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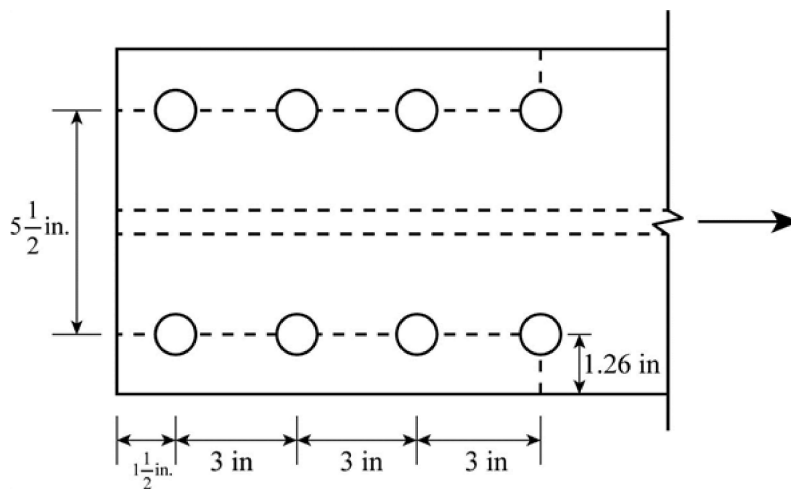
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Step-by-step solution

Step 1 of 9

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



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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.

$$\left[\frac{(8.01 \text{ in.} - 5.5 \text{ in.})}{2} \right]$$

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.

$$l_v = 3 \text{ in.} + 3 \text{ in.} + 3 \text{ in.} + 1.5 \text{ in.}$$

$$l_v = 10.5 \text{ in.}$$

$$l_t = 1.255 \text{ in.} + 1.255 \text{ in.}$$

$$l_t = 2.51 \text{ in.}$$

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Step 3 of 9

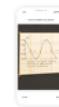
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$A_{gv} = 2 \times (10.5 \text{ in.} \times 0.515 \text{ in.})$ $= 10.815 \text{ in.}^2$ <p>-----</p> <p>Comment</p>		
<p style="text-align: center;">Step 4 of 9</p> <p>Calculate the effective hole size, d_e.</p> $d_e = d + \frac{1}{16} \text{ in.} + \frac{1}{16} \text{ in.}$ <p>Here, d is the diameter of bolt.</p> <p>Here, $1/16 \text{ in.}$ added for the needs of fabrication and $1/16 \text{ in.}$ for erection tolerance.</p> <p>Substitute $3/4 \text{ in.}$ for d.</p> $d_e = \frac{3}{4} + \frac{1}{16} + \frac{1}{16}$ $= \frac{7}{8} \text{ in.}$ <p>-----</p> <p>Comment</p>		
<p style="text-align: center;">Step 5 of 9</p> <p>Calculate the net area in the shear A_{nv}.</p> $A_{nv} = 2(l_v - nd_e)t$ <p>Here, n is the bolts involved in shear resistance.</p> <p>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.</p> <p>Substitute 10.5 in. for l_v, 3.25 for n, $7/8 \text{ in.}$ for d_e, and 0.515 in. for t.</p> $A_{nv} = 2 \times \left(10.5 \text{ in.} - 3.5 \times \frac{7}{8} \text{ in.} \right) \times 0.515 \text{ in.}$ $= 7.661 \text{ in.}^2$ <p>-----</p> <p>Comment</p>		
<p style="text-align: center;">Step 6 of 9</p> <p>Calculate the net area in the tension A_{nt}.</p> $A_{nt} = (l_t - n \times d_e)t$ <p>Substitute 2.51 in. for l_t, 1 for n, $7/8 \text{ in.}$ for d_e, and 0.515 in. for t.</p> $A_{nt} = \left(2.51 \text{ in.} - 1 \times \frac{7}{8} \text{ in.} \right) \times 0.515 \text{ in.}$ $= 0.842 \text{ in.}^2$ <p>-----</p> <p>Comment</p>		
<p style="text-align: center;">Step 7 of 9</p>		



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

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

$$R_n = \min \left\{ \begin{array}{l} \left[0.6 \times 65 \text{ ksi} \times 7.661 \text{ in.}^2 + 1 \times 65 \text{ ksi} \times 0.842 \text{ in.}^2 \right], \\ \left[0.6 \times 50 \text{ ksi} \times 10.815 \text{ in.}^2 + 1 \times 65 \text{ ksi} \times 0.842 \text{ in.}^2 \right] \end{array} \right\}$$

$$= \min (353.51 \text{ kips}, 379.18 \text{ kips})$$

$$= 353.51 \text{ kips}$$

The available block shear strength of the section is 353.51 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 265.13 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 176.75 kips.

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