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Drawing Details: The Good, The Bad, & The Ugly
May 13, 2021

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Course Description

Drawing Details: The Good, The Bad, and The Ugly
May 13, 2021

All contract documents have details to convey information, but not all details are created equal. This webinar will review examples of drawing details for clarity and simplification, identify issues such as load path, and explore potential corrections to bad details.

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Learning Objectives

- List features of a good structural steel drawing detail.
- Identify examples of structural details that do not provide valid load paths.
- Describe some common problems with connections to hollow structural sections and how they might be avoided.
- Demonstrate the value of drawing conceptual details with realistic geometry.

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Drawing Details: The Good, The Bad, and The Ugly

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Webinar Outline

- **Introduction**
- **Define Good, Bad, Ugly Details**
- **Examples**
- **Tips for Better Details & Connections**
- **Assessment and Q/A**

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Webinar Outline

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Drawing Details: The Good, The Bad, and The Ugly

Connections are essential to steel-framed structures

- Connect framing members to one another
  - Allow loads to transfer between members
  - Provide a complete load path to the foundation
- Drawing details need to accurately show how this is accomplished
  - Does new technology help or hurt?

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- **Introduction**
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Drawing Details: The Good

What makes a *good* detail?

- Valid load path
- Satisfies all limit states
- Easy to fabricate
- Easy to install
- Economical

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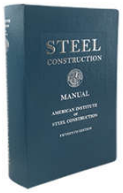
Drawing Details: The Good

Where to find examples of good details:

- AISC Manual Parts 9 – 14



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Drawing Details: The Good

Where to find examples of good details:

- AISC Manual Parts 9 – 14
- AISC Design Examples

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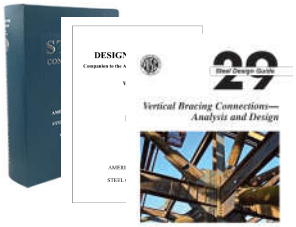
Drawing Details: The Good

Where to find examples of good details:

- AISC Manual Parts 9 – 14
- AISC Design Examples
- AISC Design Guides
  - Design Guide 4 – Moment Connections
  - Design Guide 29 – Vertical Bracing Connections



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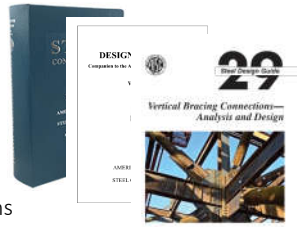
Drawing Details: The Good

Where to find examples of good details:

- AISC Manual Parts 9 – 14
- AISC Design Examples
- AISC Design Guides
  - Design Guide 4 – Moment Connections
  - Design Guide 29 – Vertical Bracing Connections
- Numerous textbooks and other publications



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Drawing Details: The Bad

What makes a *bad* detail?

- Invalid load path
- Limit state(s) are exceeded

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Drawing Details: The Ugly

What makes an *ugly* detail?

- Valid load path
- Satisfies all limit states
- Not easily fabricated and/or installed
  - Typically a result of
    - Geometry
    - Member selection
- Not economical
  - Typically a result of overly restrictive design requirements and limitations shown on the design drawings

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Drawing Details: Bad vs. Ugly

- Bad Details
  - ***Must*** be avoided
  - Life-safety issue
- Ugly Details
  - Sometimes cannot be avoided
  - Work with all parties involved (EOR, connection engineer, fabricator, erector, etc.) to find the ***best*** solution

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- **Examples**
- **Tips for Better Details & Connections**
- **Assessment and Q/A**

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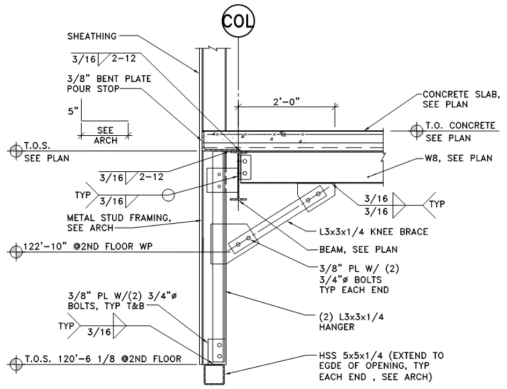
Drawing Details: Example 1



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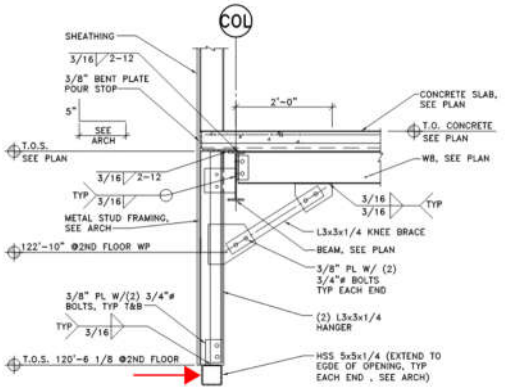

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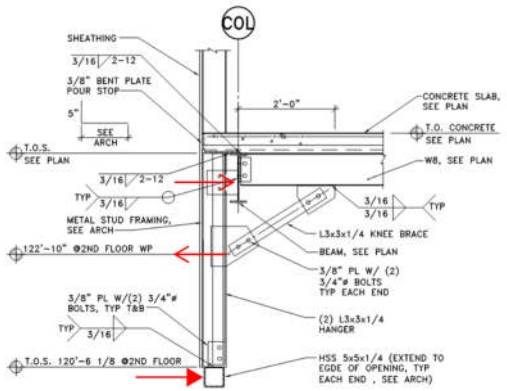

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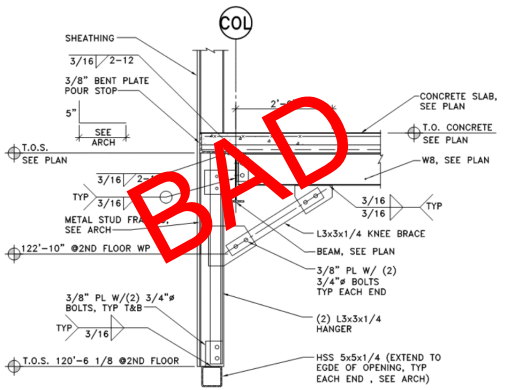

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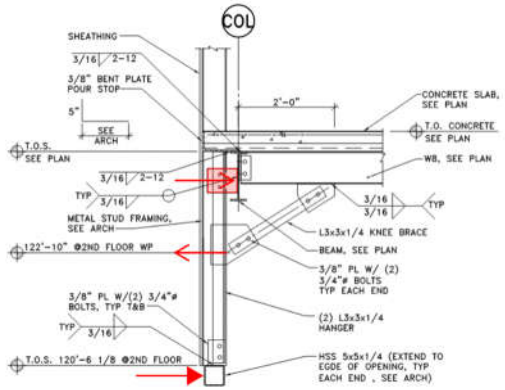
Drawing Details: Example 1



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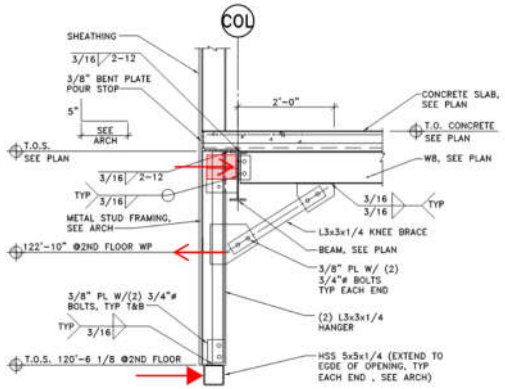

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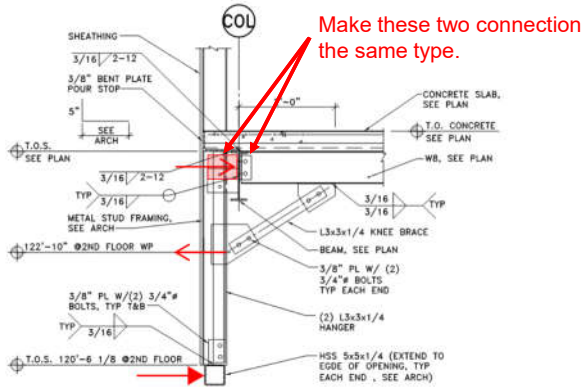

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Drawing Details: Example 1

But there is more to this detail…

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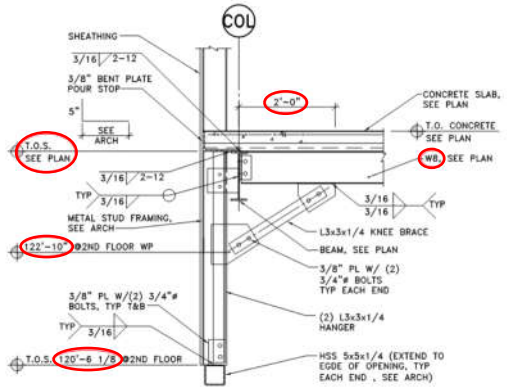
Drawing Details: Example 1



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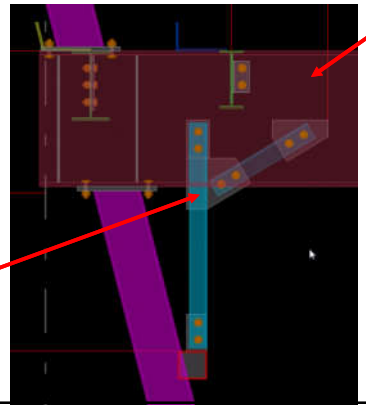

Beam is significantly larger than W8 shown in detail.

Work point elevation indicated in detail does not work.

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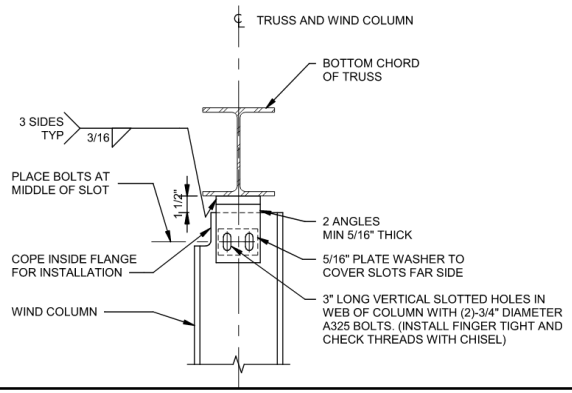
Drawing Details: Example 2



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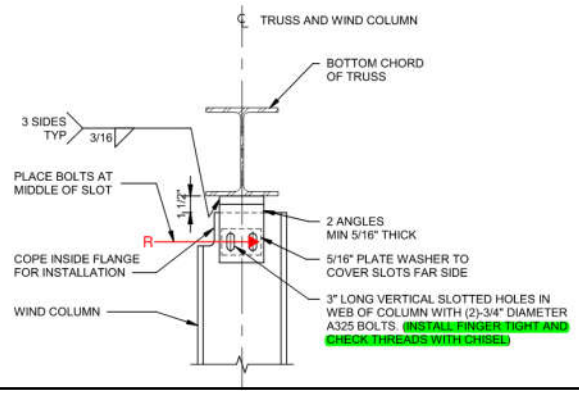
Drawing Details: Example 2



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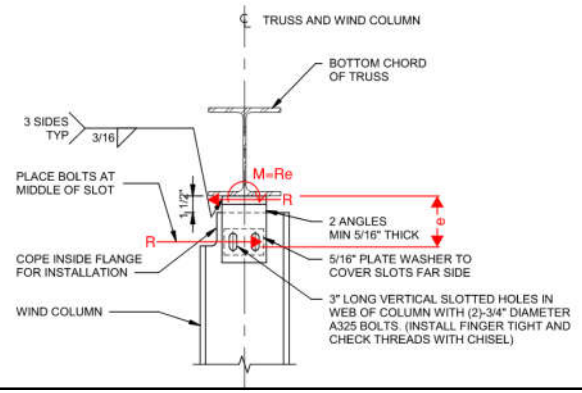
Drawing Details: Example 2



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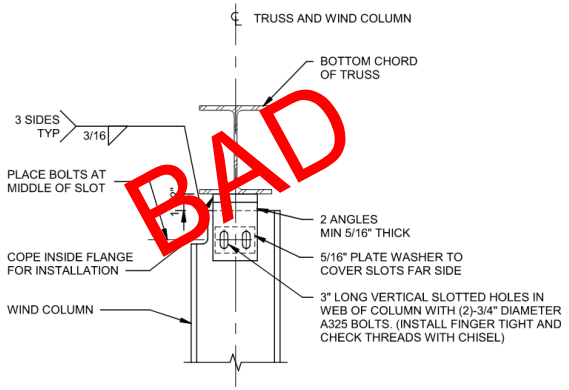

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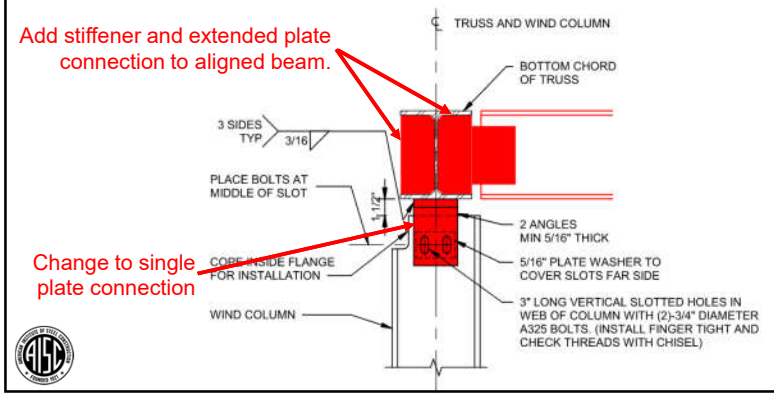

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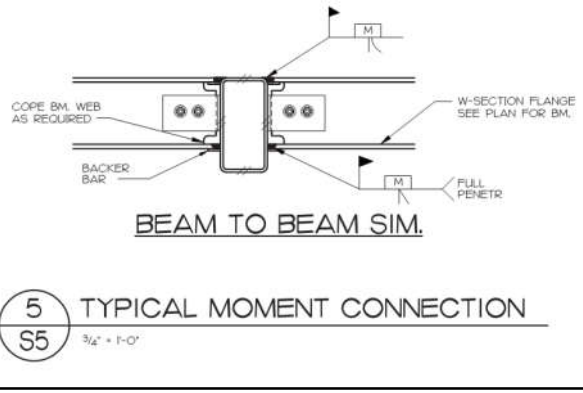
Drawing Details: Example 3



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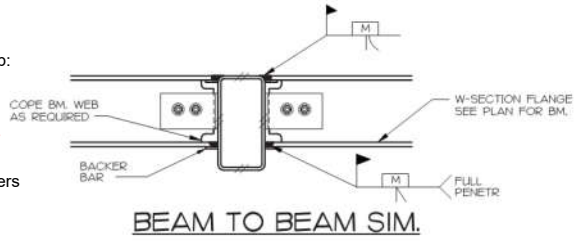
Drawing Details: Example 3

Per *Specification* Section B3.4b:

An FR connection shall have sufficient strength and stiffness to maintain the initial angle between the connected members at the strength limit state.



5/S5 TYPICAL MOMENT CONNECTION
3/4" = 1'-0"

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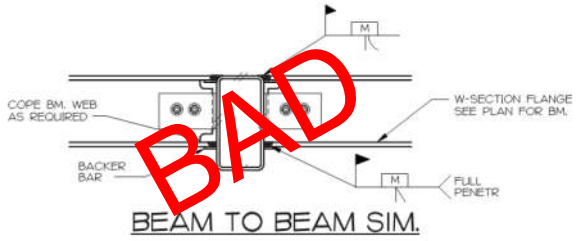
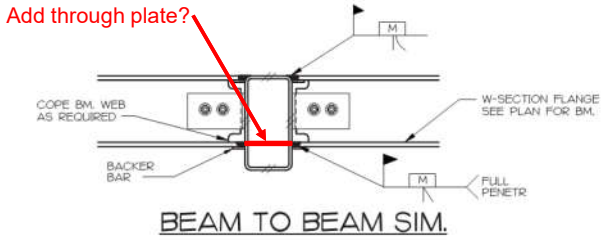
Drawing Details: Example 3



5/S5 TYPICAL MOMENT CONNECTION
3/4" = 1'-0"

38

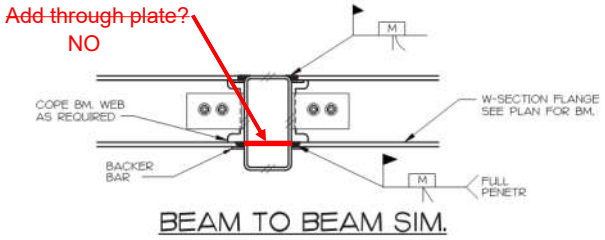
Drawing Details: Example 3



5/S5 TYPICAL MOMENT CONNECTION
3/4" = 1'-0"

39

Drawing Details: Example 3



5/S5 TYPICAL MOMENT CONNECTION
3/4" = 1'-0"

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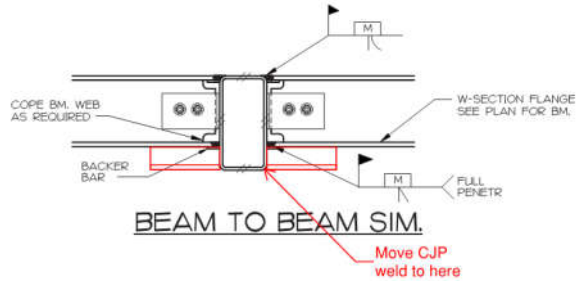
Drawing Details: Example 3



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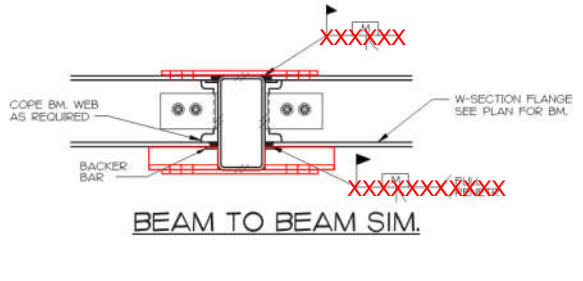
Drawing Details: Example 3



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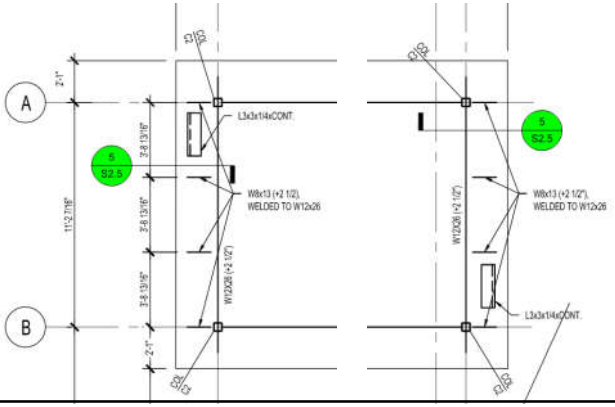
Drawing Details: Example 4



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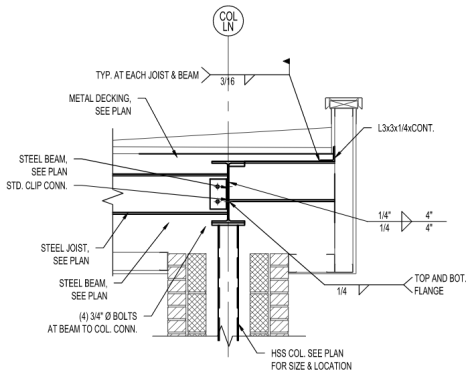

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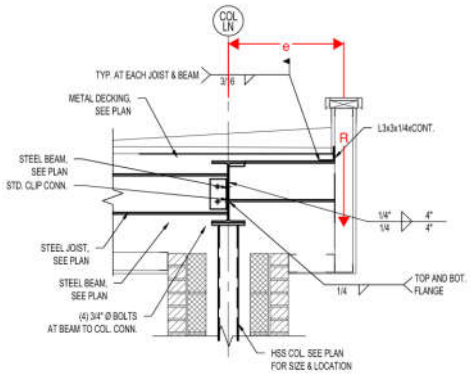
Drawing Details: Example 4



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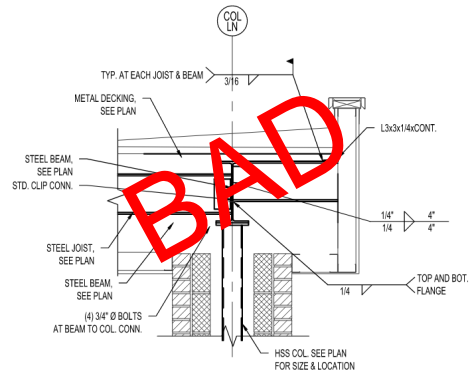

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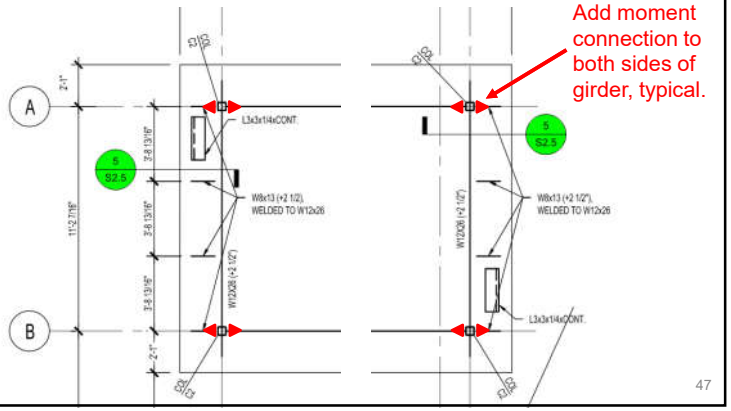

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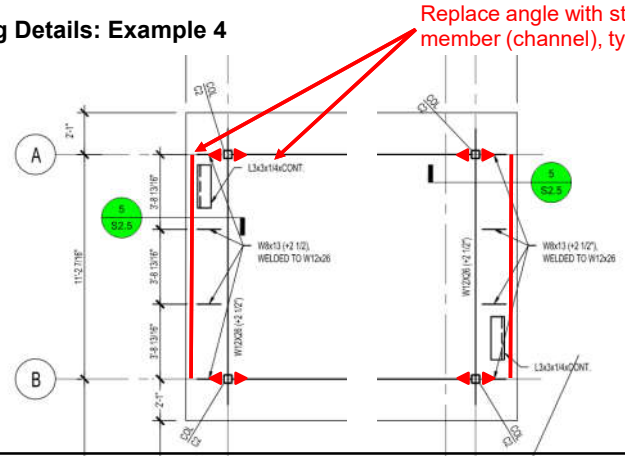

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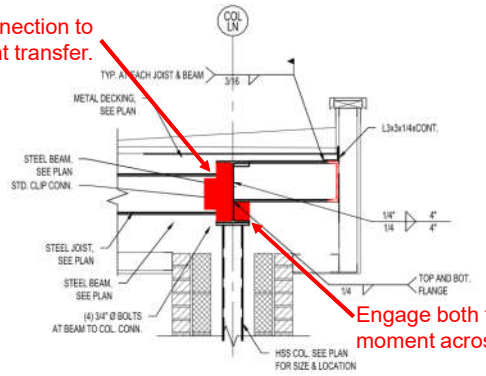
Drawing Details: Example 4



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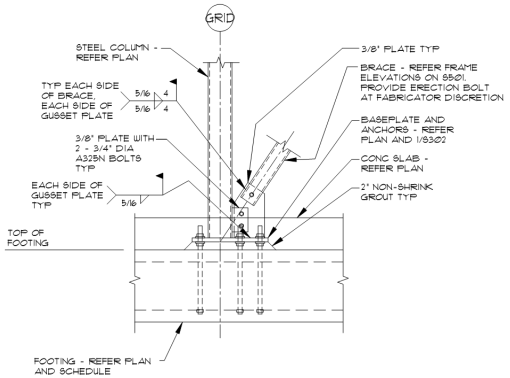
Drawing Details: Example 5



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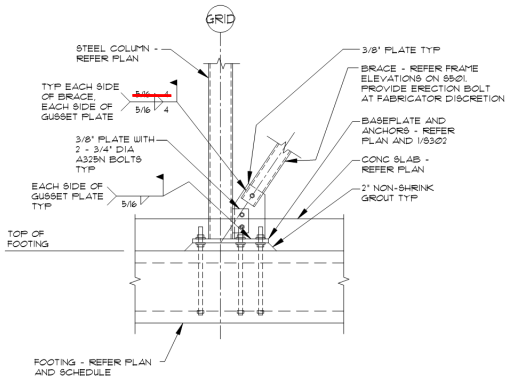

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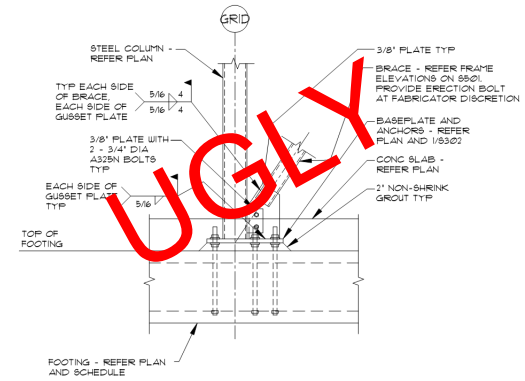
Drawing Details: Example 5



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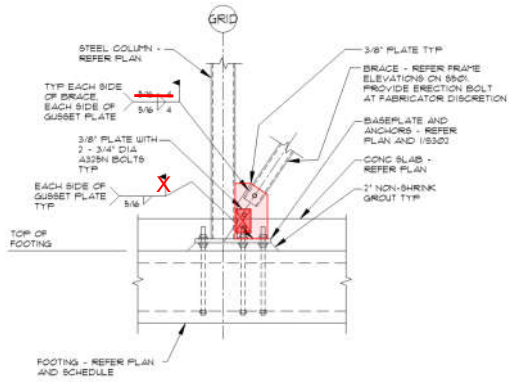
Drawing Details: Example 5



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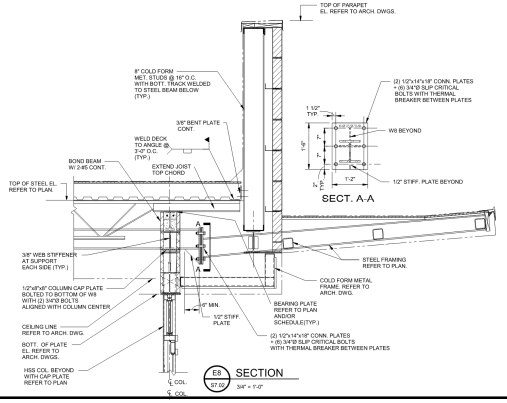
Drawing Details: Example 6



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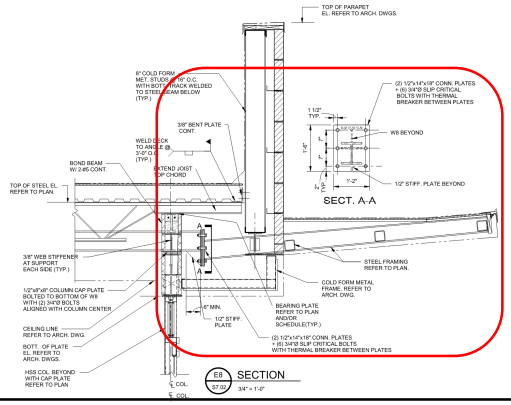
Drawing Details: Example 6



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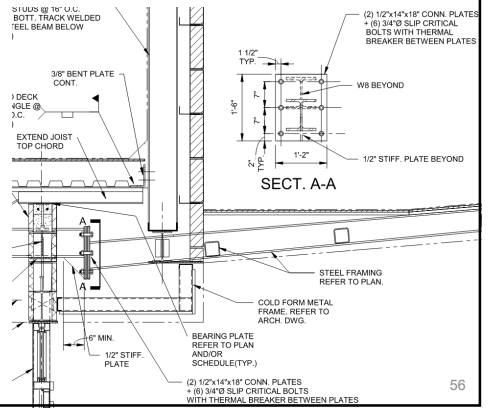
Drawing Details: Example 6

Per the *Specification for Structural Joints Using High-Strength Bolts* Section 3.1:

Unless otherwise approved by the *EOR*, all connected plies in a *joint* that are within the *grip* of the bolt … shall be steel …

The 2020 RCSC *Specification* has additional information.



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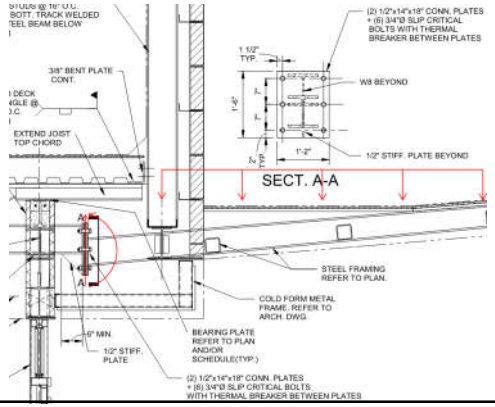
Drawing Details: Example 6



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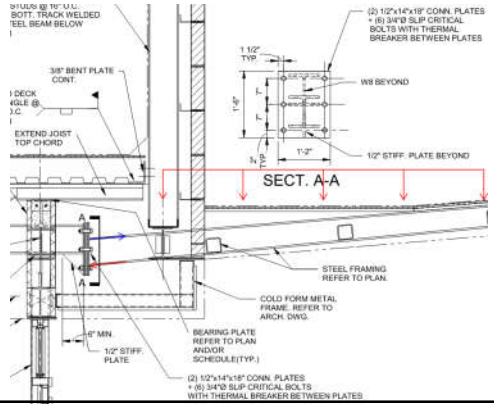
Drawing Details: Example 6



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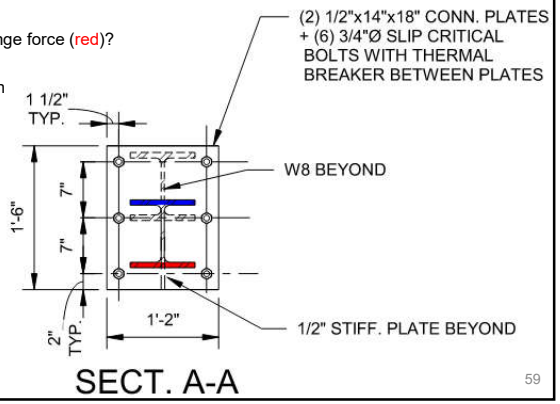
Drawing Details: Example 6

What opposes the compression flange force (red)?

What is the load path for the tension flange force (blue) to the bolts?



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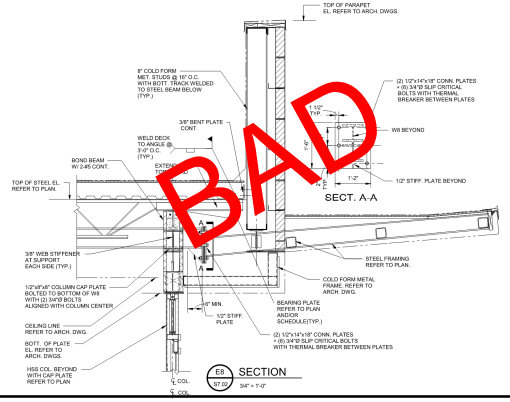
Drawing Details: Example 6



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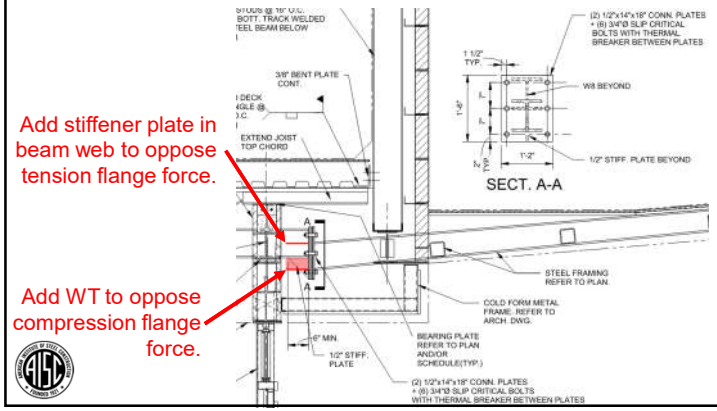
Drawing Details: Example 6



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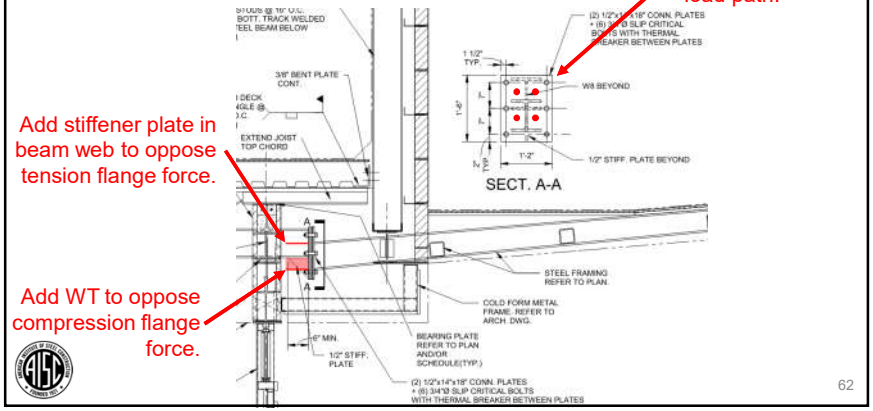
Drawing Details: Example 6



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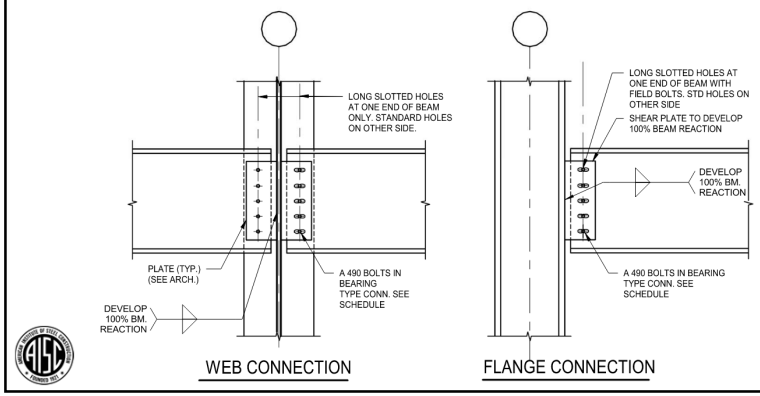
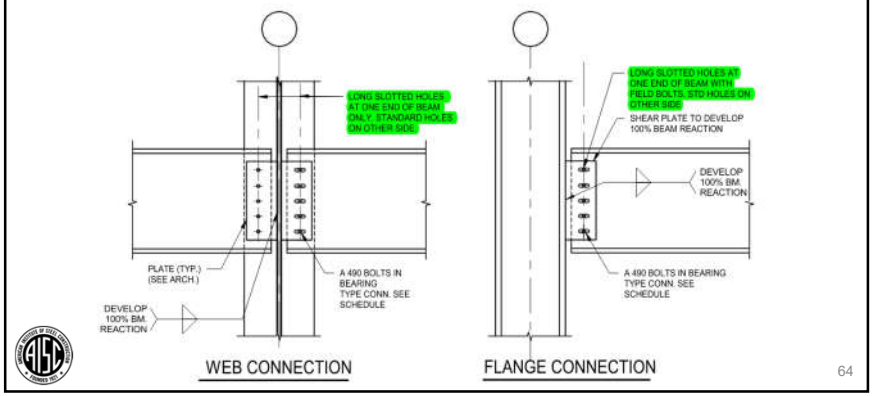
Drawing Details: Example 7



63

Drawing Details: Example 7



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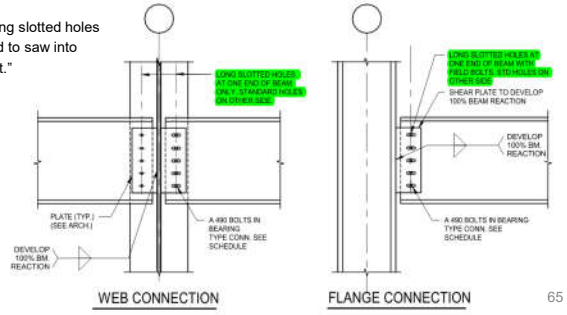
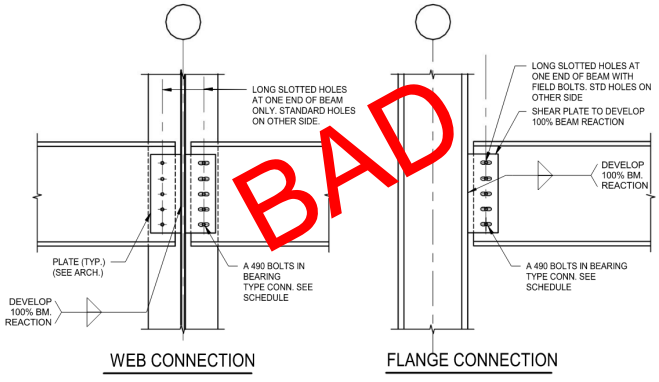
Drawing Details: Example 7

Per Expansion Joint Considerations for Buildings
from the May 2011 edition of Modern Steel Construction:

"The use of shear connections with long slotted holes **is not recommended**. The bolts tend to saw into the sides of the holes, locking the joint."



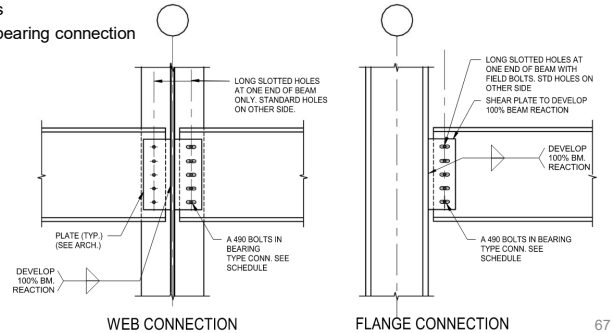
Drawing Details: Example 7



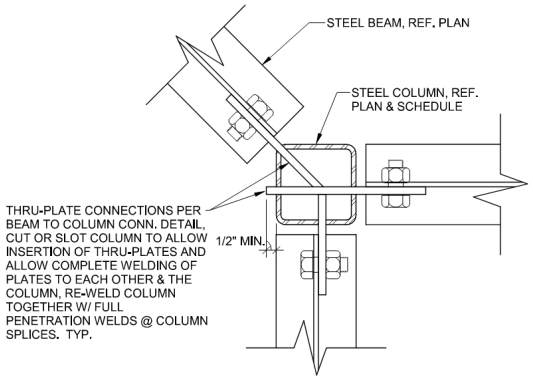
Drawing Details: Example 7

Instead, use:

- Double line of columns
- Slip surface joint at a bearing connection



Drawing Details: Example 8



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Drawing Details: Example 8

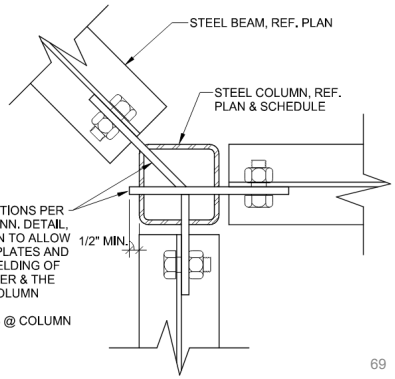
Per Part 10 of the Steel Construction Manual:

As long as the HSS wall is not classified as a slender element, the local distortion caused by the single-plate connection will be insignificant in reducing the column strength of the HSS. Therefore, single-plate connections may be used...

Use Equations 10-7(a) or (b):

$R_u e \leq \phi F_u t l_p^2 / 5$

$R_a e \leq F_u t l_p^2 / 5\Omega$



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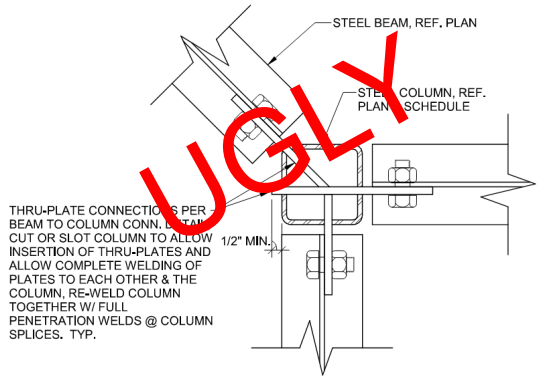
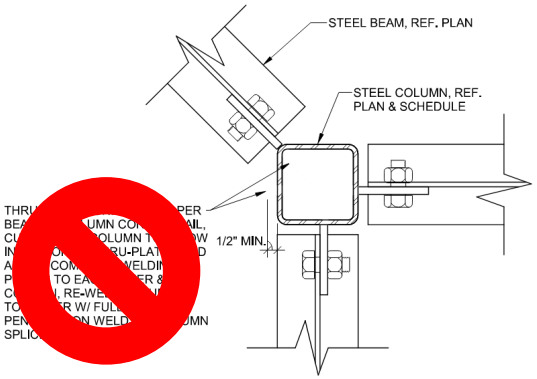
Drawing Details: Example 8

UGLY



70

Drawing Details: Example 8



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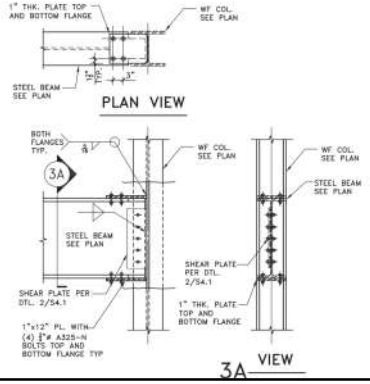
Drawing Details: Example 9



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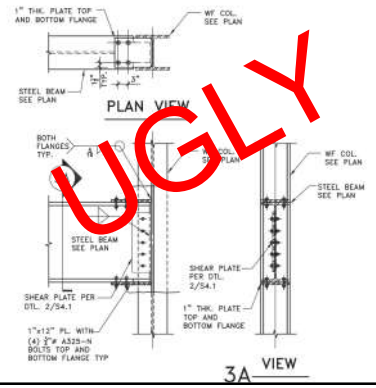
Drawing Details: Example 9



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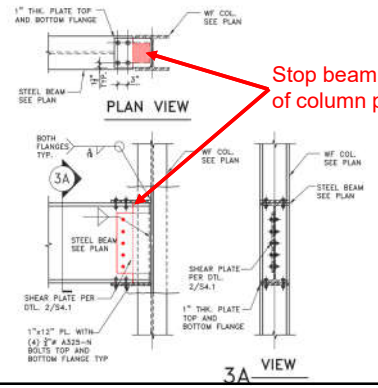
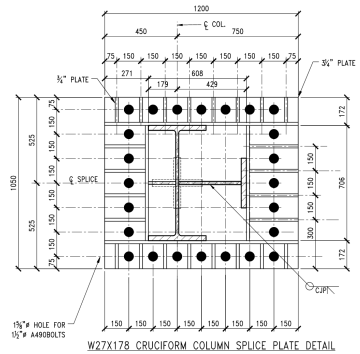
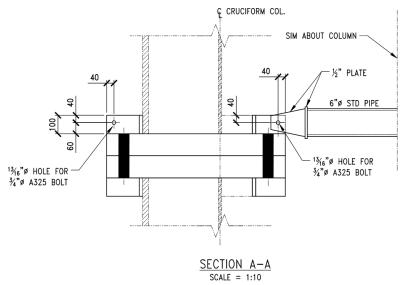
Drawing Details: Example 9



74

Drawing Details: Example 10





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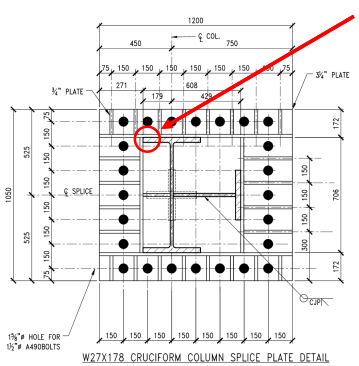
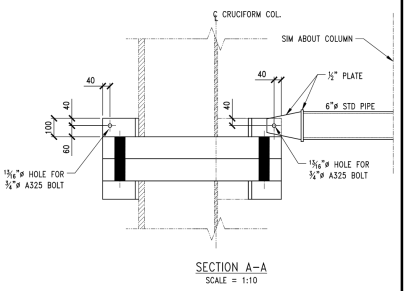
Drawing Details: Example 10





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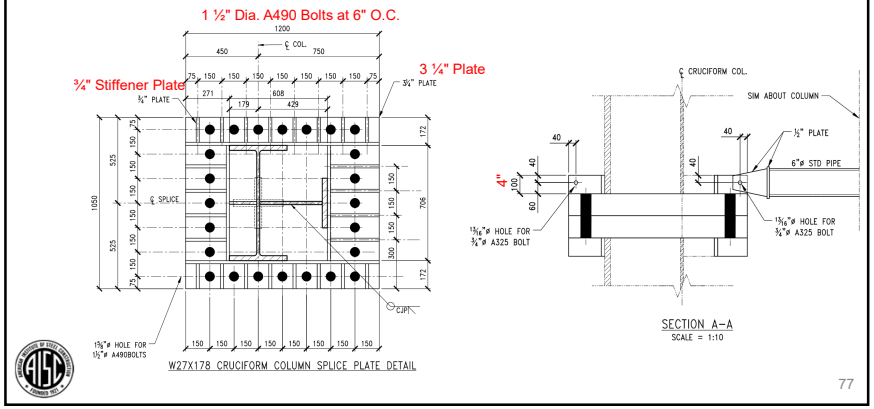
Drawing Details: Example 10



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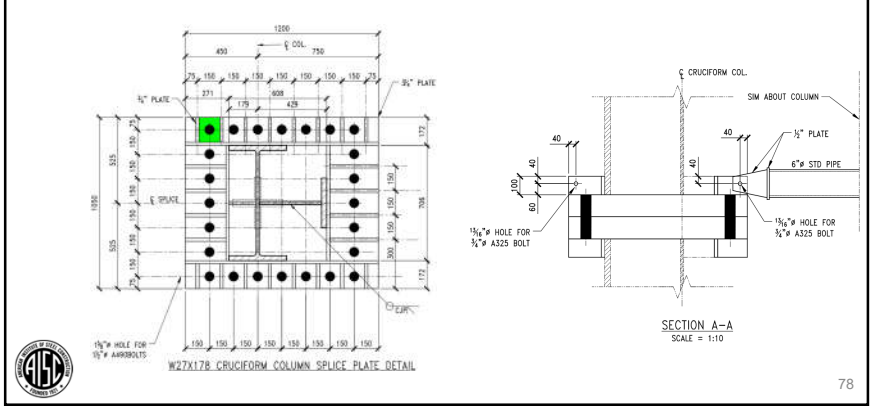
Drawing Details: Example 10



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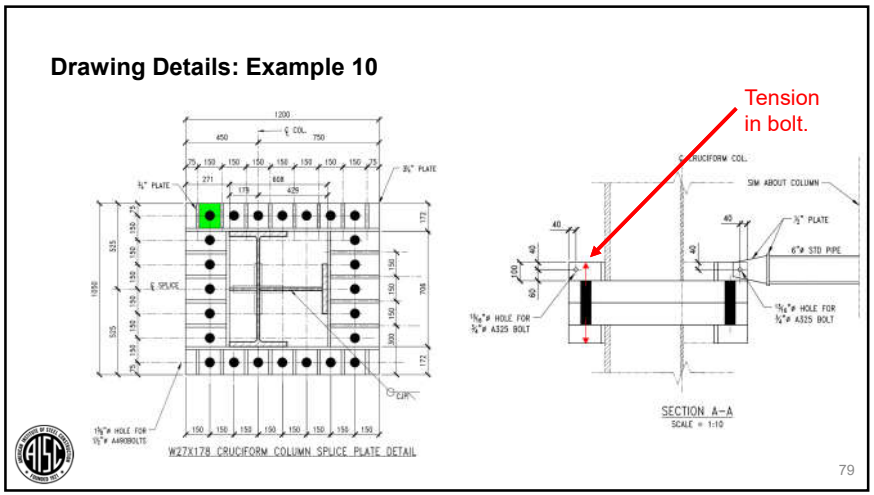
Drawing Details: Example 10



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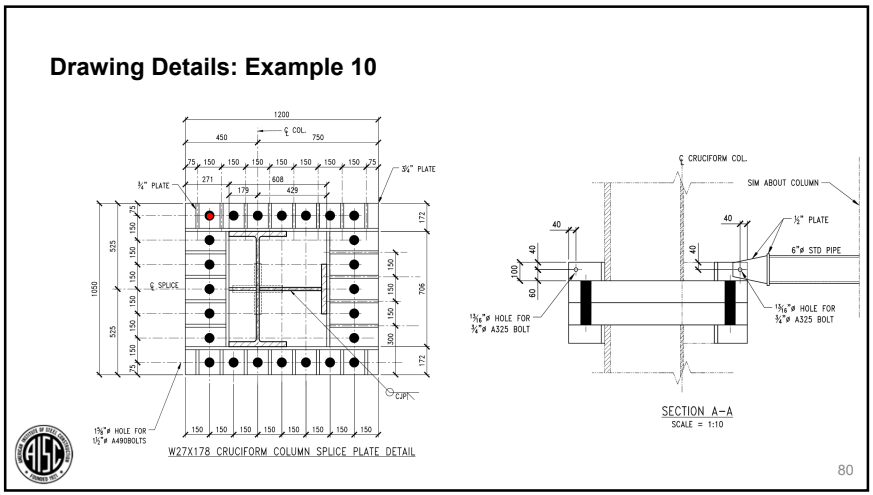
Drawing Details: Example 10



80

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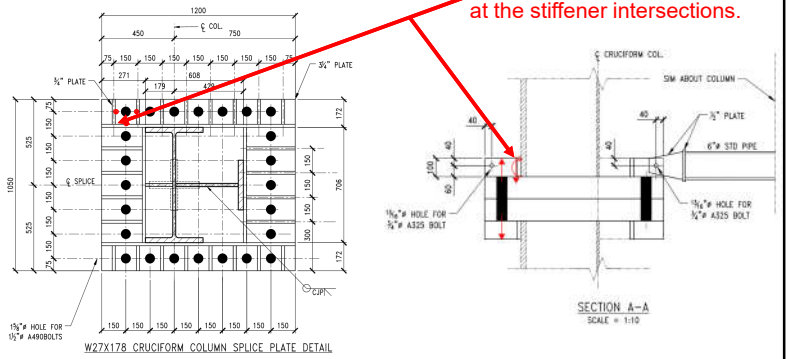
Drawing Details: Example 10

This tension induces a moment at the stiffener intersections.



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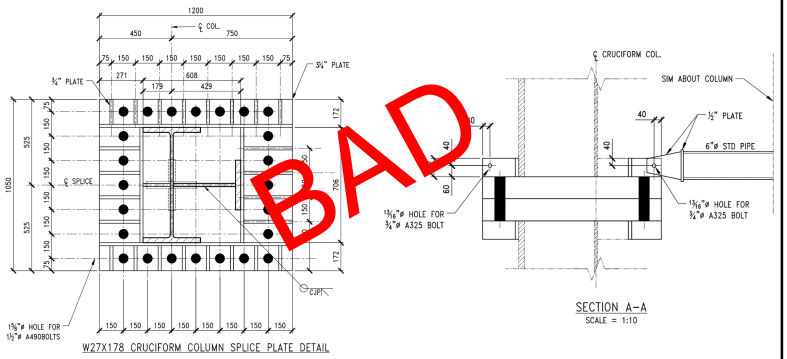
Drawing Details: Example 10

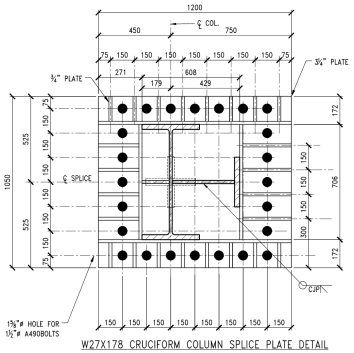


82

Drawing Details: Example 10

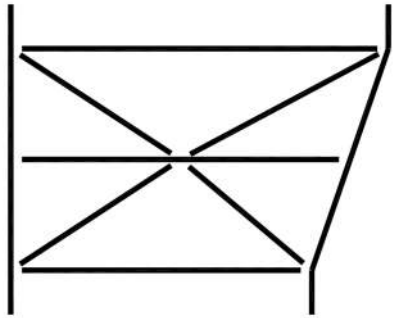
A good solution????

...would have to have a better understanding of the magnitude of loads.



83

Drawing Details: Example 11



Truss Elevation

84

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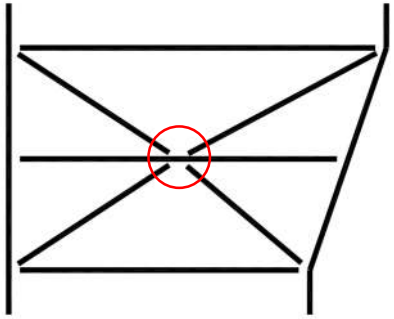
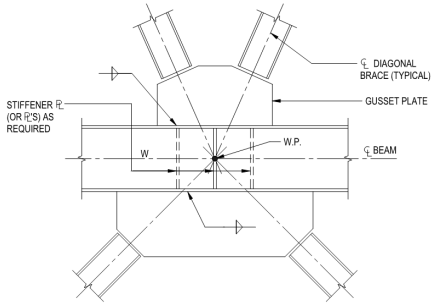
Drawing Details: Example 11



Truss Elevation

85

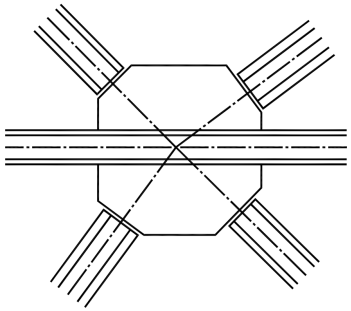
Drawing Details: Example 11



Panel Point Connection Concept from Design Drawings

86

Drawing Details: Example 11



Initial Panel Point Connection Concept

87

Drawing Details: Example 11

Top Chord

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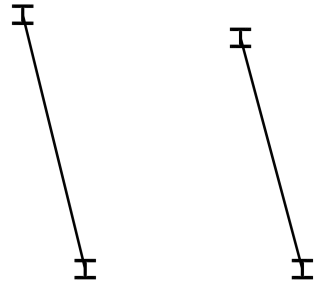
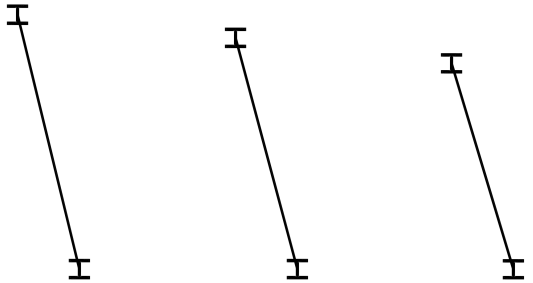
Drawing Details: Example 11



Top Chord Mid Chord

89

Drawing Details: Example 11



Top Chord Mid Chord Bottom Chord

90

Drawing Details: Example 11

Superimposed Chords

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Drawing Details: Example 11

Superimposed Chords

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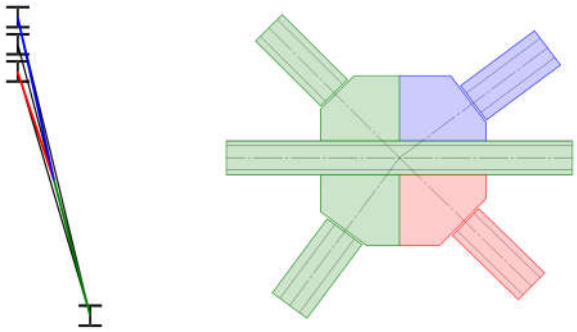
Drawing Details: Example 11



Panel Point Connection Concept

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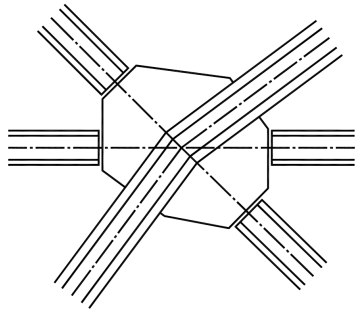
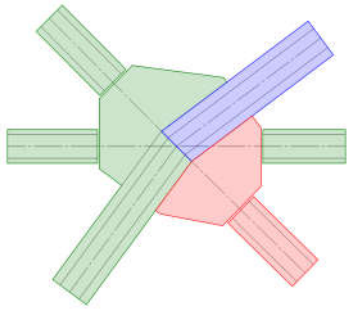
Drawing Details: Example 11



Panel Point Connection Concept

94

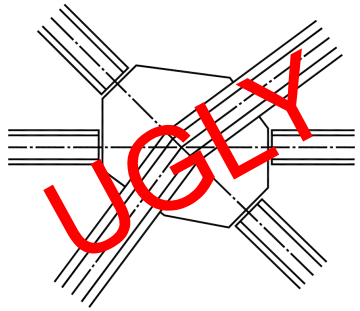
Drawing Details: Example 11



Panel Point Connection Concept

95

Drawing Details: Example 11



Panel Point Connection Concept

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Drawing Details: Example 12

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Drawing Details: Example 12

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Drawing Details: Example 13

99

Drawing Details: Example 13

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Drawing Details: Example 13

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Drawing Details: Example 13

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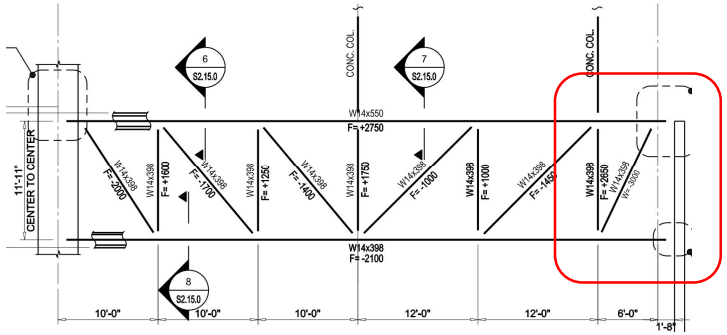
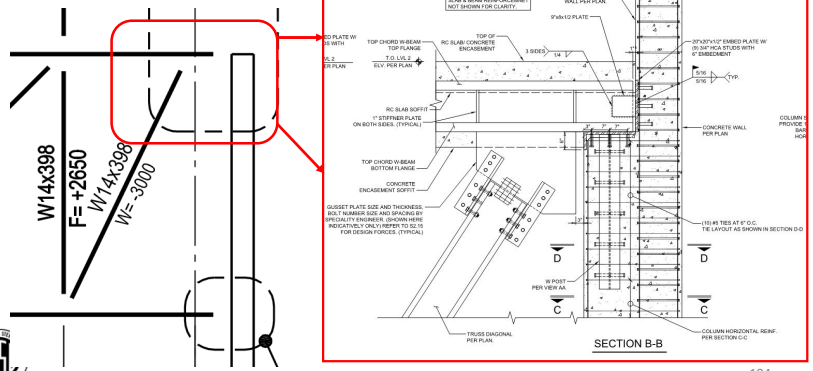
Drawing Details: Example 14



103

Drawing Details: Example 14



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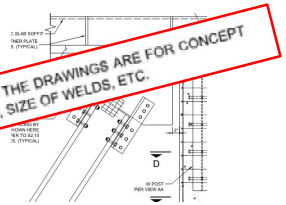
Drawing Details: Example 14

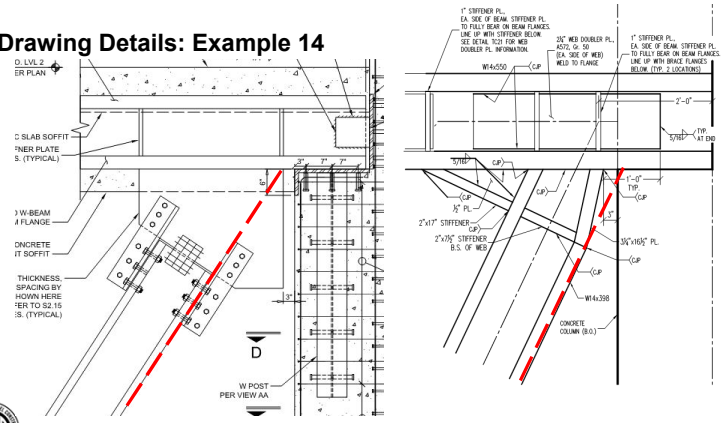
- Quick check of detail:
- Pa = 3,000 kips
- Try 8x8x1 angle
- A = 15.1 in^2 / an
- Try A
- 4 * 15.1 in^2 * 50 ksi / 1.67
- P/Ω = 1,808 kips !!!!
- Conceptual Detail Does Not Work



14. UNLESS SPECIFICALLY NOTED, STEEL DETAILS SHOWN ON THE DRAWINGS ARE FOR CONCEPT ONLY AND DO NOT INDICATE REQUIRED NUMBER OF BOLTS, SIZE OF WELDS, ETC.

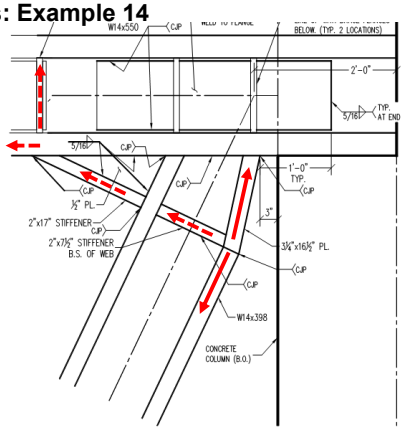
105

Drawing Details: Example 14



106

Drawing Details: Example 14



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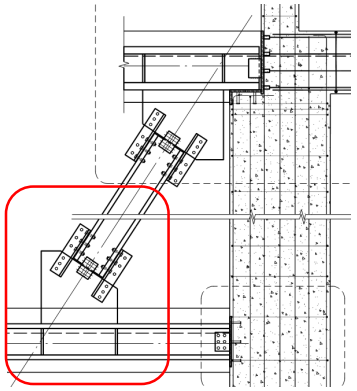
Drawing Details: Example 14



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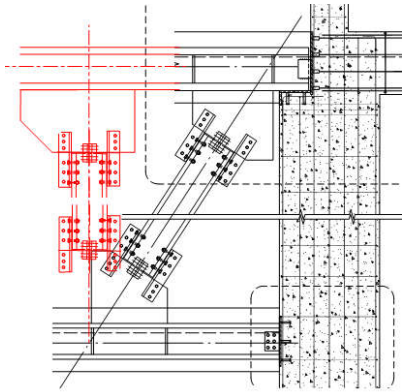
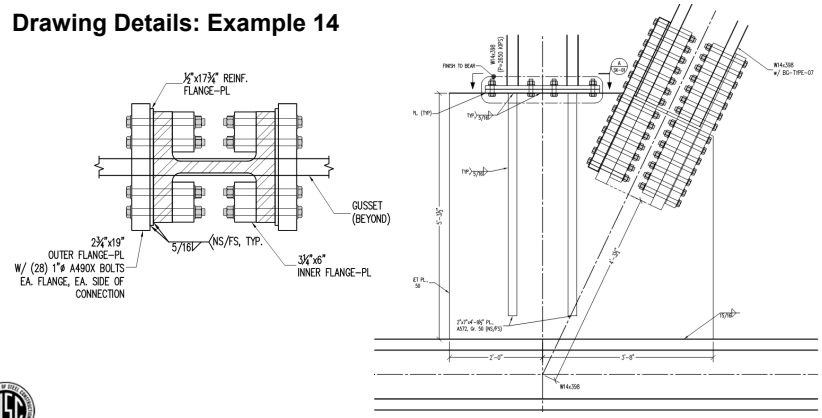
Drawing Details: Example 14



109

Drawing Details: Example 14



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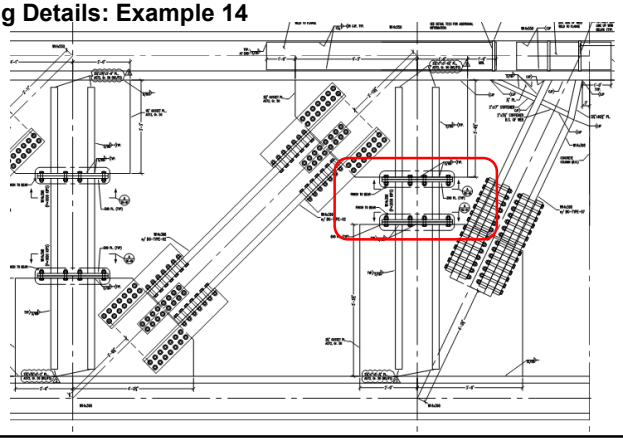
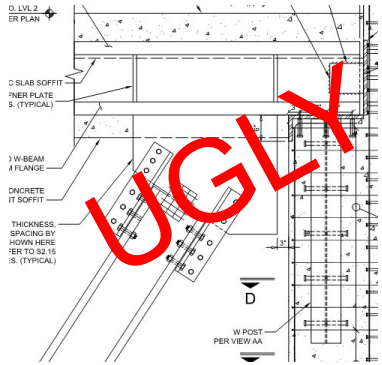


111

Drawing Details: Example 14



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Drawing Details: Example 14

WAIT… There's more

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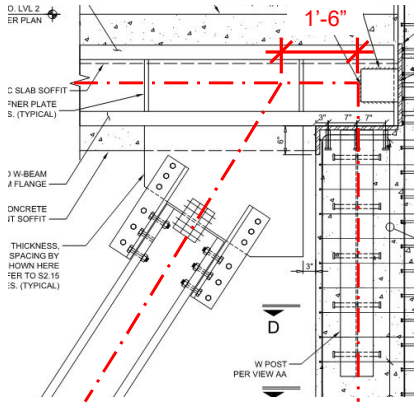
Drawing Details: Example 14



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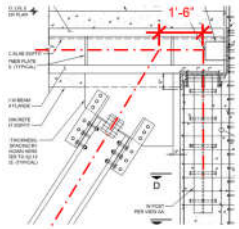
Drawing Details: Example 14

- Yet another quick check of detail:
- Pa = 3,000 kips (Diagonal)
- Vertical Component
- Pa_{vert} = 3,000 kips * sin(65)
- Pa_{vert} = 2,718 kips
- Ma = 2,718 kips * 1.5 ft = 4,077 kip-ft
- Chord Member is W14x550
- V/Ω = 962 kips, Mp/Ω = 2,940 kip-ft
- WARNING… WARNING… WARNING



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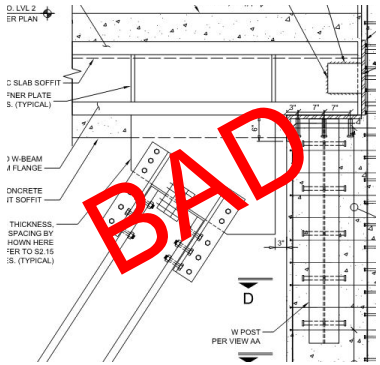
Drawing Details: Example 14



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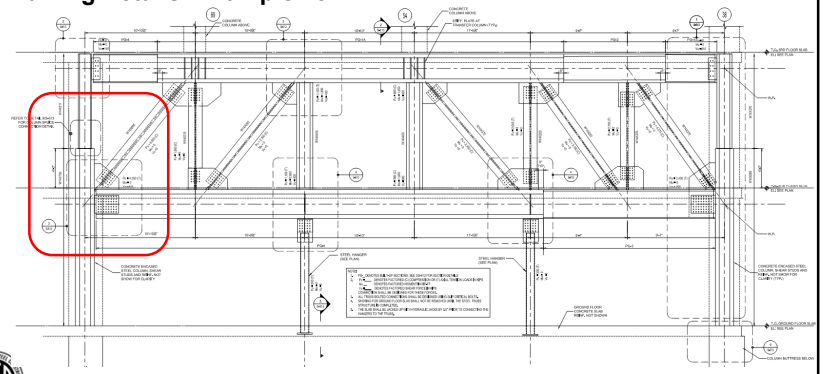
Drawing Details: Example 15



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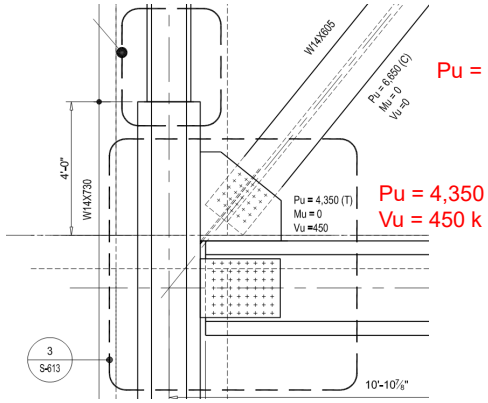
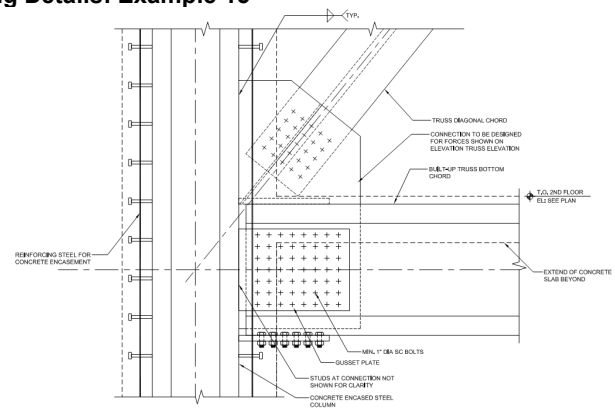
Drawing Details: Example 15



118

Drawing Details: Example 15



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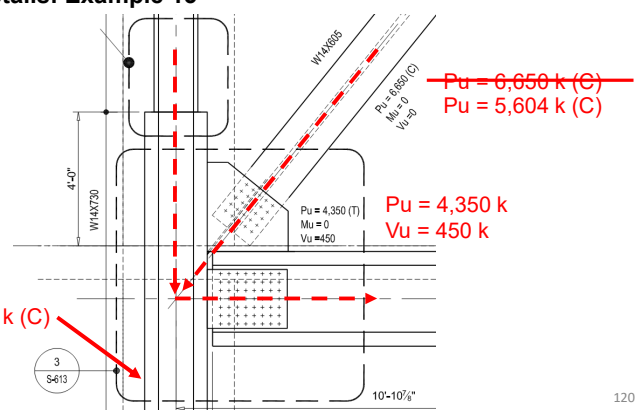
Drawing Details: Example 15



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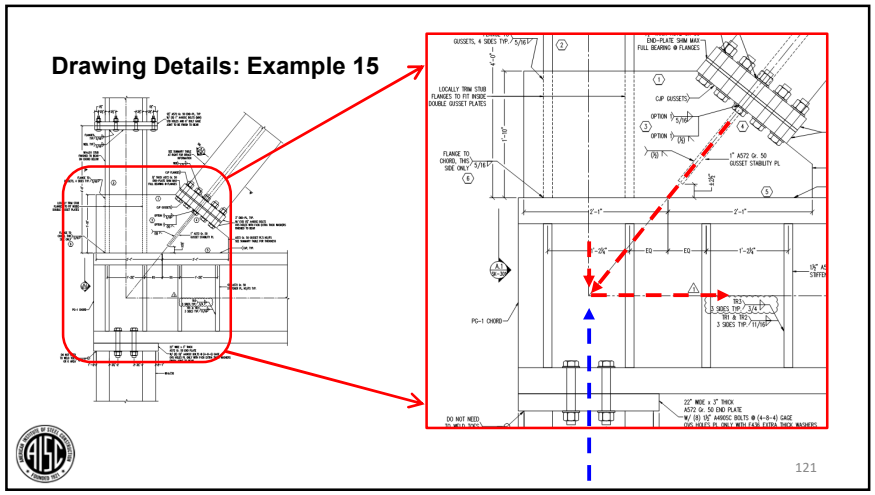

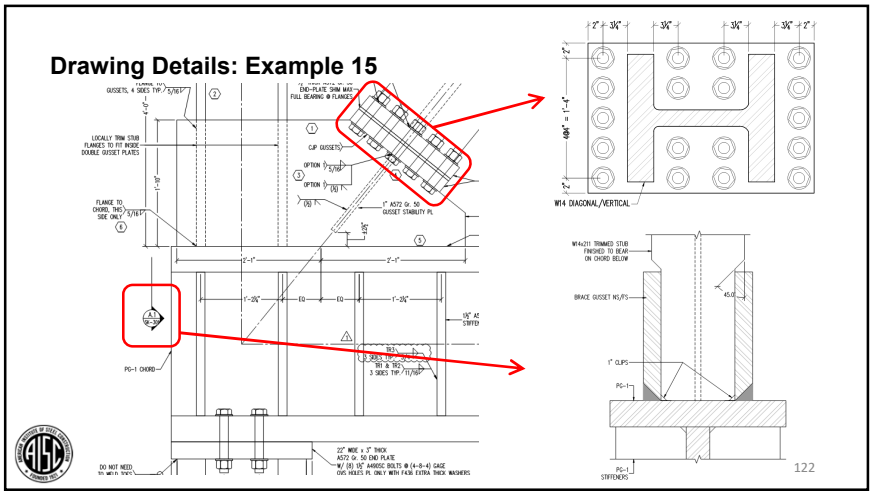

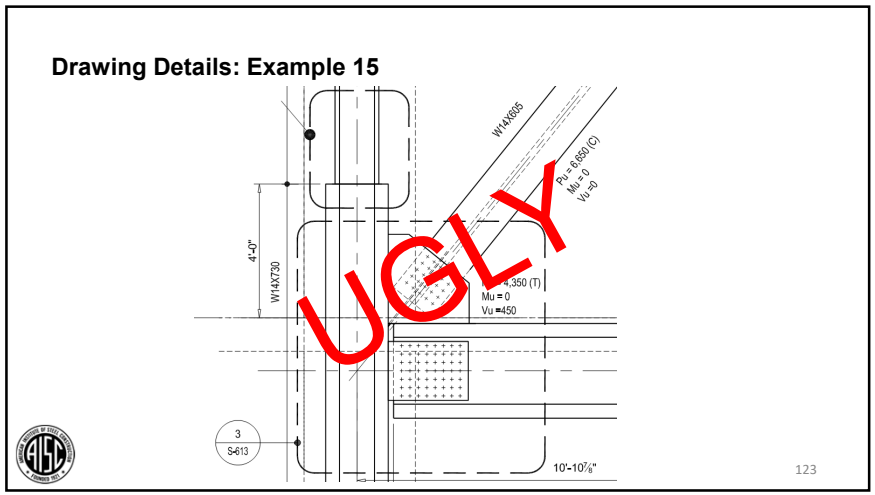

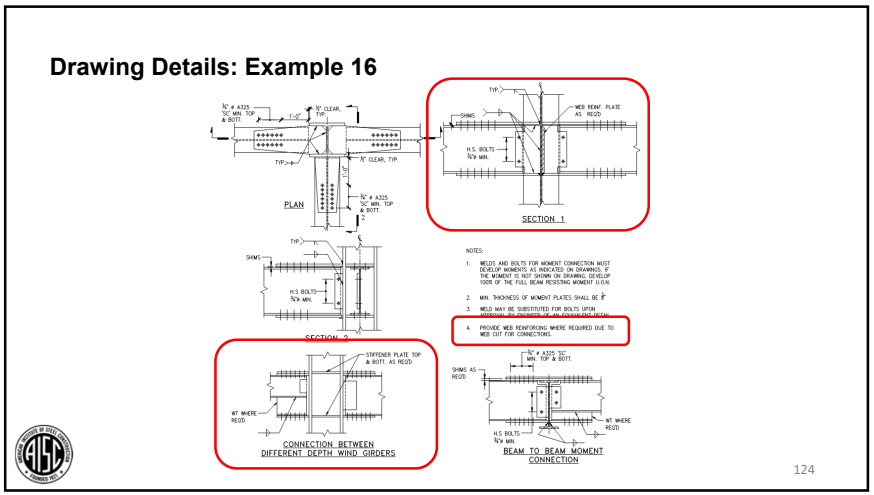

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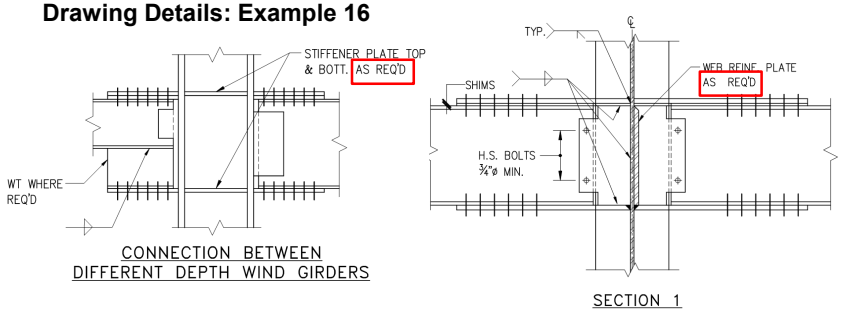
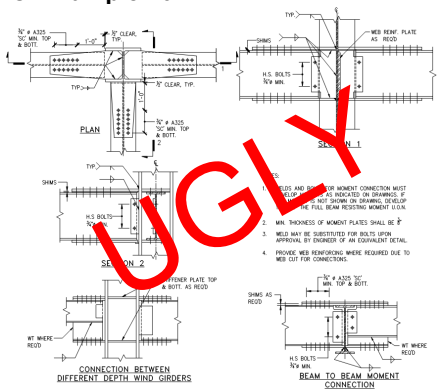
Drawing Details: Example 16



4. PROVIDE WEB REINFORCING WHERE REQUIRED DUE TO WEB CUT FOR CONNECTIONS.

125

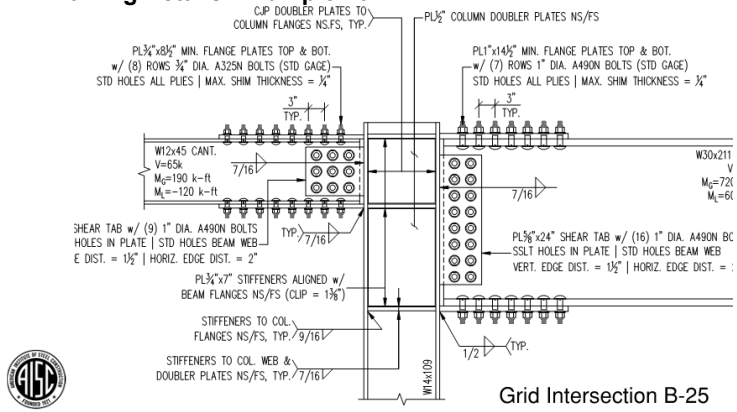
Drawing Details: Example 16



UGLY

126

Drawing Details: Example 16



127

Drawing Details: Example 16

AISC Code of Standard Practice → Section 3.1.2

- At locations of connections, the following requirements shall apply to column stiffeners, web doubler plates, beam bearing stiffeners, and all other member reinforcement required to satisfy strength and equilibrium of forces through the connection….
  - Option 3A: member reinforcement at connections shall be designed by the owner's designated representative for design
  - Option 3B: the owner's designated representative for design shall provide a bidding quantity of items required for member reinforcement at connections with corresponding project-specific details that show the conceptual configuration of reinforcement appropriate for the order of magnitude of forces to be transferred. If no quantities or conceptual configurations are shown, member reinforcement at connections will not be included in the bid.

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Drawing Details: Example 16

AISC Code of Standard Practice → Section 3.1.2

- When the actual quantity and/or details of any of the foregoing items differ from the bidding quantity and/or details, the contract price and schedule shall be adjusted equitably in accordance with Sections 9.4 and 9.5.

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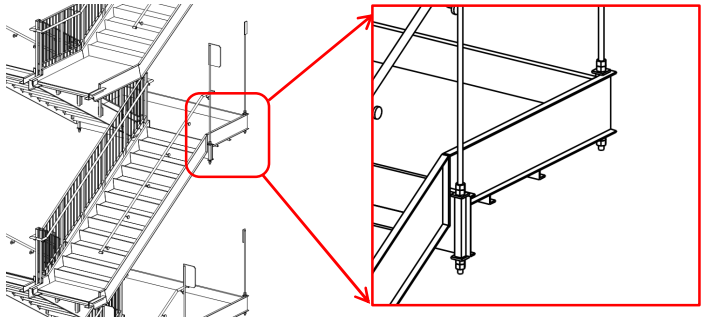
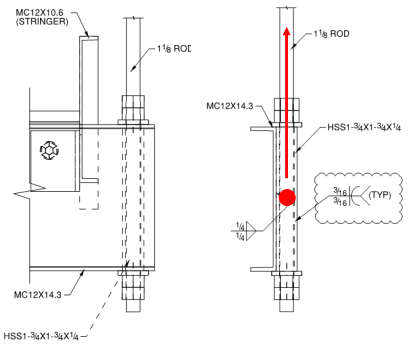
Drawing Details: Example 17



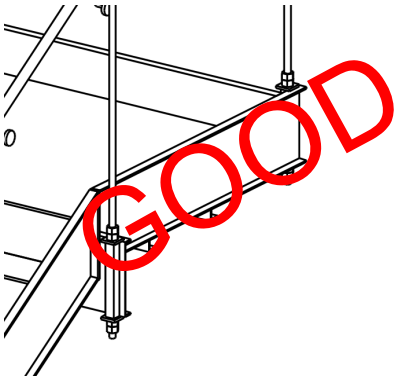
130

Drawing Details: Example 17



131

Drawing Details: Example 17



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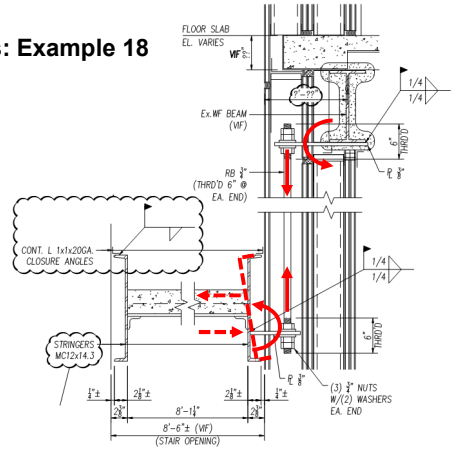
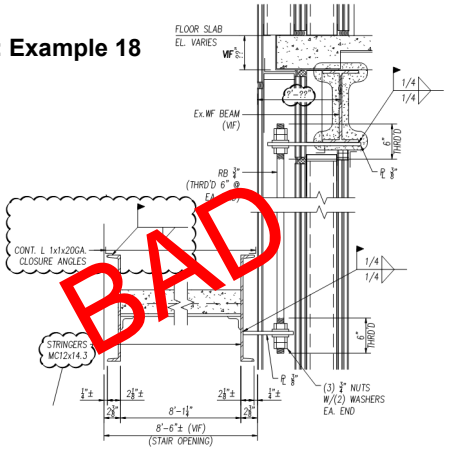
Drawing Details: Example 18



TYPICAL STAIR HANGER DETAIL

133

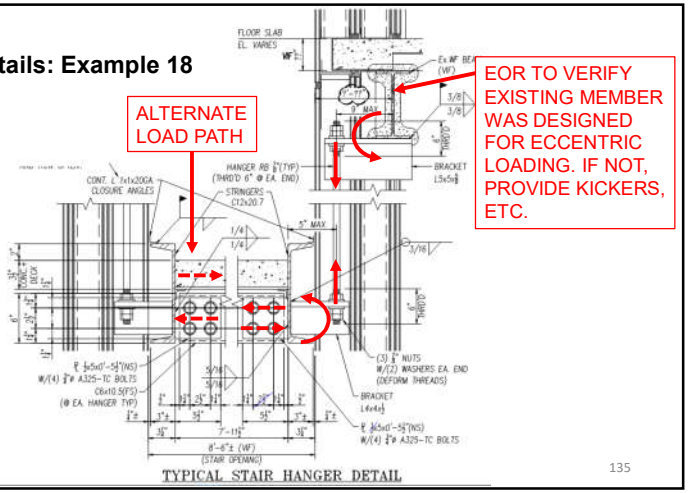
Drawing Details: Example 18



TYPICAL STAIR HANGER DETAIL

134

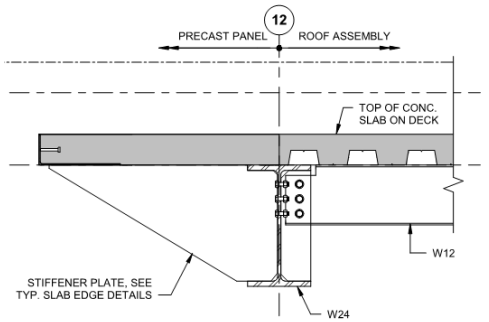
Drawing Details: Example 18



TYPICAL STAIR HANGER DETAIL

135

Drawing Details: Example 19



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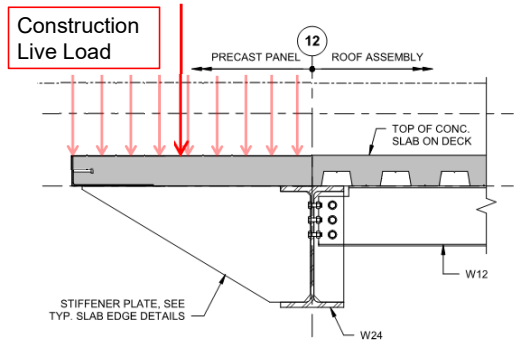
Drawing Details: Example 19

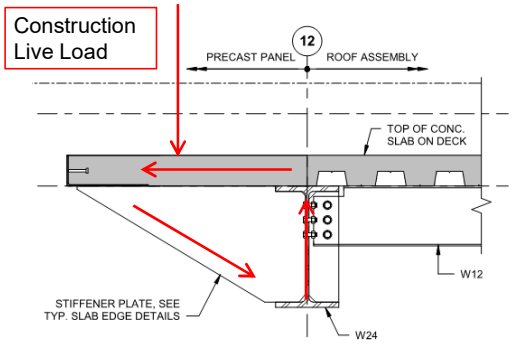


137

Drawing Details: Example 19

Option 1:

Look at plate in compression (strut-tie)

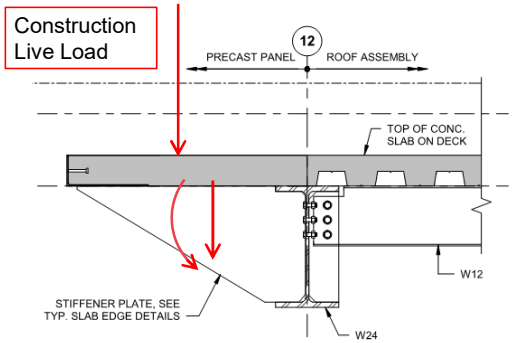


138

Drawing Details: Example 19

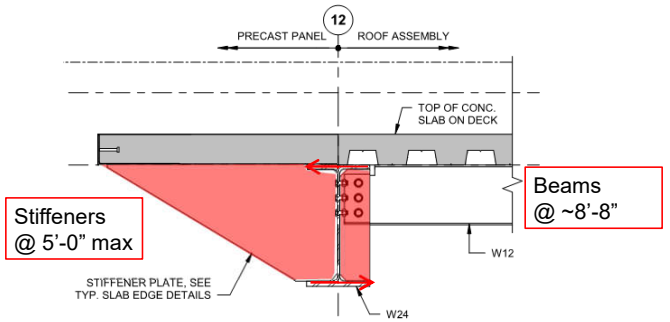
Option 2:

Look at plate in bending and shear



139

Drawing Details: Example 19



140

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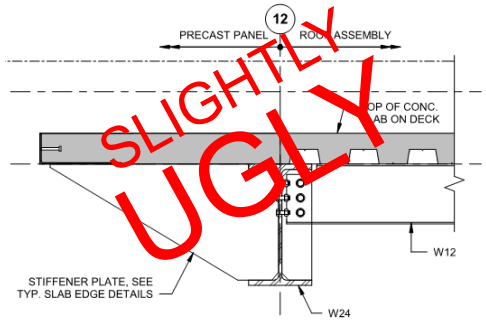
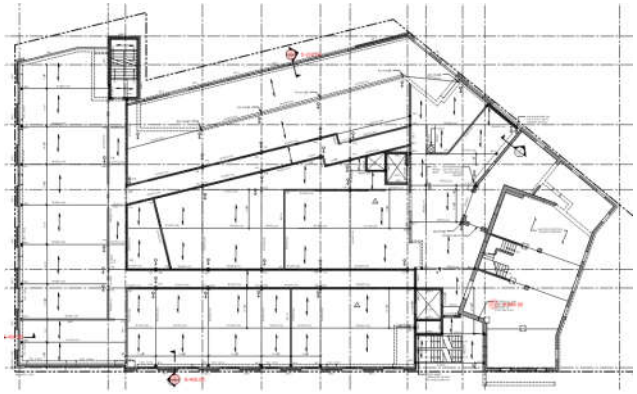
Drawing Details: Example 19



SLIGHTLY UGLY

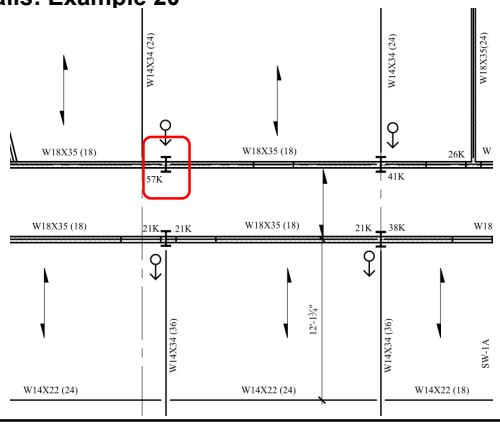
141

Drawing Details: Example 20



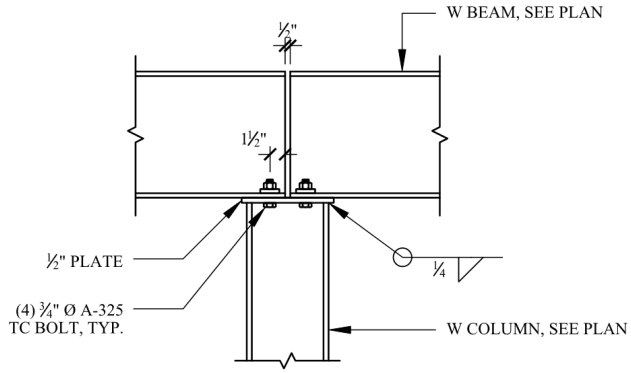
142

Drawing Details: Example 20



143

Drawing Details: Example 20



144

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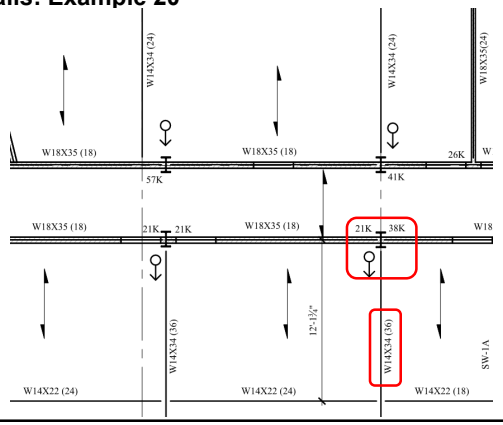
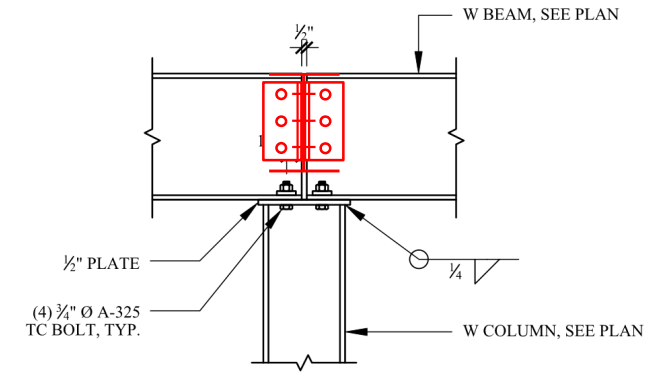
Drawing Details: Example 20



145

Drawing Details: Example 20



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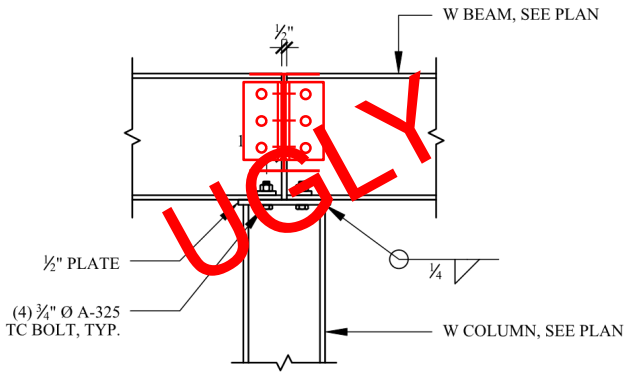
Drawing Details: Example 20



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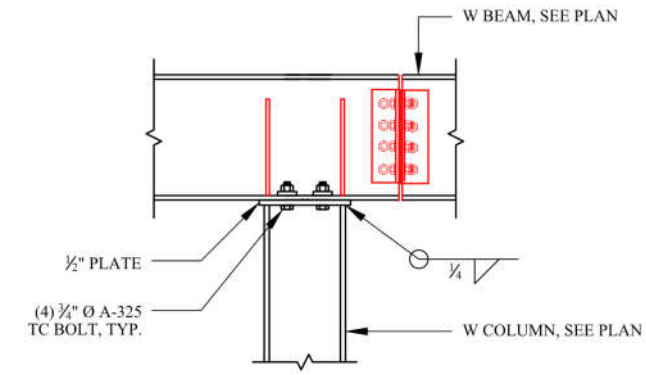

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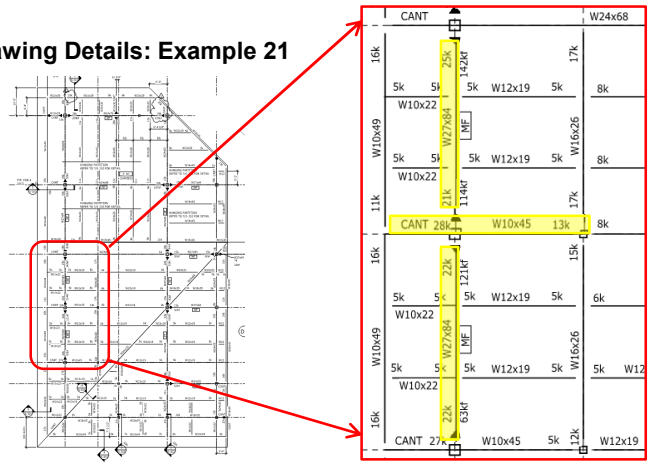
Drawing Details: Example 21



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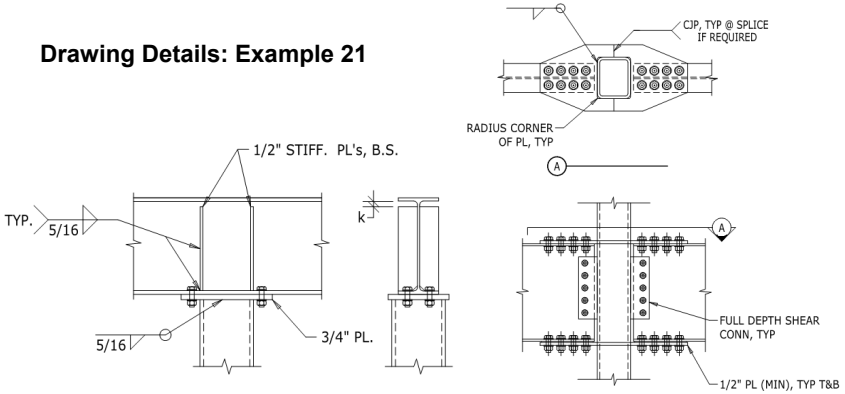

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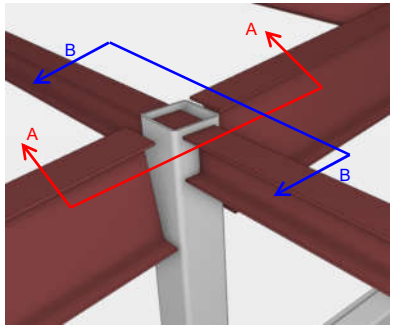
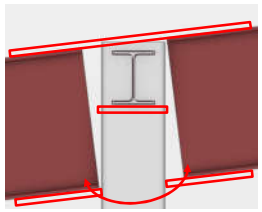
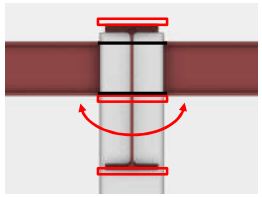




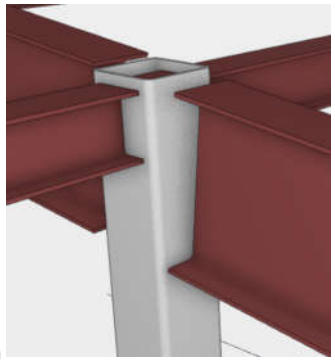
SECTION A-A

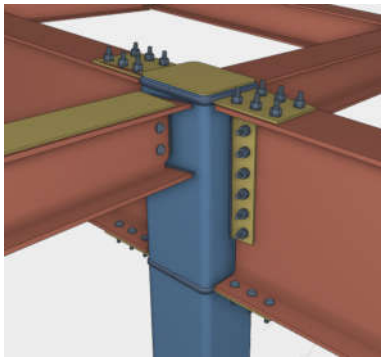


SECTION B-B

151

Drawing Details: Example 21





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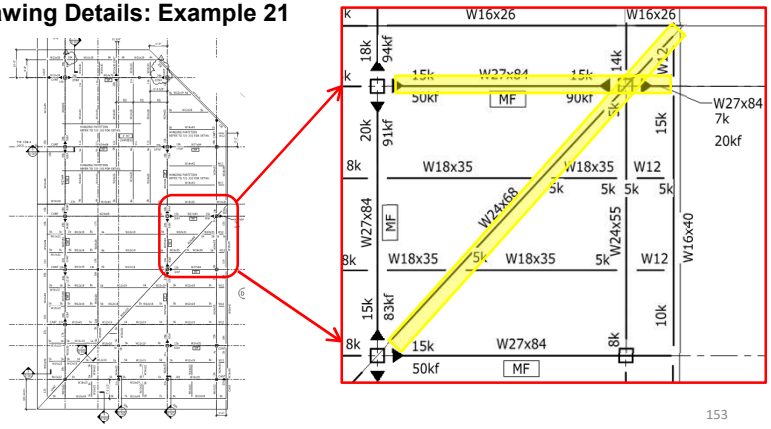
Drawing Details: Example 21



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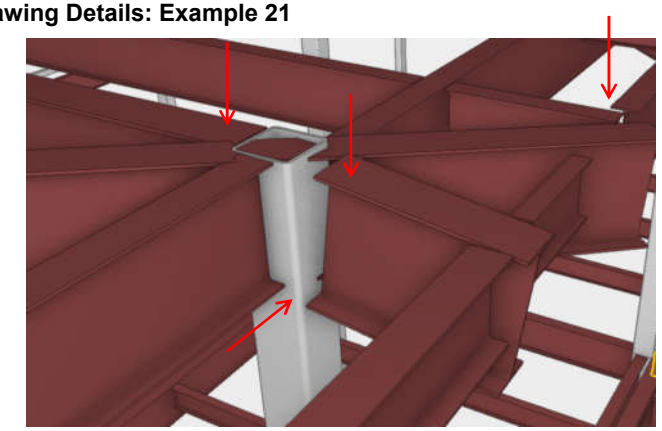

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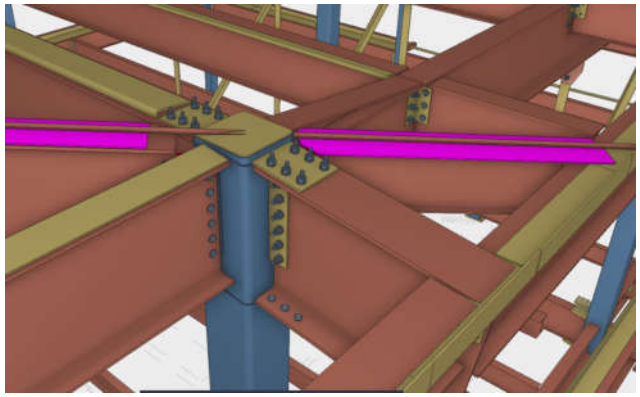

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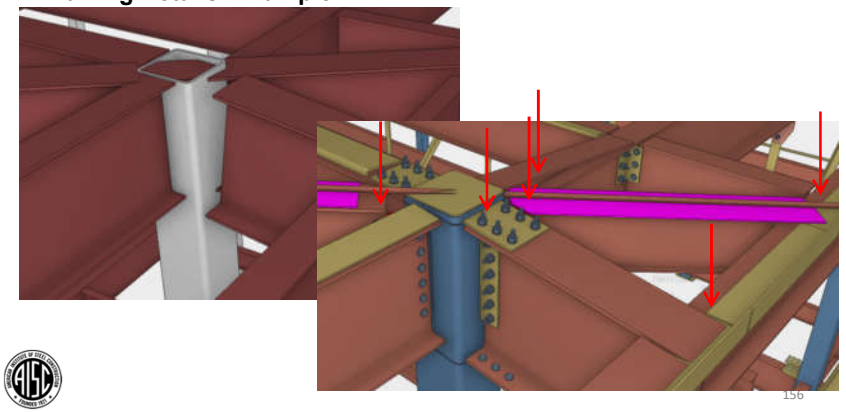

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Drawing Details: Example 21

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Webinar Outline

- **Introduction**
- **Define Good, Bad, Ugly Details**
- **Examples**
- **Tips for Better Details & Connections**
- **Assessment and Q/A**

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Tips for Better Details & Connections

1. Follow the load path through the detail
   - If needed, cut the Free Body Diagram! (FBD)
2. Check all limit states
3. Be mindful of geometric layout and member selection
4. Follow AISC procedures and examples
5. Respect the SSE and Contractor's suggested detail alternates
6. Request (and SUPPLY) all "real" loads
7. Reminder: the SSE is NOT providing a peer review
8. Does it pass "The Eye Test?"

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Webinar Outline

- **Introduction**
- **Define Good, Bad, Ugly Details**
- **Examples**
- **Tips for Better Details & Connections**
- **Assessment and Q/A**

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AISC | Questions?

Smarter. Stronger. Steel.

PDH Certificates

- Reporting site (URL will be provided in the forthcoming email).
- Username: Same as AISC website username.
- Password: Same as AISC website password.

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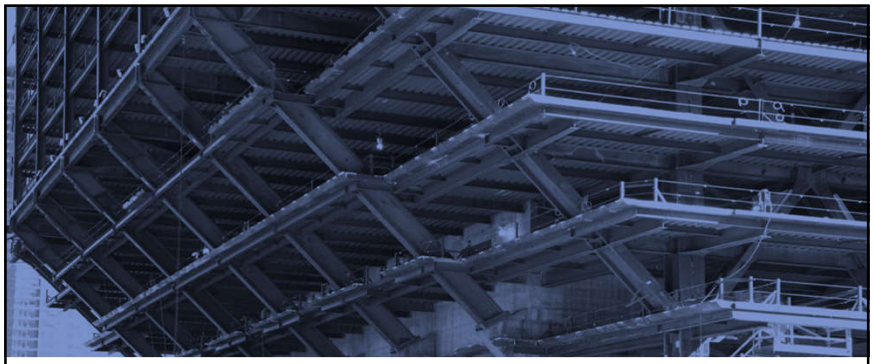

AISC | Thank you

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