Properly Specifying Steel Joists

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Keith Juedemann, PE, Valley Joist

Tim Holtermann, PE, SE, Canam

Polling Question

- New requirement to earn PDH credits
- Two questions will be asked during the duration of today's presentation
- The question will appear within the polling section of your GoToWebinar Control Panel to respond

Disclaimer

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Learning Objectives

- Proper use of reference standards.
- Avoiding common pit-falls and unnecessary RFIs.
- Tips for economy with the specified steel joist system.
- Awareness of design tools available from the Steel Joist Institute.

Properly Specifying Steel Joists

- Open web steel joists are an efficient, economical method of framing building floors and roofs, but there are some basics that should be covered in the structural design and specifying process.

- This presentation will highlight the current codes and specifications that apply to steel joist construction and provide insight into the best way to plan your next project.

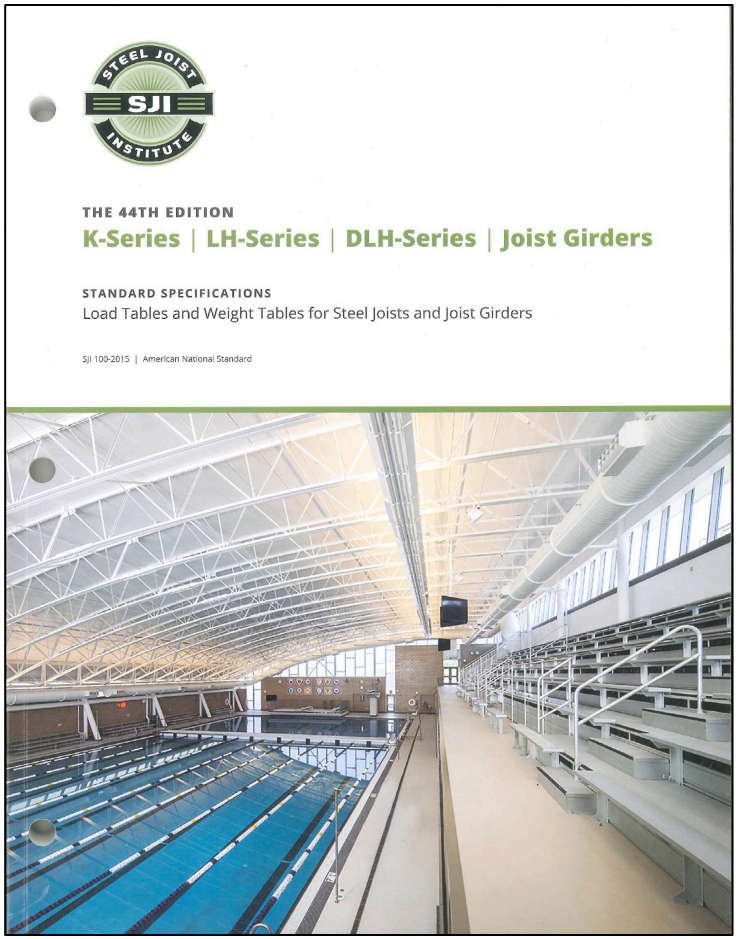
- Practical guidance will be provided to both avoid unnecessary RFIs and to maximize system economy.

Properly Specifying Steel Joists

- **Codes, Specifications, Designations**
- Additional Loads (non-uniform and non-gravity)
- Economy, Responsibility, Tools

Steel Joist Institute (SJI)

- The Steel Joist Institute (SJI) was founded in 1928 and produced first catalog and Specification in 1932
- The SJI current catalog is the 44th edition.
- The catalog includes SJI 100-2015, the Standard Specifications for **K**-Series, **LH**-Series, and **DLH**-Series Open Web Steel Joists and for Joist Girder.



Steel Joist Standard Specifications

ANSI SJI 100 - 2015

Standard Specification for K-Series, LH-Series and DLH-Series Open Web Steel Joists and for Joist Girders.

Current specification combines what were separate design specifications for the K-Series, the LH-/DLH-Series, and Joist Girders into a single specification.

Steel Joist Standard Specifications

ANSI/SJI-CJ-1.0

Standard Specifications for Composite Steel Joists, CJ-Series

Other SJI Documents

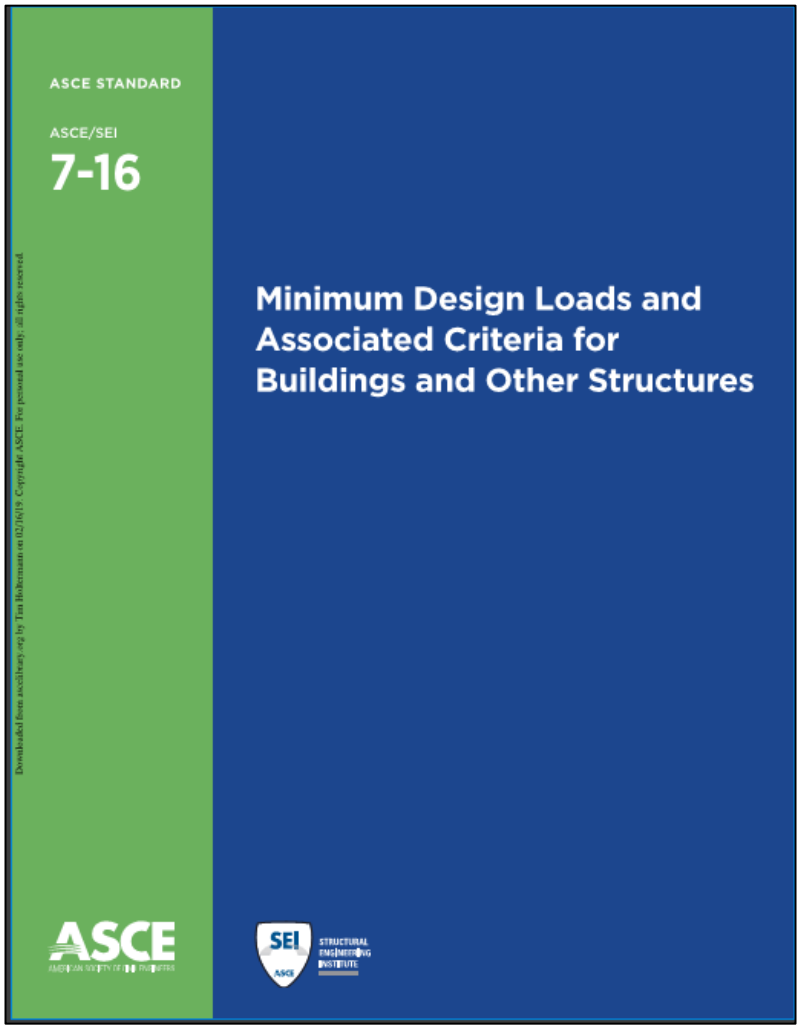
Code of Standard Practice for Steel Joists and Joist Girders (effective Jan. 2015)

ANSI/SJI-CJ COSP-1.0 (2018)

Code of Standard Practice for Composite Steel Joists

ASCE 7


ASCE STANDARD
ASCE/SEI
7-10
Minimum Design
Loads for Buildings
and Other Structures
This document uses both the
International System of Units (SI)
and customary units
ASCE


ASCE STANDARD
ASCE/SEI
7-16
Minimum Design Loads and
Associated Criteria for
Buildings and Other Structures
ASCE
SEI

ASCE 7-10 LOAD COMBINATIONS

2.3 Combining Factored Loads Using Strength Design

2.3.2 Basic Combinations

1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
4. $1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $1.2D + 1.0E + L + 0.2S$
6. $0.9D + 1.0W$
7. $0.9D + 1.0E$

ASCE 7-10 LOAD COMBINATIONS

2.4 Combining Nominal Loads Allowable Stress Design

2.4.1 Basic Combinations

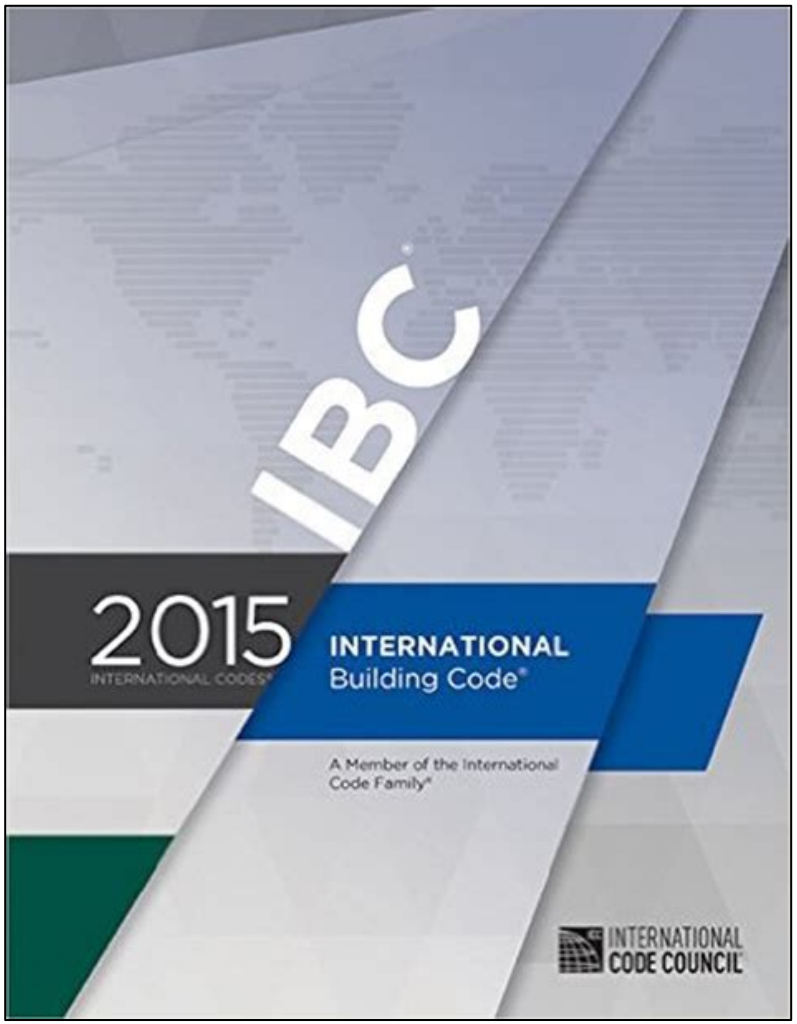
1. D
2. $D + L$
3. $D + (L_r \text{ or } S \text{ or } R)$
4. $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
5. $D + (0.6W \text{ or } 0.7E)$

6a. $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$

6b. $D + 0.75L + 0.75(0.7E) + 0.75S$

7. $0.6D + 0.6W$
8. $0.6D + 0.7E$

IBC


IBC
2015
INTERNATIONAL CODES
INTERNATIONAL
Building Code
A Member of the International Code Family
INTERNATIONAL CODE COUNCIL


2018
INTERNATIONAL CODES
IBC
A Member of the International Code Family
INTERNATIONAL
BUILDING CODE
ICC

Factory Mutual

Scope & Definitions

Joist Girders, K-Series, LH-Series, and DLH-Series shall be open web, in-plane load-carrying steel members utilizing hot-rolled or cold-formed steel, including cold-formed steel whose yield strength has been attained by cold working.

Joist Girders shall be open web steel trusses used as primary framing members designed as simple spans supporting in-plane concentrated loads for a floor or roof system. These concentrated loads shall be considered to act at the top chord panel points of the **Joist Girders** unless otherwise specified.

Joist Girders shall be designed and manufactured as either simple framing members with underslung ends and bottom chord extensions or as part of an ordinary steel moment frame (OMF). Where used as part of an OMF the specifying professional shall be responsible for carrying out all the required frame analyses (i.e. first-order and second-order), provide all the required load information and stiffness data to the joist manufacturer, and indicate the type of **Joist Girder** to column connections that are being designed on the structural drawings.

Joist Basics

2015 SJI Series

Joist Series	Depth (in.)	Span (ft.)	Capacity (lbs/ft.)
K	10 - 30	10 - 60	Varies w/ Span
KCS	10 - 30	10 - 60	In terms of Moment and Shear
Substitutes	2.5 (*)	4 - 10	Varies w/ Span
LH	18 - 48	22 - 96	Varies w/ Span
DLH	52 - 120	62 - 240	Varies w/ Span

2015 SJI Series

Joist Series	Depth (in.)	Span (ft.)	Capacity (lbs/ft.)
Joist Girders	20 - 120	20 - 120	Varies w/ Span
CJ	10 - 96	20 - 120	300 – 4500 (LRFD)

Standard Designations

The **K**-Series, **LH**-Series and **DLH**-Series standard joist designations shall be established by their nominal depth, followed by the letters **K**, **LH** or **DLH** as appropriate, and then by the Section Number designation assigned. The Section Number designations shall range from 01 to 25. The **K**-Series, **LH**-Series and **DLH**-Series standard joist designations listed in the Standard Load Tables shall support the uniformly distributed loads as provided in the applicable tables. The red figures in the tables represent the uniform load that will produce an approximate deflection of 1/360 of the span.

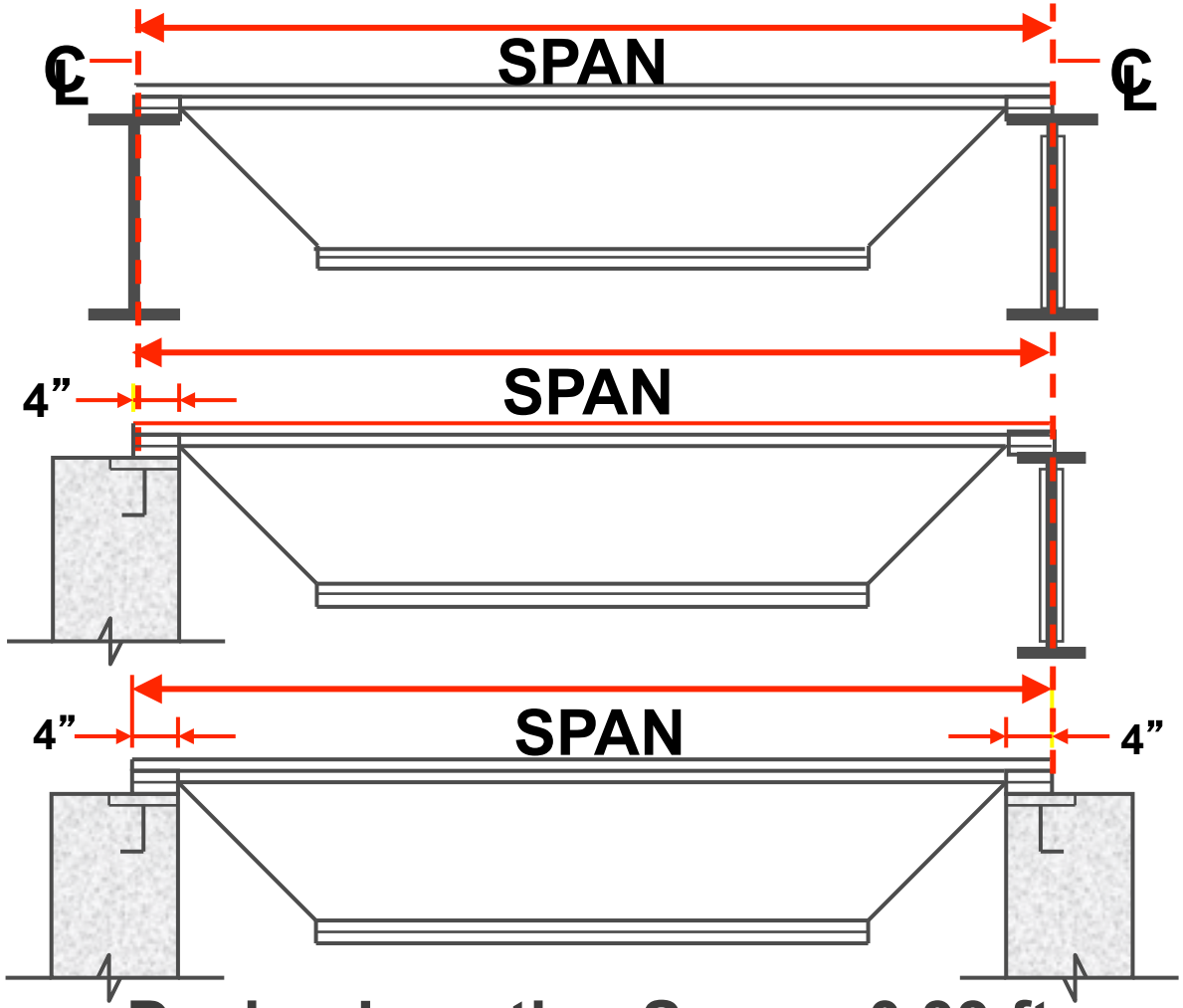
Tables are published for both **ASD** and **LRFD** (factored).

ASD

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12	26K5	26K6	26K7	26K8	26K9	26K10	26K12
Depth (In.)	24	24	24	24	24	24	24	24	26	26	26	26	26	26	26
Approx. Wt. (lbs./ft.)	7.8	7.9	8.5	9.0	9.4	10.3	11.7	13.5	8.1	8.6	9.0	9.7	10.4	11.8	13.7
Span (ft.) ↓															
23	550	550	550	550	550	550	550	550							
	550	550	550	550	550	550	550	550							
24	520	550	550	550	550	550	550	550							
	516	544	544	544	544	544	544	544							
25	479	540	550	550	550	550	550	550	550	550	550	550	550	550	550
	456	511	520	520	520	520	520	520	550	550	550	550	550	550	550
26	442	499	543	550	550	550	550	550	542	550	550	550	550	550	550
	405	453	493	499	499	499	499	499	535	541	541	541	541	541	541
27	410	462	503	550	550	550	550	550	502	547	550	550	550	550	550
	361	404	439	479	479	479	479	479	477	519	522	522	522	522	522
28	381	429	467	521	550	550	550	550	466	508	550	550	550	550	550
	323	362	393	436	456	456	456	456	427	464	501	501	501	501	501
29	354	400	435	485	536	550	550	550	434	473	527	550	550	550	550
	290	325	354	392	429	436	436	436	384	417	463	479	479	479	479

Definition of Span



Design Length = Span – 0.33 ft.

K-Series Joists

- Designations: 10K1 to 30K12
- Depths: 10 to 30 in.
- Standard Seat Depth (Height): 2.5 in.
- Span Range: 10 to 60 ft.
- ASD Load Range: 127 to 550 plf
- LRFD Load Range: 190 to 825 plf
- Maximum Span/Depth Ratio: 24

LH-Series Joists

- Designations: 18LH02 to 48LH17
- Depths: 18 to 48 in.
- Standard Seat Depth (Height): 5 in. up to #17
- Span Range: 21 to 96 ft.;
- ASD Load Range: 178 to 1068 plf;
- LRFD Load Range: 267 to 1602 plf;
- Maximum Span/Depth Ratio: 24

DLH-Series Joists

- Designations: 52DLH10 to 120DLH25
- Depths: 52 to 120 in.
- Standard Seat Depth (Height): 5 in. up to #17 chords, 7.5 in. for #18 and #25 chords
- Span Range: 90 to 240 ft.
- ASD Load Range: 211 to 1304 plf;
- LRFD Load Range: 316 to 1956 plf;
- Maximum Span/Depth Ratio: 24

LH/DLH Profiles

Profile types: Parallel Chord, Single Pitch, Double Pitch; Underslung or Bottom Chord Bearing

Parallel Chords, Underslung

Parallel Chords, Square Ends

Top Chord Pitched One Way, Underslung

Top Chord Pitched One Way, Square Ends

Top Chord Pitched Two Ways, Underslung

Top Chord Pitched Two Ways, Square Ends

Chord Section Numbers

The chord section number is simply an indicator of the Load Table column or row, as well as a key to table for bridging, bearing, etc. It does not imply a specific chord section size for all spans of a given designation.

Note: no 24K11

ASD

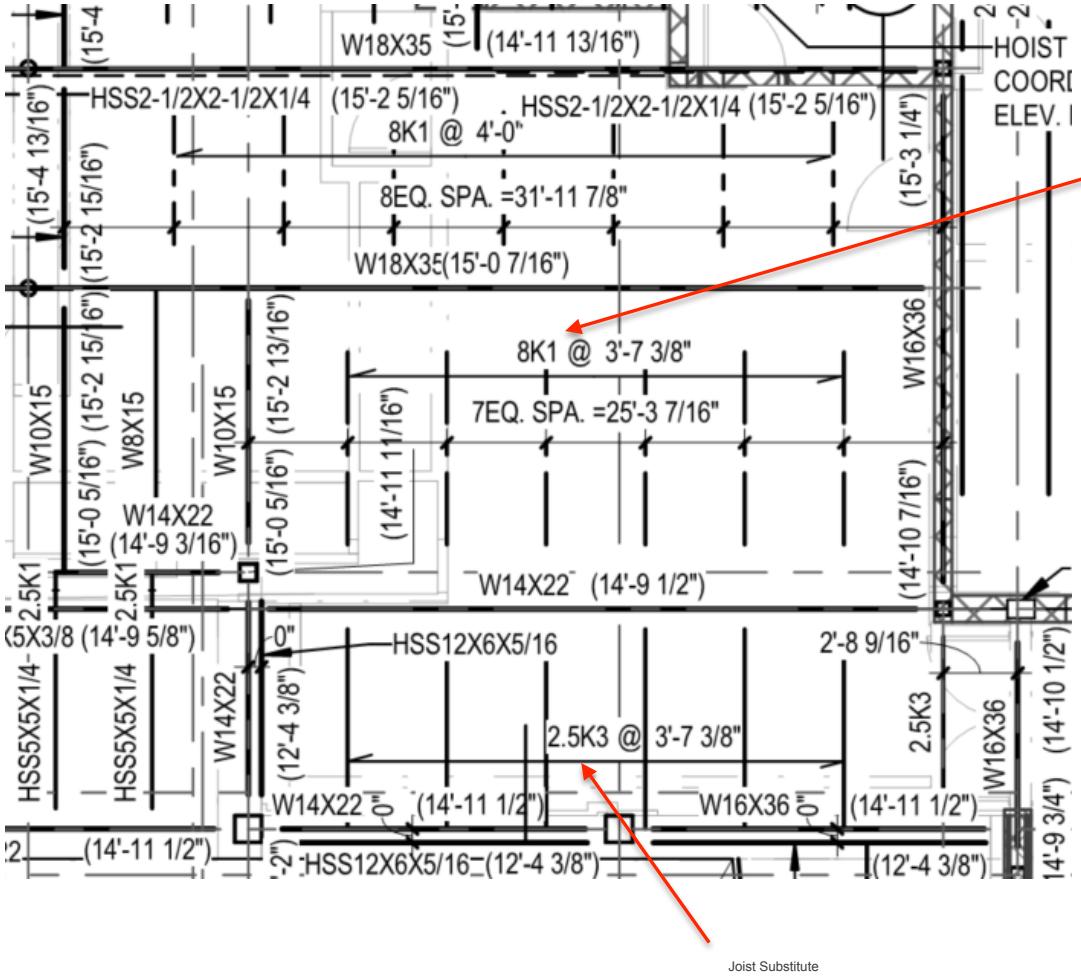
STANDARD LOAD TABLE FOR OPEN WEB S
Based on a 50 ksi Maximum Yield Strength - Loads Sho

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12
Depth (In.)	24	24	24	24	24	24	24	24

Note that for K-Series, not all sequential chord section numbers are used.

Avoid an RFI !

Short Joist Spans



The 8K1 designation has been eliminated. Either use a 10K1, or a joist substitute.

Avoid an RFI !

Joist Substitutes

Used where Open Web Steel Joist may not be applicable.

Standard depth = 2.5”. Deeper depths may be available from joist manufacturer.

(Joist) Spans 10 feet or less

Joist Substitutes standard depths are 2.5 inches and may have extended ends for overhangs (outriggers).

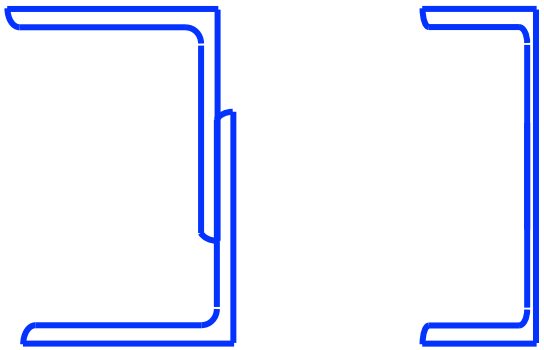
“Double” joist substitutes can be used to obtain capacities other than those in the Load Table, or the spacing can be varied.

Joist Substitutes

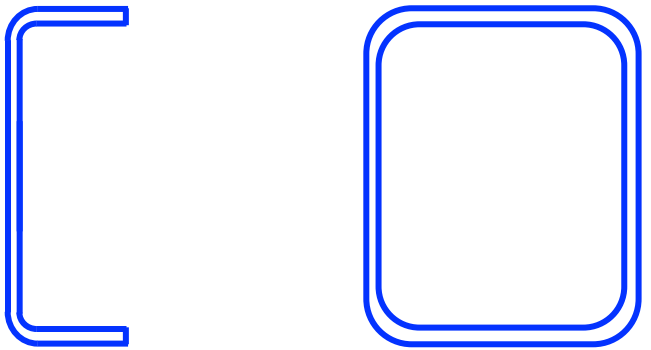
Designations: **2.5K1, 2.5K2, 2.5K3**

Construction:

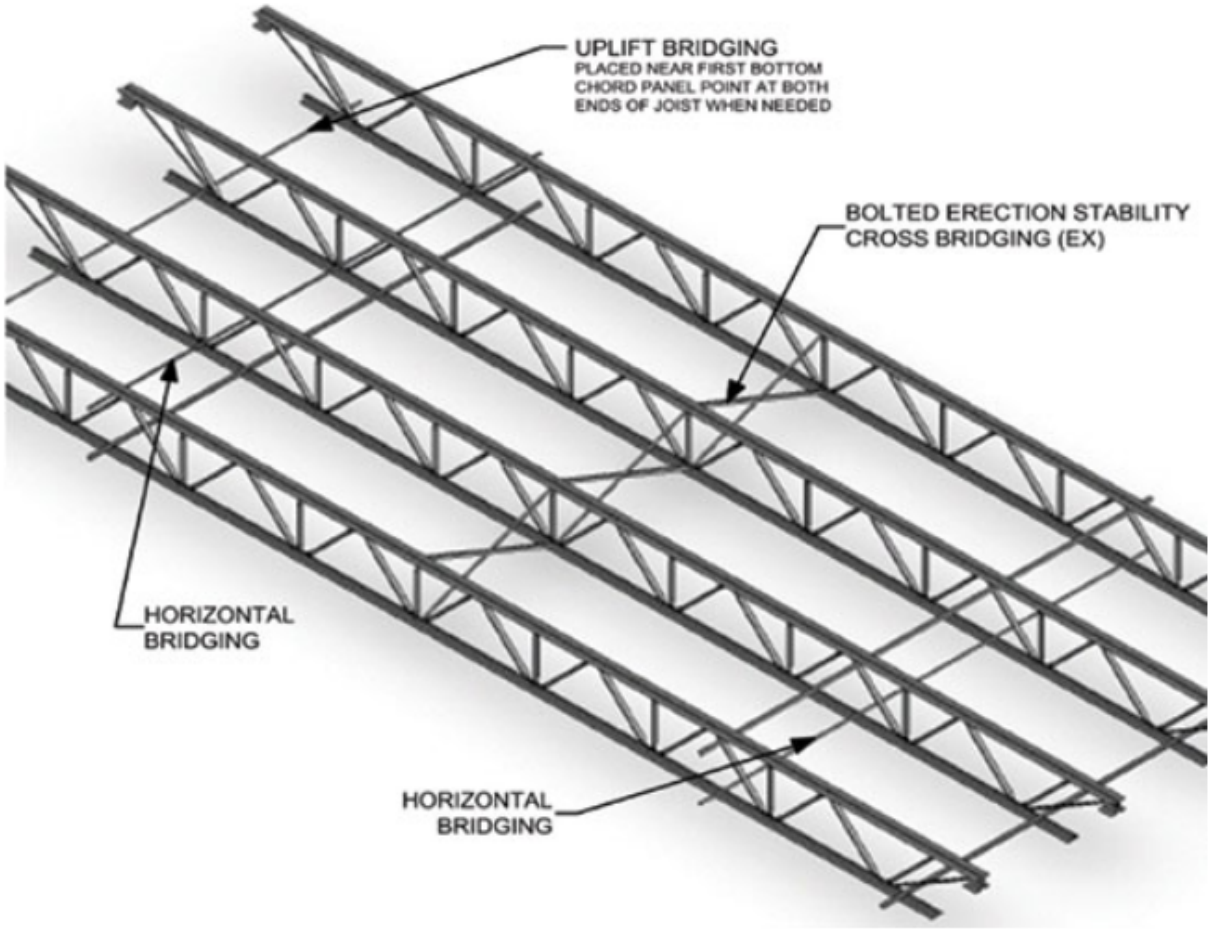
Hot-Rolled



Cold-Formed



Types of Bridging



Specifying Bridging

- The SJI Specification provides a table for the minimum number of top chord bridging rows, by chord Section Number and span.
- Shaded areas of the Load Tables indicate where bolted diagonal bridging may be required in lieu of welded horizontal bridging.
- The Code of Standard Practice provides tables for the bridging member sizes, depending on the type of bridging, the joist spacing, and the chord Section Number of joist depth.

Joist Girders

- Depths: 20 to 120 in.
- Standard Seat Depth (Height): 7.5 in.
- Spans: 20 to 120 ft.
- ASD Panel Point Loads: 4 to 56 kips
- LRFD Panel Point Loads: 6 to 84 kips
- Weights: 15 to 200 plf
- Various Web Configurations: G, VG, BG
- Designation: 48G8N9K; 48G8N13.5F
  - 48G is the Depth in inches
  - 8N is the Number of Joist Spaces
  - 9K is the unfactored load at each panel point
  - 13.5F is the factored load at each panel point

Joist Girder Weight Tables

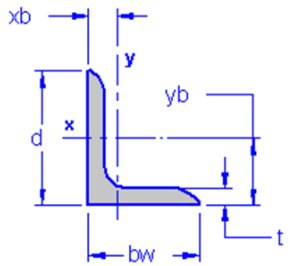
Joist Girder estimated self weight for combinations of Span, Depth, # of Panels, and panel point kip ASD or LRFD loading.

GIRDER SPAN (ft)	JOIST SPACES (ft)	GIRDER DEPTH (in)	JOIST GIRDER WEIGHT -- POUNDS PER LINEAR FOOT																					
			LOAD ON EACH PANEL POINT -- KIPS																	ASD		LRFD	
			6	8	10	12	14	16	18	20	24	28	32	36	40	44	48	52	56	60	70	80	90
			9	12	15	18	21	24	27	30	36	42	48	54	60	66	72	78	84	90	105	120	135
48	5N@ 9.60	36	26	31	37	45	52	59	66	71	87	111	113	135	136	152	167	176	189	200	228	269	
		40	23	29	35	41	46	52	59	68	77	92	112	114	136	138	155	161	178	188	203	237	272
		44	22	27	32	37	44	48	54	61	69	80	93	113	116	126	139	150	160	174	195	226	253
		48	21	25	30	36	40	48	48	55	69	78	90	96	115	116	128	140	142	166	185	219	241
		52	21	25	29	33	39	42	50	54	62	71	82	92	99	117	118	130	141	157	178	206	224
		56	21	24	29	33	38	40	46	50	59	71	79	85	100	100	119	120	133	146	170	200	212
	6N@ 8.00	36	28	35	42	51	62	70	78	83	100	122	134	147	163	175	189	202	222	233	277		
		40	25	33	39	47	56	64	71	79	93	112	124	137	148	168	179	189	212	222	247	282	
		44	24	31	36	45	50	57	65	73	81	102	115	127	138	151	168	173	192	204	236	262	292
		48	23	30	35	40	48	52	59	67	78	95	105	116	129	141	160	166	175	186	220	252	279
		52	23	27	32	38	46	51	59	60	75	83	97	107	130	131	144	162	169	178	208	234	259
		56	22	27	31	37	42	48	54	61	69	80	91	107	120	132	134	153	165	166	191	208	246
	8N@ 6.00	36	36	45	56	64	78	91	100	122	134	153	167	186	213	234	257	278					
		40	33	42	51	59	70	80	92	101	124	148	157	170	191	208	229	248	272	288			
		44	32	39	49	55	65	74	82	95	114	127	150	161	185	193	212	223	244	268			
		48	30	37	47	53	60	68	76	84	105	129	131	154	174	189	197	216	226	247	290		
		52	30	36	44	51	59	65	71	80	99	119	132	146	164	185	195	209	221	239	283		
		56	28	36	43	49	57	63	69	78	90	109	123	136	155	168	189	198	209	228	258	294	

Joist Girders

Joist Girder Weight Tables

- The weight table can not cover every combination of span, panel spacing and kip loading
- A Joist Girder can be made to fit within any of the “gaps” in the weight table
- The tables are based on a maximum chord angle size of 8” x 8”.
- Grey shading in the Weight Table indicates the bearing set depth should be increased from 7-1/2” to 10”.

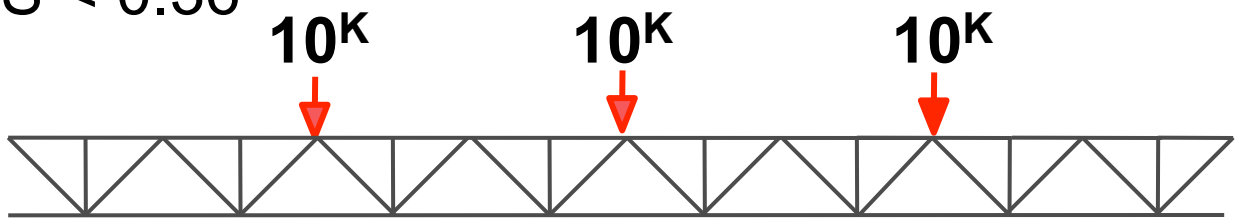


Avoid an RFI !

Joist Girder Web Configurations

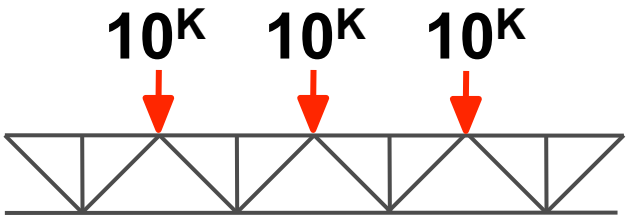
Possible joist girder web configurations:

For D/S < 0.36



G4N10K

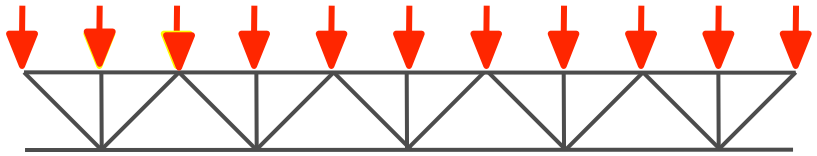
For 0.36 < D/S < 0.70



G4N10K

Joist Girder Web Configurations

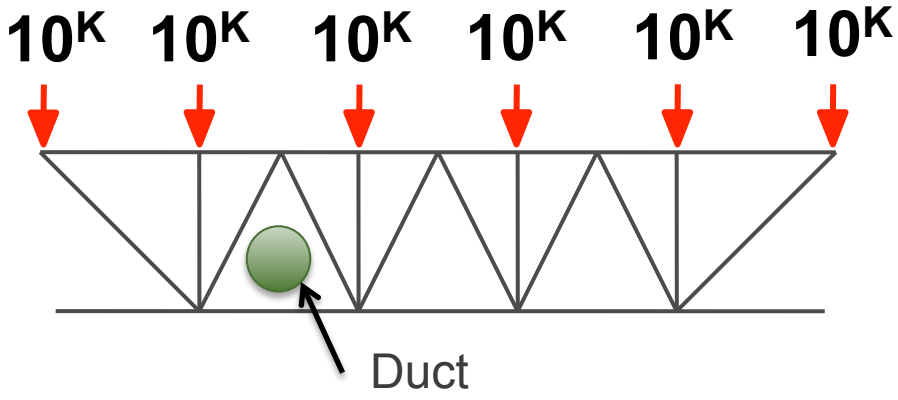
For D/S > 0.70



10K (typ.)

BG10N10K

For D/S < 0.70 only



VG5N10K

Unless a specific geometry is required, simply designate as “G” regardless of D/S ratio and all the Joist Manufacturer to make the most economical choice.

Avoid an RFI !

KCS Joists

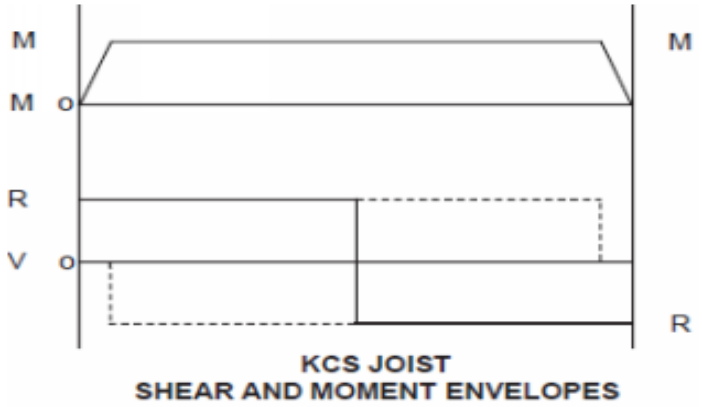
- Designations: 10KCS1 to 30KCS5
- Depths: 10 to 30 in.
- Seat Depth (Height): 2.5 in.
- Span Range: 10 to 60 ft.
- Constant Moment Capacity
- Constant Shear Capacity
- Maximum Span/Depth: 24
- Maximum uniform load = 550 plf (ASD) 825 plf (LRFD)

KCS Joists Background

- Web forces based on constant shear capacity, not shear due to uniform load
- Minimum Shear = 100% of Shear Capacity
- All Webs designed for compression (load reversal) except end web.
- **Shall be parallel chord only.**
- Gross Moment of Inertia from Tables can be used for deflection checks.
- Single concentrated load shall not exceed shear capacity in tables.
- Versatile for non-uniform loads and loading requirements which may change over time.

KCS Joists

KCS joists provide a “envelope” of moment and shear capacity.



KCS JOIST
SHEAR AND MOMENT ENVELOPES

ASD

STANDARD LOAD TABLE FOR KCS OPEN WEB STEEL JOISTS
Based on a 50 ksi Maximum Yield Strength

JOIST DESIGNATION	DEPTH (in.)	MOMENT CAPACITY (k-in.)	SHEAR CAPACITY* (lbs)	APPROX. WEIGHT** (lbs/ft.)	GROSS MOMENT OF INERTIA ($in.^4$)	ERECTION STABILITY BRIDGING REQ'D (ft.)	BRIDGING TABLE SECTION NUMBER
10KCS1	10	172	2000	6.0	29	NA	1
10KCS2	10	225	2500	7.5	37	NA	1
10KCS3	10	296	3000	10.0	47	NA	1
12KCS1	12	209	2400	6.0	43	NA	3
12KCS2	12	274	3000	8.0	55	NA	5
12KCS3	12	362	3500	10.0	71	NA	5

While KCS joists can accommodate concentrated loads within the moment and shear envelopes, there is not provision for concentrated loads away from panel points.

While KCS joists can be checked for uplift loads, they should not be called out as “SP” for other applied loads. Either select a KCS designation to cover all applied loads, or utilize a load diagram for a K- or LH-Series joist.

Avoid an RFI !

“load/load” Designation

An alternate method of specifying a standard **K-**Series, **LH-**Series, or **DLH-**Series joist shall be permitted by providing the designation in a “load/load” sequence. The format used shall be dd**K**tl/ll, dd**LH**tl/ll, or dd**DLH**tl/ll where:

- dd is the depth of the joist in **inches**.
- K-LH-DLH is the joist series
- tl is the total load in **plf**. (pounds per linear foot)
- ll is the live load in **plf**. (pounds per linear foot)

An example: 24K300/175

Note: Uplift must be specified independent to the designation.

“load/load” Designation

The SJI publishes a Weight Table to provide guidance for parallel chord “load/load” joists.

Bearing and bridging requirements can be determined from the Weight Table, the Specification requirements, and/or interpolation from Standard Designation joists.

Note that the Weight Table extends the maximum uniform load capacities well beyond the Standard Designations, for spans up to 60 feet - 2,400 plf ASD and 3,600 LRFD – which is useful for many floor loading scenarios.

STANDARD WEIGHT TABLE FOR LOAD/LOAD LH-SERIES JOISTS

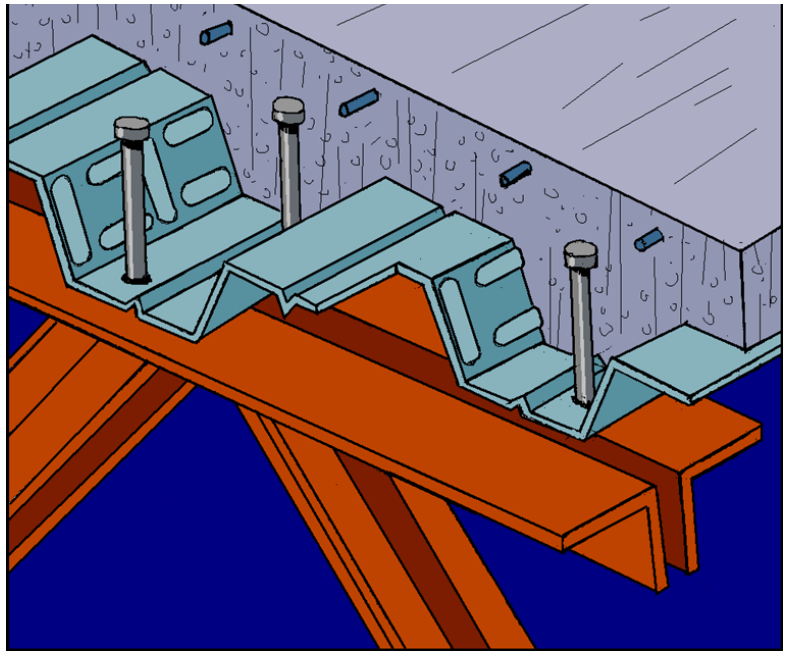
Based on a 50 ksi Maximum Yield Strength

Joist Span (ft)	Joist Depth (in)		Total Uniformly Distributed Joist Load in Pounds per Linear Foot													
		LRFD	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	2400	2550	2700
		ASD	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
	20	Wt.	16.9	20.1	23.2	27.8	30.0	32.8	40.3	40.6	46.6	46.9	50.2	53.1	59.0	63.2
		w360	259	312	360	419	456	497	587	598	689	689	744	784	833	882
		Ix	396	465	543	641	689	752	916	916	1055	1055	1118	1188	1276	1352
		Pbrg	761	921	1030	1341	1341	1467	1833	1833	2123	2123	2404	2404	2684	3044
	22	Wt.	15.2	19.1	22.0	24.4	27.7	31.0	36.3	37.4	40.2	43.6	46.3	49.7	52.5	55.6
		w360	287	357	412	458	515	578	653	681	737	790	850	901	958	993
		Ix	435	547	631	701	789	886	1017	1035	1130	1210	1302	1380	1468	1521
		Pbrg	668	875	979	1084	1275	1394	1741	1741	1741	2017	2017	2284	2284	2550

Composite Joists, CJ-Series

- CJ-Series joists utilize shear connections to create composite action between the joist top chord and the overlying concrete slab.
- An example CJ-Series designation is 26CJ1644/960/324

  where 1644 is the total factored composite design load, 960 is the total factored composite live load, and 324 is the total factored composite dead load.
- CJ-Series joists use LRFD.
- The maximum span/depth is 30.



Deflection - the red numbers

- For Standard Designations, loads noted in red are only presented so that the specifier can consider deflection in his selections. They are not used in the joist design. Actual live loads must be specified if load cases other than simple span uniform load are to be considered, such as end moments, axial loads, etc.
- The red numbers relate to a deflection of 1/360 of the span. Linear extrapolation can be used to check the deflection capacity for other limits.

ASD

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12	26K5	26K6	26K7	26K8	26K9	26K10	26K12
Depth (In.)	24	24	24	24	24	24	24	24	26	26	26	26	26	26	26
Approx. Wt. (lbs./ft.)	7.8	7.9	8.5	9.0	9.4	10.3	11.7	13.5	8.1	8.6	9.0	9.7	10.4	11.8	13.7
Span (ft.) ↓															
23	550 550	550 550	550 550	550 550	550 550	550 550	550 550	550 550							
24	520 516	550 544	550 544	550 544	550 544	550 544	550 544	550 544							
25	479 456	540 511	550 520	550 520	550 520	550 520	550 520	550 520	550 550	550 550	550 550	550 550	550 550	550 550	550 550
26	442 405	499 453	543 493	550 499	550 499	550 499	550 499	550 499	542 535	550 541	550 541	550 541	550 541	550 541	550 541
27	410 361	462 404	503 439	550 479	550 479	550 479	550 479	550 479	502 477	547 519	550 522	550 522	550 522	550 522	550 522
28	381 323	429 362	467 393	521 436	550 456	550 456	550 456	550 456	466 427	508 464	550 501	550 501	550 501	550 501	550 501
29	354 290	400 325	435 354	485 392	536 429	550 436	550 436	550 436	434 384	473 417	527 463	550 479	550 479	550 479	550 479

Seat Depths

- The current SJI Specifications are combined for K-, LH-, and DLH-Series joists.
- There are K-Series designations which “overlap” some LH-Series designations, and there is no longer a fundamental design difference.
- Note, however, the difference in standard bearing seat depths: 2.5 in. for K-Series and 5 in. for LH-Series.
- The maximum unfactored end reaction that a K joist can have with a 2.5 in. joist seat depth is approximately 10 kips.
- Special depth bearing seats are far less expensive than seats that aren’t deep enough!

Polling Question 1

For a “load/load” designation, the second load value (expressed in plf) is the?

A. Wind Load

B. The Live Load required to generate L/180 deflection

C. The Live Load for which the deflection shall be checked against the specified limits

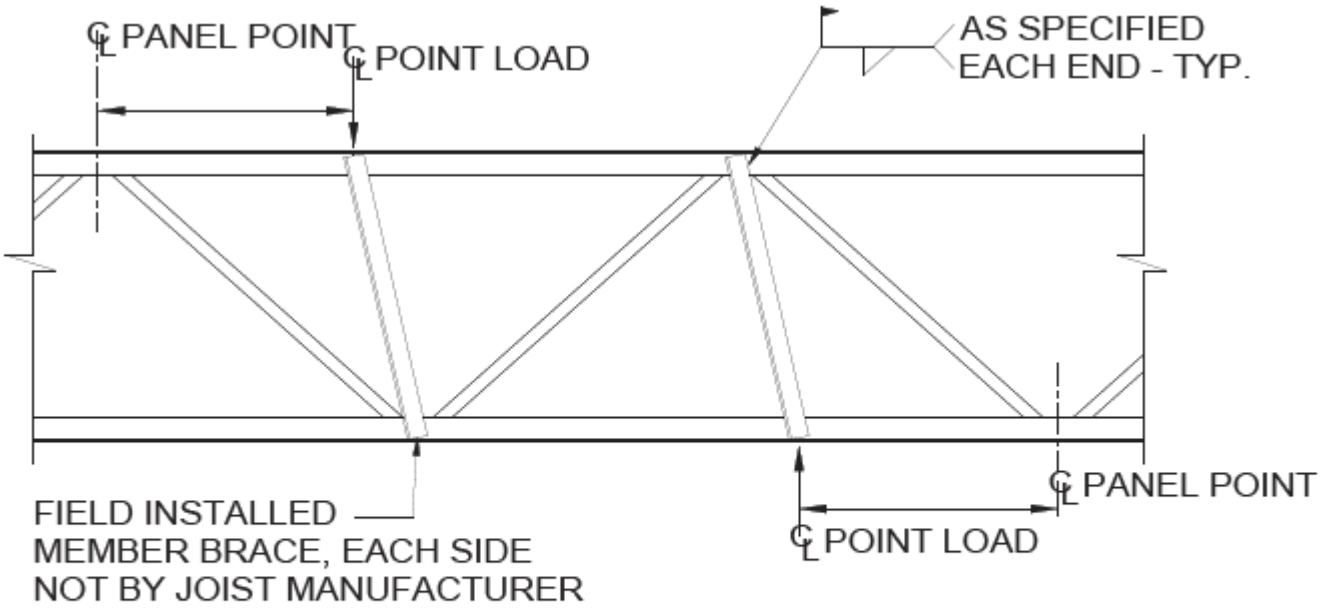
D. Collateral Load

Properly Specifying Steel Joists

- Codes, Specifications, Designations
- **Additional Loads (non-uniform and non-gravity)**
- Economy, Responsibility, Tools

Concentrated Loads at Joist Chords

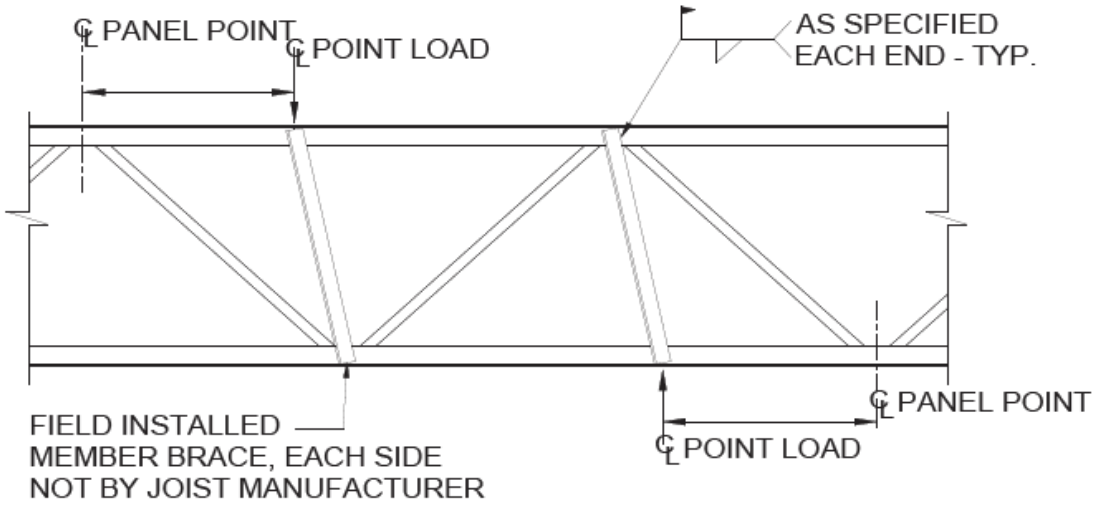
- The SJI Specifications provides a default detail for the field-added struts



TYPICAL JOIST REINFORCMENT AT CONCENTRATED LOADS

Concentrated Loads at Joist Chords

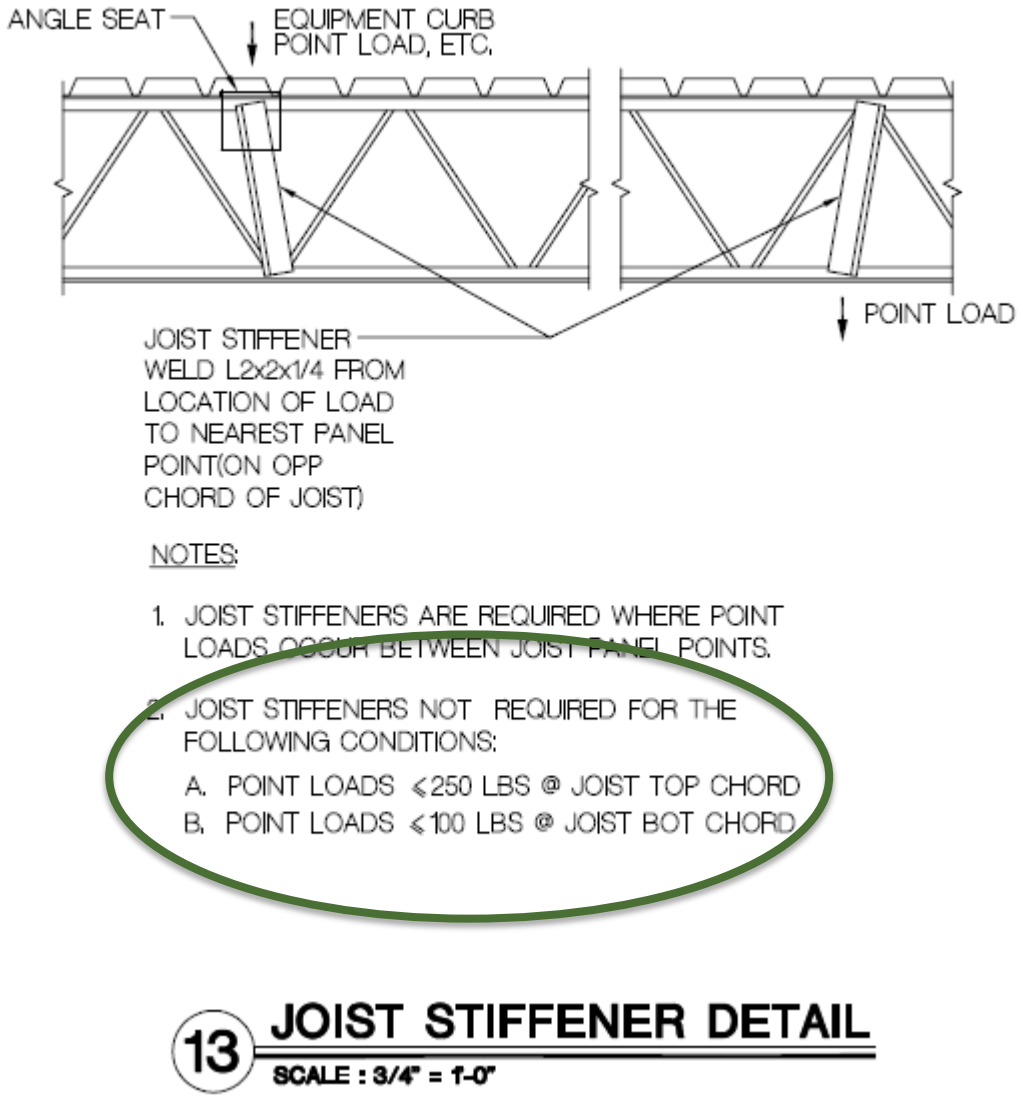
- The specifier determines the brace (strut) size, connection and point load magnitude and location limits
- The joist manufacturer will adjust detail on placement plans to match detail from contract documents



TYPICAL JOIST REINFORCMENT AT CONCENTRATED LOADS

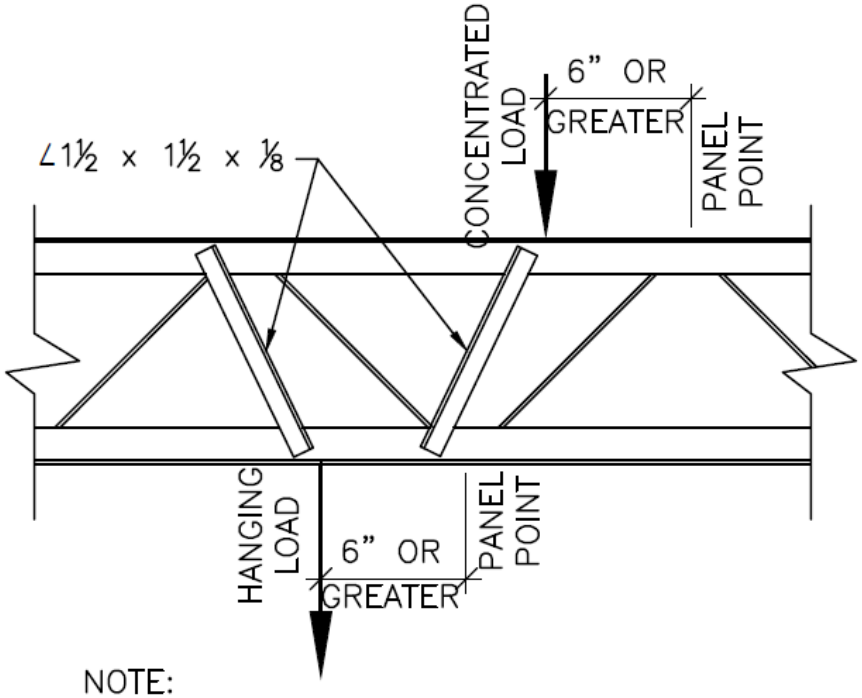
Concentrated Loads at Joist Chords

- Sample detail from structural contract documents
- Joist manufacturer will not analyze for local bending effects of top chord for a 240# point load not located at a panel point



Concentrated Loads at Joist Chords

- Sample detail from structural contract documents
- A web stiffener (strut) is not required for a 140# point load and no local bending effects will be considered



NOTE:
1. SUPPORTING LOAD AT CONDENSERS, MECHANICAL UNITS, AND ALL CONCENTRATED LOADS GREATER THAN 150LBS AND NOT EXCEEDING 500 LBS.

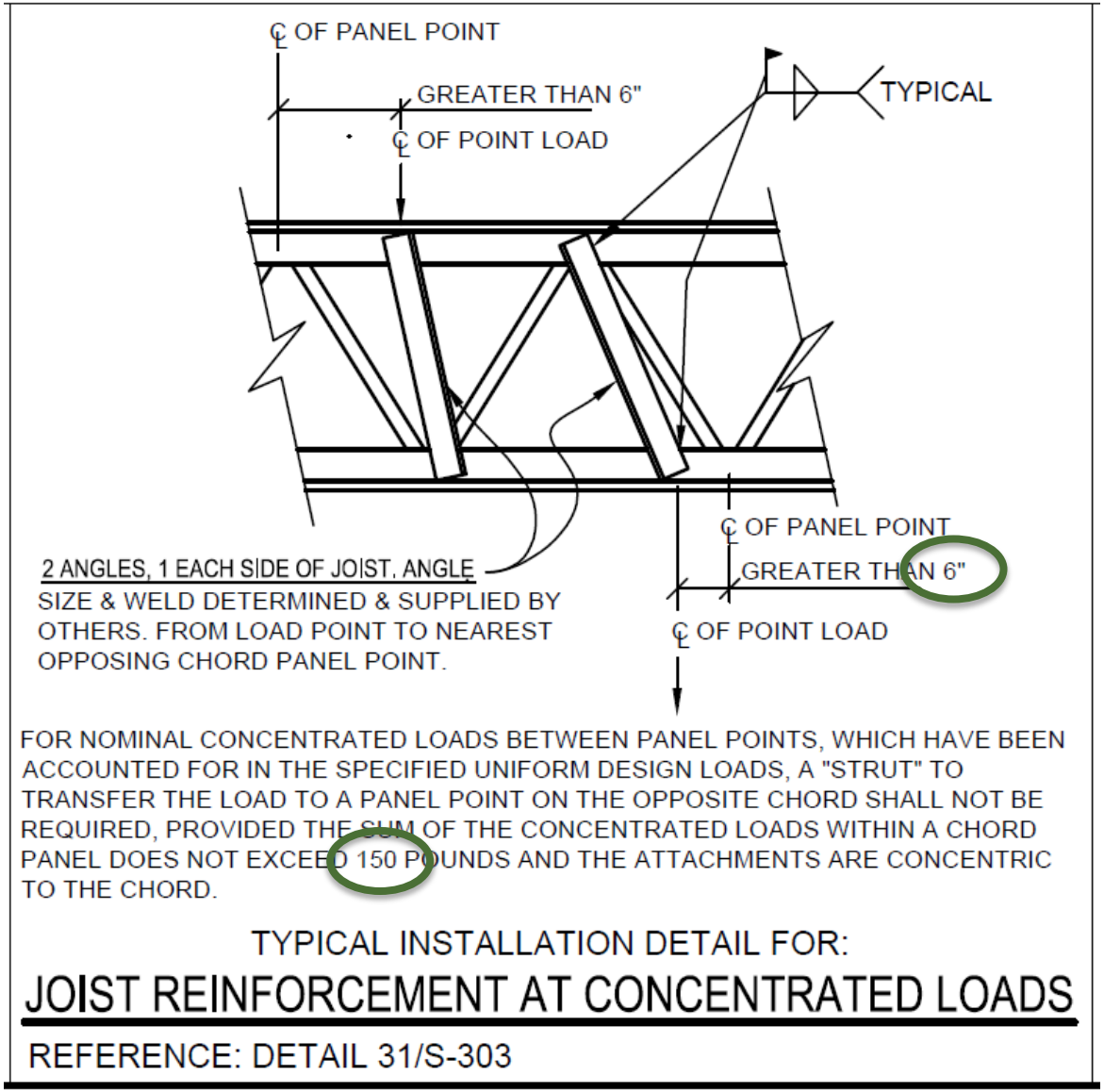
2. A WEB STIFFENER MUST BE APPLIED TO ANY JOIST WHEN A CONCENTRATED LOAD IS PLACED ON THE JOIST 6" OR MORE AWAY FROM A PANEL POINT.

WEB STIFFENER DETAIL 31

SCALE: ¾" = 1'–0"

Concentrated Loads at Joist Chords

- The joist manufacturer applied the 6” dimension and 150# minimum magnitude to require a field-added strut.



Concentrated Loads at Joist Chords

- How can the specifier have the joist manufacturer analyze for local bending effects of point loads that will be placed on joists and not have field-added struts installed?

Code of Standard Practice
Five Options to Specify Joists

Steel Joist Institute – SJI COSP - 2015

CODE OF STANDARD PRACTICE

FOR STEEL JOISTS AND JOIST GIRDERS

Adopted by the Steel Joist Institute April 7, 1931
Revised to Nov. 10, 2014 - Effective Jan.1, 2015

Specifying Joist Design Loads

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.

For other loads, the Specifying Professional shall use one of the five options described below that allows:

- The estimator to price the joists.
- The joist manufacturer to design the joists in accordance with the Standard Specifications of latest adoption.
- The owner to obtain the most economical joists.

Option #1 – Standard Designation

Option 1: Select a joist designation from the Standard Load Table (or specify a joist type using a uniform load in the designation) which has been determined to be adequate for all design loads. The shear and moment envelope resulting from the selected uniform load shall meet the actual shear and moment requirements. Thus, this option alone may not be adequate if large concentrated loads need to be designed for.

- Dead Load = 20 psf, Live Load = 30 psf
- Joists spaced at 5'-0" on center and spanning 25'
- Select economical joist for uniform loading of 250/150

ASD K-SERIES ECONOMY TABLE - STANDARD UNITS

Joist Designation	10K1	12K1	14K1	16K2	12K3	14K3	16K3	18K3	20K3	14K4	16K4	12K5	18K4	20K4	22K4	16K5
Depth (In.)	10	12	14	16	12	14	16	18	20	14	16	12	18	20	22	16
Approx. Wt. (lbs./ft)	5.0	5.0	5.2	5.5	5.7	6.0	6.3	6.4	6.5	6.7	7.0	7.1	7.2	7.2	7.3	7.5
Span (ft)																
25			180 100	234 150		226 124	260 167	294 214	329 266	272 145	313 195		355 250	396 312	438 381	353 219

Option #2 – Standard Designation +

Option 2: Select a joist designation from the Standard Load Table (or specify a joist type using a uniform load in the designation) and also provide the load and location of any additional loads on the structural plan with a note "Joist manufacturer shall design joists for additional loads at locations shown." This option works well for a few added loads per joist with known magnitude and locations.

- Select standard joist designation for uniform loading
- Also provide load and location of any additional loads
- "Joist manufacturer shall design joists for additional loads and locations shown."

Taking Option #2 Too Far

13. JOIST MANUFACTURER SHALL DESIGN THE GYM JOISTS FOR THE TYPICAL ROOF LOADS INDICATED ON S000, THE APPLICABLE DRIFT LOADS FROM THE GYM ROOF SNOW DRIFT DIAGRAM ON THIS SHEET, CONCENTRATED LOADS FROM THE ROOFTOP UNITS, AND ANY OTHER MISCELLANEOUS LOADS ON THE JOISTS INCLUDING BUT NOT LIMITED TO BASKETBALL BACKSTOPS, DIVIDER CURTAINS, SCREEN WALL SUPPORTS, KICKERS, ETC.

- JOIST MANUFACTURER SHALL DESIGN THE GYM JOISTS FOR THE TYPICAL ROOF LOADS INDICATED ON S000, THE APPLICABLE DRIFT LOADS FROM THE GYM ROOF SNOW DRIFT DIAGRAM ON THIS SHEET, CONCENTRATED LOADS FROM THE ROOFTOP UNITS, AND ANY OTHER MISCELLANEOUS LOADS ON THE JOISTS INCLUDING BUT NOT LIMITED TO BASKETBALL BACKSTOPS, DIVIDER CURTAINS, SCREEN WALL SUPPORTS, KICKERS, ETC.

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- What if exact location of additional loads are not known or we want to have flexibility for future locations of additional loads?

Concentrated Loads

- SJI provides an option for addressing concentrated loads with unknown locations.
- ADD-LOAD and BEND-CHECK LOAD

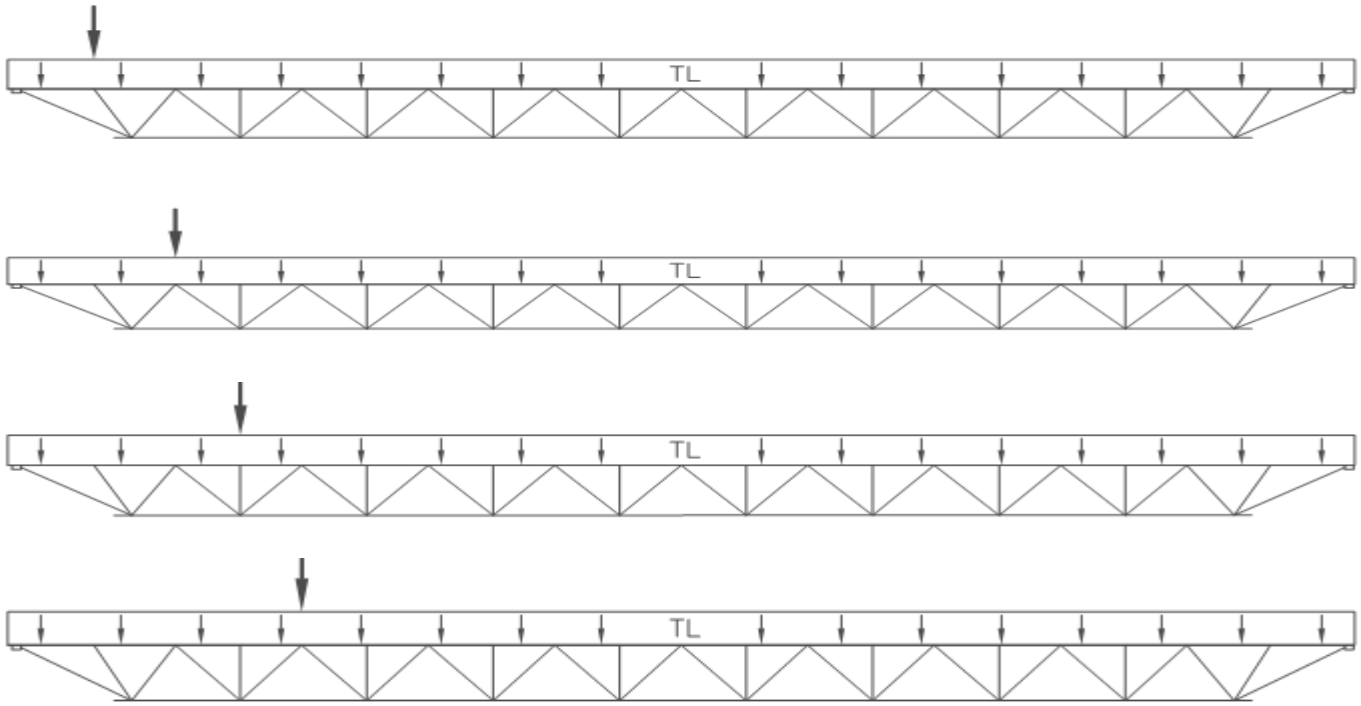
1.3 DEFINITIONS

Add-Load. A single vertical concentrated load that occurs at any one panel point along the joist chord. This load is in addition to any other gravity loads specified.

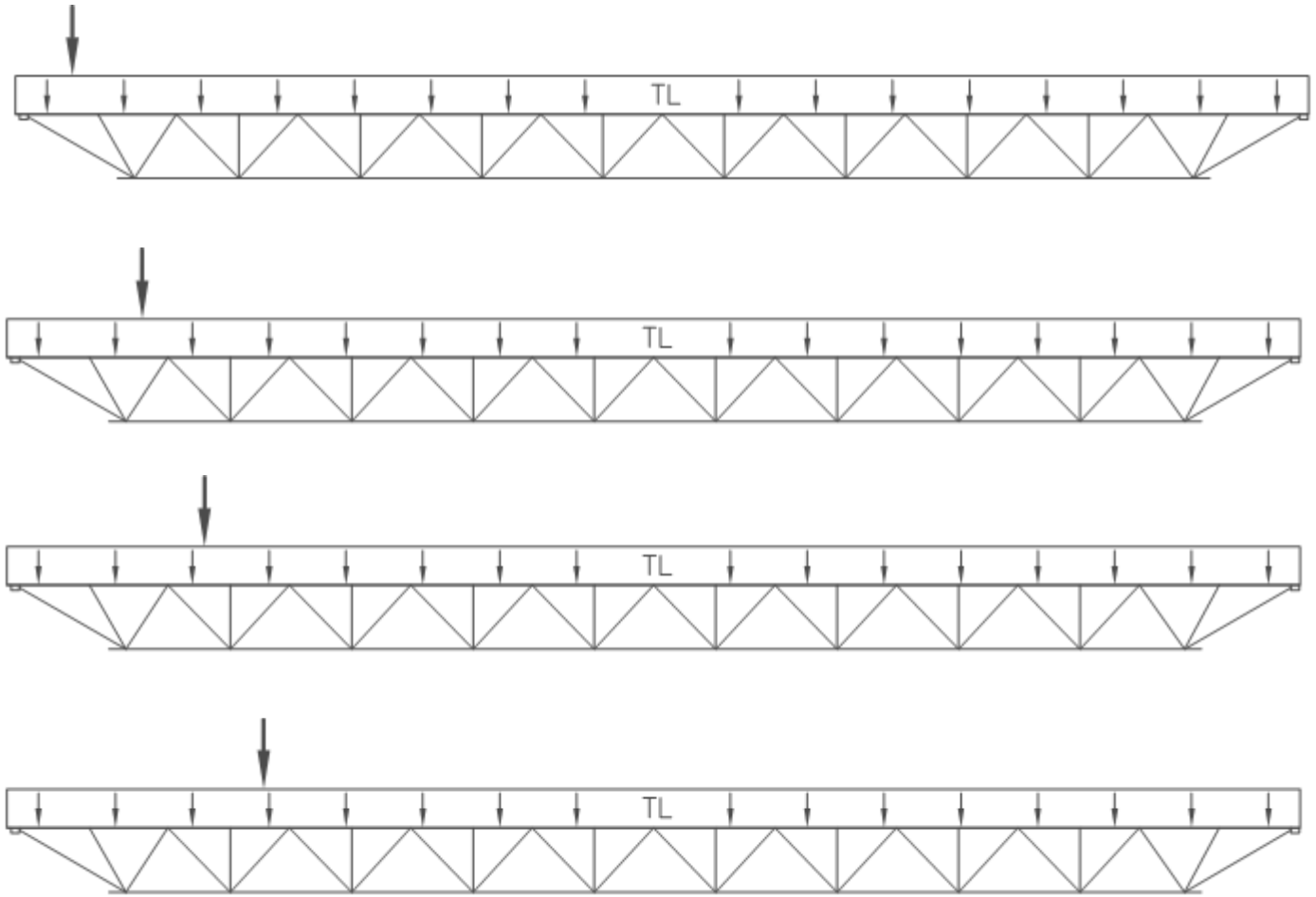
Bend-Check Load. A vertical concentrated load used to design the joist chord for the additional bending stresses resulting from this load being applied at any location between the joist panel points. This load shall already be accounted for in the specified joist designation load, uniform load, or Add-Load and is used only for the additional bending check in the chord and does not contribute to the overall axial forces within the joist. An ideal use of this is for incidental loads which have already been accounted for in the design loading but may induce additional bending stress due to this load occurring at any location along the chord.

Add-Load

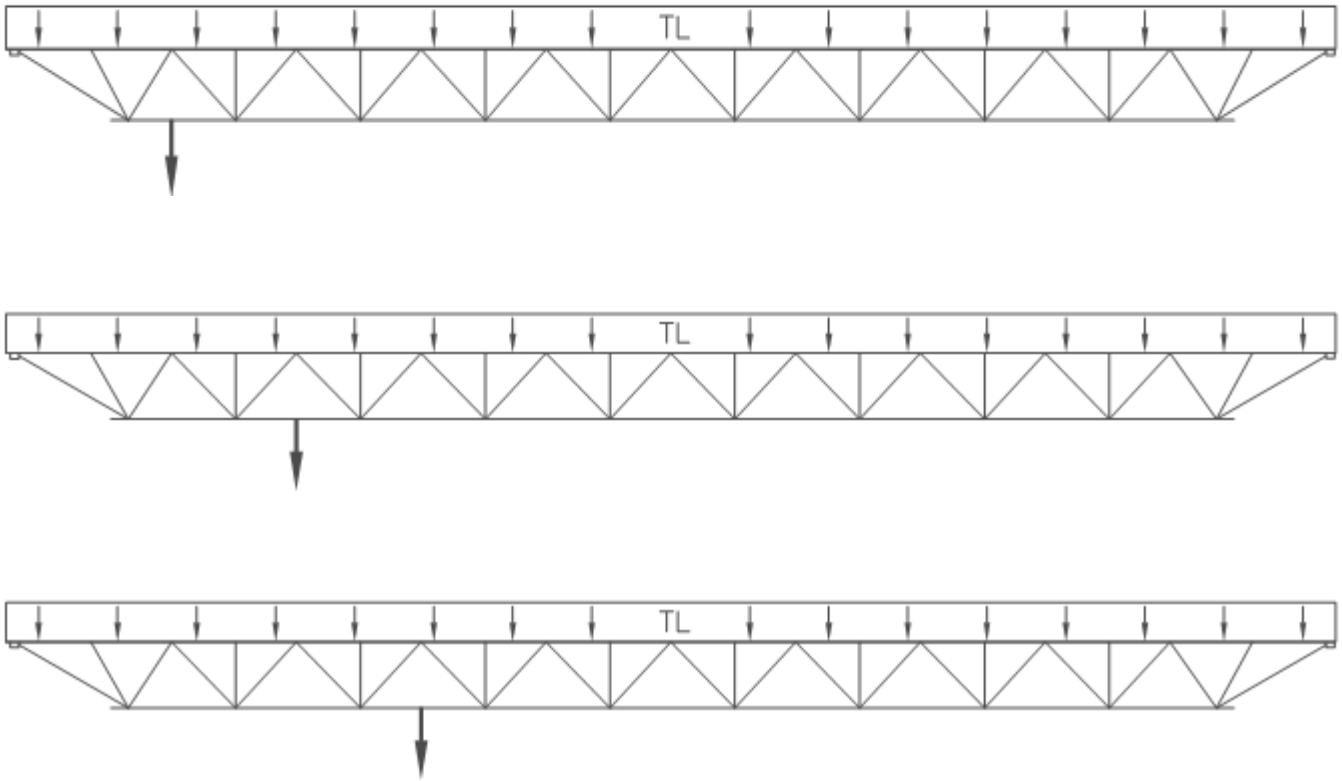
A single vertical concentrated load which occurs at any one panel point along the joist chord. This load is in addition to any other gravity loads.



Top Chord Bend-Check Load



Bottom Chord Bend-Check Load



Option #3 – Concentrated Loads

- Application of ADD-LOAD and BEND-CHECK LOAD in specifying joists on contract documents

Option 3: For additional point loads with exact locations not known along the joist or for incidental loads, any one, or both, of the following can be specified on the structural plan in addition to option 1 or 2 above:

a) "**Design for a (__) lb. concentrated load located at any one panel point along the joist**". This is referred to as an *Add-Load*.

b) "**Design for additional bending stresses resulting from a (__) lb. concentrated load located at any location along (____) chord**". This is referred to as a *Bend-Check* and can be specified on the **top** chord, **bottom** chord, or **both top and bottom** chords. This can be used when the concentrated load is already accounted for in the joist designation, uniform load, or specified *Add-Load* yet this specified amount of load shall be permitted to also be located at any location between panel points. The additional bending stresses as a result of this load are then designed for. A *Bend-Check* load shall not exceed (*Add-Load* + 400 lbs.) A *Bend-Check* load can be specified by itself without an *Add-Load*.

c) Both (a) and (b) above can be specified with equal concentrated loads for each; or simply denote **"Design joist for a (__) lb. concentrated load at any location along the (___) chord."**

Option #3

- SJI provides common situations where specifying an ADD-LOAD and/or BEND-CHECK LOAD would provide clear and economical approach

Example uses:

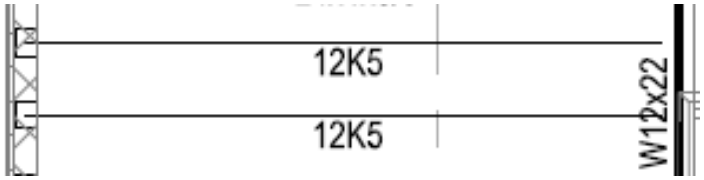
- *Specifying professional* selects a standard joist capable of carrying a 500 lb. RTU. However, the location and exact frame size is not yet known but the frame load shall result in two- 250 lb. point loads at least 5'-0" apart. **Specify a 250 lb. *Bend-Check*.**
- Standard joist specified but not selected for 500 lb. RTU load, location not known. **Specify a 500 lb. *Add-Load* and 250 lb. *Bend-Check*.**
- Standard SJI joist selected to carry collateral load of 3 psf. *Specifying professional* wants bending from 150 lb. incidental loads to also be designed for. **Specify a 150 lb. *Bend-Check*.**

Option #3

THE BOTTOM CHORD OF THE JOIST SHALL BE DESIGNED TO CARRY A 500 POUND POINT LOAD AT ANY POINT ALONG THE BOTTOM CHORD. THIS LOAD CONDITION SHALL BE COMBINED WITH THE FOLLOWING UNIFORM LOADS:

FLOOR JOISTS: (1) DEAD LOAD - 50 PSF
(2) LIVE LOAD - 50 PSF OFFICES, 80 PSF CORRIDORS
(3) PARTITION LOAD - 20 PSF

ROOF JOISTS: (1) DEAD LOAD - 25 PSF
(2) LIVE LOAD - 20 PSF, UNREDUCED



Avoid an RFI !

- Is the 500 point load at any panel point or any location (bend-check)?
- What loads were considered in selection of standard designations?
- 12K5 alone is adequate or 12K5 with add-load and/or bend-check load?

Option #4 – KCS Joists

Option 4: Select a KCS joist using moment and end reaction without specifying added loads or diagrams. This option works well for concentrated loads for which exact locations are not known or for multiple loading.

a) Determine the maximum moment.

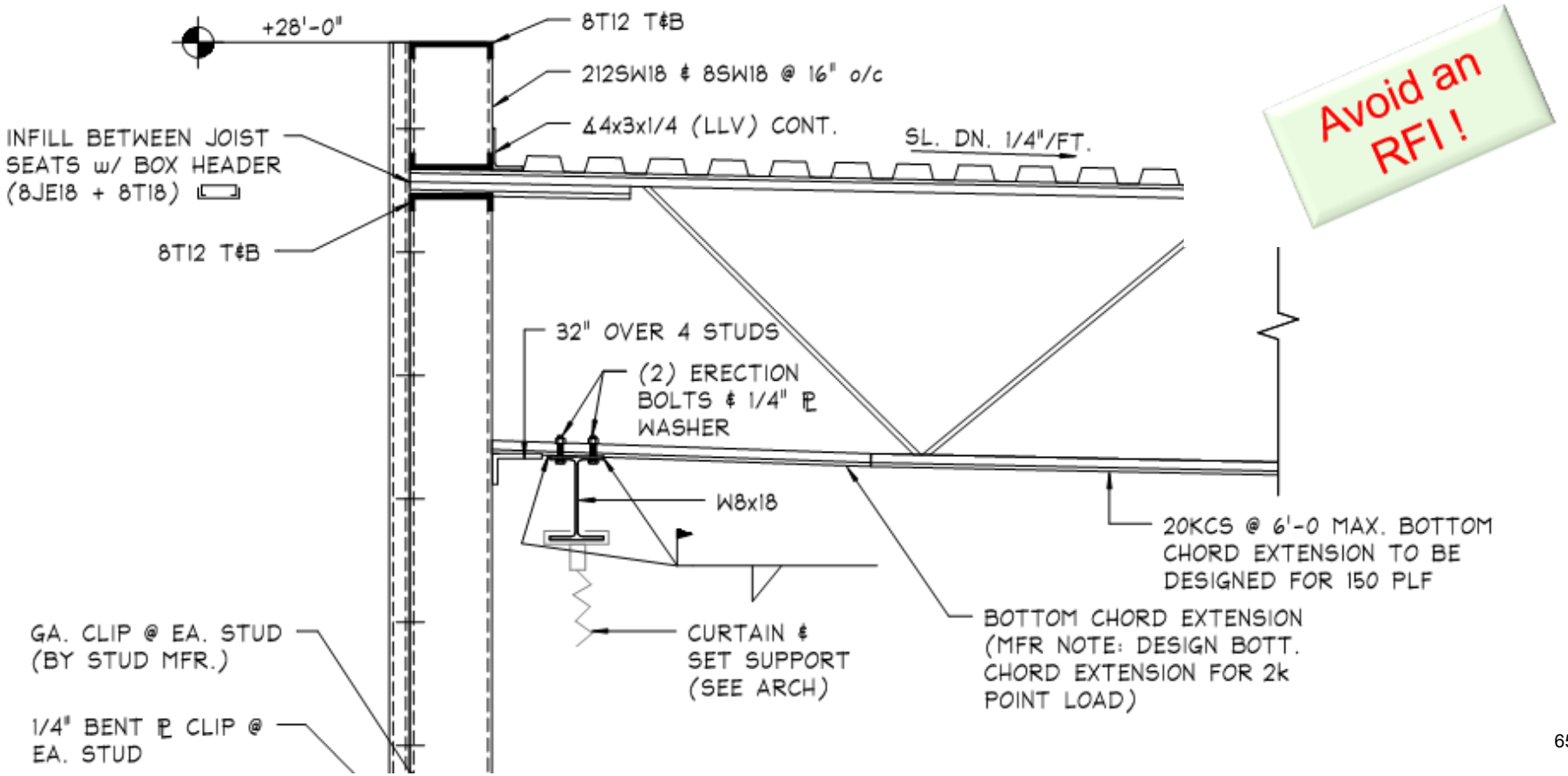
b) Determine the maximum end reaction (shear).

c) Select the required KCS joist that provides the required moment and end reaction (shear). Note that the top chord end panel is designed for axial load based on the force in the first tension web, that is based on the specified end reaction. A uniform load of 825 plf (12030 N/m) LRFD or 550 plf (8020 N/m) ASD is used to check end panel bending. If the end panel loading exceeds this, reduce the joist spacing or go to Option 5.

d) Specify on the structural drawings that an extra web shall be field applied at all concentrated loads not occurring at panel points.

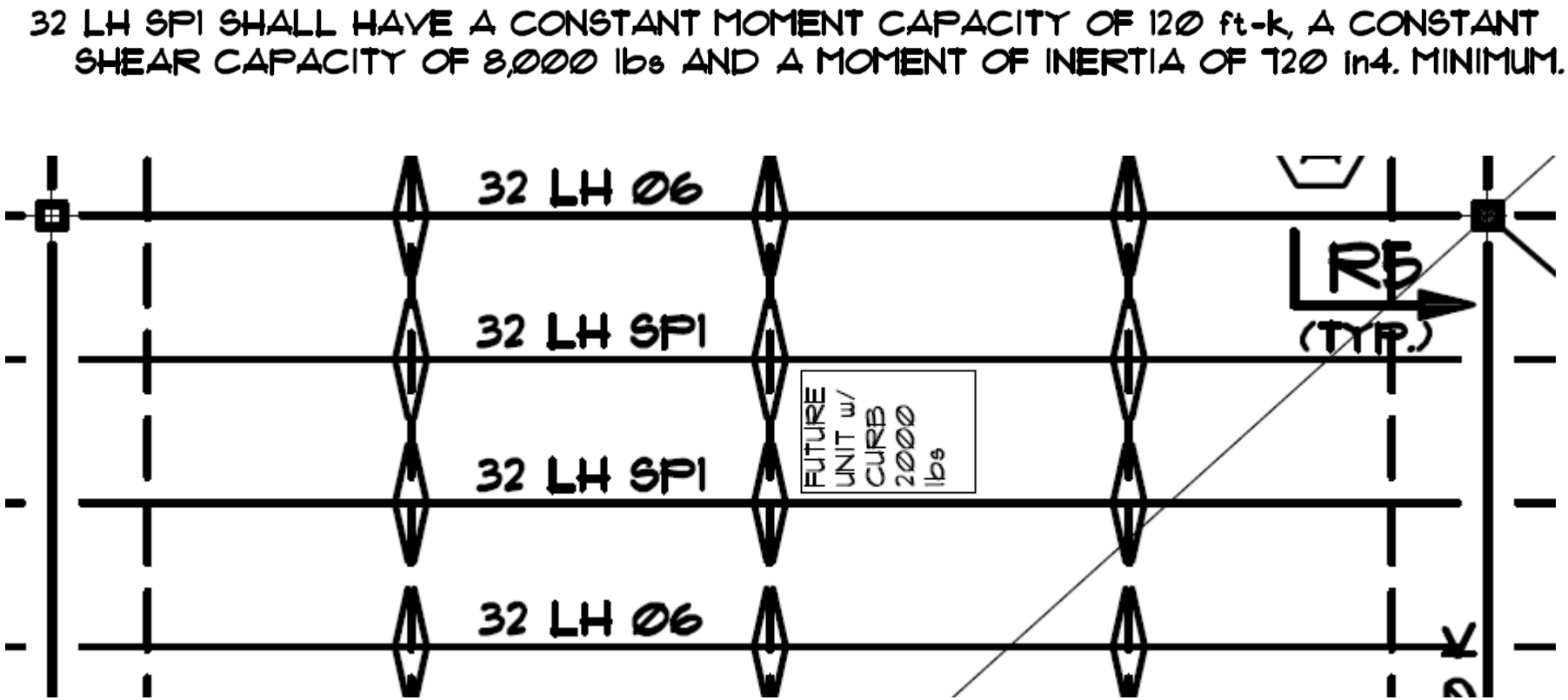
Option #4 – KCS Joists

- Joist manufacturer assumes ALL loads were considered by specifier when selecting KCS joist



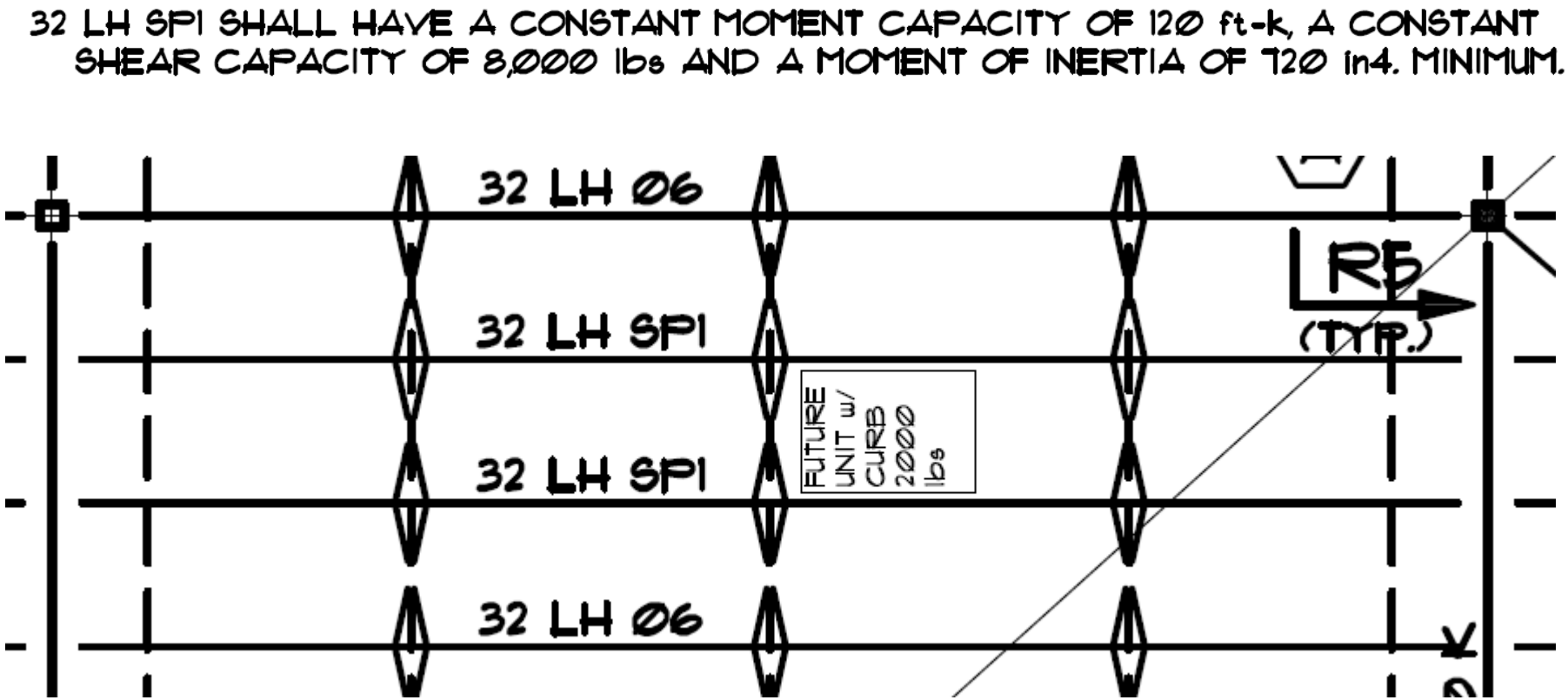
Option #4 – KCS Joists

- Refrain from creating an LHCS
- Do not mix LH-series with KCS-series



Option #4 – KCS Joists

- Better approach would be standard designation with ADD-LOAD and BEND-CHECK (option 3)



Option #5 – Load Diagram

Option 5: Specify a SPECIAL joist designation when the joist includes more complex loading or for conditions which need consideration of multiple potentially controlling load combinations.

a) Provide a load diagram and/or enough information on the drawings to clearly define ALL loads.

b) If the loading criteria are too complex to adequately communicate on the drawings or with a simple load diagram, then the *specifying professional* shall provide a load schedule along with the appropriate load combinations. Regardless of where the loads are shown, unfactored design loads broken down by load categories shall be provided in order to design the joists correctly with applicable load combinations.

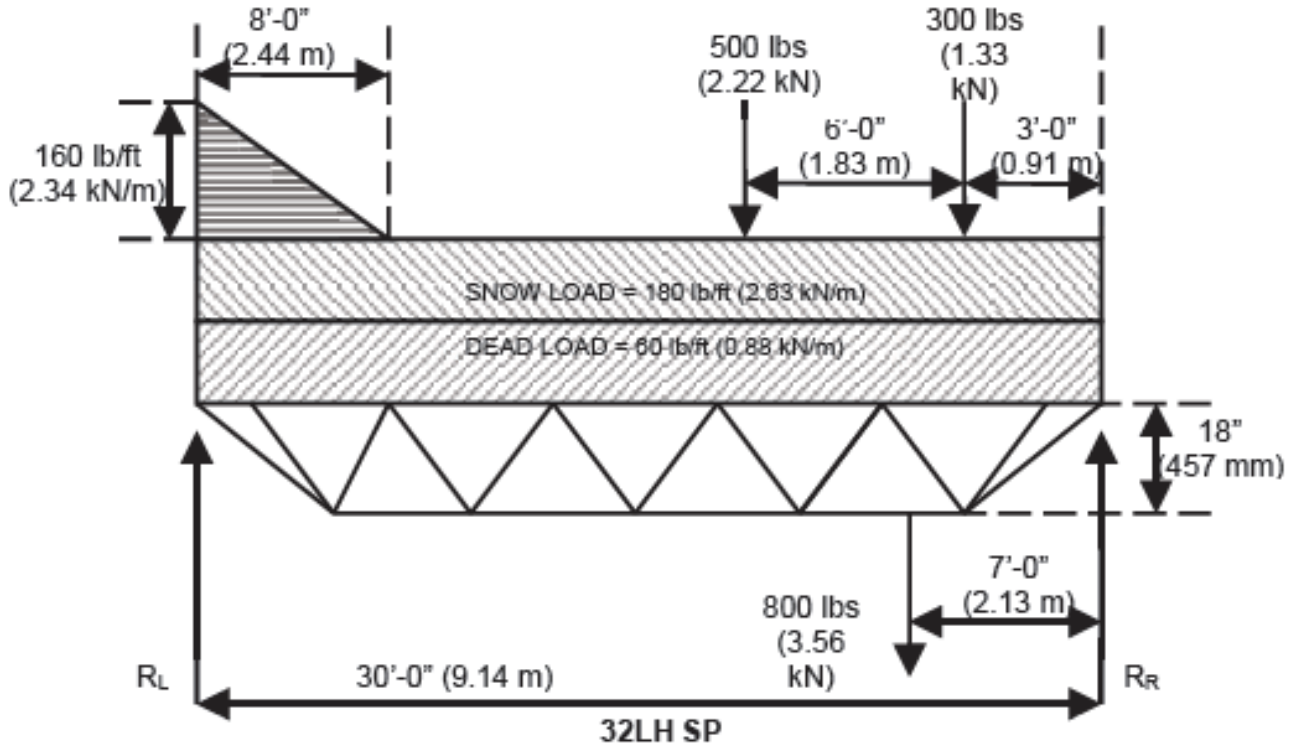
   Place the designation (e.g. 28K SP or 28LH SP) with the following note: "Joist manufacturer to design joist to support loads as shown."

Option #5 – Load Diagram

OPTION 5 - ASD EXAMPLE:

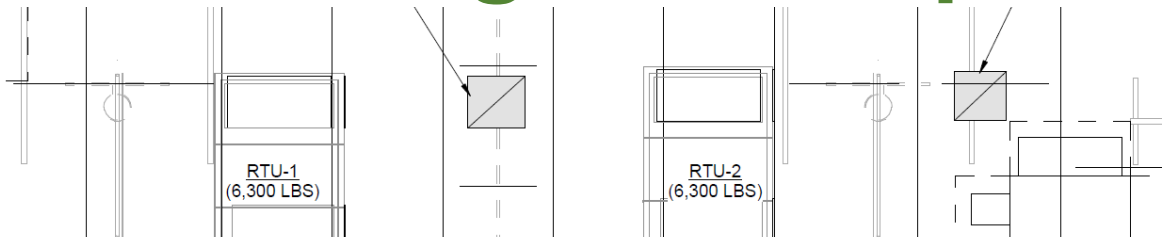
U.S. CUSTOMARY UNITS AND (METRIC UNITS)

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



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

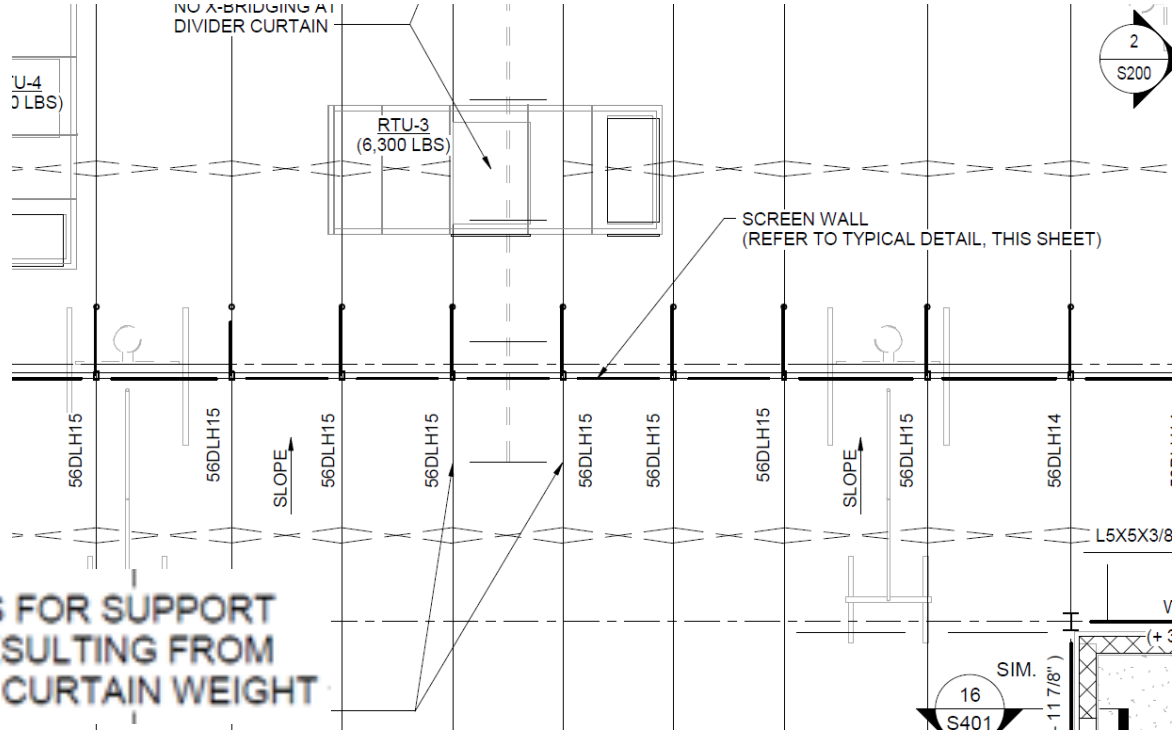
Benefits of following COSP options



For other loads, the Specifying Professional shall use one of the five options described below that allows:

- The estimator to price the joists.
- The joist manufacturer to design the joists in accordance with the Standard Specifications of latest adoption.
- The owner to obtain the most economical joists.

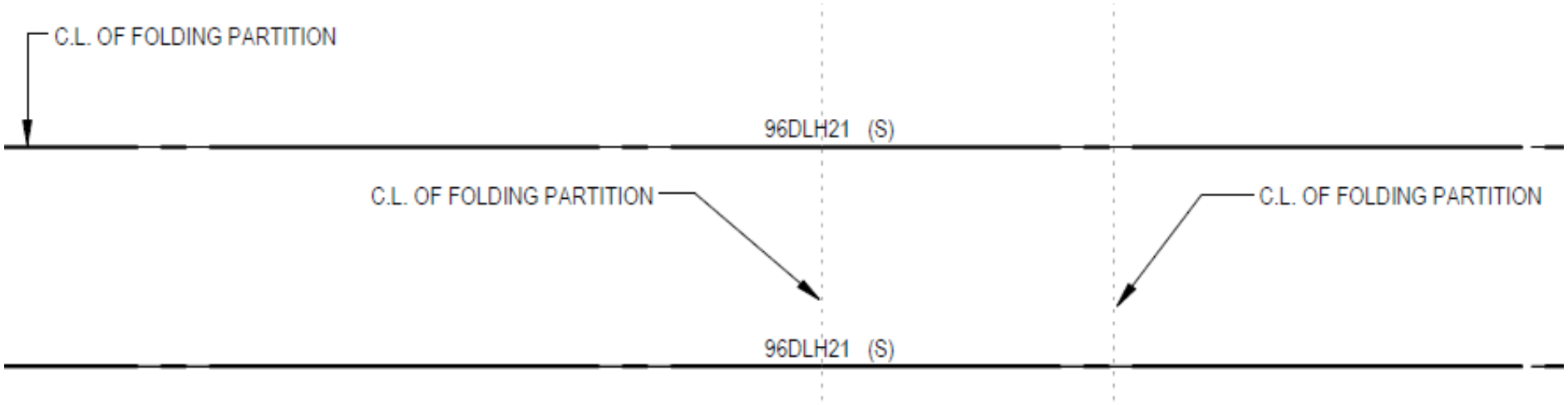
Avoid an RFI !



DESIGN JOISTS FOR SUPPORT REACTIONS RESULTING FROM 30PLF DIVIDER CURTAIN WEIGHT

Special Deflection Limits

- Framing plan showing standard designation joists with partitions



6. LIMIT 96DLH21 JOIST (SUPPORTING OPERABLE PARTITIONS) SNOW/LIVE LOAD DEFLECTION TO 1" (MAX).
7. LIMIT 96DLH22 JOIST (SUPPORTING OPERABLE PARTITIONS) SNOW/LIVE LOAD DEFLECTION TO 5/8" (MAX).

Special Deflection Limits

- 96DLH21 spanning 116’ weighs 80 pounds per foot
- Loads from table is 1149/877, joists spaced 10’ O.C.
- 115 psf total load & 88 psf live load
- L/360 deflection = 3.86”
- With 8x8x1” chord angles for top and bottom chord, joist weight jumps to 210 pounds per foot and live load deflection still exceeds 1”

Special Deflection Limits

6. LIMIT 96DLH21 JOIST (SUPPORTING OPERABLE PARTITIONS) SNOW/LIVE LOAD DEFLECTION TO 1" (MAX).
7. LIMIT 96DLH22 JOIST (SUPPORTING OPERABLE PARTITIONS) SNOW/LIVE LOAD DEFLECTION TO 5/8" (MAX).

- Deflection limit for 20 psf live load only
- 20 psf x 10’ spacing = 200 plf
- 200/877 x 3.86” = ¾” live load deflection
- Live load limit note not required

Determining Net Uplift for Joists

Steel Joist Institute (SJI) Code of Standard Practice

SPECIFYING DESIGN LOADS

Neither the Steel Joist Institute nor the joist manufacturer establishes the loading requirements for which structures are designed.

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.

Determining Net Uplift for Joists

- ASCE provides formulas for design wind pressures and net design wind pressures. These are NOT the same as the NET uplift required by SJI.

$$p = q_h[(GC_{pf}) - (GC_{pi})] \text{ (lb/ft}^2\text{) (N/m}^2\text{)} \quad (28.4\text{-}1)$$

$$p_{\text{net}} = \lambda K_{zt} p_{net30} \quad (30.5\text{-}1)$$

- ASCE net is the sum of internal and external pressures.
- SJI net, is the final resultant pressure, less appropriate dead load – result of the load combination

Determining Net Uplift for Joists

- When wind uplift is a design consideration, it should be specified as net uplift on the steel joists and joist girders.

- The chart on the following slide is a typical components and cladding roof wind pressures provided on the contract documents.

Determining Net Uplift for Joists

ROOF SURFACES						
EFFECTIVE WIND AREA	POSITIVE PRESSURES (PSF)			NEGATIVE PRESSURES (PSF)		
	ZONE					
	1	2	3	1	2	3
10 SF	12.4	12.4	12.4	-30.4	-51.0	-76.8
20 SF	11.6	11.6	11.6	-29.6	-45.6	-63.6
50 SF	10.6	10.6	10.6	-28.6	-38.4	-46.2
100 SF	9.8	9.8	9.8	-27.8	-33.0	-33.0

Determining Net Uplift for Joists

- Roof pressure needs to be converted to net uplift, or more correctly, the result of the appropriate load combination for wind forces acting upward.

- The specifying professional knows the design dead load and if there are collateral dead loads that should not be deducted from the gross uplift.

Maximum Dead Load (for gravity loading)
Minimum Dead Load (for wind uplift)

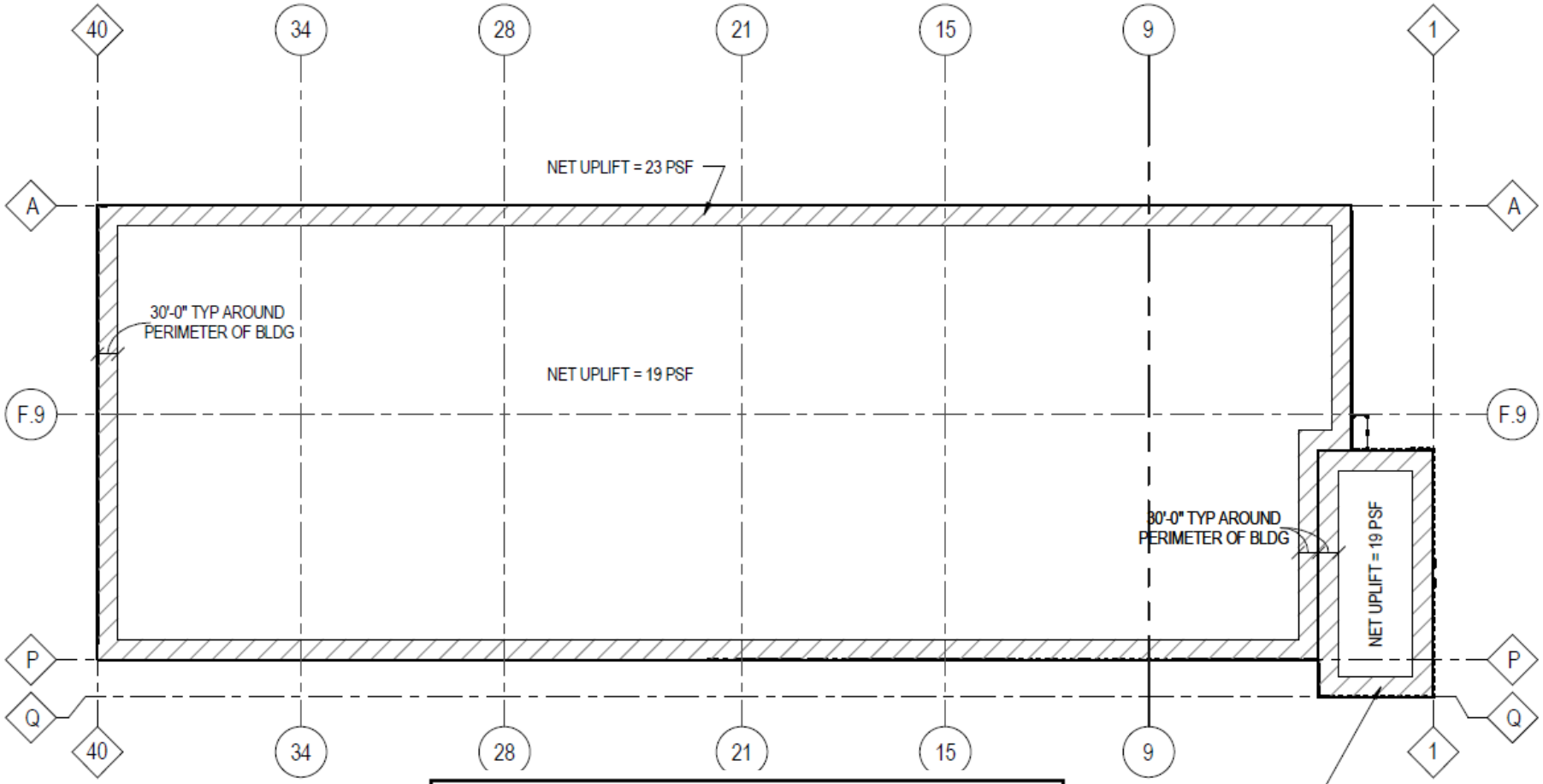
$$DL_{min} = DL_{max} - \text{Collateral Load}$$

Determining Net Uplift for Joists

- Joists are considered components and cladding (C&C).
- Joist girders can be considered part of the main wind force-resisting system (MWFRS).
- Typically, separate MWFRS pressure values are not provided for the joist girders, and the joist designer applies the C&C net uplift forces from the joists to the joist girders.

Presentation of Net Uplift

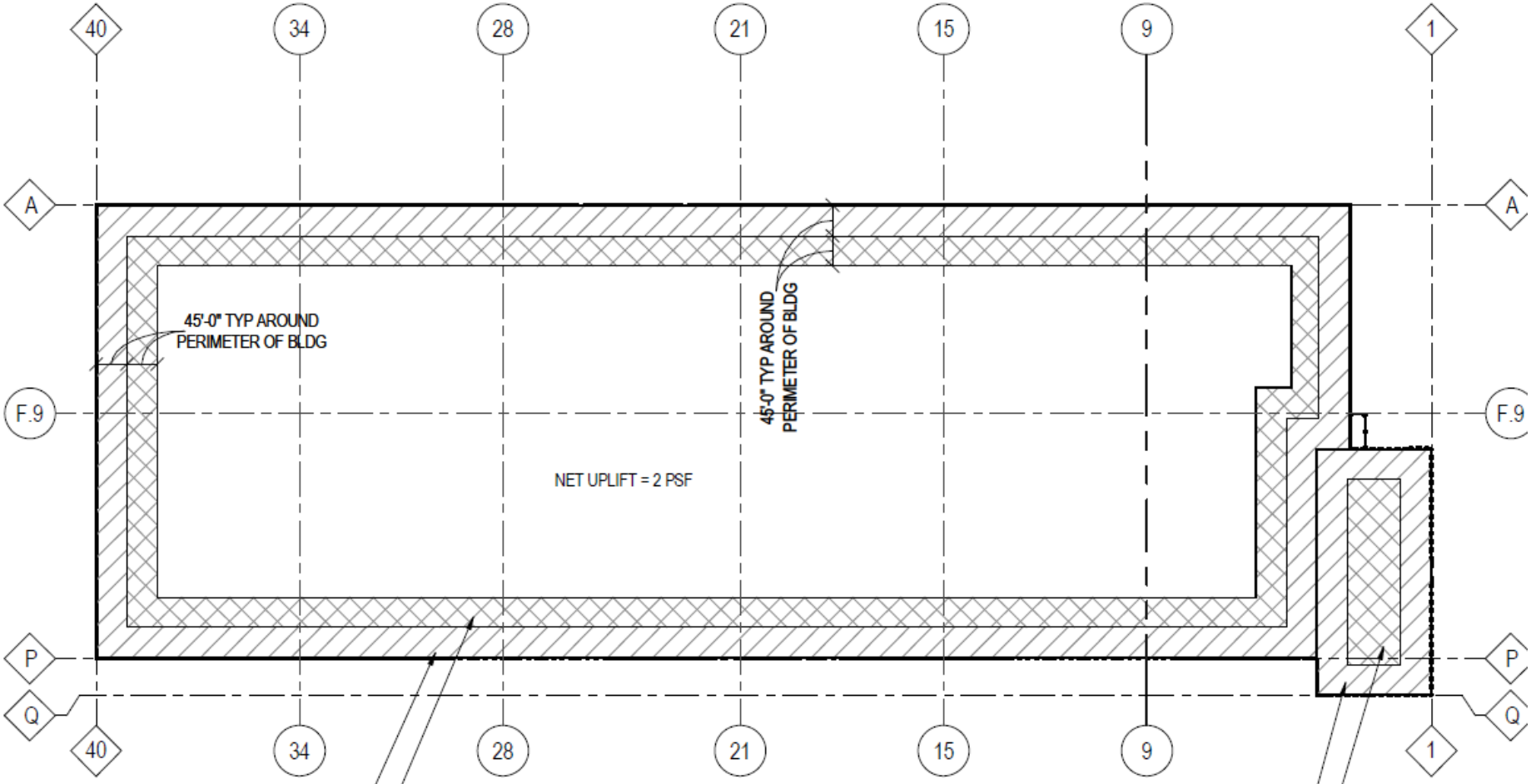
- Use a *Net Uplift* plan



NOTE:
NET UPLIFT LOADS ARE BASED ON
ASD LOAD COMBINATION: 0.6W + 0.6D

Presentation of Net Uplift

- Use a *Net Uplift* plan



JOIST GIRDER NET UPLIFT PLAN

NTS

NOTE:
NET UPLIFT LOADS ARE BASED ON ASD LOAD COMBINATION: 0.6W + 0.6D

Presentation of Net Uplift

- Chart with load combinations

UPLIFT DIAGRAM ON JOIST & JOIST GIRDER

20' TY

SCALE: NONE

NOTE:

1. LINEAR INTERPOLATION IS PERMITTED.
2. JOIST UPLIFT LOAD COMBINATION IS 0.6D + 0.6W
   DEAD LOAD = 12 PSF.

LOCATION	GROSS UPLIFT PRESSURE (ULTIMATE) (psf)			EDGE ZONE
	(1)	(2)	(3)	
AREA < 10 ft^2	-50.6	-84.9	-127.8	20'-0"
AREA = 50 ft^2	-47.6	-63.9	-53.8	20'-0"
AREA = 100 ft^2	-46.3	-54.9	-54.9	20'-0"

Presentation of Net Uplift

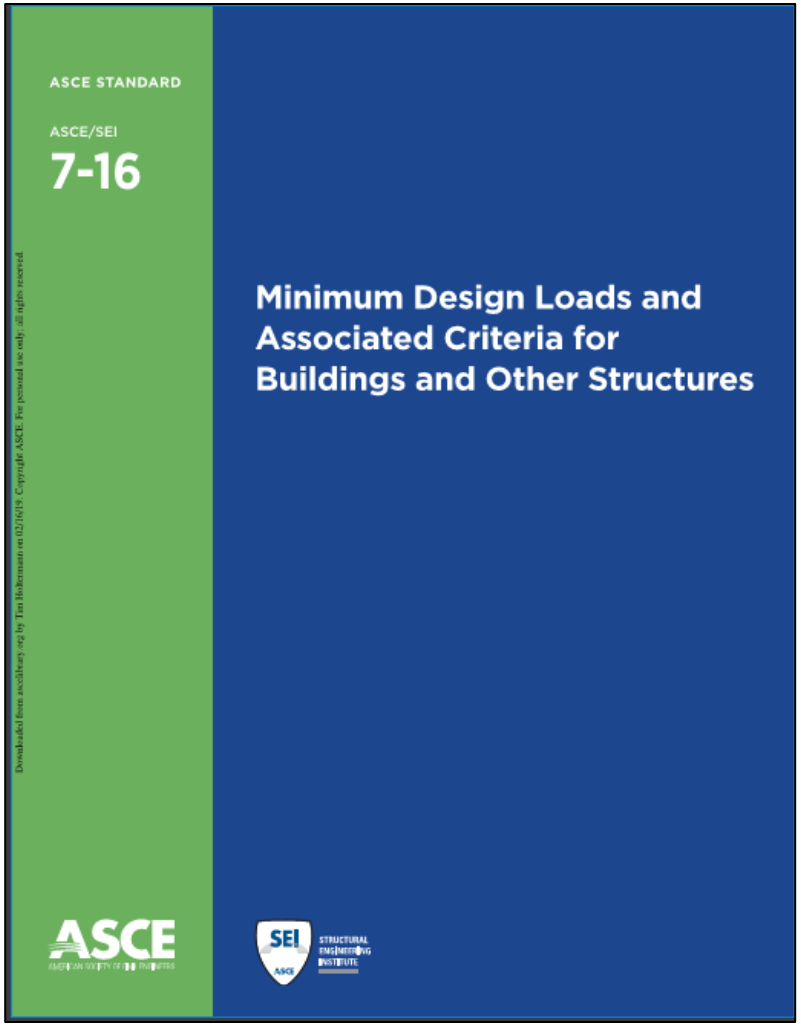
- Not clear on definition of loads shown and load combinations to be used

WIND PRESSURE TABLE					
	TRIBUTARY AREA (SQ. FT)				
ZONE	10	25	50	75	100+
1 POS	21	18.5	16.5	15.5	15
1 NEG	-22	-21	-20	-19.5	-19
2 NEG	-46	-41	-36	-33	-31
OVH NEG	-62	-62	-62	-62	-62

NOTES:
1. POSITIVE PRESSURE ACTS TOWARD SURFACE
2. NEGATIVE PRESSURE ACTS AWAY FROM SURFACE
3. DETERMINE WIND LOAD BY USING TRIBUTARY AREA OF INDIVIDUAL JOIST. LINEAR INTERPOLATION IS PERMITTED.
4. OVH PRESSURE IS APPLIED TO OVERHANG ONLY
5. ZONE 1 POSITIVE PRESSURE IS APPLIED OVER ENTIRE ROOF AREA

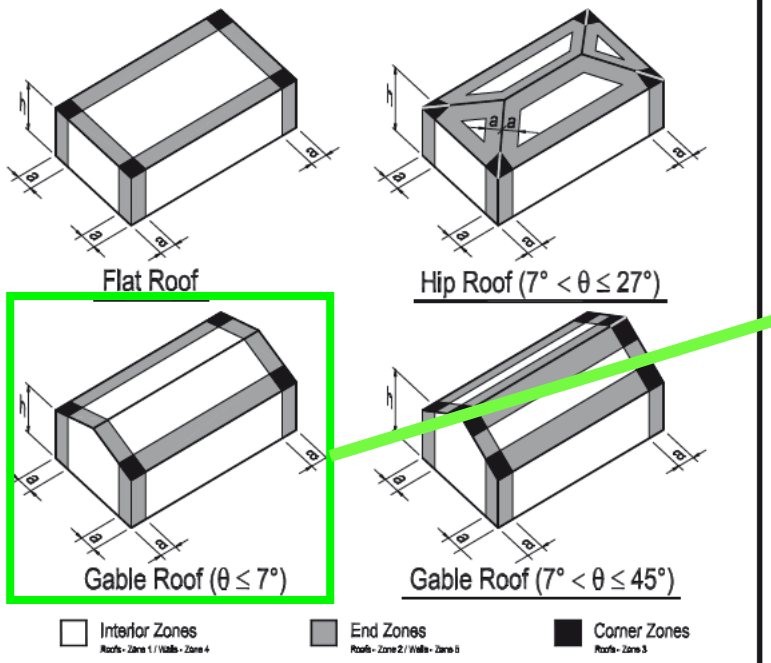
Avoid an RFI !

ASCE 7-16


ASCE STANDARD
ASCE/SEI
7-16
Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASCE
SEI
STRUCTURAL ENGINEERING INSTITUTE

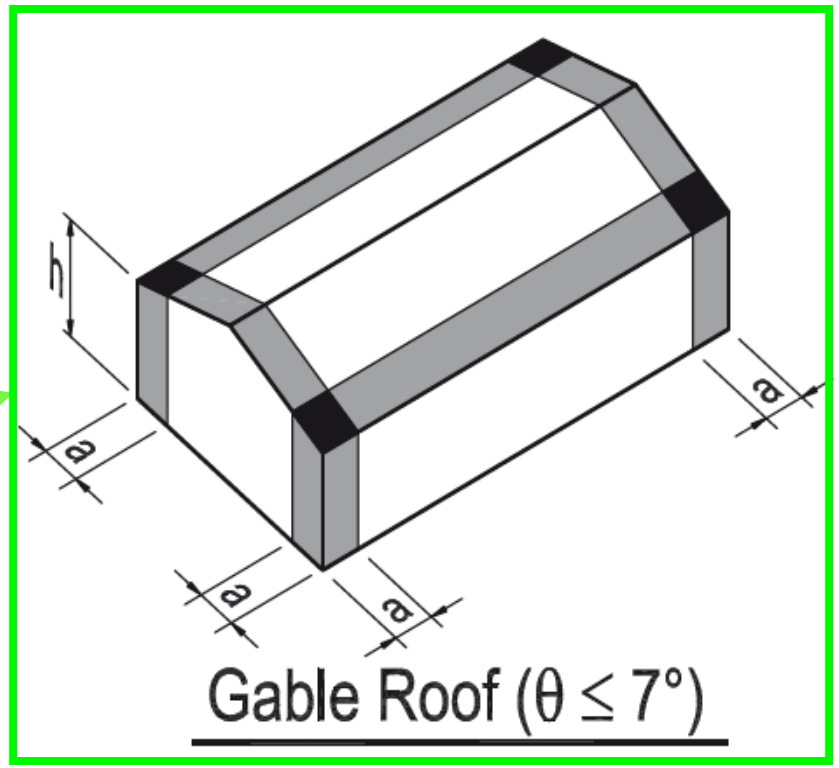
ASCE 7-10 Wind Loads

Components and Cladding – Method 1		h ≤ 60 ft.
Figure30.5-1	Design Wind Pressures	Walls & Roofs
Enclosed Buildings		

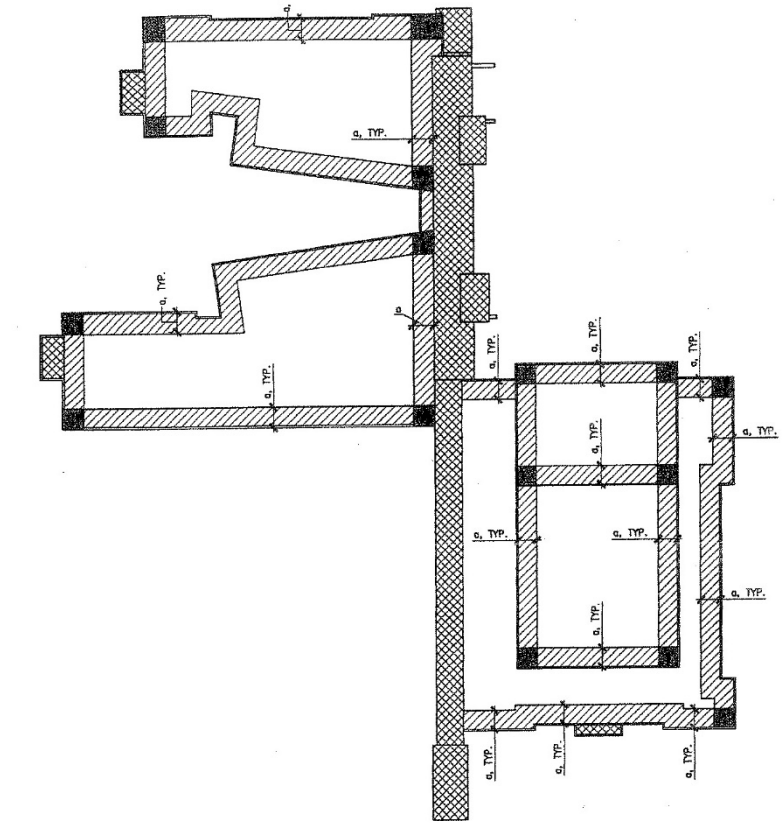


Notes:

1. Pressures shown are applied normal to the surface, for exposure B, at h=30 ft (9.1m). Adjust to other conditions using Equation 30.5-1.
2. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
3. For hip roofs with θ ≤ 25°, Zone 3 shall be treated as Zone 2.
4. For effective wind areas between those given, value may be interpolated, otherwise use the value associated with the lower effective wind area.
5. Notation:
   a: 10 percent of least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of least horizontal dimension or 3 ft (0.9 m).
   h: Mean roof height, in feet (meters), except that eave height shall be used for roof angles <10°.
   θ: Angle of plane of roof from horizontal, in degrees.



ASCE 7-10 Wind Loads



WIND PRESSURE DIAGRAM PLAN

NOT TO SCALE

ROOF UPLIFT ZONES

ZONE 1

ZONE 2

ZONE 3

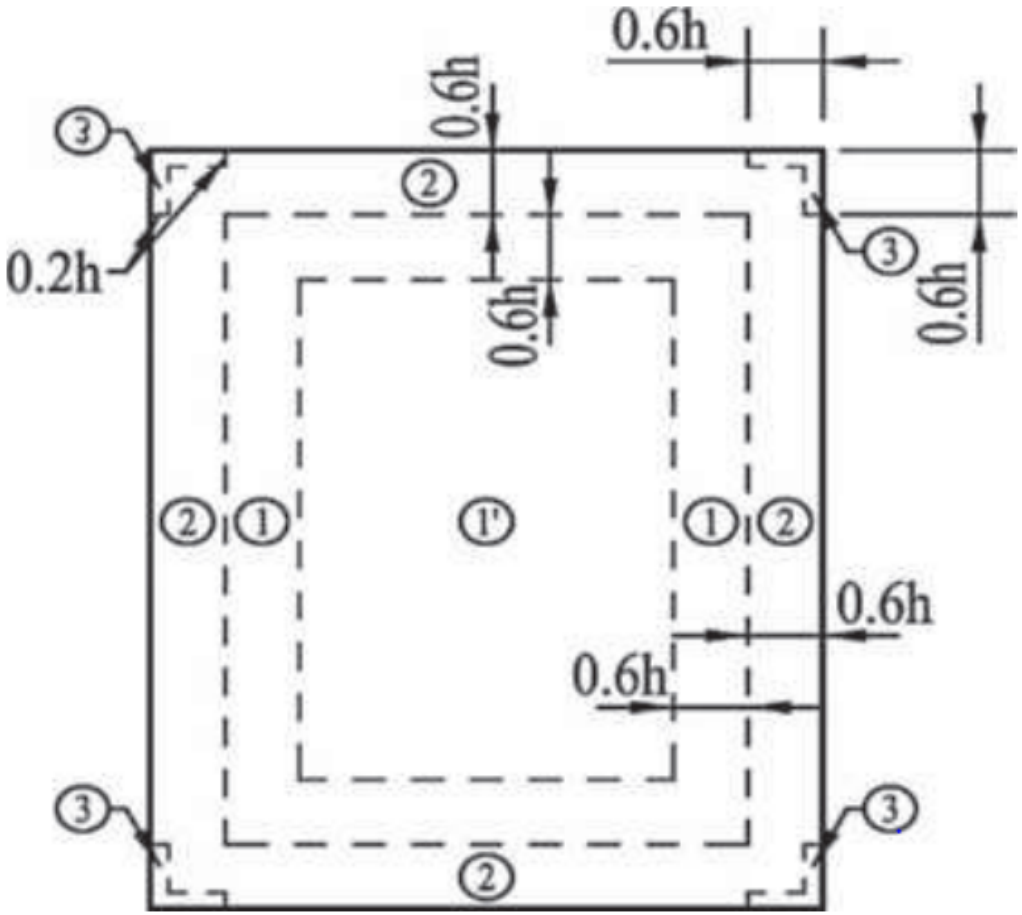
ZONE 2 OR 3 OVERHANG

OFFSET DISTANCE:

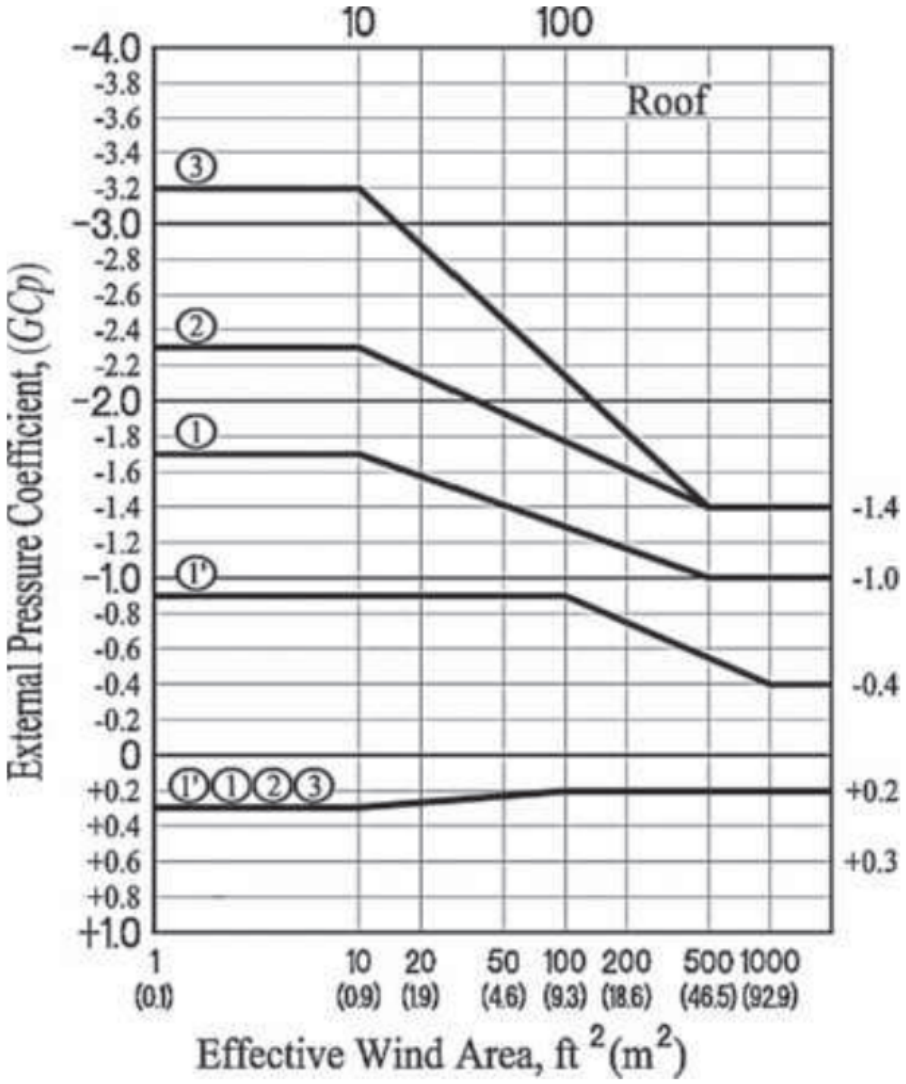
a = 20'-0"

NOTE: NO INCREASE IN STEEL JOISTS' ALLOWABLE STRESSES IS PERMITTED FOR JOIST UPLIFT DESIGN.

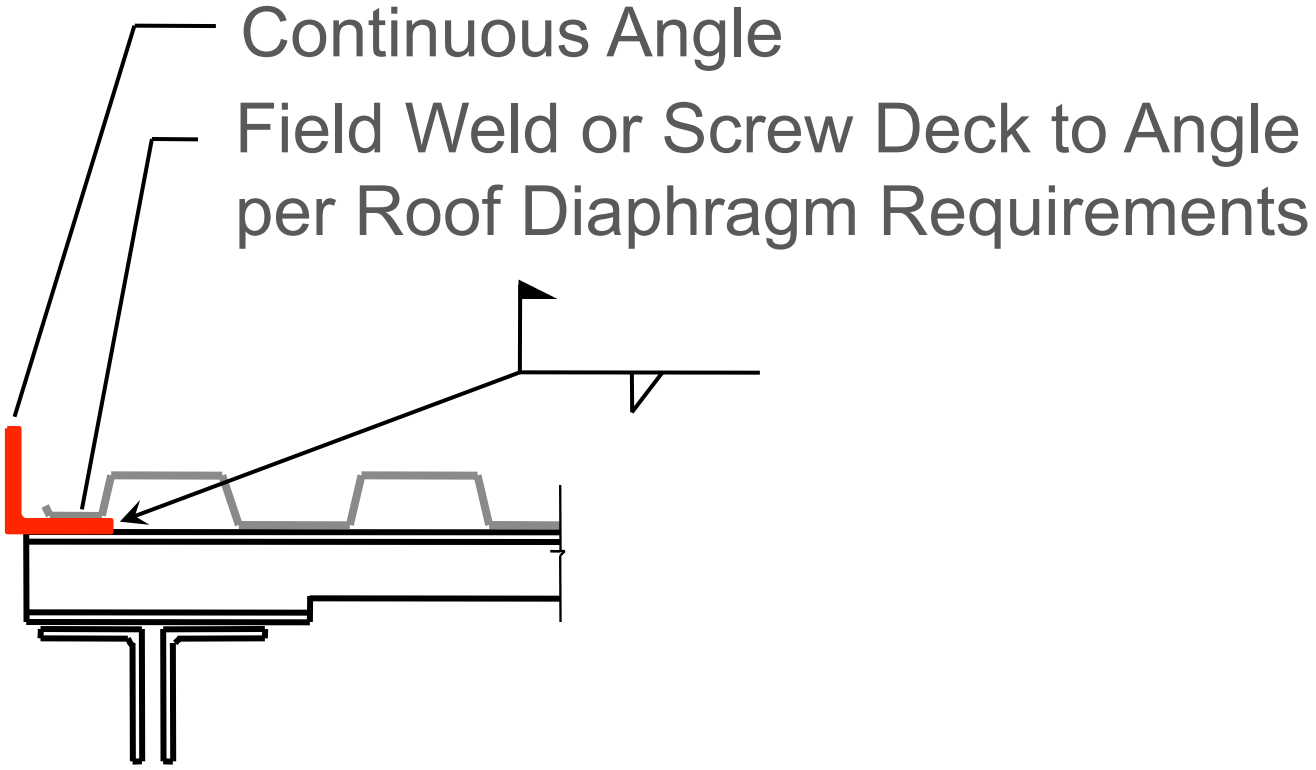
ASCE 7-16



ASCE 7-16

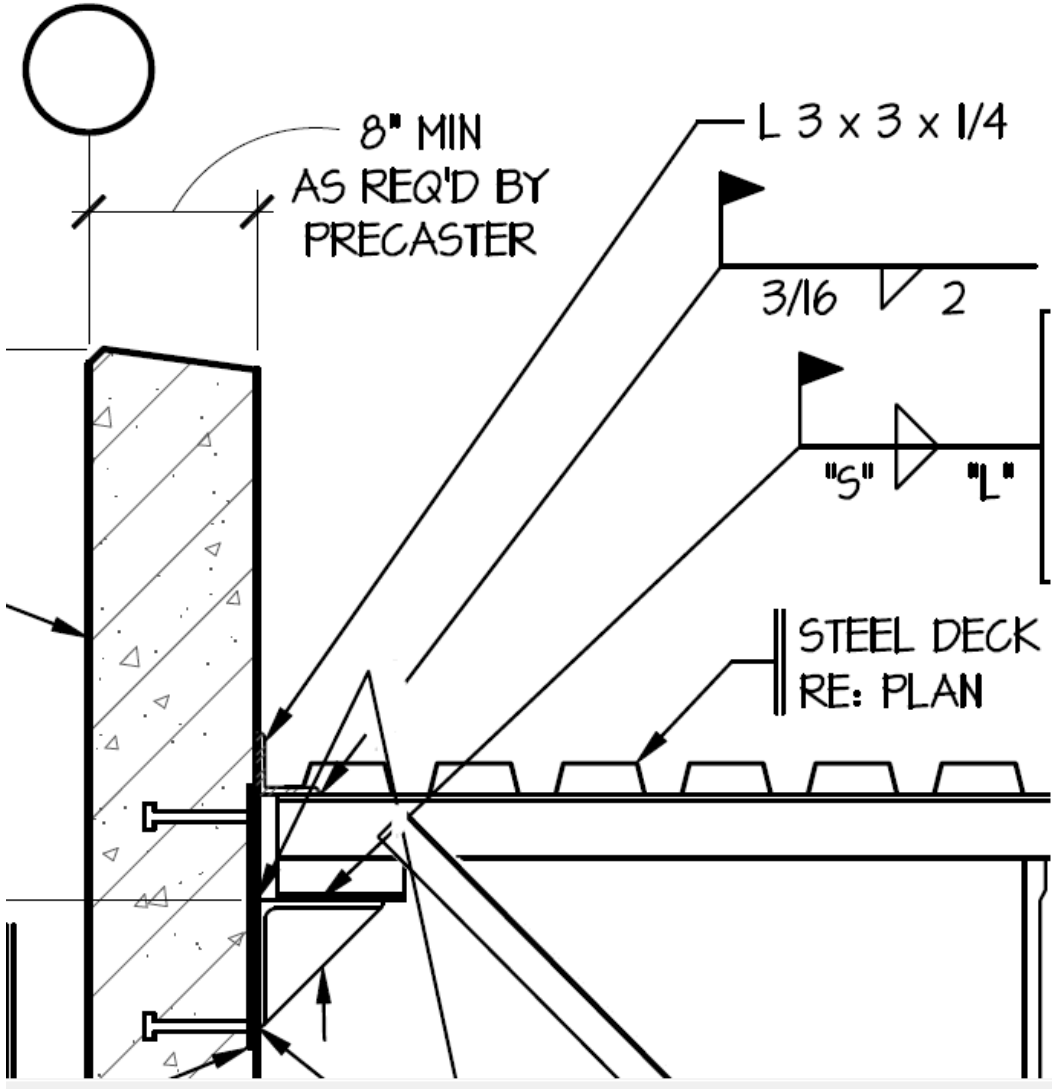

10
100
Roof
-4.0
-3.8
-3.6
-3.4
-3.2
-3.0
-2.8
-2.6
-2.4
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
-0.6
-0.4
-0.2
0
+0.2
+0.4
+0.6
+0.8
+1.0
External Pressure Coefficient, (GCp)
3
2
1
1'
1' 1 2 3
-1.4
-1.0
-0.4
+0.2
+0.3
1 (0.1)
10 (0.9)
20 (1.9)
50 (4.6)
100 (9.3)
200 (18.6)
500 (46.5)
1000 (92.9)
Effective Wind Area, ft 2 (m2)

Rollover Forces on Joist Seats



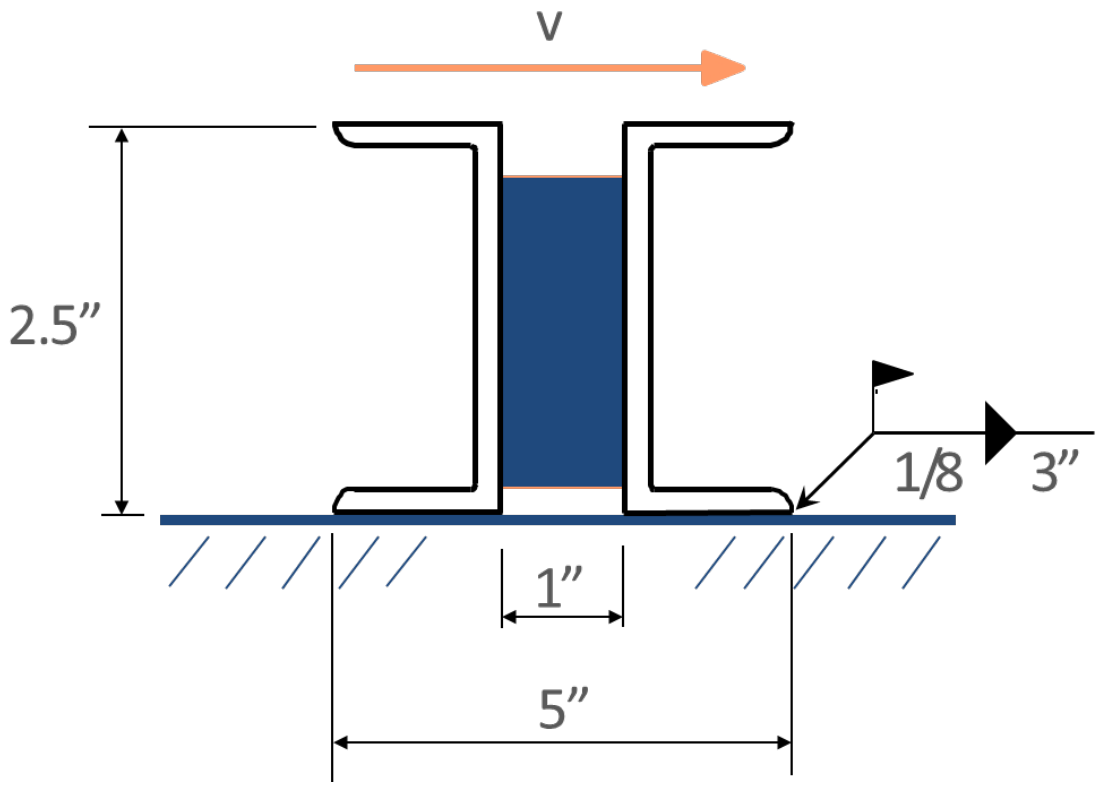
Rollover Forces on Joist Seats

- Typical detail for joist bearing at wall
- L 3 x 3 x ¼" diaphragm chord angle attached to joist and deck but not directly attached to wall
- Diaphragm chord force is transferred to wall as a rollover force through joist seat



Rollover Forces on Joist Seats

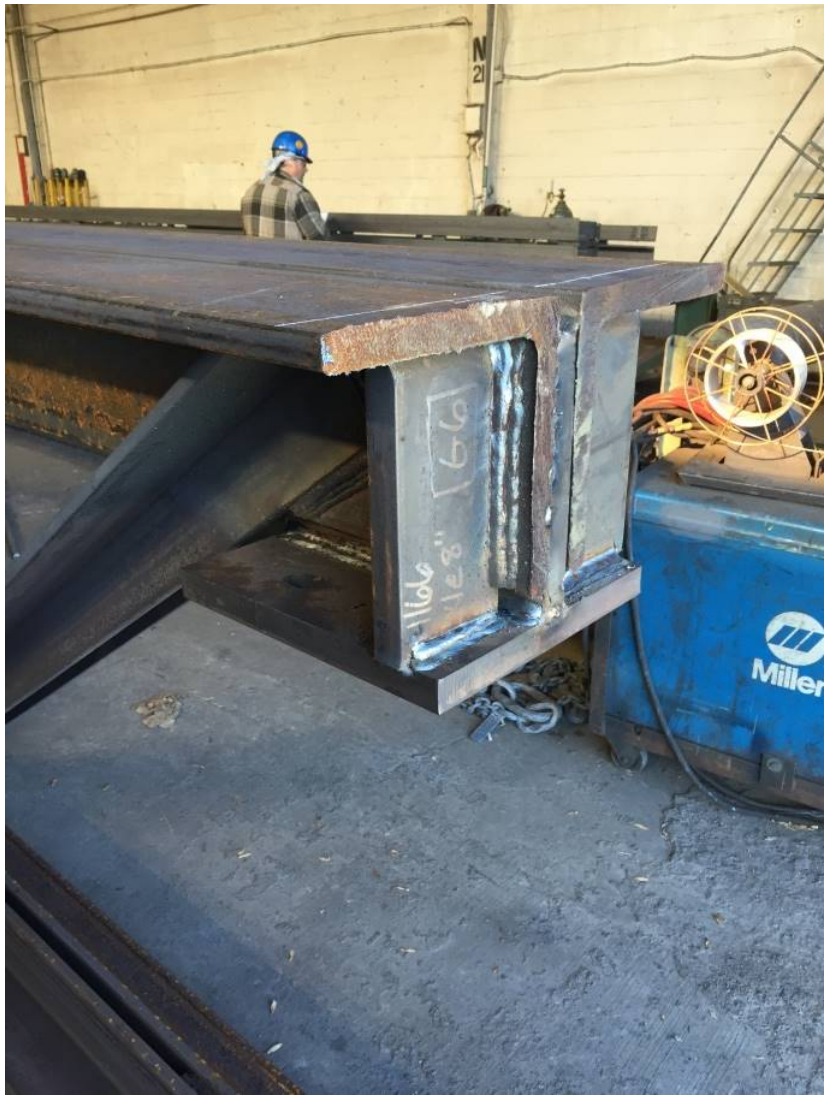
- Force ‘V’ should be given on the structural drawings as a joist design requirement.



Rollover Forces on Joist Seats

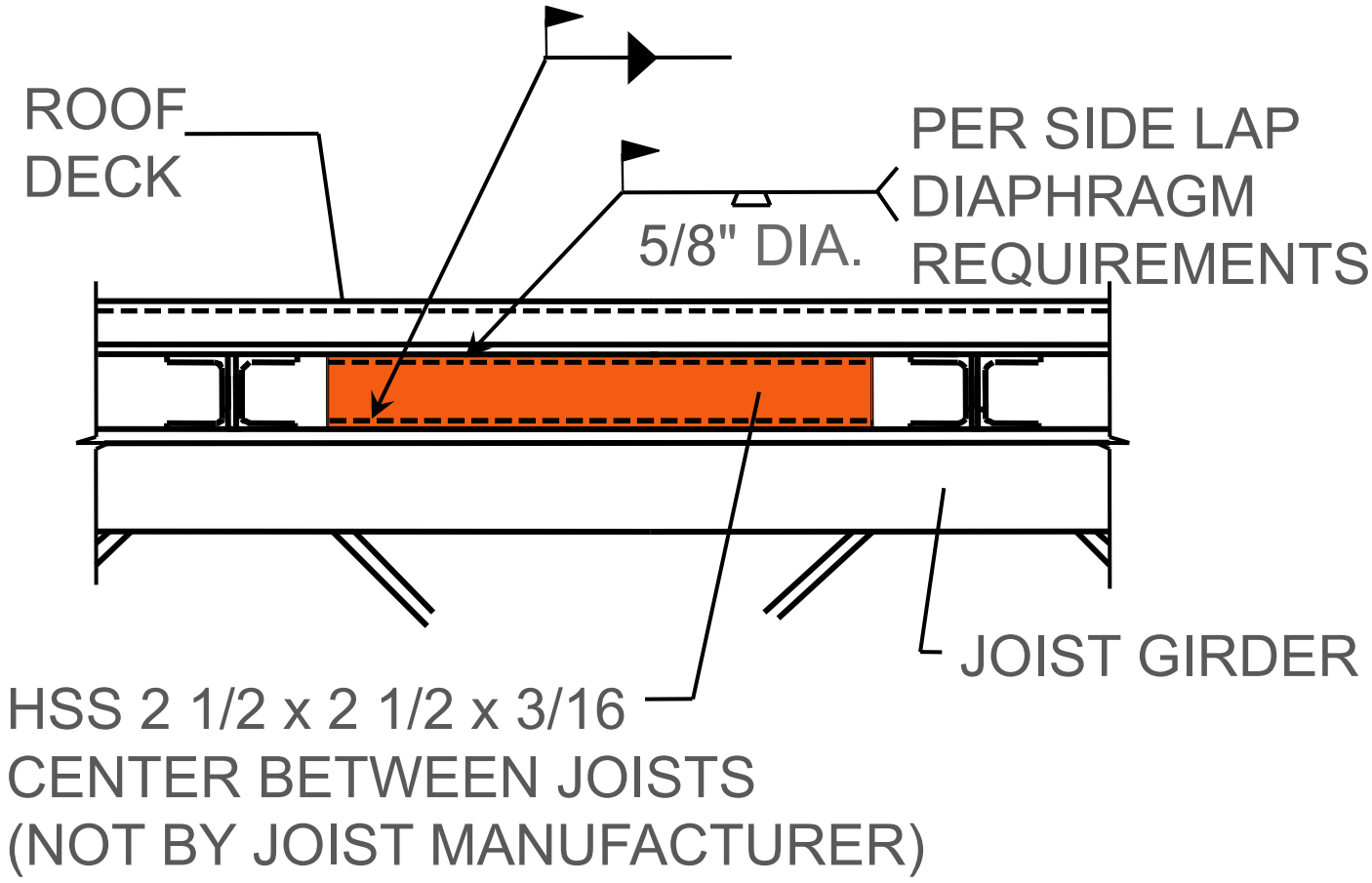
Rollover Forces on Joist Seats

- Rollover force should be noted, but 500 pounds or less will not affect the design or cost of the joist.
- Rollover forces up to 1.5 kips are handled with thicker seat angles.
- Rollover forces above 1.5 kips require seat stiffeners as shown in picture and add cost.



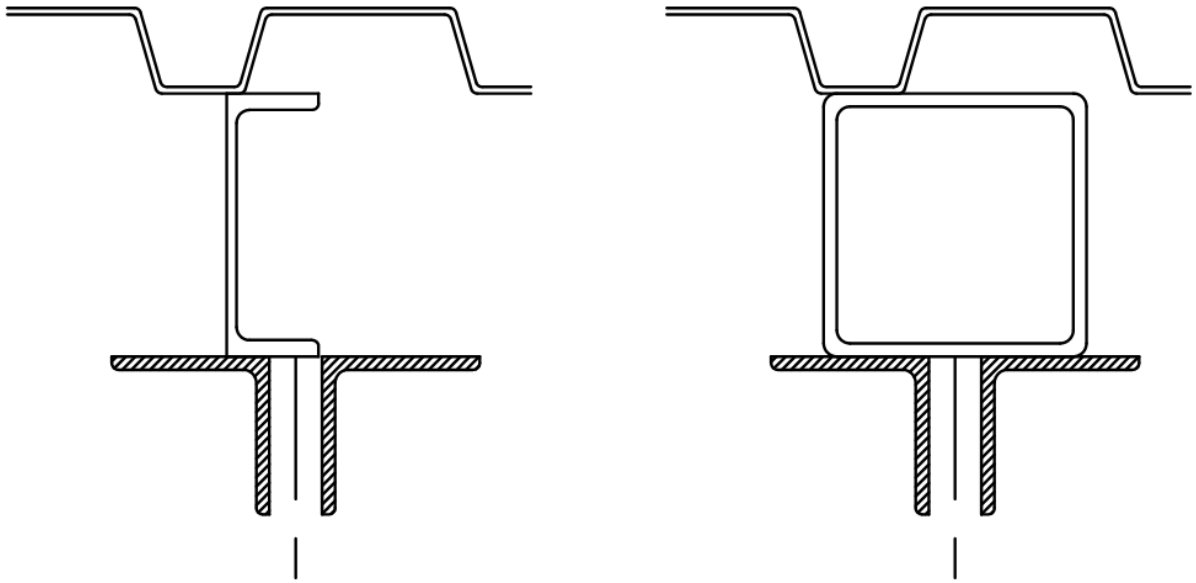
Rollover Forces on Joist Seats

- Large rollover forces can be ‘collected’ and transferred to wall or lateral support with a tube or channel between the joist seats.

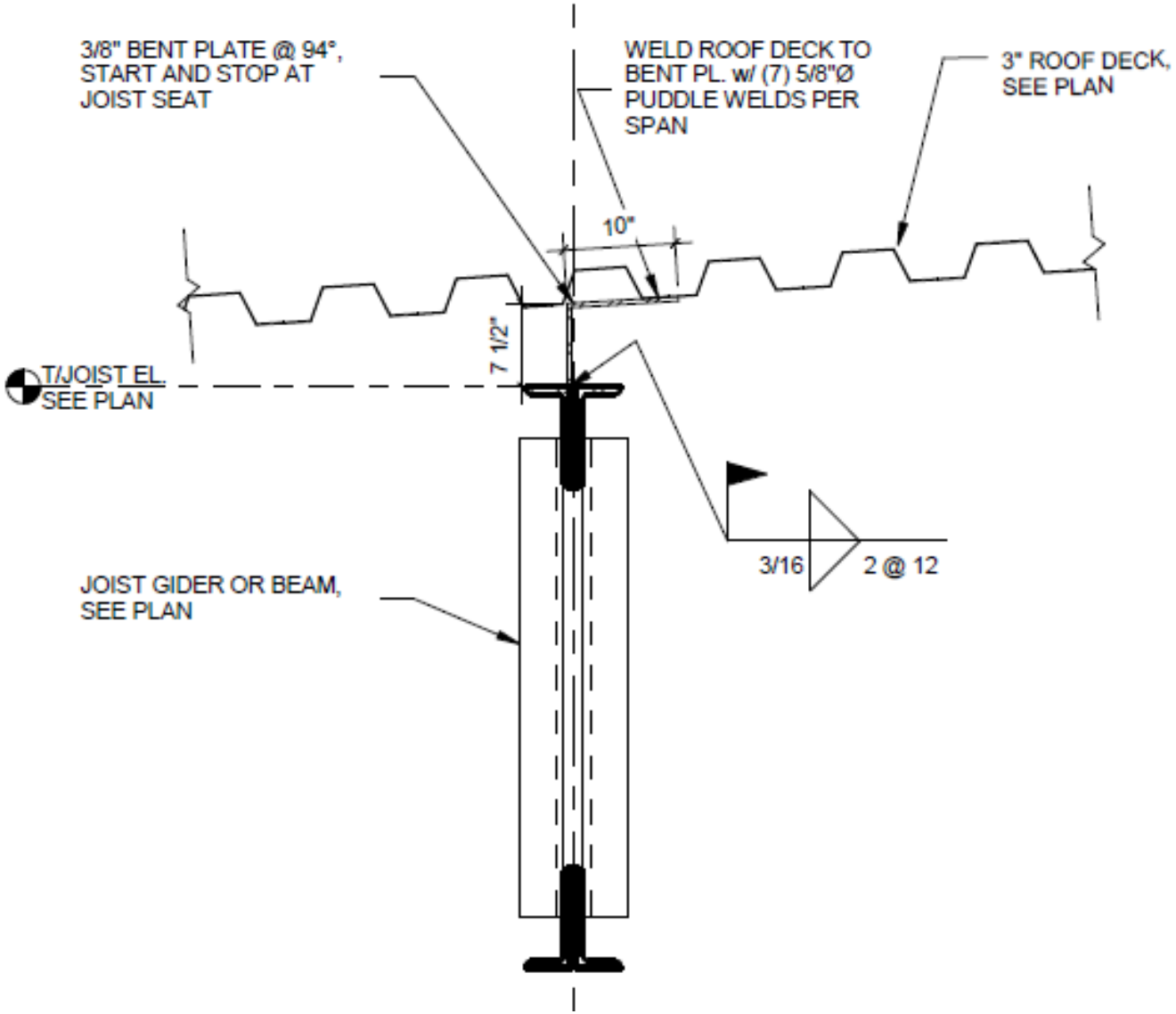


Rollover Forces on Joist Seats

- Tubes provide a wider surface to allow positive attachment to the low flute of the deck



Rollover Forces on Joist Seats

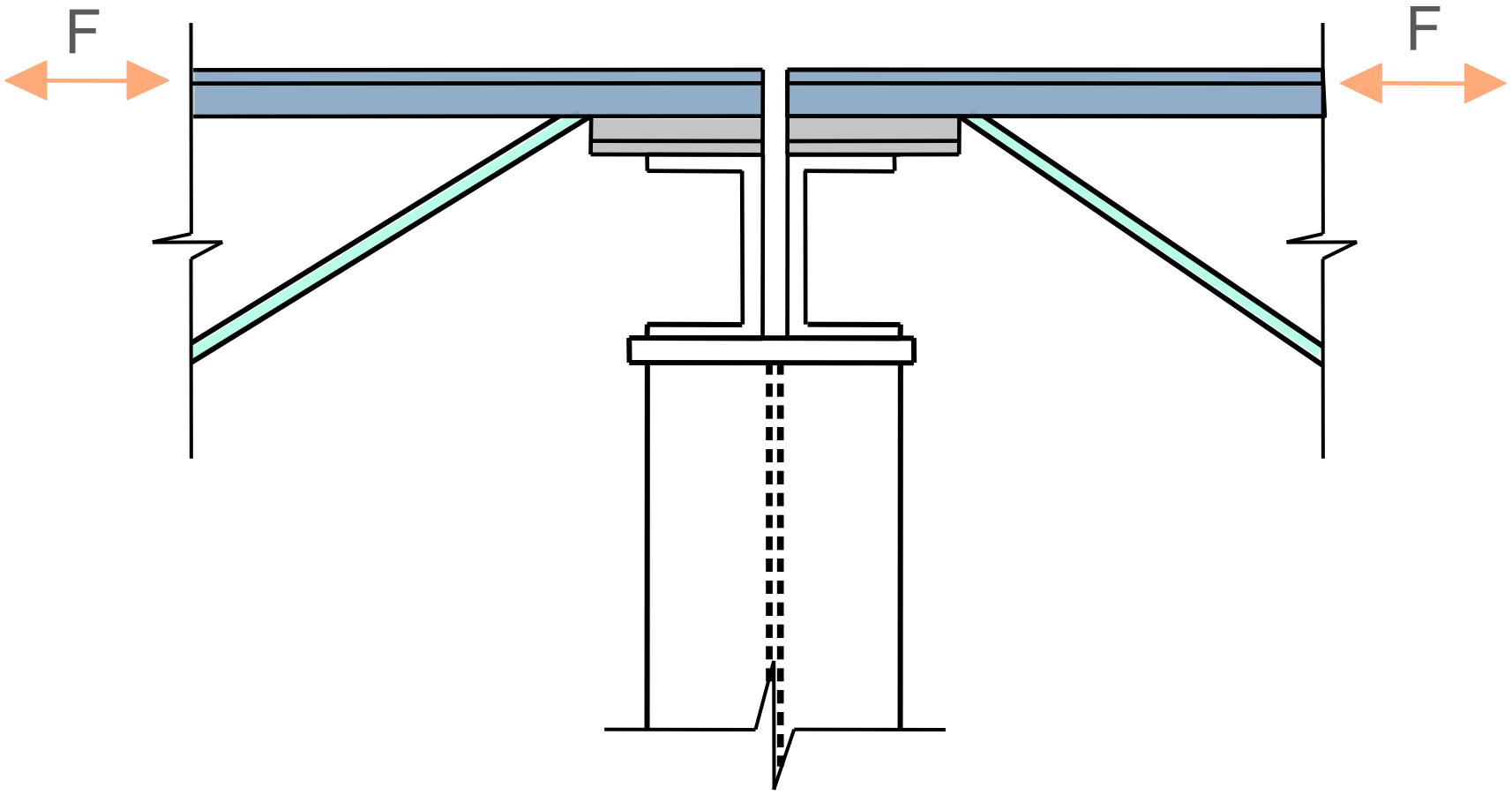


- Even for a sloped roof, there are ways to avoid applying the rollover force through the joist seat.
- This detail uses a bent plate.

Chord Forces - Axial

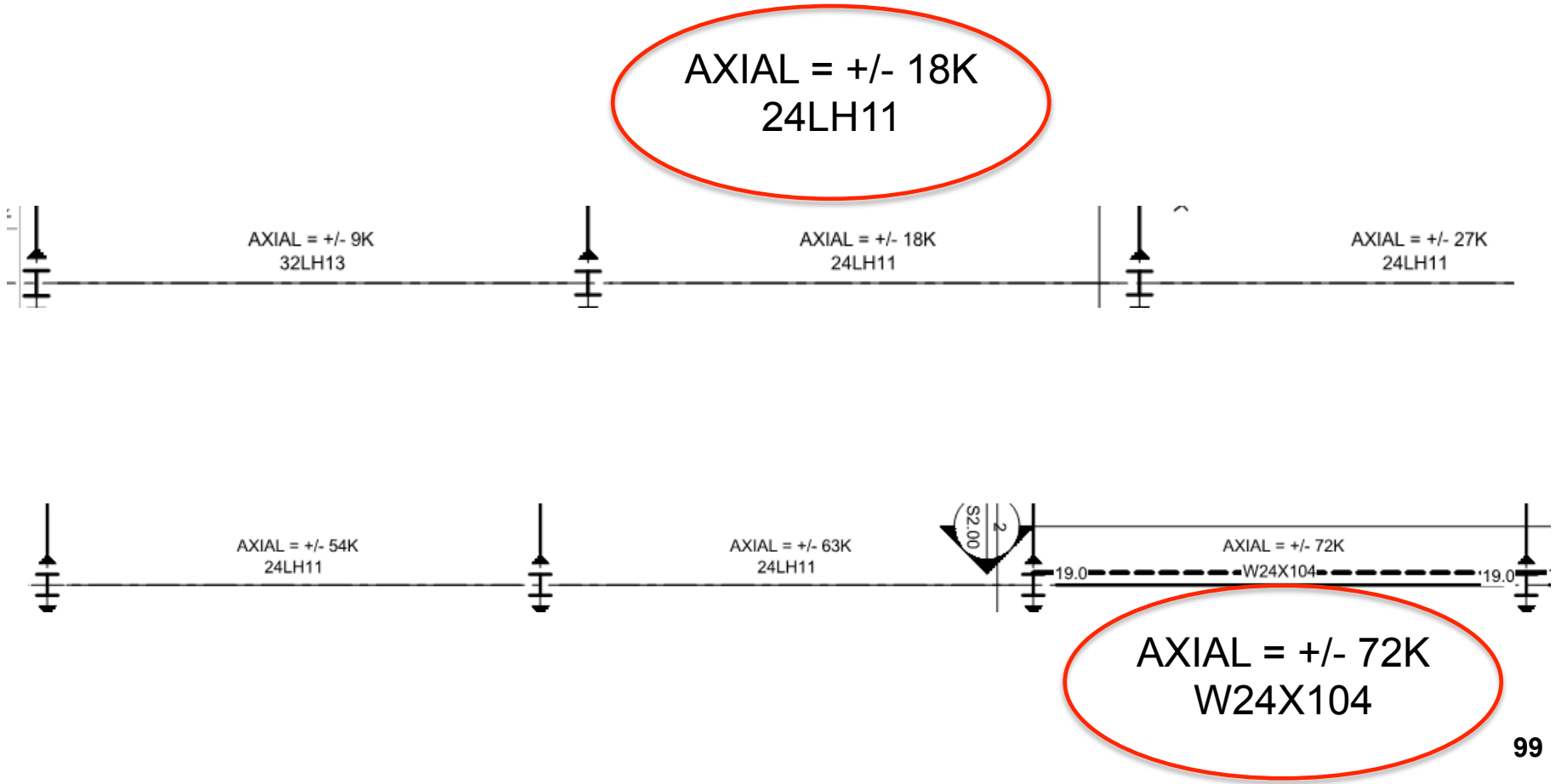
- Chord Forces are carried as additional axial loads by the top chords of joists and/or Joist Girders.
- Chord Forces may vary from one end of the chord to the other. The additional axial load for each joist and/or Joist Girder must be indicated.
- Type and magnitude of axial forces at the joist and Joist Girder end supports shall be shown on the structural drawings.
- Avoid resolving joist or Joist Girder axial forces through the bearing seat connection.

Diaphragm Chord



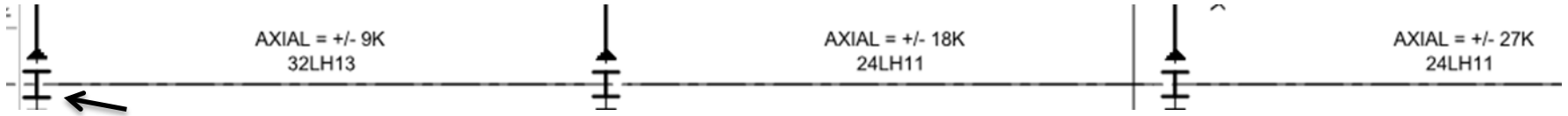
Axial Loads

- Joist or Joist Girder top chord axial loads are typically noted directly on the framing plan.



Axial Loads – Boundary Conditions

- For axial collector loads, to avoid unnecessary transfer design or an RFI from the Joist Manufacturer, it is helpful to show the magnitude of the axial load at the building perimeter.

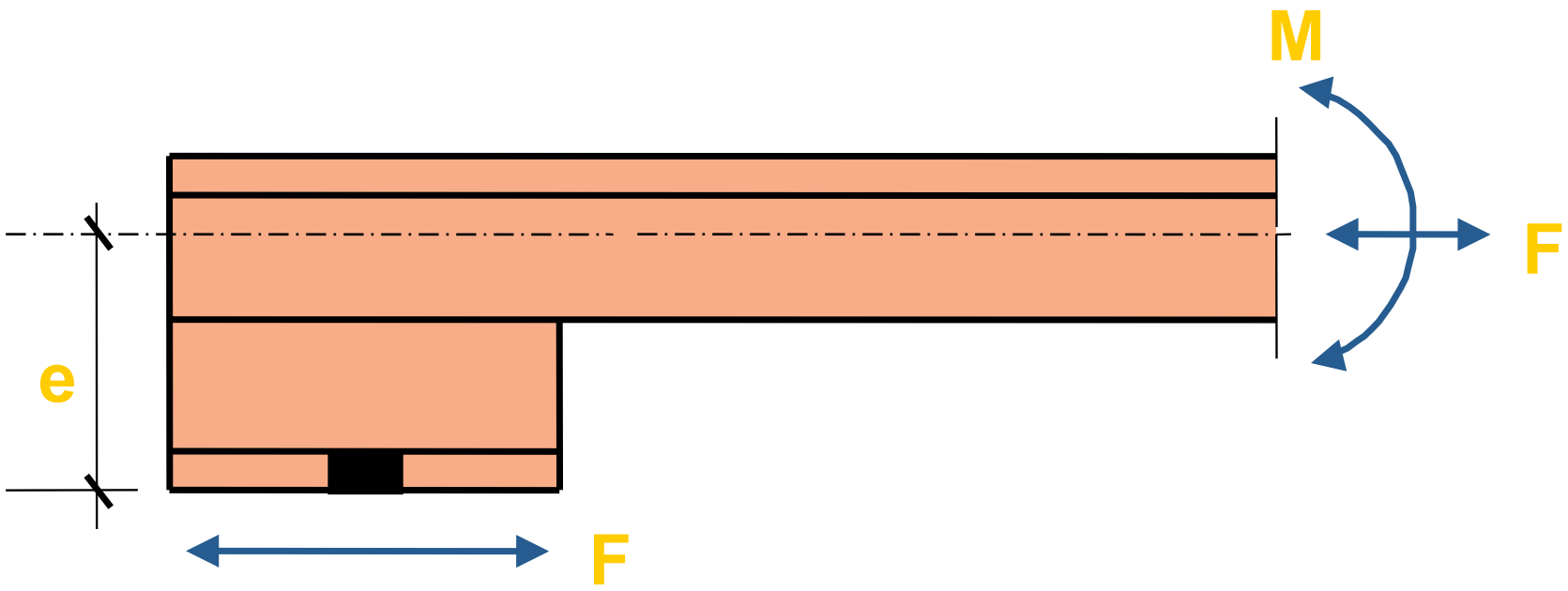


AXIAL = 0 kips
(The axial load accumulates from this end)

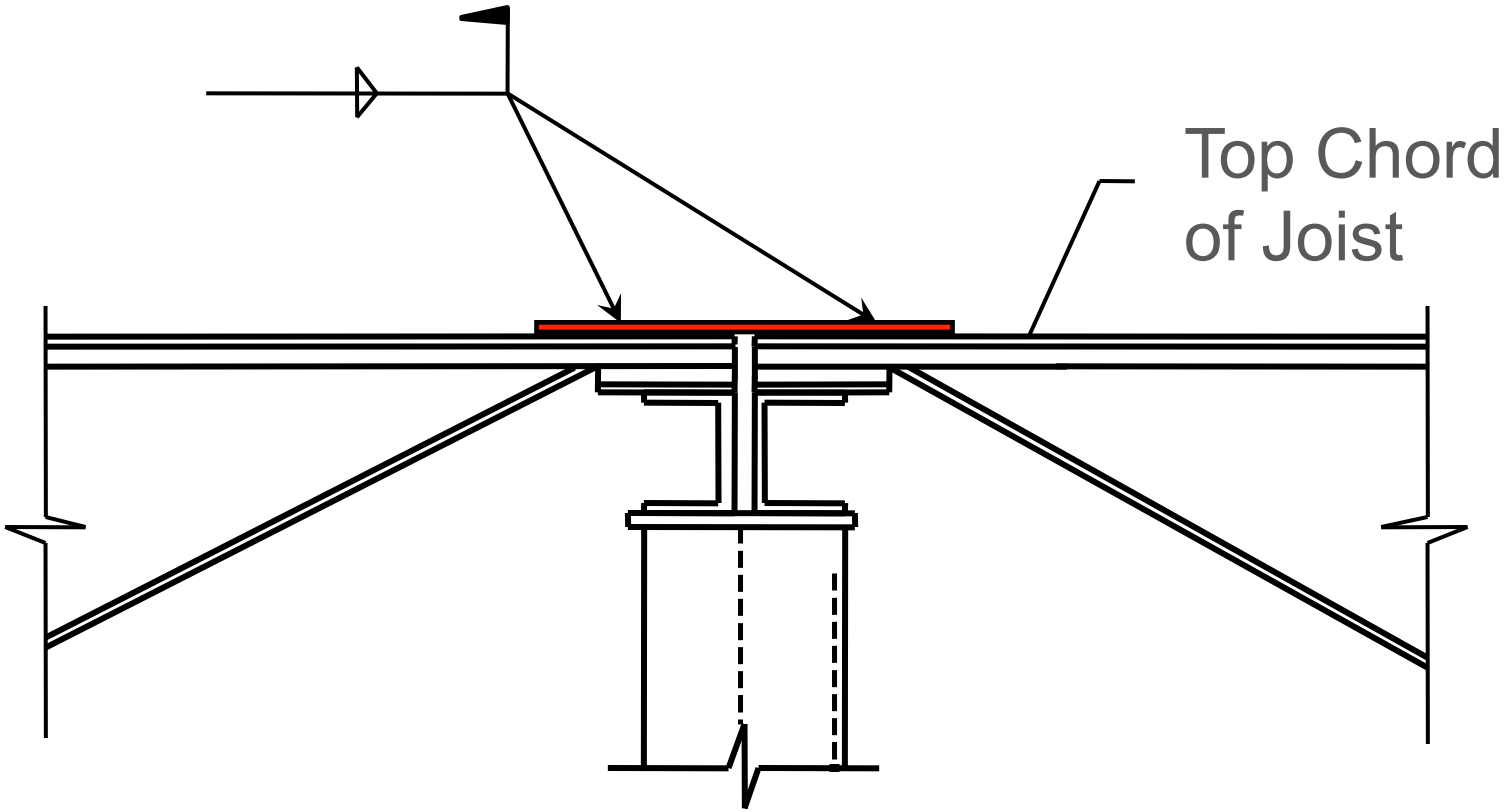
Avoid an RFI !

Wind Axial Load Transfer

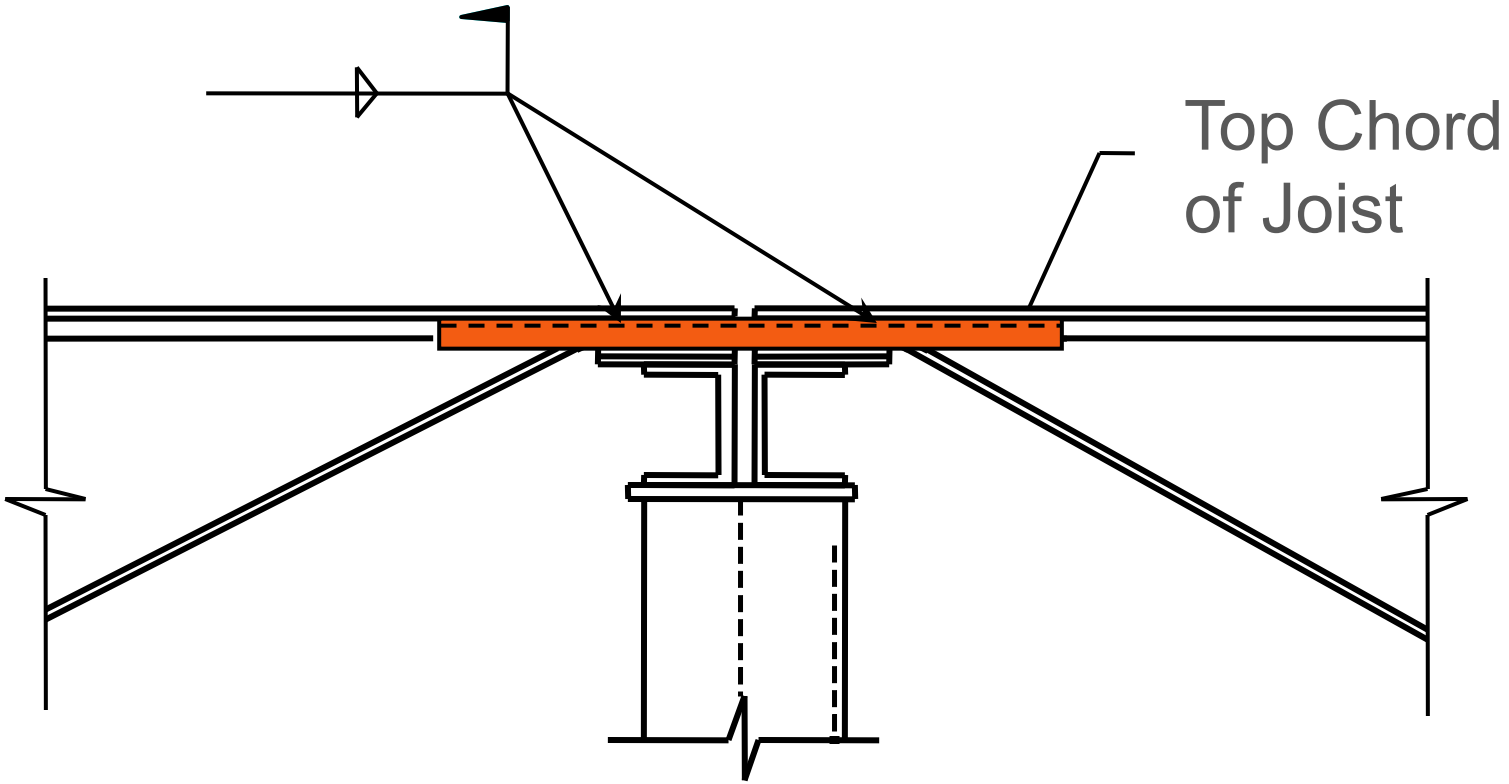
All top chord axial loads and end moments should be transmitted directly via tie plates or tie angles. The eccentricity of horizontal forces transferred through the bearing seats is then avoided.



Joist Tie Plate

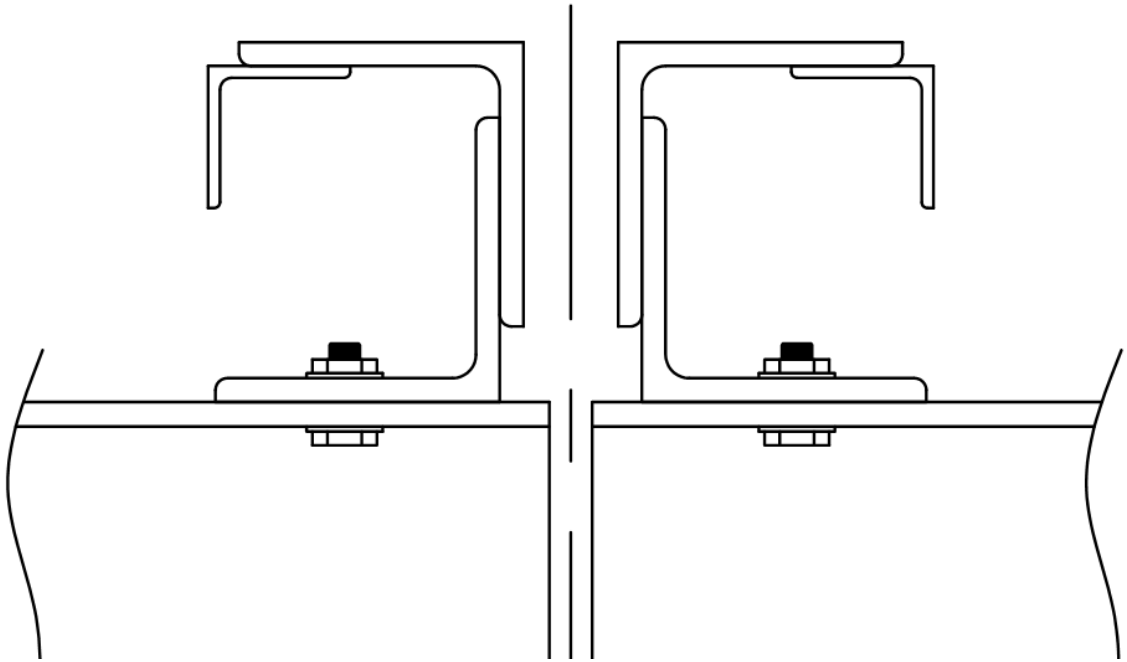


Joist Tie Angles



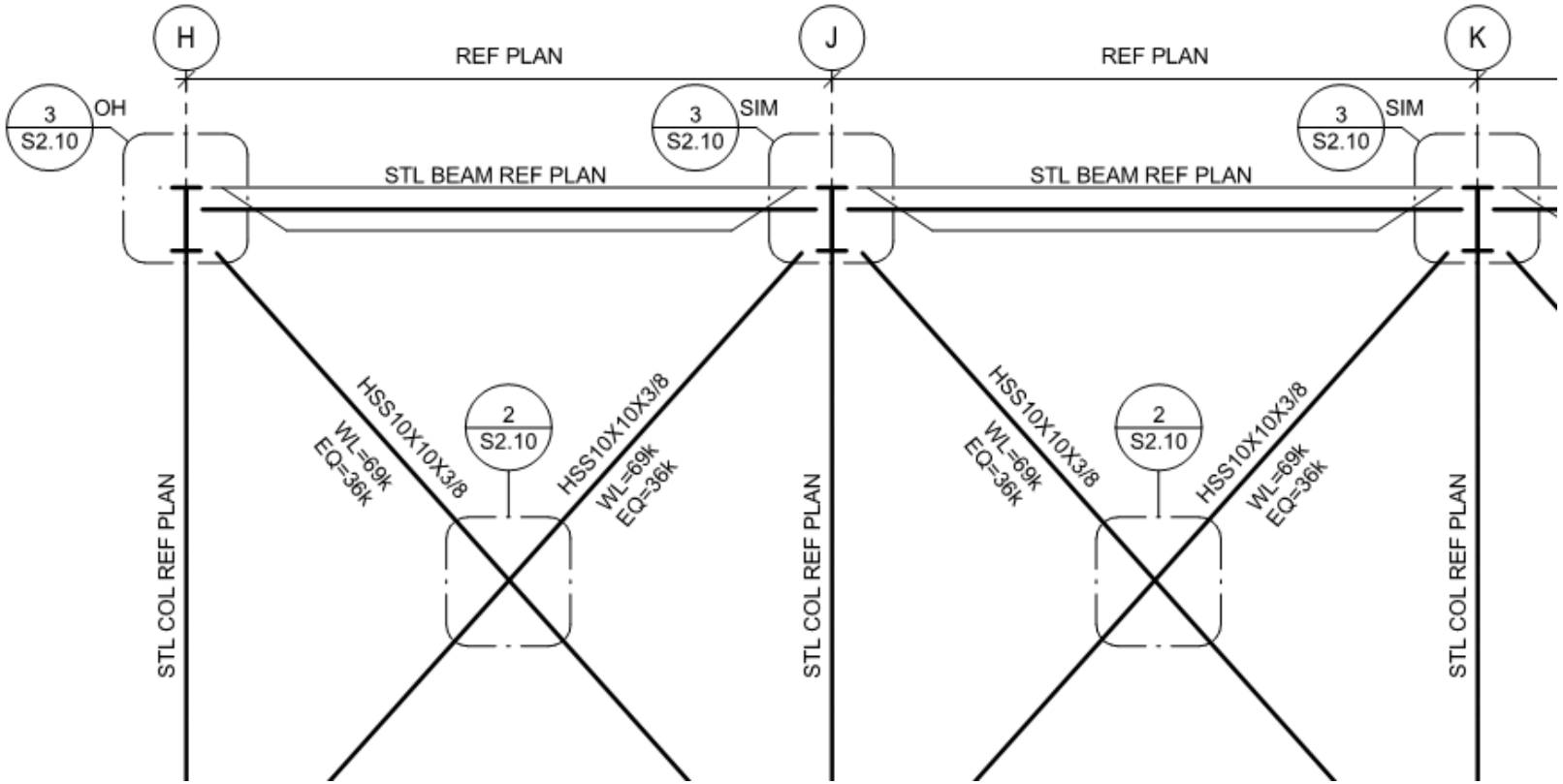
Joist Tie Angles

- Note the orientation of the tie angles, to avoid the joist end webs, in the event they are outside that chord angles rather than in the chord gap. This also allows for a down-hand field weld.



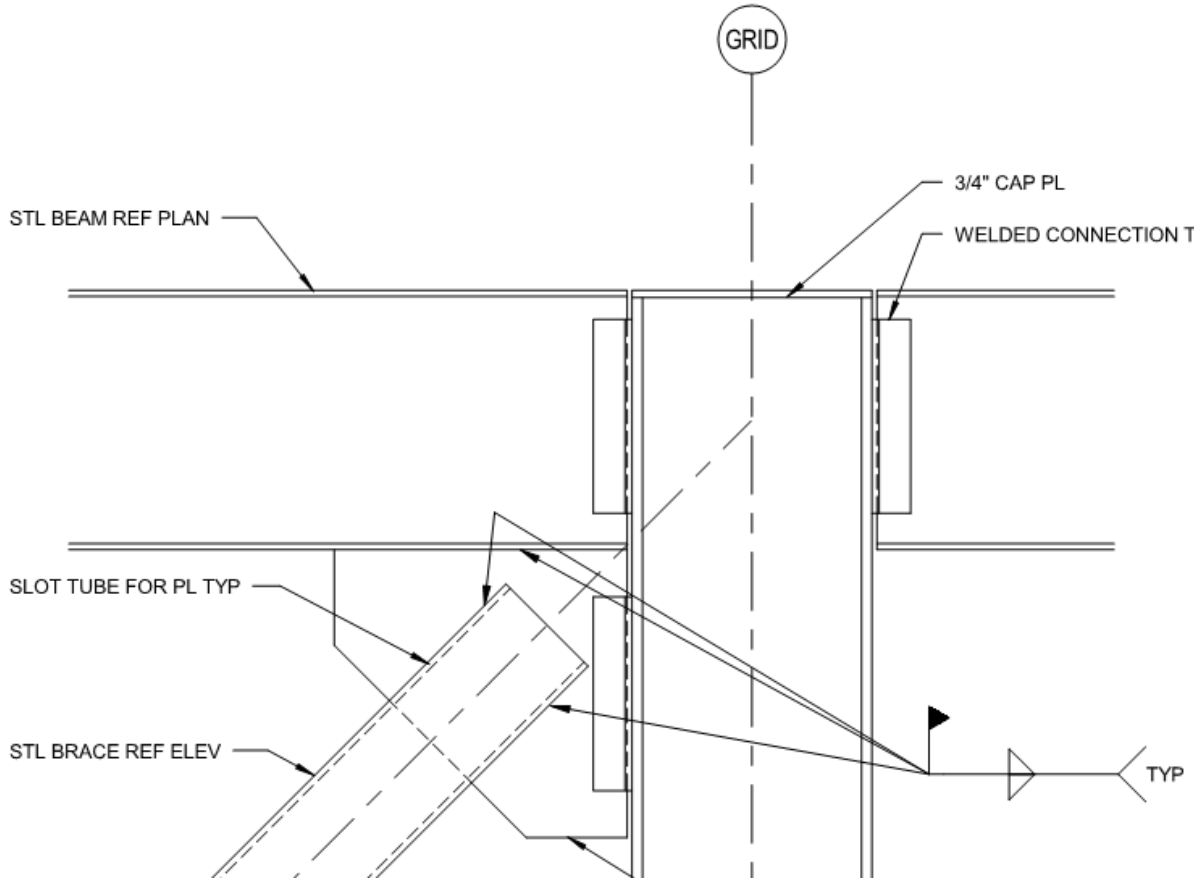
X Braced Frame

- If a joist is used in the X braced frame bay, the axial load will travel through the webs and bottom chord, in addition to the top chord.



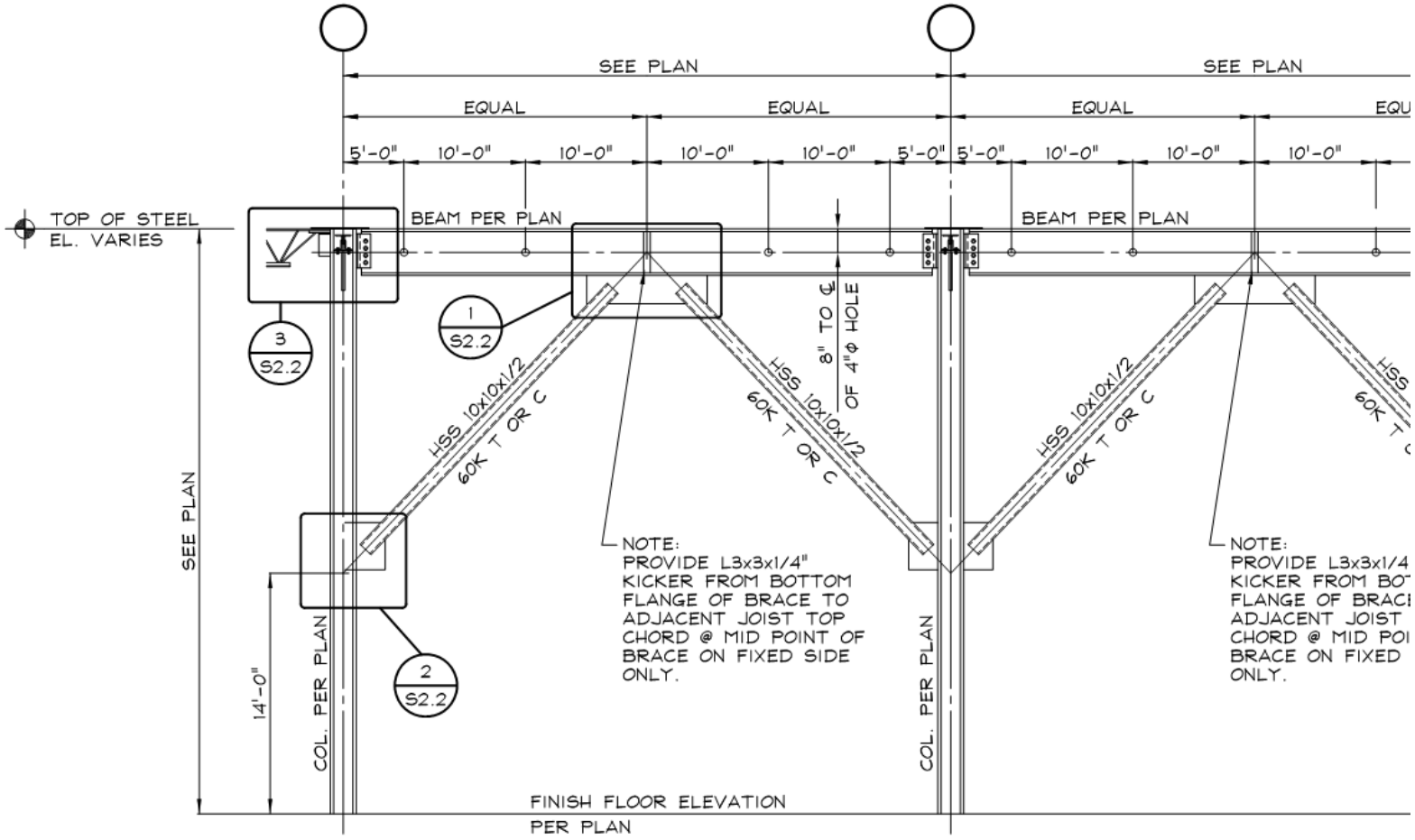
X Braced Frame

- Attention is required for the collector joist to braced frame bay transfer connection.



In this case, a "typical" detail neglects the fact that there is actually a collector joist on this side of the column.

Braced Frame and Collector Joist

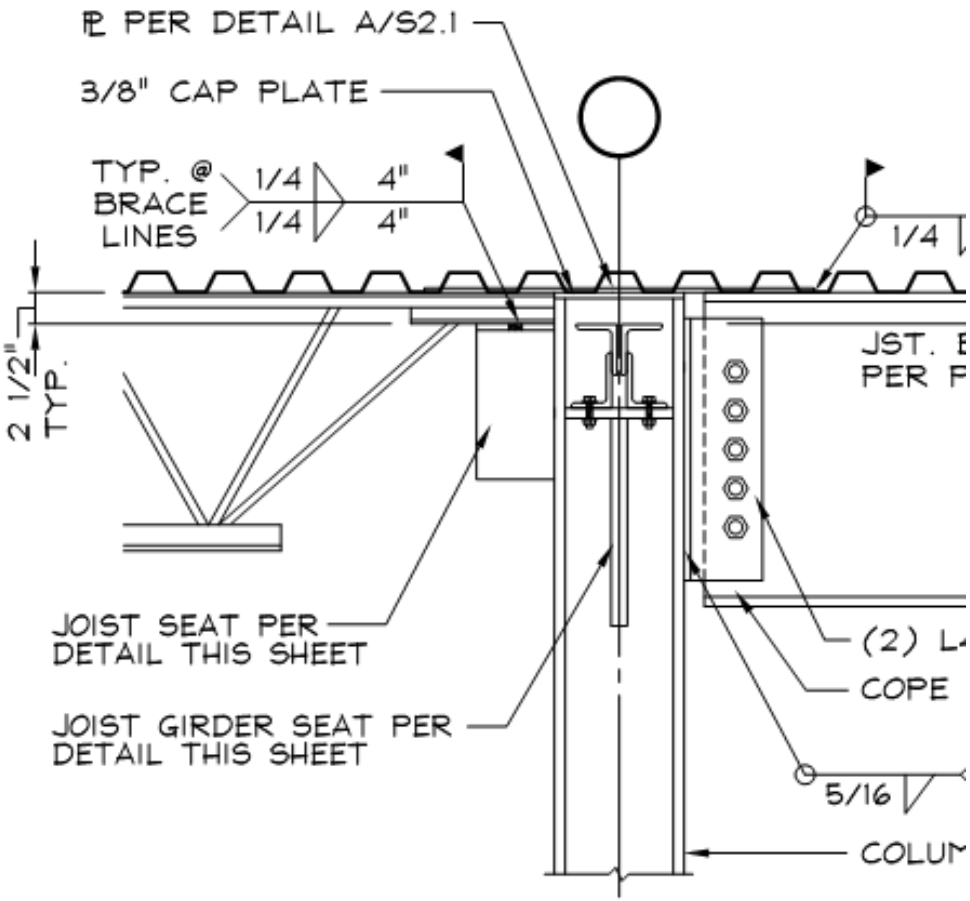


TYPICAL BRACE ELEVATION

SCALE: NONE

Braced Frame and Collector Joist

- This is a good, complete detail.



Rigid Frames – End Moments

- The Specifying Professional is responsible for the rigid frame design.
- Type and magnitude of end moments at the joist and Joist Girder end supports shall be shown on the structural drawings.
- Avoid resolving joist or Joist Girder end moments through the bearing seat connection. The top chord details can be similar to those shown for the transfer of axial loads.

Rigid Frames – End Moments

- 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.

- Unless specially designed and detailed as wind only flexible connections, rigid frame action will induce live load moments, which need to be specified.

Polling Question #2

For concentrated loads placed between panel points of a joist, SJI provides guidance that a field-added strut is not required as long as the sum of the concentrated loads between the panel points does not exceed how many pounds?

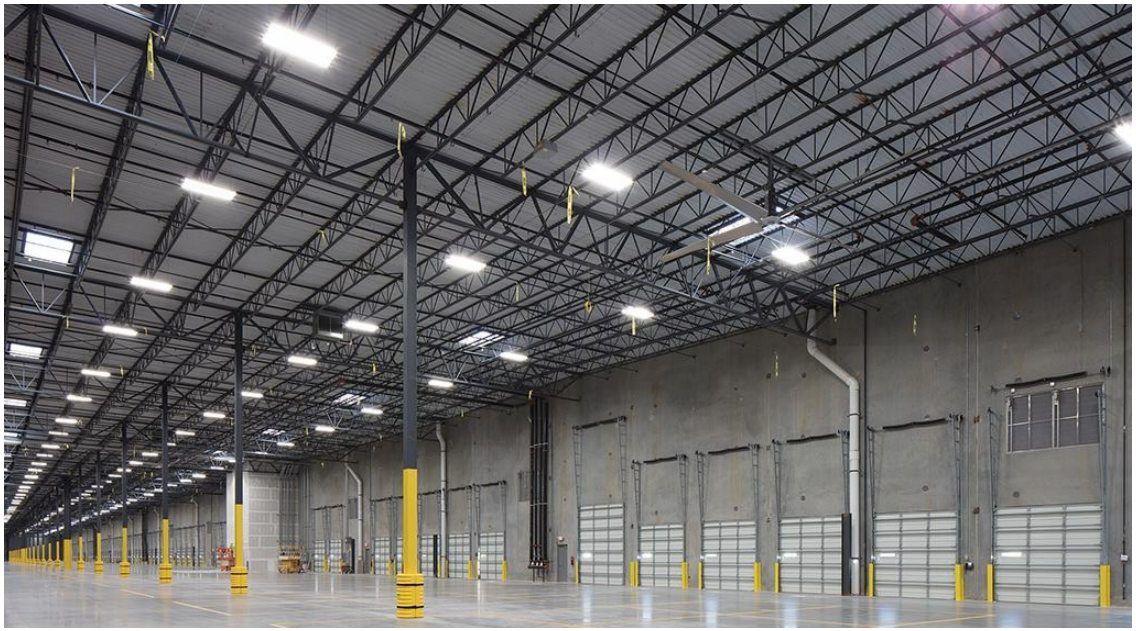
A. 3.14159 pounds

B. 100 pounds

C. 214 pounds

Properly Specifying Steel Joists

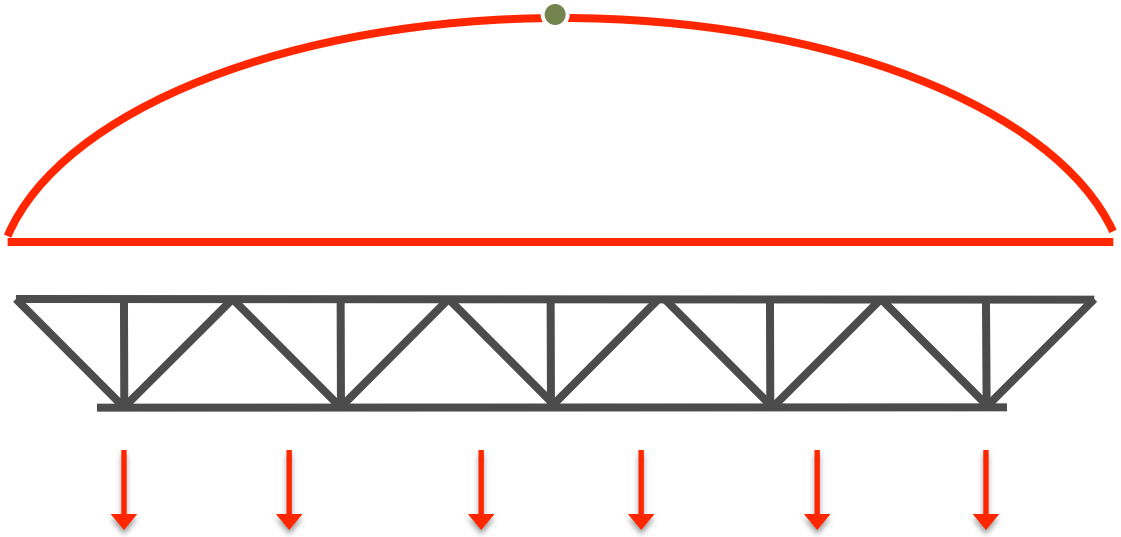
- Codes, Specifications, Designations
- Additional Loads (non-uniform and non-gravity)
- **Economy, Responsibility, Tools**



Specifying…Economy

- ***"Deeper is Cheaper"***

$$M_{max} = \frac{wL^2}{8}$$



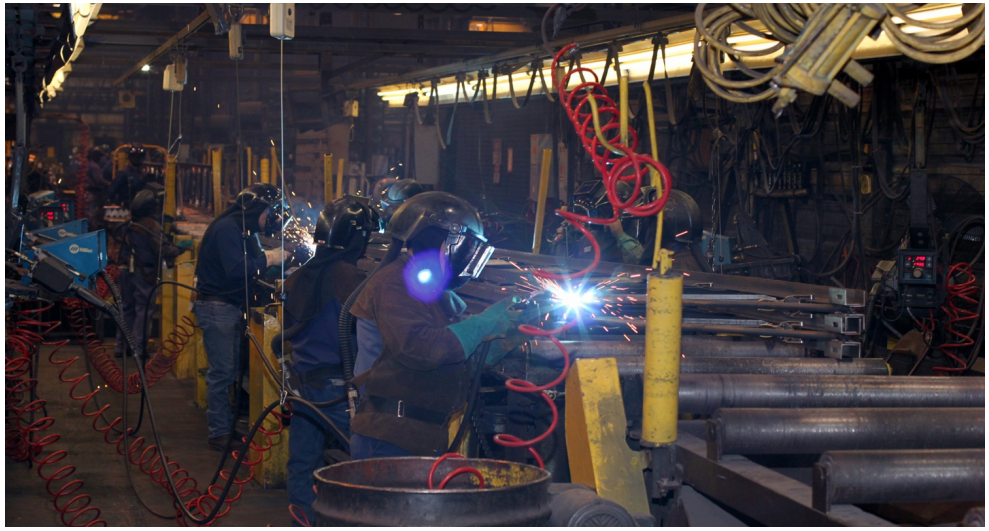
- If the global bending moment is considered as a couple between the joist top and bottom chords, then a deeper joist for the same span will have smaller chord forces.

Specifying…..Economy

- While “deeper is cheaper” there is a point of diminishing returns for increased depth.
- For joists, a SPAN/DEPTH ratio of 18 to 24 is common, with more economy nearer a ratio of 18, than 24. A SPAN/DEPTH ratio approaching 12, or less, for typical roof loads would be beyond the point of diminishing returns.
- For joists, the current SJI combined Specification blends the rules for K-Series and LH-Series. So there is no real advantage to K vs. LH, and if headroom will allow it, consider a 32” or 36” LH-Series joist for roof spans of 50 feet and greater. Note that many manufacturers will produce a 32LH on the same production line as a 30K.
- For Joist Girders, a SPAN/DEPTH ratio of about 12 or less is desirable.

Economy – Joist Depths

- Joists are built, bundled and shipped by depth. Bridging is also easiest to install between joists of the same depth.
- Avoid changing joist depths in a bay just for a small savings in joist weight per foot.



Specifying…..Economy

- For rectangular bays, the most economical framing direction will be to run the joists in the long direction, and the Joist Girders in the short direction.

Economy - Deflection

- Avoid imposing total load deflection requirements, unless absolutely required.
- Joist are built with camber. Standard camber follows a circular arc with a radius of 3,600 feet for spans up to 100 feet, and then reduces to SPAN/300.
- SJI and the IBC do not specifically require a total load deflection check for cambered steel members.

Avoid an RFI !

Self Weight of Joists and Joist Girders

- When specifying joists, always include the self weight of joists and bridging. For typical joist framing, 3 psf is a reasonable and conservative estimate.
- Long spans will have higher self weights. If in doubt whether your allowance is sufficient, a note to indicate what has been assumed and instruction to the joist manufacturer to add self weight in excess of that allowance is appropriate.
- When specifying Joist Girders, it is expected that the self weight of the girders is included in the specified kip designation. When this is not the case, the design drawings must clearly note that self weight is not included and that the manufacturer must add self weight.

Specifying…..Economy

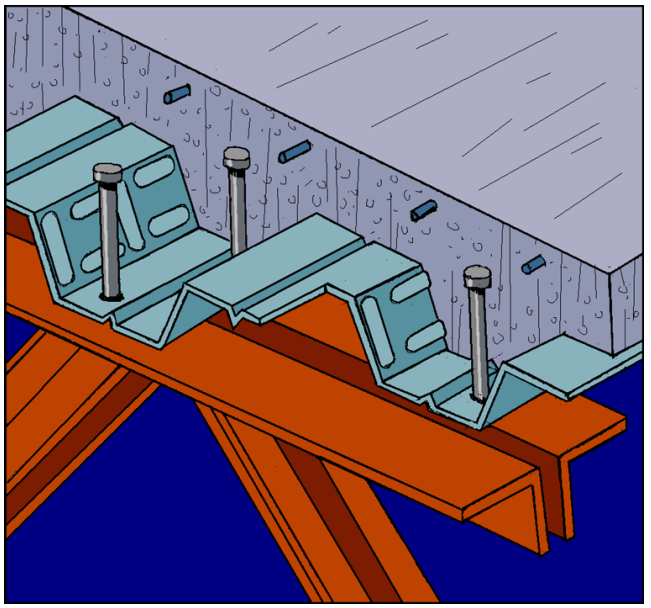
- Joists and Joist Girders can be specified as either ASD or LRFD.
- There is no clear or significant advantage of one design method over another for typical load ratios and cases.
- The joist manufacturer can factor loads for LRFD load combinations, but clarity is required on the contract drawings to be clear what is factored already, and what is not.
- Strive for consistency so as not to mix ASD loads and factored LRFD loads on the same drawings.

Floor Joists…Economy

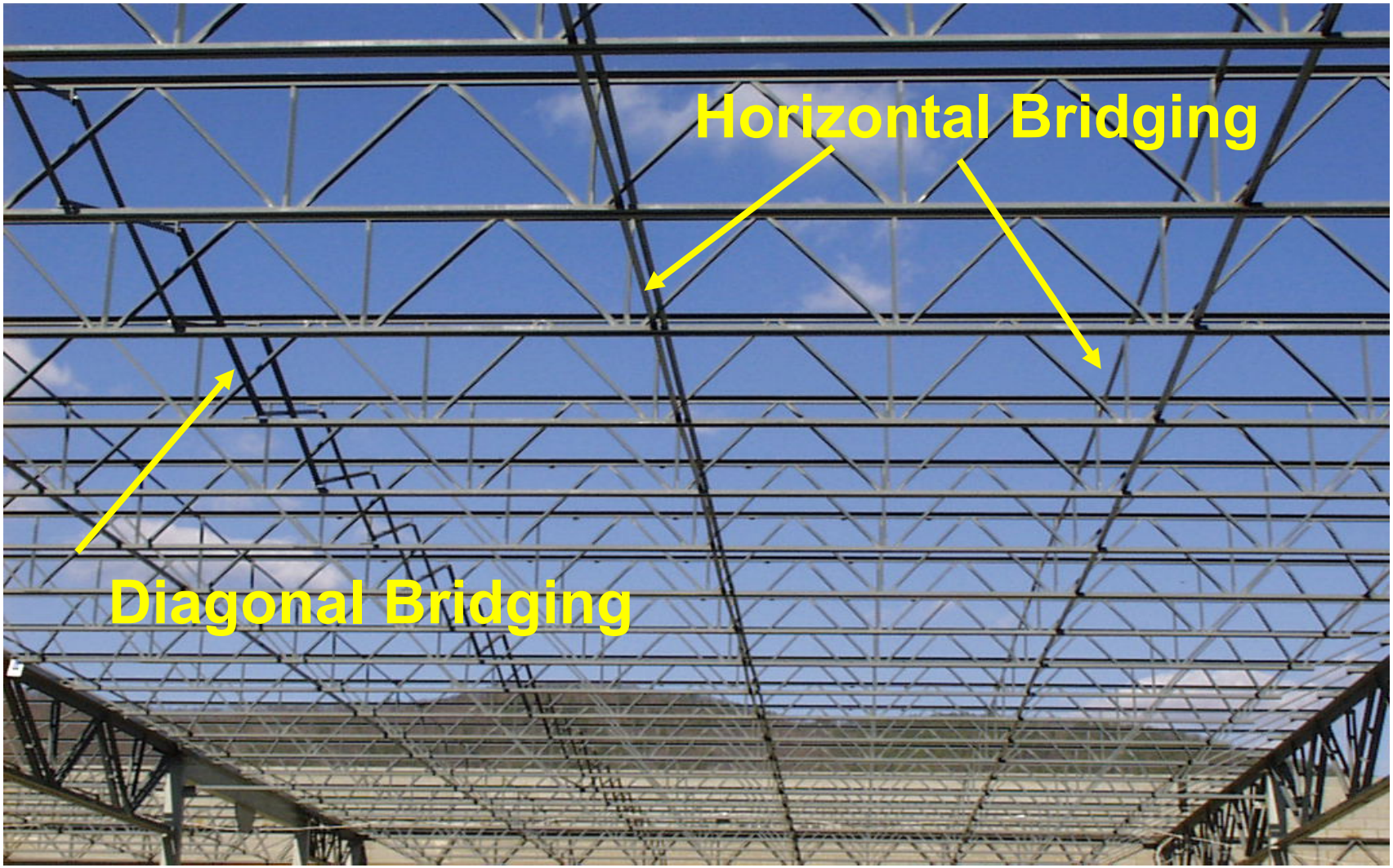
- Floor joists can be placed at spacings similar to roofs.
- Fewer, but heavier, joists may create a slight savings from the joist supplier, but there are other advantages to consider:
  - Fewer joists to handle and erect
  - Reduced cost is spray applied fireproofing is required.
  - Thicker slab for more damping and better vibration performance

Composite Joists CJ-Series

- The cost of shear stud installation can vary significantly by location and crew.
- CJ-Series joists have advantages for very heavy floor loads.
- The SPAN/DEPTH ratio of CJ-Series joists can be as high as 30, which can be advantageous where headroom is at a premium.
- Larger rectangular duct openings are possible in composite and non-composite floor joists.
- Some manufactures can provide “flush-framed” ends to keep the top of joist and supporting beam elevations the same.

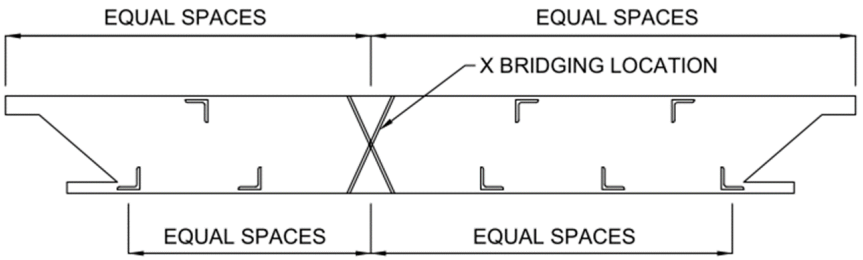


Economy – Bridging Rows

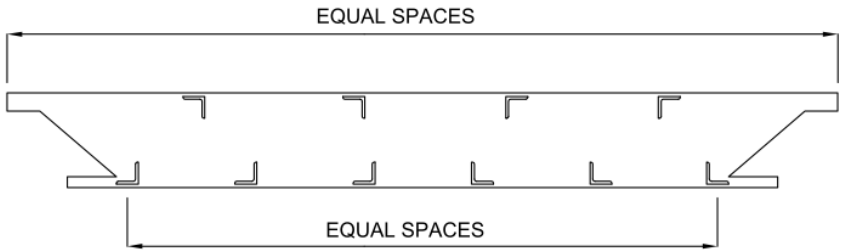


Economy - Bridging Rows

- It is not necessary to show the bridging lines on the structural contract drawings.
- The joist manufacturer can be counted upon to properly apply the bridging in accordance with the SJI requirements.
- SJI does not require top and bottom chord bridging rows to align.
- There are many instances where the joist manufacturer will call for a specific bridging arrangement on the placement plans, due to uplift loads or ESFR sprinkler systems, for example.



IF BOLTED BRIDGING IS REQUIRED, SPACE HORIZONTAL BRIDGING EQUALLY ON EITHER SIDE OF THE BOLTED BRIDGING LINE.



Joist Primer

The primer applied to the joist is a provisional coating, and should not be considered as the final coating.

This primer is generally applied by dipping the joist in a large tank. Consequently the coating will have some inconsistences in thickness and surface conditions.

Shipping…..Economy

- When exceeded, there are dimensional limits for both height (joist depth) and length that will add to the shipping costs.
- Joists over 53’ will require flags and permits, and ultimately escorts.
- Joists over about 100’ will require a field bolted splice, in order to ship in halves.
- Joists over about 8’ tall will need to lay flat, as an over width load.
- The maximum shippable depth is a little less than 16’.

Responsibilities of Specifier and Joist Manufacturer

- IBC 2018 – Chapter 22 Steel
- Section 2207 Steel Joists
- This section provides guidance on responsibilities of Specifier and joist manufacturer with regards to design and documents related to Steel Joists

2207.1 General.

The design, manufacture and use of open-web steel joists and joist girders shall be in accordance with either SJI CJ or SJI 100, as applicable.

Responsibilities of Specifier and Joist Manufacturer

- 2207.4 Steel joist drawings – Steel joist placement plans show the joist products as specified on the approved construction documents

2207.4 Steel joist drawings.

Steel joist placement plans shall be provided to show the steel joist products as specified on the *approved construction documents* and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207.2. Steel joist placement plans shall include, at a minimum, the following:

- The steel joist placement plans do not require the seal and signature of the joist manufacturer's registered design professional.

Steel joist placement plans do not require the seal and signature of the joist manufacturer's *registered design professional*.

Responsibilities of Specifier and Joist Manufacturer

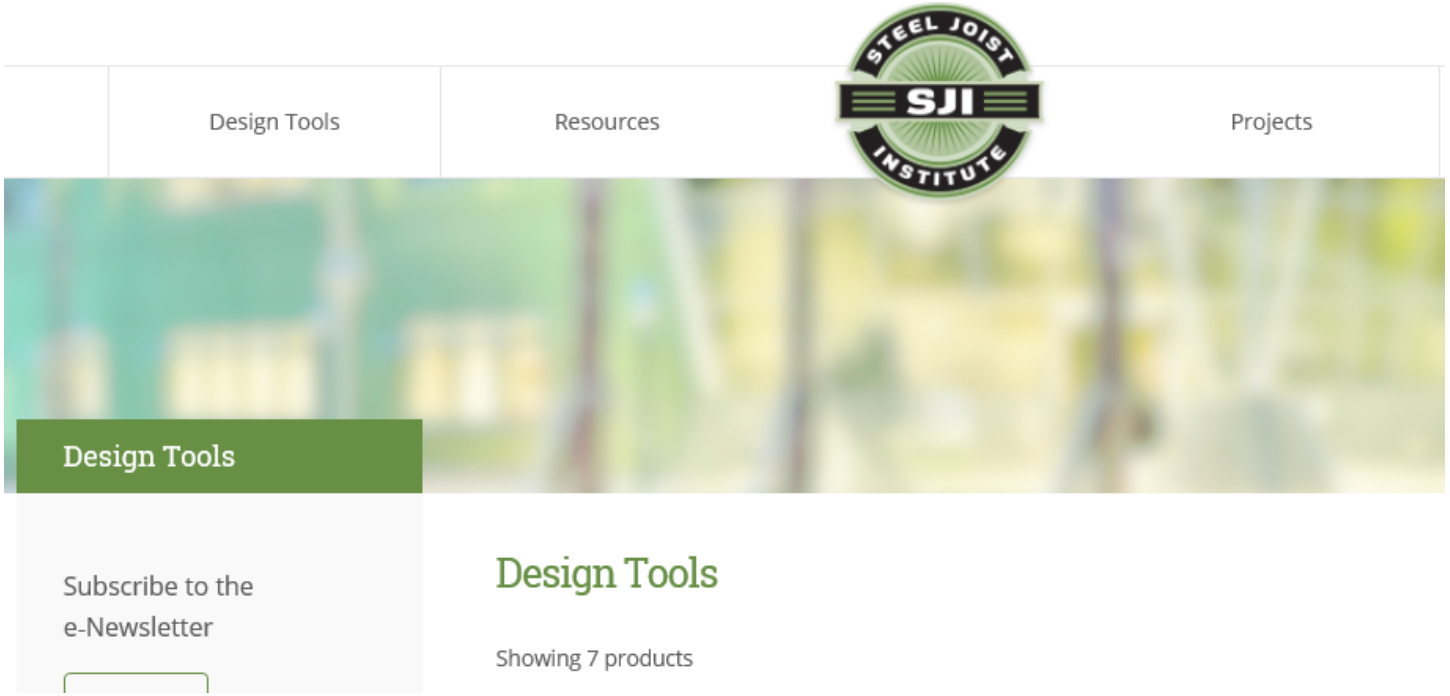
- 2207.2 Design – The registered design professional shall indicate on the construction documents the joist and girder designations
- Design professional is also responsible for joist and girder anchorage, bridging termination connections and bearing connection design to resist uplift and lateral loads.

2207.2 Design.

The *registered design professional* shall indicate on the *construction documents* the steel joist and steel joist girder designations from the specifications listed in Section 2207.1; and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, bridging design that differs from the SJI specifications listed in Section 2207.1, bridging termination connections and bearing connection design to resist uplift and lateral loads. These documents shall indicate special requirements as follows:

Joist Design Tools from the SJI

Steel Joist Institute Website has a design tools tab



Joist Design Tools from the SJI

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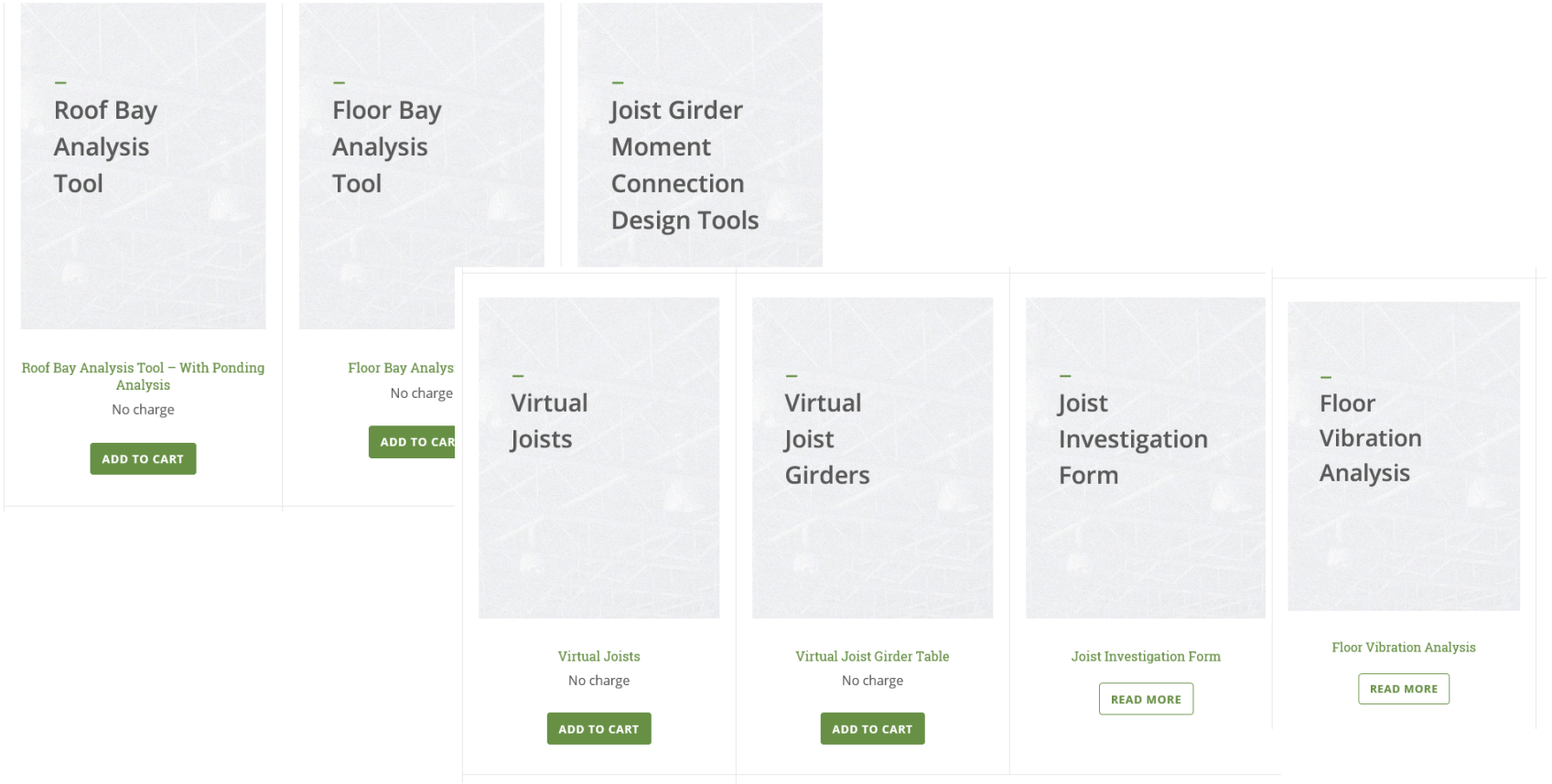


Joist Design Tools from the SJI

Steel Joist Institute Design Tools include:

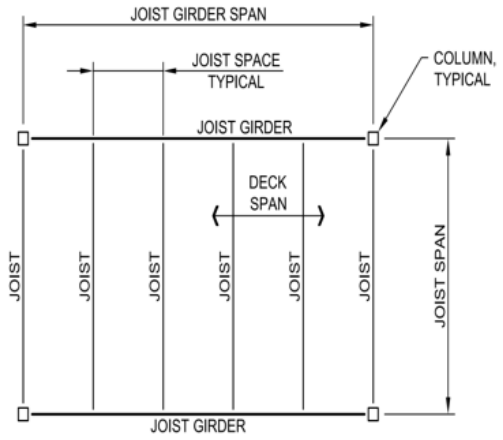
1. Roof Bay Analysis Tool
2. Floor Bay Analysis Tool
3. Joist Girder Moment Connection Design Tool
4. Virtual Joists
5. Virtual Joist Girders
6. Joist Investigation Form
7. Floor Vibration Analysis

Floor Bay Analysis Tool

- The free SJI Floor Bay analysis tool evaluates a given bay for economic comparison.
- The combined joist, deck, and slab is system is reviewed.
- The joists, and the deck, can each be selected as composite or non-composite.

TYPICAL INTERIOR BAY LAYOUT

Bay Width / Joist Span	40.0	ft.
Bay Length / Joist Girder (JG) Span	30.0	ft.



JOIST DESIGN CRITERIA

Comp. or Non-Comp.	Non-Comp	
Standard K, LH, & DLH	N	or N)
Load/Load	Y	(Y or N)
Steel Yield Stress	50	ksi

NOMINAL FLOOR LIVE LOADS CLEAR INPUT

Live Load	80	psf
Moveable Partitions	0	psf
Total Live Load	80	psf
Live Load Reduction	Y	(Y or N)

Live loads that exceed 100 psf are not reducible.

DECK & CONCRETE SLAB DESIGN CRITERIA

Deck Profile & Gage	1.5 - 22 Gage		OK
Is Deck Galvanized?	Y	(Y or N)	OK
Comp. or Non-Comp.	Comp.		OK
Reinforcement	6x6-W2.1xW2.1		OK
NW or LW Concrete	NW		
Total Slab Depth	5	in.	
Construction Live Load	20	psf	
Joist Spaces per Bay	10		

Floor Bay Analysis Tool

- In addition to providing cost results, many validations and checks are performed.

DECK AND CONCRETE SLAB SUMMARY (Superimposed Loads)

Deck Profile & Gage	Total Slab Depth & Conc Type	Deck Span ft.	Max Deck Span * ft.	Required Load psf	Available Load psf	Deck Weight psf	Conc Weight Deflection Allowable in.	Conc Weight Deflection Actual in.
1.5 - 22 Gage	5 in. NW	3.00	5.83	136	400	1.78	0.20	0.01
* Maximum Deck Construction Span (Three Span) per SDI					OK			OK

JOIST SUMMARY (Total Loads)

Joist Designation	Joist Spacing ft.	Required Load lb / ft	Available Load lb / ft	Joist Weight lb / ft	Allowable Deflection in.	Live Load Deflection in.
32LH433/240	3.00	433	500	12.1	1.33	0.76
			OK			OK

BRIDGING SUMMARY

X-Bridging Req'd (Y or N)	Number of rows X-Bridging	Length of X-Bridging ft.	Weight of X-Bridging plf	H-Bridging Req'd (Y or N)	Number of rows H-Bridging	Length of H-Bridging ft.	Weight of H-Bridging plf	
N	0	0.00	0.00	Y	2	120.00	1.07	OK

JOIST GIRDER SUMMARY (Total Panel Point Loads)

Joist Girder Depth in.	Joist Spaces	Required Load kips	Load Used to Estimate Wt. kips	Joist Girder Weight lb / ft	Allowable Deflection in.	Live Load Deflection in.
36	10	13.4	14.0	68	1.00	0.33
JG Designation: 36G10N13.4K			OK			OK

COST RESULTS

Concrete		Reinforcement		Deck		
Purchase	Installation	Purchase	Installation	Purchase	Installation	
$1.07	$2.60	$0.44	$0.20	$1.25	$0.55	$ / sf
$1,282	$3,120	$528	$240	$1,495	$660	$ / bay

Joists		Studs		Bridging		Joist Girders		
Purchase	Installation	Purchase	Installation	Purchase	Installation	Purchase	Installation	
$2.92	$1.25	$0.00	$0.00	$0.04	$0.10	$1.32	$0.17	$ / sf
$3,509	$1,500	$0	$0	$96	$240	$1,581	$200	$ / bay

	Error Checks
OK	Load/Load Joist Span
OK	Composite Joist Span
OK	Deck & Slab ID
OK	Galvanized Composite Deck
OK	Non-Composite Form Deck
OK	Reinforcement Ratio
OK	Deck Span
OK	Deck Strength
OK	Joist Depth
OK	JG Depth
OK	Deck Deflection
OK	Joist Strength
OK	Joist Deflection
OK	JG Strength
OK	JG Deflection
OK	Joist & Bridging Weight Input
OK	Joist & Bridging Weight Estimate
OK	JG Weight Input
OK	JG Weight Estimate
OK	Joist Spacing for Bridging
OK	Composite Design Methodology
OK	Composite Joist Depth Input (D49)

Roof Bay Analysis Tool

- Similarly, the free SJI Roof Bay analysis tool evaluates a given bay for economic comparison.
- The combined joist and deck system is reviewed.
- The Roof Bay Analysis Tool also has the ability to do a check for ponding water.

TYPICAL INTERIOR BAY LAYOUT

Bay Width / Joist Span	50.0	ft.
Bay Length / Joist Girder (JG) Span	50.0	ft.

ROOF NOMINAL LOADS — CLEAR INPUT

Dead Load, D

Roofing Material	5.00	psf	Live Load	Lr	20.00	psf
Deck	2.00	psf	Live Load Reduction (Per Code)		Y	(Y or N)
Joists & Bridging	3.00	psf	Snow Load *	S	5.00	psf
Joist Girders (JG)	1.00	psf	Wind Downward Load	W	10.00	psf
Collateral	9.00	psf	* Or "Rain on Snow" Load			

ROOF DECK PROFILE, GAGE & JOIST SPACES

Deck Profile & Gage	WR22	'IR' - Intermediate Rib (F deck), 'WR' - Wide Rib (B deck), 'DR' - Deep Rib (N deck)
Number of Joist Spaces	8	

ROOF DECK CHECK

Deck Profile & Gage	Deck Span ft.	Max Deck Span * ft.	Deck Moment inch-lb	Moment Interaction Check	
WR22	6.25	6.92	1582	0.44	OK

* Maximum Deck Construction Span (two or more) per SDI

DEPTH DATA

Joist Min Depth: Default	26	in.
Joist Min Depth: Manual		in.
Joist Max Depth: Default	52	in.
Joist Max Depth: Manual		in.
JG Min Depth: Default	28	in.
JG Min Depth: Manual		in.
JG Max Depth: Default	60	in.
JG Max Depth: Manual		in.

Minimum depths are span/24.

DEFLECTION CRITERIA

Deck - Total Service Load	Span /	240	0.31 in.
Joist - Lr or Snow Load	Span /	240	2.50 in.
JG - Lr or Snow Load	Span /	240	2.50 in.

Loads considered are unfactored service loads.

X-BRIDGING

Minimize X-Bridging for Spans ≤ 60 ft. Y (Y or N)

If "Y", the lightest joist without x-bridging is selected, if it's adequate.

Roof Bay Analysis Tool

- Cost results for multiple scenarios can be compared, side by side.
- In addition to providing cost results, many validations and checks are performed.
- Where desired, ponding parameters can be input and validation results are provided for the ponded roof condition.

RUN COMPARISONS

	Run 1	Run 2	Run 3	Run 4
Design Methodology	ASD	ASD	ASD	ASD
Joist Span, ft.	50.0	50.0	50.0	50.0
Joist Girder Span, ft.	50.0	50.0	50.0	50.0
Deck Profile & Gage	WR22	WR22	WR22	WR22
Deck Span, ft.	6.25	6.25	6.25	6.25
X-Bridging Rows	0	0	0	1
H-Bridging Rows	3	3	3	2
Joist Size	30K11	26K12	26K12	26K10
Joist Seat Depth, in.	2.5	2.5	2.5	2.5
Joist Girder Size	56G8N10.5K	56G8N10.5K	52G8N10.5K	56G8N10.5K
Weight, psf	4.98	5.04	5.08	4.72
Cost, $ / sf	$4.96	$5.01	$5.04	$4.85

	Error Checks
OK	Deck Span
OK	Deck Flexure
OK	Joist Depth
OK	JG Depth
OK	Deck Deflection
OK	Joist Strength
OK	Joist Deflection
OK	JG Strength
OK	JG Deflection
OK	Estimated Deck Weight
OK	Estimated Joist & Bridging Weight
OK	Estimated JG Weight
OK	Joist Spacing for Bridging

SJI Technical Digests

The SJI publishes a series of Technical Digests on topics related to steel joists, which supplement the Specification and Code of Standard Practice as resources to consult when specifying steel joists.

Technical Digest #3 February 2018

Structural Design of Steel Joist Roofs to Resist Ponding Loads

Technical Digest #5 January 2015

Vibration of Steel Joist - Concrete Floors

Technical Digest #6 April 2012

Design of Steel Joist Roofs to Resist Uplift Loads

SJI Technical Digests

Technical Digest #8 October 2008 (next edition is printing soon!)

Welding of Open-Web Steel Joists and Joist Girders

Technical Digest #9 March 2008

Handling and Erection of Steel Joists and Joist Girders

Technical Digest #10 May 2003

Design of Fire-Resistive Assemblies with Steel Joists

Technical Digest #11 November 2007

Design of Lateral Load Resisting Frames Using Steel Joists and Joist Girders

Technical Digest #12 February 2007 (an update is being written)

Evaluation and Modification of Steel Joists and Joist Girders

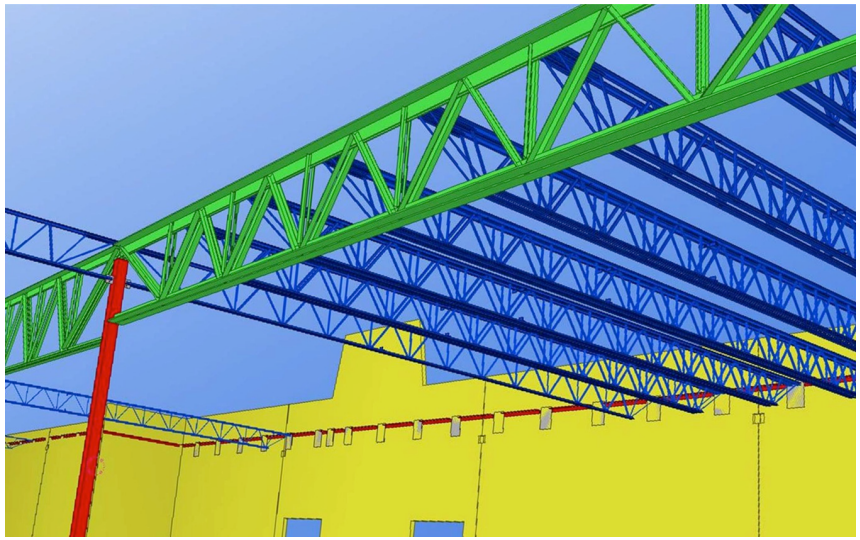
Summary

The time limits of the presentation did not allow all of the topics to be fully explored, and some other topics related to Properly Specifying Steel Joists were not covered at all.

However, please contact any Joist Manufacturer for more details or advice about how to proceed with a particular situation on your next project.

Properly Specifying Steel Joists

Any Questions?



Polling Question Answers

1. For a “load/load” designation, the second load value (expressed in plf) is the?

   A. Wind Load

   B. The Live Load required to generate L/180 deflection

   C. The Live Load for which the deflection shall be checked against the specified limits

   D. Collateral Load

2. For concentrated loads placed between panel points of a joist, SJI provides guidance that a field-added strut is not required as long as the sum of the concentrated loads between the panel points does not exceed how many pounds?

   A. 3.14159 pounds

   B. 100 pounds

   C. 214 pounds

THANK YOU