SKSAP DETAILING TEAM

Steel detailing Hand Note

SKSAP

QUALITY & SURETY

Topic: -

AISC dimensioning tool link
Structural Steel Dimensioning Tool | American Institute of Steel Construction (aisc.org)
AISC steel detailing online course
Detailer Training Series Online Course | American Institute of Steel Construction (aisc.org)
AISC 341-16
ANSI/AISC 341-16: Seismic Provisions for Structural Steel Buildings
HILTI bolts availability link
Power Tools, Fasteners, and Software for Construction - Hilti USA
Tekla Warehouse - Tekla Warehouse
Tekla Trimble learning.
Construction - Building Construction - Tekla - Learn. Trimble
SDS2 online training program - sds2.com
Bolt availability info: - https://www.portlandbolt.com
Haydon Bolts | Construction Fastener Specialists Since 1864
Bolt weight calculator: -
» Bolt Weight Calculator (portlandbolt.com)
Plate weight calculator: -
» Plate Weight Calculator (portlandbolt.com)
Ladders info: - precisionladders.com
Gates info: -https://www.hooverfence.com/
Bolt tightening Gun availability: -
TC Shear Wrenches (Tension Control) | With Bolt Size Chart (gwyinc.com)

Abbreviations

ACI - American Concrete Institute
AISC - American Institute of Steel Construction
ANSI - American National Standards Institute
ASCE - American Society of Civil Engineers
AISE - Association of Iron and Steel Engineers
ASME - American Society of Mechanical Engineers
ASTM - American Society of Testing and Material
ATLSS - Advanced Technology of Large Structural Systems
AESS - Architecturally Exposed Structural Steel
AGS - American Galvanizers Society
ASD - allowable strength design
AWS - American Welding Society
AASHTO - American Association of State Highways and Transportation Officials
AREMA - American Railway Engineering and Maintenance of Way Association
BIF - Bill Interchange Format
BRBF - buckling-restrained braced frame
CAD - Computer Aided Drafting
CASE - Council of American Structural Engineers
CC - Centre to Centre
CG - Center of Gravity
CNC - Computer Numeric Control
C-EBF - Composite Eccentrically Braced Frame
C-IMF - Composite Intermediate Moment Frame
CJP - Complete Joint Penetration
C-OBF - Composite Ordinary Braced Frame
C-OMF - Composite Ordinary Moment Frame
C-OSW - Composite Ordinary Shear Wall
C-PRMF - Composite Partially Restrained Moment Frame
CPRP - Connection Prequalification Review Panel
C-PSW - Composite Plate Shear Wall
C-SCBF - Composite Special Concentrically Braced Frame
C-SMF - Composite Special Moment Frame
C-SSW - Composite Special Shear Wall
CVN - Charpy V-Notch
CFR - Code of Federal Regulation for the construction industry
CISC - Canadian Institute of Steel Construction
CMAA - Crane Manufacturers Association of America

CMTR - Certified Mill Test Record
DXF - Drawing Interchange Format
E70LH - E70-Low Hydrogen
ERW - Electric Resistance Welding
EBF - Eccentrically Braced Frame
FCAW - Flux-Cored Arc Welding
FEMA - Federal Emergency Management Agency
FR - Fully Restrained
GMAW - Gas Metal Arc Welding
GA – Gage
GOL - Gage on Angle/Gage Outstanding Leg
GTSM - Gouge to Sound Metal
HBE - Horizontal Boundary Element
HSS - Hollow Structural Section
HVAC - Heat Ventilating and Air Conditioning
IBE - Intermediate Boundary Element
IMF - Intermediate Moment Frame
KSI - Kips Per Square Inch
LASER - Light Amplification by Stimulated Emission of Radiation
LBS - LB = Pound
LHE - Left Hand End
LLH - Long Leg Horizontal
LLV - Long Leg Vertical
LSL - Long Slot
LSLP - Long Slotted/Load Parallel Holes
LSLT - Long Slotted/Load Transverse Holes
LAST - Lowest Anticipated Service Temperature
LRFD - Load And Resistance Factor Design
MC - Miscellaneous Channel / Moment Connection
MT - Magnetic Particle Testing
MBMA - Metal Building Manufacturers Association
MT-OCBF - Multi-Tiered Ordinary Concentrically Braced Frame
MT-SCBF - Multi-Tiered Special Concentrically Braced Frame
MT-BRBF - Multi-Tiered Buckling-Restrained Braced Frame
MBMA - Metal Building Manufacturers Association
NDE – Non-Destructive Examination
NDT – Non-Destructive Testing
NACE - National Association of Corrosion Engineers International
NBCC - National Building Code of Canada
NISD - National Institute of Steel Detailing

NS - Near Side
OSHA - Occupational Safety and Health Administration
OCBF - Ordinary Concentrically Braced Frame
OCCS - Ordinary Cantilever Column System
OMF - Ordinary Moment Frame
OVS – Oversize
OSL - Out Standing Leg
PT - Penetrant Testing
PJP - Partial Joint Penetration
PR - Partially Restrained
QA - Quality Assurance
QC - Quality Control
RD - Running Dimension
RFI - Request For Information
RT - Radiographic Testing
RBS - Reduced Beam Section
RCSC - Research Council on Structural Connections
SAW - Submerged Arc Weldng
SC - Slip-Critical
SDNF - Steel Detailing Neutral File
SER/EOR - Structural Engineer Of Record
SJI - Steel Joist Institute
SCBF - Special Concentrically Braced Frame
SCCS - Special Cantilever Column System
SDC - Seismic Design Category
SEI - Structural Engineering Institute
SFRS - Seismic Force-Resisting System
SMAW - Shielded Metal Arc Welding
SMF - Special Moment Frame
SPSPW - Special Perforated Steel Plate Wall
SPSW - Special Plate Shear Wall
SRC - Steel-Reinforced Concrete
SOP - Standard Office Practice
SSL - Short Slot
SSLP - Short Slotted/Load Parallel Holes
SSLT - Short Slotted/Load Transverse Holes
SSPC - Steel Structures Painting Council / Society of Protective Coating
SSRC - Structural Stability Research Council
STMF - Special Truss Moment Frame

TBD - To Be Determined
TC - Tension Control
TYP – Typical
UDL - Uniformly Distributed Load
UM - Universal Mill
UNO - Unless Noted Otherwise
UT - Ultrasonic Testing
VT - Visual Testing
VBE - Vertical Boundary Element
WSD - Working Stress Design
WPQR - Welder Performance Qualification Records
WPS - Welding Procedure Specification

1. Required information from contract drawings to start the new project: -

The following points to review on design drawings, before starting the model:

1. Design ASD or LRFD
2. Job north direction
3. Material grade information
4. Grid to grid dimensions and numbers
5. Compare arch and structural drawings sections and grid dimension
6. Floor elevation& Top of steel elevation
7. Slab thickness
8. Beam locating dimensions
9. Typical connection type Bolted or Welded)
10. Column orientation
11. Column based plate elevation
12. Column cap plate elevation
13. Anchor bolt dia info
14. Baseplate thick and size and hole pattern
15. Baseplate extension at brace locations.
16. AB embedment information
17. Levelling plate requirements or Levelling Nuts /Temp plates
18. Grout thick info
19. Column shear lug, orientation, CJP weld, shear lug pocket
20. Embed plate information like size & elevations
21. Nailer hole requirement confirm with a customer)
22. Embedded items Angles, channels, etc.,)
23. Moment information Moment type - Bolted or Welded
24. Camber information
25. Connection bolt grade TC or Non-TC
26. If the project has Slab depression, we need to provide deck support
27. Edge of slab dimension
28. Typical connection detail - whether show min/ std/max number of bolts

29. Opening size and locating information.
30. If any pour stop shop welded or field weld, we need to confirm the
31. section and customer.
32. If any galvanize member, we need to input Galv. In model.
33. AESS members and galvanize.
34. If any load for member or Number of bolts as given in Structural drawings.
35. We need to follow per fabricator standard.
36. Erection possibility& erector note in erection plans.
37. Column lifting holes or angle.
38. Safety cable hole& Lifeline hole.
39. Deck support seating angle at column location.
40. For galvanized members, we need to provide vent & drain holes.
41. If have any frames, we need to review the erection aid.
42. If sequence, zone, we need to consider first erection members and sequence.
43. While release members to confirm connection future sequence.
44. Pour stop, if Circle area, we need to provide erection bolts.
45. Before releasing members for approval/fabrication, we need to review all emails and sketches, and RFI responses to confirm whether all points are updated or not.
46. If the Joist connects to the beam, for the parallel condition we need to fix the top of the joist elevation and the Top of the beam elevation. If perpendicular, we need to down be based on joist shoe depth size.
47. Need to review beam penetration on the plan and section.
48. SC bolts size and grade - Shop Note & Field note to add in drawings.
49. Erection bolt A307 - Confirm the Customer.
50. If any member input, we should check miscellaneous or main members. If have any questions, should be discussed with APM/PMs.

51. Anything showed field welded on the design document, if possible, to shop attach, we need to ask confirmation from the customer.
52. Member length if exceeded 40'-0" we need to confirm splice
53. requirement or shipment info.
54. If anything, we assume as a frame, before sending we need to confirm with the customer.
55. If we have a double slope, we need to consider deck seating arrangement bent plate, angle) on beam for different slab locations.
56. We need to consider if anything material adds, if possible, always keep the same sub mark. Sub mark details should follow the round value.
57. If anything is attached to for CMU wall need to review it with the wall location.
58. Wall profile to compare to arch sheets.
59. Galvanized tank details& Shipping length & width details.

2. Inputs and Outputs of steel detailing: -

Below are items that will be received from the customer. If not, needs to ask in Pre-Detailing Meeting.

Inputs from customer: -

- Structural
- Architectural
- Civil
- Mechanical, Electrical, Plumbing
- Fireproof
- Joist& Deck
- Specifications
- Flex truss
- Precast Panel
- Fabricator Standard
- Erector standard
- Sequence plan.

Outputs from Detailer: -

- Advanced Bill of Material
- Anchor bolt plans and details
- Embed plans and details
- Erection plans and details
- Assembly drawings
- Singe part drawings
- KSS File& Fabtrol reports Confirm with the customer)
- NC, DXF, XML Files
- Drawing log and transmittals.
- Field, shop, point to point bolt list
- Material Change List If required)

3. Units and Calculations: -

1'-0" = 12" inches. In architectural & structural units is 1" inch is divided into hexadecimal

COMMON FRACTIONS OF AN INCH WITH DECIMAL & METRIC EQUIVALENTS

FRACTION	DECIMAL	MM	MM	DECIMAL	FRACTION
1/64	.015625	0.396	13.096	.515625	33/64
1/32	.03125	0.793	13.493	.53125	17/32
3/64	.046875	1.190	13.890	.546875	35/64
1/16	**.0625**	1.587	14.287	**.5625**	**9/16**
5/64	.078125	1.984	14.684	.578125	37/64
3/32	.09375	2.381	15.081	.59375	19/32
7/64	.109375	2.778	15.478	.609375	39/64
1/8	**.125**	3.175	15.875	**.625**	**5/8**
9/64	.140625	3.571	16.271	.640625	41/64
5/32	.15625	3.968	16.668	.65625	21/32
11/64	.171875	4.365	17.065	.671875	43/64
3/16	**.1875**	4.762	17.462	**.6875**	**11/16**
13/64	.203125	5.159	17.859	.703125	45/64
7/32	.21875	5.556	18.256	.71875	23/32
15/64	.234375	5.953	18.653	.734375	47/64
1/4	**.250**	6.350	19.050	**.750**	**3/4**
17/64	.265625	6.746	19.446	.765625	49/64
9/32	.28125	7.143	19.843	.78125	25/32
19/64	.296875	7.540	20.240	.796875	51/64
5/16	**.3125**	7.937	20.637	**.8125**	**13/16**
21/64	.328125	8.334	21.034	.828125	53/64
11/32	.34375	8.731	21.431	.84375	27/32
23/64	.359375	9.128	21.828	.859375	55/64
3/8	**.375**	9.525	22.225	**.875**	**7/8**
25/64	.390625	9.921	22.621	.890625	57/64
13/32	.40625	10.318	23.018	.90625	29/32
27/64	.421875	10.715	23.415	.921875	59/64
7/16	**.4375**	11.112	23.812	**.9375**	**15/16**
29/64	.453125	11.509	24.209	.953125	61/64
15/32	.46875	11.906	24.606	.96875	31/32
31/64	.484375	12.303	25.003	.984375	63/64
1/2	**.500**	12.700	25.400	**1.0000**	**1**

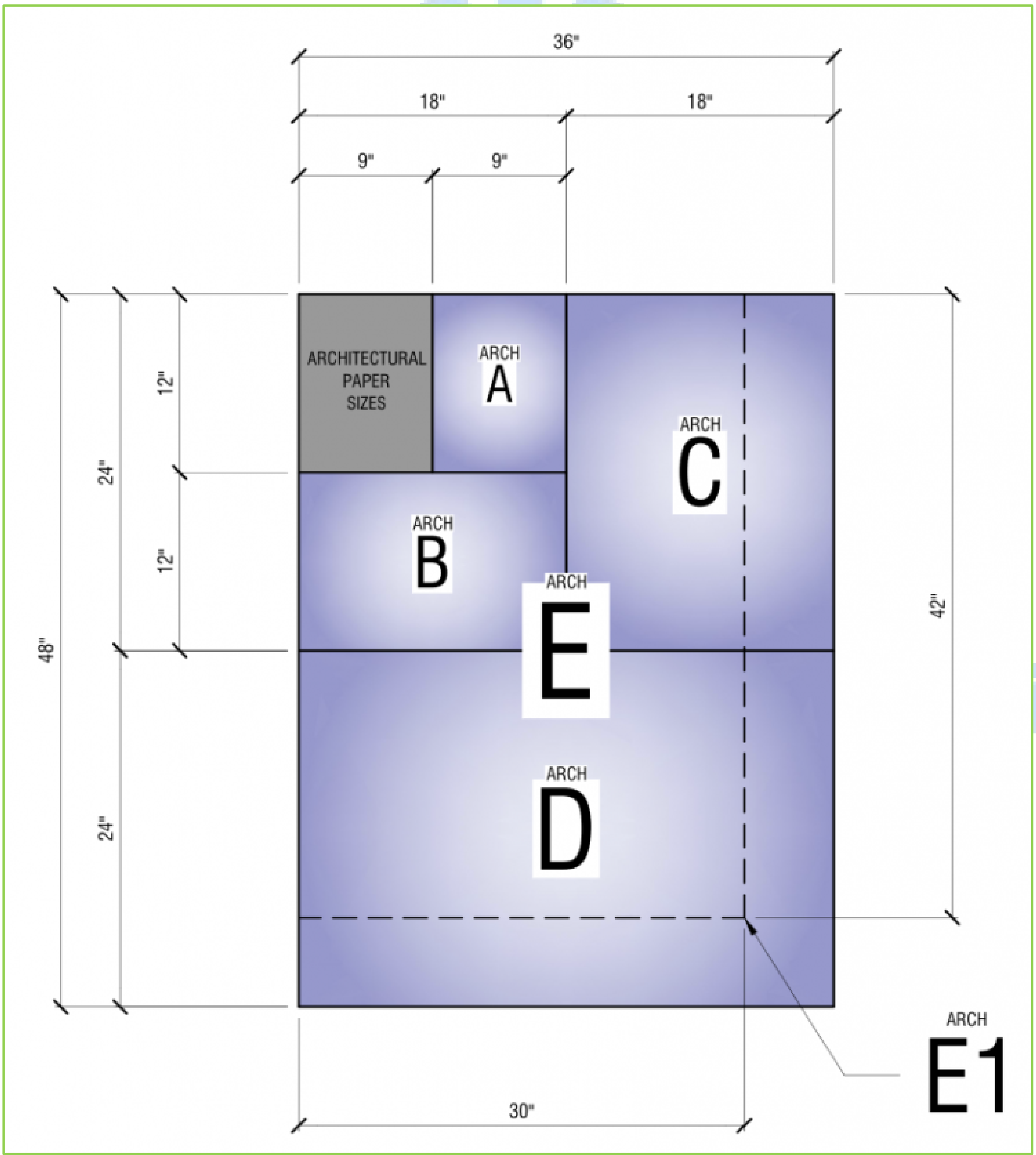
4. Drawing scale and sizes: -

Drawing Scale	8 - 1/2" x 11"	11" x 17"	24" x 36"	30" x 42"	36" x 48"
1/16" = 1'–0"	136' x 176'	176' x 272'	384' x 576'	480' x 672'	576' x 768'
1/8" = 1'–0"	68' x 88'	88' x 136'	192' x 288'	240' x 336'	288' x 384'
1/4" = 1'–0"	34' x 44'	44' x 68'	96' x 144'	120' x 168'	144' x 192'
1/2" = 1'–0"	17' x 22'	22' x 34'	48' x 72'	60' x 84'	72' x 96'
3/4" = 1'–0"	11'–4" x 14'–8"	14'–8" x 22'–8"	32' x 48'	40' x 56'	48' x 64'
1" = 1'–0"	8'–6" x 11'	11' x 17'	24' x 36'	30' x 42'	36' x 48'
1-1/2" = 1'–0"	5'–8" x 7'–4"	7'–4" x 11'–4"	16' x 24'	20' x 28'	24' x 32'
3" = 1'–0"	2'–10" x 3'–8"	3'–8" x 5'–8"	8' x 12'	10' x 14'	12' x 16'

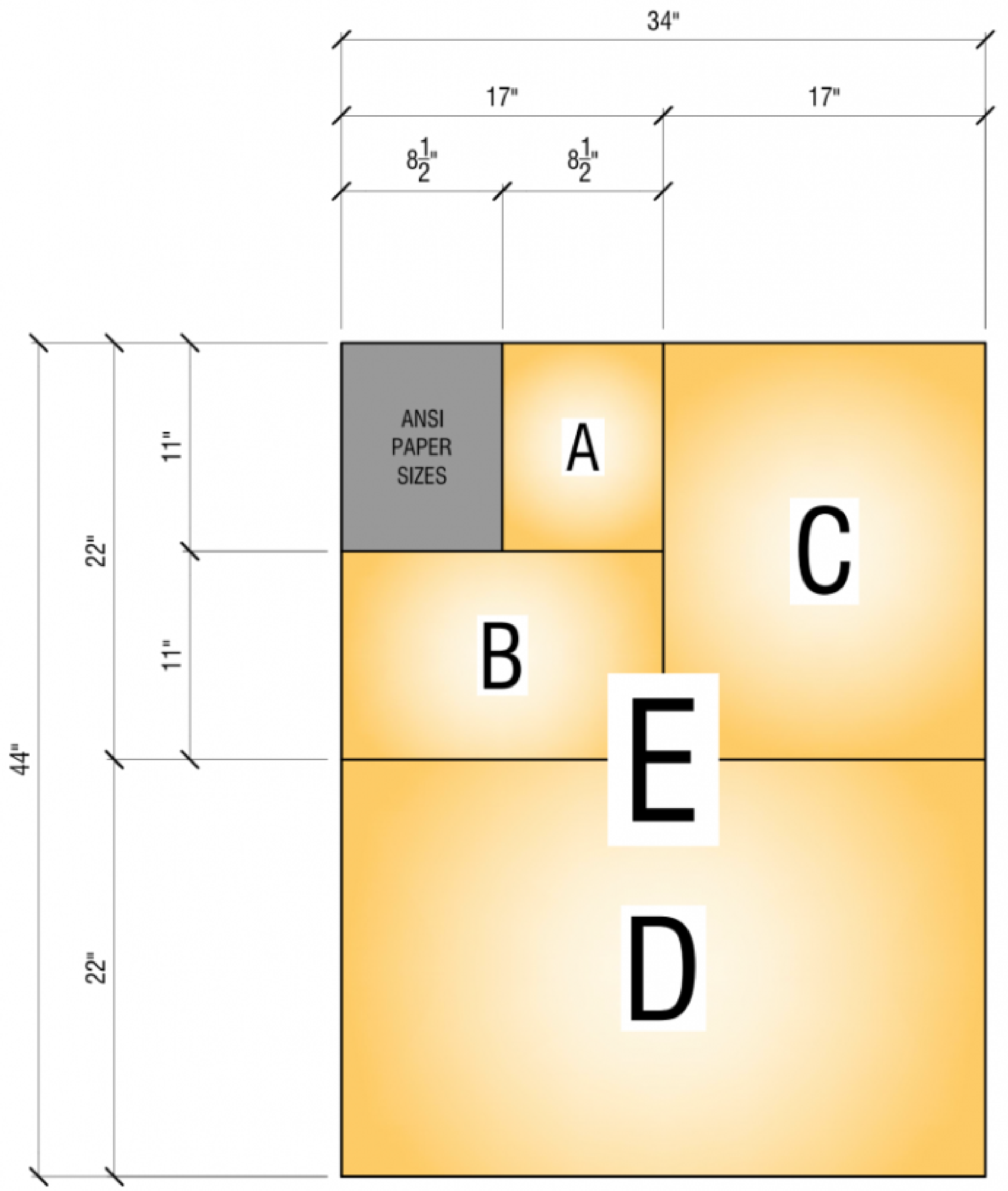
Scale Schedule

SL.NO	ARCHITECTURAL DWG.SCALE	SHEET SIZES LENGTH/ WIDTH	OVER ALL SCALE FACTOR	LINETYPE SCALE FACTOR	PAPER SPACE TEXT HEIGHT			
					3/32"	1/8"	3/16"	1/4"
					MODEL SPACE TEXT HEIGHT			
1	12"=1'	3'-2'	1	0.3	3/32"	1/8"	3/16"	1/4"
2	6"=1'	6'-4'	2	0.6	3/16"	1/4"	3/8"	1/2"
3	3"=1'	12'-8'	4	1.2	3/8"	1/2"	3/4"	1"
4	1 1/2"=1'	24'-16'	8	2.4	3/4"	1"	1 1/2"	2"
5	1"=1'	36'-24'	12	3.6	1 1/8"	1 1/2"	2 1/4"	3"
6	3/4"=1'	48'-32'	16	4.8	1 1/2"	2"	3"	4"
7	1/2"=1'	72'-48'	24	7.2	2 1/4"	3"	4 1/2"	6"
8	3/8"=1'	96'-64'	32	9.6	3"	4"	6"	8"
9	1/4"=1'	144'-96'	48	14.4	4 1/2"	6"	9"	12"
10	3/16"=1'	192'-128'	64	19.2	6"	8"	12"	16"
11	1/8"=1'	288'-192'	96	28.8	9"	12"	18"	24"
12	3/32"=1'	384'-256'	128	38.4	12"	16"	24"	32"
13	1/16"=1'	576'-384'	192	57.6	18"	24"	36"	48"

Size	Width x Height (mm)	Width x Height (in)	Aspect Ratio
Arch A	229 x 305 mm	9.0 x 12.0 in	4:3
Arch B	305 x 457 mm	12.0 x 18.0 in	3:2
Arch C	457 x 610 mm	18.0 x 24.0 in	4:3
Arch D	610 x 914 mm	24.0 x 36.0 in	3:2
Arch E	914 x 1219 mm	36.0 x 48.0 in	4:3
Arch E1	762 x 1067 mm	30.0 x 42.0 in	7:5



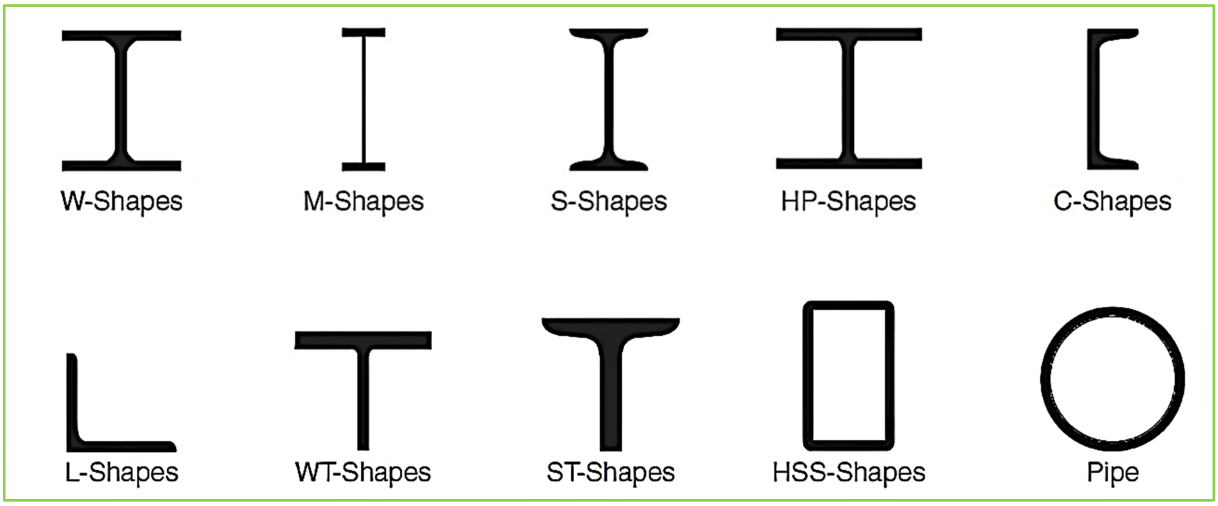
Size	Width x Height (mm)	Width x Height (in)	Aspect Ratio	Nearest ISO
A	216 x 279 mm	8.5 x 11.0 in	1:1.2941	A4
B	279 x 432 mm	11.0 x 17.0 in	1:1.5455	A3
C	432 x 559 mm	17.0 x 22.0 in	1:1.2941	A2
D	559 x 864 mm	22.0 x 34.0 in	1:1.5455	A1
E	864 x 1118 mm	34.0 x 44.0 in	1:1.2941	A0



5. Advance Bill of Material ABM)

- ✓ ABM files are KSS File or Excel or PDF.
- ✓ In addition to wide flange members, plates for built-up beams or other large quantities of the plate, angles, channel, HSS, and any material with special CVN material requirements must be shown on the ABM. Domestic only material must be noted as well. Due to Mill Rollings, main member ABMs will be required as soon as the model is developed. A secondary ABM can be provided for the remaining members.
- ✓ Create a separate ABM for all rolled material. Rolled members must be on a separate ABM with rolling sketches.
- ✓ Detail plate instead of flat bar whenever possible. Plates will be converted to the flat bar if determined by production control.
- ✓ All plates 3" and larger are to be included on the ABM. Notify the Project Management team for all plates 4" and larger.
- ✓ Base Plates and Gusset Plates over 2" thick need to be called out to size, not square footage or weight.
- ✓ Revisions to the ABM must be submitted if the final material length, as detailed, is 1'-0" short of the ABM length or 2" or more) longer than the ABM length. When the final length exceeds these limits, a revised ABM is to be submitted to the client. A narrative of the revisions should be included to the assist client purchasing department's efforts.
- ✓ Buyouts will be purchased directly from the manufacturer; therefore, these items are not listed on an ABM. However, if the "BUYOUT" is shop attached, "BUYOUT" must be noted in the Bill of Material on each detail sheet.
- ✓ The ABM should be prepared by sequence for large jobs. Typically for smaller projects, the ABM can be the material for all sequences. If the sequences are available at the time the ABM is made the sequence numbers should be shown on the ABM and import files.

6. Structural Shapes and Grades: -



W-, M-, S- and HP-Shapes

- W-shapes, which have essentially parallel inner and outer flange surface
- M-shapes, which are H-shaped members that are not classified in ASTM A6 as W-, S-or HP-shapes. M-shapes may have a sloped inside flange face or other cross-section features that do not meet the criteria for W-, S- or HP-shapes.
- S-shapes also known as American standard beams) has a slope of approximately16 2/3 % 2 on 12) on the inner flange surfaces.
- HP-shapes also known as bearing piles), are like W-shapes except their webs and flanges are of equal thickness, and the depth and flange width are nominally equal for a given designation.

These shapes are designated by the mark W, M, S, or HP, nominal depth in.), and nominal weight lb/ft). *For example, a W24×55 is a W-shape that is nominally 24 in. deep and weighs 55 lb/ft.*

Channels

Two types of channels are covered in this Manual:

- C-shapes also known as American standard channels have a slope of approximately162/3% 2 on 12) on the inner flange surfaces.

- MC-shapes also known as miscellaneous channels) have a slope other than16 2/3% 2 on 12) on the inner flange surfaces.

These shapes are designated by the mark C or MC, nominal depth in.), and nominal weight lb/ft). For example, a C12×25 is a C-shape that is nominally 12 in. deep and weighs 25 lb/ft.

Angles

Angles also known as L-shapes) have legs of equal thickness and either equal or unequal leg sizes. Angles are designated by the mark L, leg sizes in.), and thickness in.). For example, an L4×3×1/2 is an angle with one 4-in. leg, one 3-in. leg, and 1/2-in. thickness.

Structural Tees WT-, MT- and ST-Shapes)

Three types of structural tees are covered in this Manual:

- WT-shapes, which are made from W-shapes
- MT-shapes, which are made from M-shapes
- ST-shapes, which are made from S-shapes

These shapes are designated by the mark WT, MT, or ST, nominal depth in.), and nominal weight lb/ft). WT-, MT- and ST shapes are split sheared or thermal-cut) from W-, M-, and S-shapes, respectively, and have half the nominal depth and weight of that shape. For example, a WT12×27.5 is a structural tee split from a W-shape W24×55), is nominally 12 in. deep, and weighs 27.5 lb/ft

Hollow Structural Sections HSS)

- Rectangular/Square/Round HSS, has an essentially rectangular cross-section, except for rounded corners, and uniform wall thickness, except at the weld seams)

Rectangular HSS are designated by the mark HSS, overall outside dimensions in.), and wall thickness in.), with all dimensions expressed as fractional numbers. For example, an HSS10×10×1/2 is nominally 10 in. by 10 in. with a 1/2-in. wall thickness. Round HSS are designated by the term HSS, nominal outside diameter in.), and wall thickness in.) with both dimensions expressed to three decimal places. For example, an HSS10.000×0.500 is nominally 10 in. in diameter with a 1/2-in. nominal wall thickness.

Pipe

- Pipes have an essentially round cross-section and uniform thickness, except at the weld seams) for the welded pipe.

Pipes up to and including NPS 12 are designated by the term Pipe, nominal diameter in.), and weight class Std., x-Strong, xx-Strong). NPS stands for nominal pipe size. For example, Pipe 5 Std. denotes a pipe with a 5-in. nominal diameter and a 0.258-in. wall thickness, which corresponds to the standard weight series.

Pipes with wall thicknesses that do not correspond to the foregoing weight classes are designated by the term Pipe, outside diameter in.), and wall thickness in.) with both expressed to three decimal places. For example, Pipe 14.000×0.375 and Pipe 5.563×0.500 are proper designations.

Plate Products

The historical classification system for structural bars and plates suggests that there is only a physical difference between them based on size and production procedure. In raw form, the flat stock has historically been classified as a bar if it is less than or equal to 8 in. wide and as a plate if it is greater than 8 in. wide. Bars are rolled between horizontal and vertical rolls and trimmed to length by shearing or thermal cutting on the ends only. Plates are generally produced using one of two methods:

1. Sheared plates are rolled between horizontal rolls and trimmed to width and length by shearing or thermal cutting on the edges and ends; or
2. Stripped plates are sheared or thermal cut from wider sheared plates.

There is very little, if any, the structural difference between plates and bars. Consequently, the term plate is becoming a universally applied term today and a PL1/2 in.×41/2 in.×1ft 3 in., for example, might be fabricated from plate or bar stock.

For structural plates, the preferred practice is to specify thickness in 1/16-in. increments up to 3/8-in. thickness, 1/8-in. increments over 3/8-in. to 1-in. thickness, and 1/4-in. increments over 1-in. thickness.

The current extreme width for sheared plates is 200 in. Because mill practice regarding plate widths varies, individual mills should be consulted to determine preferences. For bars, the preferred practice is to specify the width in 1/4-in. increments, and thickness and diameter in 1/8-in. increments.

Other Structural Products

The following other structural products are covered in this Manual as indicated:

- High-strength bolts, common bolts, washers, nuts, and direct-tension-indicator washers.
- Welding filler metals and fluxes.
- Forged steel structural hardware items, such as clevises, turn-buckles, sleeve nuts, recessed-pin nuts, and cotter pins.
- Anchor rods and threaded rods.

Grades for structural members: -

Table 2-4
Applicable ASTM Specifications for Various Structural Shapes

Steel Type	ASTM Designation		F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Applicable Shape Series									
					W	M	S	HP	C	MC	L	HSS Rect.	HSS Round	Pipe
Carbon	A36		36	58-80[b]	▒	■	■	▒	■	■	■			
	A53 Gr. B		35	60										■
	A500	Gr. B	42	58									■	
			46	58								■		
		Gr. C	46	62									▒	
			50	62								▒		
	A501	Gr. A	36	58								▒	▒	
		Gr. B	50	70								▒	▒	
	A529[c]	Gr. 50	50	65-100	▒	▒	▒	▒	▒	▒	▒			
		Gr. 55	55	70-100	▒	▒	▒	▒	▒	▒	▒			
High-Strength Low-Alloy	A572	Gr. 42	42	60	▒	▒	▒	▒	▒	▒	▒			
		Gr. 50	50	65[d]	▒	▒	▒	■	▒	▒	▒			
		Gr. 55	55	70	▒	▒	▒	▒	▒	▒	▒			
		Gr. 60[e]	60	75	▒	▒	▒	▒	▒	▒	▒			
		Gr. 65[e]	65	80	▒	▒	▒	▒	▒	▒	▒			
	A618[f]	Gr. I & II	50[g]	70[g]								▒	▒	
		Gr. III	50	65								▒	▒	
	A913	50	50[h]	60[h]	▒	▒	▒	▒	▒	▒	▒			
		60	60	75	▒	▒	▒	▒	▒	▒	▒			
		65	65	80	▒	▒	▒	▒	▒	▒	▒			
		70	70	90	▒	▒	▒	▒	▒	▒	▒			
	A992		50	65[i]	■	▒	▒	▒	▒	▒	▒			
Corrosion Resistant High-Strength Low-Alloy	A242		42[j]	63[j]	▒									
			46[k]	67[k]	▒			▒						
			50[l]	70[l]	▒	▒	▒	▒	▒	▒	▒			
	A588		50	70	▒	▒	▒	▒	▒	▒	▒			
	A847		50	70								▒	▒	

■ = Preferred material specification
▒ = Other applicable material specification, the availability of which should be confirmed prior to specification
□ = Material specification does not apply

[a] Minimum unless a range is shown.
[b] For shapes over 426 lb/ft, only the minimum of 58 ksi applies.
[c] For shapes with a flange thickness less than or equal to 1½ in. only. To improve weldability, a maximum carbon equivalent can be specified (per ASTM Supplementary Requirement S78). If desired, maximum tensile stress of 90 ksi can be specified (per ASTM Supplementary Requirement S79).
[d] If desired, maximum tensile stress of 70 ksi can be specified (per ASTM Supplementary Requirement S91).
[e] For shapes with a flange thickness less than or equal to 2 in. only.
[f] ASTM A618 can also be specified as corrosion-resistant; see ASTM A618.
[g] Minimum applies for walls nominally ¾-in. thick and under. For wall thicknesses over ¾ in., $F_y = 46$ ksi and $F_u = 67$ ksi.
[h] If desired, maximum yield stress of 65 ksi and maximum yield-to-tensile strength ratio of 0.85 can be specified (per ASTM Supplementary Requirement S75).
[i] A maximum yield-to-tensile strength ratio of 0.85 and carbon equivalent formula are included as mandatory in ASTM A992.
[j] For shapes with a flange thickness greater than 2 in. only.
[k] For shapes with a flange thickness greater than 1½ in. and less than or equal to 2 in. only.
[l] For shapes with a flange thickness less than or equal to 1½ in. only.

Table 2-5
Applicable ASTM Specifications for Plates and Bars

Steel Type	ASTM Designation		F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Plates and Bars									
					to 0.75 incl.	over 0.75 to 1.25	over 1.25 to 1.5	over 1.5 to 2 incl.	over 2 to 2.5 incl.	over 2.5 to 4 incl.	over 4 to 5 incl.	over 5 to 6 incl.	over 6 to 8 incl.	over 8
Carbon	A36		32	58-80										
			36	58-80										
	A529	Gr. 50	50	70-100		b	b	b	b					
		Gr. 55	55	70-100		b	b							
High-Strength Low-Alloy	A572	Gr. 42	42	60										
		Gr. 50	50	65										
		Gr. 55	55	70										
		Gr. 60	60	75										
		Gr. 65	65	80										
Corrosion Resistant High-Strength Low-Alloy	A242		42	63										
			46	67										
			50	70										
	A588		42	63										
			46	67										
			50	70										
Quenched and Tempered Alloy	A514[c]		90	100-130										
			100	110-130										
Quenched and Tempered Low-Alloy	A852[c]		70	90-110										

■ = Preferred material specification
▨ = Other applicable material specification, the availability of which should be confirmed prior to specification
□ = Material specification does not apply

[a] Minimum unless a range is shown.
[b] Applicable to bars only above 1-in. thickness.
[c] Available as plates only.

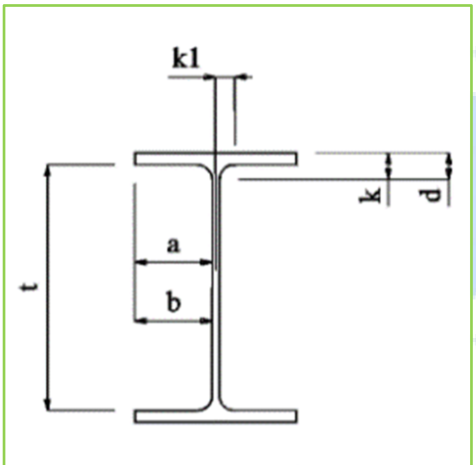
- ❖ Continuity plate & Moment connections are preferred A572-Gr.50. Confirm with the structural & customer).
- ❖ Bent plate, plate, angle length availability confirm with a customer).
- ❖ Maximum member length & shipping length confirm with the customer).

Workable Gage for structural members: -

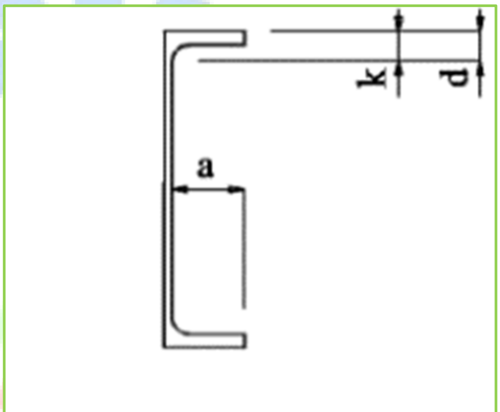
Table 1-7A
Workable Gages in Angle Legs, in.

Leg	8	7	6	5	4	$3\frac{1}{2}$	3	$2\frac{1}{2}$	2	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{3}{8}$	$1\frac{1}{4}$	1
g	$4\frac{1}{2}$	4	$3\frac{1}{2}$	3	$2\frac{1}{2}$	2	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{8}$	1	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{5}{8}$
g_1	3	$2\frac{1}{2}$	$2\frac{1}{4}$	2										
g_2	3	3	$2\frac{1}{2}$	$1\frac{3}{4}$										

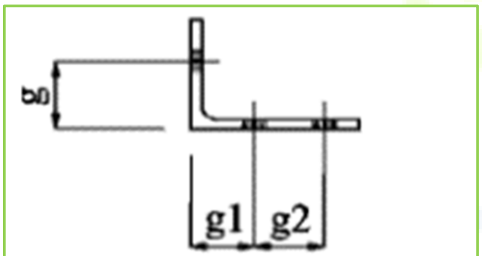
Note: Other gages are permitted to suit specific requirements subject to clearances and edge distance limitations.



WIDE FLANGE



CHANNEL



ANGLE

NOTES
* INDICATES JUMBO SIZE (GROUP 4 OR 5)
# INDICATES FOR 5/8" Ø BOLTS OR SMALLER.
+ INDICATES FOR 3/4" Ø BOLTS OR SMALLER.

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT d	BLOCKOUT a	STIFFENER t	STIFFENER b	USUAL GAGE
W44x285	44	1	1/2	11 3/4	1 3/4	1 3/8	2 11/16	2 3/4	5 3/8	40 3/8	5 1/4	5 1/2
x248	43 5/8	7/8	7/16	11 3/4	1 9/16	1 5/16	2 1/2	2 1/2	5 1/2	40 3/8	5 1/4	5 1/2
x224	43 1/4	13/16	7/16	11 3/4	1 7/16	1 5/16	2 5/16	2 3/8	5 1/2	40 3/8	5 1/2	5 1/2
x198	42 7/8	11/16	3/8	11 3/4	1 1/4	1 1/4	2 1/8	2 1/8	5 1/2	40 3/8	5 1/2	5 1/2
W40x655*	43 5/8	2	1	16 7/8	3 9/16	2 1/4	4 15/16	5	7 1/2	36 1/2	7 1/4	7 1/2
x593*	43	1 13/16	7/8	16 3/4	3 1/4	2 1/8	4 1/2	4 1/2	7 1/2	36 1/2	7 1/4	7 1/2
x531*	42 3/8	1 5/8	13/16	16 1/2	2 15/16	2	4 5/16	4 3/8	7 1/2	36 1/2	7 1/4	7 1/2
x480*	41 3/4	1 7/16	3/4	16 3/8	2 5/8	2	4	4	7 1/2	36 1/2	7 1/4	7 1/2
x436*	41 3/8	1 5/16	11/16	16 1/4	2 3/8	1 15/16	3 13/16	3 7/8	7 1/2	36 1/2	7 1/4	7 1/2
x397*	41	1 1/4	5/8	16 1/8	2 3/16	1 13/16	3 1/2	3 1/2	7 1/2	36 1/2	7 1/4	7 1/2
x362*	40 1/2	1 1/8	9/16	16	2	1 3/4	3 1/4	3 1/4	7 1/2	36 1/2	7 1/4	7 1/2
x328	40	15/16	1/2	17 7/8	1 3/4	1 11/16	3 1/8	3 1/8	8 1/2	36 1/2	8 1/2	7 1/2
x324	40 1/8	1	1/2	15 7/8	1 13/16	1 11/16	3 1/16	3 1/8	7 1/2	36 1/2	7 1/4	7 1/2
x298	39 3/4	13/16	7/16	17 7/8	1 9/16	1 5/8	3	3	8 1/2	36 1/2	8 1/2	7 1/2
x297	39 7/8	15/16	1/2	15 7/8	1 5/8	1 11/16	2 15/16	3	7 1/2	36 1/2	7 1/4	7 1/2
x277	39 3/4	13/16	7/16	15 7/8	1 9/16	1 5/8	2 7/8	2 7/8	7 1/2	36 1/2	7 1/2	7 1/2
x268	39 3/8	3/4	3/8	17 3/4	1 7/16	1 9/16	2 13/16	2 7/8	8 1/2	36 1/2	8 1/2	5 1/2
x249	39 3/8	3/4	3/8	15 3/4	1 7/16	1 9/16	2 11/16	2 3/4	7 1/2	36 1/2	7 1/2	5 1/2
x244	39	11/16	3/8	17 3/4	1 1/4	1 9/16	2 5/8	2 5/8	8 1/2	36 1/2	8 1/2	5 1/2
x221	38 5/8	11/16	3/8	17 3/4	1 1/16	1 9/16	2 7/16	2 1/2	8 1/2	36 1/2	8 1/2	5 1/2
x215	39	5/8	5/16	15 3/4	1 1/4	1 9/16	2 1/2	2 1/2	7 1/2	36 1/2	7 1/2	5 1/2
x199	38 5/8	5/8	5/16	15 3/4	1 1/16	1 9/16	2 5/16	2 3/8	7 1/2	36 1/2	7 1/2	5 1/2
x192	38 1/4	11/16	3/8	17 3/4	13/16	1 9/16	2 1/4	2 1/4	8 1/2	36 1/2	8 1/2	5 1/2
x183	39	5/8	5/16	11 3/4	1 1/4	1 9/16	2 1/2	2 1/2	5 5/8	36 1/2	5 1/2	5 1/2
x167	38 5/8	5/8	5/16	11 3/4	1	1 9/16	2 5/16	2 3/8	5 5/8	36 1/2	5 1/2	5 1/2
x149	38 1/4	5/8	5/16	11 3/4	13/16	1 1/2	2 1/8	2 1/8	5 5/8	36 1/2	5 1/2	5 1/2
W36x848*	42 1/2	2 1/2	1 1/4	18 1/8	4 1/2	2 1/4	5 11/16	5 3/4	7 3/4	33 3/8	7 3/4	7 1/2
x798*	42	2 3/8	1 3/16	18	4 5/16	2 3/8	5 9/16	5 5/8	7 3/4	33 3/8	7 3/4	7 1/2
x720*	41 1/4	2 3/16	1 1/8	17 3/4	3 7/8	2 1/16	5 1/16	5 1/8	7 3/4	33 3/8	7 3/4	7 1/2
x650*	40 1/2	2	1	17 5/8	3 9/16	2 3/16	4 13/16	4 7/8	7 3/4	33 3/8	7 3/4	7 1/2
x588*	39 7/8	1 13/16	7/8	17 3/8	3 1/4	1 7/8	4 3/8	4 3/8	7 3/4	33 3/8	7 3/4	7 1/2
x527*	39 1/4	1 5/8	13/16	17 1/4	2 15/16	2	4 3/16	4 1/4	7 3/4	33 3/8	7 3/4	7 1/2
x485*	38 3/4	1 1/2	3/4	17 1/8	2 11/16	1 3/4	3 13/16	3 7/8	7 3/4	33 3/8	7 3/4	7 1/2
x439*	38 1/4	1 3/8	11/16	17	2 7/16	1 7/8	3 11/16	3 3/4	7 3/4	33 3/8	7 3/4	7 1/2
x393*	37 3/4	1 1/4	5/8	16 7/8	2 3/16	1 13/16	3 7/16	3 1/2	7 3/4	33 3/8	7 3/4	7 1/2
x359*	37 3/8	1 1/8	9/16	16 3/4	2	1 3/4	3 1/4	3 1/4	7 3/4	33 3/8	7 3/4	7 1/2
x328*	37 1/8	1	1/2	16 5/8	1 7/8	1 3/4	3 1/8	3 1/8	7 3/4	33 3/8	7 3/4	7 1/2
x300	36 3/4	15/16	1/2	16 5/8	1 11/16	1 11/16	2 15/16	3	7 7/8	33 3/8	7 3/4	7 1/2
x280	36 1/2	7/8	7/16	16 5/8	1 9/16	1 5/8	2 13/16	2 7/8	7 7/8	33 3/8	7 3/4	7 1/2
x260	36 1/4	13/16	7/16	16 1/2	1 7/16	1 5/8	2 11/16	2 3/4	7 7/8	33 3/8	7 3/4	7 1/2
x256	37 3/8	1	1/2	12 1/4	1 3/4	1 5/16	2 5/8	2 5/8	5 5/8	33 7/8	5 1/2	5 1/2
x245	36 1/8	13/16	7/16	16 1/2	1 3/8	1 5/8	2 5/8	2 5/8	7 7/8	33 3/8	7 3/4	7 1/2
x232	37 1/8	7/8	7/16	12 1/8	1 9/16	1 1/4	2 1/2	2 1/2	5 5/8	33 7/8	5 1/2	5 1/2
x230	35 7/8	3/4	3/8	16 1/2	1 1/4	1 9/16	2 1/2	2 1/2	7 7/8	33 3/8	7 3/4	5 1/2
x210	36 3/4	13/16	7/16	12 1/8	1 3/8	1 1/4	2 5/16	2 3/8	5 5/8	33 7/8	5 1/2	5 1/2
x194	36 1/2	3/4	3/8	12 1/8	1 1/4	1 3/16	2 3/16	2 1/4	5 5/8	33 7/8	5 1/2	5 1/2
x182	36 3/8	3/4	3/8	12 1/8	1 3/16	1 3/16	2 1/8	2 1/8	5 5/8	33 7/8	5 1/2	5 1/2
x170	36 1/8	11/16	3/8	12	1 1/8	1 3/16	2	2	5 5/8	33 7/8	5 1/2	5 1/2
x160	36	5/8	5/16	12	1	1 1/8	1 15/16	2	5 5/8	33 7/8	5 1/2	5 1/2
x150	35 7/8	5/8	5/16	12	15/16	1 1/8	1 7/8	1 7/8	5 5/8	33 7/8	5 1/2	5 1/2
x135	35 1/2	5/8	5/16	12	13/16	1 1/8	1 11/16	1 3/4	5 5/8	33 7/8	5 1/2	5 1/2

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT		STIFFENER		USUAL GAGE
								d	a	t	b	
W33x619*	38 1/2	2	1	16 7/8	3 9/16	1 3/4	4 3/8	4 3/8	7 1/2	31 3/8	7 1/4	7 1/2
x567*	37 7/8	1 13/16	7/8	16 3/4	3 1/4	1 11/16	4 1/16	4 1/8	7 1/2	31 3/8	7 1/4	7 1/2
x515*	37 3/8	1 5/8	13/16	16 5/8	3	1 5/8	3 13/16	3 7/8	7 1/2	31 3/8	7 1/4	7 1/2
x468*	36 3/4	1 1/2	3/4	16 1/2	2 3/4	1 9/16	3 1/2	3 1/2	7 1/2	31 3/8	7 1/4	5 1/2
x424*	36 3/8	1 3/8	11/16	16 3/8	2 1/2	1 7/16	3 5/16	3 3/8	7 1/2	31 3/8	7 1/4	5 1/2
x387*	36	1 1/4	5/8	16 1/4	2 1/4	1 3/8	3 1/8	3 1/8	7 1/2	31 3/8	7 1/4	5 1/2
x354*	35 1/2	1 3/16	5/8	16 1/8	2 1/16	1 3/8	2 15/16	3	7 1/2	31 3/8	7 1/4	5 1/2
x318*	35 1/8	1 1/16	9/16	16	1 7/8	1 5/16	2 3/4	2 3/4	7 1/2	31 3/8	7 1/4	5 1/2
x291	34 7/8	1	1/2	15 7/8	1 3/4	1 5/16	2 5/8	2 5/8	7 1/2	31 3/8	7 1/4	5 1/2
x263	34 1/2	7/8	7/16	15 3/4	1 9/16	1 1/4	2 7/16	2 1/2	7 1/2	31 3/8	7 1/4	5 1/2
x241	34 1/8	13/16	7/16	15 7/8	1 3/8	1 1/4	2 1/4	2 1/4	7 1/2	31 3/8	7 1/2	5 1/2
x221	33 7/8	3/4	3/8	15 3/4	1 1/4	1 3/16	2 1/8	2 1/8	7 1/2	31 3/8	7 1/2	5 1/2
x201	33 5/8	11/16	3/8	15 3/4	1 1/8	1 3/16	2	2	7 1/2	31 3/8	7 1/2	5 1/2
x169	33 7/8	11/16	3/8	11 1/2	1 1/4	1 3/16	2 1/8	2 1/8	5 3/8	31 3/8	5 1/4	5 1/2
x152	33 1/2	5/8	5/16	11 5/8	1 1/16	1 1/8	1 15/16	2	5 1/2	31 3/8	5 1/4	5 1/2
x141	33 1/4	5/8	5/16	11 1/2	15/16	1 1/8	1 13/16	1 7/8	5 1/2	31 3/8	5 1/4	5 1/2
x130	33 1/8	9/16	5/16	11 1/2	7/8	1 1/8	1 3/4	1 3/4	5 1/2	31 3/8	5 1/4	5 1/2
x118	32 7/8	9/16	5/16	11 1/2	3/4	1 1/8	1 5/8	1 5/8	5 1/2	31 3/8	5 1/4	5 1/2
W30x581*	35 3/8	2	1	16 1/4	3 9/16	1 11/16	4 5/16	4 3/8	7 1/8	28 1/4	7	7 1/2
x526*	34 3/4	1 13/16	7/8	16	3 1/4	1 5/8	4	4	7 1/8	28 1/4	7	7 1/2
x477*	34 1/4	1 5/8	13/16	15 7/8	3	1 9/16	3 3/4	3 3/4	7 1/8	28 1/4	7	5 1/2
x433*	33 5/8	1 1/2	3/4	15 3/4	2 11/16	1 1/2	3 7/16	3 1/2	7 1/8	28 1/4	7	5 1/2
x391*	33 1/4	1 3/8	11/16	15 5/8	2 7/16	1 1/2	3 3/8	3 3/8	7 1/8	28 1/4	7	5 1/2
x357*	32 3/4	1 1/4	5/8	15 1/2	2 1/4	1 3/8	3	3	7 1/8	28 1/4	7	5 1/2
x326*	32 3/8	1 1/8	9/16	15 3/8	2 1/16	1 3/8	2 15/16	3	7 1/8	28 1/4	7	5 1/2
x292*	32	1	1/2	15 1/4	1 7/8	1 5/16	2 3/4	2 3/4	7 1/8	28 1/4	7	5 1/2
x261	31 5/8	15/16	1/2	15 1/8	1 5/8	1 5/16	2 9/16	2 5/8	7 1/8	28 1/4	7	5 1/2
x235	31 1/4	13/16	7/16	15	1 1/2	1 1/4	2 3/8	2 3/8	7 1/8	28 1/4	7	5 1/2
x211	31	3/4	3/8	15 1/8	1 5/16	1 3/16	2 1/4	2 1/4	7 1/8	28 1/4	7	5 1/2
x191	30 5/8	11/16	3/8	15	1 3/16	1 3/16	2 1/16	2 1/8	7 1/8	28 1/4	7	5 1/2
x173	30 1/2	5/8	5/16	15	1 1/16	1 1/8	2	2	7 1/8	28 1/4	7	5 1/2
x148	30 5/8	5/8	5/16	10 1/2	1 3/16	1 1/8	2 1/16	2 1/8	4 7/8	28 1/4	4 3/4	5 1/2
x132	30 1/4	5/8	5/16	10 1/2	1	1 1/8	1 7/8	1 7/8	5	28 1/4	4 3/4	5 1/2
x124	30 1/8	9/16	5/16	10 1/2	15/16	1 1/8	1 13/16	1 7/8	5	28 1/4	4 3/4	5 1/2
x116	30	9/16	5/16	10 1/2	7/8	1 1/8	1 3/4	1 3/4	5	28 1/4	4 3/4	5 1/2
x108	29 7/8	9/16	5/16	10 1/2	3/4	1 1/8	1 11/16	1 3/4	5	28 1/4	4 3/4	5 1/2
x99	29 5/8	1/2	1/4	10 1/2	11/16	1 1/16	1 9/16	1 5/8	5	28 1/4	4 3/4	5 1/2
x90	29 1/2	1/2	1/4	10 3/8	9/16	1 1/16	1 1/2	1 1/2	5	28 1/4	4 3/4	5 1/2
W27x539*	32 1/2	2	1	15 1/4	3 9/16	1 13/16	4 7/16	4 1/2	6 5/8	25 3/8	6 1/2	7 1/2
x494*	32	1 13/16	7/8	15 1/8	3 1/4	1 9/16	4	4	6 5/8	25 3/8	6 1/2	5 1/2
x448*	31 3/8	1 5/8	13/16	15	3	1 1/2	3 11/16	3 3/4	6 5/8	25 3/8	6 1/2	5 1/2
x407*	30 7/8	1 1/2	3/4	14 3/4	2 3/4	1 7/16	3 7/16	3 1/2	6 5/8	25 3/8	6 1/2	5 1/2
x368*	30 3/8	1 3/8	11/16	14 5/8	2 1/2	1 1/2	3 3/8	3 3/8	6 5/8	25 3/8	6 1/2	5 1/2
x336*	30	1 1/4	5/8	14 1/2	2 1/4	1 7/16	3 3/16	3 1/4	6 5/8	25 3/8	6 1/2	5 1/2
x307*	29 5/8	1 3/16	5/8	14 1/2	2 1/16	1 7/16	3	3	6 5/8	25 3/8	6 1/2	5 1/2
x281*	29 1/4	1 1/16	9/16	14 3/8	1 15/16	1 3/8	2 13/16	2 7/8	6 5/8	25 3/8	6 1/2	5 1/2
x258	29	1	1/2	14 1/4	1 3/4	1 5/16	2 11/16	2 3/4	6 5/8	25 3/8	6 1/2	5 1/2
x235	28 5/8	15/16	1/2	14 1/4	1 5/8	1 5/16	2 1/2	2 1/2	6 5/8	25 3/8	6 1/2	5 1/2
x217	28 3/8	13/16	7/16	14 1/8	1 1/2	1 1/4	2 3/8	2 3/8	6 5/8	25 3/8	6 1/2	5 1/2
x194	28 1/8	3/4	3/8	14	1 5/16	1 3/16	2 1/4	2 1/4	6 5/8	25 3/8	6 1/2	5 1/2
x178	27 3/4	3/4	3/8	14 1/8	1 3/16	1 3/16	2 1/16	2 1/8	6 5/8	25 3/8	6 1/2	5 1/2
x161	27 5/8	11/16	3/8	14	1 1/16	1 3/16	2	2	6 5/8	25 3/8	6 1/2	5 1/2
x146	27 3/8	5/8	5/16	14	1	1 1/8	1 7/8	1 7/8	6 5/8	25 3/8	6 1/2	5 1/2
x129	27 5/8	5/8	5/16	10	1 1/8	1 1/8	2	2	4 3/4	25 3/8	4 1/2	5 1/2
x114	27 1/4	9/16	5/16	10 1/8	15/16	1 1/8	1 13/16	1 7/8	4 3/4	25 3/8	4 3/4	5 1/2
x102	27 1/8	1/2	1/4	10	13/16	1 1/16	1 3/4	1 3/4	4 3/4	25 3/8	4 3/4	5 1/2
x94	26 7/8	1/2	1/4	10	3/4	1 1/16	1 5/8	1 5/8	4 3/4	25 3/8	4 3/4	5 1/2
x84	26 3/4	7/16	1/4	10	5/8	1 1/16	1 9/16	1 5/8	4 3/4	25 3/8	4 3/4	5 1/2

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT d	BLOCKOUT a	STIFFENER t	STIFFENER b	USUAL GAGE
W24x492*	29 5/8	2	1	14 1/8	3 9/16	1 9/16	4 5/16	4 3/8	6 1/8	22 1/2	6	5 1/2
x450*	29 1/8	1 13/16	7/8	14	3 1/4	1 1/2	4 1/16	4 1/8	6 1/8	22 1/2	6	5 1/2
x408*	28 1/2	1 5/8	13/16	13 3/4	3	1 3/8	3 3/4	3 3/4	6 1/8	22 1/2	6	5 1/2
x370*	28	1 1/2	3/4	13 5/8	2 3/4	1 9/16	3 5/8	3 5/8	6 1/8	22 1/2	6	5 1/2
x335*	27 1/2	1 3/8	11/16	13 1/2	2 1/2	1 1/2	3 3/8	3 3/8	6 1/8	22 1/2	6	5 1/2
x306*	27 1/8	1 1/4	5/8	13 3/8	2 1/4	1 7/16	3 3/16	3 1/4	6 1/8	22 1/2	6	5 1/2
x279*	26 3/4	1 3/16	5/8	13 1/4	2 1/16	1 7/16	3	3	6 1/8	22 1/2	6	5 1/2
x250*	26 3/8	1 1/16	9/16	13 1/8	1 7/8	1 3/8	2 13/16	2 7/8	6 1/8	22 1/2	6	5 1/2
x229	26	1	1/2	13 1/8	1 3/4	1 5/16	2 5/8	2 5/8	6 1/8	22 1/2	6	5 1/2
x207	25 3/4	7/8	7/16	13	1 9/16	1 1/4	2 1/2	2 1/2	6 1/8	22 1/2	6	5 1/2
x192	25 1/2	13/16	7/16	13	1 7/16	1 1/4	2 3/8	2 3/8	6 1/8	22 1/2	6	5 1/2
x176	25 1/4	3/4	3/8	12 7/8	1 5/16	1 3/16	2 1/4	2 1/4	6 1/8	22 1/2	6	5 1/2
x162	25	11/16	3/8	13	1 1/4	1 3/16	2 1/8	2 1/8	6 1/8	22 1/2	6	5 1/2
x146	24 3/4	5/8	5/16	12 7/8	1 1/16	1 1/8	2	2	6 1/8	22 1/2	6	5 1/2
x131	24 1/2	5/8	5/16	12 7/8	15/16	1 1/8	1 7/8	1 7/8	6 1/8	22 1/2	6	5 1/2
x117	24 1/4	9/16	5/16	12 3/4	7/8	1 1/8	1 3/4	1 3/4	6 1/8	22 1/2	6	5 1/2
x104	24	1/2	1/4	12 3/4	3/4	1 1/16	1 5/8	1 5/8	6 1/8	22 1/2	6	5 1/2
x103	24 1/2	9/16	5/16	9	1	1 1/8	1 7/8	1 7/8	4 1/4	22 1/2	4	5 1/2
x94	24 1/4	1/2	1/4	9 1/8	7/8	1 1/16	1 3/4	1 3/4	4 1/4	22 1/2	4 1/4	5 1/2
x84	24 1/8	1/2	1/4	9	3/4	1 1/16	1 11/16	1 3/4	4 1/4	22 1/2	4 1/4	5 1/2
x76	23 7/8	7/16	1/4	9	11/16	1 1/16	1 9/16	1 5/8	4 1/4	22 1/2	4 1/4	5 1/2
x68	23 3/4	7/16	1/4	9	9/16	1 1/16	1 1/2	1 1/2	4 1/4	22 1/2	4 1/4	5 1/2
x62	23 3/4	7/16	1/4	7	9/16	1 1/16	1 1/2	1 1/2	3 1/4	22 1/2	3 1/4	4
x55	23 5/8	3/8	3/16	7	1/2	1	1 7/16	1 1/2	3 1/4	22 1/2	3 1/4	4
W21x402*	26	1 3/4	7/8	13 3/8	3 1/8	1 7/16	3 7/8	3 7/8	5 7/8	19 3/4	5 3/4	5 1/2
x364*	25 1/2	1 9/16	13/16	13 1/4	2 7/8	1 3/8	3 5/8	3 5/8	5 7/8	19 3/4	5 3/4	5 1/2
x333*	25	1 7/16	3/4	13 1/8	2 5/8	1 5/16	3 3/8	3 3/8	5 7/8	19 3/4	5 3/4	5 1/2
x300*	24 1/2	1 5/16	11/16	13	2 3/8	1 1/4	3 1/8	3 1/8	5 7/8	19 3/4	5 3/4	5 1/2
x275*	24 1/8	1 1/4	5/8	12 7/8	2 3/16	1 3/16	3	3	5 7/8	19 3/4	5 3/4	5 1/2
x248*	23 3/4	1 1/8	9/16	12 3/4	2	1 1/8	2 3/4	2 3/4	5 7/8	19 3/4	5 3/4	5 1/2
x223	23 3/8	1	1/2	12 5/8	1 13/16	1 1/16	2 9/16	2 5/8	5 7/8	19 3/4	5 3/4	5 1/2
x201	23	15/16	1/2	12 5/8	1 5/8	1 5/16	2 1/2	2 1/2	5 7/8	19 3/4	5 3/4	5 1/2
x182	22 3/4	13/16	7/16	12 1/2	1 1/2	1 1/4	2 3/8	2 3/8	5 7/8	19 3/4	5 3/4	5 1/2
x166	22 1/2	3/4	3/8	12 3/8	1 3/8	1 3/16	2 1/4	2 1/4	5 7/8	19 3/4	5 3/4	5 1/2
x147	22	3/4	3/8	12 1/2	1 1/8	1 3/16	2	2	5 7/8	19 3/4	5 3/4	5 1/2
x132	21 7/8	5/8	5/16	12 1/2	1 1/16	1 1/8	1 15/16	2	5 7/8	19 3/4	5 3/4	5 1/2
x122	21 5/8	5/8	5/16	12 3/8	15/16	1 1/8	1 13/16	1 7/8	5 7/8	19 3/4	5 3/4	5 1/2
x111	21 1/2	9/16	5/16	12 3/8	7/8	1 1/8	1 3/4	1 3/4	5 7/8	19 3/4	5 3/4	5 1/2
x101	21 3/8	1/2	1/4	12 1/4	13/16	1 1/16	1 11/16	1 3/4	5 7/8	19 3/4	5 3/4	5 1/2
x93	21 5/8	9/16	5/16	8 3/8	15/16	15/16	1 5/8	1 5/8	3 7/8	19 3/4	3 3/4	5 1/2
x83	21 3/8	1/2	1/4	8 3/8	13/16	7/8	1 1/2	1 1/2	3 7/8	19 3/4	3 3/4	5 1/2
x73	21 1/4	7/16	1/4	8 1/4	3/4	7/8	1 7/16	1 1/2	3 7/8	19 3/4	3 3/4	5 1/2
x68	21 1/8	7/16	1/4	8 1/4	11/16	7/8	1 3/8	1 3/8	3 7/8	19 3/4	3 3/4	5 1/2
x62	21	3/8	3/16	8 1/4	5/8	13/16	1 5/16	1 3/8	3 7/8	19 3/4	3 3/4	5 1/2
x57	21	3/8	3/16	6 1/2	5/8	13/16	1 5/16	1 3/8	3 1/8	19 3/4	3	3 1/2
x50	20 7/8	3/8	3/16	6 1/2	9/16	13/16	1 1/4	1 1/4	3 1/8	19 3/4	3	3 1/2
x44	20 5/8	3/8	3/16	6 1/2	7/16	13/16	1 1/8	1 1/8	3 1/8	19 3/4	3	3 1/2

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT		STIFFENER		USUAL GAGE
								d	a	t	b	
W18x311*	22 3/8	1 1/2	3/4	12	2 3/4	1 3/16	3 7/16	3 1/2	5 1/4	16 3/4	5	5 1/2
x283*	21 7/8	1 3/8	11/16	11 7/8	2 1/2	1 3/16	3 3/16	3 1/4	5 1/4	16 3/4	5	5 1/2
x258*	21 1/2	1 1/4	5/8	11 3/4	2 5/16	1 1/8	3	3	5 1/4	16 3/4	5	5 1/2
x234*	21	1 3/16	5/8	11 5/8	2 1/8	1	2 3/4	2 3/4	5 1/4	16 3/4	5	5 1/2
x211*	20 5/8	1 1/16	9/16	11 1/2	1 15/16	1	2 9/16	2 5/8	5 1/4	16 3/4	5	5 1/2
x192	20 3/8	1	1/2	11 1/2	1 3/4	15/16	2 7/16	2 1/2	5 1/4	16 3/4	5	5 1/2
x175	20	7/8	7/16	11 3/8	1 9/16	1 1/4	2 7/16	2 1/2	5 1/4	16 3/4	5	5 1/2
x158	19 3/4	13/16	7/16	11 1/4	1 7/16	1 1/4	2 5/16	2 3/8	5 1/4	16 3/4	5	5 1/2
x143	19 1/2	3/4	3/8	11 1/4	1 5/16	1 3/16	2 3/16	2 1/4	5 1/4	16 3/4	5	5 1/2
x130	19 1/4	11/16	3/8	11 1/8	1 3/16	1 3/16	2 1/16	2 1/8	5 1/4	16 3/4	5	5 1/2
x119	19	5/8	5/16	11 1/4	1 1/16	1 3/16	1 15/16	2	5 1/4	16 3/4	5 1/4	5 1/2
x106	18 3/4	9/16	5/16	11 1/4	15/16	1 1/8	1 13/16	1 7/8	5 1/4	16 3/4	5 1/4	5 1/2
x97	18 5/8	9/16	5/16	11 1/8	7/8	1 1/8	1 3/4	1 3/4	5 1/4	16 3/4	5 1/4	5 1/2
x86	18 3/8	1/2	1/4	11 1/8	3/4	1 1/16	1 5/8	1 5/8	5 1/4	16 3/4	5 1/4	5 1/2
x76	18 1/4	7/16	1/4	11	11/16	1 1/16	1 9/16	1 5/8	5 1/4	16 3/4	5 1/4	5 1/2
x71	18 1/2	1/2	1/4	7 5/8	13/16	7/8	1 1/2	1 1/2	3 5/8	16 3/4	3 1/2	3 1/2
x65	18 3/8	7/16	1/4	7 5/8	3/4	7/8	1 7/16	1 1/2	3 5/8	16 3/4	3 1/2	3 1/2
x60	18 1/4	7/16	1/4	7 1/2	11/16	13/16	1 3/8	1 3/8	3 5/8	16 3/4	3 1/2	3 1/2
x55	18 1/8	3/8	3/16	7 1/2	5/8	13/16	1 5/16	1 3/8	3 5/8	16 3/4	3 1/2	3 1/2
x50	18	3/8	3/16	7 1/2	9/16	13/16	1 1/4	1 1/4	3 5/8	16 3/4	3 1/2	3 1/2
x46	18	3/8	3/16	6	5/8	13/16	1 1/4	1 1/4	2 7/8	16 3/4	2 3/4	3 1/2
x40	17 7/8	5/16	3/16	6	1/2	13/16	1 3/16	1 1/4	2 7/8	16 3/4	2 3/4	3 1/2
x35	17 3/4	5/16	3/16	6	7/16	3/4	1 1/8	1 1/8	2 7/8	16 3/4	2 3/4	3 1/2
W16x100	17	9/16	5/16	10 3/8	1	1 1/8	1 7/8	1 7/8	4 7/8	15	4 3/4	5 1/2
x89	16 3/4	1/2	1/4	10 3/8	7/8	1 1/16	1 3/4	1 3/4	4 7/8	15	4 3/4	5 1/2
x77	16 1/2	7/16	1/4	10 1/4	3/4	1 1/16	1 5/8	1 5/8	4 7/8	15	4 3/4	5 1/2
x67	16 3/8	3/8	3/16	10 1/4	11/16	1	1 9/16	1 5/8	4 7/8	15	4 3/4	5 1/2
x57	16 3/8	7/16	1/4	7 1/8	11/16	7/8	1 3/8	1 3/8	3 3/8	15	3 1/4	3 1/2
x50	16 1/4	3/8	3/16	7 1/8	5/8	13/16	1 5/16	1 3/8	3 3/8	15	3 1/4	3 1/2
x45	16 1/8	3/8	3/16	7	9/16	13/16	1 1/4	1 1/4	3 3/8	15	3 1/4	3 1/2
x40	16	5/16	3/16	7	1/2	13/16	1 3/16	1 1/4	3 3/8	15	3 1/4	3 1/2
x36	15 7/8	5/16	3/16	7	7/16	3/4	1 1/8	1 1/8	3 3/8	15	3 1/4	3 1/2
x31	15 7/8	1/4	1/8	5 1/2	7/16	3/4	1 1/8	1 1/8	2 5/8	15	2 1/2	3
x26	15 3/4	1/4	1/8	5 1/2	3/8	3/4	1 1/16	1 1/8	2 5/8	15	2 1/2	3
W14x730*	22 3/8	3 1/16	1 9/16	17 7/8	4 15/16	2 3/4	6 3/16	6 1/4	7 3/8	12 1/2	7 1/4	7 1/2
x665*	21 5/8	2 13/16	1 7/16	17 5/8	4 1/2	2 5/8	5 13/16	5 7/8	7 3/8	12 1/2	7 1/4	7 1/2
x605*	20 7/8	2 5/8	1 5/16	17 3/8	4 3/16	2 1/2	5 7/16	5 1/2	7 3/8	12 1/2	7 1/4	7 1/2
x550*	20 1/4	2 3/8	1 3/16	17 1/4	3 13/16	2 3/8	5 1/8	5 1/8	7 3/8	12 1/2	7 1/4	7 1/2
x500*	19 5/8	2 3/16	1 1/8	17	3 1/2	2 5/16	4 13/16	4 7/8	7 3/8	12 1/2	7 1/4	7 1/2
x455*	19	2	1	16 7/8	3 3/16	2 1/4	4 1/2	4 1/2	7 3/8	12 1/2	7 1/4	7 1/2
x426*	18 5/8	1 7/8	15/16	16 3/4	3 1/16	2 1/8	4 5/16	4 3/8	7 3/8	12 1/2	7 1/4	6
x398*	18 1/4	1 3/4	7/8	16 5/8	2 7/8	2 1/8	4 1/8	4 1/8	7 3/8	12 1/2	7 1/4	6
x370*	17 7/8	1 5/8	13/16	16 1/2	2 11/16	2 1/16	3 15/16	4	7 3/8	12 1/2	7 1/4	6
x342*	17 1/2	1 9/16	13/16	16 3/8	2 1/2	2	3 3/4	3 3/4	7 3/8	12 1/2	7 1/4	5 1/2
x311*	17 1/8	1 7/16	3/4	16 1/4	2 1/4	1 15/16	3 9/16	3 5/8	7 3/8	12 1/2	7 1/4	5 1/2
x283*	16 3/4	1 5/16	11/16	16 1/8	2 1/16	1 7/8	3 3/8	3 3/8	7 3/8	12 1/2	7 1/4	5 1/2
x257*	16 3/8	1 3/16	5/8	16	1 7/8	1 13/16	3 3/16	3 1/4	7 3/8	12 1/2	7 1/4	5 1/2
x233*	16	1 1/16	9/16	15 7/8	1 3/4	1 3/4	3	3	7 3/8	12 1/2	7 1/4	5 1/2
x211	15 3/4	1	1/2	15 3/4	1 9/16	1 11/16	2 7/8	2 7/8	7 3/8	12 1/2	7 1/4	5 1/2

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT		STIFFENER		USUAL GAGE
								d	a	t	b	
x211	15 3/4	1	1/2	15 3/4	1 9/16	1 11/16	2 7/8	2 7/8	7 3/8	12 1/2	7 1/4	5 1/2
x193	15 1/2	7/8	7/16	15 3/4	1 7/16	1 11/16	2 3/4	2 3/4	7 3/8	12 1/2	7 1/4	5 1/2
x176	15 1/4	13/16	7/16	15 5/8	1 5/16	1 5/8	2 5/8	2 5/8	7 3/8	12 1/2	7 1/4	5 1/2
x159	15	3/4	3/8	15 5/8	1 3/16	1 9/16	2 1/2	2 1/2	7 3/8	12 1/2	7 1/4	5 1/2
x145	14 3/4	11/16	3/8	15 1/2	1 1/16	1 9/16	2 3/8	2 3/8	7 3/8	12 1/2	7 1/4	5 1/2
x132	14 5/8	5/8	5/16	14 3/4	1	1 9/16	2 5/16	2 3/8	7	12 1/2	7	5 1/2
x120	14 1/2	9/16	5/16	14 5/8	15/16	1 1/2	2 1/4	2 1/4	7	12 1/2	7	5 1/2
x109	14 3/8	1/2	1/4	14 5/8	7/8	1 1/2	2 3/16	2 1/4	7	12 1/2	7	5 1/2
x99	14 1/8	1/2	1/4	14 5/8	3/4	1 7/16	2 1/16	2 1/8	7	12 1/2	7	5 1/2
x90	14	7/16	1/4	14 1/2	11/16	1 7/16	2	2	7	12 1/2	7	5 1/2
x82	14 1/4	1/2	1/4	10 1/8	7/8	1 1/16	1 11/16	1 3/4	4 3/4	12 1/2	4 3/4	5 1/2
x74	14 1/8	7/16	1/4	10 1/8	13/16	1 1/16	1 5/8	1 5/8	4 3/4	12 1/2	4 3/4	5 1/2
x68	14	7/16	1/4	10	3/4	1 1/16	1 9/16	1 5/8	4 3/4	12 1/2	4 3/4	5 1/2
x61	13 7/8	3/8	3/16	10	5/8	1	1 1/2	1 1/2	4 3/4	12 1/2	4 3/4	5 1/2
x53	13 7/8	3/8	3/16	8	11/16	1	1 1/2	1 1/2	3 7/8	12 1/2	3 3/4	5 1/2
x48	13 3/4	5/16	3/16	8	5/8	1	1 7/16	1 1/2	3 7/8	12 1/2	3 3/4	5 1/2
x43	13 5/8	5/16	3/16	8	1/2	1	1 3/8	1 3/8	3 7/8	12 1/2	3 3/4	5 1/2
x38	14 1/8	5/16	3/16	6 3/4	1/2	13/16	1 1/4	1 1/4	3 1/4	13	3	3 1/2
x34	14	5/16	3/16	6 3/4	7/16	3/4	1 3/16	1 1/4	3 1/4	13	3	3 1/2
x30	13 7/8	1/4	1/8	6 3/4	3/8	3/4	1 1/8	1 1/8	3 1/4	13	3	3 1/2
x26	13 7/8	1/4	1/8	5	7/16	3/4	1 1/8	1 1/8	2 3/8	13	2 1/4	+2 3/4
x22	13 3/4	1/4	1/8	5	5/16	3/4	1 1/16	1 1/8	2 3/8	13	2 1/4	+2 3/4
W12x336*	16 7/8	1 3/4	7/8	13 3/8	2 15/16	1 11/16	3 7/8	3 7/8	5 3/4	10 7/8	5 3/4	5 1/2
x305*	16 3/8	1 5/8	13/16	13 1/4	2 11/16	1 5/8	3 5/8	3 5/8	5 3/4	10 7/8	5 3/4	5 1/2
x279*	15 7/8	1 1/2	3/4	13 1/8	2 1/2	1 5/8	3 3/8	3 3/8	5 3/4	10 7/8	5 3/4	5 1/2
x252*	15 3/8	1 3/8	11/16	13	2 1/4	1 1/2	3 1/8	3 1/8	5 3/4	10 7/8	5 3/4	5 1/2
x230*	15	1 5/16	11/16	12 7/8	2 1/16	1 1/2	2 15/16	3	5 3/4	10 7/8	5 3/4	5 1/2
x210*	14 3/4	1 3/16	5/8	12 3/4	1 7/8	1 7/16	2 13/16	2 7/8	5 3/4	10 7/8	5 3/4	5 1/2
x190	14 3/8	1 1/16	9/16	12 5/8	1 3/4	1 3/8	2 5/8	2 5/8	5 3/4	10 7/8	5 3/4	5 1/2
x170	14	15/16	1/2	12 5/8	1 9/16	1 5/16	2 7/16	2 1/2	5 3/4	10 7/8	5 3/4	5 1/2
x152	13 3/4	7/8	7/16	12 1/2	1 3/8	1 1/4	2 5/16	2 3/8	5 3/4	10 7/8	5 3/4	5 1/2
x136	13 3/8	13/16	7/16	12 3/8	1 1/4	1 1/4	2 1/8	2 1/8	5 3/4	10 7/8	5 3/4	5 1/2
x120	13 1/8	11/16	3/8	12 3/8	1 1/8	1 3/16	2	2	5 3/4	10 7/8	5 3/4	5 1/2
x106	12 7/8	5/8	5/16	12 1/4	1	1 1/8	1 7/8	1 7/8	5 3/4	10 7/8	5 3/4	5 1/2
x96	12 3/4	9/16	5/16	12 1/8	7/8	1 1/8	1 13/16	1 7/8	5 3/4	10 7/8	5 3/4	5 1/2
x87	12 1/2	1/2	1/4	12 1/8	13/16	1 1/16	1 11/16	1 3/4	5 3/4	10 7/8	5 3/4	5 1/2
x79	12 3/8	1/2	1/4	12 1/8	3/4	1 1/16	1 5/8	1 5/8	5 3/4	10 7/8	5 3/4	5 1/2
x72	12 1/4	7/16	1/4	12	11/16	1 1/16	1 9/16	1 5/8	5 3/4	10 7/8	5 3/4	5 1/2
x65	12 1/8	3/8	3/16	12	5/8	1	1 1/2	1 1/2	5 3/4	10 7/8	5 3/4	5 1/2
x58	12 1/4	3/8	3/16	10	5/8	15/16	1 1/2	1 1/2	4 7/8	10 7/8	4 3/4	5 1/2
x53	12	3/8	3/16	10	9/16	15/16	1 3/8	1 3/8	4 7/8	10 7/8	4 3/4	5 1/2
x50	12 1/4	3/8	3/16	8 1/8	5/8	15/16	1 1/2	1 1/2	3 7/8	10 7/8	3 3/4	5 1/2
x45	12	5/16	3/16	8	9/16	15/16	1 3/8	1 3/8	3 7/8	10 7/8	3 3/4	5 1/2
x40	12	5/16	3/16	8	1/2	7/8	1 3/8	1 3/8	3 7/8	10 7/8	3 3/4	5 1/2
x35	12 1/2	5/16	3/16	6 1/2	1/2	3/4	1 3/16	1 1/4	3 1/8	11 3/8	3	3 1/2
x30	12 3/8	1/4	1/8	6 1/2	7/16	3/4	1 1/8	1 1/8	3 1/8	11 3/8	3	3 1/2
x26	12 1/4	1/4	1/8	6 1/2	3/8	3/4	1 1/16	1 1/8	3 1/8	11 3/8	3	3 1/2
x22	12 1/4	1/4	1/8	4	7/16	5/8	15/16	1	1 7/8	11 3/8	1 3/4	#2 1/4
x19	12 1/8	1/4	1/8	4	3/8	9/16	7/8	7/8	1 7/8	11 3/8	1 3/4	#2 1/4
x16	12	1/4	1/8	4	1/4	9/16	13/16	7/8	1 7/8	11 3/8	1 3/4	#2 1/4
x14	11 7/8	3/16	1/8	4	1/4	9/16	3/4	3/4	1 7/8	11 3/8	1 3/4	#2 1/4

W	DEPTH	WEB THK	1/2 WEB	FLG	FLG THK	k1	k	BLOCKOUT		STIFFENER		USUAL GAGE
								d	a	t	b	
W10x112	11 3/8	3/4	3/8	10 3/8	1 1/4	1	1 15/16	2	4 7/8	8 3/4	4 3/4	5 1/2
x100	11 1/8	11/16	3/8	10 3/8	1 1/8	1	1 13/16	1 7/8	4 7/8	8 3/4	4 3/4	5 1/2
x88	10 7/8	5/8	5/16	10 1/4	1	15/16	1 11/16	1 3/4	4 7/8	8 3/4	4 3/4	5 1/2
x77	10 5/8	1/2	1/4	10 1/4	7/8	7/8	1 9/16	1 5/8	4 7/8	8 3/4	4 3/4	5 1/2
x68	10 3/8	1/2	1/4	10 1/8	3/4	7/8	1 7/16	1 1/2	4 7/8	8 3/4	4 3/4	5 1/2
x60	10 1/4	7/16	1/4	10 1/8	11/16	13/16	1 3/8	1 3/8	4 7/8	8 3/4	4 3/4	5 1/2
x54	10 1/8	3/8	3/16	10	5/8	13/16	1 5/16	1 3/8	4 7/8	8 3/4	4 3/4	5 1/2
x49	10	5/16	3/16	10	9/16	13/16	1 1/4	1 1/4	4 7/8	8 3/4	4 3/4	5 1/2
x45	10 1/8	3/8	3/16	8	5/8	13/16	1 5/16	1 3/8	3 7/8	8 3/4	3 3/4	5 1/2
x39	9 7/8	5/16	3/16	8	1/2	13/16	1 3/16	1 1/4	3 7/8	8 3/4	3 3/4	5 1/2
x33	9 3/4	5/16	3/16	8	7/16	3/4	1 1/8	1 1/8	3 7/8	8 3/4	3 3/4	5 1/2
x30	10 1/2	5/16	3/16	5 3/4	1/2	11/16	1 1/8	1 1/8	2 3/4	9 3/8	2 3/4	3
x26	10 3/8	1/4	1/8	5 3/4	7/16	11/16	1 1/16	1 1/8	2 3/4	9 3/8	2 3/4	3
x22	10 1/8	1/4	1/8	5 3/4	3/8	5/8	15/16	1	2 3/4	9 3/8	2 3/4	3
x19	10 1/4	1/4	1/8	4	3/8	5/8	15/16	1	1 7/8	9 3/8	1 3/4	#2 1/4
x17	10 1/8	1/4	1/8	4	5/16	9/16	7/8	7/8	1 7/8	9 3/8	1 3/4	#2 1/4
x15	10	1/4	1/8	4	1/4	9/16	13/16	7/8	1 7/8	9 3/8	1 3/4	#2 1/4
x12	9 7/8	3/16	1/8	4	3/16	9/16	3/4	3/4	1 7/8	9 3/8	1 3/4	#2 1/4
W8x67	9	9/16	5/16	8 1/4	15/16	15/16	1 5/8	1 5/8	3 7/8	7 1/8	3 3/4	5 1/2
x58	8 3/4	1/2	1/4	8 1/4	13/16	7/8	1 1/2	1 1/2	3 7/8	7 1/8	3 3/4	5 1/2
x48	8 1/2	3/8	3/16	8 1/8	11/16	13/16	1 3/8	1 3/8	3 7/8	7 1/8	3 3/4	5 1/2
x40	8 1/4	3/8	3/16	8 1/8	9/16	13/16	1 1/4	1 1/4	3 7/8	7 1/8	3 3/4	5 1/2
x35	8 1/8	5/16	3/16	8	1/2	13/16	1 3/16	1 1/4	3 7/8	7 1/8	3 3/4	5 1/2
x31	8	5/16	3/16	8	7/16	3/4	1 1/8	1 1/8	3 7/8	7 1/8	3 3/4	5 1/2
x28	8	5/16	3/16	6 1/2	7/16	5/8	15/16	1	3 1/8	7 1/8	3	3 1/2
x24	7 7/8	1/4	1/8	6 1/2	3/8	9/16	7/8	7/8	3 1/8	7 1/8	3	3 1/2
x21	8 1/4	1/4	1/8	5 1/4	3/8	9/16	7/8	7/8	2 1/2	7 3/8	2 1/2	3
x18	8 1/8	1/4	1/8	5 1/4	5/16	9/16	13/16	7/8	2 1/2	7 3/8	2 1/2	3
x15	8 1/8	1/4	1/8	4	5/16	9/16	13/16	7/8	1 7/8	7 3/8	1 3/4	#2 1/4
x13	8	1/4	1/8	4	1/4	9/16	3/4	3/4	1 7/8	7 3/8	1 3/4	#2 1/4
x10	7 7/8	3/16	1/8	4	3/16	1/2	11/16	3/4	1 7/8	7 3/8	1 3/4	#2 1/4
W6x25	6 3/8	5/16	3/16	6 1/8	7/16	9/16	15/16	1	2 7/8	5 3/8	2 3/4	3 1/2
x20	6 1/4	1/4	1/8	6	3/8	9/16	7/8	7/8	2 7/8	5 3/8	2 3/4	3 1/2
x16	6 1/4	1/4	1/8	4	3/8	9/16	7/8	7/8	1 7/8	5 3/8	1 3/4	#2 1/4
x15	6	1/4	1/8	6	1/4	9/16	3/4	3/4	2 7/8	5 3/8	2 3/4	3 1/2
x12	6	1/4	1/8	4	1/4	9/16	3/4	3/4	1 7/8	5 3/8	1 3/4	#2 1/4
x9	5 7/8	3/16	1/8	4	3/16	1/2	11/16	3/4	1 7/8	5 3/8	1 3/4	#2 1/4
W5x19	5 1/8	1/4	1/8	5	7/16	7/16	13/16	7/8	2 3/8	4 1/4	2 1/4	2 3/4
x16	5	1/4	1/8	5	3/8	7/16	3/4	3/4	2 3/8	4 1/4	2 1/4	2 3/4
W4x13	4 1/8	1/4	1/8	4	3/8	1/2	3/4	3/4	1 7/8	3 3/8	1 3/4	#2 1/4

C	DEPTH	WEB THK	FLG	FLG THK	k	BLOCKOUT d	BLOCKOUT a	USUAL GAGE
C15x50	15	11/16	3 3/4	5/8	1 7/16	1 1/2	3 1/8	2 1/4
x40	15	1/2	3 1/2	5/8	1 7/16	1 1/2	3	2
x33.9	15	3/8	3 3/8	5/8	1 7/16	1 1/2	3	2
C12x30	12	1/2	3 1/8	1/2	1 1/8	1 1/8	2 5/8	1 3/4
x25	12	3/8	3	1/2	1 1/8	1 1/8	2 5/8	1 3/4
x20.7	12	5/16	3	1/2	1 1/8	1 1/8	2 3/4	1 3/4
C10x30	10	11/16	3	7/16	1	1	2 3/8	1 3/4
x25	10	1/2	2 7/8	7/16	1	1	2 3/8	1 3/4
x20	10	3/8	2 3/4	7/16	1	1	2 3/8	1 1/2
x15.3	10	1/4	2 5/8	7/16	1	1	2 3/8	1 1/2
C9x20	9	7/16	2 5/8	7/16	15/16	1	2 1/4	1 1/2
x15	9	5/16	2 1/2	7/16	15/16	1	2 1/4	1 3/8
x13.4	9	1/4	2 3/8	7/16	15/16	1	2 1/8	1 3/8
C8x18.75	8	1/2	2 1/2	3/8	15/16	1	2	1 1/2
x13.75	8	5/16	2 3/8	3/8	15/16	1	2 1/8	1 3/8
x11.5	8	1/4	2 1/4	3/8	15/16	1	2	1 3/8
C7x14.75	7	7/16	2 1/4	3/8	7/8	7/8	1 7/8	1 1/4
x12.25	7	5/16	2 1/4	3/8	7/8	7/8	2	1 1/4
x9.8	7	3/16	2 1/8	3/8	7/8	7/8	2	1 1/4
C6x13	6	7/16	2 1/8	5/16	13/16	7/8	1 3/4	1 3/8
x10.5	6	5/16	2	5/16	13/16	7/8	1 3/4	1 1/8
x8.2	6	3/16	1 7/8	5/16	13/16	7/8	1 3/4	1 1/8
C5x9	5	5/16	1 7/8	5/16	3/4	3/4	1 5/8	1 1/8
x6.7	5	3/16	1 3/4	5/16	3/4	3/4	1 5/8	1 1/8
C4x7.25	4	5/16	1 3/4	5/16	11/16	3/4	1 1/2	1
x5.4	4	3/16	1 5/8	5/16	11/16	3/4	1 1/2	1
C3x6	3	3/8	1 5/8	1/4	11/16	3/4	1 1/4	7/8
x5	3	1/4	1 1/2	1/4	11/16	3/4	1 1/4	7/8
x4.1	3	3/16	1 3/8	1/4	11/16	3/4	1 1/4	7/8

MC	DEPTH	WEB THK	FLG	FLG THK	k	BLOCKOUT d	BLOCKOUT a	USUAL GAGE
MC18x58	18	11/16	4 1/4	5/8	1 3/8	1 3/8	3 5/8	2 3/4
x51.9	18	5/8	4 1/8	5/8	1 3/8	1 3/8	3 1/2	2 3/4
x45.8	18	1/2	4	5/8	1 3/8	1 3/8	3 1/2	2 3/4
x42.7	18	7/16	4	5/8	1 3/8	1 3/8	3 5/8	2 3/4
MC13x50	13	13/16	4 3/8	5/8	1 3/8	1 3/8	3 5/8	2 3/4
x40	13	9/16	4 1/8	5/8	1 3/8	1 3/8	3 5/8	2 3/4
x35	13	7/16	4 1/8	5/8	1 3/8	1 3/8	3 3/4	2 3/4
x31.8	13	3/8	4	5/8	1 3/8	1 3/8	3 5/8	2 3/4
MC12x50	12	13/16	4 1/8	11/16	1 5/16	1 3/8	3 3/8	2 3/4
x45	12	11/16	4	11/16	1 5/16	1 3/8	3 3/8	2 3/4
x40	12	9/16	3 7/8	11/16	1 5/16	1 3/8	3 3/8	2 1/4
x35	12	7/16	3 3/4	11/16	1 5/16	1 3/8	3 3/8	2 1/4
x31	12	3/8	3 5/8	11/16	1 5/16	1 3/8	3 1/4	2 1/4
x10.6	12	3/16	1 1/2	5/16	11/16	3/4	1 3/8	7/8
MC10x41.1	10	13/16	4 3/8	9/16	1 1/4	1 1/4	3 5/8	2 3/4
x33.6	10	9/16	4 1/8	9/16	1 1/4	1 1/4	3 5/8	2 3/4
x28.5	10	7/16	4	9/16	1 1/4	1 1/4	3 5/8	2 3/4
x25	10	3/8	3 3/8	9/16	1 1/4	1 1/4	3	2
x22	10	5/16	3 3/8	9/16	1 1/4	1 1/4	3 1/8	2
x8.4	10	3/16	1 1/2	1/4	11/16	3/4	1 3/8	7/8
x6.5	10	1/8	1 1/8	3/16	7/16	1/2	1	7/8
MC9x25.4	9	7/16	3 1/2	9/16	1 3/16	1 1/4	3 1/8	2
x23.9	9	3/8	3 1/2	9/16	1 3/16	1 1/4	3 1/8	2
MC8x22.8	8	7/16	3 1/2	1/2	1 3/16	1 1/4	3 1/8	2
x21.4	8	3/8	3 1/2	1/2	1 3/16	1 1/4	3 1/8	2
x20	8	3/8	3	1/2	1 1/8	1 1/8	2 5/8	1 3/4
x18.7	8	3/8	3	1/2	1 1/8	1 1/8	2 5/8	1 3/4
x8.5	8	3/16	1 7/8	5/16	3/4	3/4	1 3/4	1 1/8
MC7x22.7	7	1/2	3 5/8	1/2	1 1/8	1 1/8	3 1/8	2 1/4
x19.1	7	3/8	3 1/2	1/2	1 1/8	1 1/8	3 1/8	2
MC6x18	6	3/8	3 1/2	1/2	1 1/16	1 1/8	3 1/8	2
x16.3	6	3/8	3	1/2	1 1/16	1 1/8	2 5/8	1 3/4
x15.3	6	5/16	3 1/2	3/8	7/8	7/8	3 1/4	2
x15.1	6	5/16	3	1/2	1 1/16	1 1/8	2 3/4	1 3/4
x12	6	5/16	2 1/2	3/8	13/16	7/8	2 1/4	1 1/2

Rows of bolts for WF members:

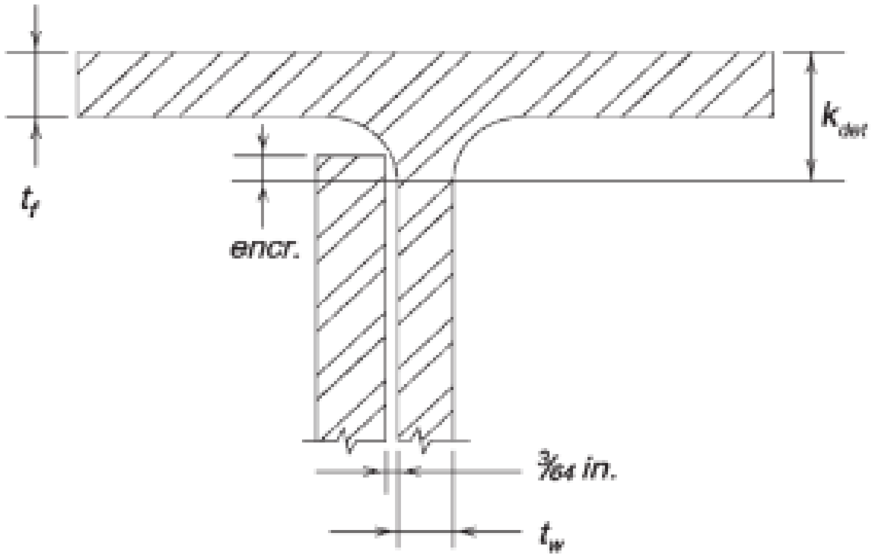
Before starting the model work, confirm with the customer or fabricator standard or as per contract drawings.

BEAM SIZE	STD ROWS	MIN. ROWS	MAX. ROWS
W6	1	1	1
W8	2	2	2
W10	2	2	2
W12	3	2	3
W14	3	3	3
W16	4	3	4
W18	4	3	5
W21	5	4	6
W24	6	4	7
W27	7	5	8
W30	8	5	9
W33	9	6	10
W36	10	6	10

GAGE OF WF BEAMS	
FLANGE WIDTH	GAGE
UNDER 5"	2 1/4
5" TO 5 3/4"	2 3/4
6" TO 7 3/4"	3 1/2
8" AND OVER	5 1/2

WF	W8	W10 - W24	W27	W30
1ST HOLE DIM. FROM TOP OF BEAM	2 1/2	3	3 1/2	3 1/2

7. Encroachment values for structural members: -



k_{det} - t_f	Encr.
in.	in.
$^{5}/_{16}$	$^{1}/_{8}$
$^{3}/_{8}$ to $^{1}/_{2}$	$^{3}/_{16}$
$^{9}/_{16}$ to $^{13}/_{16}$	$^{1}/_{4}$
$^{7}/_{8}$ to 1 $^{1}/_{4}$	$^{5}/_{16}$
1 $^{5}/_{16}$ and 1 $^{3}/_{8}$	$^{3}/_{8}$

Fig. 10-3. Fillet encroachment (riding the fillet).

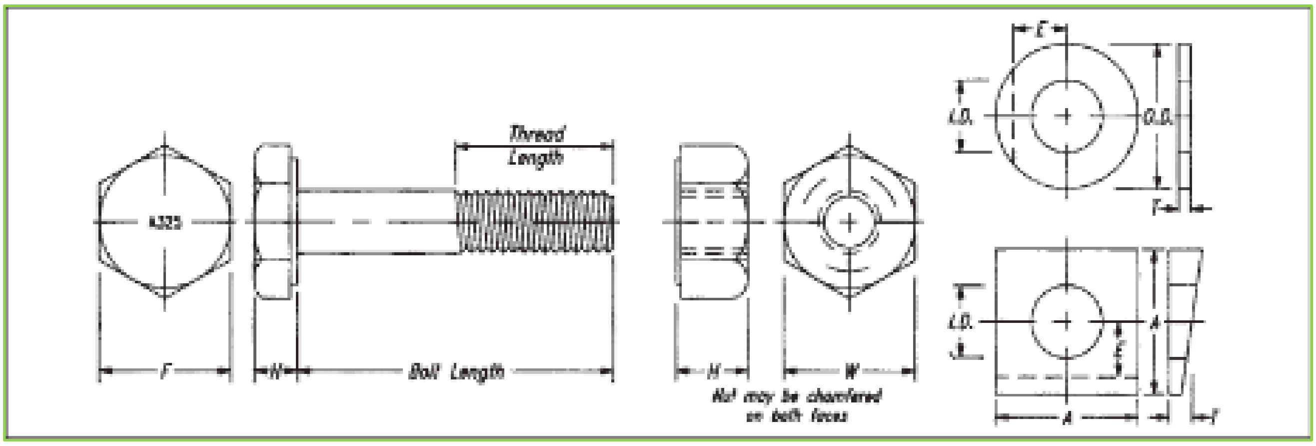
8. Edge distance of structural members: -

TABLE J3.4
Minimum Edge Distance[a] from Center of Standard Hole[b] to Edge of Connected Part, in.

Bolt Diameter, in.	Minimum Edge Distance
$^{1}/_{2}$	$^{3}/_{4}$
$^{5}/_{8}$	$^{7}/_{8}$
$^{3}/_{4}$	1
$^{7}/_{8}$	$1^{1}/_{8}$
1	$1^{1}/_{4}$
$1^{1}/_{8}$	$1^{1}/_{2}$
$1^{1}/_{4}$	$1^{5}/_{8}$
Over $1^{1}/_{4}$	$1^{1}/_{4} \times d$

[a] If necessary, lesser edge distances are permitted provided the appropriate provisions from Sections J3.10 and J4 are satisfied, but edge distances less than one bolt diameter are not permitted without approval from the engineer of record.
[b] For oversized or slotted holes, see Table J3.5.

9. Bolts standards

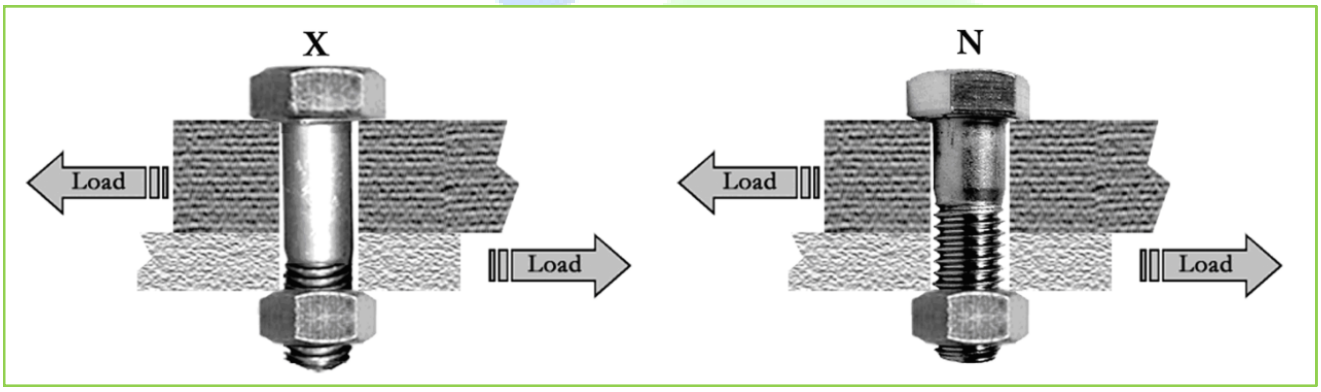


Types of bolt Connections:

a. Bearing type

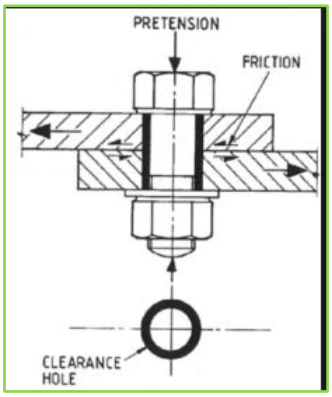
I. N - Threads Included in the shear plane

II. X - Threads excluded from the shear plane.



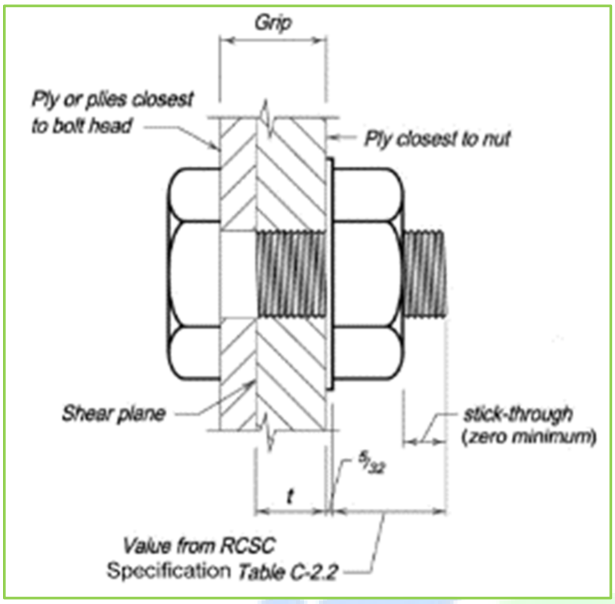
Slip-critical joint, from structural engineering, is a type of bolted structural steel connection that relies on friction between the two connected elements rather than bolt shear or bolt bearing to join two structural elements. Preferred std or OVS hole & faying surface (Class A or B) confirm with the engineer.

- ❖ Needs to specify in the Model & Erection plans. No paint mask needs to add in assembly drawings.



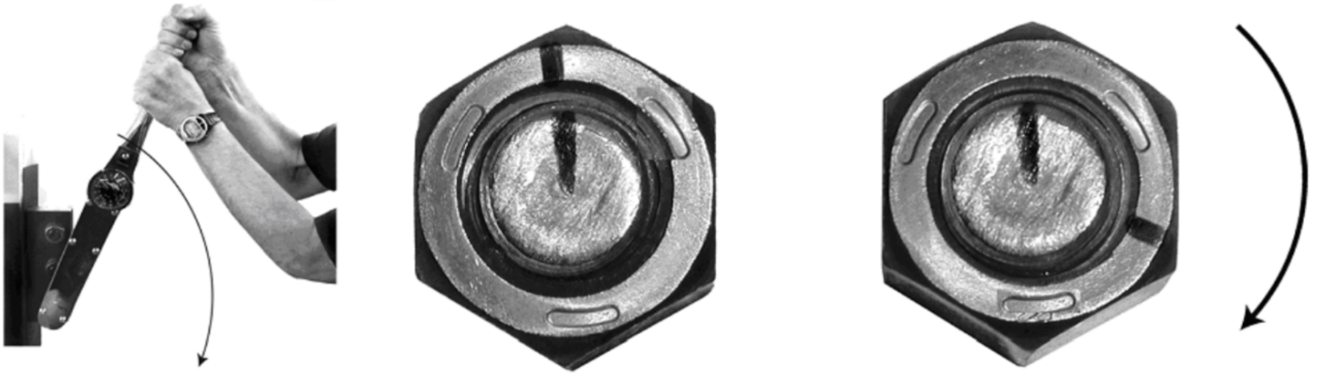
Tightening methods:

Snug tightening N or X (Wrench tight)-A325, A490



Pretension control bolt (N or X)

1. Turn-of Nut

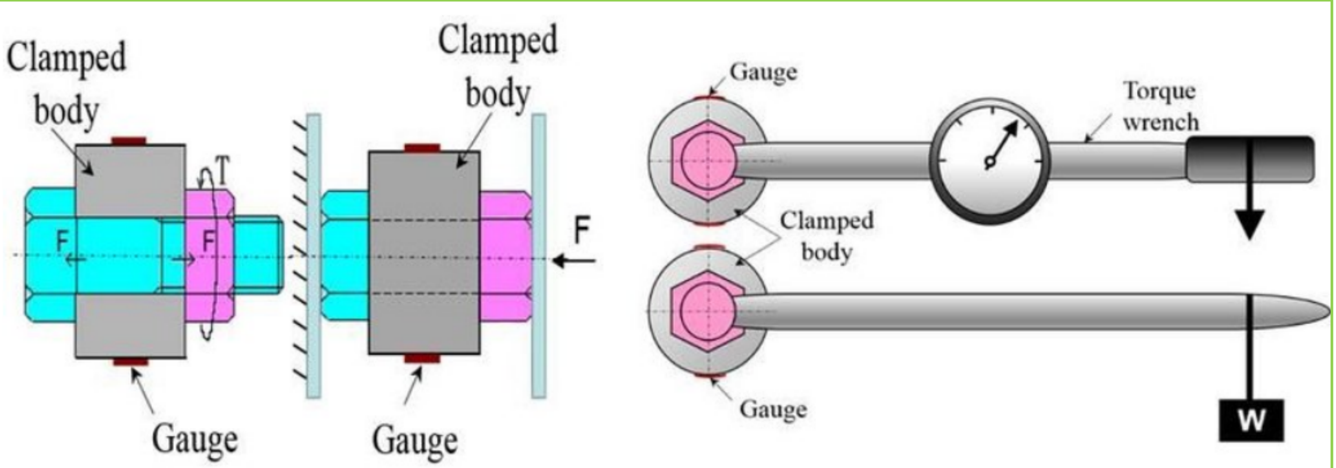


"Snug" tighten

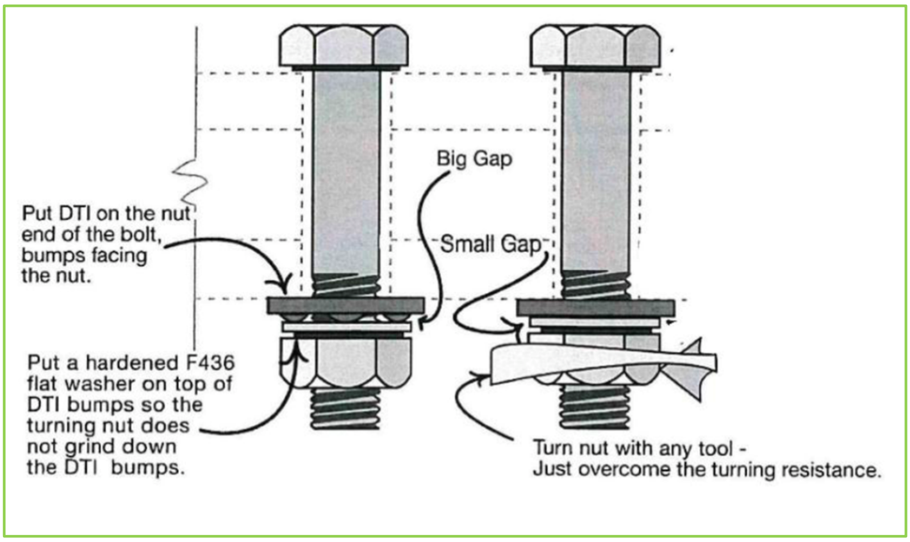
Mark nut and bolt

Desired position achieved (1/3 turn illustrated)

2. Calibrated Wrench



3. Direct Tension indicator bolts



4. Twist-off Bolt F1852, F2280)

Other Bolts &Screws: -

Blind Bolts Counter Sunk bolts Counter Sunk screws

Eye bolts

Lag Screws

Nail

Nailer hole dia- 3/16" Ø - 0"-1" thick plate
- 7/16" Ø - 1"-2" thick plate
- 9/16" Ø - 2"-3" thick plate

Continuing adding 1/8" Ø for every 1" thick increment.

Before starting the model work, confirm with the customer.

Bolt Grades

Table 2-6
Applicable ASTM Specifications for Various Types of Structural Fasteners

ASTM Designation	F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Diameter Range (in.)	High-Strength Bolts: Conventional	High-Strength Bolts: Twist-Off-Type Tension-Control	Common Bolts	Nuts	Washers	Direct-Tension-Indicator Washers	Threaded Rods	Steel Headed Stud Anchors	Anchor Rods: Hooked	Anchor Rods: Headed	Anchor Rods: Threaded & Nutted
A108	—	65	0.375 to 0.75, incl.								■			
A325[d]	—	105	over 1 to 1.5, incl.	■										
A325[d]	—	120	0.5 to 1, incl.	■										
A490[d]	—	150	0.5 to 1.5	■										
F1852[d]	—	105	1.125		■									
F1852[d]	—	120	0.5 to 1, incl.		■									
F2280[d]	—	150	0.5 to 1.125, incl.		■									
A194 Gr. 2H	—	—	0.25 to 4				▒							
A563	—	—	0.25 to 4				■							
F436[b]	—	—	0.25 to 4					■						
F959	—	—	0.5 to 1.5						■					
A36	36	58-80	to 10							■		▒		▒
A193 Gr. B7[e]	—	100	over 4 to 7							▒		▒		▒
A193 Gr. B7[e]	—	115	over 2.5 to 4							▒		▒		▒
A193 Gr. B7[e]	—	125	2.5 and under							▒		▒		▒
A307 Gr. A	—	60	0.25 to 4			■								
A354 Gr. BD	—	140	2.5 to 4, incl.							▒		▒	▒	▒
A354 Gr. BD	—	150	0.25 to 2.5, incl.							▒		▒	▒	▒
A449	—	90	1.75 to 3, incl.	c						▒		▒	▒	▒
A449	—	105	1.125 to 1.5, incl.	c						▒		▒	▒	▒
A449	—	120	0.25 to 1, incl.	c						▒		▒	▒	▒
A572 Gr. 42	42	60	to 6							▒		▒		▒
A572 Gr. 50	50	65	to 4							▒		▒		▒
A572 Gr. 55	55	70	to 2							▒		▒		▒
A572 Gr. 60	60	75	to 1.25							▒		▒		▒
A572 Gr. 65	65	80	to 1.25							▒		▒		▒
A588	42	63	Over 5 to 8, incl.							▒		▒		▒
A588	46	67	Over 4 to 5, incl.							▒		▒		▒
A588	50	70	4 and under							▒		▒		▒
A687	105	150 max.	0.625 to 3							▒		▒		▒
F1554 Gr. 36	36	58-80	0.25 to 4									■	■	■
F1554 Gr. 55	55	75-95	0.25 to 4									■	■	■
F1554 Gr. 105	105	125-150	0.25 to 3									▒	▒	▒

■ = Preferred material specification
▒ = Other applicable material specification, the availability of which should be confirmed prior to specification
□ = Material specification does not apply

— Indicates that a value is not specified in the material specification.
[a] Minimum unless a range is shown or maximum (max.) is indicated.
[b] Special washer requirements may apply per RCSC *Specification* Table 6.1 for some steel-to-steel bolting applications and per Part 14 for anchor-rod applications.
[c] See AISC *Specification* Section J3.1 for limitations on use of ASTM A449 bolts.
[d] When atmospheric corrosion resistance is desired, Type 3 can be specified.
[e] For anchor rods with temperature and corrosion resistance characteristics.

Galvanizing High-Strength Bolts and Nuts

Galvanizing of high-strength bolts is permitted as follows:

1. By the hot-dip or mechanical process for ASTM A325 Type 1 high-strength bolts, per ASTM A325 Section 4.3
2. By the mechanical process only for ASTM F1852 twist-off-type tension-control bolt assemblies, per ASTM F1852 Section 6.3
3. By the hot-dip or mechanical process for ASTM A449 bolts, per ASTM A449 Section 5.1

Nuts for ASTM A325 and F1852 bolts must be galvanized by the same process as the bolt with which they are used. See RCSC *Specification* Table 2.1 for compatible nut grade and finish requirements for ASTM A325 and F1852 bolts, and ASTM A563 for compatible nut grade and finish requirements for ASTM A449 bolts.

Group B bolts are not permitted to be galvanized, per ASTM A490 Section 5.4 and ASTM F2280 Section 6.6. See also RCSC *Specification* Commentary Section 2.3 where it discusses that ASTM A490 bolts and F2280 twist-off-type tension-control bolt assemblies are permitted to be coated using a method compliant with ASTM F1136.

- A490 bolts are not permitted to be galvanized. Discuss with the project manager.
- Erection bolts are A307 grade, confirm with the customer.

Minimum Edge distance in shear or Rolled Edge

TABLE J3.4
Minimum Edge Distance[a] from Center of Standard Hole[b] to Edge of Connected Part, in.

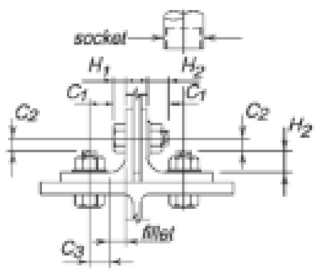
Bolt Diameter, in.	Minimum Edge Distance
1/2	3/4
5/8	7/8
3/4	1
7/8	1 1/8
1	1 1/4
1 1/8	1 1/2
1 1/4	1 5/8
Over 1 1/4	$1\frac{1}{4} \times d$

[a] If necessary, lesser edge distances are permitted provided the appropriate provisions from Sections J3.10 and J4 are satisfied, but edge distances less than one bolt diameter are not permitted without approval from the engineer of record.
[b] For oversized or slotted holes, see Table J3.5.

Bolt Tightening Clearance

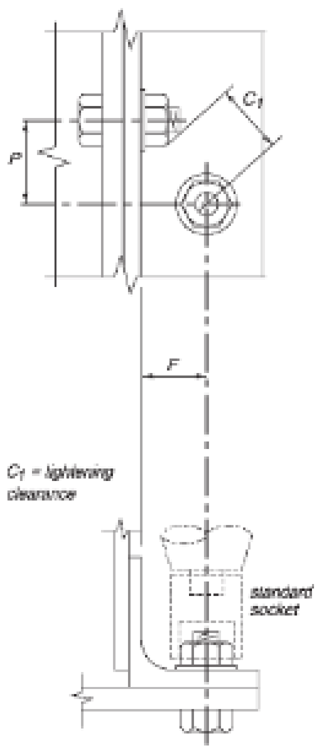
Table 7-15
Entering and Tightening Clearance, in. Conventional ASTM A325 and A490 Bolts

Aligned Bolts



Nominal Bolt Dia.	Socket Dia.	H_1	H_2	C_1	C_2	C_3 Circular	C_3 Clipped
5/8	1 3/4	25/64	1 1/4	1	11/16	11/16	9/16
3/4	2 1/4	15/32	1 3/8	1 1/4	3/4	3/4	11/16
7/8	2 1/2	35/64	1 1/2	1 3/8	7/8	7/8	13/16
1	2 5/8	39/64	1 5/8	1 7/16	15/16	1	7/8
1 1/8	2 7/8	11/16	1 7/8	1 9/16	1 1/16	1 1/8	1
1 1/4	3 1/8	25/32	2	1 11/16	1 1/8	1 1/4	1 1/8
1 3/8	3 1/4	27/32	2 1/8	1 3/4	1 1/4	1 3/8	1 1/4
1 1/2	3 1/2	15/16	2 1/4	1 7/8	1 5/16	1 1/2	1 5/16

Staggered Bolts

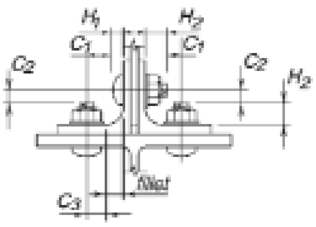


F	Stagger P, in. — Nominal Bolt Diameter, in. 5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
1	1 5/8							
1 1/8	1 1/2							
1 1/4	1 1/2	1 15/16						
1 3/8	1 7/16	1 7/8	2 3/16					
1 1/2	1 1/4	1 13/16	2 1/8	2 5/16				
1 5/8	1 1/4	1 3/4	2 1/16	2 5/16	2 9/16			
1 3/4	1 3/16	1 11/16	2	2 1/4	2 9/16	2 13/16	3	
1 7/8	1 1/8	1 9/16	1 15/16	2 3/16	2 1/2	2 3/4	3	3 3/4
2	1	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	2 15/16	3 1/4
2 1/8	13/16	1 3/8	1 11/16	2	2 3/8	2 11/16	2 15/16	3 3/16
2 1/4		1 1/4	1 9/16	1 7/8	2 1/4	2 5/8	2 7/8	3 3/16
2 3/8		1 1/8	1 1/2	1 3/4	2 1/8	2 1/2	2 13/16	3 1/8
2 1/2		7/8	1 3/8	1 5/8	2	2 7/16	2 3/4	3 1/16
2 5/8			1 3/16	1 1/2	1 15/16	2 5/16	2 7/8	3
2 3/4			15/16	1 3/8	1 7/8	2 1/8	2 1/2	2 7/8
2 7/8				1 3/16	1 3/4	2 1/16	2 3/8	2 13/16
3				7/8	1 5/8	2	2 1/4	2 11/16
3 1/8					1 1/2	1 7/8	2 1/8	2 1/2
3 1/4					1 1/4	1 3/4	2	2 3/8
3 3/8					15/16	1 5/8	1 15/16	2 1/4
3 1/2						1 3/8	1 3/4	2 1/8
3 5/8						1 1/16	1 9/16	2
3 3/4							1 5/16	1 7/8
3 7/8								1 11/16
4								1 3/8

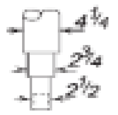
Notes:
H_1 = height of head
H_2 = maximum shank extension*
C_1 = clearance for tightening
C_2 = clearance for entering
C_3 = clearance for fillet*
P = bolt stagger
F = clearance for tightening staggered bolts
* Based on the use of one ASTM F436 washer

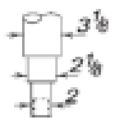
Table 7-16
Entering and Tightening Clearance, in.
Tension Control ASTM F1852 and F2280 Bolts

Aligned Bolts

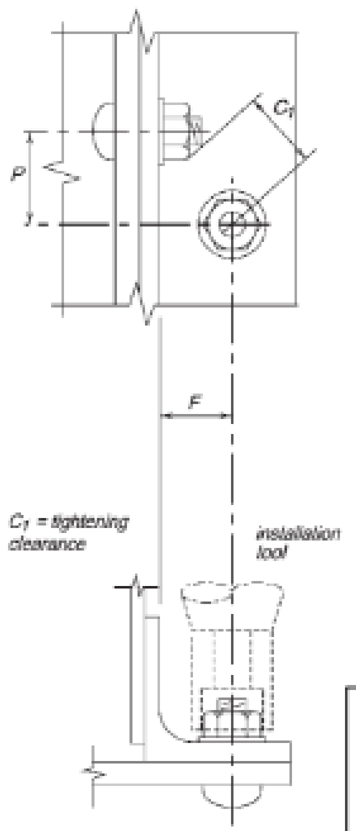


Tools	Nominal Bolt Dia.	H_1	H_2	C_1	C_2	C_3 Circular	C_3 Clipped
Large Tools	**4 1/4-in. Diameter Critical**						
	3/4	1/2	1 3/8	2 1/8	7/8	3/4	—
	7/8	9/16	1 1/2	2 1/8	1	7/8	—
	1	5/8	1 3/4	2 1/8	1 1/8	1	—
	2 3/4-in. Diameter Critical						
	3/4	1/2	1 3/8	1 3/8	7/8	3/4	—
	7/8	9/16	1 1/2	1 3/8	1	7/8	—
	1	5/8	1 3/4	1 3/8	1 1/8	1	—
Small Tools	**3 1/8-in. Diameter Critical**						
	5/8	7/16	1 1/4	1 5/8	13/16	11/16	—
	3/4	1/2	1 3/8	1 5/8	7/8	3/4	—
	7/8	9/16	1 1/2	1 5/8	1	7/8	—
	2 1/8-in. Diameter Critical						
	5/8	7/16	1 1/4	1 1/8	13/16	11/16	—
	3/4	1/2	1 3/8	1 1/8	7/8	3/4	—
	7/8	9/16	1 1/2	1 1/8	1	7/8	—



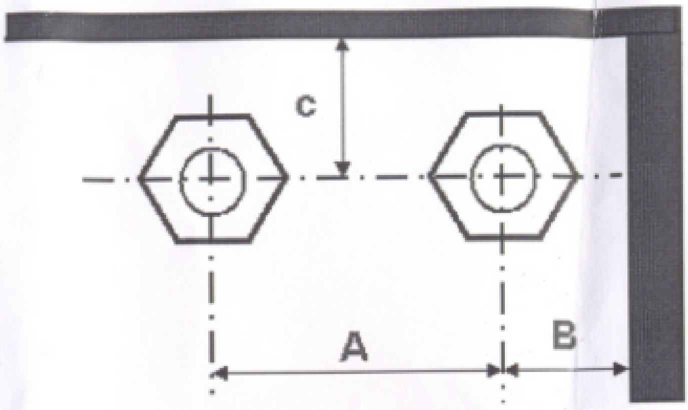


Staggered Bolts



F	Stagger P, in. — Nominal Bolt Diameter, in. 5/8	3/4	7/8	1
1 1/4	1 13/16			
1 3/8	1 3/4	2 1/16	2 1/4	2 7/16
1 1/2	1 11/16	2	2 3/16	2 3/8
1 5/8	1 9/16	1 7/8	2 1/16	2 1/4
1 3/4	1 1/2	1 13/16	2	2 3/16
1 7/8	1 7/16	1 3/4	1 7/8	2 1/8
2	1 5/16	1 5/8	1 3/4	2
2 1/8	1 1/4	1 9/16	1 11/16	1 15/16
2 1/4	1 3/16	1 1/2	1 9/16	1 7/8
2 3/8	1 1/8	1 3/8	1 1/2	1 3/4
2 1/2	1	1 5/16	1 3/8	1 11/16
2 5/8		1 3/16	1 5/16	1 9/16
2 3/4		1 1/8	1 3/16	1 1/2
2 7/8			1 1/8	1 3/8
3				1 5/16
3 3/8				1 5/16

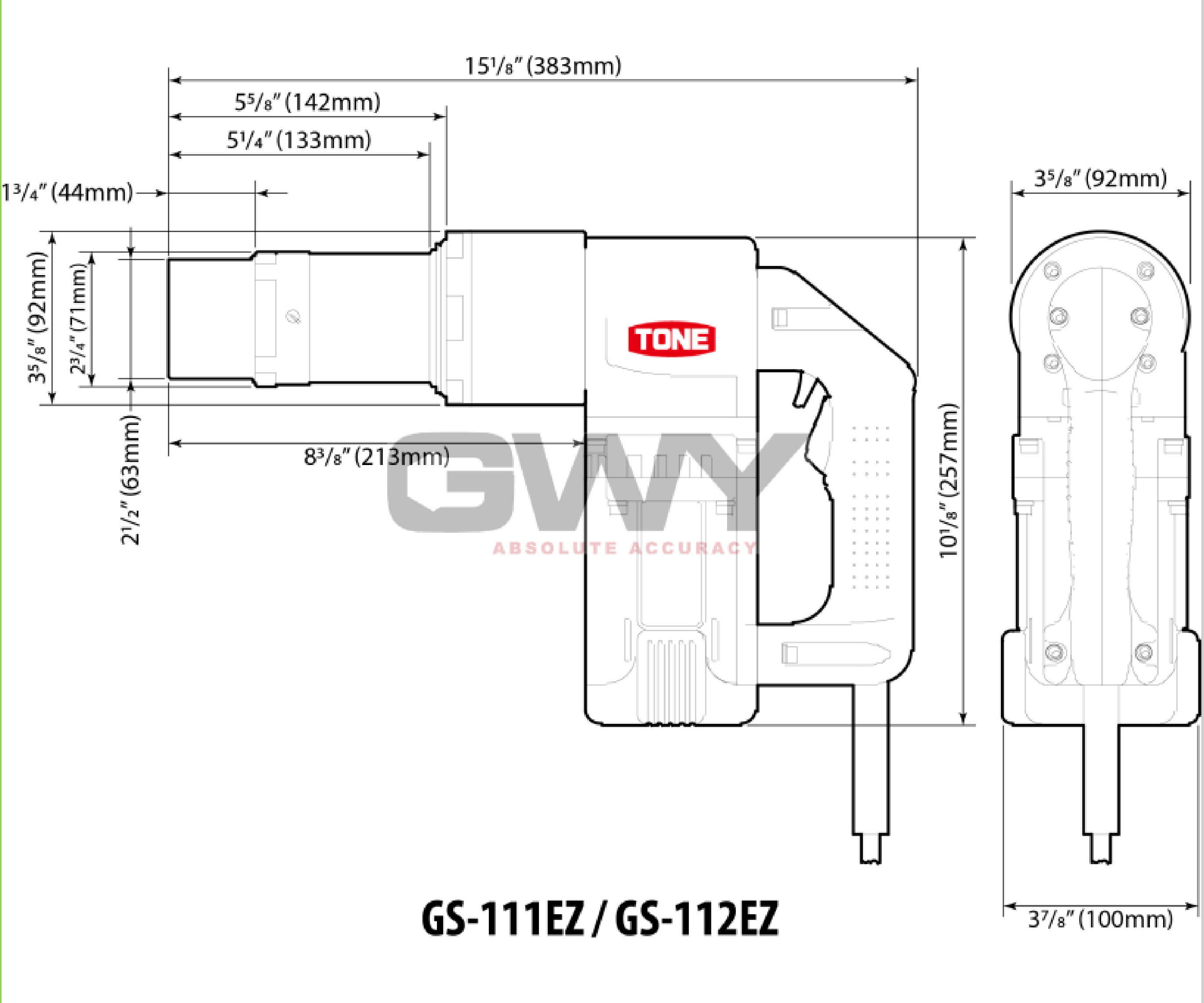
Notes:
H_1 = height of head
H_2 = maximum shank extension*
C_1 = clearance for tightening
C_2 = clearance for entering
C_3 = clearance for fillet*
P = bolt stagger
F = clearance for tightening staggered bolts
* Based on one standard hardened washer



Wrench Clearance Guide

Bolt Size Inches (mm)	Socket Wrench Inches (mm)			Open End Wrench Inches (mm)		
	A	B	C	A	B	C
1/4" (6)	3/4" (19)	1/2" (13)	1/2" (13)	1" (25)	7/8" (22)	5/8" (16)
3/8" (10)	1-1/8" (29)	3/4" (19)	3/4" (19)	1-3/8" (35)	1-1/8" (29)	3/4" (19)
1/2" (13)	1-3/8" (35)	7/8" (22)	7/8" (22)	1-3/4" (44)	1-3/8" (35)	7/8" (22)
5/8" (16)	1-5/8" (41)	1" (25)	1" (25)	2-1/8" (54)	1-1/2" (38)	1-1/8" (29)
3/4" (19)	1-7/8" (48)	1-1/8" (29)	1-1/8" (29)	2-5/8" (67)	1-5/8" (41)	1-1/4" (32)
7/8" (22)	2-1/8" (54)	1-1/4" (32)	1-1/4" (32)	3" (76)	1-7/8" (48)	1-5/8" (41)
1" (25)	2-3/8" (60)	1-3/8" (35)	1-3/8" (35)	3-1/4" (83)	2-1/8" (54)	1-7/8" (48)
1-1/8" (29)	2-5/8" (67)	1-1/2" (38)	1-1/2" (38)	3-3/8" (86)	2-1/4" (57)	1-7/8" (48)
1-1/4" (32)	2-7/8" (73)	1-5/8" (41)	1-5/8" (41)	3-7/8" (98)	2-1/2" (64)	2" (51)
1-3/8" (35)	3-1/8" (79)	1-3/4" (44)	1-3/4" (44)	4-3/8" (111)	2-3/4" (70)	2-1/4" (57)
1-1/2" (38)	3-3/8" (86)	1-7/8" (48)	1-7/8" (48)	4-7/8" (124)	2-7/8" (73)	2-1/2" (64)

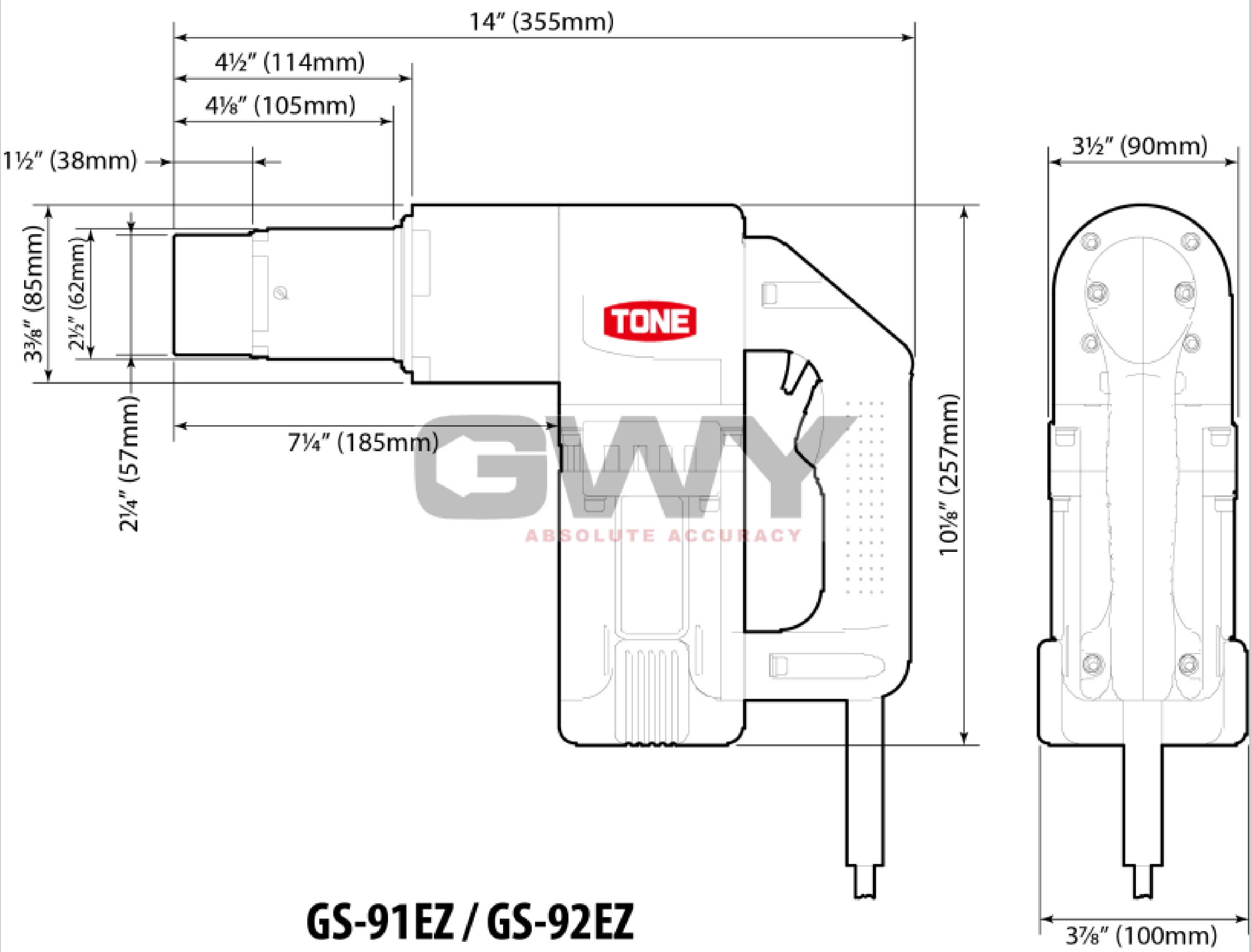
Tension control Bolt Gun Availability



GS-111EZ Shear Wrench

Our most popular heavy-duty wrench. At 19.2 lbs, this model is a versatile tool. Fits ¾", 7/8", 1" and 1-1/8" diameter bolts.

Fully- Tensioned Structural Bolts:	**Max. Torque**
A325- 3/4", 7/8", 1", 1-1/8"	1030 ft-lb (1400 N-m)
A325M- M20, M22, M24	
A490- 3/4", 7/8", 1", 1- 1/8"	
A490M- M20, M22, M24	



GS-91EZ Shear Wrench

Powerful mid-range wrench. Fits 5/8", ¾", 7/8" and 1" diameter bolts.

Fully- Tensioned Structural Bolt:

A325- 5/8", 3/4", 7/8", 1"

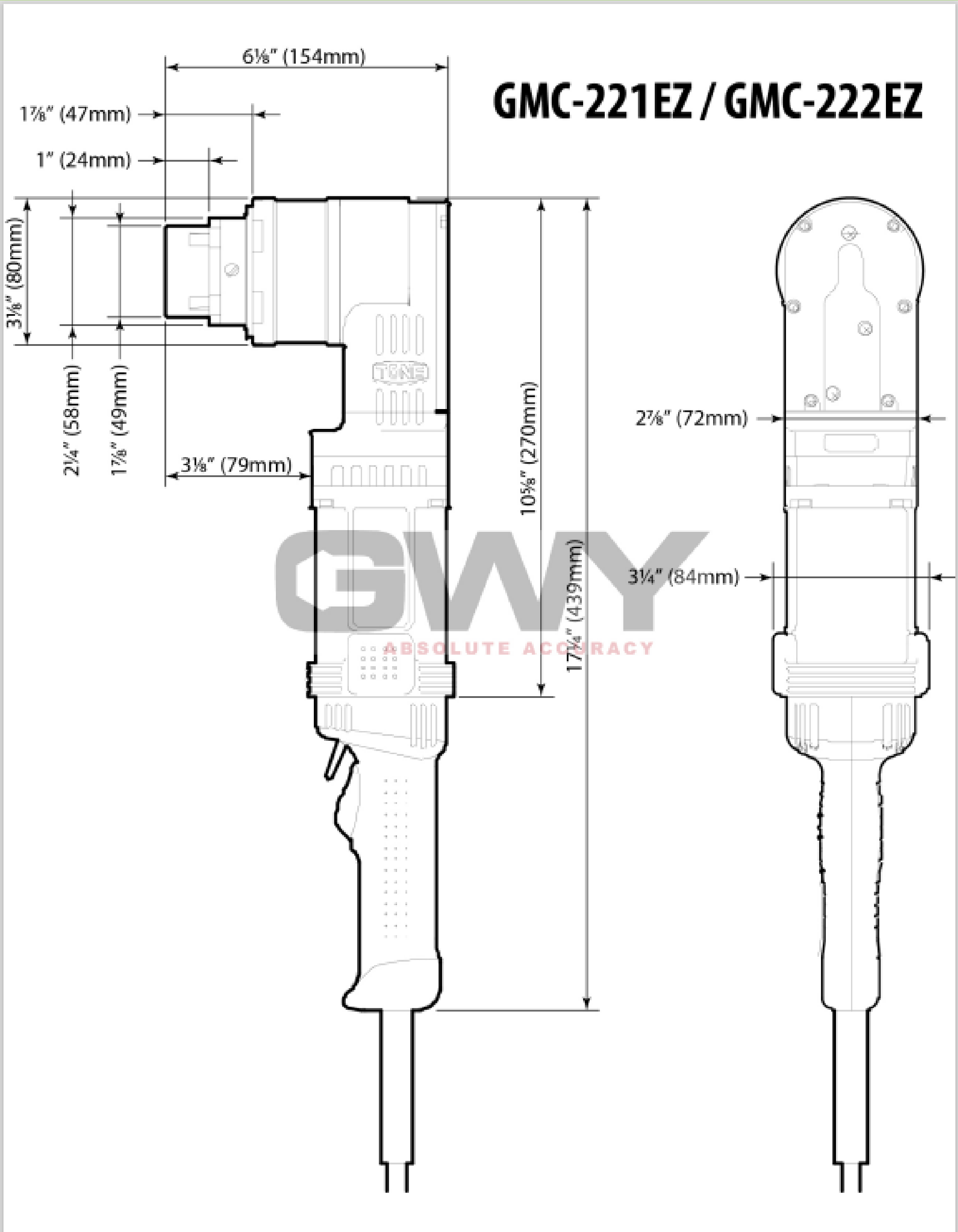
A325M- M16, M20, M22

A490- 5/8", 3/4", 7/8", 1"

A490M- M16, M20, M22

Max. Torque:

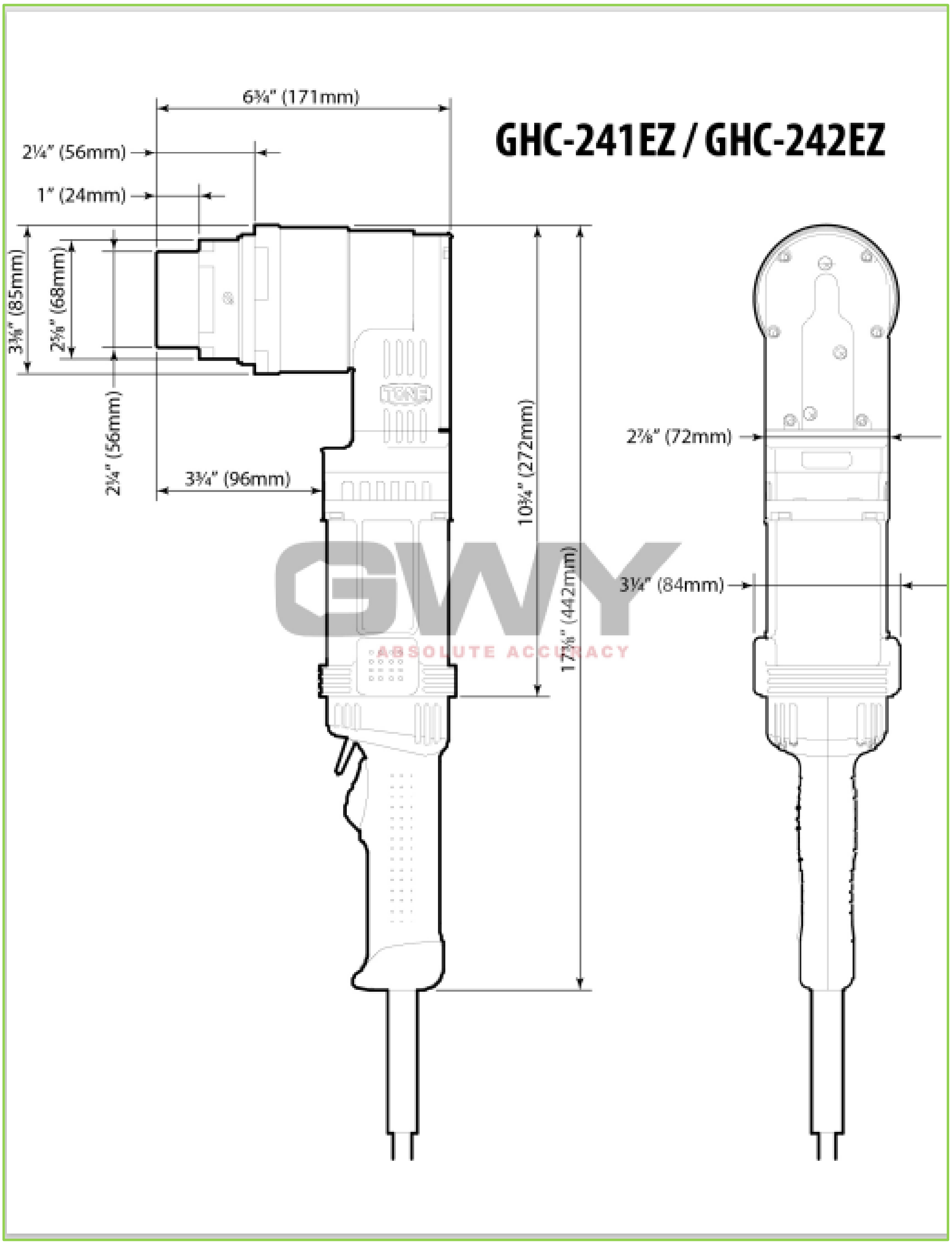
810 ft-lb (1100 N-m)



GMC-221EZ Shear Wrench

Get those tough-to-reach areas with this compact wrench weighing at just 11.7 lbs.

Fully- Tensioned Structural Bolts:	**Max. Torque:**
A325- 5/8″, 3/4″, 7/8″	590 ft-lb (800 N-m)
A325M- M16, M20, M22	
A490- 5/8″, 3/4″, 7/8″	
A490M- M16, M20, M22	



GHC-241EZ Shear Wrench

Our most popular for minimal clearance.

Fully-Tensioned Structural Bolts:	**Max. Torque:**
A325- 3/4″, 7/8″, 1″	920 ft-lb (1250 N-m)
A325M- M16, M20, M22, M24	
A490- 3/4″, 7/8″, 1″	
A490M- M16, M20, M22, M24	

TC Bolt Sizes in stock

5/8" (11) F1852/A325 TC BOLTS IN STOCK			
PART #	DESCRIPTION	WEIGHT PER 100	QTY PER KEG
PTU062150	5/8(11) X 1-1/2	40	500
PTU062175	5/8(11) X 1-13/4	43	470
PTU062200	5/8(11) X 2	45	450
PTU062225	5/8(11) X 2-1/4	47	410
PTU062250	5/8(11) X 2-1/2	49	380
PTU062275	5/8(11) X 2-3/4	51	360
PTU062300	5/8(11) X 3	54	325

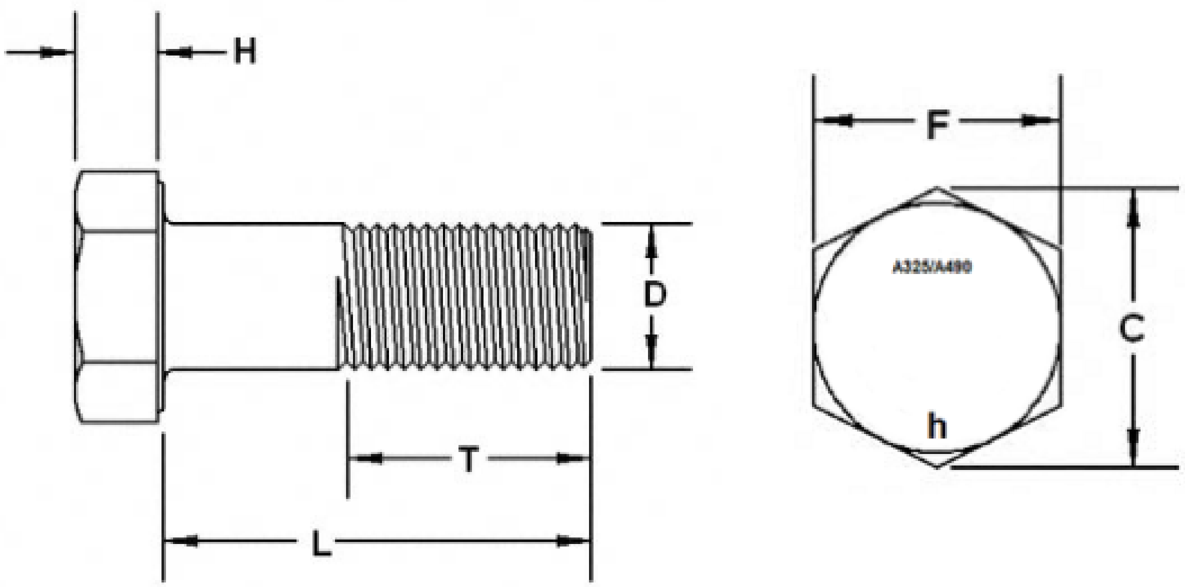
3/4" (10) F1852/A325 TC AND F2280/A490 TC BOLTS IN STOCK			
PART #	DESCRIPTION	WEIGHT PER 100	QTY PER KEG
PTU075175	3/4(10) X 1-3/4	66	300
PTU075200	3/4(10) X 2	70	280
PTU075225	3/4(10) X 2-1/4	73	270
PTU075250	3/4(10) X 2-1/2	76	250
PTU075275	3/4(10) X 2-3/4	79	250
PTU075300	3/4(10) X 3	83	240
PTU075325	3/4(10) X 3-1/4	86	230
PTU075350	3/4(10) X 3-1/2	89	220
PTU075375	3/4(10) X 3-3/4	92	200
PTU075400	3/4(10) X 4	95	190
PTU075425	3/4(10) X 4-1/4	98	180
PTU075450	3/4(10) X 4-1/2	102	180
PTU075475	3/4(10) X 4-3/4	105	160
PTU075500	3/4(10) X 5	108	150
PTU075550	3/4(10) X 5-1/2	114	150
PTU075600	3/4(10) X 6	118	130

7/8" (9) F1852/A325 TC AND F2280/A490 TC BOLTS IN STOCK			
PART #	DESCRIPTION	WEIGHT PER 100	QTY PER KEG
PTU087200	7/8 (9) X 2	106	200
PTU087225	7/8 (9) X 2-1/4	110	190
PTU087250	7/8 (9) X 2-1/2	114	180
PTU087275	7/8 (9) X 2-3/4	120	180
PTU087300	7/8 (9) X 3	124	170
PTU087325	7/8 (9) X 3-1/4	128	160
PTU087350	7/8 (9) X 3-1/2	129	150
PTU087375	7/8 (9) X 3-3/4	131	140
PTU087400	7/8 (9) X 4	136	140
PTU087425	7/8 (9) X4-1/4	140	130
PTU087450	7/8 (9) X 4-1/2	143	120
PTU087475	7/8 (9) X 4-3/4	149	120
PTU087500	7/8 (9) X 5	153	115
PTU087525	7/8 (9) X 5-1/4	157	110
PTU087550	7/8 (9) X 5-1/2	162	100
PTU087575	7/8 (9) X 5-3/4	165	100
PTU087600	7/8 (9) X 6	170	95
PTU087650	7/8 (9) X 6-1/2	185	80
PTU087700	7/8 (9) X 7	194	70
PTU087750	7/8 (9) X 7-1/2	202	70
PTU087800	7/8 (9) X 8	209	70

1" (8) F1852/A325 TC AND F2280/A490 TC BOLTS IN STOCK			
PART #	DESCRIPTION	WEIGHT PER 100	QTY PER KEG
PTU100200	1 (8) X 2	140	140
PTU100225	1 (8) X 2-1/4	143	140
PTU100250	1 (8) X 2-1/2	149	130
PTU100275	1 (8) X 2-3/4	154	130
PTU100300	1 (8) X 3	160	120
PTU100325	1 (8) X 3-1/4	166	120
PTU100350	1 (8) X 3-1/2	171	110
PTU100375	1 (8) X 3-3/4	177	110
PTU100400	1 (8) X 4	183	100
PTU100425	1 (8) X 4-1/4	188	90
PTU100450	1 (8) X 4-1/2	194	90
PTU100475	1 (8) X 4-3/4	199	80
PTU100500	1 (8) X 5	205	80
PTU100550	1 (8) X 5-1/2	217	80
PTU100600	1 (8) X 6	228	70
PTU100650	1 (8) X 6-1/2	251	60
PTU100700	1 (8) X 7	262	50
PTU100750	1 (8) X 7-1/2	273	50
PTU100800	1 (8) X 8	288	50

1-1/8" (7) F1852/A325 TC AND F2280/A490 TC BOLTS IN STOCK			
PART #	DESCRIPTION	WEIGHT PER 100	QTY PER KEG
PTU113250	1-1/8 (7) X 2-1/2	218	80
PTU113275	1-1/8 (7) X 2-3/4	225	80
PTU113300	1-1/8 (7) X 3	232	80
PTU113325	1-1/8 (7) X 3-1/4	250	70
PTU113350	1-1/8 (7) X 3-1/2	252	70
PTU113375	1-1/8 (7) X 3-3/4	254	70
PTU113400	1-1/8 (7) X 4	260	70
PTU113425	1-1/8 (7) X 4-1/4	267	60
PTU113450	1-1/8 (7) X 4-1/2	273	60
PTU113475	1-1/8 (7) X 4-3/4	280	60
PTU113500	1-1/8 (7) X 5	288	50
PTU114550	1-1/8 (7) X 5-1/2	302	50
PTU113600	1-1/8 (7) X 6	316	50
PTU113700	1-1/8 (7) X 7	320	30
PTU113750	1-1/8 (7) X 7-1/2	341	30

Hex Head Bolts



Bolt Diameter	Width Across Flats (F)			Width Across Corners (C)		Height (H)		
	Nominal	Max	Min	Max	Min	Nominal	Max	Min
1/2	7/8	0.875	0.850	1.010	0.969	11/32	0.364	0.302
5/8	1-1/16	1.062	1.031	1.227	1.175	27/64	0.444	0.378
3/4	1-1/4	1.250	1.212	1.443	1.383	1/2	0.524	0.455
7/8	1-7/16	1.438	1.394	1.660	1.589	37/64	0.604	0.531
1	1-5/8	1.625	1.575	1.876	1.796	43/64	0.700	0.591
1-1/8	1-13/16	1.812	1.756	2.093	2.002	3/4	0.780	0.658
1-1/4	2	2.00	1.938	2.309	2.209	27/32	0.876	0.749
1-3/8	2-3/16	2.188	2.119	2.526	2.416	29/32	0.940	0.810
1-1/2	2-3/8	2.375	2.300	2.742	2.622	1	1.036	0.902
1-3/4	2-3/4	2.750	2.662	3.175	3.035	1-5/32	1.196	1.054
2	3-1/8	3.125	3.025	3.608	3.449	1-11/32	1.388	1.175
2-1/4	3-1/2	3.500	3.388	4.041	3.862	1-1/2	1.548	1.327
2-1/2	3-7/8	3.875	3.750	4.474	4.275	1-21/32	1.708	1.479

Standard Thread Lengths

For Bolt Lengths ≤ 6" use: Thread Length = (2 x Diameter) + 1/4"

For Bolt Lengths > 6" use: Thread Lengtht = (2 x Diameter) 1/2"

Hex head Bolt Sizes in stock

1/2 (13) STRUCTURAL A325-1 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA050125	1/2 (13) X 1-1/4	11.7	1710	7/8	5/16	1
AAA050150	1/2 (13) X 1/1/2	12.8	1560	7/8	5/16	1
AAA050175	1/2 (13) X 1/3/4	14.1	1420	7/8	5/16	1
AAA050200	1/2 (13) X 2	15.2	1290	7/8	5/16	1
AAA050225	1/2 (13) X 2-1/4	16.8	1190	7/8	5/16	1
AAA050250	1/2 (13) X 2-1/2	18.2	1100	7/8	5/16	1
AAA050275	1/2 (13) X 2-3/4	19.5	1000	7/8	5/16	1
AAA050300	1/2 (13) X 3	20.9	950	7/8	5/16	1
AAA050325	1/2 (13) X 3-1/4	22.2	850	7/8	5/16	1
AAA050350	1/2 (13) X 3-1/2	23.6	750	7/8	5/16	1
AAA050375	1/2 (13) X 3-3/4	24.9	700	7/8	5/16	1
AAA050400	1/2 (13) X 4	26.2	675	7/8	5/16	1

5/8 (11) STRUCTURAL A325-1 & A325-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA062150	5/8(11) X 1-1/2	21.7	900	1-1/16	25/64	1-1/4
AAA062175	5/8(11) X 1-3/4	23.5	850	1-1/16	25/64	1-1/4
AAA062200	5/8(11) X 2	25.6	825	1-1/16	25/64	1-1/4
AAA062225	5/8(11) X 2-1/4	27.7	775	1-1/16	25/64	1-1/4
AAA062250	5/8(11) X 2-1/2	29.8	725	1-1/16	25/64	1-1/4
AAA062275	5/8(11) X 2-3/4	31.9	600	1-1/16	25/64	1-1/4
AAA062300	5/8(11) X 3	34	575	1-1/16	25/64	1-1/4
AAA062325	5/8(11) X 3-1/4	36	550	1-1/16	25/64	1-1/4
AAA062350	5/8(11) X 3-1/2	38.1	500	1-1/16	25/64	1-1/4
AAA062375	5/8(11) X 3-3/4	40.3	450	1-1/16	25/64	1-1/4
AAA062400	5/8(11) X 4	42.3	400	1-1/16	25/64	1-1/4
AAA062450	5/8(11) X 4-1/2	51	375	1-1/16	25/64	1-1/4
AAA062500	5/8(11) X 5	52.3	300	1-1/16	25/64	1-1/4
AAA062550	5/8(11) X 5-1/2	54.9	275	1-1/16	25/64	1-1/4
AAA062600	5/8(11) X 6	59.1	250	1-1/16	25/64	1-1/4

3/4 (9) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA075175	3/4 (10) X 1-3/4	36.5	650	1-1/4	15/32	1-3/8
AAA075200	3/4 (10) X 2	39	650	1-1/4	15/32	1-3/8
AAA075225	3/4 (10) X 2-1/4	42	550	1-1/4	15/32	1-3/8
AAA075250	3/4 (10) X 2-1/2	45	525	1-1/4	15/32	1-3/8
AAA075275	3/4 (10) X 2-3/4	48.1	475	1-1/4	15/32	1-3/8
AAA075300	3/4 (10) X 3	51.1	425	1-1/4	15/32	1-3/8
AAA075325	3/4 (10) X 3-1/4	54.1	400	1-1/4	15/32	1-3/8
AAA075350	3/4 (10) X 3-1/2	57.1	375	1-1/4	15/32	1-3/8
AAA075375	3/4 (10) X 3-3/4	60.1	350	1-1/4	15/32	1-3/8
AAA075400	3/4 (10) X 4	63.2	300	1-1/4	15/32	1-3/8
AAA075425	3/4 (10) X 4-1/4	66.2	300	1-1/4	15/32	1-3/8
AAA075450	3/4 (10) X 4-1/2	69.2	275	1-1/4	15/32	1-3/8
AAA075475	3/4 (10) X 4-3/4	72.2	250	1-1/4	15/32	1-3/8
AAA075500	3/4 (10) X 5	75.2	225	1-1/4	15/32	1-3/8
AAA075525	3/4 (10) X 5-1/4	78.2	225	1-1/4	15/32	1-3/8
AAA075550	3/4 (10) X 5-1/2	81.3	200	1-1/4	15/32	1-3/8
AAA075575	3/4 (10) X 5-3/4	84.3	190	1-1/4	15/32	1-3/8
AAA075600	3/4 (10) X 6	87.3	190	1-1/4	15/32	1-3/8
AAA075625	3/4 (10) X 6-1/4	90.1	175	1-1/4	15/32	1-3/8
AAA075650	3/4 (10) X 6-1/2	92.9	150	1-1/4	15/32	1-3/8
AAA075700	3/4 (10) X 7	99	140	1-1/4	15/32	1-3/8
AAA075750	3/4 (10) X 7-1/2	107	135	1-1/4	15/32	1-3/8
AAA075800	3/4 (10) X 8	113	120	1-1/4	15/32	1-3/8
AAA075850	3/4 (10) X 8-1/2	117	120	1-1/4	15/32	1-3/8
AAA075900	3/4 (10) X 9	138	100	1-1/4	15/32	1-3/8
AAA075950	3/4 (10) X 9-1/2	140	80	1-1/4	15/32	1-3/8
AAA07600	3/4 (10) X 10	143	60	1-1/4	15/32	1-3/8

7/8 (9) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA087175	7/8(9) X 1-3/4	52.2	450	1-7/16	35/64	1-1/2
AAA087200	7/8(9) X 2	56.4	425	1-7/16	35/64	1-1/2
AAA087225	7/8(9) X 2-1/4	60.2	375	1-7/16	35/64	1-1/2
AAA087250	7/8(9) X 2-1/2	64.2	350	1-7/16	35/64	1-1/2
AAA087275	7/8(9) X 2-3/4	68.3	325	1-7/16	35/64	1-1/2
AAA087300	7/8(9) X 3	72.4	300	1-7/16	35/64	1-1/2
AAA087325	7/8(9) X 3-1/4	76.6	275	1-7/16	35/64	1-1/2
AAA087350	7/8(9) X 3-1/2	80.7	250	1-7/16	35/64	1-1/2
AAA087375	7/8(9) X 3-3/4	84.8	250	1-7/16	35/64	1-1/2
AAA087400	7/8(9) X 4	88.9	225	1-7/16	35/64	1-1/2
AAA087425	7/8(9) X 4-1/4	94.3	200	1-7/16	35/64	1-1/2
AAA087450	7/8(9) X 4-1/2	98	200	1-7/16	35/64	1-1/2
AAA087475	7/8(9) X 4-3/4	103.3	180	1-7/16	35/64	1-1/2
AAA087500	7/8(9) X 5	106	175	1-7/16	35/64	1-1/2
AAA087525	7/8(9) X 5-1/4	112	150	1-7/16	35/64	1-1/2
AAA087550	7/8(9) X 5-1/2	114	150	1-7/16	35/64	1-1/2
AAA087575	7/8(9) X 5-3/4	116	150	1-7/16	35/64	1-1/2
AAA087600	7/8(9) X 6	122	135	1-7/16	35/64	1-1/2
AAA087625	7/8(9) X 6-1/2	125	130	1-7/16	35/64	1-1/2
AAA087650	7/8(9) X 6-1/2	130	125	1-7/16	35/64	1-1/2
AAA087675	7/8(9) X 6-3/4	138	120	1-7/16	35/64	1-1/2
AAA087700	7/8(9) X 7	141	120	1-7/16	35/64	1-1/2
AAA087725	7/8(9) X 7-1/4	147	115	1-7/16	35/64	1-1/2
AAA087750	7/8(9) X 7-1/2	149	110	1-7/16	35/64	1-1/2
AAA087775	7/8(9) X 3/4	155	100	1-7/16	35/64	1-1/2
AAA087800	7/8(9) X 8	158	90	1-7/16	35/64	1-1/2
AAA087850	7/8(9) X 8-1/2	163	85	1-7/16	35/64	1-1/2
AAA087900	7/8(9) X 9	173	80	1-7/16	35/64	1-1/2
AAA087925	7/8(9) X 9-1/4	178	80	1-7/16	35/64	1-1/2
AAA087950	7/8(9) X 9-1/2	181	80	1-7/16	35/64	1-1/2
AAA088000	7/8(9) X 10	188	65	1-7/16	35/64	1-1/2

1 (8) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA100200	1 (8) X 2	78.8	300	1-5/8	39/64	1-3/4
AAA100225	1 (8) X 2-1/4	83.4	275	1-5/8	39/64	1-3/4
AAA100250	1 (8) X 2-1/2	88	250	1-5/8	39/64	1-3/4
AAA100275	1 (8) X 2-3/4	94	225	1-5/8	39/64	1-3/4
AAA100300	1 (8) X 3	99	225	1-5/8	39/64	1-3/4
AAA100325	1 (8) X 3-1/4	104	200	1-5/8	39/64	1-3/4
AAA100350	1 (8) X 3-1/2	110	200	1-5/8	39/64	1-3/4
AAA100375	1 (8) X 3-3/4	115	175	1-5/8	39/64	1-3/4
AAA100400	1 (8) X 4	120	175	1-5/8	39/64	1-3/4
AAA100425	1 (8) X 4-1/4	125.5	150	1-5/8	39/64	1-3/4
AAA100450	1 (8) X 4-1/2	131	150	1-5/8	39/64	1-3/4
AAA100475	1 (8) X 4-3/4	136.5	130	1-5/8	39/64	1-3/4
AAA100500	1 (8) X 5	142	130	1-5/8	39/64	1-3/4
AAA100525	1 (8) X 5-1/4	147.5	125	1-5/8	39/64	1-3/4
AAA100550	1 (8) X 5-1/2	153	110	1-5/8	39/64	1-3/4
AAA100575	1 (8) X 5-3/4	159	105	1-5/8	39/64	1-3/4
AAA100600	1 (8) X 6	163	105	1-5/8	39/64	1-3/4
AAA100650	1 (8) X 6-1/2	173	100	1-5/8	39/64	1-3/4
AAA100675	1 (8) X 6-3/4	178	90	1-5/8	39/64	1-3/4
AAA100700	1 (8) X 7	184	90	1-5/8	39/64	1-3/4
AAA100725	1 (8) X 7-1/4	189	80	1-5/8	39/64	1-3/4
AAA100750	1 (8) X 7-1/2	195	80	1-5/8	39/64	1-3/4
AAA100775	1 (8) X 7-3/4	200	75	1-5/8	39/64	1-3/4
AAA100800	1 (8) X 8	206	75	1-5/8	39/64	1-3/4
AAA100825	1 (8) X 8-1/4	214	70	1-5/8	39/64	1-3/4
AAA100850	1 (8) X 8-1/2	220	70	1-5/8	39/64	1-3/4
AAA100875	1 (8) X 8-3/4	224	50	1-5/8	39/64	1-3/4
AAA100900	1 (8) X 9	228	50	1-5/8	39/64	1-3/4
AAA100950	1 (8) X 9-1/2	238	50	1-5/8	39/64	1-3/4
AAA101000	1 (8) X 10	249	50	1-5/8	39/64	1-3/4

1-1/8 (7) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA113225	1-1/8 (7) X 2-1/4	110	170	1-3/16	11/16	2
AAA113250	1-1/8 (7) X 2-1/2	115	170	1-3/16	11/16	2
AAA113275	1-1/8 (7) X 2-3/4	122	170	1-3/16	11/16	2
AAA113300	1-1/8 (7) X 3	128	170	1-3/16	11/16	2
AAA113325	1-1/8 (7) X 3-1/4	134	160	1-3/16	11/16	2
AAA113350	1-1/8 (7) X 3-1/2	141	135	1-3/16	11/16	2
AAA113375	1-1/8 (7) X 3-3/4	148	135	1-3/16	11/16	2
AAA113400	1-1/8 (7) X 4	155	125	1-3/16	11/16	2
AAA113425	1-1/8 (7) X 4-1/4	162	125	1-3/16	11/16	2
AAA113450	1-1/8 (7) X 4-1/2	168	115	1-3/16	11/16	2
AAA113475	1-1/8 (7) X 4-3/4	175	110	1-3/16	11/16	2
AAA113500	1-1/8 (7) X 5	182	105	1-3/16	11/16	2
AAA113525	1-1/8 (7) X 5-1/4	190	95	1-3/16	11/16	2
AAA113550	1-1/8 (7) X 5-1/2	196	90	1-3/16	11/16	2
AAA113575	1-1/8 (7) X 5-3/4	202	70	1-3/16	11/16	2
AAA113600	1-1/8 (7) X 6	209	70	1-3/16	11/16	2
AAA113625	1-1/8 (7) X 6-1/4	218	70	1-3/16	11/16	2
AAA113650	1-1/8 (7) X 6-1/2	227	70	1-3/16	11/16	2
AAA113675	1-1/8 (7) X 6-3/4	231	70	1-3/16	11/16	2
AAA113700	1-1/8 (7) X 7	235	70	1-3/16	11/16	2
AAA113725	1-1/8 (7) X 7-1/4	241	70	1-3/16	11/16	2
AAA113750	1-1/8 (7) X 7-1/2	255	70	1-3/16	11/16	2
AAA113775	1-1/8 (7) X 7-3/4	260	60	1-3/16	11/16	2
AAA113800	1-1/8 (7) X 8	263	60	1-3/16	11/16	2

1-1/4 (7) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA125225	1-1/4 (7) X 2-1/4	142	130	2	25/32	2
AAA125250	1-1/4 (7) X 2-1/2	150	130	2	25/32	2
AAA125275	1-1/4 (7) X 2-3/4	158	130	2	25/32	2
AAA125300	1-1/4 (7) X 3	167	130	2	25/32	2
AAA125325	1-1/4 (7) X 3-1/4	175	125	2	25/32	2
AAA125350	1-1/4 (7) X 3-1/2	183	125	2	25/32	2
AAA125375	1-1/4 (7) X 3-3/4	192	110	2	25/32	2
AAA125400	1-1/4 (7) X 4	200	100	2	25/32	2
AAA125425	1-1/4 (7) X 4-1/4	209	95	2	25/32	2
AAA125450	1-1/4 (7) X 4-1/2	217	90	2	25/32	2
AAA125475	1-1/4 (7) X 4-3/4	225	85	2	25/32	2
AAA125500	1-1/4 (7) X 5	237	85	2	25/32	2
AAA125525	1-1/4 (7) X 5-1/4	245	80	2	25/32	2
AAA125550	1-1/4 (7) X 5-1/2	251	75	2	25/32	2
AAA125600	1-1/4 (7) X 6	267	70	2	25/32	2
AAA125625	1-1/4 (7) X 6-1/4	284	70	2	25/32	2
AAA125650	1-1/4 (7) X 6-1/2	288	65	2	25/32	2
AAA125675	1-1/4 (7) X 6-3/4	301	60	2	25/32	2
AAA125700	1-1/4 (7) X 7	308	55	2	25/32	2
AAA125725	1-1/4 (7) X 7-1/4	312	50	2	25/32	2
AAA125750	1-1/4 (7) X 7-1/2	316	50	2	25/32	2
AAA125775	1-1/4 (7) X 7-3/4	324	50	2	25/32	2
AAA125800	1-1/4 (7) X 8	333	50	2	25/32	2
AAA125850	1-1/4 (7) X 8-1/2	350	40	2	25/32	2
AAA125900	1-1/4 (7) X 9	367	40	2	25/32	2
AAA125950	1-1/4 (7) X 9-1/2	384	40	2	25/32	2

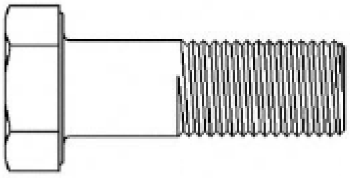
1-1/2 (6) STRUCTURAL A325-1, A325-3, A490-1 & A490-3 BOLTS IN STOCK						
PART #	LENGTH	WEIGHT PER 100	QTY PER KEG	WIDTH ACROSS FLATS	BOLT HEAD HEIGHT	LENGTH OF THREAD
AAA150300	1-1/2 (7) X 3	265	25	2-3/8	15/16	2-1/4
AAA150325	1-1/2 (7) X 3-1/4	277	25	2-3/8	15/16	2-1/4
AAA150375	1-1/2 (7) X 3-3/4	290	25	2-3/8	15/16	2-1/4
AAA150400	1-1/2 (7) X 4	313	25	2-3/8	15/16	2-1/4
AAA150425	1-1/2 (7) X 4-1/4	316	25	2-3/8	15/16	2-1/4
AAA150450	1-1/2 (7) X 4-1/2	325	25	2-3/8	15/16	2-1/4
AAA150475	1-1/2 (7) X 4-3/4	335	25	2-3/8	15/16	2-1/4
AAA150500	1-1/2 (7) X 5	350	25	2-3/8	15/16	2-1/4
AAA150525	1-1/2 (7) X 5-1/4	364	20	2-3/8	15/16	2-1/4
AAA150550	1-1/2 (7) X 5-1/2	375	18	2-3/8	15/16	2-1/4
AAA150575	1-1/2 (7) X 5-3/4	398	15	2-3/8	15/16	2-1/4
AAA150600	1-1/2 (7) X 6	408	15	2-3/8	15/16	2-1/4
AAA150650	1-1/2 (7) X 6-1/2	424	15	2-3/8	15/16	2-1/4
AAA150675	1-1/2 (7) X 6-3/4	440	15	2-3/8	15/16	2-1/4
AAA150700	1-1/2 (7) X 7	448	15	2-3/8	15/16	2-1/4
AAA150725	1-1/2 (7) X 7-1/4	470	10	2-3/8	15/16	2-1/4
AAA150750	1-1/2 (7) X 7-1/2	482	10	2-3/8	15/16	2-1/4
AAA150800	1-1/2 (7) X 8	506	10	2-3/8	15/16	2-1/4
AAA150900	1-1/2 (7) X 9	555	10	2-3/8	15/16	2-1/4
AAA151000	1-1/2 (7) X 10	600	10	2-3/8	15/16	2-1/4

Bolts – Hex and Heavy Hex

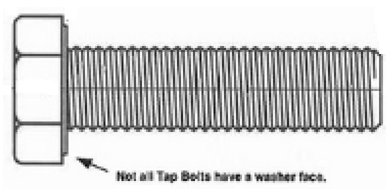
ASTM A307 Grade A and Grade B

Domestic and Imported

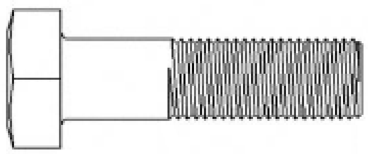
1/2" up to 2-1/2"



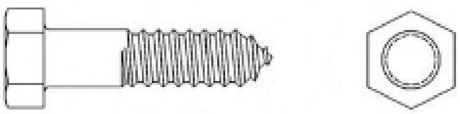
Hex Tab Bolts



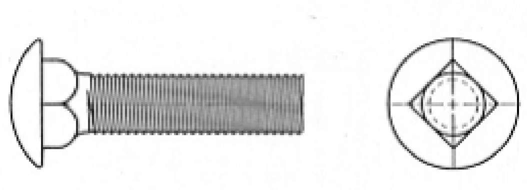
Square Bolts – ASTM A307 Grade A



Lag Screws – ASTM A307 Grade A



Carriage Bolts – ASTM A307 Grade A



Square-neck Carriage Bolt

Other Bolts Available:

Countersunk Head Bolts

Button Head Bolts

Dome Head Bolts

Other Materials Available:

Stainless Steel

Brass

Aluminum

Special Alloys

Custom bolts manufactured at our facility to your specification

Threaded Rod in Stock

Low Carbon Steel

Plain Oil Finish

Stock Lengths – 6' & 12'

Low Carbon Steel

Plated Electro-Galvanized Finish

Stock Lengths – 6' & 12'

Low Carbon Steel

Hot Dip Galvanized

Stock Lengths 6' & 12'

A-193 Grade B7 – Plain

Stock Lengths 12'

A-449 – Plain * Hot Dip Galvanized

Stock Lengths 12'

18/8 Stainless Steel

Stock Lengths – 6'

Studs

Heat-Treated Alloy Steel
ASTM A193 Grade B7

Continuous Threads
IN STOCK
Diameters

$^{3}/_{8}$ - 16	$^{1}/_{2}$ - 13	$^{5}/_{8}$ - 11	$^{3}/_{4}$ - 10	$^{7}/_{8}$ - 9
1 - 8	1 $^{1}/_{8}$ - 8	1 $^{1}/_{4}$ - 8	1 $^{1}/_{2}$ - 8	

Heavy Hex Nuts - Washer Faced

ASTM A194 Grade – 2H

Plain Finish
Tapped UNC Threads up to 4" Diameter
Or
Tapped UN 8 Threads Over 1" Diameter

10. Nut & Washer Grades

ASTM Desig.	Bolt Type	Bolt Finish [d]	ASTM A563 Nut Grade and Finish [d]	ASTM F436 Washer Type and Finish [a,d]
A325	1	Plain (uncoated)	C, C3, D, DH [c] and DH3; plain	1; plain
		Galvanized	DH [c]; galvanized and lubricated	1; galvanized
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
	3	Plain	C3 and DH3; plain	3; plain
F1852	1	Plain (uncoated)	C, C3, DH [c] and DH3; plain	1; plain [b]
		Mechanically Galvanized	DH [c]; mechanically galvanized and lubricated	1; mechanically galvanized [b]
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3 [b]
	3	Plain	C3 and DH3; plain	3; plain [b]
A490	1	Plain	DH[c] and DH3; plain	1; plain
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
	3	Plain	DH3; plain	3; plain
F2280	1	Plain	DH [c] and DH3; plain	1; plain [b]
	3	Plain	DH3; plain	3; plain [b]

[a] Applicable only if washer is required in Section 6.

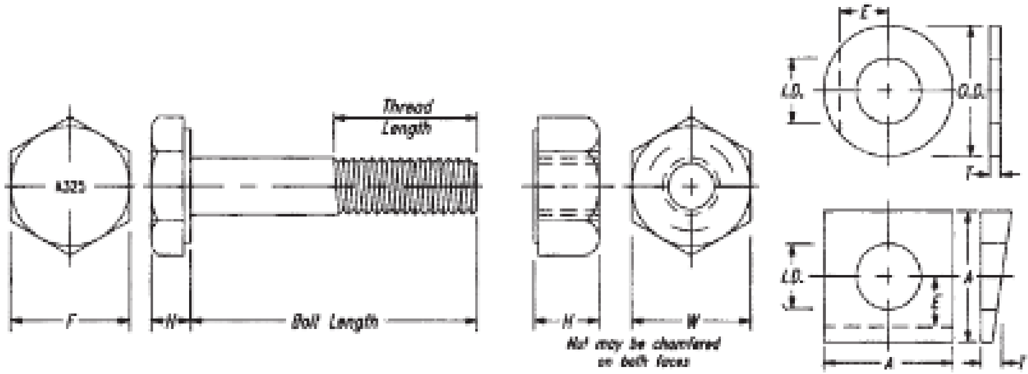
[b] Required in all cases under nut per Section 6.

[c] The substitution of ASTM A194 grade 2H nuts in place of ASTM A563 grade DH nuts is permitted.

[d] "Galvanized" as used in this table refers to hot-dip galvanizing in accordance with ASTM F2329 or mechanical galvanizing in accordance with ASTM B695.

[e] "Zn/Al Inorganic" as used in this table refers to application of a Zn/Al Corrosion Protective Coating in accordance with ASTM F1136 which has met all the requirements of IFI-144.

Table 7-14
Dimensions of High-Strength Fasteners, in.



Measurement			Nominal Bolt Diameter, in								
			1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A325 and A490 Bolts[a]	Width Across Flats, *F*		7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8
	Height, *H*		5/16	25/64	15/32	35/64	39/64	11/16	25/32	27/32	15/16
	Thread Length		1	1 1/4	1 3/8	1 1/2	1 3/4	2	2	2 1/4	2 1/4
	Bolt Length = Grip + Washer Thickness + →		11/16	7/8	1	1 1/8	1 1/4	1 1/2	1 5/8	1 3/4	1 7/8
A563 Nuts[a]	Width Across Flats, *W*		7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8
	Height, *H*		31/64	39/64	47/64	55/64	63/64	1 7/64	1 7/32	1 11/32	1 15/32
F436 Circular Washers[b]	Nom. Outside Diameter, *OD*		1 1/16	1 5/16	1 15/32	1 3/4	2	2 1/4	2 1/2	2 3/4	3
	Nom. Inside Diameter, *ID*		17/32	11/16	13/16	15/16	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8
	Thckns., *T*	Min.	0.097	0.122	0.122	0.136	0.136	0.136	0.136	0.136	0.136
		Max.	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177
	Min. Edge Distance, *E*[c]		7/16	9/16	21/32	25/32	7/8	1	1 3/32	1 7/32	1 5/16
F436 Square or Rect. Washers[b,d]	Min. Side Dimension, *A*		1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	2 1/4	2 1/4	2 1/4	2 1/4
	Mean Thickness, *T*		5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Taper in Thickness		2:12	2:12	2:12	2:12	2:12	2:12	2:12	2:12	2:12
	Min. Edge Distance, *E*[c]		7/16	9/16	21/32	25/32	7/8	1	1 3/32	1 7/32	1 5/16

[a] Tolerances as specified in ASME B18.2.6
[b] ASTM F436 washer tolerances, in.:

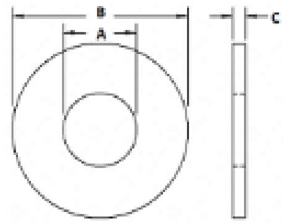
Nominal outside diameter	–1/32; +1/32
Nominal diameter of hole	–0; +1/32
Flatness: max. deviation from straight-edge placed on cut side shall not exceed	0.010
Concentricity: center of hole to outside diameter (full indicator runout)	0.030
Burr shall not project above immediately adjacent washer surface more than	0.010

[c] For clipped washers only
[d] For use with American standard beams (S) and channels (C)

Structural Washers ASTM F436

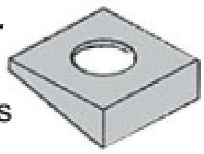
Finish: Plain, Hot Dip and Mechanical Galvanized

Special sizes available upon request.



PART #	For Bolt Diameter	Keg Qty.	Weight Per 100	I.D. (A)	O.D. (B)	Thicknes s (C)
AAW050	1/2	2500	1.93	17/32	1-1/16	.097-.177
AAW062	5/8	1800	3.73	11/16	1-5/16	.122-.177
AAW075	3/4	1300	4.33	13/16	1-15/32	.136-.177
AAW087	7/8	625	6.84	15/16	1-3/4	.136-.177
AAW100	1	700	9	1-1/8	2	.136-.177
AAW113	1-1/8	500	11.07	1-1/4	2-1/4	.136-.177
AAW125	1-1/4	300	13.67	1-3/8	2-1/20	.136-.177
AAW150	1-1/2	200	24	1-5/8	3	.136-.177
AAW175	1-3/4	150	30.67	1-7/8	3-3/8	.178-.28
AAW200	2	100	38	2-1/8	3-3/4	.178-.28
AAW225	2-1/4	50	56	2-3/8	4	.24-.34
AAW250	2-1/2	50	72	2-5/8	4-1/2	.24-.34
AAW275	2-3/4	50	91	2-7/8	5	.24-.34
AAW300	3	50	104	3-1/8	5-1/2	.24-.34

Hardened Bevel Washer
1-3/4 x 1-3/4 x 16 -2/3%
Slope for Standard Beams

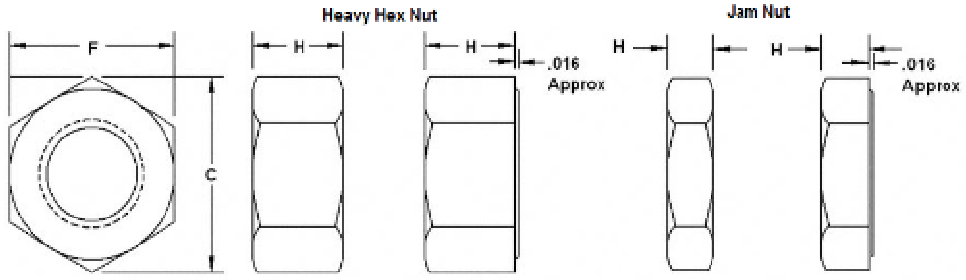


Bolt Diameter	Container Quantity	Net Weight Per 100 Pcs.
1/2	1,000	25.2
5/8	1,000	23.9
3/4	1,000	22.6
7/8	1,000	21.1
1	1,000	19.3

Direct Tension Indicator (DTI's)
Plain Finish ASTM F959 or
Mechanical Galvanized ASTM B695

Bolt Diameter	Container Quantity	Net Weight	Container Quantity	Weight Per 100 Pcs.
1/2	1,500	2.45	-	-
5/8	1,000	3.7	-	-
3/4	600	6.35	450	7.5
7/8	400	9.2	350	11.2
1	350	11.5	250	14.3
1-1/8	300	12	200	16.95
1-1/4	250	12.55	150	21.95

Nuts



Heavy Hex Nuts

ASTM A563 Grade A, C, C3

ASTM A563 DH, DH3, A194, 2H, 8, 8M

Finishes: Plain, Hot Dip Galvanized, Mechanically Galvanized and Zinc Plated

AVAILABLE MELTED AND MANUFACTURED IN THE U.S.A.

Nut Diameter	Width Across Flats (F)	Width Across Corners (C)		Thickness (H)	Weight per Nut
		Max	Min		
1/2	7/8	1.010	0.969	31/64	0.07
5/8	1-1/16	1.227	1.175	39/64	0.12
3/4	1-1/4	1.443	1.382	47/64	0.20
7/8	1-7/16	1.660	1.589	55/64	0.30
1	1-5/8	1.876	1.796	63/64	0.43
1-1/8	1-13/16	2.093	2.002	1-7/64	0.59
1-1/4	2	2.309	2.209	1-7/32	0.79
1-3/8	2-3/16	2.526	2.416	1-11/32	1.02
1-1/2	2-3/8	2.742	2.622	1-15/32	1.31
1-5/8	2-9/16	2.959	2.828	1-19/32	1.62
1-3/4	2-3/4	3.175	3.035	1-23/32	2.04
1-7/8	2-15/16	3.392	3.242	1-27/32	2.41
2	3-1/8	3.608	3.449	1-31/32	2.99
2-1/4	3-1/2	4.041	3.862	2-13/64	4.19
2-1/2	3-7/8	4.474	4.275	2-29/64	5.64
2-3/4	4-1/4	4.907	4.688	2-45/64	7.38
3	4-5/8	5.340	5.102	2-61/64	9.50
3-1/4	5	5.774	5.515	3-3/16	11.94
3-1/2	5-3/8	6.207	5.928	3-7/16	15.26
3-3/4	5-3/4	6.640	6.341	3-11/16	18.12
4	6-1/8	7.073	6.755	3-15/16	21.80

Hex Nuts

ASTM A563 Grade A

Finishes: Plain, Hot Dip Galvanized, Mechanically Galvanized and Zinc Plated

Nut Diameter	Width Across Flats (F)	Width Across Corners (C)		Thickness (H)	Weight per Nut
		Max	Min		
1/2	3/4	0.866	0.84	7/16	.038
5/8	15/16	1.083	1.051	35/64	.074
3/4	1-1/8	1.299	1.24	41/64	.12
7/8	1-5/16	1.516	1.447	3/4	.2
1	1-1/2	1.732	1.653	55/64	.29
1-1/8	1-1/16	1.949	1.859	31/32	.41
1-1/4	1-7/8	2.165	2.066	1-1/16	.55
1-3/8	2-1/16	2.382	2.273	1-11/64	.74
1-1/2	2-1/4	2.598	2.48	1-9/32	.95

Commercial Flat Washers

Bolt Size Inch	Outside Diameter Inch	Inside I.D. Inch	Thickness	Approx. Lbs per 100 Pcs.	Approx. No./Pcs. 50 Lbs.	Approx. No./Pcs. Per Lb.
3/16	9/16	1/4	.036/.065	0.28	18,050	361
1/4	3/4	5/16	.051/.080	0.67	7,450	149
5/16	7/8	3/8	.064/.104	1.11	4,350	87
3/8	1	7/16	.064/.104	1.49	3,350	67
7/16	1 1/4	1/2	.064/.104	2.44	2,050	41
1/2	1 3/8	9/16	.086/.132	3.85	1,300	26
9/16	1 15/32	5/8	.086/.132	4.55	1,100	22
5/8	1 3/4	11/16	.108/.160	7.7	650	13
3/4	2	13/16	.122/.177	11	455	9.1
7/8	2 1/4	15/16	.136/.192	15.3	325	6.5
1	2 1/2	1 1/16	.136/.192	18.8	265	5.3
1 1/4	3	1 3/8	.136/.192	22	225	4.5
1 3/8	3 1/4	1 1/2	.153/.213	33.3	150	3
1 1/2	3 1/2	1 5/8	.153/.213	38.4	130	2.6
1 5/8	3 3/4	1 3/4	.153/.213	44.8	115	2.3
1 3/4	4	1 7/8	.153/.213	50	100	2
1 7/8	4 1/4	2	.153/.213	56.9	90	1.8
2	4 1/2	2 1/8	.153/.213	63	79	1.6
2 1/4	4 3/4	2 3/8	.193/.248	82.6	60	1.2
2 1/2	5	2 5/8	.210/.280	96.1	52	1
2 3/4	5 1/4	2 7/8	.228/.310	110	45	0.9
3	5 1/2	3 1/8	.249/.327	130	43	0.8

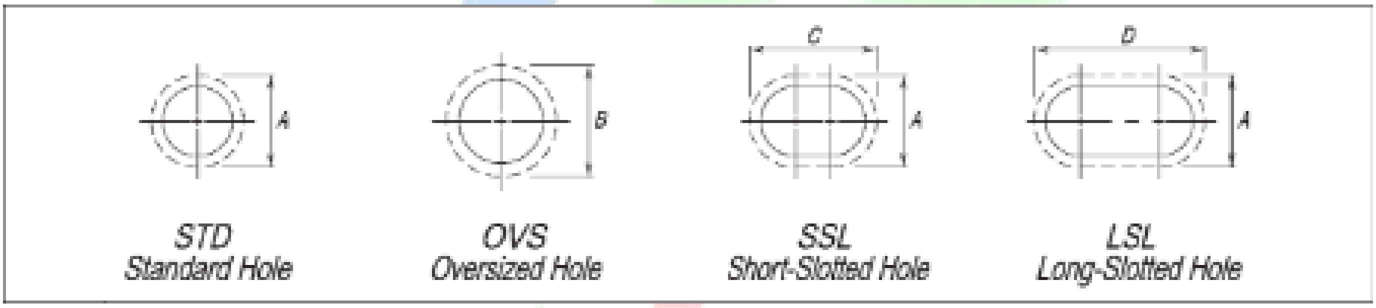
Available in Stock

Finishes: Plain, Hot Dip Galvanized & Mechanical Galvanized

11. Holes and Sizes.

TABLE J3.3
Nominal Hole Dimensions, in.

Bolt Diameter, in.	Hole Dimensions: Standard (Dia.)	Oversize (Dia.)	Short-Slot (Width × Length)	Long-Slot (Width × Length)
1/2	9/16	5/8	9/16 × 11/16	9/16 × 1 1/4
5/8	11/16	13/16	11/16 × 7/8	11/16 × 1 9/16
3/4	13/16	15/16	13/16 × 1	13/16 × 1 7/8
7/8	15/16	1 1/16	15/16 × 1 1/8	15/16 × 2 3/16
1	1 1/8	1 1/4	1 1/8 × 1 5/16	1 1/8 × 2½
≥ 1 1/8	d + 1/8	d + 5/16	(d + 1/8) × (d + 3/8)	(d + 1/8) × (2.5 × d)



- ❖ For connections, Standard holes are preferred for beams, columns, and short/std holes are preferred in connecting elements like shear plate, end plate, clip angle, splice plate, etc.
- ❖ OVS holes are preferred in post-installed anchors and brace gusset plate connections.
- ❖ Long short holes are preferred for embed to steel connection.
- ❖ For Slip critical connection STD or OVS hole is preferred.
- ❖ The distance between centers of standard, oversized, or slotted holes shall not be less than 22/3times the nominal diameter, d, of the fastener; 3d is preferred.
- ❖ Threaded studs, shot with AWP Automated Welding Procedure), require additional attention to the weld collar, which causes the holeof the connected material to the threaded stud to be oversized to accommodate the weld collar. Note: Reduced-based studs do not eliminate the oversize Requirements.

All hole requirements are confirmed with the customer, before starting the model work.

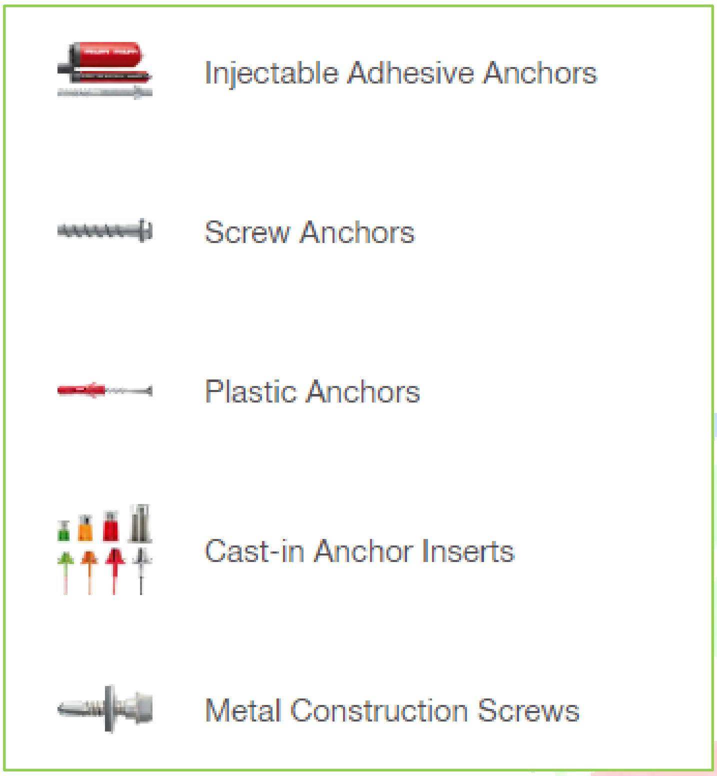
TABLE J3.5
Values of Edge Distance Increment C_2, in.

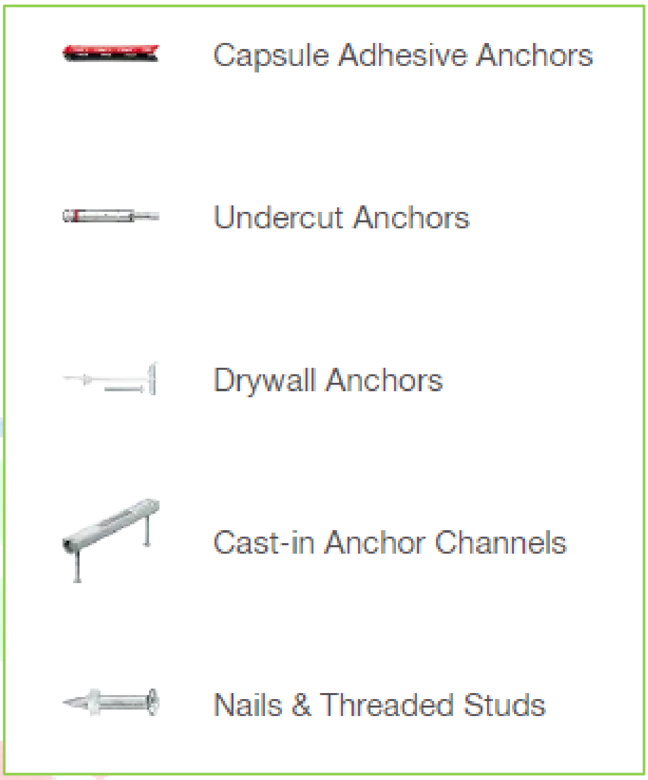
Nominal Diameter of Fastener, in.	Oversized Holes	Slotted Holes		
		Long Axis Perpendicular to Edge		Long Axis Parallel to Edge
		Short Slots	Long Slots[a]	
≤ 7/8	1/16	1/8	3/4d	0
1	1/8	1/8		
≥ 1 1/8	1/8	3/16		

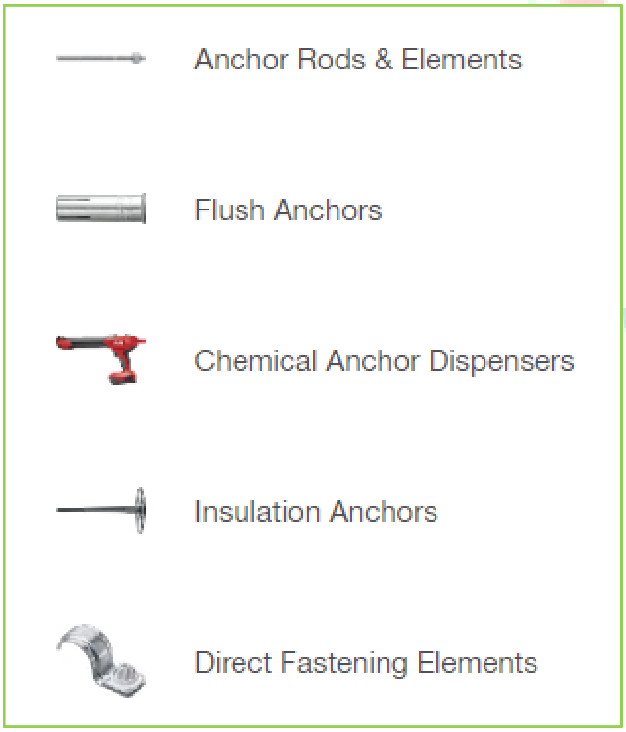
[a] When length of slot is less than maximum allowable (see Table J3.3), C_2 is permitted to be reduced by one-half the difference between the maximum and actual slot lengths.

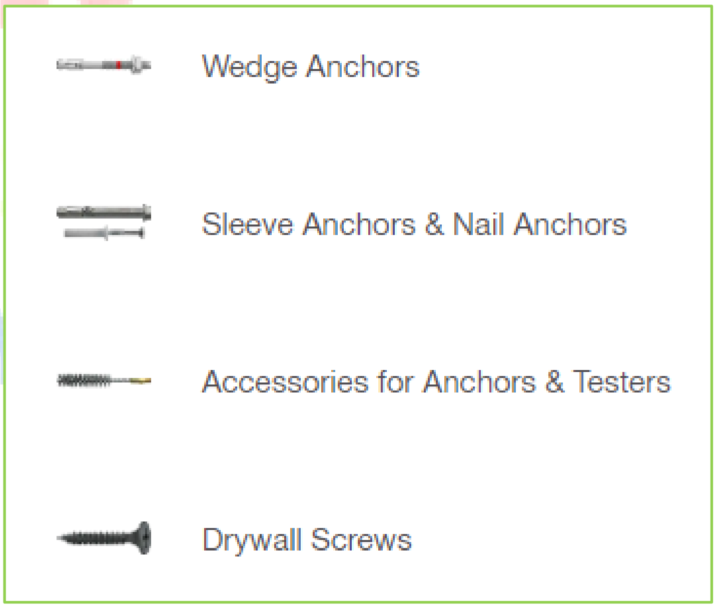
12. Post installed anchors: -

Post-installed anchors like screw anchors, Wedge anchors, Sleeve anchors) require the hole diameter to be OVS hole as per AISC table J 3.3 confirm with the customer.









Click here the title – get information

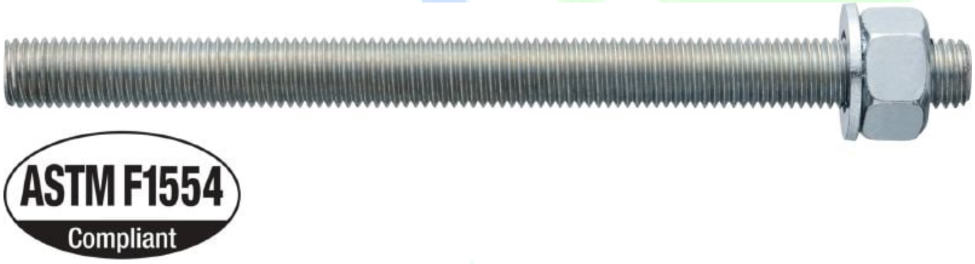
List of Anchor rods & Elements.

Carbon and stainless-steel fasteners for use with chemical adhesives in concrete and masonry and other base materials

1. HIT-Z Anchor rod - Anchor Rods & Elements - Hilti USA

2HIT-Z-R 316 SS Anchor rod - Anchor Rods & Elements - Hilti USA

3.HAS-V-36 Anchor rod - Anchor Rods & Elements - Hilti USA



4. HAS-V-36 HDG Anchor rod - Anchor Rods & Elements - Hilti USA

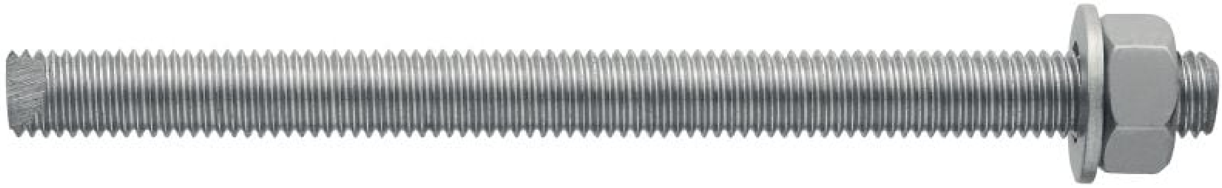
5.HAS-E-55 Anchor rod - Anchor Rods & Elements - Hilti USA

6. HAS-B-105 Anchor rod - Anchor Rods & Elements - Hilti USA

7. HAS-B-105 HDG Anchor rod - Anchor Rods & Elements - Hilti USA

8. HAS-R 304 SS Anchor rod - Anchor Rods & Elements - Hilti USA

9. HAS-R 316 SS Anchor rod - Anchor Rods & Elements - Hilti USA



10. HIS-N Internally threaded sleeve - Anchor Rods & Elements - Hilti USA

11. HIS-RN 316 SS Internally threaded sleeve - Anchor Rods & Elements - Hilti USA

12. AM Threaded rod - Grade 8.8 HDG - Anchor Rods & Elements - Hilti USA

13. HAS-V-36 Anchor rod 22.5 degrees pre-bent) - Anchor Rods & Elements - Hilti USA

List of Wedge Anchors.

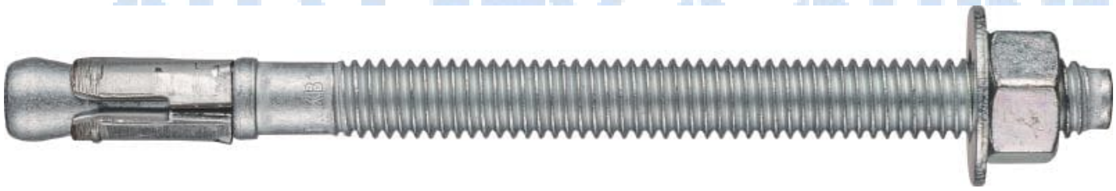
Expansion anchors in carbon steel and stainless steel, approved for cracked concrete, non-cracked concrete, and seismic – including stud anchors and sleeved anchors

1. Kwik Bolt TZ2 CS Wedge anchor - Wedge Anchors - Hilti USA

2. Kwik Bolt TZ2 SS304 Wedge anchor - Wedge Anchors - Hilti USA

3. Kwik Bolt TZ2 SS316 Wedge anchor - Wedge Anchors - Hilti USA

4. Kwik Bolt 1 carbon steel wedge anchor - Wedge Anchors - Hilti USA

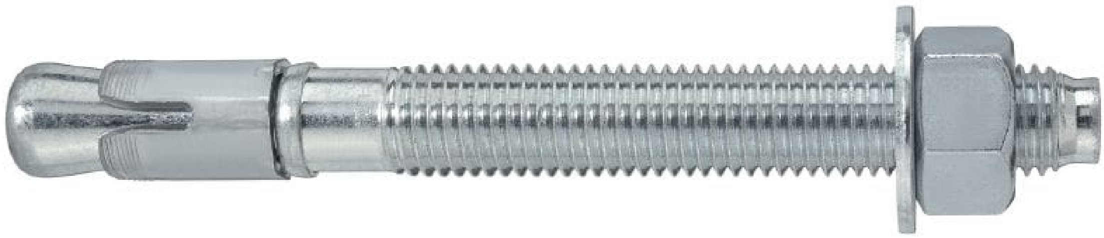


5. Kwik Bolt TZ Wedge anchor - Wedge Anchors - Hilti USA

6. Kwik Bolt TZ SS304 Wedge anchor - Wedge Anchors - Hilti USA

7. Kwik Bolt TZ SS 316 Wedge anchor - Wedge Anchors - Hilti USA

8. Kwik Bolt 3 Wedge anchor - Wedge Anchors - Hilti USA



9. Kwik Bolt 3 SS304 Wedge anchor - Wedge Anchors - Hilti USA

10. Kwik Bolt 3 SS316 Wedge anchor - Wedge Anchors - Hilti USA

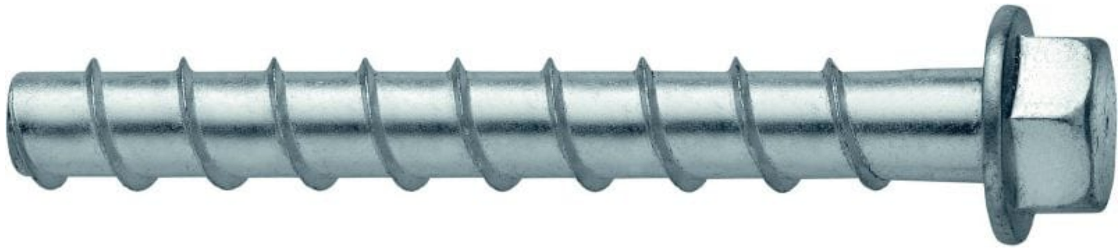
11. Kwik Bolt 3 HDG Wedge anchor - Wedge Anchors - Hilti USA

12. Kwik Bolt 3 Wedge anchor - Wedge Anchors - Hilti USA

13. Kwik Bolt 3 SS304 Wedge anchor - Wedge Anchors - Hilti USA

List of screw Anchors.

Concrete screw anchors for permanent and temporary applications – including screw anchors which can be used in solid brick and hollow-core slabs



Click here - Screw Anchors - Hilti USA

List of Injectable adhesive anchors

A wide range of chemical anchor fasteners - our injectable mortars are also designed for rebar applications and can be used on concrete and masonry

Click here - Injectable Adhesive Anchors - Hilti USA

List of Capsule adhesive anchors

Capsule adhesive anchors, covered by international approvals for applications in concrete - for sequential applications with fixed embedment depth

Click here - Capsule Adhesive Anchors - Hilti USA

13. Weld standards

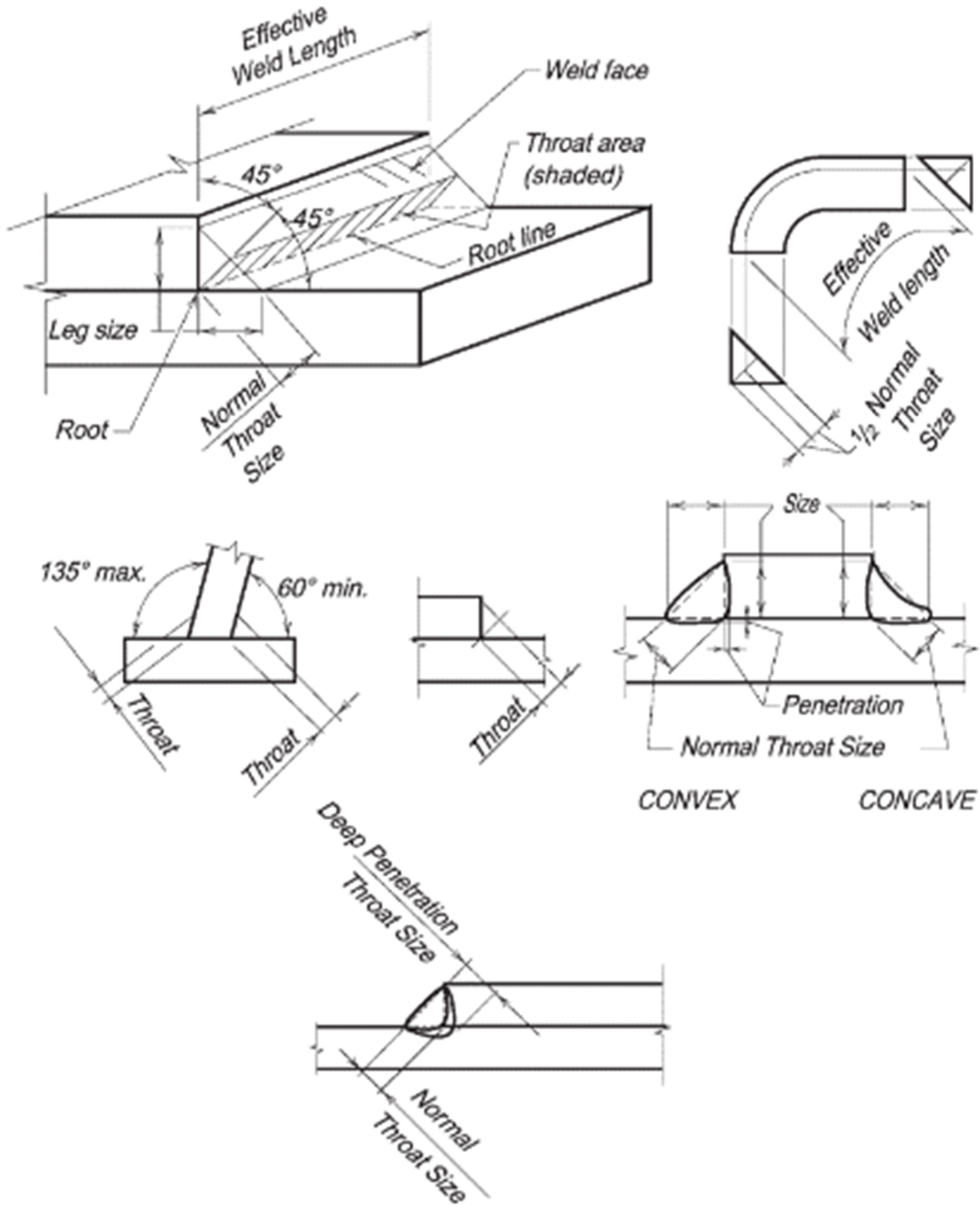


Fig. 8-21. Fillet weld nomenclature.

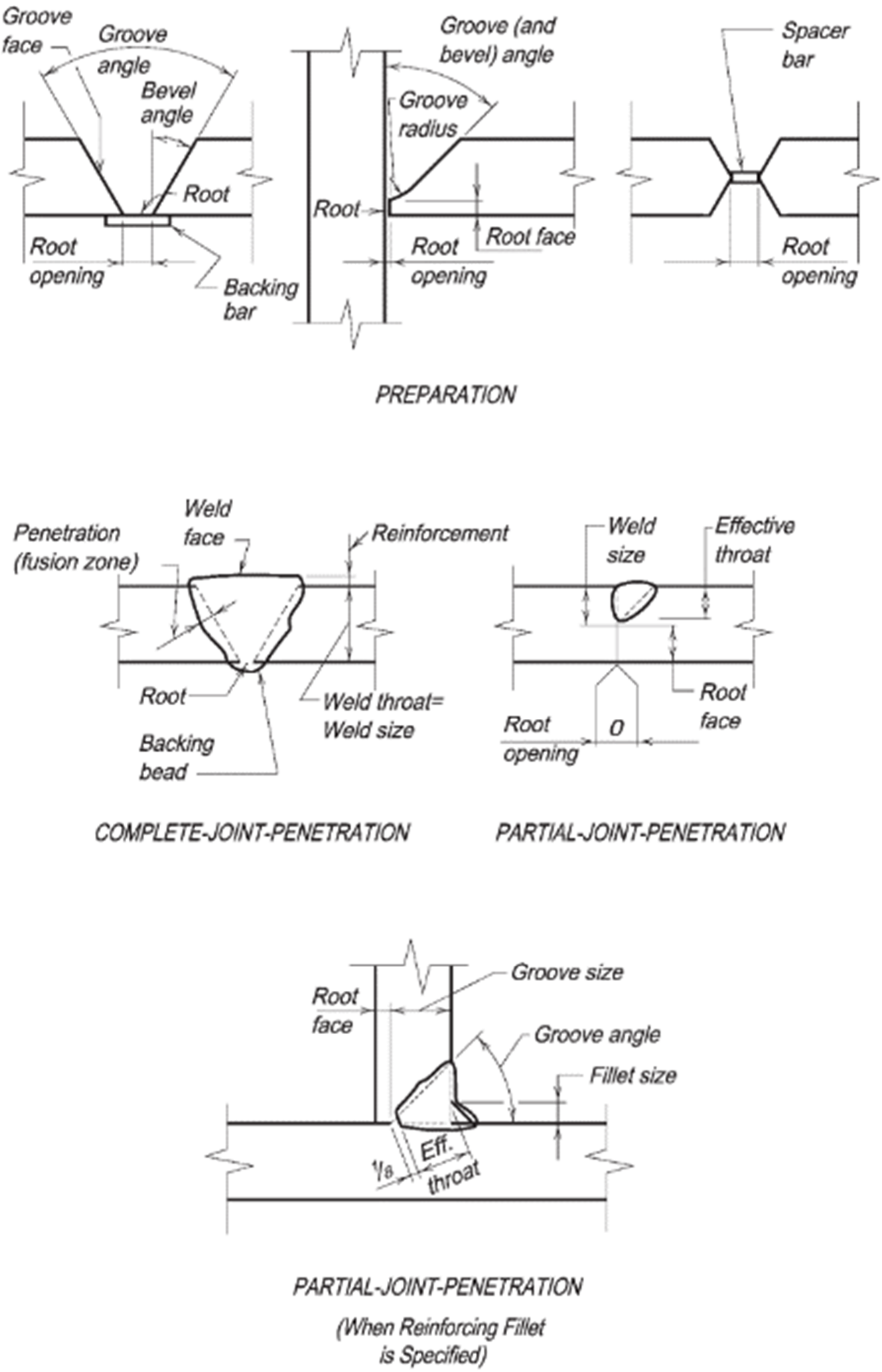
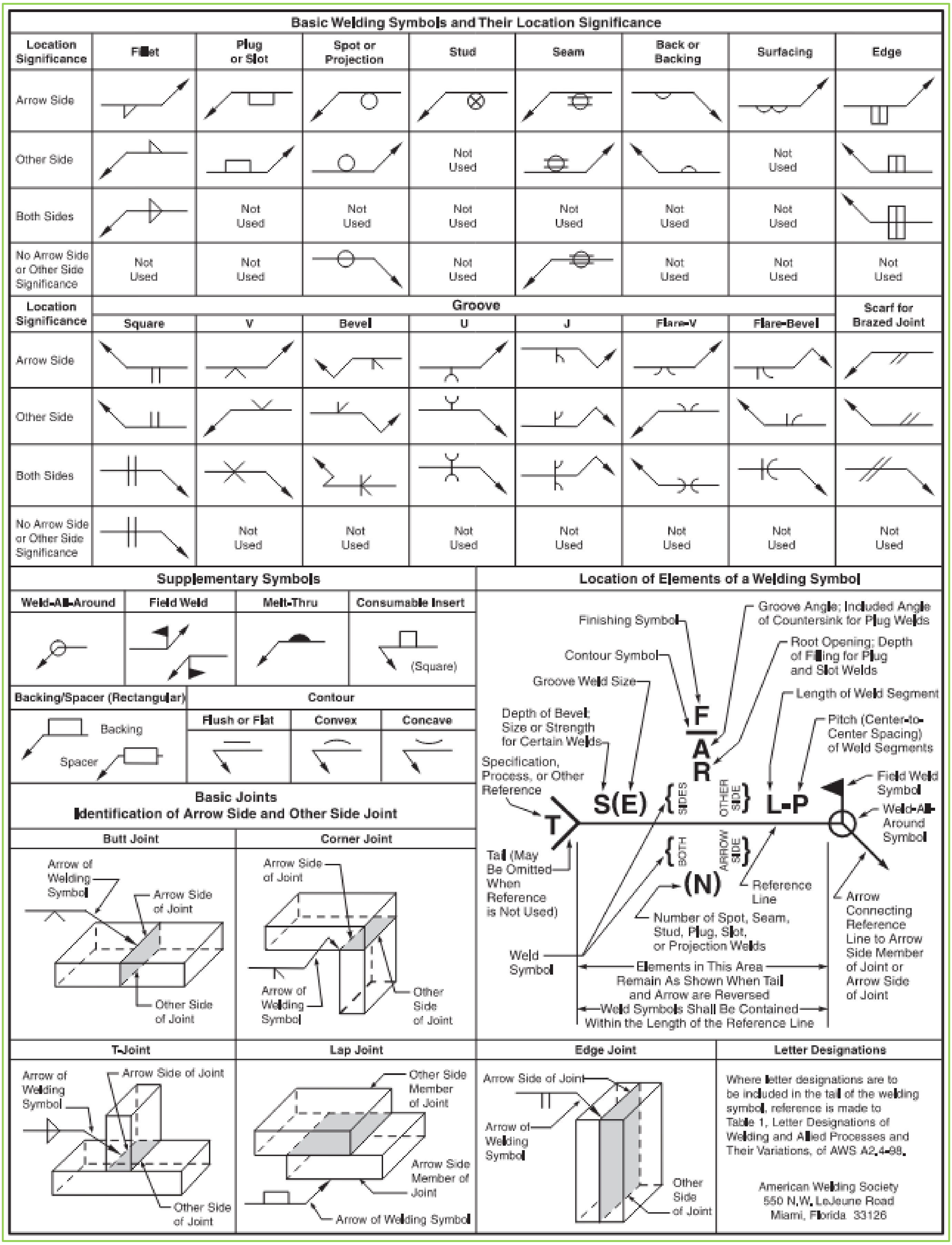
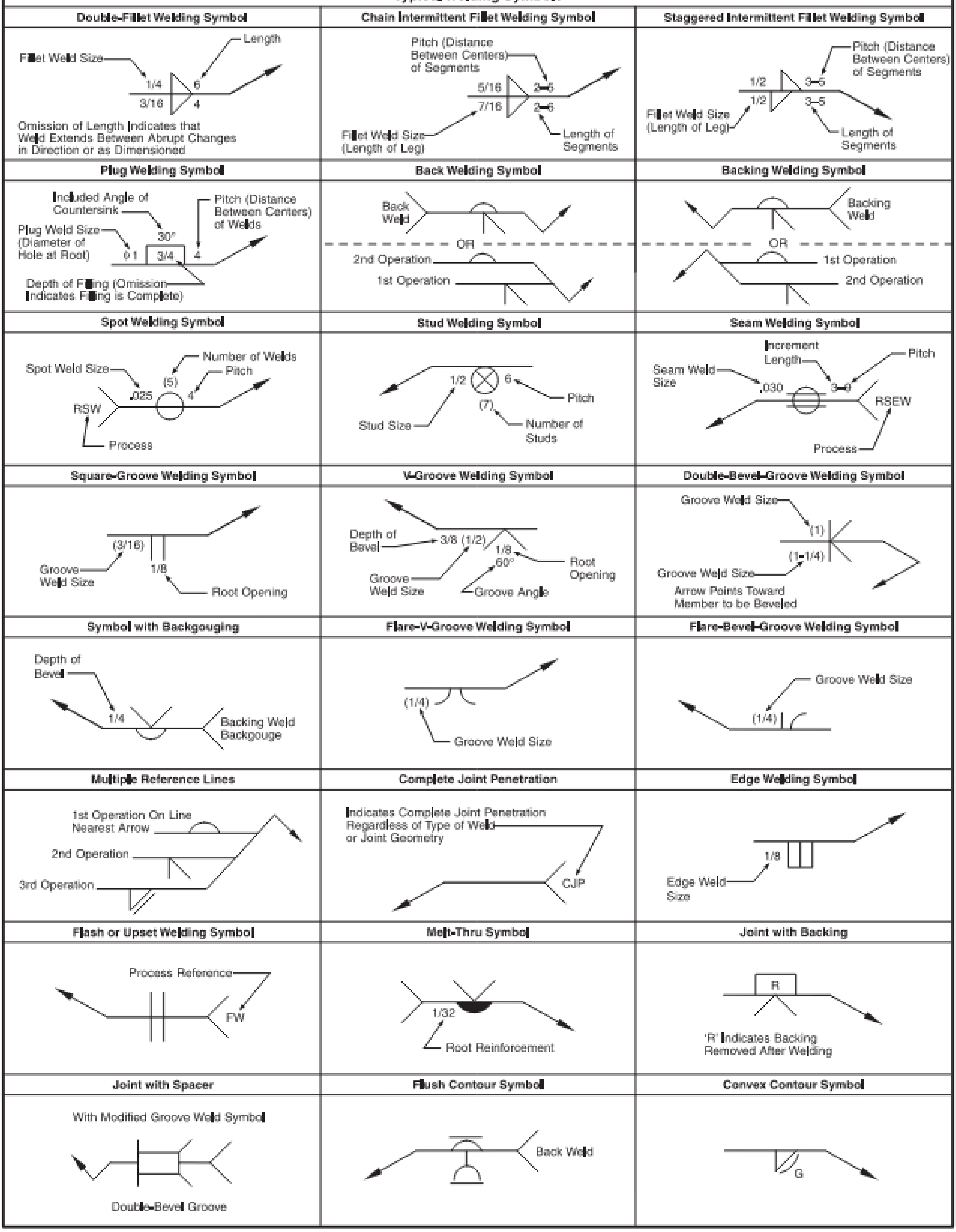


Fig. 8-22. Groove weld nomenclature.

Weld symbols



Typical Welding Symbols

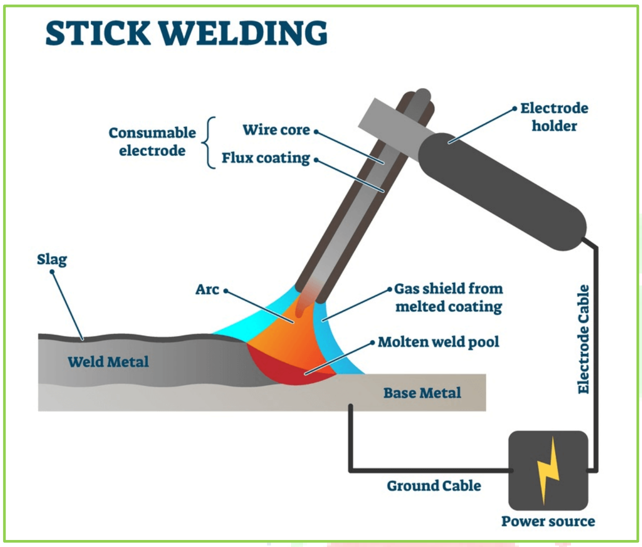


Types of welding methods: -

1. SMAW Welding

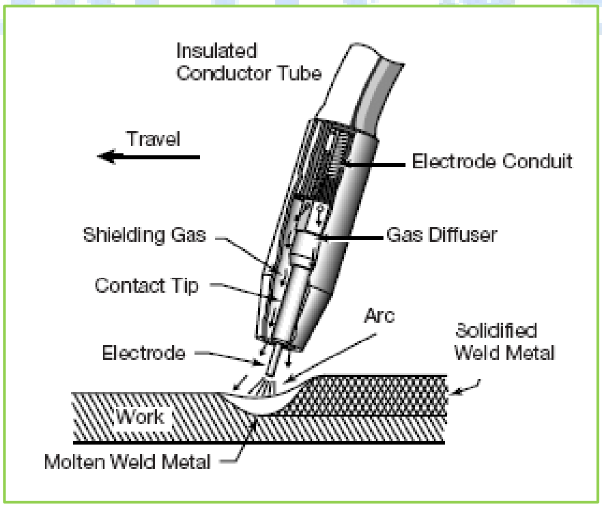
Shielded Metal Arc Welding SMAW) is also known as manual, stick, or hand welding. An electric arc is produced between the end of a coated metal electrode and the steel components to be welded. The electrode is a filler metal covered with a coating. The electrode's coating has two purposes:

- Itformsagasshieldtopreventimpuritiesintheatmospherefromgettingintotheweld.
- It contains a flux that purifies the molten metal.



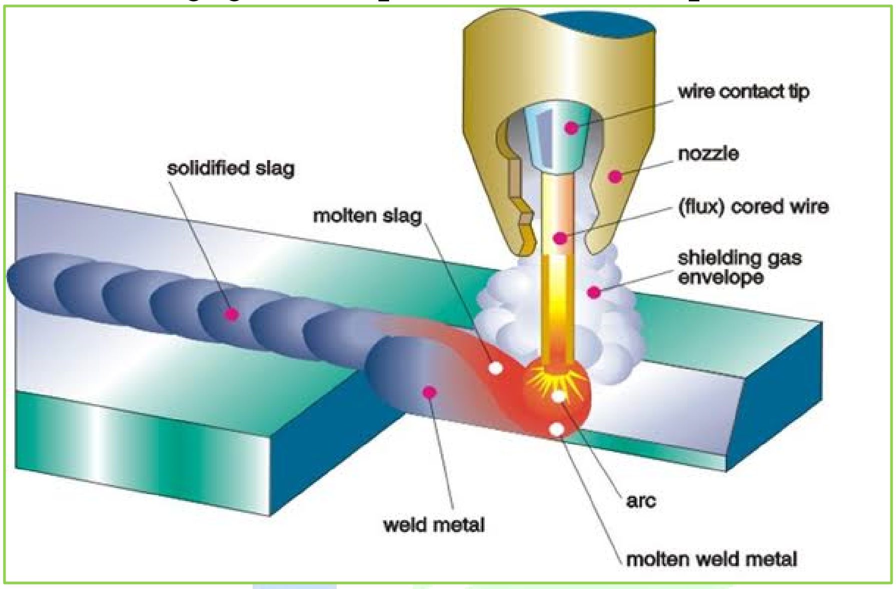
2. GMAW Welding

Gas Metal Arc Welding (GMAW) is also known as MIG welding. It is fast and economical. A continuous wire is fed in to the welding gun. The wire melts and combines with the base metal to form the weld. The molten metal is protected from the atmosphere by a gas shield which is fed through a conduit to the tip of the welding gun. This process may be automated.



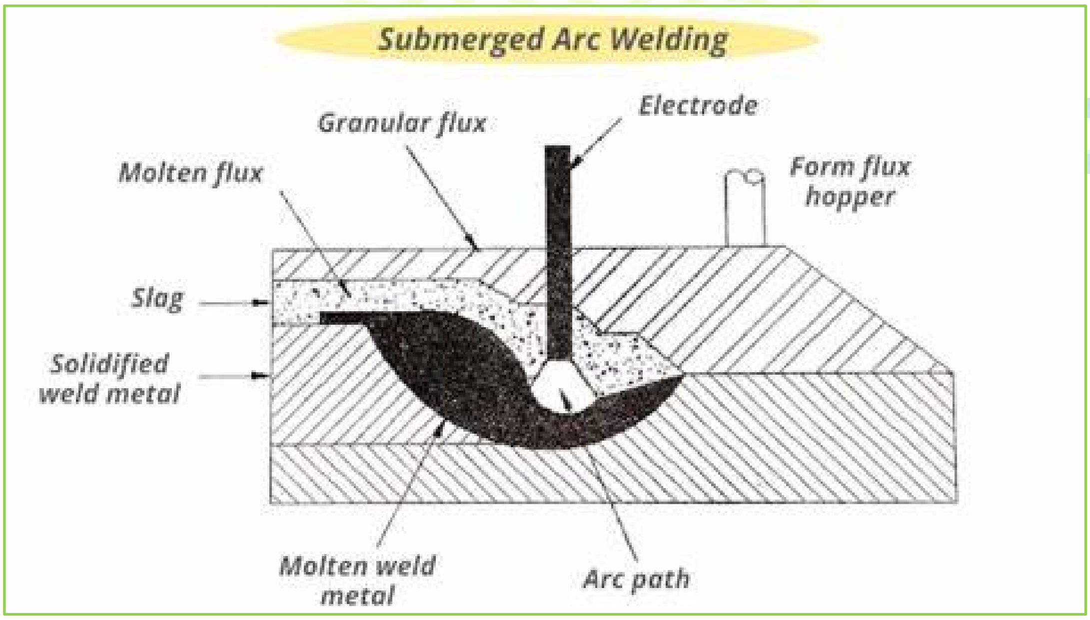
3. FCAW Welding

Flux Cored Arc Welding (FCAW) is like the GMAW process. The difference is that the filler wire has a central core that contains flux. With this process, it is possible to weld with or without shielding gas. This makes it useful for exposed conditions where a shielding gas may be affected by the wind.



4. SAW Welding

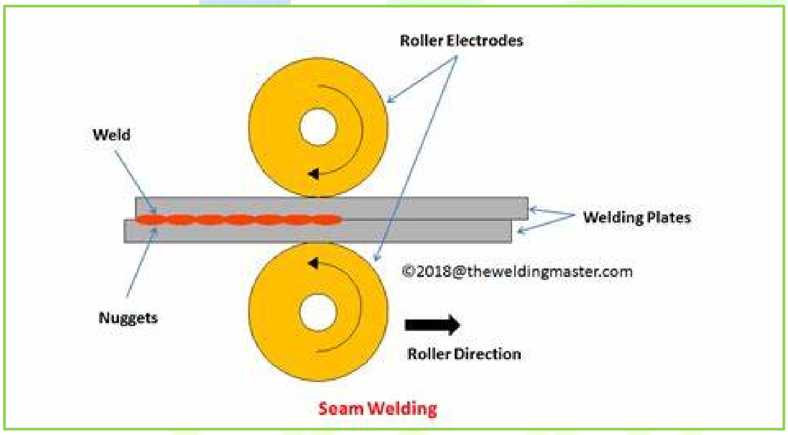
Submerged Arc Welding SAW) is only performed by automatic or semiautomatic methods. Uses a continuously fed filler metal electrode. The weld pool is protected from the surrounding atmosphere by a blanket of granular Flux fed at the welding gun. Results in a deeper weld penetration than the other process. Only flat or horizontal positions may be used.



Seam Weld: -

Rolled HSS with Weld Seams. Square and rectangular hollow structural sections commonly abbreviated as HSS) are crafted the same way as pipe and tube. The manufacturing process starts with a flat steel plate that is slowly formed into a round or rectangular shape. Once the piece is formed the two edges are ready to be welded.

Before bending or rolling the HSS, they must decide on where to locate the weld seam of the steel member. The bender roller companies have the option to put the weld seam on the inside radius of the bend, the outside radius of the bend, or on the centerline radius of the bend. These decisions become more difficult on square and rectangular sections if the seam is not centered on any of the sides. Different mills produce members with welds in different places and some mills forego this step entirely by producing more expensive seamless pipes.



Seal weld: -

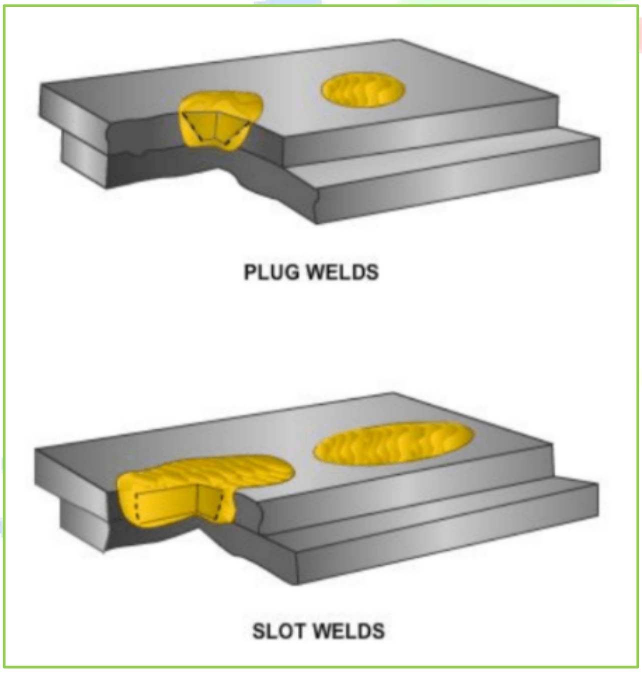
AWS A3.0, Standard Welding Terms, and Definitions define a seal weld as: "Any weld designed primarily to provide a specific degree of tightness against leakage." The purpose of a seal weld may be to contain a fluid – either gaseous or liquid. For. E.g.: Galvanized members)

Tack weld: -

A temporary weld is used to hold parts in place while more extensive, final welds are made.

Plug or slot weld: -

Plug and slot welds are made through holes or slots in one member of a lap joint.



Minimum fillet weld size: -

TABLE J2.4
Minimum Size of Fillet Welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld, [a] in. (mm)
To 1/4 (6) inclusive	1/8 (3)
Over 1/4 (6) to 1/2 (13)	3/16 (5)
Over 1/2 (13) to 3/4 (19)	1/4 (6)
Over 3/4 (19)	5/16 (8)

[a] Leg dimension of fillet welds. Single pass welds must be used.
Note: See Section J2.2b for maximum size of fillet welds.

Difference between Stitch weld and staggered weld: -

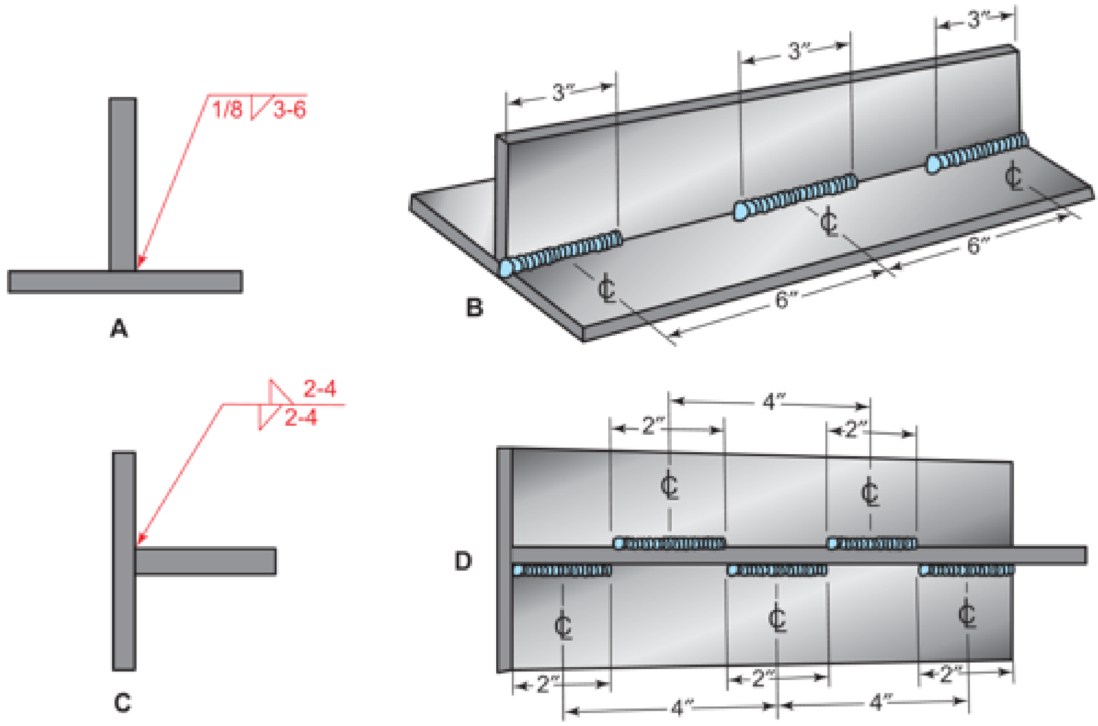


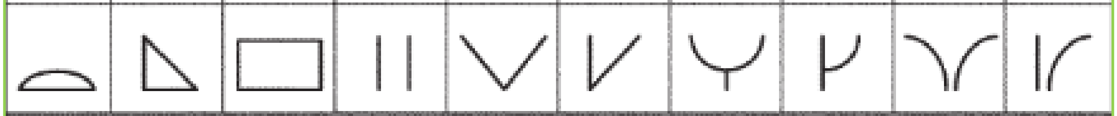
Figure 3-32. Length and pitch dimensions of weld. A—Note the placement of length (3) and pitch (6) specifications on the welding symbol. B—This image shows a series of 3″ long welds that are 6″ apart from center-to-center of the welds. C and D—Staggered weld. Notice staggered fillet symbols in C.

Pre-Qualified welds.

Table 8-2 (continued)
Prequalified Welded Joints

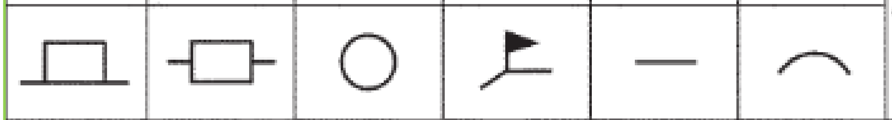
Basic Weld Symbols

Back	Fillet	Plug or Slot	Groove or Butt						
			Square	V	Bevel	U	J	Flare V	Flare Bevel

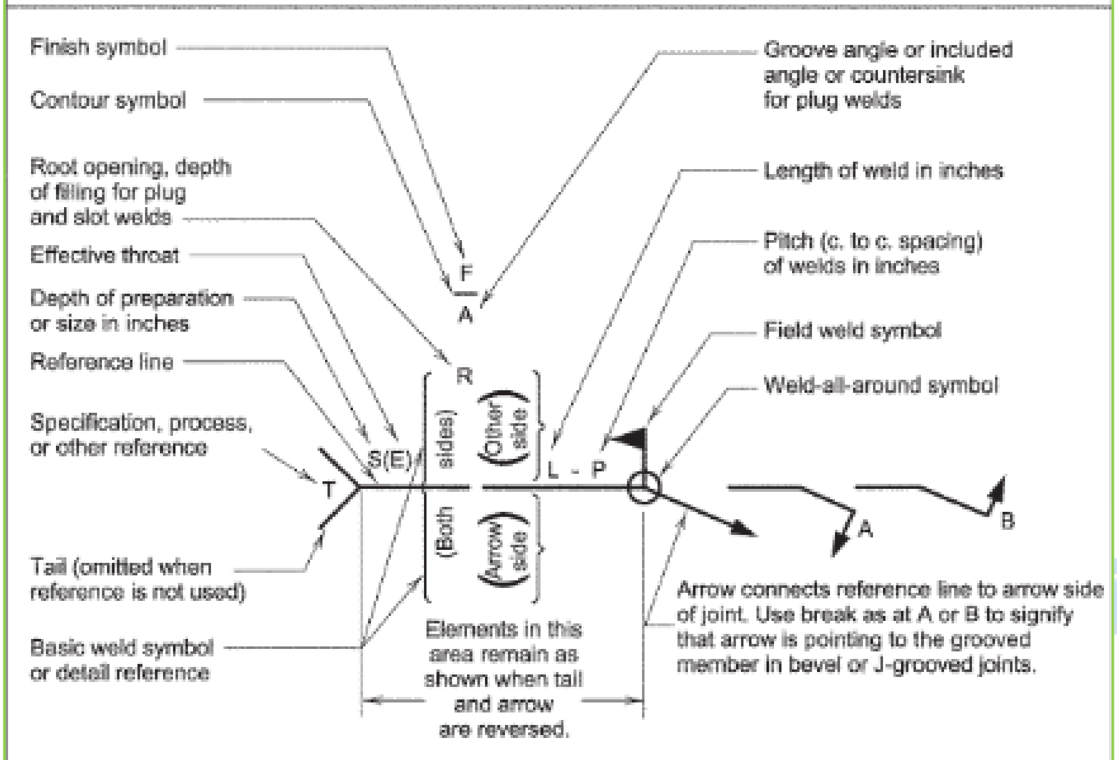


Supplementary Weld Symbols

Backing	Spacer	Weld All Around	Field Weld	Contour		For other basic and supplementary weld symbols, see AWS A2.4
				Flush	Convex	



Standard Location of Elements of a Welding Symbol



Note:
Size, weld symbol, length of weld, and spacing must read in that order, from left to right, along the reference line. Neither orientation of reference nor location of the arrow alters this rule.

The perpendicular leg of , , , , weld symbols must be at left.

Dimensions of fillet welds must be shown on both the arrow side and the other side.

Symbols apply between abrupt changes in direction of welding unless governed by the "all around" symbol or otherwise dimensioned.

These symbols do not explicitly provide for the case that frequently occurs in structural work, where duplicate material (such as stiffeners) occurs on the far side of a web or gusset plate. The fabricating industry has adopted this convention: that when the billing of the detail material discloses the existence of a member on the far side as well as on the near side, the welding shown for the near side shall be duplicated on the far side.

Refer to AISC table 8-2 pre-qualified welds for CJP & PJP.

Table 8-2
Prequalified Welded Joints

Symbols for Joint Types

B	butt joint	BC	butt or corner joint
C	corner joint	TC	T- or corner joint
T	T-joint	BTC	butt, T- or corner joint

Symbols for Base Metal Thickness and Penetration

L	limited thickness, complete-joint-penetration
U	unlimited thickness, complete-joint-penetration
P	partial-joint-penetration

Symbols for Weld Types

1	square-groove	6	single-U-groove
2	single-V-groove	7	double-U-groove
3	double-V-groove	8	single-J-groove
4	single-bevel-groove	9	double-J-groove
5	double-bevel-groove	10	flare-bevel-groove

Symbols for Welding Processes if not Shielded Metal Arc Welding (SMAW):

S	submerged arc welding (SAW)
G	gas metal arc welding (GMAW)
F	flux cored arc welding (FCAW)

Symbols for Welding Positions

F	flat
H	horizontal
V	vertical
OH	overhead

Symbols for Joint Designation

The lower case letters (e.g., a, b, c, d, etc.) are used to differentiate between joints that would otherwise have the same joint designation.

Symbols for Dimensions

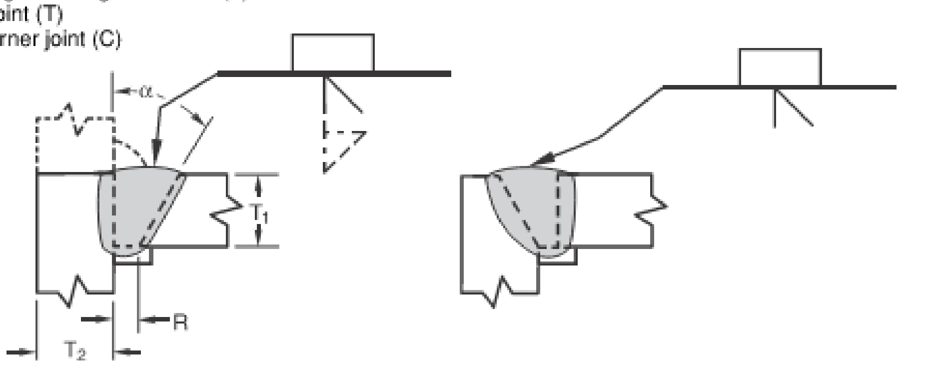
R	Root opening
α, β	Groove angles
f	Root face
r	J- or U-groove radius
S, S_1, S_2	PJP groove weld depth of groove
E, E_1, E_2	PJP groove weld sizes corresponding to S, S_1, S_2, respectively

Notes to Prequalified Welded Joints

1	Not prequalified for gas metal arc welding (GMAW) using short circuiting transfer nor GTAW. Refer to AWS D1.1 Annex A.
2	Joint is welded from one side only.
3	Cyclic load application limits these joints to the horizontal welding position. Refer to AWS D1.1 Section 2.18.2.
4	Backgouge root to sound metal before welding second side.
5	SMAW joints may be used for prequalified GMAW (except GMAW-S) and FCAW.
6	Minimum effective throat thickness (E) as shown in AISC *Specification* Table J2.3; S as specified on drawings.
7	If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to $^1/_4\,T_1$, but need not exceed $^3/_8$ in. Groove welds in corner and T-joints of cyclically loaded structures shall be reinforced with fillet welds equal to $^1/_4\,T_1$, but need not exceed $^3/_8$ in.
8	Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.
9	Double-groove welds may have grooves of unequal depth, provided these conform to the limitations of Note 6. Also, the effective throat thickness (E) applies individually to each groove.
10	The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints.
11	For corner joints, the ouside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.
12	Effective throat thickness (E) is based on joints welded flush.

See Notes on Page 65

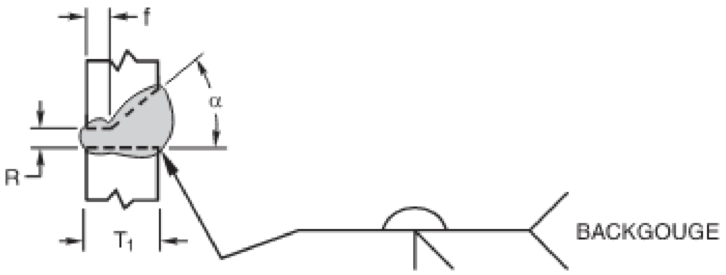
Single-bevel-groove weld (4)
T-joint (T)
Corner joint (C)



Tolerances	
As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)
R = +1/16, −0	+1/4, −1/16
α = +10°, −0°	+10°, −5°

Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation		Allowed Welding Positions	Gas Shielding for FCAW	Notes
		T_1	T_2	Root Opening	Groove Angle			
SMAW	TC-U4a	U	U	R = 1/4	α = 45°	All	—	e, g, k, o
				R = 3/8	α = 30°	F, V, OH	—	e, g, k, o
GMAW FCAW	TC-U4a-GF	U	U	R = 3/16	α = 30°	All	Required	a, g, k, o
				R = 3/8	α = 30°	F	Not req.	a, g, k, o
				R = 1/4	α = 45°	All	Not req.	a, g, k, o
SAW	TC-U4a-S	U	U	R = 3/8 R = 1/4	α = 30° α = 45°	F	—	g, k, o

Single-bevel-groove weld (4)
Butt joint (B)



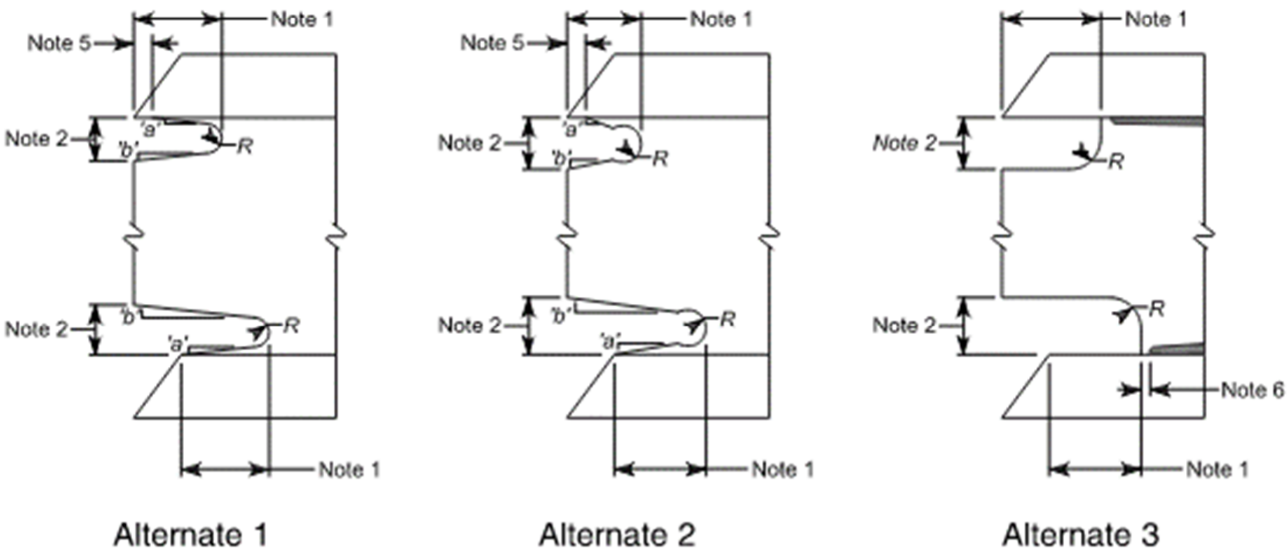
Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation			Allowed Welding Positions	Gas Shielding for FCAW	Notes
				Root Opening Root Face Groove Angle	Tolerances				
		T_1	T_2		As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)			
SMAW	B-U4b	U	—	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16, −0 +1/16, −0 +10°, −0°	+1/16, −1/8 Not limited 10°, −5°	All	—	c, d, e, j
GMAW FCAW	B-U4b-GF	U	—				All	Not required	a, c, d, j
SAW	B-U4b-S	U	—	R = 0 f = 1/4 max. α = 60°	±0 +0, −1/8 +10°, −0°	+1/4, −0 ±1/16 10°, −5°	F	—	c, d, j

Weld Access hole or Rat hole or Seismic preparation: -

6. Weld Access Holes

Weld access holes are frequently required in the fabrication of structural components. The geometry of these structural details can affect the components' performance. The size and shape of beam copes and weld access holes can have a significant effect on the ease of depositing sound weld metal, the ability to conduct nondestructive examinations, and the magnitude of the stresses at the geometric discontinuities produced by these details.

Weld access holes used to facilitate welding operations are required to have a minimum length from the toe of the weld preparation (see Figure C-J1.2) equal to 1.5 times the thickness of the material in which the hole is made. This minimum length



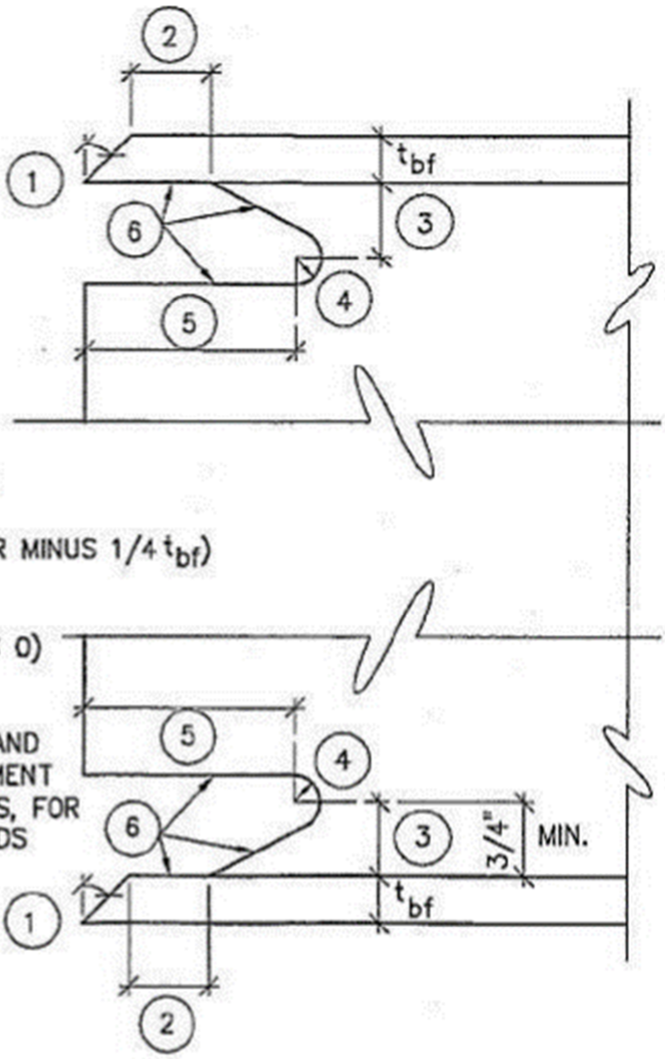
Rolled shapes and built-up shapes assembled prior to cutting the weld access hole.

Built-up shapes assembled after cutting the weld access hole.

Notes: These are typical details for joints welded from one side against steel backing. Alternative details are discussed in the commentary text.

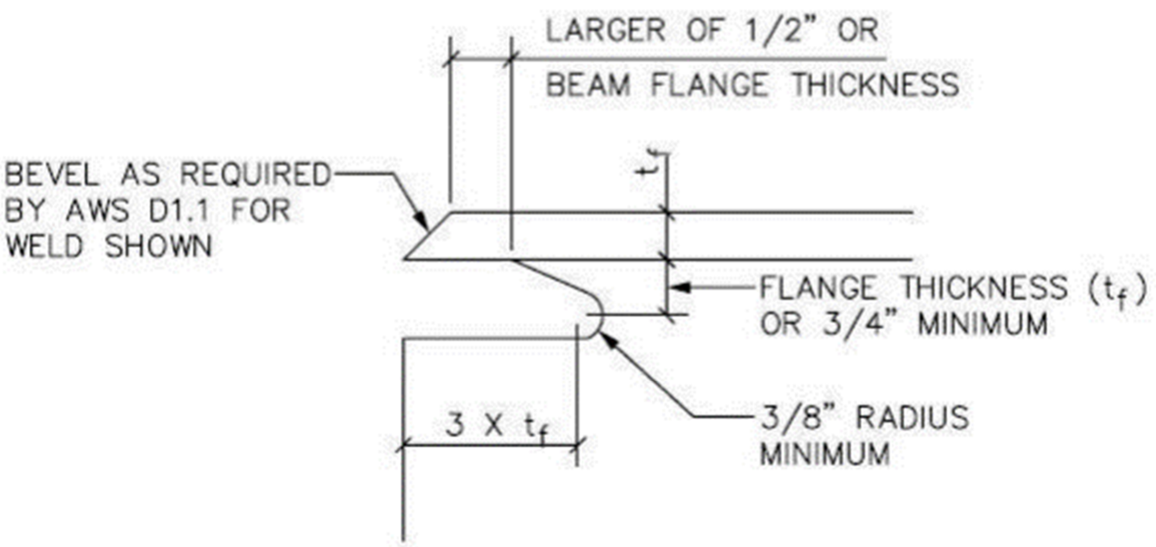
1) Length: Greater of $1.5t_w$ or $1^1/_2$ in. (38 mm)
2) Height: Greater of $1.0t_w$ or $^3/_4$ in. (19 mm) but need not exceed 2 in. (50 mm)
3) *R*: 3/8 in. min. (10 mm). Grind the thermally cut surfaces of weld access holes in heavy shapes as defined in Sections A3.1(c) and (d).
4) Slope *'a'* forms a transition from the web to the flange. Slope *'b'* may be horizontal.
5) The bottom of the top flange is to be contoured to permit the tight fit of backing bars where they are to be used.
6) The web-to-flange weld of built-up members is to be held back a distance of at least the weld size from the edge of the access hole.

TOLERANCES SHALL NOT ACCUMULATE TO THE EXTENT THAT THE ANGLE OF THE ACCESS HOLE CUT TO THE FLANGE SURFACE EXCEEDS 25°



NOTES:

1. BEVEL AS REQUIRED BY AWS D1.1 FOR SELECTED GROOVE WELD PROCEDURE.
2. LARGER OF t_{bf} OR 1/2 INCH. (PLUS 1/2 t_{bf}, OR MINUS 1/4 t_{bf})
3. 3/4 t_{bf} TO t_{bf}, 3/4" MIN. (1/4 INCH)
4. 3/8" MIN. RADIUS (PLUS NOT LIMITED, OR MINUS 0)
5. 3 t_{bf} (± 1/2 INCH)
6. SEE FEMA-353, RECOMMENDED SPECIFICATIONS AND QUALITY ASSURANCE GUIDELINES FOR STEEL MOMENT FRAME CONSTRUCTION FOR SEISMIC APPLICATIONS, FOR FABRICATION DETAILS INCLUDING CUTTING METHODS AND SMOOTHNESS REQUIREMENTS.



A WELD ACCESS HOLES

Electrode info: -

Table 8-3
Electrode Strength Coefficient, C_1

Electrode	F_{EXX} (ksi)	C_1
E60	60	0.857
E70	70	1.00
E80	80	1.03
E90	90	1.16
E100	100	1.21
E110	110	1.34

Minimum effective throat weld: -

To calculate the effective throat of a fillet weld, the formula is 0.707 x fillet weld size), therefore this ¼" fillet weld requires a 3/16) effective throat.

TABLE J2.2
Effective Weld Throats of Flare Groove Welds

Welding Process	Flare Bevel Groove[a]	Flare V-Groove
GMAW and FCAW-G	5/8 *R*	3/4 *R*
SMAW and FCAW-S	5/16 *R*	5/8 *R*
SAW	5/16 *R*	1/2 *R*

[a] For flare bevel groove with $R < 3/8$ in. (10 mm), use only reinforcing fillet weld on filled flush joint.
General note: R = radius of joint surface (can be assumed to be $2t$ for HSS), in. (mm)

TABLE J2.3
Minimum Effective Throat of Partial-Joint-Penetration Groove Welds

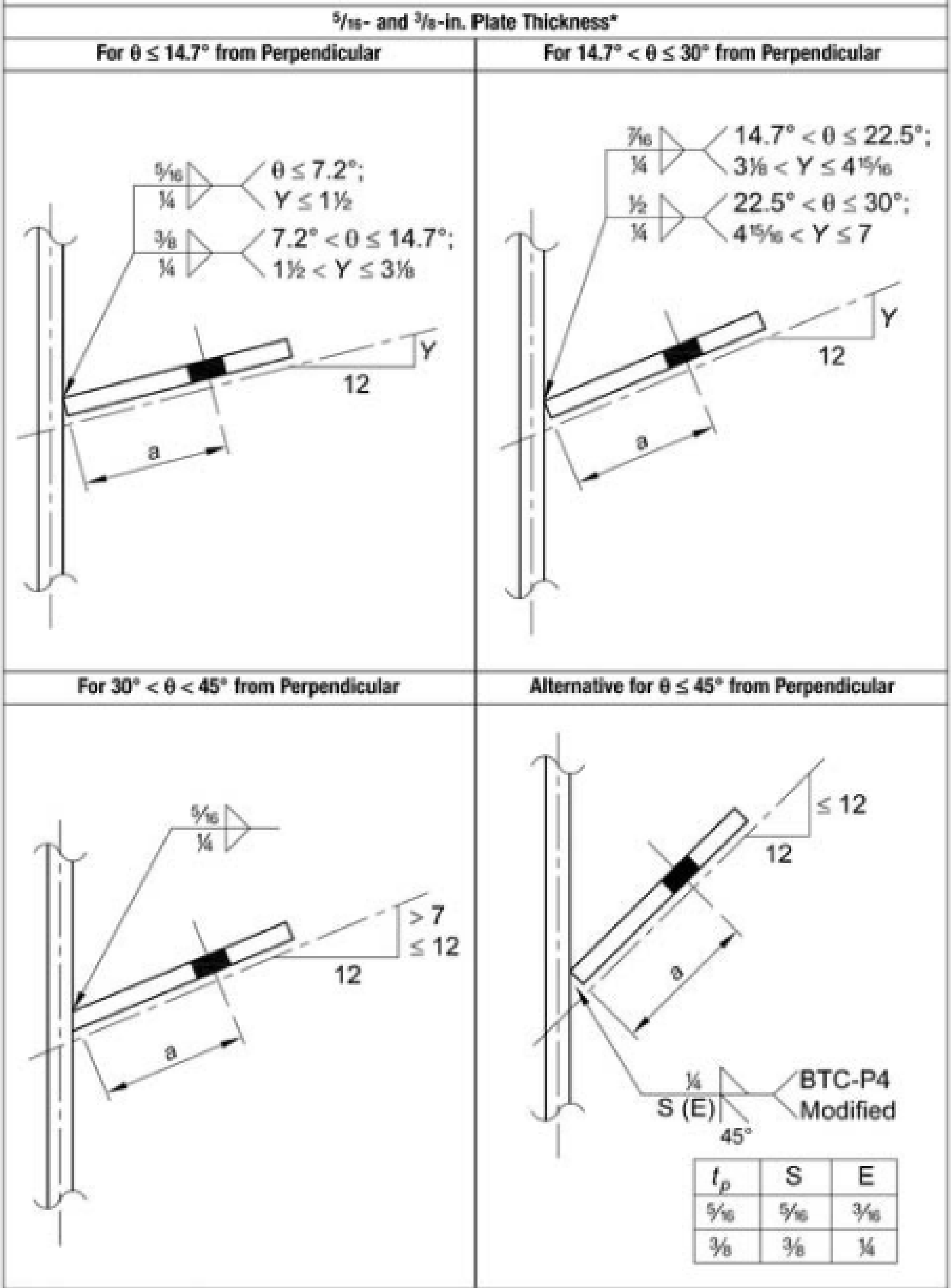
Material Thickness of Thinner Part Joined, in. (mm)	Minimum Effective Throat,[a] in. (mm)
To 1/4 (6) inclusive	1/8 (3)
Over 1/4 (6) to 1/2 (13)	3/16 (5)
Over 1/2 (13) to 3/4 (19)	1/4 (6)
Over 3/4 (19) to 1 1/2 (38)	5/16 (8)
Over 1 1/2 (38) to 2 1/4 (57)	3/8 (10)
Over 2 1/4 (57) to 6 (150)	1/2 (13)
Over 6 (150)	5/8 (16)

[a] See Table J2.1.

Skewed weld detail: -

Table 10-14C

Weld Details for Skewed Single-Plate Connections



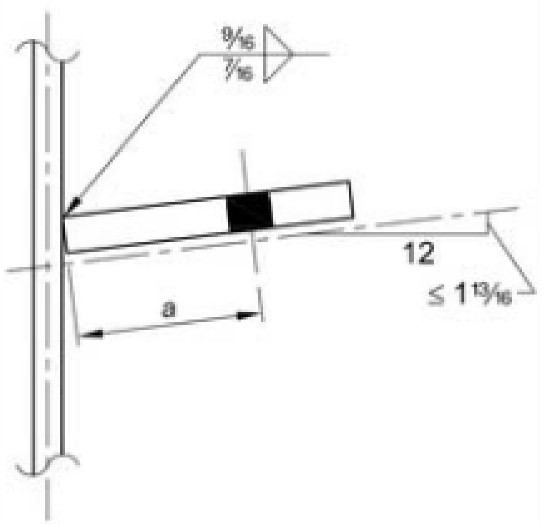
*Satisfies single-plate weld requirements for these thicknesses.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

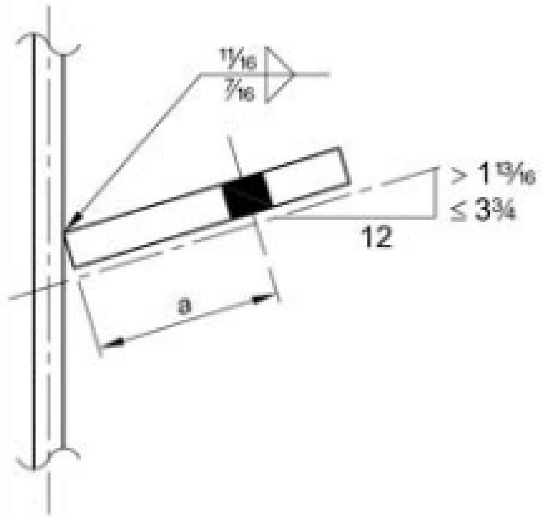
Table 10-14C (continued)
Weld Details for Skewed Single-Plate Connections

5/8-in. Plate Thickness*

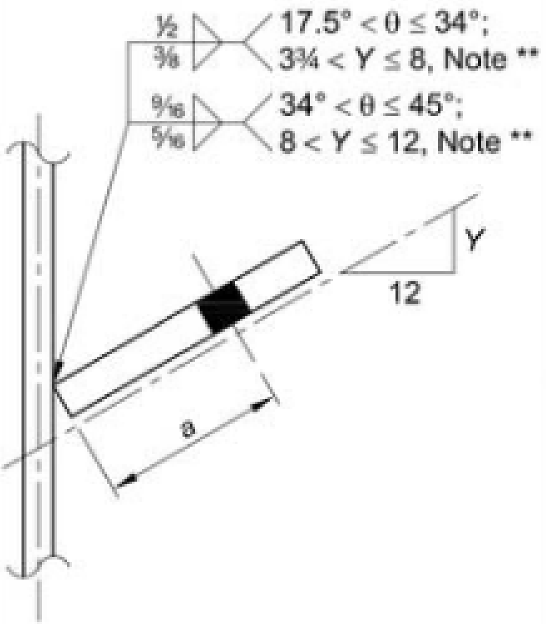
For θ ≤ 8.6° from Perpendicular



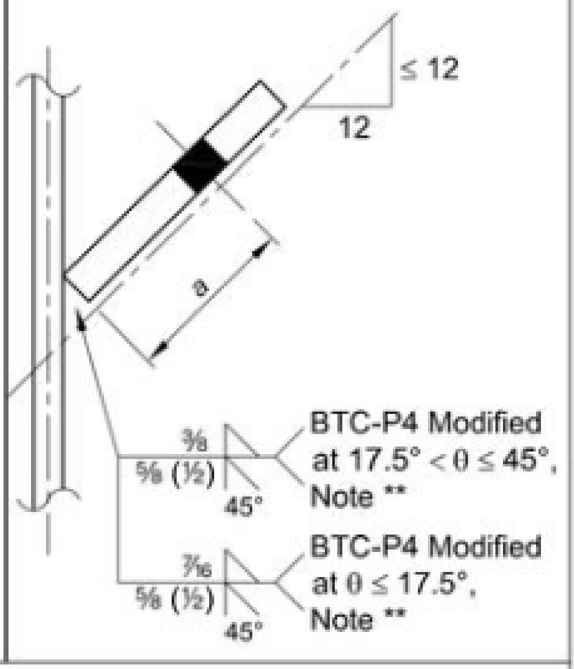
For 8.6° < θ ≤ 17.5° from Perpendicular



For 17.5° < θ ≤ 45° from Perpendicular



Alternative for θ ≤ 45° from Perpendicular



*Satisfies single-plate weld requirements for this thickness.

**Satisfies single-plate weld requirements per AWS dihedral angle "a" reduction factors (AWS D1.1/D1.1M Annex B, Table B.1).

Weld access limit: -

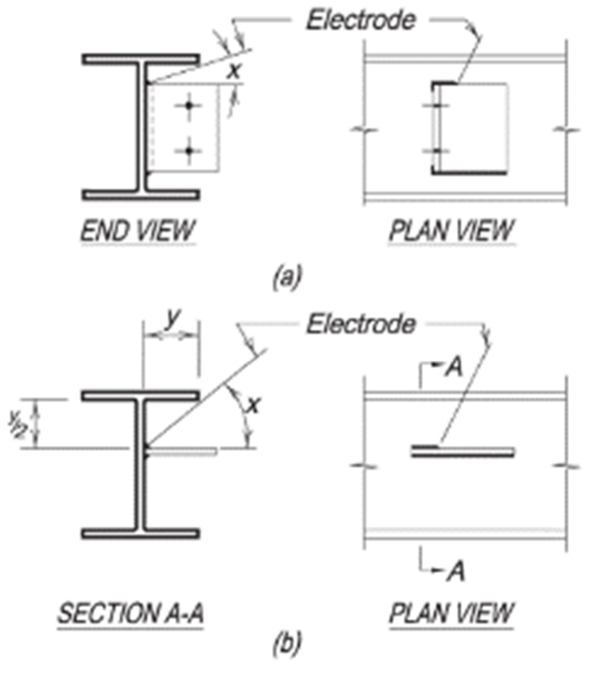
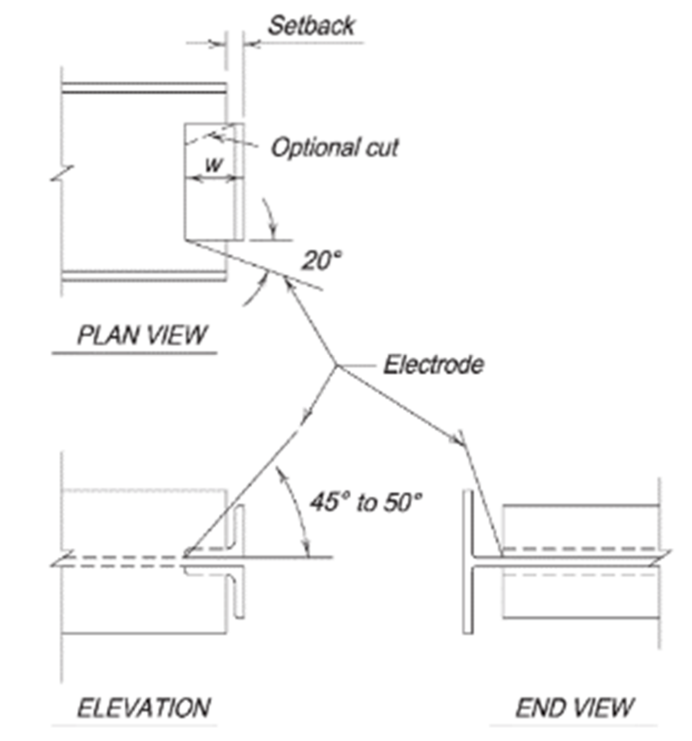


Fig. 8-9. Clearances for SMAW welding.



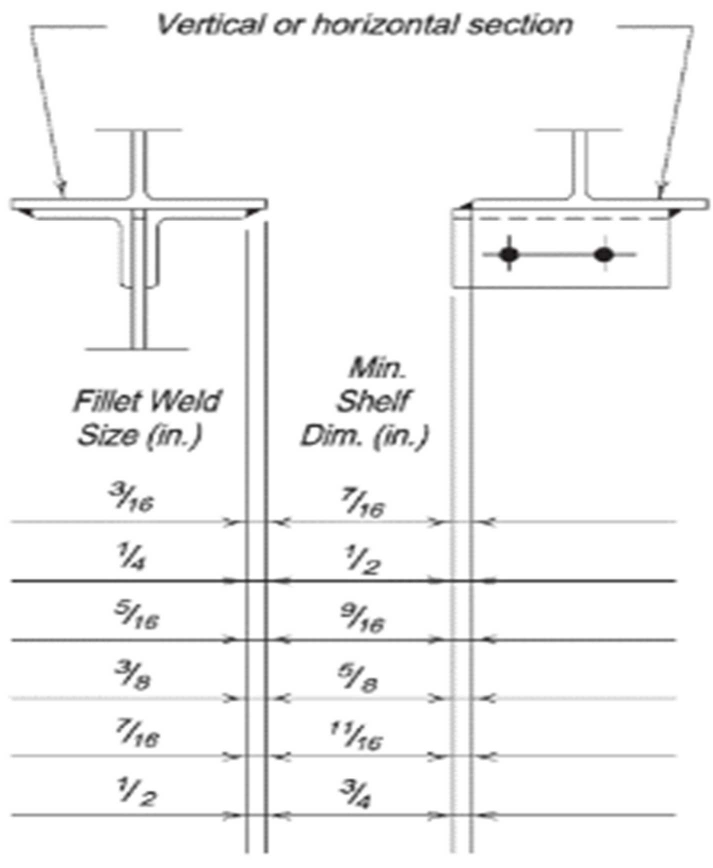


Fig. 8-11. Recommended minimum shelf dimensions for SMAW fillet welds.

Effective throat weld for Flare bevel weld: -

PROCEDURE FOR FLARE BEVEL WELDS:

A. Welds shown on contract drawings should include an effective weld size (E) or be marked for weld to be flush (flush designation usually for architectural purposes). If neither of these conditions exist, then an RFI must be prepared requesting the effective weld size (E).

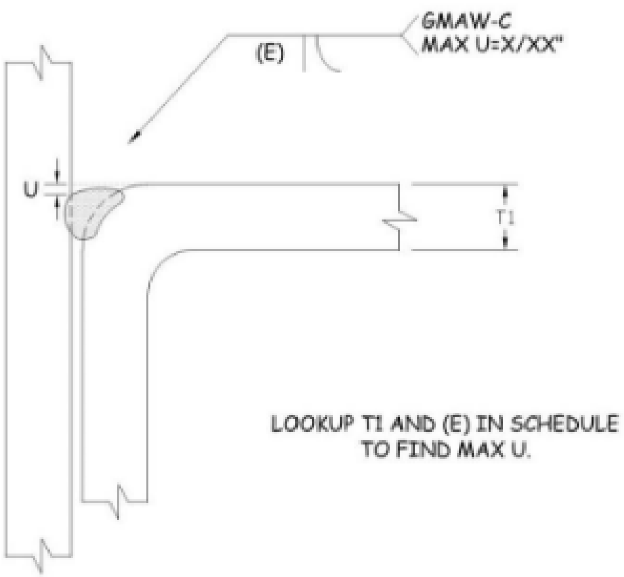
B. Using the HSS wall thickness and the specified effective weld (E), find the permitted weld underfill U in the tables. Detail all Flare Bevel Welds with the effective weld size and the underfill U=X/XX (along with the GMAW-C process indication) in the tail of the weld or flush. See Figures D-1 and D-2.

C. If the underfill size in the table indicates "RFI", an RFI should be produced to verify weld size, stating that the specified effective weld size may not achievable.

Table D-1: Single Flare Bevel Underfill Table by HSS Size and (E)

Single Flare Bevel Permitted Underfill (U) for GMAW (not -S) and FCAW-G by Specified (E) Size (inches)					
HSS Wall Thickness	1/8	3/16	1/4	5/16	3/8
T1 (in)	GMAW-C/ FCAW-G	GMAW-C/ FCAW-G	GMAW-C/ FCAW-G	GMAW-C/ FCAW-G	GMAW-C/ FCAW-G
3/16	U ≤ 1/16	RFI	RFI	RFI	RFI
1/4	U ≤ 3/32	U ≤ 1/16	RFI	RFI	RFI
5/16	U ≤ 5/32	U ≤ 1/8	U ≤ 3/32	U ≤ 1/16	RFI
3/8	U ≤ 3/16	U ≤ 5/32	U ≤ 1/8	U ≤ 3/32	U ≤ 1/16
1/2	U ≤ 1/4	U ≤ 7/32	U ≤ 3/16	U ≤ 5/32	U ≤ 1/8
5/8	U ≤ 11/32	U ≤ 5/16	U ≤ 9/32	U ≤ 1/4	U ≤ 7/32

Figure D-1: Single Flare Bevel Weld Sample Detail

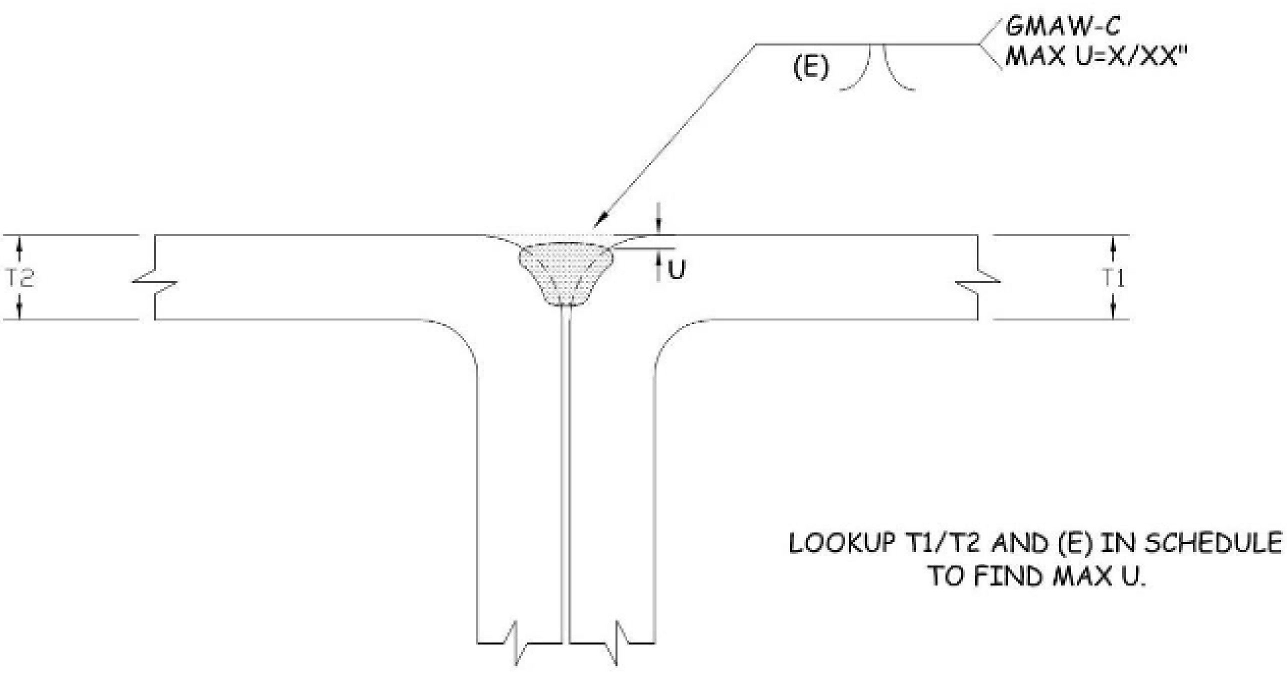


SINGLE BEVEL WELD SAMPLE DETAIL

Table D-2: Double Flare Bevel Underfill Table by HSS Size and (E)

HSS Wall Thickness (Min of T1 and T2) (in)	Double Flare Bevel Permitted Underfill (U) for GMAW (not -S) and FCAW-G by Specified (E) Size (inches)							
	1/8 GMAW-C/ FCAW-G	3/16 GMAW-C/ FCAW-G	1/4 GMAW-C/ FCAW-G	5/16 GMAW-C/ FCAW-G	3/8 GMAW-C/ FCAW-G	7/16 GMAW-C/ FCAW-G	1/2 GMAW-C/ FCAW-G	9/16 GMAW-C/ FCAW-G
3/16	U ≤ 3/32	U ≤ 1/16	RFI	RFI	RFI	RFI	RFI	RFI
1/4	U ≤ 5/32	U ≤ 1/8	U ≤ 1/16	RFI	RFI	RFI	RFI	RFI
5/16	U ≤ 7/32	U ≤ 3/16	U ≤ 1/8	U ≤ 3/32	U ≤ 1/16	RFI	RFI	RFI
3/8	U ≤ 9/32	U ≤ 1/4	U ≤ 3/16	U ≤ 5/32	U ≤ 1/8	U ≤ 1/16	U ≤ 1/32	RFI
1/2	U ≤ 13/32	U ≤ 3/8	U ≤ 5/16	U ≤ 9/32	U ≤ 1/4	U ≤ 3/16	U ≤ 5/32	U ≤ 1/8
5/8	U ≤ 17/32	U ≤ 1/2	U ≤ 7/16	U ≤ 13/32	U ≤ 3/8	U ≤ 5/16	U ≤ 9/32	U ≤ 1/4

Figure D-2: Double Flare Bevel Weld Sample Detail



DOUBLE BEVEL WELD SAMPLE DETAIL

Stiffener plate preparation &weld details: -

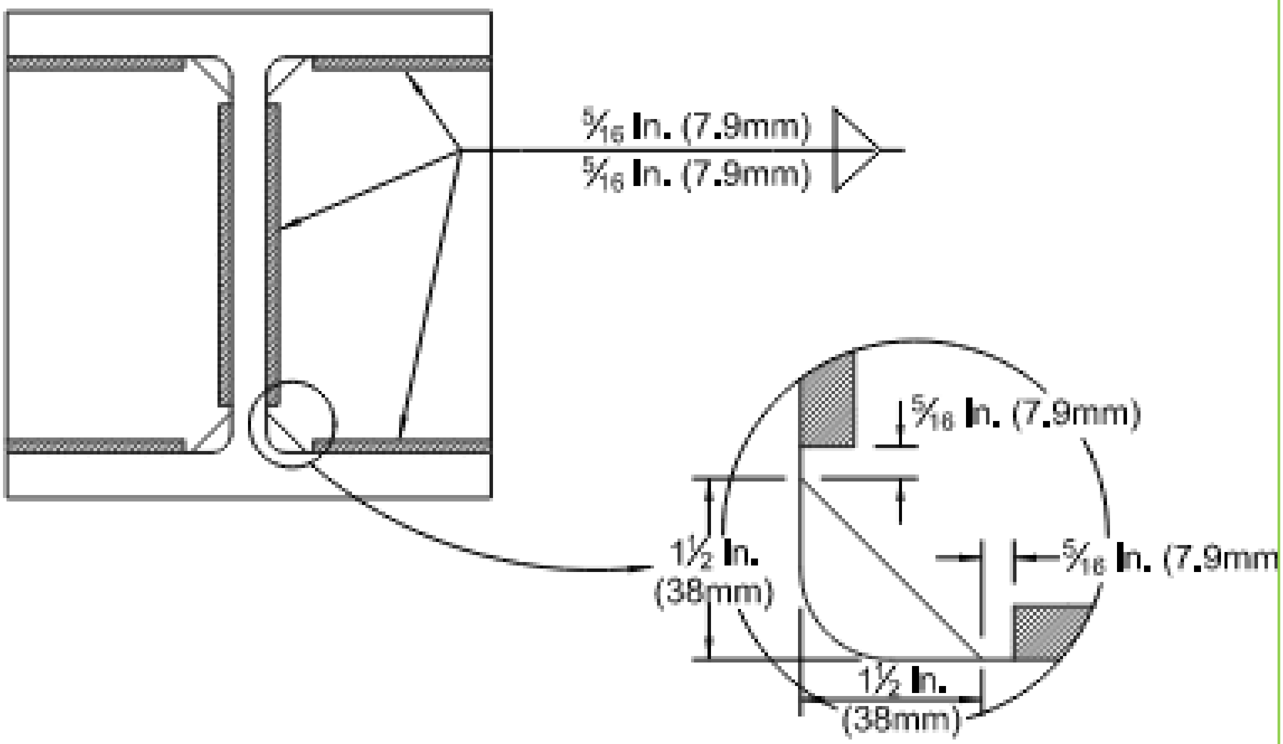
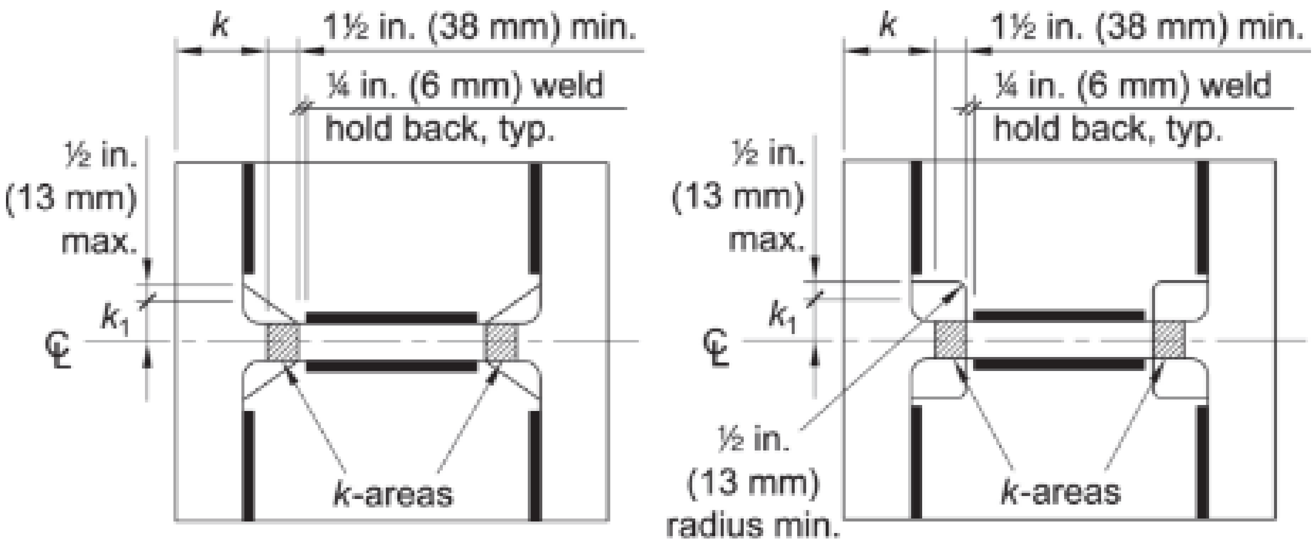


Fig. C-J10.7. Recommended placement of stiffener fillet welds to avoid contact with "k-area."

Continuity plate weld details: -



(a) Straight corner clip *(b) Curved corner clip*

Fig. C-D2.3. Configuration of continuity plates.

Web doubler plate weld details: -

As per AISC 341-16, the web doubler plate needs to extend 6" minimum from the top & bottom of the beam flange.

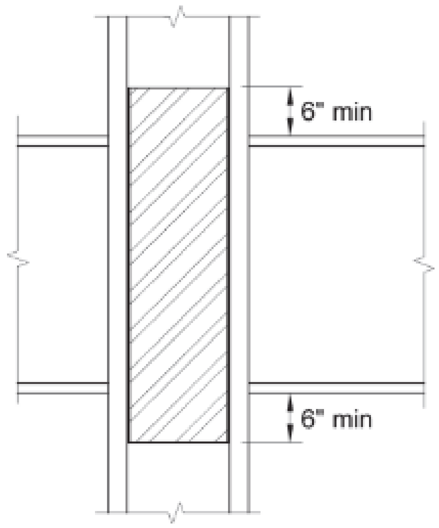
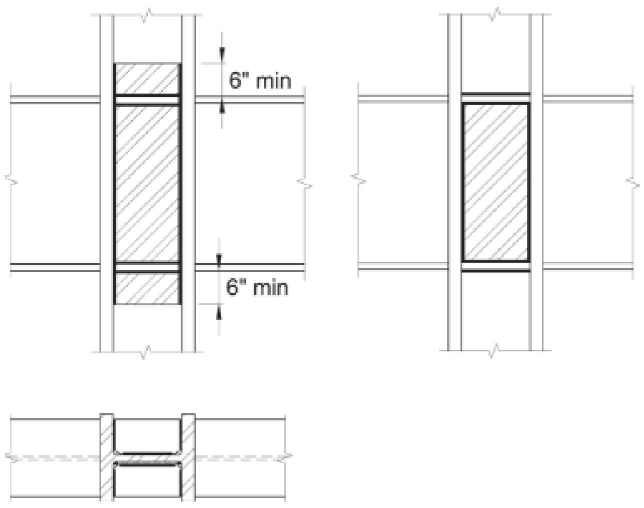


Fig. C-E3.7. Doubler plates used without continuity plates.

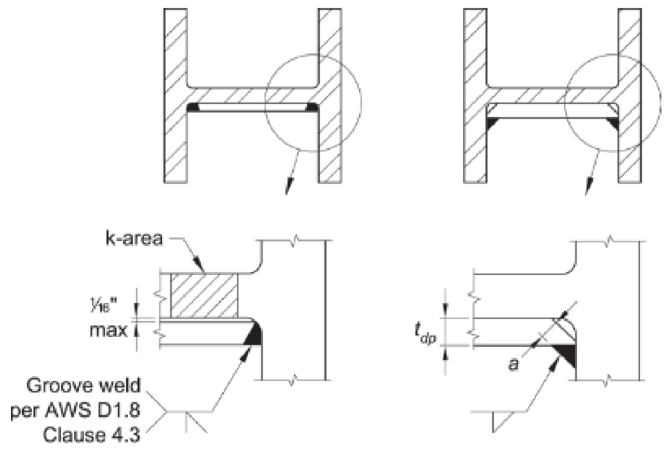


(a) Doubler plate extended beyond continuity plates

(b) Doubler plate placed between continuity plates

Fig. C-E3.8. Doubler plate used with continuity plates.

Web doubler plate preparations & plug weld confirm with the customer, before starting the model work.



(a) Doubler plate groove welded to column flanges

(b) Doubler plate fillet welded to column flanges

Fig. C-E3.6. Doubler plate in contact with column web.

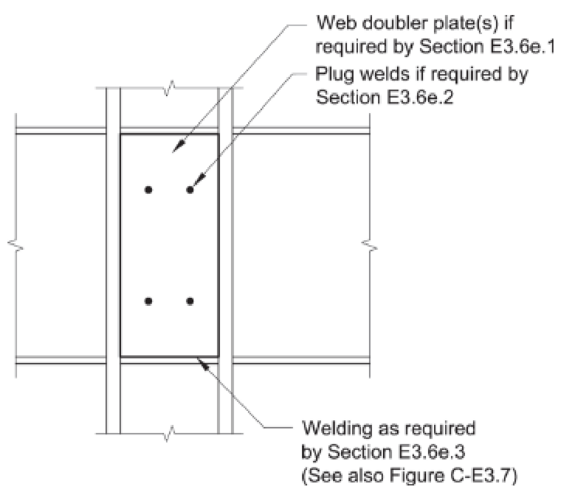
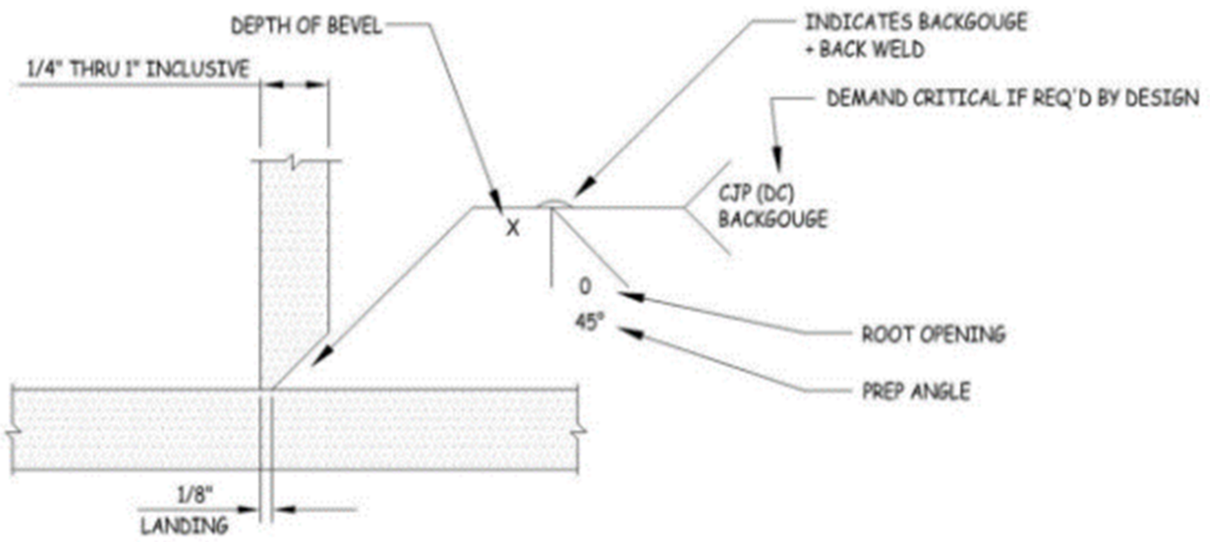


Fig. C-E3.4. Connecting web doubler plates with plug welds.

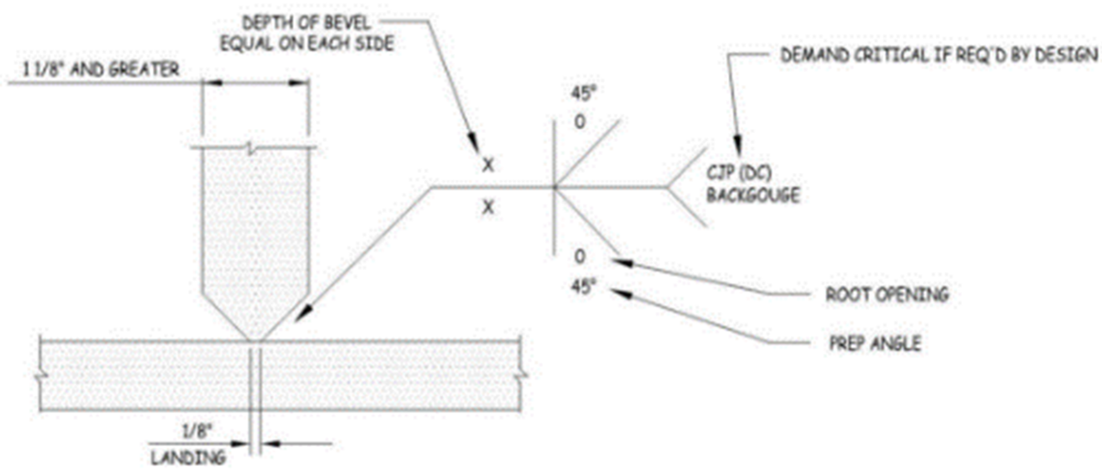
CJP Weld Shop preference: -

All shop weld preferences are for example. Needs to confirm with the project manager or follow as per fabricator standard. Note: All snaps are copied from various customer standards)

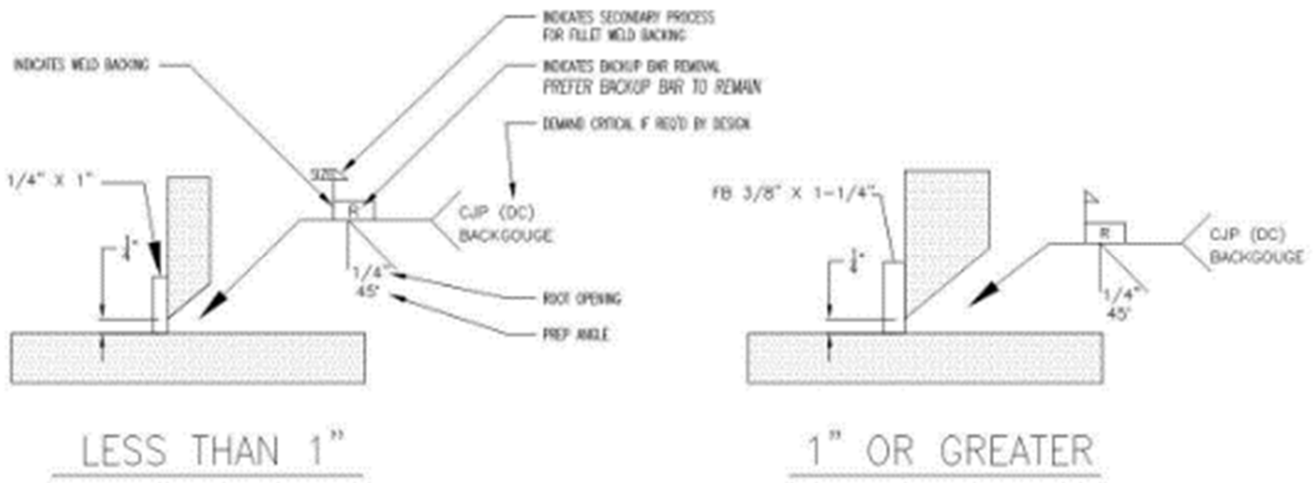


CJP WELDS 1" THICK AND LESS

Figure D-3B: Standard Plate, Wide Flange, & Channel CJP Weld Details

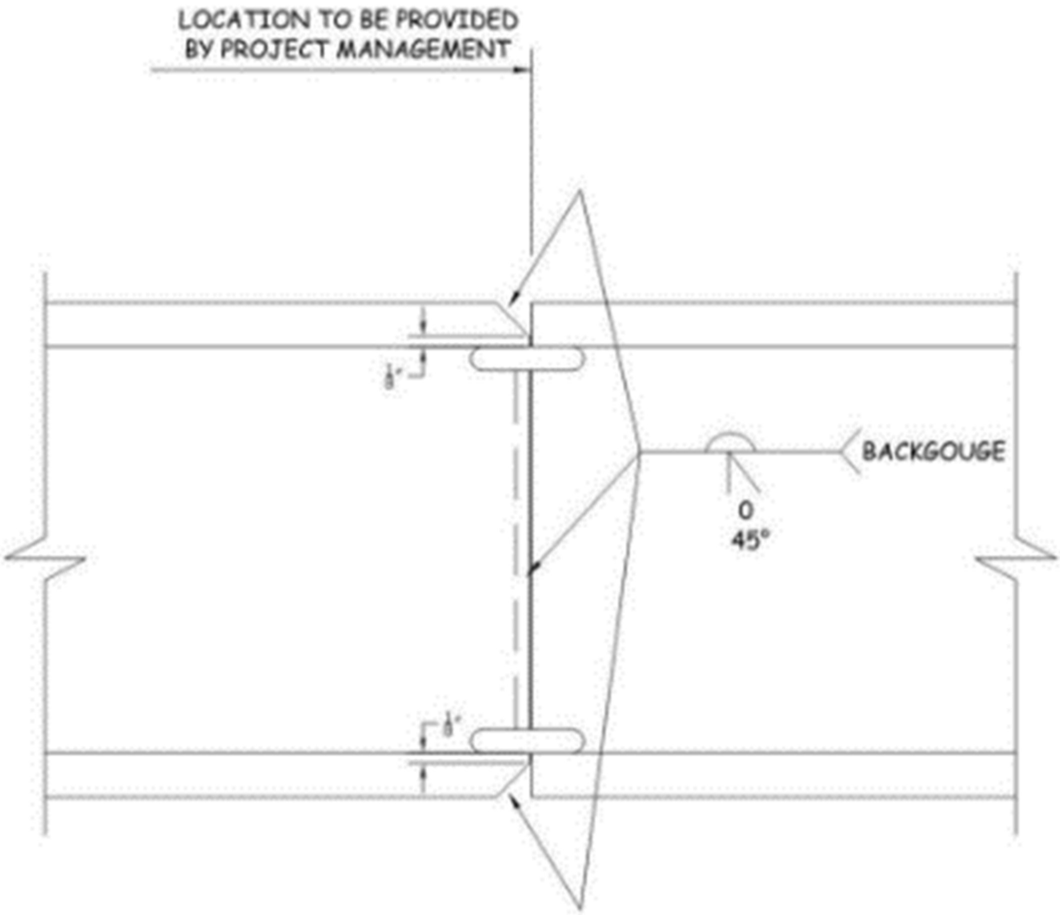


CJP WELDS 1 1/8" THICK AND GREATER

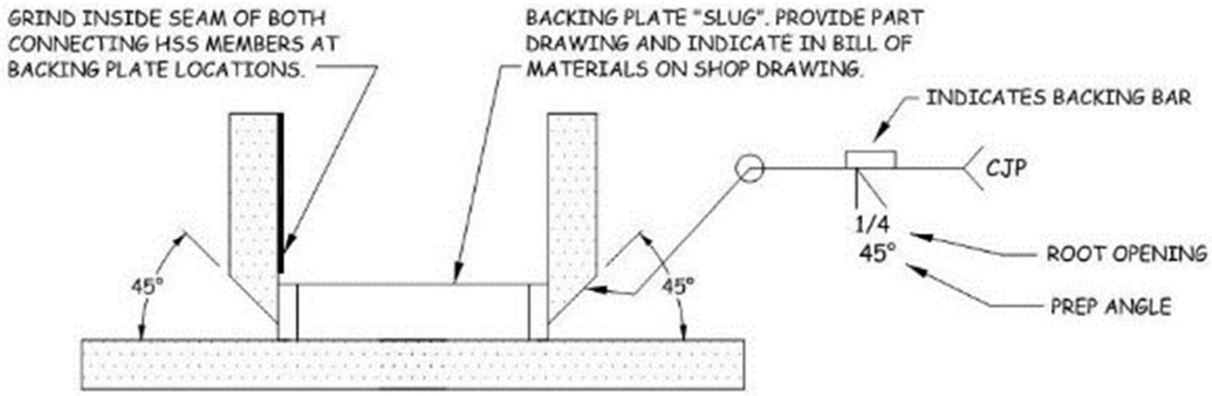


SHOP CJP WELD WITH BACKING

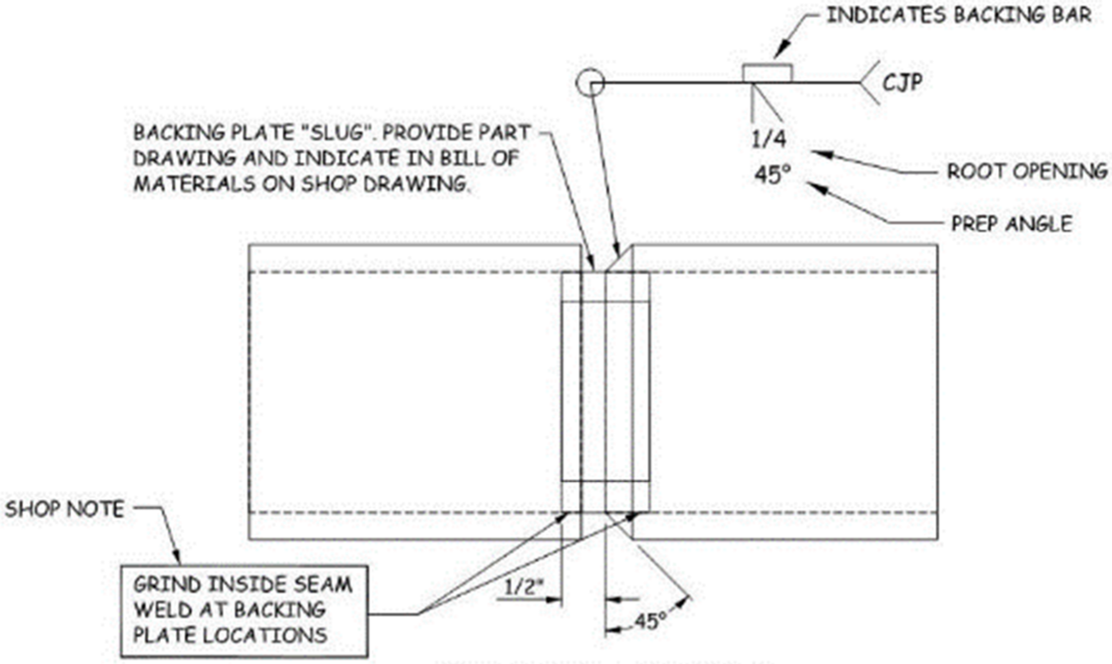
NOTE: CJP WELDS WITH BACKING ARE NOT TO BE USED FOR SHOP WELDS WITHOUT PROJECT MANAGEMENT APPROVAL.



CJP SHOP WELDED SPLICE

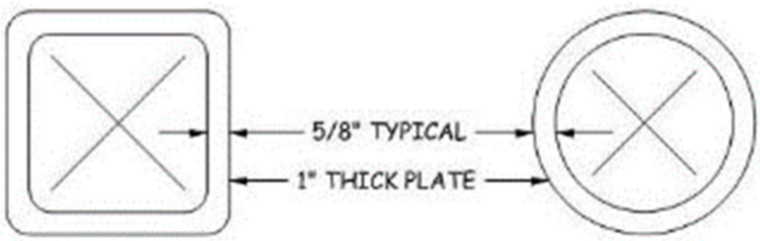


HSS TO PLATE EXAMPLE



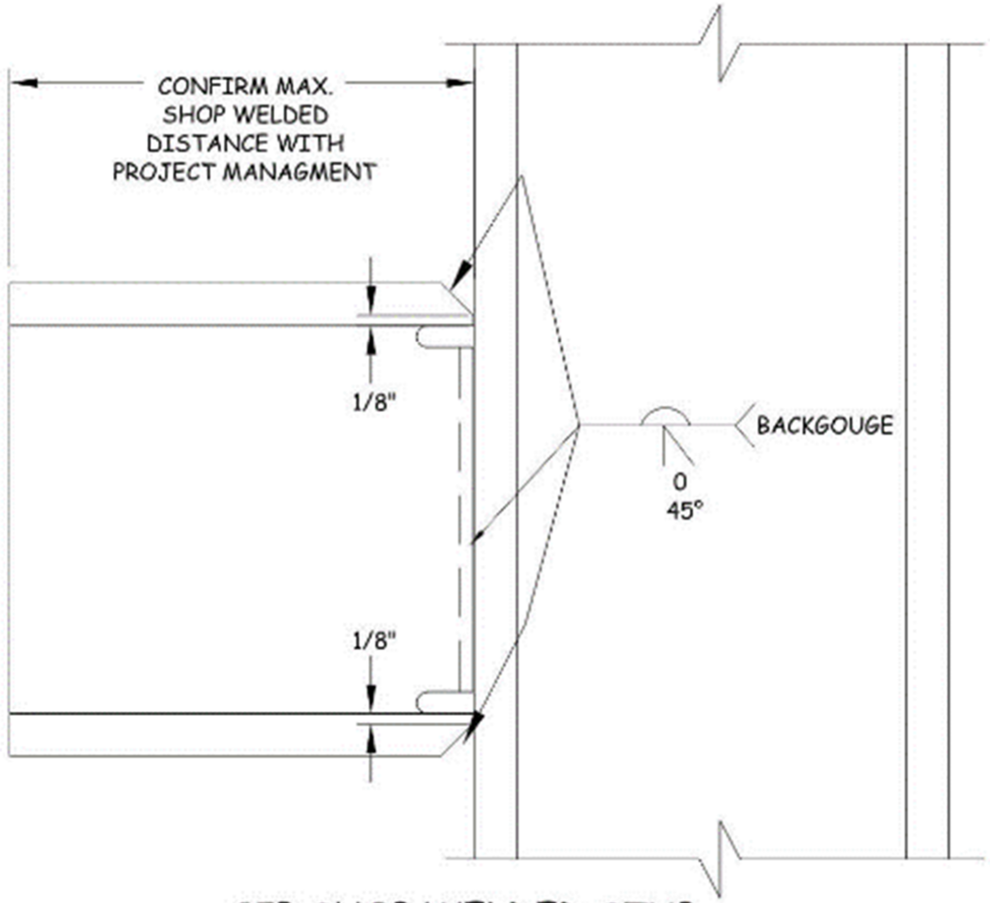
HSS TO HSS EXAMPLE

BACKING PLATE TO BE DETAILED IN BILL OF MATERIALS AS PLATE 1" X WIDTH X LENGTH. CENTER OF PLATE TO BE CUT OUT LEAVING 5/8" OF MATERIAL AROUND THE PERIMETER OF THE PLATE.



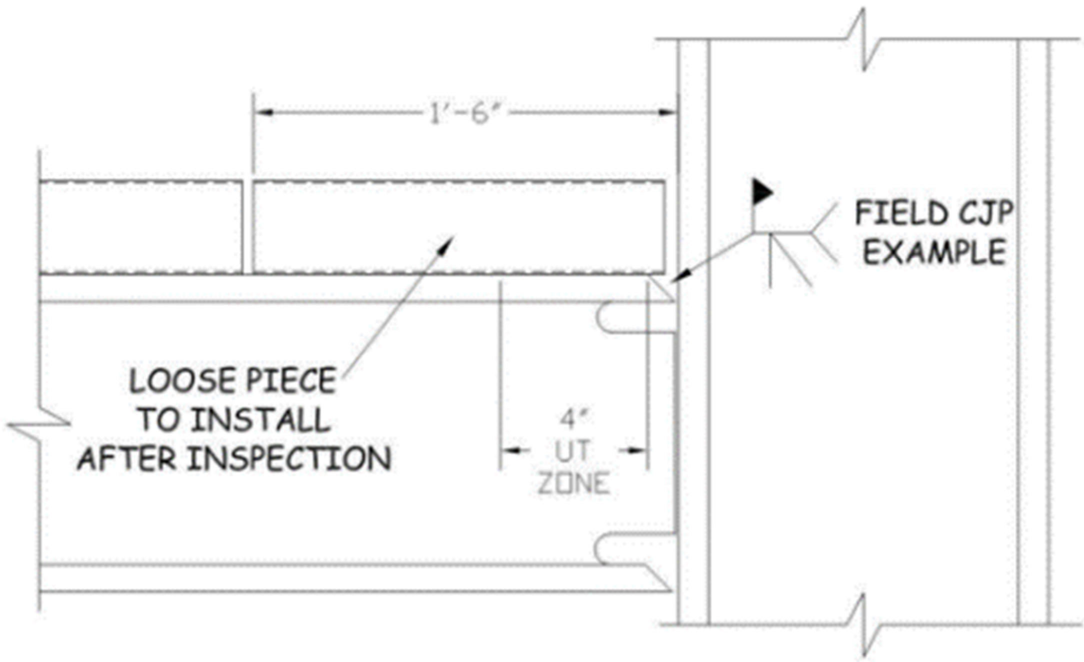
BACKING PLATE "SLUG" EXAMPLE

HSS CJP WELDS

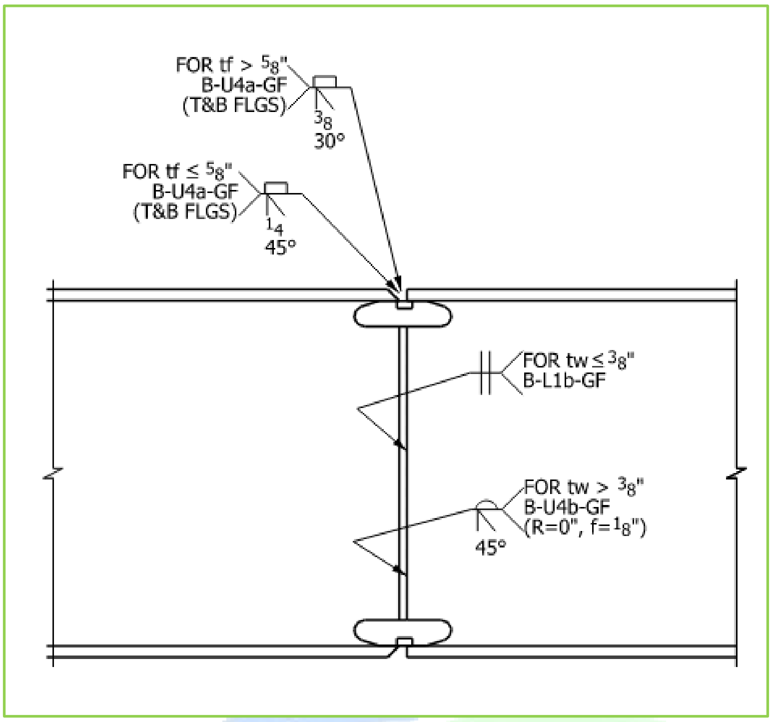


CJP SHOP WELDED STUB

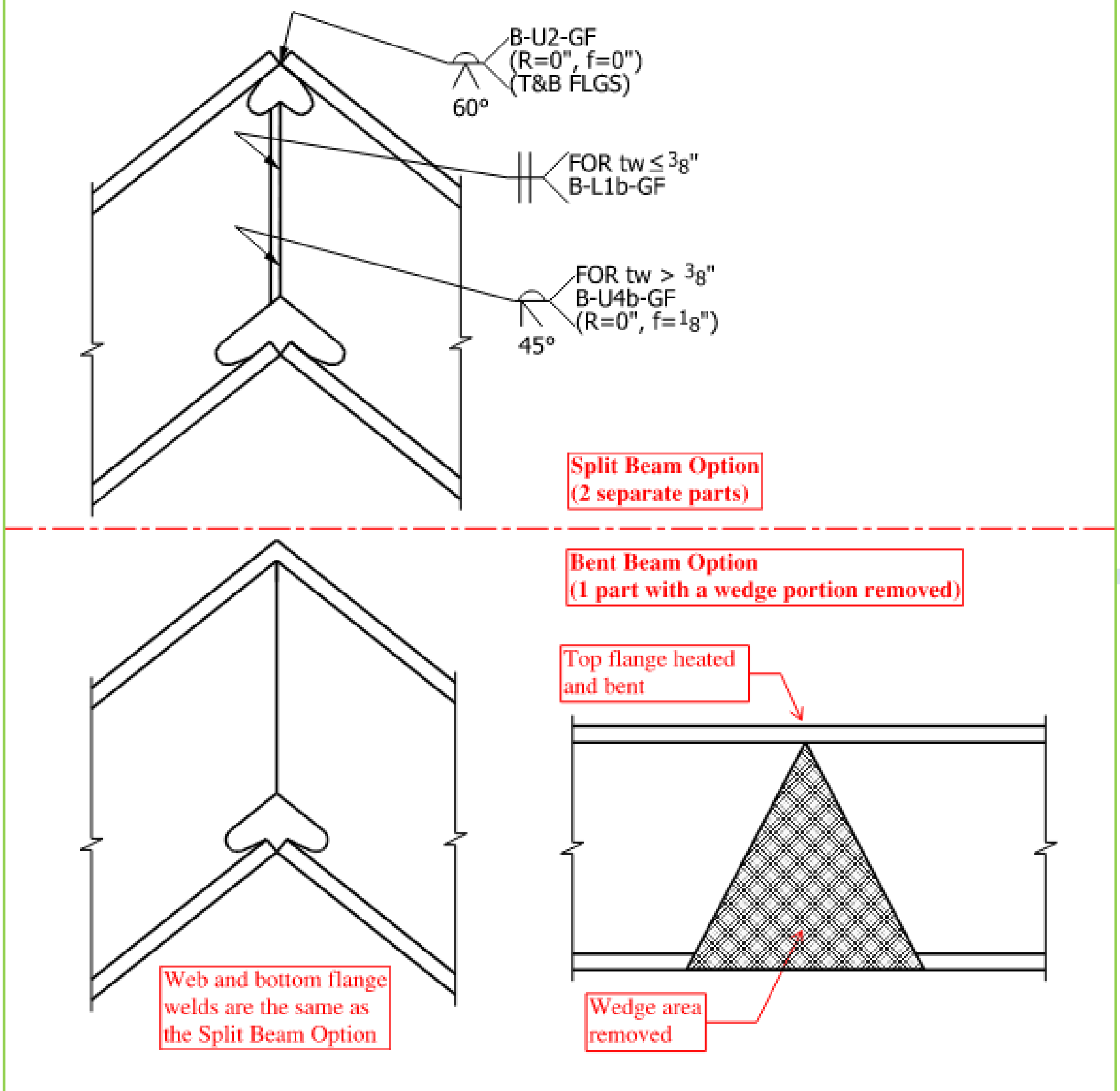
NOTE: NO SHEAR TABS ARE REQUIRED FOR THIS SHOP WELDED DETAIL



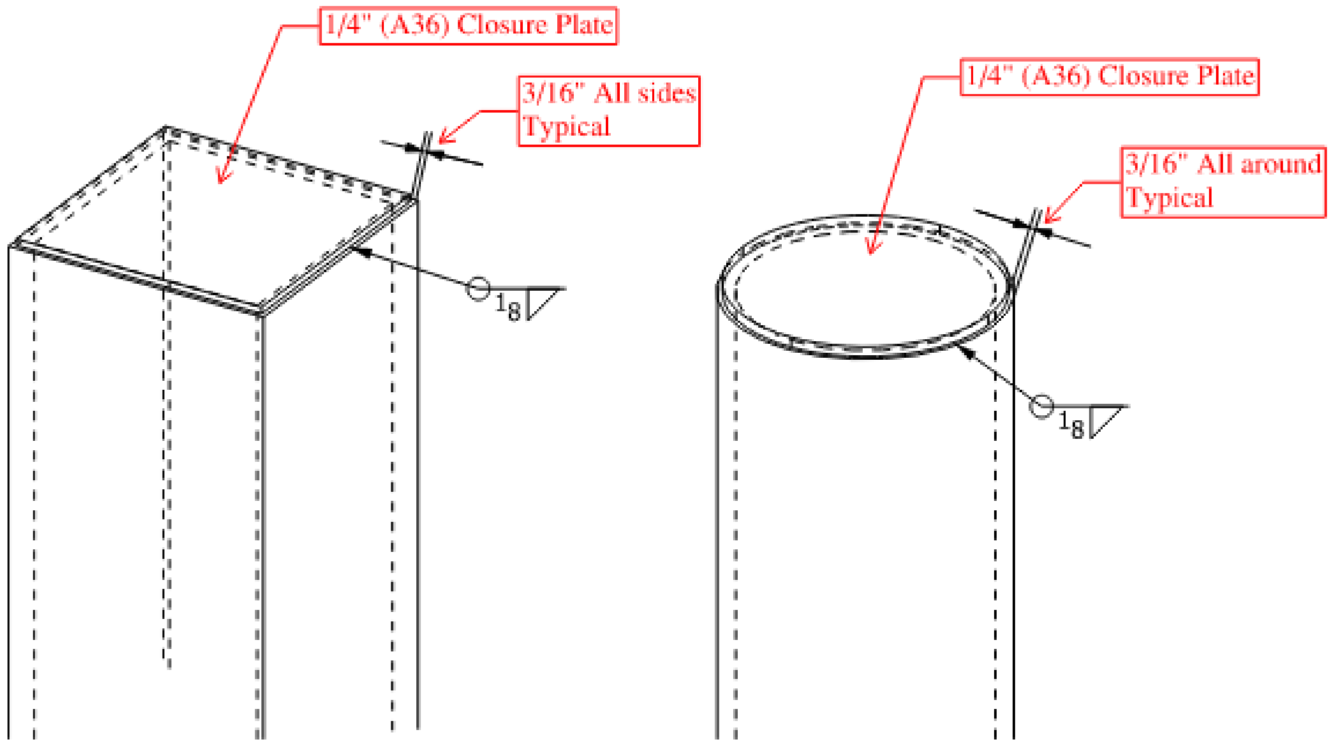
FIELD CJP INSPECTION ZONE



Mitered Wide Flange CJP Shop Splice **DS-3.12.5**



Closure plate weld preferences:



14. Bent plates: -

- Bent plate length is 10'-0" available. Please confirm with the fabricator bending machine availability.
- Bending radius ½" minimum U.N.O).
- confirm with shop splice detail with customer.

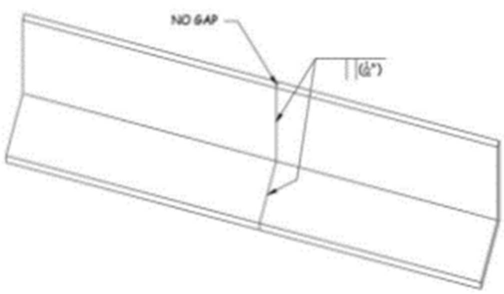
Table 10-13
Minimum Inside Radius for Cold-Bending[1]

Inside radius as a function of plate thickness

ASTM Designation[2]	Thickness, *t*, in.			
	Up to 3/4	Over 3/4 to 1	Over 1 to 2	Over 2
A36, A572-42	1½ *t*	1½ *t*	1½ *t*	2*t*
A242, A529-50, A529-55, A572-50, A588, A992	1½ *t*	1½ *t*	2 *t*	2½ *t*
A572-55, A852	1½ *t*	1½ *t*	2½ *t*	3 *t*
A572-60, A572-65	1½ *t*	1½ *t*	3 *t*	3½ *t*
A514	1¾ *t*	2¼ *t*	4½ *t*	5½ *t*

[1] Values are for bend lines perpendicular to direction of final rolling. If bend lines are parallel to final rolling direction, multiply values by 1.5.
[2] The grade designation follows the dash; where no grade is shown, all grades and/or classes are included.

Typical shop splice detail shown below.



BENT PLATE SHOP WELDED SPLICE

15. Plates: -

- ❖ Shop/field welded plate stock length – 10'-0". Confirm with customer standard. Before starting the model work, check the flat bar size availability and place it in the model.
- ❖ Above 2" thick base plate, need to provide ABM. Confirm with
customer.
- ❖ For structural plates, the preferred practice is to specify thickness in 1/16-in. increments up to 3/8-in. thickness, 1/8-in. increments over 3/8-in. to 1-in. thickness, and 1/4-in. increments over 1-in. thickness.
- ❖ For bars, the preferred practice is to specify the width in 1/4-in. increments, and thickness and diameter in 1/8-in. increments.

16. Angles: -

- ❖ Shop welded angle stock length – 40'-0" and Field welded angle stock length – 20'-0". Confirm with customer standard. Before starting the model work.

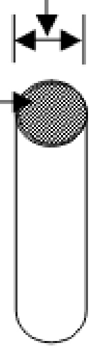
17. Rebars and DBA's: -

Rebar

Bar Dia (inch) = Bar No. / 8

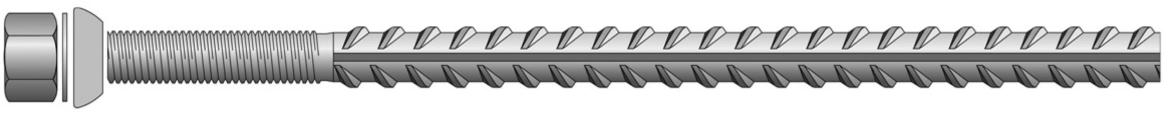
Table-1: Diameter and Area of Reinforcing Bars

Bar No.	Bar Dia. (in)	Area (Sq.in)
#3	3/8	0.11
#4	1/2	0.20
#5	5/8	0.31
#6	3/4	0.44
#7	7/8	0.60
#8	1	0.79
#9	9/8	1.00
#10	10/8	1.27
#11	11/8	1.56



DBA is preferred for field compared with rebars. IF rebars are required, should be preferred with Field weld. Please confirm with the customer.

Deformed Bar Anchors DBAs)



For DBA's is shop or field weld, consult with the customer.

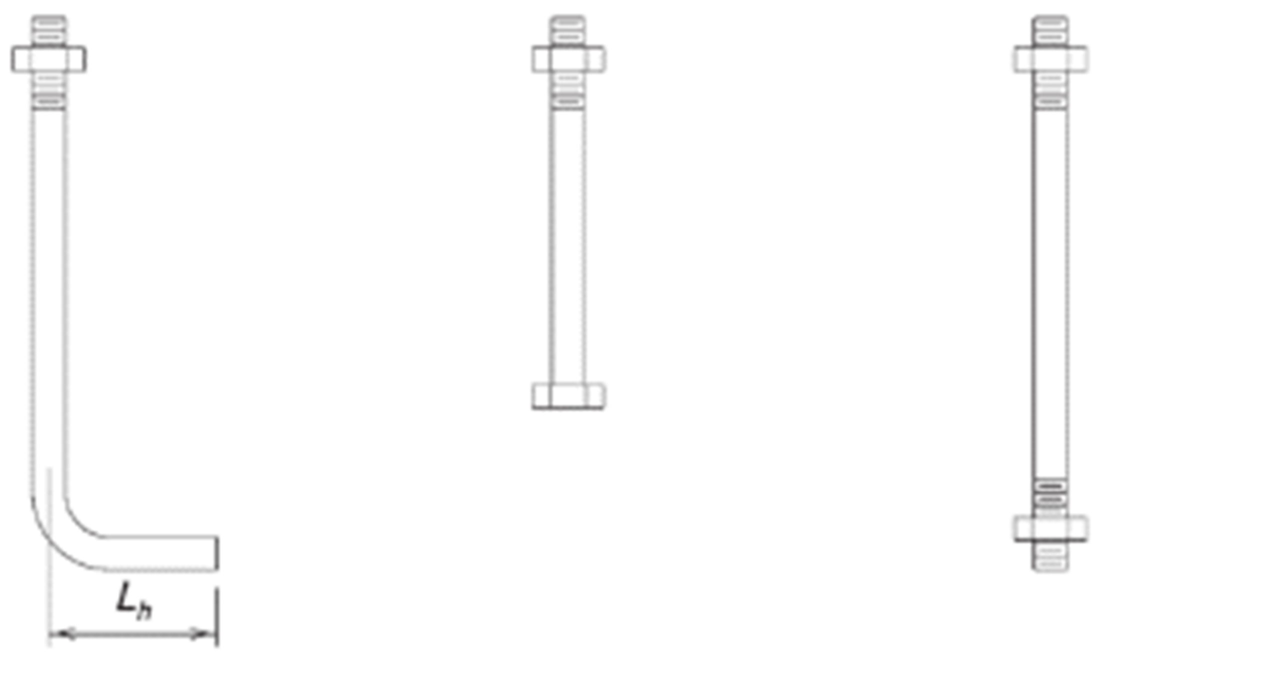
18. Anchor rods: -

Anchor bolts are used to connect structural and non-structural elements to concrete. The connection can be made by a variety of different components: anchor bolts also named fasteners), steel plates, or stiffeners. Anchor bolts transfer different types of loads: tension forces and shear forces.

A connection between structural elements can be represented by steel columns attached to a reinforced concrete foundation. A common cause of a non-structural element attached to a structural one is the connection between a facade system and a reinforced concrete wall.

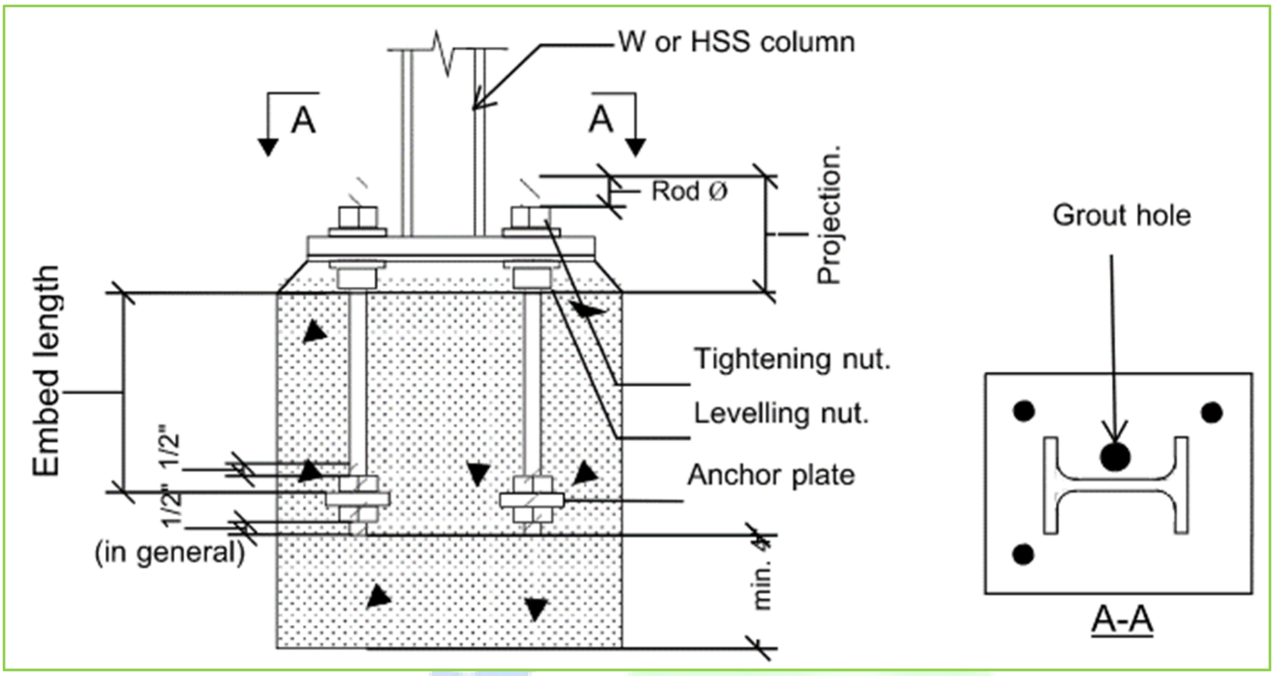
Types of Anchor rods

a. Hooked
b. Headed
c. Threaded with nut



(a) Hooked (b) Headed (c) Threaded with nut

Anchor setting detail



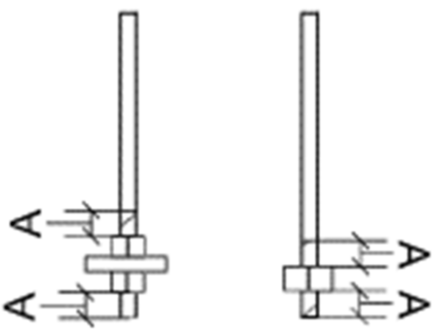
Minimum Grout thickness

If not available in contract drawings, follow as per below mentioned and confirm with the customer.

AB DIA	GROUT THICKNESS	AB DIA	GROUT THICKNESS
3/4	1"	2	2 1/2"
1	1 1/2"	2 1/4	3"
1 1/4	2"	2 1/2	3"
1 1/2	2"	2 3/4	3 1/2"
1 3/4	2 1/2"	3	3 1/2"

Minimum Threaded length as the bottom of anchor rod.

If not available in contract drawings, follow as per below mentioned and confirm with the customer.



Rod Ø	'A' Value
3/4" & 1"	1/2"
above 1"	3/4"

Below mentioned points need to be considered for anchor bolts: -

- ✓ Base plate size above 2'-0" exceeds length or width) needs to provide Grout hole.
- ✓ Above 2" base plate thickness needs to send ABM and CVN test required. Confirm with the customer.
- ✓ Anchor rods need to place with 4" minimum clearance from the bottom of the footing to the anchor rod. If not, raise RFI and confirm with the customer.
- ✓ Lateral columns Moment, Braced frames) plate washers are field welded. Confirm with the customer. Refer contract drawings before raising RFI.
- ✓ Plate washer weld detail needs to add Erection plans.
- ✓ Confirm the Nailer hole requirement in templates with the customer.
- ✓ Anchor rod F1554-GR105 is non-weldable, so add upset threads or damaged threads in assembly drawings to confirm with the customer.
- ✓ Base plate holes have followed as per AISC table 14-2& plate washers have standard holes, confirm with the customer.
- ✓ Lateral columns Moment, Braced frames) base plates are A572-Grade 50. Confirm with customer and contract drawings.
- ✓ If contract drawings provide a shear lug, needs to provide at the time of anchor bolt setting and mentioned the shear lug, and pocket in footing/pier) details in erection plans.

Grades:

Anchor rods	:	F1554 – Gr.36
		F1554 – Gr.55
		F1554 – Gr.105 – Non weldable
Std washer	:	F436
Hex Nut	:	A563
Template	:	1/8" thick plate or 12 GA or 14GA
Plate washer	:	A36.

Anchor rod base plate hole sizes

Confirm the base plate hole size minimum or maximum as per table 14-2 with the customer. Otherwise, follow as per contract drawings/fabricator standards.

9th Ed. Manual Recommended Hole Sizes	
Anchor Rod Diamer (in.)	Hole Diameter (in.)
¾	1 1/16
⅞	1 3/16
1	1 ½
1 ¼	1 ¾
1 ½	2
1 ¾	2 ¼
2	2 ½
2 ½	3 ½

Minimum Anchor rod base plate hole size

Table 14-2
Recommended Maximum Sizes for Anchor-Rod Holes in Base Plates

Anchor Rod Diameter, in.	Max. Hole Diameter, in.	Min. Washer Size, in.	Min. Washer Thickness	Anchor Rod Diameter, in.	Hole Diameter, in.	Min. Washer Size, in.	Min. Washer Thickness
3/4	1 5/16	2	1/4	1 1/2	2 3/8	4	1/2
7/8	1 9/16	2 1/2	5/16	1 3/4	2 7/8	4 1/2	5/8
1	1 7/8	3	3/8	2	3 1/4	5	3/4
1 1/4	2 1/8	3 1/2	1/2	2 1/2	3 3/4	5 1/2	7/8

Notes:
1. Circular or square washers meeting the washer size are acceptible.
2. Clearance must be considered when choosing an appropriate anchor rod hole location, noting effects such as the position of the rod in the hole with respect to the column, weld size and other interferences.
3. When base plates are less than 1 1/4 in. thick, punching of holes may be an economical option. In this case, 3/4-in. anchor rods and 1 1/16-in.-diameter punched holes may be used with ASTM F844 (USS Standard) washers in place of fabricated plate washers.

19. Embeds: -

Embed plate

An Embed Plate is a rectangular piece of steel with welding studs attached that have a head bigger than the stud's diameter. They are placed into the forms when reinforced concrete is to be poured. Once the concrete gets poured, the studs are "embedded" in it, then the plate is flush with the surface of the concrete.

- ✓ All vertical embed plates need to provide Nailer holes.
- ✓ Threaded post-installed anchors such as Simpson Titen anchors, require the hole diameter to be 1/8" larger than the anchor diameter to accommodate the cutting edge of the anchor. The anchor embedment must be shown on the bolt list.
- ✓ Shear Plates will be shipped loose to be field welded to embeds.
- ✓ Embeds must be in their sequence separate from the main steel drawing packages.
- ✓ Shear tabs field welded to embeds should be detailed with standard long slots and plate washers.
- ✓ Shear tabs must be located down from the top of the steel to the centerof the top hole in the plan with clarifying sections.

Embed angle

Embed angle is used for the support edge of the concrete.

20. Connections: -

There are two types of specification standards for the design of structural steel

❖ LRFD Load and Resistance Factor Design)

In LRFD factored loads and load combinations with separate factors for each load and the resistance are used.

❖ ASD Allowable Stress Design)

In ASD service load and load combination with a factor of safety applied to the resistance are used.

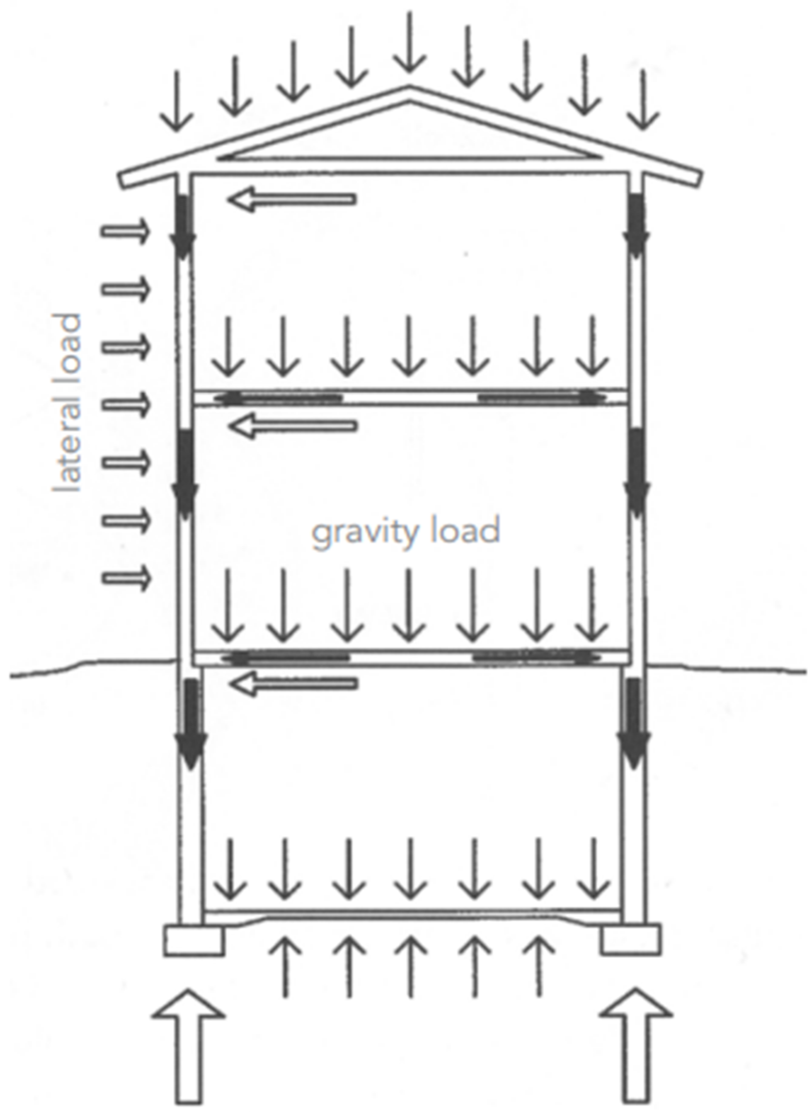


Fig. 2. Gravity and lateral loads.

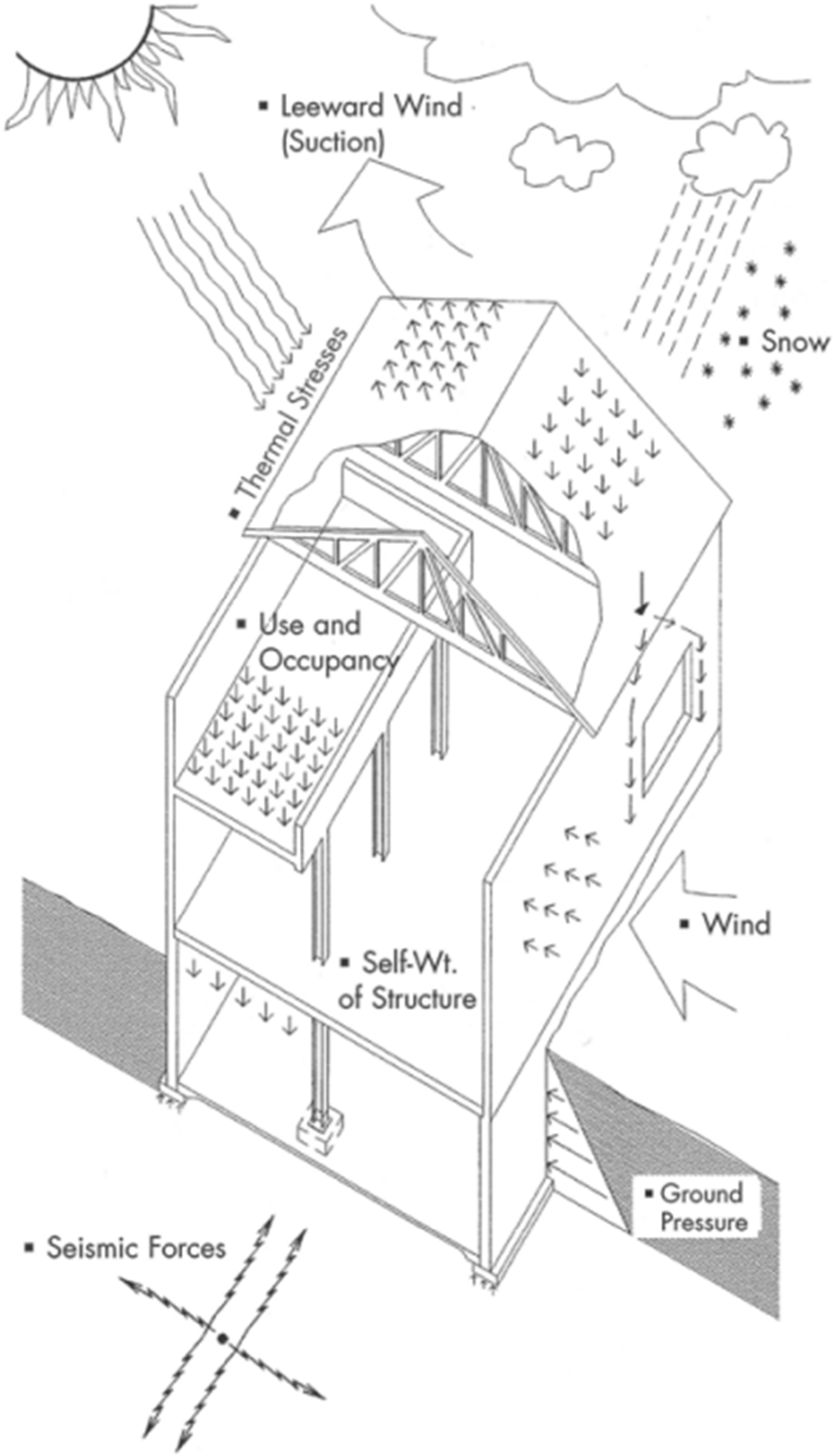


Fig. 1. Forces experienced by structures.

Gravity loads

Engineers consider two different types of forces that are related to gravity.

"Dead" loads comprise the weight of the structure itself as well as things like mechanical equipment, ceiling, and floor finishes, cladding, façades, and parapets. The dead load is essentially the amount of consistent weight that a building must always support.

"Live" loads account for more transient things, like the weight of people moving around in the building, snow atop the structure, or interior furnishings.

The floor decking and roof sheathing distribute the load to uniformly spaced beams. Girders span from column to column and support the ends of those beams. Those girders may end up supporting other girders, as well, before transferring the force to structural columns which then carry the vertical load to the foundation elements below.

Wind loads

Wind exerts varying forces across the building's façade, and the primary lateral load-resisting system must meet code requirements to handle those forces.

Wind pressures act directly on the windward side of a building, but they also create a pulling or suction force on the leeward side. This means that the exterior of the entire building must be able to resist both inward and outward pressure.

In addition, wind can create an upward or suction pressure on roofs made of lightweight material. For instance, a roof consisting of metal decking, thin insulation, and a membrane roof material without ballast may encounter a net upward force.

Roof shape gable, sawtooth, etc.) may influence net uplift pressures from the wind. Curved roofs can experience both upward and downward pressure simultaneously as the wind pushes down on the top part of the curve and pulls up from the lower part of the curve. This distribution of downward and upward pressures is similar to the principles of air pressure and lift that act on an airplane wing.

The structure must transfer these wind-related forces properly. The façade should transfer the horizontal load to the adjacent floor or roof. From there, the floor and roof systems must have the means to distribute those horizontal forces to the lateral load-resisting system such as diagonal bracing or shear walls.

Floors and roofs that are generally solid or without large openings may behave as diaphragms, which act as a single plane with the connecting beams, girders, and columns.

Picture a piece of cardboard held up by a series of vertical columns. When you push the cardboard horizontally, all the columns connected to the board will move in unison. A typical floor slab is a rigid diaphragm, just like that piece of cardboard, and that lateral shift is precisely what happens when the diaphragm plane created by a roof or floor is laterally loaded. Horizontal diaphragms are an efficient way to transfer the horizontal loads at each level of a building to the lateral load resisting systems.

Should a large opening such as an atrium, a skylight, or a raised floor interrupt the diaphragm, the lateral or horizontal loads may not flow easily to the lateral load-load resisting systems. If that is the case for your project, the structural engineer may create an alternate diaphragm system such as a horizontal truss system that uses the floor beams and/or girders.

Seismic loads

Earthquakes and other seismic events generally exert horizontal force on structures, but they can also occasionally create vertical force, too.

The weight of the various levels of a building has a direct impact on the forces that the building experiences during a seismic event. Diaphragms come into play to transfer the horizontal forces to the structure's primary lateral load resisting systems.

The building shape and the positioning of the lateral load-resisting systems can have a big impact on a structure's sensitivity to seismic forces. If your project is in an area with significant seismic activity, you may want to consider a very regular building plan to effectively handle these forces.

Types of connections: -

1. Simple shear connections
    a. Shear plate connection
        - Single shear plate
        - Full-depth shear plate
        - Extended past flange shear plate EPF)
    b. Single angle connection
    c. Double angle connection
    d. End plate connection
    e. Unstiffened seated connection
    f. Skewed connection
    g. Thru plate shear connection
2. Partial Restrained Moment connections
    a. Flange-Angle
    b. Flange-Plate
3. Fully Restrained Moment connections
    a. Flange-Plate Bolted)
        - Beam to beam
        - Beam to column
    b. Directly welded Flange Welded)
        - Beam to beam
        - Beam to column
    c. End plate
    d. Through plate
    e. Exterior plate
    f. HSS Welded Tee Flange Connections
    g. HSS Diaphragm Plate Connections
4. Lateral systems
    a. Braced frames
    b. Rigid frames
    c. Shear walls.
5. Truss connection
6. Bearing connection
    a.Beam bearing on column
    b.Column bearing on the beam
7. Hanger connections

Connecting elements

- Plates
- Angles
- WT's
- Gussets
- Brackets

Connectors

- Bolts
- Welds
- Rivet

Types of preparation in structural members.

When structural members frame together, a minimum clearance of 1/2 in. should be provided, when possible. In cases where material removal is necessary to provide such a clearance, material may be removed by coping, blocking, or cutting as noted below.

a. Cope
b. Blocks (cut flange width)
c. Cut (cut flange flush)

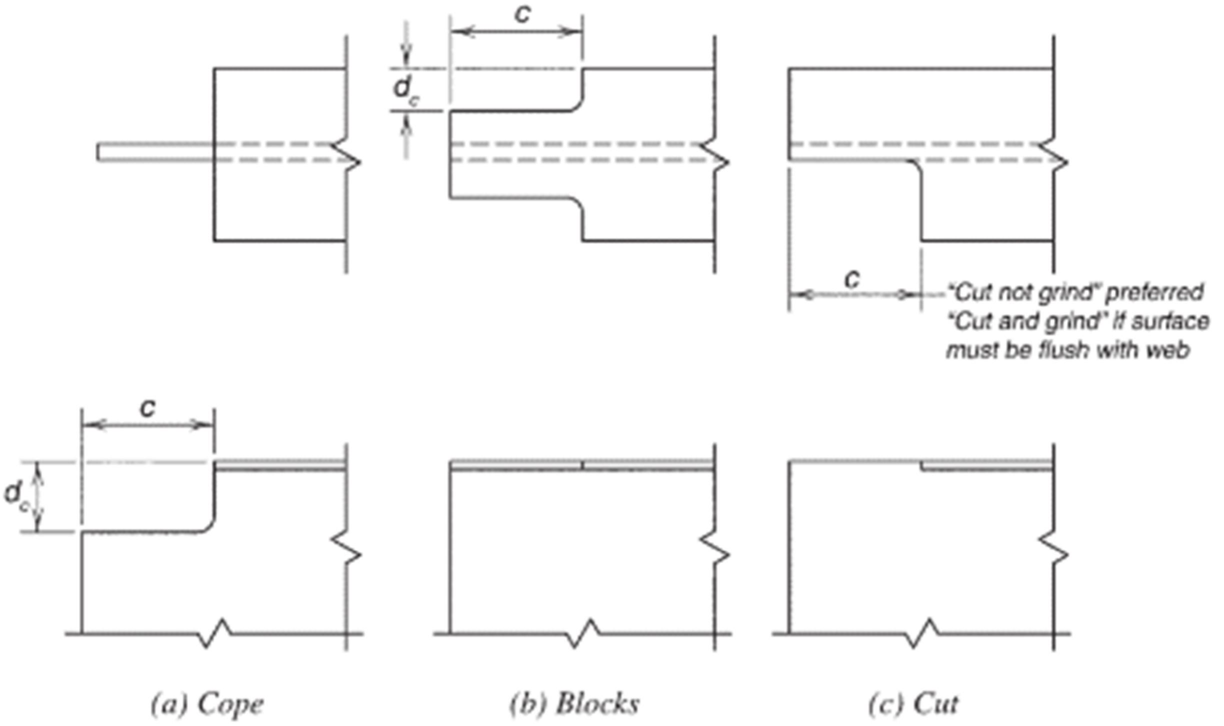


Fig. 9-7. Copes, blocks and cuts.

1. Simple shear connections

a. Shear plate connection

A shear connection is a joint that allows the transfer of shear forces
between two members.

i. Single shear plate connection

A single-plate connection is made with a plate. The plate must be welded to the support on both sides of the plate and bolted to the supported member.

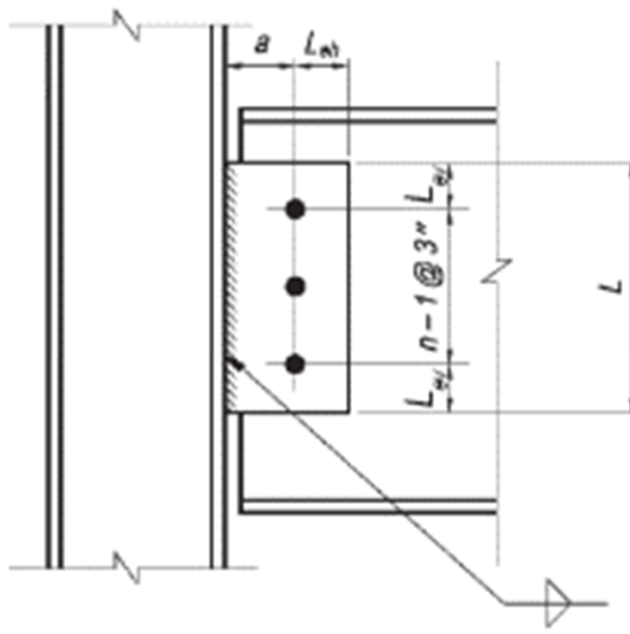
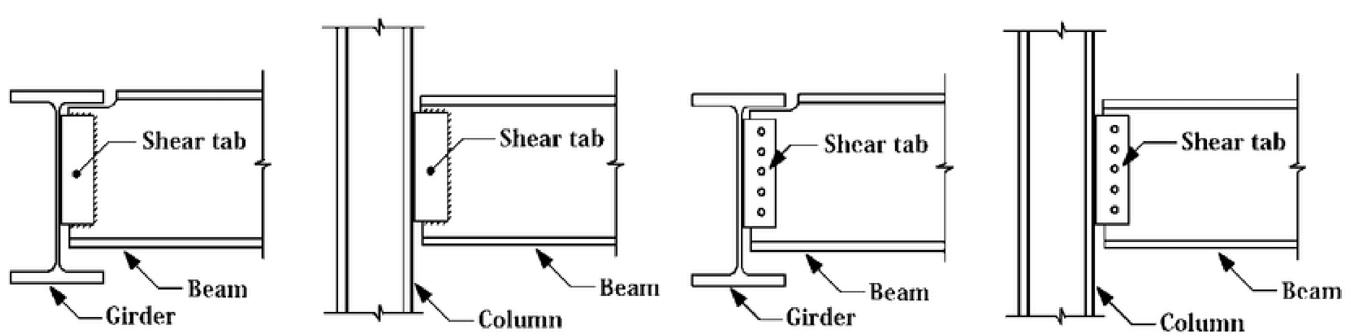
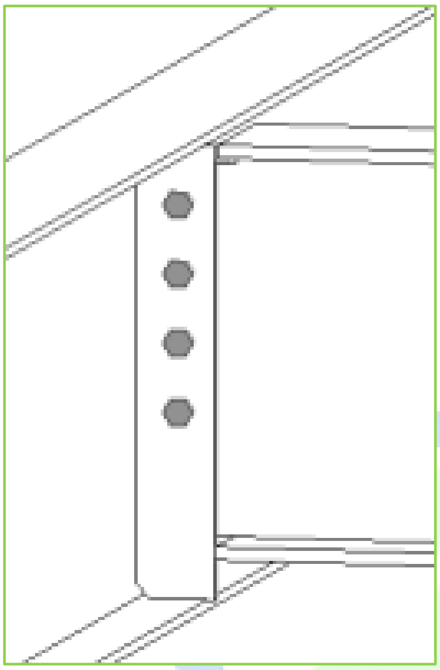


Fig. 10-11. Single-plate connection.



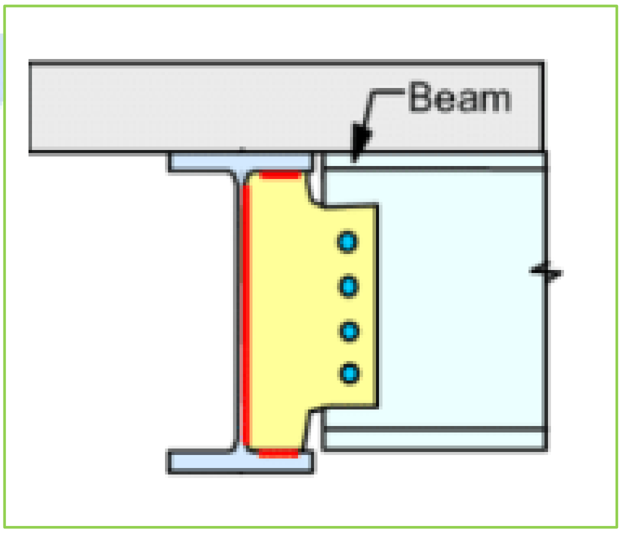
ii. Full depth shear plate

The shear tab is welded to the main beam web and flanges and bolted to the secondary beam web. The secondary beam can be leveled or sloped. A stiffener plate on the opposite side of the main beam web.



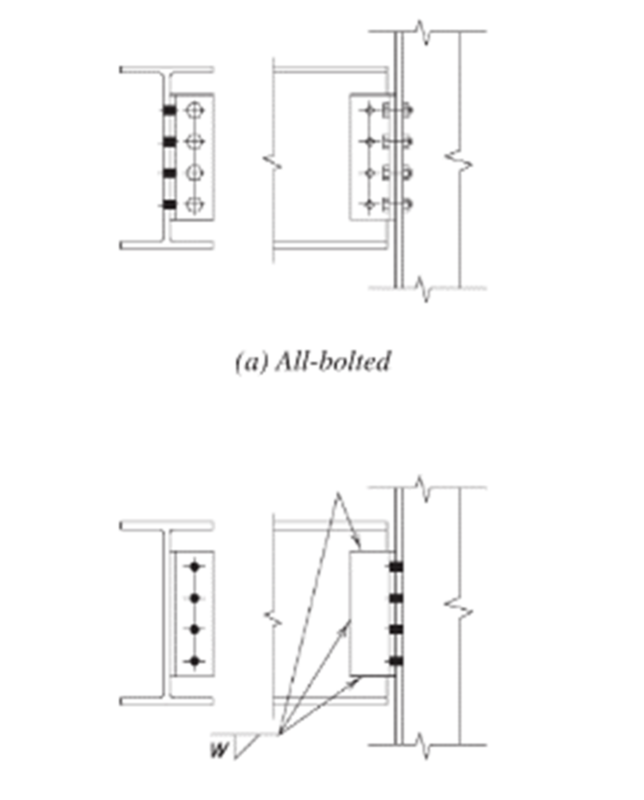
iii. Extended past flange shear plate EPF)

An extended shear tab EST) is a type of simple connection commonly used in steel building construction, wherein a plate is welded in the vertical orientation to a column or girder and bolted to the supported beam. ESTs have the same configuration as conventional shear tabs, but normally frame into the supporting member's web and extend beyond its flanges. This creates a much larger distance between the bolt group and weld, resulting in a load eccentricity.



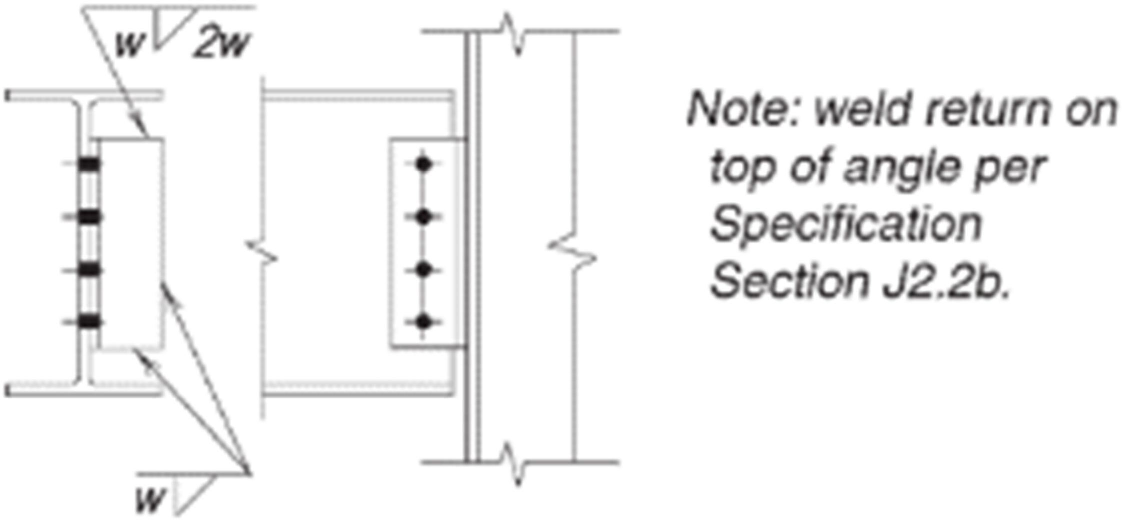
b. Single angle connection

A single-angle connection is made with an angle on one side of the web of the beam to be supported. This angle is preferably shop-bolted or welded to the supporting member and field-bolted to the supported beam.



(a) All-bolted

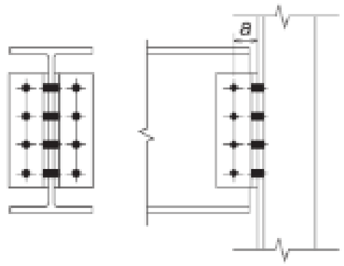
(b) Bolted/welded, angle welded to supported beam



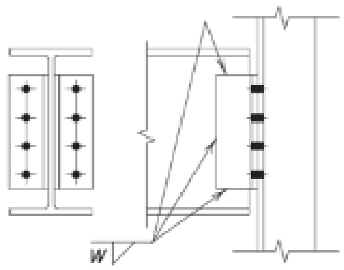
(c) Bolted/welded, angle welded to support

c. Double angle connection

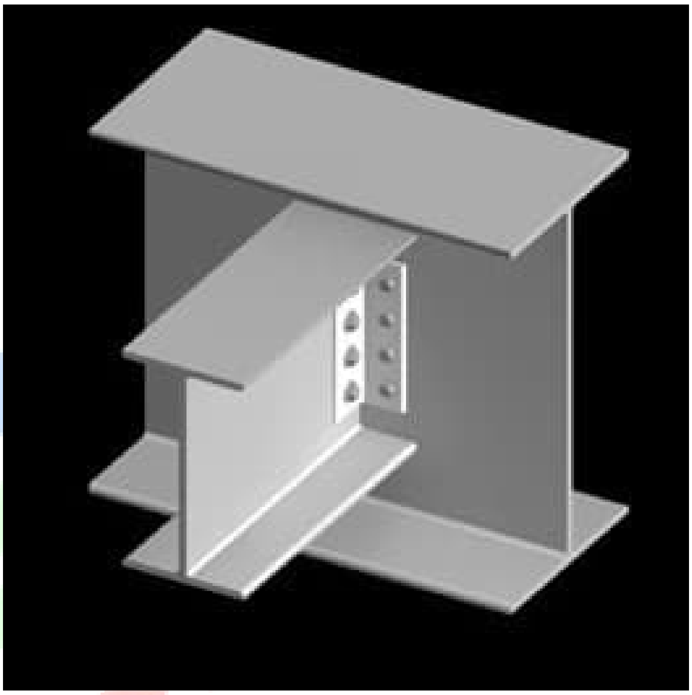
A double-angle connection is made with two angles, one on each side of the web of the beam to be supported. These angles may be bolted or welded to the supported beam as well as to the supporting member.

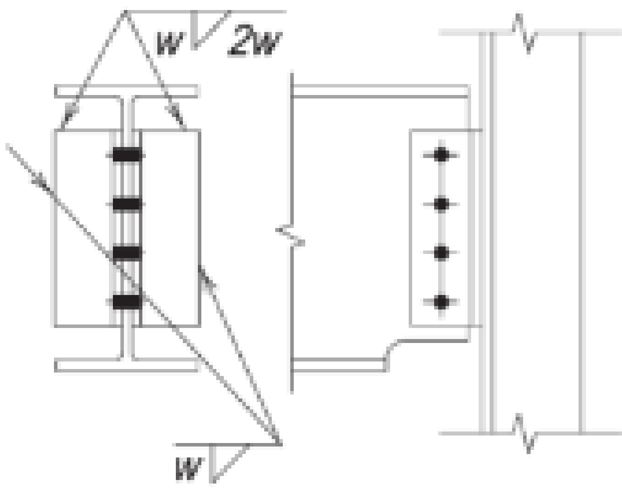


(a) All-bolted



(b) Bolted/welded, angles welded to support beam





Note: weld returns on top of angles per Specification Section J2.2b.

(c) Bolted/welded, angles welded to support

Fig. 10-4. Double-angle connections.

d. End plate connection

A shear end-plate connection is made with a plate length less than the supported beam depth. The end plate is always shop-welded to the beam web with fillet welds on each side and usually field-bolted to the supporting member. Welds connecting the end plate to the beam web should not be returned across the thickness of the beam web at the top or bottom of the end plate because of the danger of creating a notch in the beam web.

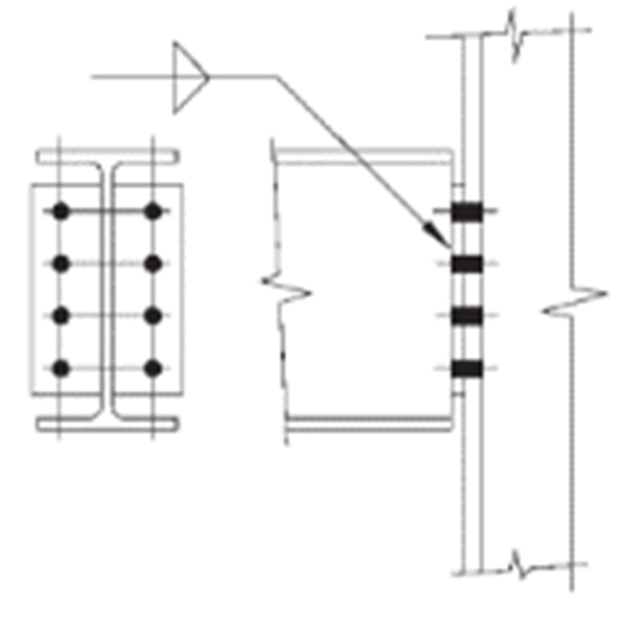


Fig. 10-6. Shear end-plate connections.

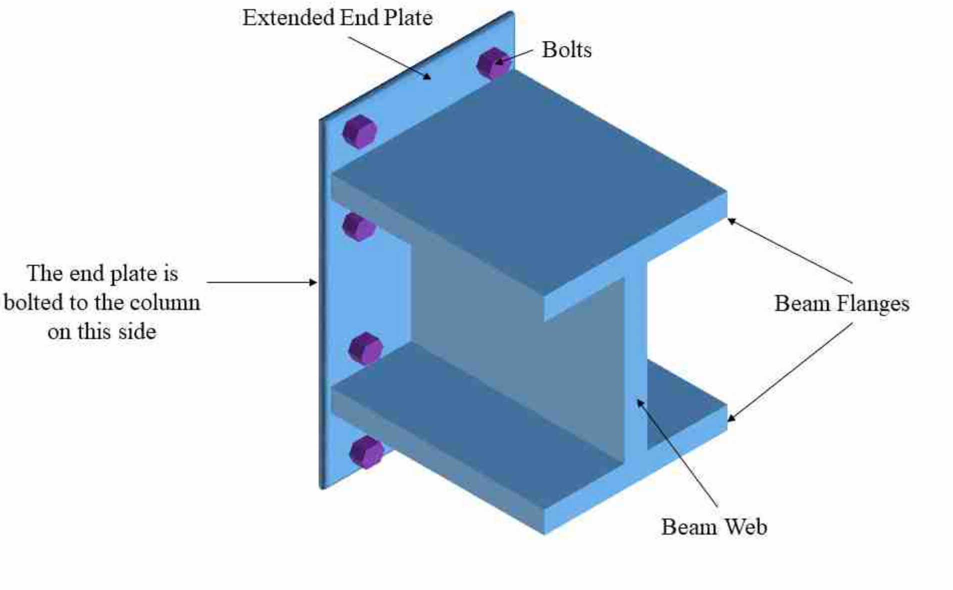
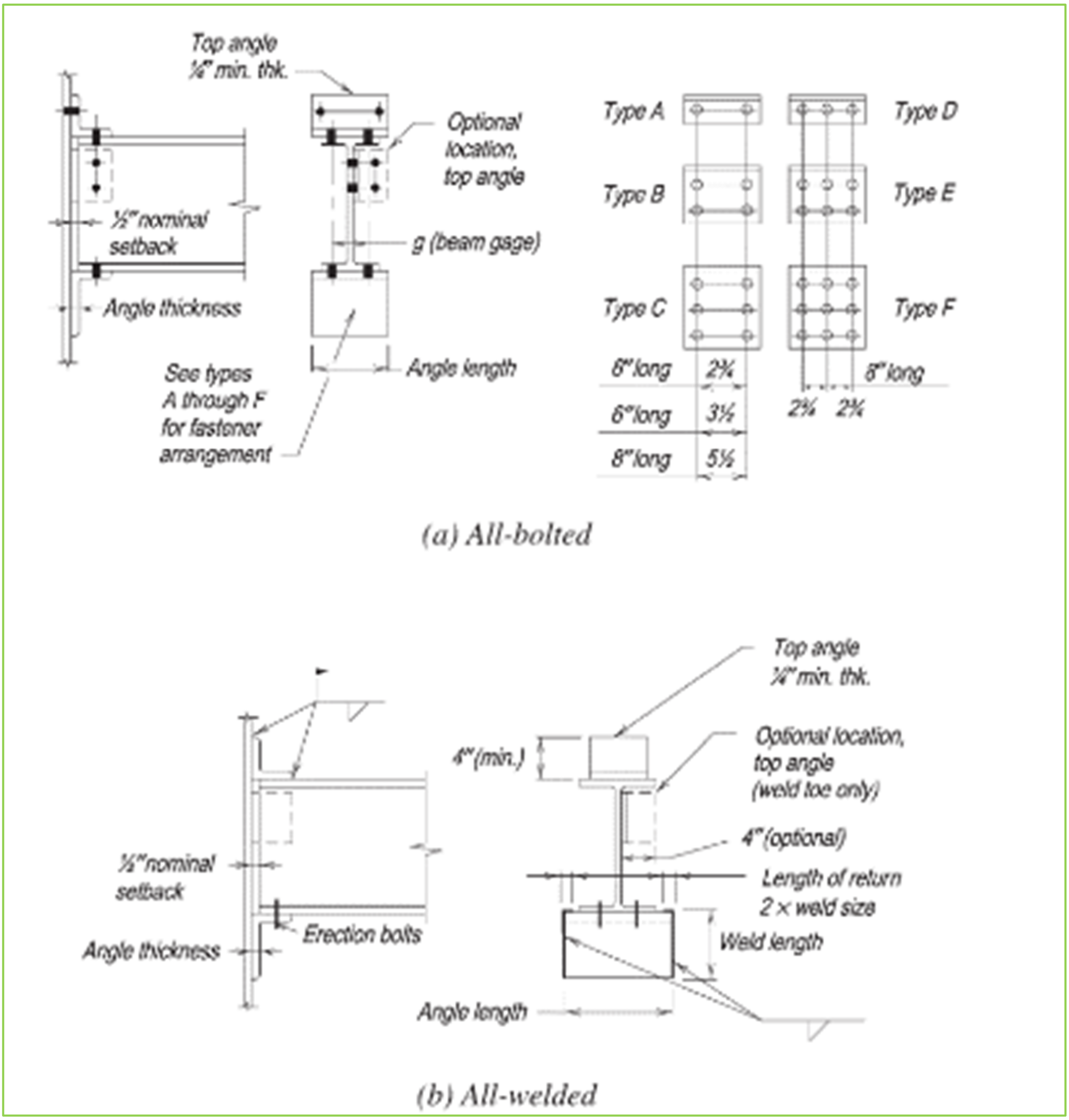
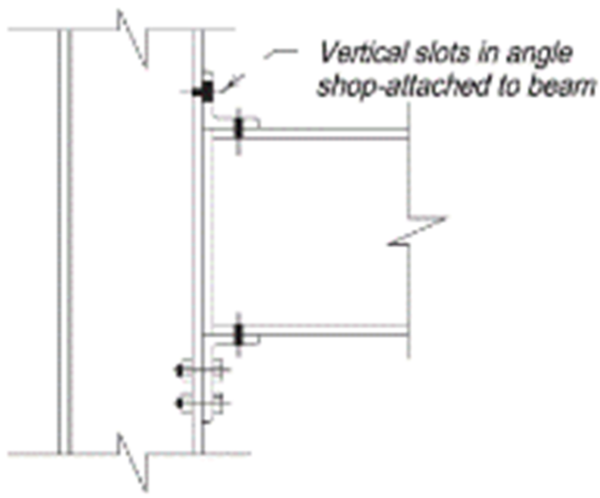


Figure 1. Diagram of a Typical Extended End-Plate Moment Steel Connection

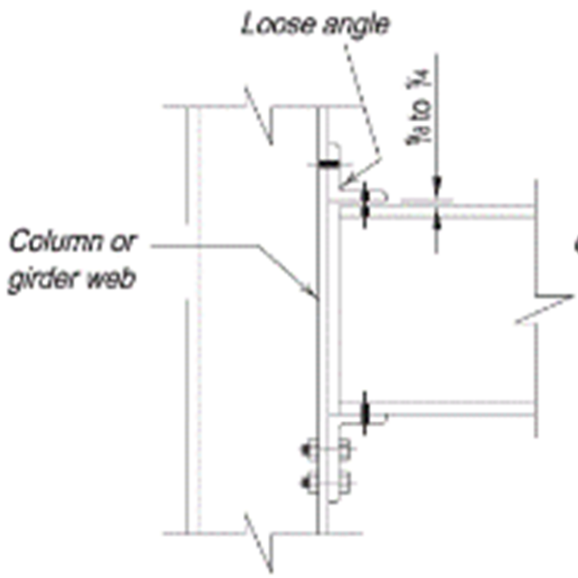
e. Unstiffened seated connection

An unstiffened seated connection is made with a seat angle and a top angle. These angles may be bolted or welded to the supported beam as well as to the supporting member.

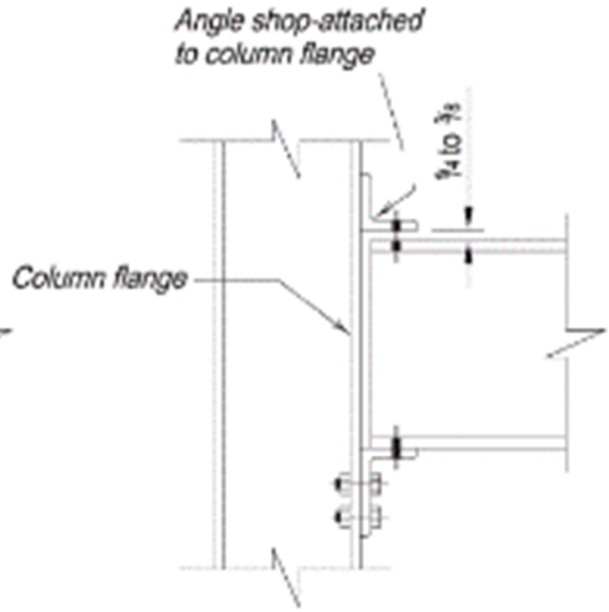




(a) Vertical slots



(b) Loose angle with clearance as shown



(c) Shop-attached to column flange with clearance as shown

f. Skewed connection

A beam is said to be skewed when its flanges lie in a plane perpendicular to the plane of the face of the supporting member, but its web is inclined to the face of the supporting member.

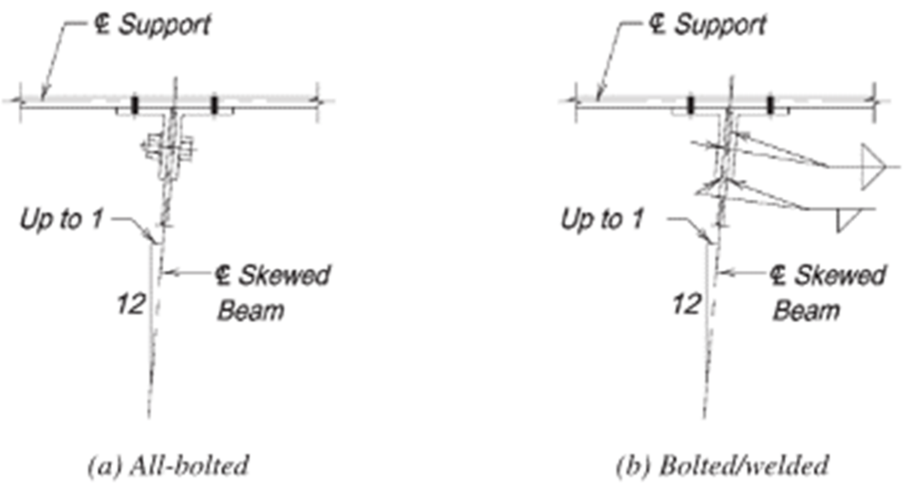


Fig. 10-34. Skewed beam connections with bent double angles.

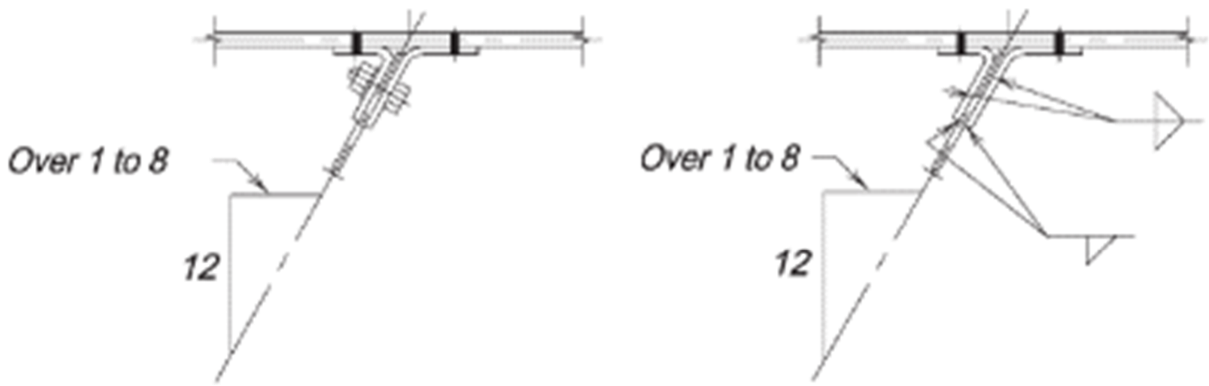


Fig. 10-35. Skewed beam connections with double bent plates.

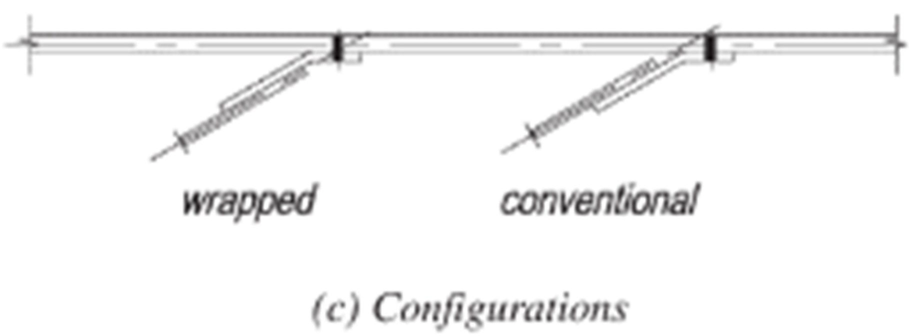
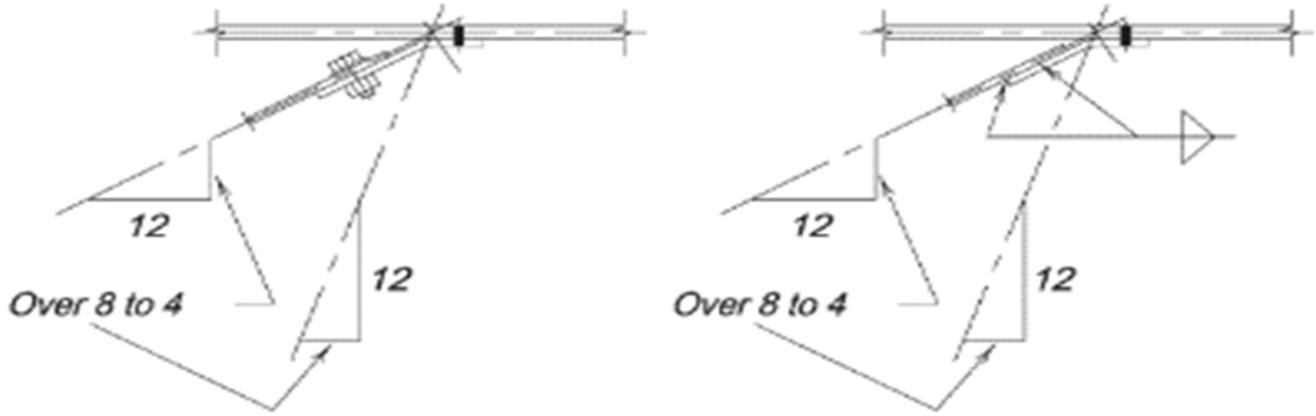
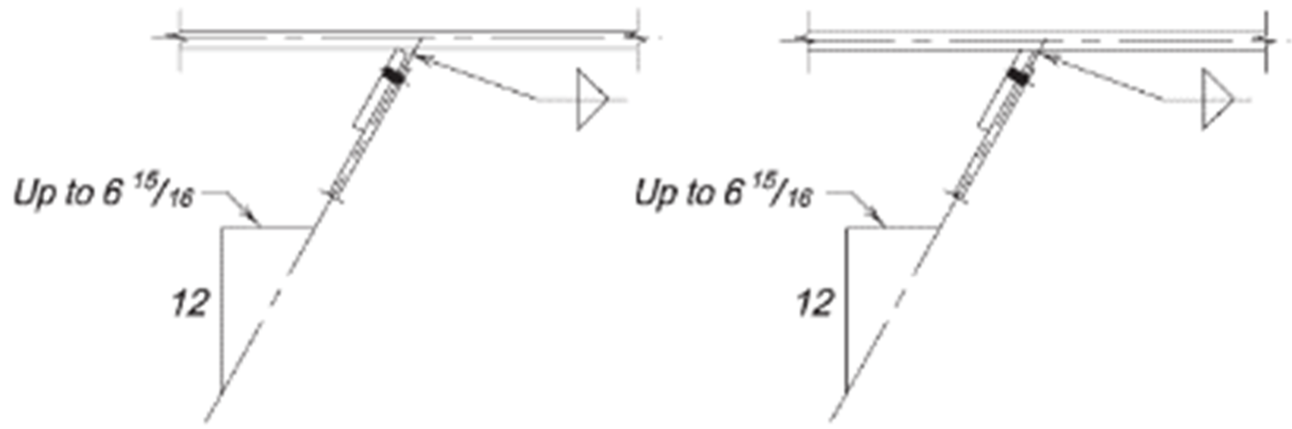


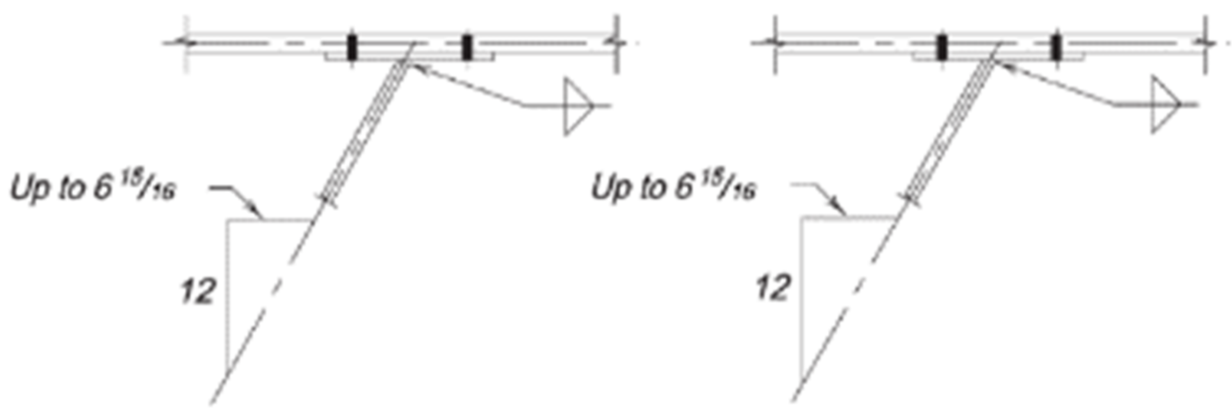
Fig. 10-36. Skewed-beam connections with single-bent plates.



(a) All-bolted (b) Bolted/welded



(a) Square edge (preferred) (b) Beveled edge (alternative)



(a) Square edge (preferred) (b) Beveled edge (alternative)

Fig. 10-38. Skewed shear end-plate connections.

g. Thru plate shear connection

In the through-plate connection, the front and rear faces of the HSS are slotted so that the plate can be passed completely through the HSS and welded to both faces

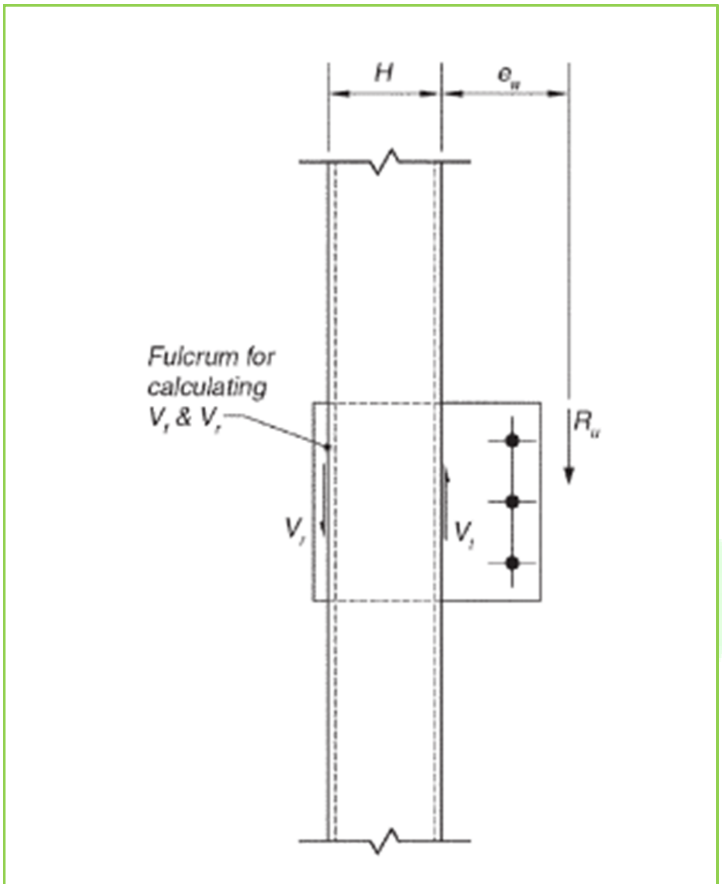
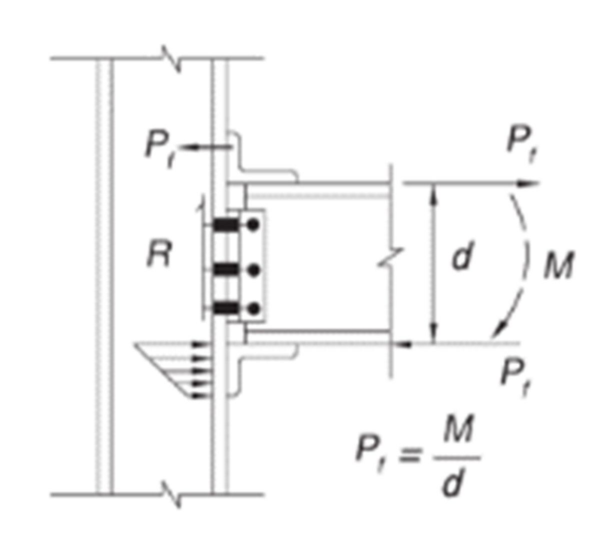


Fig. 10-47. Shear forces in a through-plate connection.

2. Partial Restrained Moment connections

a. Flange - Angle

Flange-angle PR moment connections are made with top and bottom angles and a simple shear connection.



b. Flange – Plate

A flange-plated PR moment connection consists of a simple shear connection and top and bottom flange plates that connect the flanges of the supported beam to the supporting column. These flange plates are welded to the supporting column and may be bolted or welded to the flanges of the supported beam.

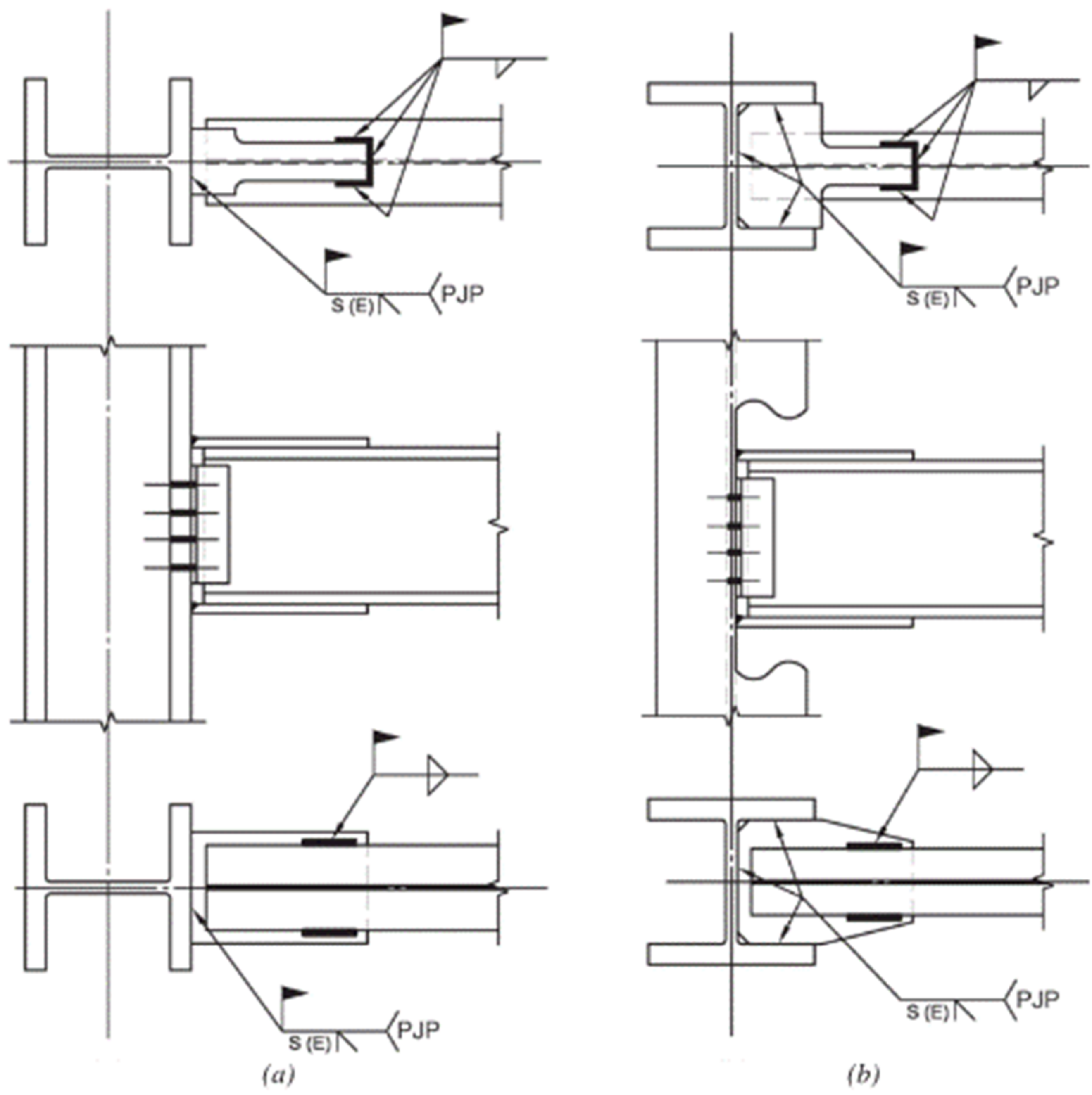


Fig. 11-4. Typical flange-plated partially restrained moment connections.

3. Fully Restrained Moment connections

a. Flange - plate bolted)

Beam to Beam connection

Moment splices can be designed to utilize flange plates and a web connection. The flange plates and web connection may be bolted or welded.

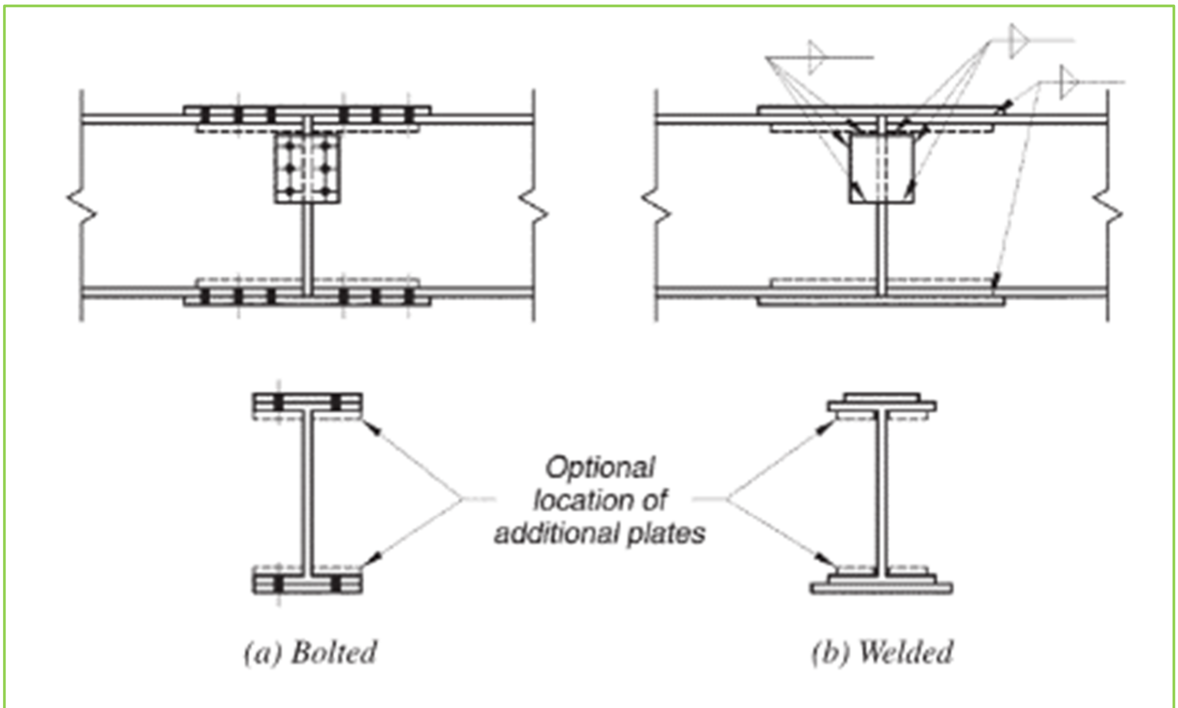


Fig. 12-7. Flange-plated moment splice.

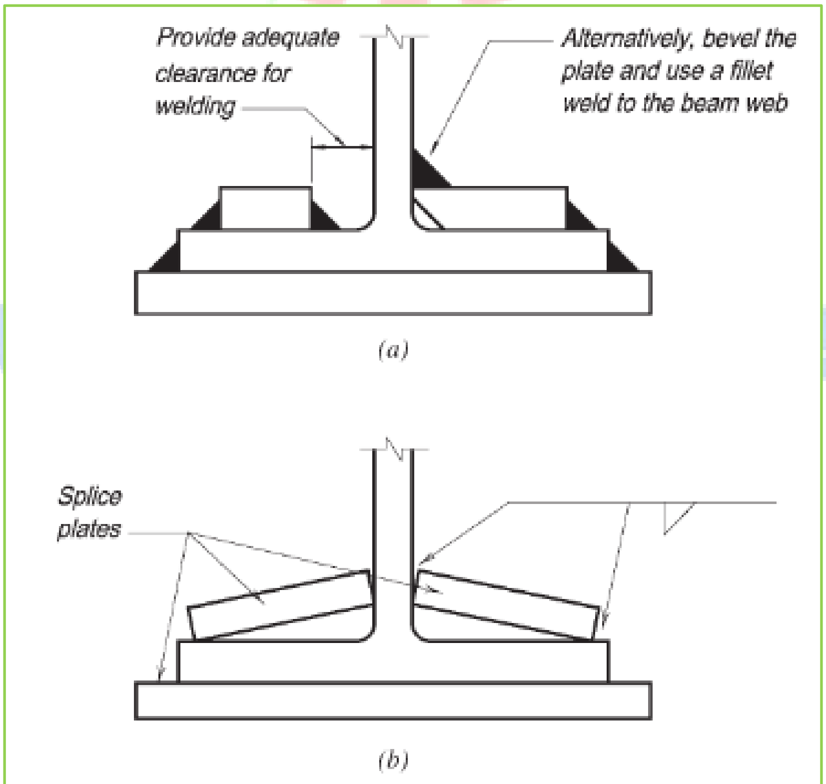
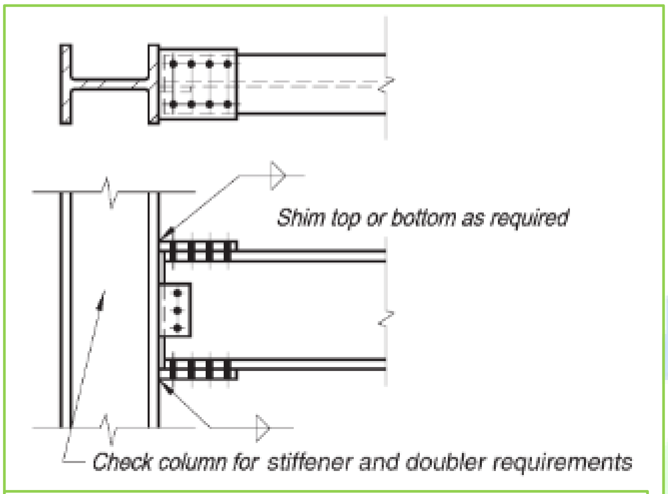
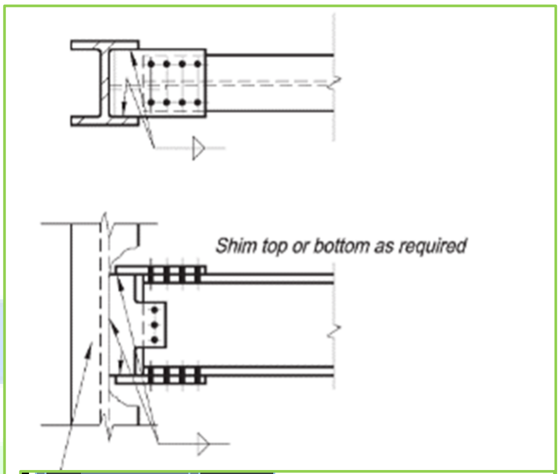


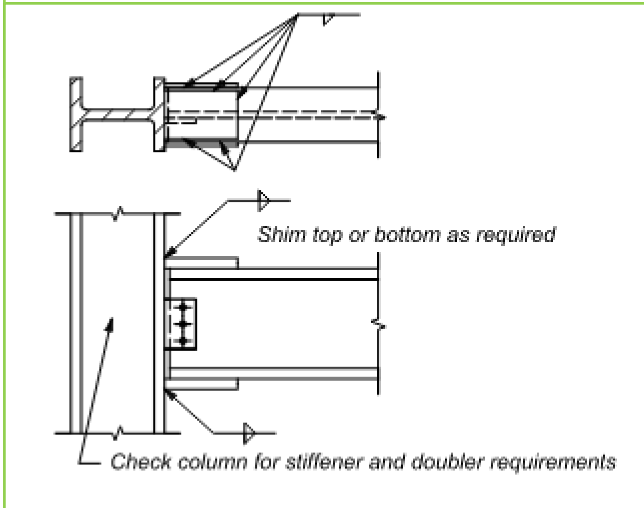
Fig. 12-8. Welding clearances for flange-plated moment splices.

Beam to column connection

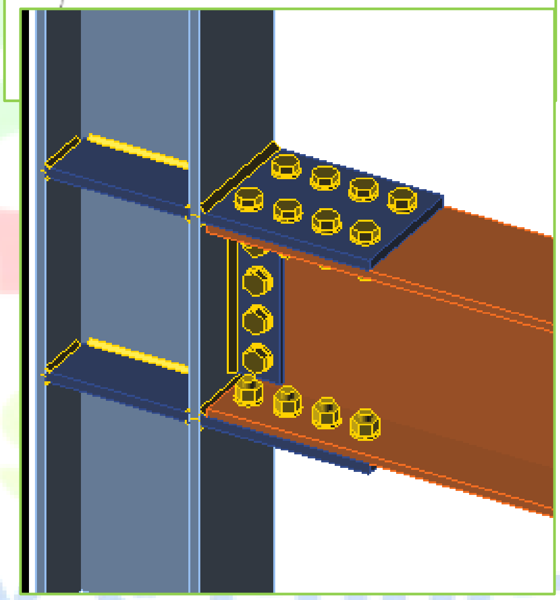
A flange-plated FR moment connection consists of a shear connection and top and bottom flange plates that connect the flanges of the supported beam to the supporting column. These flange plates are welded to the supporting column and maybe bolted or welded to the flanges of the supported beam.







(c) Column flange support, welded flange plates



b. Directly welded Flange Welded)

Beam to Beam connection

Moment splices can be designed to utilize a complete-joint-penetration groove weld connecting the flanges of the members being spliced. The web connection may then be bolted or welded.

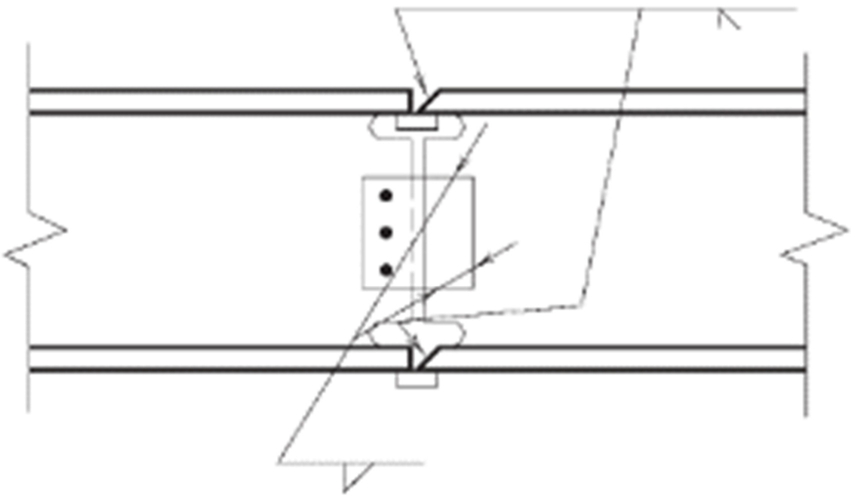
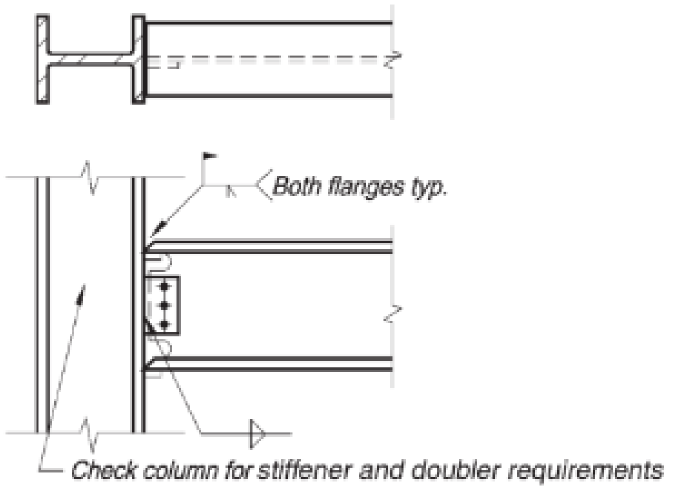


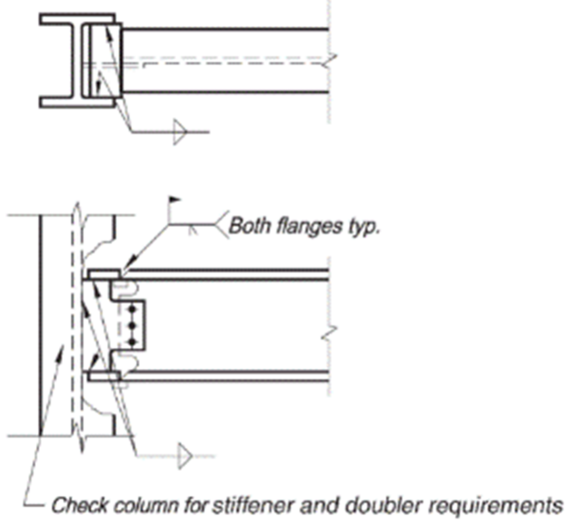
Fig. 12-9. Directly welded flange moment splice.

Beam to column connection

A directly welded flange FR moment connection consists of a shear connection and complete-joint-penetration CJP) groove welds, which directly connect the top and bottom flanges of the supported beam to the supporting column. Note, that the stiffener extends beyond the toe of the column flange to eliminate the effects of tri-axial stresses.



(a) Column flange support



(b) Column web support

c. End plate

An extended end-plate moment connection consists of a plate of length greater than the beam depth, perpendicular to the longitudinal axis of the supported beam. The endplate is always welded to the web and flanges of the supported beam and bolted to the supporting member.

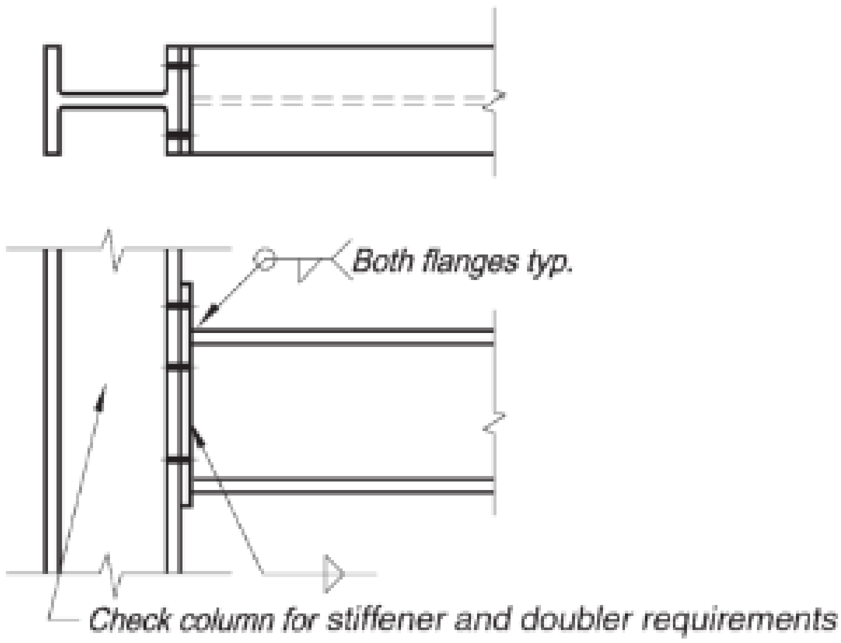


Fig. 12-5. Extended end-plate FR moment connection.

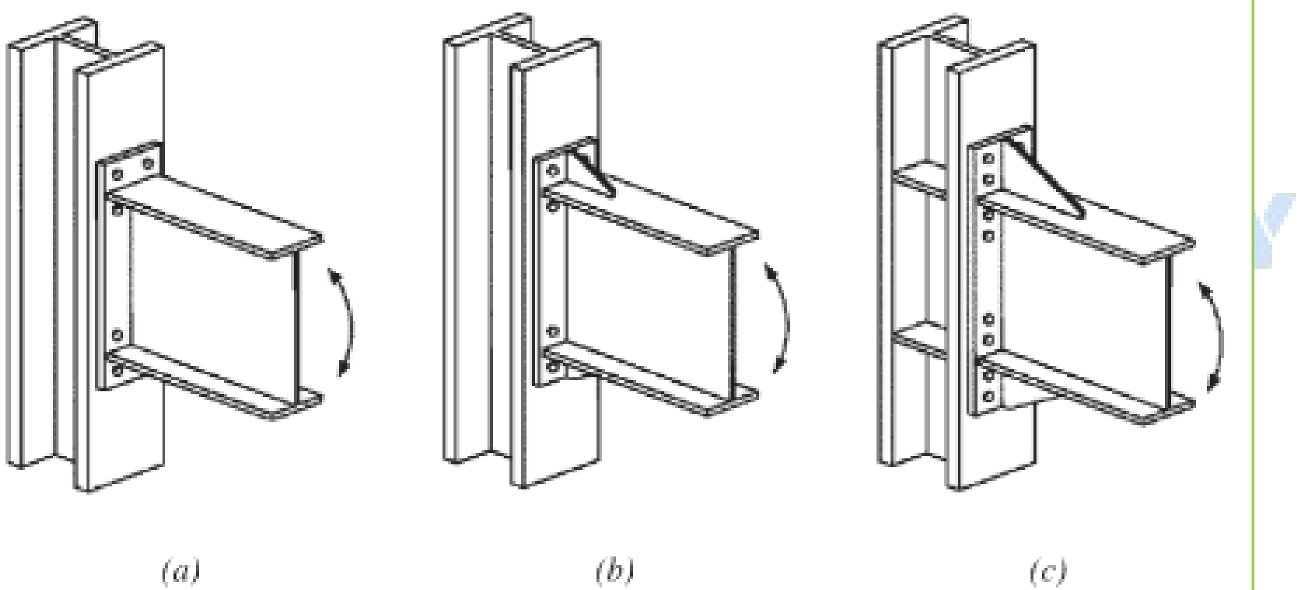


Fig. 12–6. Configurations of extended end-plate FR moment connections.

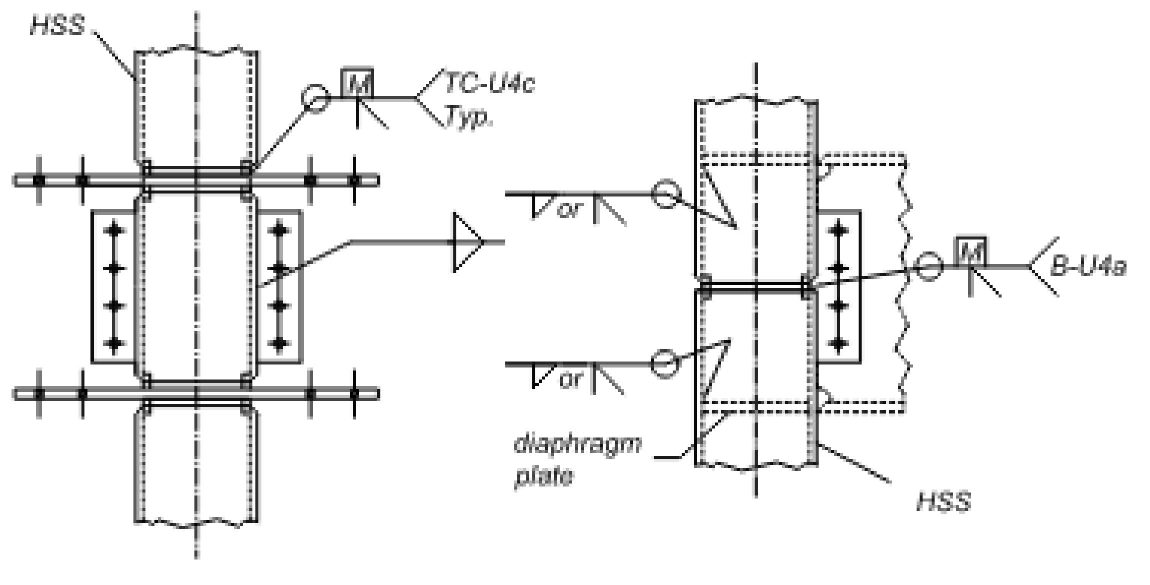
d. Through plate

If the required moment transfer to the column is larger than can be provided by the bolted base plate or cap plate, or if the HSS width is larger than that of the wide flange beam, a through-plate moment connection can be used. It should be noted that through-plate connections are more difficult to erect than continuous beam-connected framing.

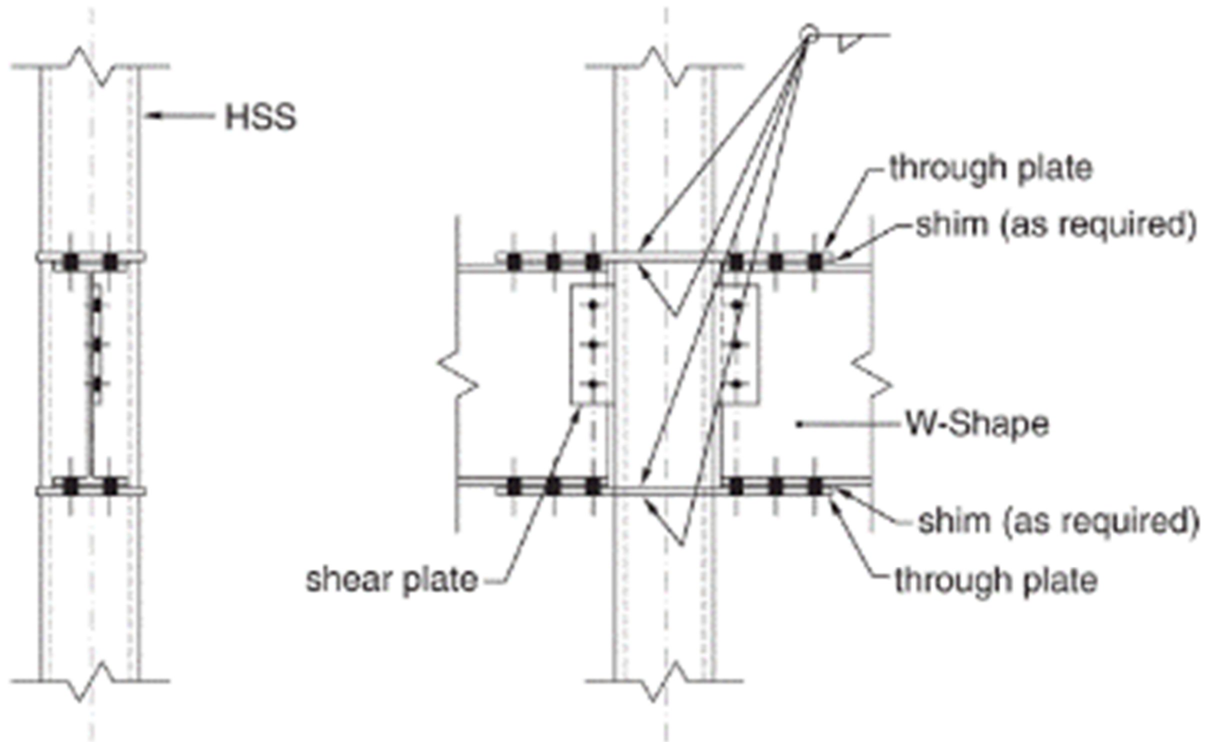
HSS cut-out plate

An alternative to interrupting the HSS for the cover or through-plate is to use a wider plate with a cut-out to slip around the HSS. A shear plate can be placed on the front and rear of the HSS faces to provide simple connections for perpendicular beams. The cut-out plate can easily be extended on the near and far sides so that a moment splice is created about both horizontal axes through the joint. The perpendicular framing should ideally be of the same depth for this detail to work well or, in the case of the simple connections, the perpendicular beams could be shallower than the space between the horizontal plates. The cut-out plates are shown as shop-welded; however, they could be field-welded.

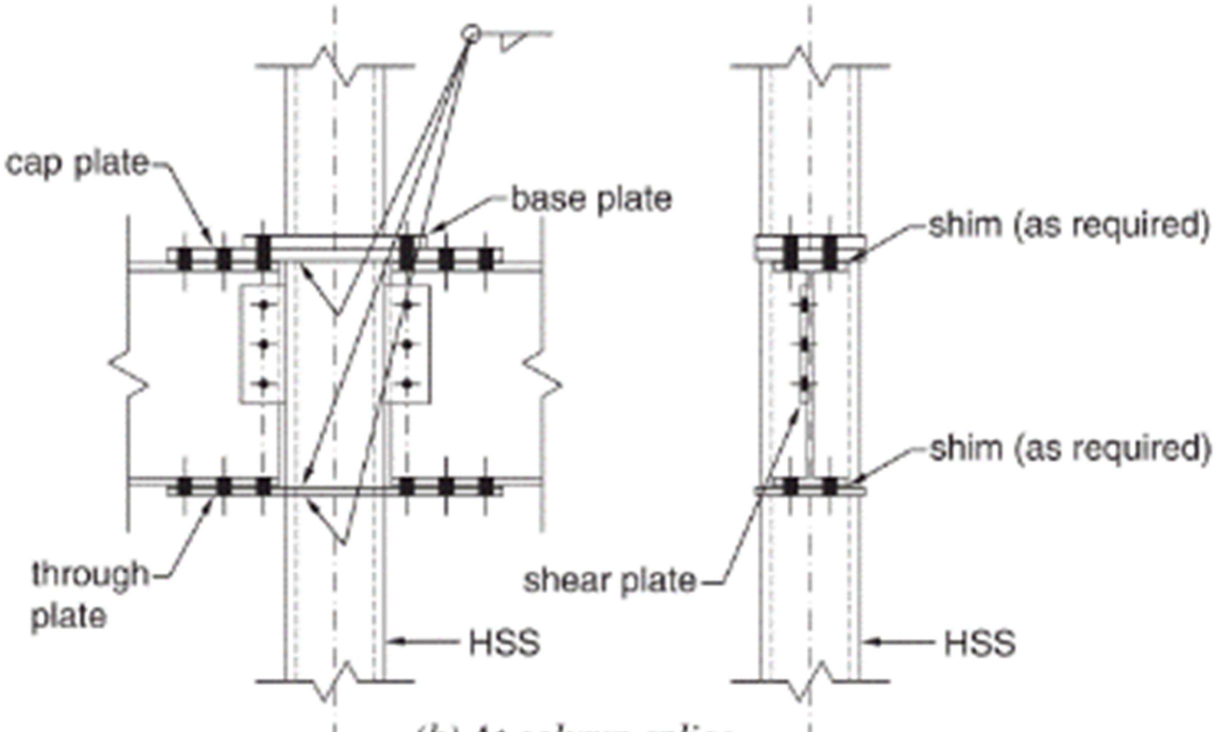
For cut-out plate connections, the erection of the beams is more difficult than for continuous beam connections. The beams must be slipped between the two plates and against the single plate connection with shimming being required unless the upper plate is field welded in place.



Through-Plate Diaphragm Interior Plate Diaphragm



(a) Between column splices



(b) At column splice

Fig. 12-16. Through-plate moment connection.

e. Exterior plate

It may be possible to accomplish the moment transfer to the HSS without having to use a WT splice plate, endplates, or diaphragm plate. Significant moment transfer can be achieved by attaching the W-shape directly to the face of the HSS either by welding or by bolting. These connections can develop the available flexural strength of the HSS. The available flexural strength of the W-shape, however, is seldom achieved because of the flexibility of the HSS wall.

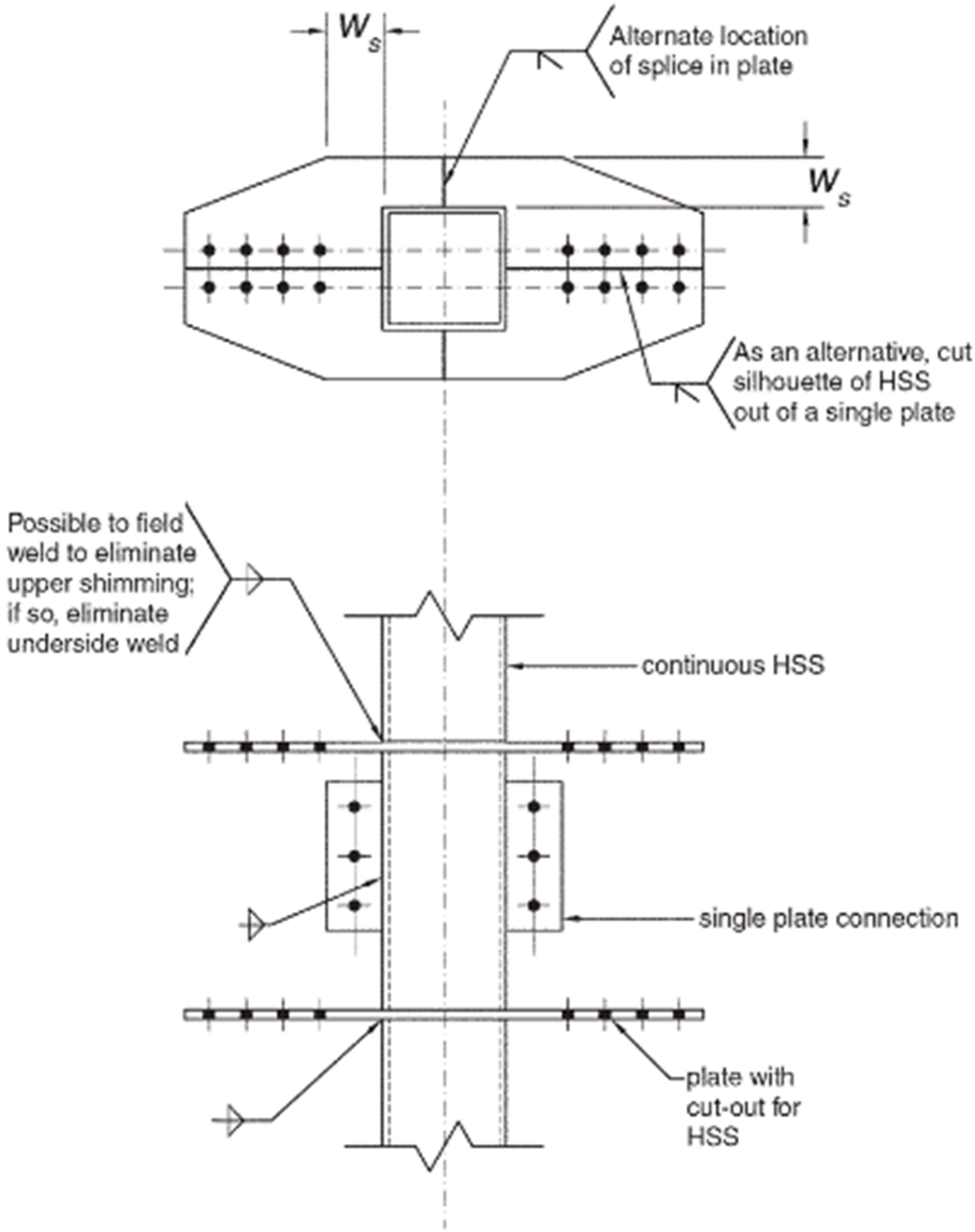
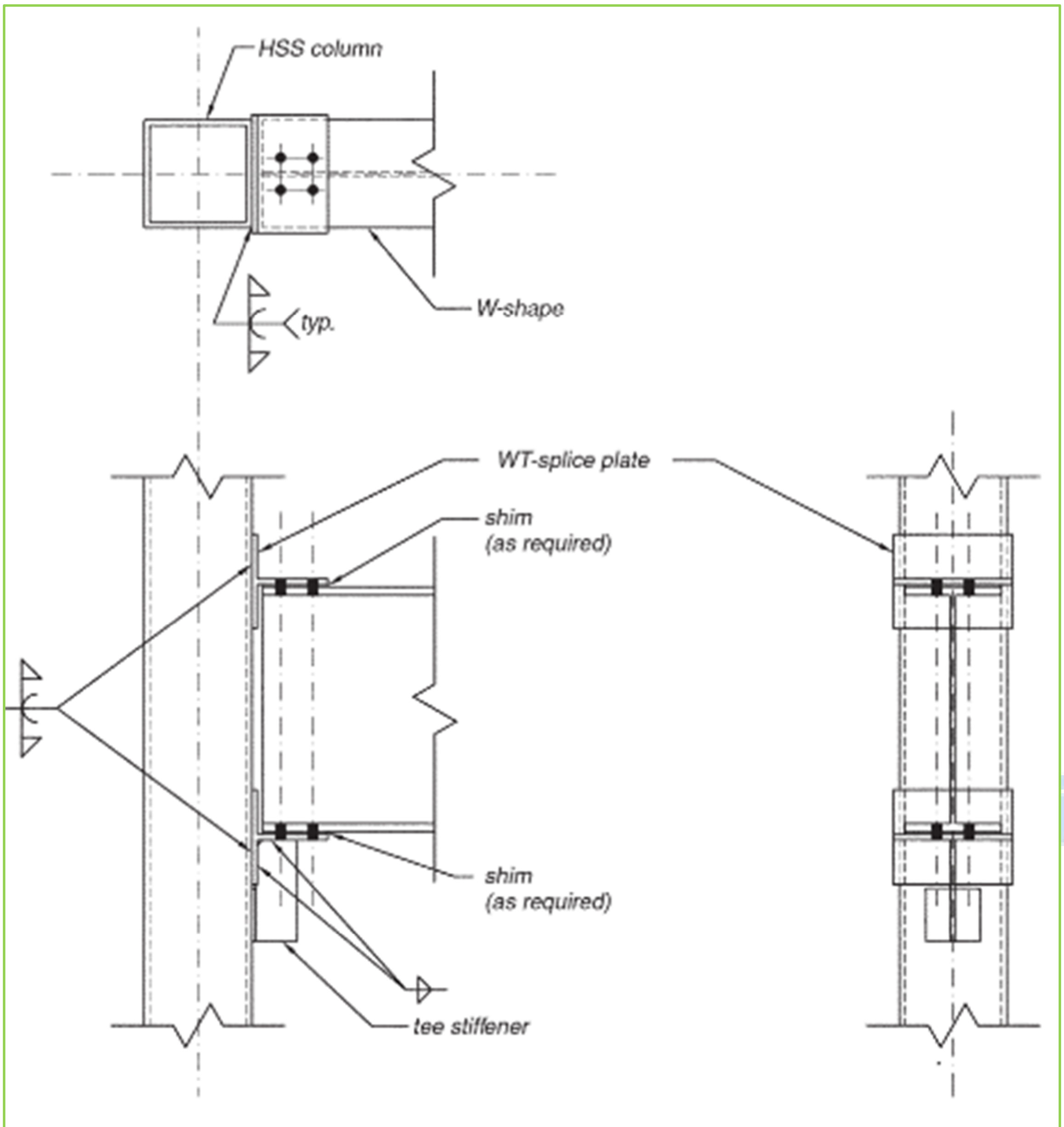


Fig. 12-17. Exterior plate moment connection.

f. HSS Welded Tee Flange Connections

If the primary moment transfer is from a wide flange to an HSS, rather than through the HSS to another wide flange, several other connection concepts will work well. One of these is to use structural tee sections to transfer the force from the flanges of the wide flange to the walls of the HSS. The tees should be long enough so that a flare bevel groove or single J-groove) weld with weld reinforcement can be used to connect the tee to the HSS. An alternative to using the tees to transfer the beam shear would be to use a single plate connection if a deep enough plate can be fitted between the flanges of the tees.

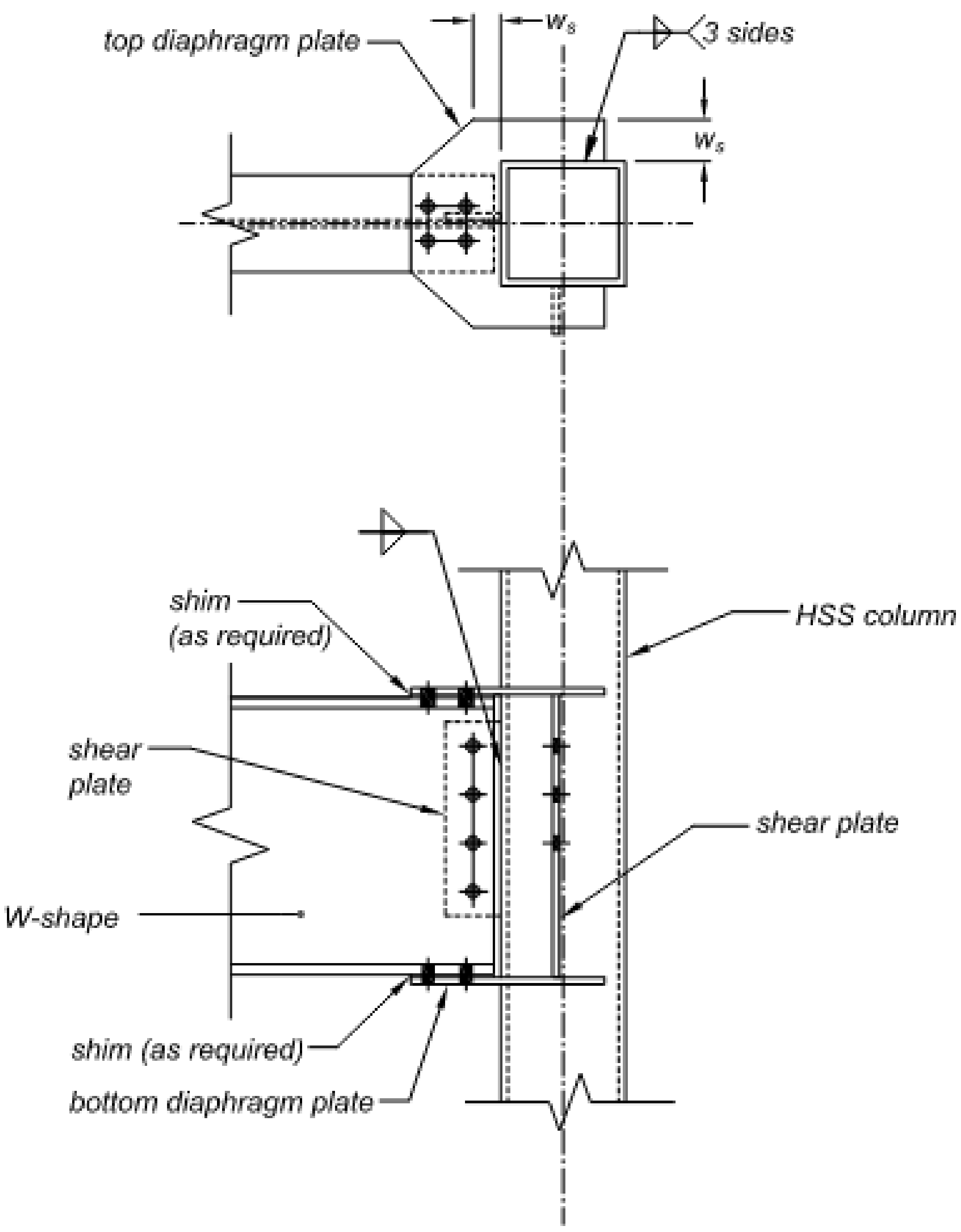


Note: A shear plate could be used in lieu of the vertical tee stiffener

Fig. 12-20. Tee splice plates to HSS column.

g. HSS Diaphragm Plate Connections.

If the moment delivered by the W-shape to the HSS cannot be transmitted by other means, then the use of diaphragm plates that transfer the flange loads to the sides of the HSS is appropriate. For this moment connection, the limit states are those indicated for the cut-out plate connection plus a check of the weld transferring shear from the flange plate to the HSS wall.



Note: A stiffened seat could also be used in lieu of the shear plate.

Fig. 12-21. Diaphragm plate splice to exterior HSS column.

4. Lateral systems

One project may use multiple types of lateral systems because each system has its strengths, limitations, and potential architectural implications. There are three common types of lateral resisting systems:

a. Braced frames
b. Rigid frames
c. Shear walls.

a. Braced frames

A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively intension-compression.

Bracing Connections involve the bolting of flat, angle, channel, I-section, hollow section, and rods members to a gusset plate to support the column or other members.

- Cross bracing
- CheVron bracing
- Inverted CheVron bracing
- Diagonal bracing
- Eccentric brace frame systems EBF)
- Buckling-Restrained braced frames BRB)

The location of doors and/or windows on the braced frame frequently determines the bracing configuration for the structure.

Eccentric bracing can help dissipate seismic forces through the beam or girder and therefore is commonly used in areas with a lot of seismic activity.

Braced frames are generally more cost-effective than other lateral systems.

Horizontal bracing (Cross, V, diagonal bracing)

The bracing at each floor level provides load paths for the transference of horizontal force to the planes of vertical bracing. Horizontal bracing is needed at each floor level. However, the floor system itself may provide sufficient resistance. Roofs May require bracing.

Vertical bracing (Cross, V, diagonal bracing)

Bracing between column lines in vertical planes) provides load paths for the transference of horizontal forces to ground level. Framed buildings require at least three planes of vertical bracing to brace both directions in plan and to resist torsion about a vertical axis.

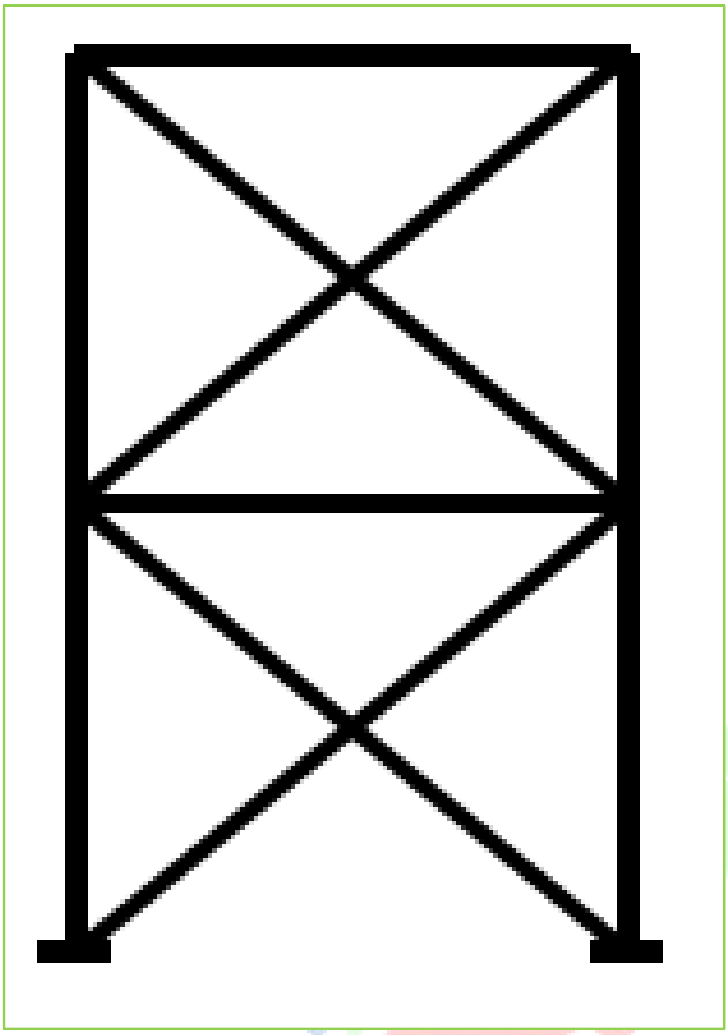
Cross bracing

The cross-brace frame is perhaps the most used system. A typical multi-floor building elevation with cross-braced bays beginning at the foundation level. Only one bay of bracing, the height and size of the specific structure may call for bracing multiple bays along a given column line. As with all braced-frame configurations, it's important to establish the location of these bays quite early in a project's development.

Each intersection will have a common "work point" at which the centerlines of a column, beams, and diagonal members intersect. Gusset plate connections are used to join the steel members because all of them can't physically intersect at the work point.

When a building exceeds two or three stories, the diagonal members may support substantial loads that require large gusset plates to be placed directly next to the column and beams. These plates can take up space that may otherwise be required for mechanical and plumbing systems as well as architectural soffit details. To avoid costly field revisions during construction, the structural engineer must provide the architect with information about the approximate size of the gussets in the planning phase.

Cross-braced bays make the most of steel's strength in tension to efficiently use small structural shapes. When a tension-only cross-braced system experiences a horizontal force from wind or a seismic event, only one leg of the cross-brace will provide resistance. When the load comes from the opposite direction, the other leg will become active in its place.



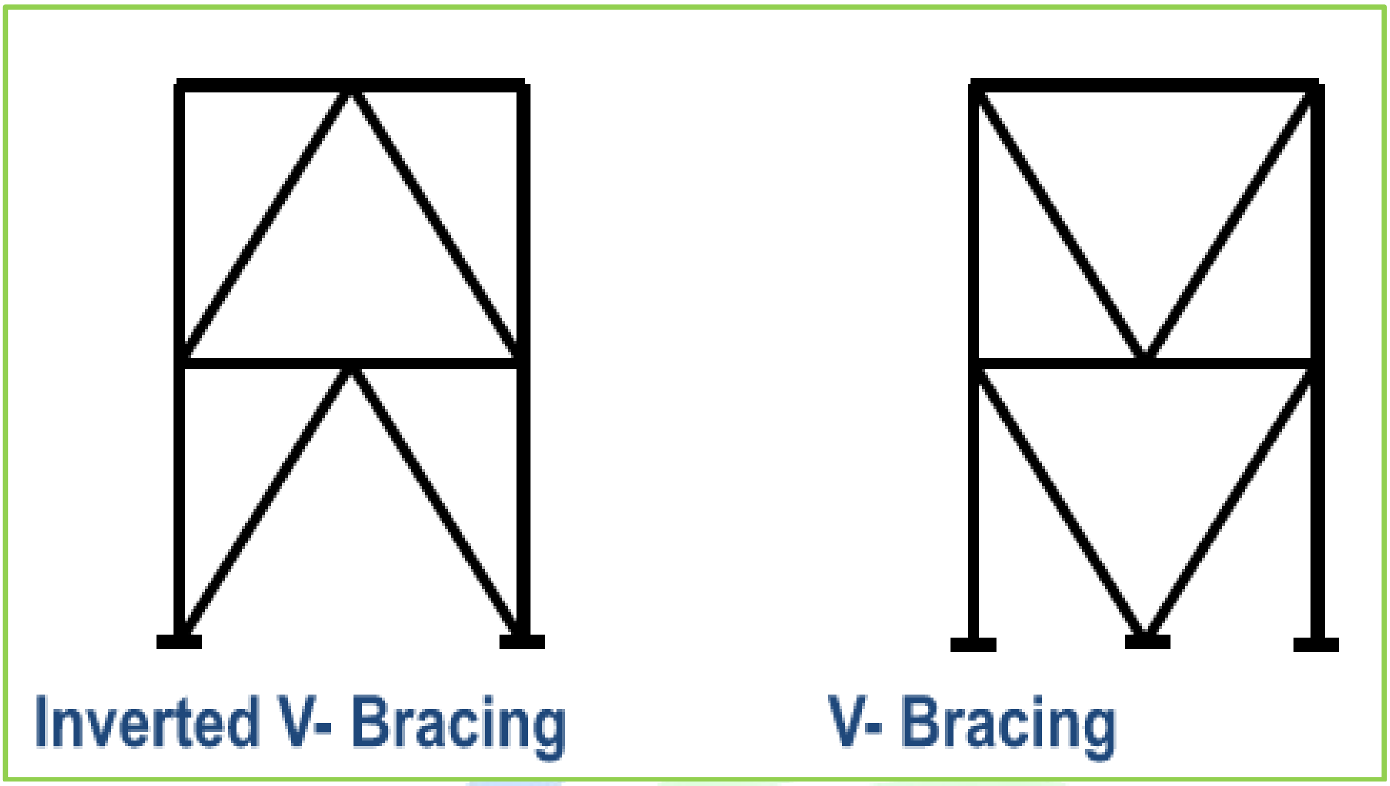
CheVron bracing (V bracing)

chevron bracing is a modified brace-frame form that generally allows for doorways or corridors in the center of the bays.

Gusset plates typically connect chevron brace elements to associated beams and columns. The members can be either welded or bolted together, depending on processes at the steel fabrication shop or aesthetic considerations.

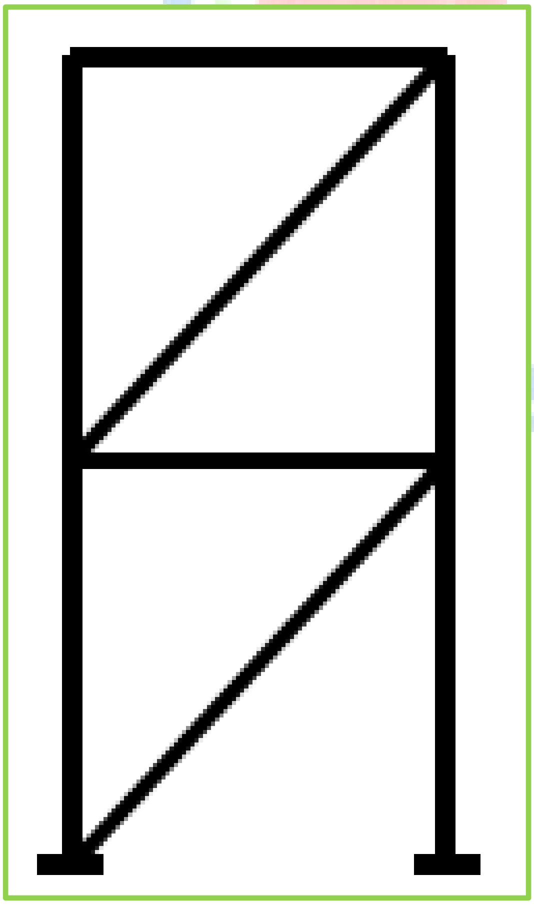
In situations where the chevron brace diagonal members attach to the structure above, the layout and coordination of mechanical ductwork and utility piping above the doorways and corridors must account for the depth of the gusset plate connection.

This bracing configuration subjects members to gravity compressive loads. Each of the bracing members is considered active in the analysis of the system when lateral loads are applied. As a result, the bracing elements experience both tensile and compressive forces.



<u>Diagonal bracing</u>

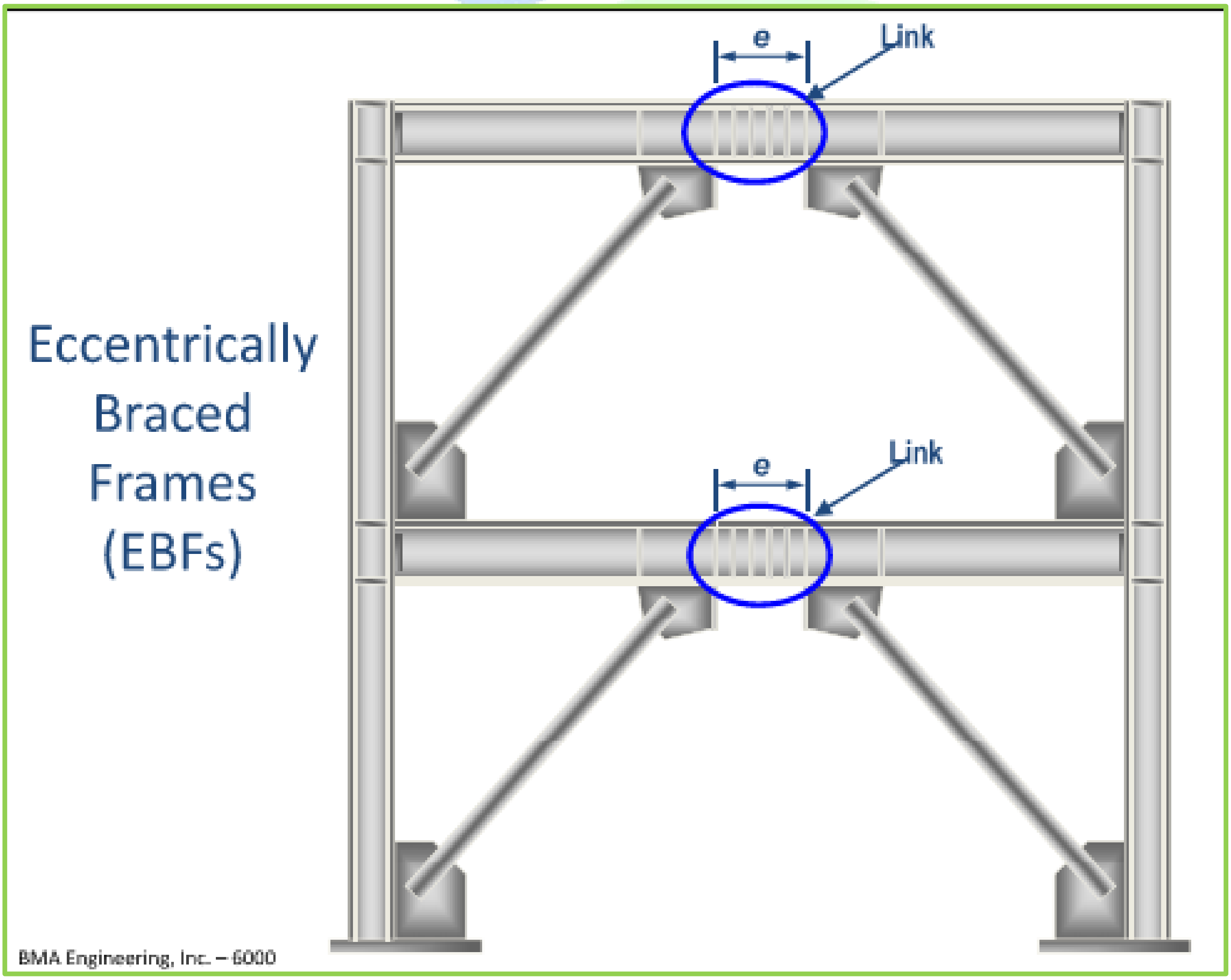
Diagonal bracing creates stable triangular configurations within the steel building frame.

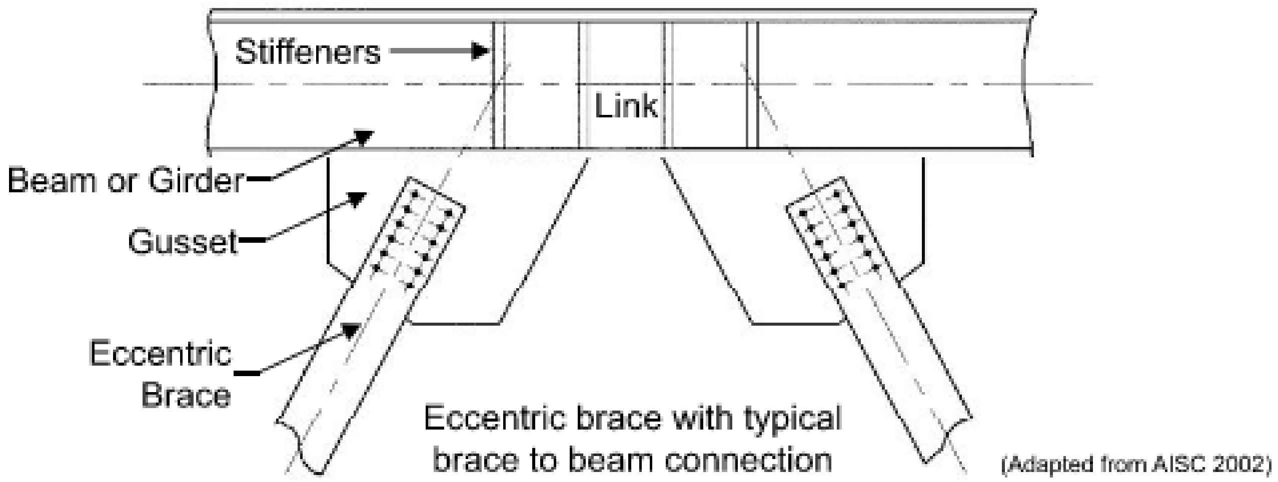


Eccentric bracing frame systems (EBF)

Eccentrically braced frames are very similar to chevron-braced frames. In both systems, the general configuration is a rotated "K" shape with the brace connected to a column and the beam/girder at the level above. However, brace members intersect at the same point in a chevron-braced frame; that is not the case in an eccentrically braced frame. You can see this condition.

An eccentric brace is commonly used in seismic regions where a structure must have a significant amount of ductility or energy absorption. The segment of beam/girder located between the diagonal bracing member is designed to "link" the diagonal braces and help the system resist lateral loads caused by seismic activity. An eccentrically braced system is typically more expensive than a traditional chevron brace system because it uses larger beams and girders and because the brace connections are more complex.





b. Rigid frames

Rigid frames, or moment frames, are used when the architectural design or some other constraint does not allow for diagonally braced frames. This type of lateral resisting system incorporates rigid welded or bolted connections between the columns and the beams/girders. Rigid frames are generally more expensive and less efficient at resisting lateral loads than a braced-frame system. However, the low-rise building spans frequently use rigid frames when the bays can't accommodate diagonal braces.

It's best to have well-proportioned bays with shorter span beams to manage building drift. This is one of the challenges of working with a rigid frame system.

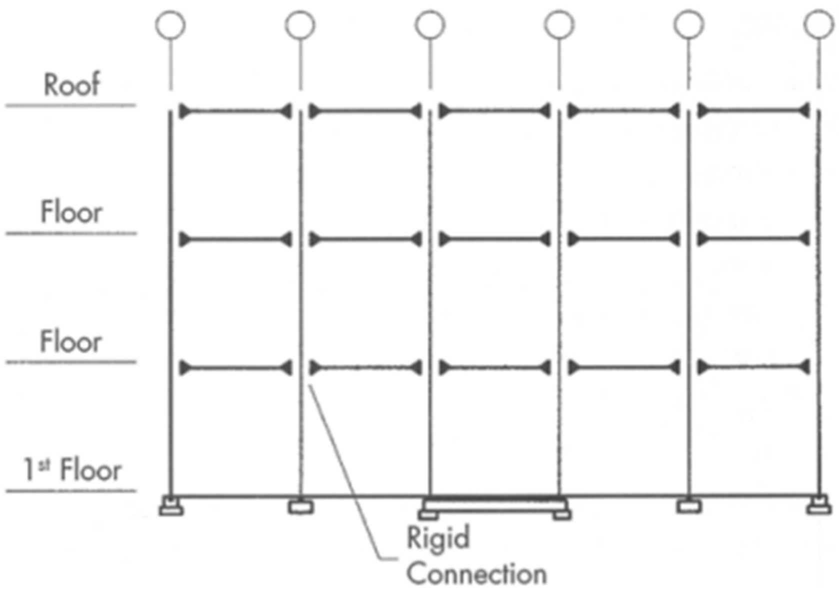
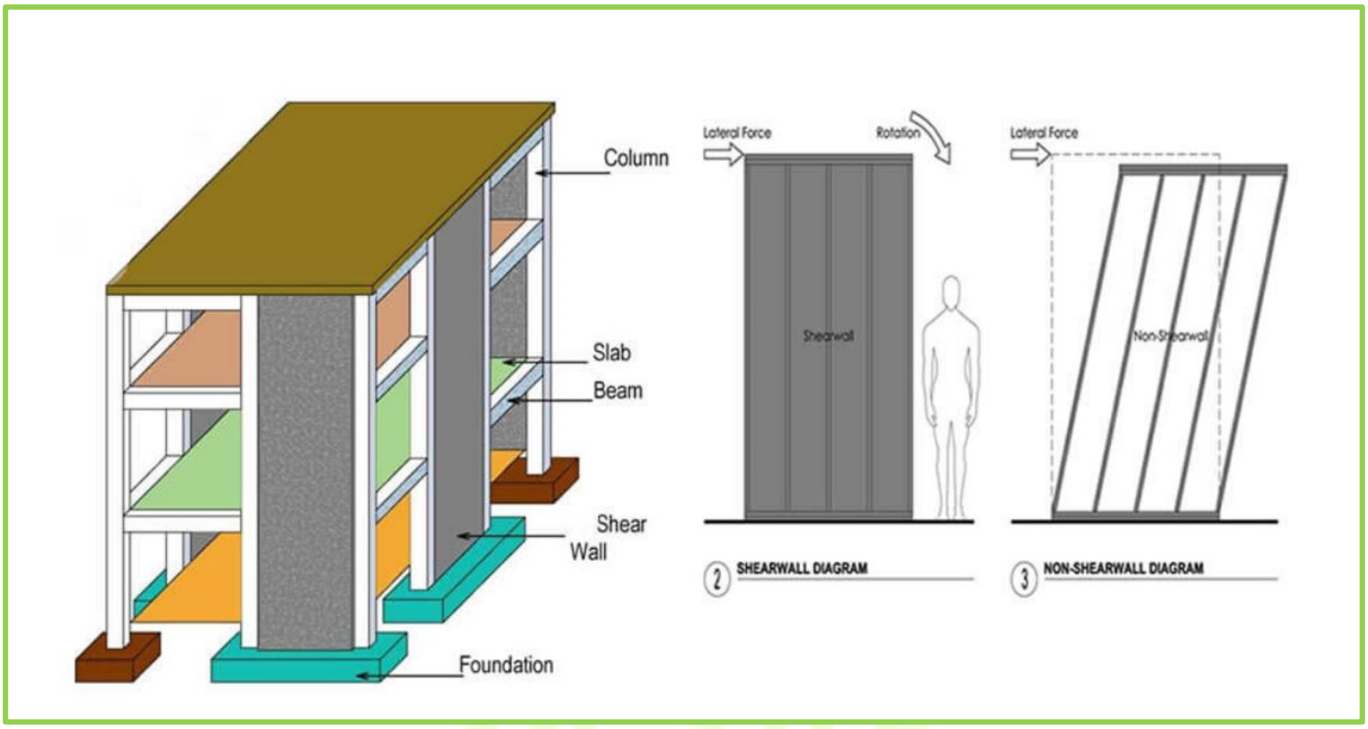


Fig. 11. Rigid frame building elevation.

c. Shear walls

This type of lateral load-resisting system engages a vertical element of the building, usually concrete or masonry, to transfer the horizontal forces to the ground by a primary shear behavior. Shear walls are inherently stiff elements and are therefore extremely effective at resisting lateral wind loads. Steel shear walls are also now available, as well as composite plate shear wall cores for tall buildings that use a non-proprietary system called Speed Core. The Speed Core system can significantly increase the speed of erection, and a shorter construction time can save a significant amount of money.

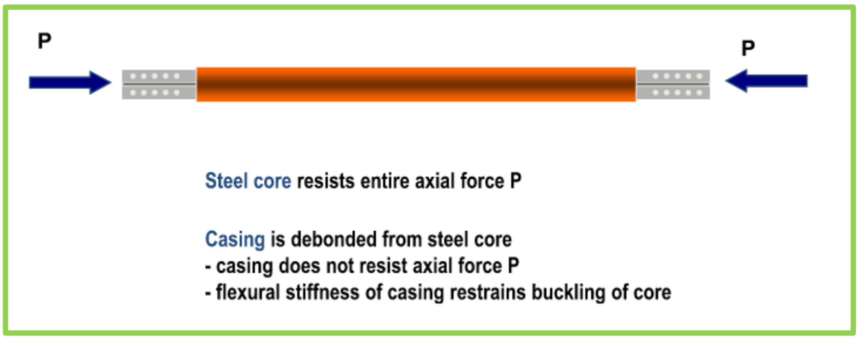


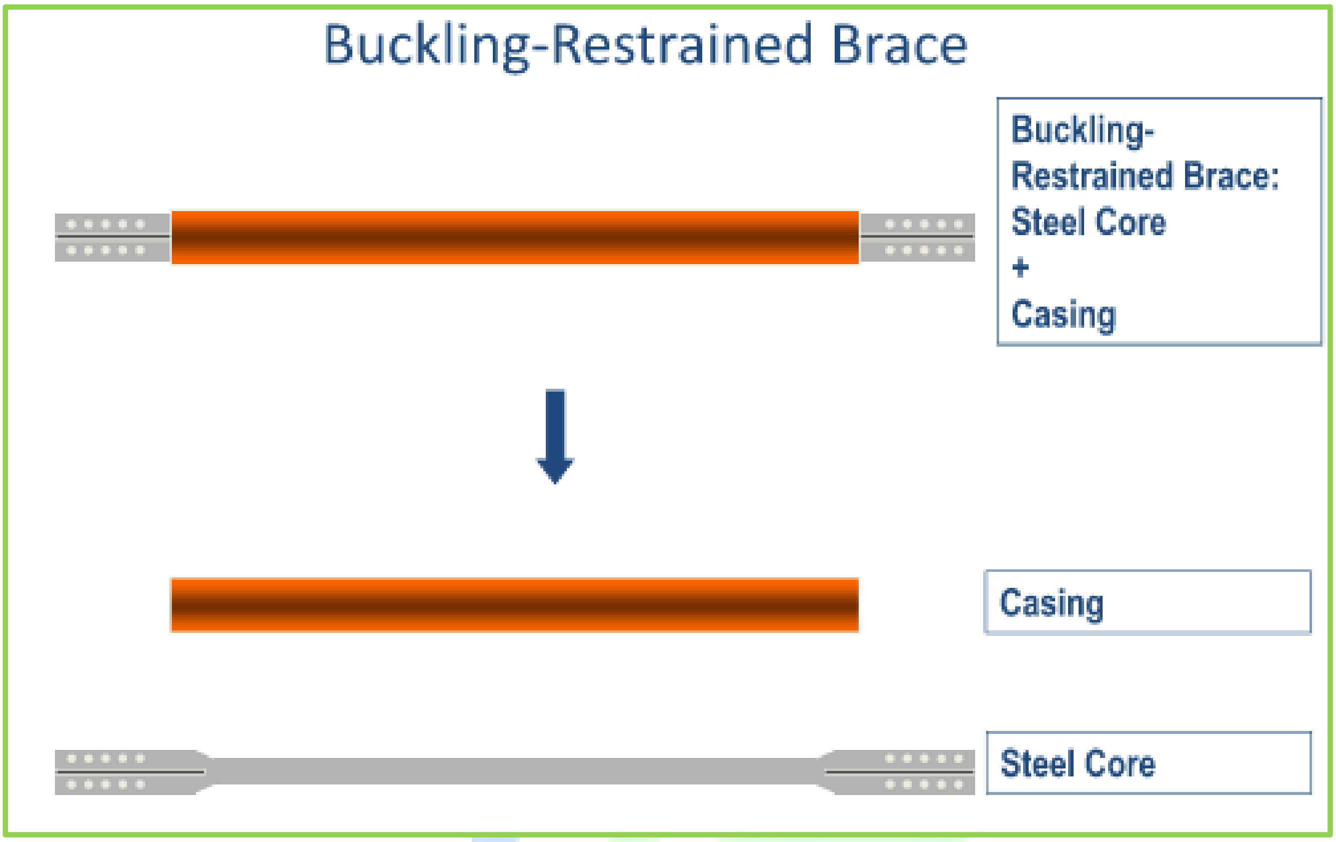
Buckling-Restrained braced frames (BRB)

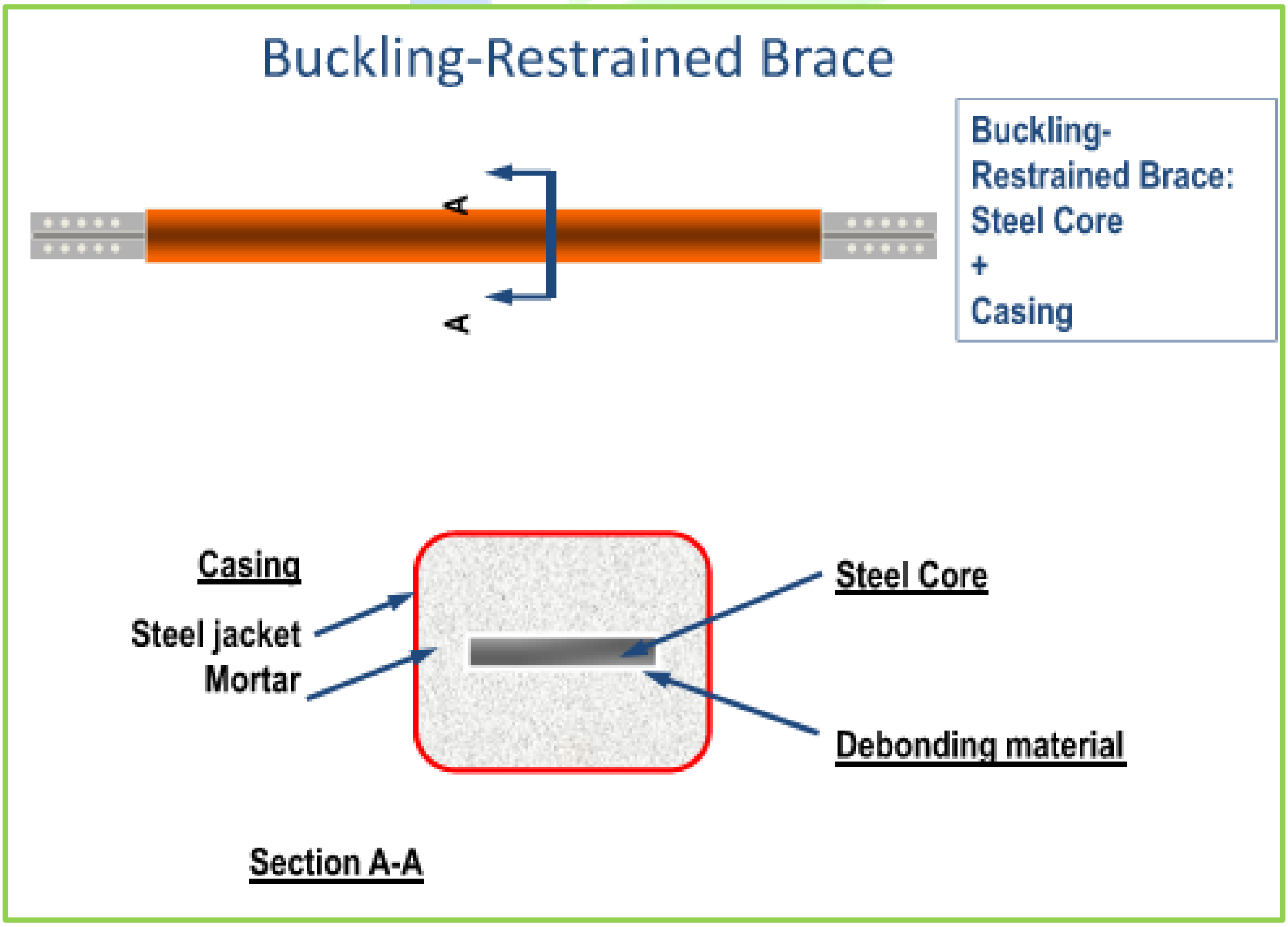
Type of concentrically braced frame

Beams, columns, and braces are arranged to form a vertical truss. Resist lateral earthquake forces by truss action

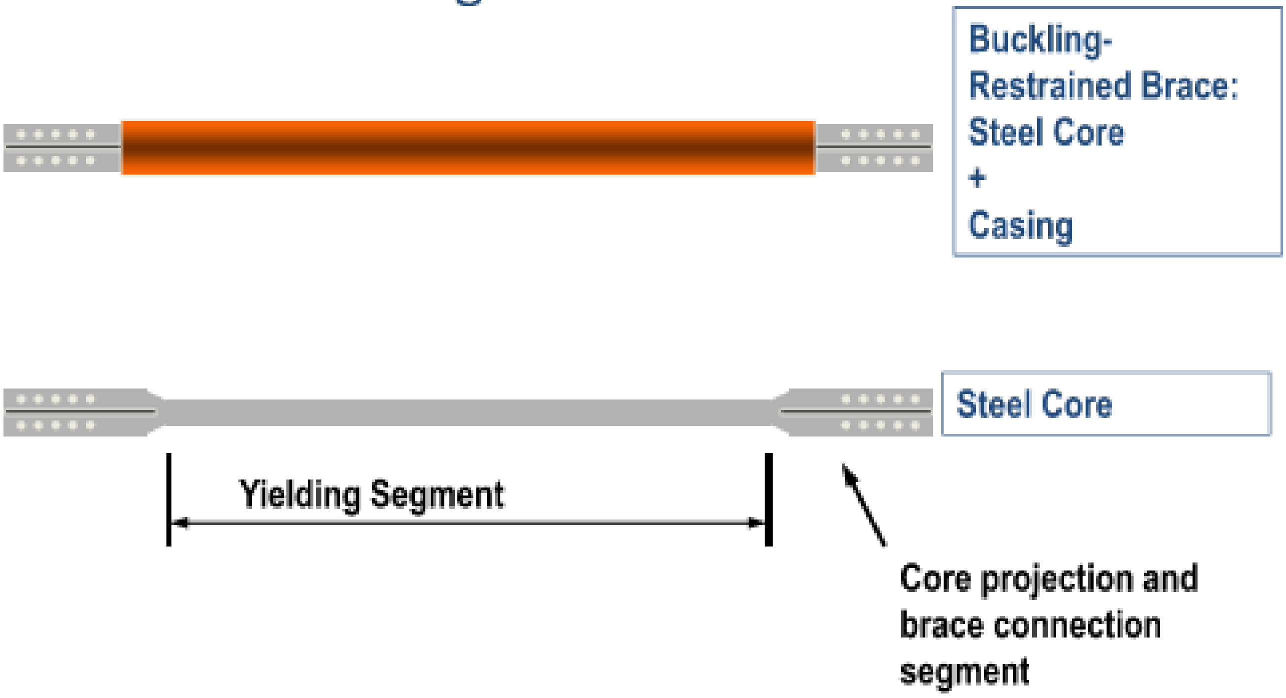
A special type of brace member is used: Buckling-restrained braces BRB). BRB yield both in tension and compression – No buckling.




Buckling-Restrained Brace
Buckling-Restrained Brace: Steel Core + Casing
Casing
Steel Core


Buckling-Restrained Brace
Buckling-Restrained Brace: Steel Core + Casing
A
A
Casing
Steel jacket
Mortar
Steel Core
Debonding material
Section A-A

Buckling-Restrained Brace



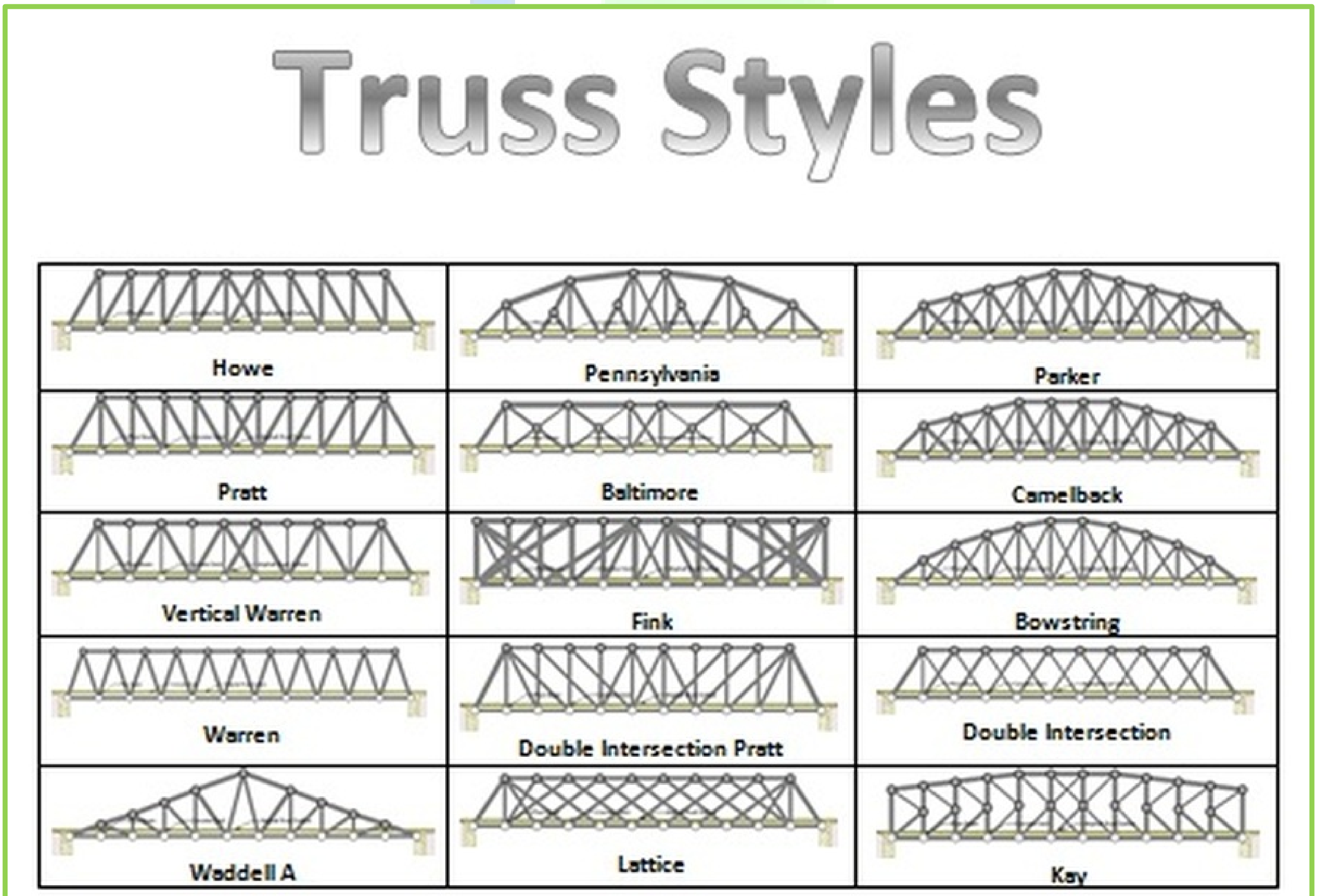
Buckling-Restrained Braced Frames (BRBFs)

5. Truss connections

A truss is an assembly of members such as beams, connected by nodes, that create a rigid structure

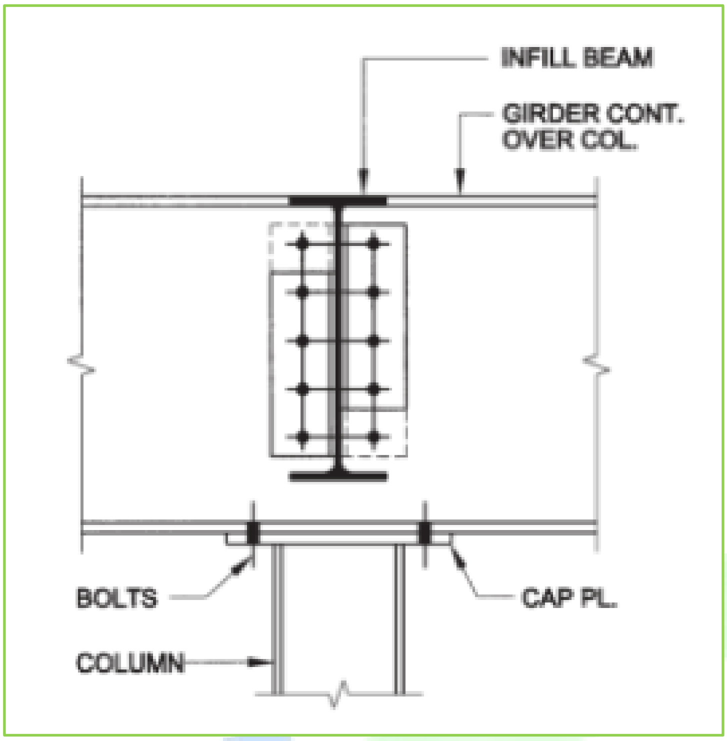
In engineering, a truss is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object. A"two-force member" is a structural component where force is applied to only two points. Although this rigorous definition allows the members to have any shape connected in any stable configuration, trusses typically comprise five or more triangular units constructed with straight members whose ends are connected at joints referred to as nodes.

In this typical context, external forces and reactions to those forces are considered to act only at the nodes and result in forces in the members that are either tensile or compressive. For straight members, moments torques) are explicitly excluded because, and only because, all the joints in a truss are treated as revolute, as is necessary for the links to be two-force members.

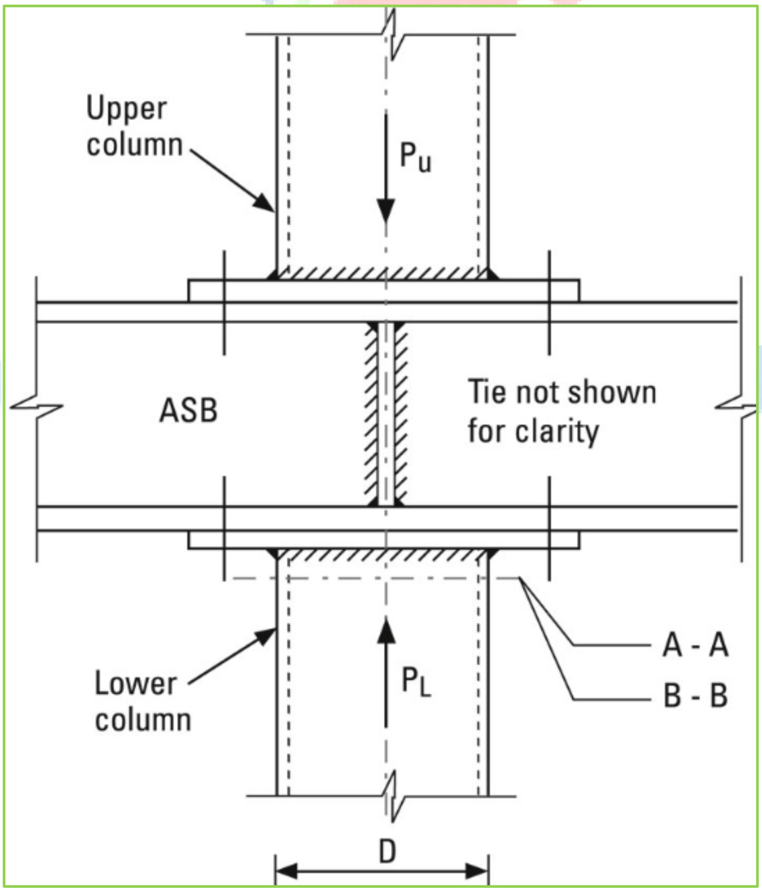


6. Bearing connection

a. Beam bearing on column connection

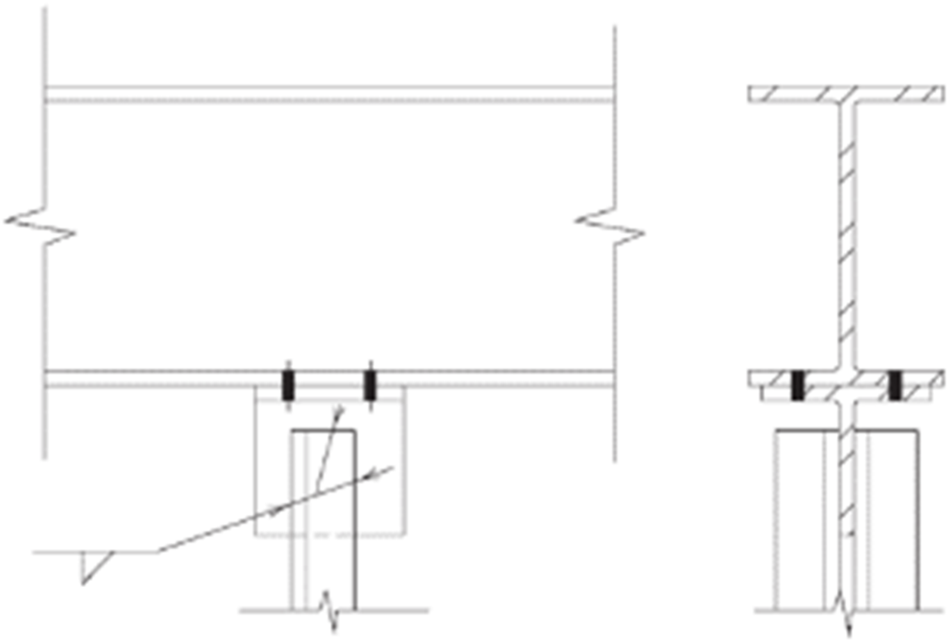


b. Column bearing on beam connection

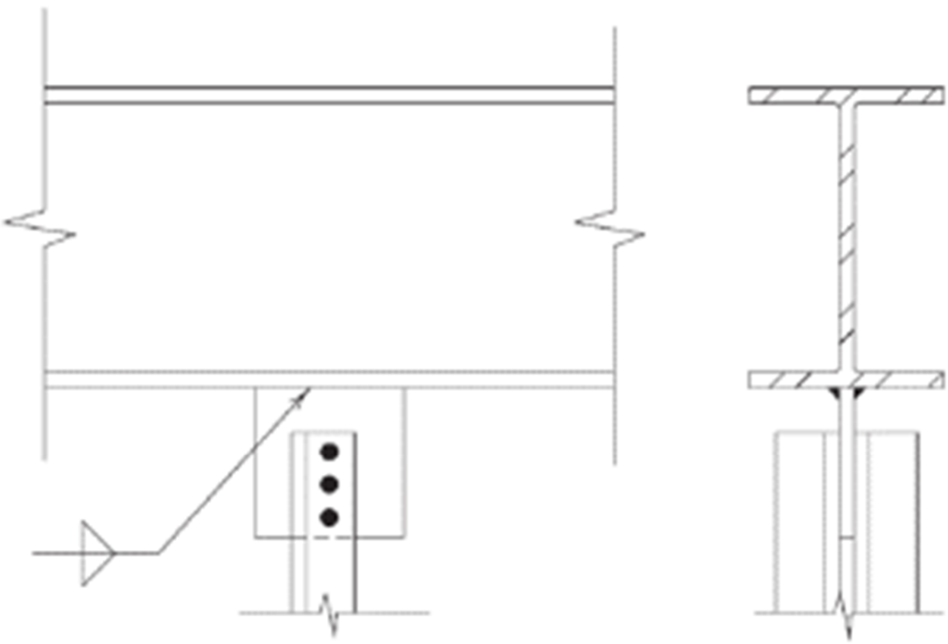


7. Hanger connections

Hanger connections are usually made with a plate, tee, angle, or pair of angles. The available strength of a hanger connection is determined from the applicable limit states for the bolts, welds, and connecting elements



(a) Tee hanger



(b) Plate hanger

Reference moment connections: -

REDUCED BEAM SECTION (RBS) MOMENT CONNECTION

5.1. GENERAL

In a reduced beam section (RBS) moment connection (Figure 5.1), portions of the beam flanges are selectively trimmed in the region adjacent to the beam-to-column connection. Yielding and hinge formation are intended to occur primarily within the reduced section of the beam.

5.2. SYSTEMS

RBS connections are prequalified for use in special moment frame (SMF) and intermediate moment frame (IMF) systems within the limits of these provisions.

5.3. PREQUALIFICATION LIMITS

1. Beam Limitations

Beams shall satisfy the following limitations:

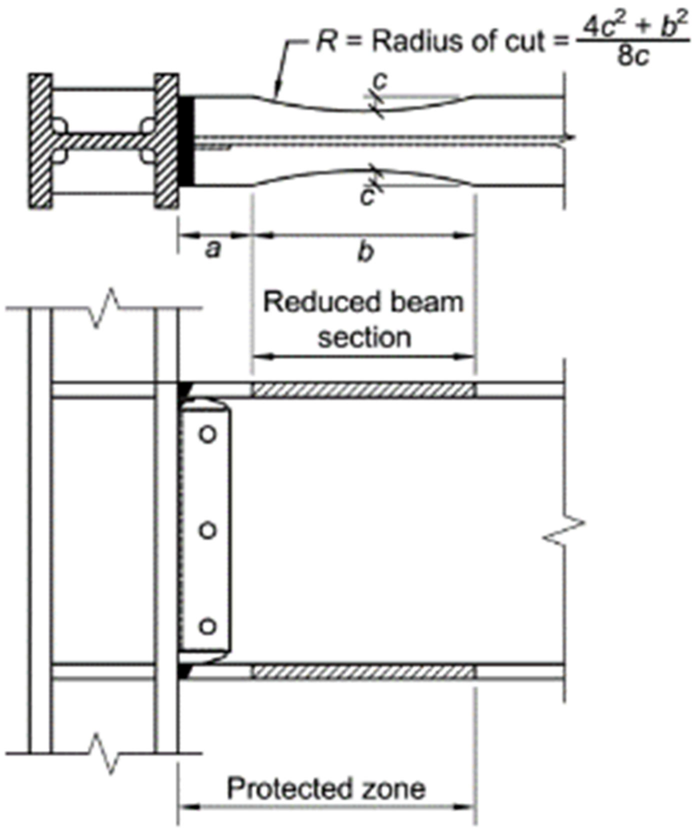


Fig. 5.1. Reduced beam section connection.

BOLTED FLANGE PLATE (BFP) MOMENT CONNECTION

7.1. GENERAL

Bolted flange plate (BFP) moment connections utilize plates welded to column flanges and bolted to beam flanges. The top and bottom plates must be identical. Flange plates are welded to the column flange using complete-joint-penetration (CJP) groove welds and beam flange connections are made with high-strength bolts. The beam web is connected to the column flange using a bolted shear tab with bolts in short-slotted holes. Details for this connection type are shown in Figure 7.1. Initial yielding and plastic hinge formation are intended to occur in the beam in the region near the end of the flange plates.

7.2. SYSTEMS

Bolted flange plate connections are prequalified for use in special moment frame (SMF) and intermediate moment frame (IMF) systems within the limitations of these provisions.

Exception: Bolted flange plate connections in SMF systems with *concrete structural slabs* are only prequalified if the concrete structural slab is kept at least 1 in. (25 mm) from both sides of both column flanges. It is permissible to place compressible material in the gap between the column flanges and the concrete structural slab.

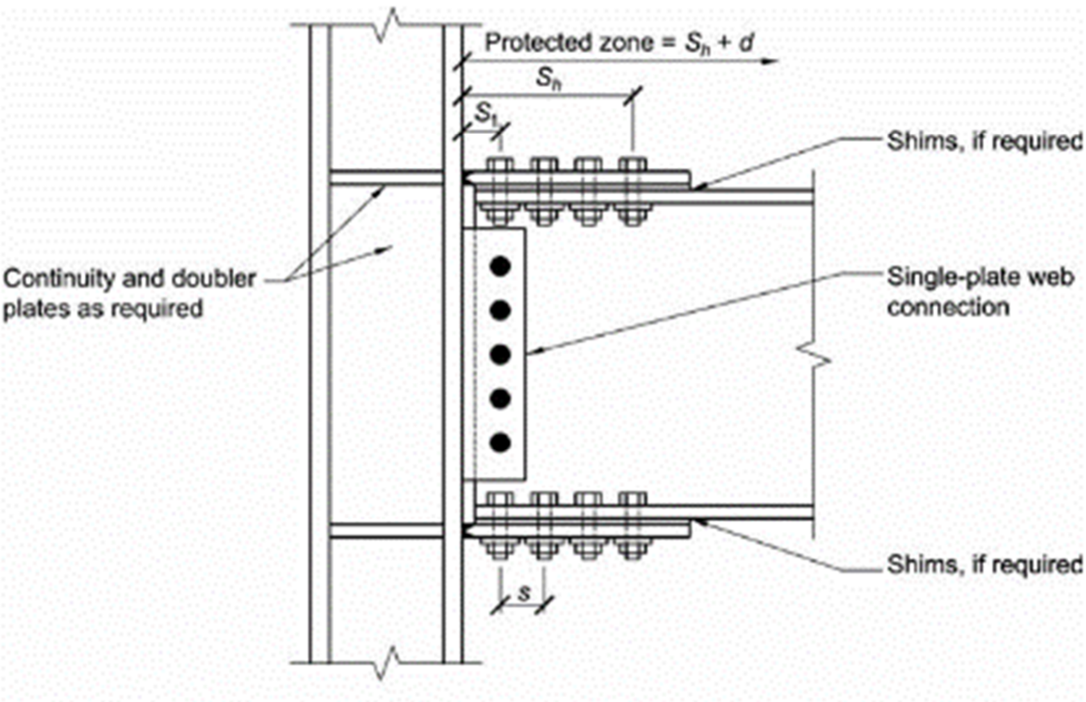


Fig. 7.1. Bolted flange plate moment connection.

WELDED UNREINFORCED FLANGE–WELDED WEB (WUF-W) MOMENT CONNECTION

8.1. GENERAL

In the welded unreinforced flange-welded web (WUF-W) moment connection, inelastic rotation is developed primarily by yielding of the beam in the region adjacent to the face of the column. Connection rupture is controlled through special detailing requirements associated with the welds joining the beam flanges to the column flange, the welds joining the beam web to the column flange, and the shape and finish of the weld access holes. An overall view of the connection is shown in Figure 8.1.

8.2. SYSTEMS

WUF-W moment connections are prequalified for use in special moment frame (SMF) and intermediate moment frame (IMF) systems within the limits of these provisions.

8.3. PREQUALIFICATION LIMITS

1. Beam Limitations

Beams shall satisfy the following limitations:

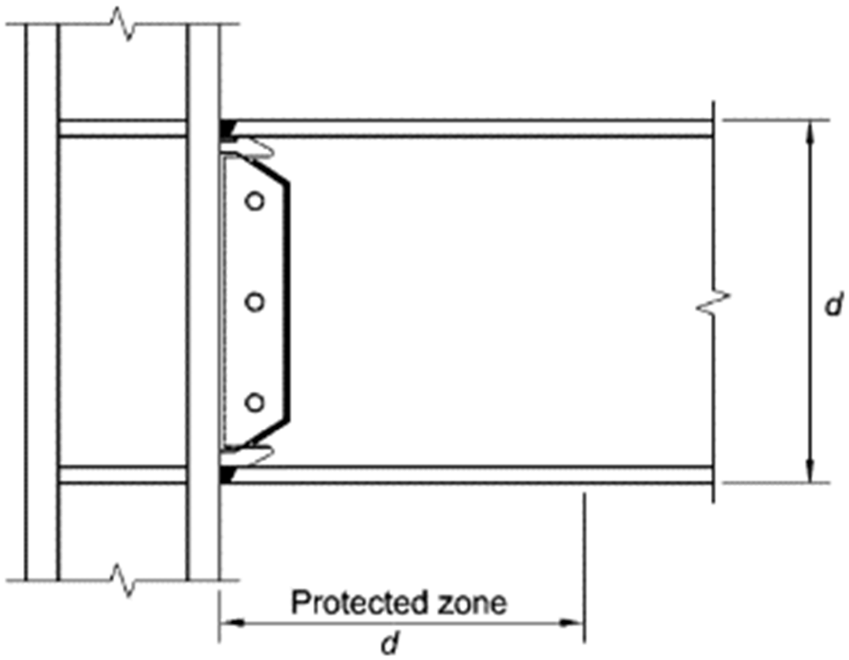


Fig. 8.1. WUF-W moment connection.

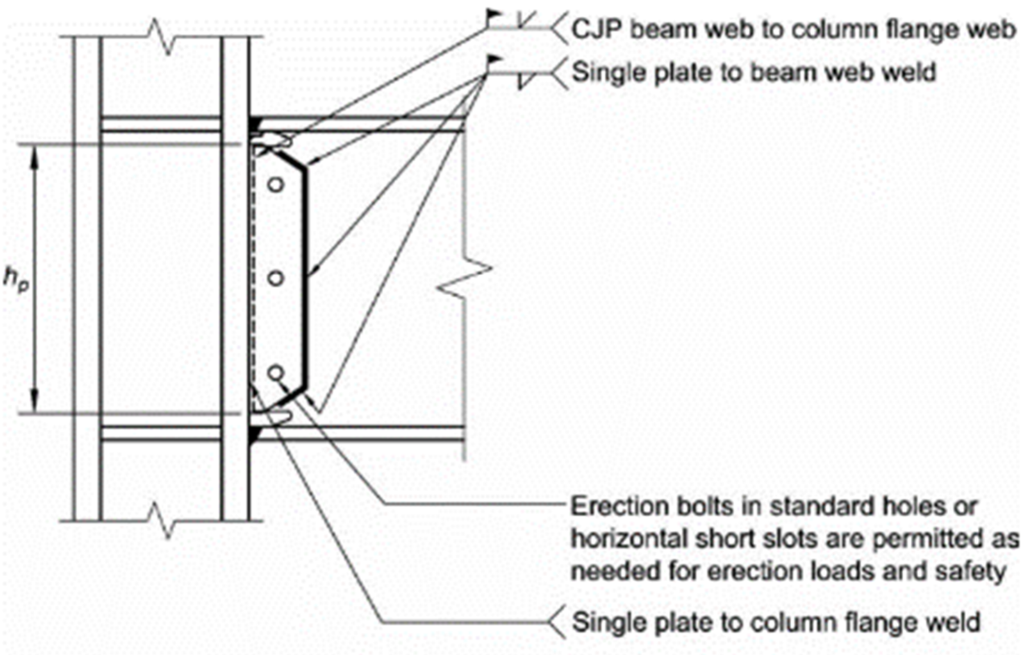


Fig. 8.2. General details of beam web-to-column flange connection.

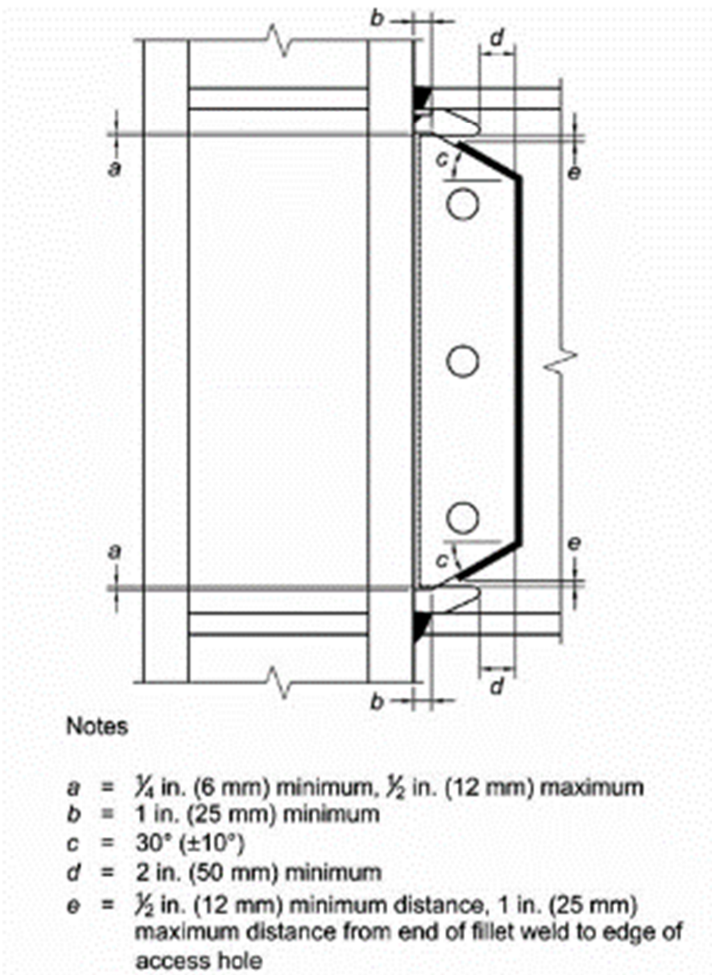


Fig. 8.3. Details at top and bottom of single-plate shear connection.

21. Joist Coordination: -

Steel joists are designed to withstand different types of loads and forces, depending on the application. A few examples of the types of forces a steel joist may be exposed to include weight load, wind uplift, and vibration. Steel joists are used in steel construction.

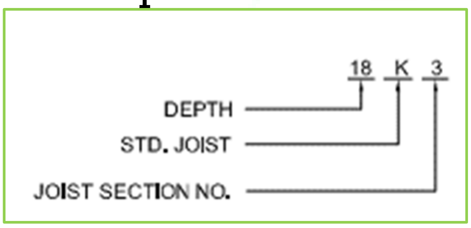
Types of Joists

- ✓ K series
- ✓ KCS series
- ✓ LH series
- ✓ DLH series
- ✓ Joist girders
- ✓ Joist substitutes

K Series Joist

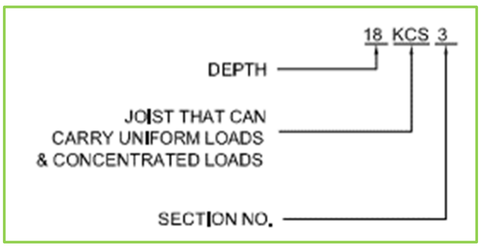
K-series Open Web Steel Joists or K-series are defined as simply supported uniformly loaded trusses that can support a floor or roof deck. The top chord of the joist is assembly braced against lateral buckling by the deck. The K-series is distinguished by the depth range of 8″ to 30″ with a maximum span of up to 60′ and standard

K-Series joists are designed for use typically with lighter loads and are most common in roof design. K-Series Joists are used typically where shorter span conditions are required.



KCS Series Joist

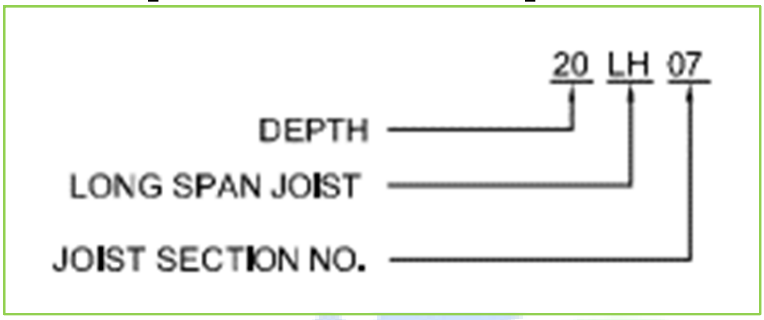
KCS K-Series Constant Shear) joists are designed by the Standard Specification for K-Series Joists. KCS joist chords are designed for a flat positive moment envelope. The moment capacity is constant on all interior panels. All webs are designed for a vertical shear equal to the specified shear capacity and interior webs will be designed for 100% stress reversal.



<u>LH series joist</u>

LH Series joists range in depth from 18" to 48" and can span up to 96'-0". These welded-steel joists are used to support a building's roof and floors. They are custom engineered to suit the design of each building. In addition to traditional designs, we supply a variety of LH long-span joists for different applications.

LH Series bar joists are designed for long-span conditions, they can support heavy loads under unique conditions.



<u>DLH series joist</u>

Deep Long span DLH) Steel Joists are relatively lightweight shop-manufactured steel trusses used in the direct support of floor or roof slabs or decks between walls, beams, and main structural members.

DLH-Series have been designed to extend the use of joists to spans and loads more than those covered by Open Web Steel Joists, K-Series. DLH-Series Joists have been standardized in depths from 52 inches 1321 mm) through 120 inches 3048 mm), for spans up to 240 feet 73,152 mm)

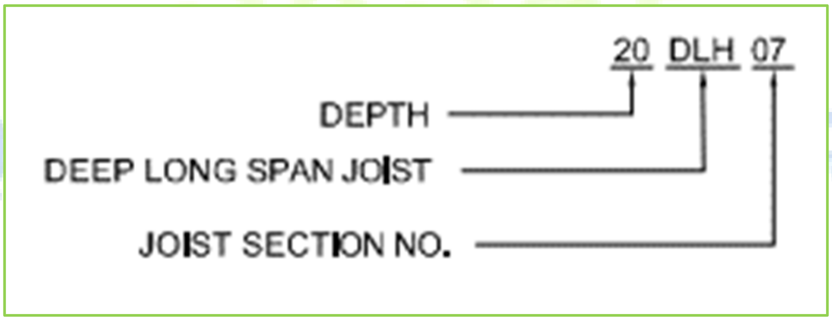
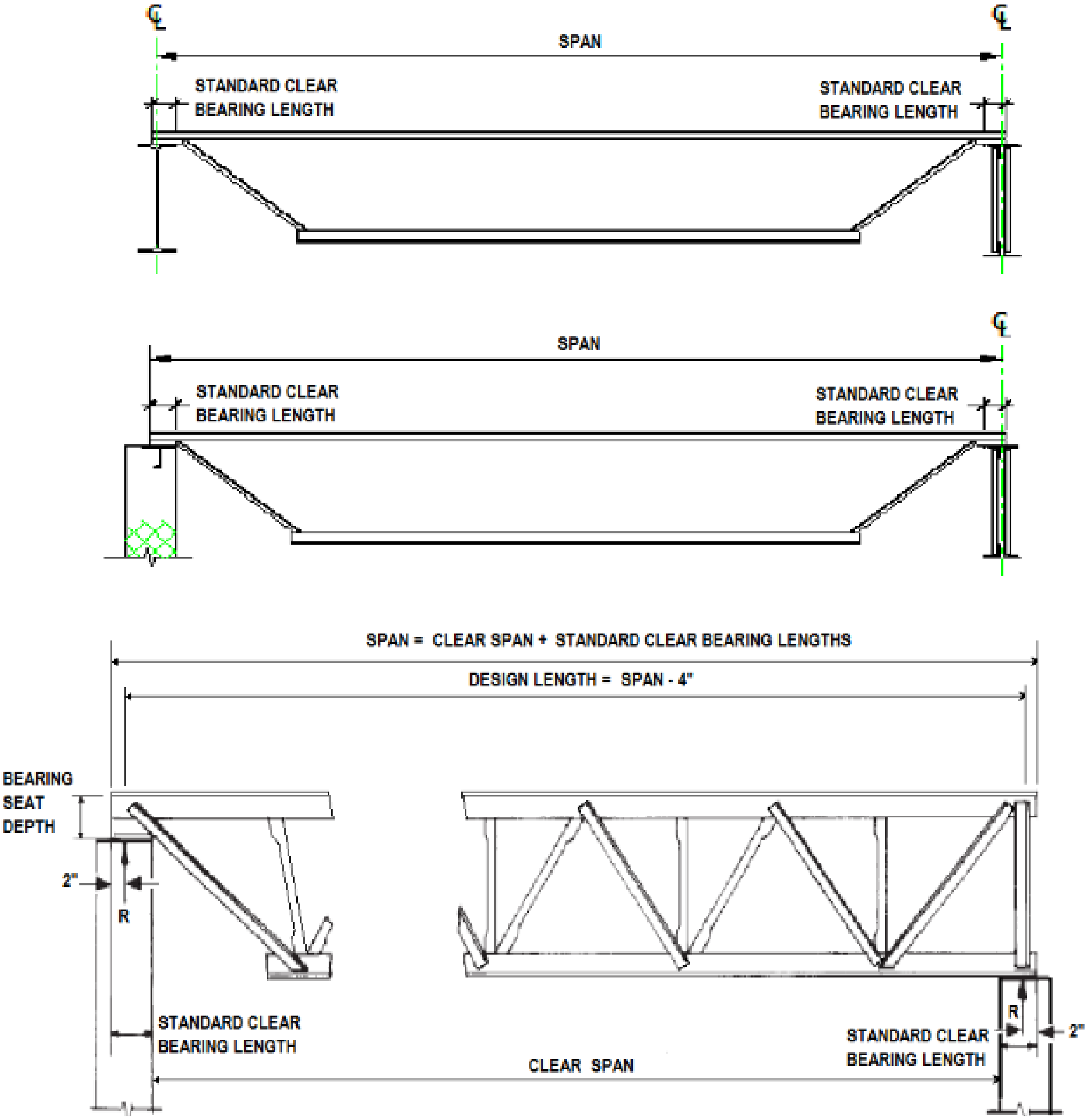


Figure 5.2-1
DEFINITION OF SPAN
(U. S. Customary Units)



NOTES:
1) DESIGN LENGTH = SPAN - 4"
2) MINIMUM BEARING LENGTHS SHALL MEET THE REQUIREMENTS OF SECTION 104.4 . BEARING LENGTHS SHOWN MAY VARY BETWEEN STANDARD CLEAR BEARING AND MINIMUM BEARING LENGTH.
3) PARALLEL CHORD JOISTS INSTALLED TO A SLOPE GREATER THAN 1/2 INCH PER FOOT SHALL USE A SPAN DEFINED BY THE LENGTH ALONG THE SLOPE.

Joist girders

Joist Girders are open web steel trusses used as primary framing members. They are designed as simple spans supporting equally spaced concentrated loads for a floor or roof system. These concentrated loads are considered to act at the panel points of the Joist Girders.

These members have been standardized for depths from 20 inches 508 mm) to 120 inches 3048 mm), and spans to 120 feet 36,576 mm).

Joist substitutes

Joist substitutes are 2.5 inches 64 mm) deep sections intended for use in very short spans less than 8 feet 2.4 m)) whereas Open Web Steel Joists are impractical. They are commonly specified to span over hallways and short spans in skewed bays. Joist substitutes are fabricated from material conforming to Steel Joist Institute Specifications.

Joist Minimum bearing length at end supports

JOIST SECTION NUMBER[1]	STANDARD CLEAR BEARING LENGTH	MINIMUM BEARING LENGTH ON STEEL
K1-12	4" (102 mm)	2 ½" (64 mm)
LH02-06	6" (152 mm)	2 ½" (64 mm)
LH07-17, DLH10-17, JG	6" (152 mm)	4" (102 mm)
DLH18-25, JG[2]	6" (152 mm)	6" (152 mm)

(1)Last digit(s) of joist designation shown in Load Table.
(2) **Joist Girders** with a self weight greater than 50 plf.

Joist Minimum bearing plate width

JOIST SECTION NUMBER[1]	MINIMUM BEARING PLATE WIDTH
K1-12, LH02-06	7" (178 mm)
LH07-17, DLH10-17, JG	9" (229 mm)
DLH18-25, JG[2]	14" (356 mm)

(1)Last digit(s) of joist designation shown in Load Table.
(2) **Joist Girders** with a self weight greater than 50 plf.

Joist Minimum bearing plate width

JOIST SECTION NUMBER[1]	STANDARD BEARING SEAT DEPTH	STANDARD CLEAR BEARING LENGTH	SPECIAL MINIMUM BEARING SEAT DEPTH[2]
K1-12	2 ½" (64 mm)	4" (102 mm)	0.6 x (RP + 2 ½" (64 mm))
LH02-17, DLH10-17	5" (127 mm)	6" (152 mm)	0.6 x (RP + 4" (102 mm))
DLH18-25	7 ½" (191 mm)	6" (152 mm)	0.6 x (RP + 4" (102 mm)) + 2 ½" (64 mm)
JG	7 ½" (191 mm)	6" (152 mm)	RP + 4" (102 mm)

(1) Last digit(s) of joist designation shown in Load Table.
(2) RP is equal to the distance the reaction is to occur from the face of the wall or leading edge of support member. The equation is not applicable for the high end of a sloped joist or Joist Girder.

Joist to steel minimum weld

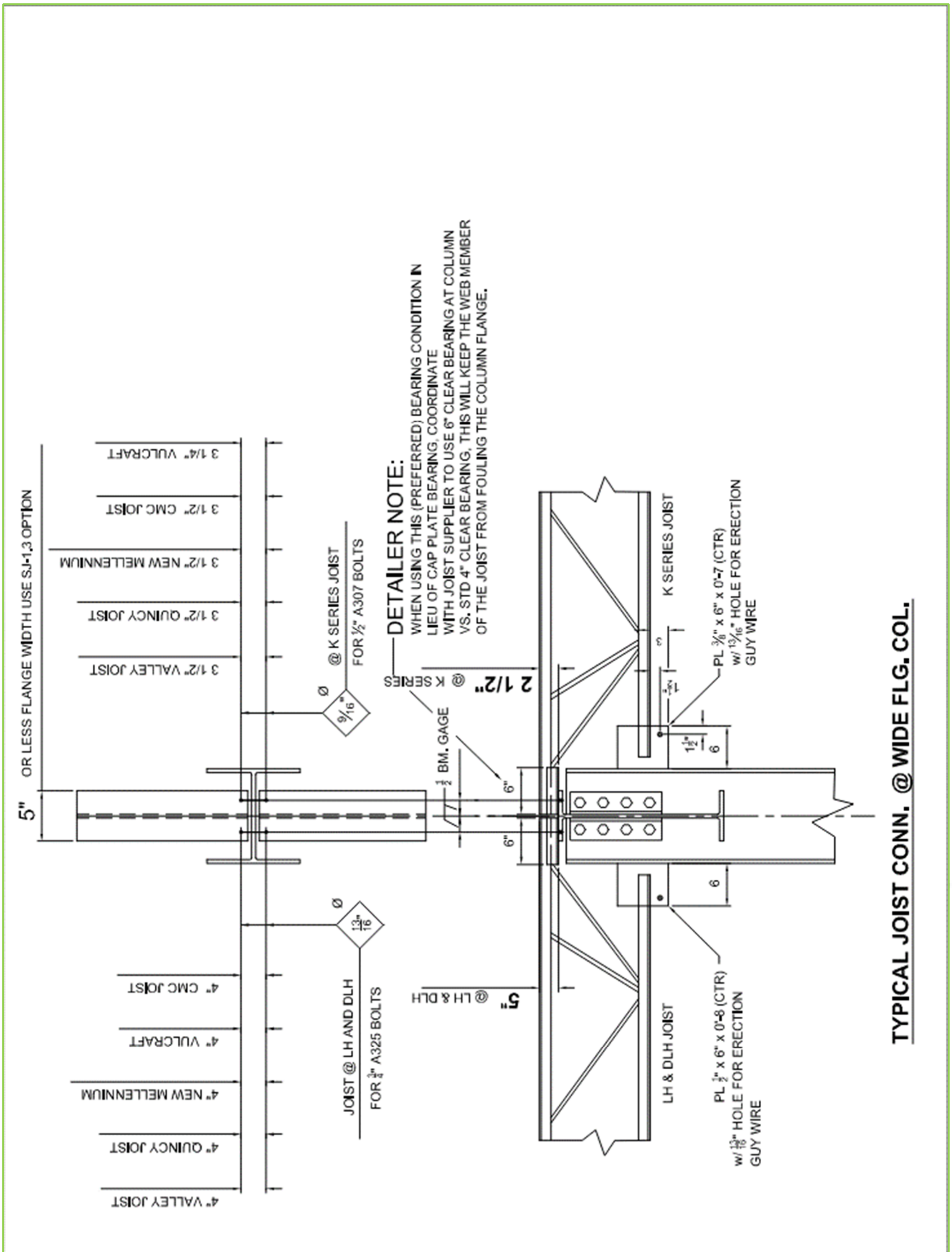
JOIST SECTION NUMBER [1]	MINIMUM FILLET WELD	MINIMUM BEARING SEAT BOLTS FOR ERECTION
K1-12	2– 1/8" x 2 1/2" (3 x 64 mm)	2– 1/2" (13 mm) A307
LH02-06	2– 3/16" x 2 1/2" (5 x 64 mm)	
LH07-17, DLH10-17, JG	2– 1/4" x 2 1/2" (6 x 64 mm)	2– 3/4" (19 mm) A307
DLH18-25, JG[2]	2– 1/4" x 4" (6 x 102 mm)	2– 3/4" (19 mm) A325

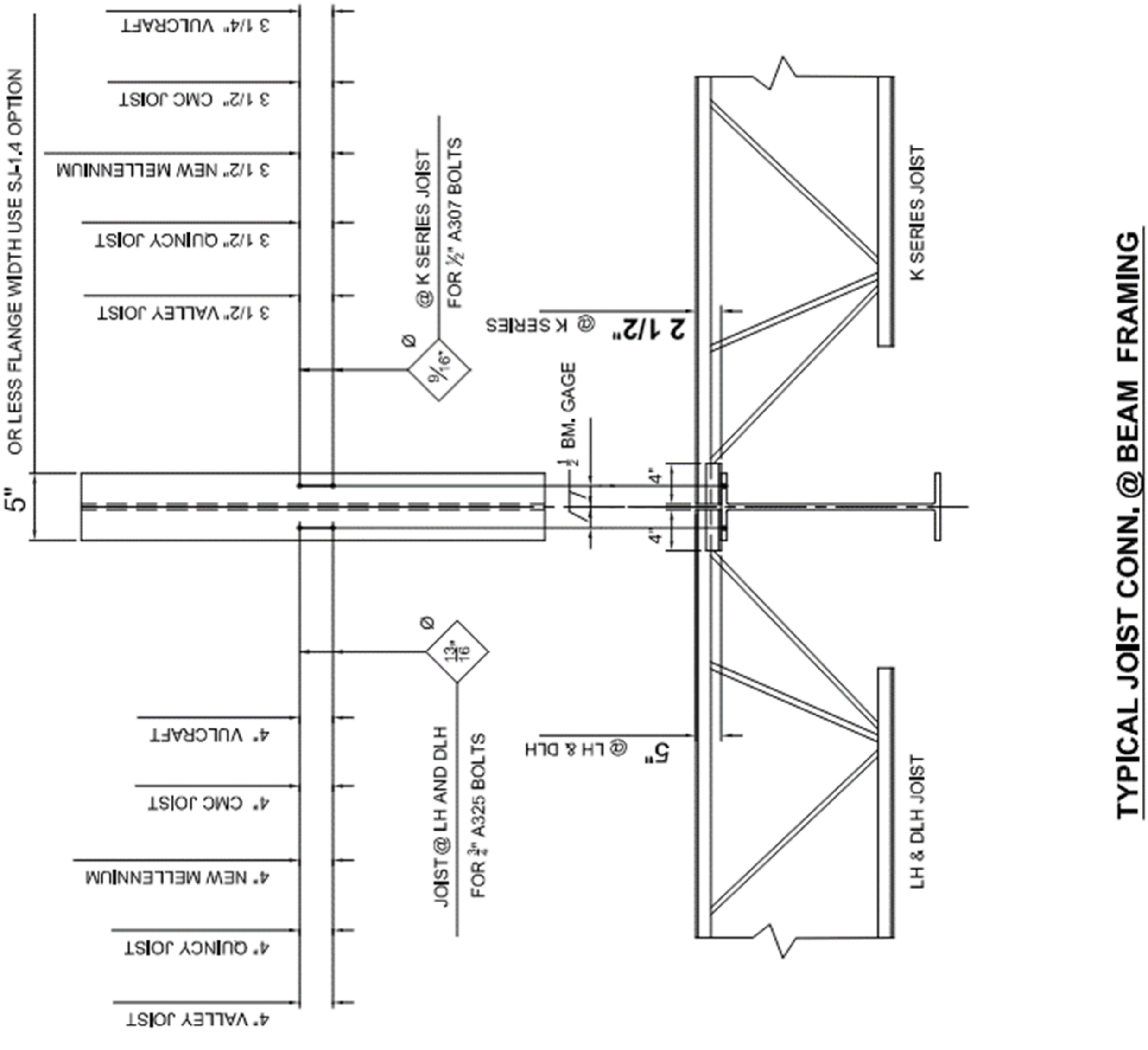
(1) Last digit(s) of joist designation shown in load table.
(2) **Joist Girders** with a self weight greater than 50 plf.

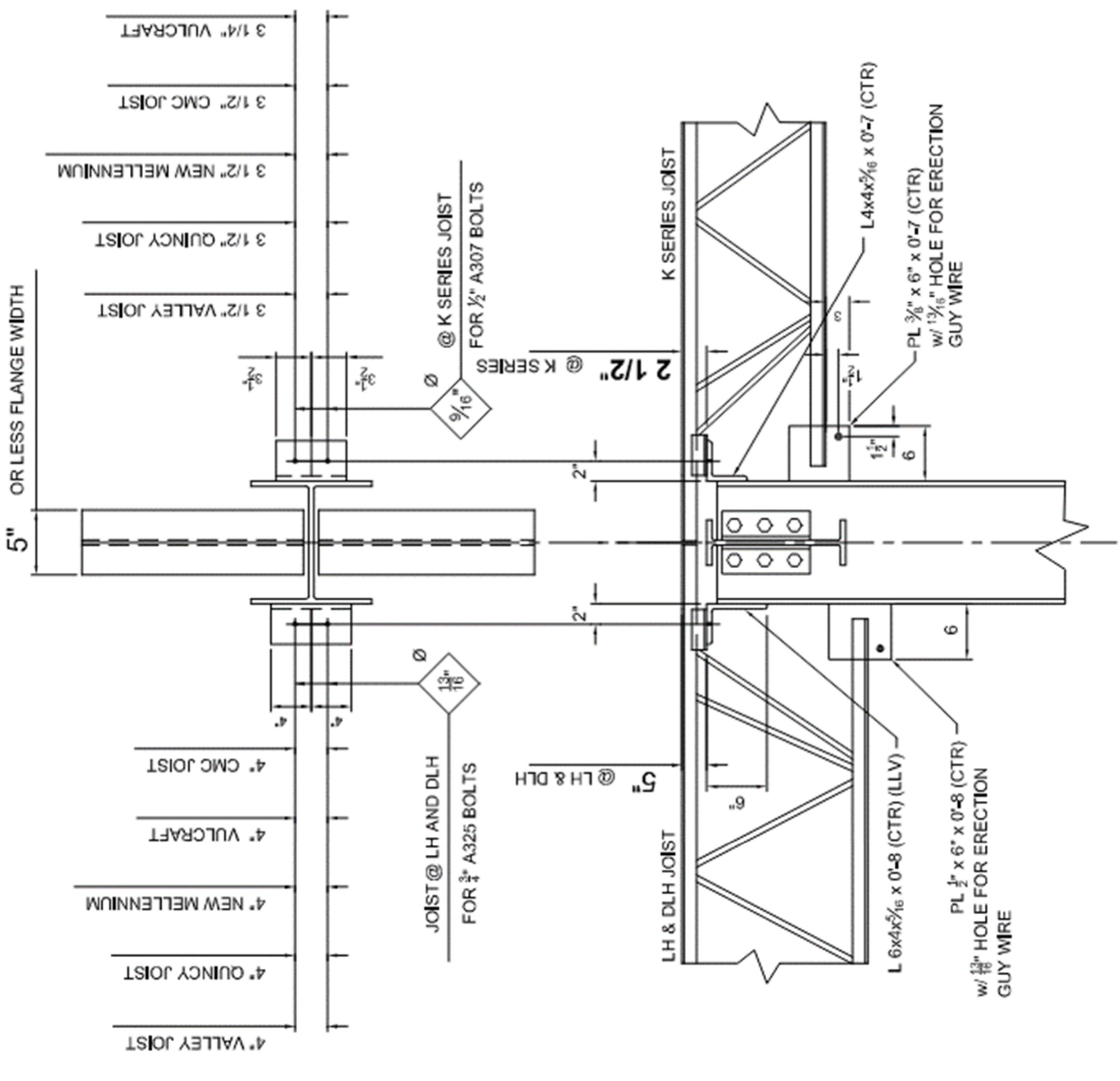
Joist connections

- ✓ Following joist connections are references. Please confirm and coordinate with the joist supplier about connections, shoe depth, and top chord width.
- ✓ Above 40'-0" long joist span needs to provide erection bolts in supported members.
- ✓ Erections bolts are A307 or A325, confirm with the customer.
- ✓ Erection bolts ½" Ø for K/KCS series, ¾" Ø for LH, DLH & joist girders.
- ✓ If structural members are painted, need to give no paint notes at joist-bearing locations.
- ✓ HSS or WT infill needs to provide in Joist bearing perpendicular structural members.
- ✓ Make sure about the stabilizer plate at column conditions.

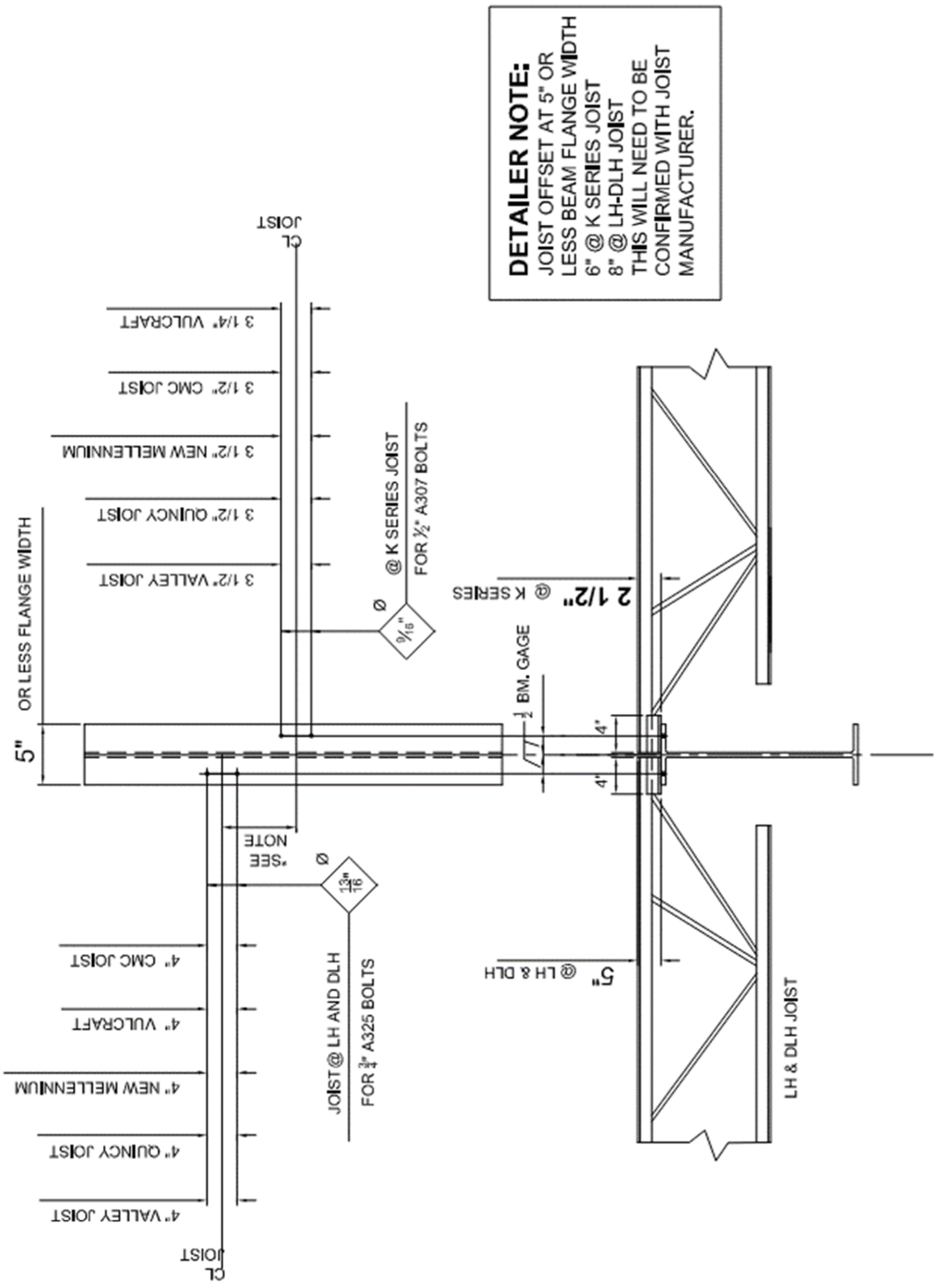
✓ Confirm the structural member elevations at perpendicular and parallel conditions of joist members based on the shoe depth.



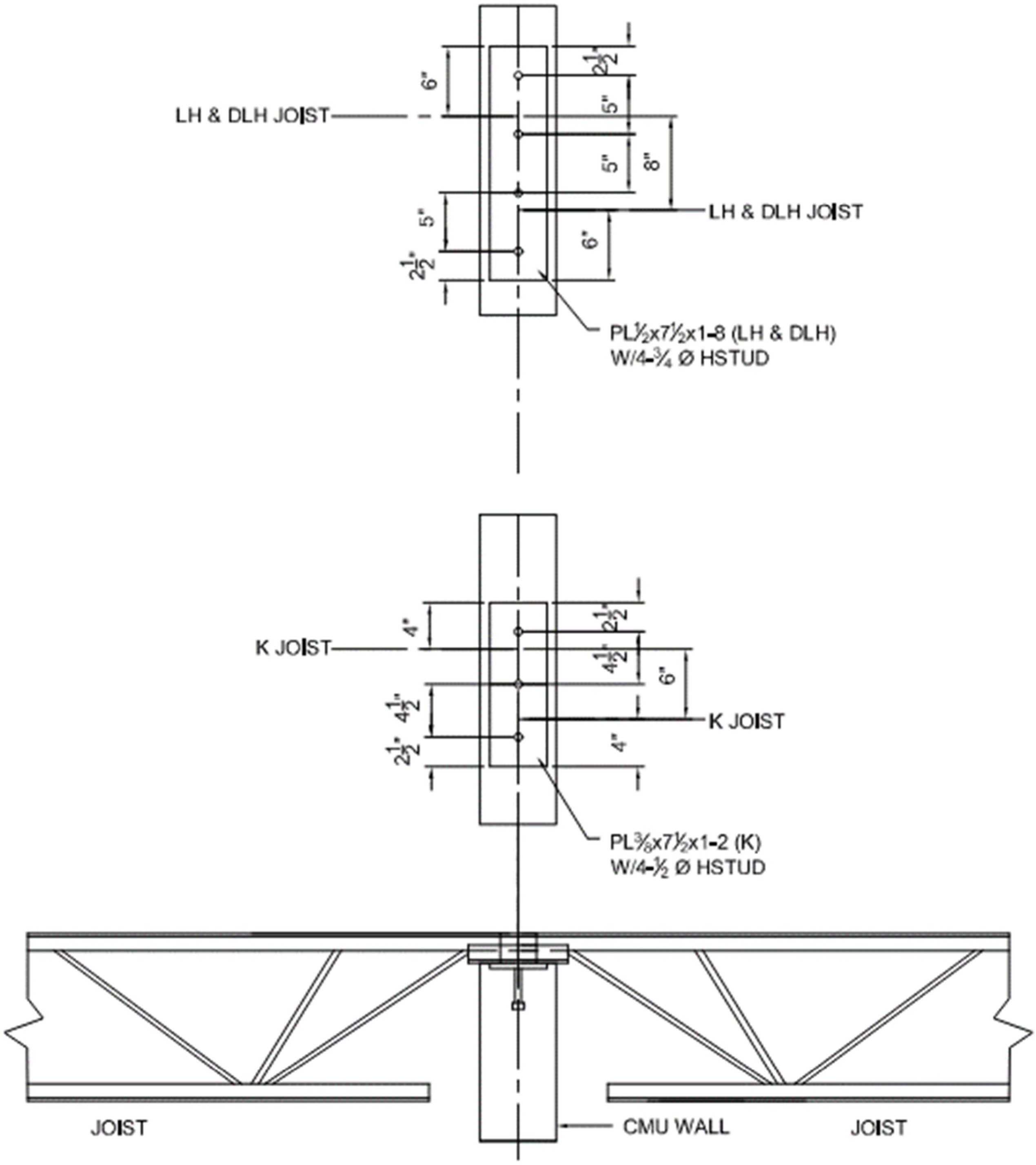

TYPICAL JOIST CONN. @ BEAM FRAMING
5"
OR LESS FLANGE WIDTH USE SJ-1.4 OPTION
3 1/4" VULCRAFT
3 1/2" CMC JOIST
3 1/2" NEW MELLENNIUM
3 1/2" QUINCY JOIST
3 1/2" VALLEY JOIST
@ K SERIES JOIST
FOR ½" A307 BOLTS
9/16"
2 1/2"
@ K SERIES
½ BM. GAGE
4"
4"
K SERIES JOIST
13/16"
JOIST @ LH AND DLH
FOR ¾" A325 BOLTS
5"
@ LH & DLH
4" VULCRAFT
4" CMC JOIST
4" NEW MELLENNIUM
4" QUINCY JOIST
4" VALLEY JOIST
LH & DLH JOIST



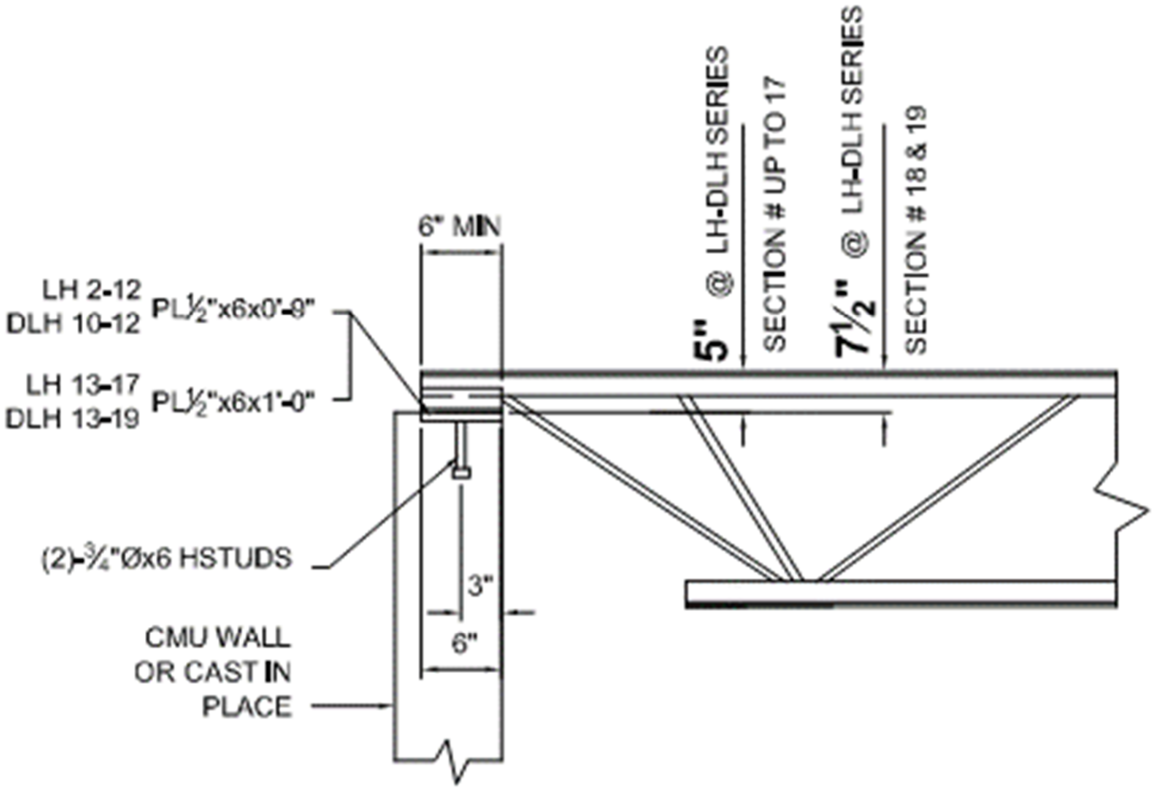
TYPICAL JOIST CONN. @COLUMN CENTERLINE w / 5" OR LESS BEAM FLANGE WIDTH



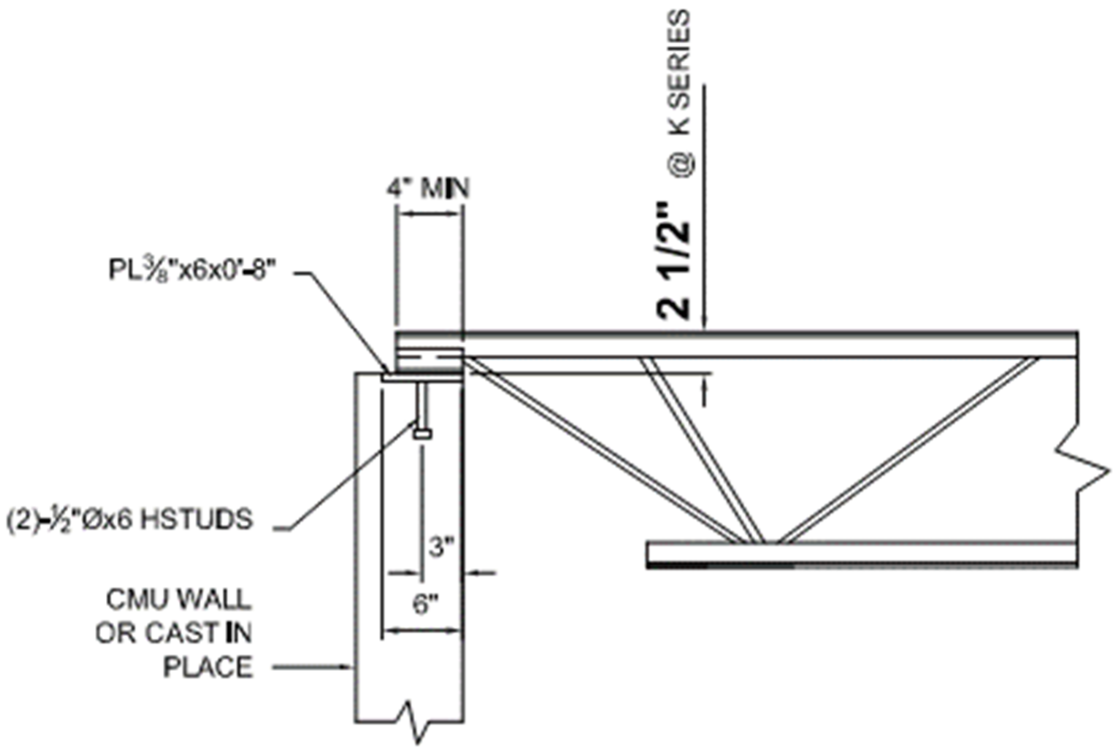
TYPICAL JOIST CONN. @ BEAM FRAMING w / 5" OR LESS BEAM FLANGE WIDTH



TYPICAL OFFSET JOIST CONN. @ CMU WALL

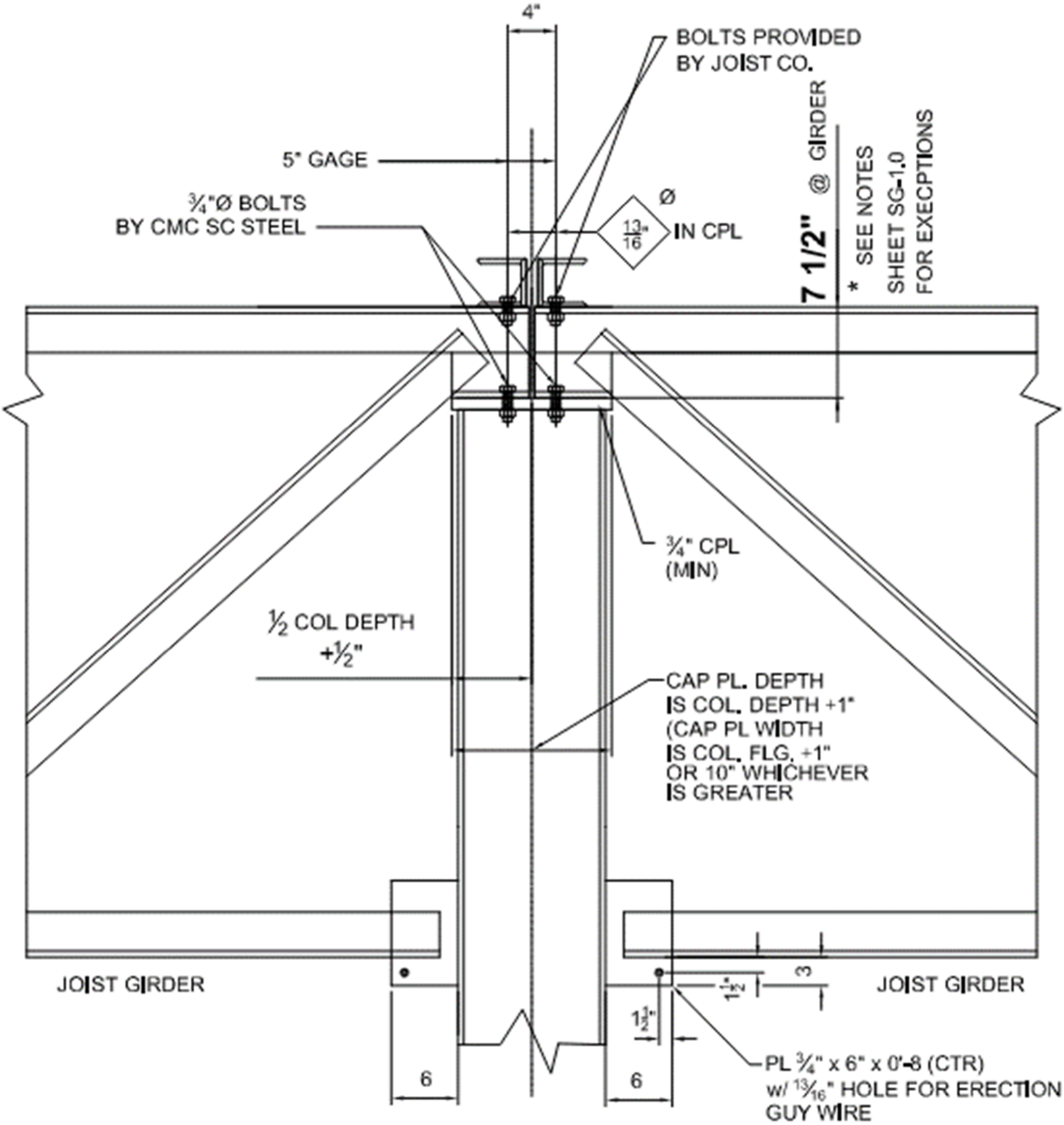


LH-DLH SERIES

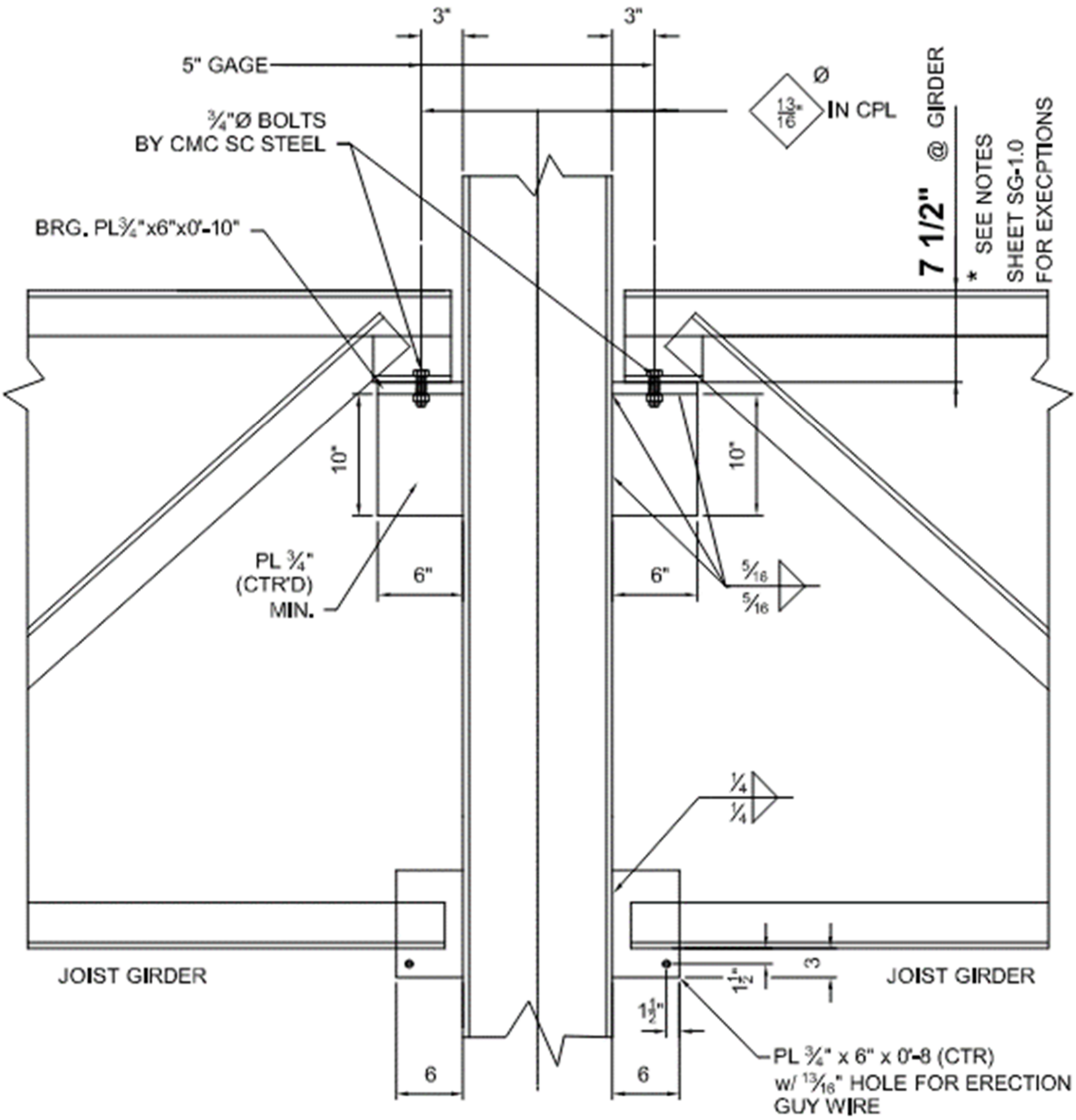


K SERIES & KCS SERIES

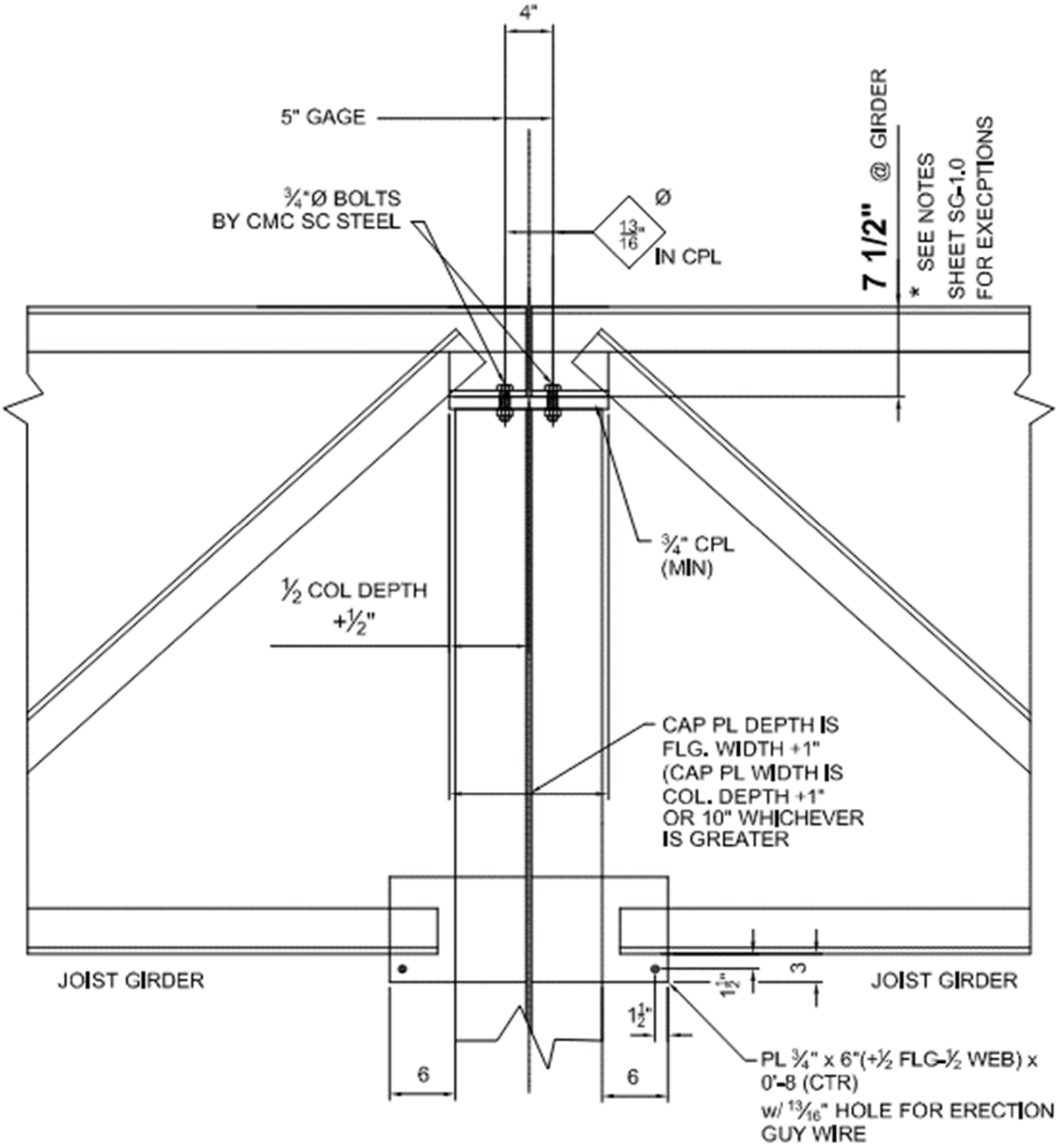
TYPICAL JOIST CONN. @ CMU WALL



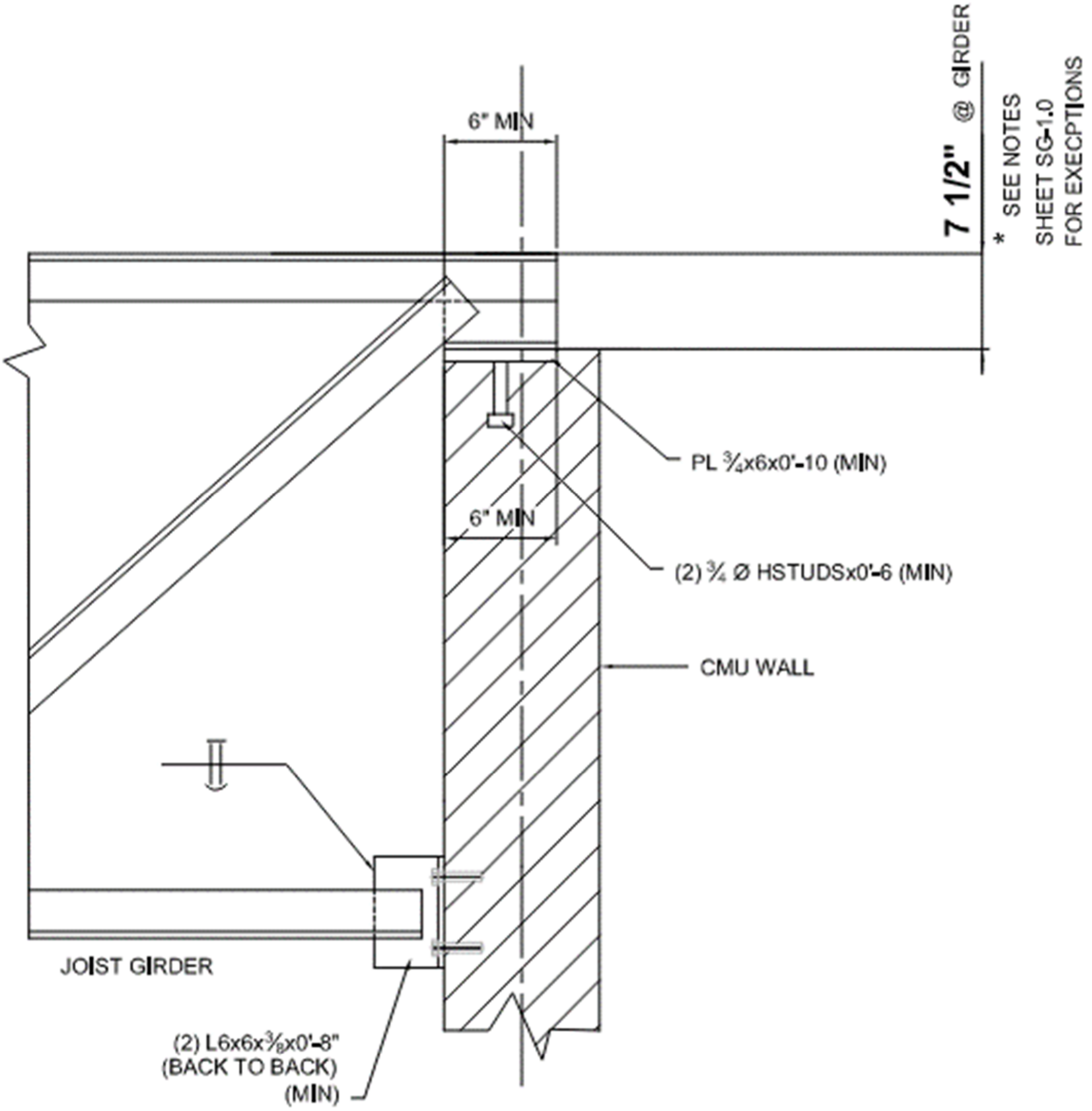
TYPICAL JOIST GIRDER CONN. @ WIDE FLG. COL.



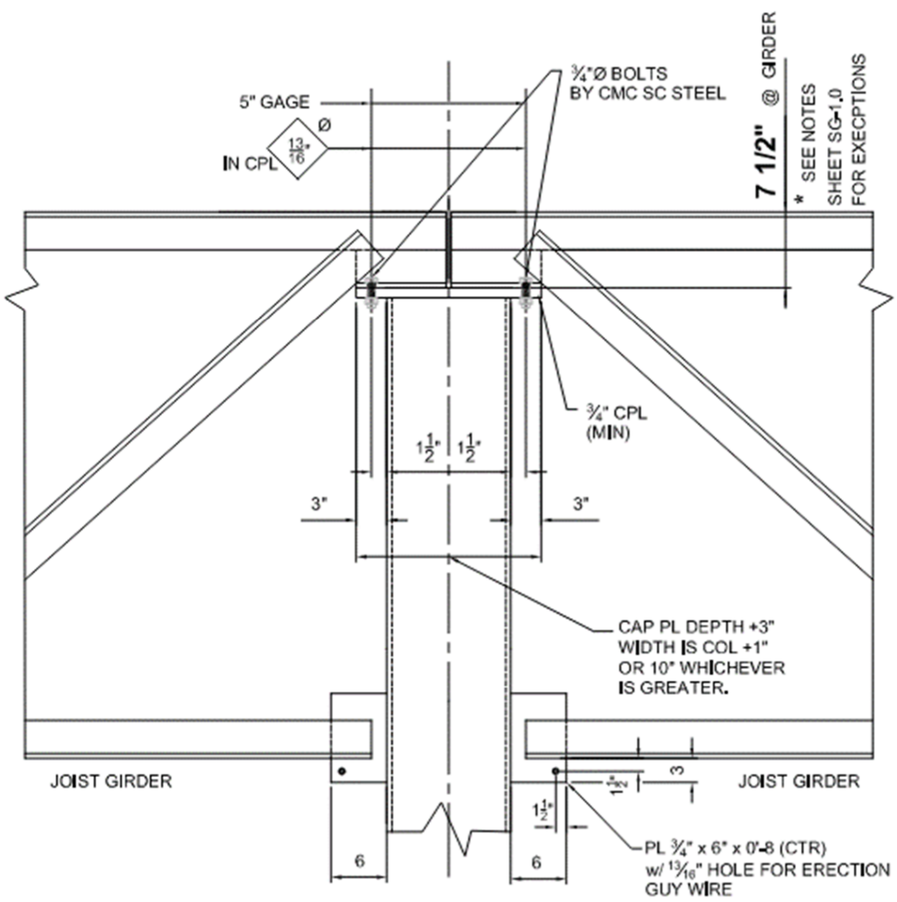
TYPICAL JOIST GIRDER CONN. @ WIDE FLG. COL.



TYPICAL COL. WEB PER. TO JOIST GIRDER CONN. @ WIDE FLG. COL.



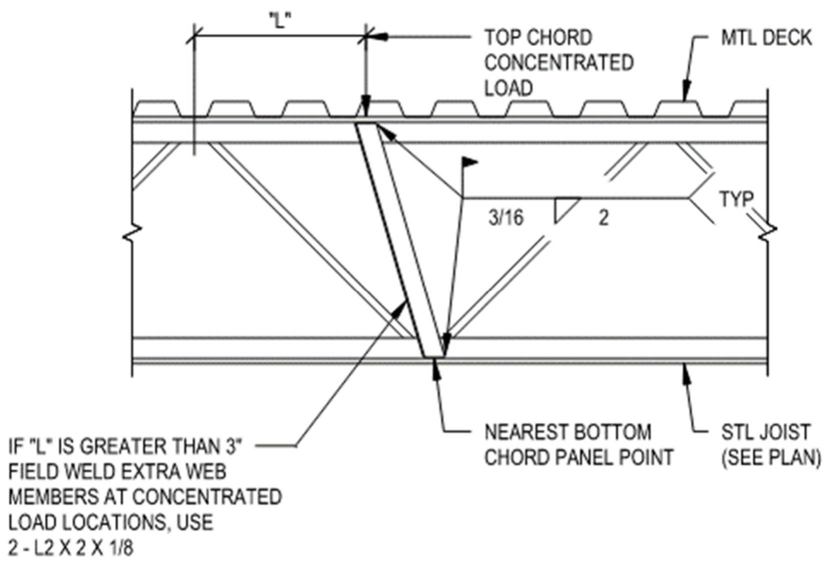
TYPICAL CMU WALL TO JOIST GIRDER @ COLUMN CENTERLINE



TYPICAL HSS RECT./ROUND COL TO JOIST GIRDER @ COLUMN CENTERLINE

Joist Reinforcement angle: -

Provide the joist reinforcement angle at concentrated/Point load locations with a cut to suit the field and confirm the joist supplier.



Joist Top chord width.

Follow top chord width as mentioned below, confirm with the customer

S.J.I. OPEN WEB STEEL JOIST TOP CHORD WIDTH

WARNING: This is only a roughly estimated guide, use at your own risk!
Always coordinate top chord size with joist manufacturer.
The standard gap between top chord angles is 1".

TYPE	TOP CHORD WIDTH(±1")	TYPE	TOP CHORD WIDTH(±1")
8K1	4"	22K6	4 1/2"
		22K7	4 1/2"
10K1	4"	22K9	5"
		22K10	5"
12K1	4"	22K11	5"
12K3	4"		
12K5	4"	24K4	4"
		24K5	4"
14K1	4"	24K6	4 1/2"
14K3	4"	24K7	4 1/2"
14K4	4"	24K8	5"
		24K9	5"
16K2	4"	24K10	5"
16K3	4"	24K12	5"
16K4	4"		
16K6	4"	26K5	4 1/2"
16K7	4"	26K6	4 1/2"
16K9	4 1/2"	26K7	4 1/2"
		26K8	5"
18K3	4"	26K9	5"
18K4	4"	26K10	5"
18K5	4"	26K12	5"
18K6	4 1/2"		
18K7	4 1/2"	28K6	5"
18K9	5"	28K7	5"
18K10	5"	28K8	5"
		28K9	5"
20K3	4"	28K10	5"
20K4	4"	28K12	5"
20K5	4 1/2"		
20K6	4 1/2"	30K7	5"
20K7	5"	30K8	5"
20K9	5"	30K9	5"
20K10	5"	30K10	5"
		30K11	5"
22K4	4"	30K12	5"
22K5	4"		

S.J.I. OPEN WEB STEEL JOIST TOP CHORD WIDTH

WARNING: This is only a roughly estimated guide, use at your own risk!
Always coordinate top chord size with joist manufacturer.
The standard gap between top chord angles is 1".

TYPE	TOP CHORD WIDTH(±1")	TYPE	TOP CHORD WIDTH(±1")
18LH02	5"	32LH10	7"
18LH03	5"	32LH11	7"
18LH04	5"	32LH12	7"
18LH05	5"	32LH13	8"
18LH06	6"	32LH14	8"
18LH07	6"	32LH15	8"
18LH08	6"		
18LH09	7"	36LH07	6"
		36LH08	6"
20LH02	5"	36LH09	6"
20LH03	5"	36LH10	7"
20LH04	5"	36LH11	7"
20LH05	5"	36LH12	7"
20LH06	5"	36LH13	8"
20LH07	6"	36LH14	8"
20LH08	6"	36LH15	8"
20LH09	7"		
20LH10	7"	40LH08	6"
		40LH09	6"
24LH03	5"	40LH10	7"
24LH04	5"	40LH11	7"
24LH05	5"	40LH12	7"
24LH06	5"	40LH13	8"
24LH07	6"	40LH14	8"
24LH08	6"	40LH15	8"
24LH09	7"	40LH16	9"
24LH10	7"		
24LH11	7"	44LH09	6"
		44LH10	7"
28LH05	5"	44LH11	7"
28LH06	5"	44LH12	7"
28LH07	6"	44LH13	8"
28LH08	6"	44LH14	8"
28LH09	7"	44LH15	8"
28LH10	7"	44LH16	9"
28LH11	7"	44LH17	9"
28LH12	7"		
28LH13	8"	48LH10	7"
		48LH11	7"
32LH06	5"	48LH13	7"
32LH07	6"	48LH14	8"
32LH08	6"	48LH15	8"
32LH09	7"	48LH16	9"
		48LH17	9"

22.Column splice: -

Table 14-3
Typical Column Splices
Case I:
All-bolted flange-plated column splices between columns with depth d_u and d_l nominally the same.

Column Size	Gage g_u or g_l	Flange Plates			
		Type	Width	Thk.	Length
W14×455 to 730	13½	1	16	¾	1′ 6½
257 to 426	11½	1	14	⅝	1′ 6½
145 to 233	11½	1	14	½	1′ 6½
90 to 132	11½	2	14	⅜	1′ 0½
43 to 82	5½	2	8	⅜	1′ 0½
W12×120 to 336	5½	2	8	⅝	1′ 0½
40 to 106	5½	2	8	⅜	1′ 0½
W10×33 to 112	5½	2	8	⅜	1′ 0½
W8×31 to 67	5½	2	8	⅜	1′ 0½
24 & 28	3½	2	6	⅜	1′ 0½

Gages shown may be modified if necessary to accommodate fittings elsewhere on the column.

Case I-A: $d_l = (d_u + 1/4 \text{ in.})$ to $(d_u + 5/8 \text{ in.})$	Flange plates: Select g_u for upper column; select g_l and flange plate dimensions for lower columns (see table above). Fillers: None. Shims: Furnish sufficient strip shims 2½×⅛ to provide 0 to $1/16$-in. clearance each side.
Case I-B: $d_l = (d_u - 1/4 \text{ in.})$ to $(d_u + 1/8 \text{ in.})$	Flange plates: Same as Case I-A. Fillers (shop bolted under flange plates): Select thickness as ⅛-in. for $d_l = d_u$ and $d_l = (d_u + 1/8 \text{ in.})$ or as ¼-in. for $d_l = (d_u - 1/8 \text{ in.})$ and $d_l = (d_u - 1/4 \text{ in.})$ Select width to match flange plate and length as 0′ 9 for Type 1 or 0′ 6 for Type 2. Shims: Same as Case I-A.
Case I-C: $d_l = (d_u + 3/4 \text{ in.})$ and over.	Flange plates: Same as Case I-A. Fillers (shop bolted to upper column): Select thickness as $(d_l - d_u)/2$ minus ⅛ in. or $3/16$ in., whichever results in ⅛-in. multiples of filler thickness. Select width to match flange plate, but not greater than upper column flange width. Select length as 1′ 0 for Type 1 or 0′ 9 for Type 2. Shims: Same as Case I-A.

For lifting devices, see Figure 14-10.

Table 14-3 (continued)

Typical Column Splices

Case I:

All-bolted flange-plated column splices between columns with depth d_u and d_l nominally the same.

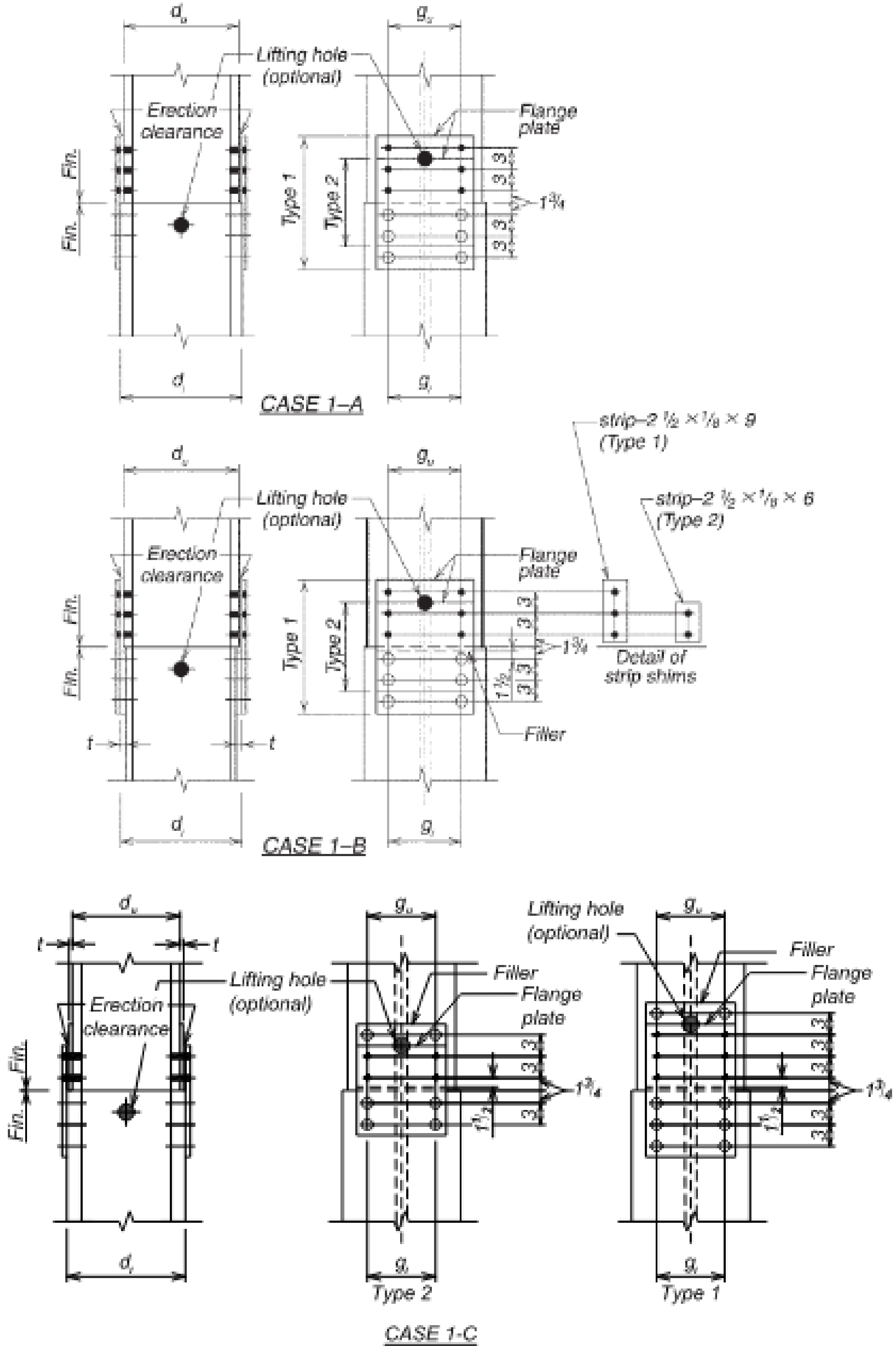


Table 14-3 (continued)

Typical Column Splices

Case II:

All-bolted flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.

Fillers on upper column developed for bearing on lower column.	Flange plates: Same as Case I-A. Fillers (shop bolted to upper column): Select thickness as $(d_l - d_u) / 2$ minus ⅛-in. or $^3/_{16}$-in., whichever results in ⅛-in. multiples of filler thickness. Select bolts through fillers (including bolts through flange plates) on each side to develop bearing strength of the filler. Select width to match flange plate, but not greater than upper column flange width unless required for bearing strength. Select length as required to accommodate required number of bolts. Shims: Same as Case I-A.

Table 14-3 (continued)

Typical Column Splices

Case III:

All-bolted flange-plated and butt-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.

Fillers on upper column developed for bearing on lower column.

Column Size	Gage g_u or g_l	Flange Plates			
		Type	Width	Thk.	Length
W14×455 to 730	13½	1	16	¾	1′ 8½
257 to 426	11½	1	14	⅝	1′ 8½
145 to 233	11½	1	14	½	1′ 8½
90 to 132	11½	2	14	⅜	1′ 2½
43 to 82	5½	2	8	⅜	1′ 2½
W12×120 to 336	5½	2	8	⅝	1′ 2½
40 to 106	5½	2	8	⅜	1′ 2½
W10×33 to 112	5½	2	8	⅜	1′ 2½
W8×31 to 67	5½	2	8	⅜	1′ 2
24 & 28	3½	2	8	⅜	1′ 2

Gages shown may be modified if necessary to accommodate fittings elsewhere on the column.

Flange plates: Select g_u for upper column, select g_l and flange plate dimensions for lower column (see table above).

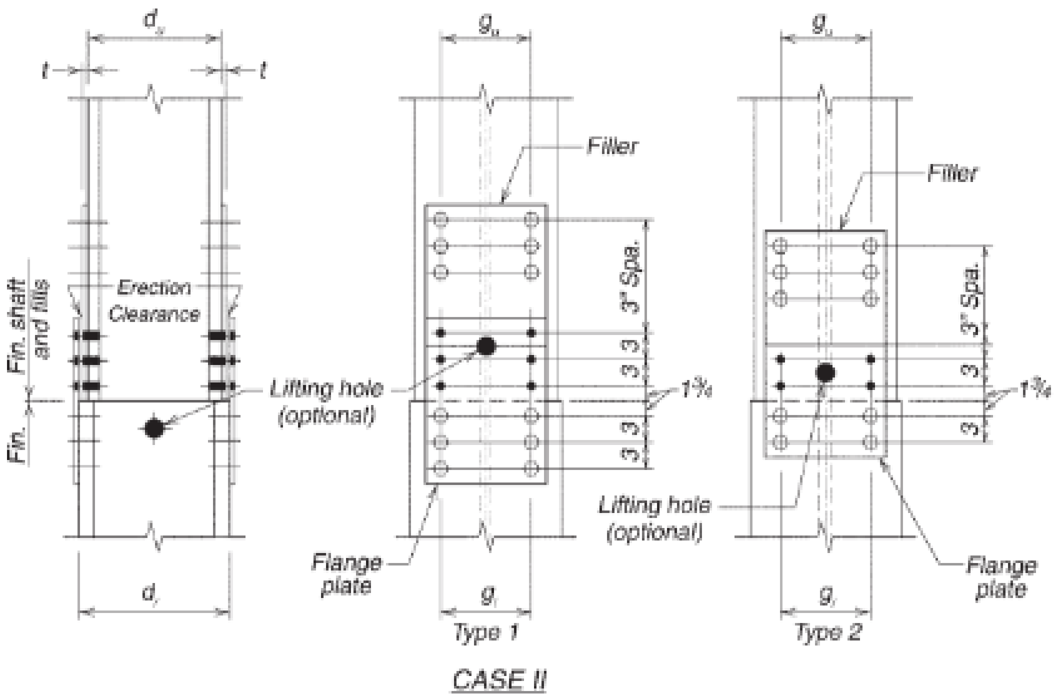
Fillers (shop bolted to upper column): Same as Case I-C.

Shims: Same as Case I-A.

Butt plate: Select thickness as 1½-in. for W8 upper column or two inches for others. Select width the same as upper column and length as d_l – ¼ in.

For lifting devices, see Figure 14-10.

Table 14-3 (continued)
Typical Column Splices
Case II and III:
All-bolted flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.



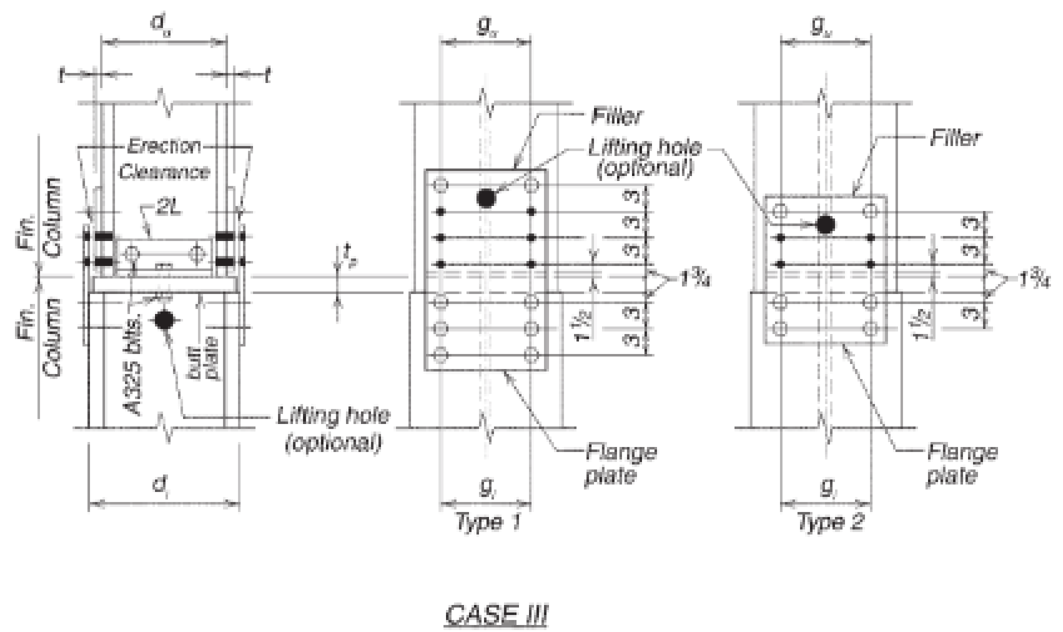


Table 14-3 (continued)
Typical Column Splices
Case IV:
All-welded flange-plated column splices between columns with depths d_u and d_l nominally the same.

Column Size	Flange Plate			Welds			Minimum Space for Welding	
	Width	Thk.	Length L	Size A	Length X	Length Y	M	N
W14×455 & over	14	5/8	1′-6	1/2	5	7	13/16	11/16
311 to 426	12	5/8	1′-4	1/2	4	6	13/16	11/16
211 to 283	12	1/2	1′-4	3/8	4	6	11/16	9/16
90 to 193	12	3/8	1′-4	5/16	4	6	5/8	1/2
61 to 82	8	3/8	1′-4	5/16	3	6	5/8	1/2
43 to 53	6	5/16	1′-2	1/4	2	5	9/16	7/16
W12×120 to 336	8	1/2	1′-4	3/8	3	6	11/16	9/16
53 to 106	8	3/8	1′-4	5/16	3	6	5/8	1/2
40 to 50	6	5/16	1′-2	1/4	2	5	9/16	7/16
W10×49 to 112	8	3/8	1′-4	5/16	3	6	5/8	1/2
33 to 45	6	5/16	1′-2	1/4	2	5	9/16	7/16
W8×31 to 67	6	3/8	1′-2	5/16	2	5	5/8	1/2
24 & 28	5	5/16	1′-0	1/4	2	4	9/16	7/16

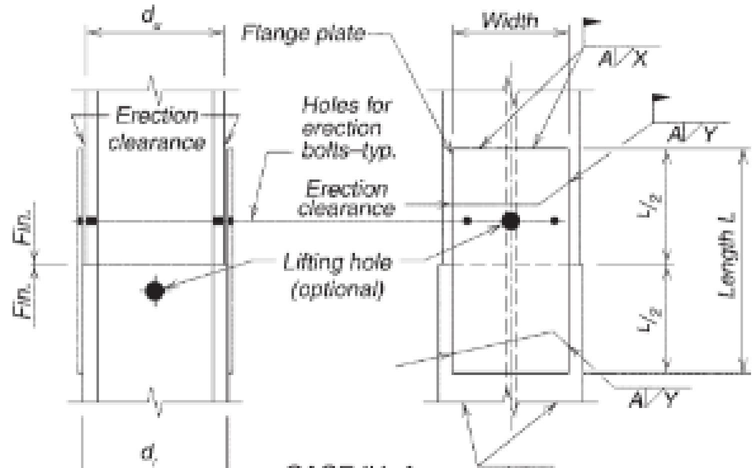
Case IV-A: $d_l = (d_u + 1/8)$	Flange plates: Select flange-plate width and length and weld lengths for upper (lighter) column; select flange-plate thickness and weld size for lower (heavier) column. Fillers: None.
Case IV-B: $d_l = (d_u - 1/4$ in.) to d_u	Flange plates: Same as Case IV-A, except use weld size $A + t$ on lower column. Fillers (undeveloped on lower column, shop welded under flange plates): Select thickness t as $(d_l - d_u) / 2 + 1/16$ in. Select width to match flange plate and length as $L / 2 - 2$ in.
Case IV-C: $d_l = (d_u + 1/4$ in.) to $(d_u + 1/2$ in.)	Flange plates: Same as Case IV-A, except use weld size $A + t$ on upper column. Fillers (undeveloped on upper column, shipped loose): Select thickness t as $(d_l - d_u) / 2 - 1/16$ in. Select width to match flange plate and length as $L / 2 - 2$ in.

For lifting devices, see Figure 14-10.

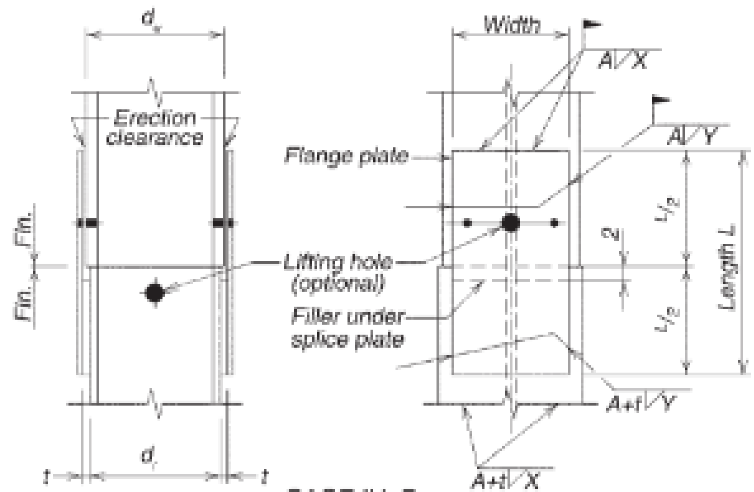
Table 14-3 (continued)
Typical Column Splices
Case IV:
All-welded flange-plated column splices between columns with depths d_u and d_l nominally the same.

Case IV-D: $d_l = (d_u + \frac{5}{8}$ in.) and over Filler width less than upper column flange width.	Flange plates: Same as Case IV-A, except see Note 1. Fillers (developed on upper column, shop welded to upper column): Select thickness t as $(d_l - d_u) / 2 - \frac{1}{16}$ in. Select weld size B from AISC Specification; $\leq \frac{5}{16}$-in. preferred. Select weld length L_B such that $L_B \geq A(X + Y) / B \geq (L / 2 + 1$ in.). Select filler width greater than flange plate width + 2N but less than upper column flange width − 2M. Select filler length as L_B, subject to Note 2.
Case IV-E: $d_l = (d_u + \frac{5}{8}$ in.) and over Filler width greater than upper column flange width. Use this case only when M or N in Case IV-D are inadequate for welds B and A.	Flange plates: Same as Case IV-A, except see Note 1. Fillers (developed on upper column, shop welded to upper column): Select thickness t as $(d_l - d_u) / 2 - \frac{1}{16}$ in. Select weld size B from AISC Specification; $\leq \frac{5}{16}$-in. preferred. Select weld length L_B such that $L_B \geq A(X + Y) / B \geq (L / 2 + 1$ in.). Select filler width as the larger of the flange plate width + 2N and the upper column flange width + 2M, rounded to the next higher $\frac{1}{4}$-in. increment. Select filler length as L_B subject to Note 2.

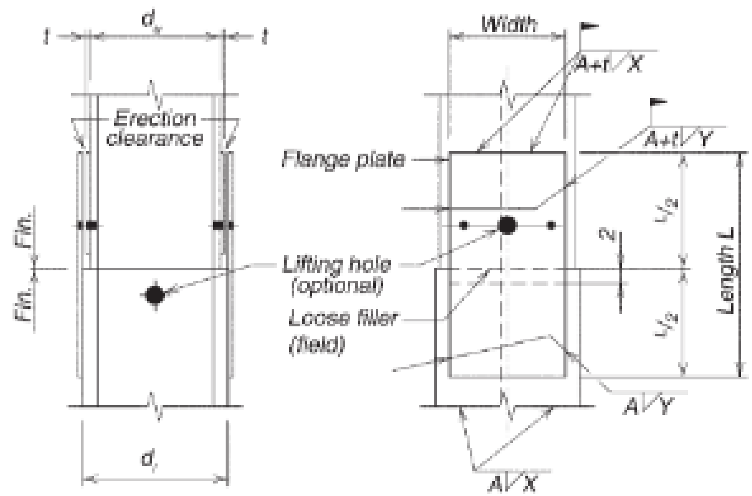
Table 14-3 (continued)
Typical Column Splices
Case IV:
All-welded flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.



CASE IV–A



CASE IV–B



CASE IV–C

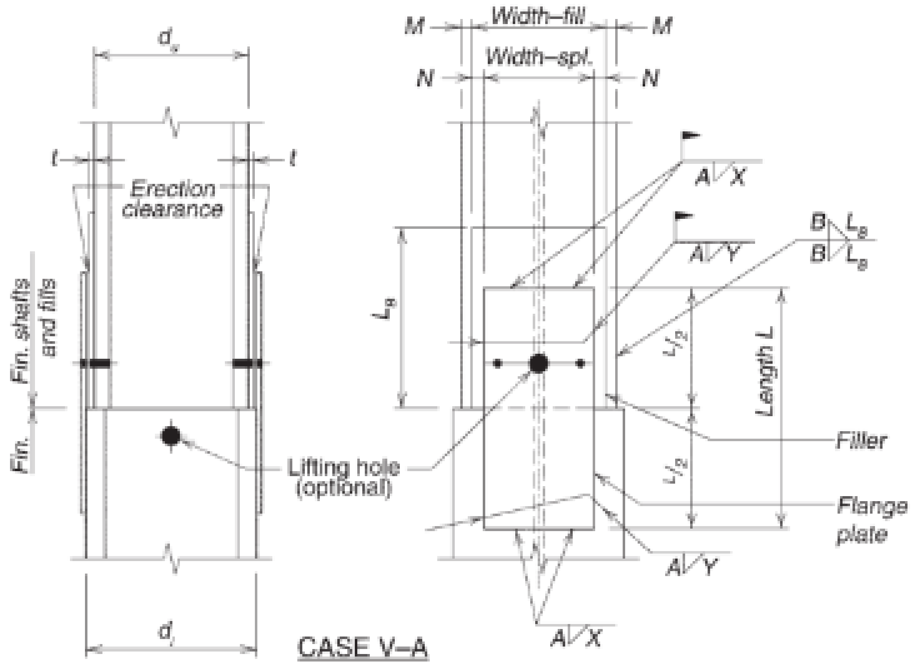
Table 14-3 (continued)
Typical Column Splices
Case V:
All-welded flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.

Case V-A: Fillers on upper column developed for bearing on lower column. Filler width less than upper column flange width.	Flange plates: Same as Case IV-A, except see Note 1. Fillers (shop welded to upper column): Select thickness as $(d_l - d_u)/2 - {}^1/_{16}$ in. Select weld size B from AISC *Specification*; $\le {}^5/_{16}$ in. preferred. Select weld length L_B to develop bearing strength of the filler but not less than $(L/2 + 1\frac{1}{2}$ in.). Select filler width greater than the flange plate width + $2N$ but less than the upper column flange width − $2M$. See Case IV for M and N.
Case V-B: Same as Case V-A except filler width is greater than upper column flange width. Use this case only when M or N in Case V-A are inadequate for weld A, or when additional filler bearing area is required.	Flange plates: Same as Case IV-A, except see Note 1. Fillers (shop welded to upper column): Select thickness as $(d_l - d_u)/2 - {}^1/_{16}$ in. Select weld size B from AISC *Specification*; $\le {}^5/_{16}$ in. preferred. Select weld length L_B to develop bearing strength of the filler but not less than $(L/2 + 1\frac{1}{2}$ in.). Select filler width as the larger of the flange plate width + $2N$ and the upper column flange width + $2M$, rounded to the next higher $\frac{1}{4}$ in. increment. Filler length as L_B, subject to Note 3.

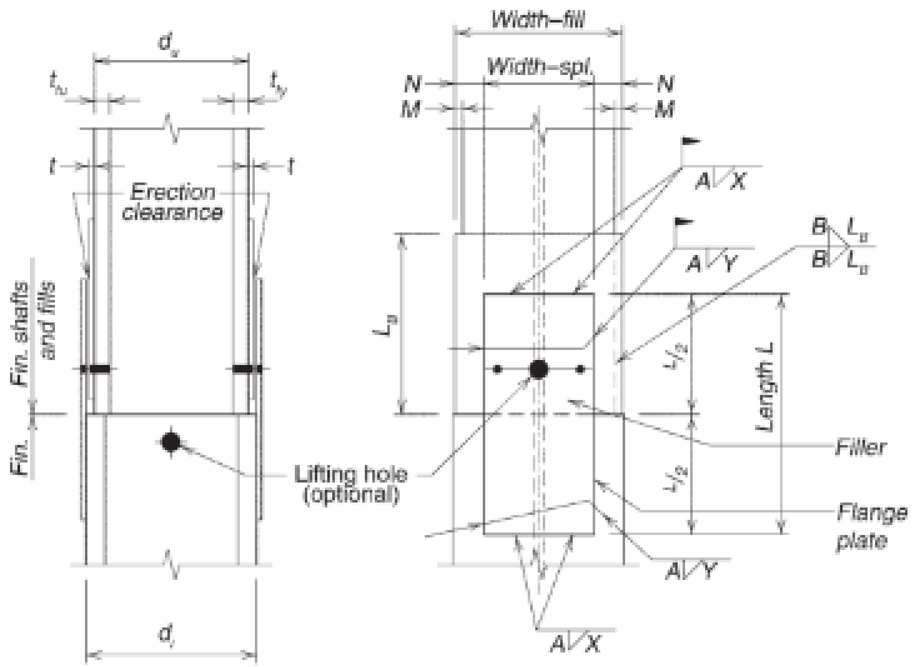
Note 3:
If fill length, based on L_B, is excessive, place weld of size B across end of fill and reduce L_B by one-half of such additional weld length, but not to less than $(L/2 + 1\frac{1}{2})$. Omit return welds in Case V-B.

Table 14-3 (continued)
Typical Column Splices

Case V:
All-welded flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.



CASE V–A



CASE V–B

Table 14-3 (continued)
Typical Column Splices
Case VI:
Combination bolted and welded column splices between columns with depths d_u and d_l nominally the same.

Column Size	Flange Plate Width	Flange Plate Thk.	Length L_U	Length L_L	Bolts No. of Rows	Bolts Gage g	Welds Size A	Welds Length X	Welds Length Y
W14×455 & over	14	5/8	9¼	9	3	11½	½	5	7
311 to 426	12	5/8	9¼	8	3	9½	½	4	6
211 to 283	12	½	9¼	8	3	9½	3/8	4	6
90 to 193	12	3/8	6¼	8	2	9½	5/16	4	6
61 to 82	8	3/8	6¼	8	2	5½	5/16	3	6
43 to 53	6	5/16	6¼	7	2	3½	¼	2	5
W12×120 to 336	8	½	6¼	8	2	5½	3/8	3	6
53 to 106	8	3/8	6¼	8	2	5½	5/16	3	6
40 to 50	6	5/16	6¼	7	2	3½	¼	2	5
W10×49 to 112	8	3/8	6¼	8	2	5½	5/16	3	6
33 to 45	6	5/16	6¼	7	2	3½	¼	2	5
W8×31 to 67	6	3/8	6¼	7	2	3½	5/16	2	5
24 & 28	5	5/16	6¼	6	2	3½	¼	2	4

Gages shown may be modified if necessary to accommodate fittings elsewhere on the columns.

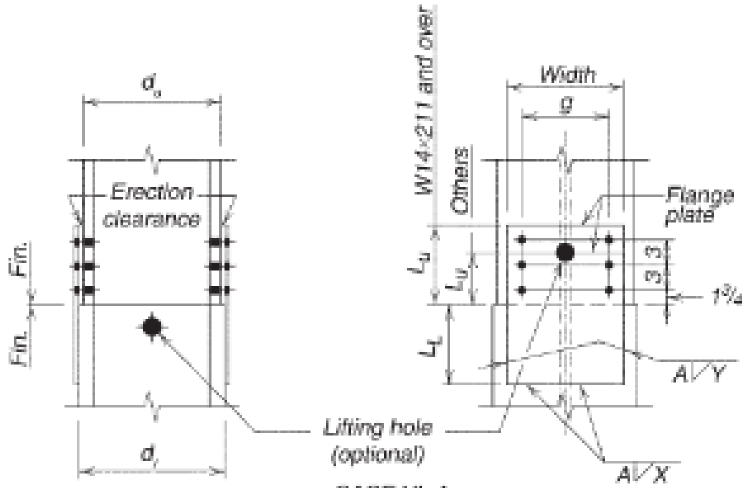
Case VI-A: $d_l = (d_u + 1/4 \text{ in.})$ to $(d_u + 5/8 \text{ in.})$	Flange plates: Select flange plate width, bolts, gage and length L_U for upper column; select flange plate thickness, weld size A, weld lengths X and Y, and length L_L for lower column. Total flange plate length is $L_U + L_L$ (see table above). Fillers: None. Shims: Furnish sufficient strip shims $2\frac{1}{2} \times \frac{1}{8}$ to obtain 0 to $1/16$-in. clearance on each side.
Case VI-B: $d_l = (d_u - 1/4 \text{ in.})$ to $(d_u + 1/8 \text{ in.})$	Flange plates: Same as Case VI-A, except use weld size $A + t$ on lower column. Fillers (shop welded to lower column under flange plate): Select thickness t as $1/8$-in. for $d_l = d_u$ and $d_l = (d_u + 1/8 \text{ in.})$ or as $3/16$-in. for $d_l = (d_u - 1/8 \text{ in.})$ and $d_l = (d_u - 1/4 \text{ in.})$. Select width to match flange plate and length as $L_L - 2$ in. Shims: Same as Case VI-A.
Case VI-C: $d_l = (d_u + 3/4 \text{ in.})$ and over	Flange plates: Same as Case VI-A. Fillers (shop welded to upper column): Select thickness t as $(d_l - d_u)/2$ minus $1/8$-in. or $3/16$-in., whichever results in $1/8$-in. multiples of fill thickness. Select weld size B as minimum size from AISC Specification Section J2. Select weld length as $L_U - 1/4$ in. Select filler width as flange plate width and filler length as $L_U - 1/4$-in. Shims: Same as Case VI-A.

Table 14-3 (continued)

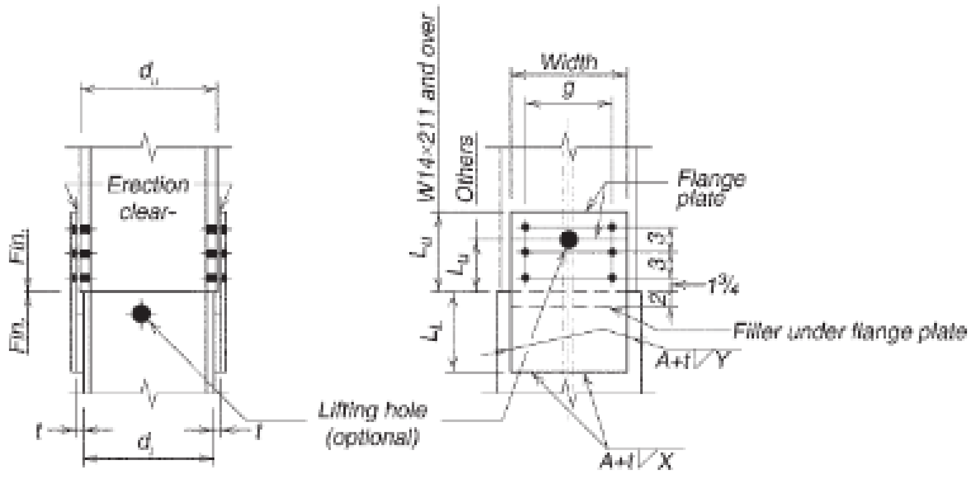
Typical Column Splices

Case VI:

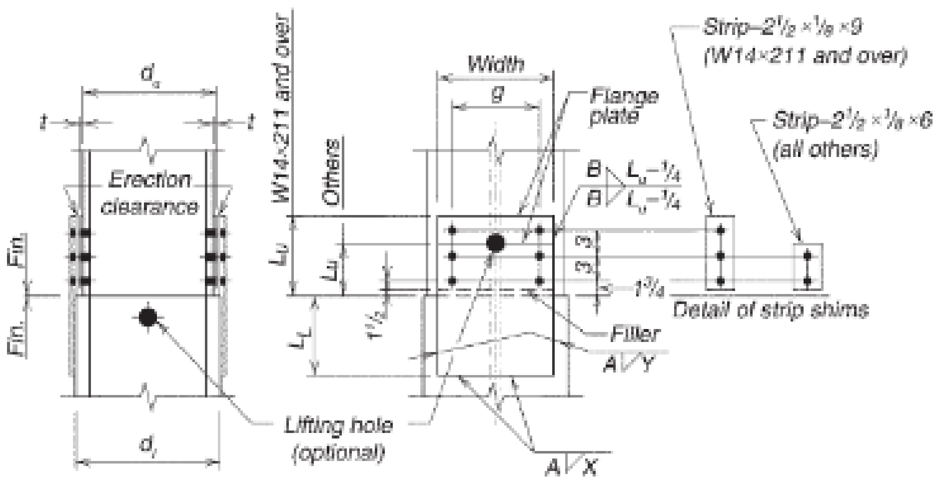
Combination bolted and welded column splices between columns with depths d_u and d_l nominally the same.



CASE VI–A



CASE VI–B



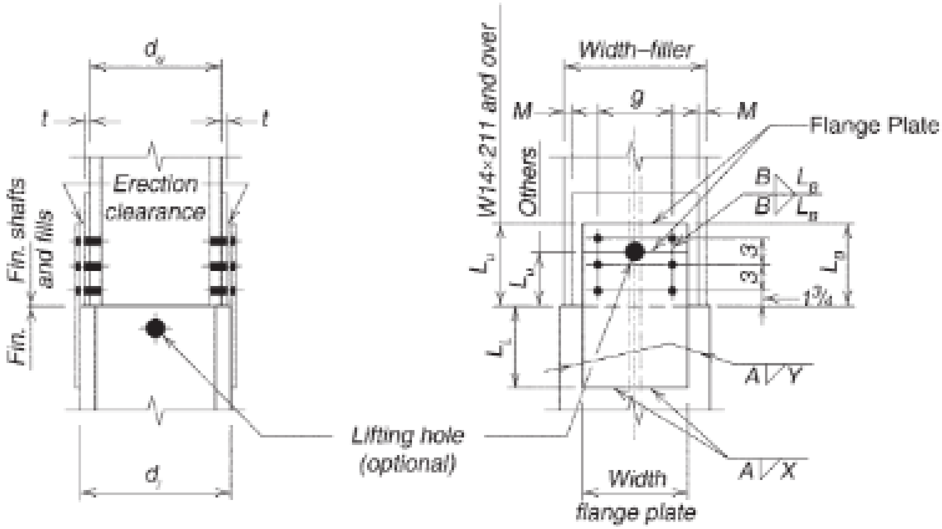
CASE VI–C

Table 14-3 (continued)
Typical Column Splices
Case VII:
Combination bolted and welded flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l. Fillers developed for bearing.

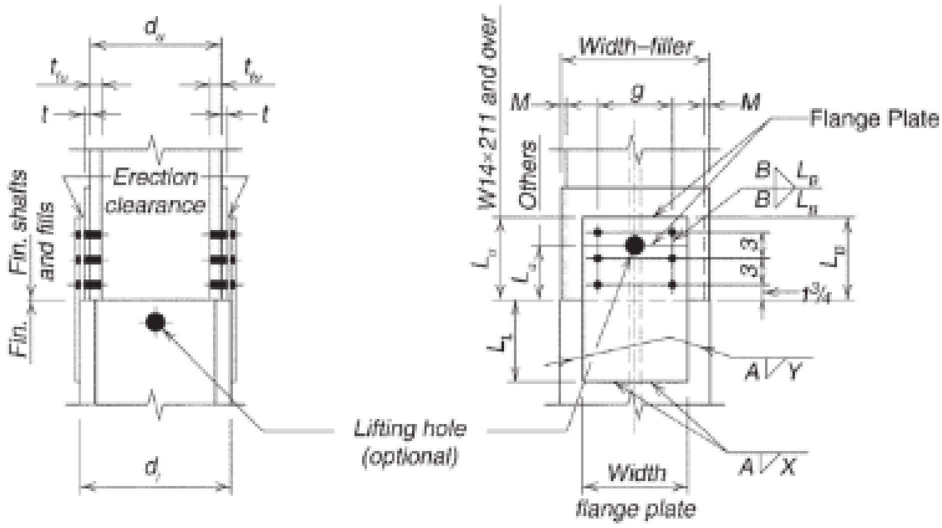
Case VII-A: Fillers of width less than upper column flange width.	Flange plates: Same as Case VI-A. Fillers (shop welded to upper column): Select filler thickness t as $(d_l - d_u)/2$ minus ⅛-in. or $^3/_{16}$-in., whichever results in ⅛-in. multiples of filler thickness. Select weld size B from AISC Specification; ≤$^5/_{16}$-in. preferred. Select weld length L_B to develop bearing strength of filler. Select filler width not less than flange plate width but not greater than upper column flange width −2M (see Case IV). Select filler length as L_B, subject to Note 4.
Case VII-B: Filler of width greater than upper column flange width. Use Case VII-B only when fillers must be widened to provide additional bearing area.	Flange plates: Same as Case VI-A. Fillers (shop welded to upper columns): Same as Case VII-A except select filler width as upper column flange width + 2M (see Case IV) rounded to the next larger ½-in. increment.

Note 4:
If fill length based on L_B is excessive, place weld of size B across end of fill and reduce L_B by one-half of such additional weld length, but not less than L_U. Omit return welds, Case VII-B.

Table 14-3 (continued)
Typical Column Splices
Case VII:
Combination bolted and welded flange-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l. Fillers developed for bearing.



CASE VII–A



CASE VII–B

Table 14-3 (continued)
Typical Column Splices
Case VIII:
Directly welded flange column splices between columns with depths d_u and d_l nominally the same.

These types of splices exhibit versatility. The flanges may be partial-joint-penetration welded as in Cases VIIIA and VIIIB, or complete-joint-penetration welded as in Cases VIIIC, VIIID, and VIIIE The webs may be spliced using the channel(s) as shown in Cases VIIIA, VIIIB, VIIIC, and VIIID, or complete-joint-penetration welded as shown in Case VIIIE. The use of a channel or channels at the web splice provides a higher degree of restraint during the erection phase than does a plate or plates. The use of partial-joint-penetration flange welds provide greater stability during the erection phase than do complete-joint-penetration welds.

The adequacy of any splice arrangement must be confirmed by the user. This is especially true in regions where high winds are prevalent or when the concentrated weight of the fabricated column is significantly off its centerline.When using partial-joint-penetration flange welds, a land width of ¼-in. or greater should be used. The weld sizes are based on the thickness of the thinner column flange, regardless of whether it is the upper or lower column.

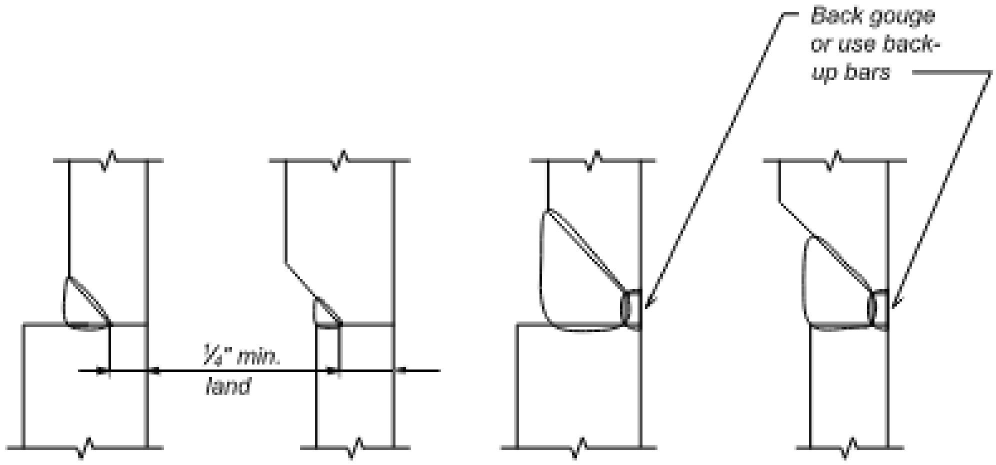
When column flange thicknesses are less than ½-in. it may be more efficient to use flange splice plates as shown in previous cases.

See the table below for minimum effective weld sizes for partial-penetration groove welds.

Partial Penetration Groove Width

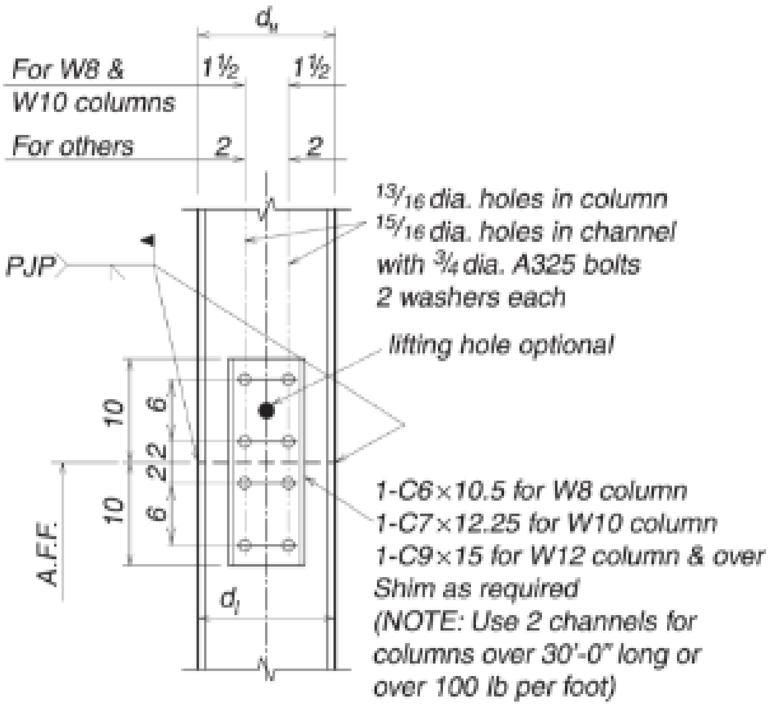
[a]Thickness of Column Material T_u	Minimum Effective Weld Size E
[b]Over ½ to ¾, incl.	¼
Over ¾ to 1½, incl.	5/16
Over 1½ to 2¼, incl.	⅜
Over 2¼ to 6, incl.	½
Over 6	⅝

[a]Thickness of thinner part joined.
[b]For less than ½, use splice plates.



(a) Partial-joint-penetration groove welds (b) Complete-joint-penetration groove welds

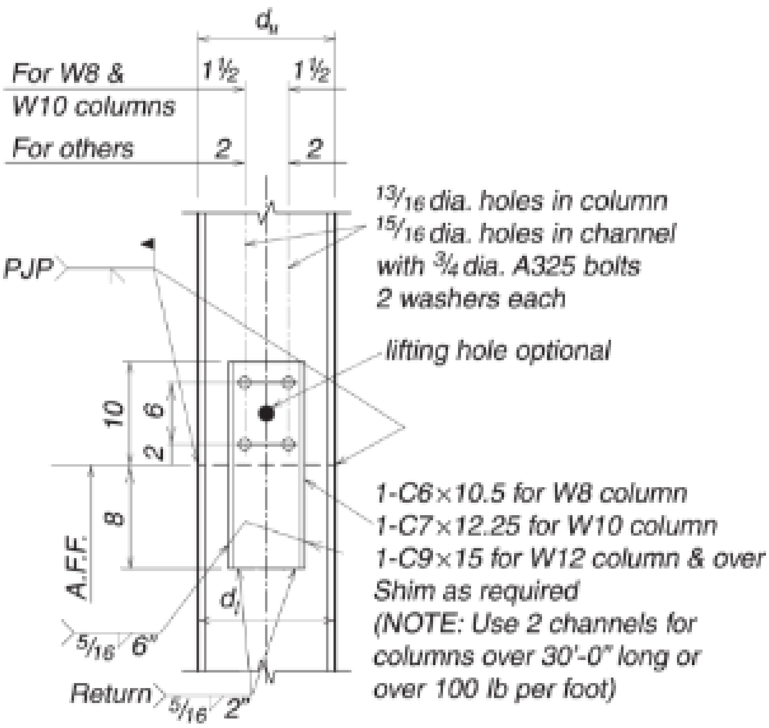
Table 14-3 (continued)
Typical Column Splices
Case VIII:
Directly welded flange column splices between columns with depths d_u and d_l nominally the same.



CASE VIII A

All-bolted web splice, partial-joint-penetration flange welds

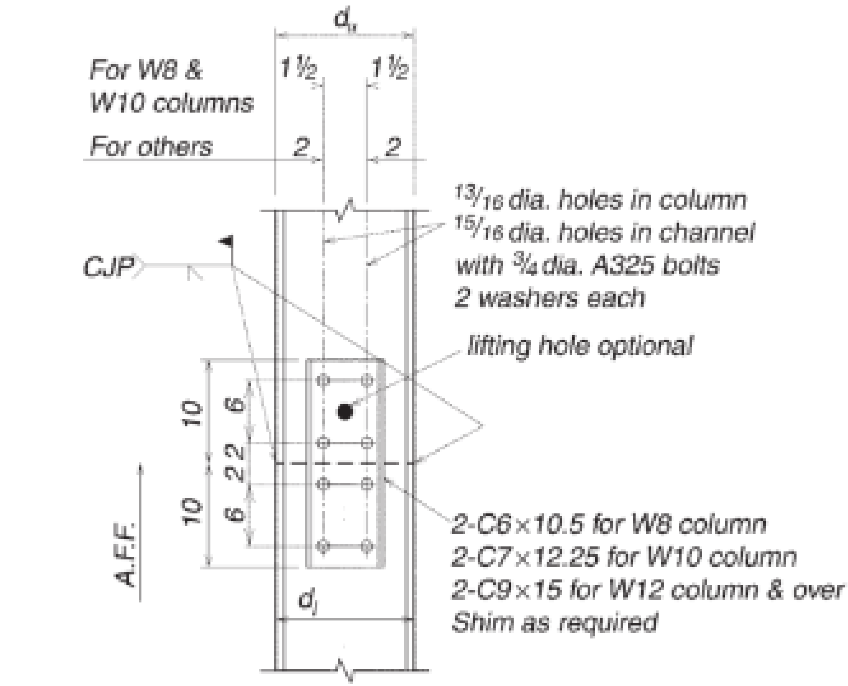
Note: User to verify weld accessibility of channel to lower column shaft, or consider the use of a bolted-bolted connection.



CASE VIII B

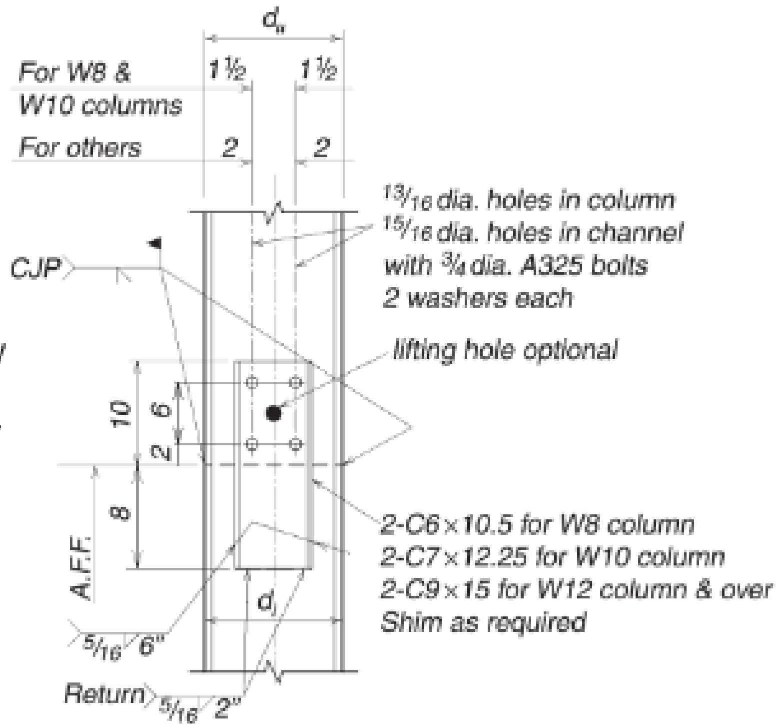
Combination bolted and welded web splice, partial-joint-penetration flange welds

Table 14-3 (continued)
Typical Column Splices
Case VIII:
Directly welded flange column splices between columns with depths d_u and d_l nominally the same.



CASE VIII C
All-bolted web splice, complete-joint-penetration flange welds

Note: User to verify weld accessibility of channel to lower column shaft, or consider the use of a bolted-bolted connection.



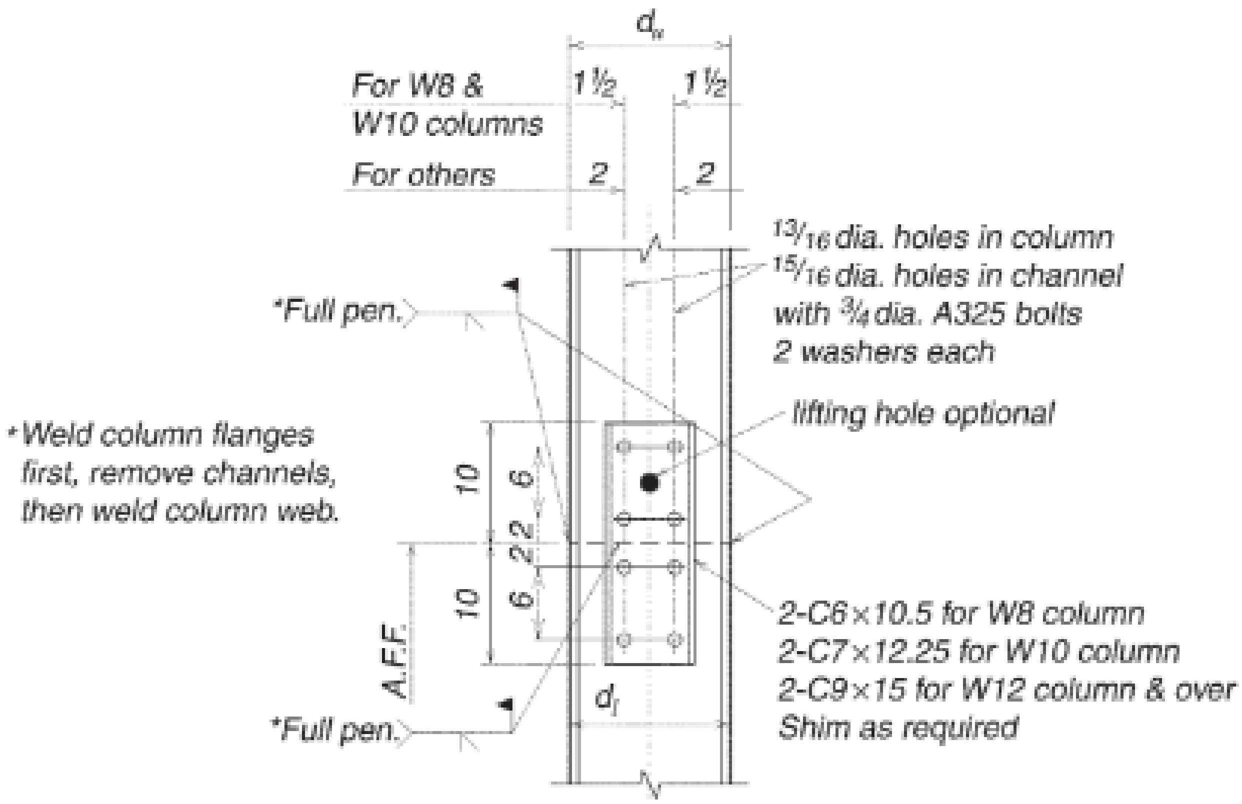
CASE VIII D
Combination bolted and welded web splice, partial-joint-penetration flange welds

Table 14-3 (continued)

Typical Column Splices

Case VIII:

Directly welded flange column splices between columns with depths d_u and d_l nominally the same.



CASE VIII E

web splice, complete-joint-penetration flange and web welds

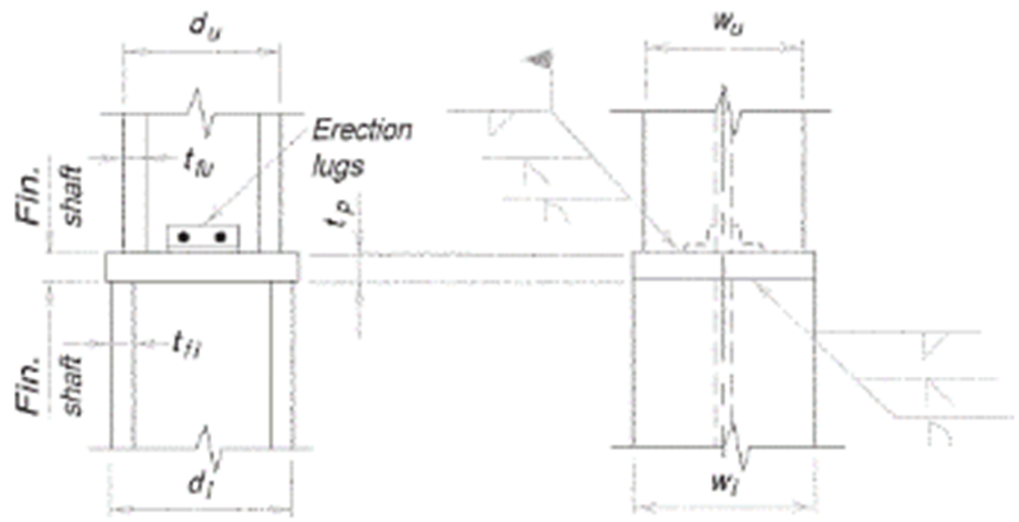
Table 14-3 (continued)
Typical Column Splices
Case IX:
Butt-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.

Butt plate: Select a butt plate thickness of 1½-in. for W8 over W10 columns and 2 in. for all other combinations. Select butt plate width and length not less than w_l and d_l assuming the lower is the larger column shaft.

Weld: Select weld to upper column based on the thicker of t_{fu} and t_p. Select weld to lower column based on the thicker of t_{fl} and t_p. The edge preparation required by the groove weld is usually performed on the column shafts. However, special cases such as when the butt plate must be field welded to the lower column require special consideration.

Erection: clip angles, such as those shown in the sketch below, help to locate and stabilize the upper column during the erection phase.

Table 14-3 (continued)
Typical Column Splices
Case IX:
Butt-plated column splices between columns with depth d_u nominally 2 in. less than depth d_l.



CASE IX

Table 14-3 (continued)
Typical Column Splices
Cases X, XI, XII
Special column splices.

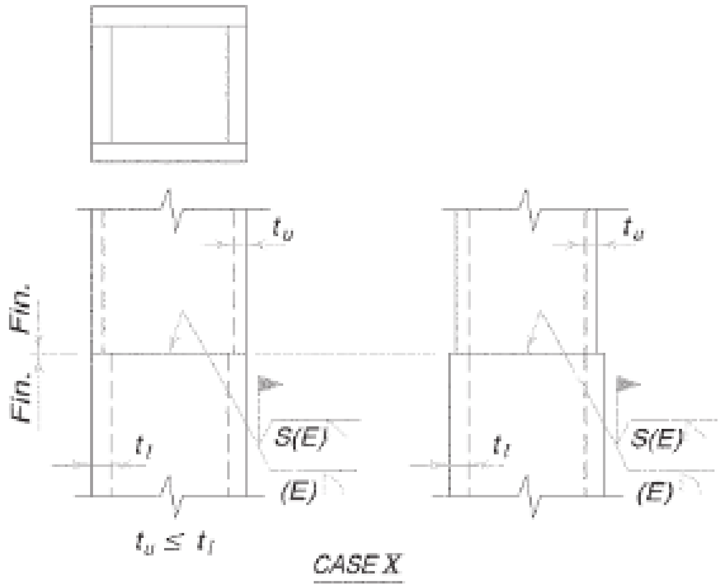
Case X: Directly welded splice between tubular and/or box-shaped columns.	Welds may be either partial-joint- or complete-joint-penetration. The strength of partial-joint-penetration welds is a function of the column wall thickness and appropriate guidelines for minimum land width and effective weld size must be observed. This type of splice usually requires lifting and alignment devices. For lifting devices see Figure 14-10. For alignment devices see Figure 14-11.
Case XI: Butt-plated splices between tubular and/or box-shaped columns.	The butt-plate thickness is selected based on the AISC Specification. Welds may be either partial- or complete-penetration-groove welds, or, if adequate space is provided, fillet welds may be used. Weld strength is based on the thickness of connected material. See comments under Case X above regarding lifting and alignment devices.
Case XII: Butt-plated column splices between W-shape columns and tubular or box-shaped columns.	See comments under Case XI above.

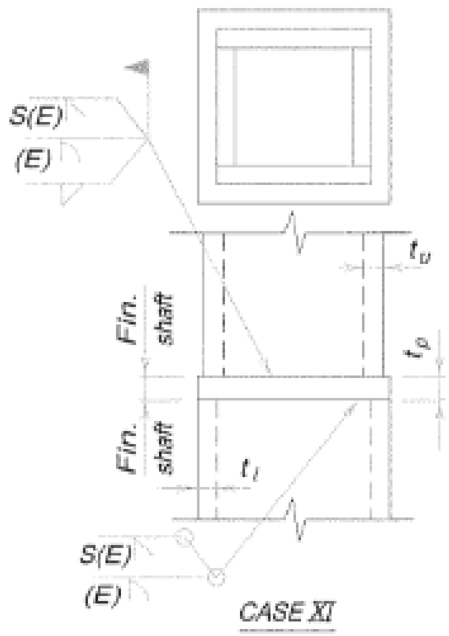
Table 14-3 (continued)

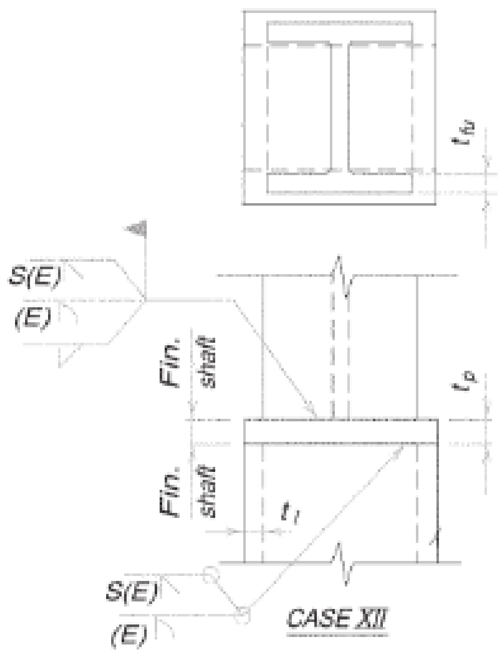
Typical Column Splices

Cases X, XI, XII

Special column splices.

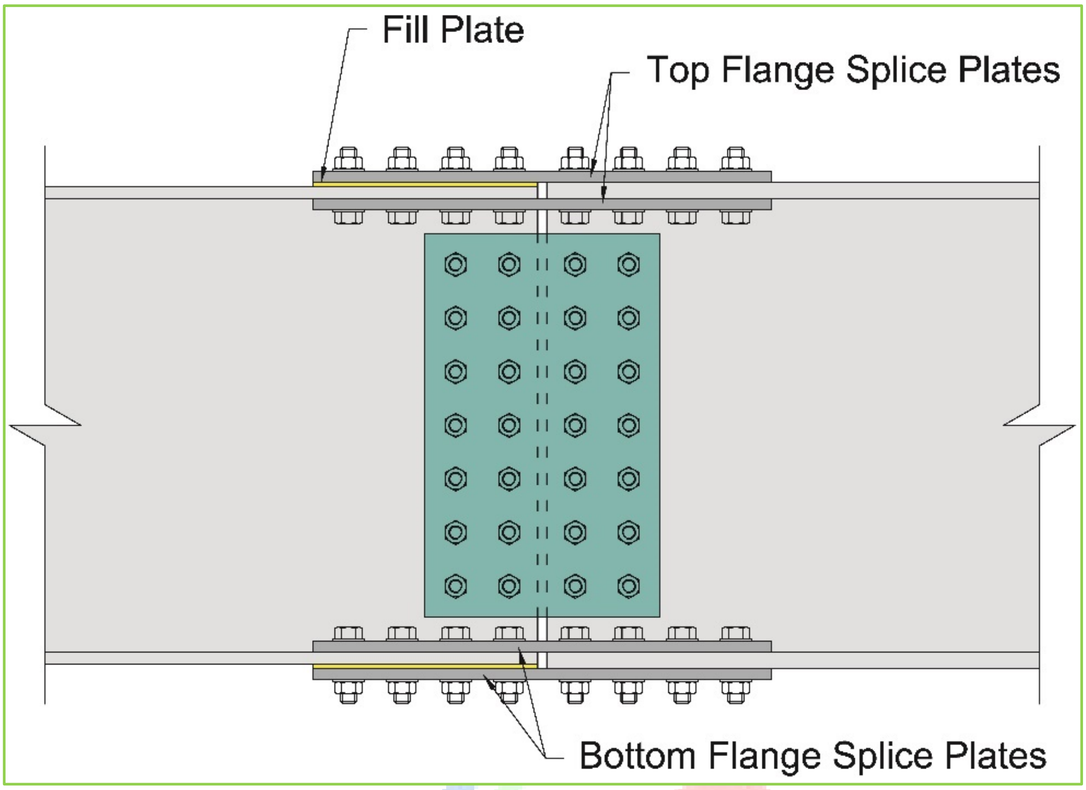






Beam splice

Beam splice connection design will be provided by the connection design engineer.



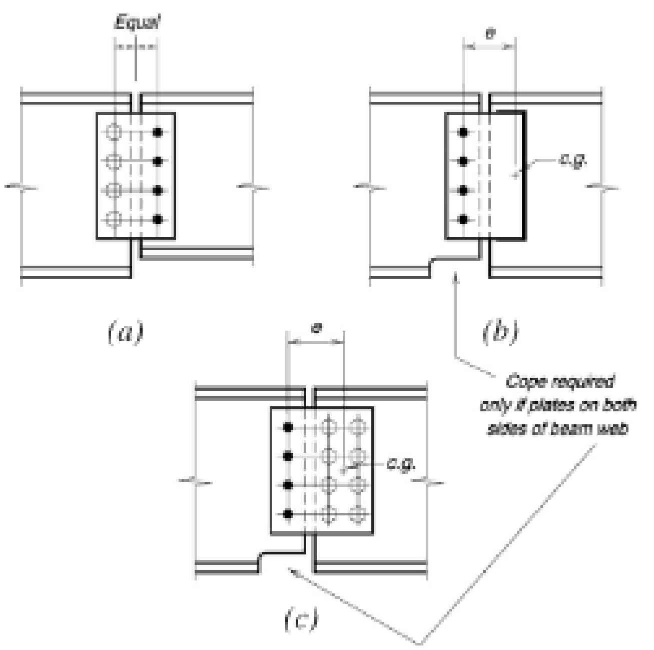


Fig. 10-16. Plate-type shear splices.

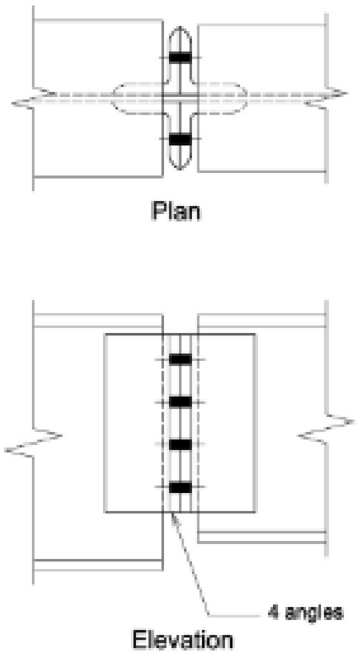


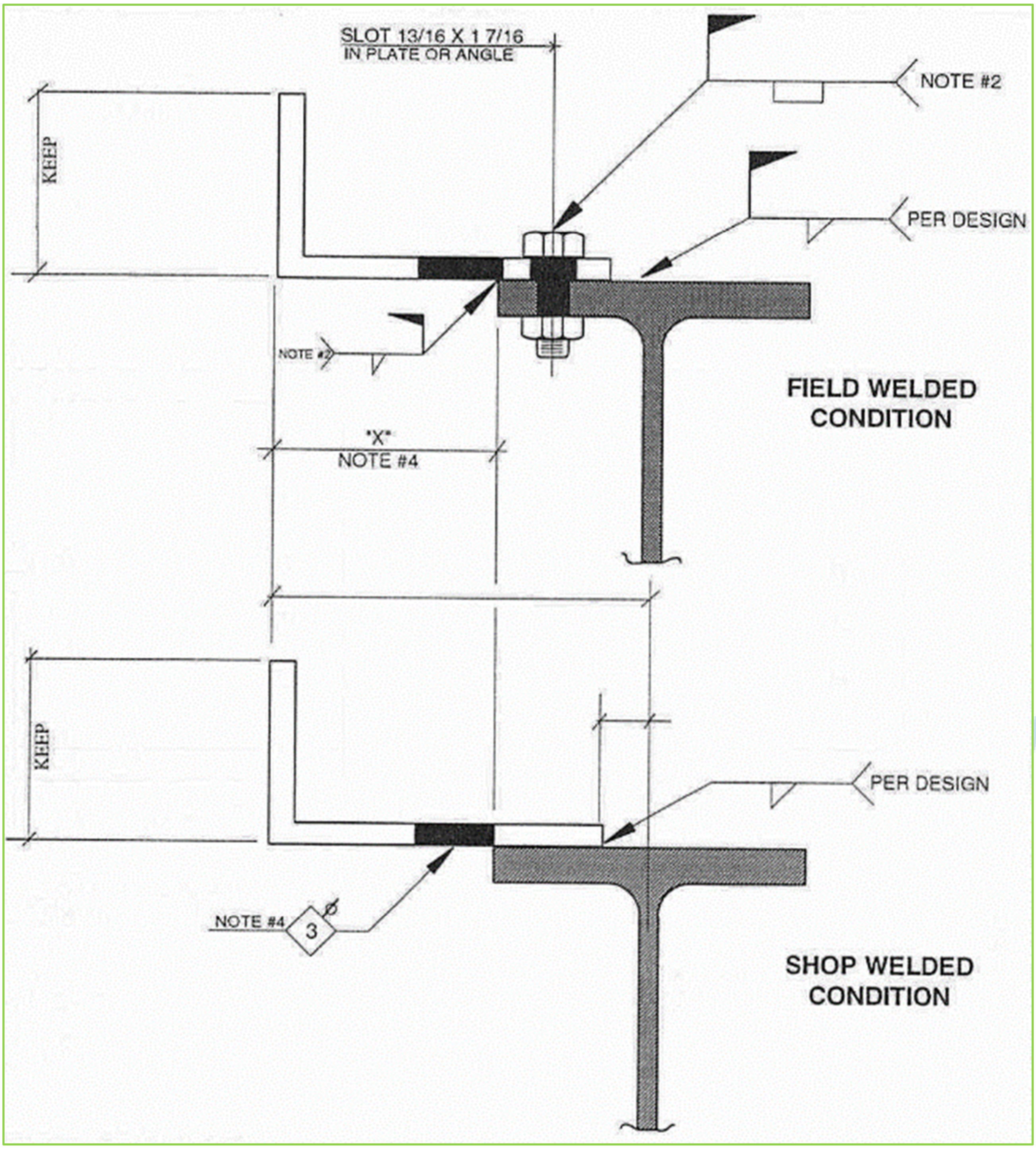
Fig. 10-17. Angle-type shear splice.

23. Erection aids

Erection aids are supposed to use for field weld and erection purposes. Erection bolts are A307 or A325N, confirm with the customer.

Bent plate:

- ✓ provide a slotted hole at each end of deck closure for field weld
  purposes.
- ✓ Provide ½" clear all-around at column conditions.



HSS column/beam to HSS beam:

Angle support

- ✓ Provide the angle for HSS beam support.
- ✓ Angle size based on the beam confirm size, confirm with the customer.
- ✓ Through bolt or threaded rods, threaded studs based on the beam depth, confirm with the customer.
- ✓ If the threaded stud will use, provided an OVS hole in angle.
- ✓ Add erector note in e-plans "Remove erection aids, after field weld the beam to column, if required."

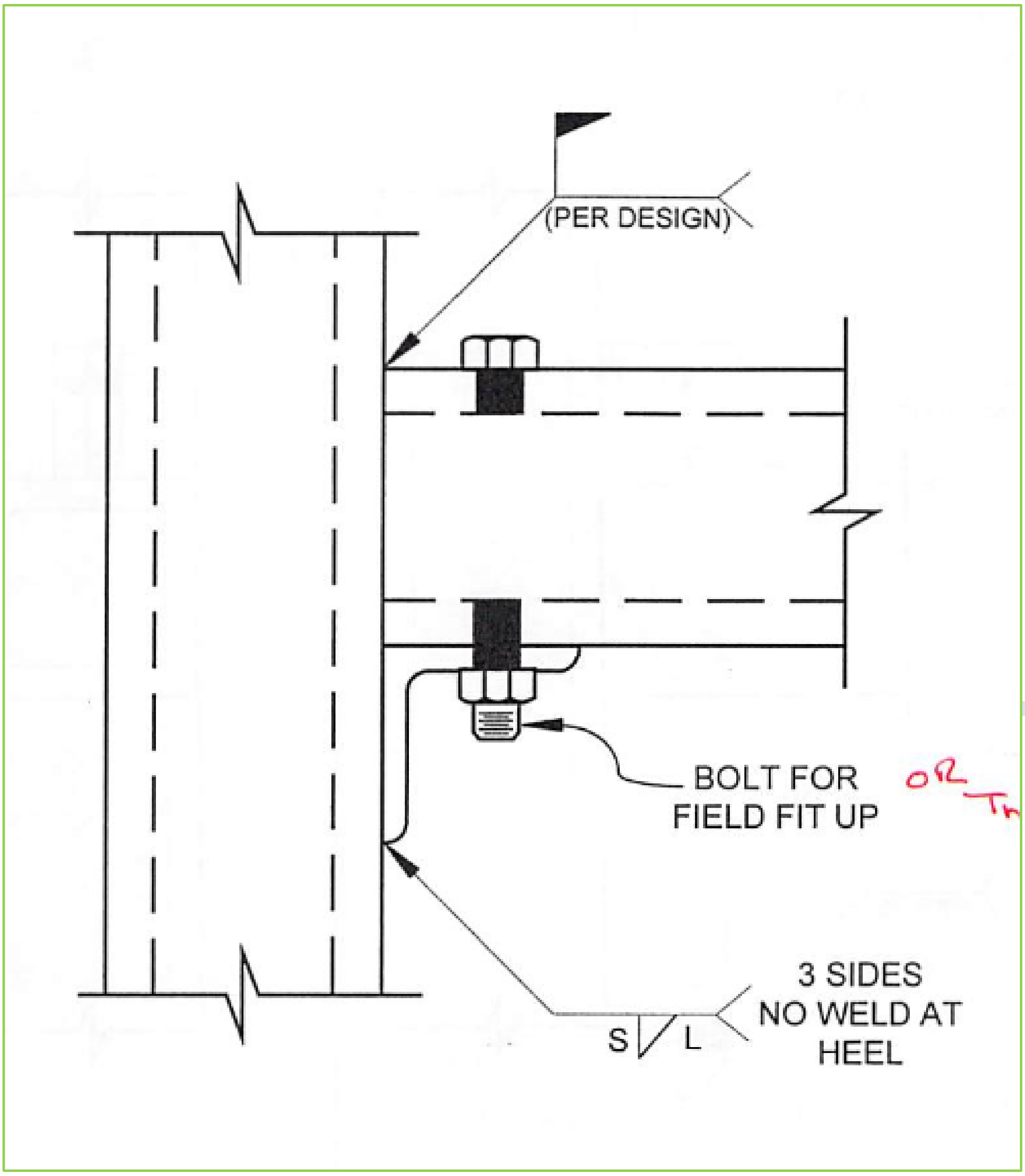
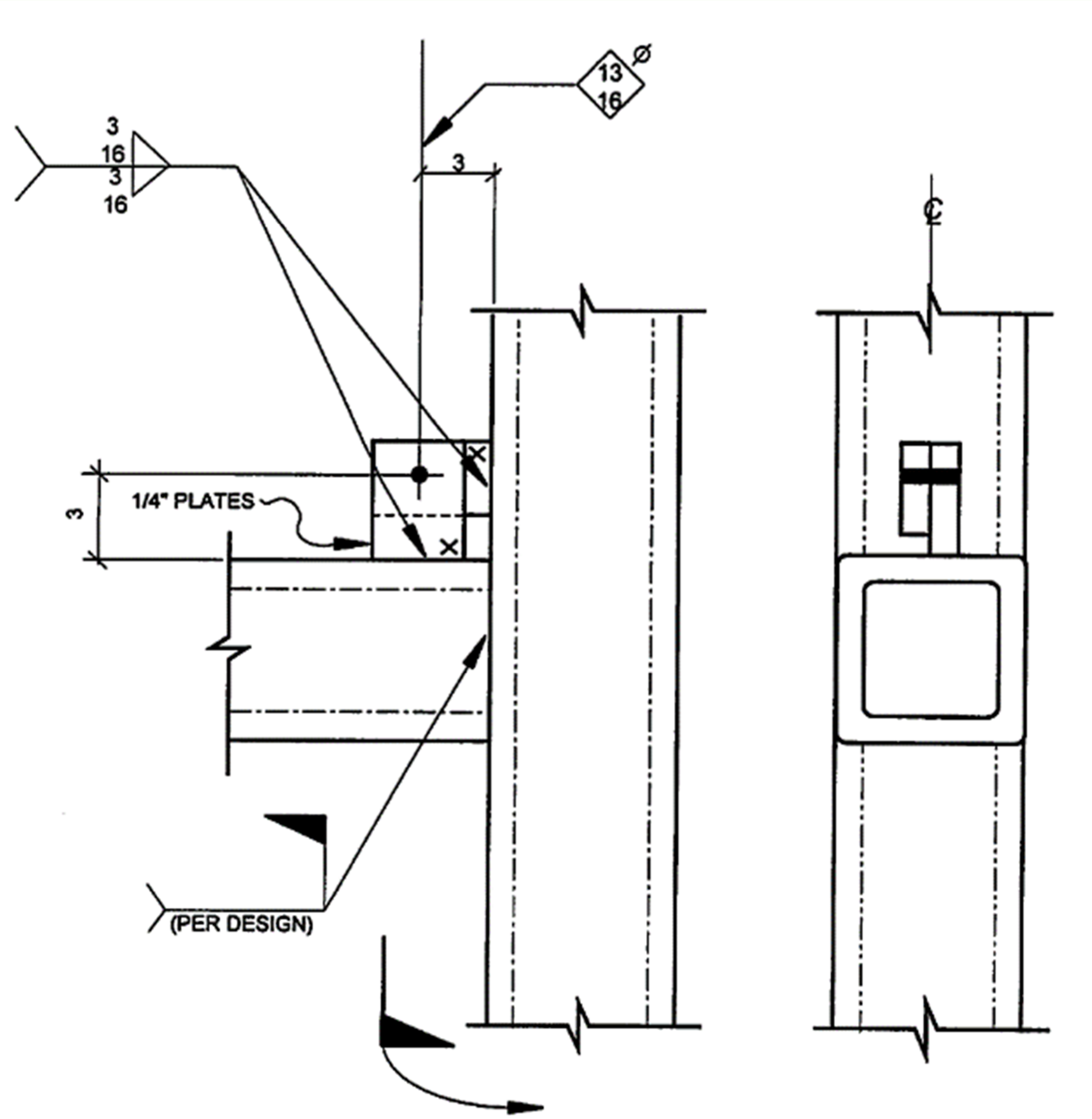


Plate support (Dog or Rabbit ear)

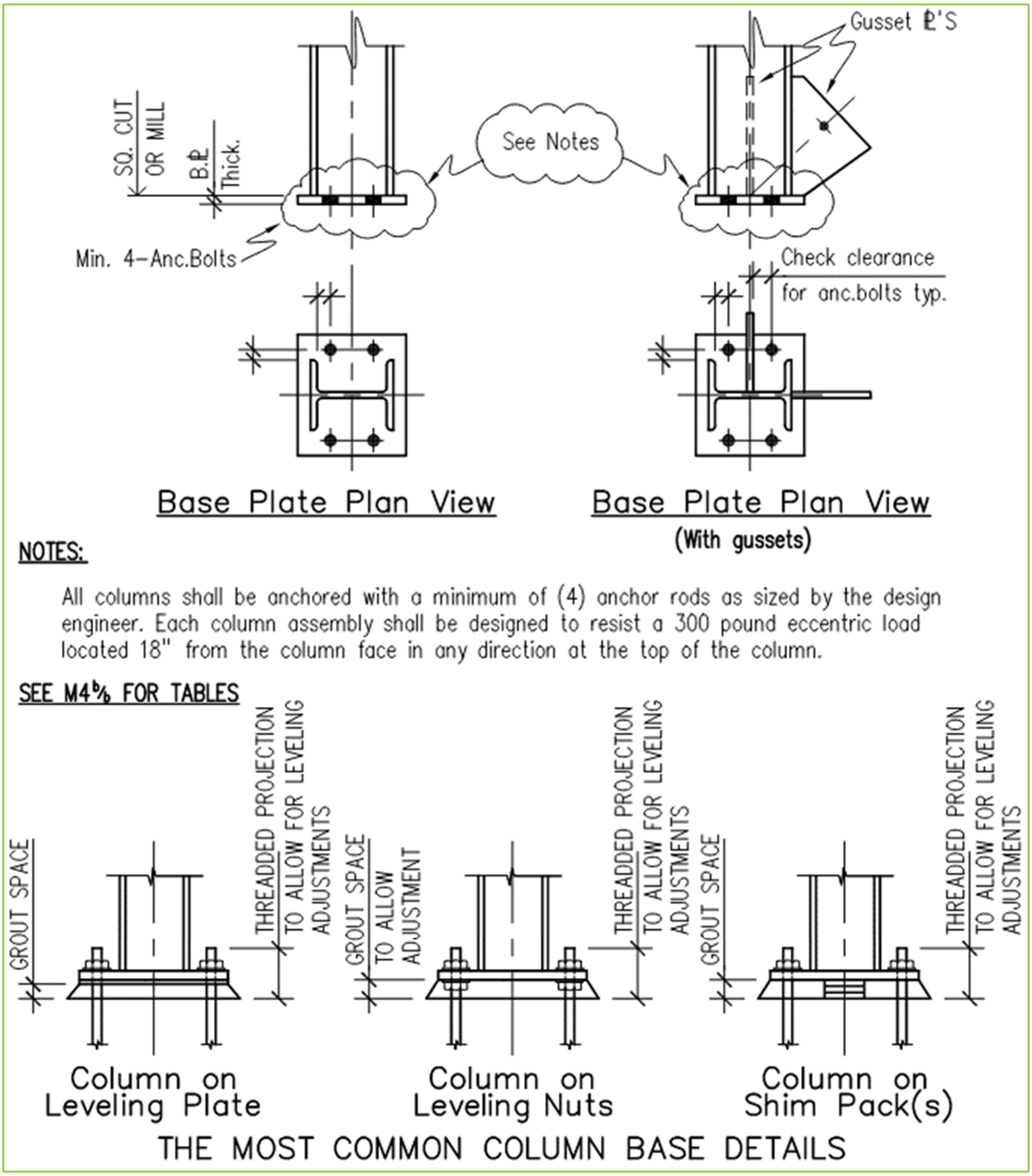
- ✓ If using the plate, provide one or two bolts based on the beam size and confirm with the customer.
- ✓ Add erector note in e-plans "Remove erection aids, after field weld the beam to column, if required."



24. OSHA standards: -

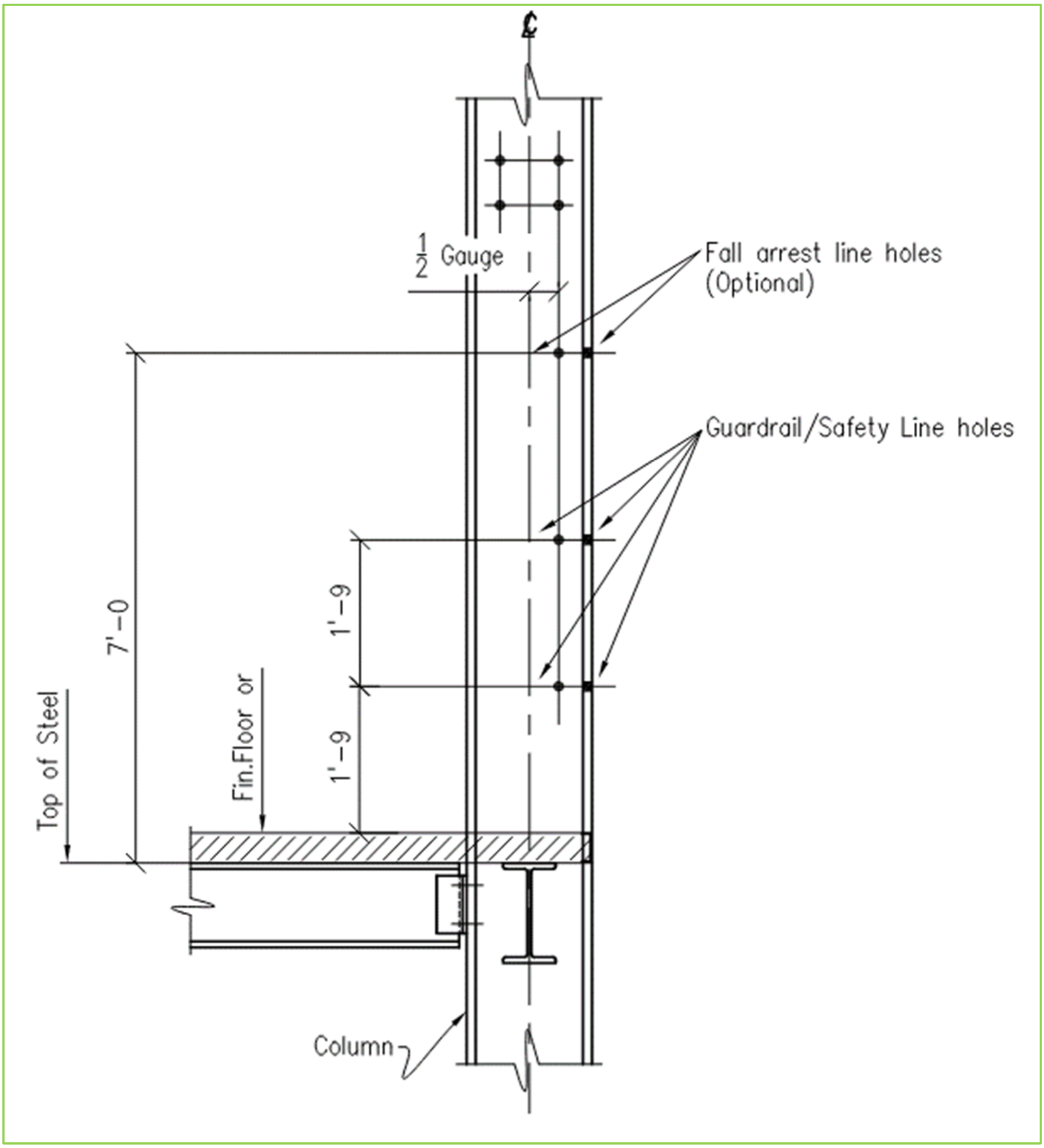
1. Columns and base plates

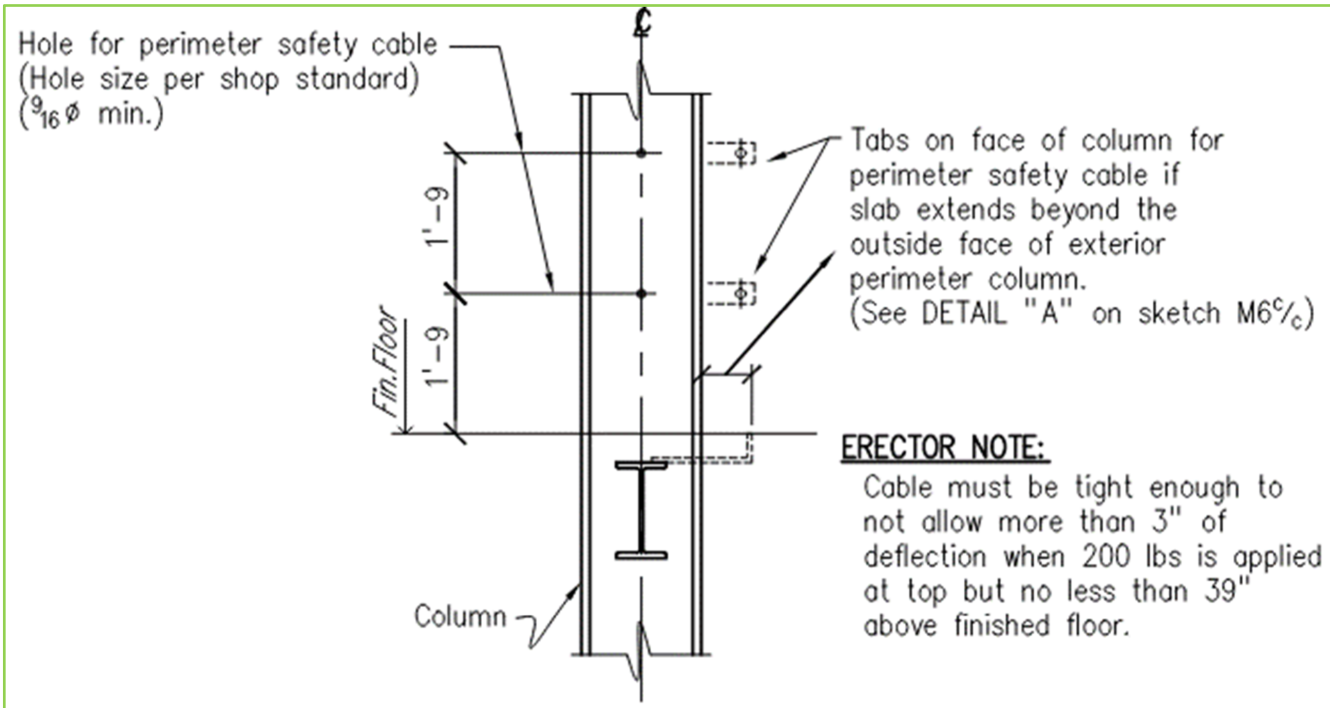
- ✓ All column base plates must be designed and fabricated with a minimum of four anchor rods.
  - >300 lbs weight is considered as columns.
  - <300 lbs weight is considered as posts.



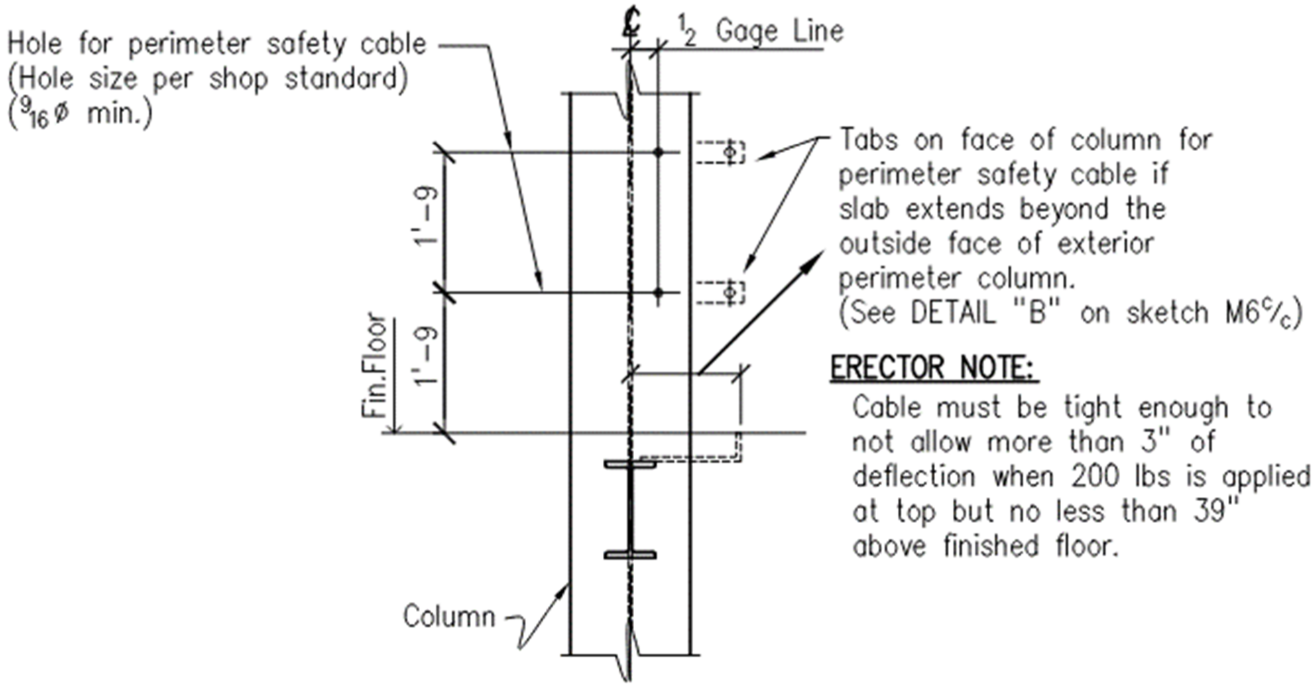
2. Safety cables

- ✓ On multi-story structures, perimeter safety cables two lines are required at the final interior and exterior perimeters of floors as soon as the deck is installed.
- ✓ Perimeter columns must extend 48 in. above the finished floor unless constructability does not allow to allow the installation of perimeter safety cables.

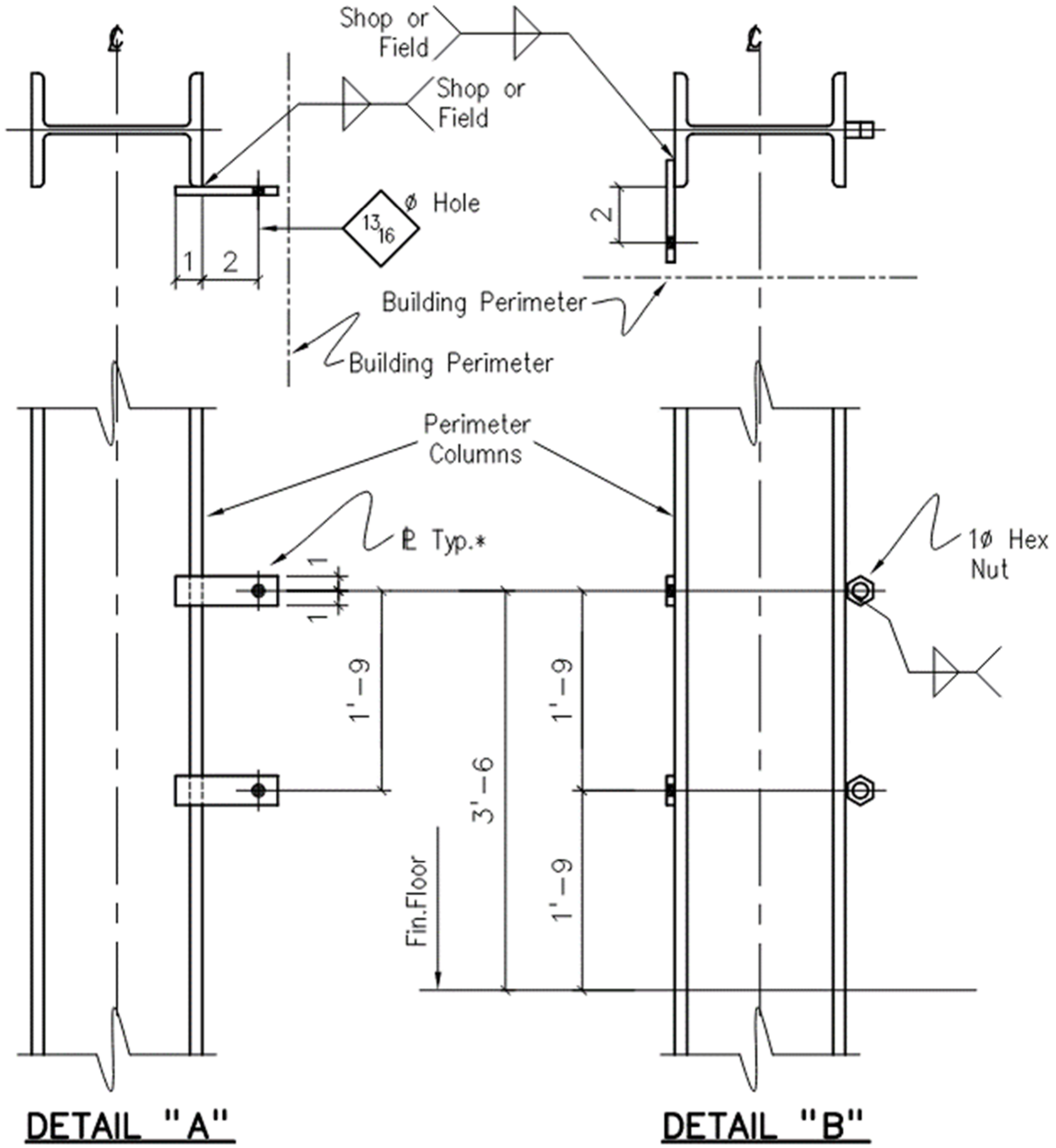




DETAIL "B"

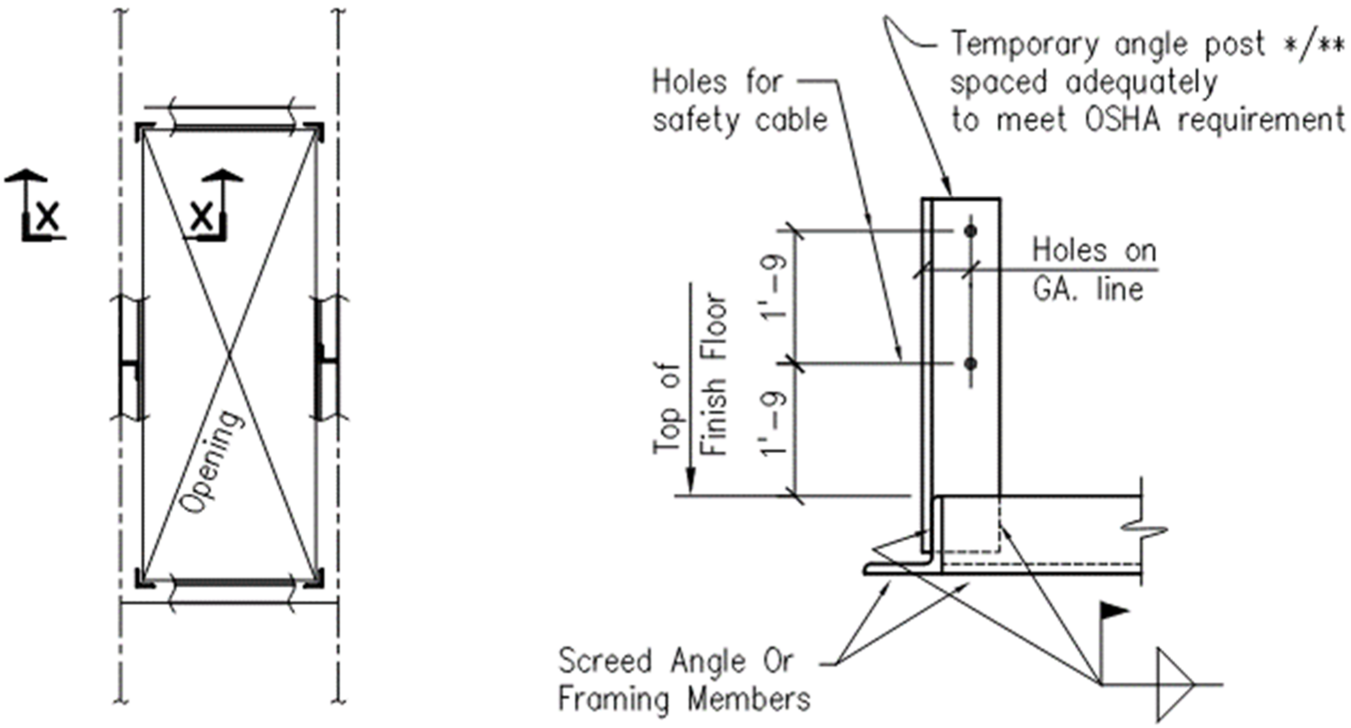


DETAIL "A"



Optional method for connection of safety line.

* Care must be taken to keep nuts or ℄s from being bent or broken off during shipping



Section X–X

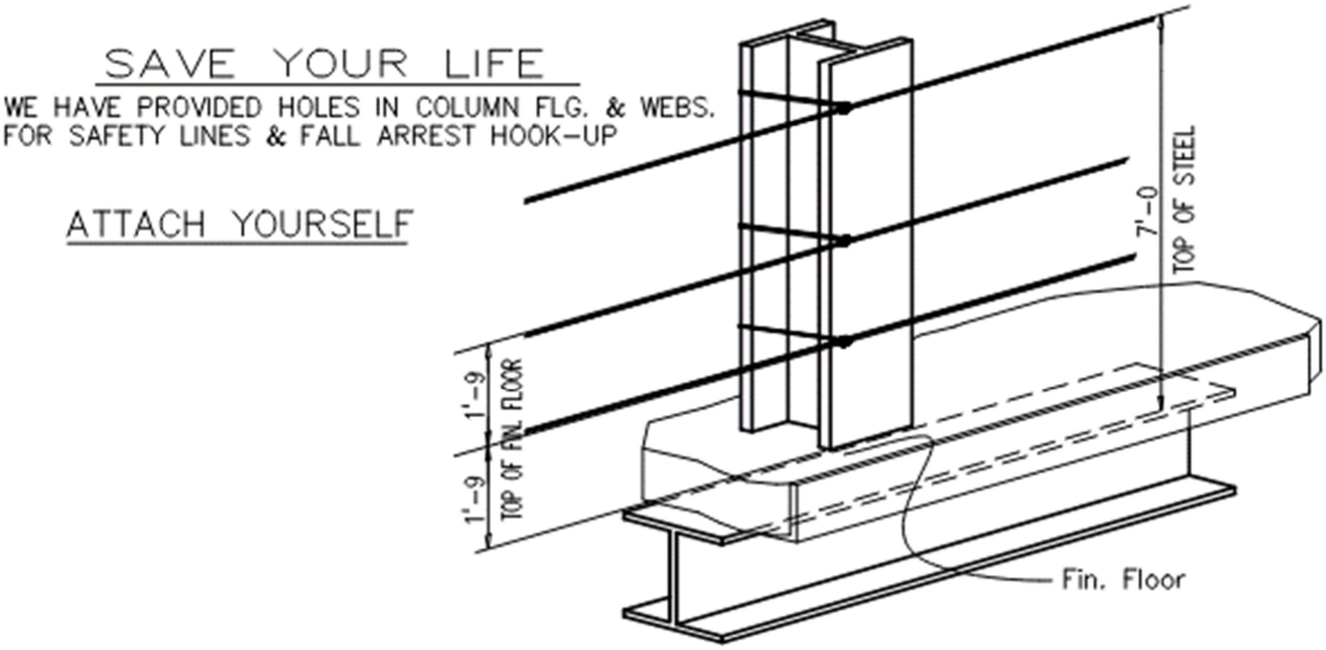
NOTE:

If beam or other framing member available at location, use it.
* Cut angle member flush with floor
& discard when no longer necessary
** Other means of achieving fall propection
also acceptable.

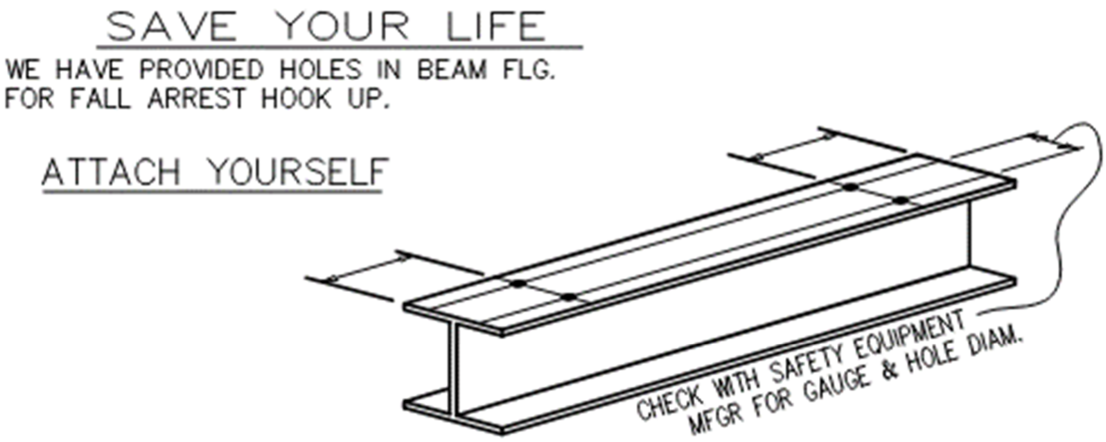
Corner Detail At Large Openings

(Framed with angles or bent ℞)

3.Typical safety line holes on beam/Column

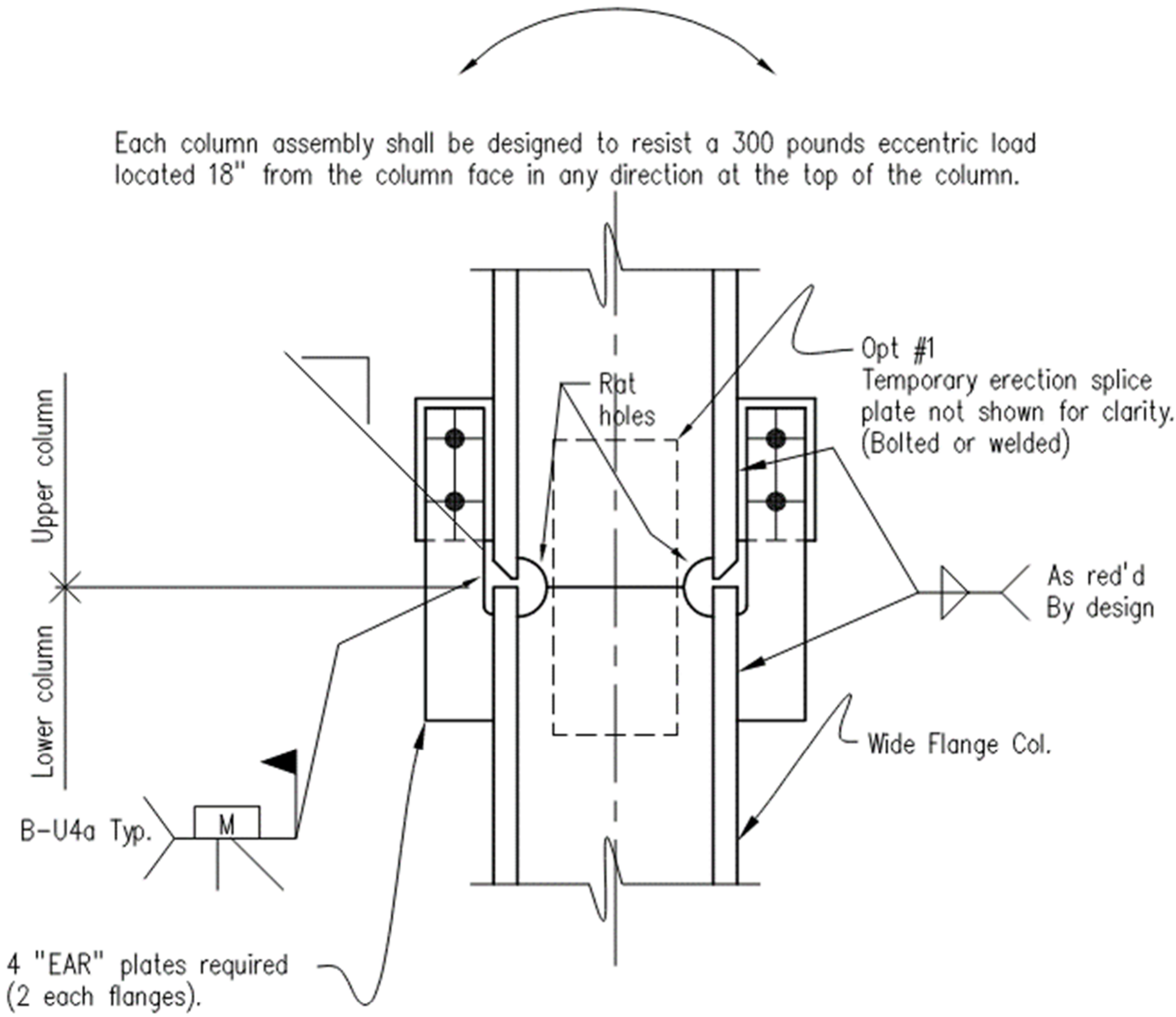


TYPICAL SAFETY LINE HOLES ON COLUMN



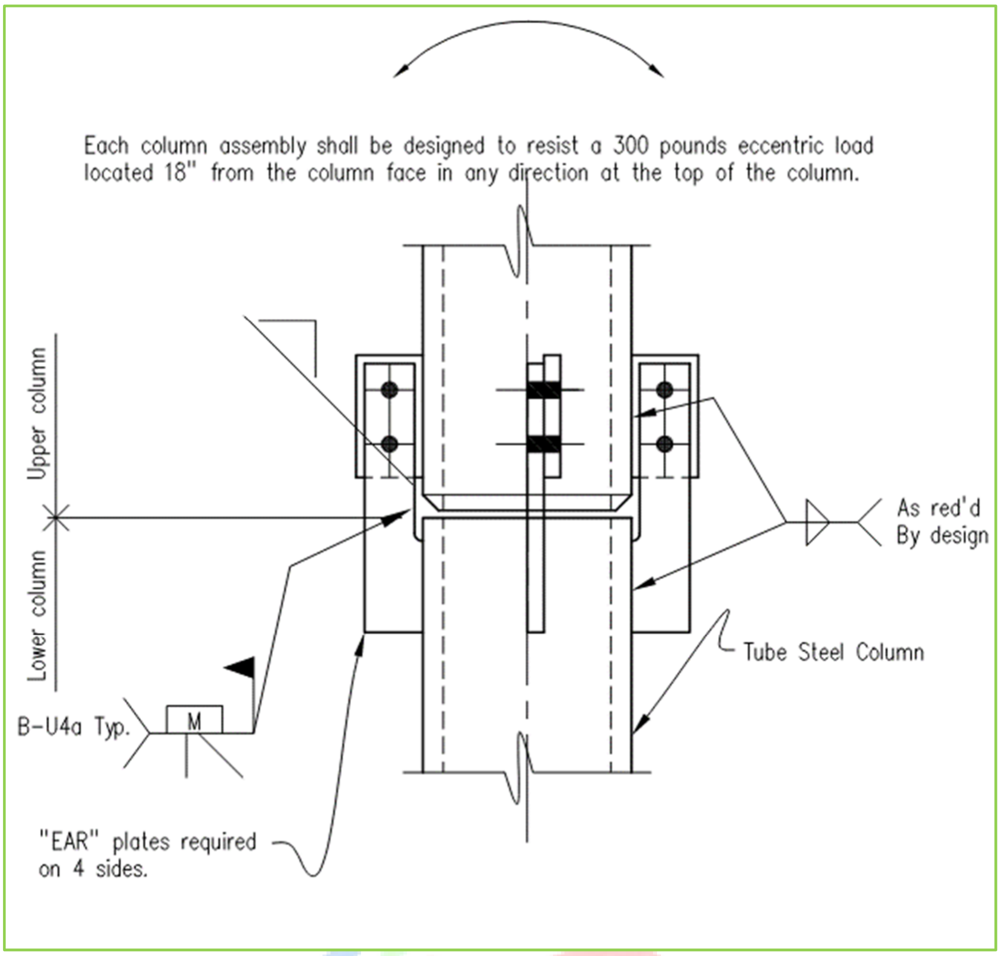
TYPICAL SAFETY TIES HOLES ON BEAM

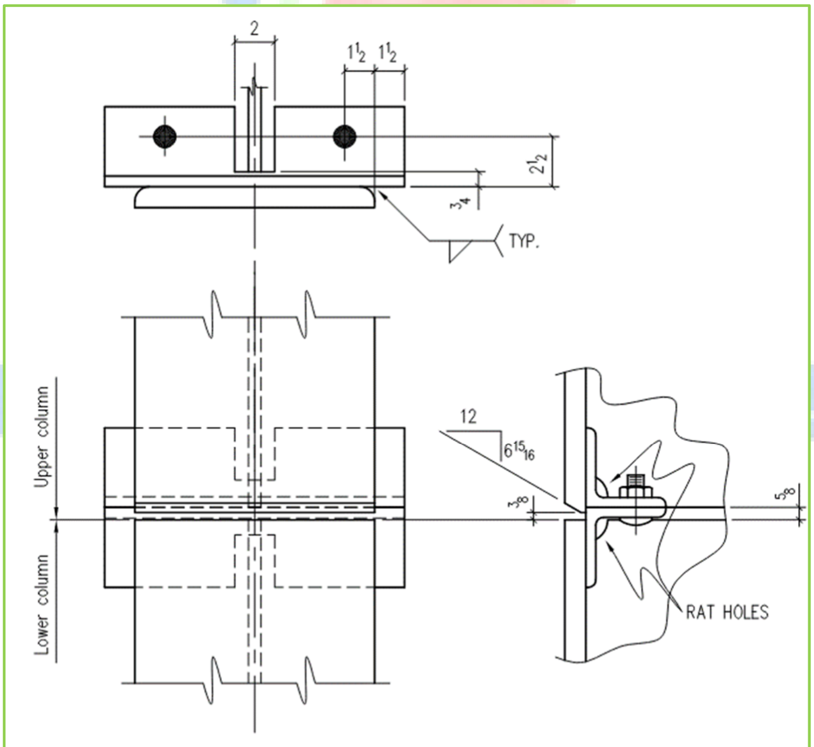
4. Welded column splice



NOTES:

Web splice plates might be sufficient at partial penetration welds where there is no root opening required. Always check with E.O.R. or design engineer for requirements



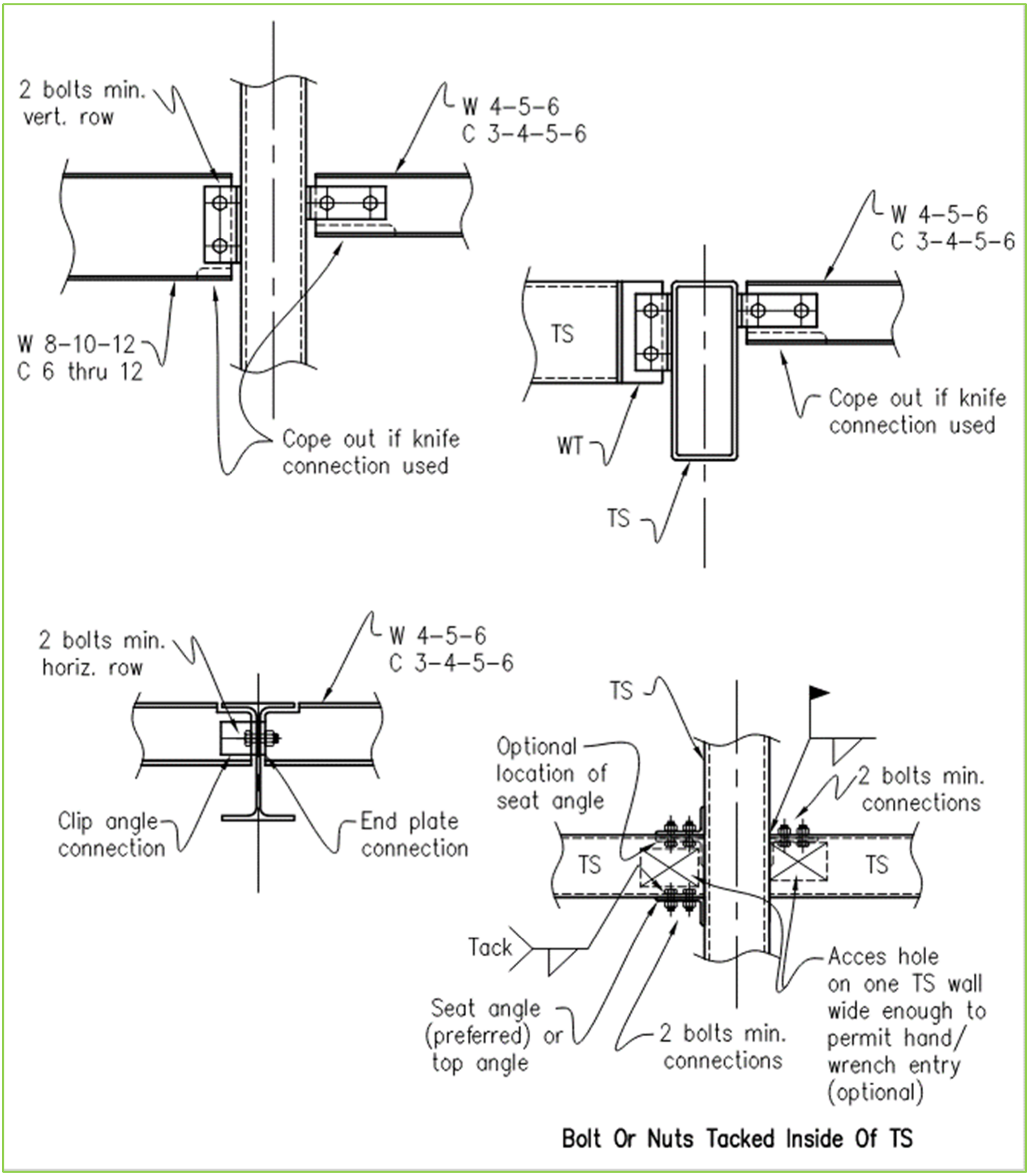


NOTE:

1) Full Penetration field weld splice with temporary connection angles also used as back-up bar. Angle must extend past root opening 1/4"+ for backup in order to make a clean weld, without the faying surfaces of the angle becoming part of the weld thus failing U.T. inspection.

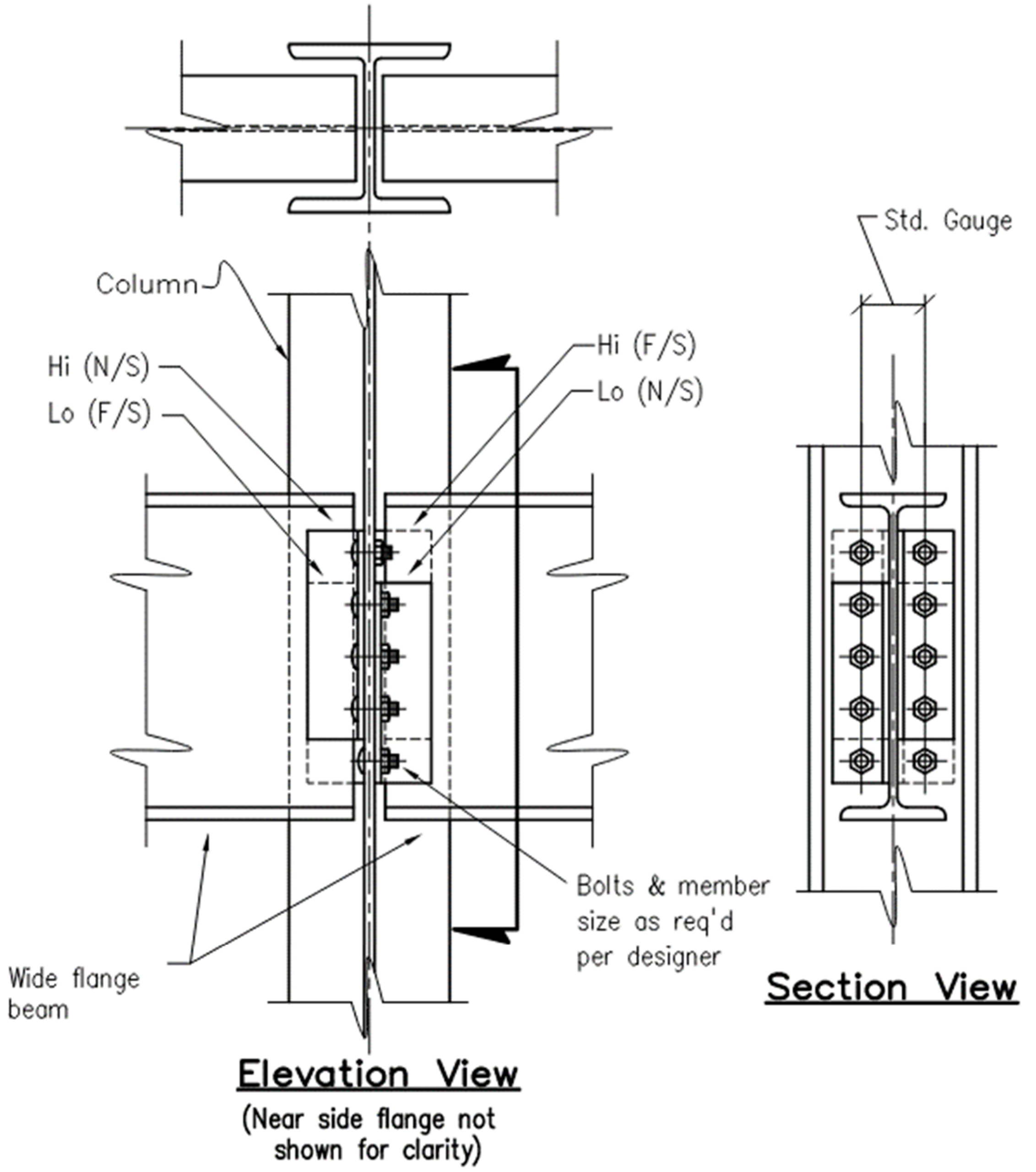
5. connections

- ✓ Solid-web members beams) must relate to a minimum of two bolts or their equivalent before the crane load line is released.

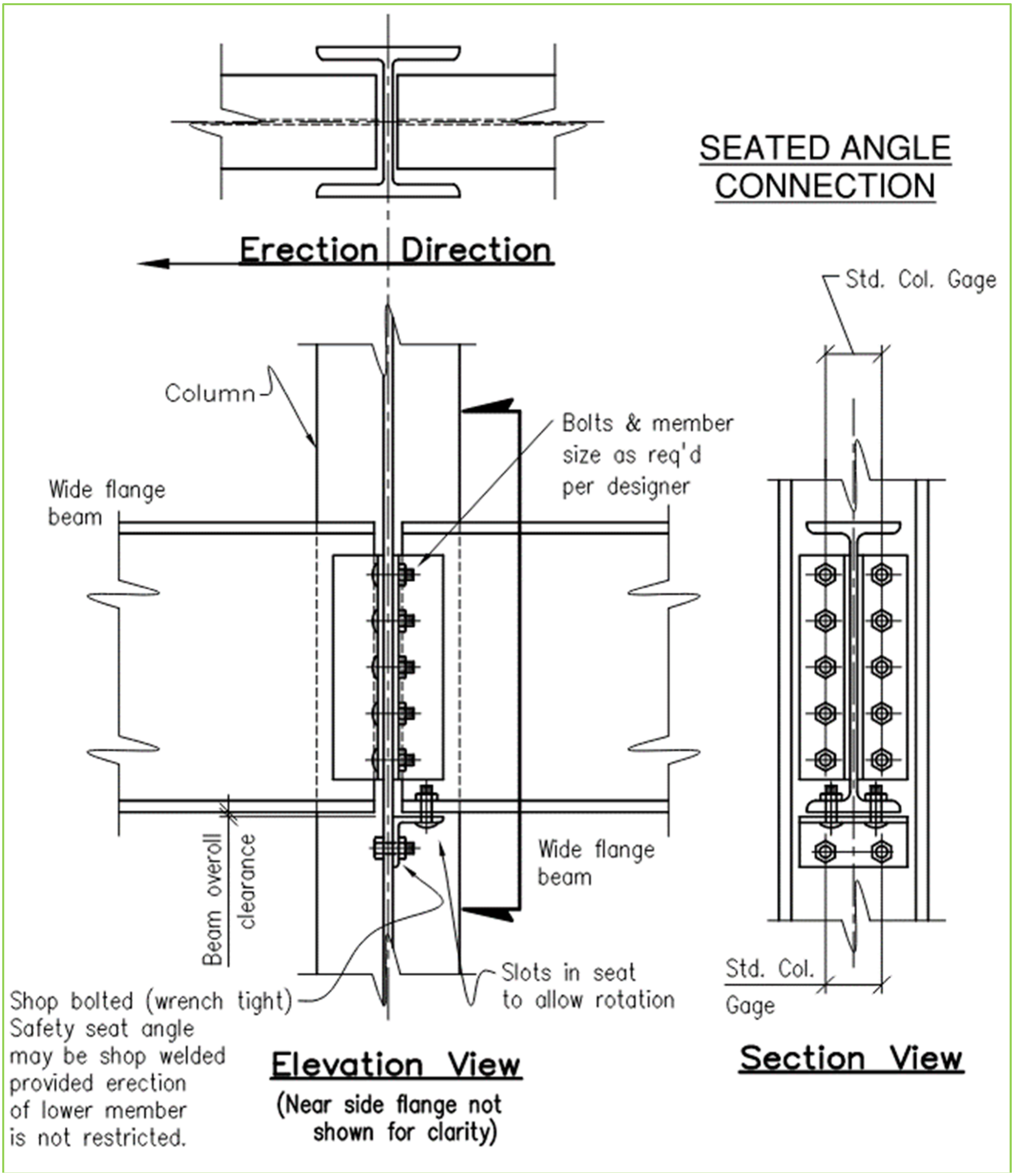


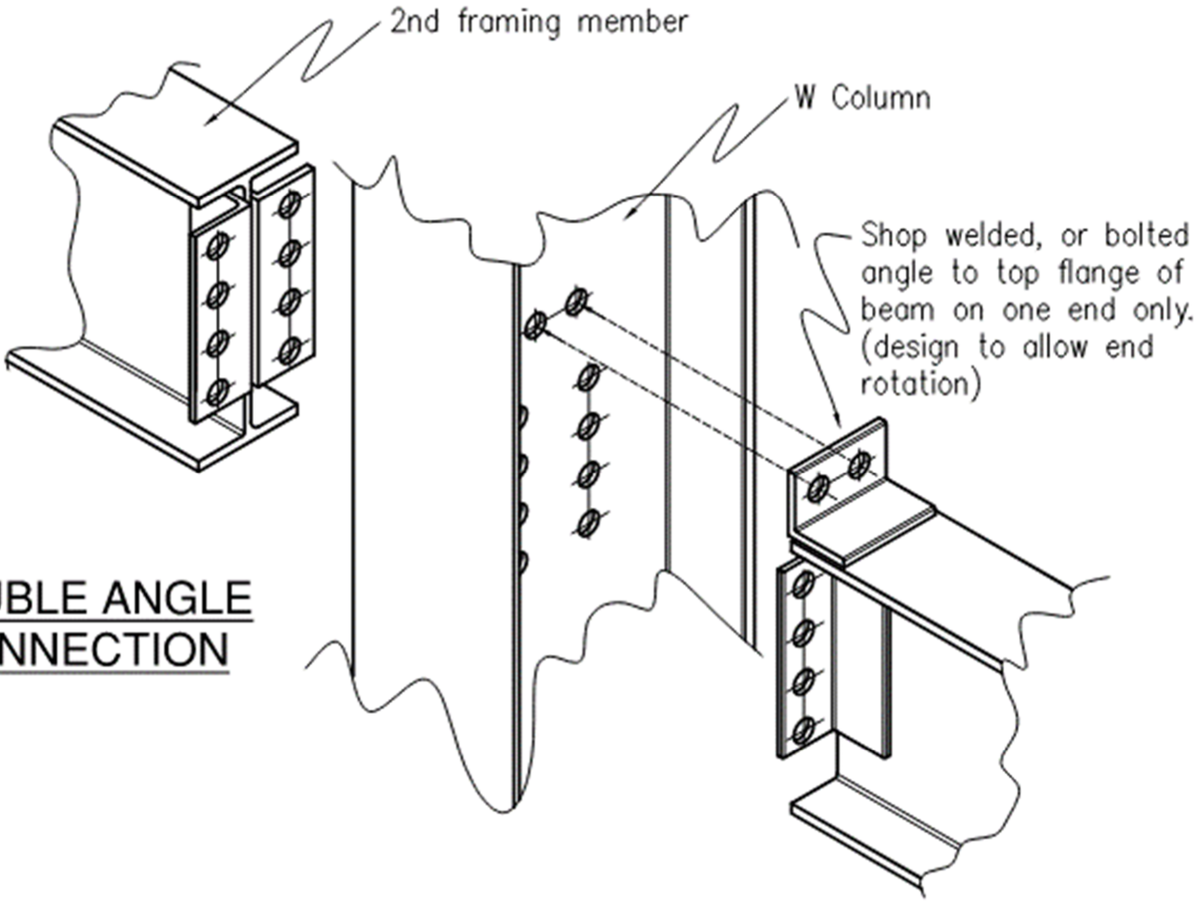
6. Safety connections

- ✓ All Double connections at column webs or beams webs that frame over columns must be designed to have at least one installed bolt remain in place to support the first beam while the second beam is being erected.
- ✓ Alternatively, the Fabricator may supply a beam seat, staggered clip angles, top flange clip angle, or equivalent device with a means of positive attachment to support the first beam while the second is being erected.



STAGGERED CONNECTION


SEATED ANGLE CONNECTION
Erection Direction
Column
Bolts & member size as req'd per designer
Std. Col. Gage
Wide flange beam
Wide flange beam
Beam overoll clearance
Slots in seat to allow rotation
Std. Col. Gage
Shop bolted (wrench tight) Safety seat angle may be shop welded provided erection of lower member is not restricted.
Elevation View
(Near side flange not shown for clarity)
Section View

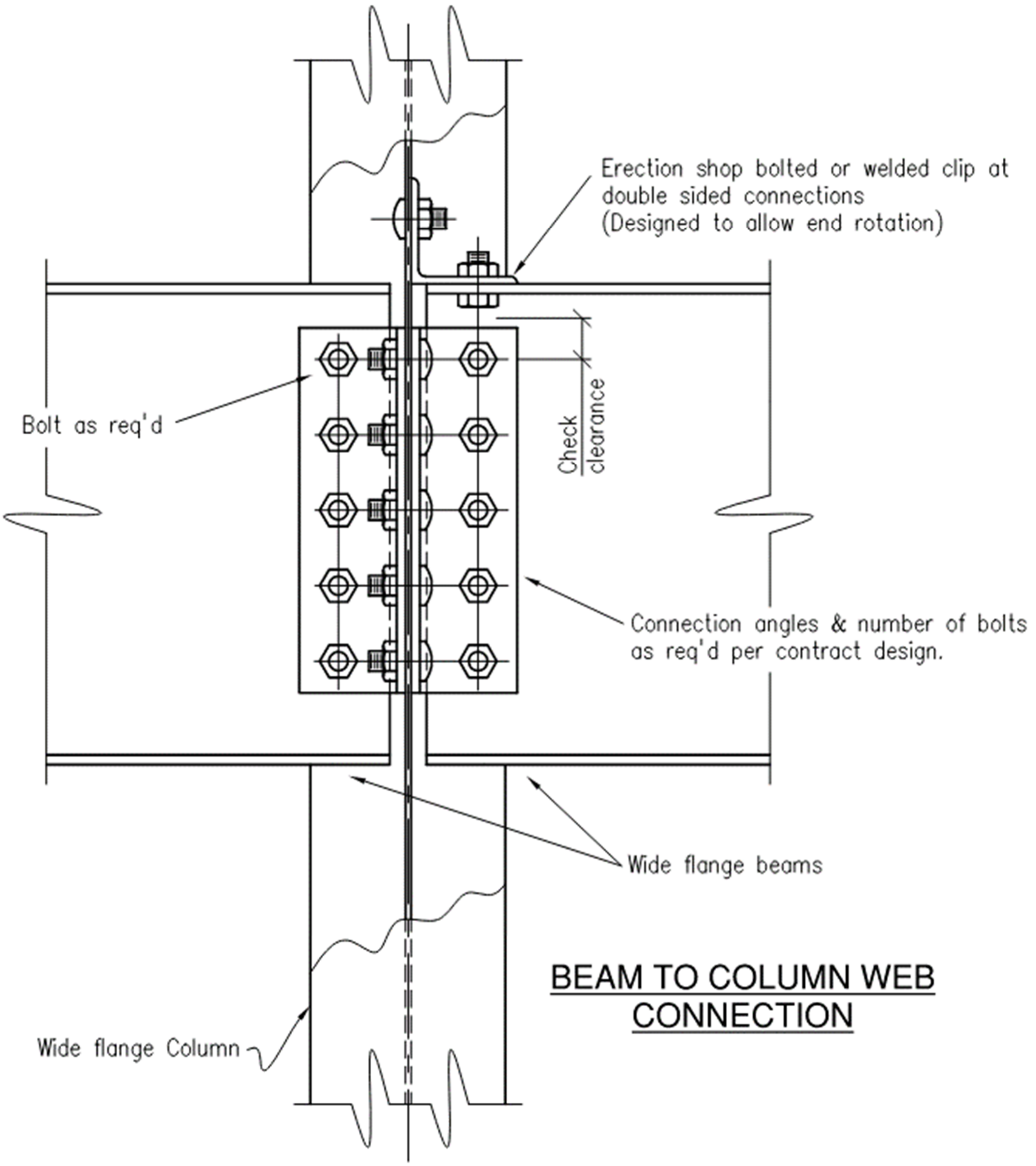


DOUBLE ANGLE CONNECTION

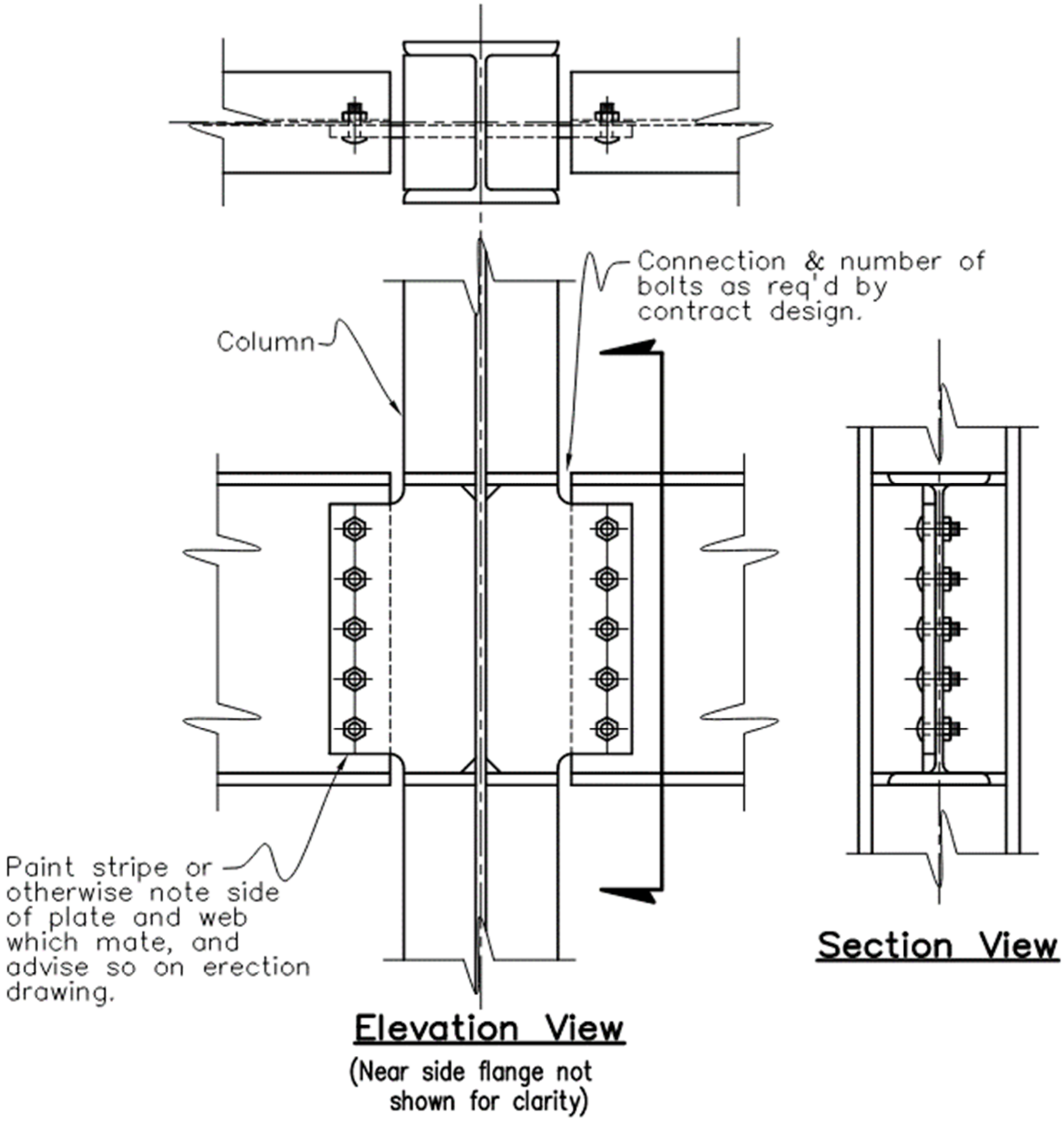
NOTES:

1) When two structural members on opposite sides of a column web share common connection holes, at least one bolt with a wrench tight nut shall remain connected to the second member, unless a shop attached, or field bolted seat, or similar connection device is present to secure the first member to prevent the column from being displaced.

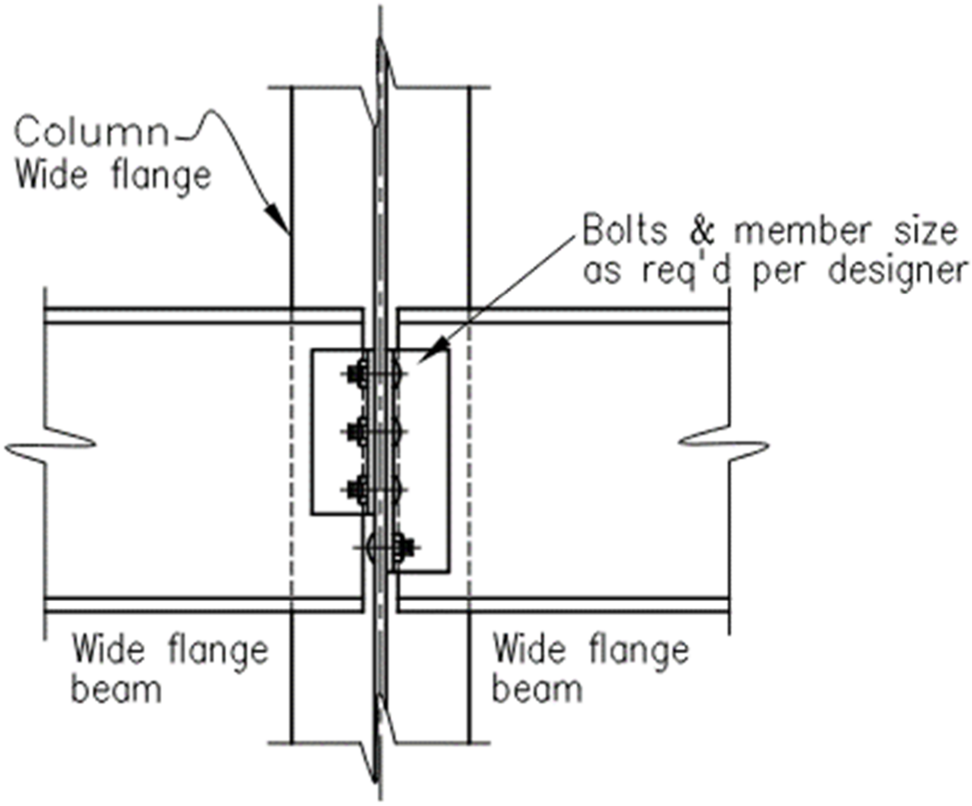
2) One way to rectify this problem, is to install an angle to the top flange of one beam, and provide (2) extra bolts to hold this member in place until the second member is erected.



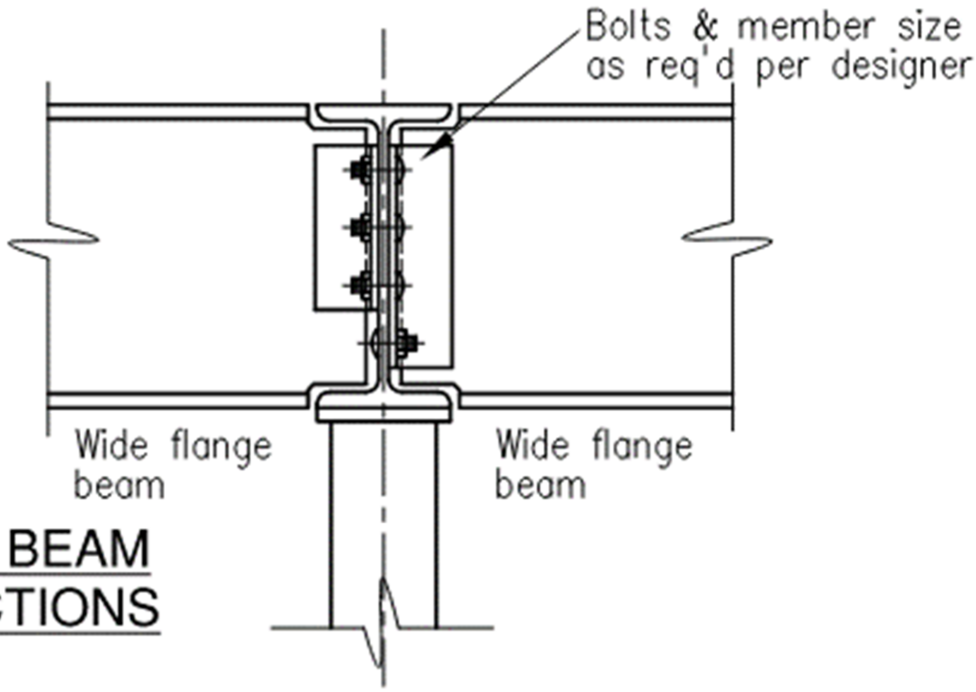
BEAM TO COLUMN WEB CONNECTION



BEAM TO COLUMN WEB CONNECTION

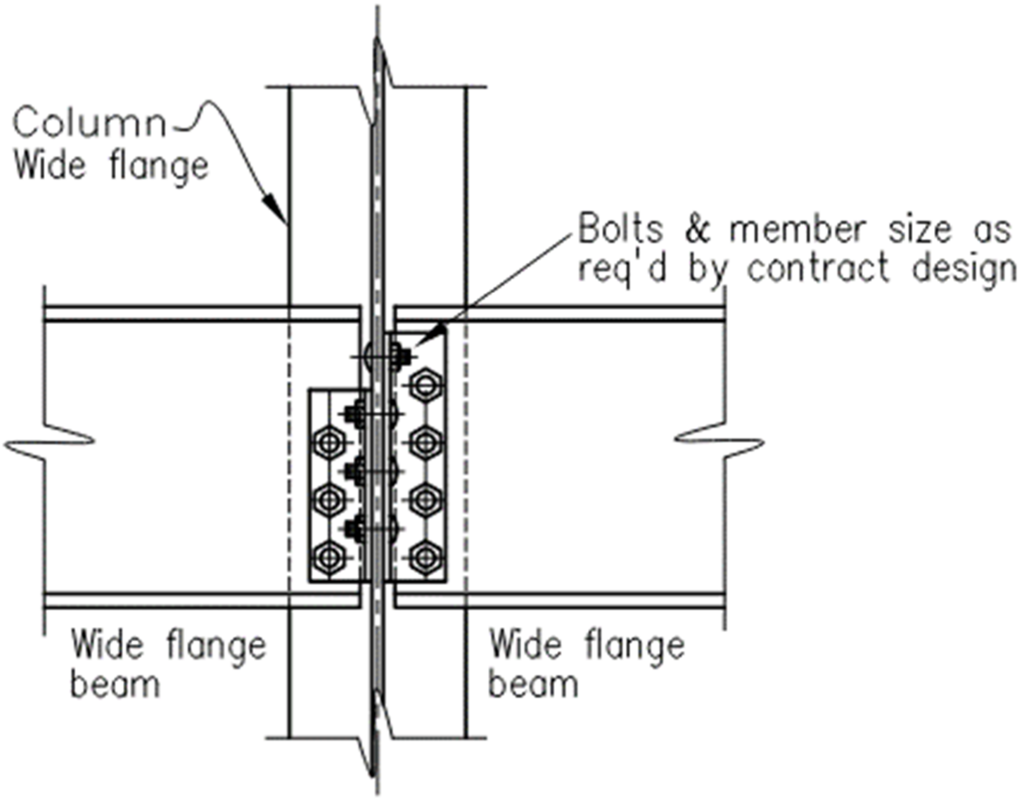


Beam Through Column Web Connection
(If single shear plates are not used)

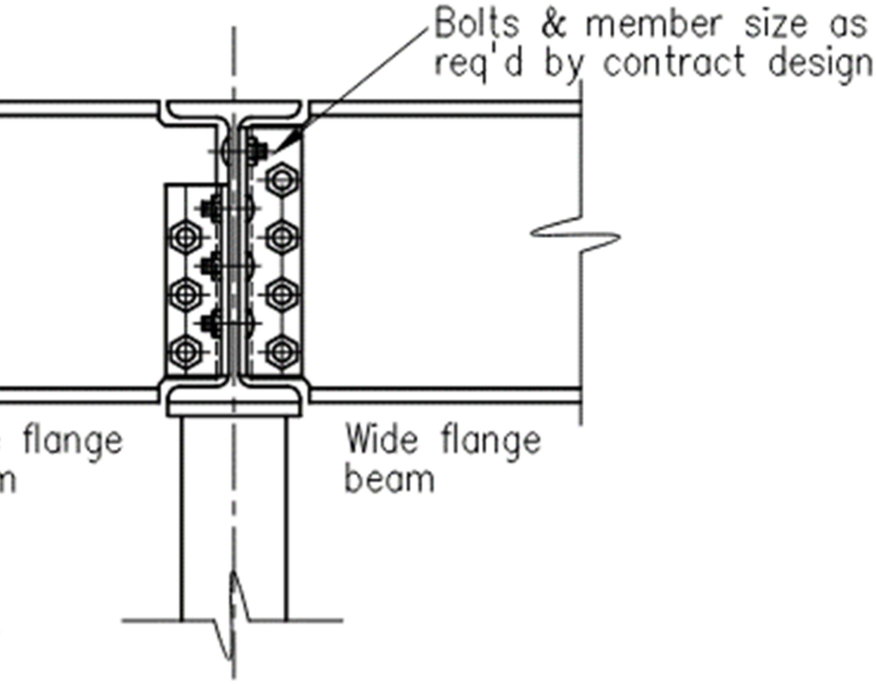


TYPICAL BEAM CONNECTIONS

Beam To Beam Connection Framing Over Column
(If single shear plates are not used)

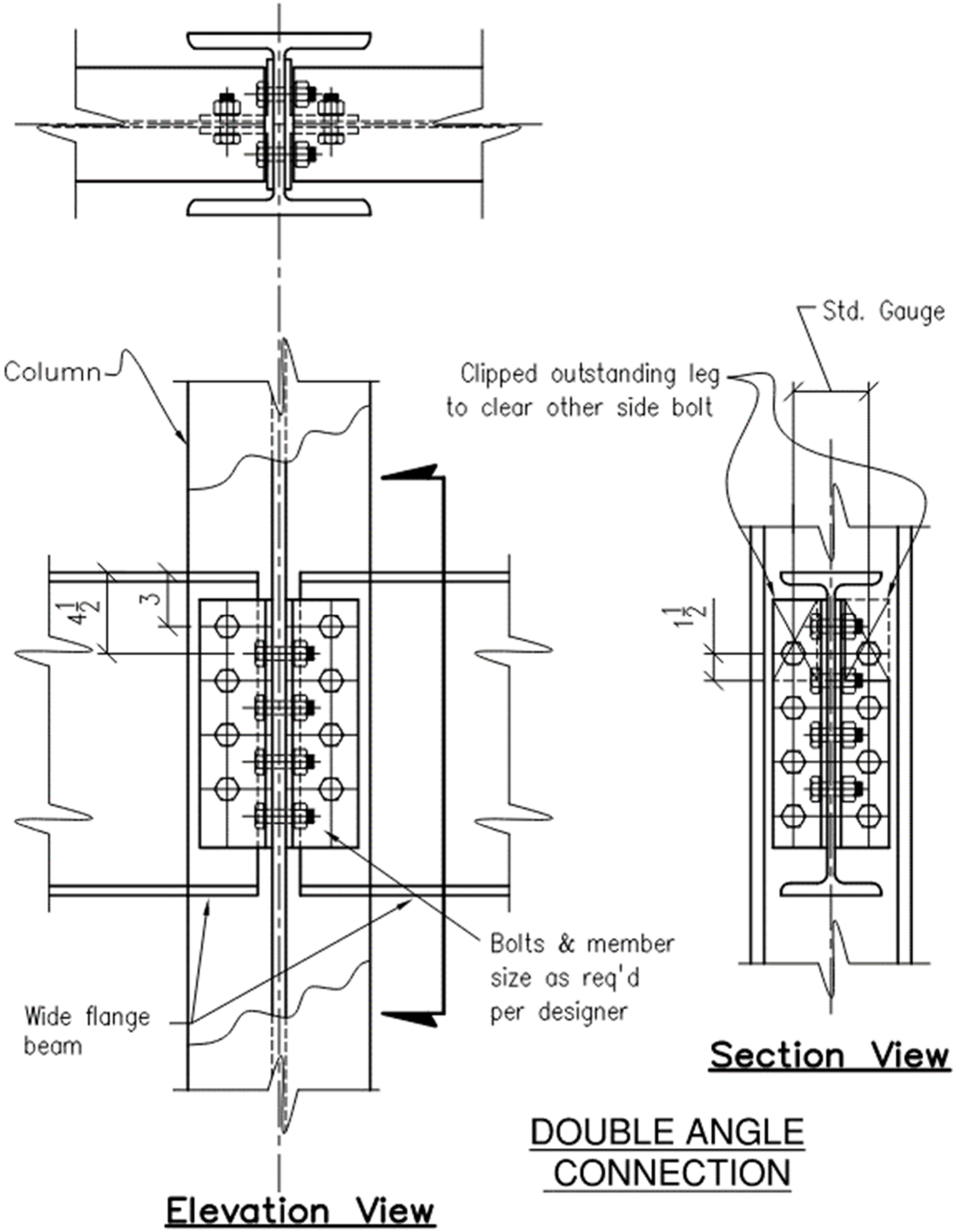


Beam Through Column Web Connection
(If single shear plates are not used)

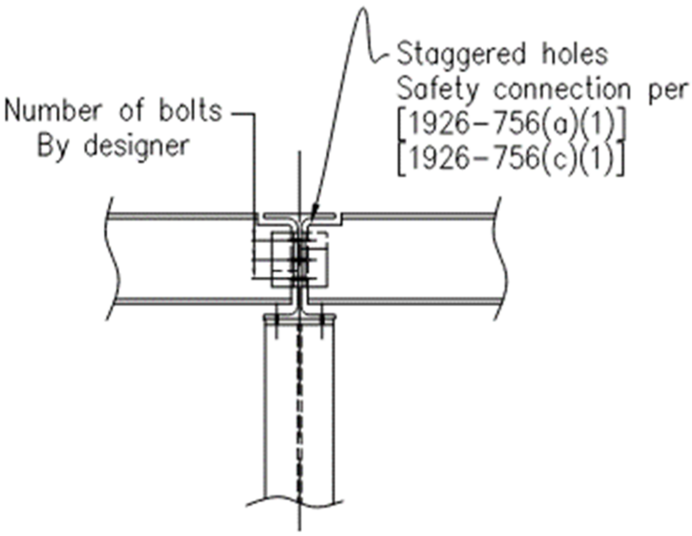


TYPICAL BEAM CONNECTIONS

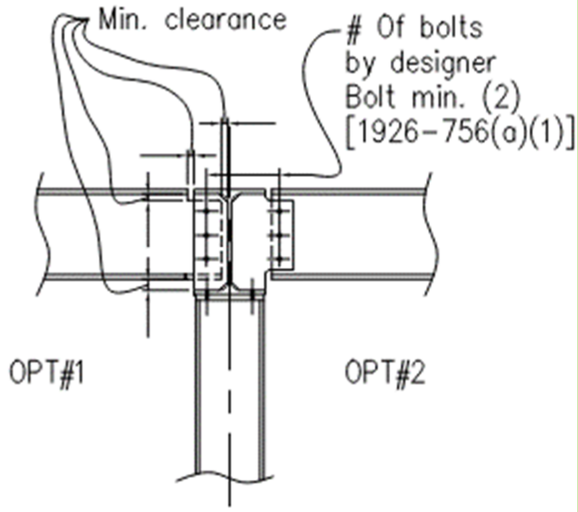
Beam To Beam Connection Framing Over Column
(If single shear plates are not used)



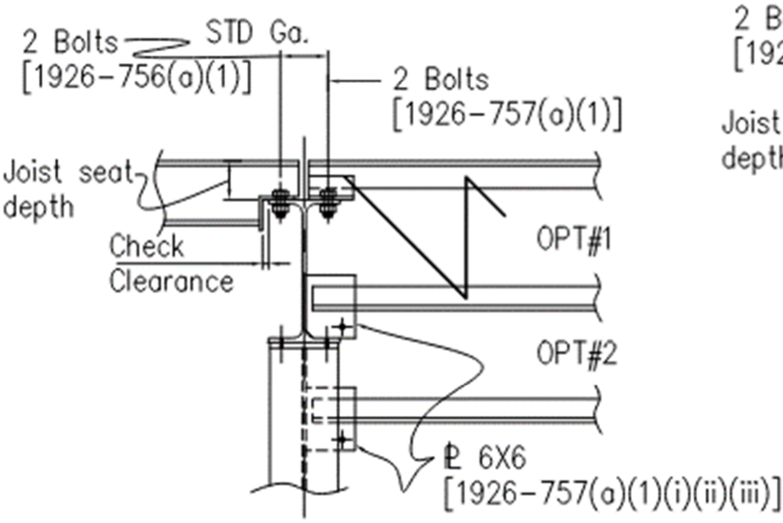
DOUBLE ANGLE CONNECTION



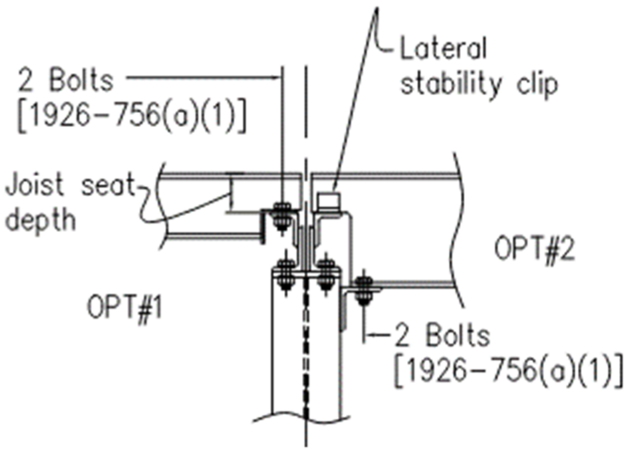
BEAM OVER COLUMN
(NO STIFFENERS)
[1926-756(c)(1)]



BEAM OVER COLUMN
(WITH STIFFENERS)
[1926-756(c)(1)]

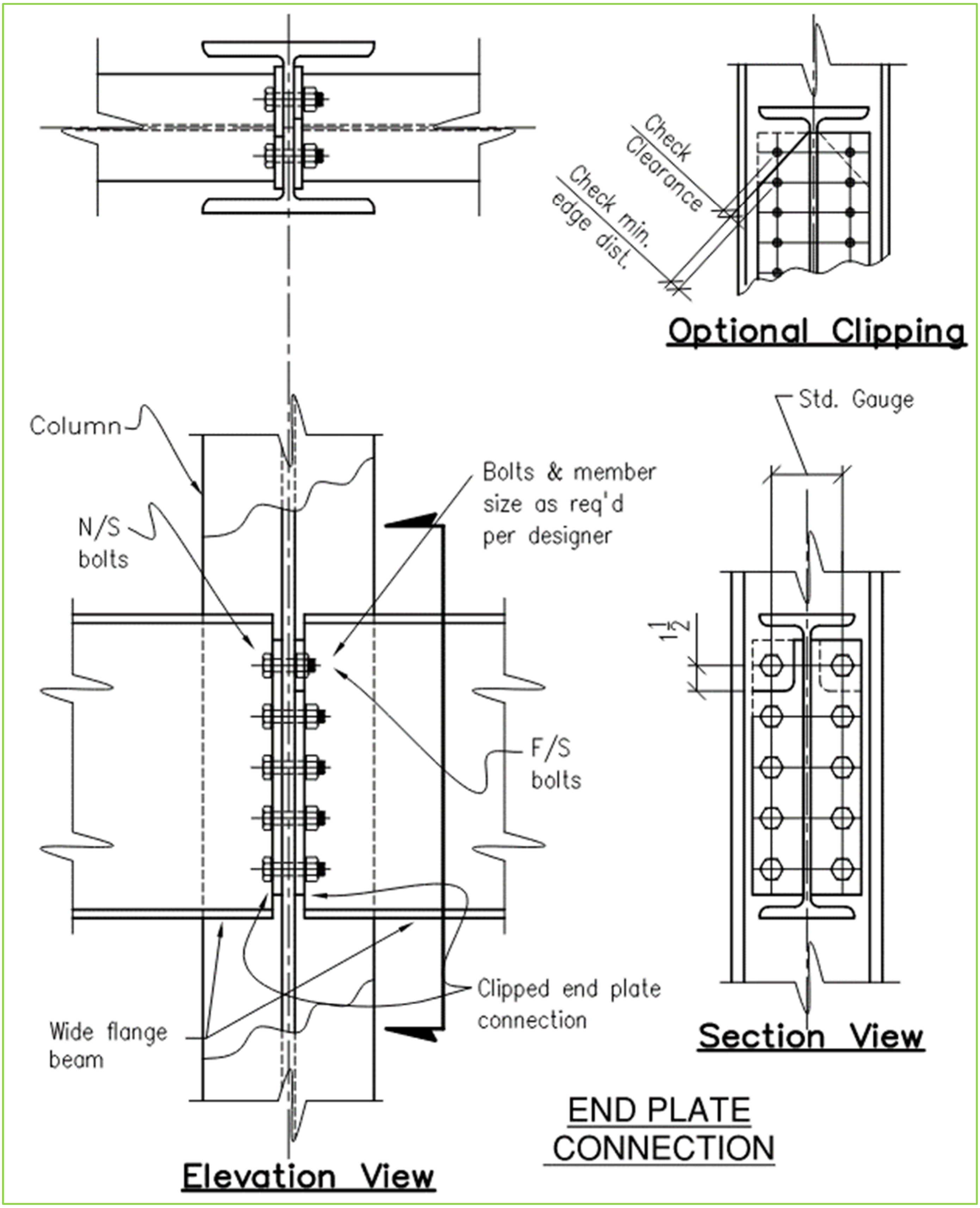


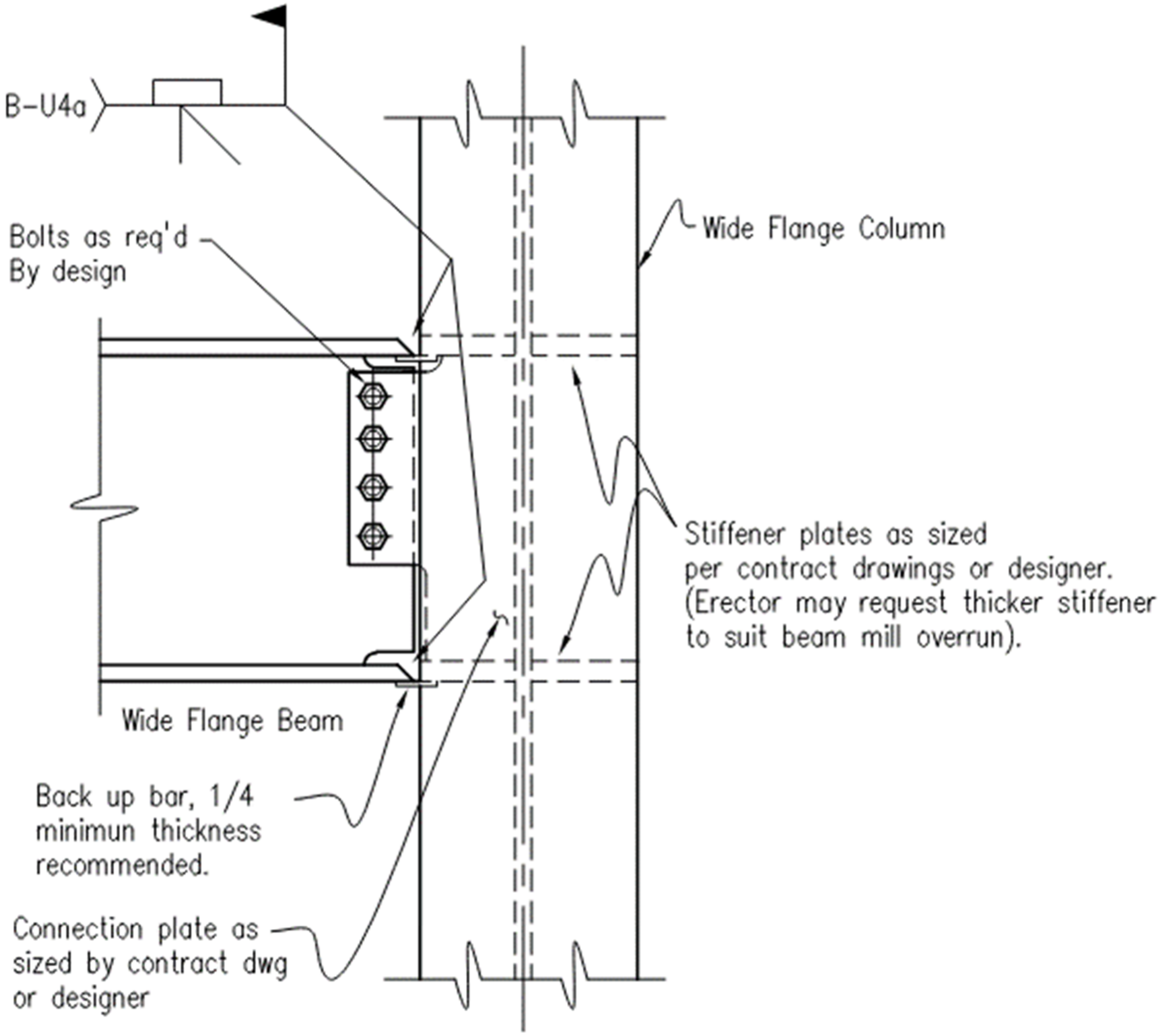
BEAM OVER COLUMN
(AT BEAM OPPOSITE TIE JOIST)
[1926-756(c)(1)]
[1926-757(a)(1)]



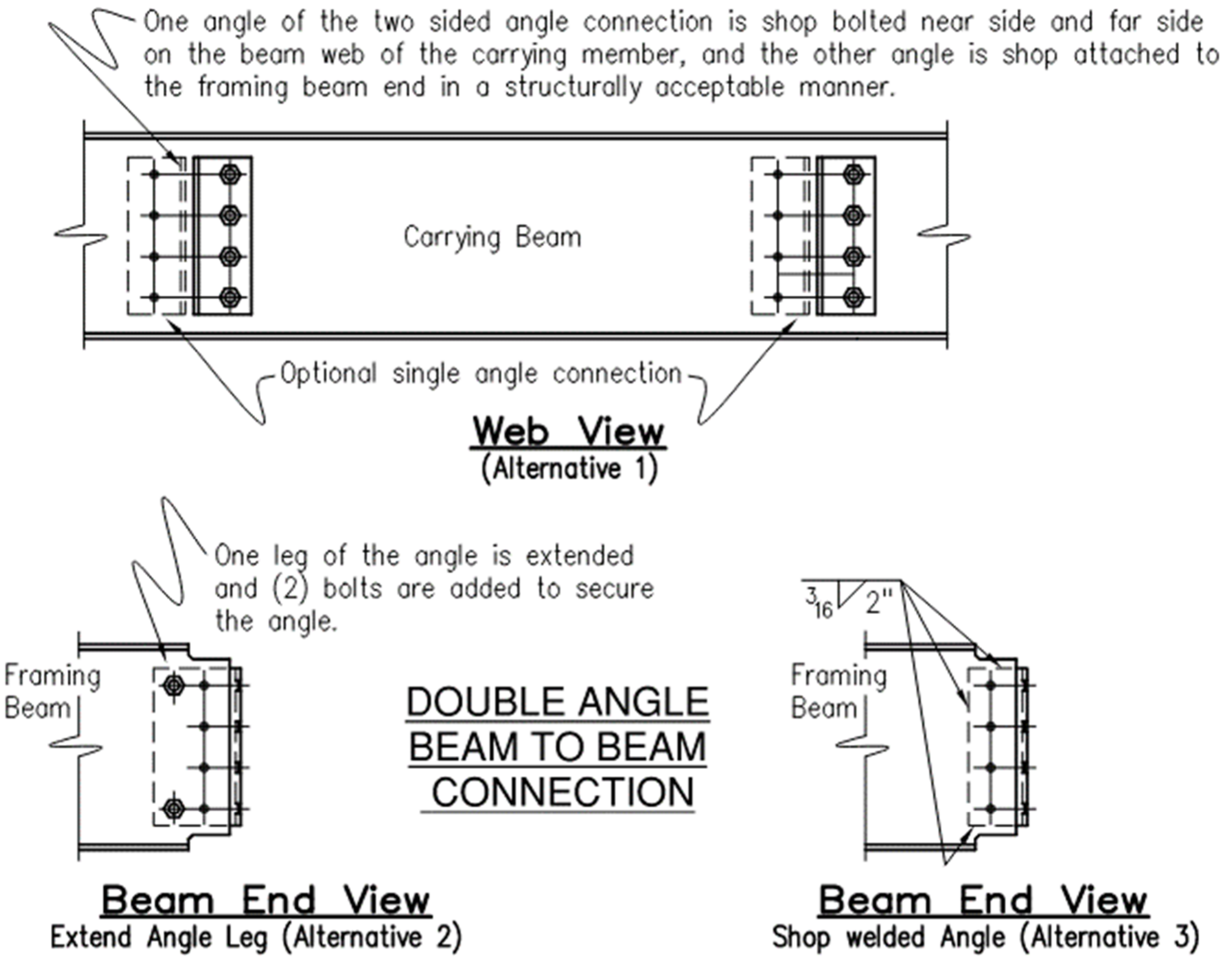
DESIGNED SEAT
[1926-756(c)(2)]
Acts As Load Bearing & Safety

TIE BEAMS OVER JOIST GIRDERS SEAT
(AT COLUMNS)
[1926-756(c)(1)]
[1926-757(a)(1)]


Check Clearance
Check min. edge dist.
Optional Clipping
Std. Gauge
Column
N/S bolts
Bolts & member size as req'd per designer
F/S bolts
1 1/2
Clipped end plate connection
Wide flange beam
Section View
Elevation View
END PLATE CONNECTION



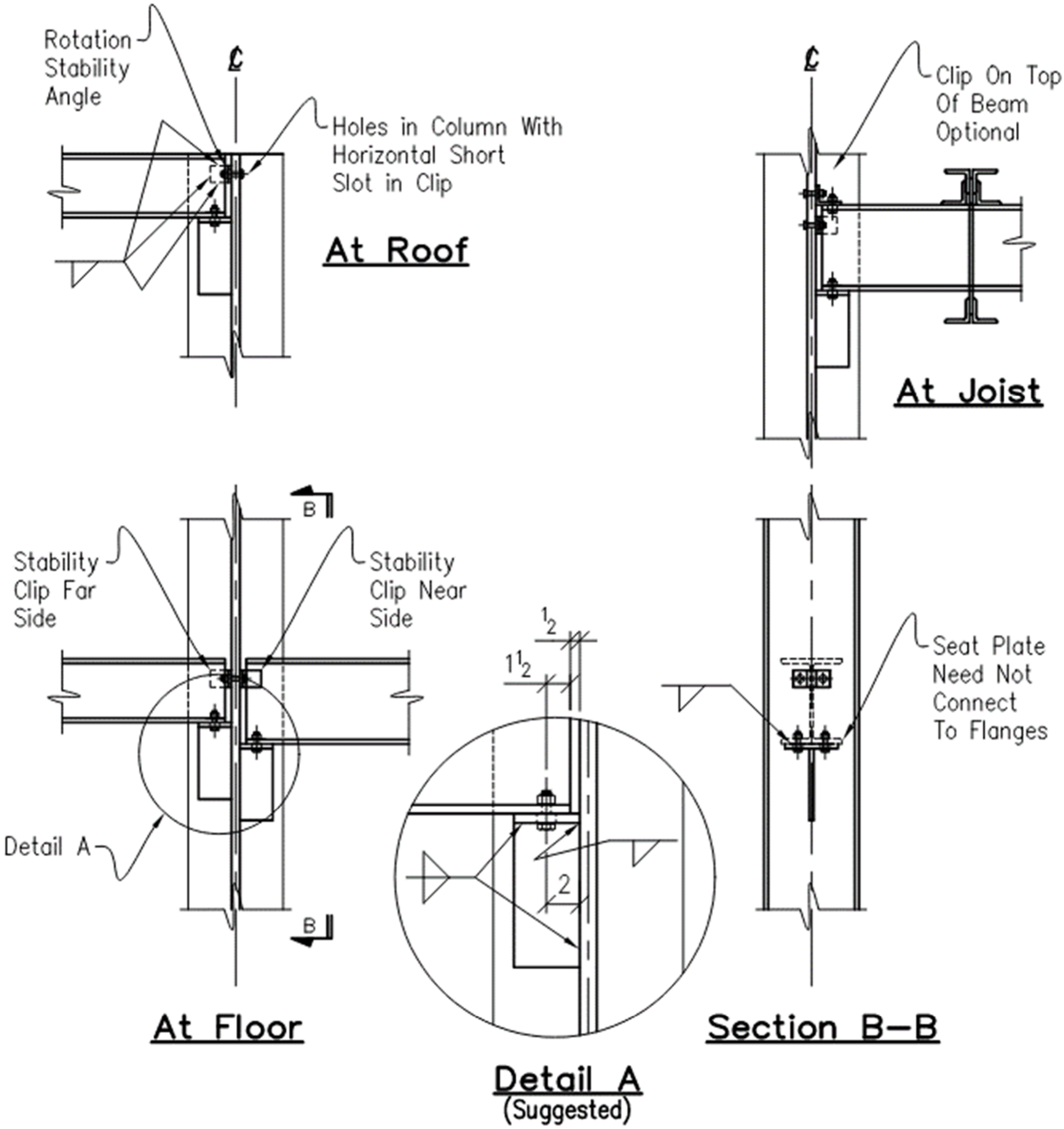
BEAM TO COLUMN WEB MOMENT CONNECTION



NOTES:

1) When two structural members on opposite sides of a beam web share common connection holes, at least one bolt with a wrench tight nut shall remain connected to the second member, unless a shop attached, or field bolted seat, or similar connection device is present to secure the first member to prevent it from being displaced.

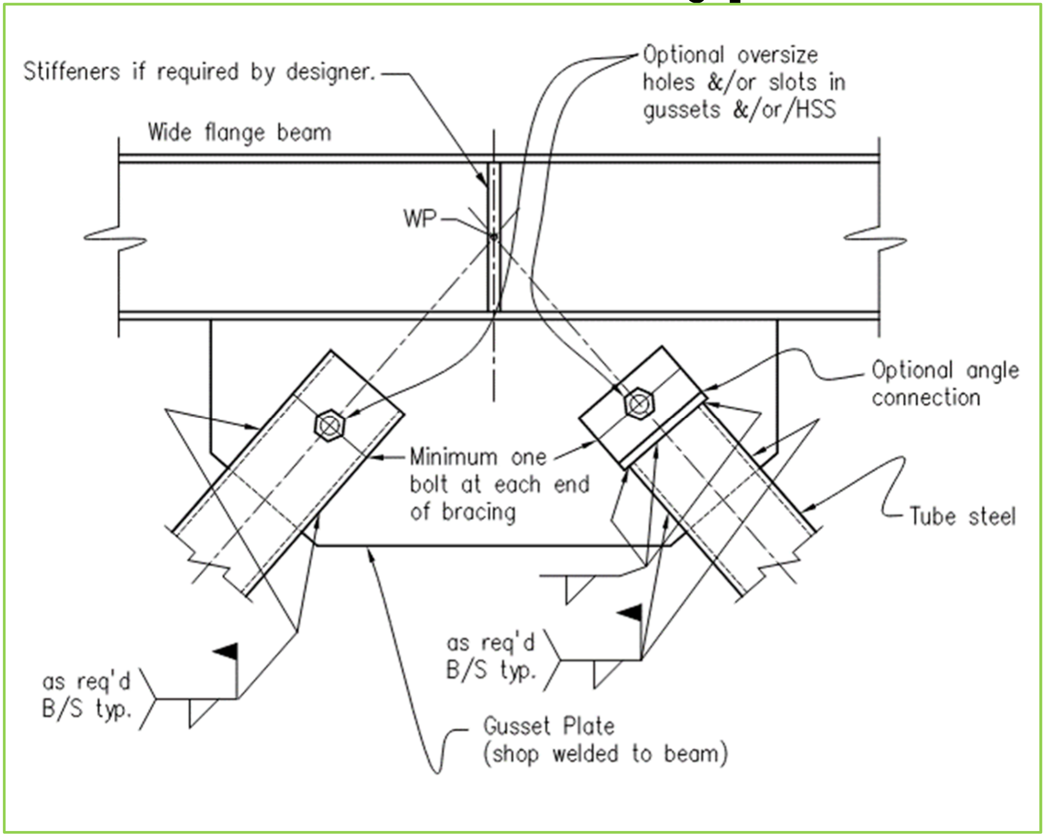
2) A few simple examples of resolving this problem are shown. Using the connection angles for erection aids is the best scenario. Time spent bolting or welding in the shop is double time saved in bolting and unbolting temporary connections in the field.

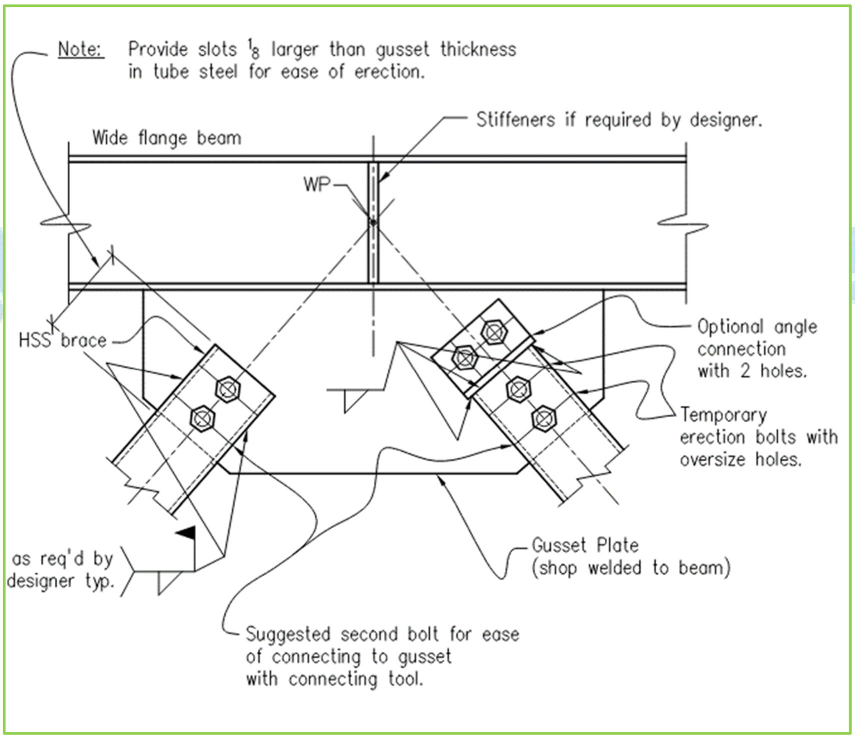


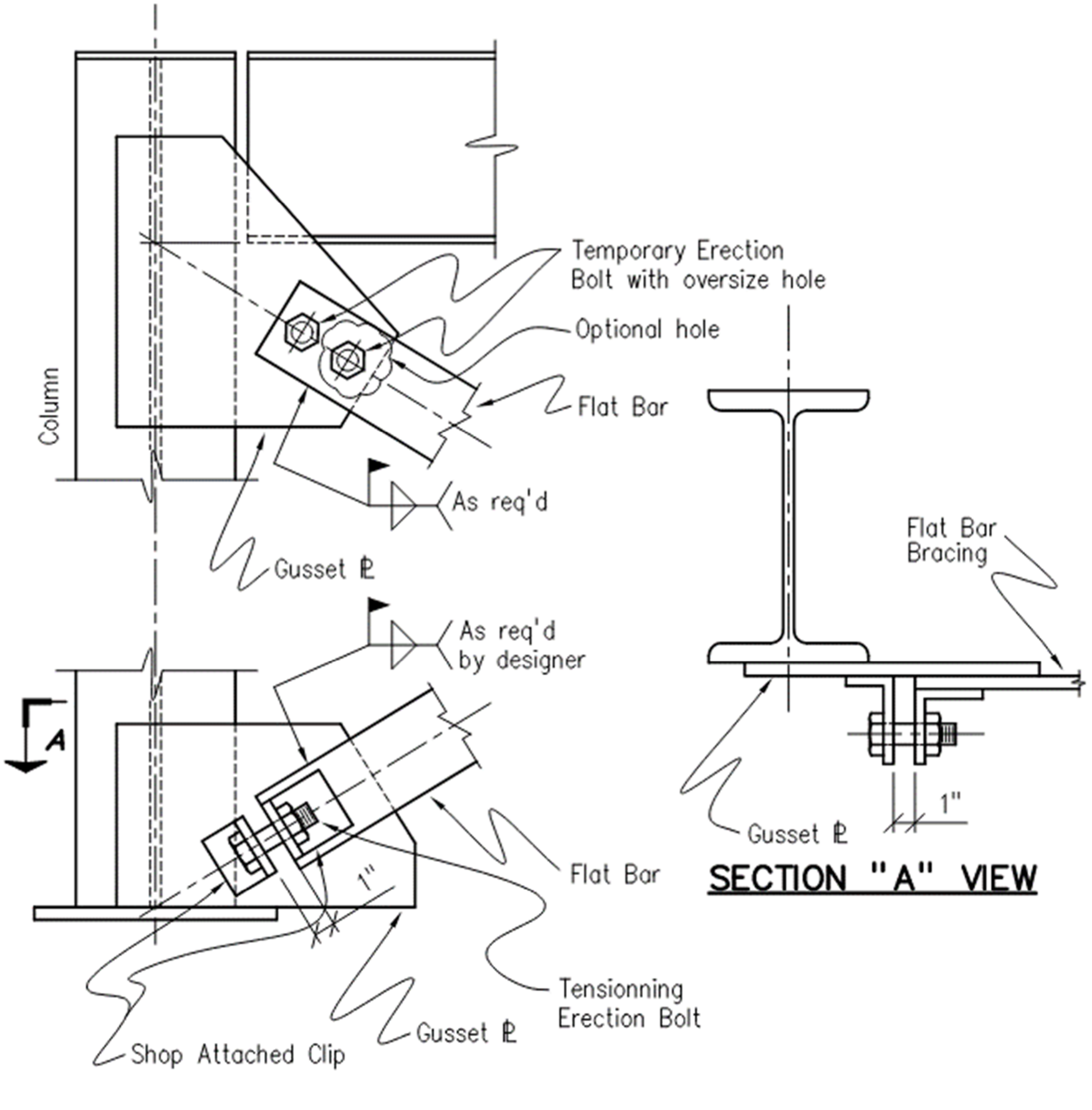
Note: Seated Connections are simple and economical to fabricate and the safest for the erector !

7. Brace connections

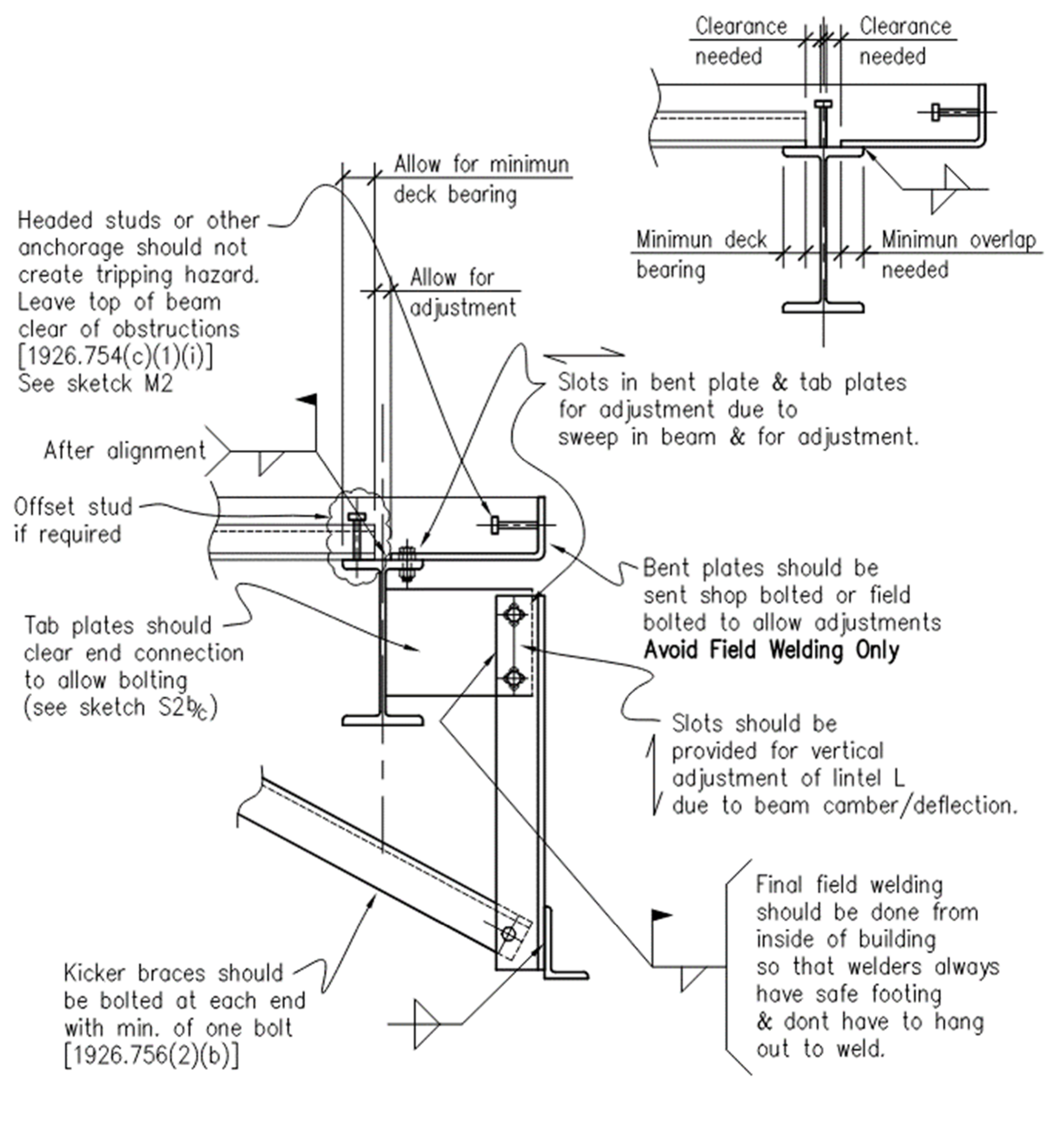
- ✓ Bracing members must relate to a minimum of one bolt or its equivalent before the crane load line is released.
- ✓ Holes for erection bolts are required at welded tube bracing. Provide a 1/8 inch oversized for erection clearance over the gusset and resize the welds accordingly.



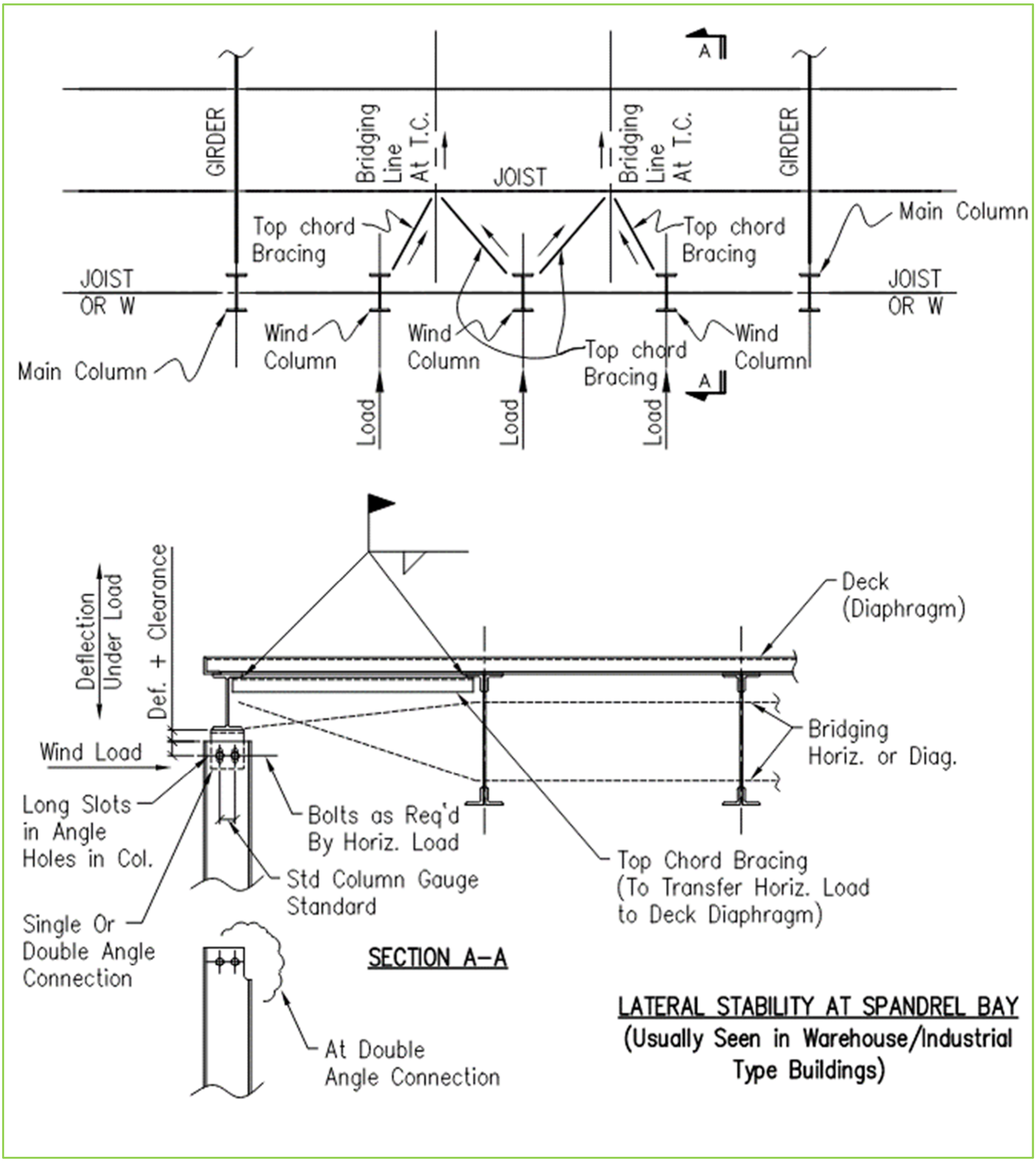



Column
Temporary Erection
Bolt with oversize hole
Optional hole
Flat Bar
As req'd
Gusset ℙ
A
As req'd
by designer
1"
Flat Bar
Tensionning
Erection Bolt
Gusset ℙ
Shop Attached Clip
Flat Bar
Bracing
Gusset ℙ
1"
SECTION "A" VIEW

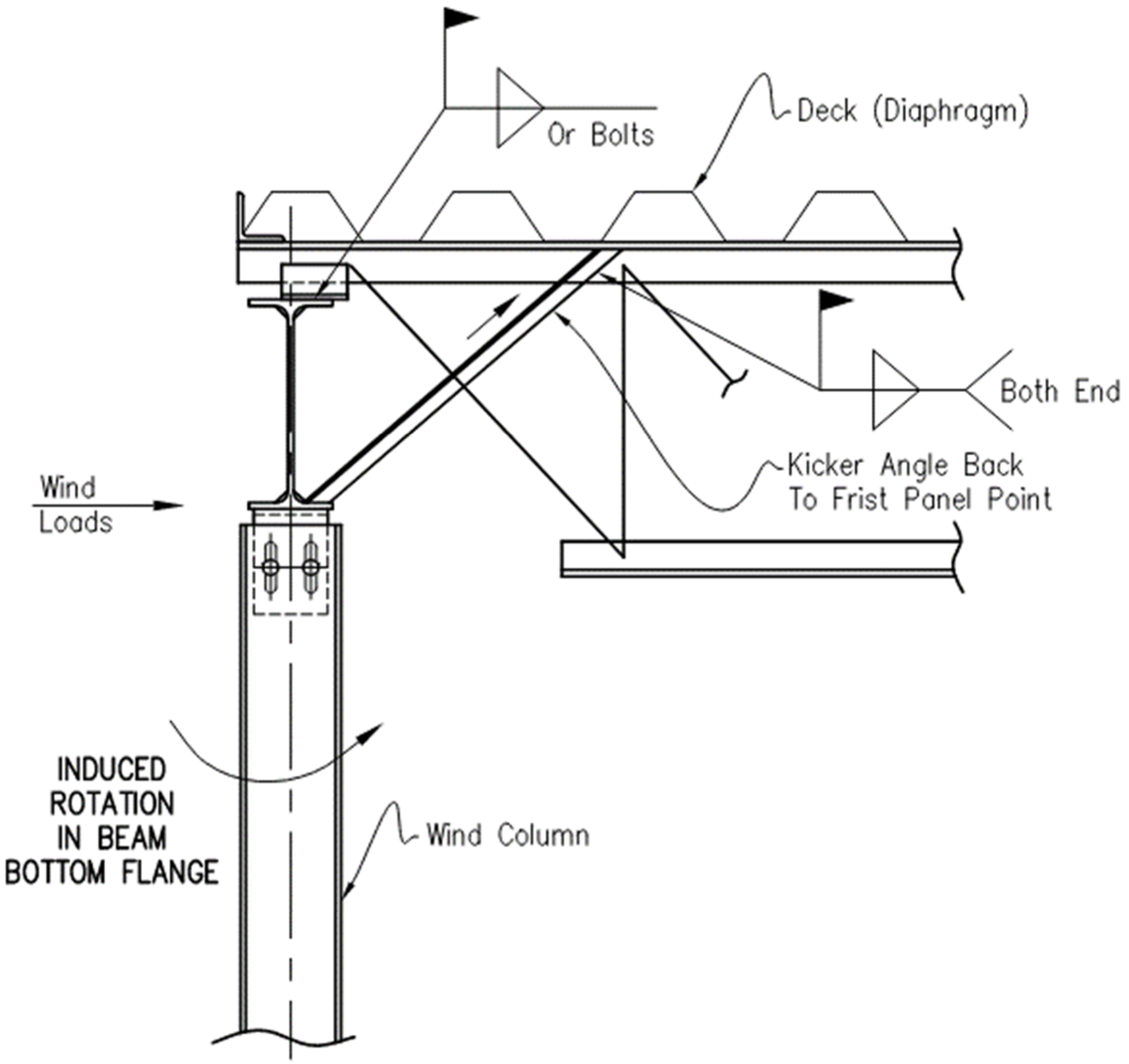
8. Spandrel detail



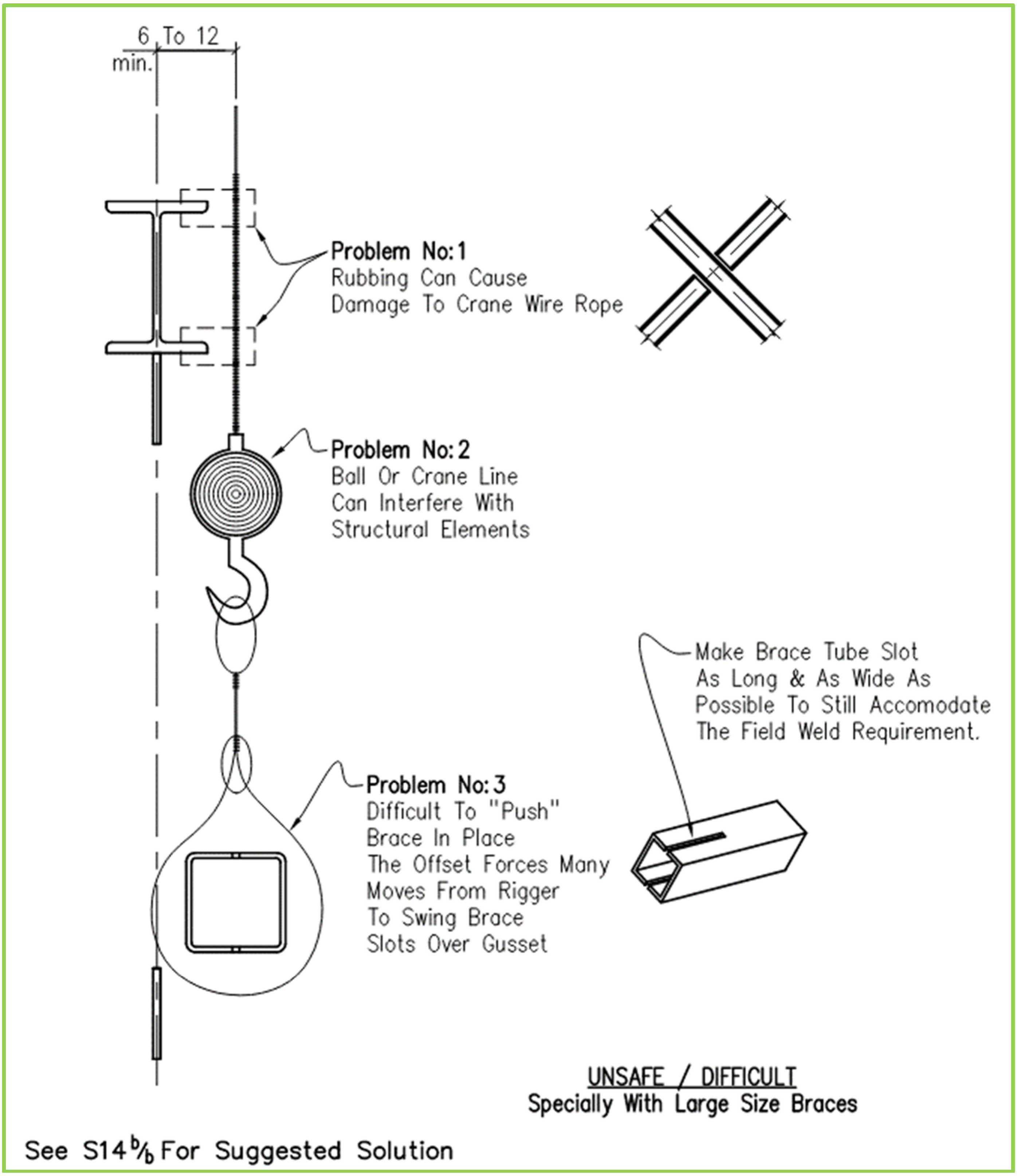
9. Wind-Column & Lateral Stability of spandrel framing



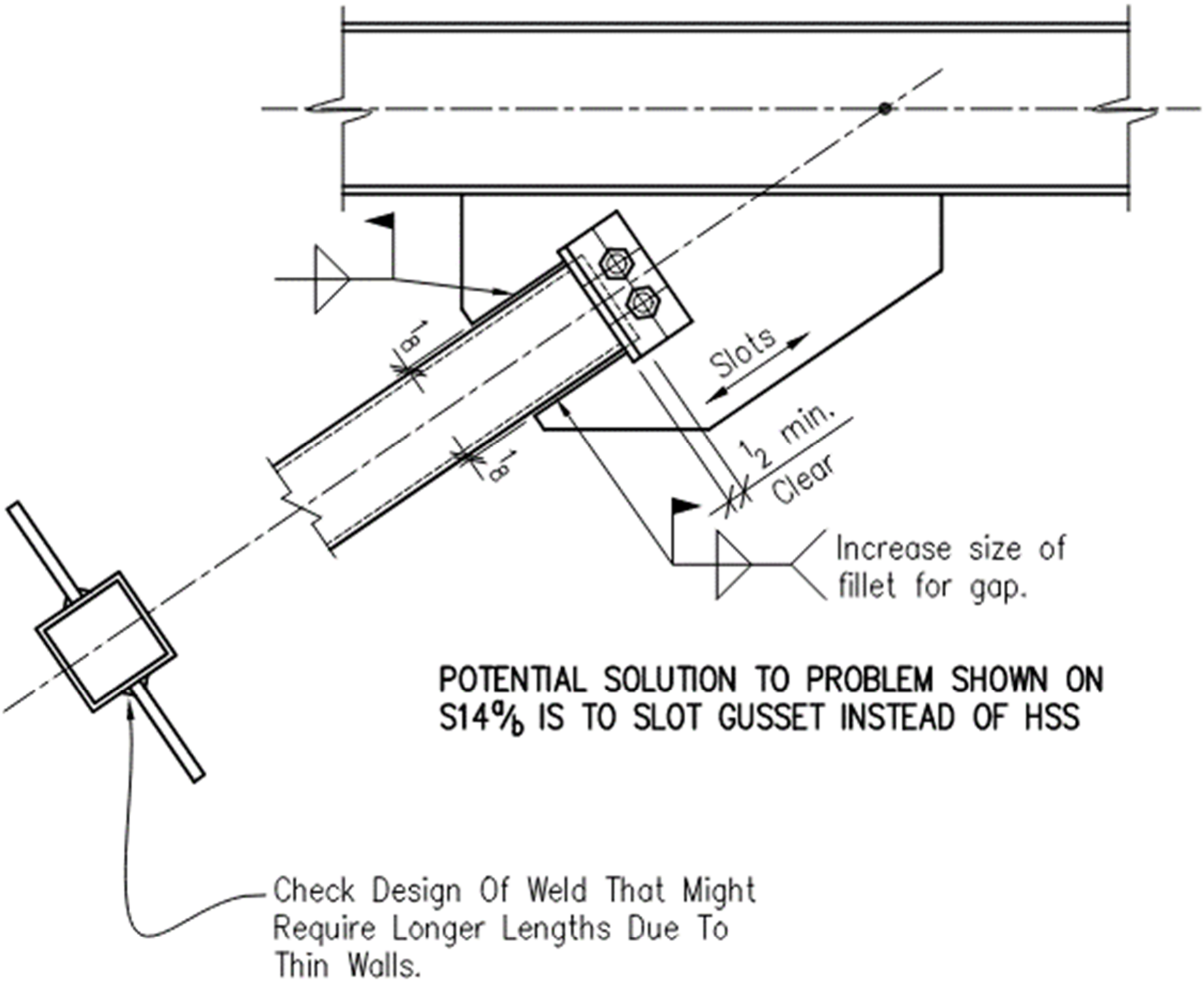
10. Joist to Wind column



11. Erection problems with HSS brace



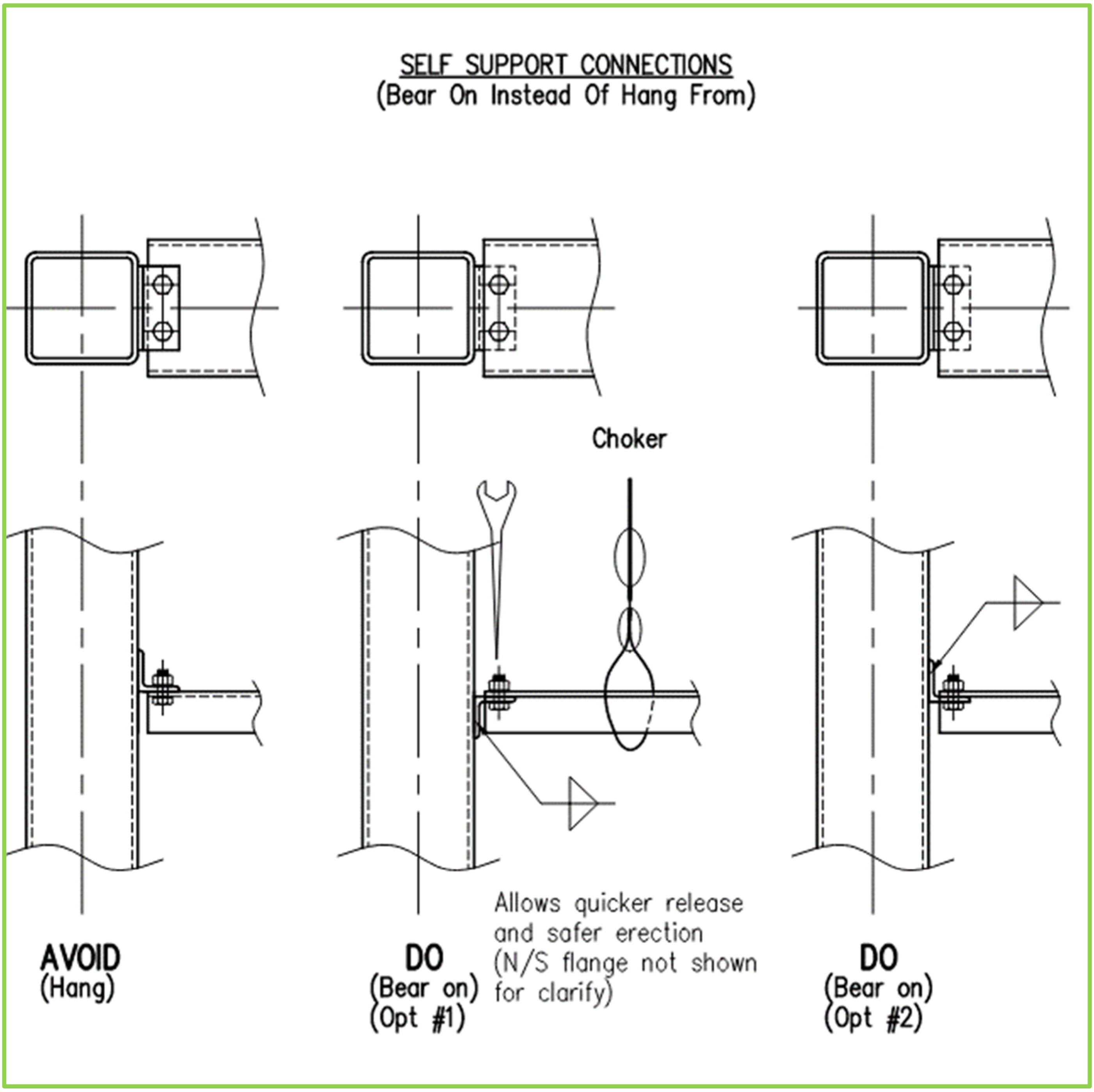
12. Tube bracing to gusset plate erection detail

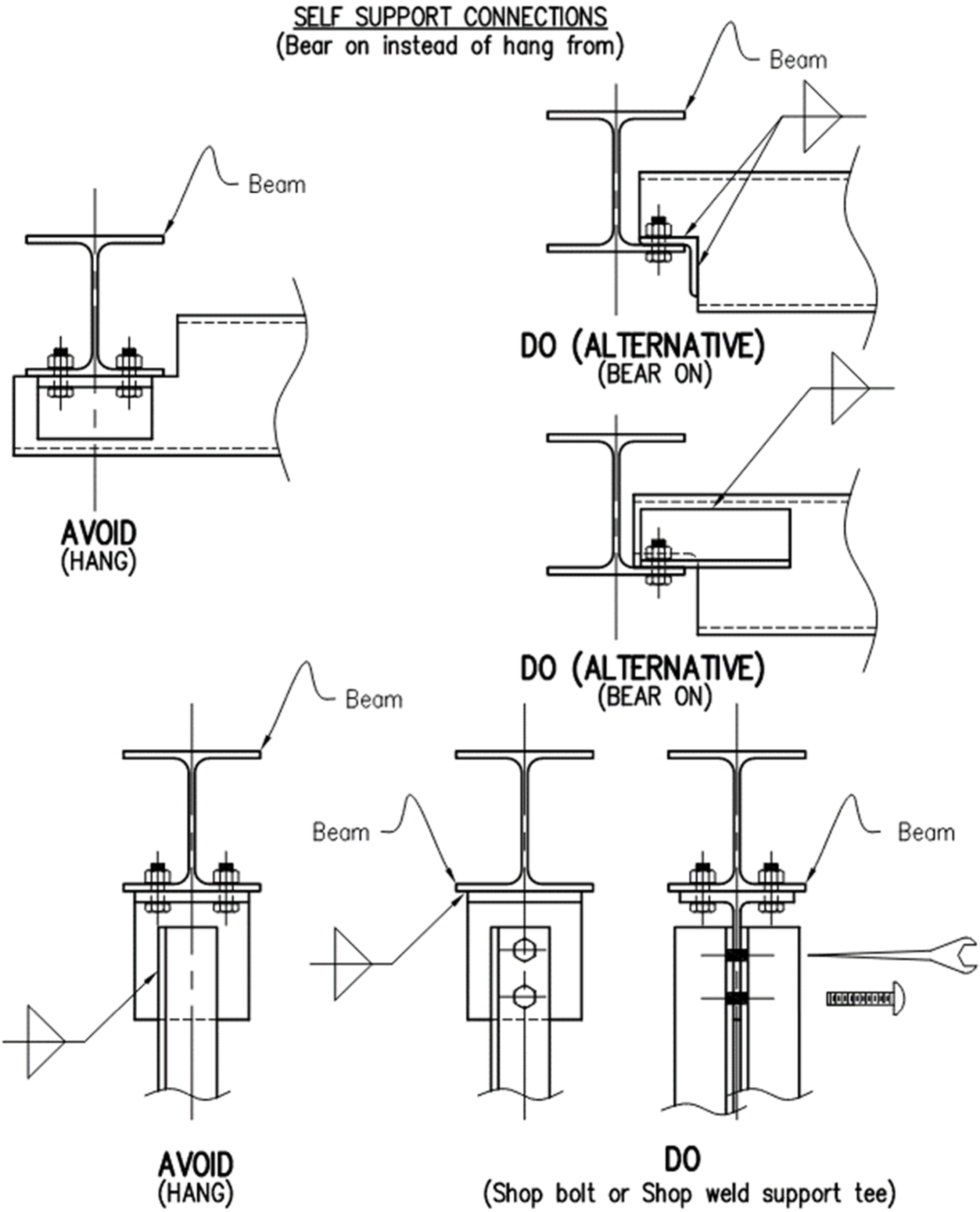


Gusset Easier To Cut Than HSS With CNC Equipment
HSS Slot No Longer A Problem Due To Heat Shrinkage

Little Cost Added To Fabricators.

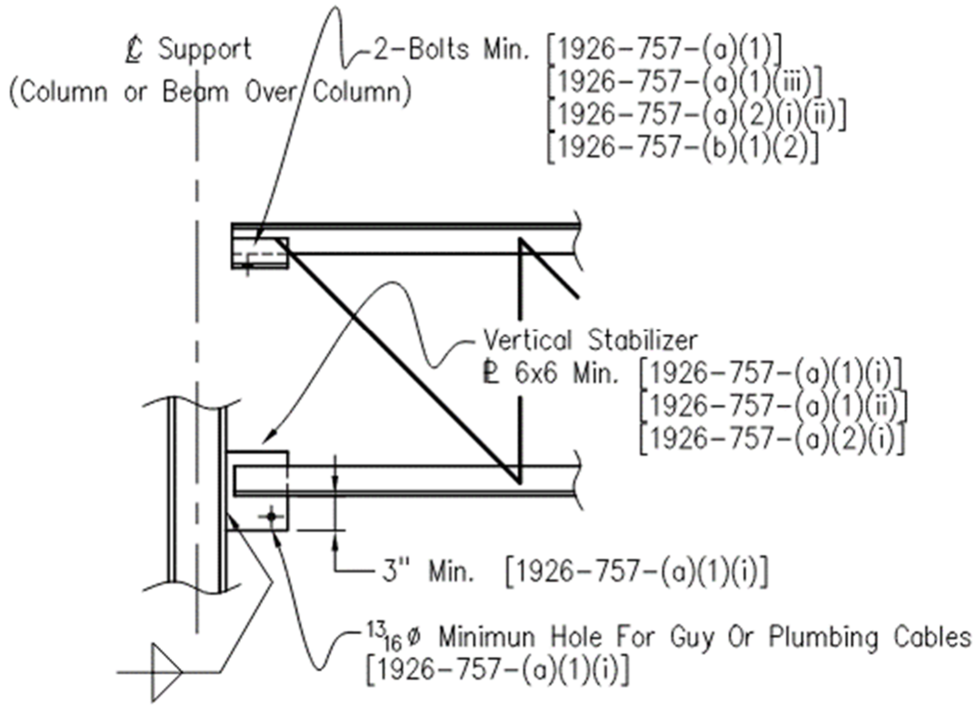
13. Self-Support connections



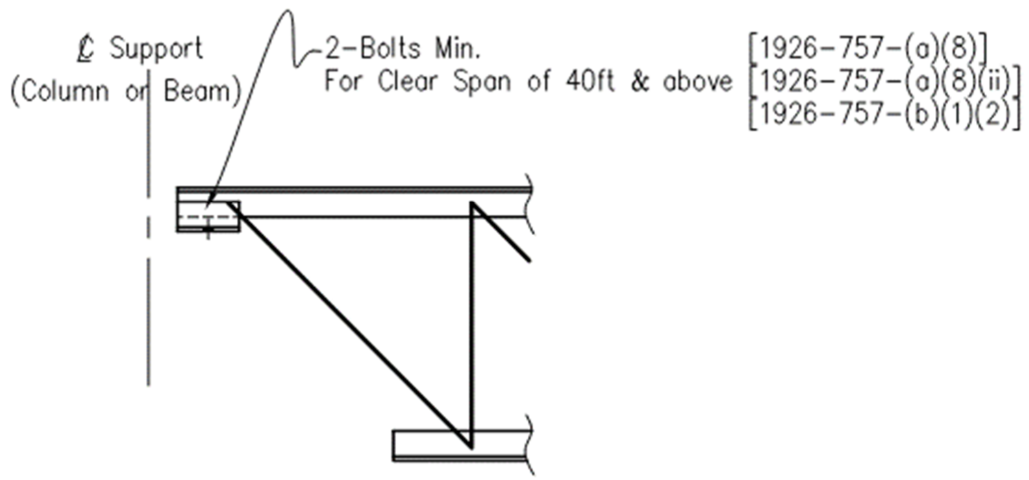

SELF SUPPORT CONNECTIONS
(Bear on instead of hang from)
Beam
Beam
AVOID
(HANG)
DO (ALTERNATIVE)
(BEAR ON)
DO (ALTERNATIVE)
(BEAR ON)
Beam
Beam
Beam
AVOID
(HANG)
DO
(Shop bolt or Shop weld support tee)

14. Joist connections

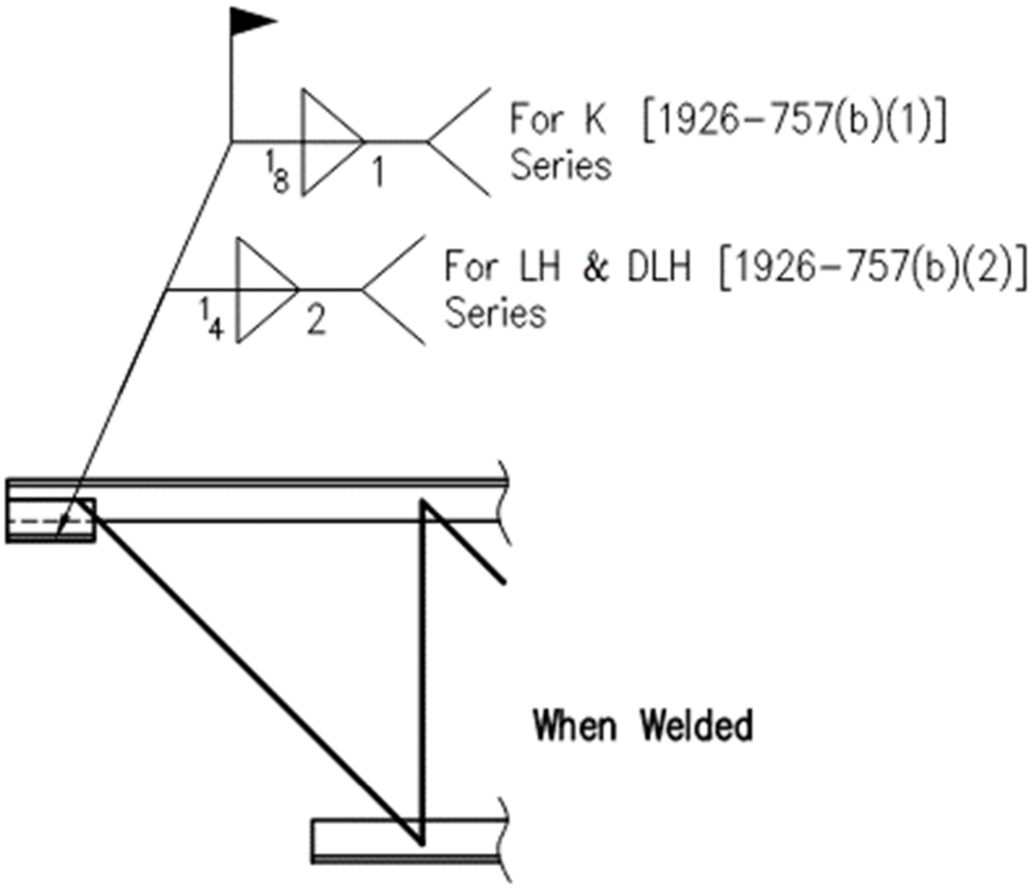
- ✓ Unless panelized, all joists are 40 ft long and longer, and their bearing members must have holes to allow for initial connections by bolting.
- ✓ The establishment of bridging terminus points for joists is mandated according to OSHA and manufacturer guidelines.
- ✓ A vertical stabilizer plate to receive the joist bottom chord must be provided in columns. Minimum sizes are given, and the stabilizer plate must have a hole for the attachment of guying or plumbing cables.

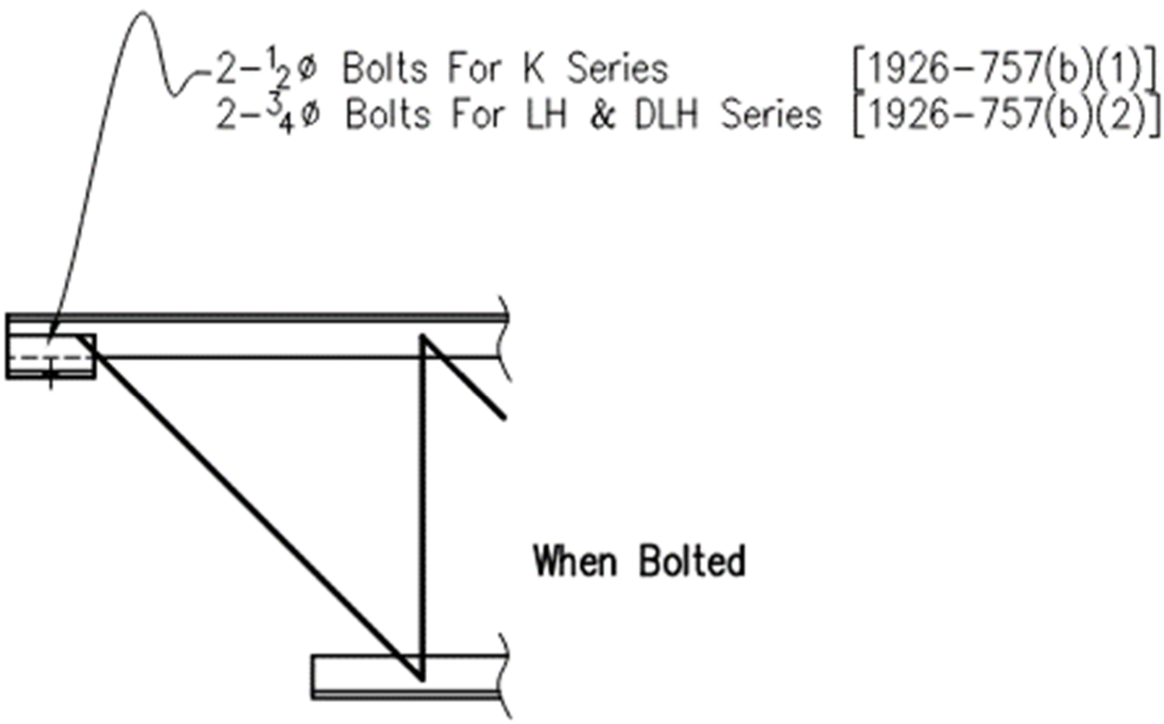


<u>OSHA Requirements For Joist / Joist Girders Over 40ft Clear Span [1926-757]</u>



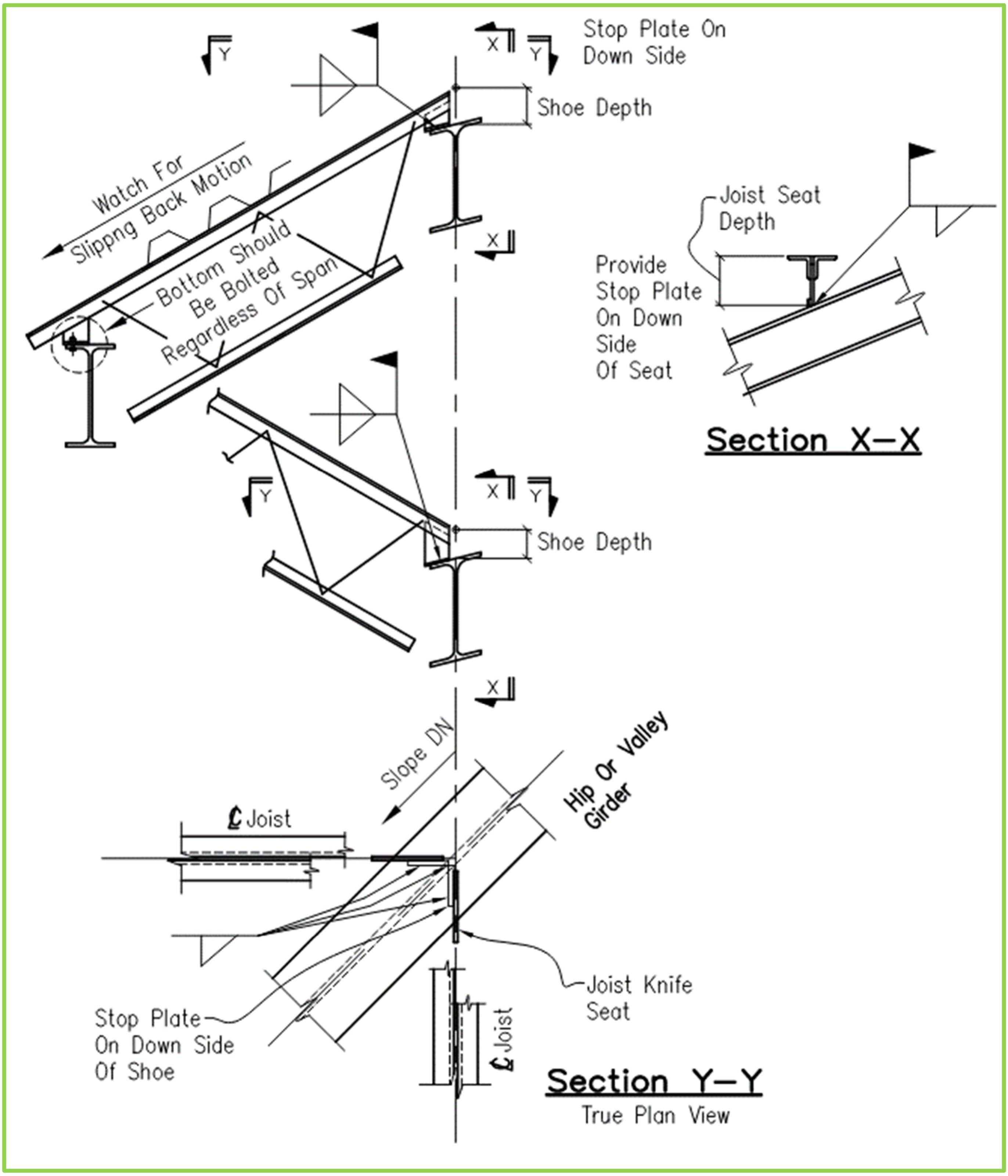
<u>We Suggest Similar Details For Joist Bearing To Non Ferrous Substrate.</u>



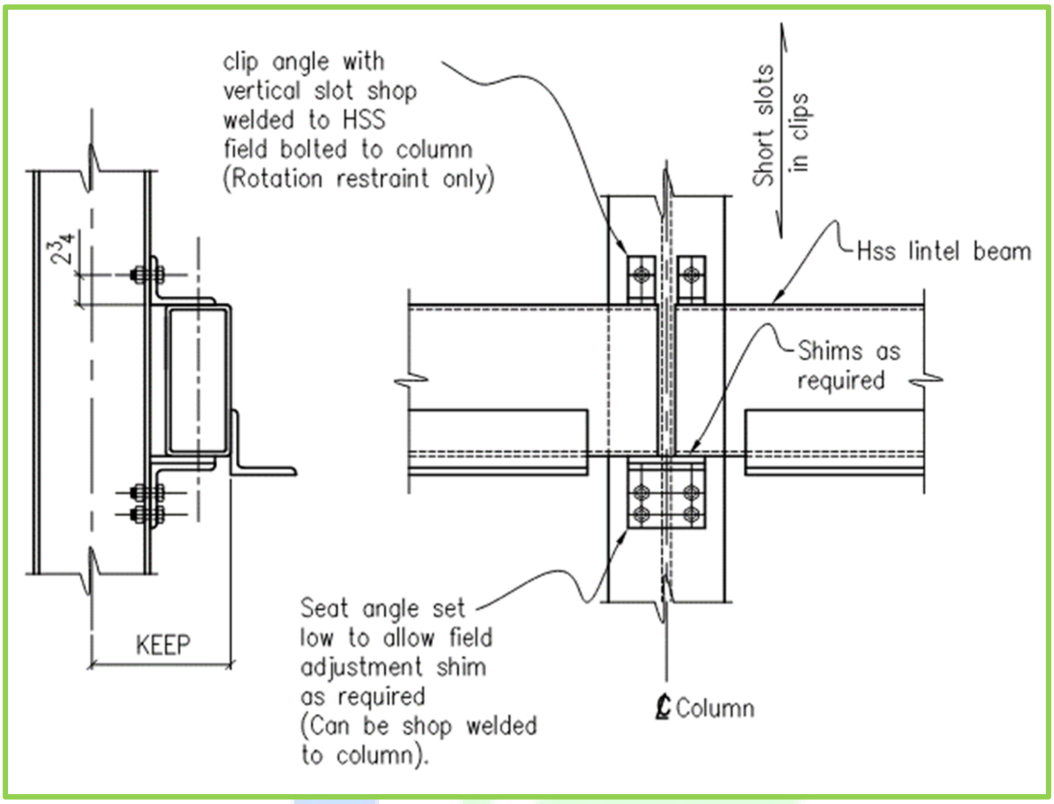


We Suggest Similar Details For Joist Bearing To Non Ferrous Substrate.

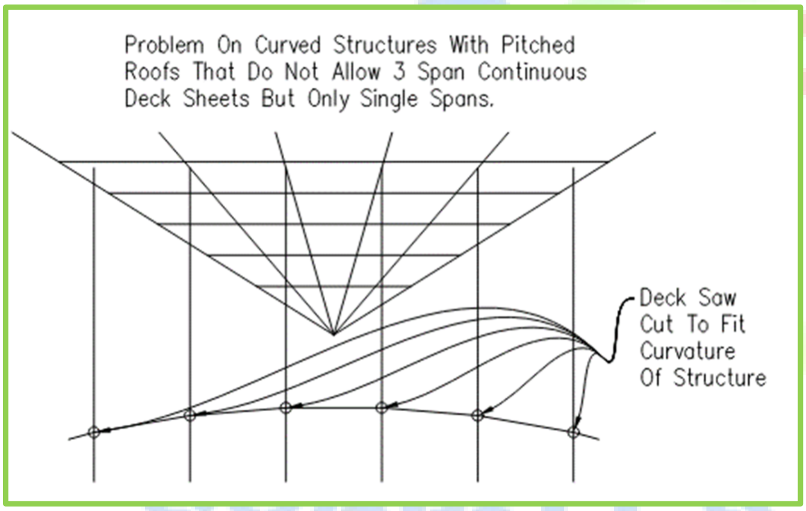
15. Joist slip at Hip & Valley Using knife plate seats



16. HSS lintel beam w/shop attached angle



Deck Issues



Watch For Sheets Sliding Down Hill !

Can Warrant EOR Or Deck MFGR To Redesign Their Deck Gauges

Also, Deck Bundles Should Be Landed Down Near Supports Especially If All Joists Welding & All Bridging Installation Is Not Completed.

17. Seismic Load Resisting systems

Notes For Seismic Load Resisting Systems

It is of utmost importance that detailers and erectors watch for general notes or details that refer to the new AISC 2006 Seismic Code or FEMA 350-353 or AWS D1.8 Seismic Supplement or similar language on plans or in specifications.

Detailers should ASK competent persons what is required at these connections BEFORE they "Bid" the job, as this has an impact on time spent to produce shop drawings & erection plans, namely sizing moment welds access (rat holes) specifically & identifying what welds have to be seismic code compliant and where backing bars & weld tabs will have to be removed.

Seismic Update

The AISC Seismic Manual published in 2006 is a great help to detailers, fabricators and erectors faced with constructing seismic resistant structural steel buildings. This manual for the most part eliminates the need to reference many other documents such as FEMA 350-353. Of particular interest to the detailer are the requirements for Shop and Erection Drawing listed in the specification sections 5.2 and 5.3.

Shop drawings shall include the following, as designated in the contract documents:

1. Designation of the members and connections that are part of the seismic load resisting system (SLRS).
2. Connection material specifications.
3. Locations of demand critical shop welds.
4. Locations and dimensions of protected zones.
5. Gusset plates drawn to scale when they are detailed to accommodate inelastic rotation.
6. Welding requirements as specified in Appendix W.

Erection drawings shall include the following, as designated by the contract documents:

1. Designation of the members and connections that are part of the seismic load resisting system (SLRS).
2. Field connection material specifications and sizes.

3. Locations of demand critical field welds.
4. Locations and dimensions of protected zones.
5. Location of pretensioned bolts.
6. Field welding requirements as specified in Appendix W.

Appendix W – Welding Provisions lists the welding information required on the Shop and Erection Drawings:

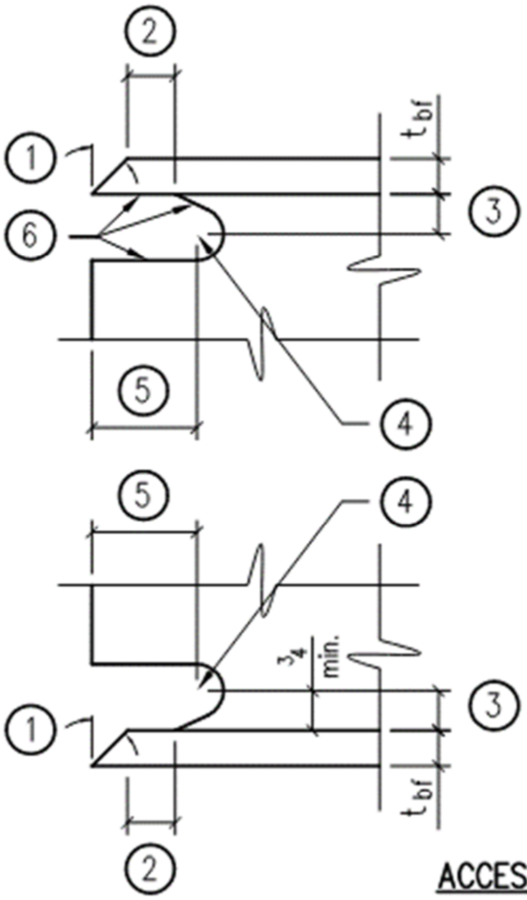
Shop drawings shall include the following, as designated in the contract documents:

1. Access hole dimensions, required shape, surface profile and finish requirements.
2. Locations where backing bars are to be removed.
3. Locations where weld tabs are to be removed.
4. NDT to be performed by the fabricator.
5. Locations where fillet welds are required to reinforce groove welds.

Erection drawings shall include the following, as designated in the contract documents:

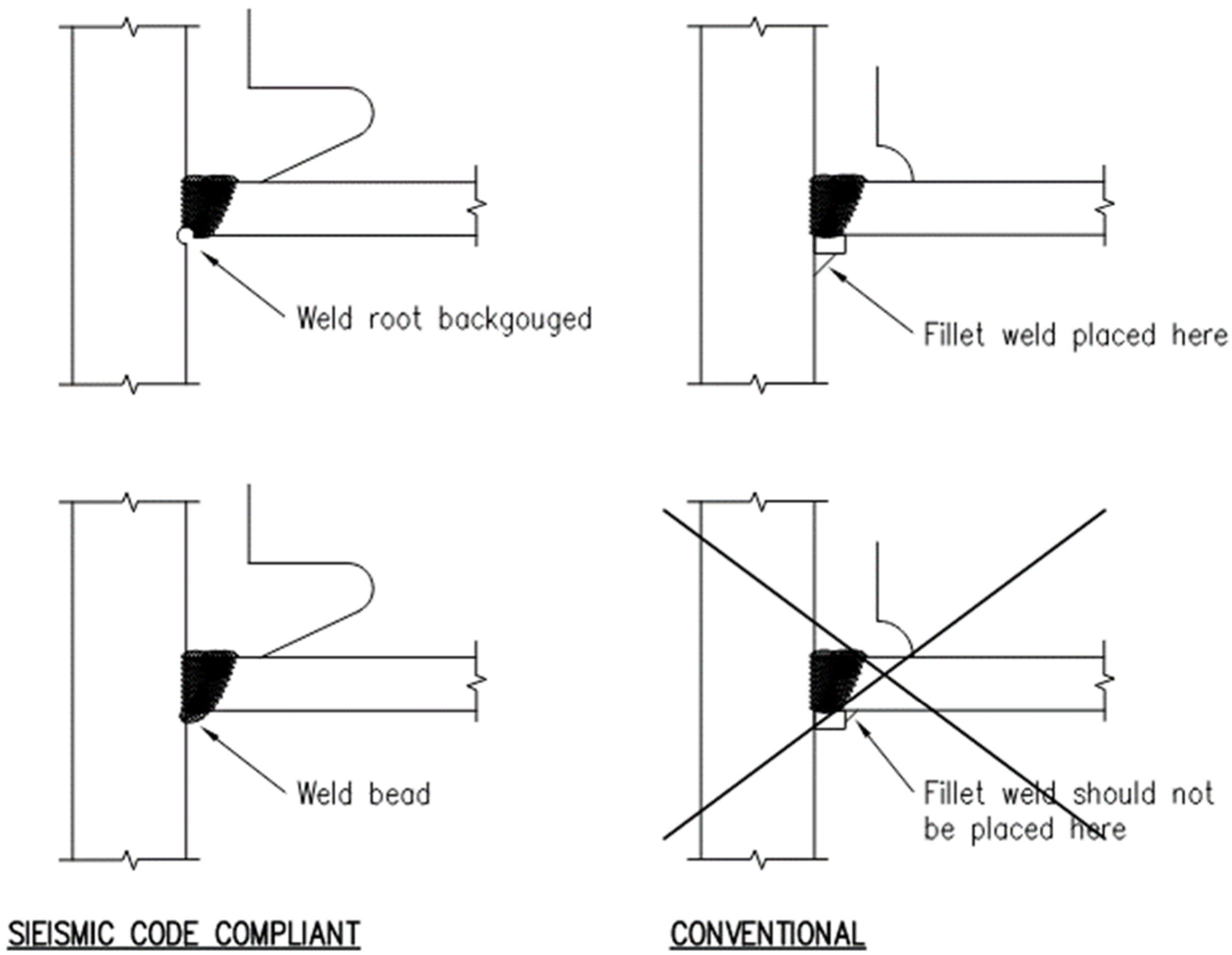
1. Locations where backing bars are to be removed.
2. Locations where supplemental fillets are required when backing is permitted to remain.
3. Locations where weld tabs are to be removed.
4. Joints or groups of joint in which a specific assembly order, welding sequence, welding technique or other special precautions are required.
5. NDT to be performed by the erector.

All the above information is required to appear on the design drawings and specifications.



ACCESS HOLE REQUIREMENTS

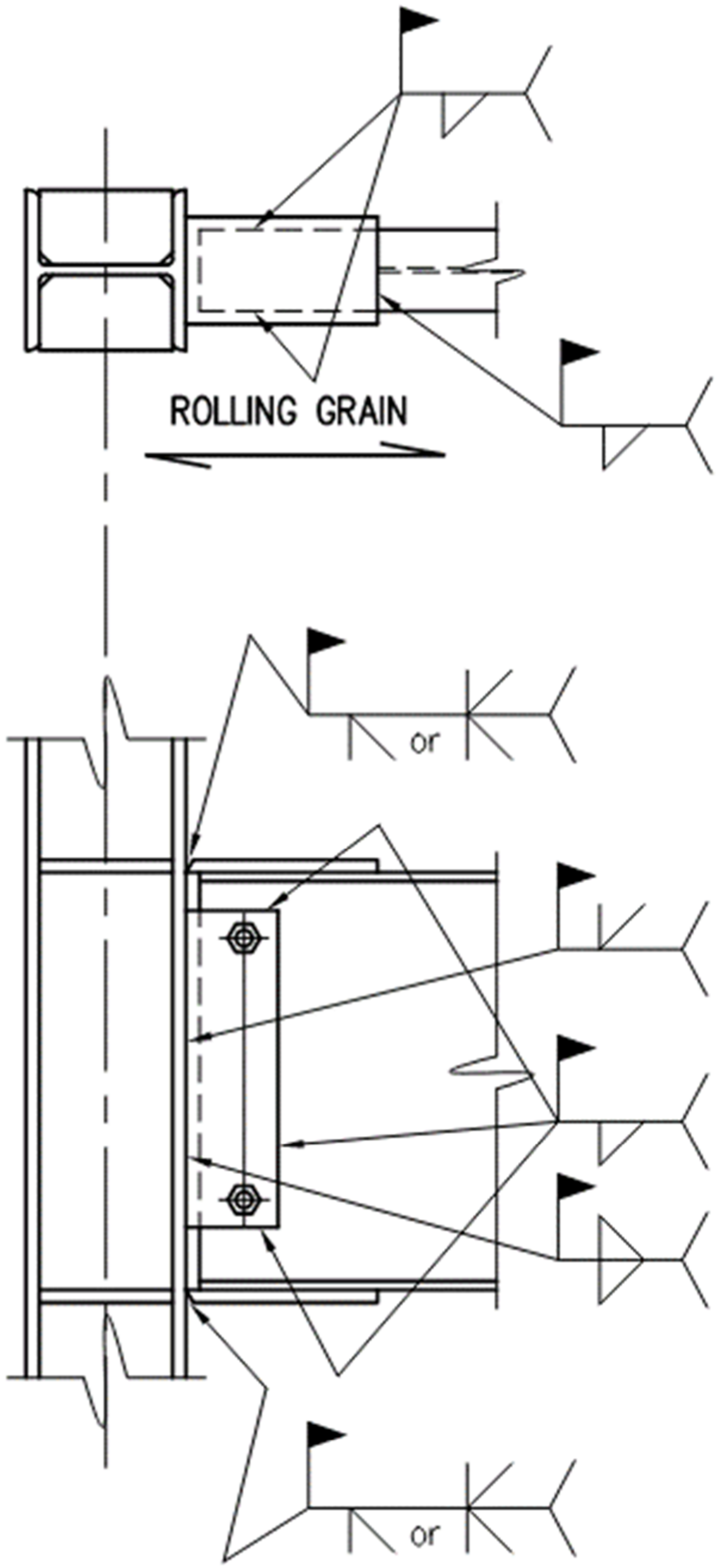
1. Bevel as required by AWS D1.1 for selected groove weld procedure.
2. Larger of t_{bf} or $\frac{1}{2}$ inch (plus $\frac{1}{2}$ t_{bf}, or minus $\frac{1}{4}$ t_{bf}).
3. $\frac{3}{4}$ t_{bf} to t_{bf}, $\frac{3}{4}$" minimun ($\pm$ $\frac{1}{4}$ inch).
4. $\frac{3}{8}$" minimum radius (plus not limited, or minus 0).
5. 3 t_{bf} ($\pm$ $\frac{1}{2}$ inch).
6. See FEMA–353, Recommended Specifications and Quality Assurance Guide lines for Steel Moment–Frame Construction for Seismic Applications, for fabrication details including cutting methods and smoothness requirements.
7. Locations of access holes and the required shape shall be standard AWS D1.1/D1.1M geometry, standard alternative geometry, or a special geometry designated in the contract documents.



Filler metal with a specified Charpy V-Notch (CVN) toughness of 20 ft-lbs (27 J) at 40°F (4°C) shall be used in the following joints:

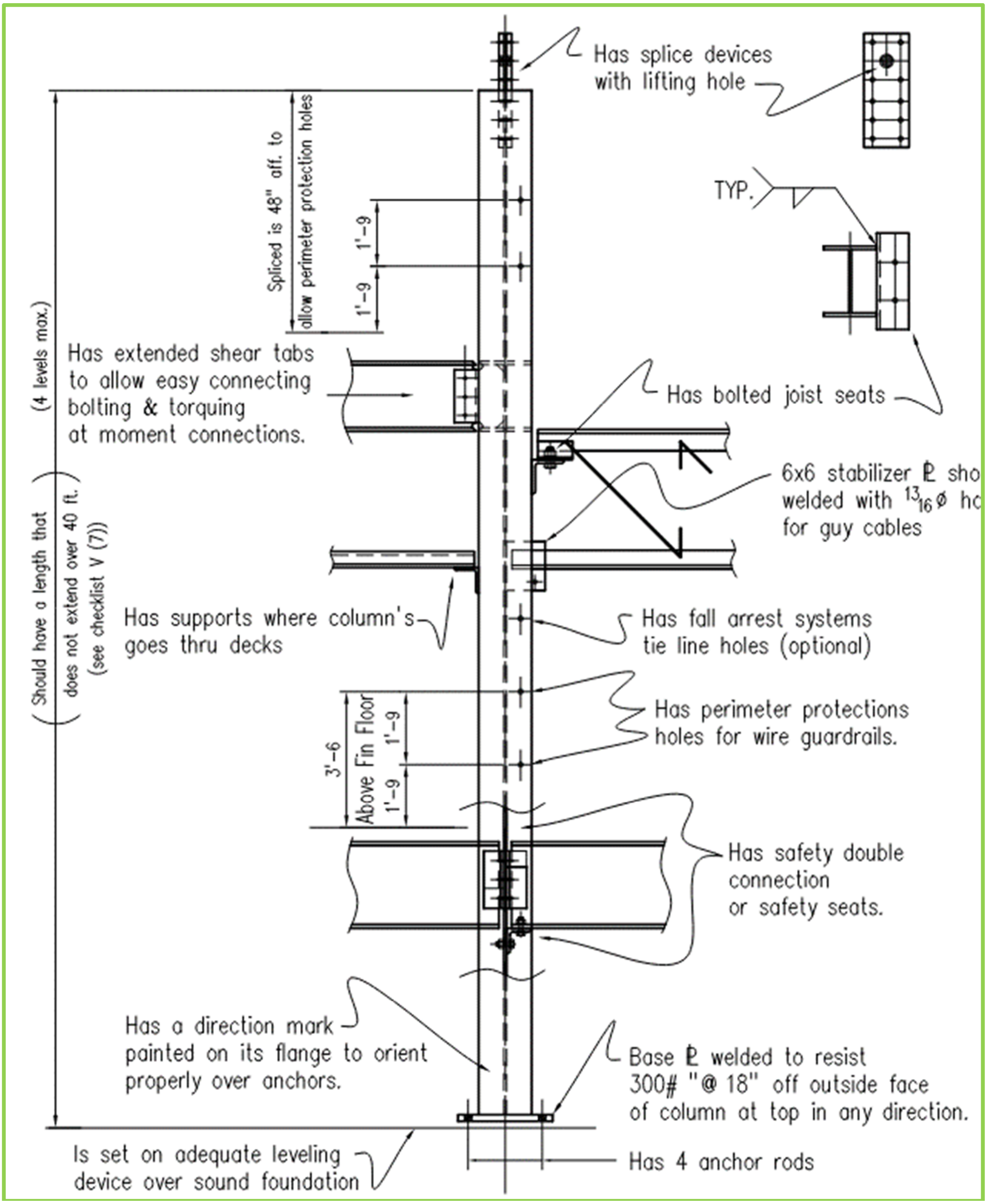
1. Complete-joint-penetration groove welded T and corner joints with steel backing left in place, subject to tension normal to the effective area, unless the joints are designed using the nominal strenght and resistance factor or safety factor as applicable for a PJP weld.

2. Complete-joint-penetration groove welded splices subject to tension normal to the effective area in heavy sections as defined in A3.1c and A3.1d.



1. Plates shall be fabricated with rolling direction parallel to the beam.

18. Erector Friendly Column



19. Column/Beam to checklist

COLUMN CHECKLIST:

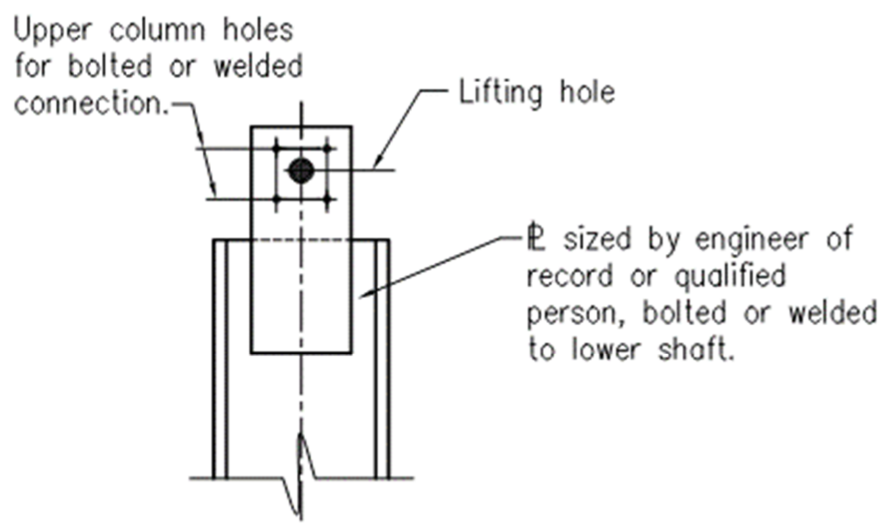
1) Single shaft when possible (Lengths under 40' preferred)

2) If spliced, 4'–0" above finish floor to accommodate perimeter safety cable. (Also better position to weld or bolt)

3) Bolted splices preferred. (Verify method with erector/fabricator)

4) Prepare upper column for field welding if splice requires welding.

5) All tiered columns shall have lifting device or hole (2"ø min.) for hoisting into place. (See sketch S6 for other suggested details)



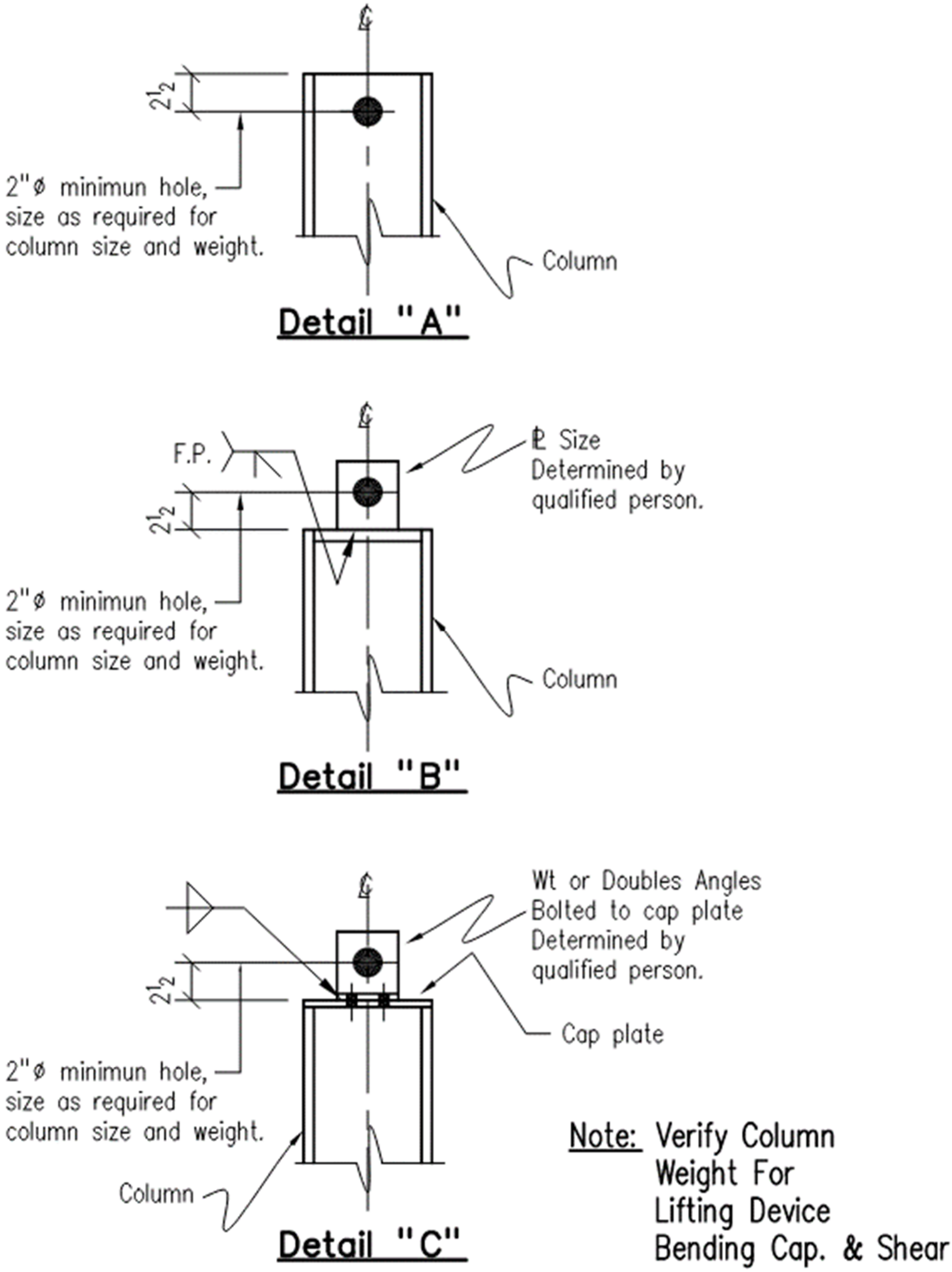
BEAM TO COLUMN CHECKLIST:

1) All double connections at column webs or beam webs over columns must have staggered clip or beam seat for erection.(SEE DETAIL)

2) Utilize permanent bolts at beam webs for moment connections, when possible

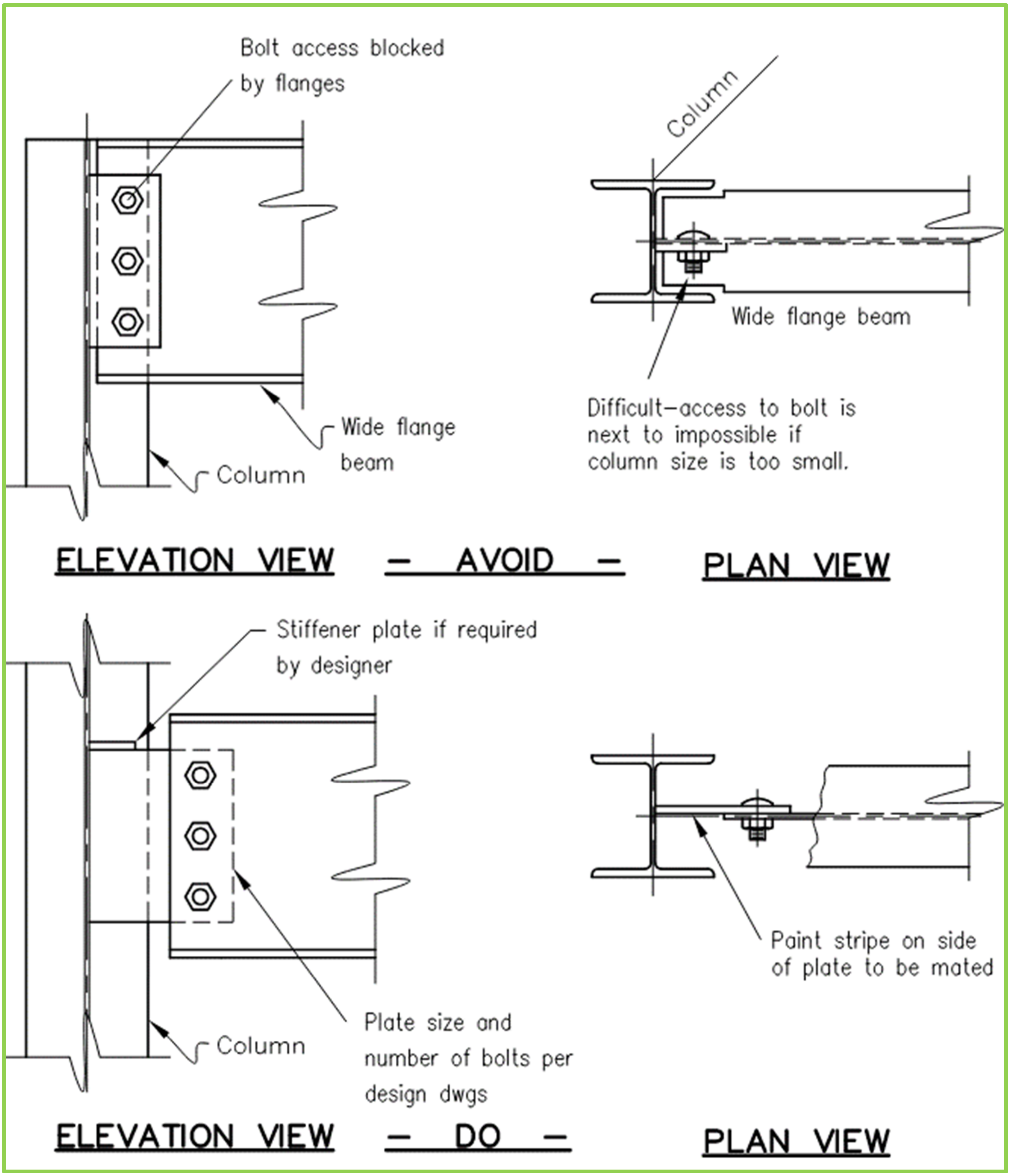
3) Minimum (2) bolts req'd at each end of beam for erection.

20. Column lifting hole/lug details

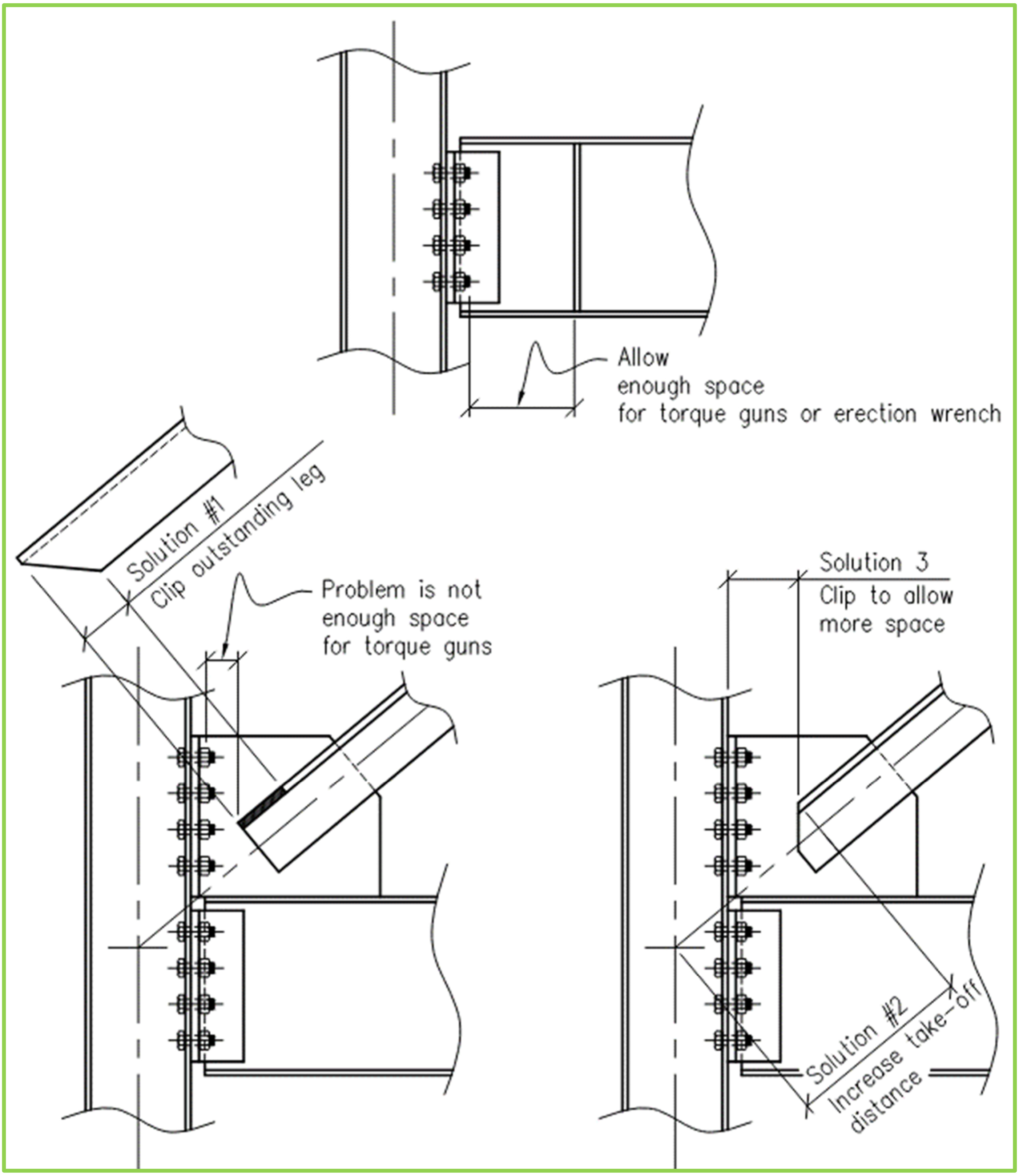


21. Bolt Access problems

At small columns



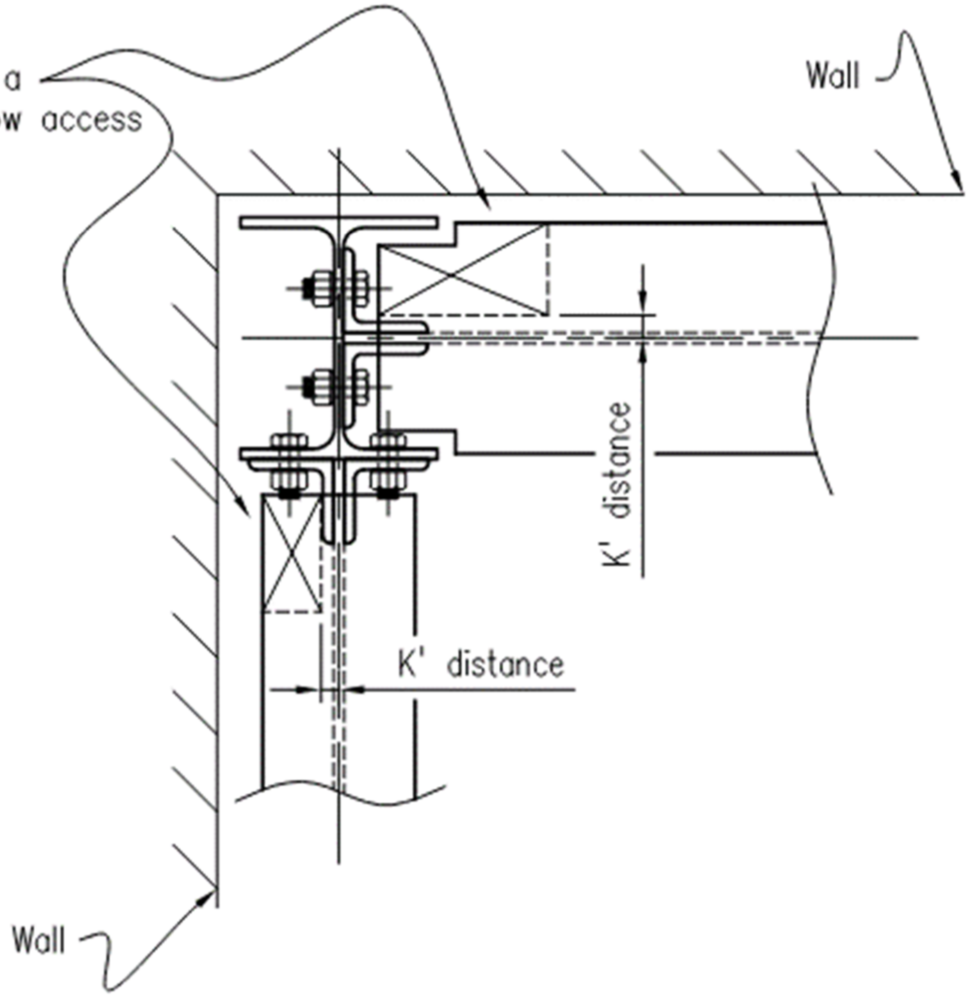
At brace locations



22. Access problem/Hand trap

Solution:

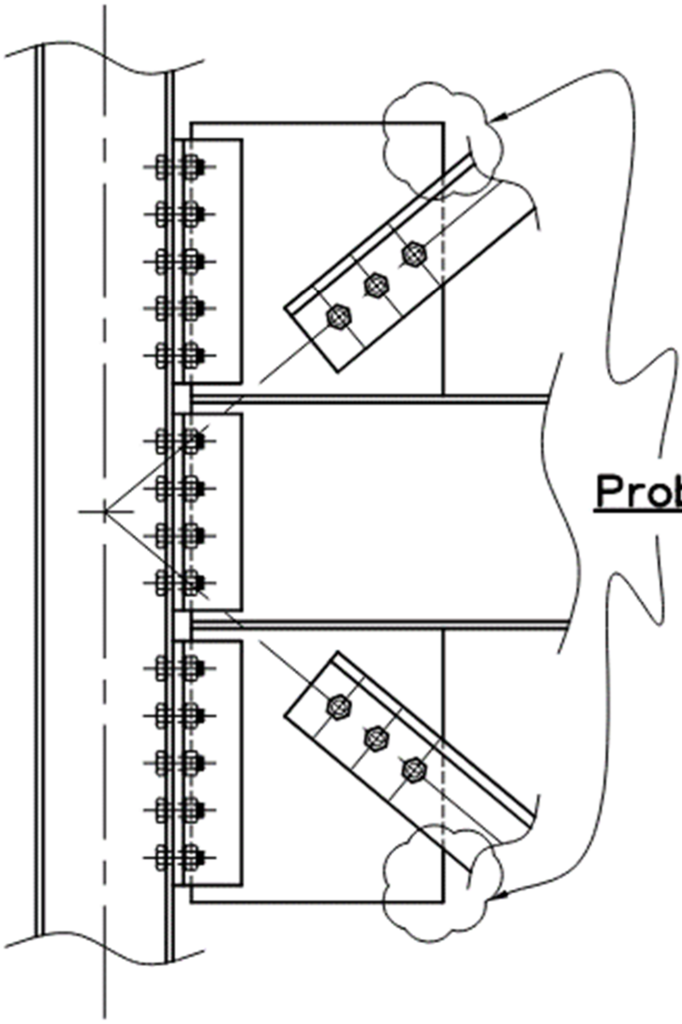
Could be to cut out a flange section to allow access



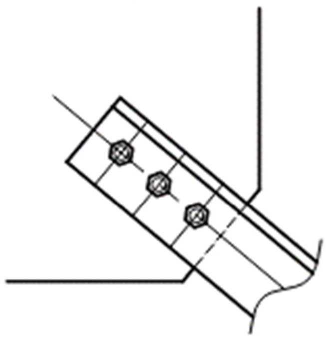
Problem:

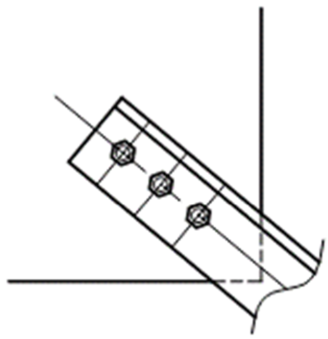
- This very common situation creates a potentially difficult and dangerous trap.
- Access to bolts holes is not possible for erection wrenches and for torque guns and hands can be caught between beams and wall if not enough space is available.

23. Puncture/Snagging Hazards

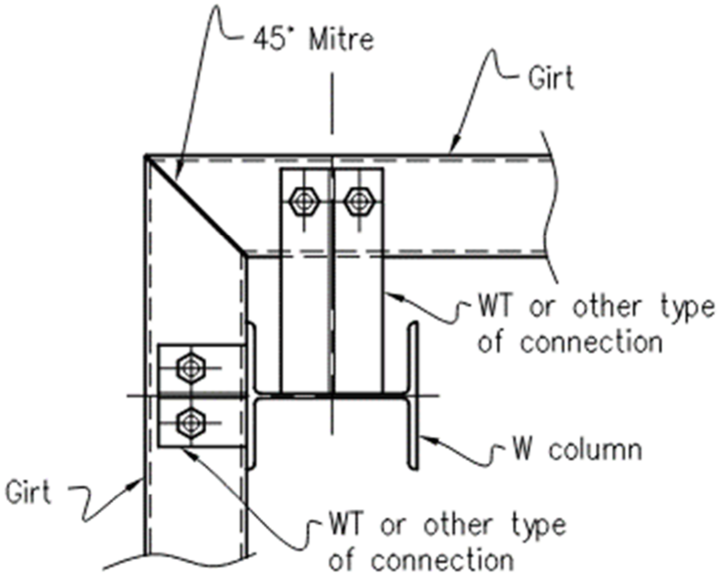


Problem: Dangerous corners can snag clothes or puncture skin in field or shop.

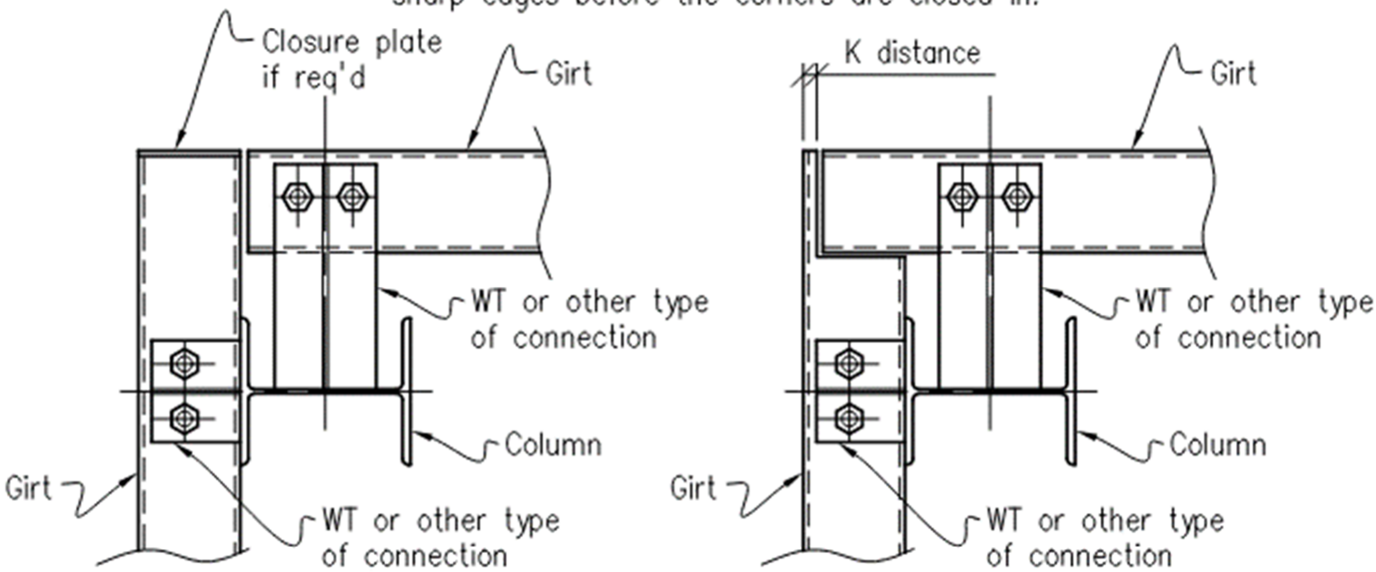




Solutions: Could be to clip gussets corner **Or:** Hide the gusset corner within the bracing depth



Problem: This typical girt wall detail has a potential for accidents where field or shop workers could hit girts on the sharp edges before the corners are closed in.

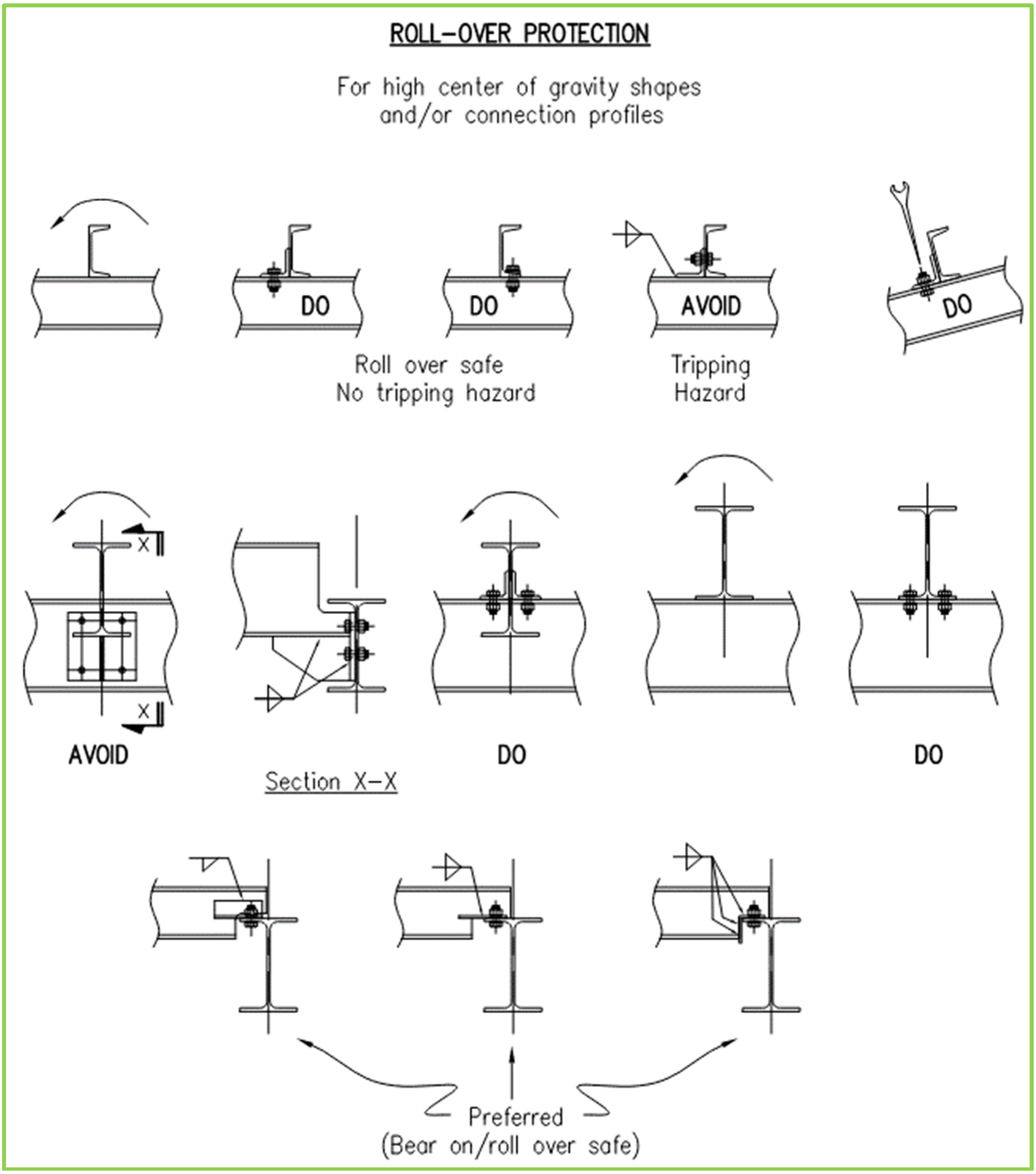


Solution option #1
Prefered

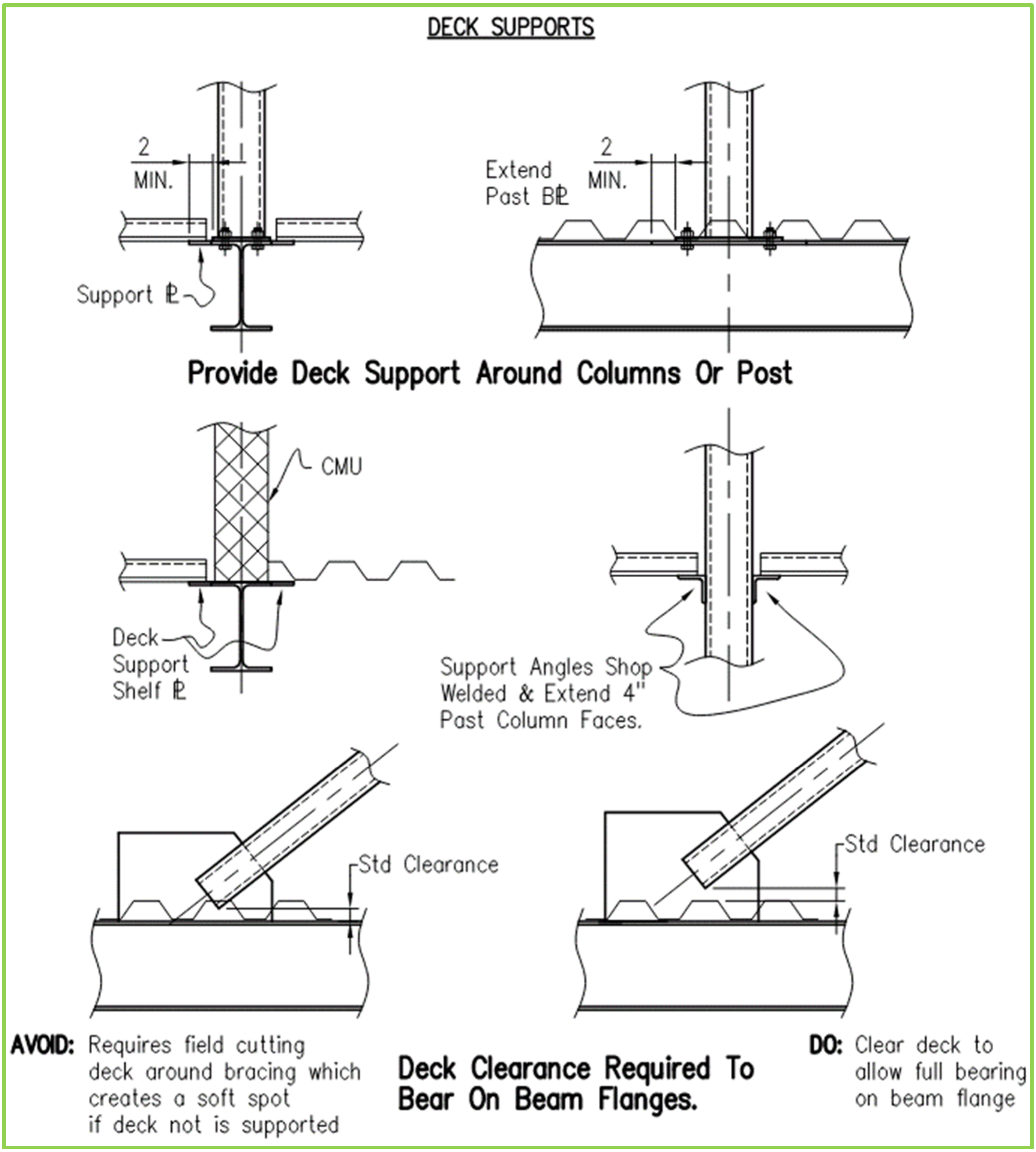
Solution option #2

Solution: Could be to run one girt past the other to offer a square end. (see also sketch S5)

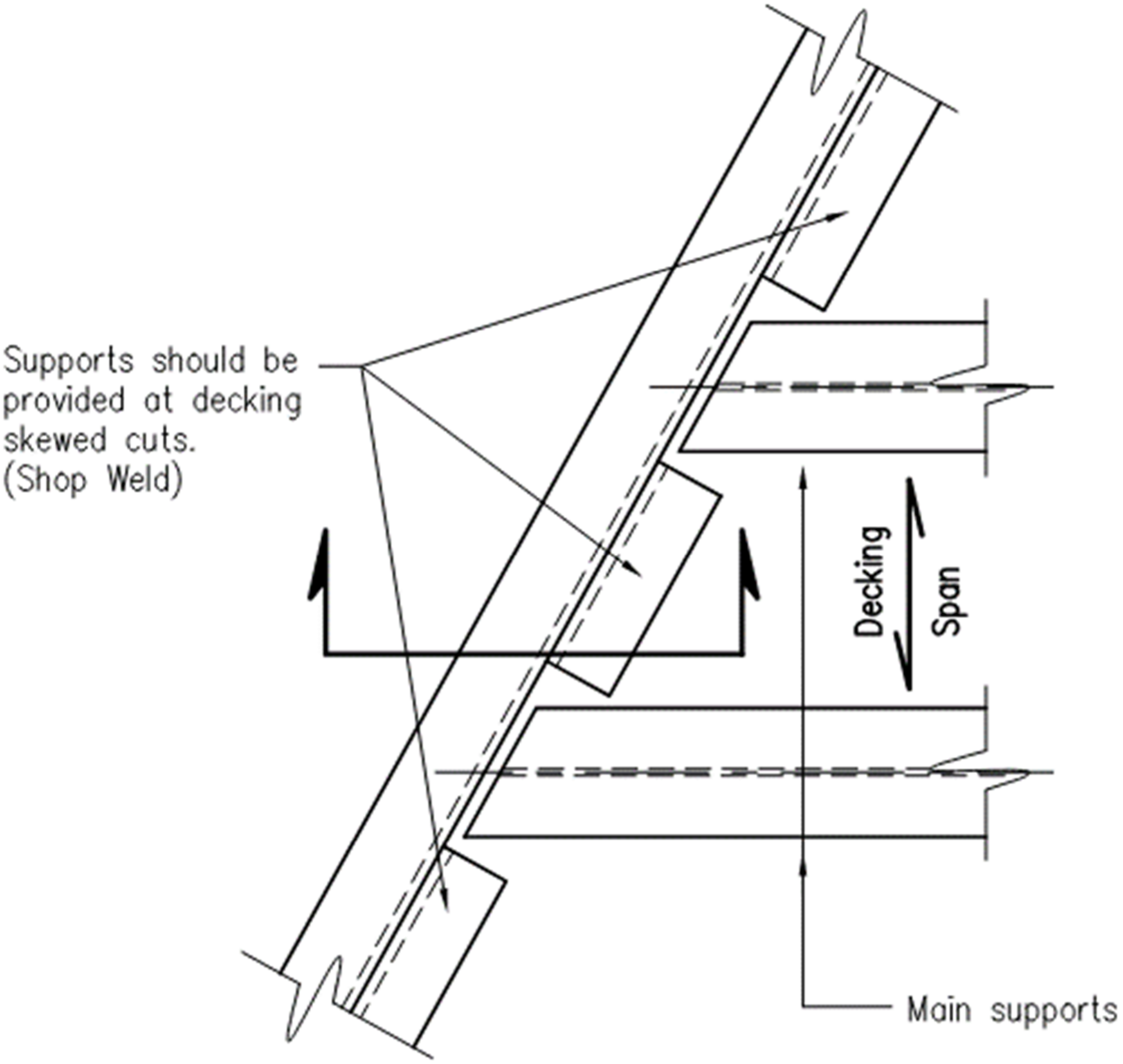
24. Roll-Over protection

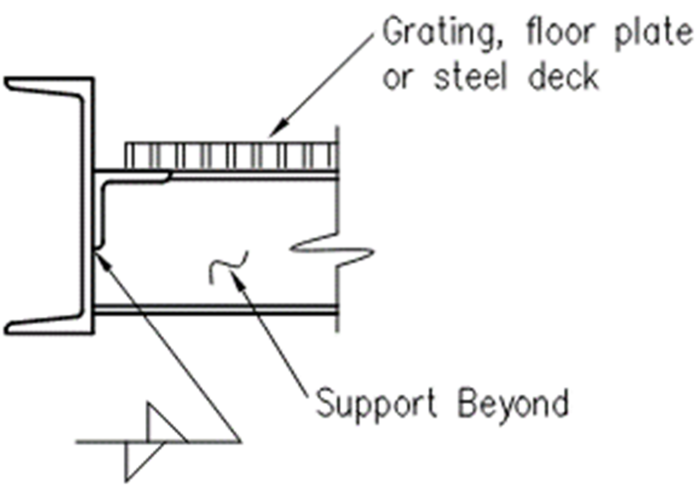


25. Deck supports

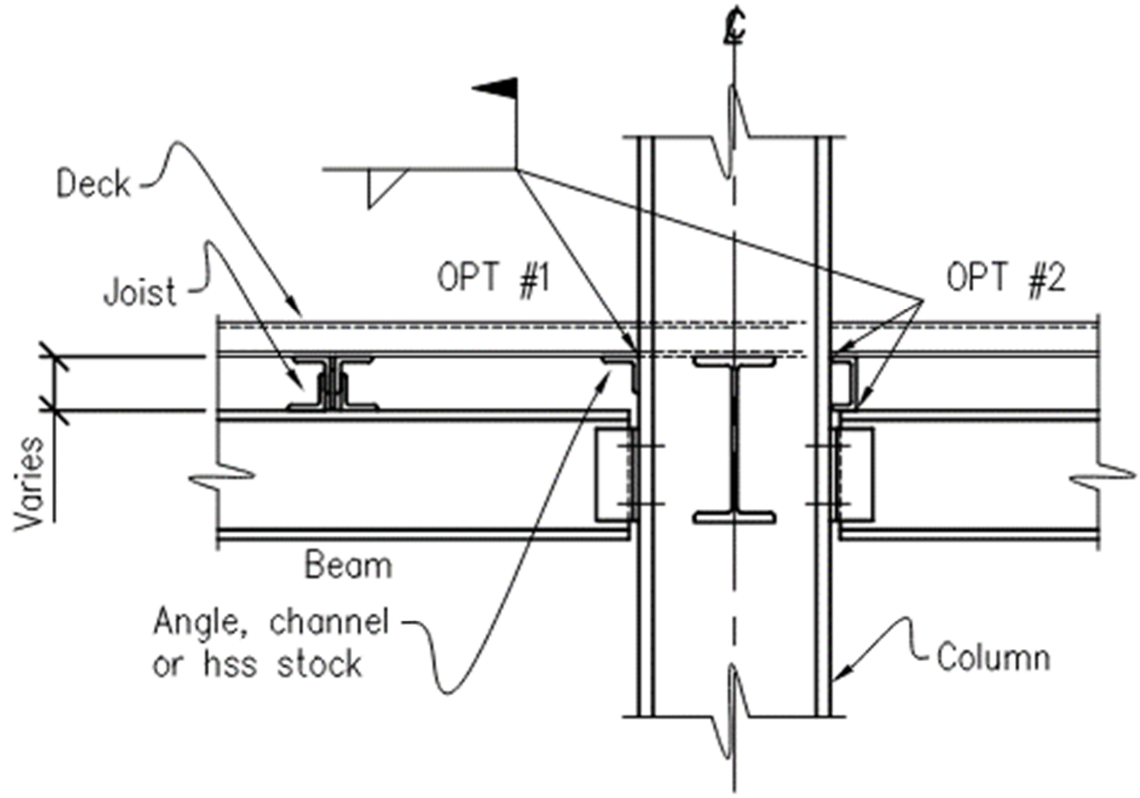


26. Decking supports Near cutouts Beam to Beam)



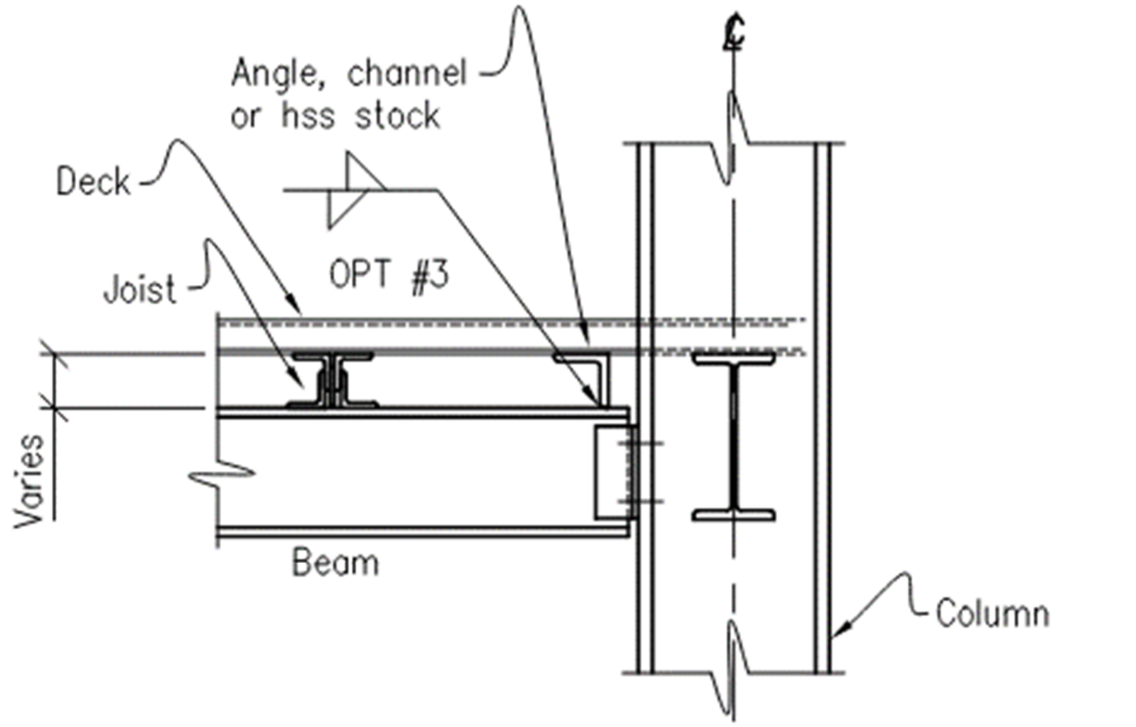


Section View



Alternative # 1

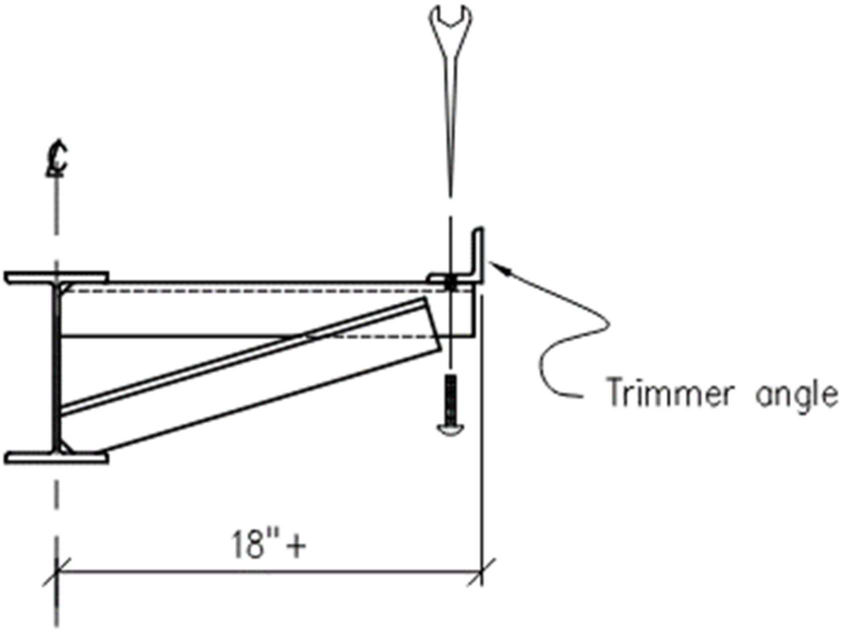
(Field welded)



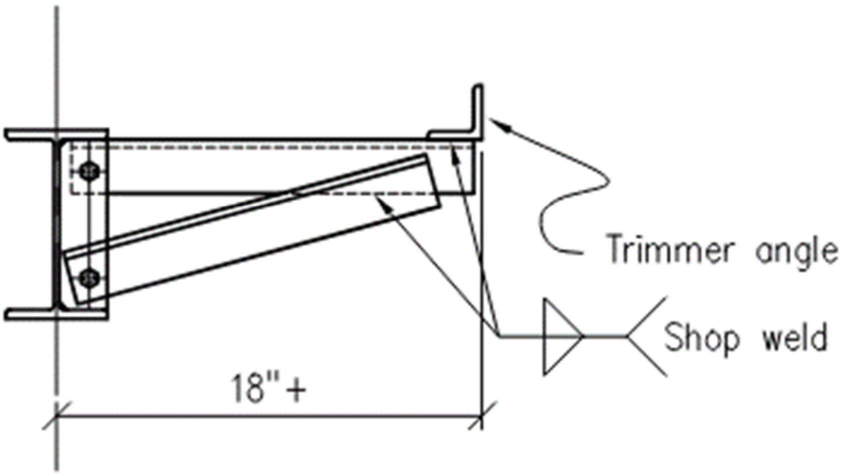
Alternative # 2

(Shop welded)

27. Out of position Bolting/Welding



Problem: Bolting or welding at this location forces connector or welder to hang his body weight out of position.



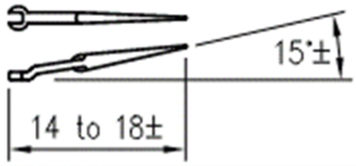
Solution: Could be to shop weld trimmer angle with bracket angles and field bolt to a tab plate or stiffener where the connector does not have to "Hang Out" to make connection always consider the erector's access.

28. The tools of the trade

APPENDIX 1

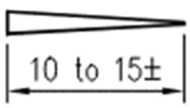
Here are sketches showing what tools look like along with dimensions to allow proper clearances when detailing in tight corners...
(Exact dimensions should be checked with actual manufacturer's and/or erector technical data)

The Erection Wrenches



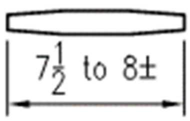
This "Connector" tool is used to guide pieces and align holes, hold parts in alignment while bolting. also known as "Spud Wrench" or "Spanner" (works best with a minimum of two holes connection)

The Bull Pins



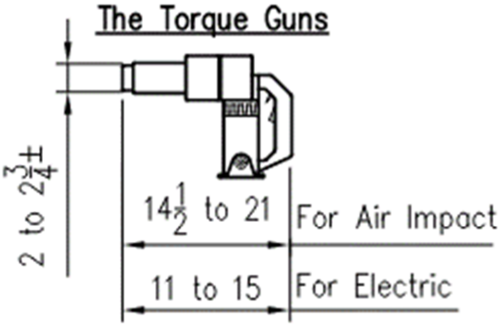
Are used to "Pull pieces together by hammering Its tapered shaft into misaligned holes.

The Drift Pins



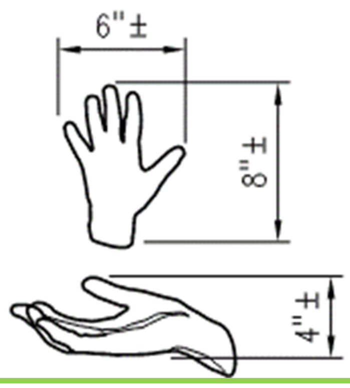
Are used to align large connection parts together. It is hammered in and has the same constant diameter as the holes in the connection.

The Torque Guns



Are used to torque bolts to proper tension. Two types are seen on jobs the impact guns (compressed air driven) or the electric guns (used with T.C. bolts). Note that electric guns have a fixed drive and have to be operated in line with bolts.

The Hands



This most important "Connector's" equipment is used for holding the tools, inserting bolts, maneuvering pieces into place, signaling to others....
Good detailing practices should always allow enough space to insert that tool for "Making" the connection.
Bear in mind that in cold weather it is gloved and needs more space.

29. Suggested Notes in erection sheets

SUGGESTED NOTES:

The detailer and erector should discuss the need for adding notes to the Anchor Rod Plan and Member Placement Drawings. Such notes might be:

a. Erect all members with the marked end in the same relative position as shown on the erection drawing. (see sketch A3a)

b. Beam connection angles have been shipped loosely secured to permit removal for ease of erection. Replace bolts and torque in field.

c. Elevations are referenced to datum elevation XXX'-XX u/n.

d. Erection North (as opposed to true North) (see sketch A3a)

e. The dimension shown on this (Anchor Rod) plan must be strictly adhered to in all masonry and building construction or the steel work will not fit. Report any error or misunderstanding at once.

f. Per OSHA 2001, all masonry and or concrete shall be certified by E.O.R. that strength has been obtained to set steel on it.

g. Note for Anchor Rod Plans & Member Placement Diagrams.

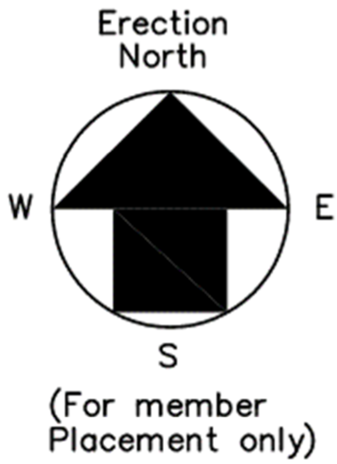
APPROVAL/REVIEW AUTHORITY
PLEASE REVIEW THESE DRAWINGS CAREFULLY.

THIS MEMBER PLACEMENT DRAWING REPRESENTS OUR INTERPRETATION OF THE CONTRACT DOCUMENTS. HOWEVER, THE STEEL FABRICATOR AND STRUCTURAL STEEL DETAILER ASSUME NO RESPONSIBILITY FOR THE ACCURACY OF THE INFORMATION SHOWN ON DRAWING. THIS IS THE RESPONSIBILITY OF THE BUYER. (AISC CODE OF STD PRATICE)

UNLESS NOTED TO THE CONTRARY ON THIS DRAWING, WHEN RETURNED FROM APPROVAL, IT WILL BE CONSIDERED THAT ALL INFORMATION SHOWN HEREON HAS THE AFFIRMATION OF THE APPROVAL AUTHORITY.

SUBSEQUENT CHANGES TO INFORMATION SHOWN ON THIS DRAWING AFTER FIRST SUBMISSION WILL BE CONSIDERED AS CONTRACT CHANGES.

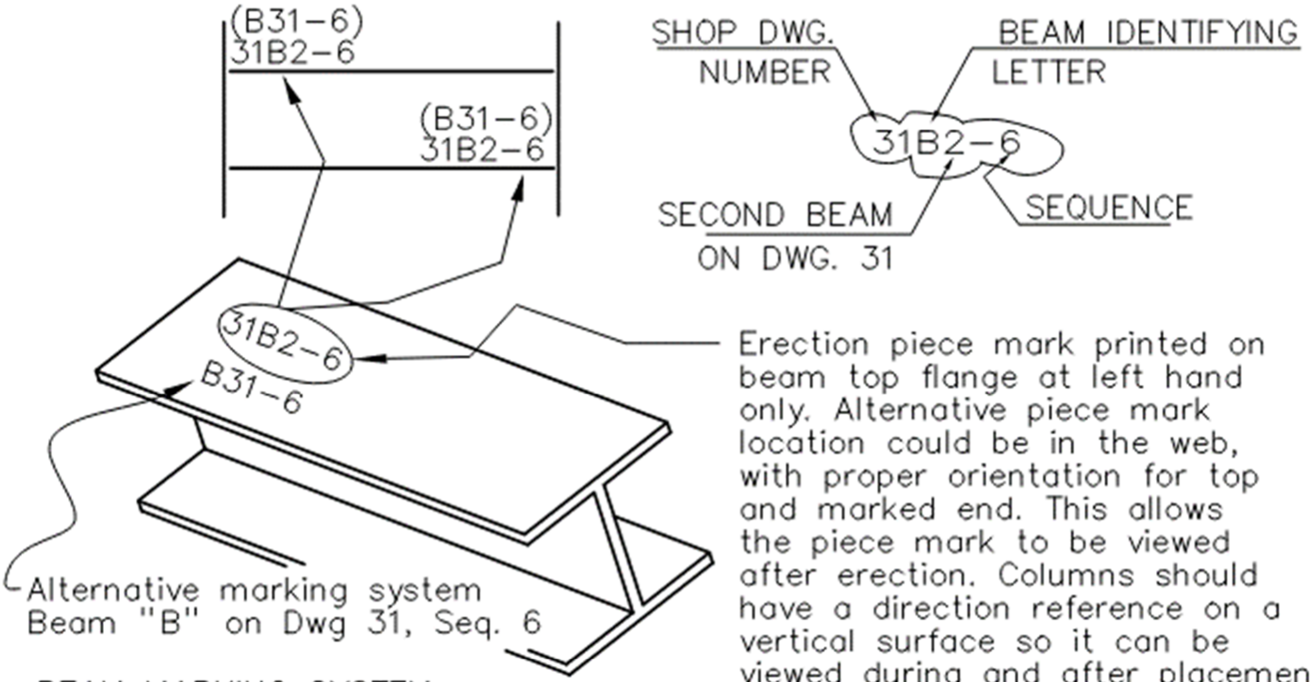
30. Direction North/Safety connection/Beam marking



NOTE:

1. Both the anchor rod placement as well as the erection drawing should reference an "Erection North" which matches column (and horizontal members, if necessary), orientation.

2. Direction of the "Erection North" should be discussed at the start up meeting.



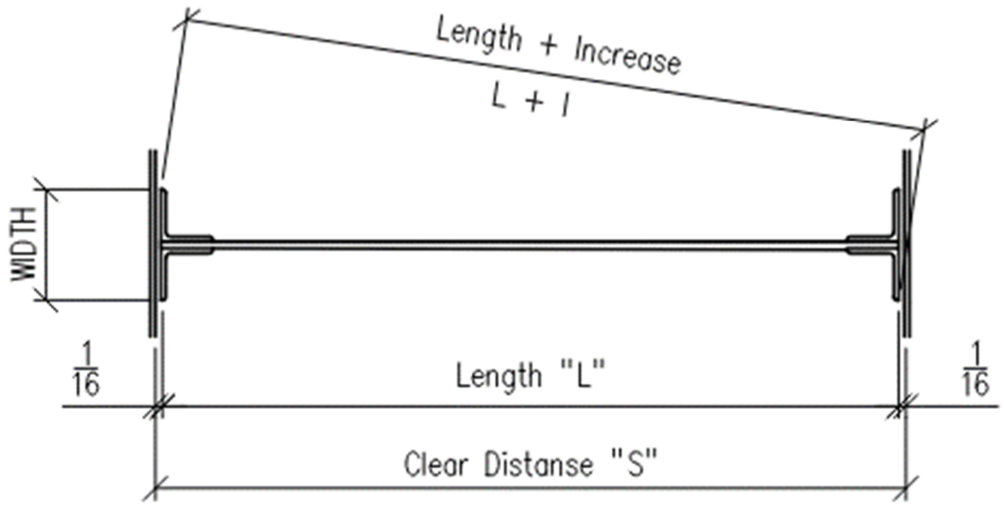
Erection piece mark printed on beam top flange at left hand only. Alternative piece mark location could be in the web, with proper orientation for top and marked end. This allows the piece mark to be viewed after erection. Columns should have a direction reference on a vertical surface so it can be viewed during and after placement.

BEAM MARKING SYSTEM

Member is swung into place matching marked end with erection mark location on plans.

31. Swinging beams to beams Horizontally

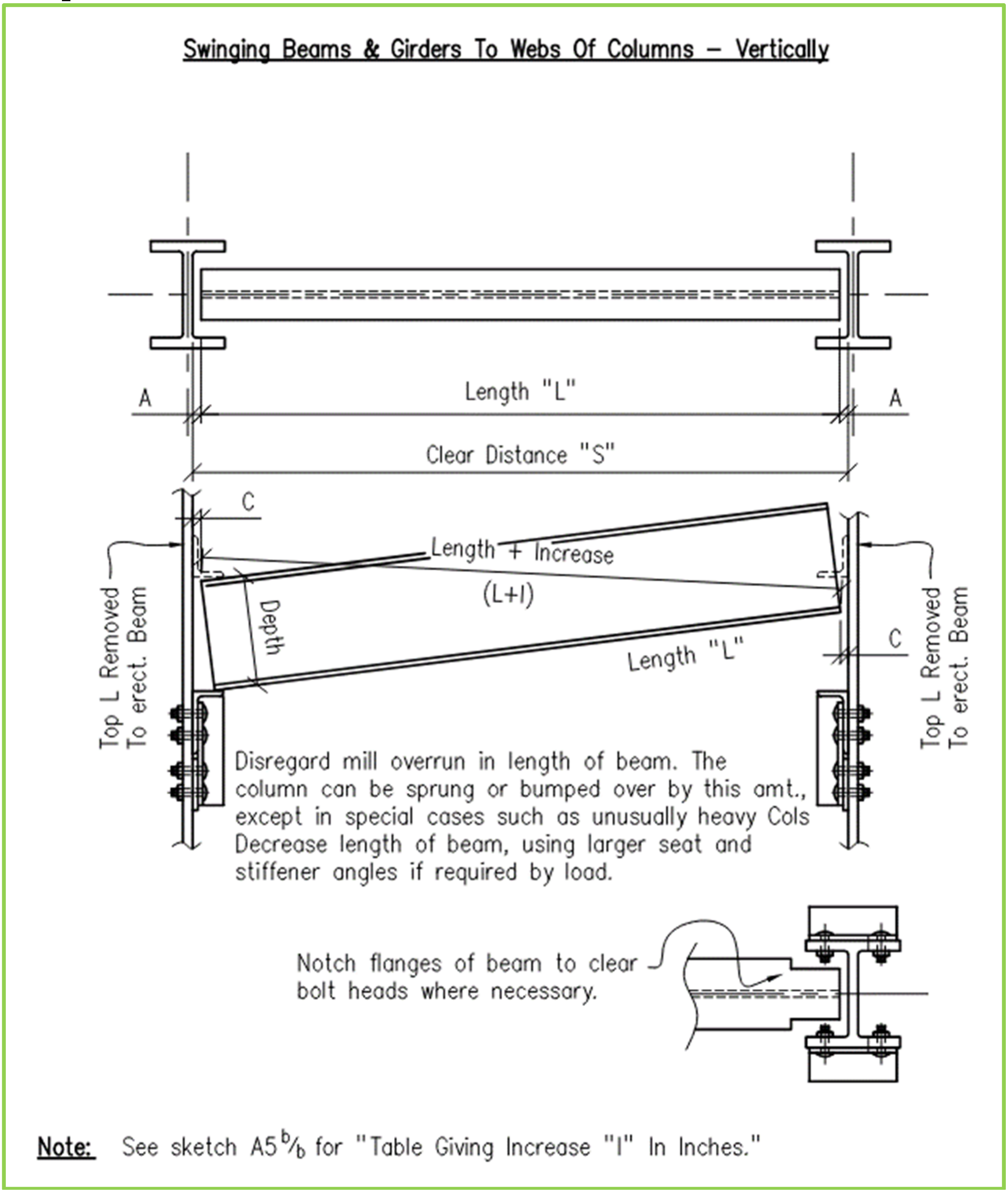
Swinging Beams To Beams Horizontally



Note: If length plus increase exceeds clear span "S", beams cannot be swung without moving supporting beams or beating into place. This is objectionable and in some cases impossible. Refer such conditions to Project Manager.

INCREASE "I"																			
Width in Inches	CLEAR DISTANCE "S" IN FEET																		
	6	8	10	12	14	16	18	20	22	24	26	28	30	35	40	45	50	55	60
6	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	0	0	0
7	3/8	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	0	0
8	1/2	3/8	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
9	5/8	1/2	3/8	3/8	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
10	3/4	1/2	1/2	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
11	7/8	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8	1/8
12	1	3/4	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8	1/8	1/8
13	1 1/4	7/8	3/4	5/8	1/2	1/2	3/8	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4	1/8	1/8	1/8
14	1 3/8	1	7/8	3/4	5/8	1/2	1/2	1/2	3/8	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/8	1/8
15	1 5/8	1 1/4	1	7/8	3/4	5/8	5/8	1/2	1/2	3/8	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/4
16	1 3/4	1 3/8	1 1/8	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4
17	2	1 1/2	1 1/4	1	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	1/2	3/8	3/8	1/4	1/4	1/4	1/4
18	2 1/4	1 3/4	1 3/8	1 1/8	1	7/8	3/4	3/4	5/8	5/8	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4

32. Swinging beams & Girders to Web of columns – Vertically



33. Table giving increase "I" in inches

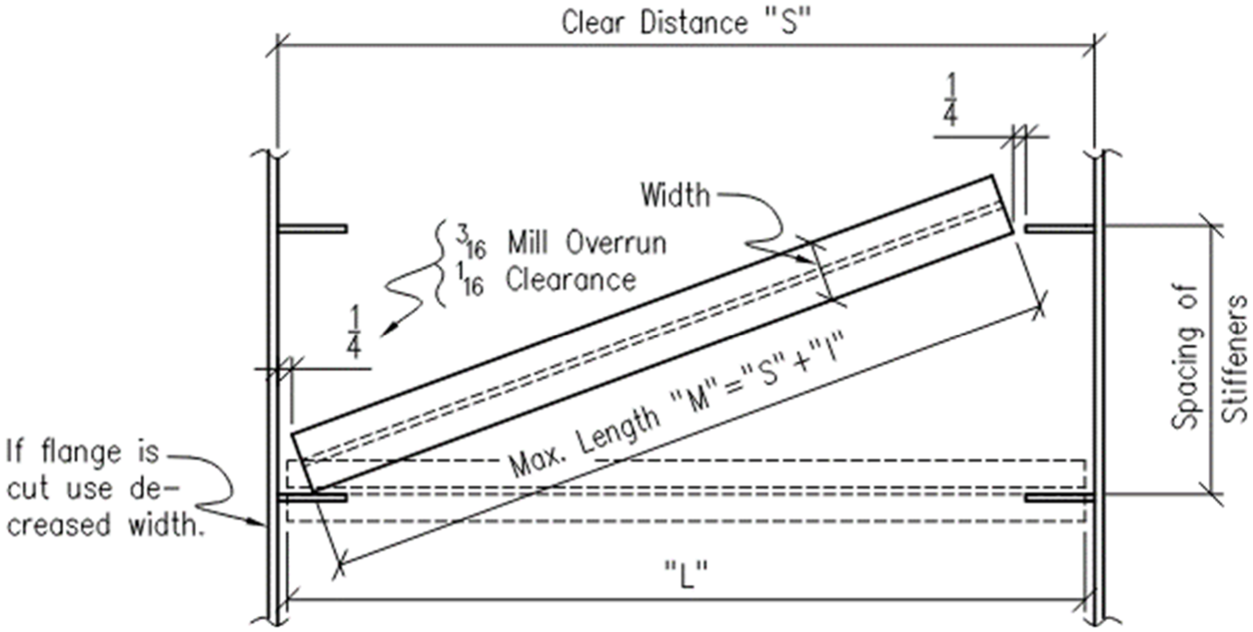
TABLE GIVING INCREASE "I" IN INCHES

	Depth in Inches	CLEAR DISTANCE "S" IN FEET																							
		6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	45	50	55	60	65
Beams	8	1/2	3/8	3/8	1/4	1/4	1/4	1/8	1/8																
	9	5/8	1/2	3/8	3/8	1/4	1/4	1/4	1/4																
	10	3/4	5/8	1/2	3/8	3/8	3/8	1/4	1/4																
	12	1	3/4	5/8	1/2	1/2	3/8	3/8	3/8	1/4	1/4	1/4	1/4	1/4											
	14	1 3/8	1	7/8	3/4	5/8	1/2	1/2	3/8	3/8	3/8	3/8	3/8	1/4											
	15	1 1/2	1 1/4	1	7/8	3/4	5/8	1/2	1/2	1/2	3/8	3/8	3/8	3/8											
	16	1 7/8	1 3/8	1 1/8	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	3/8	3/8	3/8	3/8	3/8								
	18	2 1/4	1 3/4	1 3/8	1 1/8	1	7/8	3/4	3/4	5/8	5/8	1/2	1/2	1/2	1/2	3/8	3/8								
	20	2 3/4	2 1/4	1 3/4	1 1/2	1 1/4	1	1	7/8	7/8	3/4	5/8	5/8	5/8	5/8	1/2	1/2								
	21	3	2 1/2	2	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	3/4	3/4	3/4	5/8	5/8	5/8	1/2								
	22			2 1/8	1 3/4	1 1/2	1 1/4	1 1/8	1	1	7/8	3/4	3/4	3/4	5/8	5/8	5/8								
	24			2 1/2	2 1/8	1 3/4	1 1/2	1 3/8	1 1/4	1 1/8	1	1	7/8	7/8	3/4	3/4	3/4	5/8	5/8	5/8					
	26			2 3/4	2 1/4	2	1 3/4	1 1/2	1 3/8	1 1/4	1 1/8	1	1	7/8	7/8	7/8	3/4	3/4	3/4	5/8					
	27				2 5/8	2 1/4	1 7/8	1 3/4	1 1/2	1 1/2	1 1/4	1 1/4	1 1/8	1 1/8	1	1	7/8	7/8	7/8	3/4					
	28				2 3/4	2 3/8	2 1/8	1 7/8	1 5/8	1 1/2	1 3/8	1 1/4	1 1/4	1 1/8	1	1	1	7/8	7/8	3/4					
	30				3 1/8	2 3/4	2 3/8	2 1/8	1 7/8	1 3/4	1 5/8	1 1/2	1 3/8	1 1/4	1 1/4	1 1/8	1 1/8	1	1	1					
	33				3 7/8	3 1/4	2 7/8	2 5/8	2 3/8	2 1/8	1 7/8	1 3/4	1 5/8	1 1/2	1 1/2	1 3/8	1 1/4	1 1/4	1 1/8	1 1/8					
	36				4 5/8	3 7/8	3 3/8	3	2 3/4	2 1/2	2 1/4	2 1/8	2	1 7/8	1 3/4	1 5/8	1 1/2	1 1/2	1 3/8	1 3/8					
Gors.	42					5 3/8	4 5/8	4 1/8	3 3/4	3 3/8	3 1/8	2 7/8	2 5/8	2 5/8	2 1/2	2 1/4	2 1/8	2	2	1 7/8	1 3/4	1 1/2	1 3/8	1 1/4	1 1/8
	48						6 1/8	5 3/8	4 3/4	4 3/8	4	3 3/4	3 1/2	3 1/4	3	2 7/8	2 3/4	2 5/8	2 1/2	2 3/8	2 1/8	2	1 3/4	1 5/8	1 1/2
	54							6 5/8	6	5 5/8	5 1/8	4 3/4	4 3/8	4 1/8	3 7/8	3 5/8	3 3/8	3 1/4	3 1/8	2 7/8	2 3/4	2 1/2	2 1/4	2	1 7/8
	60								7 3/8	6 3/4	6 3/8	5 7/8	5 3/8	5	4 3/4	4 1/2	4 1/4	4	3 3/4	3 5/8	3 3/8	3	2 3/4	2 1/2	2 1/4
	72									9 5/8	8 7/8	8 1/4	7 5/8	7 1/4	6 3/4	6 3/8	6	5 3/4	5 3/8	5 1/8	4 7/8	4 3/8	4	3 5/8	3 3/8

Note: Use Standard 1/2" Clearance For "A"

34. Swinging beams & Girders to plate girders - Horizontally

Swinging Beams & Girders To Plate Girders – Horizontally



Clearance for Swinging = "M" –"L".
If clearance is plus beam will swing, if minus will foul stiffeners.

Note: See sketch A6b/b for "Table Of Increase "I" Of Max. Length "M" Over Clear Dist. "S"

35. Table of increase "I" of Max length "M" over clear dist. "S"

TABLE OF INCREASE "I" OF MAX. LENGTH "M" OVER CLEAR DIST. "S"

All Figures + Unless Noted (−)

Spacing of stiffener	Width in Inches	CLEAR DISTANCE "S" IN FEET																	
		14	16	18	20	22	24	26	28	30	32	34	36	38	40	45	50	55	60
2'-6	6	1 1/8	7/8	3/4	5/8	1/2	1/2	3/8	1/4	1/8	1/8	1/8	0	0	0	0	-1/8	-1/8	-1/8
	9	5/8	3/8	1/4	1/4	1/8	1/8	1/8	0	0	0	0	-1/8	-1/8	-1/8	-1/4	-1/4	-1/4	-3/8
	12	0	-1/8	-1/8	-1/8	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-3/8	-3/8	-3/8	-3/8	-3/8	-1/2
	15	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2	-5/8	-5/8
3'-0	6	2	1 3/4	1 1/2	1 1/4	1	7/8	3/4	3/4	3/4	1/2	1/2	1/2	3/8	3/8	1/4	1/8	0	0
	9	1 3/8	1 1/8	7/8	3/4	5/8	1/2	1/2	3/8	3/8	1/4	1/4	1/4	1/4	1/4	1/8	0	-1/8	-1/8
	12	3/4	5/8	1/2	3/8	1/4	1/4	1/8	1/8	1/8	0	0	0	0	0	-1/8	-1/8	-1/8	-1/4
	15	1/8	0	0	-1/8	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-1/4	-3/8	-3/8	-3/8	-3/8
3'-6	6	3 1/4	2 3/4	2 3/8	2 1/8	1 7/8	1 5/8	1 1/2	1 3/8	1 1/4	1	1	7/8	7/8	3/4	5/8	1/2	3/8	3/8
	9	2 1/2	2 1/8	1 3/4	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	3/4	3/4	5/8	5/8	5/8	3/8	3/8	1/4	1/4
	12	1 3/4	1 1/2	1 1/4	1	7/8	3/4	5/8	1/2	1/2	3/8	3/8	1/4	1/4	1/8	1/8	1/8	0	0
	15	1	3/4	5/8	1/2	3/8	3/8	1/4	1/4	1/4	1/8	1/8	0	0	0	0	0	-1/8	-1/8
4'-0	6	4 5/8	4	3 1/2	3 1/8	2 3/4	2 1/2	2 1/4	2	1 7/8	1 3/4	1 5/8	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	7/8
	9	3 3/4	3 1/4	2 7/8	2 1/2	2 1/4	2	1 3/4	1 5/8	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	7/8	3/4	5/8	5/8
	12	3	2 1/2	2 1/8	1 7/8	1 3/4	1 1/2	1 1/4	1 1/8	1	7/8	3/4	3/4	3/4	5/8	5/8	1/2	3/8	3/8
	15	2 1/8	1 3/4	1 1/2	1 1/4	1 1/8	1	7/8	3/4	5/8	1/2	1/2	1/2	3/8	3/8	3/8	1/4	1/8	1/8
4'-6	6	6 1/8	5 3/8	4 3/4	4 1/4	3 3/4	3 3/8	3 1/8	2 7/8	2 5/8	2 3/8	2 1/4	2 1/8	2	1 7/8	1 5/8	1 3/8	1 1/4	1 1/8
	9	5 1/8	4 1/2	4	3 1/2	3 1/8	2 7/8	2 5/8	2 3/8	2 1/4	2	1 7/8	1 3/4	1 5/8	1 5/8	1 3/8	1 1/8	0	7/8
	12	4 1/4	3 3/4	3 1/4	2 7/8	2 1/2	2 1/4	2 1/8	1 7/8	1 3/4	1 5/8	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	3/4	5/8
	15	3 1/4	2 7/8	2 1/2	2 1/8	1 7/8	1 3/4	1 5/8	1 3/8	1 1/4	1 1/8	1	7/8	7/8	3/4	3/4	5/8	1/2	3/8
5'-0	6	8	7	6 1/8	5 1/2	4 7/8	4 1/2	4 1/8	3 3/4	3 1/2	3 1/4	3	2 3/4	2 5/8	2 1/2	2 1/8	1 7/8	1 5/8	1 1/2
	9	7	6 1/8	5 3/8	4 3/4	4 1/4	3 7/8	3 1/2	3 1/4	3	2 3/4	2 1/2	2 3/8	2 1/4	2	1 3/4	1 1/2	1 3/8	1 1/4
	12	6	5 1/8	4 1/2	4	3 1/2	3 1/4	3	2 3/4	2 1/2	2 1/4	2 1/8	2	1 7/8	1 5/8	1 1/2	1 1/4	1 1/8	1
	15	4 7/8	4 1/8	3 5/8	3 1/4	2 7/8	2 5/8	2 3/8	2 1/8	2	1 7/8	1 3/4	1 5/8	1 1/2	1 1/4	1 1/8	1	7/8	3/4
5'-6	6			7 5/8	7	6 1/4	5 3/4	5 1/8	4 3/4	4 3/8	4	3 3/4	3 1/2	3 3/8	3 1/8	2 3/4	2 1/2	2 1/4	2
	9		7 5/8	6 3/4	6 1/8	5 1/2	5	4 1/2	4 1/8	3 3/4	3 1/2	3 1/4	3	2 7/8	2 5/8	2 3/8	2 1/8	1 7/8	1 3/4
	12	7 5/8	6 3/4	5 7/8	5 1/4	4 3/4	4 3/8	3 7/8	3 1/2	3 1/4	3	2 3/4	2 5/8	2 1/2	2 1/4	2	1 3/4	1 5/8	1 1/2
	15	6 1/2	5 3/4	5	4 1/2	4	3 5/8	3 1/4	3	2 3/4	2 1/2	2 1/4	2 1/8	2	1 7/8	1 5/8	1 3/8	1 1/4	1 1/8
6'-0	6				8 3/8	7 5/8	6 7/8	6 3/8	5 7/8	5 1/2	5 1/8	4 3/4	4 1/2	4 1/4	3 7/8	3 1/2	3 1/8	2 3/4	2 1/2
	9			8 3/8	7 1/2	6 3/4	6 1/8	5 5/8	5 1/4	4 7/8	4 1/2	4 1/4	4	3 3/4	3 1/2	3 1/8	2 3/4	2 3/8	2
	12		8 3/8	7 3/8	6 5/8	6	5 1/2	5	4 5/8	4 1/4	4	3 3/4	3 1/2	3 3/8	3 1/8	2 3/4	2 3/8	2	1 3/4
	15	8 1/2	7 3/8	6 1/2	5 7/8	5 1/4	4 3/4	4 3/8	4	3 3/4	3 1/2	3 1/4	3	2 7/8	2 5/8	2 1/4	2	1 3/4	1 1/2

25. Paint standards

Painting a clean surface is imperative for the success of a coating system. There are many different techniques and procedures used to prepare a surface of application.

The most accepted standards for contractors and organizations are the NACE/SSPC joint surface preparation standards. These standards do an excellent job of standardizing surface prep results and providing a template to meet job specifications. That said, these standards can be confusing because the numbers, given for each level of surface preparation, either by the Society for Protective Coatings SSPC) or the National Association of Corrosion Engineers NACE), don't always correlate. Higher numbers do not necessarily mean a higher degree of surface prep, as one might expect. *All Surface preparations follow as per customer standard and contract drawings, Project specifications division 5 & 9.*

1. SSPC-SP1- Solvent cleaning

This method of surface preparation is meant to remove soluble substances from steel. Before a paint or other protective coating is applied, a solvent is used to remove all visible oil, grease, dirt, drawing or cutting compounds, or other soluble contaminants.

Solvents may include steam, emulsifying agents, or other cleaning compounds.

2. SSPC-SP2- Hand Tool Cleaning

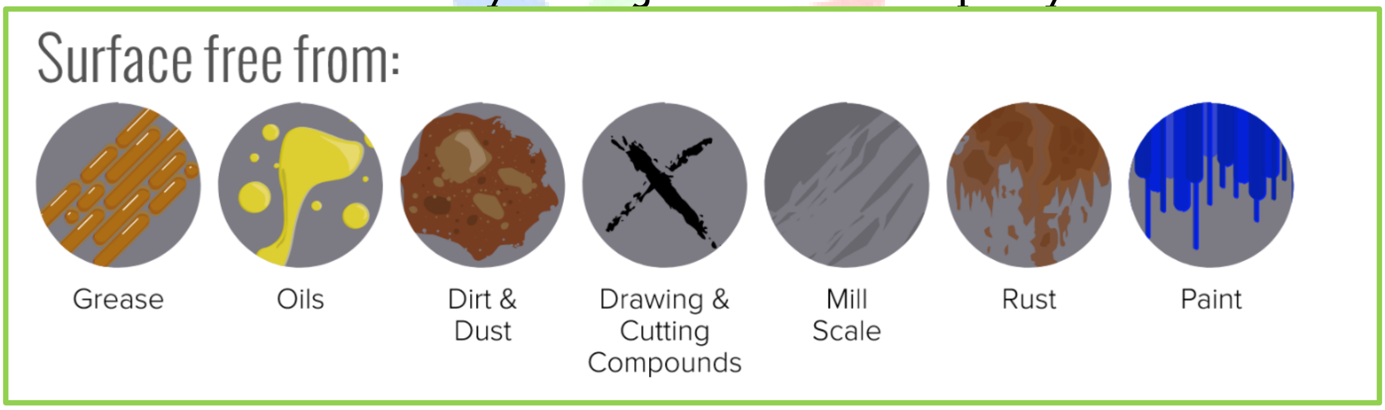
Hand tool cleaning refers to surface preparation that uses non-power handheld tools to clean a steel surface. Hand tool cleaning is intended to remove all loose mill scale, rust, paint, and other contaminants that may be detrimental to a coating application.

According to the SSPC, "loose" contaminants are those that can't be removed by lifting o with a dull putty knife.

3. SSPC-SP3- Power Tool Cleaning

As in hand tool cleaning, SP3 is a method of steel surface preparation intended to remove all loose mill scale, rust, paint, and other contaminants that may be detrimental to a coating application. As its name suggests, SP3 differs in that it used power tools to clean the surface.

Again, according to the SSPC, "loose" contaminants are those that can't be removed by lifting o with a dull putty knife



4. SSPC-SP5/NACE 1- White Metal Blast Cleaning

This SSPC/NACE joint standard describes the cleaning of a steel surface, previously painted or unpainted, to a white metal condition using abrasive blast media. The white metal is a term used to describe a surface that's uniformly free of all foreign matter and white or gray in appearance.

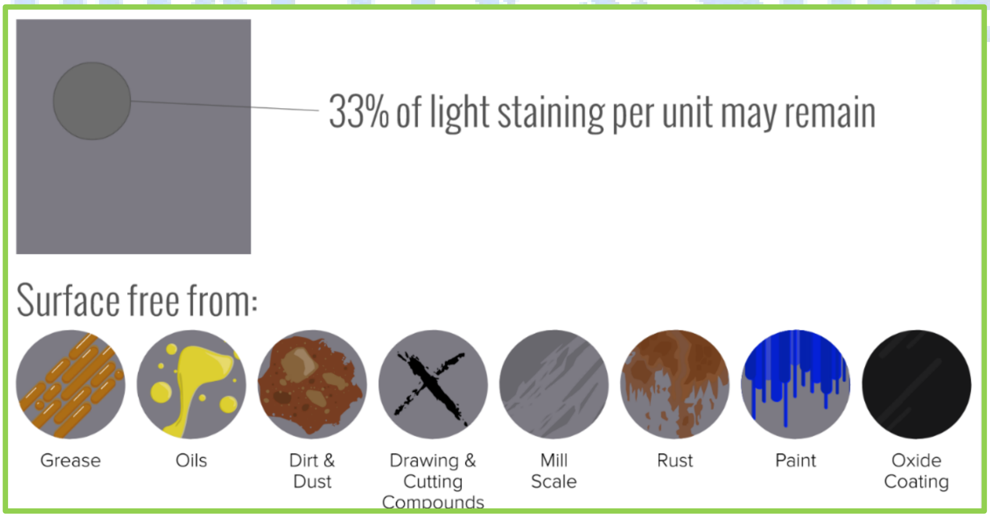
According to the SSPC, a surface blasted to white metal should, without magnification, be free of all visible "oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter."

5. SSPC-SP6/NACE 3- Commercial Blast Cleaning

SP6 is another joint standard describing the cleaning of a steel surface using abrasive blast media. It includes instructions before cleaning, as well as for the inspection of the cleaning after it has been conducted.

Like a white metal blast cleaning, surfaces prepared to an SP6 standard should be, without magnification, free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter.

Random staining from previous exposure to the above is acceptable, however, so long as it does notcomprise more than 33 percent of each area "unit", as described by the standard. Such staining may take the form of "light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating," according to the SSPC.



6. SSPC-SP7/NACE 4- Brush-Off Blast Cleaning

This standard conveys the requirements for cleaning a steel surface, painted or unpainted, with the use of abrasive blast media. It contains descriptions of the required end condition of a surface that has undergone brush-o cleaning, as well as the necessary methods for verifying the asset's end condition.

All oil, grease, dirt, and dust must be cleared from the surface when viewed without magnification. Loose mill scale, rust, and coatings must also be removed according to this standard, but tightly adherent mill scale, rust, and coatings may remain. These are considered tightly adherent if they cannot be removed by lifting with a dull putty knife.

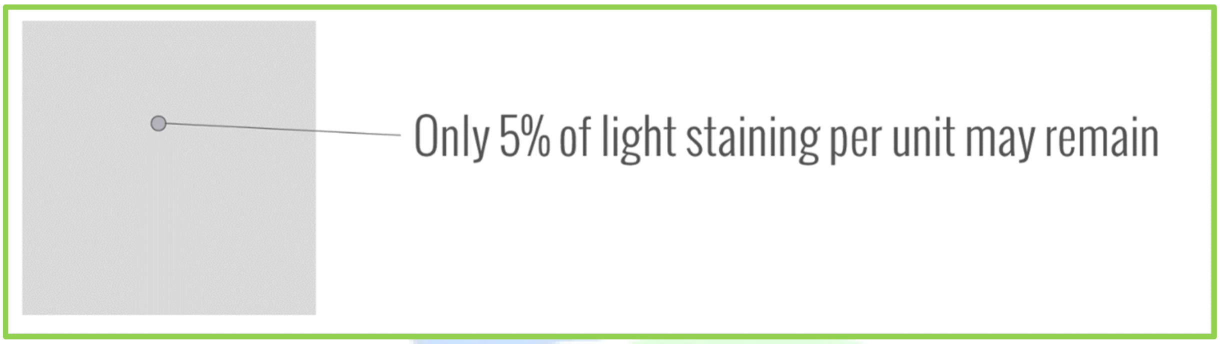
7. SSPC-SP8 – Pickling

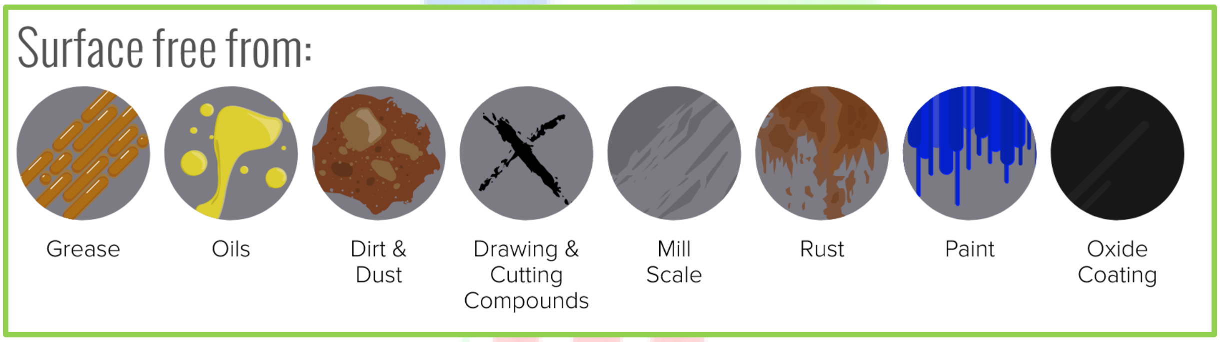
Complete removal of rust and mill scale by acid-pickling, duplex-pickling, or electrolytic pickling
.

8. SSPC-SP10/NACE 2- Near-White Commercial Blast Cleaning

This standard conveys the requirements for cleaning a steel surface, painted or unpainted, with the use of abrasive blast media. It also includes instructions for achieving and verifying the standard's required end condition. As with a commercial blast, the prepared surface must be free, when viewed without magnification, of visible oil, dust, dirt, grease, mill scale, rust, coating, oxides, corrosion, and other foreign matter, except for a limited amount of acceptable staining.

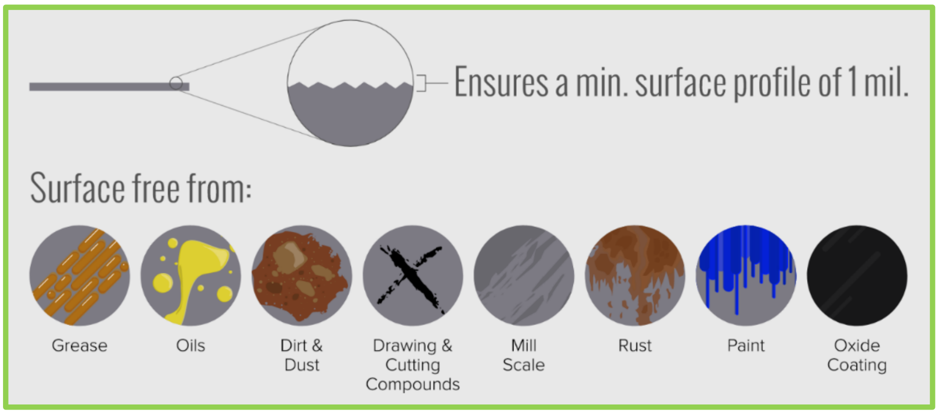
Unlike with a commercial blast, only five percent of each area "unit" as defined by the standard may exhibit staining. This five percent may consist of light shadows, slight streaks minor discolorations that could be the result of exposure to rust, mill scale, or a previous coating





8. SSPC-SP11- Power Tool Cleaning to Bare Metal

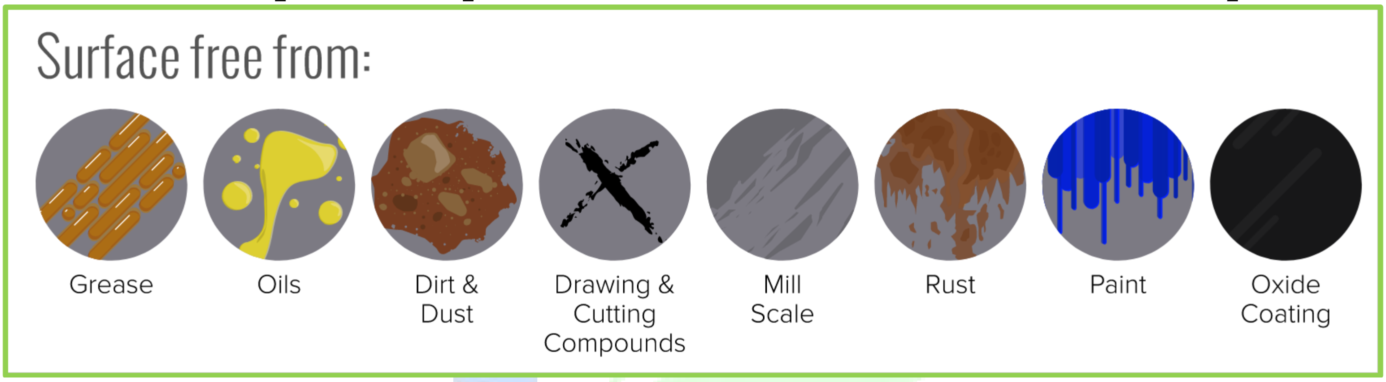
This standard describes the requirements for taking a surface to bare metal while ensuring a minimum surface profile of 1 mil 25 micrometers). It is used in situations where abrasive blasting is not possible or feasible. Unlike SP3, this standard requires the creation or preservation of a surface profile. Unlike SP15, this standard does not allow for stains from mill scale, rust, or paint to remain on the surface.



9. SSPC-SP13/NACE 6- Surface Preparation of Concrete

This joint standard concerns the preparation of concrete surfaces before the application of a bonded coating or lining systems. Surface preparation for all types of cementitious surfaces is covered under this standard, which should be free of surface contaminants including laitance, loose concrete, and dust.

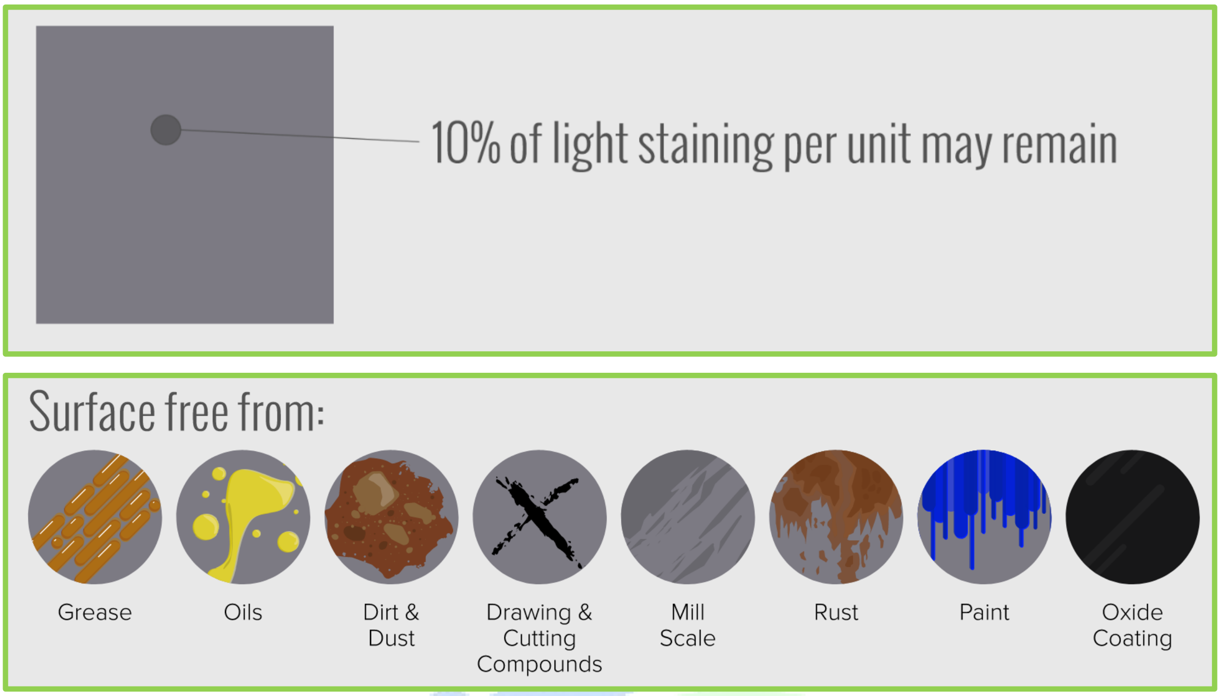
This standard covers requirements for thermal, mechanical, and chemical application methods. Minimum concrete surface strength, surface profile, and moisture content should be expressly stated in the project's specification document when necessary.



10. SSPC-SP14/NACE 8- Industrial Blast Cleaning

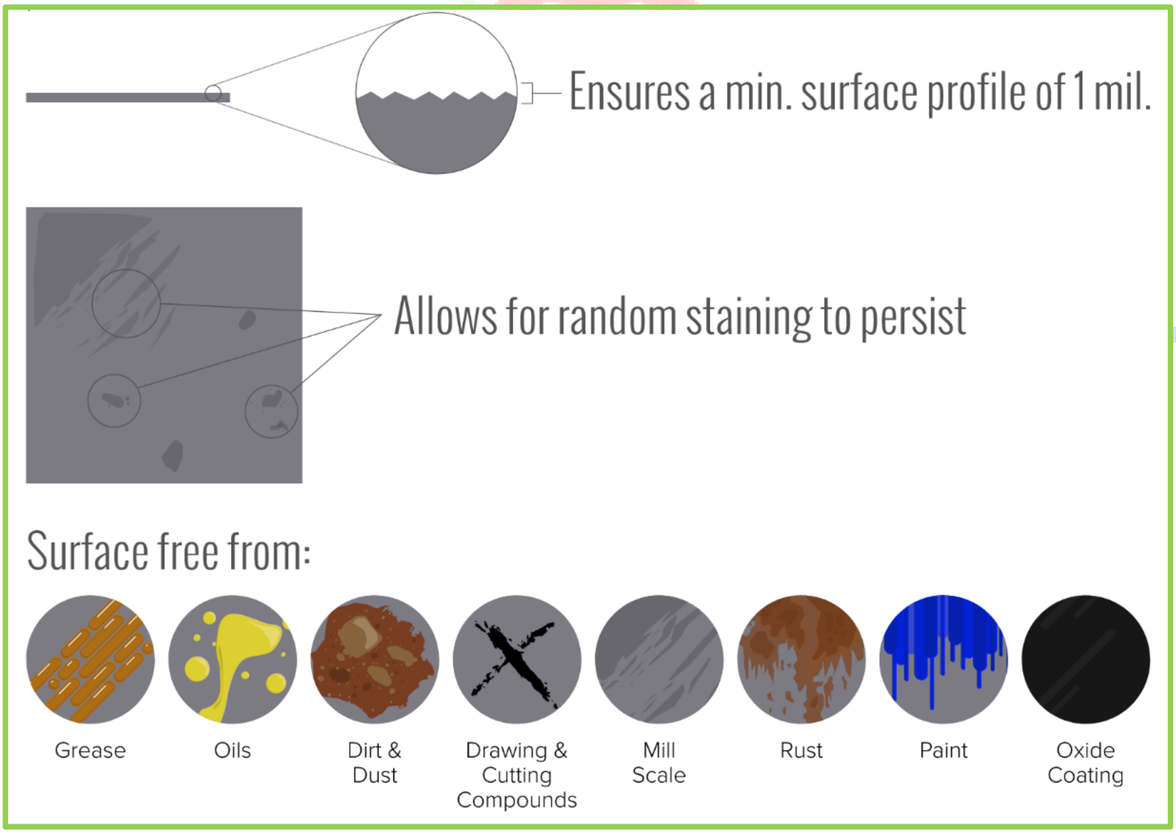
This standard conveys the requirements for cleaning a steel surface, painted or unpainted, with the use of abrasive blast media. It also includes instructions for achieving and verifying the standard's required end condition. As with a commercial blast and a near-white commercial blast, the prepared surface must be free, when viewed without magnification, of visible oil, dust, dirt, grease, mill scale, rust, coating, oxides, corrosion, and other foreign matter, except for a limited amount of acceptable staining.

SP14 differs from a commercial blast and a near-white commercial blast in the acceptable area forresidue and surface stains to remain. This standard allows for tightly adhering mill scale, rust, and coatings, as well as surface stains, to remain on ten percent of each "unit" area, as described by thestandard. Surface stains may consist of light shadows, slight streaks minor discolorations that could be the result of exposure to rust, mill scale, or a previous coating.



11. SSPC-SP15- Commercial Grade Power Tool Cleaning

Like SP11, this standard describes the requirements for taking a surface to bare metal, while ensuringa minimum surface profile of 1 mil 25 micrometers). Unlike SP11, SP15 allows for random staining to persist on the substrate.



12. SSPC-SP16- Brush-Off Blast Cleaning of Non-Ferrous Metals

This standard governs surface preparation for non-ferrous metals before the application of a protective coating. It is used when adding a surface profile to stainless steel, galvanized steel, copper, and other metals that are not carbon steel. It requires a minimum surface profile of .75 mil 19 micrometers) and for the surface to be free of loose coating and other contaminants, as verified by a visual inspection.

Mask requirements in assembly drawings

The below-mentioned points need to be added in assembly drawings If the member is painted or galvanized.

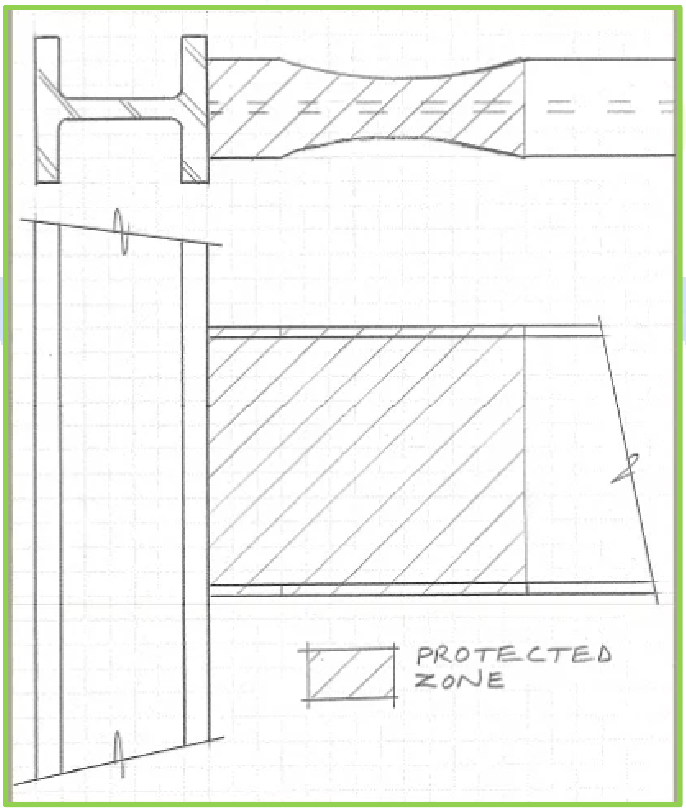
- ✓ Add note "NO PAINT AT TOP OF FLANGE" if shear studs/bent plates/Joist bearing isfield welded on the top of beam flange.
- ✓ Add note "1" NO PAINT AT ALL AROUND" at CJP weld preparation locations for the moment connection
- ✓ Add note "NO PAINT" where structural members are field welded like HSS beam to HSS column connections, bearing connection, Kicker brace field weld locations, Protected Zone area.
- ✓ Add note "3 inches NO PAINT NS/FS FOR SC BOLTS" if the connection bolts are slip critical.

26. Protected Zone area

Discontinuities specified in Section I2.1 resulting from fabrication and erection procedures and other attachments are prohibited around a member or a connection element designated as a protected zone by these Provisions or ANSI/AISC 358.

A protected zone designated by these Provisions or ANSI/AISC 358 shall comply with the following requirements:

- ✓ Within the protected zone, holes, tack welds, erection aids, air-arc gouging, and unspecified thermal cutting from fabrication or erection operations shall be repaired as required by the engineer of record.
- ✓ Steel headed stud anchors shall not be placed on beam flanges within the protected zone.
- ✓ Arc spot welds as required to attach decking are permitted.
- ✓ Decking attachments that penetrate the beam flange shall not be placed on beam flanges within the protected zone, except powder-actuated fasteners up to 0.18 in. diameter is permitted.
- ✓ Welded, bolted, or screwed attachments or power-actuated fasteners for perimeter edge angles, exterior facades, partitions, ductwork, piping, or other construction shall not be placed within the protected zone.

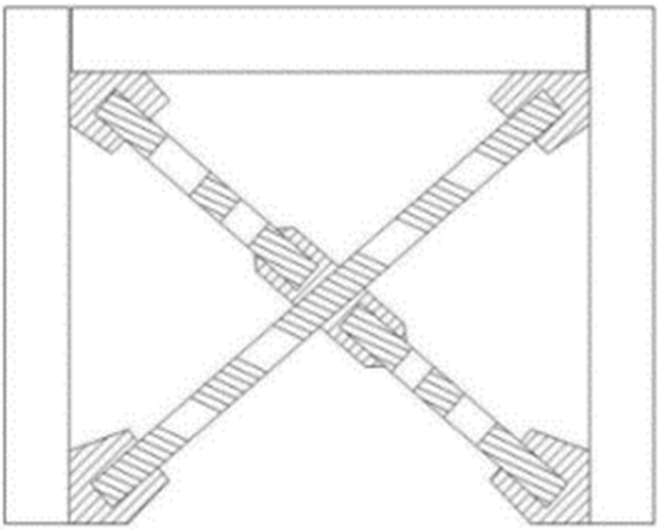


Demand Critical Welds

Demand critical weld designation is based on the inelastic strain demand and the consequence of failure of the weld. Demand critical welds are specified by AISC 341-16 for each respective SFRS type. Additional demand critical welds may also be specified by the Engineer of Record. Demand Critical welds will be identified on the erection drawings with the designation "DC" provided in the tail of the weld symbol. Clauses 6.2.1, 6.2.2, 6.2.3 and 6.3.1 of AWS D1.8 (Structural Welding Code - Seismic Supplement) will apply to all demand critical welds.	**A3.4, A4.2** NA *6.2, 6.3.1*	ALL

Protected Zones

Protected zones are locations on the SFRS members (generally in the vicinity of the structural connections) where limitations apply to erection and attachments. The protected zones will be clearly identified and dimensioned on the erection drawings. Within the protected zone, holes, tack welds, erection aids, air-arc gouging, and unspecified thermal cutting from erection operations shall be repaired as required by the Engineer of Record. Steel headed stud anchors shall not be placed on beam flanges within the protected zone. Arc spot welds as required to secure decking shall be permitted. Decking attachments that penetrate the beam flange shall not be placed on beam flanges within the protected zone, except power-actuated fasteners up to 0.18 inch diameter are permitted. Welded, bolted, or screwed attachments (or power-actuated fasteners) for perimeter edge angles, exterior facades, partitions, duct work, piping or other construction shall not be placed within the protected zone. Exception: Other attachments are permitted where designated or approved by the Engineer of Record.	**D1.3, I2.1** NA *6.18*	SMF, IMF SCBF, EBF, BRBF

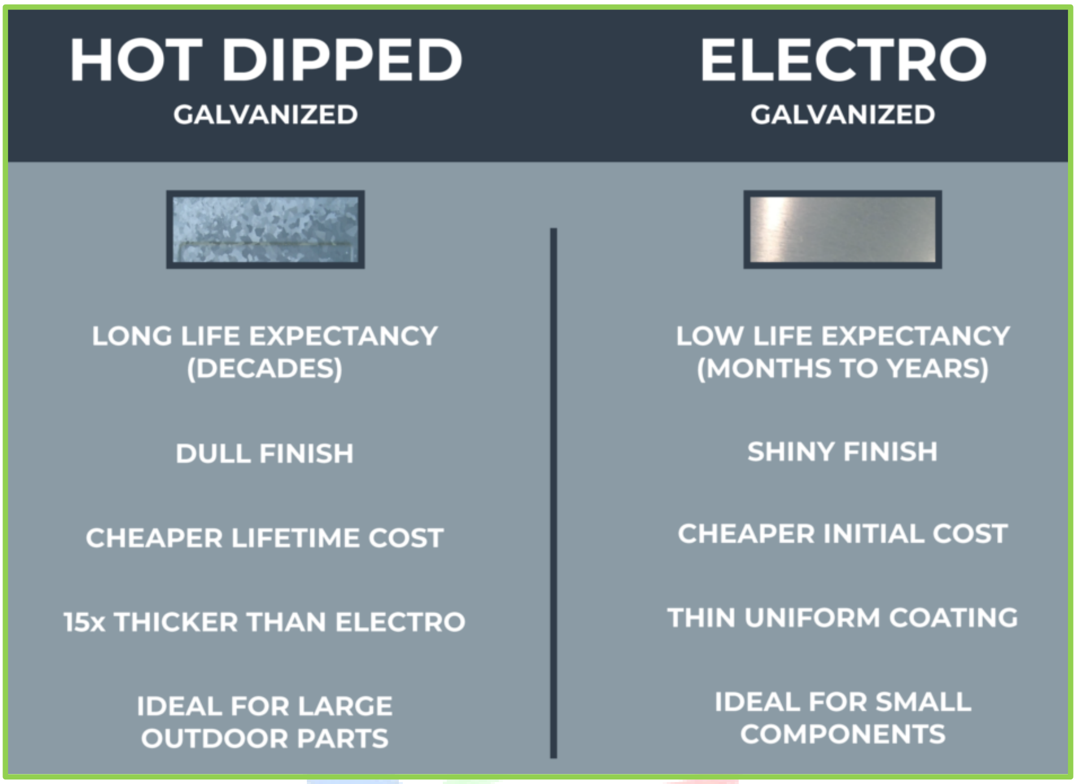


WELDED, BOLTED, SCREWED OR SHOT-IN ATTACHMENTS FOR NON-STRUCTURAL ELEMENTS ARE PROHIBITED WITHIN THE SHADED REGIONS DEFINED IN THIS DETAIL. IT IS A VIOLATION OF THE CONTRACT AND THE BUILDING CODE TO MAKE SUCH ATTACHMENTS.

SAMPLE PROTECTED ZONE DETAIL

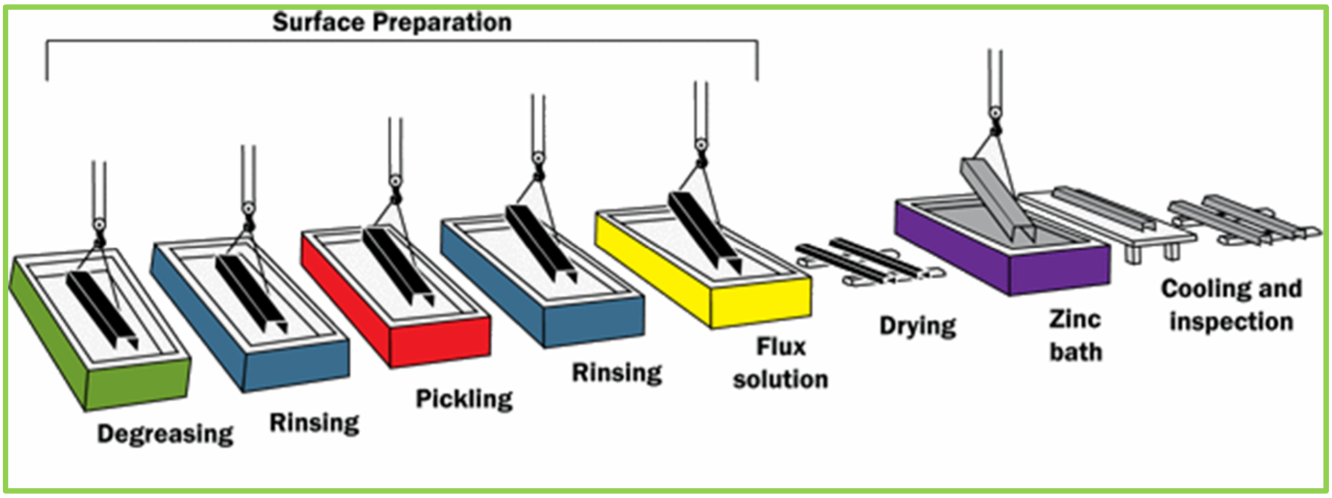
27. Galvanization standards

1. Hot dipped galvanized
2. Electro-galvanized



General requirements

- ✓ Standard shop preferences for material receiving zinc coatings hot-dip galvanizing) shall be detailed by ASTM A385, except as indicated otherwise in this section.
- ✓ The graphic below represents the typical procedure that our galvanizing vendors perform. Below you will find a list of tank sizes that our vendors have at their disposal. Confirm with the project management team which galvanizer is on the project.
- ✓ No galvanizing members are to be detailed with fitting material as bolt-to-ship or wire-to-ship.
- ✓ Seal welds will only be used if required by design and contract drawings. Seal welding on some materials can cause bending and warpage
- ✓ Notify the Project Management team if shop assemblies exceed 32' x 4' x 5' kettle size before detailing.
- ✓ Consult the Project Management team if vent and drain holes are required to be plugged. If so, take into consideration the available plug sizes when detailing vent anddrain holes.

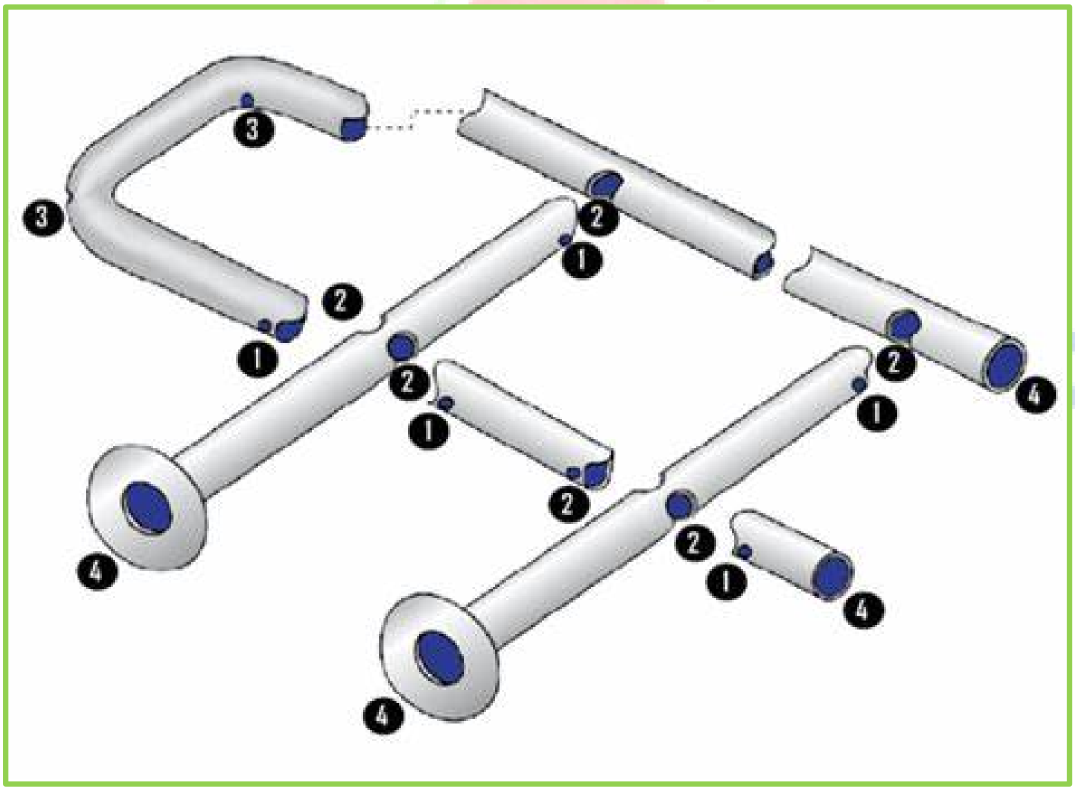


Galvanization tank limitations

Spokane Galvanizing	Ace Galvanizing	Seattle Galvanizing	Galvanizers Company	Valmont Coatings
Kettle (LxWxD)	*Kettle (LxWxD)*	*Kettle (LxWxD)*	*Kettle (LxWxD)*	*Kettle (LxWxD)*
32' x 5' x 9'	44'- x 4' x 5'	45' x 6' x 9'	43' x 5'-6" x 6'-4"	44' x 5'-3" x 8'-9"

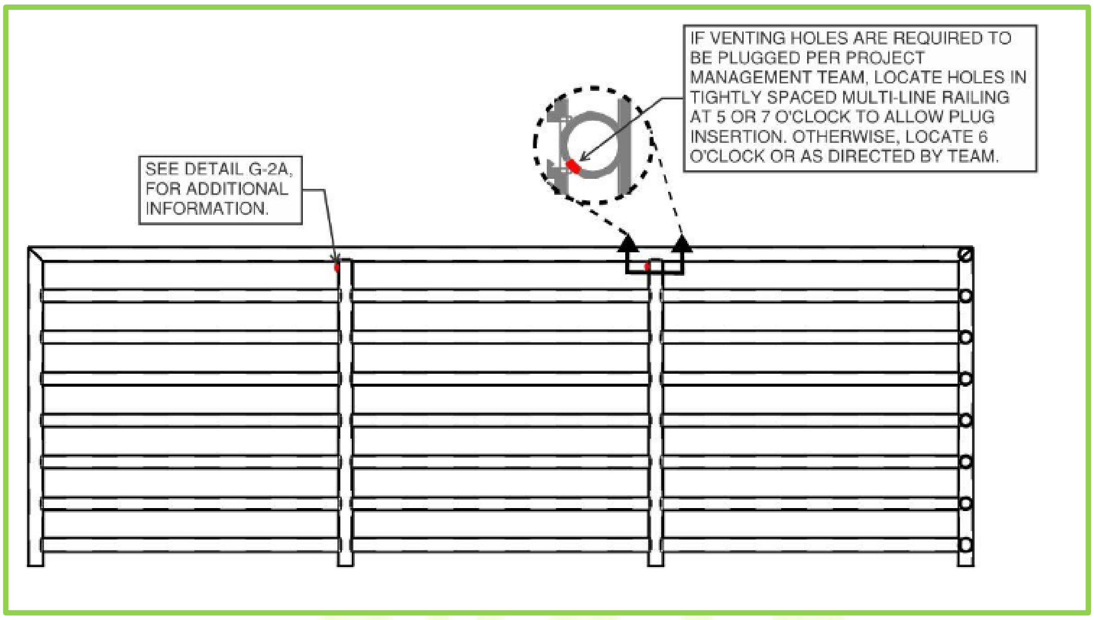
Galvanization Vent & Drain Hole procedures.

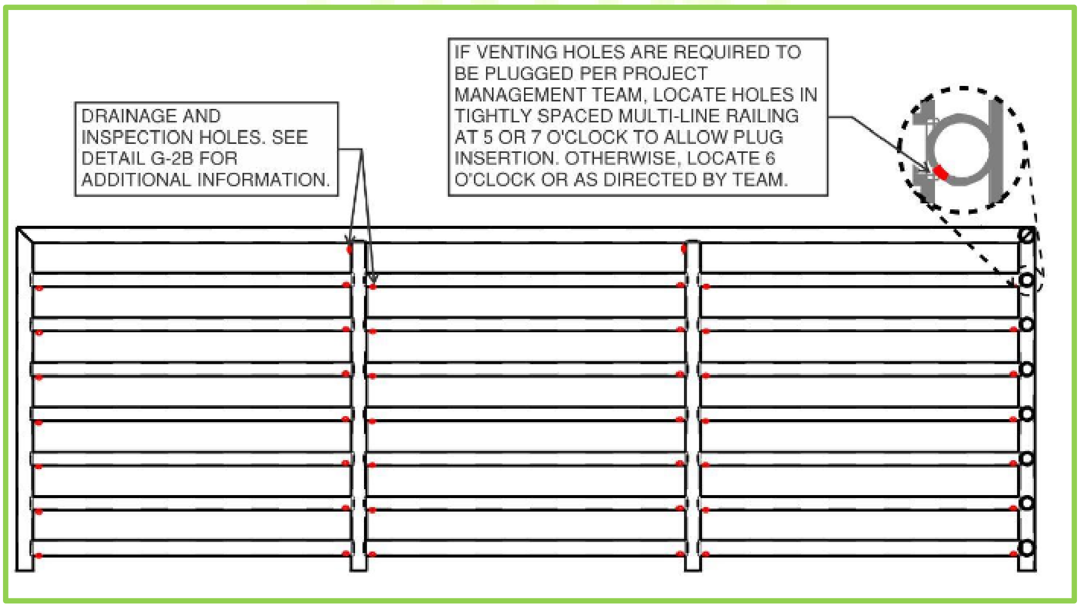
This is different from fabricators. Follow as per fabricator standard. Below mentioned details as per ASTM385-17.



1. Each vent hole shall be as close to the weld as possible with the edge of the hole less than ½" from the edge of the weld bead, must be 25% of the inside diameter of the pipe but not less than ½" in diameter. The two holes at each end and each intersection shall be 180⁰ apart and in the proper location as shown.
2. Vent holes in end sections or similar sections shall be at least ½" in diameter.

3 & 4. Any device used for erection in the field that prevents full openings on ends of horizontal rails and vertical legs shall be attached after galvanizing.





Alternate Table G-1A: Venting/ Drainage hole Sizes for **Round** Hollow Structural sections

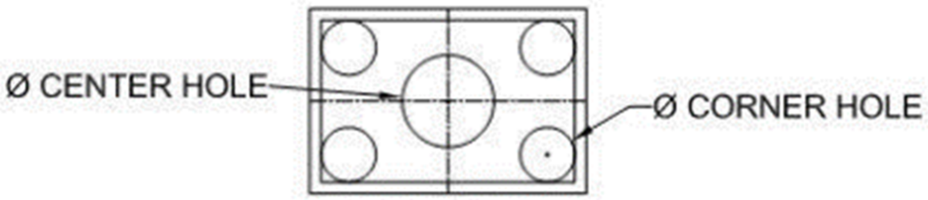
Round HSS Diameter	**2 Holes Hole Diameter**	**4 Holes Hole Diameter**
	See *Figure 3* (sim) for Example	See *Figure 4* (sim) for Example
2" (50 mm)	1/2" (13 mm)	3/8" (10 mm)
3" (75 mm)	3/4" (19 mm)	1/2" (13 mm)
4" (100 mm)	1" (25 mm)	3/4" (18 mm)
5.563" (141 mm)	1-3/8" (35 mm)	7/8" (22 mm)
6.625" (168 mm)	1-1/2" (40 mm)	1-1/4" (30 mm)
8.625" (219 mm)	1-3/4" (54 mm)	1-5/16" (35 mm)
10.75" (273 mm)	2-1/2" (65 mm)	1-3/4" (45 mm)
12.75" (324 mm)	3" (75 mm)	2-1/4" (55 mm)
14" (350 mm)	3-3/8" (90 mm)	2-3/8" (65 mm)
16" (400 mm)	3-7/8" (100 mm)	3" (75 mm)
18" (350 mm)	4-1/8" (105 mm)	2-1/2" (65 mm)
20" (400 mm)	4-3/8" (111 mm)	3" (75 mm)

Alternate Table G-1A: Venting/ Drainage hole Sizes for **Square** Hollow Structural sections or Box Sections

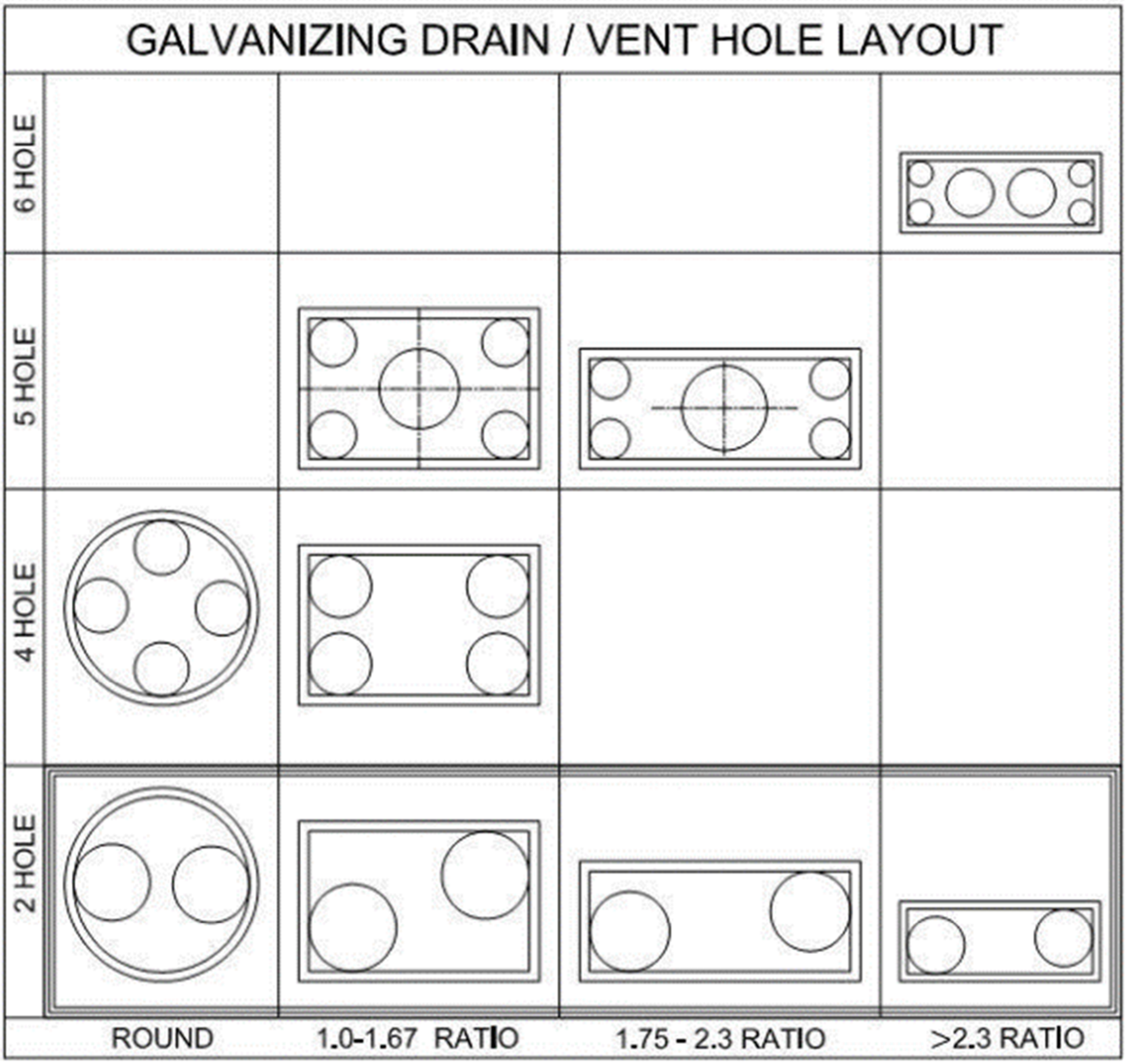
Square HSS Size	**2 Holes Hole Diameter**	**4 Holes Hole Diameter**
	See *Figure 3* for Example	See *Figure 4* for Example
2 x 2" (50 x 50 mm)	1/2" (13 mm)	3/8" (10 mm)
3 x 3" (75 x 75 mm)	3/4" (19 mm)	1/2" (13 mm)
4 x 4" (100 x 100 mm)	1" (25 mm)	3/4" (18 mm)
5 x 5" (125 x 125 mm)	1-3/8" (35 mm)	7/8" (22 mm)
6 x 6" (150 x 150 mm)	1-1/2" (40 mm)	1-1/4" (30 mm)
8 x 8" (200 x 200 mm)	2" (50 mm)	1-3/8" (35 mm)
10 x 10" (250 x 250 mm)	2-1/2" (65 mm)	1-3/4" (45 mm)
12 x 12" (300 x 300 mm)	3" (75 mm)	2-1/4" (55 mm)
14 x 14" (350 x 350 mm)	3-1/2" (90 mm)	2-1/2" (65 mm)
16 x 16" (400 x 400 mm)	4" (100 mm)	3" (75 mm)

Alternate Table G-2A: Venting/Drainage Hole Sizes for **rectangular** Hollow Structural Sections

Rectangular HSS Size	**2 Holes Hole Diameter**	**4 Holes Hole Diameter**
	See *Figure* 5 for Example	See *Figure 6* For Example
3 x 2" (75 x 50 mm)	5/8" (16 mm)	1/2" (11 mm)
4 x 2" (100 x 50 mm)	3/4" (20 mm)	5/8" (14 mm)
5 x 3" (125 x 75 mm)	1-1/4" (30 mm)	3/4" (18 mm)
6 x 2" (150 x 50 mm)	1-1/4" (30 mm)	7/8" (20 mm)
6 x 4" (150 x 100 mm)	1-3/8" (35 mm)	1" (25 mm)
8 x 4" (200 x 100 mm)	1-5/8" (40 mm)	1-1/8" (30 mm)
10 x 6" (250 x 150 mm)	2-1/4" (55 mm)	1-1/2" (40 mm)
12 x 8" (300 x 200 mm)	2-1/2" (65 mm)	1-3/4" (45 mm)
14 x 10" (350 x 250 mm)	3-1/8" (80 mm)	2-1/8" (55 mm)
16 x 8" (400 x 200 mm)	3-1/8" (80 mm)	2-3/8" (60 mm)
16 x 12" (400 x 300 mm)	3-1/2" (90 mm)	2-1/2" (65 mm)



RATIO = LENGTH / DEPTH OF SECTION



2 HOLE CONFIGURATION PREFERRED

28. Stairs and Rails

There are a variety of stair types that may be used on a project.
The geometry, layout, and finishes are based on the project needs and available space. Several common stairs types are discussed herein, including straight stairs, circular stairs, curved stairs, alternating tread devices, and ships ladders.

Stair Nomenclature

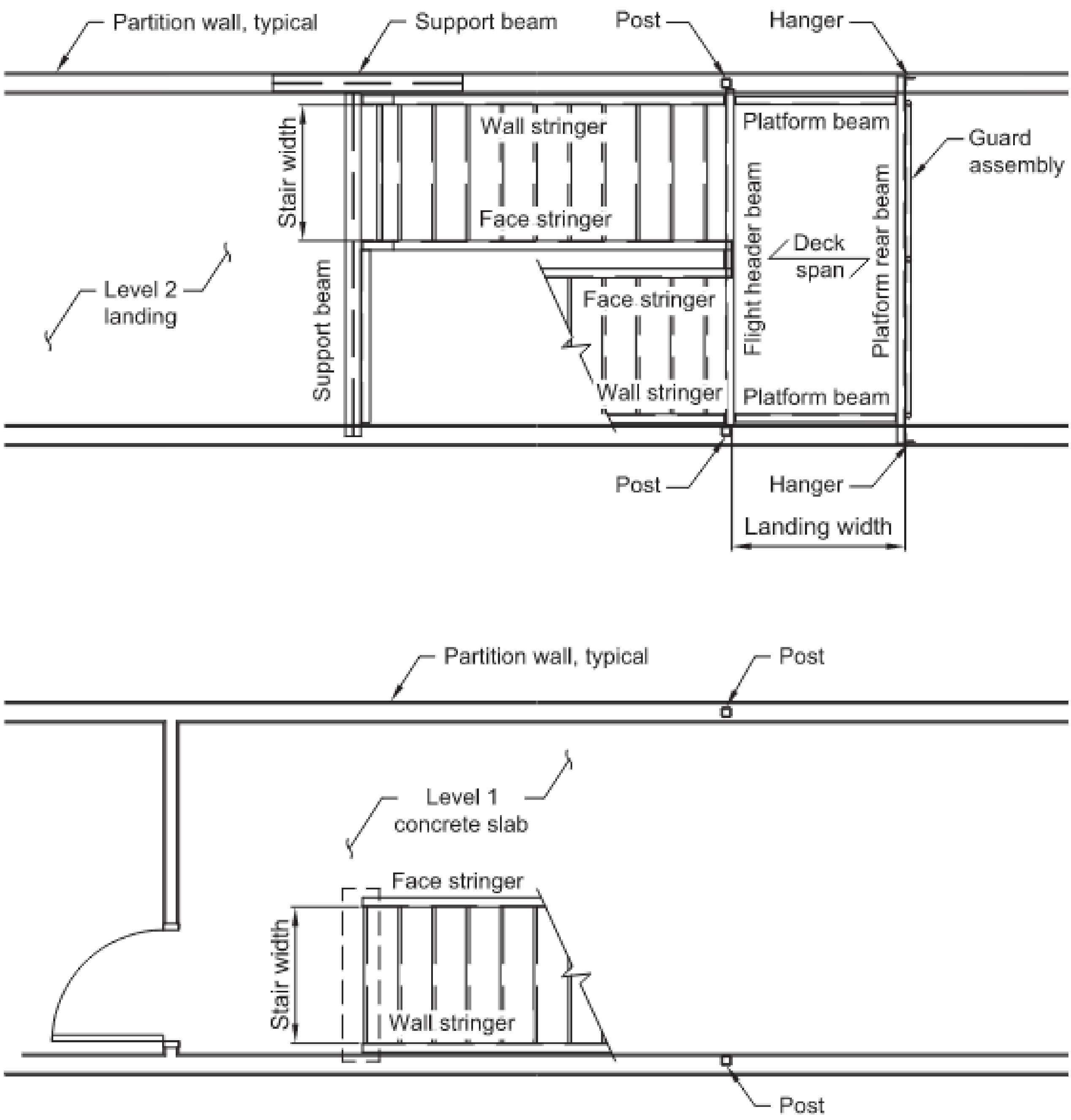


Fig. 2-11. Nomenclature—plan views.

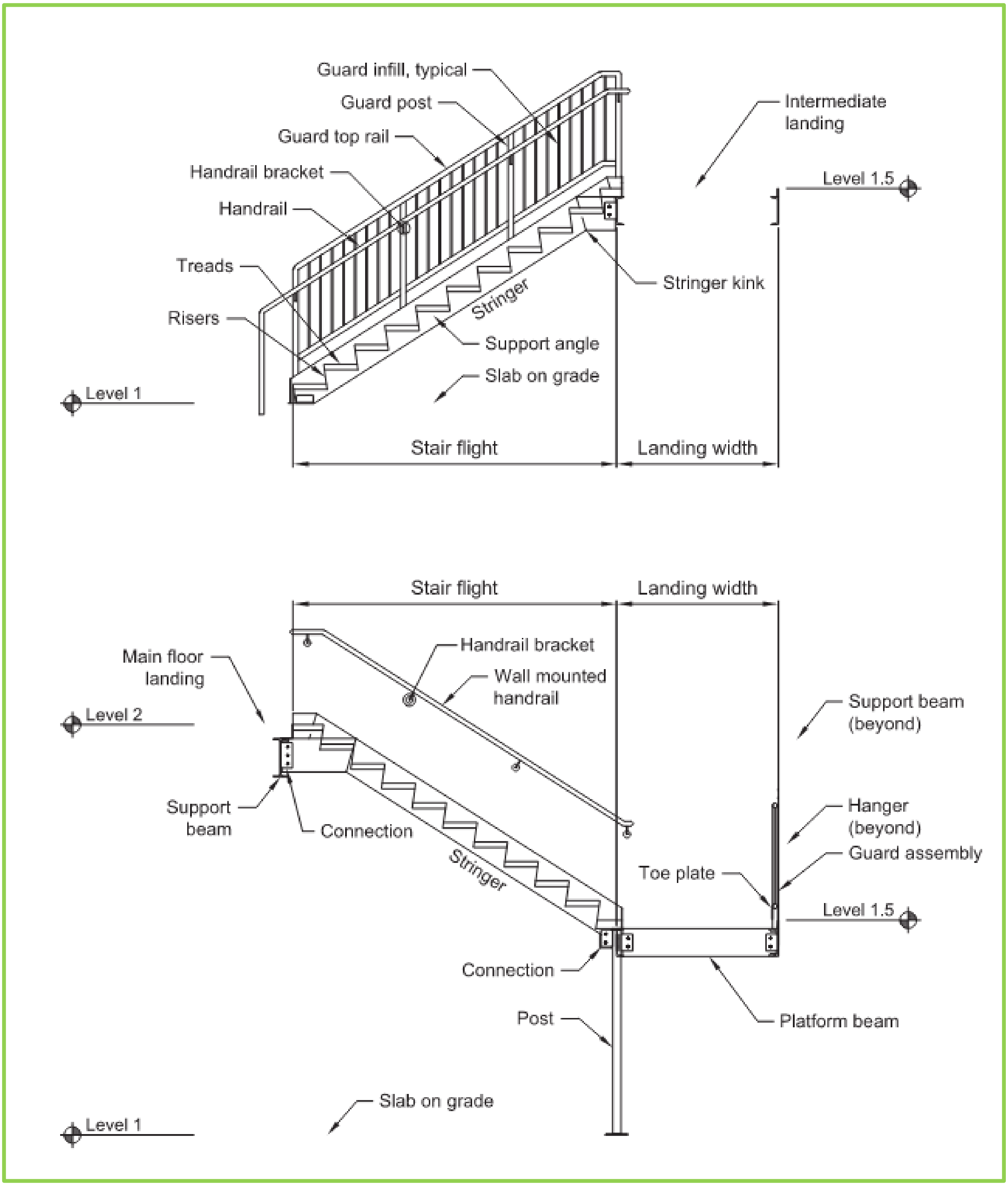

Guard infill, typical
Guard post
Guard top rail
Handrail bracket
Handrail
Treads
Risers
Level 1
Intermediate landing
Level 1.5
Stringer
Stringer kink
Support angle
Slab on grade
Stair flight
Landing width
Stair flight
Landing width
Main floor landing
Level 2
Handrail bracket
Wall mounted handrail
Support beam (beyond)
Support beam
Connection
Hanger (beyond)
Guard assembly
Stringer
Toe plate
Level 1.5
Connection
Post
Platform beam
Slab on grade
Level 1

Table 3-8. Overview of Stairway Code Requirements

Requirement	IBC 2015, Sections 1011, 1014 and 1015	IBC 2015, Section 1011, Less than 50 Occupants, Group I-3, F, S, H	OSHA Standards 1910.25/.28/.29 and 1910.36 for Means of Egress
Stairway Requirements			
Minimum width	44 in. (1011.2)	36 in. (1011.2, Exception 1)	22 in. [1910.25(c)(4)] or 28 in. [1910.36(g)(2)]
Projections into minimum width	4½ in. at or below the handrail height each side maximum (1014.8)		
Minimum headroom at nosing edge	80 in. (1011.3)		80 in. [1910.25(b)(2)]
Risers, vertically between nosings	7 in. maximum, 4 in. minimum (1011.5.2)	Group I-3 has exception for certain cases, otherwise conform to typical requirements.	9½ in. maximum [1910.25(c)(2)]
Treads, horizontally between nosings	11 in. minimum (1011.5.2)		9½ in. minimum [1910.25(c)(3)]
Dimensional uniformity	⅜-in. variation in tread depth or riser height within stair flight (1011.5.4)		Uniform riser heights and tread depths between landings [1910.25(b)(3)]
Maximum angle from the horizontal	32.47° (based on rise over run limits)		30° minimum to 50° maximum from horizontal [1910.25(c)(1)]
Closed (solid) riser	Required (1011.5.5.3)	Not required (1011.5.5.3, Exception 2)	
Landing width	Matching stair width (1011.6)		Matching stair (platform) [1910.25(b)(4)]
Landing length	Straight run 48 in. (1011.6)		30 in. in direction of travel [1910.24(b)(4)]
Treads (solid/grating)	Solid required (openings up to ½-in. diameter maximum) (1011.7.1, Exception 1)	Solid required (openings up to 1⅜-in. diameter maximum) (1011.7.1, Exception 2)	
Vertical rise between landings	12 ft maximum (1011.8)		
Guard and Handrail Requirements			
Stairway guard minimum height measured from the nose vertically	42 in. (1015.3)		42 in. [1910.29(f)(1)(ii)(B)]
Landing/platform guard minimum height	42 in. (1015.3)		42 in. ± 3 in. [1910.29(b)(1)]
Maximum openings	<4-in. sphere from base to 36 in. high <4⅜-in. sphere from 36 in. to 42 in. <6-in. sphere at triangular opening formed by riser, tread and bottom rail (1015.4; Ex. 1; Ex. 2)	<21-in. sphere (1015.4 Ex. 4)	19 in. maximum at least dimension [1910.29(f)(4)]
Handrail location	Required at each side of stair (1011.11)		Varies—refer to Table D-2 OSHA Standard 1910.28(b)(11)(ii)
Handrail height from nosing line	34 in. minimum to 38 in. maximum (1014.2)		30 in. minimum to 38 in. maximum [1910.29(f)(1)(i)]
Handrail graspability/construction	Type I (1014.3.1) Circular cross section: 1.25 in. minimum to 2 in. maximum Not circular section: perimeter of 4 in. minimum to 6.25 in. maximum, cross-section dimension of 1 in. minimum to 2.25 in. maximum Type II (1014.3.2) Larger than type I but requires additional graspable finger recess		Finger clearance between handrail and any other object is 2-1/4 in. [1910.29(f)(2)] Smooth surface to protect from injury and prevent snagging of clothing [1910.29(f)(3)] Shape and dimension necessary to grasp handrail firmly [1910.29(f)(5)]
Handrails extensions	Must return to wall, guard, walking surface, or adjacent stair run Extend 12 in. horizontally past top riser Extend one tread length horizontally past bottom riser (may be sloping or 34 in. minimum height running horizontal) (1014.6)		The ends of handrails and stair rail systems do not present any projection hazard [1910.29(f)(6)]

Note: Refer to IBC 2015 (ICC, 2015a) and OSHA Standards 1910.25/.28/.29/.36 (OSHA, 2014; 2016) for additional requirements, exceptions and detailed information.

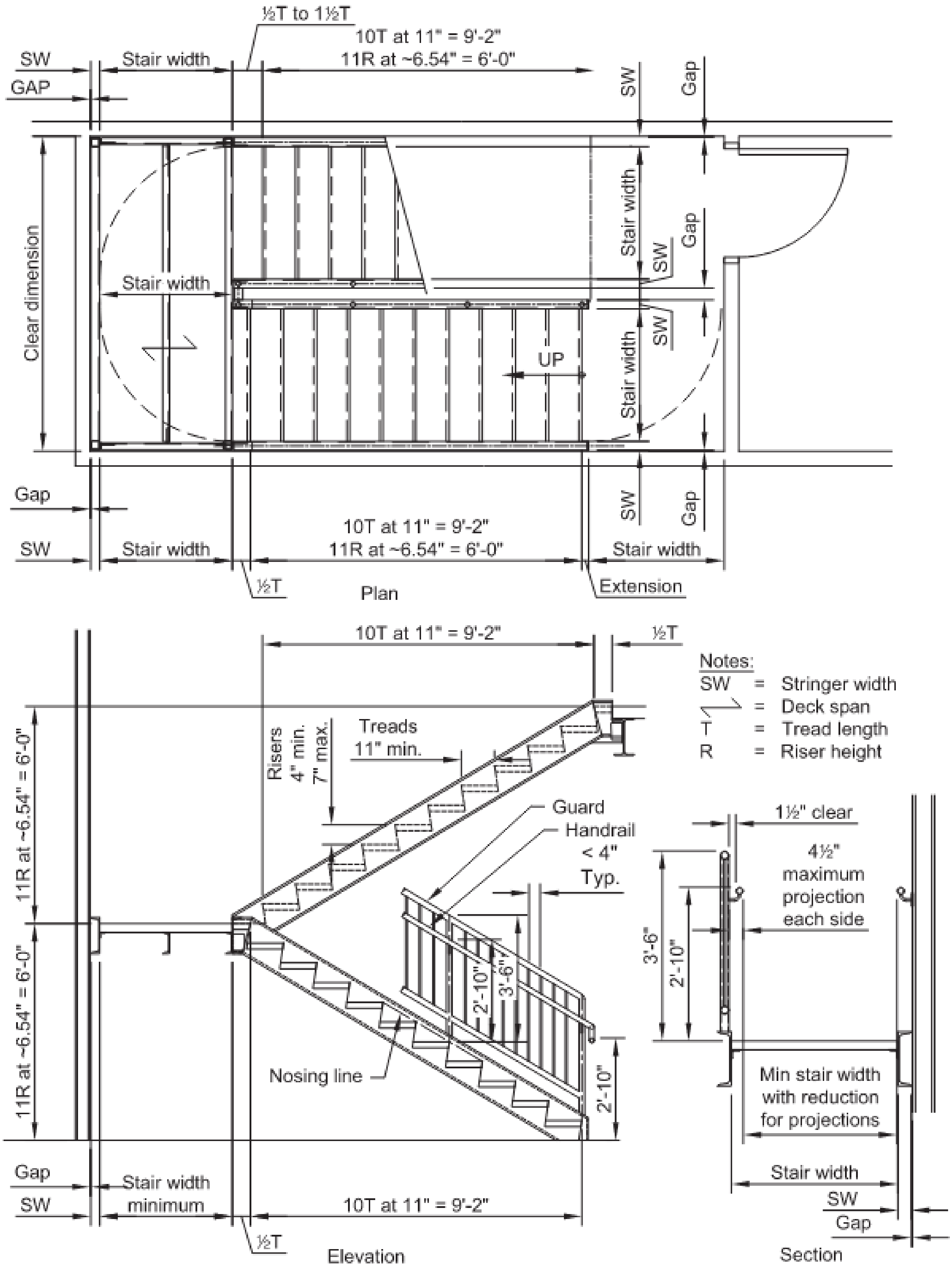
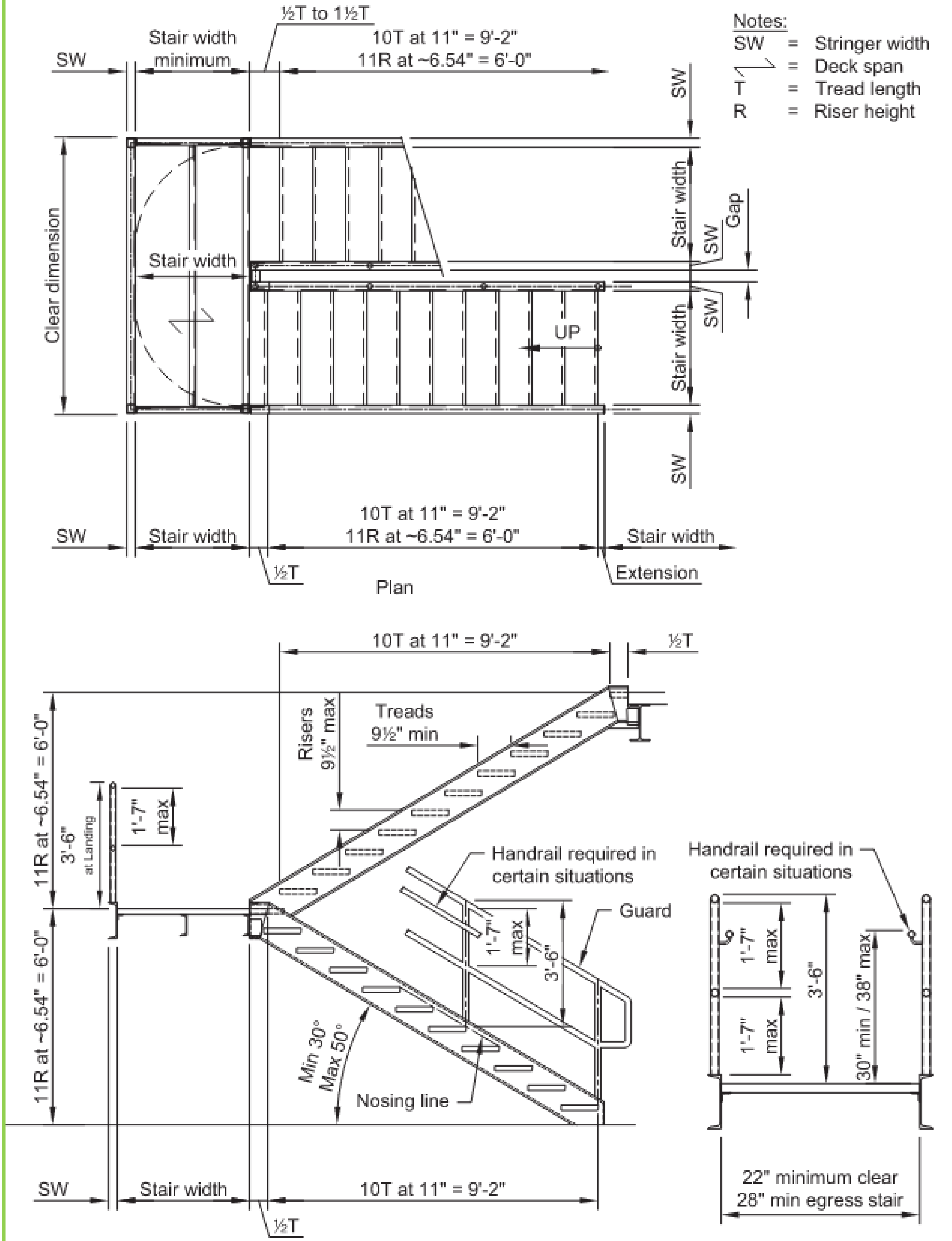


Fig. 3-1. Egress stairway based on IBC requirements.



Plan

Elevation

Section

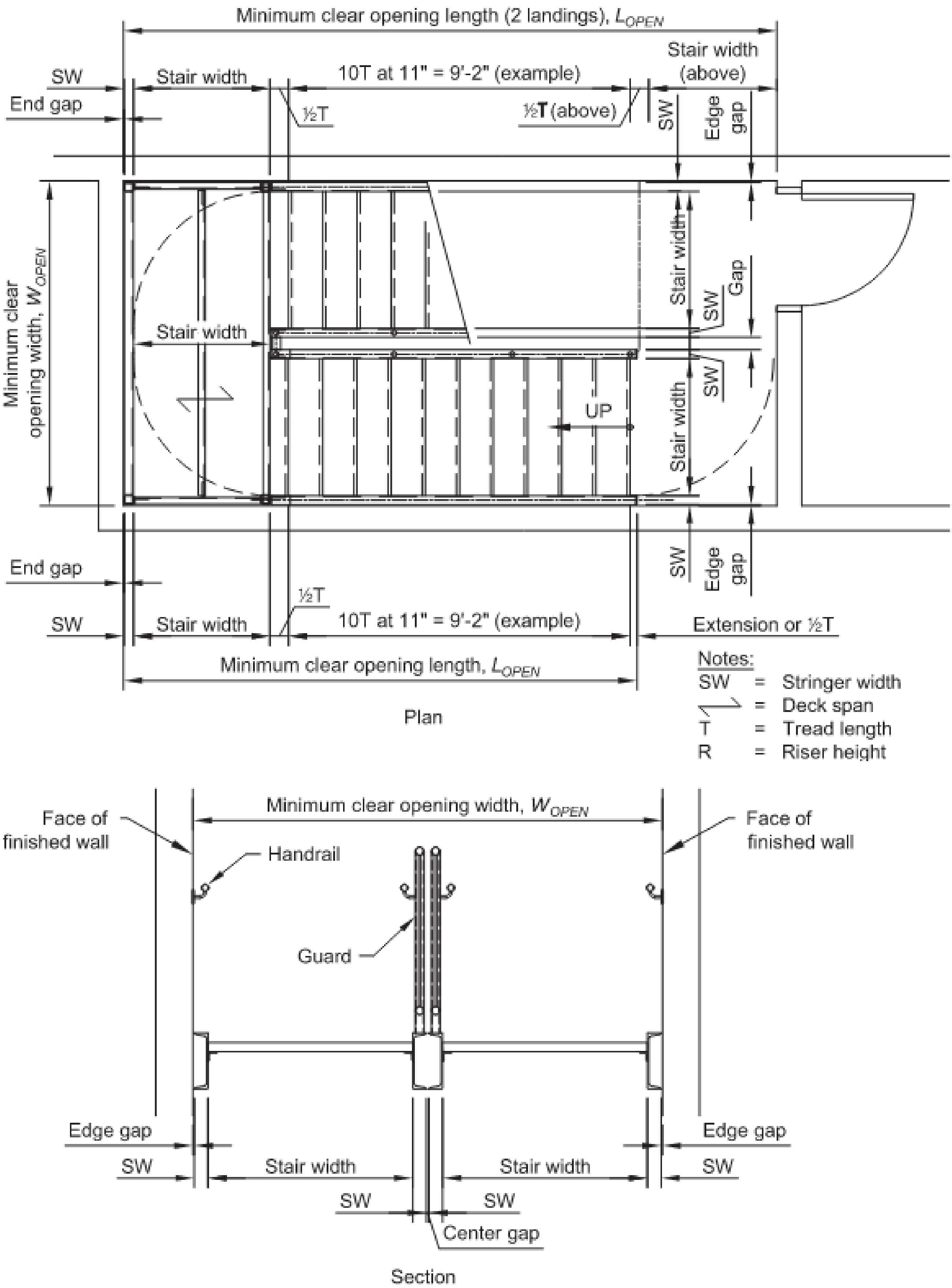


Fig. 3-3. Determination of stairway opening dimensions.

Stringer member

Table 4-1. Stringer Member Overview		
Stringer Type	**Advantages**	**Disadvantages**
Channel (C or MC)	• Variety of sizes, weights and depths that are widely available • Flange can be used to support guard posts • End connections can use typical bolted simple shear connections	• Wider than plate and some HSS members
Plate	• Readily available • Narrower than other alternatives • End connections can use typical bolted simple shear connections	• Lower flexural strength than other options compared to member weight • Lower member strength for lateral loading
Rectangular HSS	• Variety of sizes, weights, and depths that are widely available • Flange can be used to support guardrail posts	• Additional fabrication required at joints and connections • More difficult end connections than other options • Typically heavier weight per foot than other options

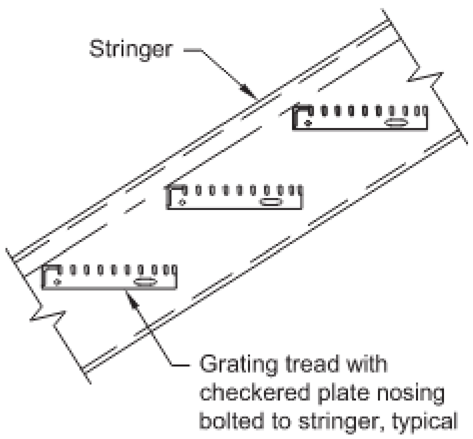


Fig. 4-6. Stringer with bolted grating treads.

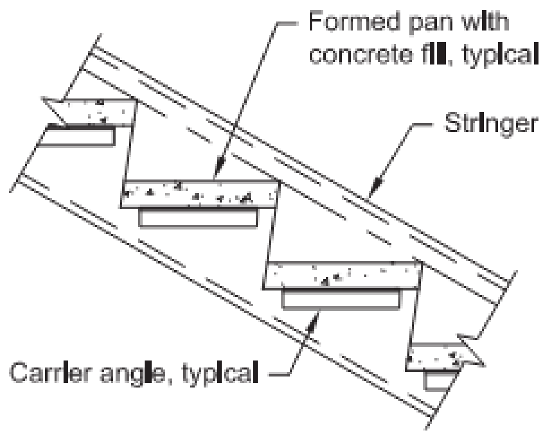


Fig. 4-5. Stringer with welded metal pan for treads and risers.

Lateral bracing

Table 5-1. Comparison of Bracing Types		
Type	**Advantages**	**Disadvantages**
Tension-only bracing	• Smaller member sizes • Can be concealed in walls • Can fit under landings	• Will require more members and more connections
Tension-compression bracing	• Fewer members • Fewer connections • Can be concealed in walls • Can fit under landings	• Members may be heavier and larger • Splices at member intersections are needed
Moment frames	• Members do not cross path of travel (if required) • Can be concealed in walls • Beam member can also act as landing support member	• More lateral drift than other options • Connections typically more complex and more expensive

Stairway connections

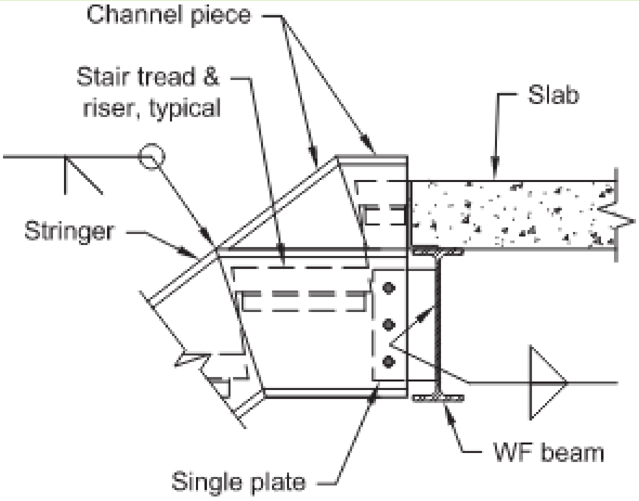


Fig. 6-1. Stair stringer with single-plate connection.

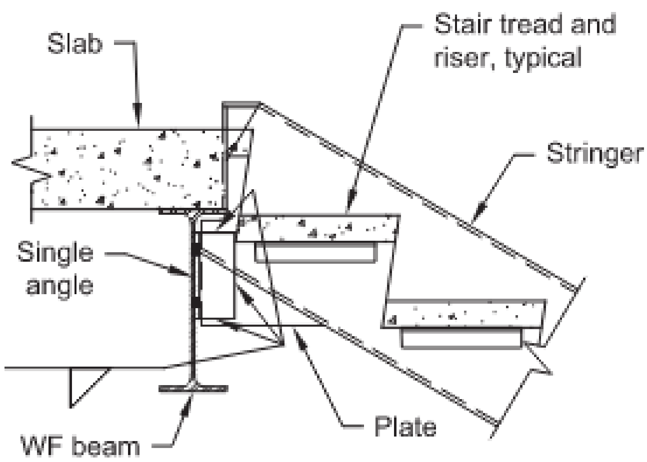


Fig. 6-2. Stair stringer with single-angle connection.

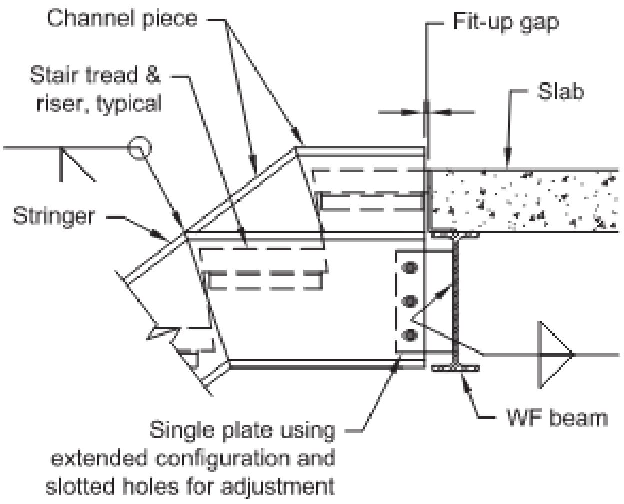


Fig. 6-3. Stair stringer with single-plate connection using extended configuration.

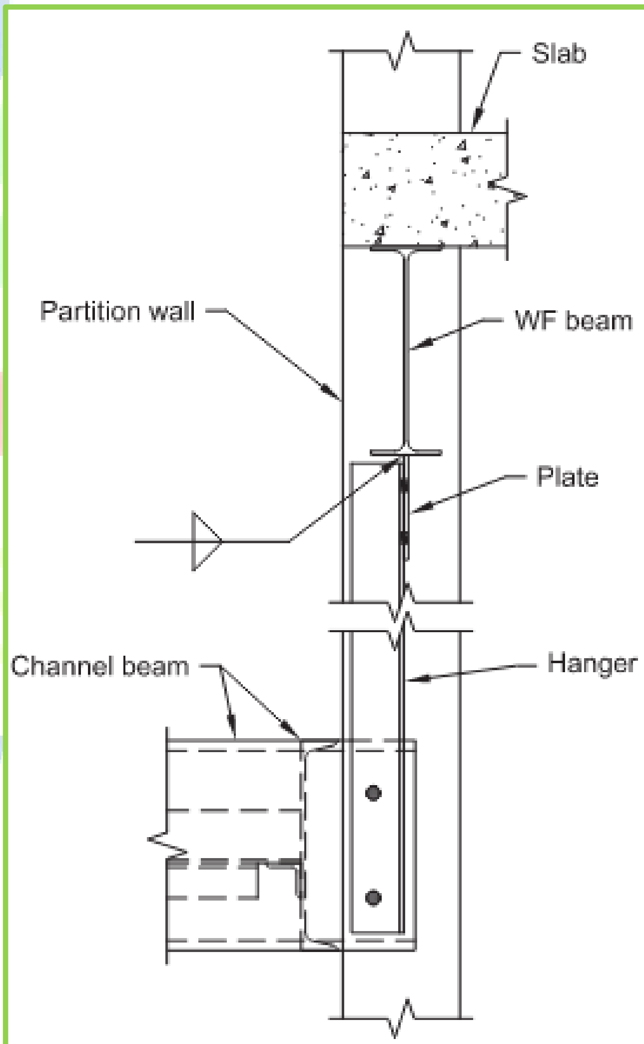


Fig. 6-4. Stair beam with hanger to support beam.

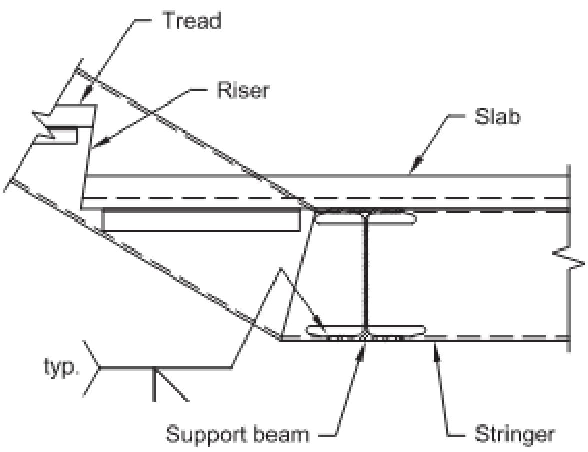


Fig. 6-5. Stair stringer with through-beam moment connection.

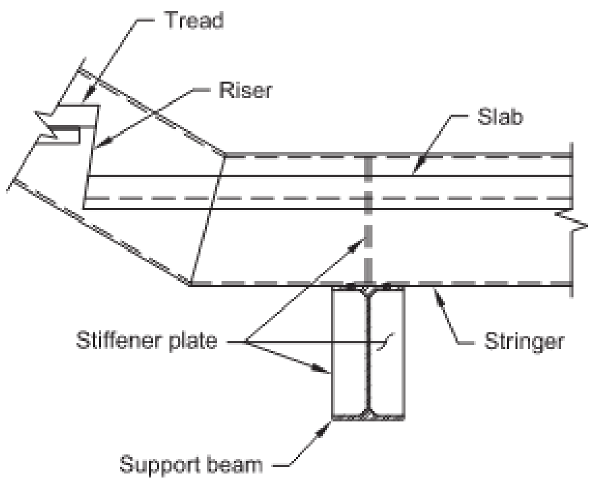


Fig. 6-6. Stair stringer continuous over support beam.

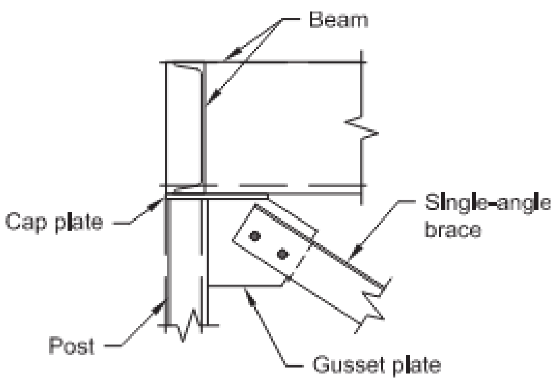
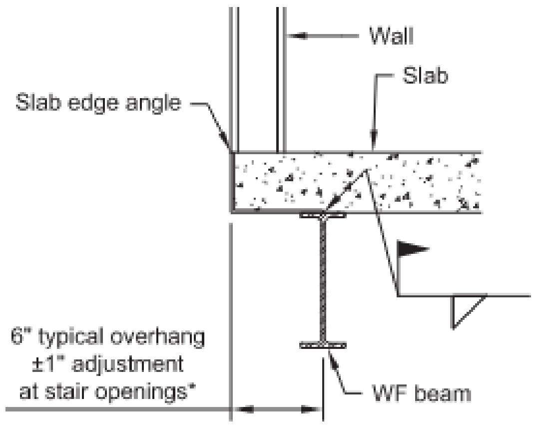


Fig. 6-7. Stair landing single-angle brace connection.



*Coordinate final opening dimensions
with Architect & SER during detailing.

Fig. 6-8. Slab edge detail at stair opening.

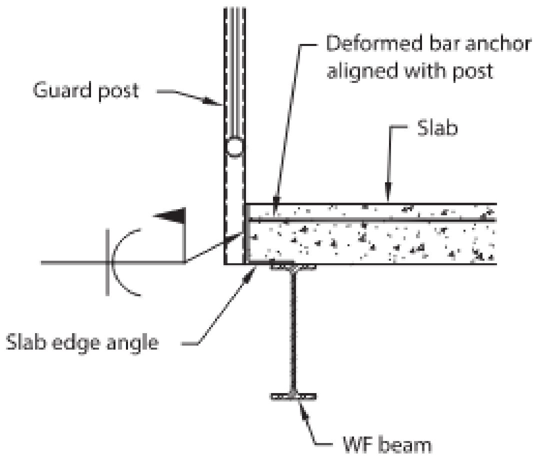


Fig. 6-9. Guard to side of slab edge.

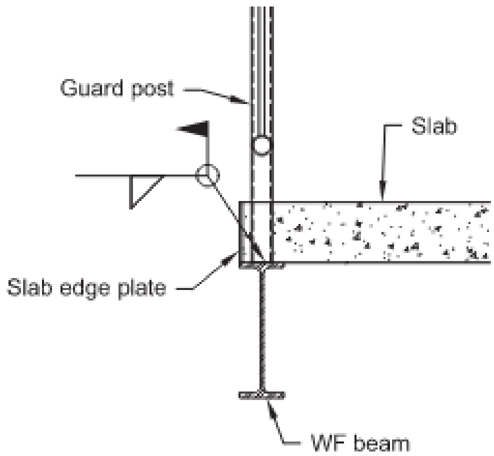


Fig. 6-10. Guard to top of support beam.

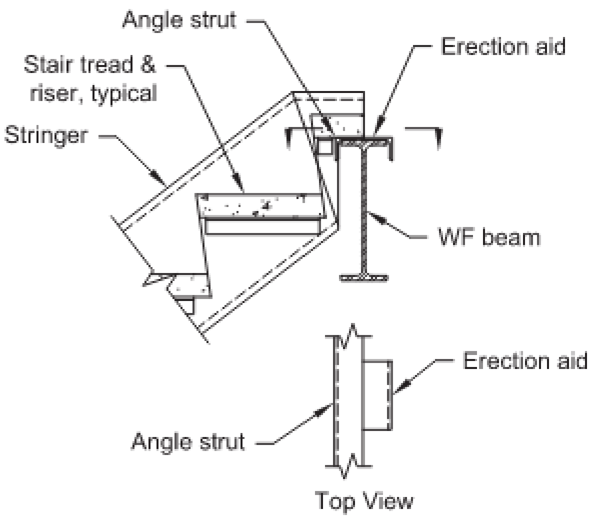


Fig. 6-11. Stair flight with erection aid.

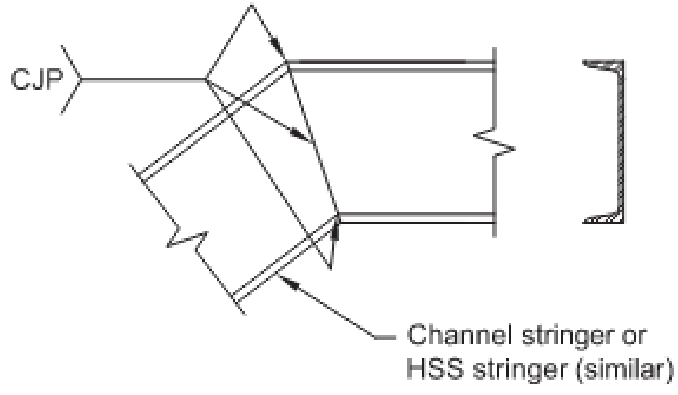


Fig. 6-12. Kinked channel stringer or HSS stringer.

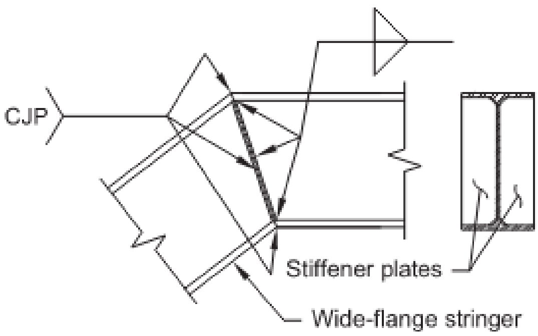


Fig. 6-13. Kinked wide-flange stringer.

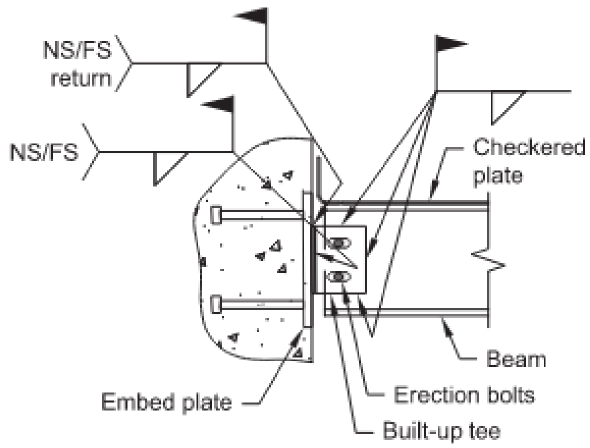


Fig. 6-14. Stair beam to embed-plate connection.

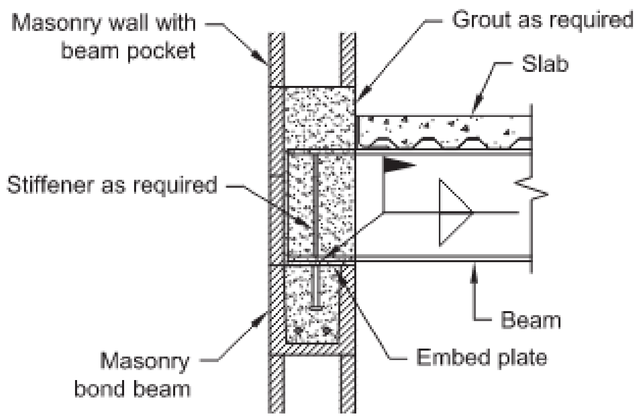


Fig. 6-15. Stair beam connection to masonry wall pocket.

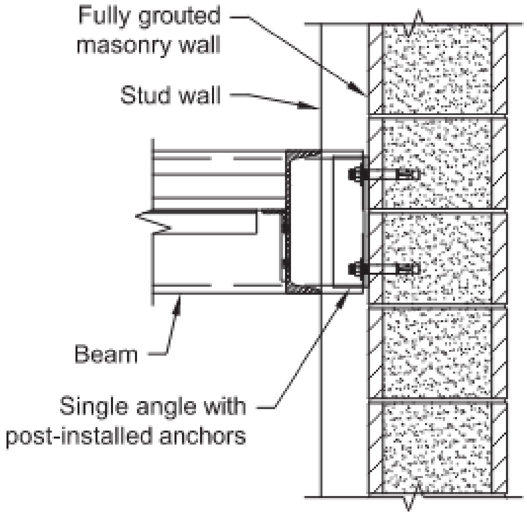


Fig. 6-16. Stair beam single-angle connection using post-installed anchors.

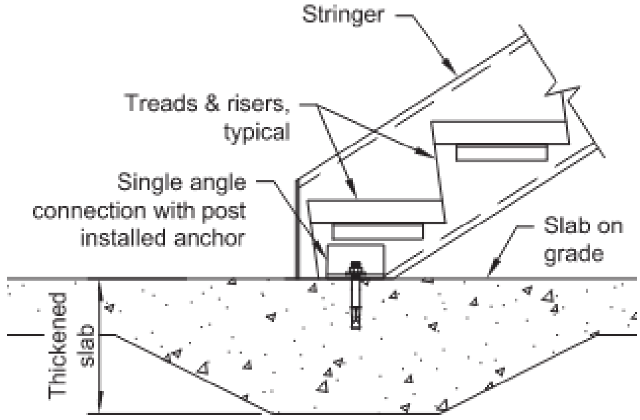


Fig. 6-17. Stringer base at thickened slab.

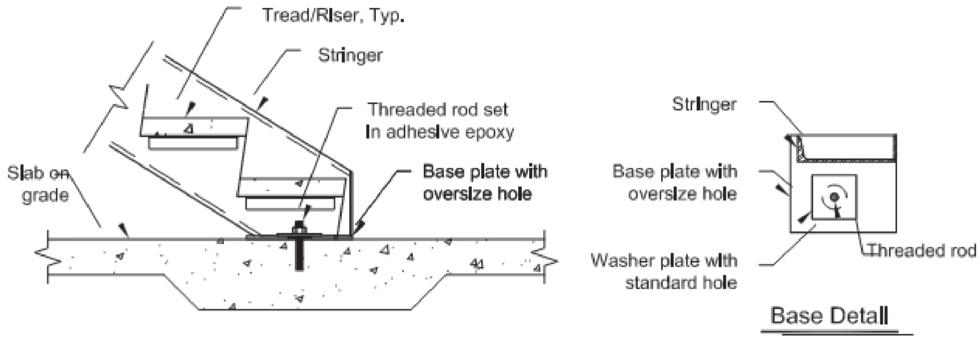


Fig. 6-18. Seismic displacement detail using sliding connection at concrete slab on grade.

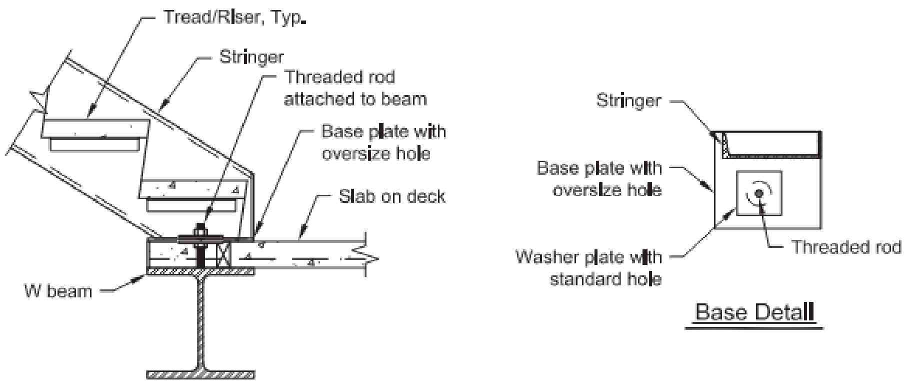


Fig. 6-19. Seismic displacement detail using sliding connection at concrete slab on deck.

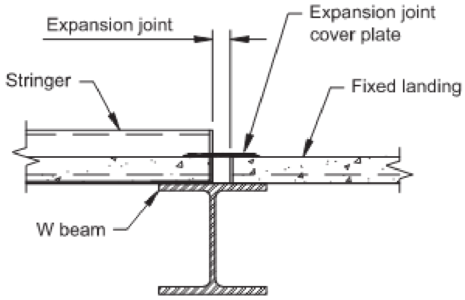


Fig. 6-20. Seismic displacement detail using expansion joint.

Guard and Handrail design

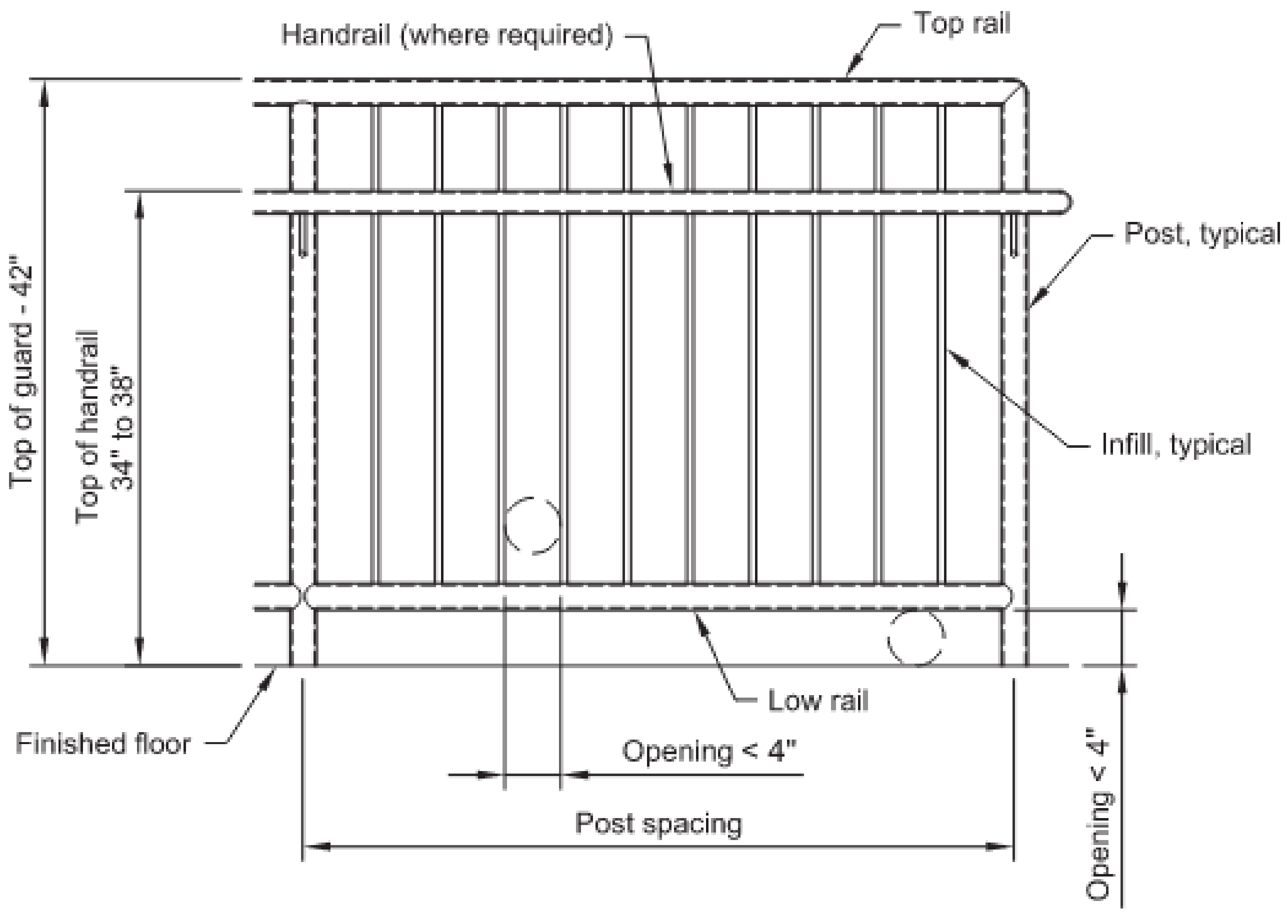


Fig. 7-1. IBC-style guard, elevation view.

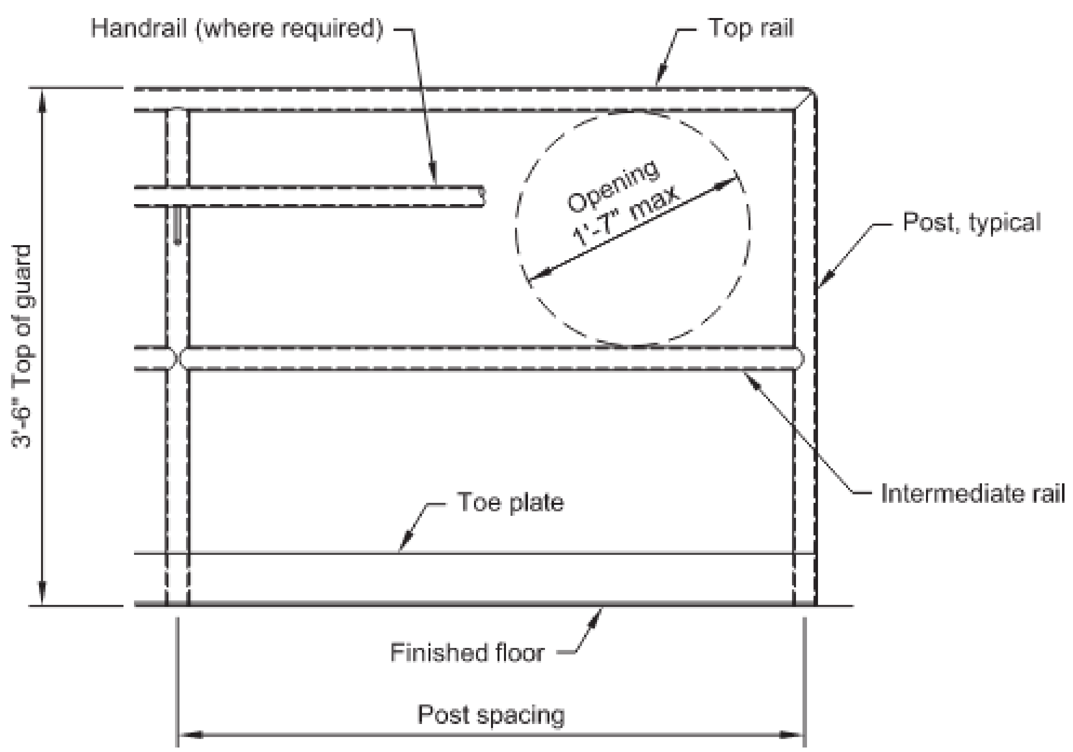


Fig. 7-3. OSHA-style guard, elevation view.

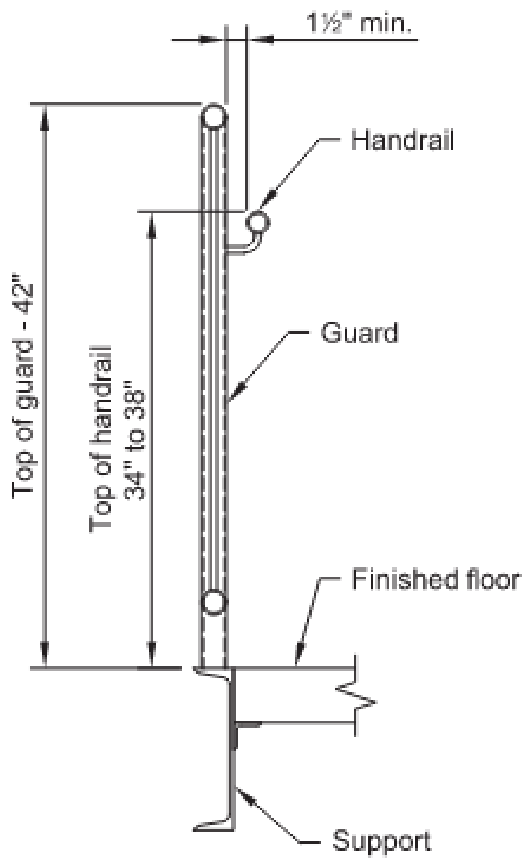


Fig. 7-2. IBC-style stairway guard, section view.

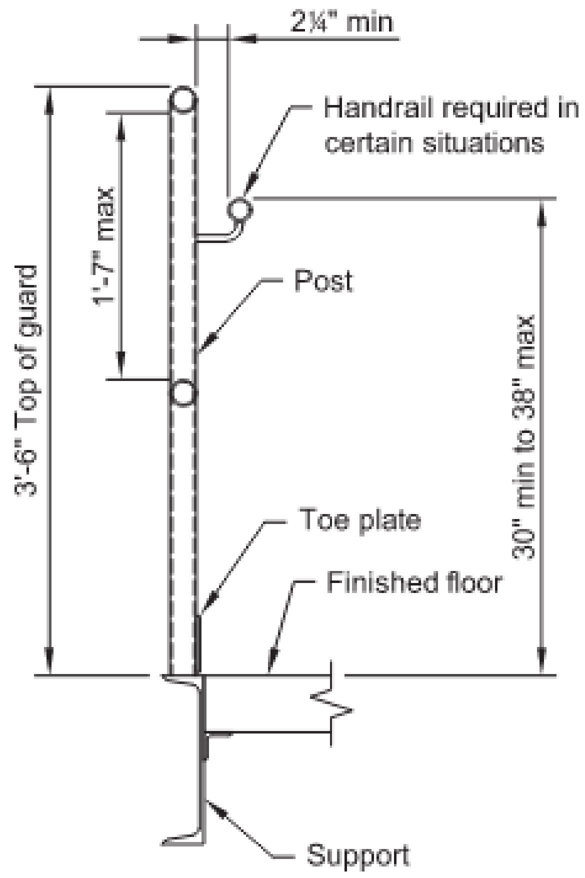


Fig. 7-4. OSHA-style stairway guard, section view.

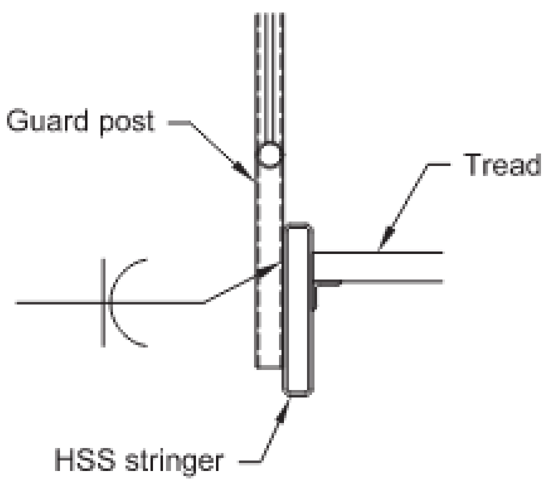


Fig. 7-5. Guard post mounted to side of HSS member.

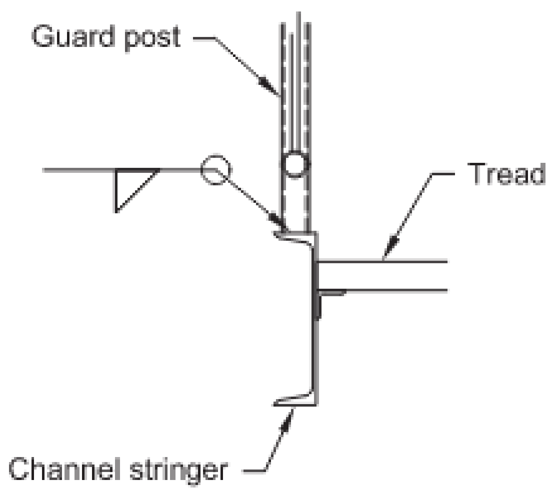


Fig. 7-6. Guard post mounted to top of channel.

Commercial Stairway

Rise and run per step

1. Maximum rise height) per step is 7 inches.
2. Minimum rise height) per step is 4 inches.
3. Minimum run depth) per step is 11 inches.
4. A nosing is required on stairways with solid risers, except where the tread depth is less than 11 inches. The nosing shall be between 3/4 inch and 1 1/4 inch.
5. Avoid variations in tread depth and riser height. 3/8 inch is the maximum variation allowed between the highest and lowest risers, and/or between the shallowest and deepest treads in a stair run.

Stairway run and landings

1. Maximum rise of a stairway between floors or landings is 12 feet.
2. A floor or landing is required at the top and bottom of each stairway.
3. Minimum size of any landing is 44 inches by 44 inches.
4. The minimum width of a landing is 44 inches or the width of the stairway it serves, whichever is wider.
5. The minimum length of a landing is 44 inches or the width of the stairway it serves, whichever is wider. The maximum length required for stairways with straight runs is 48 inches regardless of the width.

Clear height and width

1. Minimum clear headroom above a stairway is 80 inches. The measurement is taken vertically from the front edge of the tread nosing) to the ceiling or other projection.
2. The minimum clear width at stairways, measured above the handrails, is 44 inches, or the width determined by the provisions of Section 1005.1 based on occupant load. Clear width is required at any point between the top of the handrail and the required minimum headroom 80"). NOTE: Required width is measured differently for accessible means of egress stairways see c) below).
3. The minimum clear width, measured between handrails, for accessible means of egress stairways, is 48 inches, unless the building is equipped throughout with a sprinkler system.

4. The maximum distance a handrail or other projection) can project into the required stairway width, measured at or below the handrail height, is 4 ½ inches.
5. The minimum clear stairway width, measured at and below handrails is 35 inches or the width determined by the provisions of Section 1005.1 based on occupant load, minus 9 inches. NOTE: Required width is measured differently for accessible means of egress stairways see c) above).
6. The maximum distance from any point on a required egress stairway to a handrail is 30 inches.

Guardrails

1. The minimum guard height on the open sides of stairs is 42 inches.
2. The minimum guard height on the open sides of the interior and exterior stair landings where the walking surface is more than 30 inches above the adjacent floor or grade is 42 inches. At exterior stair landings, the measurement is taken from a point 36 inches horizontally from the edge of the landing walking surface to the grade.
3. Guards are not required at stairs or landings that are 30 inches or less above adjacent walkingsurfaces or grades.
4. Guards on the open sides of interior stairways shall have no openings that allow the passage of a 4-inch sphere. From a height of 36 inches to 42 inches there shall be no openings that allow the passage of a 4 3/8-inch sphere.
5. Triangular openings at stair tread/riser and the bottom of the guard shall have no openings that allow the passage of a 6" sphere.
6. Clear space at open risers shall not allow the passage of a 4" sphere.

Handrails

1. Handrails are required on both sides of each flight or continuous run of a stairway.
2. Handrails are required where there is more than 1 change in elevation and the landing length is not greater than the width, along a walkway. In other words, handrails are required where there are 2 or more risers.
3. The minimum height of handrails is 34 inches.
4. The maximum height of handrails is 38 inches.

5. The measurement is taken vertically from the face nosing) of the tread to the top of the handrail.
6. Handrails are required to be continuous on each flight or run of a stairway. Handrails are required to extend at least 12 inches horizontally from a point directly above the top riser. Handrails shall continue sloping past the nosing of the bottom tread to a point the depth of the bottom tread. NOTE: Accessible stair handrails are required to then extend 12 inches horizontally at the bottom tread.
7. Handrails are required to return to the wall, floor, or guard at the top and bottom of the stairway.
8. Bending's or fittings used to provide for continuous transitions are permitted to exceed the maximum height.
9. Handrails are not required at landings.

<u>Handrail types and profiles</u>

1. Type I handrails are permitted:
   a. Circular shaped with an outside diameter of 1 ¼ inches minimum to 2 inches maximum.
   b. Other shapes with a perimeter dimension of 4 inches minimum to 6 ¼ inches maximum, with a cross-section of 2 ¼ inches maximum.
   c. All edges shall have a minimum radius of 0.01 1/100) inches.
2. Type II handrails are permitted:
   a. Shapes with a perimeter dimension greater than 6 ¼ inches that have a graspable finger recess area on both sides of the profile.

<u>Walk line and winder treads</u>

1. The walk line refers to a curved line that is 12 inches from the narrowest part of the winding tread that follows the turn.
2. Winder treads are required to be:
   a) Minimum 10 inches tread depth at the walk line.
   b) Minimum 6 inches tread depth at any point in the stairway clear width.
   c) Consistently shaped winder treads at the walk line are permitted within the same stair run as rectangular treads.

d) The winder tread depths and the rectangular tread depths do not have to be within 3/8 inch of each other.
e) Avoid variations in winder tread depth at the walkline. 3/8 inch is the maximum variation allowed between the shallowest and deepest winder treads along the walkline.
f) All risers, at both winder steps and rectangular steps in the same stair run shall have no height variations greater than 3/8 inch.

<u>Fire protection</u>

1. Provide one-hour fire-resistive construction on walls and ceiling under the interior of the stairway

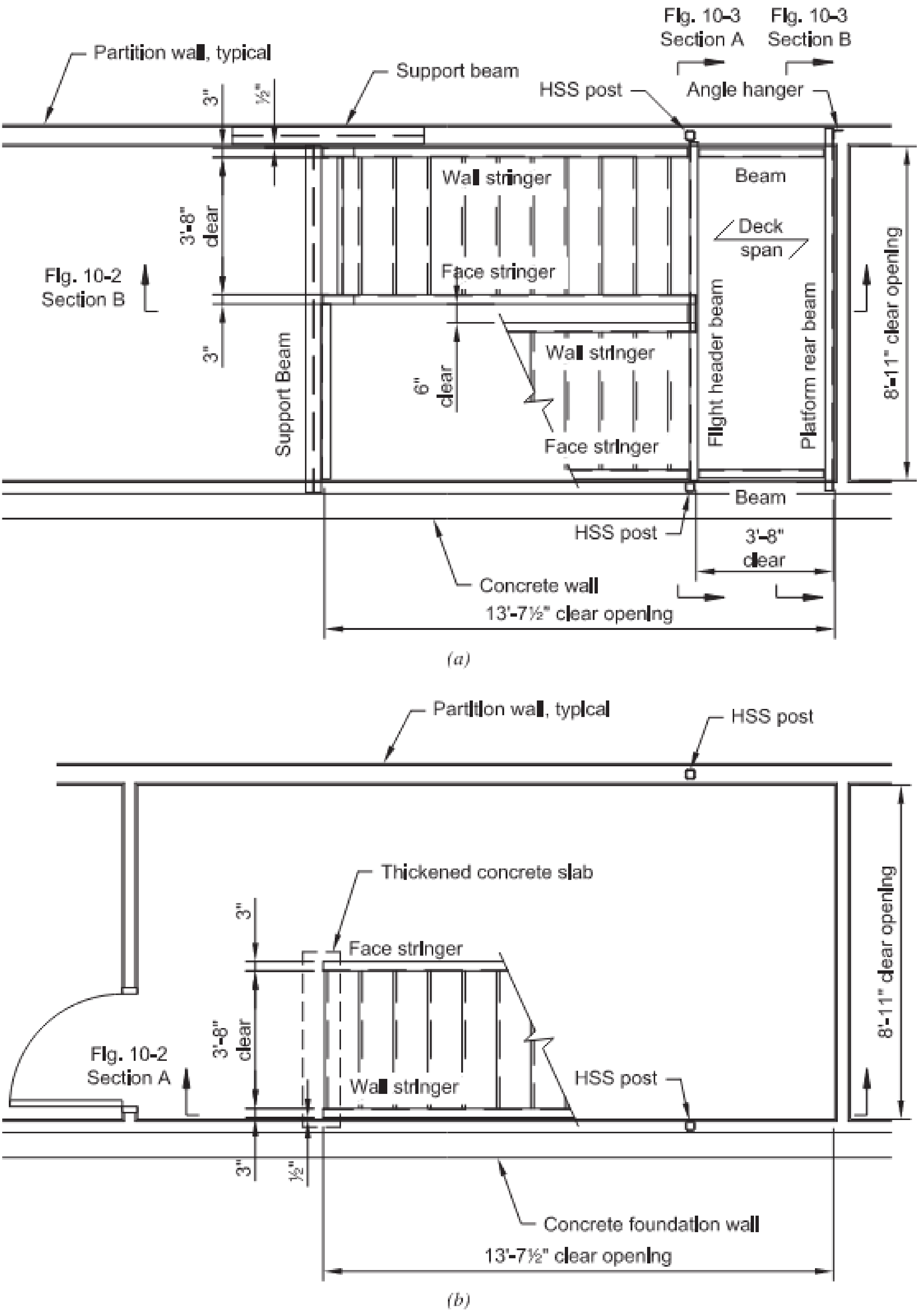


Fig. 10-1. Commercial stairway plans: (a) intermediate landing plan; (b) first floor plan.

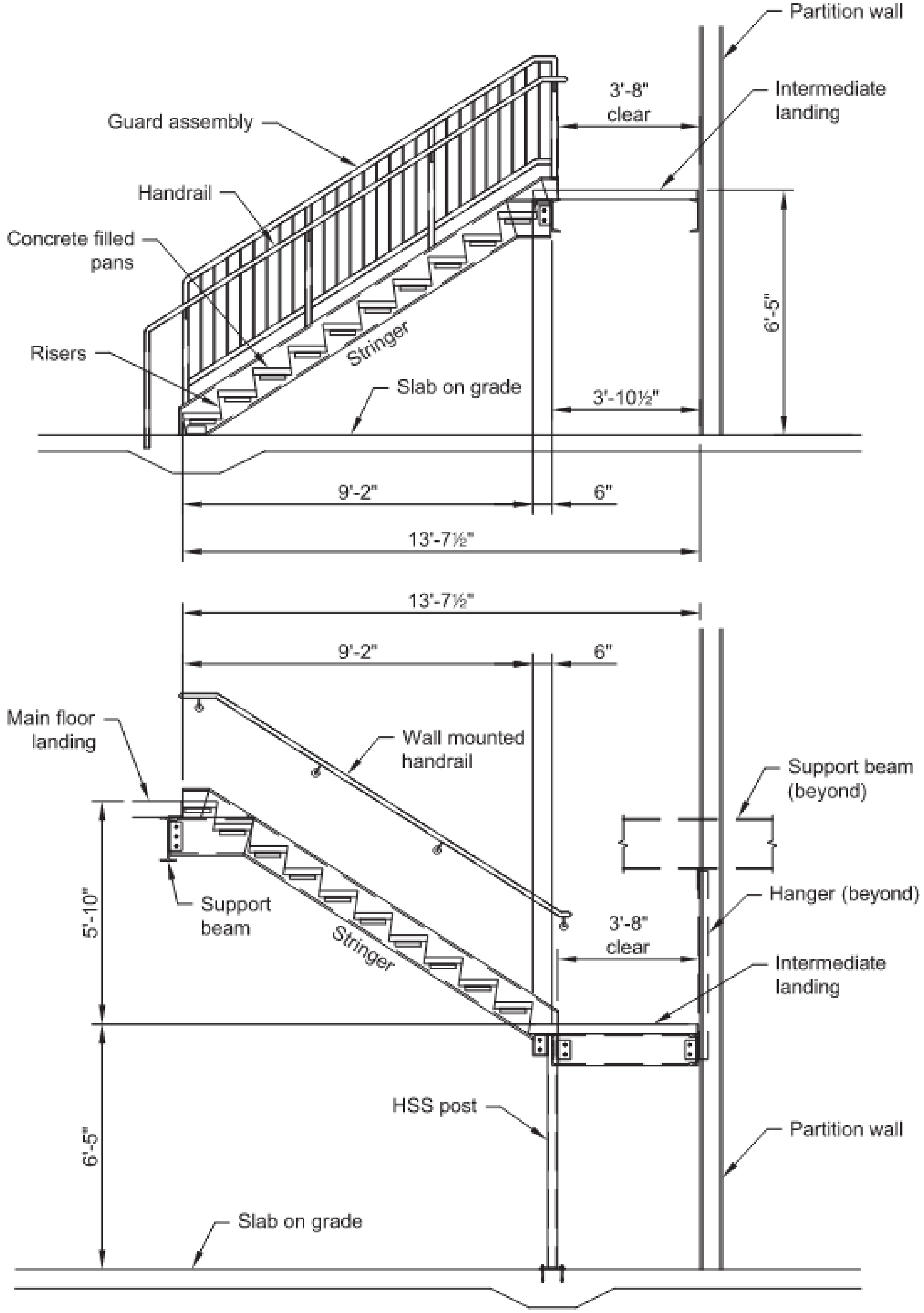


Fig. 10-2. Commercial stairway sections for Figure 10-1.

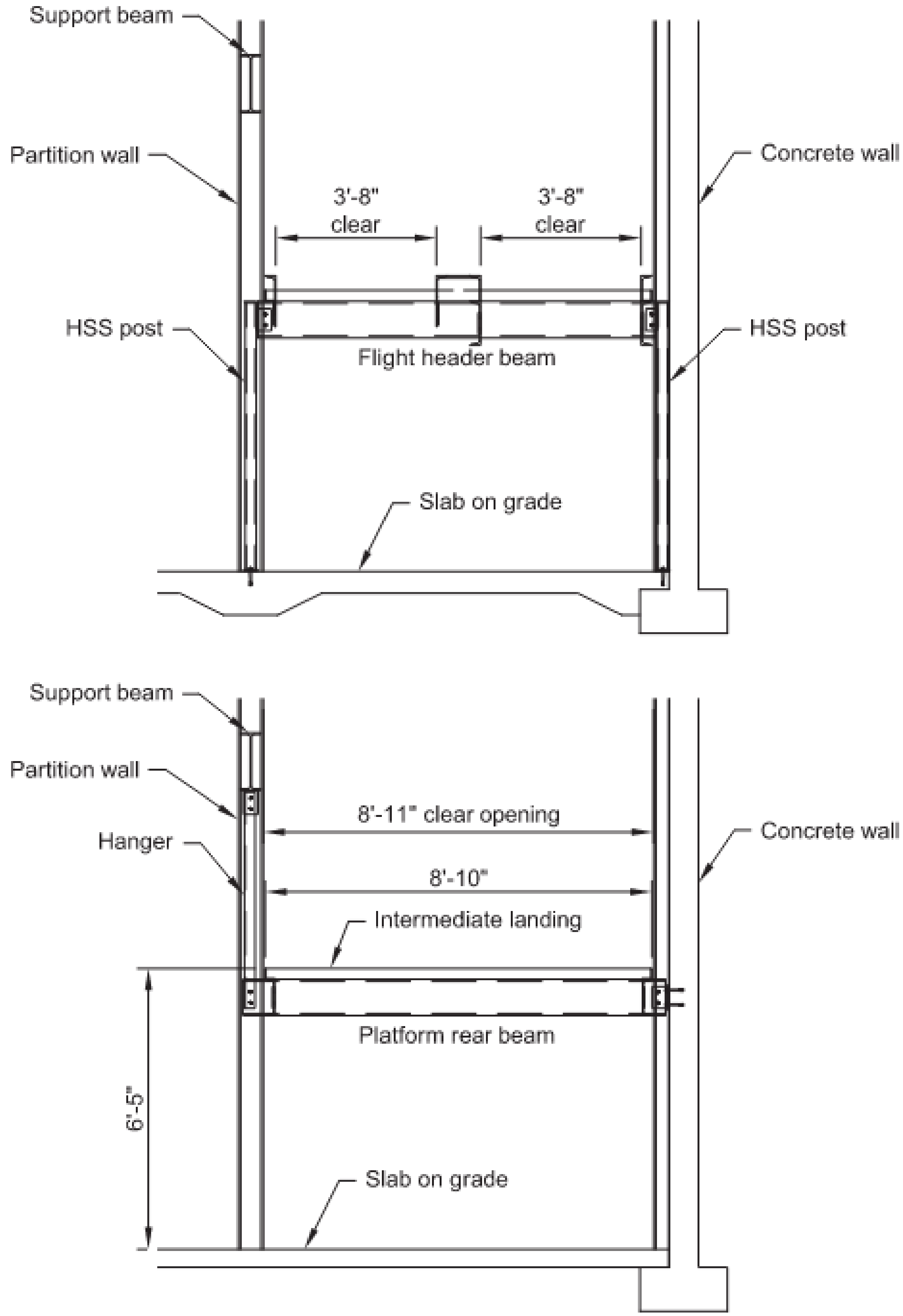


Fig. 10-3. Commercial stairway sections for Figure 10-1.

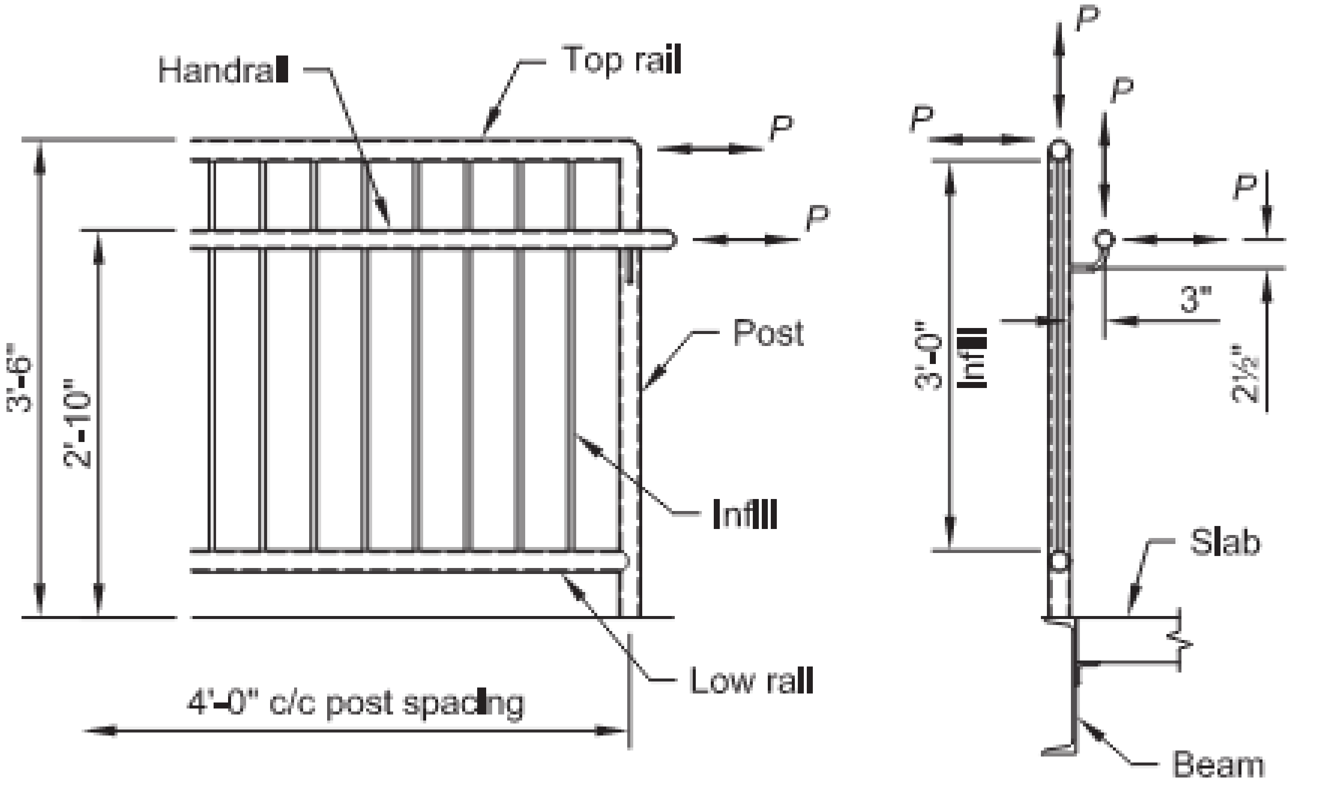


Fig. 10-7. Guard layout and loading diagram.

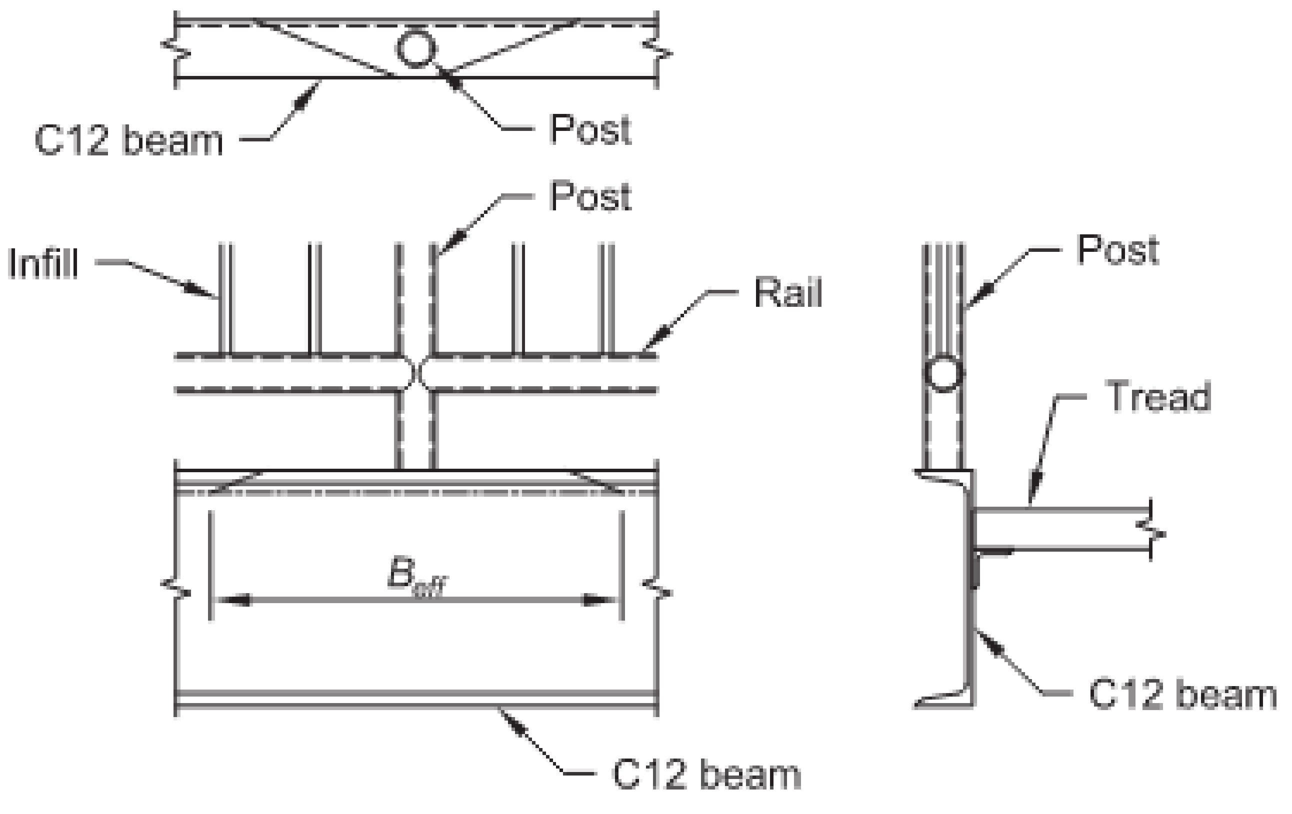


Fig. 10-8. Guard post to channel flange diagram.

Industrial stairway

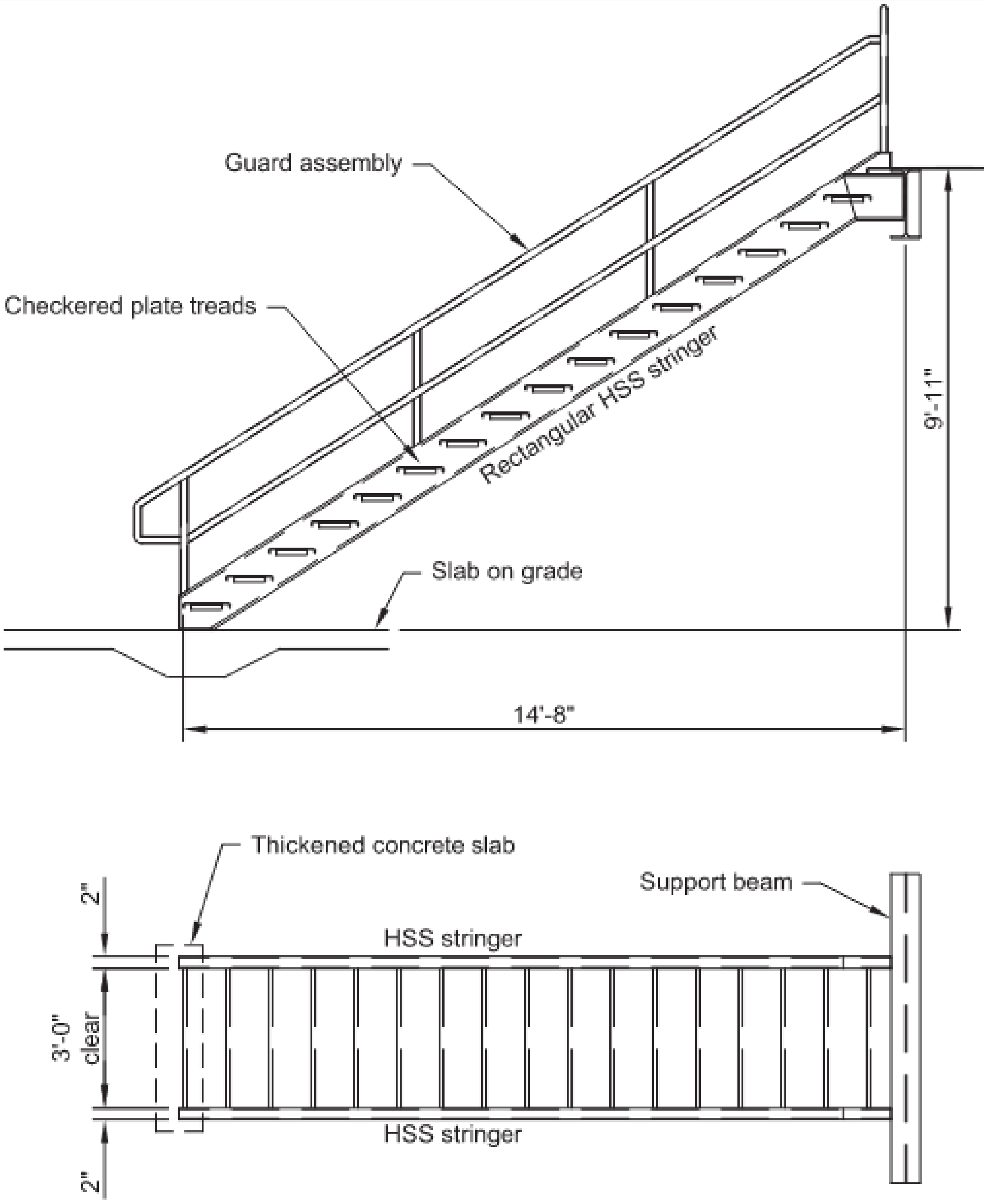


Fig. 10-9. Industrial stairway section and plan.

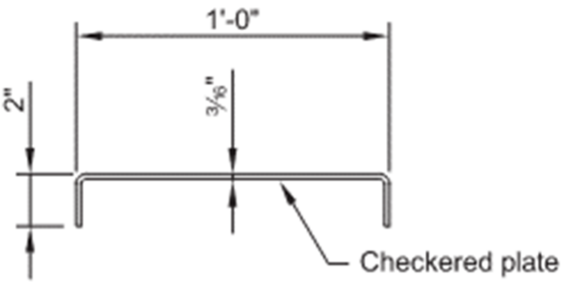


Fig. 10-10. Checkered plate geometry.

Accessible stairway requirements

CBC Chapter 11B contains specific requirements for stairways in commercial buildings and the public use areas of multi-family buildings. Some requirements may override the basic requirements of Chapter 10. Specific requirements are listed below.

1. The characteristics of stair treads and risers are:
   a. Risers 4" min / 7" max
   b. Treads 11" min
   c. All treads and risers' uniform
2. Open risers are not permitted.
3. The maximum permitted opening in stair risers is ½" between the bottom of the riser and the tread, for exterior stairways.
4. Risers for interior stairways are not permitted to be constructed of gratings, however, exterior stairways are permitted to have risers constructed of gratings provided the maximum opening is ½".
5. 1:48 2.083%) is the maximum slope for treads.
6. The marking requirements for interior and exterior stair treads are:
   a. Interior:
      1) Stripe at top approach and bottom tread
   b. Exterior
      1) Stripe at the top approach and on all treads
   c. Stripes to be:
      1) 2"- 4" wide
      2) Contrasting
      3) Placed not more than 1" from the nosing
      4) Parallel to the nosing
      5) Across the full tread width
      6) Slip resistant
      7) Can be painted
      8) Grooves are not permitted
7. The requirements for tread nosings are:
   a. Leading edge of tread radius = ½" max
   b. If nosing projects, the underside shall be curved or beveled
   c. Nosing maximum projection = 1 ¼"
   d. Maximum riser slope = 30 degrees

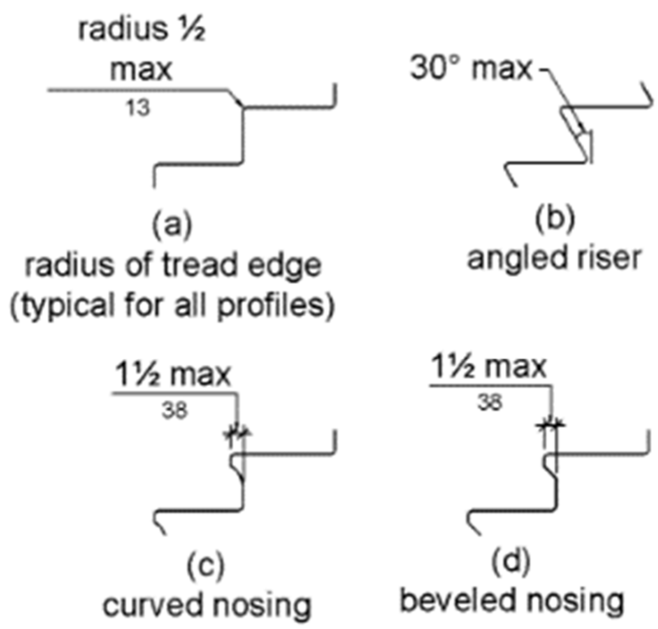


Figure 504.5
Stair Nosings

8. In an existing building, nosing's projecting 1 1/2", which was constructed in conformance with code at the time, are not required to be altered to 1 ¼".
9. Stairs and landings are required to be constructed to prevent the accumulation of water.
10. All stairways are not required to have floor identification signs. However, stairways required to have signs by Chapter 10 Section 1022.9 are required to provide signs.
11. The characteristics of floor identification signs in stairways, when required by Chapter 10 Section 1022.9, are:
    a. Comply with sign requirements for:
        1) Tactile characters 11B-703.2)
        2) Have Braille 11B-703.3)
        3) Meet Visual Character size 11B-703.5
        4) Be reviewed and inspected 11B-703.1)
    b. Be placed adjacent to the door latch side at each landing, in all
    enclosed stairways
    c. At the exit discharge level, a raised 5-pointed star shall be placed on the left of the floor level character.
    d. Size of the star the same height/outside diameter as the characters.

12. Handrails are required on both sides of stairways and ramps, except:
    a. At assembly aisle ramps, where a handrail is provided on one side or within the aisle width
    b. At curb ramps
13. At door landings when the ramp run is less than 6" in rising or less than 72" in length. Handrails are required to be continuous within the full length of each run of stairways and ramps.
14. Handrails are not required at landings.
15. Inside handrails on switchback or dogleg stairs and ramps are required to be continuous between flights or runs.
16. The required height for handrails is as follows:
    a. 34" to 38" above:
        1) The walk or walkway surface
        2) Vertically above the ramp surface
        3) Vertically at the tread nosing on stairways
    b. Measured to the top of the handrail.
17. The minimum required clearance between the handrail gripping surface and adjacent surfaces is 1 ½ ".

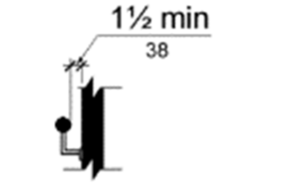


Figure 505.5
Handrail Clearance

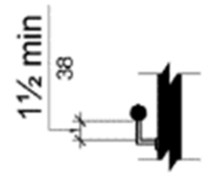


Figure 505.6
Horizontal Projections Below Gripping Surface

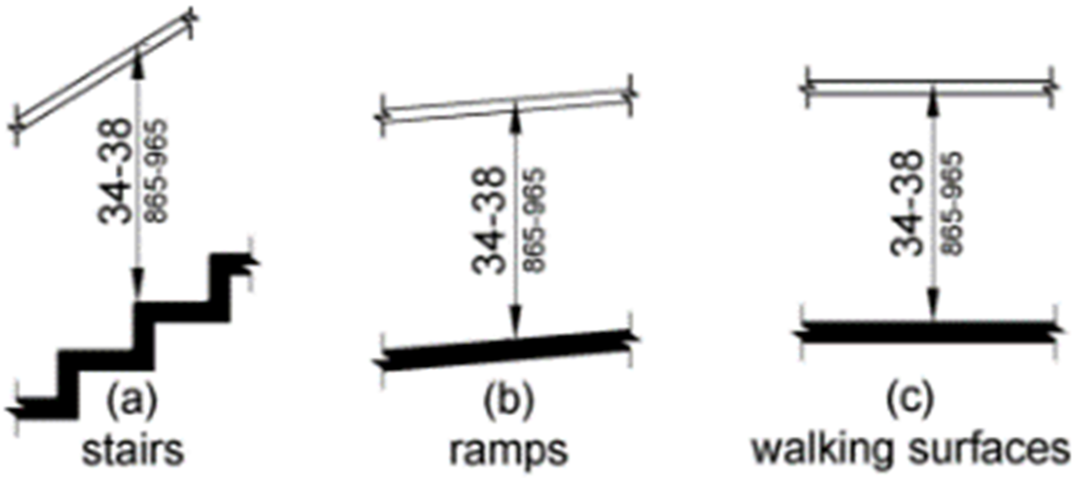


Figure 505.4
Handrail Height

18. If a handrail is located in a recess the required clearances are:
    a. Recess not more than 3" deep
    b. Shall be at least 18" clear above the top of the handrail
19. The characteristics of the handrail gripping surface are:
    a. Continuous along the full length
    b. Have no obstructions on the top or sides
    c. No more than 20% obstructions on the bottom
    d. If provided, horizontal projects shall be at least 1-½" below the bottom of the rail
20. If the handrail perimeter exceeds 4", the distance between a horizontal projection and the bottom of the rail can be reduced by 1/8" for each 1/2" of additional perimeter distance.
21. The dimension range permitted for a circular handrail is between 1 ¼" to 2"
22. The dimension ranges for a non-circular handrail are:
    1) Perimeter not less than 4"
    2) Perimeter not more than 6 ¼"
    3) Cross-section not more than 2 ¼"
23. The dimension ranges permitted for handrails are:
    a. 1 1/4" - min circular
    b. 2" - max circular
    c. 2 1/4" - max non-circular
    d. 4" - min perimeter
    e. 6 1/4" - max perimeter

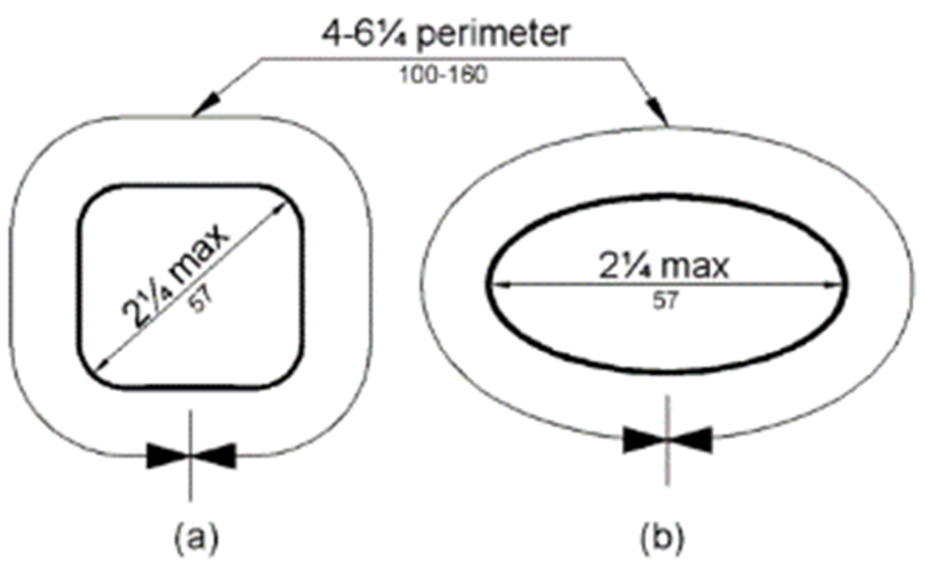


Figure 505.7.2
Handrail Non-Circular Cross Section

24. Handrail gripping surfaces shall be:
    a. Smooth
    b. No sharp or abrasive elements
    c. Edges shall be rounded
    d. Handrails shall not rotate in their fittings
25. In general, handrail extensions are required to extend beyond and in the same direction as the stair flights and ramps.
26. At the inside turn of switchback or dogleg stairs or ramps, handrail extensions are not required toextend beyond and in the same direction as the stair flights and ramps.
27. In alterations, where the extension of the handrail would create a hazard, the handrail extension is permitted to be turned 90 degrees from the ramp run
28. At the top of a stair flight or run, the handrail is required to extend horizontally 12" past the first riser nosing. The handrail shall make the transition to horizontal at the nosing.

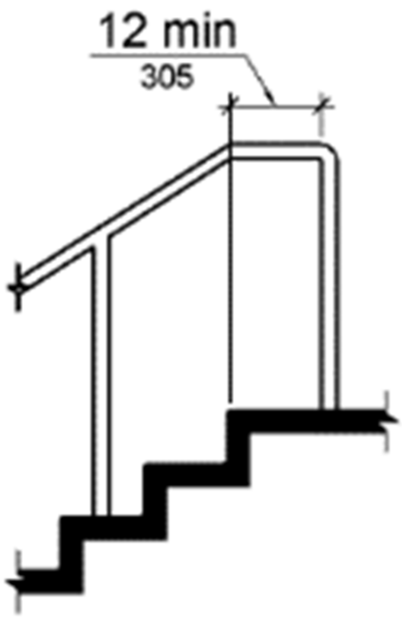
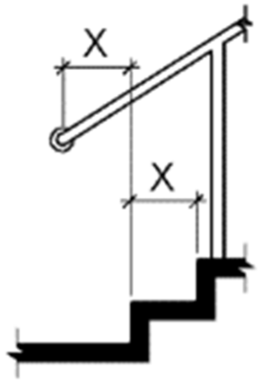


Figure 505.10.2
Top Handrail Extension at Stairs

29. The handrail is required to be returned to the wall, guard, or landing surface. OR it shall be continuous to the handrail of the adjacent stair flight.
30. At the bottom of a stair flight or run, the handrail is required to extend at the slope of the stair run, for a horizontal distance equal to the tread width, then transition to the horizontal for an additional 12".



Note: X = tread depth

Figure 505.10.3
Bottom Handrail Extension at Stairs

31. The options for handrails at the bottom of a flight of stairs when there is a landing continuing to another flight of stairs are:
    a. At the end of the sloped portion, extend 12" or more
    b. Extend continuously and connect to the handrail at the top of the next stair flight
    c. If either of the above, the horizontal height shall be the same as the height above the stair tread nosing.
    d. Extend 12", then terminate at the wall, guard, or floor surface.

29. Ladders

The following rules apply to all ladders:

- Maintain ladders free of oil, grease, and other
- slipping hazards.
- Do not load ladders beyond their maximum intended load nor beyond their manufacturer's rated capacity.
- Use ladders only for their designed purpose.
- Use ladders only on stable and level surfaces unless secured to prevent accidental movement.
- Do not use ladders on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental movement. Do not use slip-resistant feet as a substitute for exercising care when placing, lashing, or holding a ladder upon slippery surfaces.
- Secure ladders placed in areas such as passageways, doorways, or driveways, or where they can be displaced by workplace activities or traffic to prevent accidental movement. Or use a barricade to keep traffic or activity away from the ladder.
- Keep areas clear around the top and bottom of ladders.
- Do not move, shift, or extend ladders while in use.
- Use ladders equipped with nonconductive side rails if the worker or the ladder could contact exposed energized electrical equipment.
- Face the ladder when moving up or down.
- Use at least one hand to grasp the ladder when climbing.
- Do not carry objects or loads that could cause loss of balance and falling.

In addition, the following general requirements apply to all ladders, including ladders built at the Jobsite:

- Double-cleated ladders or two or more ladders must be provided when ladders are the only way to enter or exit a work area where 25 or more employees work or when a ladder serves simultaneous two-way traffic.

- Ladder rungs, cleats, and steps must be parallel level and uniformly spaced when the ladder is in position for use.
- Rungs, cleats, and steps of portable and fixed ladders except as provided below) must not be spaced less than 10 inches 25 cm) apart, nor more than 14 inches 36 cm) apart, along the ladder's side rails.
- Rungs, cleats, and steps of step stools must not be less than 8 inches 20 cm) apart, nor more than 12 inches 31 cm) apart, between the center lines of the rungs, cleats, and steps.
- Rungs, cleats, and steps at the base section of extension trestle ladders must not be less than 8 inches 20 cm) nor more than 18 inches 46 cm) apart, between the center lines of the rungs, cleats, and steps. The rung spacing on the extension section must not be less than 6 inches 15 cm) nor more than 12 inches 31 cm).
- Ladders must not be tied or fastened together to create longer sections unless they are specifically designed for such use.
- When splicing side rails, the resulting side rail must be equivalent in strength to a one-piece side rail made of the same material.
- Two or more separate ladders used to reach an elevated work area must be offset with a platform or landing between the ladders, except when portable ladders are used to gain access to fixed ladders.
- Ladder components must be surfaced to prevent snagging of clothing and injury from punctures or lacerations
- Wood ladders must not be coated with any opaque covering except for identification or warning labels, which may be placed only on one face of a side rail.

Note: A competent person must inspect ladders for visible defects periodically and after any incident that could affect their safe use.

Specific Types of Ladders

- Do not use single-rail ladders.
- Use non-self-supporting ladders at an angle where the horizontal distance from the top support to the foot of the lad-

der is approximately one-quarter of the working length of the ladder.

- Use wooden ladders built at the Jobsite with spliced side rails at an angle where the horizontal distance is one-eighth of the working length of the ladder. In addition, the top of a non-self-supporting ladder must be placed with two rails supported equally unless it is equipped with a single support attachment.

Stepladders

- Do not use the top or top step of a step ladder as a step.
- Do not use cross-bracing on the rear section of stepladders for climbing unless the ladders are designed and provided with steps for climbing on both front and rear sections.
- Metal spreader or locking devices must be provided on stepladders to hold the front and back sections in an open position when ladders are being used.

Portable Ladders

- The minimum clear distance between side rails for all portable ladders must be 11.5 inches 29 cm).

In addition, the rungs and steps of portable metal ladders must be corrugated, knurled, dimpled, coated with skid-resistant material, or treated to minimize slipping.

Non-self-supporting and self-supporting portable ladders must support at least four times the maximum intended load; extra-heavy-duty type 1A metal or plastic ladders must sustain 3.3times the maximum intended load. To determine whether a self-supporting ladder can sustain a certain load, apply the load to the ladder in a downward vertical direction with the ladder placed at a horizontal angle of 75.5 degrees. When portable ladders are used for access to an upper landing surface, the side rails must extend at least 3 feet .9 m) above the upper landing surface. When such an extension is not possible, the ladder must be secured and a grasping device such as a grab rail must be provided to assist workers in mounting and dismounting the ladder. A ladder extension must not deflect under a load that would cause the ladder to slip off its supports.

Fixed Ladders

If the total length of the climb on a fixed ladder equals or exceeds 24 feet 7.3 m), the ladder must be equipped with ladder safety devices; or self-retracting lifelines and rest platforms at intervals not to exceed 150 feet 45.7 m), or a cage or well and multiple ladder sections with each ladder section not to exceed 50 feet 15.2 m) in length. These ladder sections must be offset from adjacent sections and landing platforms must be provided at maximum intervals of 50 feet 15.2 m). In addition, fixed ladders must meet the following requirement:

- Fixed ladders must be able to support at least two loads of 250 pounds 114 kg) each, concentrated between any two consecutive attachments. Fixed ladders also must support added anticipated loads caused by ice buildup, winds, rigging, and impact loads resulting from using ladder safety devices.
- Individual rung/step ladders must extend at least 42 inches 1.1 m) above an access level or landing platform either by the continuation of the rung spacings as horizontal grab bars or by providing vertical grab bars that must have the same lateral spacing as the vertical legs of the ladder rails.
- Each step or rung of a fixed ladder must be able to support a load of at least 250 pounds 114 kg) applied in the middle of the step or rung.
- Minimum clear distance between the sides of individual rung/step ladders and between the side rails of other fixed ladders must be 16 inches 41 cm).
- Rungs of individual rung/step ladders must be shaped to prevent slipping off the end of the rungs.
- Rungs and steps of fixed metal ladders manufactured after March 15, 1991, must be corrugated, knurled, dimpled, coated with
- skid-resistant material or treated to minimize slipping.
- Minimum perpendicular clearance between fixed ladder rungs, cleats, and steps and any obstruction behind the ladder must be 7 inches 18 cm), except that the clearance for an elevator pit ladder must be 4.5 inches 11 cm).

- Minimum perpendicular clearance between the centerline of fixed ladder rungs, cleats, and steps, and any obstruction on the climbing side of the ladder must be 30 inches 76 cm). If obstructions are unavoidable, clearance may be reduced to 24 inches 61 cm), provided a deflection device is installed to guide workers around the obstruction.
- Step-across distance between the center of the steps or rungs of fixed ladders and the nearest edge of a landing area must be no less than 7 inches 18 cm) and no more than 12 inches 30 cm). A landing platform must be provided if the step-across distance exceeds 12 inches 30 cm).
- Fixed ladders without cages or wells must have at least a 15-inch 38 cm) clearance width to the nearest permanent object on each side of the centerline of the ladder.
- Fixed ladders must be provided with cages, wells, ladder safety devices, or self-retracting lifelines where the length of climb is less than 24 feet 7.3 m), but the top of the ladder is at a distance greater than 24 feet 7.3 m) above lower levels.
- Side rails of through or side-step fixed ladders must extend 42 inches 1.1 m) above the top level or landing platform served by the ladder. Parapet ladders must have an access level at the roof if the parapet is cut to permit passage through it. If the parapet is continuous, the access level is at the top of the parapet.
- Steps or rungs for through-fixed-ladder extensions must be omitted from the extension, and the extension of side rails must be flared to provide between 24 inches 61 cm) and 30 inches 76 cm) clearance between side rails.
- When safety devices are provided, the maximum clearance distance between side rail extensions must not exceed 36 inches 91 cm).
- Fixed ladders must be used at a pitch no greater than 90 degrees from the horizontal, measured from the backside of the ladder.

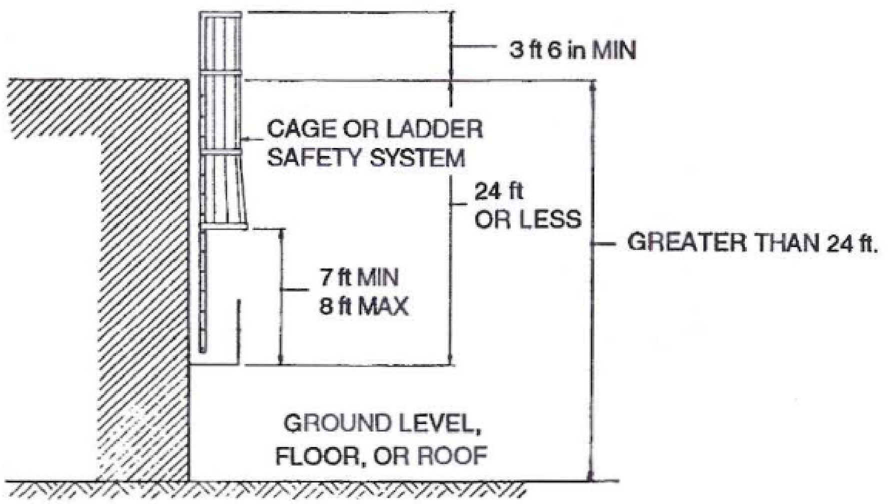
Cages for Fixed Ladders

The requirements for cages for fixed ladders are as follows:

- Horizontal bands must be fastened to the side rails of rail ladders or directly to the structure, building, or equipment for individual-rung ladders.
- Vertical bars must be on the inside of the horizontal bands and must be fastened to them.
- Cages must not extend less than 27 inches 68 cm), or more than 30 inches 76 cm) from the centerline of the step or rung and must not be less than 27 inches 68 cm) wide.
- Insides of cages must be clear of projections.
- Horizontal bands must be spaced at intervals not more than 4 feet 1.2 m) apart measured from centerline to centerline.
- Vertical bars must be spaced at intervals, not more than 9.5 inches 24 cm), measured from centerline to centerline.
- Bottoms of cages must be between 7 feet 2.1 m) and 8 feet 2.4 m) above the point of access to the bottom of the ladder. The bottom of the cage must be flared not less than 4 inches 10 cm) between the bottom horizontal band and the next higher band.
- Tops of cages must be a minimum of 42 inches1.1 m) above the top of the platform or the point of access at the top of the ladder. There must be a way to access the platform or other point of access.

Figure 3

Length of Climb 24ft. Less with Elevated Access – Cage or Ladder Safety System Required



Wells for Fixed Ladders

The requirements for wells for fixed ladders are as follows:

- Wells must completely encircle the ladder.
- Wells must be free of projections.
- Inside faces of wells on the climbing side of the ladder must extend between 27 inches 68 cm) and 30 inches 76 cm) from the centerline of the step or rung.
- Inside widths of wells must be at least 30 inches76 cm).
- Bottoms of wells above the point of access to the bottom of the ladder must be between 7feet 2.1 m) and 8 feet 2.4 m).

Ladder Safety Devices and Related Support Systems for Fixed Ladders

The connection between the carrier or lifeline and the point of attachment to the body belt or harness must not exceed 9 inches 23 cm) in length. In addition, ladder safety devices and related support systems on fixed ladders must conform to the following:

- All safety devices must be able to withstand, without failure, a drop test consisting of a 500-pound weight 226 kg) dropping 18 inches 41 cm).
- All safety devices must permit the worker to ascend or descend without continually having to hold, push or pull any part of the device, leaving both hands free for climbing.
- All safety devices must be activated within 2 feet .61 m) after a fall occurs and limit the descending velocity of an employee to 7 feet/second 2.1 m/sec) or less.

Requirements for Mounting Ladder Safety Devices for Fixed Ladders

The requirements for mounting ladder safety devices for fixed ladders are as follows:

- Mountings for rigid carriers must be attached at each end of the carrier, with intermediate mountings spaced along the entire length of the carrier, to provide the necessary strength to stop workers' falls.
- Mountings for flexible carriers must be attached at each end of the carrier. Cable guides for flexible carriers must be installed with a spacing between 25 feet 7.6 m) and 40 feet 12.2

m) along the entire length of the carrier, to prevent wind damage to the system.

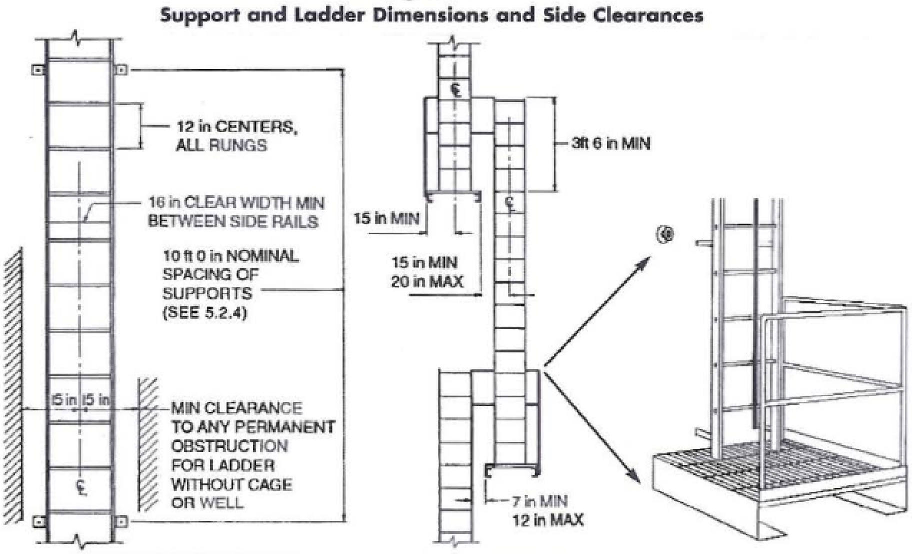
- Design and installation of mountings and cable guides must not reduce the strength of the ladder.
- Side rails and steps or rungs for side-step fixed ladders must be continuous in extension.

Defective Ladders

Ladders needing repairs are subject to the following rules:

- Portable ladders with structural defects—such as broken or missing rungs, cleats, or steps, broken or split rails, corroded components, or other faulty components—must immediately be marked defective or tagged with "Do Not Use" or similar language and withdrawn from service until repaired.
- Fixed ladders with structural defects—such as broken or missing rungs, cleats, or steps, broken or split rails, or corroded components—must be withdrawn from service until repaired.
- Defective fixed ladders are considered withdrawn from use when they are immediately tagged with "Do Not Use" or similar language or marked in a manner that identifies them as defective or blocked—such as with a plywood attachment that spans several rungs.
- Ladder repairs must restore the ladder to a condition meeting its original design criteria before the ladder is returned to use.

Figure 6
Support and Ladder Dimensions and Side Clearances



SUPPORT SPACING, LADDER DIMENSIONS AND SIDE CLEARANCES

SIDE CLEARANCES FOR SIDE-STEP LADDERS

Figure 7
Rung Ends

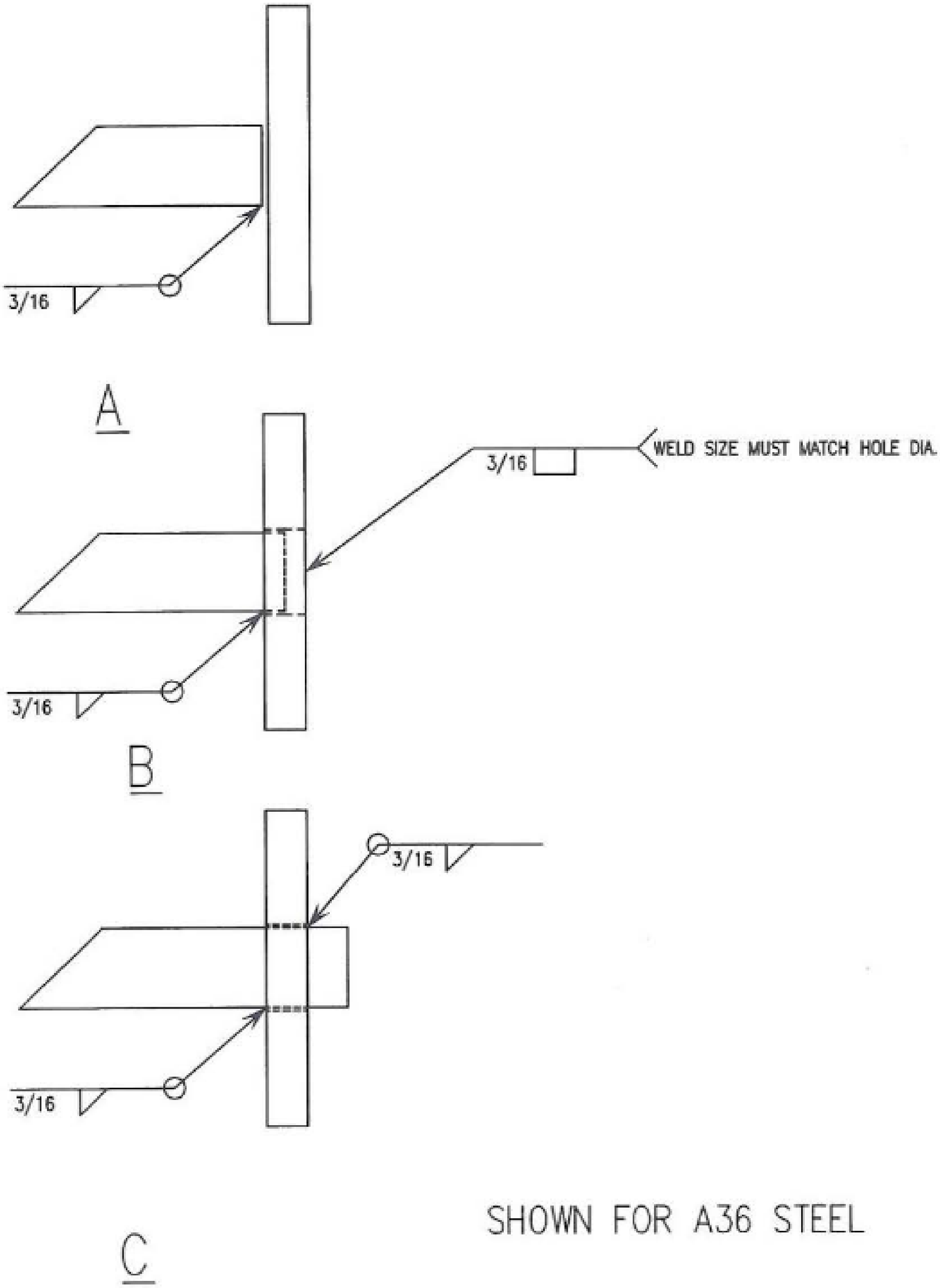


Figure 8

Individual Rung Ladders – Suggested Design of Rungs

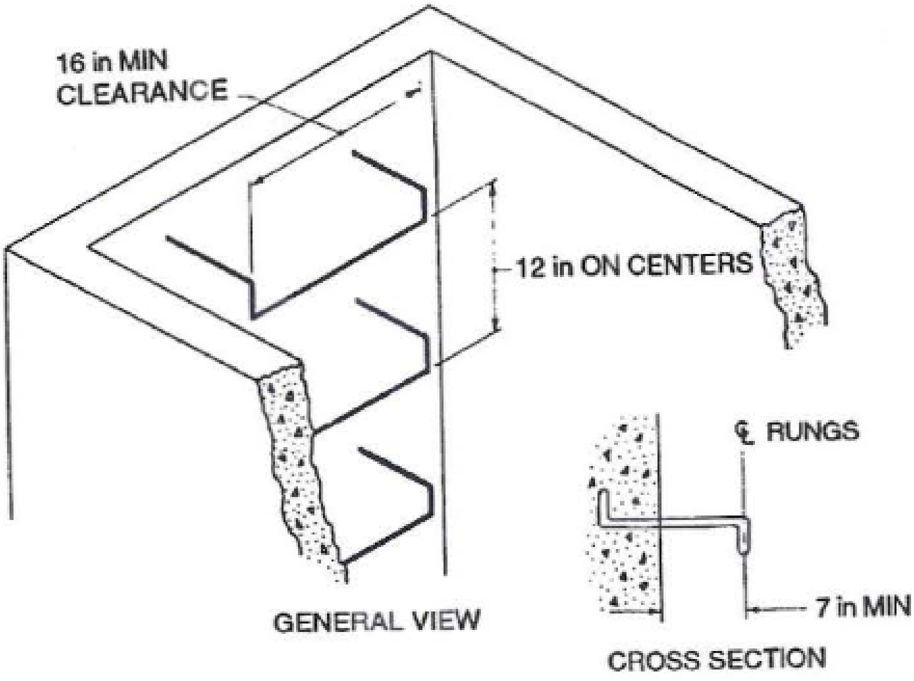


Figure 9

Termination at Floor or Platform

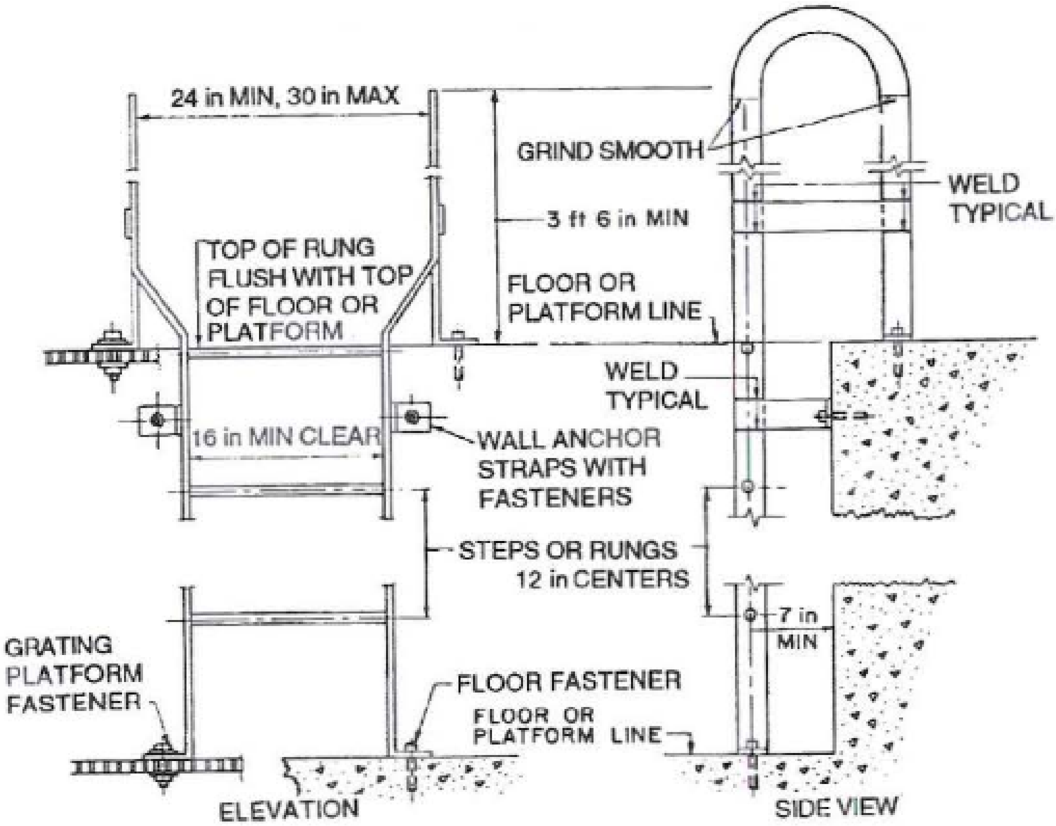


Figure 10
Terminations at Roof

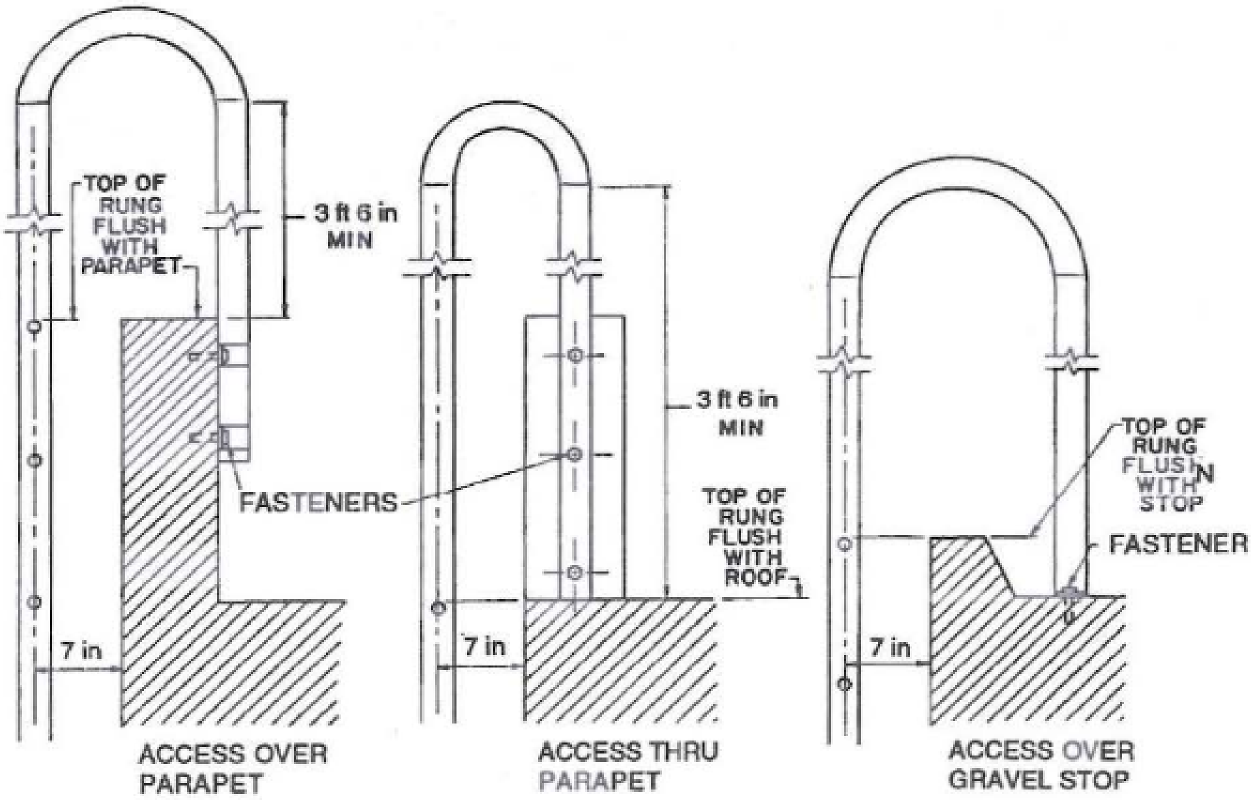


Figure 11
Grab Bars

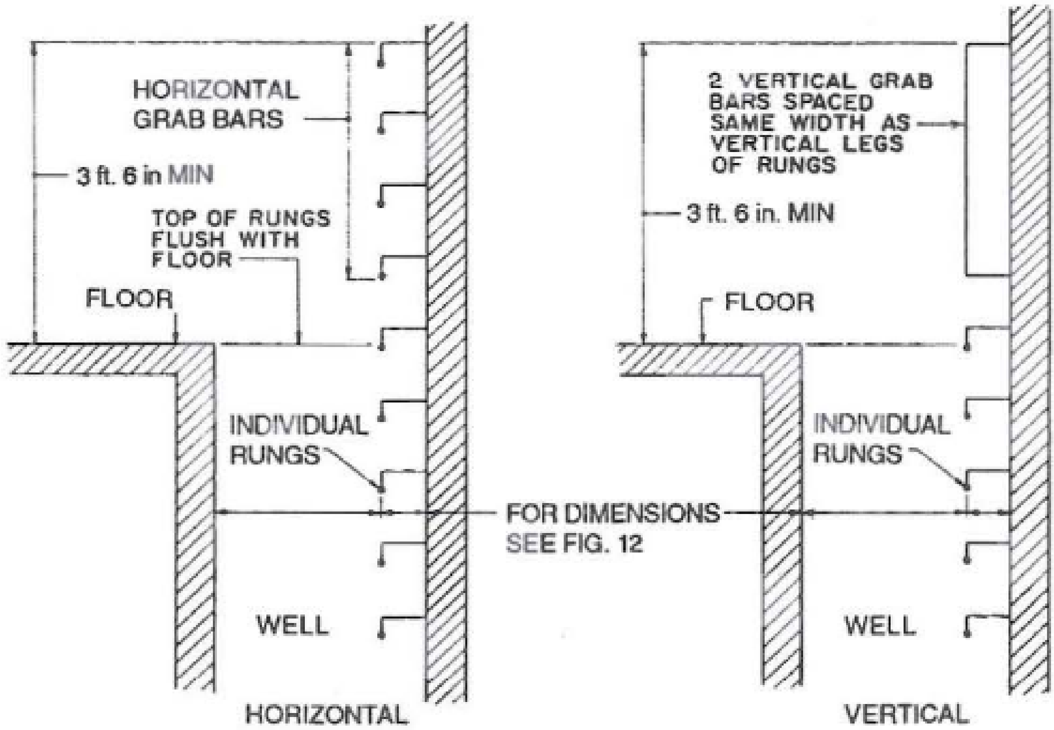


Figure 12
General Arrangements for Ladders in Wells

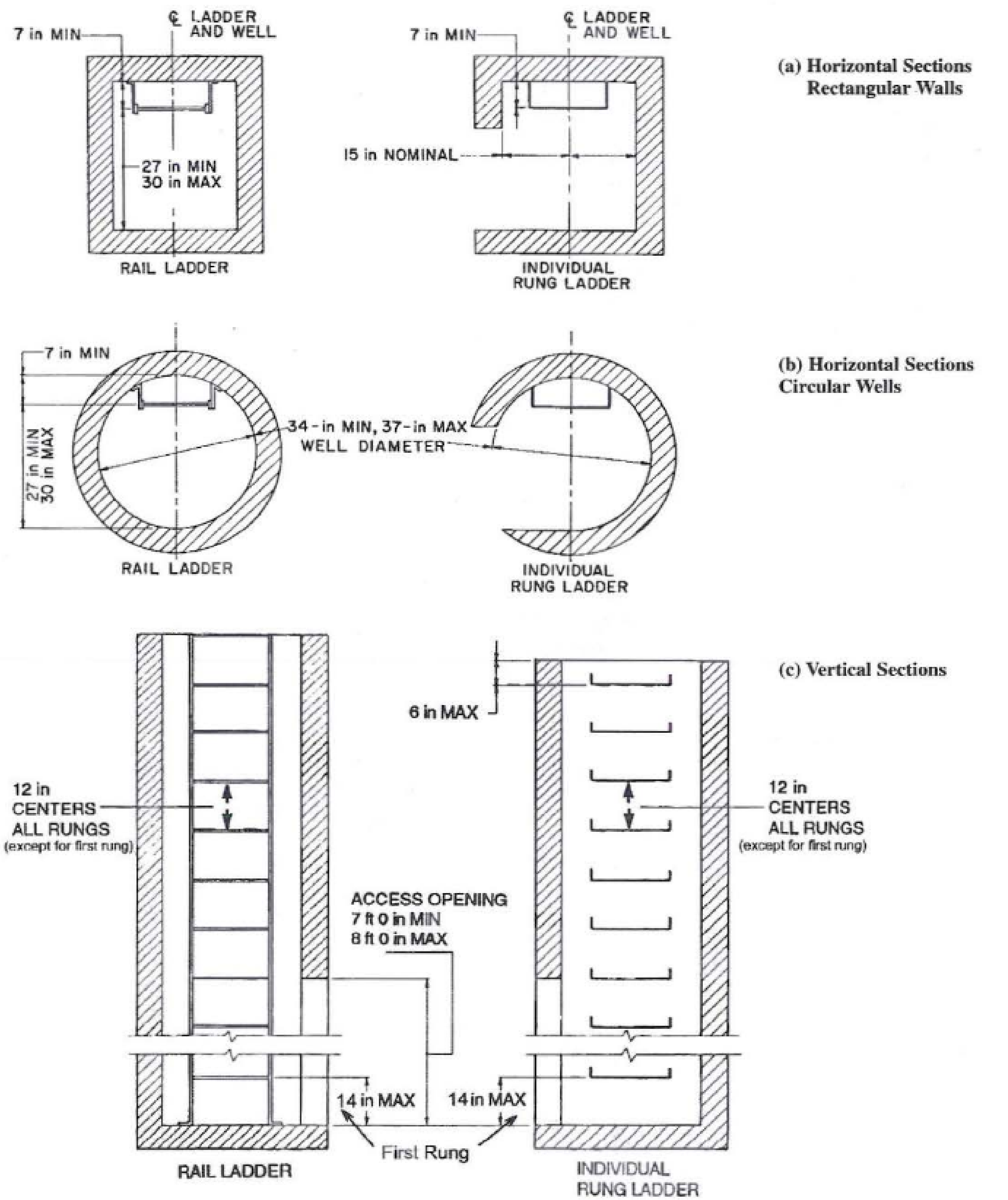


Figure 13

Deflector Plate for Hatch Opening with Reduced Clearance

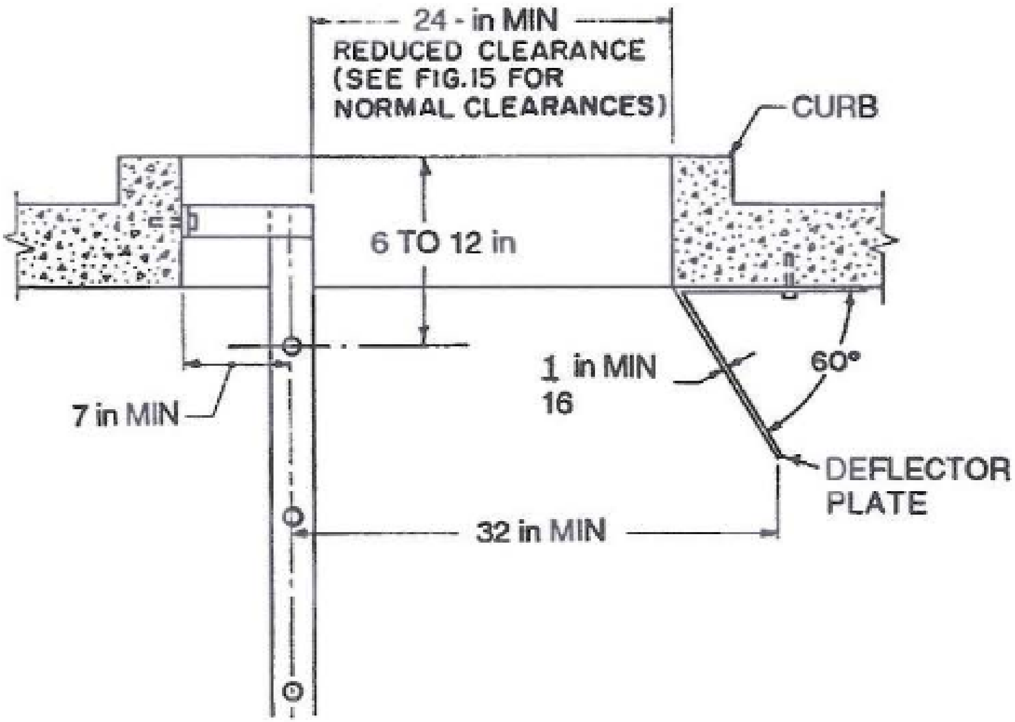


Figure 14

Counterbalanced Hatch Cover at Roof

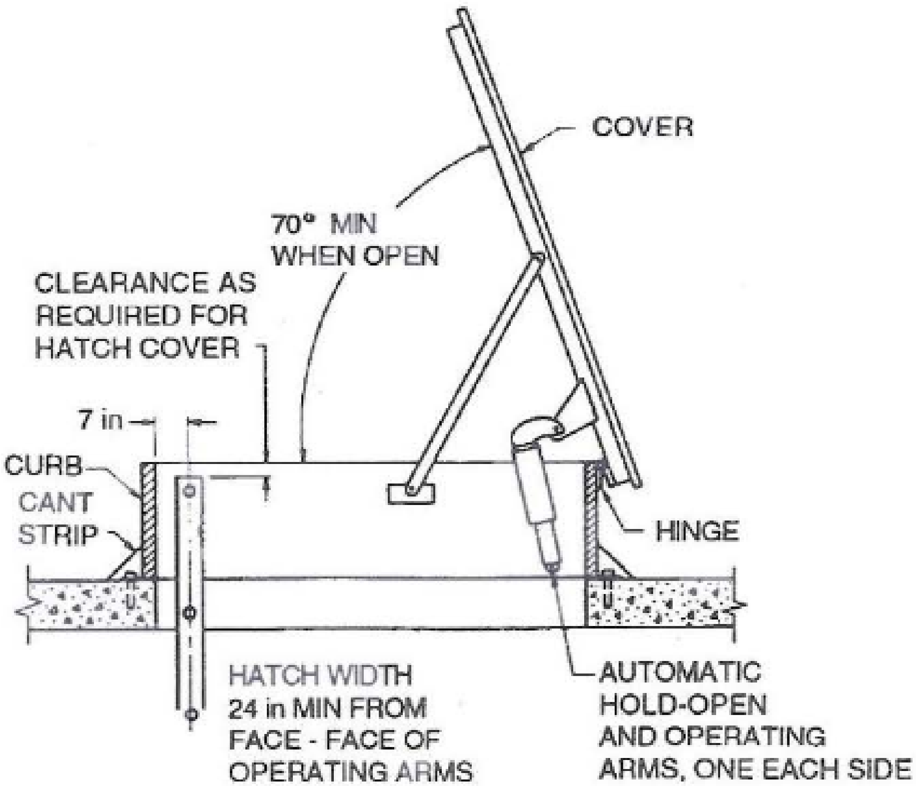


Figure 15

Minimum Ladder Clearance

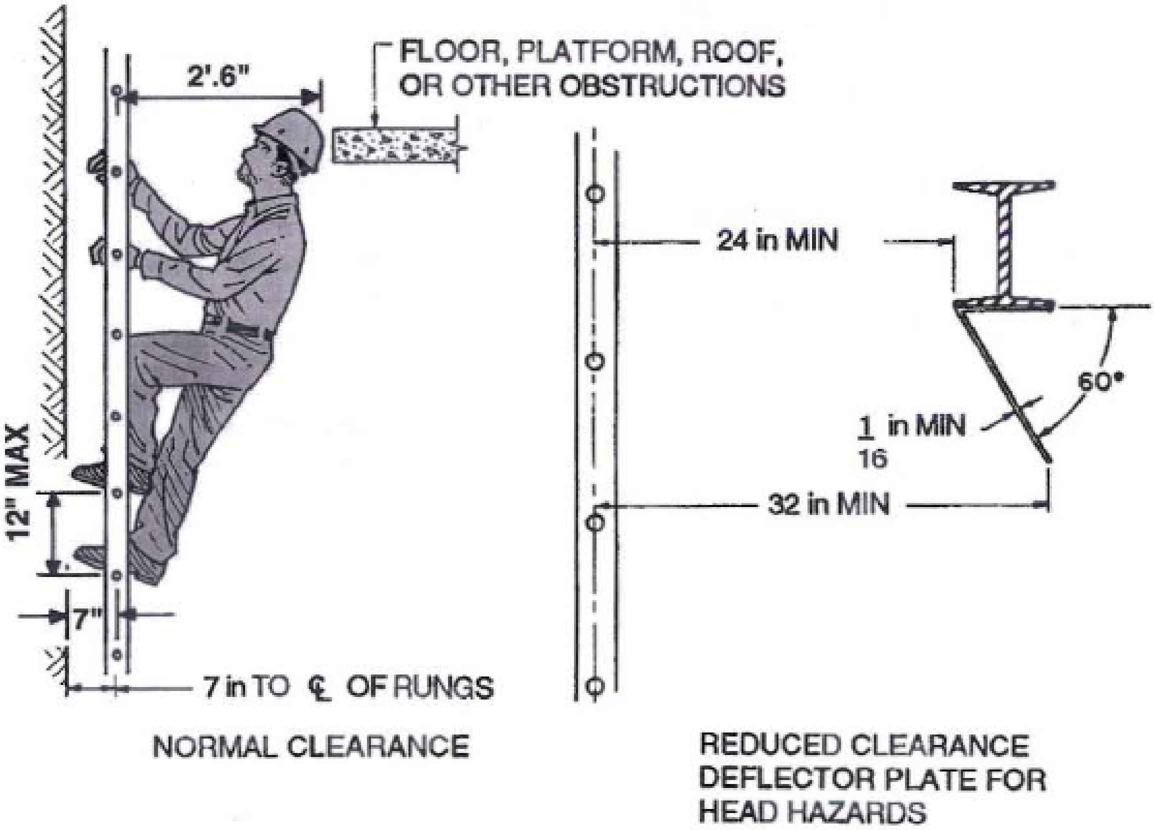
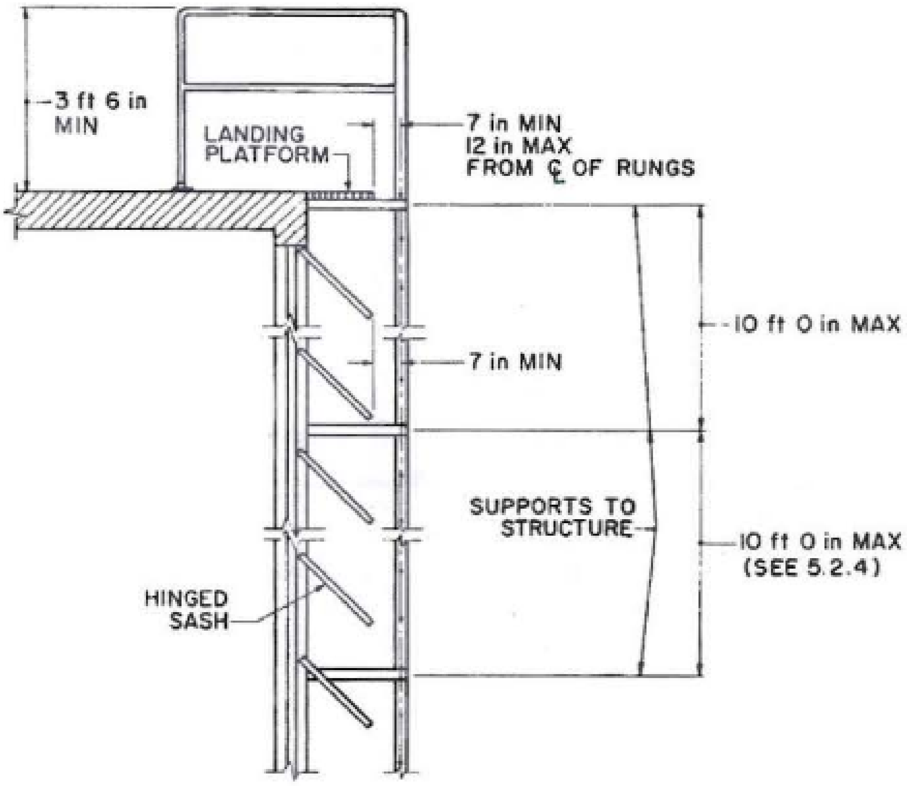
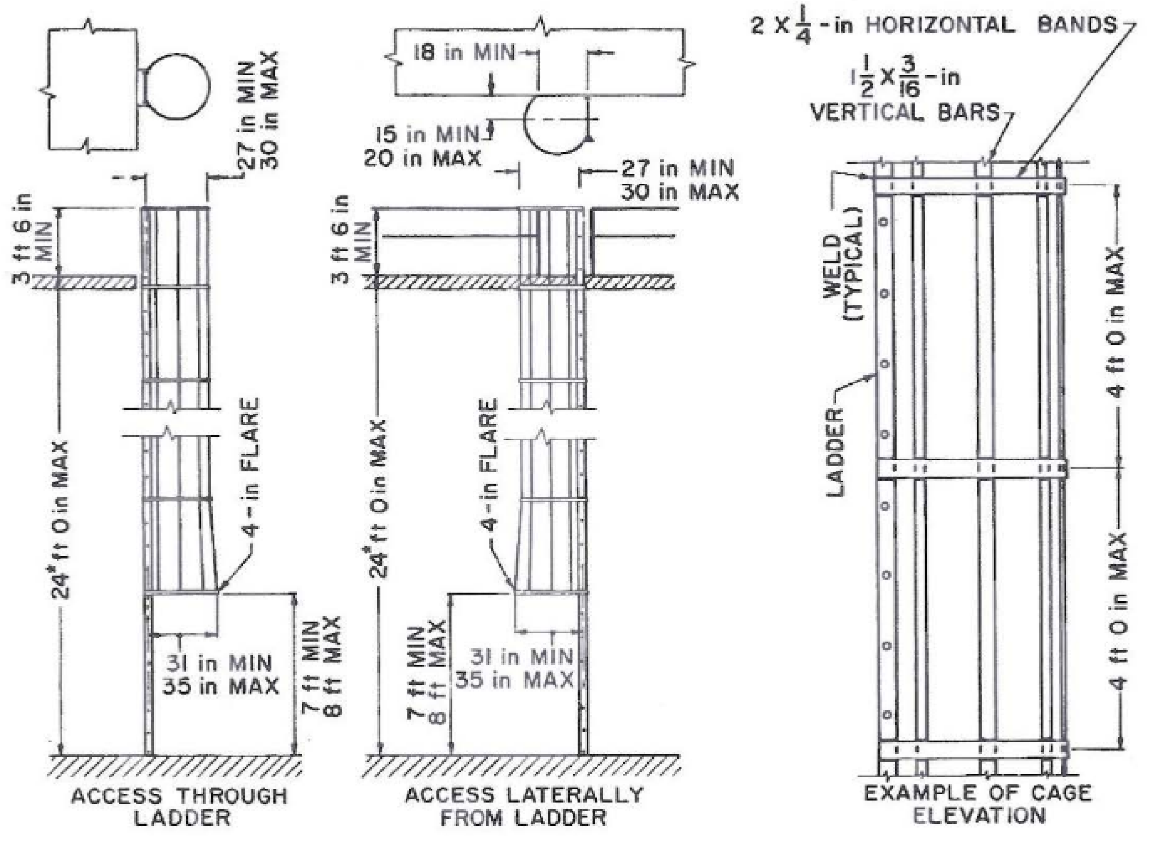


Figure 16

Through Ladder Clearance - Ladder Placed Far From Wall





* 24' without a ladder safety system

Figure 18
Example of a Cage Plan

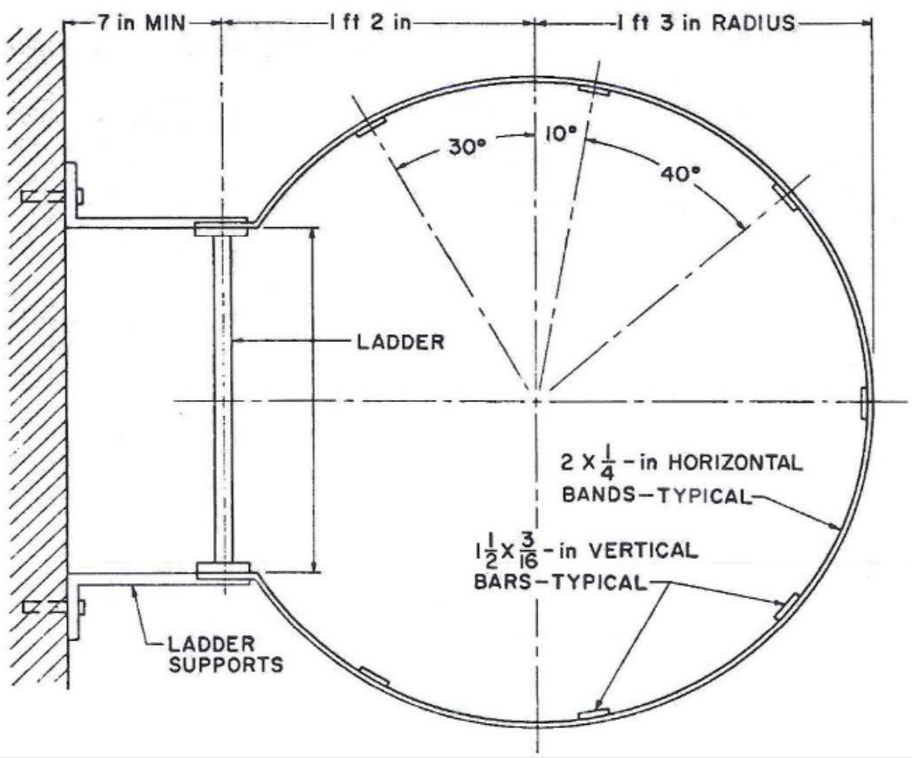


Figure 19
Display of Power Grip

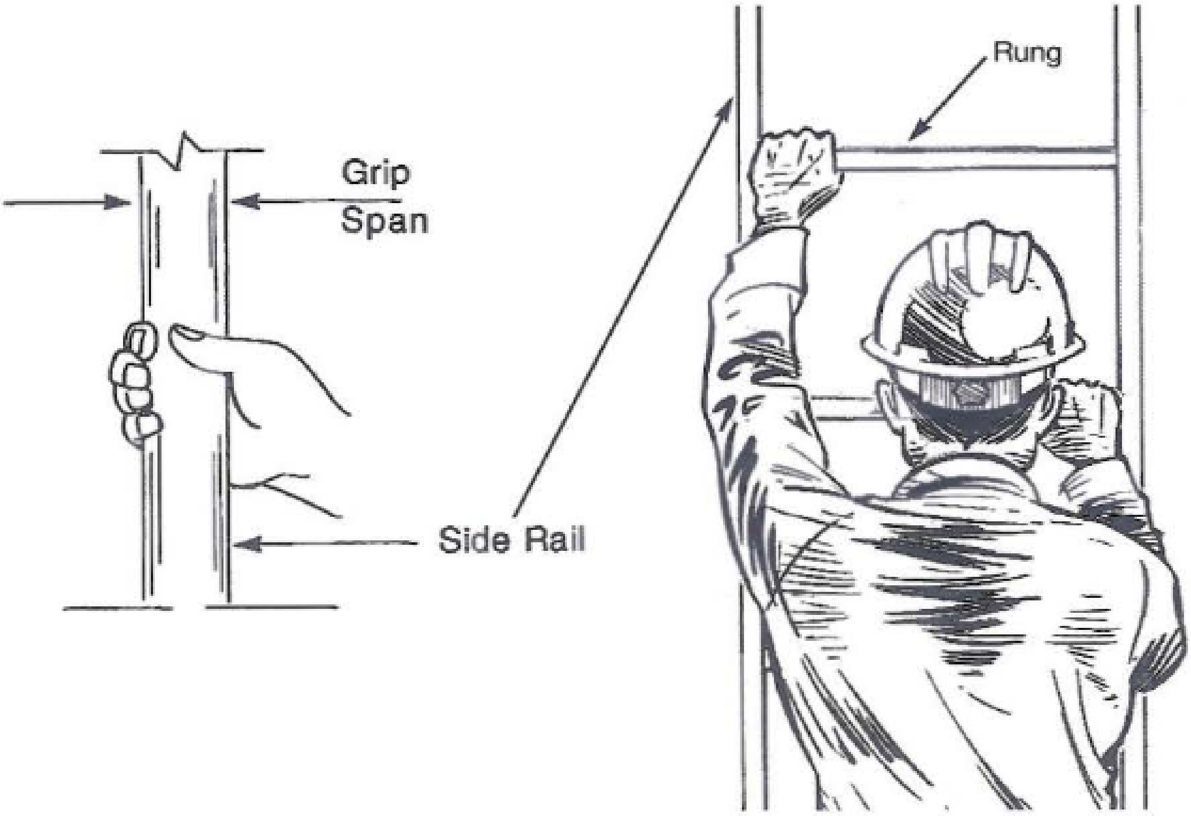


Figure 20
Connection Length Between Carrier and Safety Sleeve

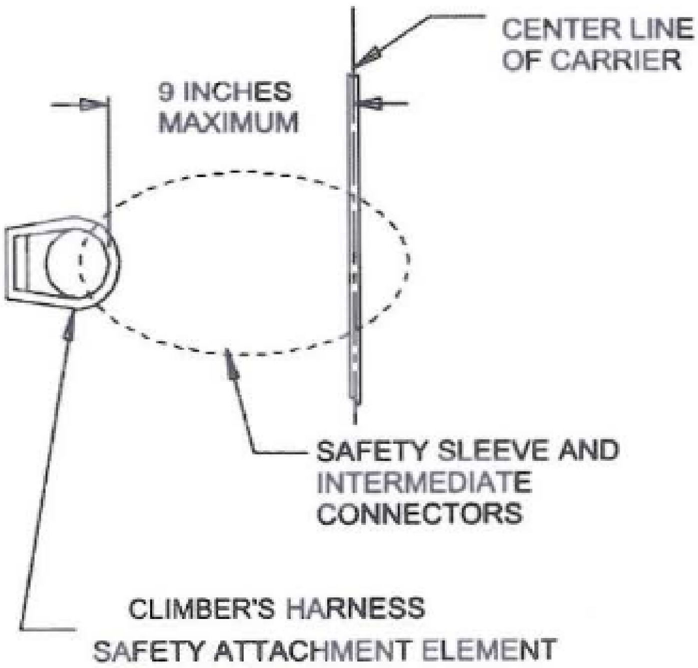
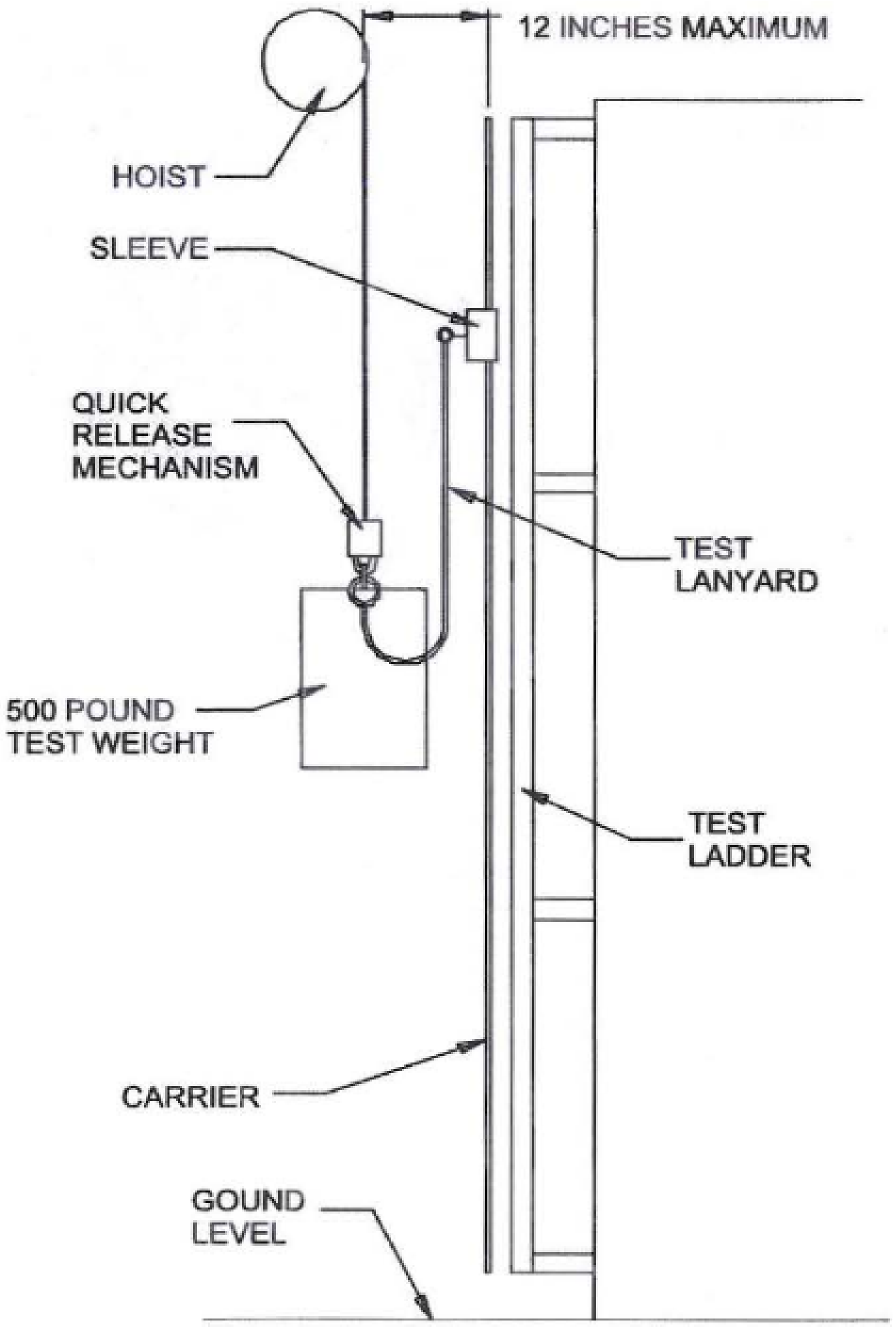


Figure 21

Dynamic Strength Test, Ladder Safety System, Shown Prior to Release of the Test Weight

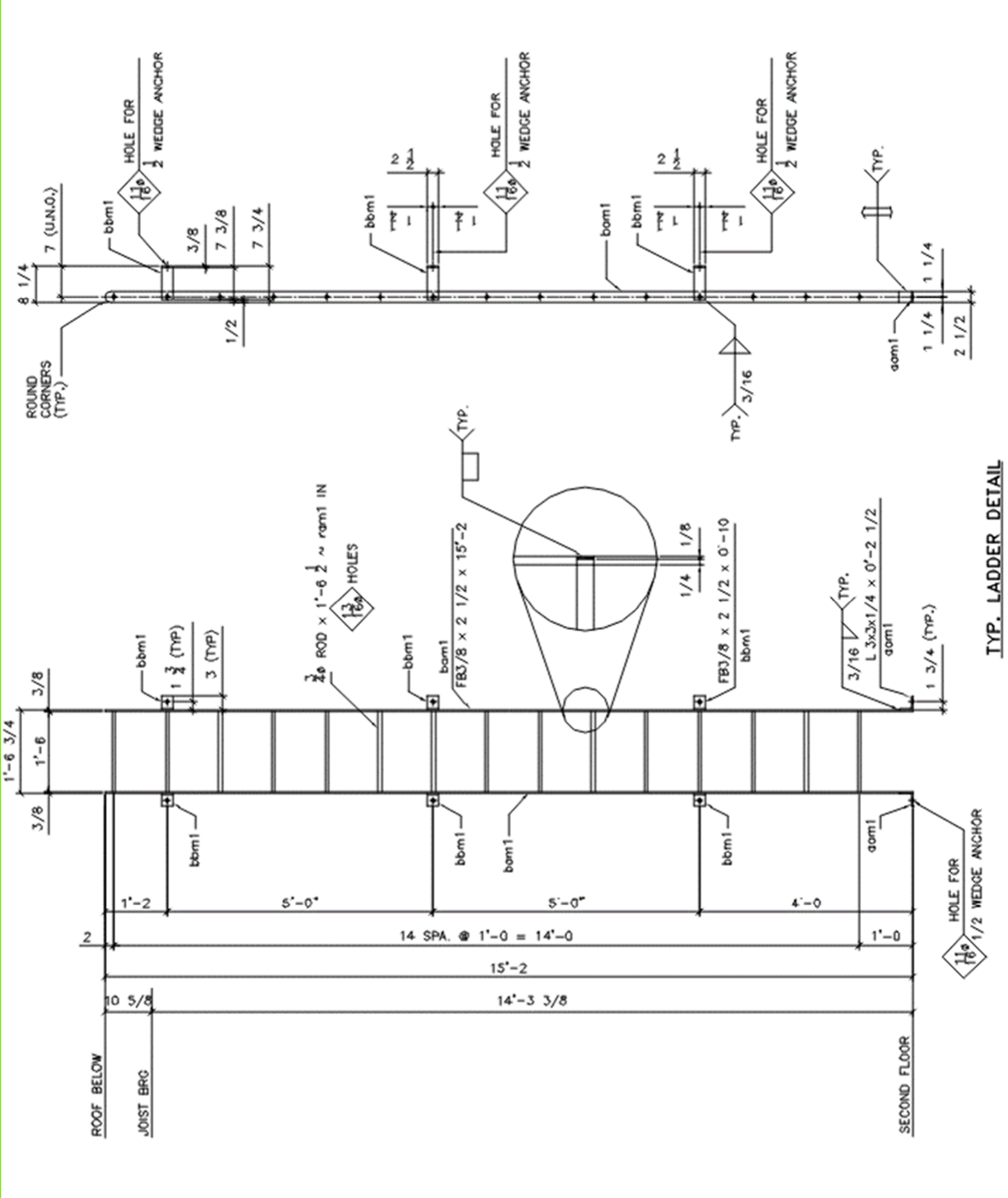


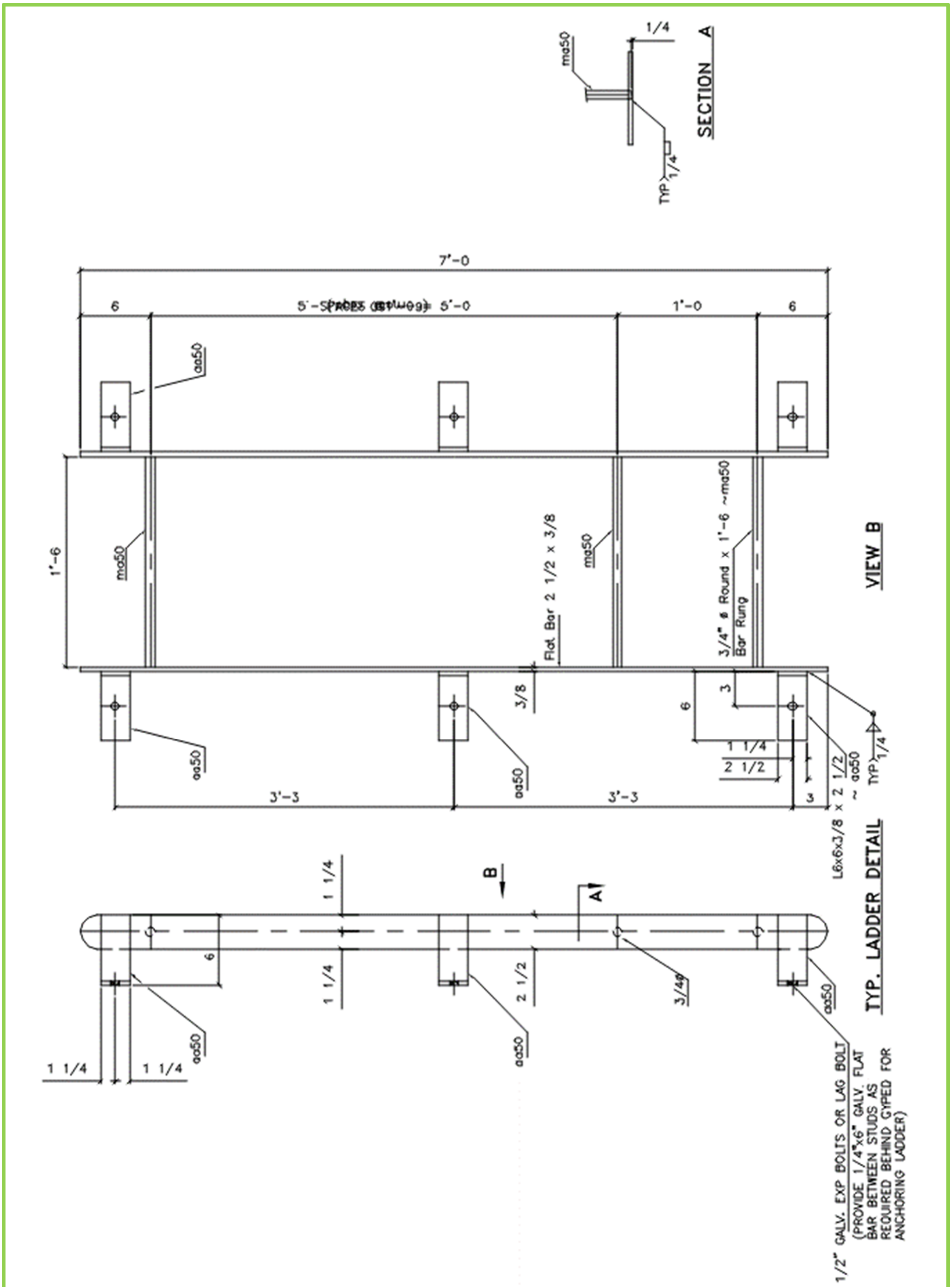
12.7.3 Ladders

i. Materials: Stringers – 3/8 x 2-1/2 F.B.;
  a. Rungs – ¾ diameter rods;
  b. Connection material – 3/8 x 2-1/2
  c. F.B. – Bent;
  d. Bolts – ½" Diameter (U.N.O)

ii. Width = 1'-6" inside; rung spacing = 1'-0" +/-

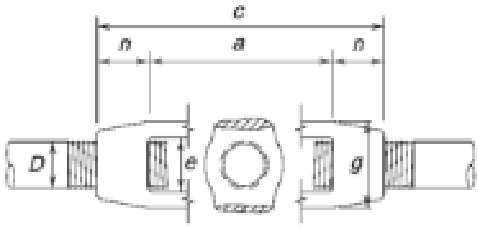
iii. Otherwise detail as shown on contract documents or as noted in contract specifications.




SECTION A
1/4
ma50
TYP 1/4
7'-0
6
5'-0
1'-0
6
aa50
1'-6
ma50
Flat Bar 2 1/2 x 3/8
3/4" ø Round x 1'-6 ~ma50
Bar Rung
VIEW B
3/8
3
6
1 1/4
2 1/2
3'-3
3'-3
3
L6x6x3/8 x 2 1/2 ~ aa50
TYP 1/4
B
A
1 1/4
6
2 1/2
3/4ø
TYP. LADDER DETAIL
1/2" GALV. EXP BOLTS OR LAG BOLT
(PROVIDE 1/4"x6" GALV. FLAT
BAR BETWEEN STUDS AS
REQUIRED BEHIND GYPED FOR
ANCHORING LADDER)

30. Turnbuckles and clevis

Table 15-6
Dimensions and Weights of Turnbuckles

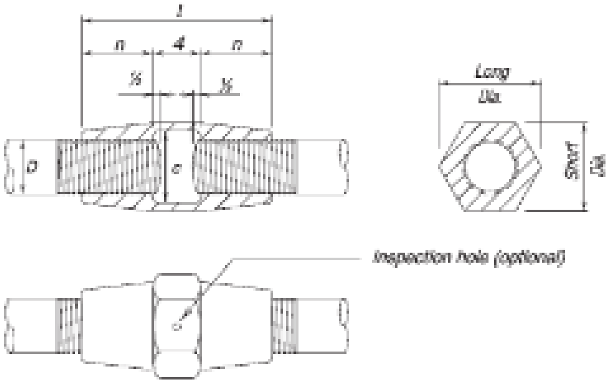


Threads: UNC and 4UN Class 2B

Diameter D, in.	Dimensions, in.					Weight (lb) for Length a, in.						Available Strength, kips	
	a	n	c	e	g	6	9	12	18	24	26	ASD R_n/Ω*	LRFD ϕR_n*
3/8	6	9/16	7 1/8	9/16	1 1/32	0.42						2.00	3.00
1/2	6	25/32	7 9/16	11/16	1 5/16	0.65	0.90	1.20				3.67	5.50
5/8	6	15/16	7 7/8	13/16	1 1/2	0.98	1.35	1.58	2.43			5.83	8.75
3/4	6	1 1/16	8 1/8	15/16	1 23/32	1.45	1.84	2.35	3.06	4.25		8.67	13.0
7/8	6	1 5/16	8 5/8	1 3/32	1 7/8	1.85		3.02	4.20	5.43		12.0	18.0
1	6	1 7/16	8 7/8	1 9/32	2 1/32	2.60		4.02	4.40	6.85	10.0	15.5	23.3
1 1/8	6	1 9/16	9 1/8	1 13/32	2 9/32	4.06		4.70	6.10			19.3	29.0
1 1/4	6	1 9/16	9 1/8	1 9/16	2 17/32	4.00		6.49	7.13	11.3	13.1	25.3	38.0
1 3/8	6	1 13/16	9 5/8	1 11/16	2 3/4	6.15						29.0	43.5
1 1/2	6	1 7/8	9 3/4	1 27/32	3 1/32	6.15		9.70	9.13	16.8	19.4	35.0	52.5
1 5/8	6	2 1/2	11	1 31/32	3 9/32	9.80						40.9	61.3
1 3/4	6	2 1/2	11	2 1/8	3 9/16	9.80		15.3	16.0	19.5		47.2	70.8
1 7/8	6	2 13/16	11 5/8	2 3/8	4	14.0		15.3				62.0	93.0
2	6	2 13/16	11 5/8	2 3/8	4	14.0		15.3		27.5		62.0	93.0
2 1/4	6	3 5/16	12 5/8	2 11/16	4 5/8	19.6		30.9		43.5		80.0	120
2 1/2	6	3 3/4	13 1/2	3	5	23.3		30.9		42.4		100	150
2 3/4	6	4 3/16	14 3/8	3 1/4	5 5/8	31.5				54.0		125	188
3	6	4 5/16	14 5/8	3 5/8	6 1/8	39.5						161	242
3 1/4	6	5 7/16	16 7/8	3 7/8	6 3/4	60.5		79.5				203	305
3 1/2	6	5 7/16	16 7/8	3 7/8	6 3/4	60.5	70.0	79.5				203	305
3 3/4	6	6	18	4 5/8	8 1/2	95.0						280	420
4	6	6	18	4 5/8	8 1/2	95.0						280	420
4 1/4	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
4 1/2	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
4 3/4	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
5	9	7 1/2	24	6	10		200					491	737

Notes:
Weights and dimensions of turnbuckles are typical; products of all suppliers are essentially similar. Users shall verify with the manufacturer that product meets strength specifications above.
* Tabulated available strengths are based on $\phi = 0.50$, $\Omega = 3.00$.

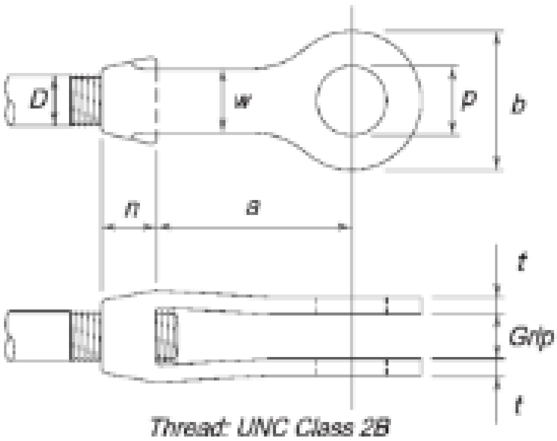
Table 15-7
Dimensions and Weights of Sleeve Nuts



Screw Dia., D, in.	Dimensions, in.					Weight, lb
	Short Dia.	Long Dia.	Length l	Nut n	Clear c	
3/8	11/16	25/32	4	—	—	0.27
7/16	25/32	7/8	4	—	—	0.34
1/2	7/8	1	4	—	—	0.43
9/16	15/16	1 1/16	5	—	—	0.64
5/8	1 1/16	1 7/32	5	—	—	0.93
3/4	1 1/4	1 7/16	5	—	—	1.12
7/8	1 7/16	1 5/8	7	1 7/16	1	1.75
1	1 5/8	1 13/16	7	1 7/16	1 1/8	2.46
1 1/8	1 13/16	2 1/16	7 1/2	1 5/8	1 1/4	3.10
1 1/4	2	2 1/4	7 1/2	1 5/8	1 3/8	4.04
1 3/8	2 3/16	2 1/2	8	1 7/8	1 1/2	4.97
1 1/2	2 3/8	2 11/16	8	1 7/8	1 5/8	6.16
1 5/8	2 9/16	2 15/16	8 1/2	2 1/16	1 3/4	7.36
1 3/4	2 3/4	3 1/8	8 1/2	2 1/16	1 7/8	8.87
1 7/8	2 15/16	3 5/16	9	2 5/16	2	10.4
2	3 1/8	3 1/2	9	2 5/16	2 1/8	12.2
2 1/4	3 1/2	3 15/16	9 1/2	2 1/2	2 3/8	16.2
2 1/2	3 7/8	4 3/8	10	2 3/4	2 5/8	21.1
2 3/4	4 1/4	4 13/16	10 1/2	2 15/16	2 7/8	26.7
3	4 5/8	5 1/4	11	3 3/16	3 1/8	33.2
3 1/4	5	5 5/8	11 1/2	3 3/8	3 3/8	40.6
3 1/2	5 3/8	6	12	3 5/8	3 5/8	49.1
3 3/4	5 3/4	6 3/8	12 1/2	3 13/16	3 7/8	58.6
4	6 1/8	6 7/8	13	4 1/16	4 1/8	69.2
4 1/4	6 1/2	7 1/2	13 1/2	4 3/4	4 3/8	75.0
4 1/2	6 7/8	7 15/16	14	5	4 3/4	90.0
4 3/4	7 1/4	8 3/8	14 1/2	5 1/4	5	98.0
5	7 5/8	8 7/8	15	5 1/2	5 1/4	110
5 1/4	8	9 1/4	15 1/2	5 3/4	5 1/2	122
5 1/2	8 3/8	9 3/4	16	6	5 3/4	142
5 3/4	8 3/4	10 1/8	16 1/2	6 1/4	6	157
6	9 1/8	10 5/8	17	6 1/2	6 1/4	176

Notes:
Weights and dimensions of sleeve nuts are typical; products of all suppliers are essentially similar. User shall verify with the manufacturer that strengths of sleeve nut are greater than the corresponding connecting rod when the same material is used.

Table 15-4
Dimensions and Weights of Clevises



Grip = plate thickness + ¼ in.

Clevis Number	Dimensions, in.							Weight, lb	Available Strength, kips*	
	Max. *D*	Max. *p*	*b*	*n*	*a*	*w*	*t*		ASD	LRFD
2	5/8	3/4	1 7/16	5/8	3 9/16	1 1/16	5/16 (+1/32, -0)	1	5.83	8.75
2 1/2	7/8	1 1/2	2 1/2	1	4	1 1/4	5/16 (+1/32, -0)	2.5	12.5	18.8
3	1 3/8	1 3/4	3	1 1/4	5 1/16	1 1/2	1/2 (+1/16, -1/32)	4	25.0	37.5
3 1/2	1 1/2	2	3 1/2	1 1/2	6	1 3/4	1/2 (+1/16, -1/16)	6	30.0	45.0
4	1 3/4	2 1/4	4	1 3/4	5 15/16	2	1/2 (+1/16, -1/16)	9	35.0	52.5
5	2 1/8	2 1/2	5	2 1/4	7	2 1/2	5/8 (+3/32, -0)	16	62.5	93.8
6	2 1/2	3	6	2 3/4	8	3	3/4 (+3/32, -0)	26	90.0	135
7	3	3 3/4	7	3	9	3 1/2	7/8 (+1/8, -1/16)	36	114	171
8	4	4 1/4	8	4	10 1/8	4	1 1/2 (+1/8, -1/16)	90	225	338

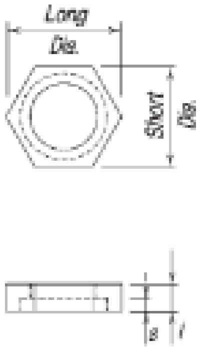
Notes:
Weights and dimensions of clevises are typical; products of all suppliers are essentially similar. User shall verify with the manufacturer that product meets available strength specifications above.
* Tabulated available strengths are based on $\phi = 0.50$, $\Omega = 3.00$. Strength at service load corresponds to a 3:1 safety factor using maximum pin diameter.

Table 15-5
Clevis Numbers Compatible with Various Rods and Pins

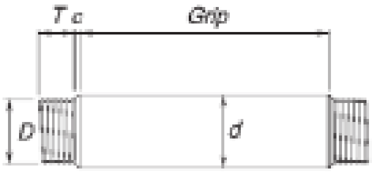
Dia. of Tap, in.	Diameter of Pin, in.																	
	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4
3/8	2	2	2															
1/2	2	2	2															
5/8	2	2	2	2 1/2	2 1/2	2 1/2	2 1/2											
3/4			2 1/2	2 1/2	2 1/2	2 1/2	2 1/2											
7/8				2 1/2	2 1/2	2 1/2	2 1/2	3										
1					3	3	3	3										
1 1/8					3	3	3	3	3 1/2									
1 1/4					3	3	3	3	3 1/2									
1 3/8						3	3	3 1/2	3 1/2	4								
1 1/2						3 1/2	3 1/2	4	4	5								
1 5/8						4	4	4	5	5	5							
1 3/4							4	5	5	5	5							
1 7/8							5	5	5	5	5							
2							5	5	5	5	5	6	6					
2 1/8								5	5	6	6	6	6					
2 1/4									6	6	6	6	6	7	7			
2 3/8									6	6	6	6	7	7	7	7		
2 1/2									6	6	6	7	7	7	7	7		
2 5/8											7	7	7	7	7	8		
2 3/4											7	7	7	7	8	8		
2 7/8											7	8	8	8	8	8	8	8
3											7	8	8	8	8	8	8	8
3 1/8												8	8	8	8	8	8	8
3 1/4												8	8	8	8	8	8	8
3 3/8												8	8	8	8	8	8	8
3 1/2													8	8	8	8	8	8
3 5/8													8	8	8	8	8	
3 3/4													8	8	8	8	8	
3 7/8														8	8	8		
4														8	8			

Notes:
Tabular values assume that the net area of the clevis through the pin hole is greater than or equal to 125% of the net area of the rod, and is applicable to round rods without upset ends. For other net area ratios, the required clevis size may be calculated by referring to the dimensions tabulated in Tables 15-4 and 7-17.

Table 15-8
Dimensions and Weights of Recessed-Pin Nuts

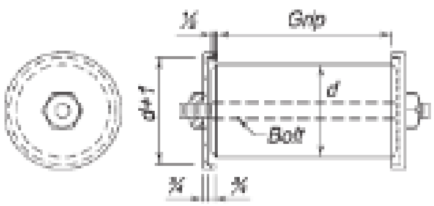


Material: Steel



Thread: 6 UN Class 2A/2B

Pin Dia. d, in.	Pin Dimensions, in.			Nut Dimensions, in.					Weight, lb
	Thread				Diameter		Recess		
	D	T	c	Thick-ness t	Short Dia.	Long Dia.	Rough Dia.	s	
2, 2 1/4	1 1/2	1	1/8	7/8	3	3 3/8	2 5/8	1/4	1
2 1/2, 2 3/4	2	1 1/8	1/8	1	3 5/8	4 1/8	3 1/8	1/4	2
3, 3 1/4, 3 1/2	2 1/2	1 1/4	1/8	1 1/8	4 3/8	5	3 7/8	3/8	3
3 3/4, 4	3	1 3/8	1/4	1 1/4	4 7/8	5 5/8	4 3/8	3/8	4
4 1/4, 4 1/2, 4 3/4	3 1/2	1 1/2	1/4	1 3/8	5 3/4	6 5/8	5 1/4	1/2	5
5, 5 1/4	4	1 5/8	1/4	1 1/2	6 1/4	7 1/4	5 3/4	1/2	6
5 1/2, 5 3/4, 6	4 1/2	1 3/4	1/4	1 5/8	7	8 1/8	6 1/2	5/8	8
6 1/4, 6 1/2	5	1 7/8	3/8	1 3/4	7 5/8	8 7/8	7	5/8	10
6 3/4, 7	5 1/2	2	3/8	1 7/8	8 1/8	9 3/8	7 1/2	3/4	12
7 1/4, 7 1/2	5 1/2	2	3/8	1 7/8	8 5/8	10	8	3/4	14
7 3/4, 8, 8 1/4	6	2 1/4	3/8	2 1/8	9 3/8	10 7/8	8 3/4	3/4	19
8 1/2, 8 3/4, 9	6	2 1/4	3/8	2 1/8	10 1/4	11 7/8	9 5/8	3/4	24
9 1/4, 9 1/2	6	2 3/8	3/8	2 1/4	11 1/4	13	10 5/8	3/4	32
9 3/4, 10	6	2 3/8	3/8	2 1/4	11 1/4	13	10 5/8	3/4	32



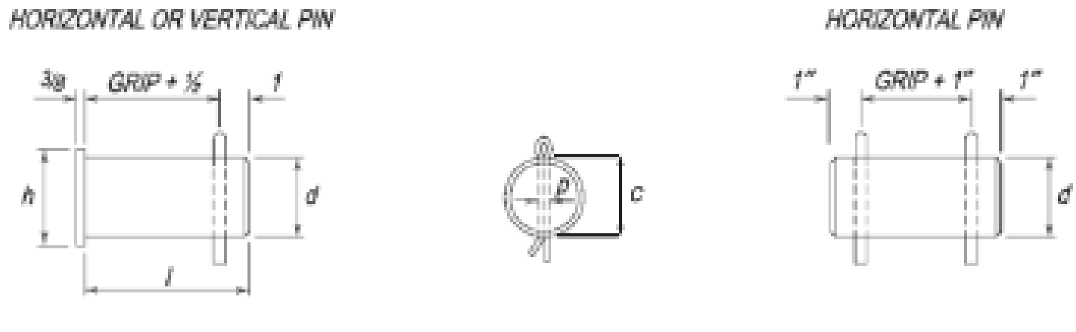
Typical Pin Cap Detail for Pins over 10 in. in dia.

Dimensions shown are approximate

Notes:

Although nuts may be used on all sizes of pins as shown above, a detail similar to that shown at the left is preferable for pin diameters over 10 in. In this detail, the pin is held in place by a recessed cap at each end and secured by a bolt passing completely through the caps and pin. Suitable provisions must be made for attaching pilots and driving nuts.

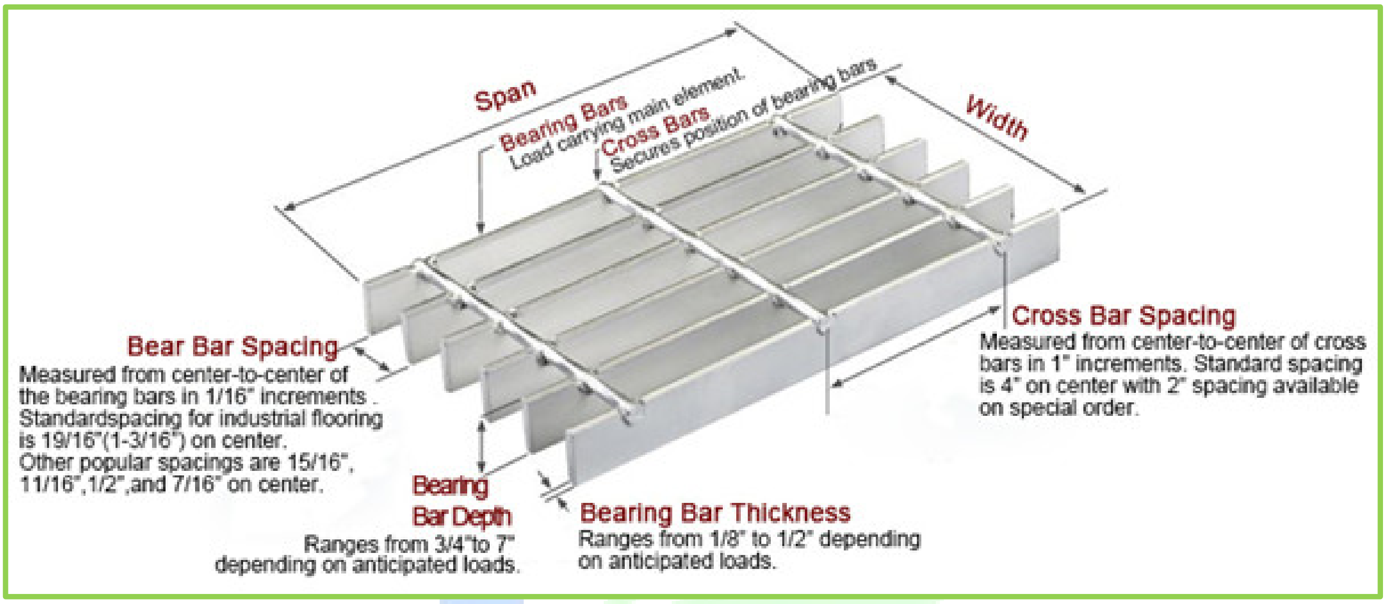
Table 15-9
Dimensions and Weights of Clevis and Cotter Pins



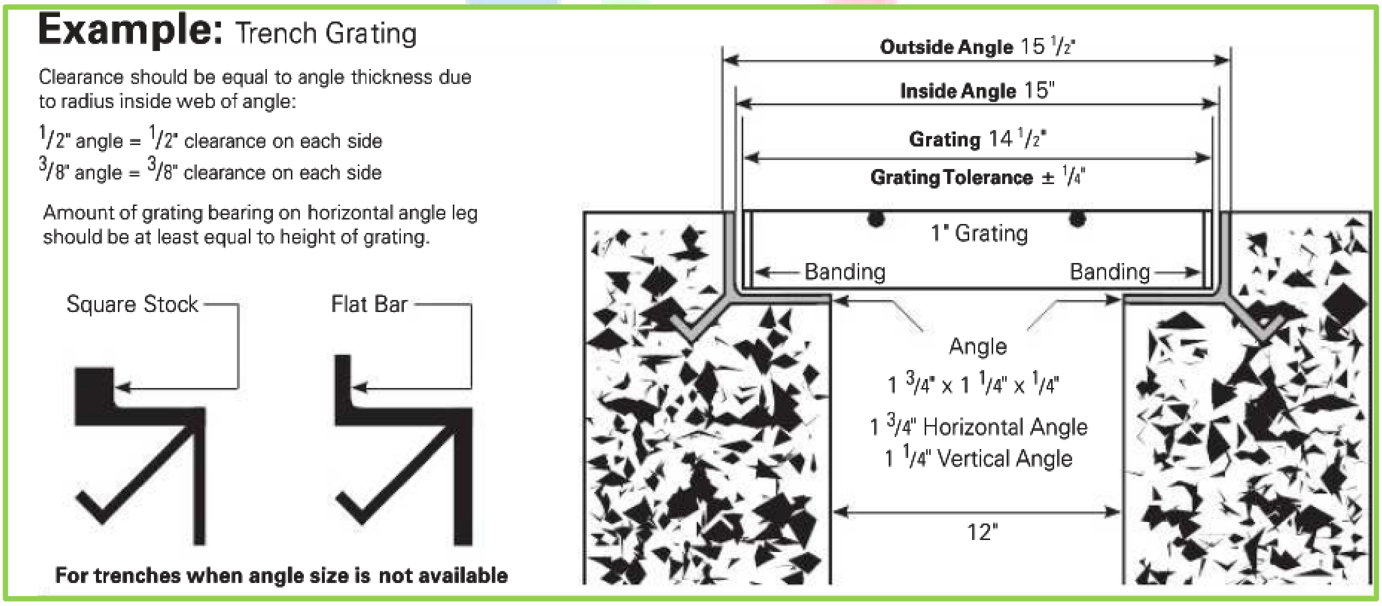
Pin Diameter d, in.	Pins with Heads		Cotter		
	Head Diameter h, in.	Weight of One, lb	Length c, in.	Diameter p, in.	Weight per 100, lb
$1\frac{1}{4}$	$1\frac{1}{2}$	$0.19 + 0.35l$	2	$\frac{1}{4}$	2.64
$1\frac{1}{2}$	$1\frac{3}{4}$	$0.26 + 0.50l$	$2\frac{1}{2}$	$\frac{1}{4}$	3.10
$1\frac{3}{4}$	2	$0.33 + 0.68l$	$2\frac{3}{4}$	$\frac{1}{4}$	3.50
2	$2\frac{3}{8}$	$0.47 + 0.89l$	3	$\frac{3}{8}$	9.00
$2\frac{1}{4}$	$2\frac{5}{8}$	$0.58 + 1.13l$	$3\frac{1}{4}$	$\frac{3}{8}$	9.40
$2\frac{1}{2}$	$2\frac{7}{8}$	$0.70 + 1.39l$	$3\frac{3}{4}$	$\frac{3}{8}$	10.9
$2\frac{3}{4}$	$3\frac{1}{8}$	$0.82 + 1.68l$	4	$\frac{3}{8}$	11.4
3	$3\frac{1}{2}$	$1.02 + 2.00l$	5	$\frac{1}{2}$	28.5
$3\frac{1}{4}$	$3\frac{3}{4}$	$1.17 + 2.35l$	5	$\frac{1}{2}$	28.5
$3\frac{1}{2}$	4	$1.34 + 2.73l$	6	$\frac{1}{2}$	33.8
$3\frac{3}{4}$	$4\frac{1}{4}$	$1.51 + 3.13l$	6	$\frac{1}{2}$	33.8

31. Grating

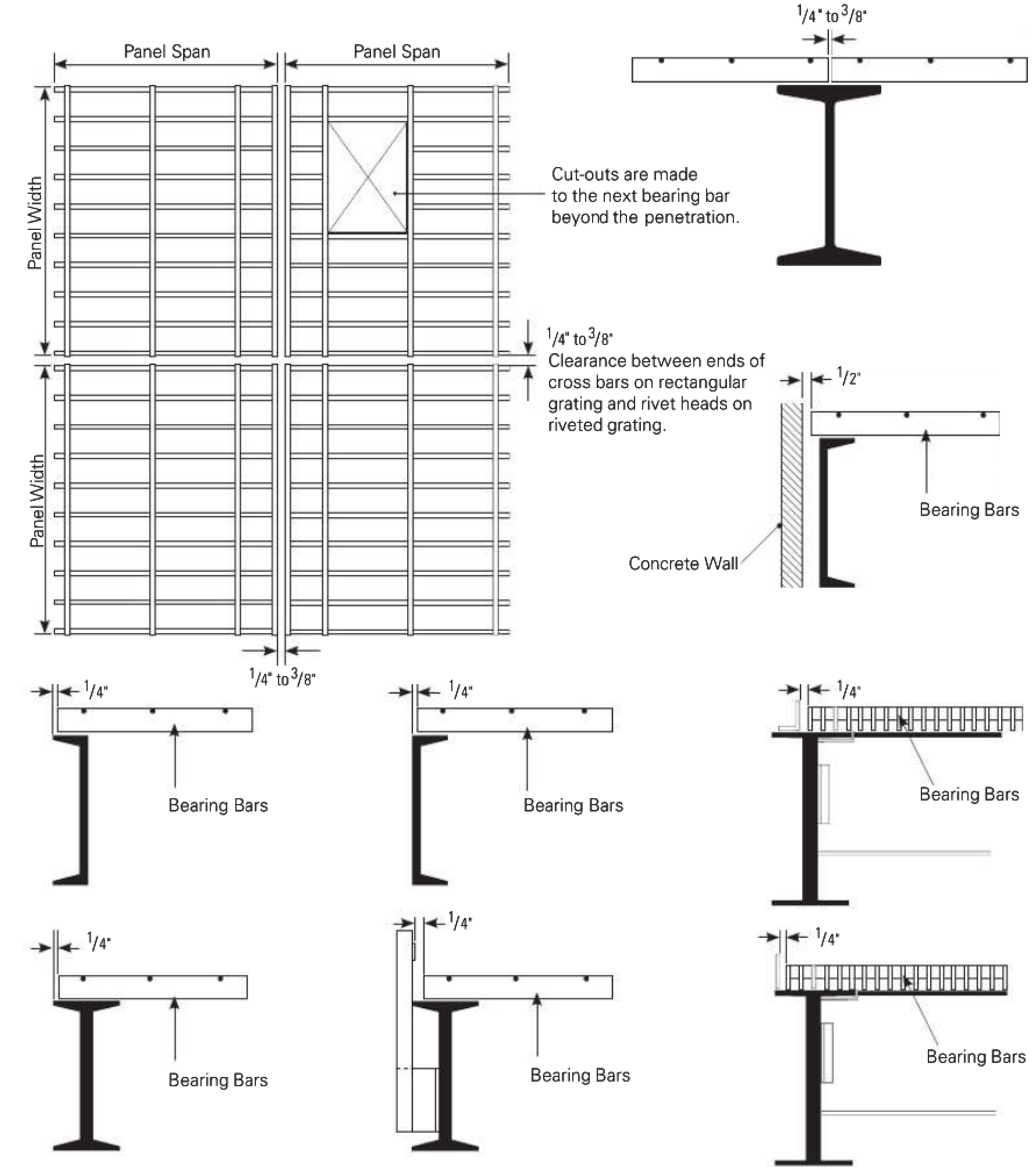
Steel bar grating is the staple of the grating industry, mainly used for flooring applications. With a large list of options, any need can be met. The most economical choice of steel grating product.



Installation clearances



Standard Installation Clearances

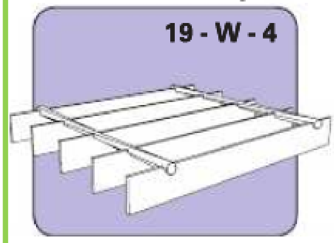


19-W-4 19-W-2 19-P-4 19-P-2

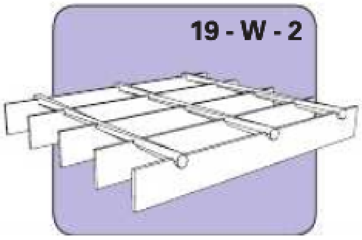
Carbon Steel Welded Bar Grating
Carbon Steel Press-Locked Bar Grating

Steel Welded Grating – 1 3/16" Center to Center of Bearing Bars

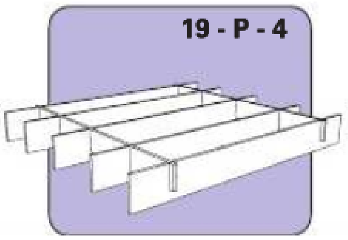
Steel Pressure-Locked – 1 3/16" Center to Center of Bearing Bars



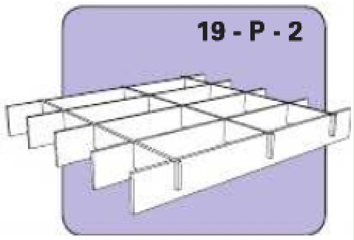
1/4" Round Twisted Cross Bars
4" Center to Center



1/4" Round Twisted Cross Bars
2" Center to Center



Rectangular Cross Bars
4' Center to Center



Rectangular Cross Bars
2" Center to Center

Panel Width Chart in Inches Dimensions are Outside to Outside of Bearing Bars. **Also Available in Stainless Steel**

No. of Bars	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/8" Bar	1 5/16	2 1/2	3 11/16	4 7/8	6 1/16	7 1/4	8 7/16	9 5/8	10 13/16	12	13 3/16	14 3/8	15 9/16	16 3/4	17 15/16
3/16" Bar	1 3/8	2 9/16	3 3/4	4 15/16	6 1/8	7 5/16	8 1/2	9 11/16	10 7/8	12 1/16	13 1/4	14 7/16	15 5/8	16 13/16	18
No. of Bars	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
1/8" Bar	19 1/8	20 5/16	21 1/2	22 11/16	23 7/8	25 1/16	26 1/4	27 7/16	28 5/8	29 13/16	31	32 3/16	33 3/8	34 9/16	35 3/4
3/16" Bar	19 3/16	20 3/8	21 9/16	22 3/4	23 15/16	25 1/8	26 5/16	27 1/2	28 11/16	29 7/8	31 1/16	32 1/4	33 7/16	34 5/8	35 13/16

Shaded columns indicate Standard Panel Width

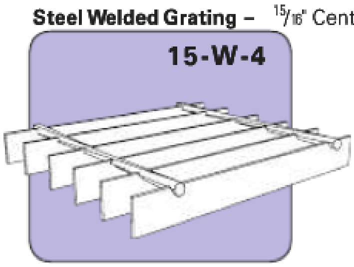
Carbon Steel Material: ASTM A-1011

15-W-4 15-W-2 15-P-4 15-P-2

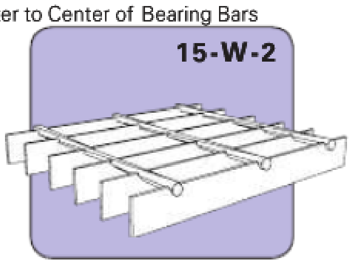
Carbon Steel Welded Bar Grating
Carbon Steel Press-Locked Bar Grating

Steel Welded Grating – 15/16" Center to Center of Bearing Bars

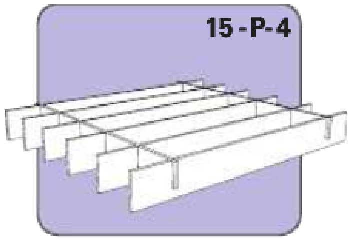
Steel Pressure-Locked – 15/16" Center to Center of Bearing Bars



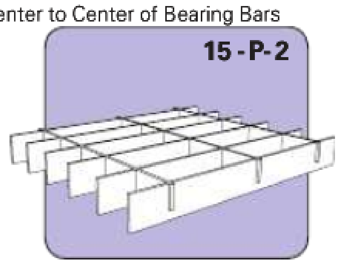
1/4" Round Twisted Cross Bars
4" Center to Center



1/4" Round Twisted Cross Bars
2" Center to Center



Rectangular Cross Bars
4" Center to Center



Rectagular Cross Bars
2" Center to Center

Panel Width Chart in Inches Dimensions are Outside to Outside of Bearing Bars. **Also Available in Stainless Steel**

No. of Bars	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/8" Bar	1 1/16	2	2 15/16	3 7/8	4 13/16	5 3/4	6 11/16	7 5/8	8 9/16	9 1/2	10 7/16	11 3/8	12 5/16	13 1/4	14 3/16
3/16" Bar	1 1/8	2 1/16	3	3 15/16	4 7/8	5 13/16	6 3/4	7 11/16	8 5/8	9 9/16	10 1/2	11 7/16	12 3/8	13 5/16	14 1/4
No. of Bars	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
1/8" Bar	15 1/8	16 1/16	17	17 15/16	18 7/8	19 13/16	20 3/4	21 11/16	22 5/8	23 9/16	24 1/2	25 7/16	26 3/8	27 5/16	28 1/4
3/16" Bar	15 3/16	16 1/8	17 1/16	18	18 15/16	19 7/8	20 13/16	21 3/4	22 11/16	23 5/8	24 9/16	25 1/2	26 7/16	27 3/8	28 5/16
No. of Bars	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**							
1/8" Bar	29 3/16	30 1/8	31 1/16	32	32 15/16	33 7/8	34 13/16	35 3/4							
3/16" Bar	29 1/4	30 3/16	31 1/8	32 1/16	33	33 15/16	34 7/8	35 13/16							

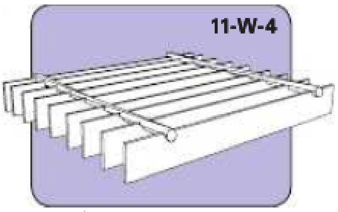
Shaded columns indicate Standard Panel Width

Carbon Steel Material: ASTM A-1011

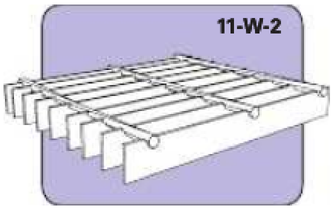
11-W-4 11-W-2
11-P-4 11-P-2

Carbon Steel Welded Bar Grating
Carbon SteelPress-Locked Bar Grating

Steel Welded Grating – 11/16" Center to Center of Bearing Bars

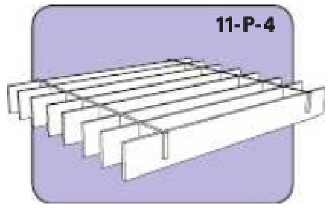


1/4" Round Twisted
Cross Bars
4" Center to Center

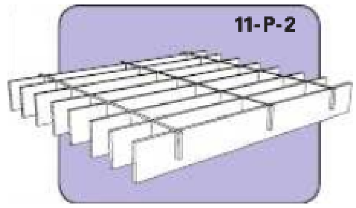


1/4" Round Twisted
Cross Bars
2" Center to Center

Steel Pressure-Locked – 11/16" Center to Center of Bearing Bars



Rectangular
Cross Bars
4" Center to Center



Rectangular
Cross Bars
2" Center to Center

Panel Width Chart in Inches Dimensions are Outside to Outside of Bearing Bars. **Also Available in Stainless Steel**

No. Of Bars	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1/8" Bar	13/16	1 1/2	2 3/16	2 7/8	3 9/16	4 1/4	4 15/16	5 5/8	6 5/16	7	7 11/16	8 3/8	9 1/16	9 3/4	10 7/16	11 1/8	11 13/16	12 1/2	13 3/16	13 7/8
3/16" Bar	7/8	1 9/16	2 1/4	2 15/16	3 5/8	4 5/16	5	5 11/16	6 3/8	7 1/16	7 3/4	8 7/16	9 1/8	9 13/16	10 1/2	11 3/16	11 7/8	12 9/16	13 1/4	13 15/16

No. of Bars	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1/8" Bar	14 9/16	15 1/4	15 15/16	16 5/8	17 5/16	18	18 11/16	19 3/8	20 1/16	20 3/4	21 7/16	22 1/8	22 13/16	23 1/2	24 3/16	24 7/8	25 9/16	26 1/4	26 15/16	27 5/8
3/16" Bar	14 5/8	15 5/16	16	16 11/16	17 3/8	18 1/16	18 3/4	19 7/16	20 1/8	20 13/16	21 1/2	22 3/16	22 7/8	23 9/16	24 1/4	24 15/16	25 5/8	26 5/16	27	27 11/16

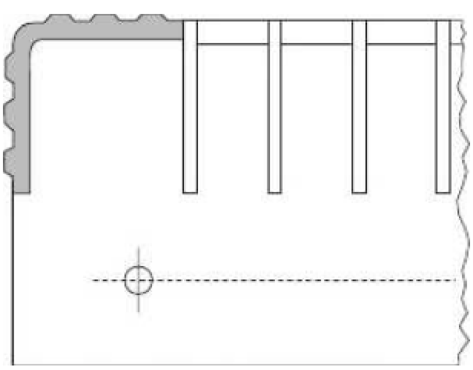
No. of Bars	42	43	44	45	46	47	48	49	50	51	52	53	54
1/8" Bar	28 5/16	29	29 11/16	30 3/8	31 1/16	31 3/4	32 7/16	33 1/8	33 13/16	34 1/2	35 3/16	35 7/8	36 9/16
3/16" Bar	28 3/8	29 1/16	29 3/4	30 7/16	31 1/8	31 13/16	32 1/2	33 3/16	33 7/8	34 9/16	35 1/4	35 15/16	36 5/8

Maximum Available Panel Width:
2'-0" (24 1/4") Maximum

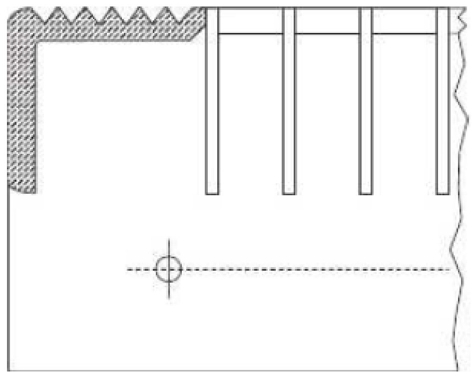
Carbon Steel Material: ASTM A-1011

Stair Treads

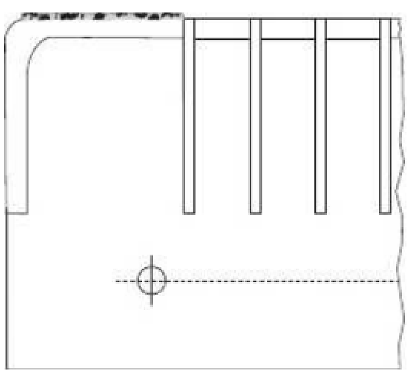
Nosings, Tread Widths & Standard End Plates



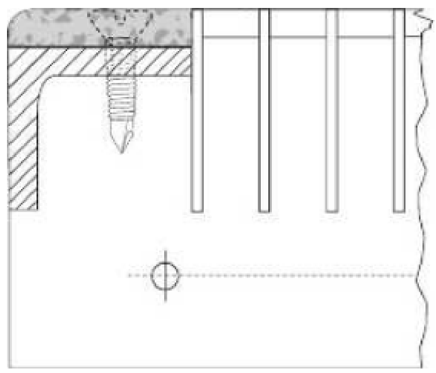
Checkered Plate Angle Nosing
(Carbon Steel)



Extruded Aluminum Corrugated Nosing



Mebac® Nosing
(Carbon Steel or Aluminum)

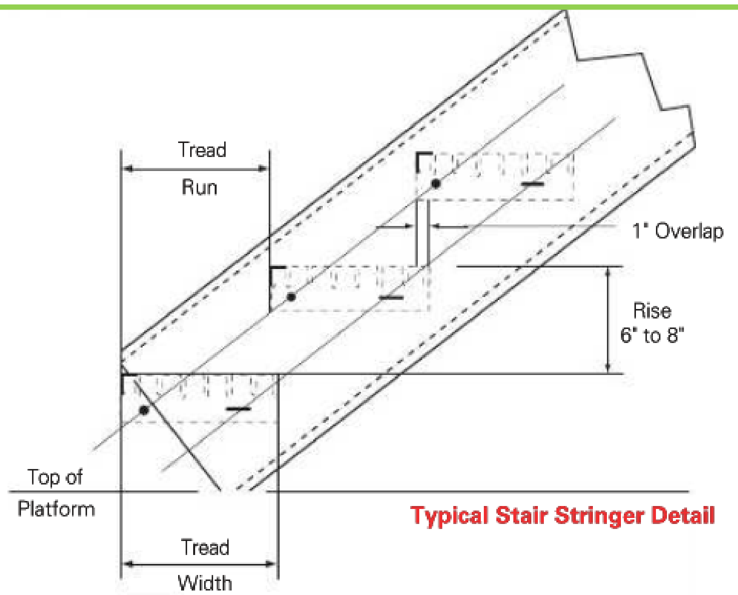


Cast Aluminum Abrasive Nosing
(attached to Carbon Steel or Aluminum Angles)

Bearing Bar Spacing

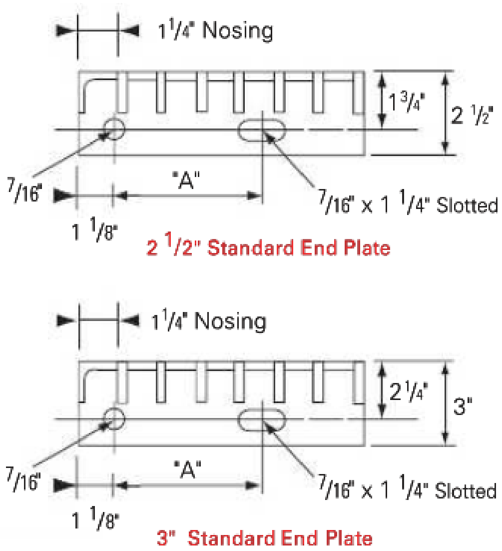
1 3/16" Center to Center		15/16" Center to Center	
Width	"A" Dim.	Width	"A" Dim.
6 3/16"	2 1/2"	6 1/8"	2 1/2"
7 3/8"	4 1/2"	7 1/16"	4 1/2"
8 9/16"	4 1/2"	8"	4 1/2"
9 3/4"	7"	8 15/16"	4 1/2"
10 15/16"	7"	9 7/8"	7"
12 1/8"	7"	10 13/16"	7"
13 5/16"	7"	11 3/4"	7"

NOTE: Widths are based on using 3/16" thick bearing bars. When using 1/8" thick bearing bars, tread width is 1/16" less.

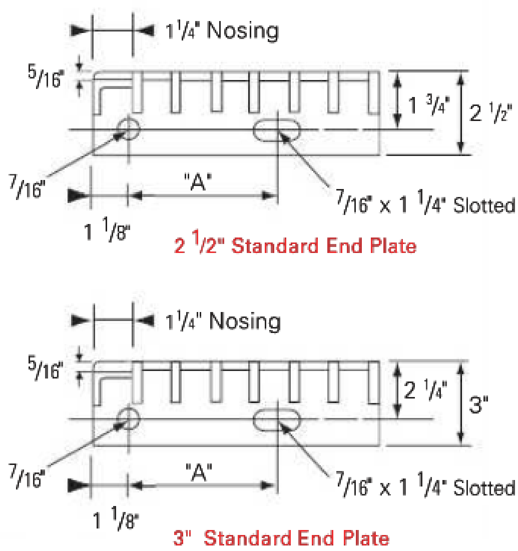


Typical Stair Stringer Detail

Checkered, Corrugated or Mebac® Nosings



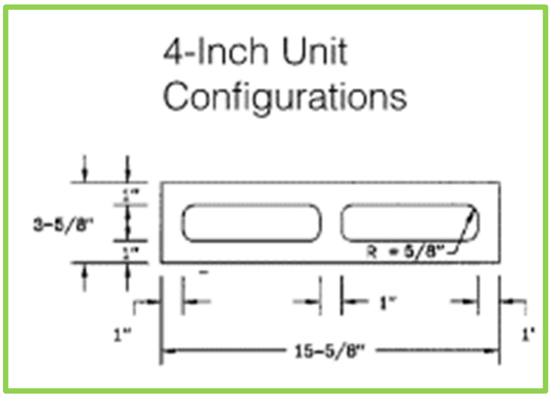
Cast Aluminum Abrasive Nosings

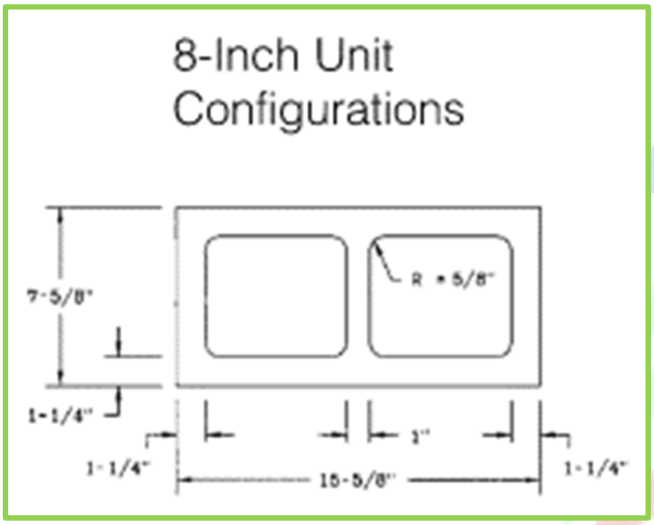


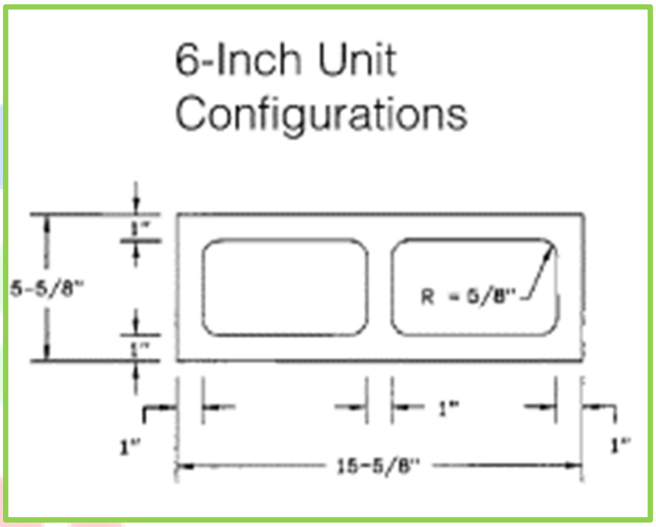
32. CMU wall: -

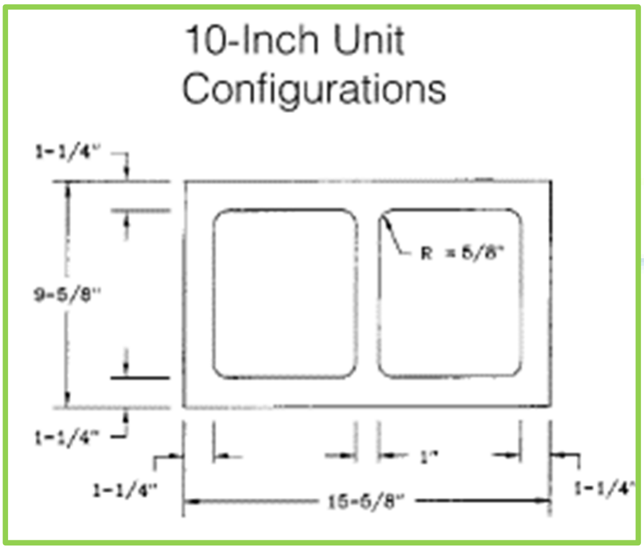
CMU - Concrete Masonry Unit Dimensions

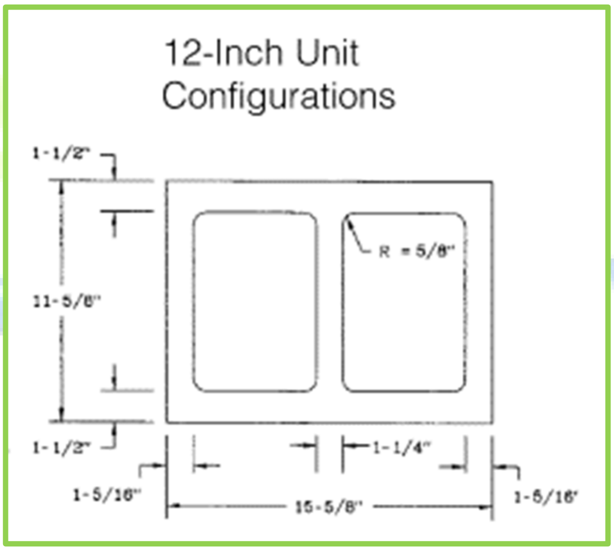
Nominal	Actual
4"	3 5/8"
6"	5 5/8"
8"	7 5/8"
10"	9 5/8"
12"	11 5/8"











33. Anchor bolt drawings: -

AB Plan

1. North direction
2. Grid dimensions, grid naming.
3. Top of pier, top of footing, base plate elevation.
4. Offset distance (if needed).
5. Column size, orientation.
6. Column locating dimensions.
7. Column type.
8. Hole pattern.
9. Erector notes.
10. Heading.
11. Title block.
12. Base plate orientation (brace connections).

AB Setting Details

1. Type.
2. Hole pattern.
3. Column orientation.
4. Anchor bolt projection.
5. Levelling plate (or) nut.
6. Grout thickness.
7. Hook type.
8. Embedment length.
9. Anchor bolt dia and count.
10. Base plate thickness.
11. Grid offset dimensions.
12. Plate washer detail.
13. Base plate extension direction.

Anchor Rod Details

1. Anchor bolt dia, overall length.
2. Grade.
3. Plate washer, nut.
4. Hook dimension.
5. Quantity.
6. To follow in BOM

34. Embed plan detail list: -

1. Study the structural and architectural where the embed to be located
2. Initially check the model for all wall and embed location
3. Save the view how to represent very simple and pier
4. View scales based on fabricator standard and clear vision
5. Plan should have following items
   - ✓ Key plan, Plan north
   - ✓ Job and fab name, Date of delivery & Title of the plan
   - ✓ Primary and secondary relevant grids are shown clearly
   - ✓ Elevation of member [top of embed plate elevation] (U.N.O) or member (individually)
   - ✓ XYZ dimension for individual piece marks
   - ✓ Wall profile with locating dimension
   - ✓ Embeds are shown on wire
   - ✓ If the embed have any anchors, it's also shown
   - ✓ All plans should have standard text sizes
   - ✓ All members are same sequence mostly. If differs shown in a separate sequence
   - ✓ If the embed arrangements do not show clearly in the plan, take a separate plan with the next scale, or other-wise take a blow-up
   - ✓ Typically, texts embed details in the plan
   - ✓ If embed arrangements have sections, section symbols placed closure to the arrangements
6. The section should have the following items:
   - ✓ Top of embed plate elevation
   - ✓ Reference of the section should be shown
   - ✓ Field weld and bolt details should be shown

- ✓ Some projects have clip angles to be loose. At the field connection to embed provide a horizontal offset to the centreline of the embed plate
- ✓ How to connect in the field is shown clearly (wall or any embed arrangement)

35. Erection plan detail list: -

1. Reference elevation/ Top of steel and Top of slab should be noted
2. Thickness of slab
3. Deck orientation, span direction
4. Edge of slab at openings etc.,
5. Wall layout for the entire building
6. Deck support angle locations. If any as per structural drawings
7. Provision of brick relieving/ shelf angle/ lintel angle
8. Slab depression
9. Gauge pour stop/ gauge material
10. To check whether the floor is composite or non-composite
11. True north/ Job north
12. Key plan
13. Camber value should be indicated in the framing plan
14. Beam penetration should be noted and indicated by the symbol
15. Shear plate position should be indicated in the framing plan by means of symbols at the location in the structural members
16. Beam piece mark and beam size always to keep left end., the PM beam size to keep right end side
17. Shear stud connectors should be provided in terms of their length, Dia as per structural documents
18. Different wall profiles should be referred from architectural drawings
19. Various bolt types such as A325N, and A490N should be indicated in the framing plan in terms of symbols for easy identification
20. If the floor is composite, then it should be noted in the erecter notes
21. Elevator openings and stair openings should be clearly shown as per the structural drawing

22. Column above/ Below Top of steel elevation should be noted as
    CU - Column up & CD - Column down
23. Sections call out are shown in the framing plan with reference [Sheet name/ Sheet #]
24. Location of structural steel member as per structural members
25. Brace views are indicated by a -------- line type and named as brace frame/ Brace view
26. If the members are in the same location with the difference in elevation it is shown in the plan as below
27. Moment symbol should be clearly noted and indicated with the distinct symbol as shown
    a. Field moment
    b. Shop moment
28. If there is a continuation of members with the following sequence, then the following sequence number with reference E-sheet name should be given with a broken line Which indicates the continuation of members in the following sequence.
29. If there are multiple sequences in the same plan, then the sequence division line is clearly shown
30. The locating dimension for the intermediate beams should be given precisely
31. In the case of fitted shear tab connection it should be clearly shown with a symbol indication
32. The title for the framing plan should be fixed correctly with the following Top of steel elevation/ Top slab elevation etc.,
33. The members in the following sequence are shown with a broken line with section size and sequence indicated below.

36. Lintel plan detail list: -

1. Prefer architectural drawings more than structural drawings
2. All the doors/window openings need to be noted
3. Provide lintel as noted on structural [Lintel schedule]. If not provided, use architectural drawings for reference
4. Opening size must be noted [Architectural Drawing]
5. Provide bearing as required [Minimum bearing should be followed as per design]
6. Use door schedule [architectural] to find opening size and type of openings
7. Lintel type [Beam/Angle] to be noted
8. Provide lintels at brick recess, If stated on design drawings
9. At brick walls [maximum] angle lintels are to be provided [Maximum]
10. Beam lintels are provided at CMU walls
11. On Erection sheets provide
    a. Locations
    b. Elevation [For each lintel]
    c. Opening size
    d. Bearing [Minimum]
    e. Special case lintel [If stated]
12. Provide masonry anchor and coupler on beam lintels, if noted
13. All the lintels on our drawings must match with structural and architectural drawings

37. Beam detailing list: -

1. Approval return / Engineer command
2. Beam and attachment grades
3. Work point, Elevation
4. Assembly dimension should be checked
5. Set back value
6. Seismic moment calculation
7. Holes-RD, Edge distance
8. Check typical comments of the job
9. Piece mark & Qty
10. Paint system
11. Field/shop bolts
12. Hex. Head
13. Face indicator – clearance, RD
14. Weld- Fillet/ CJP
15. Slot hole orientation- V,H
16. Nut-tack weld
17. Bevel cut details and notes
18. If stud comes on the top flange "Notes – No paint on top of flange surface"
19. If skewed plates are attached-Bevel, RD

Column detailing list: -

1. Approval return / Engineer command
2. Column and attachment grades
3. Work point, Elevation
4. Assembly dimension should be checked
5. Set back value
6. Holes-RD, Edge distance
7. Check typical comments of the job
8. Piece mark & Qty
9. Paint system
10. Field/shop bolts
11. Face direction – (North, South, West, East)

12. Weld- Fillet/ CJP
13. Slot hole orientation- V,H
14. Bevel cut details and notes
15. If CJP comes on the face of column "Mark No paint Notes "
16. If skewed plates are attached-Bevel, RD
17. Add Sq. Cut, Mill Cut, Bev. Cut
18. Base plate Hole size & Weld
19. Gusset plate weld
20. Cap plate weld
21. Joist stabilizer plate and weld.
22. Joist connection cap plate thickness & Hole gage.
23. Shear plate offset dimension.
24. View Name (A, B, C).
25. Connecting Side Mark.
26. Keep dimension (Top & Bot. Moment plate & Gusset plate Hole).
27. The section should be taken from Right to Left direction

References:

1. AISC Manual all editions
2. AWS Manual all editions
3. HILT USA
4. SDS2
5. Tekla
6. Portlandbolt
7. Haydon Bolts
8. Precision ladders
9. Hoover fence
10. GWYinc