Unified Design of Steel Structures | (1st Edition)

Chapter 4, Problem 23P | Bookmark | Show all steps: ON

Step-by-step solution

Step 1 of 6

Find the gross area in shear $\left(A_{gv}\right)$ 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 $\frac{3}{8}\text{in.}$ for *t* to get:

$$\begin{aligned} A_{gv} &= 7.5 \times \frac{3}{8} \\ &= 2.813\,\text{in.}^2 \end{aligned}$$

Comment

Step 2 of 6

Find the effective hole size $\left(d_e\right)$ using the formula:

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

Denote diameter of bolt as *d*.

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

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

$$\begin{aligned} d_e &= \frac{3}{4} + \frac{1}{16} + \frac{1}{16} \\ &= \frac{7}{8}\text{in.} \end{aligned}$$

Comment

Step 3 of 6

Find the net area in the shear $\left(A_{nv}\right)$ using the formula:

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

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*, $\frac{7}{8}\text{in.}$ for d_e, and $\frac{3}{8}\text{in.}$ for *t* to get:

$$\begin{aligned} A_{nv} &= \left(7.5 - 2.5 \times \frac{7}{8}\right) \times \frac{3}{8} \\ &= 1.992\,\text{in.}^2 \end{aligned}$$

Step 4 of 6

From Figure (1):

Find the net area in the tension (A_{nt}) using the relation:

$$A_{nt} = \left(b_{\text{bolts in tension}} - \frac{1}{2}d_e\right)t$$

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

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

Comment

Step 5 of 6

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

$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt} \le 0.6F_yA_{gv} + U_{bs}F_uA_{nt}$$

Denote yield strength of steel in shear as F_u.

The value of U_{bs} is 1.0.

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

$$\begin{aligned} R_n &= 0.6\times58\times1.992 + 1\times58\times0.398 \le 0.6\times36\times2.813 + 1\times58\times0.398 \\ &= 92.406\,\text{kips} \le 83.845\,\text{kips} \end{aligned}$$

Select the lowest nominal strength.

The available block shear strength of the section is $\boxed{83.845\,\text{kips}}$.

a)

LRFD:

Find the value of ϕR_n:

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

$$\begin{aligned} \phi R_n &= 0.75\times83.845 \\ &= 62.884\,\text{kips} \end{aligned}$$

The available block shear strength of the section by LRFD is $\boxed{62.884\,\text{kips}}$.

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 $\boxed{41.923\,\text{kips}}$.

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Recommended solutions for you in Chapter 9

Chapter 9, Solution 6P

7185-9-6P AID: 1825 | 31/08/2013 Consider the composite beam of a) Design strength by LRFD: Calculate the effective flange...

See solution

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