AISC Live Webinars

Today's live webinar will begin shortly. Please stand by.

Today's audio will be broadcast through the internet. Please be sure to turn up the volume on your speakers.

Please type any questions or comments in the Q&A window.

Smarter. Stronger. Steel.

AISC Live Webinars

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AISC Live Webinars

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AISC Live Webinars

Course Description – Submitted for AIA CE Credit

Steel Quiz Live!
September 23, 2021

This webinar an adaptation of the popular quiz feature from Modern Steel Construction. The presenter will a series of steel-related poll questions on topics such as bolt prying, beam splices, yield line analysis and design for stability. The audience will first vote on the correct answer. The presenter will then share the correct answers and provide technical instruction to explain the answers.

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AISC Live Webinars

Learning Objectives – Submitted for AIA CE Credit

- Explain the behavior of a connection angle with and without consideration of prying effects.
- Identify the connection configuration requirements for which the AISC Manual procedures apply.
- Describe the "k-area" of a wide-flange section and how it relates to AISC requirements.
- Identify an appropriate yield line pattern for an end-plate connection.

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Steel Quiz Live!

Carlo R. Lini
Director of the AISC Steel Solutions Center
American Institute of Steel Construction
Chicago, IL

Smarter. Stronger. Steel.

Today's Presentation

Live Quiz Format

A Calculator Will Be Helpful for a Few Questions 😮

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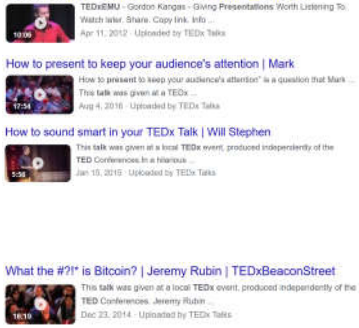
Ted Talks

Gordon Kangas - Giving Presentations Worth Listening To



How to present to keep your audience's attention | Mark

How to sound smart in your TEDx Talk | Will Stephen

What the #?!* is Bitcoin? | Jeremy Rubin | TEDxBeaconStreet

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Senior Staff Engineer

Carlo Lini, PE
Director of the Steel Solutions Center

Jonathan Tavarez, PE
Staff Engineer

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Industry Consultants

Larry Muir, PE
The Steel Connection

Bo Dowswell, PE, PhD
ARC International

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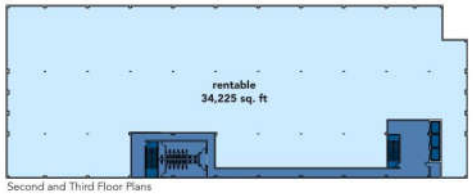
SSC
Project Assistance

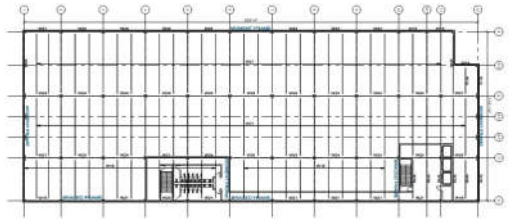
13

SSC
Project Assistance

- **Conceptual Plans**
- Estimated Tonnage
- Early Fabricator Involvement



Second and Third Floor Plans



SSC
Project Assistance

- Conceptual Plans
- **Estimated Tonnage**
- Early Fabricator Involvement

Steel Quantity Takeoff

Suspended Steel Floor Areas		**Total Area**	**192,730 ft²**	
		Typical Floor	155,340 ft²	
		Roof	37,390 ft²	
Estimated Steel Quantities				
Gravity Columns	W14s	63 tons	0.65 psf	109 pieces
Gravity Beams	Wide Flange	535 tons	5.55 psf	695 pieces
		10,722 studs		
		354 Beams cambered between 0.75 and 2.00 inches		
Lateral Frames	Beams	38 tons	0.39 psf	43 pieces
	Columns	44 tons	0.46 psf	66 pieces
	Braces (HSS)	13 tons	0.13 psf	26 pieces
Steel not indicated in sketches (5%)		35 tons	0.36 psf	
		728 tons	**7.55 psf**	**939 pieces**

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SSC
Project Assistance

- Conceptual Plans
- Estimated Tonnage
- **Early Fabricator Involvement**

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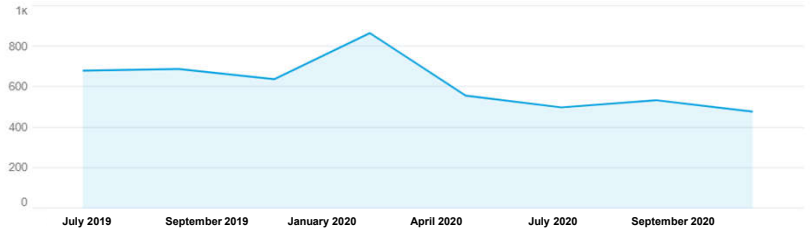
SSC

Technical Inquiries



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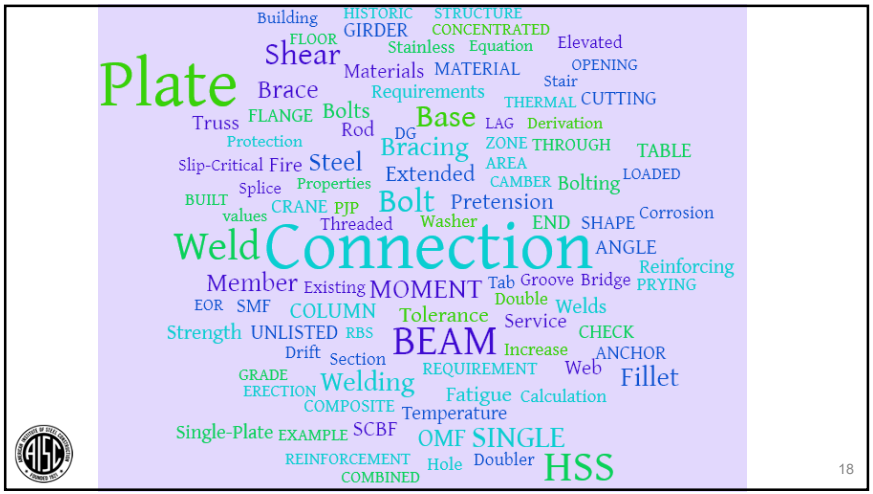

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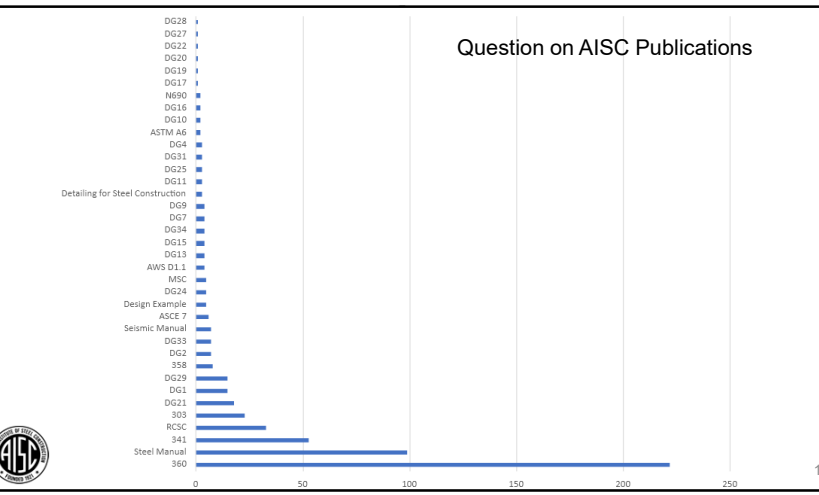

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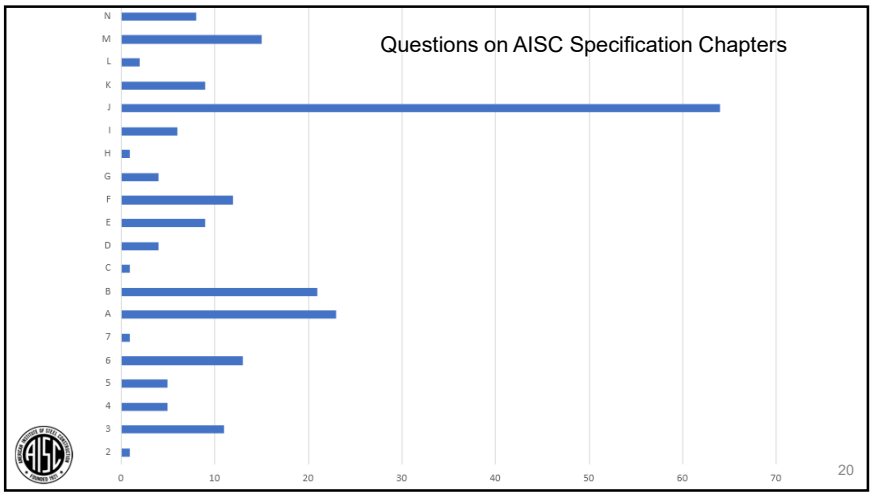

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Practice Question

Question:
Which one of these statements did Larry Muir make in a response he provided to a question received in the Solutions Center?

a.) "Based on my experiences at the AISC Steel Solutions Center, I suspect that if you built two rockets – one to carry a steel column and one to carry a forklift and sent them to opposite ends of the galaxy, somehow the forklift would eventually find its way to the column and run into it."

b.) "The owner would be within his rights to call out in the contract documents that all welding is to be performed by trained monkeys accompanied by an organ grinder, but he would also then have to expect to pay a premium to cover the cost of training the monkeys, paying the organ grinder, and presumably the purchase of a large quantity of bananas."

c.) Both a.) and b.)

d.) None of the above

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POLL QUESTION

22

POLL QUESTION

-- SELECT YOUR ANSWER --

23

Practice Question

Answer: ?
Which one of these statements did Larry Muir make in a response he provided to a question received in the Solutions Center?

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c.) Both a.) and b.)

d.) None of the above

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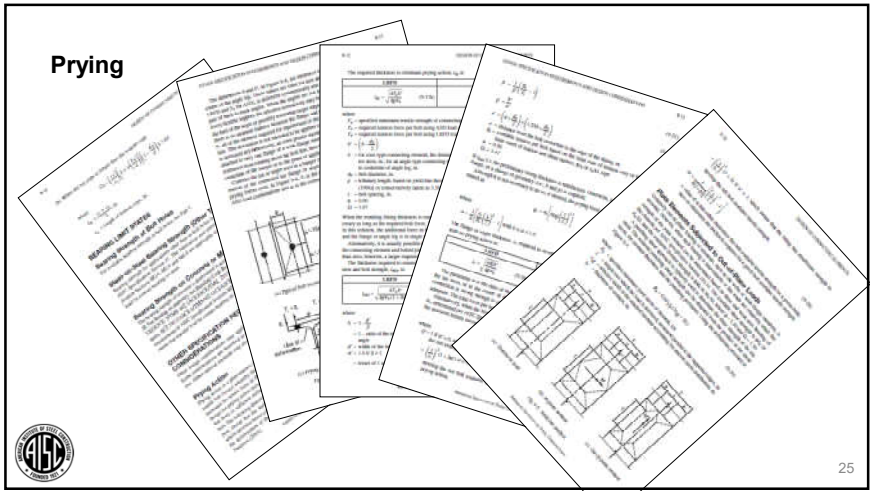
Prying

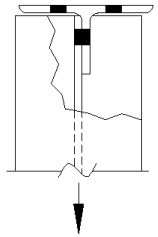


25

Question:

The following connection was designed without considering prying action and the strength was determined to be equal to 20 kips. Keeping all things the same (angle size, bolt diameter. etc.), if one were to now consider prying action, the strength of the connection will likely

a.) increase
b.) decrease



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POLL QUESTION

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POLL QUESTION

-- SELECT YOUR ANSWER --

28

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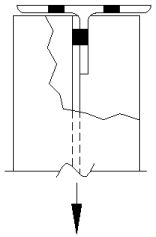

Answer: ?

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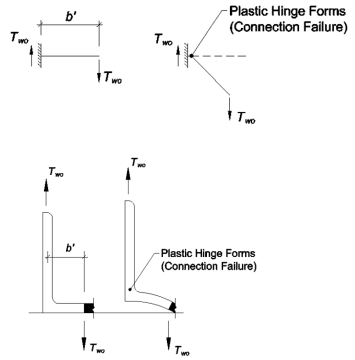

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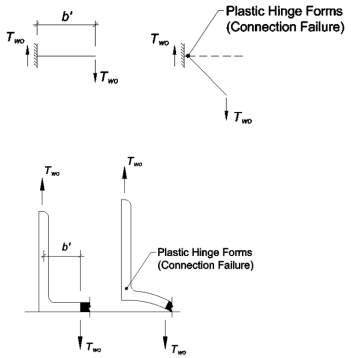

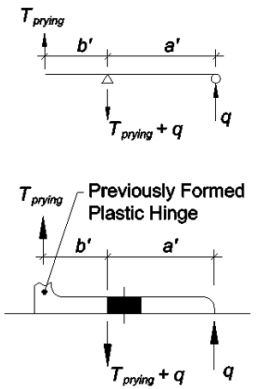

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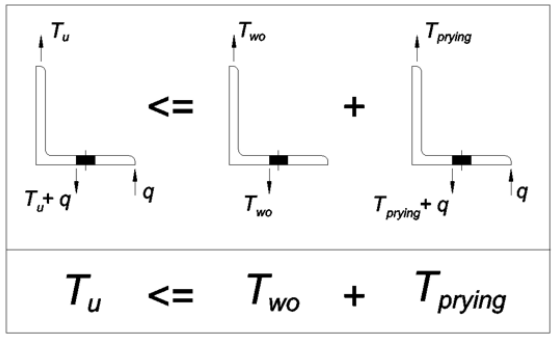

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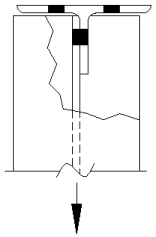
Question:

The following connection was designed without considering prying action and the strength was determined to be equal to 20 kips. Keeping all things the same (angle size, bolt diameter. etc.), if one were to now consider prying action, the strength of the connection will likely

a.) increase
b.) decrease



Answer: ?

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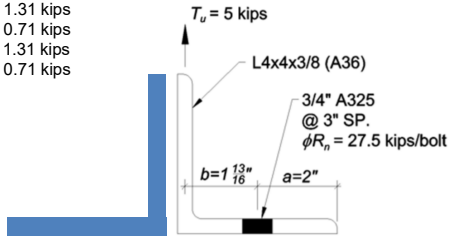
Question: **(LFRD)**

For the angle and geometry shown, the available tensile strength, T_c, per Equation 9-27 in the 15th Edition, and prying force, q_r, per Equation 9-24 is equal to

a.) T_c = 8.24 kips and q_r = 1.31 kips
b.) T_c = 8.24 kips and q_r = 0.71 kips
c.) T_c = 6.62 kips and q_r = 1.31 kips
d.) T_c = 6.62 kips and q_r = 0.71 kips



Eq. 9-25: $\alpha = 0.4$
Eq. 9-26: $t_c = 1.0$
Eq. 9-20: $\delta = 0.73$
Eq. 9-22: $\rho = 0.61$
Eq. 9-28: $\alpha' = 5.28$

Given:
p = 3 in B_c = 27.5 kips
b' = 1 7/16 a' = 2 3/8" d' = 13/16 in

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POLL QUESTION

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POLL QUESTION

-- SELECT YOUR ANSWER --

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For the angle and geometry shown, the available tensile strength, T_c, per Equation 9-27 in the 15th Edition, and prying force, q_r, per Equation 9-24 is equal to

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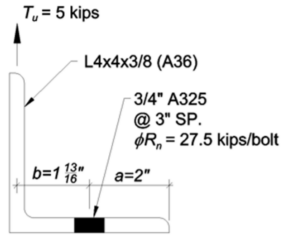
d.) T_c = 6.62 kips and q_r = 0.71 kips

Answer: ?



Given:
p = 3 in B_c = 27.5 kips
b' = 1 7/16 a' = 2 3/8" d' = 13/16 in

37

$$\delta = 1 - \frac{d'}{p} \quad (9\text{-}20) \qquad \rho = \frac{b'}{a'} \quad (9\text{-}22)$$

$$t_c = \sqrt{\frac{4B_c b'}{\phi p F_u}} \quad (9\text{-}26)$$

$$\alpha = \frac{1}{\delta}\left[\frac{T_r}{B_c}\left(\frac{t_c}{t}\right)^2 - 1\right] \text{ with } 0 \le \alpha \le 1.0 \quad (9\text{-}25)$$

$$\alpha' = \frac{1}{\delta(1+\rho)}\left[\left(\frac{t_c}{t}\right)^2 - 1\right] \quad (9\text{-}28)$$

$$q_r = B_c\left[\delta\alpha\rho\left(\frac{t}{t_c}\right)^2\right] \quad (9\text{-}24)$$

For α' >1…$Q = \left(\frac{t}{t_c}\right)^2 (1 + \delta)$ if $\alpha' > 1$,

"the fitting has insufficient strength to develop the full bolt available strength."

$$T_c = B_c Q \quad (9\text{-}27)$$

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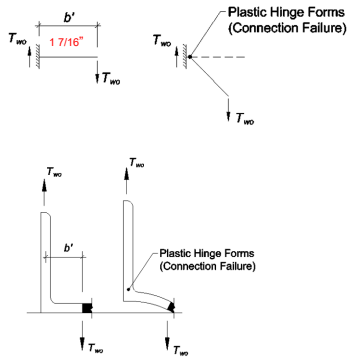
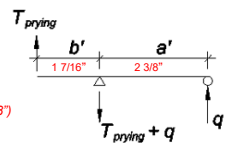


T_{wo} = 0.9 [3"(3/8")^2/4] x 58 / 1 7/16"

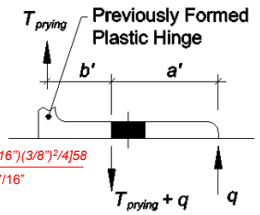
T_{wo} = 3.83 kips < 5 kips (NG…consider prying)

$T_{prying(req)}$ = 5 kips – 3.83 kips = 1.17 kips



q = 1.17 (1 7/16" / 2 3/8")

q = 0.71 kips



$T_{prying} = \frac{0.9\,[(3" - 13/16")(3/8")^2/4]58}{1\ 7/16"}$

T_{prying} = 2.79 kips

T_c = 3.83 kips + 2.79 kips = 6.62 kips > 5 kips (OK)

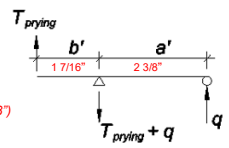
39

α' > 1
"the fitting has insufficient strength to develop the full bolt available strength."

Load on bolt = 5 kips + 0.71 kips
= 5.71 kips < 27.5 kips

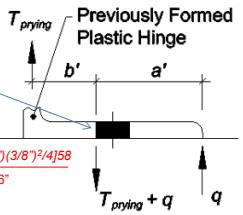
Flexural Yielding

$T_{prying(req)}$ = 5 kips – 3.83 kips = 1.17 kips



q = 1.17 (1 7/16" / 2 3/8")

q = 0.71 kips



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T_{prying} = 2.79 kips

T_c = 3.83 kips + 2.79 kips = 6.62 kips > 5 kips (OK)

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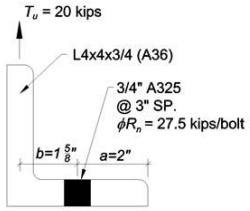


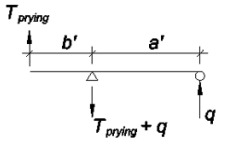
Given:
p = 3 in
B = 27.5 kips

b′ = 1 1/4 in
a′ = 2 3/8 in
d′ = 13/16 in

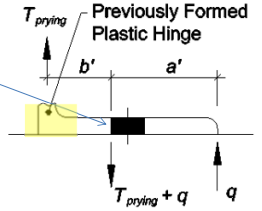
41

$0 < \alpha' < 1$
"the fitting has sufficient strength to develop the full bolt available Tensile strength, but insufficient strength to prevent prying action.

Load on bolt = 20 kips + q kips = 27.5 kips



Bolt Tension



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$$q = B\left[\left(1-\frac{d'}{p}\right)\left\{\frac{1}{\left(1-\frac{d'}{p}\right)}\left[\frac{T}{B}\left(\frac{\sqrt{\frac{4Bb'}{\varphi p F_u}}}{t}\right)^2 - 1\right]\right\}\frac{b'}{a'}\left(\frac{t}{\sqrt{\frac{4Bb'}{\varphi p F_u}}}\right)^2\right]$$

```
p:=3   B:=27.5   T:=5   φ:=0.9   F_u:=58
b':=1.4375   a':=2.375   d':=13/16   t:=0.375
q:=B·((1-d'/p)·(1/(1-d'/p))·((T/B)·(√(4·B·b'/(φ·p·F_u))/t)^2 - 1))·(b'/a')·(t/√(4·B·b'/(φ·p·F_u)))^2
q=0.7082
```

$$q = \frac{1.17\ kips\ x\ 1\,{}^{7}/_{16}in}{2\,{}^{3}/_{8}} = 0.7082\ \text{kips}$$

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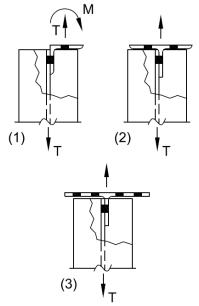
Question:
The prying procedure presented in the AISC Steel Construction Manual is not applicable to which of the following connections.

a.) Figure 1
b.) Figure 2
c.) Figure 3
d.) Figure 1 and 3
e.) None of the above



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POLL QUESTION

45

POLL QUESTION

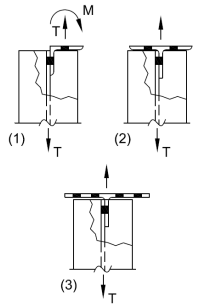
-- SELECT YOUR ANSWER --

46

Question:

The prying procedure presented in the AISC Steel Construction Manual is not applicable to which of the following connections.

a.) Figure 1
b.) Figure 2
c.) Figure 3
d.) Figure 1 and 3
e.) None of the above



Answer: ?

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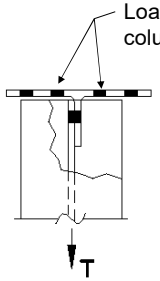

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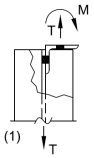

February 2015 Steel Interchange (Muir & Dowswell)

When the load is delivered asymmetrically, an even greater moment might result. For instance, if the angle were attached to only one flange of a wide-flange member used as a hanger and the hanger were not restrained from rotating about the bolt line, then eccentricity would have to be measured from the centerline of the hanger or to the point of application of the load. The prying action discussion in Part 9 of the *Manual* is not intended to be applied to asymmetrical conditions.

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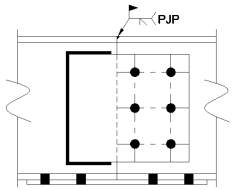
Question:

What portion of the beam splice detail would not technically meet the requirements of the AISC Specification?



a.) The use of a welded top flange and bolted bottom flange
b.) The use of welds on one side of the web splice and bolts on the other side
c.) The use of a PJP weld to connect the beam flange
d.) None of the above

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POLL QUESTION

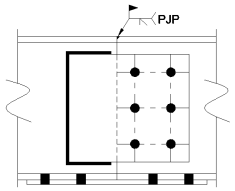
51

POLL QUESTION

-- SELECT YOUR ANSWER --

52

Question:
What portion of the beam splice detail would not technically meet the requirements of the AISC Specification?



a.) The use of a welded top flange and bolted bottom flange
b.) The use of welds on one side of the web splice and bolts on the other side
c.) The use of a PJP weld to connect the beam flange
d.) None of the above

Answer: ?

53

2016 AISC *Specification*

J6. SPLICES

Groove-welded splices in plate girders and beams shall develop the nominal strength of the smaller spliced section. Other types of splices in cross sections of plate girders and beams shall develop the strength required by the forces at the point of the splice.

54

1946 AISC *Specification*

www.aisc.org/publications/historic-standards

Section 26 (f)

(f) Splices.

Web splices in plate girders and in beams shall be proportioned to transmit the full shearing and bending stresses in the web at the point of splice. Web splices in welded girders shall preferably be complete penetration butt welds.

If the flanges are spliced, the splices shall either develop the full effective strength of the material or they shall develop the strength required by the total stresses, but in no case shall the strength developed be less than 50 percent of the effective strength of the material spliced, nor shall butt-welded joints be only partially welded.

55

Question:
True/False: The AISC Specification prohibits welding in the k-area of a wide flange shape.

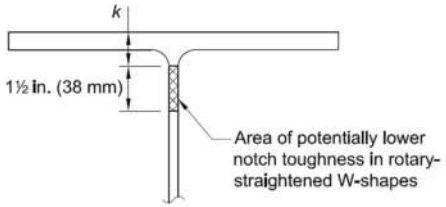


Fig. C-J10.7. Representative "k-area" of a wide-flange shape.

56

POLL QUESTION

57

POLL QUESTION

-- SELECT YOUR ANSWER --

58

Question:
True/False: The AISC Specification prohibits welding in the k-area of a wide flange shape.

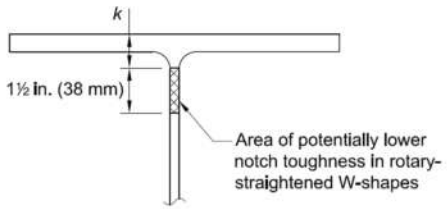


Fig. C-J10.7. Representative "k-area" of a wide-flange shape.

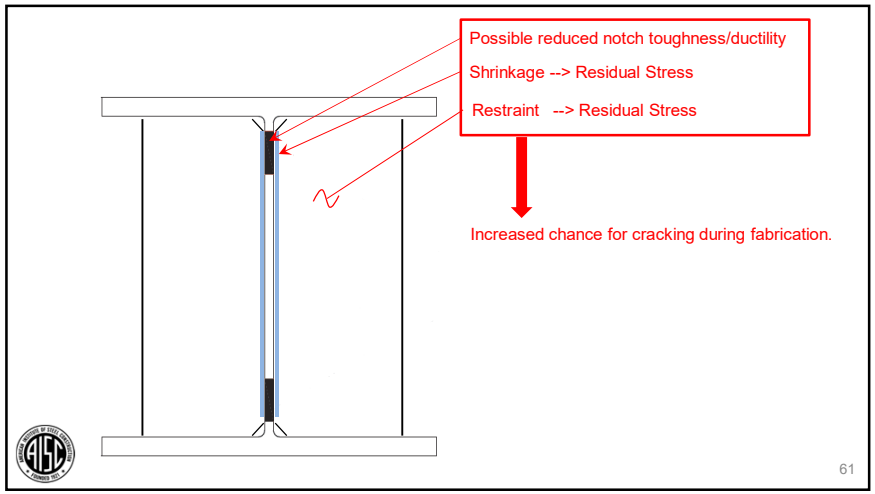
Answer: ?

59

AISC Advisory Statement (1997)

Welding of highly restrained joints, such as those associated with continuity plates and/or doubler plates in columns, induces residual stresses in steel members.

60



AISC Advisory Statement (1997)

Based on the review conducted at the AISC January workshop, the number of examples reported has been limited and these have occurred during construction or laboratory tests, with no evidence of difficulties with steel members in service.

62

2016 AISC *Specification*

TABLE N5.4-3
Inspection Tasks After Welding

Inspection Tasks After Welding	QC	QA
Welds cleaned	O	O
Size, length and location of welds	P	P
Welds meet visual acceptance criteria • Crack prohibition • Weld/base-metal fusion • Crater cross section • Weld profiles • Weld size • Undercut • Porosity	P	P
Arc strikes	P	P
k-area[a]	P	P
Weld access holes in rolled heavy shapes and built-up heavy shapes[b]	P	P
Backing removed and weld tabs removed (if required)	P	P
Repair activities	P	P
Document acceptance or rejection of welded joint or member	P	P
No prohibited welds have been added without the approval of the EOR	O	O

[a] When welding of doubler plates, continuity plates or stiffeners has been performed in the *k*-area, visually inspect the web *k*-area for cracks within 3 in. (75 mm) of the weld.
[b] After rolled heavy shapes (see Section A3.1c) and built-up heavy shapes (see Section A3.1d) are welded, visually inspect the weld access hole for cracks.

P – Perform these tasks for each welded joint or member.

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2016 AISC *Specification*

TABLE N5.4-3
Inspection Tasks After Welding

Inspection Tasks After Welding	QC	QA
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[b] After rolled heavy shapes (see Section A3.1c) and built-up heavy shapes (see Section A3.1d) are welded, visually inspect the weld access hole for cracks.

Weld access holes in rolled heavy shapes and built-up heavy shapes[b]	P	P
Backing removed and weld tabs removed (if required)	P	P
Repair activities	P	P
Document acceptance or rejection of welded joint or member	P	P
No prohibited welds have been added without the approval of the EOR	O	O

P – Perform these tasks for each welded joint or member.

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2016 AISC *Specification*

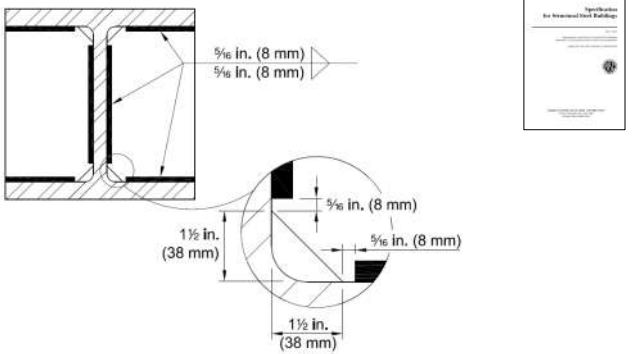


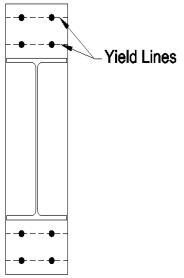
Fig. C-J10.8. Recommended placement of stiffener fillet welds to avoid contact with "k-area."

65

Question:

For the end-plate moment connection illustrated, do the yield lines shown seem reasonable?

a.) Yes
b.) No



66

POLL QUESTION

67

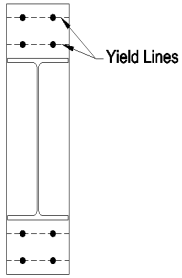
POLL QUESTION

-- SELECT YOUR ANSWER --

68

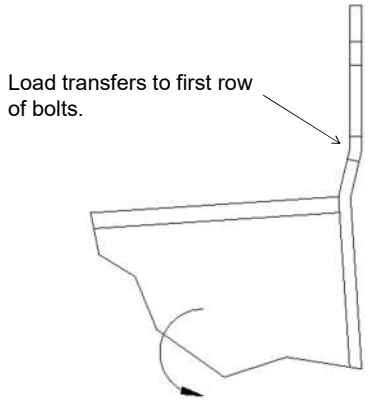
Question:
For the end-plate moment connection illustrated, do the yield lines shown seem reasonable?

a.) Yes
b.) No



Answer: ?

69



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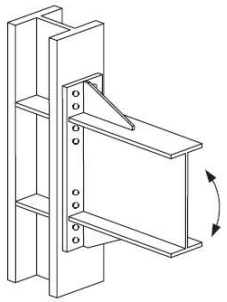
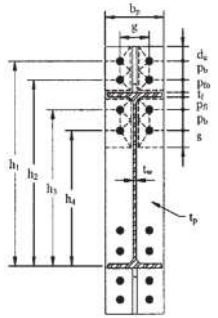
AISC Design Guide 4



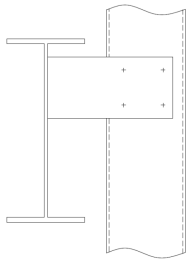
(c) Eight Bolt Stiffened, 8ES



71

Question:
A ¼" plate is used to attach metal studs to a spandrel beam. The plate is fillet welded to the beam web. Which of the following is true.

a.) The plate is not structural steel and therefore not part of the fabricators contract unless noted otherwise.
b.) The plate is structural steel since it is a minimum ¼" thick.
c.) The plate is structural steel since it is welded to a structural steel beam.
d.) Both b.) and c.)



72

POLL QUESTION

73

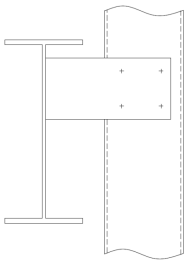
POLL QUESTION

-- SELECT YOUR ANSWER --

74

Question:
A ¼" plate is used to attach metal studs to a spandrel beam. The plate is fillet welded to the beam web. Which of the following is true.

a.) The plate is not structural steel and therefore not part of the fabricators contract unless noted otherwise.
b.) The plate is structural steel since it is a minimum of ¼" thick.
c.) The plate is structural steel since it is welded to a structural steel beam.
d.) Both b.) and c.)



Answer: ?

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2016 AISC *Code of Standard Practice*

- Section 2.1 – Definition of Structural Steel
  - Connection materials for framing structural steel to structural steel
- Section 2.2 – Other Steel, Iron or Metal Items
  - Cold-formed steel products

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2016 AISC *Code of Standard Practice*

Commentary:

Section 2.2 includes many items that may be furnished by the *fabricator* if contracted to do so by specific notation and detail in the *contract documents*. When such items are contracted to be provided by the *fabricator*, coordination will normally be required between the *fabricator* and other material suppliers and trades. The provisions in this Code are not intended to apply to items in Section 2.2.

In previous editions of this Code, provisions regarding who should normally furnish field-installed shear stud connectors and cold-formed steel deck support angles were included in Section 7.8. These provisions have been eliminated since field-installed shear stud connectors and steel deck support angles are not defined as *structural steel* in this Code.

Stainless steel is not covered in this Code. AISC Design Guide 27, *Structural Stainless Steel*, is a source of useful information regarding the practical fabrication and installation issues associated with structural stainless steel components.

77

Question:

A contractor had determined that a steel edge angle has not been placed within tolerance. The concrete has already been placed. Is the fabricator responsible for correcting the steel edge angle location?

a.) Likely yes
b.) Likely no

78

POLL QUESTION

79

POLL QUESTION

-- SELECT YOUR ANSWER --

80

Question:
A contractor had determined that a steel edge angle has not been placed within tolerance. The concrete has already been placed. Is the fabricator responsible for correcting the steel edge angle location?

a.) Likely yes
b.) Likely no

Answer: ?

81

2016 AISC *Code of Standard Practice*

7.13.3. Prior to placing or applying any other materials, the *owner's designated representative for construction* shall determine that the location of the *structural steel* is acceptable for plumbness, elevation and alignment. The *erector* shall be given either timely notice of acceptance by the *owner's designated representative for construction* or a listing of specific items that are to be corrected in order to obtain acceptance. Such notice shall be rendered promptly upon completion of any part of the work and prior to the start of work by other trades that may be supported, attached or applied to the *structural steel* frame.

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2016 AISC *Code of Standard Practice*

7.11.5. Unless the interaction and safety of activities of others, such as construction by others or the storage of materials that belong to others, are coordinated with the work of the *erector* by the *owner's designated representative for construction*, such activities shall not be permitted until the erection of the *structural steel* frame or portion thereof is completed by the *erector* and accepted by the *owner's designated representative for construction*.

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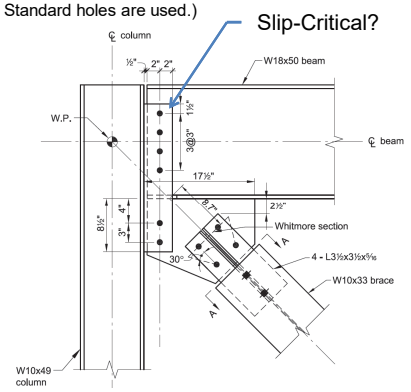
2016 AISC *Code of Standard Practice*

Commentary to Section 7.13.2

panels that are supported by the *structural steel* frame because the accumulation of shortening of loaded steel columns will result in the unstressed facade supported at each floor level being higher than the *structural steel* framing to which it must be attached. Observations in the field have shown that where a heavy facade is erected to a greater height on one side of a multistory building than on the other, the *structural steel* framing will be pulled out of alignment. Facades should be erected at a relatively uniform rate around the perimeter of the structure.

84

Question:
True/False: In the Ordinary Concentrically Braced Frame detail shown below, the AISC Seismic Provisions requires that the single-plate connection to the W10x49 column be designed as a slip-critical connection. (Note: Standard holes are used.)



85

POLL QUESTION

86

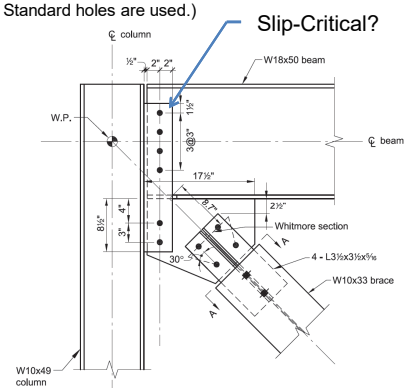
POLL QUESTION

-- SELECT YOUR ANSWER --

87

Question:
True/False: In the Ordinary Concentrically Braced Frame detail shown below, the AISC Seismic Provisions requires that the single-plate connection to the W10x49 column be designed as a slip-critical connection. (Note: Standard holes are used.)

Answer: ?



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2016 AISC *Seismic Provisions*

D2. CONNECTIONS

2. Bolted Joints

Bolted joints shall satisfy the following requirements:

(a) The available shear strength of bolted joints using standard holes or short-slotted holes perpendicular to the applied load shall be calculated as that for bearing-type joints in accordance with *Specification* Sections J3.6 and J3.10. The nominal bolt bearing and tearout equations per Section J3.10 of the *Specification* where deformation at the bolt hole at service load is a design consideration shall be used.

Exception: Where the required strength of a connection is based upon the expected strength of a member or element, it is permitted to use the bolt bearing and tearout equations in accordance with *Specification* Section J3.10 where deformation is not a design consideration.

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2016 AISC *Seismic Provisions*

D2. CONNECTIONS

(d) All bolts shall be installed as pretensioned high-strength bolts. Faying surfaces shall satisfy the requirements for slip-critical connections in accordance with *Specification* Section J3.8 with a faying surface with a Class A slip coefficient or higher.

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2016 AISC *Seismic Provisions*

D2. CONNECTIONS (Commentary)

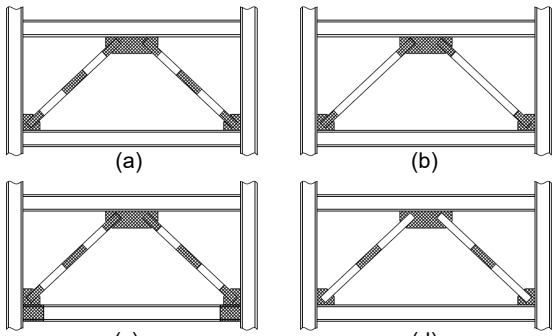
2. Bolted Joints

The potential for full reversal of design load and the likelihood of inelastic deformations of members and/or connected parts necessitates that pretensioned bolts be used in bolted joints in the SFRS. However, earthquake motions are such that slip cannot and need not be prevented in all cases, even with slip-critical connections. Accordingly, the Provisions call for bolted joints to be proportioned as pretensioned bearing joints but with faying surfaces prepared as for Class A or better slip-critical connections. That is, bolted connections can be proportioned with available strengths for bearing connections as long as the faying surfaces are still prepared to provide a minimum slip coefficient, $\mu = 0.30$. The resulting nominal amount of slip resistance may minimize damage in more moderate seismic events. This requirement is intended for joints where the faying surface is primarily subjected to shear. Where the faying surface is primarily subjected to tension or compression from seismic load effects, for example, in a bolted end plate moment connection, the requirement for preparation of the faying surfaces may be relaxed.

91

Question:

Which of the following figures correctly illustrates the required protected zones for a Special Concentrically Braced Frame (SCBF)?



92

POLL QUESTION

93

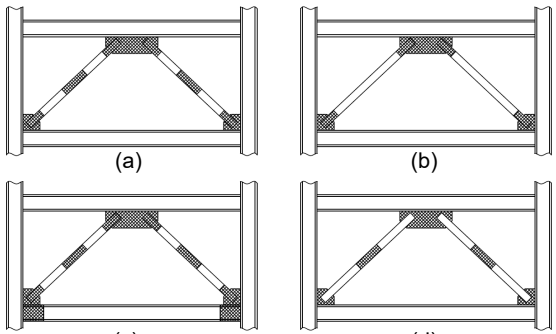
POLL QUESTION

-- SELECT YOUR ANSWER --

94

Answer: ?

Which of the following figures correctly illustrates the required protected zones for a Special Concentrically Braced Frame (SCBF)?



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2016 AISC *Seismic Provisions*

I2. FABRICATION AND ERECTION

1. Protected Zone

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

(a) 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.

(b) Steel headed stud anchors shall not be placed on beam flanges within the protected zone.

(c) Arc spot welds as required to attach decking are permitted.

(d) 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 in. diameter are permitted.

(e) 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. See Section D1.3.

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2016 AISC *Code of Standard Practice*

1.11. Marking of Protected Zones in High-Seismic Applications

The *fabricator* shall permanently mark protected zones that are designated on the structural *design documents* in accordance with ANSI/AISC 341 Section A4.1. If these markings are obscured in the field, such as after the application of fire protection, the *owner's designated representative for construction* shall re-mark the protected zones as they are designated on the structural *design documents*.

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For those participating at their own connection…

- Reporting attendance is not necessary.
- Certificates will be issued based on AISC's attendance record.
- You will be receiving certificates via email from registration@aisc.org.

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CEU / PDH Certificates

For those participating at one connection with a group…

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  - Username: Same as AISC website username.
  - Password: Same as AISC website password.
- Once attendance has been reported, each group member will be receiving certificates via email from registration@aisc.org.

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AISC | Thank you

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