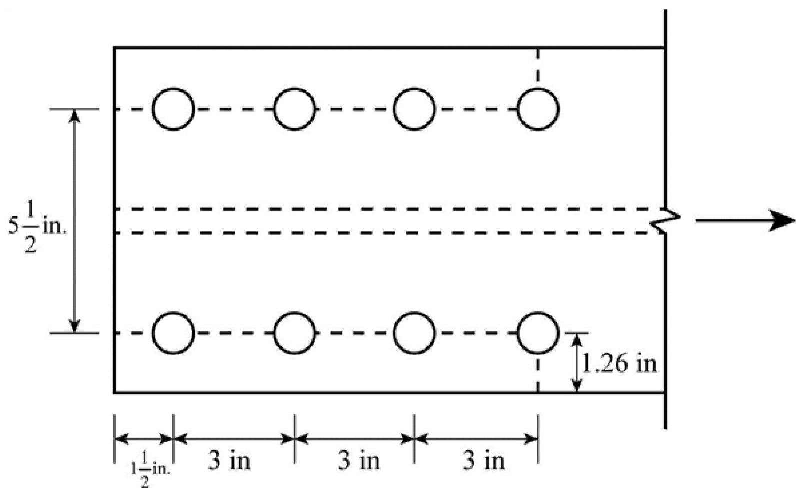
Unified Design of Steel Structures | (0th Edition)

Step-by-step solution

Step 1 of 9

Show the geometry of block shear failure of the as in Figure (1).



Comment

Step 2 of 9

Get the value of flange width, b_f and flange thickness, t_f of the section from Table 1-8 "WT dimensions" in AISC steel construction manual.

$$b_f = 8.01\,\text{in.}$$
$$t_f = 0.515\,\text{in.}$$

The distance between the outer edge and the center of bolt (each row) is 1.255 in. $\left[(8.01\,\text{in.} - 5.5\,\text{in.})/2\right]$.

There are two stretches of shear failure path and two stretches of tensile failure path.

The length of single shear failure path, l_v is 10.5 in. and the total length of tensile path, l_t is 2.51 in.

$$l_v = 3\,\text{in.} + 3\,\text{in.} + 3\,\text{in.} + 1.5\,\text{in.}$$
$$l_v = 10.5\,\text{in.}$$
$$l_t = 1.255\,\text{in.} + 1.255\,\text{in.}$$
$$l_t = 2.51\,\text{in.}$$

Comment

Step 3 of 9

$$A_{gv} = 2\times(10.5\,\text{in.}\times 0.515\,\text{in.})$$
$$= 10.815\,\text{in.}^2$$

Comment

Step 4 of 9

Calculate the effective hole size, d_e.

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

Here, *d* is the diameter of bolt.

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

Substitute $3/4\,\text{in.}$ for *d*.

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

Comment

Step 5 of 9

Calculate the net area in the shear A_{nv}.

$$A_{nv} = 2(l_v - nd_e)t$$

Here, *n* is the bolts involved in shear resistance.

Here, 3.5 indicates the bolts in the cross section. Three bolts will completely participate whereas the fourth bolt will partially participate in shear resistance.

Substitute 10.5 in. for l_v, 3.25 for *n*, $7/8\,\text{in.}$ for d_e, and 0.515 in. for *t*.

$$A_{nv} = 2\times\left(10.5\,\text{in.} - 3.5\times\frac{7}{8}\text{in.}\right)\times 0.515\,\text{in.}$$
$$= 7.661\,\text{in.}^2$$

Comment

Step 6 of 9

Calculate the net area in the tension A_{nt}.

$$A_{nt} = (l_t - n\times d_e)t$$

Substitute 2.51 in. for l_t, 1 for *n*, $7/8\,\text{in.}$ for d_e, and 0.515 in. for *t*.

$$A_{nt} = \left(2.51\,\text{in.} - 1\times\frac{7}{8}\text{in.}\right)\times 0.515\,\text{in.}$$
$$= 0.842\,\text{in.}^2$$

Comment

Step 7 of 9

For tension members, the value of U_{bs} is 1.0.

Substitute 65 ksi for F_u, $7.661\,\text{in.}^2$ for A_{nv}, 1 for U_{bs}, $0.842\,\text{in.}^2$ for A_{nt}, 50 ksi for F_y, and $10.815\,\text{in.}^2$ for A_{gv}.

$$R_n = \min\left\{\begin{matrix}\left[0.6\times 65\,\text{ksi}\times 7.661\,\text{in.}^2 + 1\times 65\,\text{ksi}\times 0.842\,\text{in.}^2\right], \\ \left[0.6\times 50\,\text{ksi}\times 10.815\,\text{in.}^2 + 1\times 65\,\text{ksi}\times 0.842\,\text{in.}^2\right]\end{matrix}\right\}$$
$$= \min(353.51\,\text{kips}, 379.18\,\text{kips})$$
$$= 353.51\,\text{kips}$$

The available block shear strength of the section is $\boxed{353.51\,\text{kips}}$.

Comment

Step 8 of 9

a)

LRFD:

Determine the design strength of the section for LRFD, ϕR_n

Here, ϕ is the shear resisting factor.

Substitute 0.75 for ϕ and 353.51 kips for R_n.

$$\phi R_n = 0.75\times 353.51$$
$$= 265.13\,\text{kips}$$

Therefore, the design strength of the section for LRFD is $\boxed{265.13\,\text{kips}}$.

Comment

Step 9 of 9

b)

ASD:

Determine the allowable strength of the section for ASD, R_n/Ω.

Here, Ω is the safety factor

Substitute 2 for Ω and 353.51 kips for R_n to get:

$$\frac{R_n}{\Omega} = \frac{353.51}{2}$$
$$= 176.75\,\text{kips}$$

Therefore, the allowable strength of the section for ASD is $\boxed{176.75\,\text{kips}}$.

Comment

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Recommended solutions for you in Chapter 4

Chapter 4, Problem 46P	3 Bookmarks	Show all steps: ON