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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.

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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.

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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

structural STEEL

SCHEDULE

- October 03, 2017 Fundamental Concepts Part I
- October 10, 2017 Fundamental Concepts Part II
- October 17, 2017 Shear Connections Part I
- October 24, 2017 Shear Connections Part II
- November 07, 2017 Moment Connections Part I
- November 14, 2017 Moment Connections Part II
- November 28, 2017 Introduction to Seismic Connections
- December 05, 2017 Bracing Connections and More

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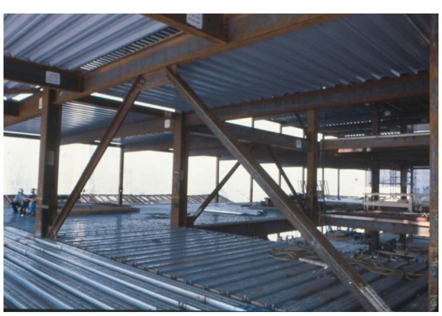
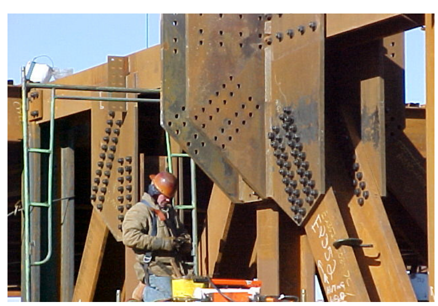
BRACING CONNECTIONS





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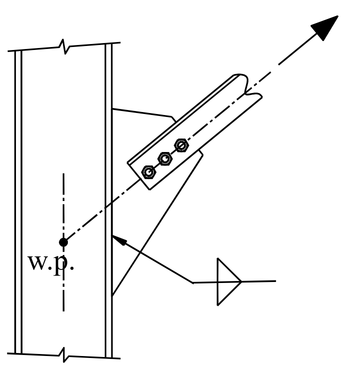
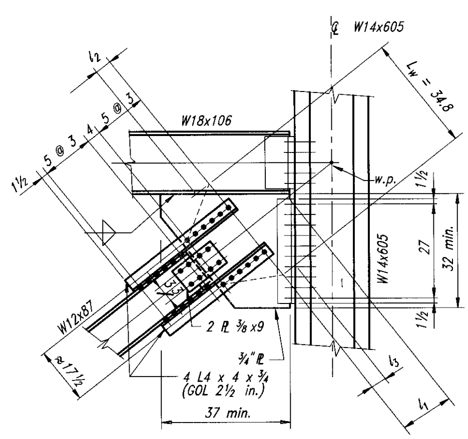
TOPICS

- Light Bracing Connections
- Heavy Bracing Connections
- Erection Considerations
- Poor Designs and More

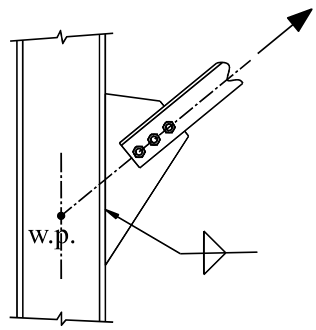
Bracing Connections

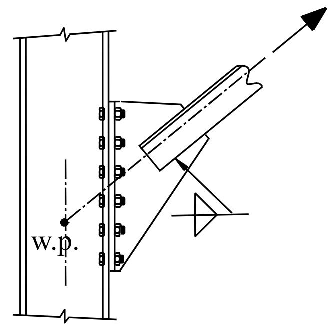




Light and Heavy Bracing Connections

Light Bracing Connections





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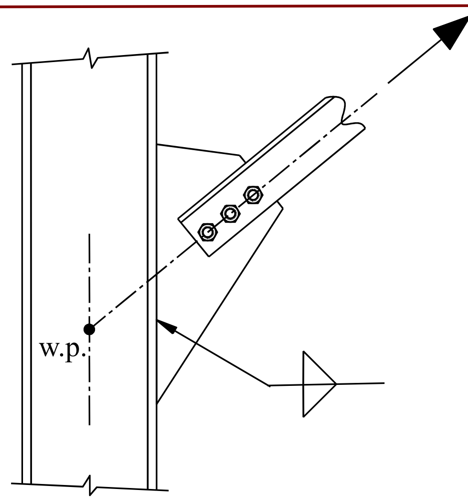
Light Bracing Connections



Welded to Column Flange

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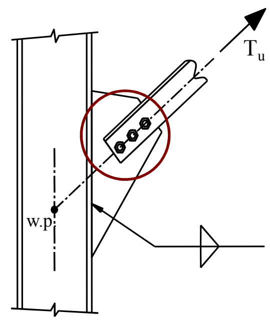
Bolted-Welded Light Bracing Connections

Limit States

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



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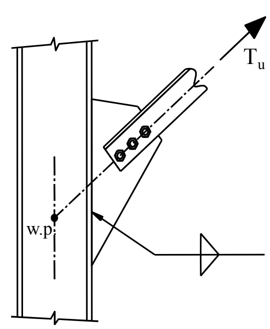
Bolted-Welded Light Bracing Connections

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.



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Bolted-Welded Light Bracing Connections

Limit States

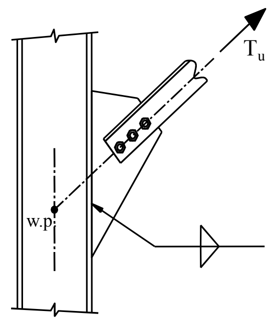
- Welds
  - Weld Rupture on Whitmore Section
  - Design Weld Rupture Strength

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

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

Or, for E70xx electrode

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



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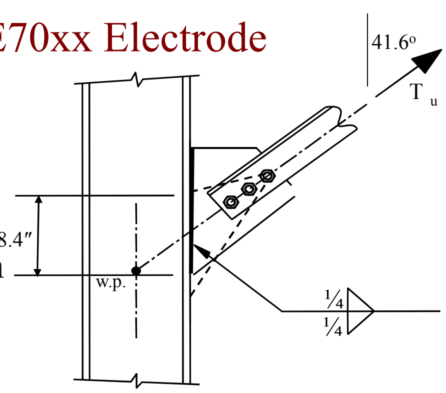
Bolted-Welded Light Bracing Connections

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.



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

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

$=$ 115 kips $\geq T_u$

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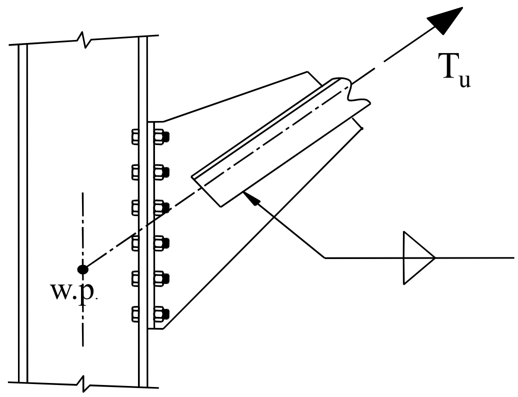
Welded-Bolted Light Bracing Connections

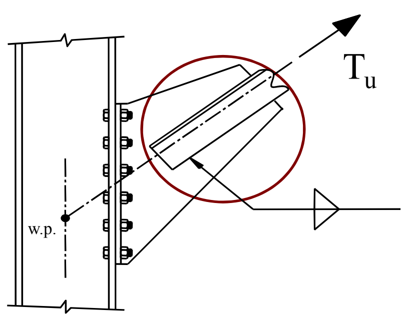


Bolted to Column Flange

Welded-Bolted Light Bracing Connections

Limit States

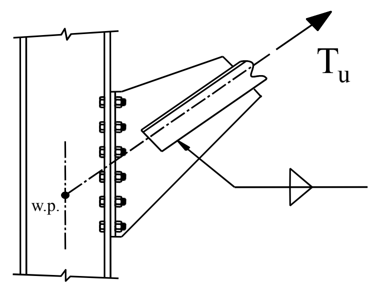
- Angles
  - Tension Yielding
  - Tension Rupture
- Weld:
  - Weld Rupture
  - Plate Shear Rupture Strength at Weld



Welded-Bolted Light Bracing Connections

Limit States

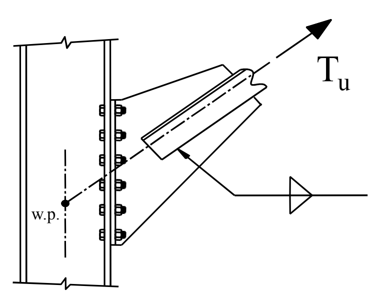
- Tee Stem
  - Tension Yielding on Whitmore Section
  - Tension Rupture on Whitmore Section
  - Block Shear
  - Shear Yielding



Welded-Bolted Light Bracing Connections

Limit States

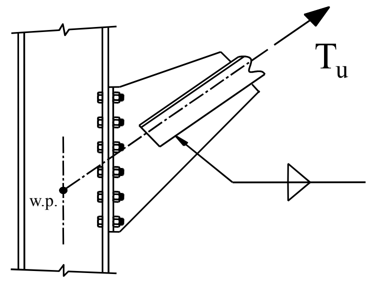
- Tee Flange
  - Flange Bending (Tee-Hanger)
  - Shear Yielding
  - Shear Rupture
  - Block Shear



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, $\theta = 40^o$ 3/4″A325-SC Bolts Class B OVS Holes.

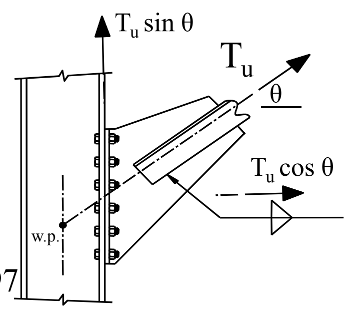
From *Specification* Eqns J3-4 & J3-5a:

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

$\phi = 0.85$ $\mu = 0.5$ $D_u = 1.13$
$h_f = 1.0$ $T_b = 28$ kips $n_s = 1$

Spec. Eqn. J3-5a:

$$k_{sc} = 1 - \frac{T_u \cos\theta}{D_u T_b n_b} = 1 - \frac{150\cos 40^o}{1.13x28x12} = 0.697$$



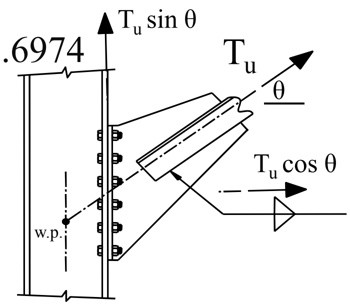
Welded-Bolted Light Bracing Connections

Example. Check Slip Resistance.

T_u = 150 kips ϕ = 0.85 μ = 0.5 D_u = 1.13
h_f = 1.0 T_b = 28 kips n_s = 1 k_{sc} = 0.6974

$\phi R_n = \phi\, \mu D_u h_f T_b n_s k_{sc}$ /bolt
= 0.85x0.50x1.13x1.0x28x1x0.6974
= 9.35 kips/bolt

$\sum \phi R_n$ = 9.35 x12 = 112 k
$T_u \sin\theta$ = 150 sin40°
= 96.4 k < 112 k OK



Welded-Bolted Light Bracing Connections

Example. Check Bolt Design Strength (V_u+ T_u)

T_u = 150 kips 3/4″A325-N Bolts (A_b = 0.4418 in²)
Assume Thick Plate Design: Prying Force = Q_u = 0.0
ϕR_{nt} = 0.75 $F'_{nt} A_b$ per bolt (*Spec.* J3-2)

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

f_{uv} = 150 sin 40°/(12x0.4418) = 18.2 ksi
With F_{nt} = 90 ksi F_{nv} = 54 ksi

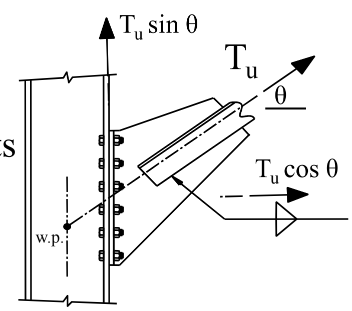
$$F'_{nt} = 1.3x90 - \frac{90}{0.75x54} 18.2 = 76.6\text{ksi} \leq 90\text{ksi}$$

ϕR_{nt} = 0.75x76.6x0.4418 = 25.4k $\geq$ 150 cos40°/12 =
9.58k 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



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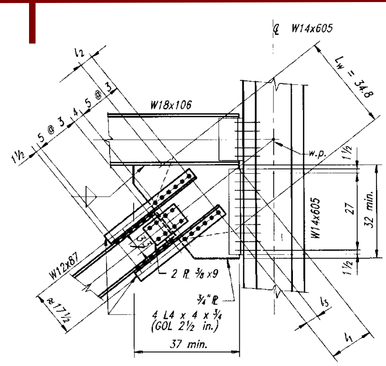
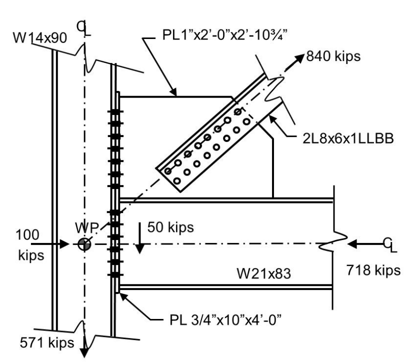
Heavy Bracing Connections





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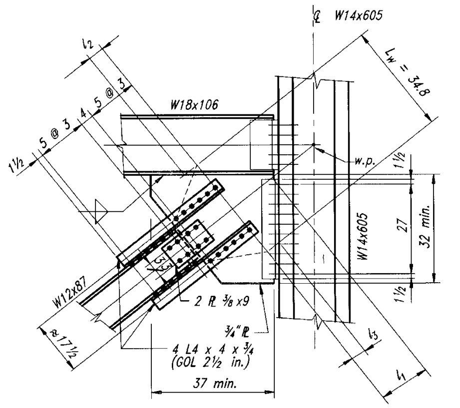
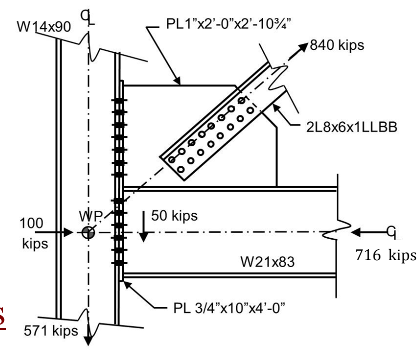
Heavy Bracing Connections



Connection with "Claw" Angles



Large Diagonal Angles

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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.

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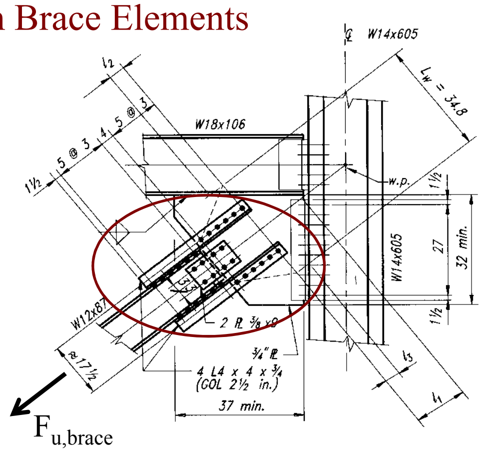
Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

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

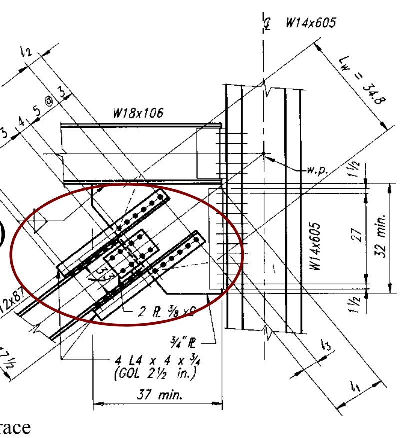


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Brace-to-Gusset Plate Forces

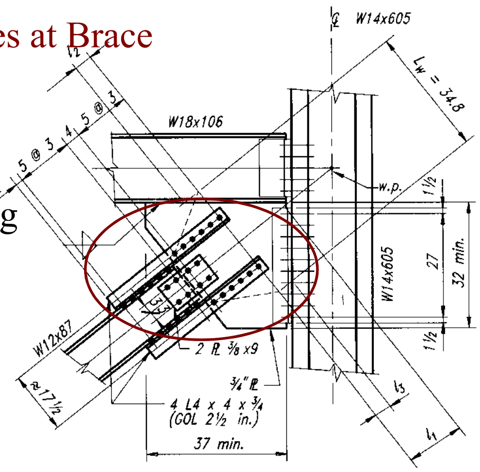
$$F_{u,angles} = F_{u,brace}\,(A_{flanges}/A_{brace})$$
$$F_{u,web\ conn} = F_{u,brace}\,(A_{web}/A_{brace})$$



Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace
  - Whitmore Sections
  - Tension Rupture
  - Block Shear
  - Compression Buckling

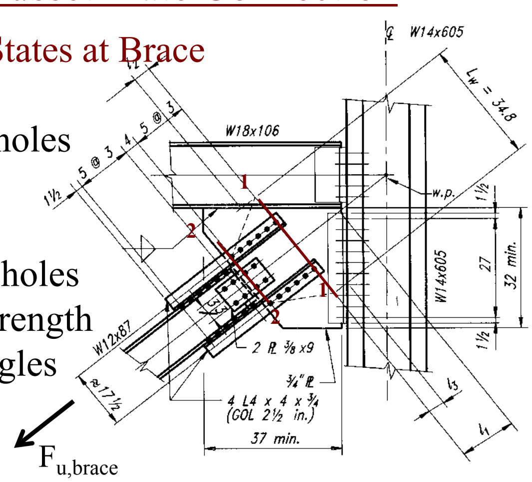


Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace
  - Whitmore Sections:
    1-1 longer w/2 bolt holes

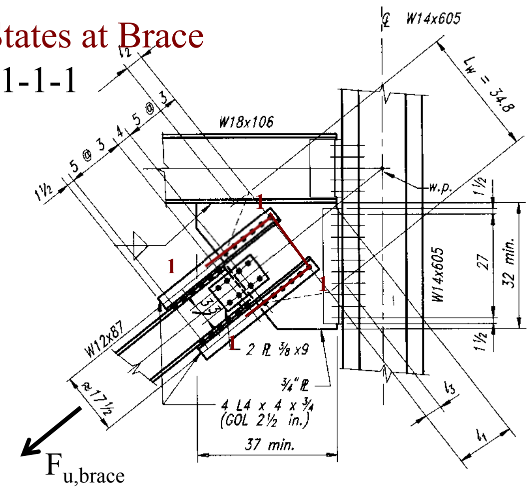
    2-2 shorter w/4 bolt holes plus shear rupture strength of 8 bolts at claw angles



Heavy Bracing Connections

Diagonal Brace-to-Gusset Plate Connection

- Gusset Plate Limit States at Brace
  - Block Shear Path:1-1-1-1



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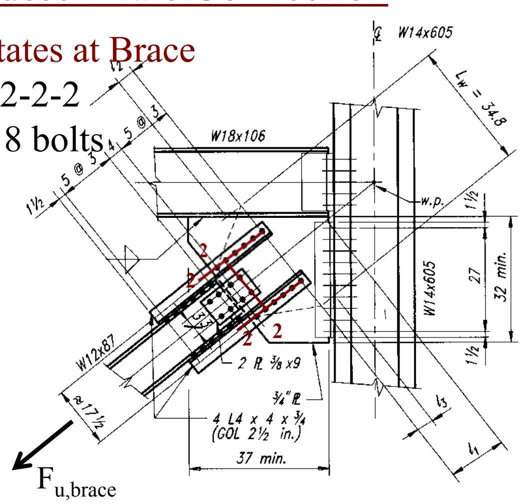
Heavy Bracing Connections

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.



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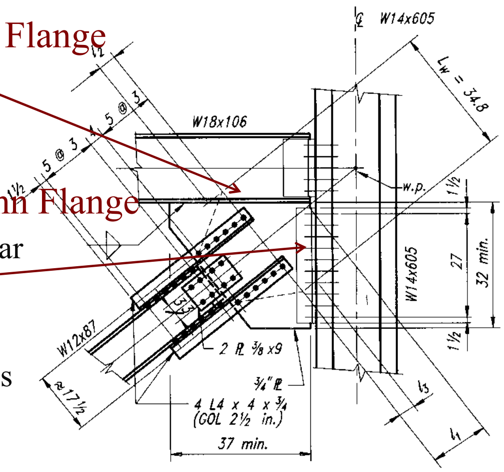
Heavy Bracing Connections

Gusset Plate Connections

- Gusset Plate-to-Beam Flange
  - CJP or Fillet Welds
- Gusset Plate-to-Column Flange
  - Double angles with shear plus tension
  - Prying forces possible
  - Other typical limit states apply



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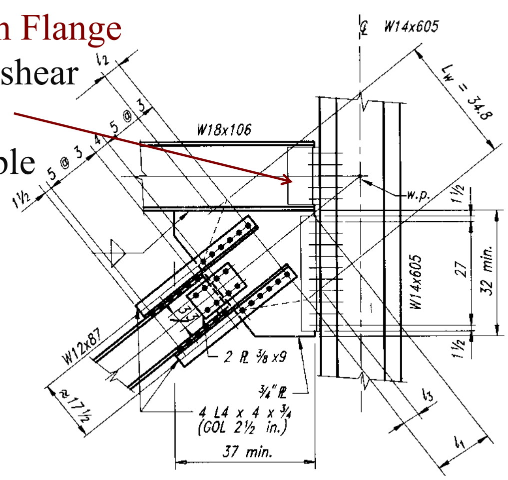
Heavy Bracing Connections

Beam Connections

- Beam Web-to-Column Flange
  - Double angles with shear plus tension
  - Prying forces possible
  - Other typical limit states apply



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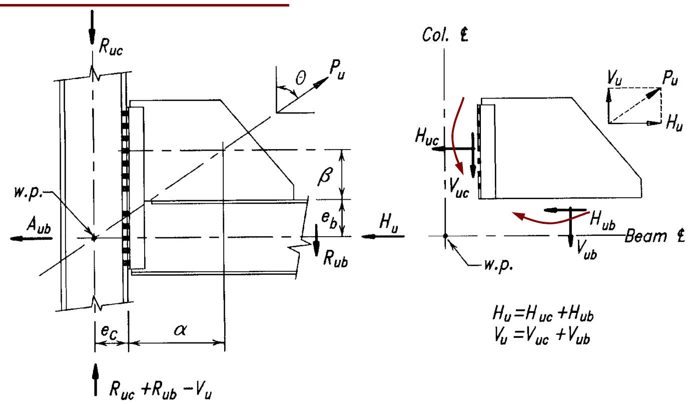
Heavy Bracing Connections

Gusset Plate Forces

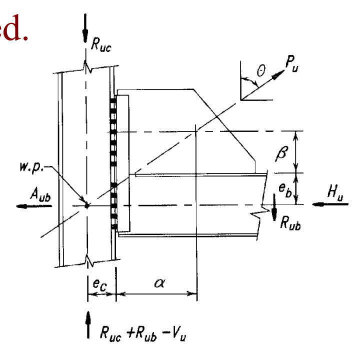


(a) External Forces (b) FBD of Gusset Plate

Heavy Bracing Connections

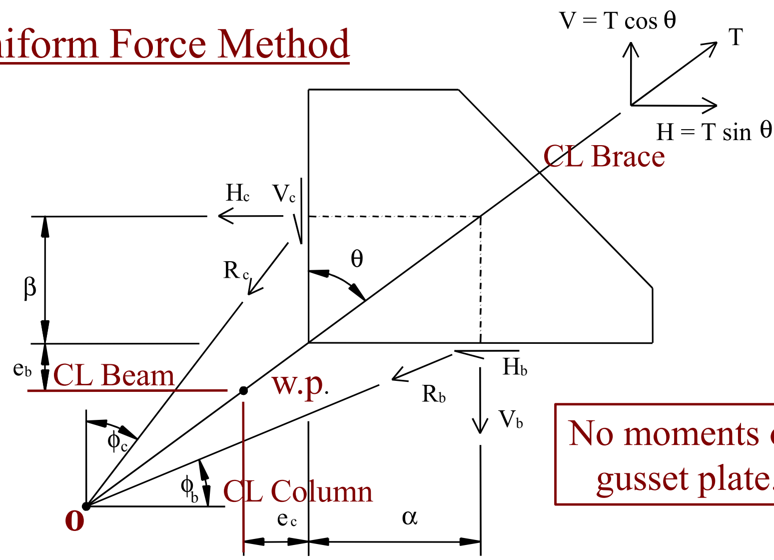
Uniform Force Method for Gusset Plate Forces

- Eliminates Moments on Gusset Plate.
- A Lower Bound Solution, therefore:
  - Must satisfy equilibrium.
  - No limit state may be exceeded.
  - Requires all connections to be ductile so that forces can redistribute.



Heavy Bracing Connections

Uniform Force Method



No moments on gusset plate.

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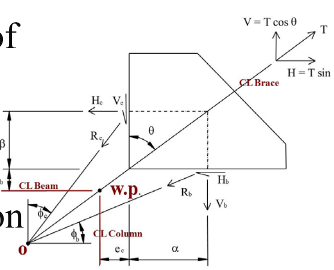
Heavy Bracing Connections

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

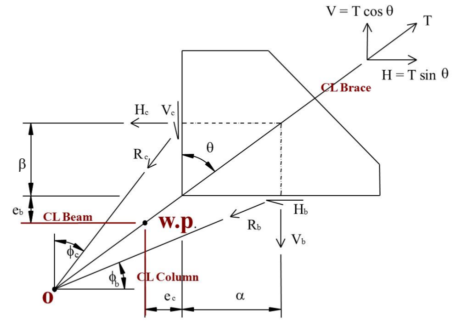
Uniform Force Method

$$\sum F_y = 0$$

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

$$\sum F_x = 0$$

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



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

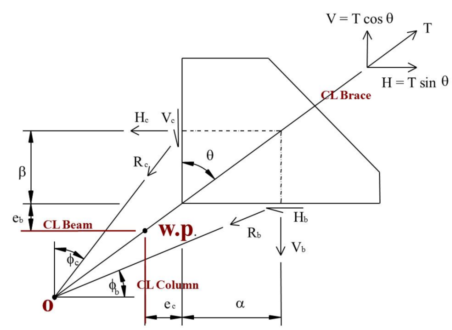
Heavy Bracing Connections

Uniform Force Method

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

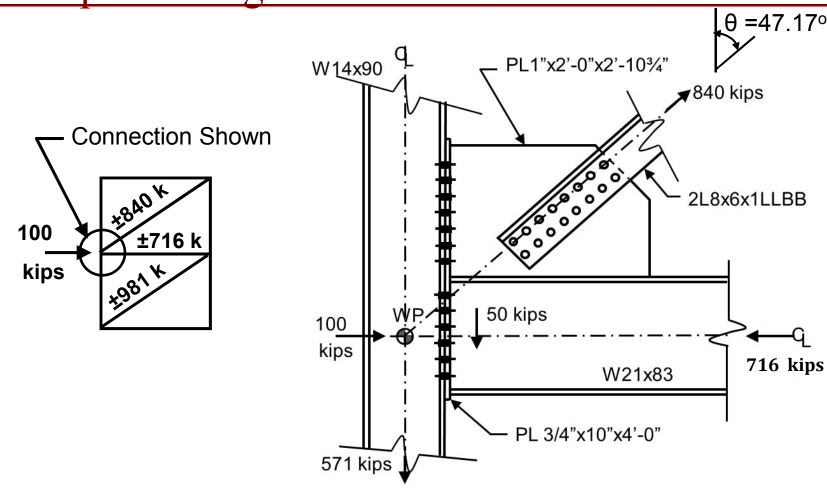
$$V_c = \frac{\beta}{r} T \qquad H_c = \frac{e_c}{r} T$$

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



Heavy Bracing Connection Example

Example. Design Beam and Column Connections



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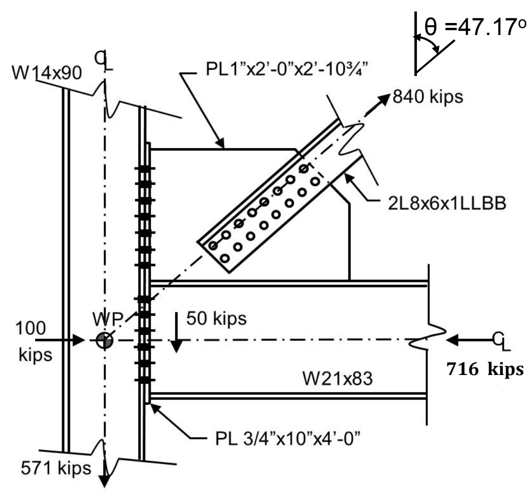
Heavy Bracing Connection Example

Materials

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



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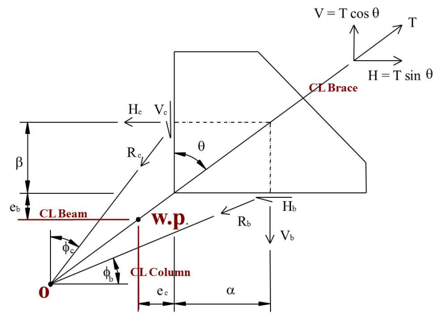
Heavy Bracing Connection Example

Determine Interface Forces using the UFM

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

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

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



Column W14x90 d = 14.0″→ e_c = 7.0″
Beam W21x83 d = 21.4″→ e_b = 10.7″
$V_u = T_u \cos\theta = 840 \cos 47.17^o = 571k$
$H_u = T_u \sin\theta = 840 \sin 47.17^o = 616k$

Heavy Bracing Connection Example

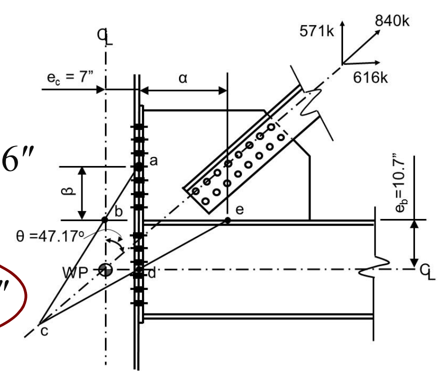
Estimate α and β

α:
Assume 7/16″ fillet welds
L_w = 616/(2x1.392x7) = 31.6″
Try α = 17.5″

β:

$$\beta = \frac{7.0+17.5}{\tan 47.17^0} - 10.7 = 12.0''$$

Try 7 rows 7/8″A490
β = 3+3x3 = 12″



Heavy Bracing Connection Example

Compute Interface Forces

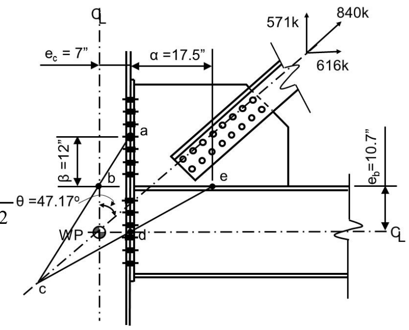
$\alpha = 17.5'' \quad \beta = 12.0''$

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

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

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

$$= 33.40''$$



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

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

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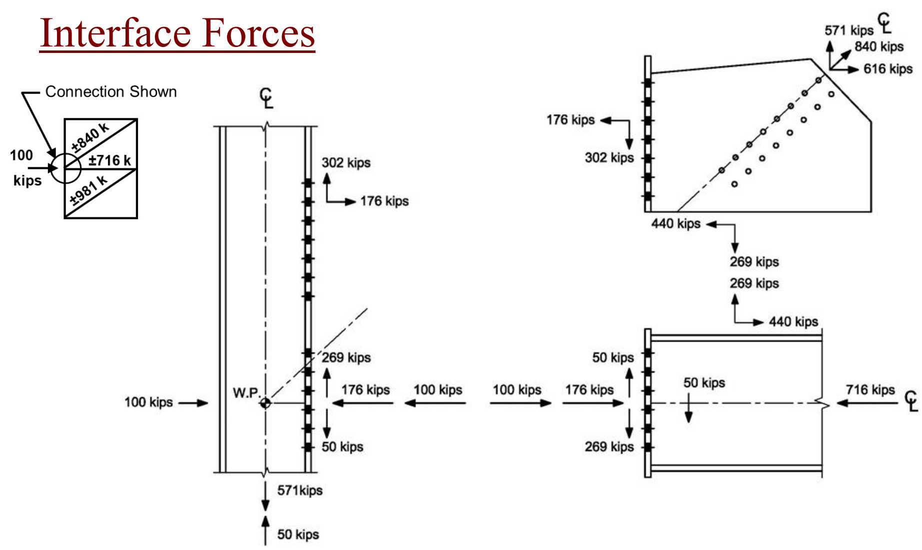
Heavy Bracing Connection Example

Interface Forces



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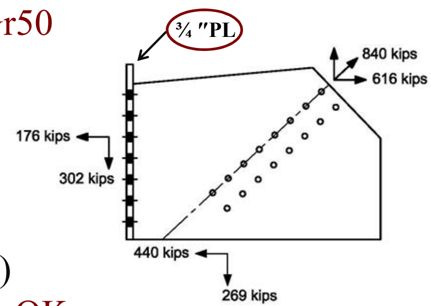
Heavy Bracing Connection Example

Check Gusset Plate Strength at Beam Flange

PL1 x 24 x 2′-10¾″ A572 Gr50



$\alpha = 17.5''$

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

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

$\phi V_n = 1.0(0.6x50)(1.0x33.5)$
$= 1{,}005k > H_{ub} = 440k$ OK

$\phi T_n = 0.9(50)(1.0x33.5)$
$= 1{,}508k > V_{ub} = 269k$ OK

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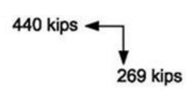
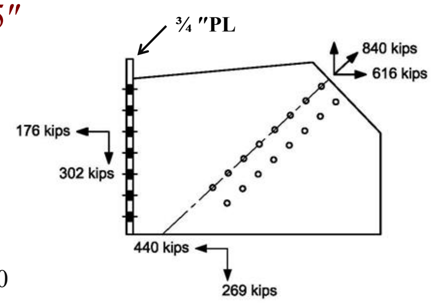
Heavy Bracing Connection Example

Design Gusset-to-Beam Flange Weld

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





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

$\theta = \tan^{-1}(269/440) = 31.44^0$

$D_{req'd} = 516/[(2x1.392x33.5)(1+0.5\sin^{1.5}31.44^0)]$
$= 4.66$ 1/16s

Increase 25%: 1.25x4.66 = 5.81-1/16s Use 3/8″ B.S.

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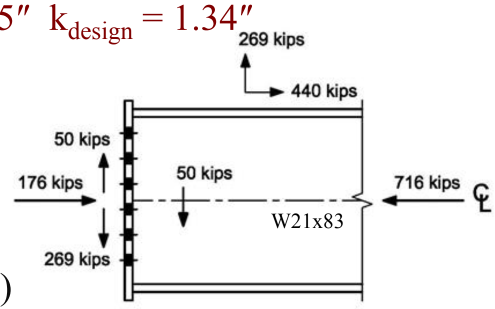
Heavy Bracing Connection Example

Check Beam Local Web Yielding

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

$l_b = 33.5''$



$\phi R_n = \phi F_y t_w (l_b + 2.5k_{design})$
$= 1.0(50x0.515)(33.5+2.5x1.34)$
$= 949k > R_u = 269k$ OK

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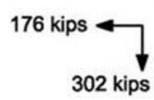
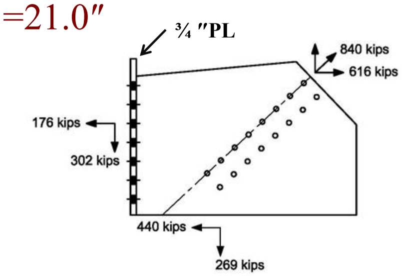
Heavy Bracing Connection Example

Design Gusset-to-End-Plate Weld

Fillet B.S. E70xx $L_w = 7x3.0 = 21.0''$



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



$\theta = \tan^{-1}(176/302) = 30.2^0$

$D_{req'd} = 350/[(2x1.392x21.0)(1+0.5\sin^{1.5}30.2^0)$
$= 5.07\text{-}1/16s$ Min. – 5/16

Use 3/8″ Filet Welds B.S.

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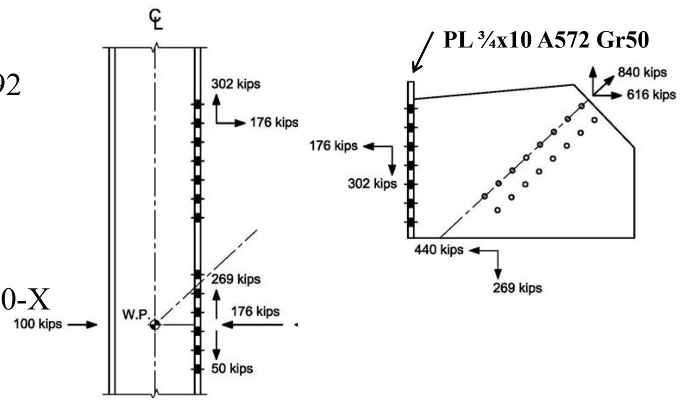
Heavy Bracing Connection Example

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
ϕr_{nv} = 37.9k
ϕr_{nt} = 51.0k



r_{uv} = 302/14 = 21.6k < ϕr_{nv} = 37.9k
r_{ut} = 176/14 = 12.6k < ϕr_{nt} = 51.0k

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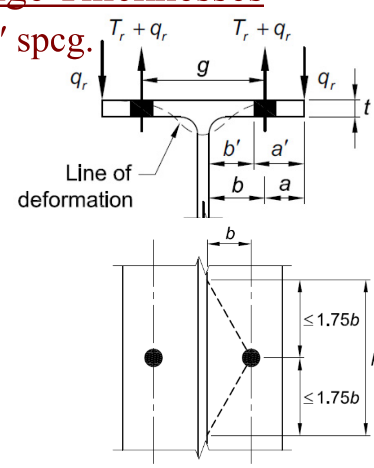
Heavy Bracing Connection Example

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″
a = (10.0 – 5.0)/2
  = 2.50″ ≤ 1.25b = 2.50″
p = s = 3.0″ < 2x1.75b = 7.0″

For no prying, F_u = 65 ksi



$$t_{req} = \sqrt{\frac{4\ r_{ut}\ b'}{\phi_b p\ F_u}} = \sqrt{\frac{4\ x12.6x1.56}{0.9x3.0x6\ 5}}$$

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

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Heavy Bracing Connection Example

Check End-Plate to Col. Flange Bolt Strength

14 – 7/8″ A490-X Bolts $A_b = 0.601$ in^2 (No Prying)

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

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

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

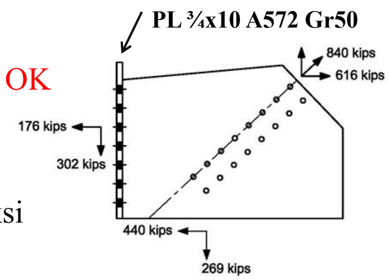
$f_{uv} = 21.6/0.601 = 35.9$ ksi ksi

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

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

$$= 1.3x113 - \frac{113}{0.75x84} 35.9 = 82.5\text{ksi} < 113\text{ksi}$$

$\phi R_{nt} = 0.75x82.5x0.601 = \underline{37.2\text{k}} \ge r_{ut} = 12.6\text{k}$ OK



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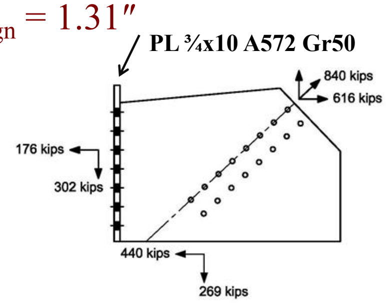
Heavy Bracing Connection Example

Check Column Local Web Yielding

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

$l_b = 7x3.0 = 21.0″$



$\phi R_n = \phi F_y t_w (l_b + 5k_{design})$

$= 1.0(50x0.440)(21.0+5x1.31)$

$= 606\text{k} > R_u = 176\text{k}$ OK

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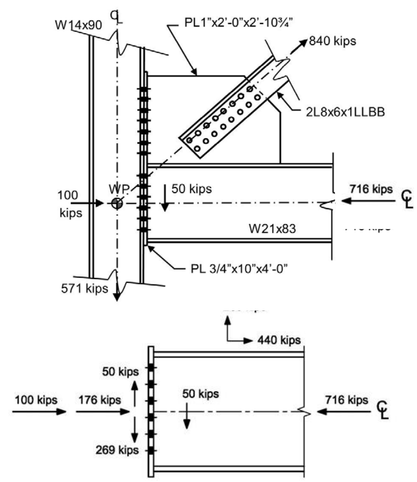
Heavy Bracing Connection Example

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.



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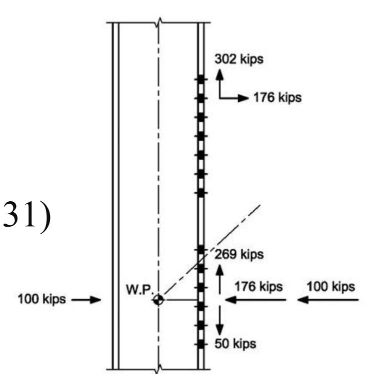
Heavy Bracing Connection Example

Check Column Local Web Yielding

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

$l_b = d_b = 21.4''$

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



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Heavy Bracing Connection Example

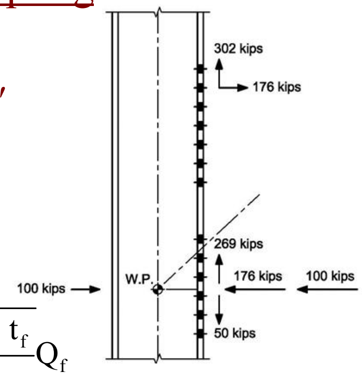
Check Column Local Web Crippling

W14x90 A992

$t_w = 0.440''$ $t_f = 0.710''$ $d = 14.0''$

$l_b = d_b = 21.4''$

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



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

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

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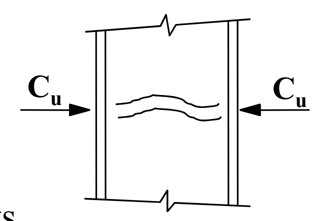
4. Web Compression Buckling (*Spec.* J10.5)

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

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



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

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Heavy Bracing Connection Example

Check Column Compression Web Buckling

W14x90 A992

$t_w = 0.440''$ $h/t_w = 25.9$

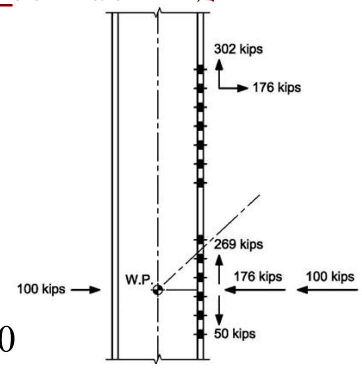
$h = 25.9 \text{x} 0.440 = 11.4''$

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

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

$$= 216\text{k}$$

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



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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.

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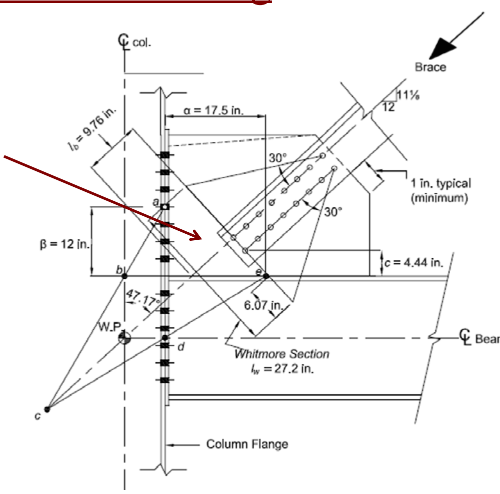
Heavy Bracing Connection Example

Gusset Plate Flexural Buckling

Flexural Buckling



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

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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.

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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.

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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.

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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.

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

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Night School Resources for 8-session package Registrants

Find all your handouts, quizzes and quiz scores, recording access, and attendance information all in one place!

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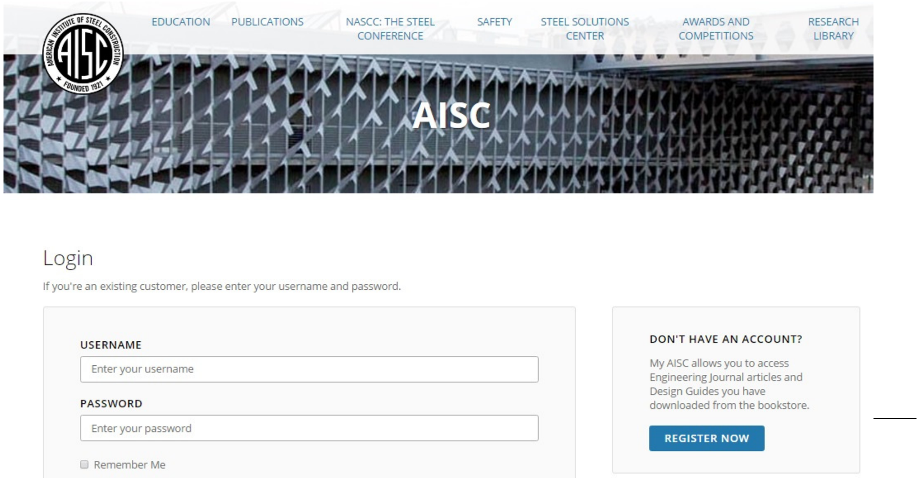
Night School Resources for 8-session package Registrants

Go to www.aisc.org and sign in.



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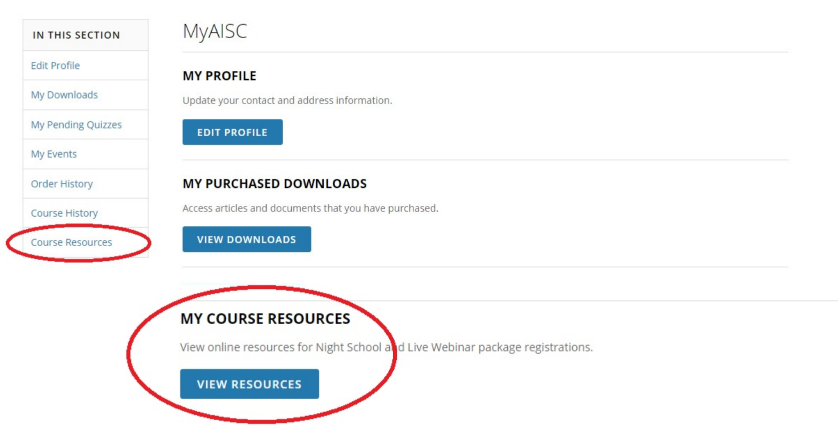

Night School Resources for 8-session package Registrants

AISC › MYAISC › COURSE RESOURCES

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

AISC › MYAISC › NIGHT SCHOOL RESOURCES › NS13 8-SESSION PACKAGE RESOURCES

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	4/3/2017 7:00:00 PM	Handouts	Available 04/05/2017 5pm EST	Available 04/05/2017 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.

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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.

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There's always a solution in steel.

Thank You

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

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