STANDARD SPECIFICATIONS
FOR COMPOSITE STEEL JOISTS, CJ-SERIES

Adopted by the Steel Joist Institute May 10, 2006
- Effective May 10, 2006

SECTION 100. SCOPE

This specification covers the Load and Resistance Factor Design (LRFD), manufacture, and use of simply-supported Open Web Composite Steel Joists, **CJ-**Series.

SECTION 101. DEFINITION

The term "Composite Steel Joists", as used herein, refers to open web, parallel chord, load-carrying members suitable for direct support of one-way floor or roof systems. Members may consist of hot-rolled or cold-formed steel, including cold-formed steel whose yield strength* has been attained by cold working. Shear connection between the joist top chord and overlying concrete slab allows the steel joist and slab to act together as an integral unit after the concrete has adequately cured.

The design of **CJ-**Series joist chord sections shall be based on a yield strength of 50 ksi (345 MPa). 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 **CJ-**Series joist chord or web sections shall have a minimum yield strength determined in accordance with one of the procedures specified in Section 102.1(b), which is equal to the yield strength assumed in the design.

Composite Steel Joists shall be designed in accordance with these specifications to support the loads defined by the specifying professional.

* The term "Yield Strength" as used herein shall designate the yield level of a material as determined by the applicable method outlined in ASTM A 370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, paragraph 13.1 "Yield Point", and in paragraph 13.2 "Yield Strength", or as specified in Section 102.1(b) of this Specification.

SECTION 102. MATERIALS

102.1 STEEL CHORD and WEB MEMBERS

(a) Specifications

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

- 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 millimeters) thick, ASTM A588/A588M.
- Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric 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 102.1(b).

(b) 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 not 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 with mechanical properties that 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 with mechanical properties that 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, or 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.

102.2 STEEL SHEAR STUDS

Headed steel shear studs shall conform to the requirements of AWS D1.1 *Structural Welding Code-Steel*, Sections 7 and C7, *Stud Welding* with a minimum tensile strength of 65 ksi (450 MPa). Manufacturer's certification shall constitute sufficient evidence of conformity with AWS D1.1.

102.3 REINFORCING STEEL

The specified minimum yield stress of reinforcing bars utilized in the concrete slab shall not exceed 75 ksi (525 MPa). Additional concrete and steel reinforcing bar material limitations are specified in the American Concrete Institute, ACI-318, *Building Code Requirements for Structural Concrete and Commentary.*

102.4 CONCRETE

For the determination of the available strength, concrete shall have a compressive strength, f'_c , of not less than 3 ksi (21 MPa) nor more than 10 ksi (70 MPa) for normal weight concrete and not less than 3 ksi (21 MPa) nor more than 6 ksi (42 MPa) for light weight concrete.

102.5 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 102.5(a).

Other welding methods, providing equivalent strength as demonstrated by tests, shall be permitted.

102.6 PAINT

Standard shop practice is to furnish composite joists unpainted. Paint may potentially hinder the installation of welded shear studs to the joist top chord.

SECTION 103.
DESIGN AND MANUFACTURE

103.1 METHOD

The design of Composite Steel Joists shall be based on achieving the nominal flexural strength of the composite member and is limited to the design of one-way, composite joist systems that meet the following criteria:

a) Members are simply-supported and are not considered part of the lateral load-resisting system.

b) Horizontal shear connection is achieved by direct bearing of embedments within the concrete slab.

Where any applicable design feature is not specifically covered herein, the design shall be in accordance with the following specifications:

- For steel that consists of hot-rolled shapes, bars, or plates, use the American Institute of Steel Construction, *Specification for Structural Steel Buildings*.
- 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*.

103.2 LOAD COMBINATIONS

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:

(a) Noncomposite

$1.4D_c$ (103.2-1)

$1.2D_c + 1.6L_c$ (103.2-2)

Where:

D_c = construction dead load due to weight of the joist, the decking, and the fresh concrete, lb/ft.^{2} (kPa)

L_c = construction live load due to the work crews and the construction equipment, lb/ft.^{2} (kPa)

(b) Composite

$1.4D$ (103.2-3)

$1.2D + 1.6$ (L, or L_r, or S, or R) (103.2-4)

Where:

D = dead load due to the weight of the structural elements and the permanent features of the structure, lb/ft.^{2} (kPa)

L = live load due to occupancy and movable equipment, lb/ft.^{2} (kPa)

L_r = roof live load, when composite joists are utilized in roofs, lb/ft.^{2} (kPa)

S = snow load, when composite joists are utilized in roofs, lb/ft.^{2} (kPa)

R = load due to initial rainwater or ice exclusive of the ponding contribution, when composite joists are utilized in roofs, lb/ft.^{2} (kPa)

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

103.3 NOMINAL STRESSES

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

f_u = required stress computed for the factored loads based on the factors and load combinations, ksi (MPa)

ϕ = resistance factor

F_n = nominal stress, ksi (MPa)

ϕF_n = design stress, ksi (MPa)

F_y = specified minimum yield stress, ksi (MPa)

E = modulus of elasticity of steel, ksi (MPa)

(a) Tension: $\phi_t = 0.90$

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

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

$$F_n = F_y \quad (103.3\text{-}1)$$

$$\phi F_n = \phi_t F_y \quad (103.3\text{-}2)$$

(b) Compression: $\phi_c = 0.90$

For members with $K\ell/r \leq 4.71\sqrt{E/QF_y}$

$$F_{cr} = Q\left[0.658^{\left(\frac{QF_y}{F_e}\right)}\right]F_y \quad (103.3\text{-}3)$$

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

$$F_{cr} = 0.877F_e \quad (103.3\text{-}4)$$

Where, F_e = elastic buckling stress determined in accordance with Equation 103.3-5.

$$F_e = \frac{\pi^2 E}{\left(\frac{K\ell}{r}\right)^2} \quad (103.3\text{-}5)$$

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

$$F_n = F_{cr} \quad (103.3\text{-}6)$$

$$\phi F_n = \phi_c F_{cr} \quad (103.3\text{-}7)$$

In the above equations, ℓ is taken as the distance in inches (millimeters) between panel points for the chord members and 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 $1.2/\ell_x$ 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 compressive strength is given in the AISI, *North American Specification for the Design of Cold-Formed Steel Structural Members*.

(c) Bending: $\phi_b = 0.90$

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)

$$F_n = F_y \quad (103.3\text{-}8)$$

$$\phi F_n = \phi_b F_y \quad (103.3\text{-}9)$$

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

$$F_n = 1.6\ F_y \quad (103.3\text{-}10)$$

$$\phi F_n = \phi_b(1.6\ F_y) \quad (103.3\text{-}11)$$

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

$$F_n = 1.5\ F_y \quad (103.3\text{-}12)$$

$$\phi F_n = \phi_b(1.5\ F_y) \quad (103.3\text{-}13)$$

(d) Weld Design Strength: $\phi_w = 0.75$

$$F_n = 0.6\ F_{exx} \quad (103.3\text{-}14)$$

$$\phi F_n = \phi_w(0.6\ F_{exx}) \quad (103.3\text{-}15)$$

Design Shear Strength = $\phi R_n = \phi F_n A = \phi_w(0.6\ F_{exx})\ A$

$$(103.3\text{-}16)$$

Where, A = effective throat area

Made with E70 series electrodes or F7XX-EXXX flux-electrode combinations

$$F_{exx} = 70 \text{ ksi (483 MPa)}$$

Made with E60 series electrodes or F6XX-EXXX flux-electrode combinations

$$F_{exx} = 60 \text{ ksi (414 MPa)}$$

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

103.4 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 103.4-1, Parts A.

The effective slenderness ratio, $k\ell/r$ (Chod and Galambos 1975), to be used in calculating the nominal stresses, F_{cr} and F'_e, is the largest value as determined from Table 103.4-1, 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 103.4-1 are defined as follows:

- ℓ = length center-to-center of panel points, except ℓ = 36 inches (914 millimeters) for calculating ℓ/r_y of top chord member, in. (mm).
- ℓ_s = maximum length center-to-center between panel point and filler (tie), or between adjacent fillers (ties), in. (mm).
- r_x = member radius of gyration in the plane of the joist, in. (mm).
- r_y = member radius of gyration out of the plane of the joist, in. (mm).
- r_z = least radius of gyration of a member component, in. (mm).

TABLE 103.4-1

MAXIMUM AND EFFECTIVE SLENDERNESS RATIOS

	Description	$k\ell/r_x$	$k\ell/r_y$	$k\ell/r_z$	$k\ell_s/r_z$
I	TOP CHORD INTERIOR PANEL				
	A. 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 90.				
	B. The effective slenderness ratio, $k\ell/r$, to determine F_{cr} where k is:				
	1. With fillers or ties	0.75	1.0	---	1.0
	2. Without fillers or ties	---	---	0.75	---
	3. Single component members	0.75	1.0	---	---
	C. The effective slenderness ratio, $k\ell/r$, to determine F'_e where k is:				
	1. With fillers or ties	0.75	---	---	---
	2. Without fillers or ties	0.75	---	---	---
	3. Single component members	0.75	---	---	---
II	TOP CHORD END PANEL				
	A. 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 120.				
	B. The effective slenderness ratio, $k\ell/r$, to determine F_{cr} where k is:				
	1. With fillers or ties	1.0	1.0	---	1.0
	2. Without fillers or ties	---	---	1.0	---
	3. Single component members	1.0	1.0	---	---
	C. The effective slenderness ratio, $k\ell/r$, to determine F'_e where k is:				
	1. With fillers or ties	1.0	---	---	---
	2. Without fillers or ties	1.0	---	---	---
	3. Single component members	1.0	---	---	---
III	TENSION MEMBERS – CHORDS AND WEBS				
	A. 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 240.				
IV	COMPRESSION MEMBERS				
	A. 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 200.				
	B. The effective slenderness ratio, $k\ell/r$, to determine F_{cr} where k is:				
	1. With fillers or ties	0.75	1.0	---	1.0
	2. Without fillers or ties	---	---	1.0	---
	3. Single component members	0.75*	1.0	---	---

* If moment-resistant weld groups are not used at the ends of a crimped, first primary compression web member, then 1.2 ℓ/r_x must be used.

CJ-SERIES SPECIFICATIONS

103.5 MEMBERS

(a) Chords

(1) Non-composite Design

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

The top chord must resist the construction loads, at which time the joist is behaving non-compositely. An analysis shall be made using an effective depth of the joist to determine the member forces due to construction loads. The effective depth for a non-composite joist shall be considered the vertical distance between the centroids of the top and bottom chord members.

The minimum horizontal flat leg width and minimum thickness of top chord shall be as specified in Table 103.5-1.

TABLE 103.5-1

MINIMUM TOP CHORD SIZES FOR INSTALLING WELDED SHEAR STUDS

Shear Stud Diameter in. (mm)	Minimum Horizontal Flat Leg Width in. (mm)	Minimum Leg Thickness in. (mm)
0.375 (10)	1.50 (38)	0.125 (3.2)
0.500 (13)	1.75 (44)	0.167 (4.2)
0.625 (16)	2.00 (51)	0.209 (5.3)
0.750 (19)	2.50 (64)	0.250 (6.3)

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

at the panel point:

$$f_{au} + f_{bu} \le 0.9F_y \qquad (103.5\text{-}1)$$

at the mid panel:

$$\text{for } \frac{f_{au}}{\phi_c F_{cr}} \ge 0.2, \quad \frac{f_{au}}{\phi_c F_{cr}} + \frac{8}{9}\left[\frac{C_m f_{bu}}{\left[1-\left(\frac{f_{au}}{\phi_c F'_e}\right)\right]Q\phi_b F_y}\right] \le 1.0 \qquad (103.5\text{-}2)$$

$$\text{for } \frac{f_{au}}{\phi_c F_{cr}} < 0.2, \quad \left(\frac{f_{au}}{2\phi_c F_{cr}}\right) + \left[\frac{C_m f_{bu}}{\left[1-\left(\frac{f_{au}}{\phi_c F'_e}\right)\right]Q\phi_b F_y}\right] \le 1.0 \qquad (103.5\text{-}3)$$

Where,

f_{au} = P_u/A_t = 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 103.4

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

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

F_y = specified minimum yield strength, ksi (MPa)

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

ℓ = chord panel length per Section 103.4, in. (mm)

r_x = radius of gyration about the axis of bending, in. (mm)

Q = form factor defined in Section 103.3

A_t = area of the top chord, in.^{2}, (mm^2)

The top chord shall be considered as stayed laterally by the floor provided the requirements of Section 104.9(d) of these specifications are met.

(2) Composite Design

The distance between the centroid of the tension bottom chord and the centroid of the concrete compression block, d_e, shall be computed using a concrete stress of $0.85f'_c$ and an effective concrete width, b_e, taken as the sum of the effective widths for each side of the joist centerline, each of which shall be the lowest value of the following:

1. one-eighth of the joist span, center-to-center of supports;
2. one-half the distance to the center-line of the adjacent joist;
3. the distance to the edge of the slab.

$$a = M_n/(0.85\, f'_c\, b_e\, d_e) \le t_c, \text{ in. (mm)} \qquad (103.5\text{-}4)$$

$$d_e = d_j - y_{bc} + h_{deck} + t_c - a/2, \text{ in. (mm)} \qquad (103.5\text{-}5)$$

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Where,

- a = depth of concrete compressive stress block, in. (mm)
- b_e = effective width of concrete slab over the joist, in. (mm)
- d_j = steel joist depth, in. (mm)
- f'_c = specified minimum 28 day concrete compressive strength, ksi (MPa)
- h_{deck} = height of metal deck, in. (mm)
- M_n = nominal moment capacity of the composite joist, kip-in. (N-mm)
- t_c = thickness of concrete slab above the steel deck, in. (mm)
- y_{bc} = vertical distance to centroidal axis of bottom chord measured from the bottom of the bottom chord, in. (mm)

When the metal deck ribs are perpendicular to the steel joists, the concrete below the top of the metal deck shall be neglected when determining section properties and in calculating the concrete compressive block.

The contribution of the steel joist top chord to the moment capacity of the composite system shall be ignored. The first top chord end panel member shall be designed for the full factored load requirements as a non-composite member per Section 103.5(a)(1).

$$M_u \leq \phi M_n \qquad (103.5\text{-}6)$$

- ϕM_n = minimum design flexural strength of composite section as determined from Equations 103.5-7, 103.5-8, 103.5-9, and 103.5-10 kip-in. (N-mm)
- M_u = required flexural strength determined from applied factored loads, kip-in. (N-mm)

The design flexural strength of the composite section, ϕM_n, shall be computed as the lowest value of the following limit states: Bottom Chord Tensile Yielding, Bottom Chord Tensile Rupture, Concrete Crushing, and Shear Connector Strength.

a) Bottom Chord Tensile Yielding: $\phi_t = 0.90$

$$\phi M_n = \phi_t A_b F_y d_e \qquad (103.5\text{-}7)$$

b) Bottom Chord Tensile Rupture: $\phi_{tr} = 0.75$

$$\phi M_n = \phi_{tr} A_n F_u d_e \qquad (103.5\text{-}8)$$

c) Concrete Crushing: $\phi_{cc} = 0.85$

$$\phi M_n = \phi_{cc}\, 0.85 f'_c b_e t_c d_e \qquad (103.5\text{-}9)$$

d) Shear Connector Strength: $\phi_{stud} = 0.90$

$$\phi M_n = \phi_{stud}\, N Q_n d_e \geq 0.50 \phi_t A_b F_y d_e \qquad (103.5\text{-}10)$$

Where,

- A_b = cross-sectional area of steel joist bottom chord, in.^{2} (mm^2)
- A_n = net cross-sectional area of the steel joist bottom chord, in.^{2} (mm^2)
- b_e = effective width of concrete slab over the joist, in. (mm)
- d_e = vertical distance from the centroid of steel joist bottom chord to the centroid of resistance of the concrete in compression, in.(mm)
- F_u = tensile strength of the steel joist bottom chord, ksi (MPa)
- F_y = specified minimum yield stress of steel joist bottom chord, ksi (MPa)
- N = number of shear studs between the point of maximum moment and zero moment
- t_c = minimum thickness of the concrete slab above the top of the metal deck, in. (mm)

(b) Webs

Vertical shears to be used in the design of the web members shall be determined from the controlling load combination from Section 103.2(b), but such vertical shears shall not be less than the following:

i. 25% of the factored end reaction.

ii. Tension web members controlled by (i.) shall be designed for a compressive force resulting from a factored shear value of:

$$V_{c\ min} = \frac{(1.6 w_L)L}{8} \qquad (103.5\text{-}11)$$

Where,

- w_L = non-factored live load due to occupancy and moveable equipment, plf (kN/m)
- L = design length for the composite joist as defined in Table 104.2-1, Definition of Span, ft. (m) where design length = Span – 0.33 ft. (Span – 102 mm)
- $V_{c\ min}$ = minimum factored compressive design shear in tension web members, lb (kN)

Interior vertical web members used in modified Warren type web systems shall be designed to resist the gravity loads supported by the member plus 2.0 percent of the composite bottom chord axial force.

Maximum slenderness ratios shall be in accordance with Sections III and IV of Table 103.4-1.

(c) Chord Configuration

Composite joists shall have parallel chords.

(d) Eccentricity

Members connected at a joint shall have their centers 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.

Eccentricity between the intersection of the centroid of the web members and center of compression in the concrete slab may be neglected. 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 design loads to be supported, the deflection requirements, and the proper bracing shall be clearly indicated on the structural drawings. The extended steel top chord shall support all end loads without relying on any composite action.

Design of concrete reinforcing steel in the negative moment region shall be the responsibility of the specifying professional.

(f) Joist Bearing Depths

The joist bearing depths shall range from 2 1/2 inches (64 millimeters) to 7 1/2 inches (191 millimeters).

103.6 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 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 splatter 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 103.6(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 develop the maximum force due to any of the design loads, but not less than 50 percent of the nominal 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 nominal member strength. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57 ksi (390 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 nominal member strength.

(d) Shear Studs

Shear studs, after installation, shall extend not less than 1 1/2 in. (38 mm) above the top of the steel deck and there shall be at least 1/2 in. (13 mm) of concrete cover above the top of the installed studs.

For studs in 1.5 in. (38 mm), 2 in. (51 mm), or 3 in. (76 mm) deep decks with $d_{stud}/t_{top\ chord} \leq 2.7$:

$$Q_n = \text{Min}\left[0.5A_{stud}\sqrt{f'_cE_c}\ ,\ R_pR_gA_{stud}\ F_{u\ stud}\right] \quad \text{(kips)} \tag{103.6-1}$$

$$Q_n = \text{Min}\left[0.5A_{stud}\sqrt{f'_cE_c}\ ,\ (R_pR_gA_{stud}\ F_{u\ stud})\right] \quad \text{(N)} \tag{103.6-2}$$

For studs in 1.5 in. (38 mm), 2 in. (51 mm), or 3 in. (76 mm) deep decks with $2.7 < d_{stud} / t_{top\ chord} \leq 3.0$:

$$Q_n = \text{Min}\begin{bmatrix} 0.5A_{stud}\sqrt{f'_c E_c} \\ R_p R_g A_{stud}\ F_{u\ stud} - 1.5\left(\frac{d_{stud}}{t_{top\ chord}} - 2.7\right) \end{bmatrix} \text{(kips)} \qquad (103.6\text{-}3)$$

$$Q_n = \text{Min}\begin{bmatrix} 0.5A_{stud}\sqrt{f'_c E_c} \\ R_p R_g A_{stud}\ F_{u\ stud}) - 6670\left(\frac{d_{stud}}{t_{top\ chord}} - 2.7\right) \end{bmatrix} \text{(N)} \qquad (103.6\text{-}4)$$

Where:

A_{stud} = cross–sectional area of shear stud, in.^{2} (mm^2)
d_{stud} = diameter of shear stud, in. (mm)
E_c = modulus of elasticity of the concrete, ksi (MPa)
f'_c = specified minimum 28 day concrete compressive strength, ksi (MPa)
$F_{u\ stud}$ = minimum tensile strength of stud, 65 ksi (450 MPa)
Q_n = shear capacity of a single shear stud, kips (N)
R_p = shear stud coefficient from Table 103.6-1
R_g = 1.00 for one stud per rib or staggered position studs
= 0.85 for two studs per rib side-by-side
= 0.70 for three studs per rib side-by-side
$t_{top\ chord}$ = thickness of top chord horizontal leg or flange, in. (mm)

TABLE 103.6-1
VALUES FOR R_p

Deck Height	Wr @ mid-height	3/8 in. (10 mm) Dia. Stud	1/2 in. (13 mm) Dia. Stud	5/8 in. (16 mm) Dia. Stud	3/4 in. (19 mm) Dia. Stud
1 in. (25 mm)	1.9 in. (48 mm)	0.55	0.55	0.50	0.45
1.5 in. (38 mm)	2.1 in. (53 mm)	0.55	0.50	0.45	0.40
1.5 in. (38 mm) Inverted	3.9 in. (99 mm)	0.85	0.60	0.60	0.60
2 in. (51 mm)	6 in. (152 mm)	–	0.55	0.50	0.45
3 in. (76 mm)	6 in. (152 mm)	–	0.50	0.50	0.50

Notes: 1) $Wr_{@\ mid\text{-}height}$ = Average deck rib width of deck rib containing the shear stud.
2) The deck is assumed to be oriented perpendicular to the joists.

103.7 CAMBER

CJ-Series joists shall be cambered. The approximate camber will be based on the deflection associated with 100% of the non-composite unfactored dead load plus any additional loads defined by the specifying professional.

103.8 VERIFICATION OF DESIGN AND MANUFACTURE

(a) Design Calculations

Companies manufacturing any **CJ-**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 his ability to manufacture **CJ-**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

The specifications shall apply to any type of structure where floor and roof decks are to be supported directly by Composite Steel Joists installed as hereinafter specified. Joists used other than for simple spans as prescribed in Section 103.1 shall be investigated and modified as necessary by the specifying professional to limit the unit stresses to those listed in Section 103.3. Design for large openings that interrupt truss action is beyond the scope of this specification.

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 non-composite dead loads. The joist is 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 span of a standard SJI composite joist shall be from 12 to 30 times the depth of the steel joist. The term "Span" is defined in Table 104.2-1, Definition of Span.

104.3 DEPTH

The depth of the composite joist shall be the vertical distance from the top of the steel top chord to the bottom of the bottom chord.

104.4 END SUPPORTS

(a) Masonry and Concrete

CJ-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 **CJ-**Series Joists shall extend over the masonry or concrete support as shown below and be anchored to a steel bearing plate. This steel bearing plate shall be located no more than 1/2 inch (13 millimeters) from the face of the wall. The distance over the wall that the composite joist shall bear, width of the steel bearing plate and anchorage of the **CJ-**Series Joists shall be as defined below:

For 2 1/2" ≤ Seat Depth < 5":

- The ends of **CJ-**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 width of the plate perpendicular to the span of the Composite Steel Joist shall be not less than 6 inches (152 millimeters).
- The Composite Steel Joists must bear a minimum of 2 1/2 inches (64 millimeters) on the steel bearing plate.

For Seat Depth ≥ 5":

- The ends of **CJ-**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 width of the plate perpendicular to the span of the Composite Steel Joist shall be not less than 9 inches (229 millimeters).
- The Composite Steel Joists must bear a minimum of 4 inches (102 millimeters) on the steel bearing plate.

The steel bearing 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 the dimensions listed above 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 joist must meet the minimum bearing requirement 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.

For 2 1/2" ≤ Seat Depth < 5":

The ends of **CJ-**Series Joists shall extend a distance of not less than 2 1/2 inches (64 millimeters) over the steel supports.

For Seat Depth ≥ 5":

The ends of **CJ-**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 ratio 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 lines 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 bridging members and the connections to the chords of the joists.

(c) Bridging Lines

For spans up through 60 feet (18.3 meters), welded horizontal bridging may be used except where the row of bridging nearest the center is required to be bolted diagonal bridging as indicated on the joist manufacturer's joist placement plans. When the span of the composite steel joist is over 60 feet (18.3 meters), but not greater than 100 feet (30.5 meters), hoisting cables shall not be released until the two rows of bridging nearest the third points are completely installed. When the span exceeds 100 feet (30.5 meters) hoisting cables shall not be released until all rows of bridging are completely installed. For spans over 60 feet (18.3 meters) all rows of bridging shall be diagonal bridging with bolted connections at the chords and intersections.

(d) Spacing

Bridging must be properly spaced and anchored to support the decking and the employees prior to the attachment of the deck to the top chord. The maximum spacment of the deck to the top chord. The maximum spacing of lines of bridging, l_{br} shall be the lesser of,

$$\ell_{br} = \left(100 + 0.67d_j + 40\frac{d_j}{L}\right) r_y \text{, in.} \qquad (104.5\text{-}1a)$$

$$\ell_{br} = \left(100 + 0.026d_j + 0.48\frac{d_j}{L}\right) r_y \text{, mm} \qquad (104.5\text{-}1b)$$

or $$\ell_{br} = 170r_y \qquad (104.5\text{-}2)$$

Where,

d_j is the steel joist depth, in. (mm)

L is the design length for the composite joist, ft. (m)

r_y is the out-of-plane radius of gyration of the top chord, in. (mm)

The number of rows of bottom chord bridging 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.

(e) Connections

Connection of bridging to the chords of the Composite Steel Joists shall be made by positive mechanical means or by welding. Ends of all bridging lines terminating at walls, beams, or double joists boxed by diagonal bridging shall be anchored.

Connection of the horizontal and diagonal bridging to the joist chord or bridging terminus point shall be capable of resisting the nominal top chord horizontal force, P_{br} given in Equation 104.5-3.

$$P_{br} = 0.0025\, n\, A_t\, F_{construction} \text{, lbs (N)} \qquad (104.5\text{-}3)$$

Where,

n = 8 for horizontal bridging

n = 2 for diagonal bridging

A_t = cross sectional area of joist top chord, in.^{2} (mm^2)

$F_{construction}$ = assumed nominal stress in top chord due to construction loads

$$F_{construction} = \left[\frac{\pi^2 E}{\left(\frac{0.9\ell_{br}}{r_y}\right)^2}\right] \geq 12.2\text{ksi} \qquad (104.5\text{-}4a)$$

$$F_{construction} = \left[\frac{\pi^2 E}{\left(\frac{0.9\ell_{br}}{r_y}\right)^2}\right] \geq 84.1 \text{ MPa} \qquad (104.5\text{-}4b)$$

Where,

E = Modulus of Elasticity of steel = 29,000 ksi (200,000 MPa)

and $\frac{\ell_{br}}{r_y}$ is determined from Equations 104.5-1a, 104.5-1b or 104.5-2

(f) Sizing of Bridging

Horizontal joist bridging shall be designed to resist the nominal compressive force shown in Equation 104.5-3. Diagonal bridging shall be capable of resisting in tension the nominal horizontal force shown in Equation 104.5-3.

(g) 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 be provided to support the top chord during installation of the decking prior to the attachment of the deck to the top chord. All bridging and bridging anchors shall be completely installed before construction loads are placed on the joists. 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.

104.7 END ANCHORAGE

(a) Masonry and Concrete

Ends of Composite Steel Joists resting on steel bearing plates on masonry or structural concrete shall be attached thereto as defined below:

For 2 1/2" ≤ Seat Depth < 5":

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 with the equivalent.

For Seat Depth ≥ 5":

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.

(b) Steel

Ends of Composite Steel Joists resting on steel supports shall be attached thereto as defined below:

For 2 1/2" ≤ Seat Depth < 5":

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 with the equivalent.

For Seat Depth ≥ 5"

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.

In steel frames, where columns are not framed in at least two directions with solid structural steel members, joists at column lines shall be field bolted and the joist bottom chords must be restrained by a vertical stabilizer plate attached to the column providing lateral stability during construction. Where constructability does not allow a steel joist to be installed directly at the column, an alternate means of stabilizing the joist shall be installed on both sides near the column (OSHA 2001). When **CJ-**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, composite joists used in roof applications shall be anchored to resist such forces (Refer to Section 104.12).

104.8 JOIST SPACING

Composite joists shall be spaced so that the loading on each joist does not exceed the design load.

104.9 DECKS

(a) Material

Floor deck shall consist of formed steel 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 above the deck.

(c) Bearing

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

(d) Attachments of the steel deck

The deck shall be attached per Steel Deck Institute requirements prior to placing construction loads on the composite joists. The spacing of the attachments along the top chord shall not exceed 36 inches (914 millimeters).

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 due consideration to the effects of deflection, both short and long term, and vibration* in the selection of composite joists. All deflection calculations should account for the inherent flexibility of the open web configuration.

* 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

When Composite Steel Joists are used in roofs, a ponding* investigation shall be performed by the specifying professional.

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

104.12 UPLIFT

When Composite Steel Joists are used in roofs, and 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 (kilopascals). When these forces are specified, they must be considered in the design of the 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.*

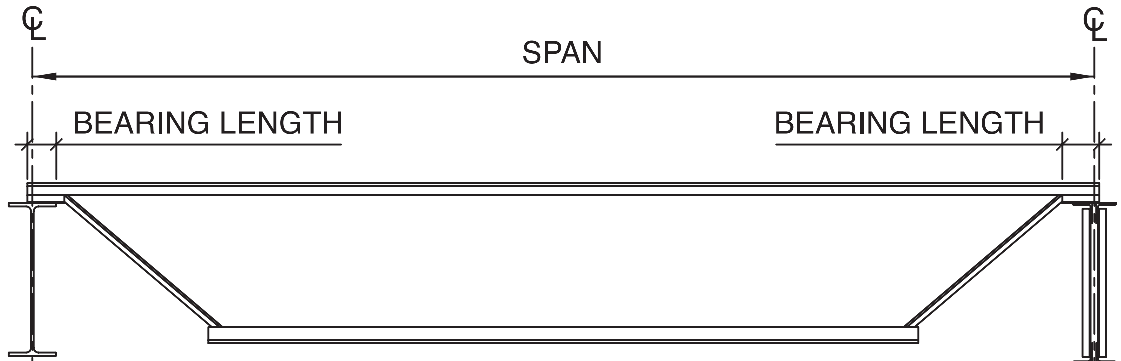
* For further reference, refer to Steel Joist Institute Technical Digest #6, “Structural Design of Steel Joist Roofs to Resist Uplift Loads”.

104.13 INSPECTION

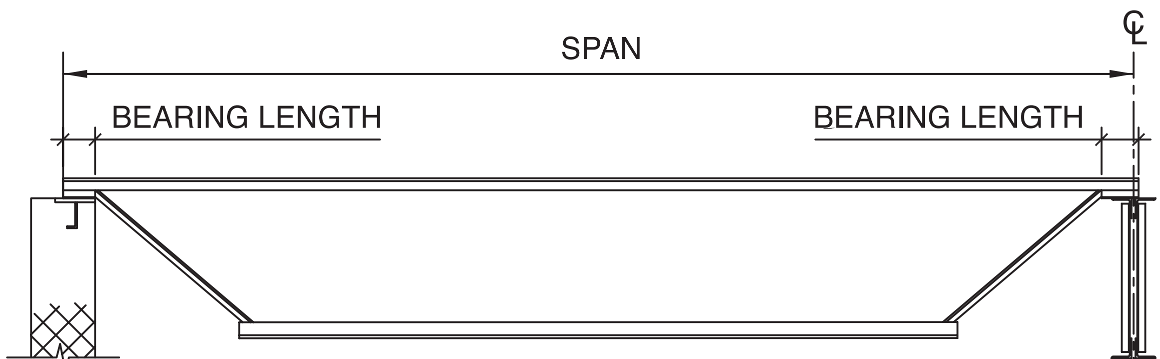
Joists shall be inspected by the manufacturer before shipment to verify compliance of materials and workmanship with the requirements of these specifications. If the purchaser wishes an inspection of the steel joists by someone other than the manufacturer’s own inspectors, they may reserve the right 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.

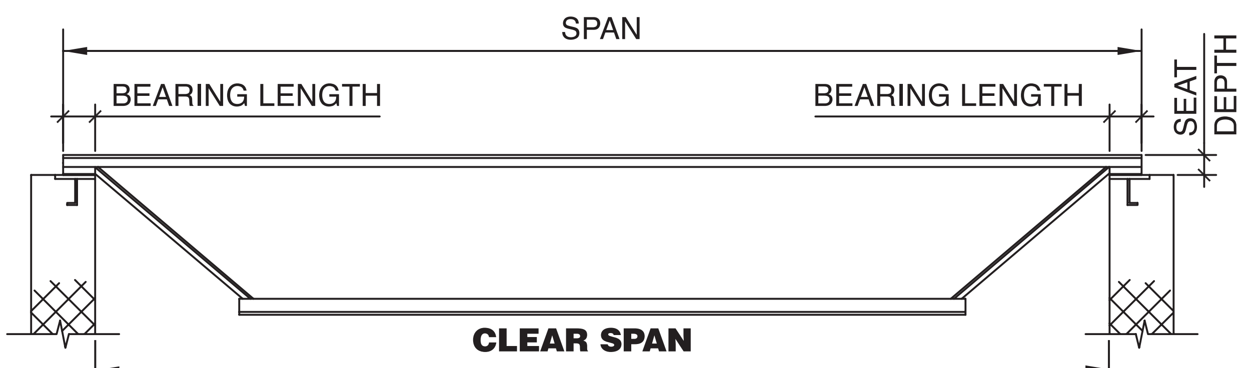
TABLE 104.2-1
DEFINITION OF SPAN



DETAIL #1



DETAIL #2



DETAIL #3

NOTES:

1) **DESIGN LENGTH (ENGLISH UNITS) = SPAN - 0.33 FT.**
   DESIGN LENGTH (METRIC UNITS) = SPAN - 102 mm
2) **MINIMUM BEARING LENGTH IS A FUNCTION OF THE SEAT DEPTH. (SEE SECTION 104.2)**

SECTION 105.*

ERECTION STABILITY AND HANDLING

105.1 Joist Erection

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

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

(a) Erection Stability

Joist erection bridging requirements shall be determined by the joist manufacturer and indicated on the joist placement plans.

(b) Stability Requirements during Joist Erection

(1) Before an employee is allowed on the composite steel joist: BOTH ends of composite joists at columns (or composite joists designated as column joists) shall be attached to its supports. For all other composite joists a minimum of one end shall be attached before the employee is allowed on the composite 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 composite steel joists that do not require erection bridging as shown on the joist placement plans, only one employee shall be allowed on the composite joist unless all bridging is installed and anchored.

(3) Where the span of the composite steel joist requires one line of bolted diagonal erection bridging nearest the mid-span of the joist, as indicated on the joist placement plans, the following shall apply:

a. Hoisting cables shall not be released until the row of bolted diagonal erection bridging is installed and anchored, unless an alternate method of stabilizing the composite steel joist has been provided; and

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

(4) Where the span of the Composite Steel Joist requires two lines of bolted diagonal erection bridging nearest the third points of the joist, as indicated on the joist placement plans, the following shall apply:

a. Hoisting cables shall not be released until the two rows of bolted diagonal erection bridging are installed and anchored; and

b. 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 composite steel joist requires all lines of bridging to be bolted diagonal erection bridging as indicated on the joist placement plans, the following shall apply:

a. Hoisting cables shall not be released until all bridging is installed and anchored; and

b. 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 can not 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 composite joist must be restrained laterally per Section 104.5(g) before releasing the hoisting cables.

(8) After the composite steel 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.

(c) Landing and Placing Loads

(1) Except as stated in paragraph 105(c)(3) of this section, no "Construction Loads" are allowed on the Composite Steel Joists until all bridging is installed and anchored, and all joist bearing ends are attached. "Construction Loads" (for joist erection) means any load other than the weight of the employee(s), the joists, and the bridging bundle(s).

(2) During the construction period, loads placed on the Composite Steel Joists shall be distributed so as not to exceed the non-composite capacity of the composite steel joists.

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

a. The contractor has first determined from a "*qualified person*" and documented in a site specific erection plan that the structure or portion of structure is capable of supporting the load. A "*qualified person*" 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 mater, the work, or the project;

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

c. The composite steel 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);

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

(4) The edge of any construction load shall be placed within 1 foot (0.30 meter) of the bearing surface of the composite steel joist end.

(d) Field Welding

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

(e) Handling

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

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

(f) Fall Arrest Systems

Composite 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*" as defined in paragraph 105(c)(3)(a).

SECTION 106. SHEAR CONNECTOR PLACEMENT AND WELDING

(a) Shear connectors required on each side of the point of maximum positive or negative bending moment, shall be distributed uniformly between that point and the adjacent points of zero moment, unless otherwise specified. However the number of shear connectors placed between any concentrated load and the nearest point of zero moment shall be sufficient to develop the maximum moment required at the concentrated load point.

(b) Studs shall be alternately placed on each chord angle section for double angle top chords. When constructability does not allow this to occur, stud placement shall be limited as follows:

1. No more than three studs shall be placed consecutively on any one chord angle, and

2. No more than 60% of the total number of studs shall be placed on any one chord angle.

Studs shall have a minimum of 1/2 inch (13 millimeters) concrete cover over the head of each stud (see Section 103.6(d)).

(c) The minimum center-to-center spacing of stud connectors shall be six stud diameters along the longitudinal axis of the supporting composite joist, except that within the ribs of formed steel decks oriented perpendicular to the steel joists, the minimum center-to-center spacing shall be four stud diameters in any direction.

(d) The distance measured along the longitudinal axis of the joist from the free edge of the concrete slab to the first stud shall not be less than the deck height plus four stud diameters.

(e) The spacing of stud shear connectors along the length of the supporting joist shall not exceed eight times the slab depth or 36 inches (914 millimeters).

(f) To resist uplift, the steel deck shall be anchored to all supporting members at a spacing not to exceed 18 inches (460 millimeters). Such anchorage shall be provided by stud connectors, a combination of stud connectors and arc spot (puddle) welds, or other devices.

SECTION 107. SPECIAL CASES

When a method of shear transfer is used other than headed shear studs for developing composite joist behavior, the strength of shear connectors and details of composite construction shall be established by a test program that has been submitted to and accepted by the SJI.

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NOTES:

Responsibility of the Specifying Professional

SJI member companies have developed computer programs to provide composite steel joist designs quickly and efficiently. To do this, some basic information must be provided to the manufacturer. The following list summarizes the needed information from the Specifying Professional:

1) Joist Depth:
   The joist depth must be provided in inches (mm). This depth includes the steel joist portion only, not the deck slab.
2) Joist Span:
   The joist span must be given in feet (mm). The span is from the centerline of the supporting joist girder (structural steel) to the centerline of the opposite supporting joist girder (structural steel). In the case of masonry and/or concrete walls, span is measured from the inside face of walls plus 8 inches (203 mm). For more information on span see the Standard Specifications for Composite Steel Joists, CJ-Series, Section 104.2.
3) Adjacent Member Spacing:
   The distance in feet (mm) to the adjacent member or to the edge of the slab (if an exterior joist) must be provided.
4) Type of Floor Deck:
   Review each deck manufacturer's deck load capacity and deflection characteristics and specify the deck depth, profile, and thickness to meet the building design.
5) Concrete Unit Weight:
   The unit weight in pcf (kg/m^3) must be indicated.
6) Concrete Compressive Strength:
   The 28 day specified compressive strength of concrete in ksi (MPa) must be provided.
7) Slab Thickness above Floor Deck:
   The actual slab thickness in inches (mm) above the top of the deck must be indicated.
8) Composite Design Loads:
   The loads which must be specified are as follows:
   a) Noncomposite DL:
      Concrete, joists, deck, bridging, and any other non-composite dead loads.
   b) Construction LL:
      A suggested minimum construction live load calculation can be found in the COSP for Composite Steel Joists, SJI Composite Joist Floor Design Parameters Checklist.
   c) Composite DL:
      Partitions, mechanical, electrical, fireproofing, floor covering, ceilings, and other composite dead loads.
   d) Composite LL:
      Reduced design live loads may be specified if applicable.

   Note: The Specifying Professional shall provide the nominal loads and load combinations as stipulated by the applicable code under which the structure is designed.
9) Camber:
   The load to be used to calculate the camber must be specified.

The "Composite Joist Floor Design Parameters Checklist" that can be found in the **Code of Standard Practice for Composite Steel Joists**, includes a form for filling in the above information.

Composite steel joists have some limitations that the Specifying Professional must be aware of.

These include:

(a) Parallel top and bottom chords.

(b) The minimum and maximum deck heights are 1 inch (25 mm) and 3 inches (76 mm), respectively.

(c) The minimum slab thickness above the top of the deck must be 2 inches (51 mm).

(d) Shear studs must have at least 1/2 inch (13 mm) of concrete cover.

(e) The concrete shall be placed to provide a constant thickness along the entire span.

Provisions for field inspection of projects involving composite steel joists shall be made by the Specifying Professional. This inspection shall include, as a minimum, verifying the concrete strength, concrete thickness, and shear stud attachment and placement. For more information on shear stud placement and welding see the Standard Specifications for Composite Steel Joists, CJ-Series, Section 106.

This inspection will not be provided by SJI member manufacturers.

NON-COMPOSITE AND COMPOSITE EFFECTIVE MOMENTS OF INERTIA

$$I_{chords} = I_{tc} + I_{bc} + \frac{d_e^2 (A_{tc} A_{bc})}{(A_{tc} + A_{bc})}$$

Where,

A_{tc} = Area of the top chord (in.^{2})

A_{bc} = Area of the bottom chord (in.^{2})

I_{tc} = Moment of inertia of the top chord about the top chord x-x axis (in.^{4})

I_{bc} = Moment of inertia of the bottom chord about the bottom chord x-x axis (in.^{4})

d_e = Effective depth for the steel joist (in.)

Web Type	C_r	L / D
Single or Double Angle Web Members	$0.90\,(1 - e^{-0.28\,(L/D)})^{2.8}$	$6 \leq L/D \leq 24$
Continuous Round Rod Web Members	$0.721 + 0.00725\,(L/D)$	$10 \leq L/D \leq 24$

Where,

L = Span length (in.)

D = Nominal depth of steel joist (in.)

The non-composite moment of inertia of the joist can be determined as follows,

$$I_{non-comp\ eff} = C_r I_{chords}$$

and the composite effective moment of inertia of the joist can be determined as follows,

$$I_{eff} = \frac{1}{\dfrac{\gamma}{I_{chords}} + \dfrac{1}{I_{composite}}}$$

Where,

$$\gamma = \frac{1}{C_r} - 1$$

$I_{composite}$ = Transformed moment of inertia using the actual joist chord areas (in.^{4})

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