(a) \( P_u = 1.2D + 1.6L = 1.2(30) + 1.6(90) = 180.0 \) kips

Required \( A_g = \frac{P_u}{0.9F_y} = \frac{180}{0.90(50)} = 4.00 \) in.\(^2\)

Required \( A_e = \frac{P_u}{0.75F_u} = \frac{180}{0.75(65)} = 3.69 \) in.\(^2\)

Required \( r_{\min} = \frac{L}{300} = \frac{25 \times 12}{300} = 1.0 \) in.

The angle leg must be at least 5 in. long to accommodate two lines of bolts (See usual gages for angles, Fig. 3.24. Also see the last table in the single-angle section of the Dimensions and Properties tables in the Manual.)

Try 2L5 × 5 × 5/16

\[ A_g = 6.13 \text{ in.}^2 > 4.00 \text{ in.}^2 \quad (\text{OK}) \quad r_{\min} = r_x = 1.56 \text{ in.} > 1.0 \text{ in.} \quad (\text{OK}) \]

\[ A_n = 6.13 - 4(7/8 + 1/8)(5/16) = 4.880 \text{ in.}^2 \]

From AISC Table D4.1, for 4 or more bolts per line, \( U = 0.80 \)

\[ A_e = A_n U = 4.880(0.80) = 3.90 \text{ in.}^2 > 3.69 \text{ in.}^2 \quad (\text{OK}) \]

Use 2L5 × 5 × 5/16

(b) \( P_a = D + L = 30 + 90 = 120 \) kips

Required \( A_g = \frac{P_a}{0.6F_y} = \frac{120}{0.6(50)} = 4.00 \) in.\(^2\)

Required \( A_e = \frac{P_a}{0.5F_u} = \frac{120}{0.5(65)} = 3.69 \) in.\(^2\)

Required \( r_{\min} = \frac{L}{300} = \frac{25 \times 12}{300} = 1.0 \) in.

The angle leg must be at least 5 in. long to accommodate two lines of bolts (See usual gages for angles, Fig. 3.24. Also see the last table in the single-angle section of the Dimensions and Properties tables in the Manual.)

Try 2L5 × 5 × 5/16
\[ A_g = 6.13 \text{ in.}^2 > 4.00 \text{ in.}^2 \quad \text{(OK)} \quad r_{\text{min}} = r_x = 1.56 \text{ in.} > 1.0 \text{ in.} \quad \text{(OK)} \]

\[ A_n = 6.13 - 4(7/8 + 1/8)(5/16) = 4.880 \text{ in.}^2 \]

From AISC Table D4.1, for 4 or more bolts per line, \( U = 0.80 \)

\[ A_e = A_n U = 4.880(0.80) = 3.90 \text{ in.}^2 > 3.69 \text{ in.}^2 \quad \text{(OK)} \]

Use \( 2\text{L5} \times 5 \times \frac{5}{16} \)
3.6-6

From Part 1 of the Manual, all W10 shapes have a flange thickness \( \leq 1.25 \) in. Therefore, from Table 2-3 in Part 2 of the Manual, \( F_y = 50 \) ksi and \( F_u = 70 \) ksi.

\[
P_u = 1.2D + 1.6L = 1.2(175) + 1.6(175) = 490.0 \text{ kips}
\]

Required \( A_g = \frac{P_u}{0.9F_y} = \frac{490}{0.9(50)} = 10.9 \text{ in.}^2 \)

Required \( A_e = \frac{P_u}{0.75F_u} = \frac{490}{0.75(70)} = 9.33 \text{ in.}^2 \)

Required \( r_{\text{min}} = \frac{L}{300} = \frac{30 \times 12}{300} = 1.2 \text{ in.} \)

Try W10 × 49

\( A_g = 14.4 \text{ in.}^2 > 10.9 \text{ in.}^2 \) \hspace{1cm} (OK)

\( r_{\text{min}} = r_y = 2.54 \text{ in.} > 1.2 \text{ in.} \) \hspace{1cm} (OK)

\( A_n = 14.4 - 0.560(1.25 + 0.125)(4) = 11.32 \text{ in.}^2 \)

\[
\frac{b_f}{d} = \frac{10.0}{10.0} > \frac{2}{3} \hspace{1cm} \Rightarrow \hspace{1cm} \text{From AISC Table D3.1, Case 7, } U = 0.90
\]

\( A_e = A_n U = 11.32(0.90) = 10.2 \text{ in.}^2 > 9.33 \text{ in.}^2 \) \hspace{1cm} (OK)

Use a W10 × 49
\[ \Sigma F_x = -95.69 + \frac{30 \cdot 50}{30.15} F_{ac} = 0 \]

\[ F_{ac} = 96.17 \text{ kips} \]

\[ \Sigma M_B = 6.337(10) + 6.337(20) + 3.232(30) - R_{ax}(3) = 0 \]

Joint B:

- \( R_{ax} = 95.69 \text{ kips} \)
- \( 95.69 \text{ kips} \)
- \( 50 \text{ kips} \)
- \( 30.15 \text{ kips} \)
- \( 30 \text{ kips} \)
- \( 3 \text{ kips} \)

Exterior joint load: Use half of the above loads except for the purlin weight, which is the same:

- \( 1.2D + 1.68 R_{by} = 1.2(1.508 + 0.1063 + 0.3333) + 1.6(2.5) = 6.337 \text{ kips} \)
- \( 6.337 \text{ kips} \)
- \( 3.232 \text{ kips} \)
- \( 2 \text{ kips} \)

Load combination 3 controls:

- Truss weight: 1000/3 = 333.3 lb
- Purlins: 8.5(12.5) = 106.3 lb
- Roofing: 12(10)(30)(15)(30)(12.5) = 1508 lb

- 20(10)(12.5) = 2500 lb

Snow:

- 30.15

Exterior joint load:

- 3

(The assumption that the truss weight is distributed equally to the joints is approximate but is consistent with the approximate nature of the estimate of total truss weight.)
Required \( A_g = \frac{F_{BC}}{0.9F_y} = \frac{96.17}{0.9(36)} = 2.97 \text{ in.}^2 \)

Required \( A_e = \frac{F_{BC}}{0.75F_u} = \frac{96.17}{0.75(58)} = 2.21 \text{ in.}^2 \)

\( L = 10 \left( \frac{30.15}{30} \right) = 10.05 \text{ ft} \)

Required \( r_{\min} = \frac{L}{300} = \frac{10.05 \times 12}{300} = 0.402 \text{ in.} \)

Try WT5 \( \times \) 11

\( A_g = 3.24 \text{ in.}^2 > 2.79 \text{ in.}^2 \) (OK) \( r_{\min} = 1.33 \text{ in.} > 0.402 \text{ in.} \) (OK)

\( U = 1 - \frac{x}{L} = 1 - \frac{1.07}{11} = 0.9027 \)

\( A_e = A_gU = 3.24(0.9027) = 2.93 \text{ in.}^2 > 2.21 \text{ in.}^2 \) (OK) \hspace{1cm} \text{Use WT5} \times 9.5 \)

(b) Load combination 3 controls:

\( D + L = 1.508 + 0.1063 + 0.3333 + 2.5 = 4.448 \text{ kips} \)

Exterior joint load: use half of the above loads except for the purlin weight, which is the same:

\( D + L = \frac{1.508}{2} + 0.1063 + \frac{0.3333}{2} + \frac{2.5}{2} = 2.277 \text{ kips} \)

For a free-body diagram of the entire truss,

\[ \sum M_A = 4.448(10) + 4.448(20) + 2.277(30) - R_{Bx}(3) = 0 \]

\( R_{Bx} = 67.25 \text{ kips} \)

For a free body of joint B:

\[ \sum F_x = -67.25 + \frac{30}{30.15}F_{BC} = 0, \quad F_{BC} = 67.59 \text{ kips} \]

Required \( A_g = \frac{F_{BC}}{0.6F_y} = \frac{67.59}{0.6(36)} = 3.13 \text{ in.}^2 \)

Required \( A_e = \frac{F_{BC}}{0.5F_u} = \frac{67.59}{0.5(58)} = 2.33 \text{ in.}^2 \)

Required \( r_{\min} = \frac{L}{300} = \frac{10.05 \times 12}{300} = 0.402 \text{ in.} \)

Try WT5 \( \times \) 11

\( A_g = 3.24 \text{ in.}^2 > 3.13 \text{ in.}^2 \) (OK) \( r_{\min} = 1.33 \text{ in.} > 0.402 \text{ in.} \) (OK)

\( U = 1 - \frac{x}{L} = 1 - \frac{1.07}{11} = 0.9027 \)

\( A_e = A_gU = 3.24(0.9027) = 2.93 \text{ in.}^2 > 2.33 \text{ in.}^2 \) (OK) \hspace{1cm} \text{Use WT5} \times 9.5 \)