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:**

\[ \phi R_n = A_b F_{nv} n \]
\[ \phi = .75 \]

\[ A_b = \frac{\pi}{4} \left( \frac{3}{4} \right)^2 = 0.442 \text{in}^2 \]

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

\( n = 2 \)

\[ \phi R_n = 0.75(0.442)(48)(2) = 31.82 \text{kips} \]

**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.

\( L_c = 1 \frac{3}{4} \) in.  Found in AISC/LRFD Manual Table J3.4 (at sheared edge)

\( t = 5/16 \) in.  Thickness of base material

\( d = \frac{3}{4} \) in.  Bolt diameter

\( F_u = 65 \) ksi

\[ 1.2(1.25) \leq 2.4(.75) \]

\[ 1.2(1.25) \text{controls} = 1.5 \text{in.} \]

\[ \phi R_n = 1.5 \left( \frac{5}{16} \right) (65) = 30.47 \text{kips} \]
Shear Yielding:

\[ \phi R_n = 0.60 F_y A_g \]
\[ \phi = 1.00 \]

For W10x30

\[ A_g = 8.84 \text{ in}^2 \]
\[ F_y = 50 \text{ ksi} - \text{A992 Steel} \]
\[ \phi R_n = 0.60(50)(8.84) = 265.2 \text{kips} \]

For W12x30

\[ A_g = 8.79 \text{ in}^2 \]
\[ F_y = 50 \text{ ksi} - \text{A992 Steel} \]
\[ \phi R_n = 0.60(50)(8.79) = 263.7 \text{kips} \]

Shear Rupture:

\[ \phi R_n = 0.60 F_u A_{nv} \]
\[ \phi = 0.75 \]

For W10x30

\[ A_{nv} = 8.84 - 2\left( \frac{3}{4} + \frac{1}{8}\right)\left(\frac{5}{16}\right) = 8.29 \text{ in}^2 \]
\[ F_u = 65 \text{ ksi} \]
\[ \phi R_n = 0.6(65)(8.29) = 323.3 \text{kips} \]

For W12x30

\[ A_{nv} = 8.79 - 2\left( \frac{3}{4} + \frac{1}{8}\right)\left(\frac{1}{4}\right) = 8.35 \text{ in}^2 \]
\[ F_u = 65 \text{ ksi} \]
\[ \phi R_n = 0.6(65)(8.35) = 325.7 \text{kips} \]
Weld Strength:

\[
\phi R_n = \min \left\{ \frac{\phi F_w A_w}{\phi F_{BM} A_{BM}} \right\} \quad \phi F_{BM} A_{BM} = \min \left\{ \begin{array}{c} \frac{0.75 t_{BM} L_w (0.6 F_u)}{U} \\
\frac{0.75 U A_n F_u}{1.0} \end{array} \right. \\
\phi F_w A_w = 0.6 F_{EXX} (0.707 D_w) L_w \\
\phi = 0.75 \\
F_{EXX} = 80 \text{ ksi} \\
D_w = 3/16 \text{ in.} \\
L_w = 8.25 \text{ in.} \text{ Found in AISC/LRFD Manual Table 1-1, T} \\
\phi F_w A_w = 0.6(80) \left( 0.707 \left( \frac{3}{16} \right) \right)(8.25) = 52.5 \text{kips} \\
t_{BM} = 1/4 \text{ in.} \text{ Thickness of base material} \\
A_n = A_g = 8.79 \text{ in}^2 \\
F_u = 65 \text{ ksi} \\
F_y = 50 \text{ ksi} \\
U = 1.0 \text{ Found in AISC/LRFD Manual Table D3.1 case 3} \\
\begin{align*}
(1) &= 0.75 \left( \frac{1}{4} \right)(8.25)(0.6)(65) = 60.3 \text{kips } \leftarrow \text{controls} \\
(2) &= 0.75(1.0)(8.79)(65) = 428.5 \text{kips} \\
(3) &= 1.0(8.79)(0.6)(50) = 263.7 \text{kips}
\end{align*}
\]

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

**Controlling \( \Phi P_n \) Value**

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