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Course Description

Session 8: December 5, 2017 – Bracing Connections

This live webinar presents information on light and heavy bracing connections and discusses the differences and similarities between the two. Typical details for light and heavy connections will be presented. Member, bolt and weld limit states will be reviewed. The presentation then introduces the Uniform Force Method for designing bracing connections.



Learning Objectives

At the end of this program, participants will be able to:

- Identify design considerations for light bracing connections.
- Identify design considerations for heavy bracing connections.
- Identify advantages of using the Uniform Force Method.
- Identify concepts to incorporate into connection design that take into account constructibility.



Fundamentals of Connection Design

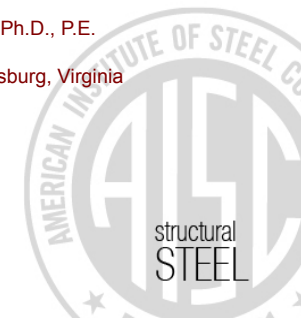
Session 8: Bracing Connections

December 5, 2017



Presented by
Thomas M. Murray, Ph.D., P.E.
Emeritus Professor
Virginia Tech, Blacksburg, Virginia

There's always a solution in steel.



Light Bracing Connections

w.p.

w.p.

VirginiaTech 13

Light Bracing Connections

w.p.

Welded to Column Flange

VirginiaTech 14

Bolted-Welded Light Bracing Connections

Limit States

- Angles
 - Tension Yielding
 - Tension Rupture
 - Block Shear
- **Shear Transfer at Elements**
 - Brg/Tear Out/Bolt Shear Rupture

w.p.

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Bolted-Welded Light Bracing Connections

Limit States

- Plate
 - Tension Yielding on Whitmore Section
 - Tension Rupture on Whitmore Section
 - Block Shear if more than two rows of bolts in the direction of force.
 - Plate shear rupture strength at weld.

w.p.

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Bolted-Welded Light Bracing Connections

Limit States

- Welds

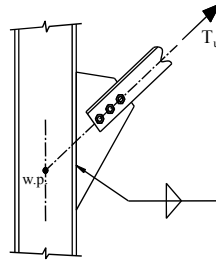
- Weld Rupture on Whitmore Section
- Design Weld Rupture Strength

$$\phi R_n = 0.75 F_{nw} A_{we}$$

$$F_{nw} = 0.60 F_{EXX} (1.0 + 0.50 \sin^{1.5}\theta)$$

Or, for E70xx electrode

$$\phi R_n = 1.392 D L_w (1.0 + 0.50 \sin^{1.5}\theta)$$

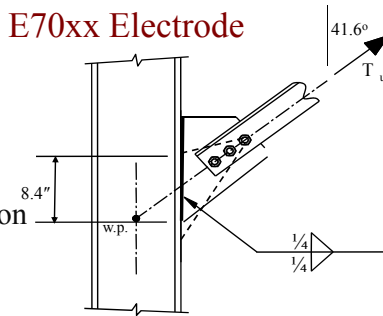


Bolted-Welded Light Bracing Connections

Ex. Weld Strength with E70xx Electrode

$$\phi R_n = 0.75 F_{nw} A_{we}$$

Effective weld length is concentric with line of action of brace force.

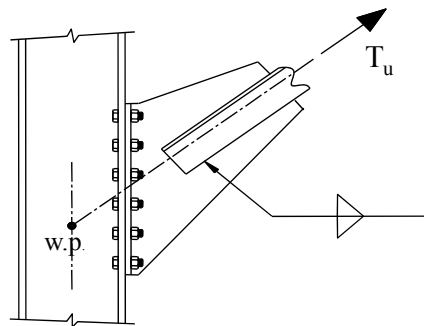


$$\phi R_n = 1.392 D L_w (1.0 + 0.50 \sin^{1.5}\theta)$$

$$= 1.392 (2 \times 4) (8.4 - 0.25) (1.0 + 0.50 \sin^{1.5} 41.6^\circ)$$

$$= \mathbf{115 \text{ kips}} \geq T_u$$

Welded-Bolted Light Bracing Connections



Bolted to Column Flange

Welded-Bolted Light Bracing Connections

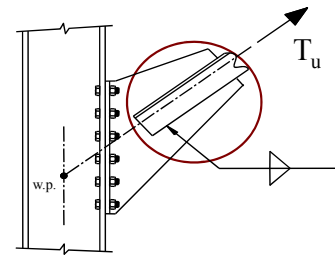
Limit States

- Angles

- Tension Yielding
- Tension Rupture

- Weld:

- Weld Rupture
- Plate Shear Rupture Strength at Weld

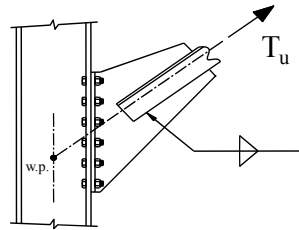


Welded-Bolted Light Bracing Connections

Limit States

• Tee Stem

- Tension Yielding on Whitmore Section
- Tension Rupture on Whitmore Section
- Block Shear
- Shear Yielding

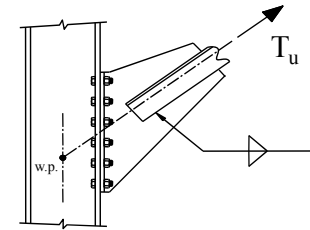


Welded-Bolted Light Bracing Connections

Limit States

• Tee Flange

- Flange Bending (Tee-Hanger)
- Shear Yielding
- Shear Rupture
- Block Shear



Welded-Bolted Light Bracing Connections

Limit States

• Bolts

- Combined Shear Plus Tension

• Shear Transfer at Elements

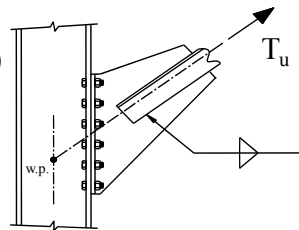
- Brg/Tear Out/Bolt Shear Rupture

• Column Flange:

- Flange Bending (Tee-Hanger)
- ~~Bearing~~ / Tear Out

• Column Web

- Local Web Yielding



Welded-Bolted Light Bracing Connections

Example. Determine if the slip resistance of the connection shown is sufficient for $T_u = 150k$, $\theta = 40^\circ$ 3/4" A325-SC Bolts Class B OVS Holes. From *Specification* Eqns J3-4 & J3-5a:

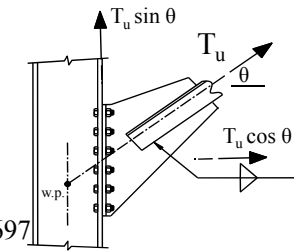
$$\phi R_n = \phi \mu D_u h_f T_b n_s k_{sc} / \text{bolt}$$

$$\phi = 0.85 \quad \mu = 0.5 \quad D_u = 1.13$$

$$h_f = 1.0 \quad T_b = 28 \text{ kips} \quad n_s = 1$$

Spec. Eqn. J3-5a:

$$k_{sc} = 1 - \frac{T_u \cos \theta}{D_u T_b n_b} = 1 - \frac{150 \cos 40^\circ}{1.13 \times 28 \times 12} = 0.697$$



Welded-Bolted Light Bracing Connections

Example. Check Slip Resistance.

$$T_u = 150 \text{ kips} \quad \phi = 0.85 \quad \mu = 0.5 \quad D_u = 1.13$$

$$h_f = 1.0 \quad T_b = 28 \text{ kips} \quad n_s = 1 \quad k_{sc} = 0.6974$$

$$\phi R_n = \phi \mu D_u h_f T_b n_s k_{sc} / \text{bolt}$$

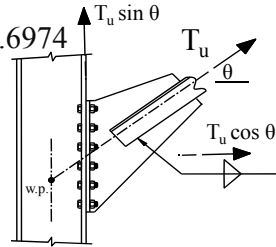
$$= 0.85 \times 0.50 \times 1.13 \times 1.0 \times 28 \times 1 \times 0.6974$$

$$= 9.35 \text{ kips/bolt}$$

$$\sum \phi R_n = 9.35 \times 12 = 112 \text{ k}$$

$$T_u \sin \theta = 150 \sin 40^\circ$$

$$= 96.4 \text{ k} < 112 \text{ k} \quad \text{OK}$$



Welded-Bolted Light Bracing Connections

Example. Check Bolt Design Strength ($V_u + T_u$)

$$T_u = 150 \text{ kips} \quad 3/4'' \text{ A325-N Bolts } (A_b = 0.4418 \text{ in}^2)$$

Assume Thick Plate Design: Prying Force = $Q_u = 0.0$

$$\phi R_{nt} = 0.75 F'_{nt} A_b \text{ per bolt} \quad (\text{Spec. J3-2})$$

$$F'_{nt} = 1.3 F_{nt} - \frac{F_{nt}}{\phi F_{nv}} f_{uv} \leq F_{nt} \quad (\text{Spec. J3-3a})$$

$$f_{uv} = 150 \sin 40^\circ / (12 \times 0.4418) = 18.2 \text{ ksi}$$

With $F_{nt} = 90 \text{ ksi}$ $F_{nv} = 54 \text{ ksi}$

$$F'_{nt} = 1.3 \times 90 - \frac{90}{0.75 \times 54} \times 18.2 = 76.6 \text{ ksi} \leq 90 \text{ ksi}$$

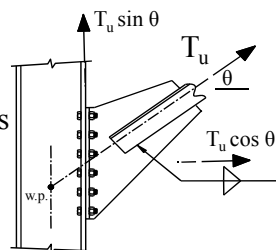
$$\phi R_{nt} = 0.75 \times 76.6 \times 0.4418 = 25.4 \text{ k} \geq 150 \cos 40^\circ / 12 =$$

$$9.58 \text{ k} \quad \text{OK}$$

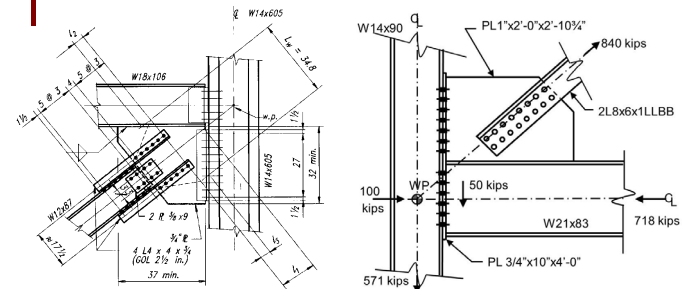
Welded-Bolted Light Bracing Connections

Example. Notes

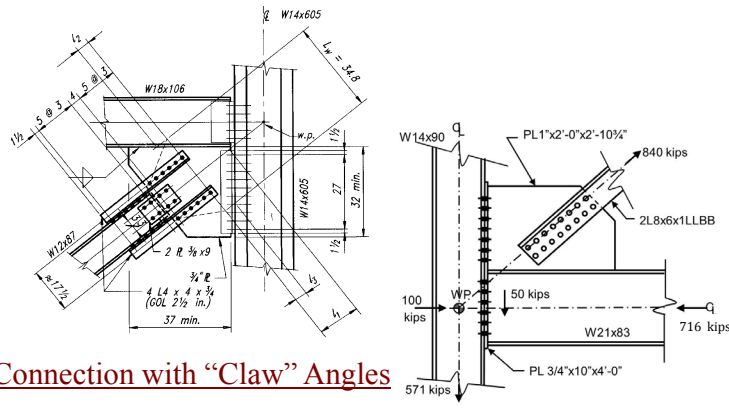
- Tee flange Limit States that also must be checked for –SC connections:
 - Shear Yielding
 - Shear Rupture
 - Block Shear
 - Shear Transfer at the Elements



Heavy Bracing Connections



Heavy Bracing Connections



Connection with “Claw” Angles

Large Diagonal Angles

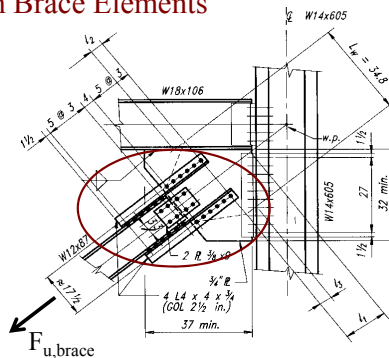
Heavy Bracing Connections

- Gusset plate is generally welded to beam and bolted to column.
- One new limit state: Gusset Plate Compression Buckling.
- Forces at beam and column determined using the Uniform Force Method.
- **Beam-to-gusset plate weld is increased 25% to account for non-uniform distribution of forces along weld length.**

Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Limit States for Tension Brace Elements
 - Tension Yielding
 - Tension Rupture
 - Block Shear
 - Shear Transfer at Elements



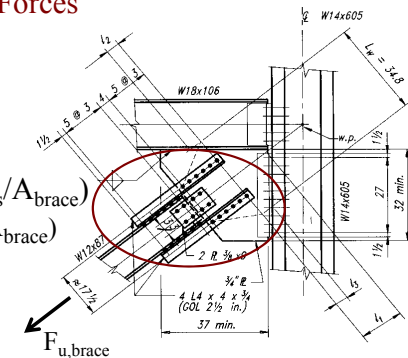
Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Brace-to-Gusset Plate Forces

$$F_{u, \text{angles}} = F_{u, \text{brace}} \left(\frac{A_{\text{flanges}}}{A_{\text{brace}}} \right)$$

$$F_{u, \text{web conn}} = F_{u, \text{brace}} \left(\frac{A_{\text{web}}}{A_{\text{brace}}} \right)$$

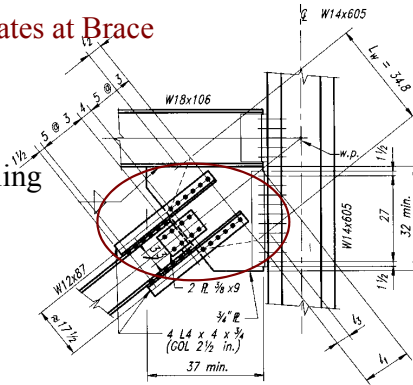


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace

- Whitmore Sections
- Tension Rupture
- Block Shear
- Compression Buckling

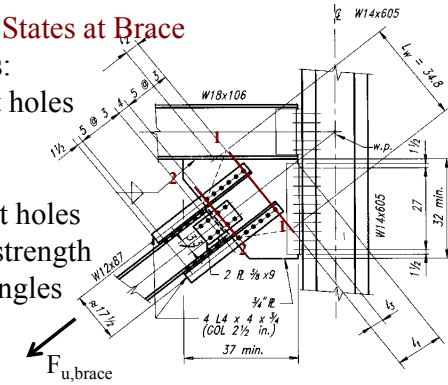


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace

- Whitmore Sections:
1-1 longer w/2 bolt holes
- 2-2 shorter w/4 bolt holes
plus shear rupture strength
of 8 bolts at claw angles

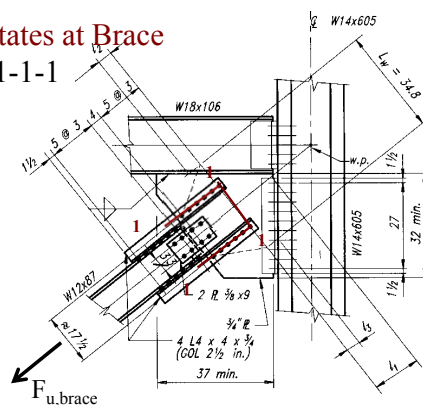


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace

- Block Shear Path: 1-1-1-1

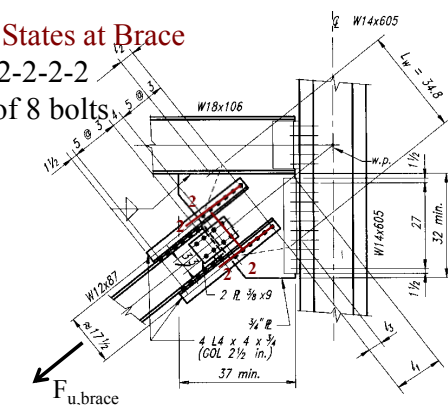


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace

- Block Shear Path: 2-2-2-2
plus shear rupture of 8 bolts
at claw angles.



Heavy Bracing Connections

Uniform Force Method

No moments on gusset plate.

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Heavy Bracing Connections

Uniform Force Method

- e_b = one-half the depth of the beam
- e_c = one-half the depth of the column
- α = distance from the face of the column flange to the centroid of the gusset-to-beam connection
- β = distance from the face of the beam flange to the centroid of the gusset-to-column connection

Note: Iteration may be needed to establish α and β .

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Heavy Bracing Connections

Uniform Force Method

$$\sum F_y = 0$$

$$T \cos \theta = R_c \cos \phi_c + R_b \sin \phi_b \quad (1)$$

$$\sum F_x = 0$$

$$T \sin \theta = R_c \sin \phi_c + R_b \cos \phi_b \quad (2)$$

Combining (1) and (2) and using angle relationships, to obtain:

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Heavy Bracing Connections

Uniform Force Method

$$r = \sqrt{(\alpha + e_c)^2 + (\beta + e_b)^2}$$

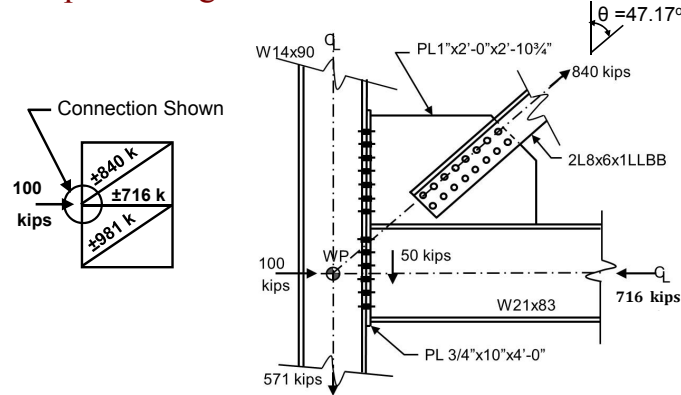
$$V_c = \frac{\beta}{r} T \quad H_c = \frac{e_c}{r} T$$

$$H_b = \frac{\alpha}{r} T \quad V_b = \frac{e_b}{r} T$$

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Heavy Bracing Connection Example

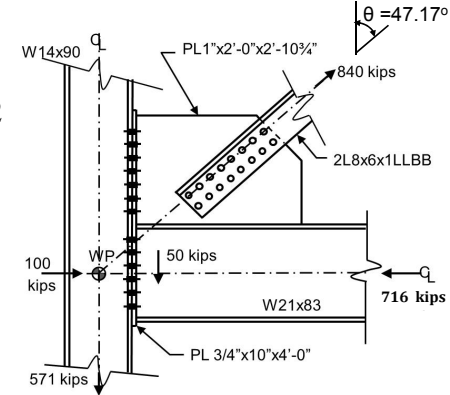
Example. Design Beam and Column Connections



Heavy Bracing Connection Example

Materials

Bolts: 7/8" A490-X
 Holes: 15/16" STD
 Beam/Column: A992
 Angles: A36
 Electrode: E70xx
 Plate: A572 Gr50



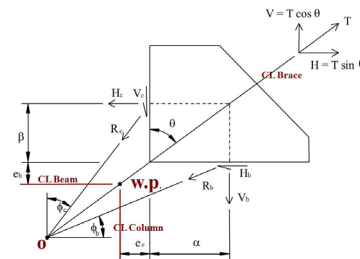
Heavy Bracing Connection Example

Determine Interface Forces using the UFM

$$r = \sqrt{(\alpha + e_c)^2 + (\beta + e_b)^2}$$

$$V_c = \frac{\beta}{r} T \quad H_c = \frac{e_c}{r} T$$

$$H_b = \frac{\alpha}{r} T \quad V_b = \frac{e_b}{r} T$$



Column W14x90 $d = 14.0'' \rightarrow e_c = 7.0''$

Beam W21x83 $d = 21.4'' \rightarrow e_b = 10.7''$

$V_u = T_u \cos \theta = 840 \cos 47.17^\circ = 571\text{k}$

$H_u = T_u \sin \theta = 840 \sin 47.17^\circ = 616\text{k}$

Heavy Bracing Connection Example

Estimate α and β

α :

Assume 7/16" fillet welds

$$L_w = 616 / (2 \times 1.392 \times 7) = 31.6''$$

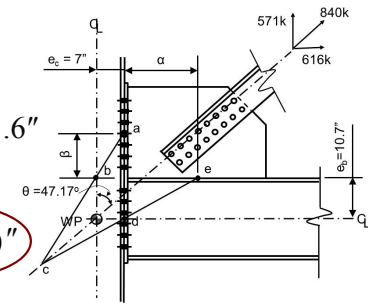
Try $\alpha = 17.5''$

β :

$$\beta = \frac{7.0 + 17.5}{\tan 47.17^\circ} = 10.7 = 12.0''$$

Try 7 rows 7/8" A490

$\beta = 3 + 3 \times 3 = 12''$



Heavy Bracing Connection Example

Compute Interface Forces

$$\alpha = 17.5'' \quad \beta = 12.0''$$

$$e_c = 7.0'' \quad e_b = 10.7''$$

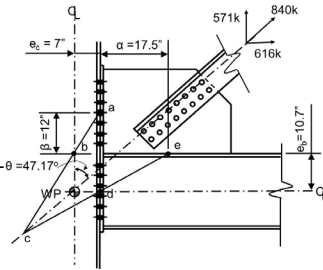
$$r = \sqrt{(\alpha + e_c)^2 + (\beta + e_b)^2}$$

$$= \sqrt{(17.5 + 7.0)^2 + (12.0 + 10.7)^2}$$

$$= 33.40''$$

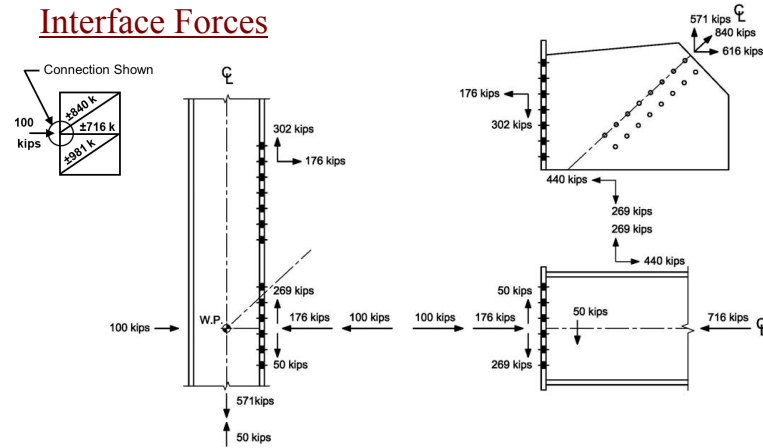
$$V_c = \frac{\beta}{r} T = \frac{12.0}{33.40} 840 = 302\text{k} \quad H_c = \frac{e_c}{r} T = \frac{7.0}{33.40} 840 = 176\text{k}$$

$$H_b = \frac{\alpha}{r} T = \frac{17.5}{33.40} 840 = 440\text{k} \quad V_b = \frac{e_b}{r} T = \frac{10.7}{33.40} 840 = 269\text{k}$$



Heavy Bracing Connection Example

Interface Forces



Heavy Bracing Connection Example

Check Gusset Plate Strength at Beam Flange

PL1 x 24 x 2'-10 3/4" A572 Gr50

$$\alpha = 17.5''$$

$$H_{ub} = 440\text{k} \quad V_{ub} = 269\text{k}$$

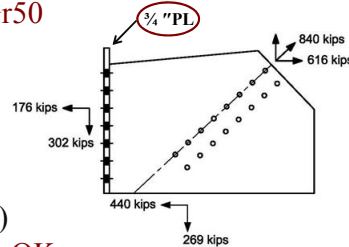
$$L_w = 2(17.5 - 0.75) = 33.5''$$

$$\phi V_n = 1.0(0.6 \times 50)(1.0 \times 33.5)$$

$$= 1,005\text{k} > H_{ub} = 440\text{k} \quad \text{OK}$$

$$\phi T_n = 0.9(50)(1.0 \times 33.5)$$

$$= 1,508\text{k} > V_{ub} = 269\text{k} \quad \text{OK}$$



Heavy Bracing Connection Example

Design Gusset-to-Beam Flange Weld

Fillet B.S. E70xx $L_w = 33.5''$

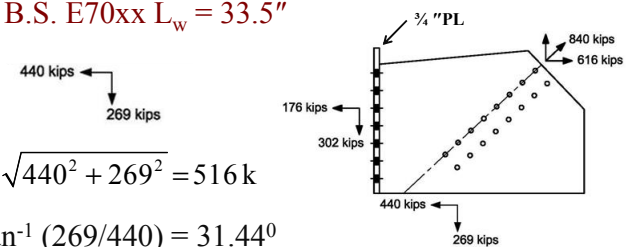
$$R_u = \sqrt{440^2 + 269^2} = 516\text{k}$$

$$\theta = \tan^{-1}(269/440) = 31.44^\circ$$

$$D_{req'd} = 516 / [(2 \times 1.392 \times 33.5)(1 + 0.5 \sin^{1.5} 31.44^\circ)]$$

$$= 4.66 \text{ 1/16s}$$

$$\text{Increase 25\%: } 1.25 \times 4.66 = 5.81 \text{ 1/16s} \quad \text{Use } \underline{\underline{3/8'' \text{ B.S.}}}$$

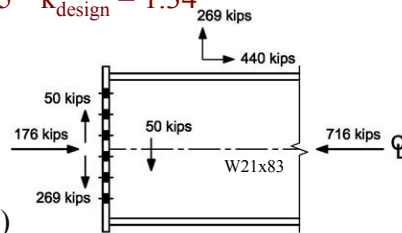


Heavy Bracing Connection Example

Check Beam Local Web Yielding

W21x83 A992 $t_w = 0.515"$ $k_{design} = 1.34"$

$I_b = 33.5"$



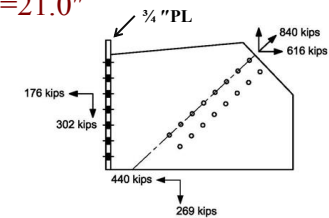
$$\begin{aligned}\phi R_n &= \phi F_y t_w (l_b + 2.5 k_{design}) \\ &= 1.0(50 \times 0.515)(33.5 + 2.5 \times 1.34) \\ &= 949k > R_u = 269k \quad \text{OK}\end{aligned}$$

Heavy Bracing Connection Example

Design Gusset-to-End-Plate Weld

Fillet B.S. E70xx $L_w = 7 \times 3.0 = 21.0"$

176 kips
302 kips



$$R_u = \sqrt{176^2 + 302^2} = 350k$$

$$\theta = \tan^{-1}(176/302) = 30.2^\circ$$

$$\begin{aligned}D_{req'd} &= 350 / [(2 \times 1.392 \times 21.0)(1 + 0.5 \sin^{1.5} 30.2^\circ)] \\ &= 5.07 - 1/16s \quad \text{Min.} - 5/16\end{aligned}$$

Use 3/8" Fillet Welds B.S.

Heavy Bracing Connection Example

Check End-Plate-to-Column Flange Connection

Column
W14x90 A992

$b_f = 14.5"$

$t_f = 0.710"$

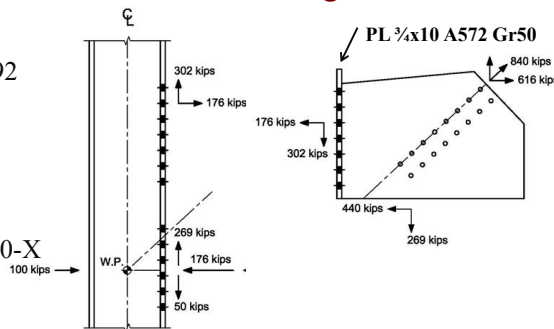
$g = 5"$

Bolts

14- 7/8" A490-X

$\phi r_{nv} = 37.9k$

$\phi r_{nt} = 51.0k$



$$r_{uv} = 302/14 = 21.6k < \phi r_{nv} = 37.9k$$

$$r_{ut} = 176/14 = 12.6k < \phi r_{nt} = 51.0k$$

Heavy Bracing Connection Example

Check End-Plate and Col. Flange Thicknesses

1"x10" Gusset Plate 5" gage 3" spcg.

$$b = (5.0 - 1.0)/2 = 2.0"$$

$$b' = 2.0 - 0.875/2 = 1.56"$$

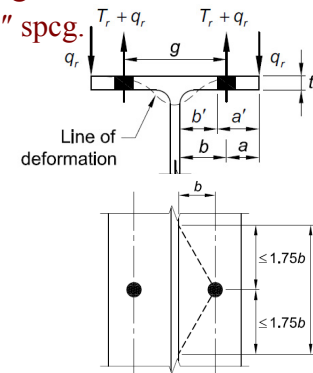
$$\begin{aligned}a &= (10.0 - 5.0)/2 \\ &= 2.50" \leq 1.25b = 2.50"$$

$$p = s = 3.0" < 2 \times 1.75b = 7.0"$$

For no prying, $F_u = 65$ ksi

$$t_{req} = \sqrt{\frac{4 r_{ut} b'}{\phi_b p F_u}} = \sqrt{\frac{4 \times 12.6 \times 1.56}{0.9 \times 3.0 \times 65}}$$

$$= 0.669" < t_p = 0.75" \text{ and } t_f = 0.710" \quad \text{OK}$$



Heavy Bracing Connection Example

Check End-Plate to Col. Flange Bolt Strength

14 – 7/8" A490-X Bolts $A_b = 0.601 \text{ in}^2$ (No Prying)

$$\phi R_{nt} = 0.75 F'_t A_b \text{ per bolt (J3-3a)}$$

$$r_{uv} = 302/14 = 21.6\text{k} < \phi V_n = 37.9\text{k} \text{ OK}$$

$$r_{ut} = 176/14 = 12.6\text{k}$$

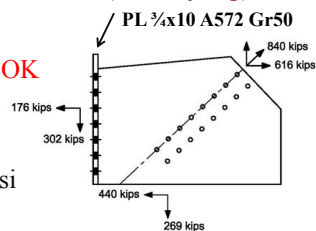
$$f_{uv} = 21.6/0.601 = 35.9 \text{ ksi}$$

and with $F_{nt} = 113 \text{ ksi}$ $F_{nv} = 84 \text{ ksi}$

$$F'_t = 1.3F_{nt} - \frac{F_{nt}}{\phi F_{nv}} f_{uv} \leq F_{nt}$$

$$= 1.3 \times 113 - \frac{113}{0.75 \times 84} \times 35.9 = 82.5\text{ksi} < 113\text{ksi}$$

$$\phi R_{nt} = 0.75 \times 82.5 \times 0.601 = 37.2\text{k} \geq r_{ut} = 12.6\text{k} \text{ OK}$$



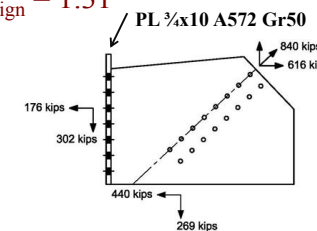
Heavy Bracing Connection Example

Check Column Local Web Yielding

W14x90 A992 $t_w = 0.440"$ $k_{design} = 1.31"$

$$I_b = 7 \times 3.0 = 21.0"$$

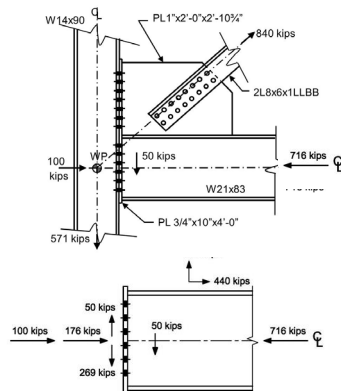
$$\begin{aligned} \phi R_n &= \phi F_y t_w (I_b + 5k_{design}) \\ &= 1.0(50 \times 0.440)(21.0 + 5 \times 1.31) \\ &= 606\text{k} > R_u = 176\text{k} \text{ OK} \end{aligned}$$



Heavy Bracing Connection Example

Beam-to-Column Flange Connection

For this loading case the only limit states at the column are local web yielding, local web crippling, and transfer of shear at the elements.



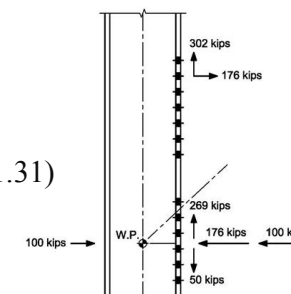
Heavy Bracing Connection Example

Check Column Local Web Yielding

W14x90 A992 $t_w = 0.440"$ $k_{design} = 1.31"$

$$I_b = d_b = 21.4"$$

$$\begin{aligned} \phi R_n &= \phi F_y t_w (I_b + 5k_{design}) \\ &= 1.0(50 \times 0.440)(21.4 + 5 \times 1.31) \\ &= 615\text{k} > R_u = 276\text{k} \text{ OK} \end{aligned}$$



Heavy Bracing Connection Example

Check Column Local Web Crippling

W14x90 A992

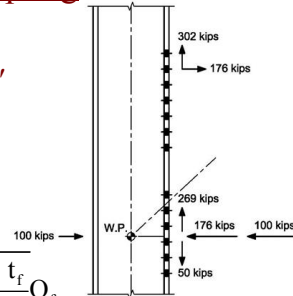
$$t_w = 0.440" \quad t_f = 0.710" \quad d = 14.0"$$

$$l_b = d_b = 21.4"$$

Use Eqn. J10-4 since $@ > d/2$.

$$R_n = 0.8 t_w^2 \left[1 + 3 \left(\frac{l_b}{d} \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{\frac{E F_{yw} t_f}{t_w}} Q_f$$

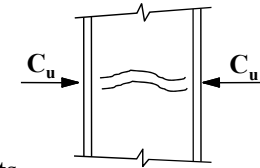
$$\phi R_n = 0.75 \times 767k = 575k > R_u = 276k \quad \text{OK}$$



4. Web Compression Buckling (*Spec. J10.5*)

$$C_u \leq \phi R_n \quad \phi = 0.9$$

$$\phi R_n = 0.9 \frac{24 t_{wc}^3 \sqrt{E F_{yc}}}{h} Q_f$$



h = clear distance between fillets
 (get from tabulated h/t_w value)

$Q_f = 1.0$ for wide flange sections

If $\max C_u > \phi R_n$, full depth stiffeners required

Heavy Bracing Connection Example

Check Column Compression Web Buckling

W14x90 A992

$$t_w = 0.440" \quad h/t_w = 25.9$$

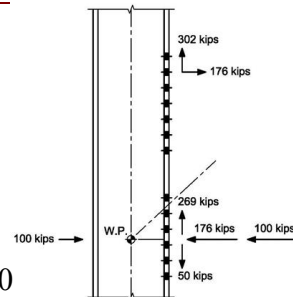
$$h = 25.9 \times 0.440 = 11.4"$$

$$R_n = \frac{24 t_{wc}^3 \sqrt{E F_{yc}}}{h} Q_f$$

$$= \frac{24 \times 0.440^3 \sqrt{29,000 \times 50.0}}{11.4} \times 1.0$$

$$= 216k$$

$$\phi R_n = 0.9 \times 216k = 194k < R_u = 276k \quad \text{Stiffener Req'd}$$



Heavy Bracing Connection Example

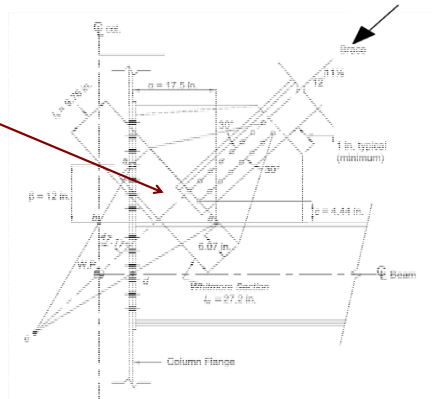
Notes

- All limit states have not been checked
- If the brace force is reversed the beam-to-column flange connection is in tension and the design checks are the same as those shown in this example for the gusset plate-to-column flange connection.
- Beam local web crippling must be checked
- Gusset plate flexural buckling must be checked at the Whitmore section as discussed in Session 7.

Heavy Bracing Connection Example

Gusset Plate Flexural Buckling

Flexural Buckling



WRAP-UP SLIDES
-Erection Considerations
-Poor Designs and More

THE END!!
Thank You for
Attending!!

Individual Webinar Registrants

CEU/PDH Certificates

Within 2 business days...

- You will receive an email on how to report attendance from: registration@aisc.org.
- Be on the lookout: Check your spam filter! Check your junk folder!
- Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

Individual Webinar Registrants

CEU/PDH Certificates

Within 2 business days...

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

8-Session Registrants

CEU/PDH Certificates

One certificate will be issued at the conclusion of all 8 sessions.

Certificates will be issued the first week of January 2018.

8-Session Registrants

FINAL EXAM

The final exam will be issued Tuesday, December 12.

Due Date: December 31.

The final exam is required for the certificate of completion (EEU).
It is NOT required for PDH credit.

8-Session Registrants

Access to the quiz: Information for accessing the quiz will be emailed to you by Thursday. It will contain a link to access the quiz. EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG

Quiz and Attendance records: Posted Wednesday mornings.
www.aisc.org/nightschool - click on Current Course Details.

Reasons for quiz:

- EEU – must take all quizzes and final to receive EEU
- CEUs/PDHS – If you watch a recorded session you must take quiz for CEUs/PDHS.
- REINFORCEMENT – Reinforce what you learned tonight. Get more out of the course.

NOTE: If you attend the live presentation, you do not have to take the quizzes to receive CEUs/PDHS.

8-Session Registrants

Access to the recording: Information for accessing the recording will be emailed to you by this Thursday. The recording will be available for three weeks. For 8-session registrants only. EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG.

CEUs/PDHS – If you watch a recorded session you must take AND PASS the quiz for CEUs/PDHS.



Night School Resources for 8-session package Registrants

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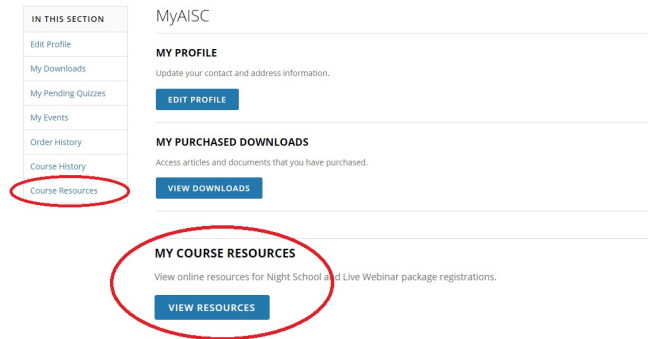
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Night School Resources for 8-session package Registrants

Course Resources

Event	Start Date
NS 13 8-Session Package-Night School 13 - Design of Industrial Buildings	1/30/2017 7:00:00 PM
NS 14 8-Session Package-Night School 14 - Fundamentals of Stability	6/5/2017 7:00:00 PM

Night School Resources for 8-session package Registrants

Night School 13: Design of Industrial Buildings

8-SESSION PACKAGE RESOURCES

Event	Date	Handouts	Video	Quiz	Attendance
NS13 - Design Criteria	1/30/2017 7:00:00 PM	Handouts	View Passcode: NS13DSN	Pass Score: 80	Pending
NS13 - Economic Considerations	2/6/2017 7:00:00 PM	Handouts	Available 02/08/2017 5pm EST	Available 02/08/2017 5pm EST	Pending
NS13 - Lateral Load Systems and Details	2/13/2017 7:00:00 PM	Handouts	Available 02/15/2017 5pm EST	Available 02/15/2017 5pm EST	Pending
NS13 - Preliminary Design Procedures	2/27/2017 7:00:00 PM	Handouts	Available 03/01/2017 5pm EST	Available 03/01/2017 5pm EST	Pending
NS13 - Crane Girder Design and Frame Analysis	3/6/2017 7:00:00 PM	Handouts	Available 03/08/2017 5pm EST	Available 03/08/2017 5pm EST	Pending
NS13 - Frame Member and Connection Design	3/13/2017 7:00:00 PM	Handouts	Available 03/15/2017 5pm EST	Available 03/15/2017 5pm EST	Pending
NS13 - Transfer Crane Girder & Longitudinal Bldg Bracing Dsn	3/27/2017 7:00:00 PM	Handouts	Available 03/29/2017 5pm EST	Available 03/29/2017 5pm EST	Pending
NS13 - Building Envelope and Bracing Design	4/9/2017 7:00:00 PM	Handouts	Available 04/09/2017 5pm EST	Available 04/09/2017 5pm EST	Pending
NS13 - Final Exam	4/10/2017 7:00:00 PM			Available 04/12/2017 5pm EST	

Night School Resources for 8-session package Registrants

- Weekly “quiz and recording” email.
- Weekly updates of the master Quiz and Attendance record found at www.aisc.org/nightschool. Scroll down to Quiz and Attendance records.
 - Updated on Wednesday mornings.

Night School Resources for 8-session package Registrants

- Webinar connection information:
 - Found in your registration confirmation/receipt.
 - Reminder email sent out Tuesday mornings.
- Link to handouts also found here.



There's always a solution in steel.

Thank You

Please give us your feedback!
Survey at conclusion of webinar.

