Solved problems For net Areas regarding Tension Members.

Example 3-1 Mccormac.

Example 3-2 Mccormac.

McCormac.

Example 3-1

Determine the net area of the 3/8 × 8-in plate shown in Fig. 3.2. The plate is connected at its end with two lines of 3/4-in bolts.

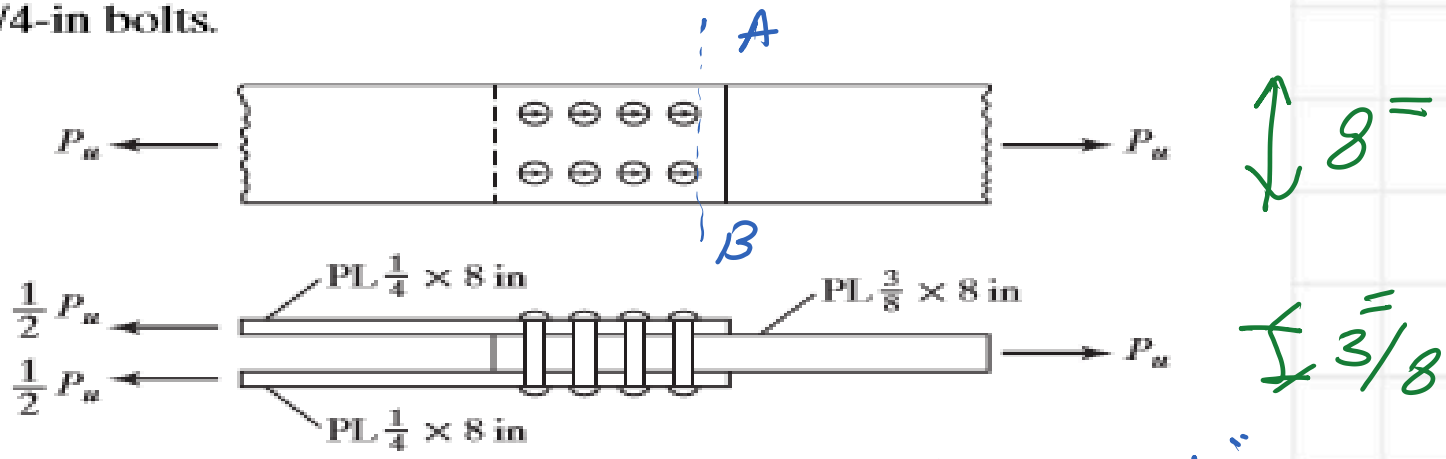
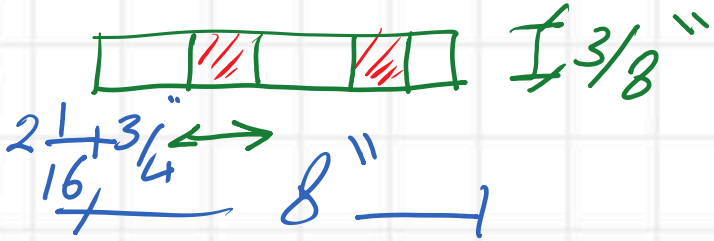


FIGURE 3.2

Solution



Section A-B

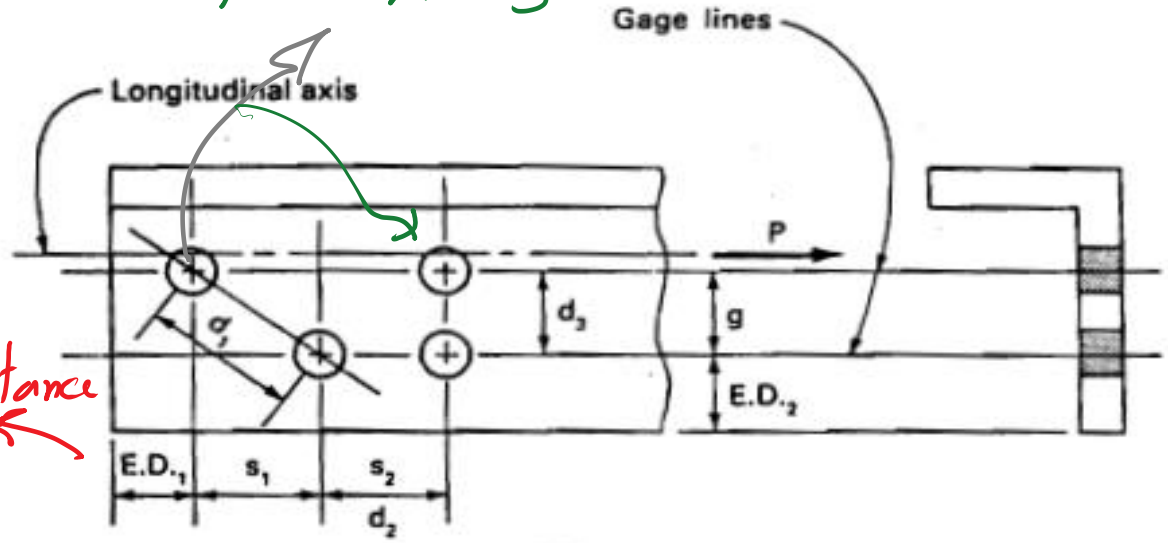
For design purpose add $2(\frac{1}{16}") = \frac{1}{8}"$

$A_g = \frac{3}{8}"(8) = 3\ inch^2$

holes Areas $= 2\left[\frac{3}{8}\right]\left[\frac{3}{4}+\frac{1}{8}\right] = \frac{6}{8}\left(\frac{7}{8}\right) =$

$A_e : A_{net} = 3 - (42/64) = 2.34\ inch^2$

Fasteners



S in the direction of Loading

g per to the Loading direction

Gauge Line - 1

Gauge Line - 2

g

Edge distance

gauge Line // Pitch ⟷

E.D. = edge distance
g = gage
s = pitch
d = distance between bolts

Figure 2-3 shows a tension member composed of a single steel angle with a 4-bolt connection. The tensile load *P* is assumed to be applied parallel to and coincident with the longitudinal axis of the member. The bolt holes are located on *gage lines* that are also parallel to the longitudinal axis. The dimension *g* between the gage lines is called the *gage*. The dimension *s* parallel to the gage line and taken between centers of bolt holes is called the *pitch* (or the *bolt spacing*). The *distance between bolts* is a straight line distance between any two bolts. The *edge distance* is the perpendicular distance from the *center of a hole* to the nearest edge.

McCormac

As a result of the preceding information, the AISC Specification (D2) states that the nominal strength of a tension member, P_n, is to be the smaller of the values obtained by substituting into the following two expressions:

For the limit state of yielding in the gross section (which is intended to prevent excessive elongation of the member),

Limit state of yielding

$$P_n = F_y A_g \quad \text{(AISC Equation D2-1)}$$

$\phi_t P_n = \phi_t F_y A_g$ = design tensile strength by LRFD ($\phi_t = 0.9$)

$$\frac{P_n}{\Omega_t} = \frac{F_y A_g}{\Omega_t} = \text{allowable tensile strength for ASD } (\Omega_t = 1.67)$$

For tensile rupture in the net section, as where bolt or rivet holes are present,

Limit state of Rupture

$$P_n = F_u A_e \quad \text{(AISC Equation D2-2)}$$

$\phi_t P_n = \phi_t F_u A_e$ = design tensile rupture strength for LRFD ($\phi_t = 0.75$)

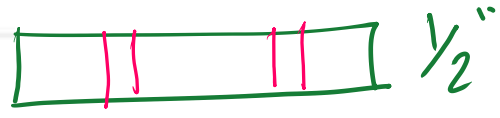
$$\frac{P_n}{\Omega_t} = \frac{F_u A_e}{\Omega_t} \text{ allowable tensile rupture strength for ASD } (\Omega_t = 2.00)$$

Example 3-2

Determine the critical net area of the 1/2-in-thick plate shown in Fig. 3.5, using the AISC Specification (Section B4.3b). The holes are punched for 3/4-in bolts.

Deduct Two holes areas

$d_b = 3/4 + \frac{1}{8} = 7/8$"



$\phi = \frac{3}{4}$"

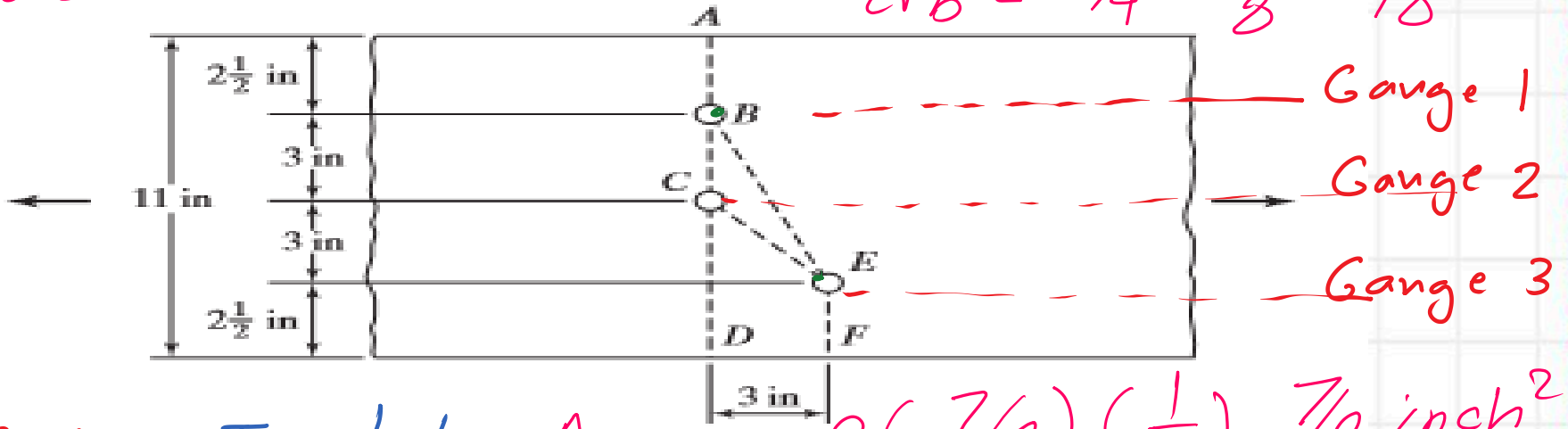


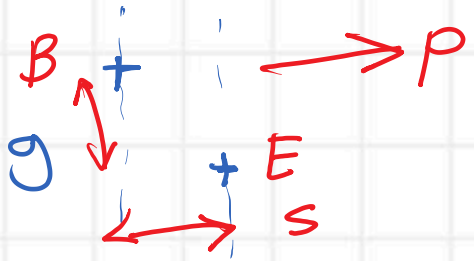
FIGURE 3.5

Line ABCD : Two holes Area $= 2(7/8)(\frac{1}{2}) = 7/8$ inch^2

Solution

$A_{net\ ABCD} = 11(\frac{1}{2}) - 7/8 = 4.63$ inch^2 (AG)

ABEF deduct 2 holes but add $(s^2/4g)t$



$(\frac{s^2}{4g})t$ $\quad s = 3$ $\quad g = 6$"

$\frac{s^2}{4g} = \frac{3^2}{24} = \frac{9}{24}$

Example 3-2

Determine the critical net area of the 1/2-in-thick plate shown in Fig. 3.5, using the AISC Specification (Section B4.3b). The holes are punched for 3/4-in bolts.

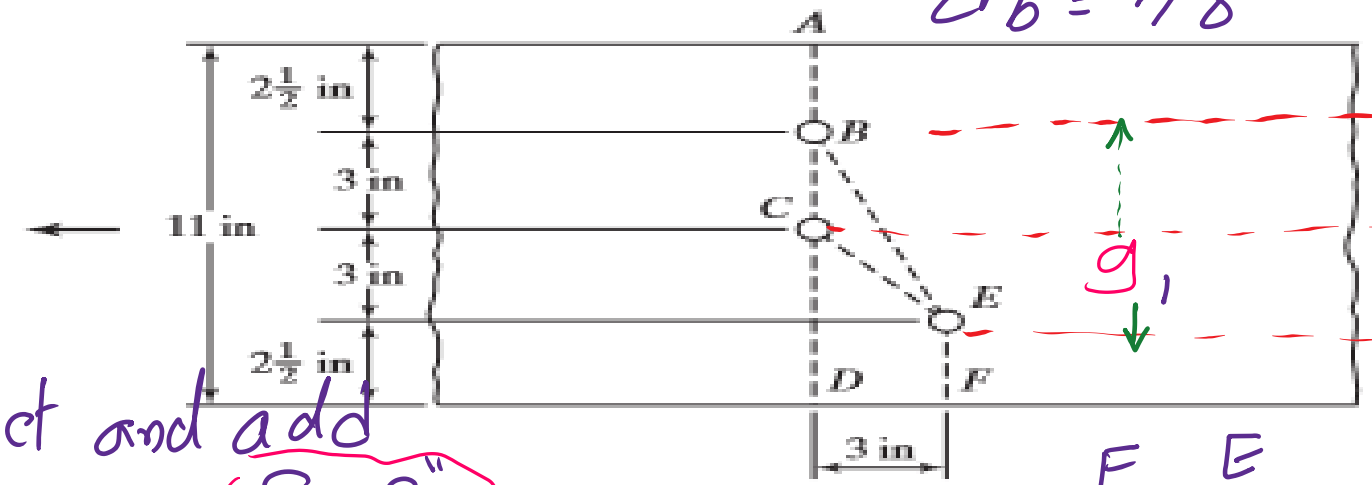


FIGURE 3.5

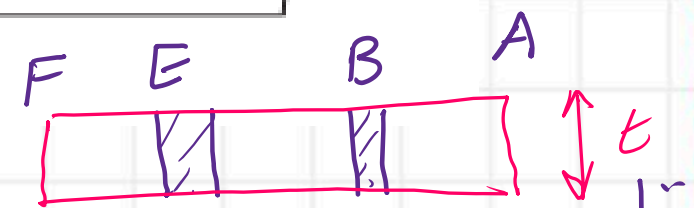
$d_b = 7/8"$

$\phi = \frac{3}{4}"$

Deduct and add

$S = 3"$

$g_1 = 6"$



Solution Line ABEF

$$A_{gross} = 11\left(\frac{1}{2}\right) = 5.5 \text{ inch}^2$$

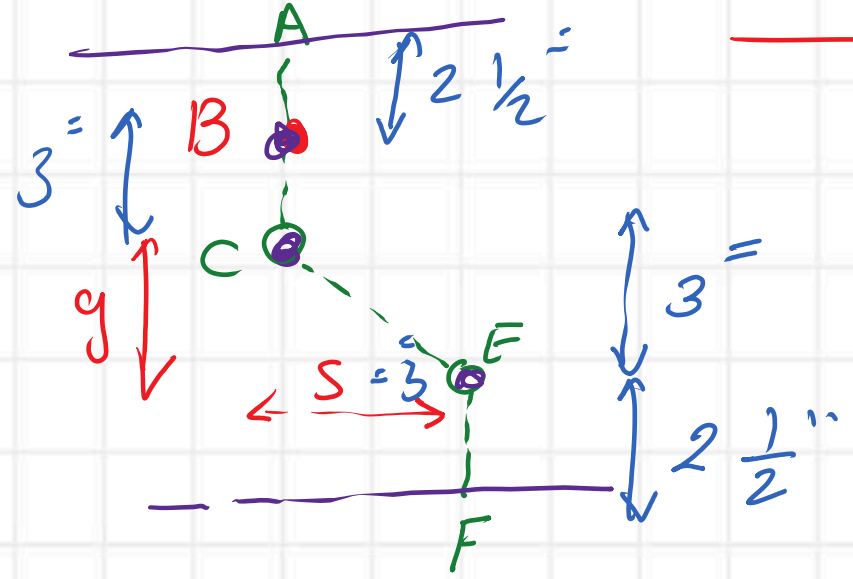
$$\frac{S^2}{4g_1} = \frac{(3)^2}{4(6)}$$

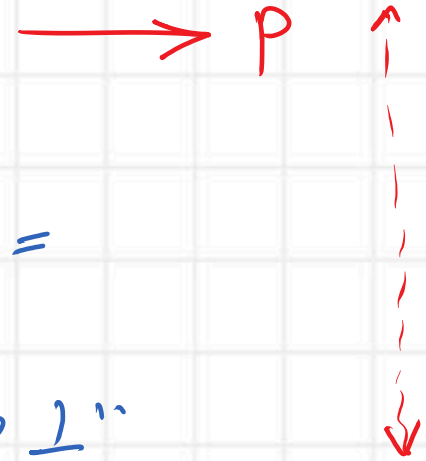
$$\text{deductions} = -2\left(\frac{3}{4}+\frac{1}{8}\right)\left(\frac{1}{2}\right) + \left(\frac{9}{24}\right)\left(\frac{1}{2}\right) = \frac{1}{2}\left(-\frac{14}{8}+\frac{9}{24}\right) = -\frac{11}{16} \text{ inch}^2$$

(No; t)

$$A_{net} = 5.5 - \left(\frac{11}{16}\right) = 4.81 \text{ inch}^2$$

Line - ABCEF





thickness = $\frac{1}{2}$"

List of net areas

$A_{gross} = 11\left(\frac{1}{2}\right) = 5.50 \text{ inch}^2$

deduct 3 holes $\frac{7}{8} \times \frac{1}{2}$" $= 3\left(\frac{7}{8}\right)\left(\frac{1}{2}\right) = -\frac{21}{16}$

Add $\frac{S^2}{4g}t = (3)^2\left(\frac{1}{12}\right)\left(\frac{1}{2}\right) = \frac{9}{24}$

$A_{net} = 5.50 - \frac{21}{16} + \frac{9}{24} = 4.56 \text{ inch}^2$

Least A_{net} = 4.56 inch^2 critical

ABCD

$A_{net,1} = 4.63 \text{ inch}^2$

ABEF

$A_{net-2} = 4.81 \text{ inch}^2$

$= 4.56 \text{ inch}^2$

Prepared by Eng.Maged Kamel.