1004.9 UPLIFT

Where uplift forces due to wind are a design requirement, these forces must be indicated on the contract drawings in terms of NET uplift in pounds per square foot (Pascals). The contract drawings must indicate if the net uplift is based on ASD or LRFD. When these forces are specified, they must be considered in the design of Joist Girders and/or bracing. If the ends of the bottom chord are not strutted, bracing must be provided near the first bottom chord panel points whenever uplift due to wind forces is a design consideration.*

* For further reference, refer to Steel Joist Institute Technical Digest #6, "Structural Design of Steel Joist Roofs to Resist Uplift Loads".

1004.10 INSPECTION

Joist Girders shall be inspected by the manufacturer before shipment to verify compliance of materials and workmanship with the requirements of this specification. If the purchaser wishes an inspection of the Joist Girders by someone other than the manufacturer's own inspectors, they may reserve the right to do so in their "Invitation to Bid" or the accompanying "Job Specifications". Arrangements shall be made with the manufacturer for such inspection of the Joist Girders at the manufacturing shop by the purchaser's inspectors at purchaser's expense.

SECTION 1005.*
HANDLING AND ERECTION

Particular attention should be paid to the erection of Joist Girders.

Care shall be exercised at all times to avoid damage through careless handling during unloading, storing and erecting. Dropping of Joist Girders shall not be permitted.

In steel framing, where Joist Girders are utilized at column lines, the Joist Girder shall be field-bolted at the column. Before hoisting cables are released and before an employee is allowed on the Joist Girder the following conditions must be met:

a) The seat at each end of the Joist Girder is attached in accordance with Section 1004.6.

   When a bolted seat connection is used for erection purposes, as a minimum, the bolts must be snug tightened. The snug tight condition is defined as the tightness that exists when all plies of a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of an employee using an ordinary spud wrench.

b) Where stabilizer plates are required the Joist Girder bottom chord must engage the stabilizer plate.

During the construction period, the contractor shall provide means for the adequate distribution of loads so that the carrying capacity of any Joist Girder is not exceeded.

Joist Girders shall not be used as anchorage points for a fall arrest system unless written direction to do so is obtained from a "qualified person".(1)

Field welding shall not damage the Joist Girder. The total length of weld at any one cross-section on cold-formed members whose yield strength has been attained by cold working and whose as-formed strength is used in the design, shall not exceed 50 percent of the overall developed width of the cold-formed section.

* For a thorough coverage of this topic, refer to SJI Technical Digest #9, "Handling and Erection of Steel Joists and Joist Girders".

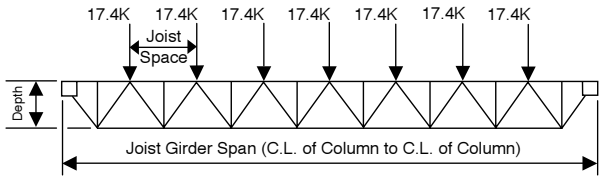
(1) See Appendix E for OSHA definition of "qualified person".

SECTION 1006.
HOW TO SPECIFY JOIST GIRDERS

For a given Joist Girder span, the specifying professional first determines the number of joist spaces. Then the panel point loads are calculated and a depth is selected. The following tables give the Joist Girder weight in pounds per linear foot (kiloNewtons per meter) for various depths and loads.

1. The purpose of the Joist Girder Design Guide Weight Table is to assist the specifying professional in the selection of a roof or floor support system.
2. It is not necessary to use only the depths, spans, or loads shown in the tables.
3. Holes in chord elements present special problems which must be considered by both the specifying professional and the Joist Girder Manufacturer. The sizes and locations of such holes shall be clearly indicated on the structural drawings.

Example using *Load and Resistance Factor Design (LRFD)* and U. S. Customary units:



STANDARD DESIGNATION

44G	8N	17.4F
Depth in Inches	Number of Joist Spaces	Factored Load in Kips at Each Panel Point

Given 42'-0" x 50"-0" bay. Joists spaced on 5'-3" centers

Live Load = 30 psf x 1.6

Dead Load = 15 psf x 1.2
(includes the approximate Joist Girder weight)

Total Load = 66 psf (factored)

Note: Web configuration may vary from that shown. Contact Joist Girder manufacturer if exact layout must be known.

1. Determine number of actual joist spaces (N).
   In this example, N = 8
2. Compute total factored load:

   Total load = 5.25 x 66 psf = 346.5 plf
3. Joist Girder Section: (Interior)

   a) Compute the factored concentrated load at top chord panel points

   P = 346.5 x 50 = 17,325 lbs = 17.4 kips
   (use 18K for depth selection).

   b) Select Joist Girder depth:

   Refer to the LRFD Joist Girder Design Guide Weight Table for the 42'-0" span, 8 panel, 18.0K Joist Girder. The rule of about one inch of depth for each foot of span is a good compromise of limited depth and economy. Therefore, select a depth of 44 inches.

   c) The Joist Girder will then be designated 44G8N17.4F. Note that the letter "F" is included at the end of the designation to clearly indicate that this is a factored load.

   d) The LRFD Joist Girder Design Guide Weight Table shows the weight for a 44G8N17.4K as 49 pounds per linear foot. The designer should verify that the weight is not greater than the weight assumed in the Dead Load above.

   e) Check live load deflection:

   Live load = 30 psf x 50 ft = 1500 plf

   Approximate Joist Girder moment of inertia

   = 0.018 NPLd

   = 0.018 x 8 x 17.4 x 42 x 44 = 4630 in.^{4}

Allowable deflection for plastered ceilings

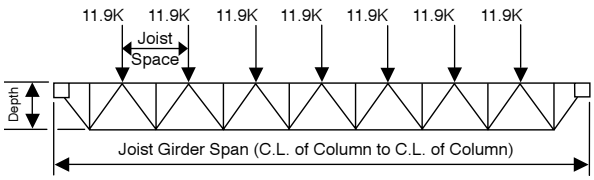
$$= L/360 = \frac{42(12)}{360} = 1.40 \text{ in.}$$

$$\text{Deflection} = 1.15\left[\frac{5wL^4}{384EI}\right] = \frac{1.15(5)(1.500/12)(42x12)^4}{384(29000)(4630)}$$

= 0.90 in. < 1.40 in., Okay

Live load deflection rarely governs because of the relatively small span-depth ratios of Joist Girders.

Example using *Allowable Strength Design (ASD)* and U. S. Customary units:



STANDARD DESIGNATION

44G	8N	11.9K
Depth in Inches	Number of Joist Spaces	Load in Kips at Each Panel Point

Given 42'-0" x 50'-0" bay. Joists spaced on 5'-3" centers.

Live Load = 30 psf

Dead Load = 15 psf
(includes the approximate Joist Girder weight)

Total Load = 45 psf

Note: Web configuration may vary from that shown. Contact Joist Girder manufacturer if exact layout must be known.

1. Determine number of actual joist spaces (N).

   In this example, N = 8
2. Compute total load:

   Total load = 5.25 x 45 psf = 236.25 plf
3. Joist Girder Section: (Interior)

   a) Compute the concentrated load at top chord panel points

   P = 236.25 x 50 = 11,813 lbs = 11.9 kips
   (use 12K for depth selection).

   b) Select Joist Girder depth:

   Refer to the ASD Joist Girder Design Guide Weight Table for the 42'-0" span, 8 panel, 12.0K Joist Girder.

The rule of about one inch of depth for each foot of span is a good compromise of limited depth and economy. Therefore, select a depth of 44 inches.

c) The Joist Girder will then be designated 44G8N11.9K.

d) The ASD Joist Girder Design Guide Weight Table shows the weight for a 44G8N12K as 49 pounds per linear foot. The designer should verify that the weight is not greater than the weight assumed in the Dead Load above.

e) Check live load deflection:

Live load = 30 psf x 50 ft = 1500 plf.

Approximate Joist Girder moment of inertia

= 0.027 NPLd

= 0.027 x 8 x 11.9 x 42 x 44 = 4750 in.^{4}

Allowable deflection for plastered ceilings

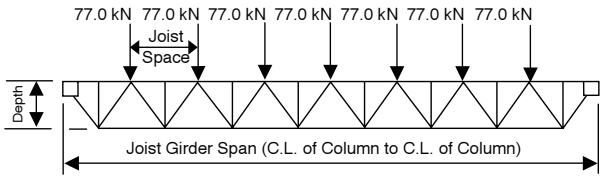
$$= L/360 = \frac{42(12)}{360} = 1.40 \text{ in.}$$

$$\text{Deflection} = 1.15\left[\frac{5wL^4}{384EI}\right] = \frac{1.15(5)(1.500/12)(42x12)^4}{384(29000)(4750)}$$

= 0.88 in. < 1.40 in., Okay

Live load deflection rarely governs because of the relatively small span-depth ratios of Joist Girders.

Joist Girder design example using Load and Resistance Factor Design (LRFD) and Metric Units:



STANDARD DESIGNATION

1118G	8N	77.0F
Depth in mm	Number of Joist Spaces	Factored Load in kN at Each Panel Point

Given 12.80 m x 15.24 m bay. Joists spaced on 1.600 m centers.

Live Load = 1.436 kN/m^2 x 1.6

Dead Load = 0.718 kN/m^2 x 1.2
(includes approximate Joist Girder weight)

Total Load = 3.160 kN/m^2 (Factored)

Note: Web configuration may vary from that shown. Contact Joist Girder manufacturer if exact layout must be known.

1. Determine number of actual joist spaces (N).

In this example N = 8

2. Compute total load:

Total Load = 1.600 m x 3.160 kN/m^2 = 5.055 kN/m

3. Joist Girder Selection: (Interior)

a) Compute the factored concentrated load at top chord panel points

P = 5.055 kN/m x 15.24 m = 77.0 kN (use 80.0 kN).

b) Select Joist Girder depth:

Refer to the LRFD Metric Joist Girder Design Guide Weight Table for the 12800 mm span, 8 panel, 80.0 kN Joist Girder. The rule of about one millimeter of depth for each 12 millimeters of span is a good compromise of limited depth and economy. Therefore, select a depth of 1118 mm.

c) The Joist Girder will then be designated 1118G8N77.0F. Note that the letter "F" is included at the end of the designation to clearly indicate that this is a factored load.

d) The LRFD Metric Joist Girder Design Guide Weight Table shows the weight for a 1118G8N80F as 73 kg/m. To convert the mass to a force multiply 73 kg/m x 0.0098 = 0.715 kN/m. The designer should verify that the weight is not greater than the weight assumed in the Dead Load above.

e) Check live load deflection:

Live load = 1.436 kN/m^2 x 15.24 m = 21.88 kN/m

Approximate Joist Girder moment of inertia:

I_{JG} = 0.2197NPLd where d = effective depth

= 0.2197 x 8 x 77.0 x 12800 x 1118

= 1937 x 10^6 mm^4

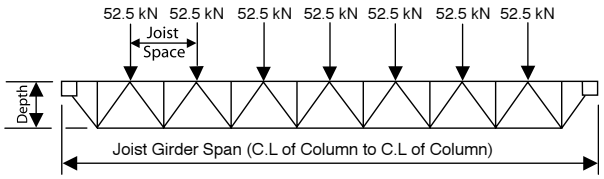
Allowable deflection for plastered ceilings

$$= L/360 = \frac{12800}{360} = 35.56 \text{ mm}$$

$$\text{Deflection} = 1.15\left[\frac{5wL^4}{384EI}\right] = \frac{1.15(5)(21.88)(12800)^4}{384(200000)(1937x10^6)}$$

= 27.7 mm < 35.56 mm, Okay

Joist Girder design example using *Allowable Strength Design (ASD)* and Metric Units:



STANDARD DESIGNATION

1118G	8N	52.5 kN
Depth in mm	Number of Joist Spaces	kN Load on Each Panel Point

Given 12.80 m x 15.24 m bay. Joists spaced on 1.600 m centers.

Live Load = 1.436 kN/m^2

Dead Load 0.718 kN/m^2
(includes approximate Joist Girder weight)

Total Load 2.155 kN/m^2

Note: Web configuration may vary from that shown. Contact Joist Girder manufacturer if exact layout must be known.

1. Determine number of actual joist spaces (N).

   In this example N = 8

2. Compute total load:

   Total Load = 1.600 m x 2.155 kN/m^2 = 3.44 kN/m

3. Joist Girder Selection: (Interior)

   a) Compute the concentrated load at top chord panel points

      P = 3.44 kN/m x 15.24 m = 52.5 kN (use 54.0 kN).

   b) Select Joist Girder depth:

      Refer to the ASD Metric Joist Girder Design Guide Weight Table for the 12800 mm span, 8 panel, 54.0 kN Joist Girder. The rule of about one millimeter of depth for each 12 millimeters of span is a good compromise of limited depth and economy. Therefore, select a depth of 1118 mm from the table.

   c) The Joist Girder will then be designated 1118G8N52.5 kN.

   d) The ASD Metric Joist Girder Design Guide Weight Table shows the weight for a 1118G8N52.5K as 73 kg/m. To convert the mass to a force multiply 73 kg/m by 0.0098 = 0.715 kN/m. The designer should verify that the weight is not greater than the weight assumed in the dead load above.

   e) Check live load deflection:

      Live load = 1.436 kN/m^2 x 15.24 m = 21.88 kN/m

      Approximate Joist Girder moment of inertia:

      IJG = 0.3296NPLd where d = effective depth

      = 0.3296 x 8 x 52.5 x 12800 x 1118

      = 1981 x 10^6 mm^4

Allowable deflection for
plastered ceilings = L/360 = 12800/360 = 35.56 mm

$$\text{Deflection} = 1.15\left[\frac{5wL^4}{384EI}\right] = \frac{1.15(5)(21.88)(12800)^4}{384(200000)(1981\times10^6)}$$

= 22.20 mm < 35.56 mm, Okay

CODE OF STANDARD PRACTICE FOR STEEL JOISTS AND JOIST GIRDERS

Adopted by the Steel Joist Institute April 7, 1931
Revised to May 1, 2000 - Effective May 03, 2005

SECTION 1. GENERAL

1.1 SCOPE

The practices and customs set forth herein are in accordance with good engineering practice, tend to ensure safety in steel joist and Joist Girder construction, and are standard within the industry. There shall be no conflict between this code and any legal building regulation. This code shall only supplement and amplify such laws. Unless specific provisions to the contrary are made in a contract for the purchase of steel joists or Joist Girders, this code is understood to govern the interpretation of such a contract.

1.2 APPLICATION

This Code of Standard Practice is to govern as a standard unless otherwise covered in the architects' and engineers' plans and specifications.

1.3 DEFINITIONS

Material. Steel joists, Joist Girders, and accessories as provided by the seller.

Seller. A company certified by the Steel Joist Institute engaged in the manufacture and distribution of steel joists, Joist Girders, and accessories.

Buyer. The entity that has agreed to purchase Material from the manufacturer and has also agreed to the terms of sale.

Owner. The entity that is identified as such in the Contract Documents.

Erector. The entity that is responsible for the safe and proper erection of the Materials in accordance with all applicable codes and regulations.

Specifying Professional. The licensed professional who is responsible for sealing the building Contract Documents, which indicates that he or she has performed or supervised the analysis, design and document preparation for the structure and has knowledge of the load-carrying structural system.

Structural Drawings. The graphic or pictorial portions of the Contract Documents showing the design, location and dimensions of the work. These documents generally include plans, elevations, sections, details, connections, all loads, schedules, diagrams and notes.

Placement Plans. Drawings that are prepared depicting the interpretation of the Contract Documents requirements for the Material to be supplied by the Seller. These floor and/or roof plans are approved by the **Specifying Professional**, Buyer or owner for conformance with the design requirements. The Seller uses the information contained on these drawings for final Material design. A unique piece mark number is typically shown for the individual placement of the steel joists, Joist Girders and accessories along with sections that describe the end bearing conditions and minimum attachment required so that material is placed in the proper location in the field.

1.4 DESIGN

In the absence of ordinances or specifications to the contrary, all designs prepared by the **specifying professional** shall be in accordance with the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

1.5 RESPONSIBILITY FOR DESIGN AND ERECTION

When Material requirements are specified, the Seller shall assume no responsibility other than to furnish the items listed in Section 5.2 (a). When Material requirements are not specified, the Seller shall furnish the items listed in Section 5.2 (a) in accordance with Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption, and this code. Pertinent design information shall be provided to the Seller as stipulated in Section 6.1. The Seller shall identify material by showing size and type. In no case shall the Seller assume any responsibility for the erection of the item furnished.

1.6 PERFORMANCE TEST FOR K-SERIES STEEL JOIST CONSTRUCTION

When performance tests on a structure are required, joists in the test panel shall have bridging and top deck applied as used. In addition to the full dead load, the test panel shall sustain for one hour a test load of 1.65 times the nominal live load. After this test load has been removed for a minimum of 30 minutes, the remaining deflection shall not exceed 20% of the deflection caused by the test load. The weight of the test panel itself shall constitute the dead load of the construction and shall include the weight of the joists, bridging, top deck, slab, ceiling materials, etc. The nominal live load shall be the live load specified and in no case shall it be more than the published joist capacity less the dead load. The cost of such tests shall be borne by the purchaser.

SECTION 2. JOISTS AND ACCESSORIES

2.1 STEEL JOISTS AND JOIST GIRDERS

Steel joists and Joist Girders shall carry the designations and meet the requirements of the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

K-Series joists are furnished with parallel chords only, and with minimum standard end bearing depth of 2 1/2 inches (64 mm).

LH- and **DLH-**Series joists are furnished either underslung or square ended, with top chords either parallel, pitched one way or pitched two ways. Underslung types are furnished with standard end bearing depth of 5 inches (127 mm) for

LH-Series. **DLH**-Series are furnished with standard end bearing depths of 5 inches (127 mm) for section numbers thru 17 and 7 1/2 inches (191 mm) for section numbers 18 and 19. The standard pitch is 1/8 inch in 12 inches (1:96). The nominal depth of a pitched Longspan Joist is taken at the center of the span.

Joist Girders are furnished either underslung or square ended with top chords either parallel, pitched one way or pitched two ways. Underslung types are furnished with a standard end bearing depth of 7 1/2 inches (191 mm). The standard pitch is 1/8 inch in 12 inches (1:96). The nominal depth of a pitched Joist Girder is taken at the center of the span.

Because **LH-** and **DLH-**Series joists may have exceptionally high end reactions, it is recommended that the supporting structure be designed to provide a nominal minimum unit bearing pressure of 750 pounds per square inch (5171 kilo Pascal).

2.2 JOIST LOCATION AND SPACING

The maximum joist spacing shall be in accordance with the requirements of the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

Where sidewalls, wall beams or tie beams are capable of supporting the floor slab or roof deck, the first adjacent joists may be placed one full space from these members. Joists are provided with camber and may have a significant difference in elevation with respect to the adjacent structure because of this camber. This difference in elevation should be given consideration when locating the first joist adjacent to a side wall, wall beam or tie beam.

Open Web Steel Joists, **K**-Series, should be placed no closer than 6 inches (152 mm) to supporting walls or members. Where partitions occur parallel to joists, there shall be at least one joist provided under each such partition, and more than one such joist shall be provided if necessary to safely support the weight of such partition and the adjacent floor, less the live load, on a strip of floor one foot (305 mm) in width. When partitions occur perpendicular to the joists, they shall be treated as concentrated loads, and joists shall be investigated as indicated in Section 6.1.

2.3 SLOPED END BEARINGS

Where steel joists or Joist Girders are sloped, beveled ends or sloped end bearings may be provided where the slope exceeds 1/4 inch in 12 inches (1:48). When sloped end bearings are required, the seat depths shall be adjusted to maintain the standard height at the shallow end of the sloped bearing. For Open Web Steel Joists, **K**-Series, bearing ends will not be beveled for slopes of 1/4 inch or less in 12 inches (1:48).

2.4 EXTENDED ENDS

Steel joist extended ends shall be in accordance with Manufacturer's Standard and shall meet the requirements of — Appendix B.

2.5 CEILING EXTENSIONS

Ceiling extensions shall be furnished to support ceilings which are to be attached to the bottom of the joists. They are not furnished for the support of suspended ceilings. The ceiling extension shall be either an extended bottom chord element or a loose unit, whichever is standard with the manufacturer, and shall be of sufficient strength to properly support the ceiling.

TABLE 2.6-1a
K-SERIES JOISTS
MAXIMUM JOIST SPACING FOR HORIZONTAL BRIDGING

	BRIDGING MATERIAL SIZE						
	Round Rod	**Equal Leg Angles**					
SECTION NUMBER*	1/2" round (13 mm) r = 0.13" (3.30 mm)	1 x 7/64 (25 mm x 3 mm) r = 0.20" (5.08 mm)	1-1/4 x 7/64 (32 mm x 3 mm) r = 0.25" (6.35 mm)	1-1/2 x 7/64 (38 mm x 3 mm) r = 0.30" (7.62 mm)	1-3/4 x 7/64 (45 mm x 3 mm) r = 0.35" (8.89 mm)	2 x 1/8 (52 mm x 3 mm) r = 0.40" (10.16 mm)	2-1/2 x 5/32 (64 mm x 4 mm) r = 0.50" (12.70 mm)
1 – 9	3'- 3" (991 mm)	5'- 0" (1524 mm)	6'- 3" (1905 mm)	7'- 6" (2286 mm)	8'- 7" (2616 mm)	10'- 0" (3048 mm)	12'- 6" (3810 mm)
10	3'- 0" (914 mm)	4'- 8" (1422 mm)	6'- 3" (1905 mm)	7'- 6" (2286 mm)	8'- 7" (2616 mm)	10'- 0" (3048 mm)	12'- 6" (3810 mm)
11–12	2'- 7" (787 mm)	4'- 0" (1219 mm)	5'- 8" (1727 mm)	7'- 6" (2286 mm)	8'- 7" (2616 mm)	10'- 0" (3048 mm)	12'- 6" (3810 mm)

* Refer to last digit(s) of Joist Designation
* * Connection to Joist must resist a nominal unfactored 700 pound force (3114 N)

TABLE 2.6-1b
LH-SERIES JOISTS
MAXIMUM JOIST SPACING FOR HORIZONTAL BRIDGING
SPANS OVER 60 ft. (18.3 m) REQUIRE BOLTED DIAGONAL BRIDGING

SECTION NUMBER*	**BRIDGING ANGLE SIZE – (EQUAL LEG ANGLE)					
	1 x 7/64 (25 mm x 3 mm) r = 0.20" (5.08 mm)	1-1/4 x 7/64 (32 mm x 3 mm) r = 0.25" (6.35 mm)	1-1/2 x 7/64 (38 mm x 3 mm) r = 0.30" (7.62 mm)	1-3/4 x 7/64 (45 mm x 3 mm) r = 0.35" (8.89 mm)	2 x 1/8 (52 mm x 3 mm) r = 0.40" (10.16 mm)	2-1/2 x 5/32 (64 mm x 4 mm) r = 0.50" (12.70 mm)
02, 03, 04	4' – 7" (1397 mm)	6' – 3" (1905 mm)	7' – 6" (2286 mm)	8' – 9" (2667 mm)	10' – 0" (3048 mm)	12' – 4" (3759 mm)
05 – 06	4' – 1" (1245 mm)	5' – 9" (1753 mm)	7' – 6" (2286 mm)	8' – 9" (2667 mm)	10' – 0" (3048 mm)	12' – 4" (3759 mm)
07 – 08	3' – 9" (1143 mm)	5' – 1" (1549 mm)	6' – 8" (2032 mm)	8' – 6" (2590 mm)	10' – 0" (3048 mm)	12' – 4" (3759 mm)
09 – 10		4' – 6" (1372 mm)	6' – 0" (1829 mm)	7' – 8" (2337 mm)	10' – 0" (3048 mm)	12' – 4" (3759 mm)
11 – 12		4' – 1" (1245 mm)	5' – 5" (1651 mm)	6' – 10" (2083 mm)	8' – 11" (2718 mm)	12' – 4" (3759 mm)
13 – 14		3' – 9" (1143 mm)	4' – 11" (1499 mm)	6' – 3" (1905 mm)	8' – 2" (2489 mm)	12' – 4" (3759 mm)
15 – 16			4' – 3" (1295 mm)	5' – 5" (1651 mm)	7' – 1" (2159 mm)	11' – 0" (3353 mm)
17			4' – 0" (1219 mm)	5' – 1" (1549 mm)	6' – 8" (2032 mm)	10' – 5" (3175 mm)

* Refer to last two digits of Joist Designation

** Connection to Joist must resist force listed in Table 104.5-1

2.6 BRIDGING AND BRIDGING ANCHORS

(a) Bridging standard with the manufacturer and complying with the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption shall be used for bridging all joists furnished by the manufacturer. Positive anchorage shall be provided at the ends of each bridging row at both top and bottom chords.

(b) For **K-** and **LH-**Series Joists horizontal bridging is recommended for spans up to and including 60 feet (18.3 m) except where the Steel Joist Institute Standard Specifications Load Tables & Weight Tables require bolted diagonal bridging for erection stability.

LH- and **DLH-**Series Joists exceeding 60 feet (18.3 m) in length shall have bolted diagonal bridging for all rows.

Refer to Section 6 in the **K-**Series Specifications and Section 105 in the **LH-** and **DLH-**Series Specifications for erection stability requirements.

Refer to Appendix E for OSHA steel joist erection stability requirements.

Horizontal bridging shall consist of continuous horizontal steel members. The ℓ/r ratio for horizontal bridging shall not exceed 300. The material sizes shown in Tables 2.6-1a and 2.6-1b meet the criteria.

(c) Diagonal cross bridging consisting of angles or other shapes connected to the top and bottom chords, of **K-**, **LH-** and **DLH-**Series Joists shall be used when required by the applicable Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

Diagonal bridging, when used, shall have an ℓ/r ratio not exceeding 200.

When the bridging members are connected at their point of intersection, the material sizes listed in Table 2.6-2 will meet the above specification.

(d) When bolted diagonal erection bridging is required, the following shall apply:

1. The bridging shall be indicated on the joist placement plan.
2. The joist placement plan shall be the exclusive indicator for the proper placement of this bridging.
3. Shop installed bridging clips, or functional equivalents, shall be provided where the bridging bolts to the steel joist.
4. When two pieces of bridging are attached to the steel joist by a common bolt, the nut that secures the first piece of bridging shall not be removed from the bolt for the attachment of the second piece.
5. Bridging attachments shall not protrude above the top chord of the steel joists.

TABLE 2.6-2
K, LH AND DLH SERIES JOISTS
MAXIMUM JOIST SPACING FOR DIAGONAL BRIDGING

JOIST DEPTH	**BRIDGING ANGLE SIZE – (EQUAL LEG ANGLE)				
	1 x 7/64 (25 mm x 3 mm) r = 0.20" (5.08 mm)	1-1/4 x 7/64 (32 mm x 3 mm) r = 0.25" (6.35 mm)	1-1/2 x 7/64 (38 mm x 3 mm) r = 0.30" (7.62 mm)	1-3/4 x 7/64 (45 mm x 3 mm) r = 0.35" (8.89 mm)	2 x 1/8 (50 mm x 3 mm) r = 0.40" (10.16 mm)
12" (305 mm)	6' – 6" (1981 mm)	8' – 3" (2514 mm)	9' – 11" (3022 mm)	11' – 7" (3530 mm)	
14" (356 mm)	6' – 6" (1981 mm)	8' – 3" (2514 mm)	9' – 11" (3022 mm)	11' – 7" (3530 mm)	
16" (406 mm)	6' – 6" (1981 mm)	8' – 2" (2489 mm)	9' – 10" (2997 mm)	11' – 6" (3505 mm)	
18" (457 mm)	6' – 6" (1981 mm)	8' – 2" (2489 mm)	9' – 10" (2997 mm)	11' – 6" (3505 mm)	
20" (508 mm)	6' – 5" (1955 mm)	8' – 2" (2489 mm)	9' – 10" (2997 mm)	11' – 6" (3505 mm)	
22" (559 mm)	6' – 4" (1930 mm)	8' – 1" (2463 mm)	9' – 10" (2997 mm)	11' – 6" (3505 mm)	
24" (610 mm)	6' – 4" (1930 mm)	8' – 1" (2463 mm)	9' – 9" (2971 mm)	11' – 5" (3479 mm)	
26" (660 mm)	6' – 3" (1905 mm)	8' – 0" (2438 mm)	9' – 9" (2971 mm)	11' – 5" (3479 mm)	
28" (711 mm)	6' – 2" (1879 mm)	8' – 0" (2438 mm)	9' – 8" (2946 mm)	11' – 5" (3479 mm)	
30" (762 mm)	6' – 2" (1879 mm)	7' – 11" (2413 mm)	9' – 8" (2946 mm)	11' – 4" (3454 mm)	
32" (813 mm)	6' – 1" (1854 mm)	7' – 10" (2387 mm)	9' – 7" (2921 mm)	11' – 4" (3454 mm)	13' – 0" (3962 mm)
36" (914 mm)		7' – 9" (2362 mm)	9' – 6" (2895 mm)	11' – 3" (3429 mm)	12' – 11" (3973 mm)
40" (1016 mm)		7' – 7" (2311 mm)	9' – 5" (2870 mm)	11' – 2" (3403 mm)	12' – 10" (3911 mm)
44" (1118 mm)		7' – 5" (2260 mm)	9' – 3" (2819 mm)	11' – 0" (3352 mm)	12' – 9" (3886 mm)
48" (1219 mm)		7' – 3" (2209 mm)	9' – 2" (2794 mm)	10' – 11" (3327 mm)	12' – 8" (3860 mm)
52" (1321 mm)			9' – 0" (2743 mm)	10' – 9" (3276 mm)	12' – 7" (3835 mm)
56" (1422 mm)			8' – 10" (2692 mm)	10' – 8" (3251 mm)	12' – 5" (3784 mm)
60" (1524 mm)			8' – 7" (2616 mm)	10' – 6" (3200 mm)	12' – 4" (3759 mm)
64" (1626 mm)			8' – 5" (2565 mm)	10' – 4" (3149 mm)	12' – 2" (3708 mm)
68" (1727 mm)			8' – 2" (2489 mm)	10' – 2" (3098 mm)	12' – 0" (3657 mm)
72" (1829 mm)			8' – 0" (2438 mm)	10' – 0" (3048 mm)	11' – 10" (3606 mm)

MINIMUM A307 BOLT REQUIRED FOR CONNECTION

SERIES	*SECTION NUMBER	BOLT DIAMETER
K	ALL	3/8" (10 mm)
LH, DLH	2 - 12	3/8" (10 mm)
LH, DLH	13 - 17	1/2" (13 mm)
DLH	18 and 19	5/8" (16 mm)

*Refer to last digit(s) of Joist Designation

2.7 HEADERS

Headers for Open Web Steel Joists, **K**-Series as outlined and defined in Section 5.2 (a) shall be furnished by the Seller. Such headers shall be any type standard with the manufacturer. Conditions involving headers shall be investigated and, if necessary, provisions made to provide a safe condition. Headers are not provided for Longspan Steel Joists, **LH**-Series, and Deep Longspan Steel Joists, **DLH**-Series.

2.8 BOTTOM CHORD LATERAL BRACING FOR JOIST GIRDERS

Bottom chord lateral bracing may be furnished to prevent lateral movement of the bottom chord of the Joist Girder and to prevent the ratio of chord length to chord radius of gyration from exceeding that specified in the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption. The lateral bracing shall be that which is standard with the manufacturer, and shall be sufficient to properly brace the bottom chord of the Joist Girder.

SECTION 3.
MATERIALS

3.1 STEEL

The steel used in the manufacture of joists and Joist Girders shall comply with the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

3.2 PAINT

(a) Standard Shop Paint - The shop coat of paint, when specified, shall comply with the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption.

(b) Disclaimer - The typical shop applied paint that is used to coat steel joists and Joist Girders is a dip applied, air dried paint. The paint is intended to be an impermanent and provisional coating which will protect the steel for only a short period of exposure in ordinary atmospheric conditions.

Since most steel joists and Joist Girders are painted using a standard dip coating, the coating may not be uniform and may include drips, runs, and sags. Compatibility of any coating including fire protective coatings applied over a standard shop paint shall be the responsibility of the specifier and/or painting contractor.

The shop applied paint may require field touch-up/repair as a result of, but not limited to, the following:

1. Abrasions from: Bundling, banding, loading and unloading, chains, dunnage during shipping, cables and chains during erection, bridging, installation, and other handling at the jobsite.

   NOTE: Rusting should be expected at any abrasion.
2. Dirt.
3. Diesel smoke.
4. Road salt.
5. Weather conditions during storage.

The joist manufacturer shall not be responsible for the condition of the paint if it is not properly protected after delivery.

SECTION 4.
INSPECTION

Inspections shall be made in accordance with the Steel Joist Institute Standard Specifications Load Tables & Weight Tables Section 5.12 for **K**-Series, Section 104.13 for **LH**- and **DLH**-Series, and Section 1004.10 for Joist Girders.

SECTION 5.
ESTIMATING

5.1 PLANS FOR BIDDING

Plans to serve as the basis for bids shall show the character of the work with sufficient clarity to permit making an accurate estimate and shall show the following:

Designation and location of Materials (See Section 5.2 [a]), including any special design or configuration requirements.

Locations and elevations of all steel and concrete supporting members and bearing walls.

Location and length of joist extended ends.

Location and size of all openings in floors and roofs.

Location of all partitions.

Loads and their locations as defined in Section 6.1.

Construction and thickness of floor slabs, roof deck, ceilings and partitions.

Joists or Joist Girders requiring extended bottom chords.

Paint, if other than manufacturer's standard.

5.2 SCOPE OF ESTIMATE

(a) Unless otherwise specified, the following items shall be included in the estimate, and requirements shall be determined as outlined in Section 6.1.

Steel Joists.

Joist Girders.

Joist Substitutes.

Joist Extended Ends.

Ceiling Extensions.

Extended bottom chord used as strut.

Bridging and bridging anchors.

Joist Girder bottom chord bracing.

Headers which are defined as members supported by and carrying Open Web Steel Joists, **K**-Series.

One shop coat of paint, when specified, shall be in accordance with Section 3.2.

(b) The following items shall not be included in the estimate but may be quoted and identified by the joist manufacturer as separate items:

Headers for Longspan Steel Joists, **LH**-Series.

Headers for Deep Longspan Steel Joists, **DLH**-Series.

Reinforcement in slabs over joists.

Centering material, decking, and attachments.

Miscellaneous framing between joists for openings at ducts, dumbwaiters, ventilators, skylights, etc.

Loose individual or continuous bearing plates and bolts or anchors for such plates.

Erection bolts for joist and Joist Girder end anchorage.

Horizontal bracing in the plane of the top and bottom chords from joist to joist or joist to structural framing and walls.

Wood nailers.

Moment plates.

Special joist configuration or bridging layouts for ductwork or sprinkler systems.

Shear Studs.

SECTION 6.

PLANS AND SPECIFICATIONS

6.1 PLANS FURNISHED BY BUYER

The Buyer shall furnish the Seller plans and specifications as prepared by the **specifying professional** showing all Material requirements and steel joist and/or steel Joist Girder designations, the layout of walls, columns, beams, girders and other supports, as well as floor and roof openings and partitions correctly dimensioned. The live loads to be used, the wind uplift if any, the weights of partitions and the location and amount of any special loads, such as monorails, fans, blowers, tanks, etc., shall be indicated. The elevation of finished floors, roofs, and bearings shall be shown with due consideration taken for the effects of dead load deflections.

(a) Loads -

The Steel Joist Institute does not presume to establish the loading requirements for which structures are designed.

The Steel Joist Institute Load Tables are based on uniform loading conditions and are valid for use in selecting joist sizes for gravity loads that can be expressed in terms of "pounds per linear foot" (kiloNewtons per Meter) of joist. The Steel Joist Institute Joist Girder Weight Tables are based on uniformly spaced panel point loading conditions and are valid for use in selecting Joist Girder sizes for gravity conditions that can be expressed in kips (kiloNewtons) per panel point on the Joist Girder.

The **specifying professional** shall provide the nominal loads and load combinations as stipulated by the applicable code under which the structure is designed and shall provide the design basis (ASD or LRFD).

The **specifying professional** shall calculate and provide the magnitude and location of ALL JOIST and JOIST GIRDER LOADS. This includes all special loads (drift loads, mechanical units, net uplift, axial loads, moments, structural bracing loads, or other applied loads) which are to be incorporated into the joist or Joist Girder design. For Joist Girders, reactions from supported members shall be clearly denoted as point loads on the Joist Girder. When necessary to clearly convey the information, a Load Diagram or Load Schedule shall be provided.

The **specifying professional** shall give due consideration to the following loads and load effects:

1. Ponded rain water.
2. Accumulation of snow in the vicinity of obstructions such as penthouses, signs, parapets, adjacent buildings, etc.
3. Wind.
4. Type and magnitude of end moments and/or axial forces at the joist and Joist Girder end supports shall be shown on the structural drawings. For moment resisting joists or Joist Girders framing near the end of a column, due consideration shall be given to extend the column length to allow a plate type connection between the top of the joist or Joist Girder top chord and the column.

   Avoid resolving joist or Joist Girder end moments and axial forces through the bearing seat connection.

   A note shall be provided on the structural drawings stating that all moment resisting joists shall have all dead loads applied to the joist before the bottom chord struts are welded to the supporting connection whenever the moments provided do not include dead load.

   The top and bottom chord moment connection details shall be designed by the **specifying professional**. The joist designer shall furnish the **specifying professional** with the joist detail information if requested.

The nominal loads, as determined by the **specifying professional**, shall not be less than that specified in the applicable building codes.

Where concentrated loads occur, the magnitude and location of these concentrated loads shall be shown on the **structural drawings** when, in the opinion of the **specifying professional**, they may require consideration by the joist manufacturer.

The **specifying professional** shall use one of the following options that allows the:

- Estimator to price the joists.
- Joist manufacturer to design the joists properly.
- Owner to obtain the most economical joists.

Option 1: Select a Standard Steel Joist Institute joist for the uniform design loading and provide the load and location of any additional loads on the structural plan with a note "Joist manufacturer shall design joists for additional loads as shown". This option works well for a few added loads per joist with known locations.

Option 2: Select a KCS joist using moment and end reaction. This option works well for concentrated loads for which exact locations are not known or for multiple loading. See examples and limitations on the pages accompanying the KCS Joist Load Tables.

a) Determine the maximum moment

b) Determine the maximum end reaction (shear)

c) Select the required KCS joist that provides the required moment and end reaction (shear).

Option 3: Specify a SPECIAL joist with load diagrams. This option is preferred when the joist includes loading that cannot clearly be denoted on the structural drawings.

a) Provide a load diagram to clearly define ALL loads

b) Place the designation (i.e. 18K SP or 18LH SP) under the load diagram with the following note: "Joist manufacturer to design joist to support loads as shown above".

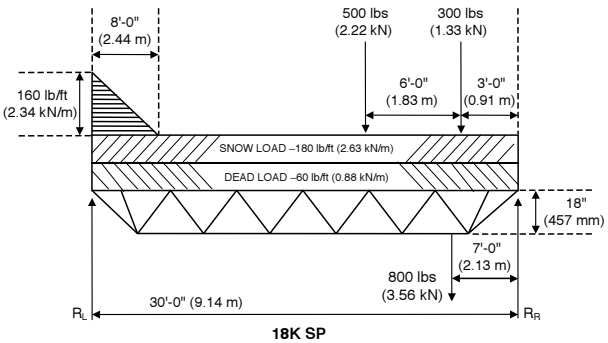
CAUTION: The **specifying professional** shall compare the equivalent uniform loads derived from the maximum moment and shear to the uniform loads tabulated in the **K**-Series Load Table. An equivalent unfactored uniform load in excess of 550 plf (8020 N/m) or a maximum unfactored end reaction exceeding 9200 lbs (40.9 kN) indicates that the **specifying professional** shall consider using additional joists to reduce the loading or use an **LH**-Series Joist and make provisions for 5 inch (127 mm) deep bearing seats.

SPECIAL LOADING : Please note the load combinations shown are for referenced examples only and it is not to be presumed that the joist designer is responsible for the applicable building code load combinations. If the loading criteria are too complex to adequately communicate in a simple load diagram, then the specifying professional shall provide a load schedule showing the specified design loads, load categories, and required load combinations with applicable load factors.

ASD EXAMPLE:

U.S. CUSTOMARY UNITS AND (METRIC UNITS)

Load diagram per ASCE 7 2.4.1(3) D + S

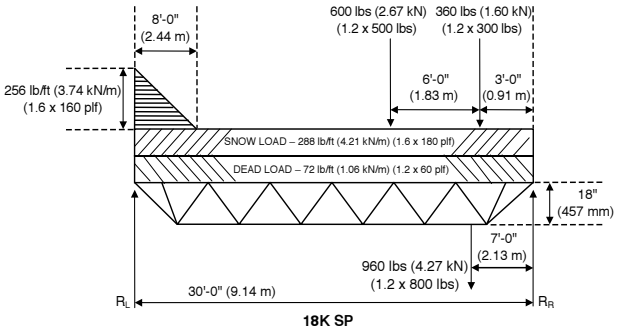


Joist manufacturer to design joist to support loads as shown above.

LRFD EXAMPLE:

U.S. CUSTOMARY UNITS AND (METRIC UNITS)

Factored Load diagram per ASCE 7 2.3.2(3) 1.2D + 1.6S



Joist manufacturer to design joist to support **factored loads** as shown.

(b) Connections -

Minimum End Anchorage for simple span gravity loading shall be in accordance with Steel Joist Institute Standard Specifications Load Tables & Weight Tables Section 5.6 for **K**-Series, Section 104.4 for **LH**- and **DLH**-Series, and Section 1004.6 for Joist Girders. The **specifying professional** is responsible for the design of the joist and Joist Girder connection when it is subject to any loads other than simple span gravity loading including uplift and lateral loads. The **specifying professional** is also responsible for bridging termination connections. The contract documents must clearly illustrate these connections.

(c) Special Considerations

The **specifying professional** shall indicate on the construction documents special considerations including:

a) Profiles for non-standard joist and Joist Girder configurations (Standard joist and Joist Girder configurations are as indicated in the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption).

b) Oversized or other non-standard web openings

c) Extended ends

d) Deflection criteria for live and total loads for non-SJI standard joists

e) Non-SJI standard bridging

6.2 PLANS FURNISHED BY SELLER

The Seller shall furnish the Buyer with steel joist placement plans to show the Material as specified on the construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 6.1. Steel placement plans shall include, at a minimum, the following:

1. Listing of all applicable loads as stated in Section 6.1 and used in the design of the steel joists and Joist Girders as specified in the construction documents.

2. Profiles for non-standard joist and Joist Girder configurations (Standard joist and Joist Girder configurations are as indicated in the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption).
3. Connection requirements for:
   a) Joists supports
   b) Joist Girder supports
   c) Field splices
   d) Bridging attachments
4. Deflection criteria for live load and total loads for non-SJI standard joists.
5. Size, location, and connections for all bridging
6. Joists headers

All Material shall be identified with its mark which also appears on the bill of material. The shop paint shall be as noted on the joist placement plans. **Steel joist placement plans do not require the seal and signature of the joist manufacturer's registered design professional.**

6.3 DISCREPANCIES

The specifying professional's bid plans and specifications will be assumed to be correct in the absence of written notice from the Buyer to the contrary. When plans are furnished by the Buyer which do not agree with the Architect's bid plans, such detailed plans shall be considered as a written notice of change of plans. However, it shall be the Buyer's responsibility to advise the Seller of those changes which affect the joists or Joist Girders.

6.4 APPROVAL

When joist placement plans are furnished by the Seller, prints thereof are submitted to the Buyer and owner for examination and approval. The Seller allows a maximum of fourteen (14) calendar days in their schedule for the return of placement plans noted with the owner's and customer's approval, or approval subject to corrections as noted. The Seller makes the corrections, furnishes corrected prints for field use to the owner/customer and is released by the owner/customer to start joist manufacture.

Approval by the owner/customer of the placement plans, sections, notes and joist schedule prepared by the Seller indicates that the Seller has correctly interpreted the contract requirements, and is released by the owner/customer to start joist manufacture. This approval constitutes the owner's/customer's acceptance of all responsibility for the design adequacy of any detail configuration of joist support conditions shown by the Seller as part of the preparation of these placement plans.

Approval does not relieve the Seller of the responsibility for accuracy of detail dimensions on the plans, nor the general fit-up of joists to be placed in the field.

6.5 CHANGES

When any changes in plans are made by the buyer (or the buyers representative) either prior to or after approval of detailed plans, or when any Material is required and was not shown on the plans used as the basis of the bid, the cost of such changes and/or extra Material shall be paid by the Buyer at a price to be agreed upon between Buyer and Seller.

6.6 CALCULATIONS

The seller shall design the steel joists and/or steel Joist Girders in accordance with the current Steel Joist Institute Standard Specifications Load Tables & Weight Tables to support the load requirements of Section 6.1. The **specifying professional** may require submission of the steel joist and Joist Girder calculations as prepared by a registered design professional responsible for the product design. If requested by the **specifying professional**, the steel joist manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's registered design professional. In addition to standard calculations under this seal and signature, submittal of the following shall be included:

1. Non-SJI standard bridging details (e.g. for cantilevered conditions, net uplift, etc.)
2. Connection details for:
   a) Non-SJI standard connections (e.g. flush framed or framed connections)
   b) Field splices
   c) Joist headers

SECTION 7.*
HANDLING AND ERECTION

The current OSHA SAFETY STANDARDS FOR STEEL ERECTION, 29 CFR PART 1926, SUBPART R- STEEL ERECTION, refers to certain joists at or near columns to be designed with sufficient strength to allow one employee to release the hoisting cable without the need for erection bridging. **This STANDARD shall not be interpreted that any joist at or near a column line is safe to support an employee without bridging installed.** Many limitations exist that prevent these joists from being designed to safely allow an employee on an un-bridged joist. Because of these limitations these joists must be erected by incorporating erection methods ensuring joist stability and either:

1) Installing bridging or otherwise stabilizing the joist prior to releasing the hoisting cable, or
2) Releasing the hoisting cable without having a worker on the joist.

A steel joist or Joist Girder shall not be placed on any support structure unless such structure is stabilized. When steel joists or Joist Girders are landed on a structure, they shall be secured to prevent unintentional displacement prior to installation.

A bridging terminus point shall be established before joist bridging is installed.

Steel joist and Joist Girders shall not be used as anchorage points for a fall arrest system unless written directions to do so is obtained from a "qualified person"[1].

No modification that affects the strength of a steel joist or Joist Girder shall be made without the written approval of the project engineer of record.

The Buyer and/or Erector shall check all materials on arrival at job site and promptly report to Seller any discrepancies and/or damages. The Buyer and/or Erector shall comply with the requirements of the Steel Joist Institute Standard Specifications Load Tables & Weight Tables of latest adoption in the handling and erection of Material.

The Seller shall not be responsible for the condition of paint finish on Material if it is not properly protected after delivery.

The Seller shall not be responsible for improper fit of Material due to inaccurate construction work.

* For thorough coverage of this topic, refer to SJI Technical Digest #9, "Handling and Erection of Steel Joists and Joist Girders".

(1) See Appendix E for OSHA definition of a qualified person.

SECTION 8.
BUSINESS RELATIONS

8.1 PRESENTATION OF PROPOSALS

All proposals for furnishing Material shall be made on a Sales Contract Form. After acceptance by the Buyer, these proposals must be approved or executed by a qualified official of the Seller. Upon such approval the proposal becomes a contract.

8.2 ACCEPTANCE OF PROPOSALS

All proposals are intended for prompt acceptance and are subject to change without notice.

8.3 BILLING

Contracts on a lump sum basis are to be billed proportionately as shipments are made.

8.4 PAYMENT

Payments shall be made in full on each invoice without retention.

8.5 ARBITRATION

All business controversies which cannot be settled by direct negotiations between Buyer and Seller shall be submitted to arbitration. Both parties shall sign a submission to arbitration and if possible agree upon an arbitrator. If they are unable to agree, each shall appoint an arbitrator and these two shall appoint a third arbitrator. The expenses of the arbitration shall be divided equally between the parties, unless otherwise provided for in the agreements to submit to arbitration. The arbitrators shall pass final judgment upon all questions, both of law and fact, and their findings shall be conclusive.

REFERENCED SPECIFICATIONS, CODES AND STANDARDS

The following documents are referenced in the Open Web Steel Joists, K-Series, Longspan and Deep Longspan Steel Joists, LH-and DLH-Series and Joist Girder Specifications:

American Institute of Steel Construction, Inc. (AISC) (2005), *Specification for Structural Steel Buildings,* Chicago, IL.

American Iron and Steel Institute (AISI) (2001), *North American Specification for Design of Cold-Formed Steel Structural Members,* Washington, D.C.

American Society of Civil Engineers (ASCE) (2002), *Minimum Design Loads for Buildings and Other Structures,* ASCE 7-02, Reston, VA.

American Society of Testing and Materials (2004), ASTM A6/A6M-04b, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A36/A36M-04, Standard Specification for Carbon Structural Steel, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A242/242M-04, Standard Specification for High-Strength Low-Alloy Structural Steel, West Conshohocken, PA.

American Society of Testing and Materials (2004), A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength, West Conshohocken, PA.

American Society of Testing and Materials (2003), ASTM A370-03a, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A529/A529M-04, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A572/A572M-04, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A588/A588M-04, Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A606-04, Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A1008/A1008M-04b, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, West Conshohocken, PA.

American Society of Testing and Materials (2004), ASTM A1011/A1011M-04a, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, West Conshohocken, PA.

American Welding Society, AWS A5.1-2004, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding, Miami, FL.

American Welding Society, AWS A5.5-96, Specification for Low Alloy Steel Electrodes for Shielded Metal Arc Welding, Miami, FL.

American Welding Society, AWS A5.17-97, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding, Miami, FL.

American Welding Society, AWS A5.18-2001, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding, Miami, FL.

American Welding Society, AWS A5.20-95, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding, Miami, FL.

REFERENCED SPECIFICATIONS, CODES AND STANDARDS

American Welding Society, AWS A5.23-97, Specification for Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding, Miami, FL.

American Welding Society, AWS A5.28-96, Specification for Low Alloy Steel Filler Metals for Gas Shielded Arc Welding, Miami, FL.

American Welding Society, AWS A5.29-98, Specification for Low Alloy Steel Electrodes for Flux Cored Arc Welding, Miami, FL.

Federal Register, Department of Labor, Occupational Safety and Health Administration (2001), 29 CFR Part 1926 Safety Standards for Steel Erection; Final Rule, §1926.757 Open Web Steel Joists - January 18, 2001, Washington, D.C.

Fire Resistance Directory – Volume 1 (2004), Underwriters Laboratories Inc., Chicago, IL.

Steel Joist Institute (SJI) (2006), Technical Digest #3, *Structural Design of Steel Joist Roofs to Resist Ponding Loads,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (1988), Technical Digest #5, *Vibration of Steel Joist-Concrete Slab Floors,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (2006), Technical Digest #6, *Structural Design of Steel Joist Roofs to Resist Uplift Loads,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (1983), Technical Digest #8, *Welding of Open Web Steel Joists,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (2006), Technical Digest #9, *Handling and Erection of Steel Joists and Joist Girders,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (2003), Technical Digest #10, *Design of Fire Resistive Assemblies with Steel Joists,* Myrtle Beach, SC.

Steel Joist Institute (SJI) (1999), Technical Digest #11, *Design of Joist-Girder Frames*, Myrtle Beach, SC.

Steel Structures Painting Council (SSPC) (2000), *Steel Structures Painting Manual, Volume 2, Systems and Specifications,* Paint Specification No. 15, Steel Joist Shop Primer, May 1, 1999, Pittsburgh, PA.

GLOSSARY

NOTES:

Terms in **Bold** and their definitions come from the AISC AND AISI STANDARD Standard Definitions for Use in the Design of Steel Structures, 2004 Edition, First Printing April 2005.

* These terms are usually qualified by the type of *load effect*, e.g., nominal tensile strength, available compressive strength, design flexural strength.

** Term usually qualified by the type of component, e.g. local web buckling, local flange buckling, etc.

Accessories. Structural components related to the design, fabrication and erection of *joists* and *Joist Girders* including, but not limited to sloped *end bearings, extended ends, ceiling extensions, bridging* and bridging anchors, *headers* and bottom chord lateral bracing for *Joist Girders*.

ASD (Allowable Strength Design). Method of proportioning structural components such that the *allowable strength* equals or exceeds the *required strength* of the component under the action of the *ASD load combinations*.

ASD Load Combination. *Load* combination in the *applicable building code* intended for allowable *strength design* (allowable stress design).

Allowable Strength*. *Nominal strength* divided by the safety factor, R_n/Ω.

Applicable Building Code. Building code under which the structure is designed.

Available Strength*. *Design strength* or *allowable strength* as appropriate.

Bay. The distance between the main structural frames or walls of a building.

Bearing. The distance that the bearing shoe or seat of a *joist* or *Joist Girder* extends over its masonry, concrete or steel support.

Bearing Plate. The steel plate used for a *joist* or *Joist Girder* to bear on when it is supported by masonry or concrete supports. The plate is designed by the *Specifying Professional* to carry the *joist* reaction to the supporting structure.

Bottom Chord Extension (BCX). The two angle extended part of a *joist* bottom chord from the first bottom chord panel point towards the end of the joist.

Bridging. In general, a member connected to a joist to brace it from lateral movement. See also Diagonal Bridging and Horizontal Bridging

Buckling. *Limit state* of sudden change in the geometry of a structure or any of its elements under a critical loading condition.

Buckling Strength. *Nominal strength* for *buckling* or instability *limit states*.

Buyer. The entity that has agreed to purchase *material* from the manufacturer and has also agreed to the terms of sale.

Camber. An upward curvature of the chords of a *joist* or *Joist Girder* induced during shop fabrication. Note this is in addition to the pitch of the top chord.

Ceiling Extension. A *bottom chord extension* except that only one angle of the *joist* bottom chord is extended from the first bottom chord panel point towards the end of the joist.

Chords. The top and bottom members of a *joist* or *Joist Girder*. When a chord is comprised of two angles there is usually a gap between the members.

Clear Span. The actual clear distance or opening between supports for a joist, that is the distance between walls or the distance between the edges of flanges of beams.

Cold-Formed Steel Structural Member. Shape manufactured by press-braking blanks sheared from sheets, cut lengths of coils or plates, or by roll forming cold- or hot-rolled coils or sheets; both forming operations being performed at ambient room temperature, that is, without manifest addition of heat such as would be required for hot forming.

Collateral Load. All additional dead loads other than the weight of the building, such as sprinklers, pipes, ceilings, and mechanical or electrical components.

Connection. Combination of structural elements and *joints* used to transmit forces between two or more members. See also Splice.

Deck. A floor or roof covering made out of gage metal attached by welding or mechanical means to *joists*, beams, *purlins*, or other structural members and can be galvanized, painted, or unpainted.

Design Load. Applied load determined in accordance with either *LRFD load combinations* or *ASD load combinations*, whichever is applicable.

Design Strength*. *Resistance factor* multiplied by the *nominal strength*, ϕR_n.

Diagonal Bridging. Two angles or other structural shapes connected from the top chord of one *joist* to the bottom chord of the next joist to form an 'X' shape. These members are almost always connected at their point of intersection.

Diaphragm. Roof, floor or other membrane or bracing system that transfers in-plane forces to the lateral force resisting system.

Effective Length. Length of an otherwise identical column with the same strength when analyzed with pin-ended boundary conditions.

Elastic Analysis. *Structural analysis* based on the assumption that the structure returns to its original geometry on removal of the *load*.

End Diagonal or Web. The first web member on either end of a joist or Joist Girder which begins at the top chord at the seat and ends at the first bottom chord panel point.

Erector. The entity that is responsible for the safe and proper erection of the *materials* in accordance with all applicable codes and regulations.

Extended End. The extended part of a joist top chord with the seat angles also being extended from the end of the joist extension back into the joist and maintaining the standard end *bearing* depth over the entire length of the extension.

Factored Load. Product of a *load factor* and the *nominal load*.

Filler. A rod, plate or angle welded between a two angle web member or between a top or bottom chord panel to tie them together, usually located at the middle of the member.

Flexural Buckling. Buckling mode in which a compression member deflects laterally without twist or change in cross-sectional shape.

Flexural-Torsional Buckling. Buckling mode in which a compression member bends and twists simultaneously without change in cross-sectional shape.

Girt. Horizontal structural member that supports wall panels and is primarily subjected to bending under horizontal loads, such as wind load.

Gravity Load. *Load*, such as that produced by dead and live loads, acting in the downward direction.

Header. A structural member located between two *joists* or between a joist and a wall which carries another joist or joists. It is usually made up of an angle, channel, or beam with saddle angle connections on each end for bearing.

Horizontal Bridging. A continuous angle or other structural shape connected to the top and bottom chord of a joist.

Inelastic Analysis. *Structural analysis* that takes into account inelastic material behavior, including plastic analysis.

Instability. *Limit state* reached in the loading of a *structural component*, frame or structure in which a slight disturbance in the loads or geometry produces large displacements.

Joint. Area where two or more ends, surfaces or edges are attached. Categorized by type of fastener or weld used and the method of force transfer.

Joist. A structural load-carrying member with an open web system which supports floors and roofs utilizing hot-rolled or cold-formed steel and is designed as a simple span member. Currently, the SJI has the following joist designations: K-Series including KCS, LH-Series and DLH-Series.

Joist Girder. A primary structural load-carrying member with an open web system designed as a simple span supporting equally spaced concentrated loads of a floor or roof system acting at the panel points of the member and utilizing hot-rolled or cold-formed steel.

Joist Substitute. A structural member who's intended use is for very short spans (10 feet or less) where open web steel joists are impractical. They are usually used for short spans in skewed bays, over corridors or for outriggers. It can be made up of two or four angles to form channel sections or box sections.

Lateral Buckling. Buckling mode of a flexural member involving deflection normal to the plane of bending.

Lateral-Torsional Buckling. Buckling mode of a flexural member involving deflection normal to the plane of bending occurring simultaneously with twist about the shear center of the cross section.

Limit State. Condition in which a structure or component becomes unfit for service and is judged either to be no longer useful for its intended function (*serviceability limit state*) or to have reached its ultimate load-carrying capacity (*strength limit state*).

Load. Force or other action that results from the weight of building materials, occupants and their possessions, environmental effects, differential movement, or restrained dimensional changes.

Load Effect. Forces, stresses, and deformations produced in a *structural component* by the applied loads.

Load Factor. Factor that accounts for deviations of the *nominal load* from the actual *load*, for uncertainties in the analysis that transforms the *load* into a *load effect*, and for the probability that more than one extreme *load* will occur simultaneously.

Local Buckling**. *Limit state* of *buckling* of a compression element within a cross section.

LRFD (Load and Resistance Factor Design). Method of proportioning *structural components* such that the *design strength* equals or exceeds the *required strength* of the component under the action of the LRFD load *combinations*.

LRFD Load Combination. Load combination in the *applicable building code* intended for strength design *(Load and Resistance Factor Design)*.

Material. *Joists*, *Joist Girders* and accessories as provided by the *Seller*.

Nailers. Strips of lumber attached to the top chord of a *joist* so plywood or other flooring can be nailed directly to the *joist*.

Nominal Load. Magnitude of the load specified by the *applicable building code*.

Nominal Strength*. Strength of a structure or component (without the *resistance factor or safety factor* applied) to resist the *load effects*, as determined in accordance with these *Standard Specifications*.

Owner. The entity that is identified as such in the Contract Documents.

Permanent Load. *Load* in which variations over time are rare or of small magnitude. All other *loads* are *variable loads*.

Placement Plans. Drawings that are prepared depicting the interpretation of the Contract Documents requirements for the *material* to be supplied by the *Seller*. These floor and/or roof plans are approved by the *Specifying Professional*, *Buyer* or *Owner* for conformance with the design requirements. The *Seller* uses the information contained on these drawings for final material design. A unique piece mark number is typically shown for the individual placement of *joists*, *Joist Girders* and accessories along with sections that describe the *end bearing* conditions and minimum attachment required so that *material* is placed in the proper location in the field.

Ponding. Retention of water at low or irregular areas on a roof due solely to the deflection of flat roof framing.

Purlin. Horizontal structural member that supports roof deck and is primarily subjected to bending under vertical loads such as dead, snow or wind loads.

Quality Assurance. System of shop and field activities and controls implemented by the *owner* or his/her designated representative to provide confidence to the *owner* and the building authority that quality requirements are implemented.

Quality Control. System of shop and field controls implemented by the *seller* and *erector* to ensure that contract and company fabrication and erection requirements are met.

Required Strength*. Forces, stress, and deformations produced in a *structural component*, determined by either *structural analysis*, for the *LRFD* or *ASD load combinations*, as appropriate, or as specified by these *Standard Specifications*.

Resistance Factor, ϕ. Factor that accounts for unavoidable deviations of the *nominal strength* from the actual strength and for the manner and consequences of failure.

Safety Factor, Ω. Factor that accounts for deviations of the actual strength from the *nominal strength*, deviations of the actual load from the *nominal load*, uncertainties in the analysis that transforms the load into a load effect and for the manner and consequences of failure.

Seller. A company certified by the Joist Institute engaged in the manufacture and distribution of *joists*, *Joist Girders* and accessories.

Service Load. Load under which serviceability limit states are evaluated.

Serviceability Limit State. Limiting condition affecting the ability of a structure to preserve its appearance, maintainability, durability, or the comfort of its occupants or function of machinery, under normal usage.

Slenderness Ratio. The ratio of the effective length of a column to the radius of gyration of the column about the same axis of bending.

Span. The centerline-to-centerline distance between structural steel supports such as a beam, column or *Joist Girder* or the *clear span* distance plus four inches onto a masonry or concrete wall.

Specified Minimum Yield Stress. Lower limit of *yield stress* specified for a material as defined by ASTM.

Specifying Professional. The licensed professional who is responsible for sealing the building Contract Documents, which indicates that he or she has performed or supervised the analysis, design and document preparation for the structure and has knowledge of the load-carrying structural system.

Splice. *Connection* between two structural members joined at their ends by either bolting or welding to form a single, longer member.

Stability. Condition reached in the loading of a *structural component*, frame or structure in which a slight disturbance in the loads or geometry does not produce large displacements.

Stabilizer Plate. A steel plate at a column or wall inserted between the end of a bottom *chord of a joist or Joist Girder*.

Standard Specifications. Documents developed and maintained by the Steel Joist Institute for the design and manufacture of open web steel joists and Joist Girders. The term "SJI Standard Specifications" encompass by reference the following:

ANSI/SJI-K-1.1 Standard Specifications for Open Web Steel Joists, **K-Series;** ANSI/SJI-LH/DLH-1.1 Standard Specifications for Longspan Steel Joists, **LH-Series** and Deep Longspan Steel Joists, **DLH-Series;** and ANSI/SJI-JG-1.1 Standard Specifications for **Joist Girders**.

Strength Limit State. Limiting condition affecting the safety of the structure, in which the ultimate load-carrying capacity is reached.

Structural Analysis. Determination of *load effects* on members and connections based on principles of structural mechanics.

Structural Drawings. The graphic or pictorial portions of the Contract Documents showing the design, location and dimensions of the work. These documents generally include plans, elevations, sections, details, connections, all loads, schedules, diagrams and notes.

Tagged End. The end of a *joist* or *Joist Girder* where an identification or piece mark is shown by a metal tag. The member must be erected with this tagged end in the same position as the tagged end noted on the *placement plan*.

Tensile Strength (of material). Maximum tensile stress that a material is capable of sustaining as defined by ASTM.

Tie Joist. A *joist* that is bolted at a column.

Top Chord Extension (TCX). The extended part of a *joist* top chord. This type of extension only has the two top chord angles extended past the joist seat.

Torsional Buckling. *Buckling* mode in which a compression member twists about its shear center axis.

Unbraced Length. Distance between braced points of a member, measured between the centers of gravity of the bracing members.

Variable Load. *Load* not classified as *permanent load*.

Webs. The vertical or diagonal members joined at the top and bottom *chords* of a *joist* or *Joist Girder* to form triangular patterns.

Yield Point. First stress in a material at which an increase in strain occurs without an increase in stress as defined by ASTM.

Yield Strength. Stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain as defined by ASTM.

Yield Stress. Generic term to denote either *yield point or yield strength*, as appropriate for the material.

FIRE-RESISTANCE RATINGS WITH STEEL JOISTS

The Underwriters Laboratories (U.L.) Fire Resistance Directory lists hundreds of assemblies and their fire resistance ratings. The Specifying Professional can choose between numerous Floor-Ceiling and Roof-Ceiling assemblies that include steel joists and Joist Girders.

As a convenience, a selected number of assemblies are listed on the following pages. In addition, the Steel Joist Institute's Technical Digest #10 "Design of Fire Resistive Assemblies with Steel Joists" has a complete listing of steel joist assemblies and additional information about fire ratings. However, the listing that follows and the Technical Digest are intended as a guide only, and the Specifying Professional must refer to the current U.L. Fire Resistance Directory for complete design requirements.

Hundreds of fire tests on steel joist-supported assemblies have been conducted at nationally recognized testing laboratories in accordance with ASTM Standard E119, ANSI A2.1/UL 263, and NFPA 251. Because of practical loading restrictions and limitations of furnace dimensions, the vast majority of these tests were run using lightweight joists – normally from 8 inches to 14 inches (203 mm to 356 mm) deep. This practice was advantageous in that it established the minimum acceptable joists at the shallow and lightweight end of the joist load tables. This also resulted in a specified minimum joist designation being listed in the U.L. Fire Resistance Assembly, which is the joist that combines the required minimum depth and minimum weight per foot. Joists of the same series which equal or exceed the specified minimum joist depth and joist weight per foot may be used provided the accessories are compatible. The dimension from the bottom chord of the joists to the ceiling, whether given or calculated, is a minimum.

Where a U.L. Fire Resistance Assembly is being utilized, the Specifying Professional shall indicate the assembly number being used on the structural contract drawings. In addition, the Specifying Professional shall consider the following, as applicable:

- Joist designations specified on the structural contract drawings shall not be less than the minimum size for that assembly. The assembly may also require a minimum bridging size that may be larger than required by the SJI Specifications for the particular designation and joist spacing.
- Some assemblies stipulate minimum size materials or minimum cross sectional areas for individual joist and Joist Girder components. It is the responsibility of the Specifying Professional to show all special requirements on the contract drawings.
- Note that the maximum joist spacing shown for Floor-Ceiling Assemblies may be increased from the spacing listed in the U.L. Fire Resistance Directory to a maximum of 48 inches on center, provided the floor slab meets the structural requirements and the spacing of hanger wires supporting the ceiling is not increased.
- Some assemblies stipulate an allowable maximum joist design stress level less than the 30 ksi (207 MPa) used in the joist and Joist Girder Specifications. It is the responsibility of the Specifying Professional to apply the proper stress level reductions (when applicable) when selecting joists and/or Joist Girders. This is accomplished by prorating the joist and/or Joist Girder capacities. To adjust the stress level of joists or Joist Girders, multiply the design load by the ratio of the joist design stress to the required maximum [e.g. 30/26 (207/179), 30/24 (207/165), 30/22 (207/152)], and then using this increased load, select a joist or Joist Girder from the load and/or weight tables.
- Some U.L. Roof-Ceiling Assemblies using direct applied protection limit the spacing of the joists for certain types and gages of metal decking – refer to the U.L. Fire Resistance Directory for this information.
- Where fire protective materials are to be applied directly to the steel joists or Joist Girders, it is often desired to have the joist furnished as unpainted. The Specifying Professional should indicate on the structural contract drawings if the joists or Joist Girders are to be painted or not.
- Certain older U.L. fire rated assemblies may refer to joist series that predate the K-Series joists. Where one of these assemblies is selected, refer to the U.L Fire Resistance Directory for special provisions for substituting a K-Series joist in lieu of an S-, J-, and/or H-Series joist.

FLOOR – CEILING ASSEMBLIES WITH MEMBRANE PROTECTION

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Concrete		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Minimum Thickness (in.)	Type			
1 Hr.	Acoustical	12K1, 18LH02	2.5	LW, NW	NL	20G@13plf W8 x 15	D216
							D219
	Exposed Grid	10K1	2.5	NW	72	20G@14plf* W6 x 12	G205
		10K1	2		72	W6 x 12	G208
		10K1	2.5		72	20G@14plf* W6 x 12	G256
	Gypsum Board	10K1	2.5	NW	48	W8 x 24	G548
1 1/2 Hr.	Acoustical	12K1, 18LH02	2.5	LW, NW	NL	20G@13plf W8 x 15	D216
							D219
	Gypsum Board			NW		20G@20plf W8 x 28	D502
	Exposed Grid	10K1	2.5	NW	24 (48)	20G@13plf W6 x 12	G203
		10K1	2.5		72	20G@14plf* W6 x 12	G205
		10K1	2		72	W6 x 12	G208
		10K1	2.5		24 (48)		G213
		10K1	2.5		24 (48)	20G@13plf W8 x 31	G228
		10K1	2		24 (48)	20G@13plf W8 x 24	G229
		10K1	2.5		24 (48)	20G@13plf W6 x 12	G243
		10K1	2.5		24 (48)	20G@13plf W8 x 31	G268
	Gypsum Board	12K1	2	NW	24 (48)	NS	G502
2 Hr.	Acoustical	12K1, 18LH02	2.5	LW, NW	NL	20G@13plf W8 x 15	D216
							D219
	Gypsum Board			NW		20G@20plf W8 x 28	D502
	Concealed Grid	10K1	2.25	NW	24 (48)	W6 x 25	G023
		8K1	2.5		24 (48)	20G@13plf W8 x 20	G031
		10K1			30 (48)	20G@13plf W10 x 21	G036
	Exposed Grid	10K1	2.5	NW	24 (48)	20G@13plf W6 x 12	G203
		10K1	2.5		72	20G@14plf* W6 x 12	G205
		10K1	2.5		72	W6 x 12	G208
		10K1	2.5		24 (48)		G213
		10K1	2.5		24 (48)	W8 x 31	G227
		10K1	2.5		24 (48)	20G@13plf W8 x 31	G228

FLOOR – CEILING ASSEMBLIES WITH MEMBRANE PROTECTION

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Concrete		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Minimum Thickness (in.)	Type			
2 Hr.	Exposed Grid	10K1	2.5	NW	24 (48)	20G@13plf W8 x 24	G229
		10K1	2.5		24 (48)	20G@13plf W6 x 12	G243
		10K1	2.5		72	20G@14plf* W6 x 12	G256
		10K1	2.5		24 (48)	20G@13plf W8 x 31	G268
	Gypsum Board	10K1	2	NW	24 (48)	NS	G505
		10K1	2.5		24 (48)	20G@14plf* W8 x 31	G514
		10K1	2.5		24 (48)	20G@13plf W10 x 21	G523
		10K1	2.5		24 (48)	20G@13plf W8 x 24	G529
		10K1	2.5		24 (48)	20G@13plf W10 x 21	G547
3 Hr.	Acoustical	12K1, 18LH02	3.25	LW, NW	NL	20G@13plf W8 x 15	D216
							D219
	Concealed Grid	10K1	3.5	NW	24 (48)	20G@13plf W8 x 20	G033
		10K1	3.25		30 (48)	20G@13plf W10 x 21	G036
	Exposed Grid	10K1	3.5	NW	48	20G@14plf* W6 x 12	G205
		10K1	3.5		24 (48)	W6 x 12	G213
		10K1	3.25		24 (48)	20G@13plf W8 x 24	G229
		10K1	3.5		48	20G@14plf* W6 x 12	G256
		10K1 (22 ksi max.)	2.63		24 (48)	20G@13plf W8 x 31	G268
	Gypsum Board	10K1	3	NW	24 (48)	20G@13plf W10 x 21	G523
		10K1	2.75		24 (48)	20G@13plf W8 x 24	G529
		10K1	3		24 (48)	20G@13plf W10 x 21	G547

* Special Area Requirements
NL = Not Listed
NS = Not Specified

FLOOR – CEILING ASSEMBLIES WITH SPRAY APPLIED FIRE RESISTIVE MATERIALS

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Concrete		Maximum Joist Spacing	Minimum Primary Support Member	UL Design Number
			Minimum Thickness (in.)	Type			
1 Hr.	SAFRM	NS	2.5	LW, NW	NL	W8 x 28	D759
		10K1	2.5				D779
		10K1	2.5				D780
		NS	3.25	LW			D782
		10K1*	2.5	LW			D925
			3.5	NW			
		16K6*	NS	LW, NW	42	20G@20plf W8 x 28	G701
		16K6	3	LW	50.5	NS	G702
			3.75	NW			
		16K6*	2.5	LW, NW	42	NS	G705
		16K6	3	LW	50.5	NS	G706
			3.75	NW			
		16K6*	2.5	LW, NW	42	20G@20plf W8 x 28	G708
		NS	2.5		42	W8 x 28	G709
		16K6*	2.5		42	20g@20plf W8 x 24	G801
		12K1	3	LW	50.5	NS	G802
			3.75	NW			
1 1/2 Hr.	SAFRM	NS	2.5	LW, NW	NL	W8 x 28	D759
		10K1	2.5				D779
		10K1	2.5				D780
		NS	3.25	LW			D782
		10K1*	3	LW			D925
			4	NW			
		16K6*	2.5	LW, NW	42	20G@20plf W8 x 28	G701
		16K6	3.5	LW	50.5	NS	G702
			4.5	NW			
		16K6*	2.5	LW, NW	42	NS	G705
		16K6	3.5	LW	50.5	NS	G706
			4.5	NW			
		16K6*	2.5	LW, NW	42	20G@20plf W8 x 28	G708
		NS	2.5		42	W8 x 28	G709
		16K6*	2.5		42	20G@20plf W8 x 24	G801
		12K5	3.5	LW	50.5	NS	G802
			4.5	NW			

FLOOR – CEILING ASSEMBLIES WITH SPRAY APPLIED FIRE RESISTIVE MATERIALS

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Concrete		Maximum Joist Spacing	Minimum Primary Support Member	UL Design Number
			Minimum Thickness (in.)	Type			
2 Hr.	SAFRM	NS	2.5	LW, NW	NL	W8 x 28	D759
		10K1	2.5				D779
		10K1	2.5				D780
		NS	3.25	LW			D782
		10K1*	3.25	LW			D925
			4.5	NW			
		16K6*	2.5	LW, NW	42	20G@20plf W8 x 28	G701
		16K6	4	LW	50.5	NS	G702
			5.25	NW			
		16K6*	2.5	LW,NW	42	NS	G705
		16K6	4	LW	50.5	NS	G706
			5.25	NW			
		16K6*	2.5	LW, NW	42	20G@20plf W8 x 28	G708
		NS	2.5		42	W8 x 28	G709
		16K6*	2.5		42	20G@20plf W8 x 24	G801
		12K5	4	LW	50.5	NS	G802
			5.25	NW			
3 Hr.	SAFRM	NS	2.5	LW, NW	NL	W8 x 28	D759
		10K1	2.5				D779
		10K1	2.5				D780
		NS	3.25	LW			D782
		10K1*	4.19	LW			D925
			5.25	NW			
		16K6*	NS	LW, NW	42	20G@20plf W8 x 28	G701
		16K6*	2.75		42	NS	G705
		16K6*	2.75		42	20G@20plf W8 x 28	G708
		NS	2.75		42	W8 x 28	G709
		16K6*	2.75		42	20G@20plf W8 x 24	G801
4 Hr.	SAFRM	10K1	2.5	LW, NW	NL	W8 x 28	D779
		NS	3.25	LW			D782

* Special Area Requirements
NL = Not Listed
NS = Not Specified

ROOF – CEILING ASSEMBLIES WITH MEMBRANE PROTECTION

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Built Up Roof		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Deck Material Description	Insulation			
1 Hr.	Exposed Grid	12K1	22 MSG Min.	Fiber Board	84	W8 x 17	P201
		10K1	26 MSG Min.		48	W6 x 12	P202
		10K1	26 MSG Min.		48	20G@13plf	P211
		12K3	28 MSG Min.		72	20G@13plf W8 x 17	P214
		12K1	26 MSG Min.		72	20G@13plf W6 x 12	P225
		12K3	24 MSG Min.	Building Units	48	NS	P227
		12K3	26 MSG Min.	Fiber Board	72	20G@13plf W6 x 12	P230
		12K1	26 MSG Min.	Insulating Concrete	48	20G@14plf* W8 x 15	P231
		12K3	24 MSG Min.	Foamed Plastic	72	W8 x 15	P235
		10K1	28 MSG Min.	Insulating Concrete	72	20G@13plf W8 x 15	P246
		12K5	26 MSG Min.	Fiber Board	48	W6 x 12	P250
		12K1	28 MSG Min.	Insulating Concrete	72	20G@13plf W6 x 12	P251
		10K1	22 MSG Min.	Fiber Board	72	W6 x 12	P254
		10K1	28 MSG Min.	Insulating Concrete	72	W8 x 15	P255
		10K1	24 MSG Min.	Fiber Board	72	NS	P259
		12K1	28 MSG Min.	Insulating Concrete	72	20G@13plf W6 x 12	P261
		12K1	26 MSG Min.	Insulating Concrete	72	20G@14plf* W8 x 15	P264
		10K1	Metal Roof Deck Panels	Batts and Blankets	60	NS	P265
		10K1	26 MSG Min.	Fiber Board	48	W6 x 16	P267
		10K1	Metal Roof Deck Panels	Batts and Blankets	60	NS	P268
		12K1	26 MSG Min.	Insulating Concrete	72	20G@14plf* W8 x 15	P269
	Fiber Board	10K1	24 MSG Min.	Fiber Board	NS	W6 x 16	P301
		10K1	22 MSG Min.		48	NS	P302
		10K1	22 MSG Min.		NS	W6 x 16	P303
	Gypsum Board	12K3	26 MSG Min.	Insulating Concrete	60	W8 x 24	P509
		12K3	24 MSG Min.	Fiber Board	72	20G@13plf W8 x 13	P510
		10K1	20 MSG Min.	Fiber Board	48	NS	P519

ROOF – CEILING ASSEMBLIES WITH MEMBRANE PROTECTION

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Built Up Roof		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Deck Material Description	Insulation			
1 1/2 Hr.	Exposed Grid	12K1	26 MSG Min.	Fiber Board	72	20G@13plf W6 x 12	P225
		12K3	24 MSG Min.	Building Units	48	NS	P227
		12K3	26 MSG Min.	Fiber Board	48	20G@13plf W6 x 12	P230
		12K1	26 MSG Min.	Insulating Concrete	48	20G@14plf* W8 x 24	P231
		12K5	26 MSG Min.	Fiber Board	48	W6 x 12	P250
		12K1	28 MSG Min.	Insulating Concrete	72	20G@13plf W6 x 12	P251
		10K1	24 MSG Min.	Fiber Board	72	NS	P259
		10K1	Metal Roof Deck Panels	Batts and Blankets	60	NS	P265
		10K1	20 MSG Min.	Fiber Board	48	NS	P266
		10K1	Metal Roof Deck Panels	Batts and Blankets	60	NS	P268
		12K1	26 MSG Min.	Insulating Concrete	72	20G@14plf* W8 x 24	P269
	Fiber Board	10K1	24 MSG Min.	Fiber Board	NS	W6 x 16	P301
	Metal Lath	12K5	22 MSG Min.	Fiber Board	72	NS	P404
	Gypsum Board	12K3	24 MSG Min.	Fiber Board	72	20G@13plf W8 x 13	P510
2 Hr.	Exposed Grid	10K1	24 MSG Min.	Fiber Board	72	W6 x 12	P237
		12K1	28 MSG Min.	Insulating Concrete	72	20G@13plf W6 x 12	P251
		10K1	20 MSG Min.	Fiber Board	48	NS	P266
	Fiber Board	10K1	24 MSG Min.	Fiber Board	NS	W6 x 16	P301
	Metal Lath	12K5	22 MSG Min.	Fiber Board	72	NS	P404
	Gypsum Board	10K1	22 MSG Min.	Fiber Board	72	20G@13plf	P514
			20 MSG Min.		48	NS	P519
		14K1	26 MSG Min.	Insulating Concrete	66	NS	P520
3 Hr.	Metal Lath	10K1	28 MSG Min.	Insulating Concrete	48	NS	P405

* Special Area Requirements
NL = Not Listed
NS = Not Specified

ROOF – CEILING ASSEMBLIES WITH SPRAY APPLIED FIRE RESISTIVE MATERIALS

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Built Up Roof		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Deck Material Description	Insulation			
1 Hr.	SAFRM	10K1	22 MSG Min.	Building Units	NS	NS	P822
		12K3	22 MSG Min.	Fiber Board	NS	W8 x 20	P824
1 Hr. and 1-1/2 Hr.	SAFRM	12K5	28 MSG Min.	Insulating Concrete	96	W6 x 16	P919
1-1/2 Hr. and 2 Hr.	SAFRM	10K1	22 MSG Min.	Building Units	NS	W6 x 16	P728
1 Hr., 1-1/2 Hr. and 2 Hr.	SAFRM	14K4	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P701
		14K4	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P711
		12K3	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P717
		10K1	22 MSG Min.	Foamed Plastic	NS	20G@13plf W8 x 28	P725
		10K1	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P726
		14K4	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P734
		14K4	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P736
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P739
		10K1	22 MSG Min.	Fiber Board	NS	W6 x 16	P740
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P743
		12K3	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P801
		10K1	22 MSG Min.	Fiber Board	NS	20G@13plf W6 x 16	P815
		10K1	22 MSG Min.	Fiber Board	NS	W6 x 16	P816
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P819
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P825
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P827
		12K1	22 MSG Min.	Fiber Board	NS	20G@13plf W8 x 20	P828
		10K1	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P902
		10K1	28 MSG Min.	Insulating Concrete	NS	W8 x 10	P907
		10K1	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P908

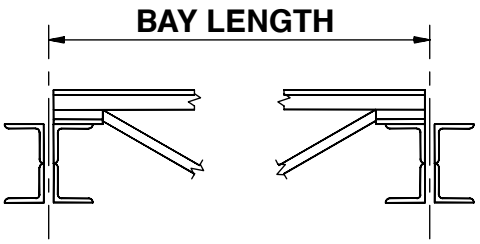
ROOF – CEILING ASSEMBLIES WITH SPRAY APPLIED FIRE RESISTIVE MATERIALS

Restrained Assembly Rating	Protection Material	Minimum Joist Size	Built Up Roof		Maximum Joist Spacing (in.)	Minimum Primary Support Member	UL Design Number
			Deck Material Description	Insulation			
1 Hr., 1-1/2 Hr. and 2 Hr.	SAFRM	10K1	28 MSG Min.	Insulating Concrete	NS	W8 x 10	P920
		12K5	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P921
		10K1	28 MSG Min.	Insulating Concrete	NS	W6 x 16	P922
		10K1	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P923
		10K1	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P925
		12K5	28 MSG Min.	Insulating Concrete	NS	W8 x 10	P926
		14K4	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P927
		12K5	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P928
		12K3	28 MSG Min.	Insulating Concrete	NS	20G@13plf W8 x 10	P929
		10K1	28 MSG Min.	Insulating Concrete	NS	W6 x 16	P936
2 Hr.	SAFRM	12K3	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P718
		12K3	22 MSG Min.	Foamed Plastic	NS	20G@13plf W6 x 16	P720
		12K3	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P729
1 Hr., 1-1/2 Hr., 2 Hr. and 3 Hr.	SAFRM	10K1	22 MSG Min.	Foamed Plastic	NS	20G@13plf W6 x 16	P719
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P722
		10K1	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P723
		10K1	22 MSG Min.	Foamed Plastic	NS	W8 x 28	P732
		10K1*,16K2	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P733
		10K1*	22 MSG Min.	Foamed Plastic	NS	W6 x 16	P826

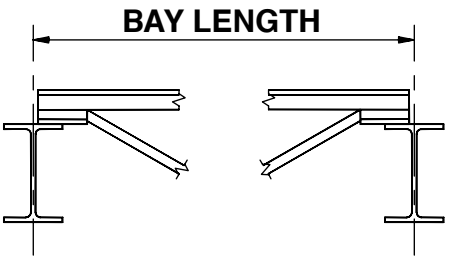
* Special Area Requirements
NS = Not Specified

OSHA SAFETY STANDARDS FOR STEEL ERECTION

BAY LENGTH DEFINITIONS



JOIST GIRDERS



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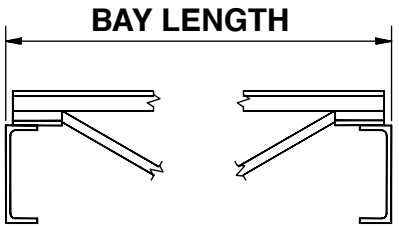

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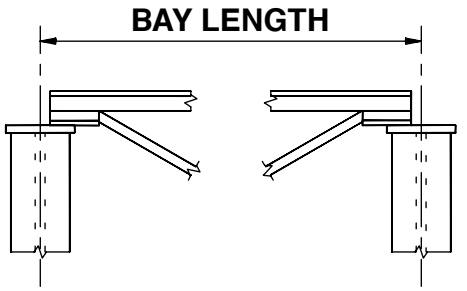
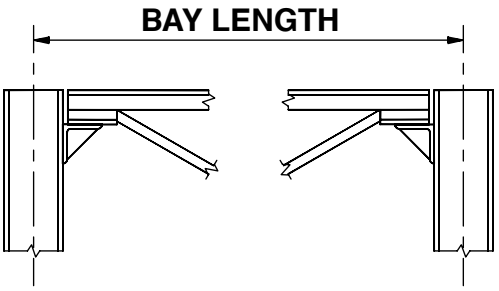


STEEL COLUMN



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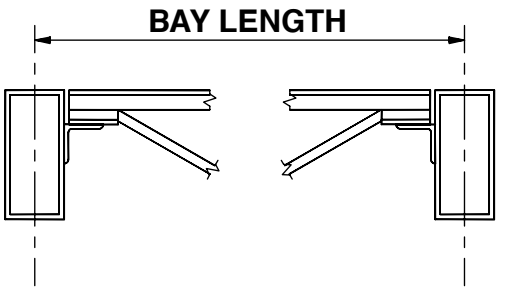

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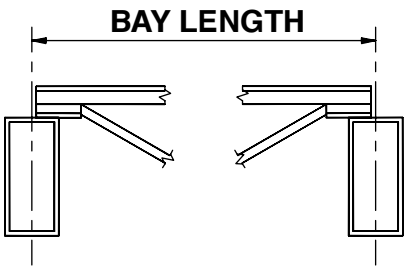

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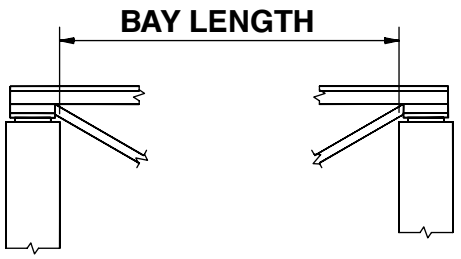
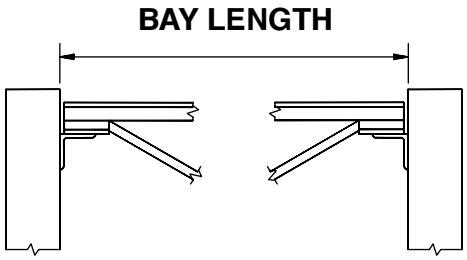


MASONRY OR TILT-UP



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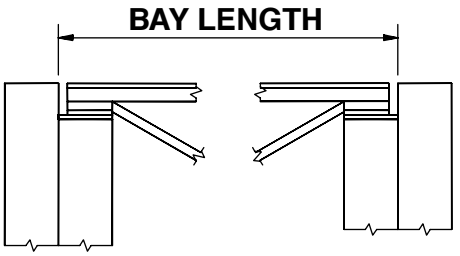
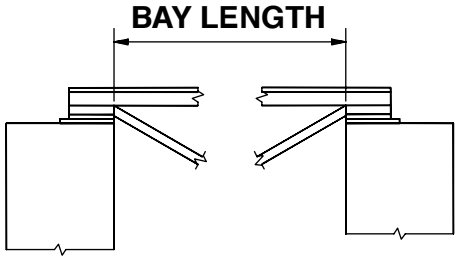


MASONRY WITH PILASTER



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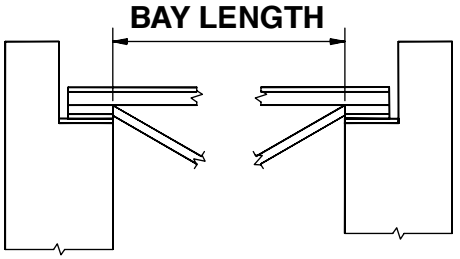

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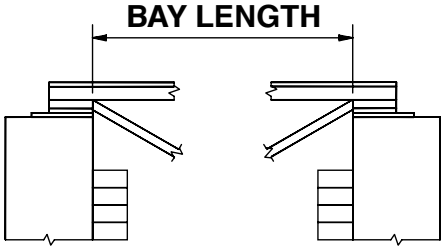


MASONRY WITH FACE BRICK

§ 1926.751 DEFINITIONS
(Selected items only).

Anchored bridging means that the steel joist bridging is connected to a bridging terminus point.

Bolted diagonal bridging means diagonal bridging that is bolted to a steel joist or joists.

Bridging clip means a device that is attached to the steel joist to allow the bolting of the bridging to the steel joist.

Bridging terminus point means a wall, a beam, tandem joists (with all bridging installed and a horizontal truss in the plane of the top chord) or other element at an end or intermediate point(s) of a line of bridging that provides an anchor point for the steel joist bridging.

Column means a load-carrying vertical member that is part of the primary skeletal framing system. Columns do not include posts.

Constructibility means the ability to erect structural steel members in accordance with subpart R without having to alter the over-all structural design.

Construction load (for joist erection) means any load other than the weight of the employee(s), the joists and the bridging bundle.

Erection bridging means the bolted diagonal bridging that is required to be installed prior to releasing the hoisting cables from the steel joists.

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. A personal fall arrest system consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combination of these. The use of a body belt for fall arrest is prohibited.

Project structural engineer means the registered, licensed professional responsible for the design of structural steel framing and whose seal appears on the structural contract documents.

Qualified person (also defined in § 1926.32) means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

Steel joist means an open web, secondary load-carrying member of 144 feet (43.9 m) or less, designed by the manufacturer, used for the support of floors and roofs. This does not include structural steel trusses or cold-formed joists.

Steel joist girder means an open web, primary load-carrying member, designed by the manufacturer, used for the support of floors and roofs. This does not include structural steel trusses.

Structural steel means a steel member, or a member made of a substitute material (such as, but not limited to, fiberglass, aluminum or composite members). These members include, but are not limited to, steel joists, joist girders, purlins, columns, beams, trusses, splices, seats, metal decking, girts, and all bridging, and cold formed metal framing which is integrated with the structural steel framing of a building.

§ 1926.757 OPEN WEB STEEL JOISTS

(a) General.

(1) Except as provided in paragraph (a)(2) of this section, where steel joists are used and columns are not framed in at least two directions with solid web structural steel members, a steel joist shall be field-bolted at the column to provide lateral stability to the column during erection. For the installation of this joist:

(i) A vertical stabilizer plate shall be provided on each column for steel joists. The plate shall be a minimum of 6 inch by 6 inch (152 mm by 152 mm) and shall extend at least 3 inches (76 mm) below the bottom chord of the joist with a 13 /16 inch (21 mm) hole to provide an attachment point for guying or plumbing cables.

(ii) The bottom chords of steel joists at columns shall be stabilized to prevent rotation during erection.

(iii) Hoisting cables shall not be released until the seat at each end of the steel joist is field-bolted, and each end of the bottom chord is restrained by the column stabilizer plate.

(2) Where constructibility does not allow a steel joist to be installed at the column:

(i) an alternate means of stabilizing joists shall be installed on both sides near the column and shall:

(A) provide stability equivalent to paragraph (a)(1) of this section;

(B) be designed by a qualified person;

(C) be shop installed; and

(D) be included in the erection drawings.

(ii) hoisting cables shall not be released until the seat at each end of the steel joist is field-bolted and the joist is stabilized.

(3) Where steel joists at or near columns span 60 feet (18.3 m) or less, the joist shall be designed with sufficient strength to allow one employee to release the hoisting cable without the need for erection bridging.

(4) Where steel joists at or near columns span more than 60 feet (18.3 m), the joists shall be set in tandem with all bridging installed unless an alternative method of erection, which provides equivalent stability to the steel joist, is designed by a qualified person and is included in the site-specific erection plan.

(5) A steel joist or steel joist girder shall not be placed on any support structure unless such structure is stabilized.

(6) When steel joist(s) are landed on a structure, they shall be secured to prevent unintentional displacement prior to installation.

(7) No modification that affects the strength of a steel joist or steel joist girder shall be made without the approval of the project structural engineer of record.

(8) *Field-bolted joists*.

(i) Except for steel joists that have been pre-assembled into panels, connections of individual steel joists to steel structures in bays of 40 feet (12.2 m) or more shall be fabricated to allow for field bolting during erection.

(ii) These connections shall be field-bolted unless constructibility does not allow.

(9) Steel joists and steel joist girders shall not be used as anchorage points for a fall arrest system unless written approval to do so is obtained from a qualified person.

(10) A bridging terminus point shall be established before bridging is installed. (See Appendix C to this subpart.)

(b) Attachment of steel joists and steel joist girders.

(1) Each end of "K" series steel joists shall be attached to the support structure with a minimum of two 1/8 -inch (3 mm) fillet welds 1 inch (25 mm) long or with two 1/2 -inch (13 mm) bolts, or the equivalent.

(2) Each end of "LH" and "DLH" series steel joists and steel joist girders shall be attached to the support structure with a minimum of two 1/4 -inch (6 mm) fillet welds 2 inches (51 mm) long, or with two 3/4 -inch (19 mm) bolts, or the equivalent.

(3) Except as provided in paragraph (b)(4) of this section, each steel joist shall be attached to the support structure, at least at one end on both sides of the seat, immediately upon placement in the final erection position and before additional joists are placed.

(4) Panels that have been pre-assembled from steel joists with bridging shall be attached to the structure at each corner before the hoisting cables are released.

(c) Erection of steel joists.

(1) Both sides of the seat of one end of each steel joist that requires bridging under Tables A and B shall be attached to the support structure before hoisting cables are released.

(2) For joists over 60 feet, both ends of the joist shall be attached as specified in paragraph (b) of this section and the provisions of paragraph (d) of this section met before the hoisting cables are released.

(3) On steel joists that do not require erection bridging under Tables A and B, only one employee shall be allowed on the joist until all bridging is installed and anchored.

▶ NOTE: TABLES "A" & "B" HAVE BEEN EDITED TO CONFORM WITH STEEL JOIST INSTITUTE BOLTED DIAGONAL BRIDGING REQUIREMENTS.

▶ TABLE A. — ERECTION BRIDGING FOR SHORT SPAN JOISTS

Joist	Sp
8K1	NM
10K1	NM
12K1	23–0
12K3	NM
12K5	NM
14K1	27–0
14K3	NM
14K4	NM
14K6	NM
16K2	29–0
16K3	30–0
16K4	32–0
16K5	32–0
16K6	NM
16K7	NM
16K9	NM
18K3	31–0
18K4	32–0
18K5	33–0
18K6	35–0
18K7	NM
18K9	NM
18K10	NM
20K3	32–0
20K4	34–0
20K5	34–0
20K6	36–0
20K7	39–0
20K9	39–0
20K10	NM
22K4	34–0
22K5	35–0
22K6	36–0
22K7	40–0
22K9	40–0
22K10	NM
22K11	NM
24K4	36–0
24K5	38–0
24K6	39–0
24K7	43–0
24K8	43–0
24K9	44–0
24K10	NM
24K12	NM
26K5	38–0
26K6	39–0

NM = diagonal bolted bridging not mandatory

▶ TABLE A. — ERECTION BRIDGING FOR SHORT SPAN JOISTS (continued)

Joist	Span
26K7	43–0
26K8	44–0
26K9	44–0
26K10	49–0
26K12	NM
28K6	40–0
28K7	43–0
28K8	44–0
28K9	45–0
28K10	49–0
28K12	53–0
30K7	44–0
30K8	45–0
30K9	45–0
30K10	50–0
30K11	52–0
30K12	54–0
10KCS1	NM
10KCS2	NM
10KCS3	NM
12KCS1	NM
12KCS2	NM
12KCS3	NM
14KCS1	NM
14KCS2	NM
14KCS3	NM
16KCS2	NM
16KCS3	NM
16KCS4	NM
16KCS5	NM
18KCS2	35–0
18KCS3	NM
18KCS4	NM
18KCS5	NM
20KCS2	36–0
20KCS3	39–0
20KCS4	NM
20KCS5	NM
22KCS2	36–0
22KCS3	40–0
22KCS4	NM
22KCS5	NM
24KCS2	39–0
24KCS3	44–0
24KCS4	NM
24KCS5	NM
26KCS2	39–0
26KCS3	44–0
26KCS4	NM
26KCS5	NM
28KCS2	40–0
28KCS3	45–0
28KCS4	53–0
28KCS5	53–0
30KCS3	45–0
30KCS4	54–0
30KCS5	54–0

NM = diagonal bolted bridging not mandatory

▶ TABLE B. — ERECTION BRIDGING FOR LONG SPAN JOISTS

Joist	Span
18LH02	33–0
18LH03	NM
18LH04	NM
18LH05	NM
18LH06	NM
18LH07	NM
18LH08	NM
18LH09	NM
20LH02	33–0
20LH03	38–0
20LH04	NM
20LH05	NM
20LH06	NM
20LH07	NM
20LH08	NM
20LH09	NM
20LH10	NM
24LH03	35–0
24LH04	39–0
24LH05	40–0
24LH06	45–0
24LH07	NM
24LH08	NM
24LH09	NM
24LH10	NM
24LH11	NM
28LH05	42–0
28LH06	46–0
28LH07	54–0
28LH08	54–0
28LH09	NM
28LH10	NM
28LH11	NM
28LH12	NM
28LH13	NM
32LH06	47–0 through 60–0
32LH07	47–0 through 60–0
32LH08	55–0 through 60–0
32LH09	NM through 60–0
32LH10	NM through 60–0
32LH11	NM through 60–0
32LH12	NM through 60–0
32LH13	NM through 60–0
32LH14	NM through 60–0
32LH15	NM through 60–0
36LH07	47–0 through 60–0
36LH08	47–0 through 60–0
36LH09	57–0 through 60–0
36LH10	NM through 60–0
36LH11	NM through 60–0
36LH12	NM through 60–0
36LH13	NM through 60–0
36LH14	NM through 60–0
36LH15	NM through 60–0
40LH08	47–0 through 60–0
40LH09	47–0 through 60–0
44LH09	52–0 through 60–0

NM = diagonal bolted bridging not mandatory

(4) Employees shall not be allowed on steel joists where the span of the steel joist is equal to or greater than the span shown in Tables A and B except in accordance with § 1926.757(d).

(5) When permanent bridging terminus points cannot be used during erection, additional temporary bridging terminus points are required to provide stability. (See appendix C of this subpart.)

(d) Erection bridging.

(1) Where the span of the steel joist is equal to or greater than the span shown in Tables A and B, the following shall apply:

(i) A row of bolted diagonal erection bridging shall be installed near the midspan of the steel joist;

(ii) Hoisting cables shall not be released until this bolted diagonal erection bridging is installed and anchored; and

(iii) No more than one employee shall be allowed on these spans until all other bridging is installed and anchored.

(2) Where the span of the steel joist is over 60 feet (18.3 m) through 100 feet (30.5 m), the following shall apply:

(i) All rows of bridging shall be bolted diagonal bridging;

(ii) Two rows of bolted diagonal erection bridging shall be installed near the third points of the steel joist;

(iii) Hoisting cables shall not be released until this bolted diagonal erection bridging is installed and anchored; and

(iv) No more than two employees shall be allowed on these spans until all other bridging is installed and anchored.

(3) Where the span of the steel joist is over 100 feet (30.5 m) through 144 feet (43.9 m), the following shall apply:

(i) All rows of bridging shall be bolted diagonal bridging;

(ii) Hoisting cables shall not be released until all bridging is installed and anchored; and

(iii) No more than two employees shall be allowed on these spans until all bridging is installed and anchored.

(4) For steel members spanning over 144 feet (43.9 m), the erection methods used shall be in accordance with § 1926.756.

(5) Where any steel joist specified in paragraphs (c)(2) and (d)(1), (d)(2), and (d)(3) of this section is a bottom chord bearing joist, a row of bolted diagonal bridging shall be provided near the support(s). This bridging shall be installed and anchored before the hoisting cable(s) is released.

(6) When bolted diagonal erection bridging is required by this section, the following shall apply:

(i) The bridging shall be indicated on the erection drawing;

(ii) The erection drawing shall be the exclusive indicator of the proper placement of this bridging;

(iii) Shop-installed bridging clips, or functional equivalents, shall be used where the bridging bolts to the steel joists;

(iv) When two pieces of bridging are attached to the steel joist by a common bolt, the nut that secures the first piece of bridging shall not be removed from the bolt for the attachment of the second; and

(v) Bridging attachments shall not protrude above the top chord of the steel joist.

(e) Landing and placing loads.

(1) During the construction period, the employer placing a load on steel joists shall ensure that the load is distributed so as not to exceed the carrying capacity of any steel joist.

(2) Except for paragraph (e)(4) of this section, no construction loads are allowed on the steel joists until all bridging is installed and anchored and all joist-bearing ends are attached.

(3) The weight of a bundle of joist bridging shall not exceed a total of 1,000 pounds (454 kg). A bundle of joist bridging shall be placed on a minimum of three steel joists that are secured at one end. The edge of the bridging bundle shall be positioned within 1 foot (.30 m) of the secured end.

(4) No bundle of decking may be placed on steel joists until all bridging has been installed and anchored and all joist bearing ends attached, unless all of the following conditions are met:

(i) The employer has first determined from a qualified person and documented in a site-specific erection plan that the structure or portion of the structure is capable of supporting the load;

(ii) The bundle of decking is placed on a minimum of three steel joists;

(iii) The joists supporting the bundle of decking are attached at both ends;

(iv) At least one row of bridging is installed and anchored;

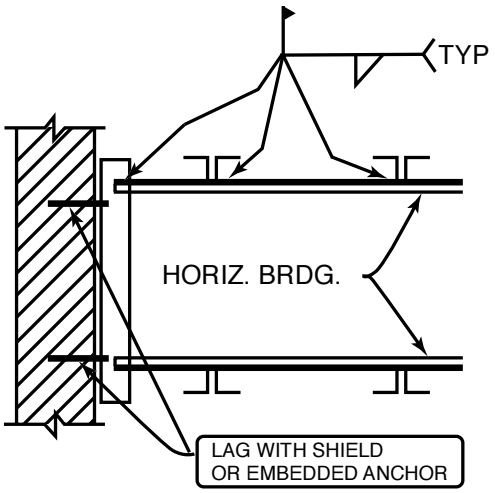
(v) The total weight of the bundle of decking does not exceed 4,000 pounds (1816 kg); and

(vi) Placement of the bundle of decking shall be in accordance with paragraph (e)(5) of this section.

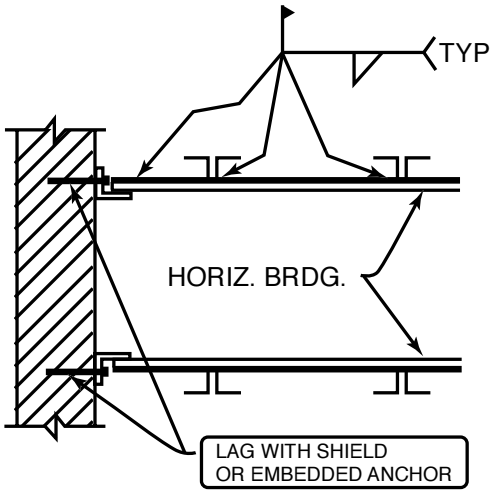
(5) The edge of the construction load shall be placed within 1 foot (.30 m) of the bearing surface of the joist end.

ILLUSTRATIONS OF OSHA BRIDGING TERMINUS POINTS
(NON-MANDATORY)

Guidelines for Complying with OSHA Steel Erection Standard, Paragraph §1926.757(a)(10) and §1926.757(c)(5).



HORIZONTAL BRIDGING
TERMINUS AT WALL



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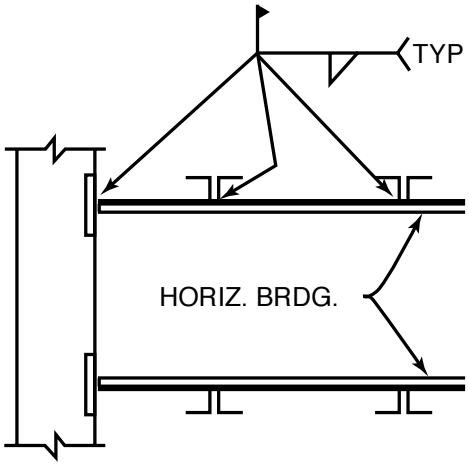
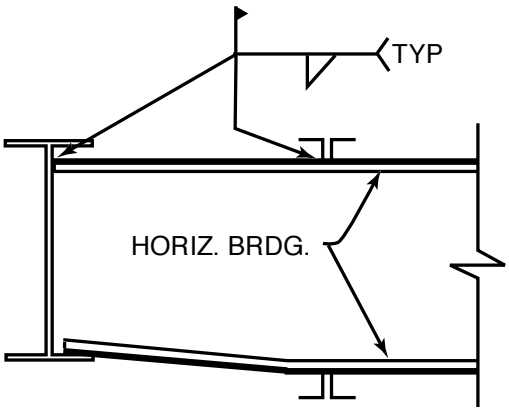
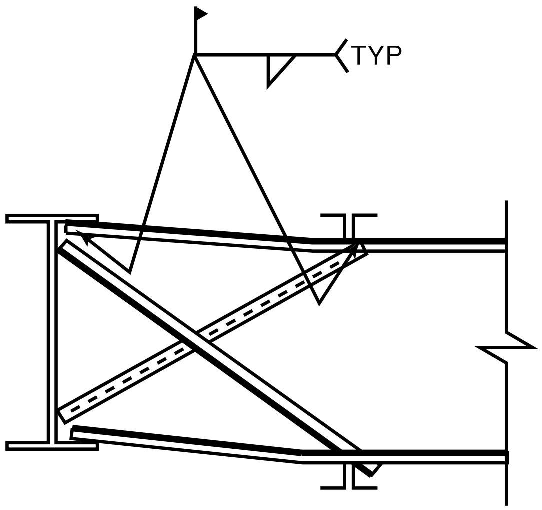


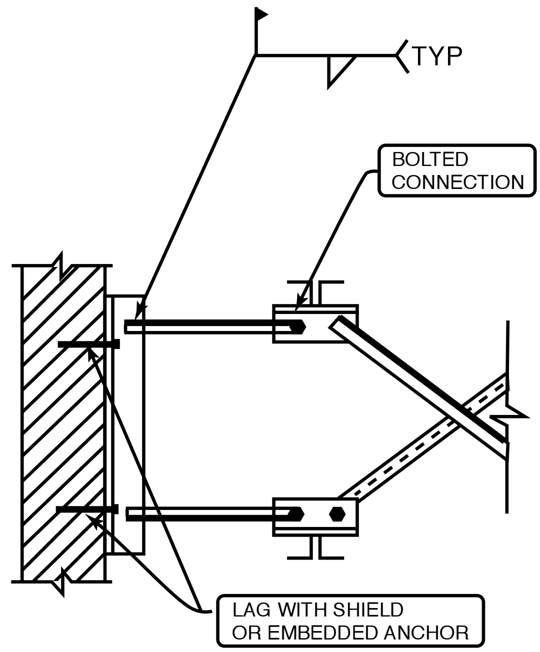
HORIZONTAL BRIDGING
TERMINUS AT PANEL WALL



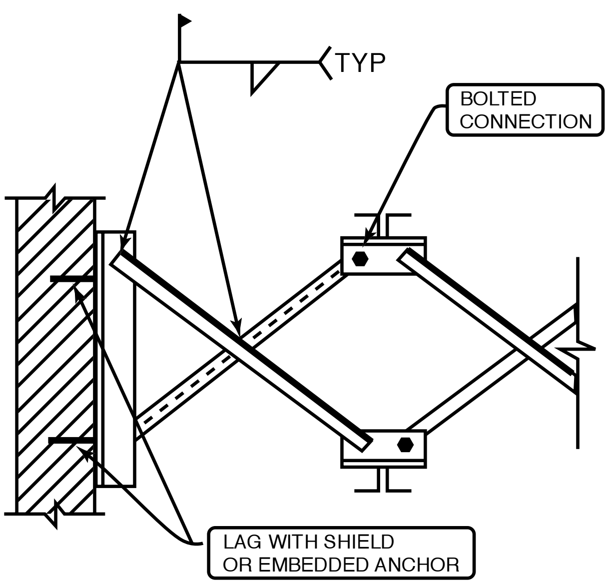
HORIZONTAL BRIDGING
TERMINUS AT
STRUCTURAL SHAPE



HORIZONTAL BRIDGING
TERMINUS AT STRUCTURAL
SHAPE WITH OPTIONAL
"X-BRIDGING"



BOLTED DIAGONAL BRIDGING
TERMINUS AT WALL



BOLTED DIAGONAL BRIDGING
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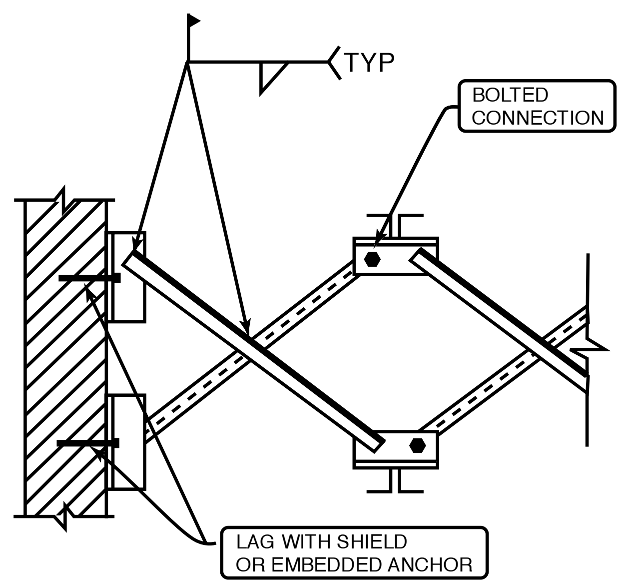
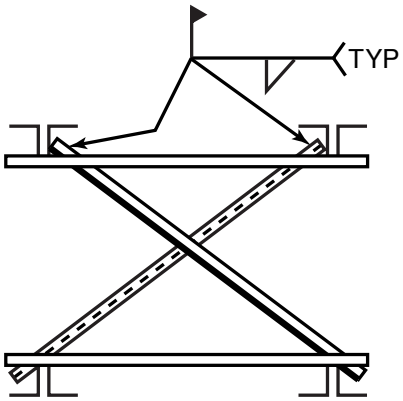
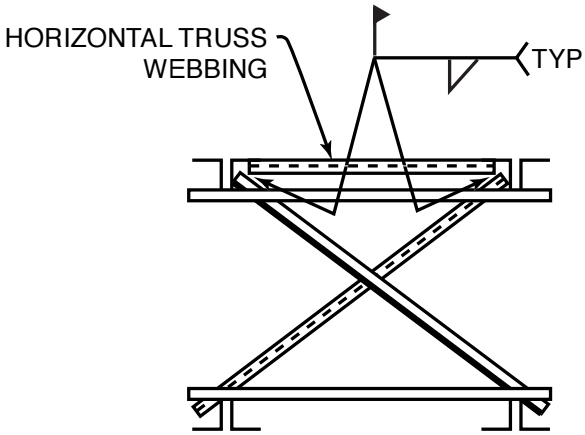


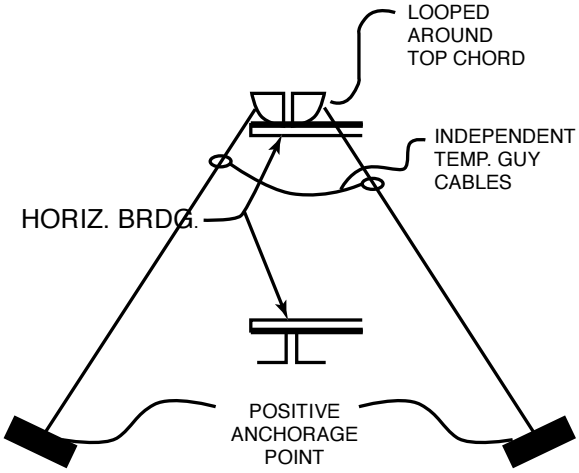
BOLTED DIAGONAL BRIDGING
TERMINUS AT WALL



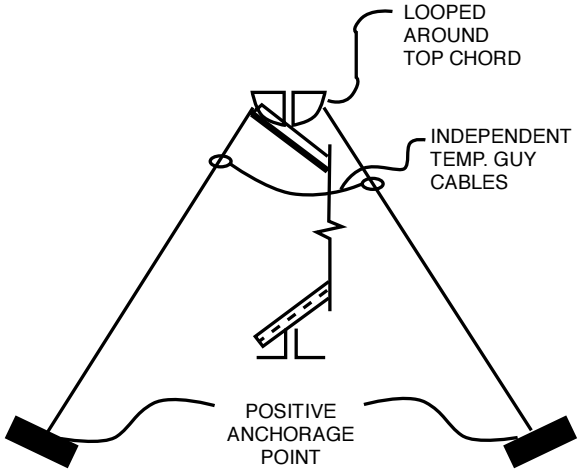
JOISTS PAIR BRIDGING
TERMINUS POINT



JOISTS PAIR BRIDGING
TERMINUS POINT



HORIZONTAL BRIDGING
TERMINUS POINT
SECURED BY TEMP.
GUY CABLES



DIAGONAL BRIDGING
TERMINUS POINT
SECURED BY TEMP.
GUY CABLES