

Problem 1

As all spacings, and material strengths are identical, thinner gusset will govern ($t = 3/8$ in)

$$S_{min} = 2\frac{2}{3} d_b = \left(\frac{8}{3}\right) \left(\frac{3}{4} \text{ in}\right) = 2 \text{ in} < S = 3 \text{ in} \quad \therefore \text{O.K.}$$

$$L_{e min} = 1 \text{ in (From Table J3.4)} < L_e = 1.5 \text{ in} \quad \therefore \text{O.K.}$$

Edge holes

$$R_n = 1.2 L_e t F_u \leq 2.4 d t F_u$$

$$R_n = (1.2) \left(1.5 \text{ in} - \frac{3/4 \text{ in} + 1/16 \text{ in}}{2}\right) \left(\frac{3}{8} \text{ in}\right) (70 \text{ ksi}) \leq (2.4) \left(\frac{3}{4} \text{ in}\right) \left(\frac{3}{8} \text{ in}\right) (70 \text{ ksi})$$

$$R_n = 34.45 \text{ k} \leq 47.25 \text{ k}$$

$$R_n = 34.45 \text{ k controls}$$

Interior holes

$$R_n = 1.2 L_e t F_u \leq 2.4 d t F_u$$

$$R_n = (1.2) \left(3 \text{ in} - \left(\frac{3}{4} \text{ in}\right) - \left(\frac{1}{16} \text{ in}\right)\right) \left(\frac{3}{8} \text{ in}\right) (70 \text{ ksi}) \leq (2.4) \left(\frac{3}{4} \text{ in}\right) \left(\frac{3}{8} \text{ in}\right) (70 \text{ ksi})$$

$$R_n = 68.91 \text{ k} \leq 47.25 \text{ k}$$

$$R_n = 47.25 \text{ k controls}$$

Total

$$R_n = (2)(34.45 \text{ k}) + (4)(47.25 \text{ k})$$

$$\boxed{R_n = 257.9 \text{ k}}$$

Problem 2

$$S_{\min} = 2\frac{2}{3} d_b = \left(\frac{8}{3}\right) \left(\frac{7}{8} \text{ in}\right) = 2.33 \text{ in} < S = 3 \text{ in} \quad \therefore \text{O.K.}$$

$$L_{e \min} = 1\frac{1}{8} \text{ in (From table J3.4)} < L_e = 2 \text{ in} \quad \therefore \text{O.K.}$$

From table 7-1, for $\frac{7}{8}$ in diameter A307 bolts in single shear, $\phi r_n = 10.8 \text{ k/bolt}$

From table 7-5, for A572 Gr 50 steel ($F_u = 65 \text{ ksi}$), with $S = 3 \text{ in}$, $d_b = \frac{7}{8} \text{ in}$, $\phi r_n = 102 \text{ k/in}$

From table 7-5, for A36 steel, ($F_u = 58 \text{ ksi}$), with $S = 3 \text{ in}$, $d_b = \frac{7}{8} \text{ in}$, $\phi r_n = 91.4 \text{ k/in}$

From table 7-6, for A572 Gr 50 steel ($F_u = 65 \text{ ksi}$), with $L_e = 2 \text{ in}$, $d_b = \frac{7}{8} \text{ in}$, $\phi r_n = 89.6 \text{ k/in}$

For edge gusset

$$\phi R_n = \phi 1.2 L_e \leq F_u \leq \phi 2.4 d \leq F_u$$

$$\phi R_n = (0.75) \left(1.2 \left(3 \text{ in} - \frac{\frac{7}{8} \text{ in} + \frac{1}{16} \text{ in}}{2} \right) \right) \left(\frac{3}{8} \text{ in} \right) (58 \text{ ksi}) \leq (0.75) (2.4) \left(\frac{3}{8} \text{ in} \right) (58 \text{ ksi})$$

$$\phi R_n = 49.55 \text{ k} \leq 34.26 \text{ k}$$

Total

$$\begin{aligned} \phi R_n &= (6) \left(10.8 \frac{\text{k}}{\text{bolt}} \right) \leq (0.487 \text{ in}) \left((4) \left(102 \frac{\text{k}}{\text{in}} \right) + (2) \left(89.6 \frac{\text{k}}{\text{in}} \right) \right) \\ &\leq (34.26 \text{ k}) (2) + (4) \left(\frac{3}{8} \text{ in} \right) (91.4 \frac{\text{k}}{\text{in}}) \end{aligned}$$

$$\phi R_n = 64.8 \text{ k} \leq 285.97 \text{ k} \leq 205.62 \text{ k}$$

$$\boxed{\phi R_n = 64.8 \text{ k}}$$

Problem 3

$$S_{\min} = 2\frac{2}{3}d_b = \left(\frac{8}{3}\right)\left(\frac{3}{4}\text{in}\right) = 2\text{in}$$

$$\text{Assume } S = 3\text{in}$$

$$L_{\min} = 1\text{in (From table J3.4)}$$

$$\text{Assume } L_e = 2\text{in}$$

$$T_u = 1.4D \geq 1.2D + 1.6L$$

$$T_u = (1.4)(7k) \geq (1.2)(7k) + (1.6)(14k)$$

$$T_u = 30.8k$$

From table 7-1, for $\frac{3}{4}\text{in}$ diameter A325 bolts in double shear, $\phi r_n = 31.8\text{ k/bolt}$

As all spacing and materials are identical, and as total thickness of both parts of double angle is greater than gusset thickness, gusset will control in bearing. ($t = \frac{3}{8}\text{in}$)

From table 7-5, for A36 steel ($F_u = 58\text{ksi}$) with $\frac{3}{4}\text{in}$ diameter bolts and $S = 3\text{in}$, $\phi r_n = 78.3\text{ k/in}$

From table 7-6, for A36 steel ($F_u = 58\text{ksi}$) with $d_b = \frac{3}{4}\text{in}$, $L_e = 2\text{in}$, $\phi r_n = 78.3\text{ k/in}$

$$N \geq \frac{T_u}{\phi r_{n\text{bolt}}} = 30.8k / 31.8\text{ k/bolt} = 0.97\text{ bolts}$$

$$T_u = 30.8k \leq (t)(\phi r_{n\text{edge}}) + (n-1)(t)(\phi r_{n\text{int.}})$$

$$30.8k \leq (0.375\text{in})(78.3\frac{k}{\text{in}}) + (n-1)(78.3\frac{k}{\text{in}})$$

$$N \geq 1.05\text{ bolts}$$

$$\boxed{N = 2\text{ bolts}}$$

Problem 4

$$S_{\min} = 2\frac{2}{3} d_b = \left(\frac{8}{3}\right)\left(\frac{7}{8} \text{ in}\right) = 2.33 \text{ in} < S = 2.75 \text{ in} \quad \therefore \text{O.K.}$$

$$L_{\min} = 1\frac{1}{8} \text{ in (From table J3.4)} < L_e = 1.5 \text{ in} \quad \therefore \text{O.K.}$$

As all spacing, material, and total thicknesses are identical, bearing strength in both splices and tension members will be identical. ($t = \frac{1}{2} \text{ in}$)

From table 7-1, for A325 bolts in double shear

$$\text{with } d_b = \frac{7}{8} \text{ in}, \quad \phi r_n = 43.3 \text{ k/bolt}$$

$$r_n = \frac{\phi r_n}{\phi} = \frac{43.3 \text{ k/bolt}}{0.75} = 57.73 \text{ k/bolt}$$

Edge holes

$$R_n = 1.2 L_e t F_u \leq 2.4 d t F_u \leq r_{n \text{ bolt}}$$

$$R_n = (1.2) \left(1.5 \text{ in} - \frac{\frac{7}{8} \text{ in} - 1/16 \text{ in}}{2}\right) \left(\frac{1}{2} \text{ in}\right) (58 \text{ ksi}) \leq (2.4) \left(\frac{7}{8} \text{ in}\right) \left(\frac{1}{2} \text{ in}\right) (58 \text{ ksi}) \leq 57.73 \text{ k}$$

$$R_n = 35.89 \text{ k} \leq 60.9 \text{ k} \leq 57.73 \text{ k}$$

$$R_n = 35.89 \text{ k} \quad \text{controls}$$

Interior holes

$$R_n = 1.2 L_e t F_u \leq 2.4 d t F_u \leq r_{n \text{ bolt}}$$

$$R_n = (1.2) \left(2.75 \text{ in} - \frac{7}{8} \text{ in} - \frac{1}{16} \text{ in}\right) \left(\frac{1}{2} \text{ in}\right) (58 \text{ ksi}) \leq (2.4) \left(\frac{7}{8} \text{ in}\right) \left(\frac{1}{2} \text{ in}\right) (58 \text{ ksi}) \leq 57.73 \text{ k}$$

$$R_n = 63.08 \text{ k} \leq 60.9 \text{ k} \leq 57.73 \text{ k}$$

$$R_n = 57.73 \text{ k}$$

Total

$$R_n = (2)(35.89 \text{ k}) + (2)(57.73 \text{ k})$$

$$\boxed{R_n = 187.24 \text{ k}}$$