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Unified Design of Steel Structures | (1st Edition)

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Chapter 4, Problem 23P	Bookmark	Show all steps: ON
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Step-by-step solution

Step 1 of 6

Find the gross area in shear (A_{gv}) using the formula:

$$A_{gv} = b \times t$$

Denote thickness of plate as t and width of the first hole from the end of the plate as b .

Substitute 7.5 in. for b and $\frac{3}{8}$ in. for t to get:

$$A_{gv} = 7.5 \times \frac{3}{8}$$

$$= 2.813 \text{ in.}^2$$

[Comment](#)

Step 2 of 6

Find the effective hole size (d_e) using the formula:

$$d_e = d + \frac{1}{16} \text{ in.} + \frac{1}{16} \text{ in.}$$

Denote diameter of bolt as d .

Here, $\frac{1}{16}$ in. is added for the needs of fabrication and $\frac{1}{16}$ in. for erection tolerance.

Substitute $\frac{3}{4}$ in. for d to get:

$$d_e = \frac{3}{4} + \frac{1}{16} + \frac{1}{16}$$

$$= \frac{7}{8} \text{ in.}$$

[Comment](#)

Step 3 of 6

Find the net area in the shear (A_{nv}) using the formula:

$$A_{nv} = (b - 2.5d_e)t$$

Here, 2.5 indicates the bolts involved in shear resistance. Two bolts will completely participate whereas the third bolt will partially participate in shear resistance.

Substitute 7.5 in. for b , $\frac{7}{8}$ in. for d_e , and $\frac{3}{8}$ in. for t to get:

$$A_{nv} = \left(7.5 - 2.5 \times \frac{7}{8} \right) \times \frac{3}{8}$$

$$= 1.992 \text{ in.}^2$$

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Step 4 of 6

From Figure (1):

Find the net area in the tension (A_n) using the relation:

$$A_n = \left(b_{\text{bolts in tension}} - \frac{1}{2} d_c \right) t$$

Substitute 1.5 in. for $b_{\text{bolts in tension}}$, $\frac{7}{8}$ in. for d_c , and $\frac{3}{8}$ in. for t to get:

$$\begin{aligned} A_n &= \left(1.5 - \frac{1}{2} \times \frac{7}{8} \right) \times \frac{3}{8} \\ &= 0.398 \text{ in.}^2 \end{aligned}$$

[Comment](#)

Step 5 of 6

Determine the nominal block shear strength (R_n) using the formula:

$$R_n = 0.6F_u A_{nv} + U_{bs}F_u A_{nt} \leq 0.6F_y A_{gv} + U_{bs}F_u A_{nt}$$

Denote yield strength of steel in shear as F_u .

The value of U_{bs} is 1.0.

Substitute 36 ksi for F_u , 1.992 in.^2 for A_{nv} , 1 for U_{bs} , 0.398 in.^2 for A_{nt} , 58 ksi for F_y , and 2.813 in.^2 for A_{gv} to get:

$$\begin{aligned} R_n &= 0.6 \times 58 \times 1.992 + 1 \times 58 \times 0.398 \leq 0.6 \times 36 \times 2.813 + 1 \times 58 \times 0.398 \\ &= 92.406 \text{ kips} \leq 83.845 \text{ kips} \end{aligned}$$

Select the lowest nominal strength.

The available block shear strength of the section is **83.845 kips**.

a)

LRFD:

Find the value of ϕR_n :

Substitute 0.75 for ϕ and 83.845 kips for R_n to get:

$$\begin{aligned} \phi R_n &= 0.75 \times 83.845 \\ &= 62.884 \text{ kips} \end{aligned}$$

The available block shear strength of the section by LRFD is **62.884 kips**.

[Comment](#)

Step 6 of 6

b)

ASD:

Find the value of $\frac{R_n}{\Omega}$.

Substitute 2 for Ω and 83.845 kips for R_n to get:

$$\begin{aligned} \frac{R_n}{\Omega} &= \frac{83.845}{2} \\ &= 41.923 \text{ kips} \end{aligned}$$

The available block shear strength of the section by ASD is **41.923 kips**.

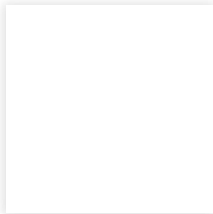


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Chapter 9, Solution 6P

7185-9-6P AID: 1825 |
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