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SAMPLE CALCULATIONS – Connection 1

Sample calculations were performed to demonstrate how the connection is analyzed. The following properties were used in the calculations.

1. W10x30 connected to W12x30
2. A992 steel with F_y = 50 ksi, F_u = 65 ksi

$\phi P_n \geq P_u$

Bolt Shear Strengths:

$$\phi R_{ns} = A_b F_{nv} n$$
$$\phi = .75$$

$$A_b = \frac{\pi}{4}\left(\frac{3}{4}''\right)^2 = 0.442 in^2$$

F_{nv} = 48 ksi – found in AISC/LRFD Manual Table J3.2

$n = 2$

$$\phi R_{ns} = 0.75(0.442)(48)(2) = 31.82 kips$$

Bearing Strength at Bolt Holes:

$$\phi R_n = 1.2 L_c t F_u \leq 2.4 d t F_u$$
$$\phi = .75$$

Deformation around the bolt holes is a design consideration.

L_c = 1 ¼ in. Found in AISC/LRFD Manual Table J3.4 (at sheared edge)
t = 5/16 in. Thickness of base material
d = ¾ in. Bolt diameter
F_u = 65 ksi

1.2(1.25) ≤ 2.4(.75)

1.2(1.25) controls = 1.5 in.

$$\phi R_n = 1.5\left(\frac{5}{16}\right)(65) = 30.47 kips$$

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Shear Yielding:

$$\phi R_n = 0.60 F_y A_g$$
$$\phi = 1.00$$

For W10x30

A_g = 8.84in^2
F_y = 50 ksi – A992 Steel

$$\phi R_n = 0.60(50)(8.84) = 265.2 kips$$

For W12x30

A_g = 8.79in^2
F_y = 50 ksi – A992 Steel

$$\phi R_n = 0.60(50)(8.79) = 263.7 kips$$

Shear Rupture:

$$\phi R_n = 0.60 F_u A_{nv}$$
$$\phi = 0.75$$

For W10x30

$$A_{nv} = 8.84 - 2\left(\frac{3}{4} + \frac{1}{8}\right)\left(\frac{5}{16}\right) = 8.29 in^2$$

F_u = 65 ksi

$$\phi R_n = 0.6(65)(8.29) = 323.3 kips$$

For W12x30

$$A_{nv} = 8.79 - 2\left(\frac{3}{4} + \frac{1}{8}\right)\left(\frac{1}{4}\right) = 8.35 in^2$$

F_u = 65 ksi

$$\phi R_n = 0.6(65)(8.35) = 325.7 kips$$

Weld Strength:

$$\phi R_n = \min\begin{cases} \phi F_w A_w \\ \phi F_{BM} A_{BM} \end{cases}$$

$$\phi F_{BM} A_{BM} = \min\begin{cases} .75 t_{BM} L_w (.6 F_u) \text{.......(1)} \\ .75 U A_n F_u \text{............(2)} \\ 1.0 A_g (.6 F_y) \text{...........(3)} \end{cases}$$

$$\phi F_w A_w = .6 F_{EXX} (.707 D_w) L_w$$

$$\phi = .75$$

F_{EXX} = 80 ksi
D_w = 3/16 in.
L_w = 8.25 in. Found in AISC/LRFD Manual Table 1-1, T

$$\phi F_w A_w = 0.6(80)\left(0.707\left(\frac{3}{16}\right)\right)(8.25) = 52.5 kips$$

t_{BM} = ¼ in. Thickness of base material
$A_n = A_g$ = 8.79 in^2
F_u = 65 ksi
F_y = 50 ksi
U = 1.0 Found in AISC/LRFD Manual Table D3.1 case 3

$$(1) = 0.75\left(\frac{1}{4}\right)(8.25)(0.6)(65) = 60.3 kips \leftarrow controls$$

$$(2) = 0.75(1.0)(8.79)(65) = 428.5 kips$$

$$(3) = 1.0(8.79)(0.6)(50) = 263.7 kips$$

Since 52.5 kips < 60.3 kips, the 52.5 kips value controls for welds.

Controlling ∅P_n Value

$$\phi P_n = \min(31.82, 30.47, 263.7, 323.3, 52.5) = 30.47 \text{ kips}$$