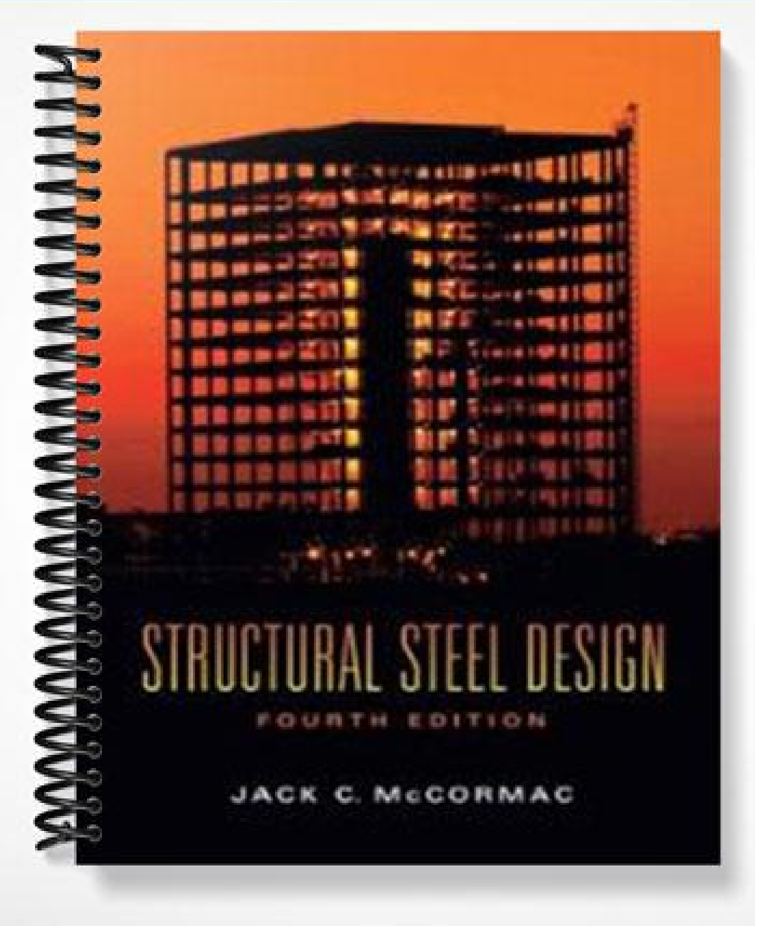
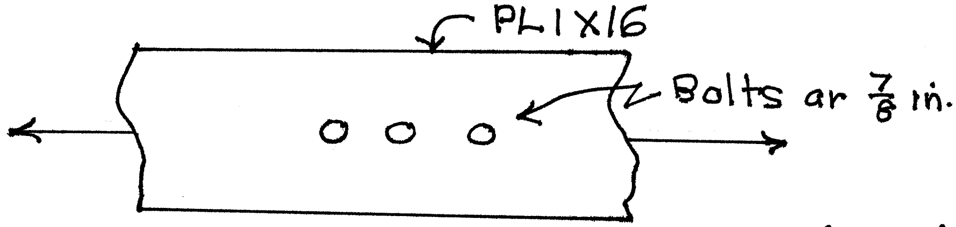
SOLUTIONS MANUAL



CHAPTER 3

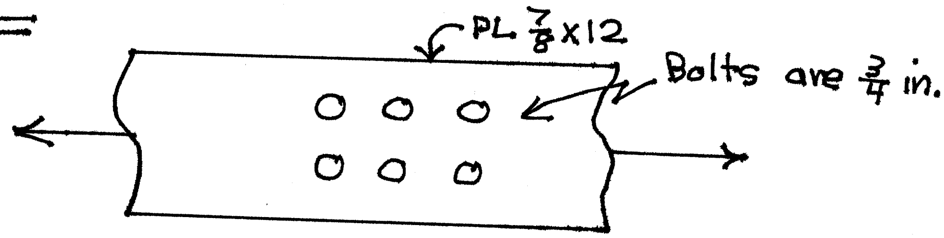
PROB # 3-1



$$\text{Net } A = (1)(16) - (1)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(1) = \boxed{15 \text{ in.}^2}$$

rgcm[c]

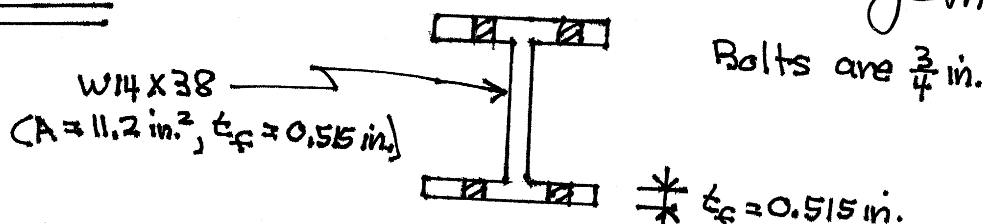
PROB # 3-2



$$\text{Net } A = \left(\tfrac{7}{8}\right)(12) - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)\left(\tfrac{7}{8}\right) = \boxed{8.97 \text{ in.}^2}$$

rgcm[c]

PROB # 3-3

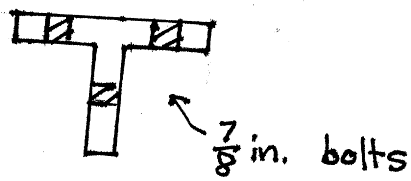


$$\text{Net } A = 11.2 - (4)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.515) = \boxed{9.40 \text{ in.}^2}$$

rgcm[c]

PROB #3-4

WT 10.5 × 61
($A = 17.9$ in.^{2}, $t_w = 0.600$ in,
$t_f = 0.960$ in.)



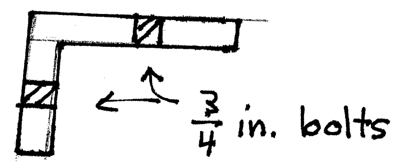
$$\text{Net } A = 17.9 - (2)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(0.960) - (1)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(0.600)$$

$$= \boxed{15.38 \text{ in.}^2}$$

✓ JCM

PROB #3-5

Using 1 L8×4×$\tfrac{3}{4}$ ($A = 8.44$ in.^{2})

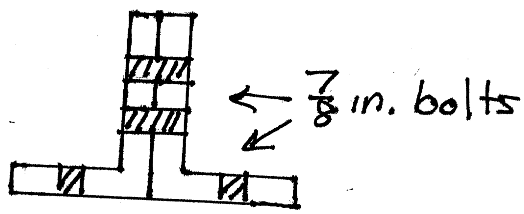


$$\text{Net } A = 8.44 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)\left(\tfrac{3}{4}\right)$$

$$= \boxed{7.13 \text{ in.}^2}$$

✓ JCM

PROB #3-6



Using 2Ls 7×4×$\tfrac{5}{8}$ ($A = 13.0$ in.^{2})

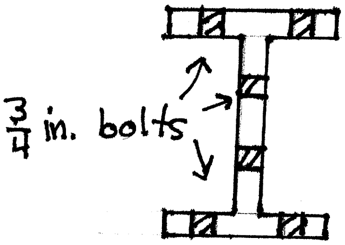
$$\text{Net } A = 13.0 - (2)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)\left(\tfrac{5}{8}\right) - (2)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)\left(2 \times \tfrac{5}{8}\right)$$

$$= \boxed{9.25 \text{ in.}^2}$$

✓ JCM

Note Areas for single angles times two vary a little from the double angle areas given in Steel Manual

PROB #3-7

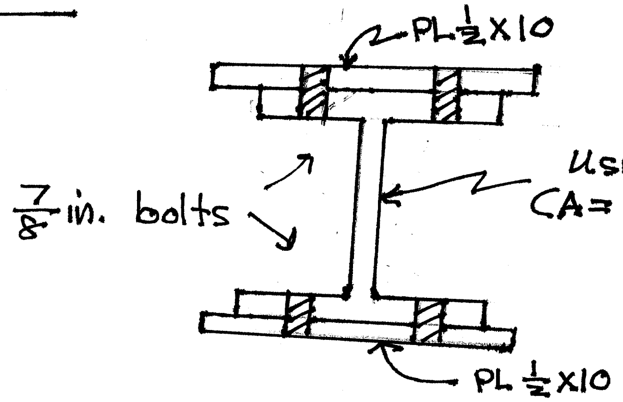


Using a W21X44
($A = 13.0\text{ in.}^2$, $t_w = 0.350\text{ in.}$, $t_f = 0.450\text{ in.}$)

$$\text{Net } A = 13.0 - (4)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.450) - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.350)$$
$$= \boxed{10.81\text{ in.}^2}$$

✓ gcm©

PROB #3-8



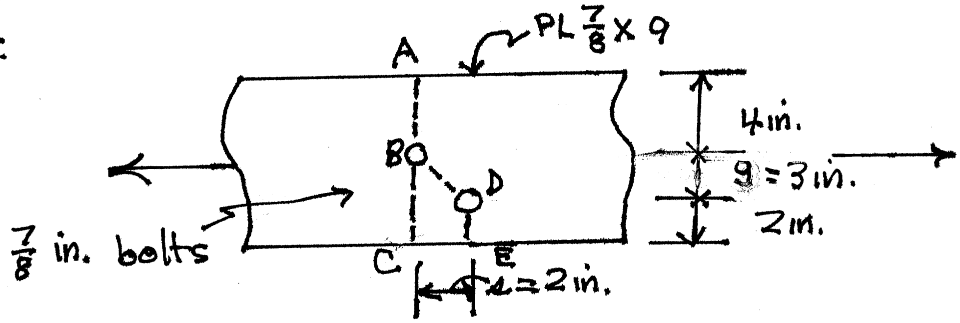
Using a W21X57
($A = 16.7\text{ in.}^2$, $t_f = 0.650\text{ in.}$)

$$A_g = 16.7 + (2)\left(\tfrac{1}{2}\times 10\right) = 26.7\text{ in.}^2$$

$$\text{Net } A = 26.7 - (4)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(0.650 + 0.500)$$
$$= \boxed{22.1\text{ in.}^2}$$

✓ gcm©

PROB # 3-9



Net widths

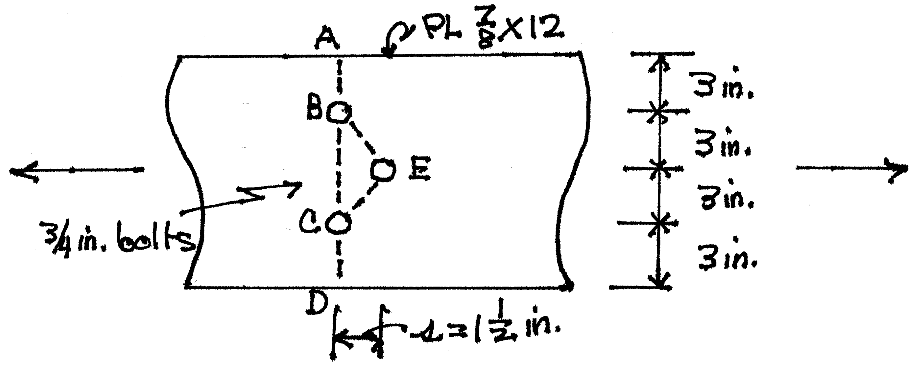
$$ABC = 9-(1)\left(\tfrac{7}{8}+\tfrac{1}{8}\right) = 8.00 \text{ in.}$$

$$ABDE = 9-(2)\left(\tfrac{7}{8}+\tfrac{1}{8}\right) + \frac{(2)^2}{(4)(3)} = 7.33 \text{ in.} \leftarrow$$

$$\text{Net Area} = (7.33)\left(\tfrac{7}{8}\right) = \boxed{6.41 \text{ in.}^2}$$

✓ gcmc

PROB # 3-10



Net widths

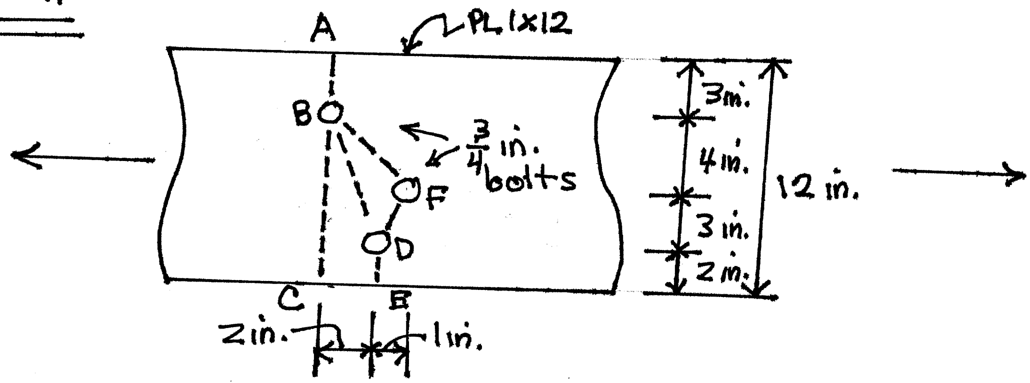
$$ABCD = 12-(2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right) = 10.25 \text{ in.}$$

$$ABECD = 12-(3)\left(\tfrac{3}{4}+\tfrac{1}{8}\right) + (2)\left(\frac{1.5^2}{4 \times 3}\right) = 9.75 \text{ in.} \leftarrow$$

$$\text{Net Area} = (9.75)(0.875) = \boxed{8.53 \text{ in.}^2}$$

✓ gcmc

PROB # 3-11



Net widths

$ABC = 12 - (1)(\frac{3}{4} + \frac{1}{8}) = 11.125$ in.

$ABDE = 12 - (2)(\frac{3}{4} + \frac{1}{8}) + \frac{(2)^2}{(4)(7)} = 10.39$ in.

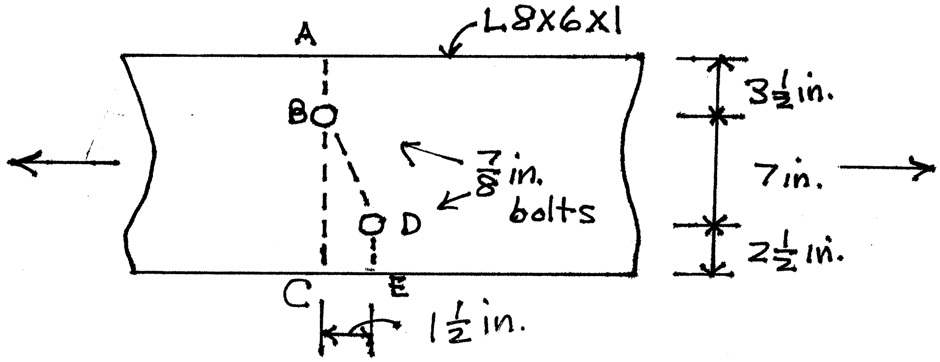
$ABFDE = 12 - (3)(\frac{3}{4} + \frac{1}{8}) + \frac{(3)^2}{(4)(4)} + \frac{(1)^2}{(4)(3)} = 10.02$ in. ←

Net Area = (10.02)(1.0) = **10.02 in.²**

✓ gcm^c

PROB # 3-12

Flattening angle



Net widths

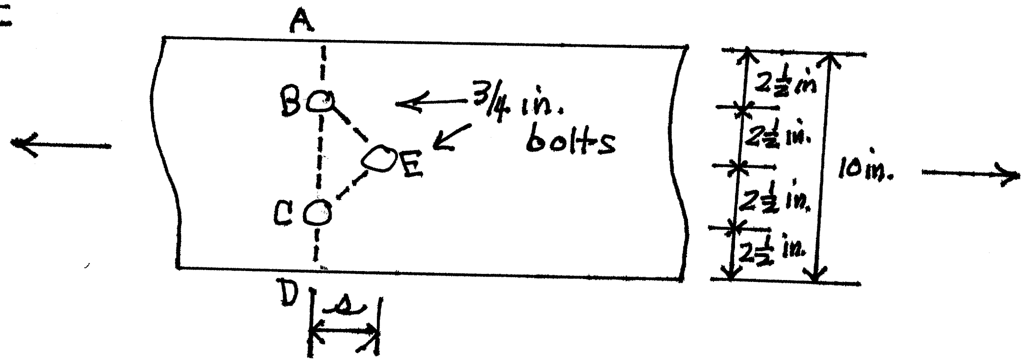
$ABC = 13.00 - (1)(\frac{7}{8} + \frac{1}{8}) = 12.00$ in.

$ABDE = 13.00 - (2)(\frac{7}{8} + \frac{1}{8}) + \frac{(1.5)^2}{(4)(7)} = 11.08$ in. ←

Net Area = (11.08)(1) = **11.08 in.²**

✓ gcm^c

PROB #3-13



Net widths

ABCD = $10 - (2)(\frac{3}{4}+\frac{1}{8}) = 8.25$ in.

ABECD = $10 - (3)(\frac{3}{4}+\frac{1}{8}) + (2)\frac{s^2}{(4)(2.5)} = 7.375 + \frac{s^2}{5}$

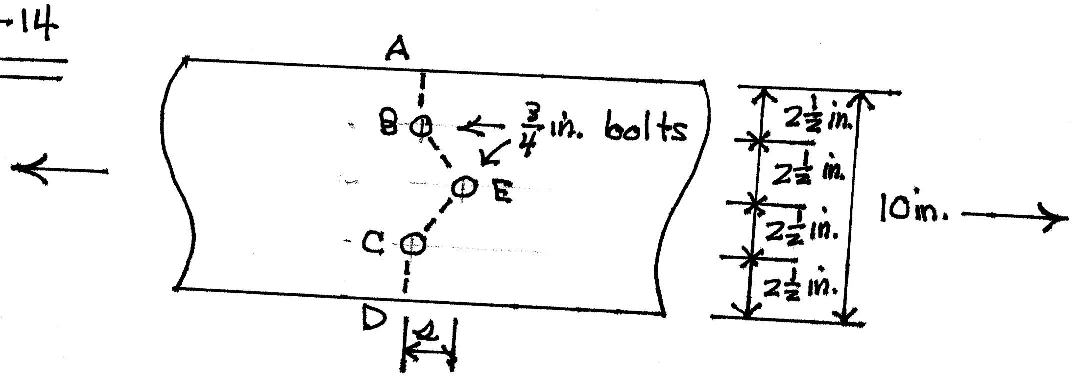
Equating

$$8.25 = 7.375 + \frac{s^2}{5}$$

$s = 2.09$ in.

✓ gcm[c]

PROB #3-14



Net width with $2\frac{1}{2}$ bolt holes subtracted

$= 10.00 - (2\frac{1}{2})(\frac{3}{4}+\frac{1}{8}) = 7.8125$

Net width ABECD

$= 10.00 - (3)(\frac{3}{4}+\frac{1}{8}) + (2)\frac{s^2}{(4)(2.5)} = 7.375 + \frac{s^2}{5}$

Equating

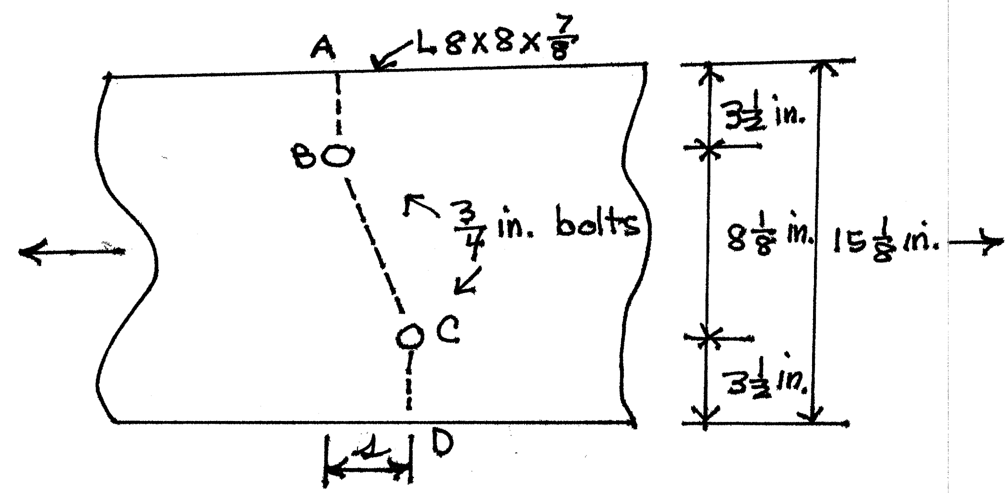
$$7.8125 = 7.375 + \frac{s^2}{5}$$

$s = 1.48$ in.

✓ gcm[c]

PROB # 3-15

Flattening the angle



(a) Net width with 1 hole subtracted

$$= 15.125 - (1)\left(\frac{3}{4} + \frac{1}{8}\right) = 14.25 \text{ in.}$$

Net width ABCD

$$= 15.125 - (2)\left(\frac{3}{4} + \frac{1}{8}\right) + \frac{s^2}{(4)(8.125)}$$

$$= 13.375 + \frac{s^2}{32.5}$$

Equating

$$14.25 = 13.375 + \frac{s^2}{32.5}$$

$$\boxed{s = 5.33 \text{ in.}}$$

(b) Net A if s = 2 in.

$$\text{Net width ABCD} = 15.125 - (2)\left(\frac{3}{4} + \frac{1}{8}\right) + \frac{(2)^2}{(4)(8.125)}$$

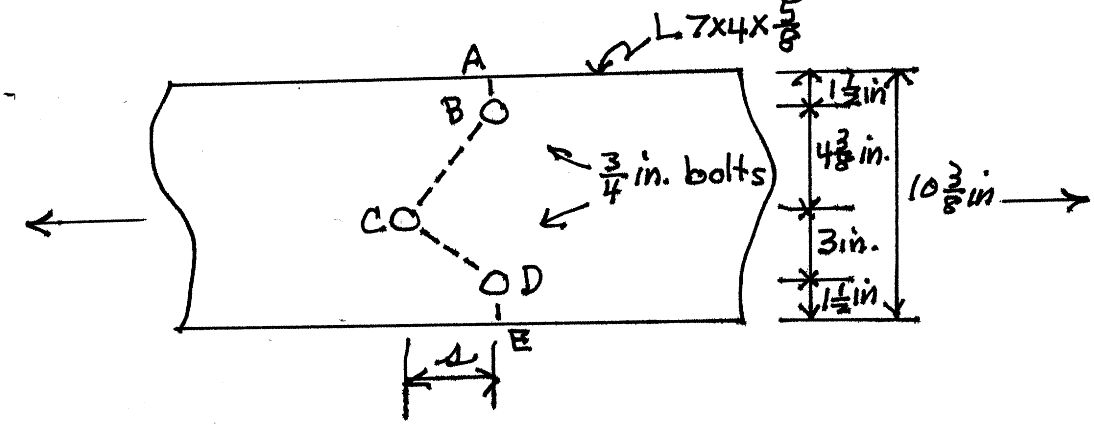
$$= 13.50 \text{ in.}$$

$$\text{Net area} = (13.50)\left(\frac{7}{8}\right) = \boxed{11.81 \text{ in.}^2}$$

✓ JCMc

PROB # 3-16

Flattening the angle



Net width ABCDE

$$= 10.375 - (3)\left(\tfrac{3}{4}+\tfrac{1}{8}\right) + \frac{s^2}{(4)(4.375)} + \frac{s^2}{(4)(3)}$$

$$= 7.75 + 0.1405\, s^2$$

Net width with 2 holes out

$$= 10.375 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right) = 8.625 \text{ in.}$$

Equating

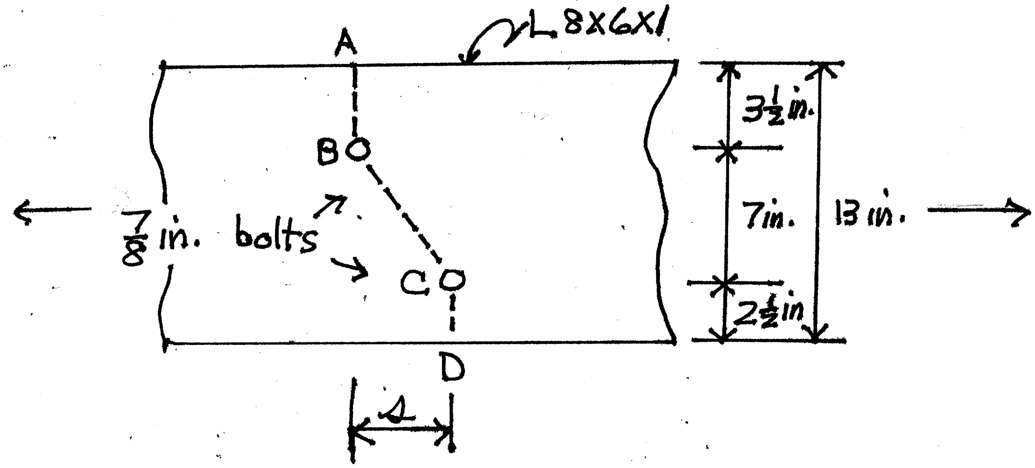
$$7.75 + 0.1405 s^2 = 8.625$$

$$\boxed{s = 2.50 \text{ in.}}$$

✓ JCMcC

PROB # 3.17

Flattening the angle



Net width with 1 hole out

$$= 13 - (1.5)\left(\frac{7}{8}+\frac{1}{8}\right) = 11.50 \text{ in.}$$

Net width ABCD

$$= 13.00 - (2)\left(\frac{7}{8}+\frac{1}{8}\right) + \frac{s^2}{(4)(7)}$$

$$= 11.00 + \frac{s^2}{28}$$

Equating

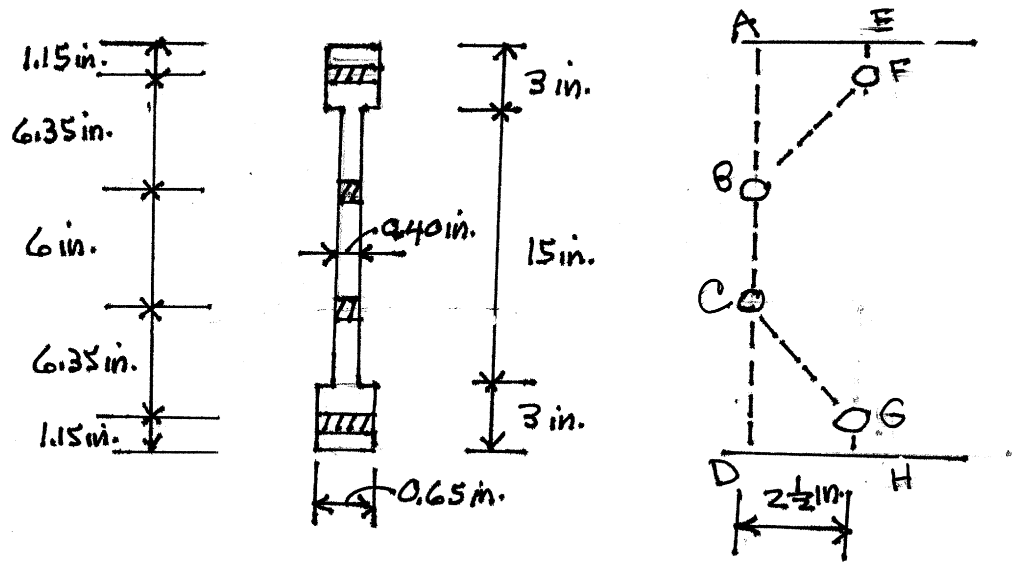
$$11.50 = 11.00 + \frac{s^2}{28}$$

$$\boxed{s = 3.74 \text{ in.}}$$

✓ gcm ©

PROB #3-18

Using a C15x33.9 ($A = 10.0\ in.^2$, $t_w = 0.400\ in.$, $t_f = 0.650\ in.$)



Net areas

$$ABCD = 10.00 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.40) = 9.30\ in.^2$$

$$EFBCGH = 10.00 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.65) - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.40) + (2)\frac{(2.5)^2}{(4)(6.35)}\left(\frac{0.65+0.40}{2}\right) = 8.42\ in.^2 \leftarrow$$

Noting that $U = 1.0$ since all parts are connected

$$A_e = UA_{net} = (1.0)(8.42) = \boxed{8.42\ in.^2}$$

✓ JCMc

PROB #3-19

Using 2 MCs 18x42.7 (For each $A = 12.60\ in^2$, $t_f = 0.625$ in.)
plus 2 – $\frac{3}{4}$x16 PLs

$$A_{net} = (2)(12.60) + (2)(\tfrac{3}{4}\times 16) - (4)(\tfrac{7}{8}+\tfrac{1}{8})(0.625+\tfrac{3}{4})$$

$$= 43.7\ in^2$$

U given $= 0.85$

$$A_e = U A_{net} = (0.85)(43.7) = \boxed{37.14\ in.^2}$$

✓ gcm^c

PROB #3-20

Using 1 L 8x4x$\frac{3}{4}$ ($A = 8.44\ in.^2$)

$$A_{net} = 8.44 - (1)(1+\tfrac{1}{8})(\tfrac{3}{4}) = 7.60\ in.$$

$U = 0.60$ as given in AISC Table D3-1 (Case 8)

or

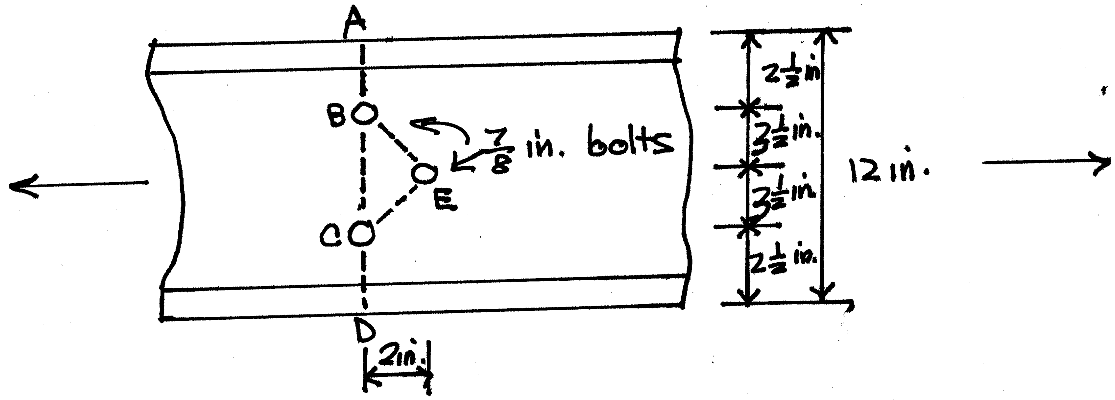
$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{0.949}{2\times 4} = 0.88 \leftarrow$$

$$A_e = U A_n = (0.88)(7.60) = \boxed{6.69\ in.}$$

✓ gcm^c

PROB # 3-21

Using an MC12X40 ($A_g = 11.8\,in.^2$, $t_w = 0.590$ in., $\bar{x} = 1.04$ in.)



Net areas

$$ABCD = 11.8 - (2)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(0.590) = 10.62\ in.^2$$

$$ABECD = 11.8 - (3)\left(\tfrac{7}{8}+\tfrac{1}{8}\right)(0.590) + (2)\frac{(2)^2}{(4)(3.5)}(0.590)$$

$$= 10.37\ in.^2 \leftarrow$$

$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{1.04}{2 \times 4} = 0.87$$

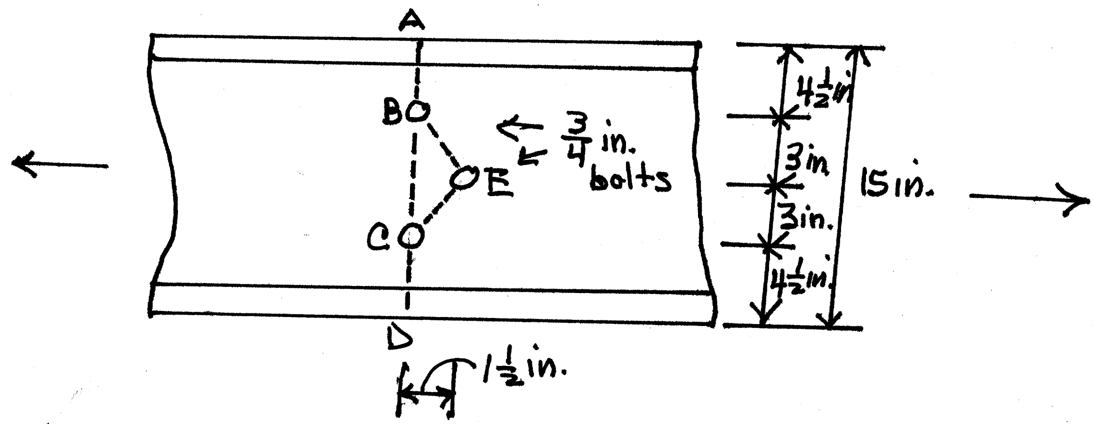
Effective area

$$A_e = U A_n = (0.87)(10.37) = \boxed{9.02\ in.^2}$$

v g c m c

PROB # 3-22

Using a C15X40 ($A = 11.8\text{ in.}^2$, $t_w = 0.520\text{ in.}$, $\bar{x} = 0.778\text{ in.}$)



Net areas

$$ABCD = 11.8 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.520) = 10.89\text{ in.}^2$$

$$ABECD = 11.8 - (3)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)(0.520) + (2)\frac{(1.5)^2}{(4)(3)}(0.520)$$

$$= 10.63\text{ in.}^2 \leftarrow$$

Effective area

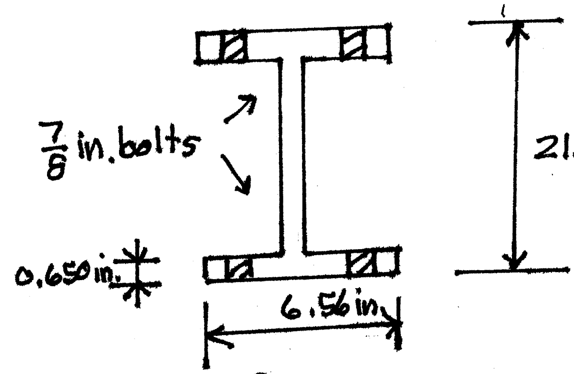
$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{0.778}{9} = 0.914$$

$$A_e = U A_n = (0.914)(10.63)$$

$$= \boxed{9.72\text{ in.}^2}$$

✓ JCM[c]

PROB # 3-23



Using a W21X57 ($A_g = 16.7 \text{ in.}^2$, $\bar{y} = 2.85$ in.)

$A_{net} = 16.7 - (4)(\frac{7}{8} + \frac{1}{8})(0.650) = 14.1 \text{ in.}^2$

$\bar{y} = \bar{x}$ for WT 10.5 x 28.5 = 2.85 in.

$U = 1 - \frac{2.85}{3 \times 4} = 0.762$

or

$U = \underline{0.85}$ since $b_f = 6.56 < \frac{2}{3} \times 21.1 = 14.07$ in. ←

(AISC Table D3.1 Case 7)

$A_e = U A_n = (0.85)(14.1) =$ **11.98 in.²**

✓ gcm^c

PROB #3-24

Using 1L7x4x$\frac{3}{8}$ ($A = 3.98\ in.^2$, $\bar{x} = 0.861\ in.$

Gross section yielding

$P_n = (36)(3.98) = 143.28\ k$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(143.28) = 129\ k$	$\frac{P_n}{\Omega_t} = \frac{143.28}{1.67} = 85.8\ k$

Tensile rupture strength

$A_n = 3.98 - (1)(\frac{3}{4} + \frac{1}{8})(\frac{3}{8}) = 3.65\ in.^2$

$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{0.861}{8} = 0.892 \leftarrow$

or 0.6 Case 8 AISC Table D3.1

$A_e = (0.892)(3.65) = 3.26\ in.^2$

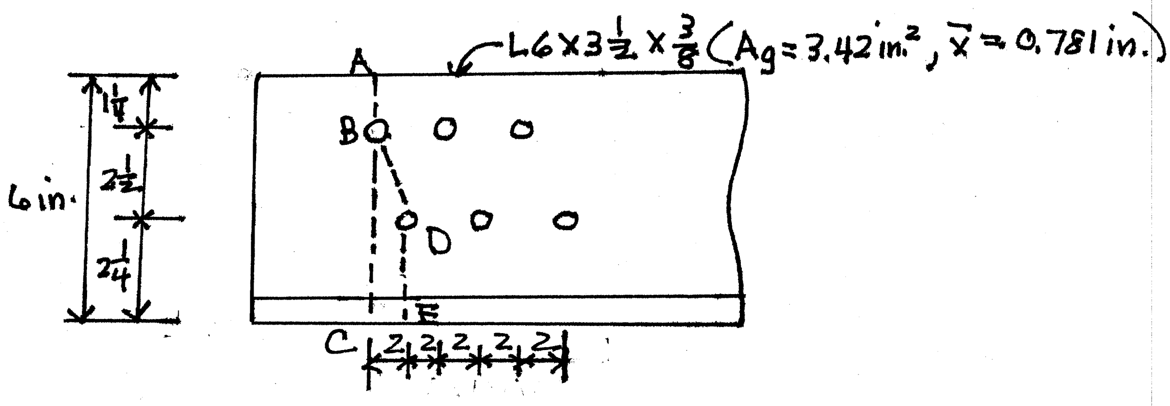
$P_n = (58)(3.26) = 189.1\ k$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(189.1) = 141.8\ k$	$\frac{P_n}{\Omega_t} = \frac{189.1}{2.00} = 94.5\ k$

ANSWRS LRFD 129 k ASD 85.8 k

✓ JCMc

PROB # 3-25



Net areas

$$ABC = 3.42 - (1)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)\left(\tfrac{3}{8}\right) = 3.09 \text{ in.}^2$$

$$ABDE = 3.42 - (2)\left(\tfrac{3}{4}+\tfrac{1}{8}\right)\left(\tfrac{3}{8}\right) + \frac{(2)^2}{(4)(2.5)}\left(\tfrac{3}{8}\right) = 2.914 \text{ in.}^2 \leftarrow$$

Effective area

$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{0.781}{(2)(4)} = 0.90 \leftarrow$$

or $U = 0.60$ (Case 8 AISC Table D3.1)

$$A_e = U A_n = (0.90)(2.914) = 2.62 \text{ in.}^2$$

Gross section yielding

$$P_n = F_y A_g = (36)(3.42) = 123.1 \text{ k}$$

LRFD $\phi_t = 0.90$	ASD with $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(123.1) = 110.8 \text{ k}$	$P_n/\Omega_t = \frac{123.1}{1.67} = 73.7 \text{ k}$ ←

Tensile rupture strength

$$P_n = F_u A_e = (58)(2.62) = 152.0 \text{ k}$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(152) = 114 \text{ k}$	$P_n/\Omega_t = 152/2.00 = 76 \text{ k}$

ANS **LRFD = 110.8 k** **ASD = 73.7 k**

✓ JCMc

PROB# 3-26

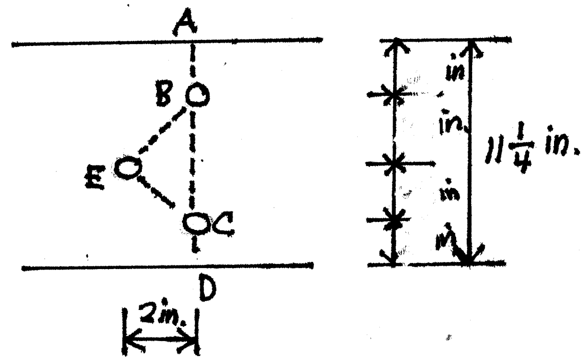
Using 2 Ls 6X6X $\frac{3}{4}$ (A_g = 8.46 in.^{2} each)

Gross section yielding

$$P_n = F_y A_g = (36)(8.46)(2) = 609.1$$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(609.1) = 548.2k$	$\frac{P_n}{\Omega_t} = \frac{609.1}{1.67} = 364.7k$

Net widths



$$ABCD = 11.25 - (2)\left(\frac{7}{8}+\frac{1}{8}\right) = 9.25 \text{ in.}$$

$$ABECD = 11.25 - (3)\left(\frac{7}{8}+\frac{1}{8}\right) + \frac{(2)^2}{(4)(2.5)} + \frac{2^2}{(4)(5)} = 8.85 \text{ in.}$$

$$A_{net} = (8.85)\left(\frac{3}{4}\right) = 6.64 \text{ in.}^2$$

Effective area

$U = 1.0$ since both angle legs connected

$$A_e = UA_n = (1.0)(6.64)(2) = 13.28 \text{ in.}^2$$

Tensile rupture strength

$$P_n = F_u A_e = (58)(13.28) = 770.2k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(770.2) = 577.6k$	$\frac{P_n}{\Omega_t} = \frac{770.2}{2.00} = 385.1k$

Ans → **LRFD = 548.2 k** **ASD = 364.7k**

PROB # 3-27

Using a W12X53 ($A_g = 15.6 \text{ in.}^2$, $d = 12.1$ in., $b_f = 10.00$ in., $t_f = 0.575$ in.)

Nominal or available tensile strength of member

$$P_n = F_y A_g = (50)(15.6) = 780\,k$$

(a) Gross section yielding

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(780) = 702\,k$	$\frac{P_n}{\Omega_t} = \frac{780}{1.67} = 467.1\,k$

(b) Tensile rupture strength

$$A_n = 15.6 - (4)\left(\frac{7}{8}+\frac{1}{8}\right)(0.575) = 13.3 \text{ in.}^2$$

$\bar{x} = 1.02$ for one half of a W12X53 (WT6X26.5)

$$U = 1 - \frac{1.02}{6} = 0.83$$

$b_f = 10.00 \text{ in} > \left(\frac{2}{3}\right)(12.1) = 8.07$ in.

$\therefore U = 0.90$ Case 7 AISC Table D3.1

$$A_e = U A_n = (0.90)(13.3) = 11.97 \text{ in.}^2$$

$$P_n = F_u A_e = (65)(11.97) = 778\,k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(778) = 583.5\,k$	$\frac{P_n}{\Omega_t} = \frac{778}{2.00} = 389\,k$

Ans. LRFD = **583.5 k** ASD = **389 k**

✓ JCMc

PROB # 3-28

Using a W18x119 ($A_g = 35.1$ in.^{2}, $b_f = 11.3$ in., $t_f = 1.06$ in., $d = 19.00$ in.)

Nominal or available tensile strength of member

$$P_n = F_y A_g = (50)(35.1) = 1755\ k$$

(a) Gross section yielding

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(1755) = 1579.5\ k$	$\frac{P_n}{\Omega_t} = \frac{1755}{1.67} = 1050.9\ k$

(b) Tensile rupture strength

$$A_n = 35.1 - (4)(1 + \tfrac{1}{8})(1.06) = 30.33\ \text{in.}^2$$

$\bar{y} = 2.03$ for one half of a W18x119 (WT 9x59.5) $= \bar{X}$

$$U = 1 - \frac{\bar{X}}{L} = 1 - \frac{2.03}{9.00} = 0.774$$

$$b_f = 11.3 < \left(\tfrac{2}{3}\right)(19.00) = 12.67\ \text{in.}$$

$\therefore U = 0.85$ Case 7 AISC Table D3.1

$$A_e = U A_n = (0.85)(30.33) = 25.78\ \text{in.}^2$$

$$P_n = F_u A_e = (65)(25.78) = 1675.7\ k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(1675.7) = 1257\ k$	$\frac{P_n}{\Omega_t} = \frac{1675.7}{2.00} = 837.8\ k$

Ans. LRFD = **1257 k** ASD = **837.8 k**

rgcMc

PROB #3-29

using a W18×119 (A_g = 35.1 in.^{2}, b_f = 11.3 in., t_f = 1.06 in., d = 19.00 in.)

Nominal available tensile strength of member

$$P_n = F_y A_g = (50)(35.1) = 1755 k$$

(a) Gross section yielding

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(1755) = 1579.5 k$	$\frac{P_n}{\Omega_t} = \frac{1755}{1.67} = 1050.9 k$

(b) Tensile rupture strength

$$A_n = 35.1 - (4)(1.06)(\tfrac{3}{4}+\tfrac{1}{8}) = 31.39 \text{ in.}^2$$

$\bar{y} = \bar{x} = 2.03$ in. for one half of a W18×119 (WT 9×59.5)

$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{2.03}{9} = 0.774$$

$$b_f = 11.3 < (\tfrac{2}{3})(19.00) = 12.67 \text{ in.}$$

$\therefore U = 0.85$ Case 7 AISC Table D3.1

$$A_e = U A_n = (0.85)(31.39) = 26.68 \text{ in.}^2$$

$$P_n = F_u A_e = (70)(26.68) = 1867.6 k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(1867.6) = 1400.7 k$	$\frac{P_n}{\Omega_t} = \frac{1867.6}{2.00} = 933.8 k$

Ans. LRFD = **1400.7 k** ASD = **933.8 k**

JCMc

PROB # 3-30

Using a W14X61 (A_g = 17.9 in.^{2}, d = 13.9 in., b_f = 10.0 in., t_f = 0.645 in.)

Nominal or available tensile strength of member

$$P_n = F_y A_g = (50)(17.9) = 895k$$

(a) Gross section yielding

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(895) = 805.5k$	$\frac{P_n}{\Omega_t} = \frac{895}{1.67} = 535.9k$

(b) Tensile rupture strength

$A_n = 17.9 - (4)(\frac{3}{4} + \frac{1}{8})(0.645) = 15.64 in.^2$

$\bar{x} = \bar{y} = 1.25$ in. for half of a W14X61 (WT 7X30.5)

$U = 1 - \frac{1.25}{8} = 0.843$

$b_f = 10.00 > (\frac{2}{3})(13.9) = 9.27$ in.

$\therefore U = 0.90$ Case 7 AISC Table D3.1

$A_e = U A_n = (0.90)(15.64) = 14.08 in.^2$

$P_n = F_u A_e = (65)(14.08) = 915.2k$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(915.2) = 686.4k$	$\frac{P_n}{\Omega_t} = \frac{915.2}{2.00} = 457.6k$

Ans. LRFD = **686.4k** ASD = **457.6k**

✓ JCMc

PROB # 3-31

using a C12X30 ($A_g = 8.81 \text{ in}^2$, $d = 12.0$ in., $t_w = 0.510$ in., $\bar{x} = 0.674$ in.)

Nominal or available tensile strength of member

(a) Gross section yielding

$$P_n = F_y A_g = (50)(8.81) = 440.5k$$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(440.5) = 396.4k$	$\frac{P_n}{\Omega_t} = \frac{440.5}{1.67} = 263.8k$

(b) Tensile rupture strength

$$A_n = 8.81 - (3)\left(\frac{7}{8} + \frac{1}{8}\right)(0.510) = 7.28 \text{ in.}$$

$$\bar{x} = \bar{y} = 0.674 \text{ in.}$$

$$L = (3)(3) = 9 \text{ in.}$$

$$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{0.674}{9} = 0.925$$

$$A_e = U A_n = (0.925)(7.28) = 6.734 \text{ in.}^2$$

$$P_n = F_u A_e = (65)(6.734) = 437.7k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(437.7) = 328.3k$	$\frac{P_n}{\Omega_t} = \frac{437.7}{2.00} = 218.8k$

Ans. LRFD **328.3k** ASD = **218.8k**

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PROB# 3-32

Using a WT15x74 with transverse welds to its flange only ($A_g = 21.7\ in.^2$, $t_f = 1.18$ in., $\bar{y} = 3.84$ in.)

Nominal or available tensile strength of member

(a) Gross section yielding

$$P_n = F_y A_g = (50)(21.7) = 1085\,k$$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(1085) = 976.5\,k$	$\frac{P_n}{\Omega_t} = \frac{1085}{1.67} = 649.7\,k$

(b) Tensile rupture strength

$$A_n = \text{area of flange} = b_f t_f = (10.5)(1.18) = 12.39\ in.^2$$

$$U = 1.0$$

$$A_e = U A_n = (1.0)(12.39) = 12.39\ in.^2$$

$$P_n = F_u A_e = (65)(12.39) = 805.3\,k$$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(805.3) = 604\,k$	$\frac{P_n}{\Omega_t} = \frac{805.3}{2.00} = 402.6\,k$

Ans. **LRFD = 604 k** **ASD = 402.6 k**

✓ JCMc

PROB # 3-33

Using two MCs 18X42.7 (A_g = 12.6 in.^{2} each, d = 18.0 in., t_w = 0.450 in.

(a) Gross section yielding

$P_n = F_y A_g = (36)(12.6)(2) = 907.2k$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(907.2) = 816.5k$	$\frac{P_n}{\Omega_t} = \frac{907.2}{1.67} = 543.2k$

(b) Tensile rupture strength

A_n = web area $= (2)(18.0)(0.450) = 16.2$ in.^{2}

$U = 1.0$

$A_e = UA_n = (1.0)(16.2) = 16.2$ in.^{2}

$P_n = F_u A_e = (58)(16.2) = 939.6k$

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(939.6) = 704.7k$	$\frac{P_n}{\Omega_t} = \frac{939.6}{2.00} = 469.8k$ ←

Answers LRFD 704.7k ASD = 469.8k

RJCMc

PROB # 3-34

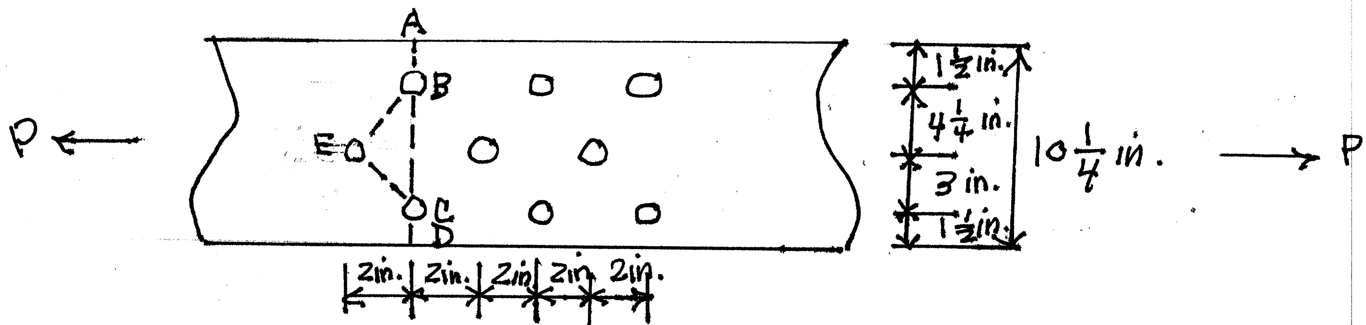
Using one L 7x4x$\frac{3}{4}$ ($A_g = 7.69 \text{ in.}^2$)

(a) Gross section yielding

$$P_n = F_y A_g = (36)(7.69) = 276.8 \text{ k}$$

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(276.8) = 249.1 \text{ k}$	$\frac{P_n}{\Omega_t} = \frac{276.8}{1.67} = 165.7 \text{ k}$ ←

(b) Tensile rupture strength



Net widths

$$ABCD = 10.25 - (2)\left(\frac{7}{8}+\frac{1}{8}\right) = 8.25 \text{ in.}^2$$

$$ABECD = 10.25 - (3)\left(\frac{7}{8}+\frac{1}{8}\right) + \frac{(2)^2}{4 \times 3} + \frac{(2)^2}{4 \times 4.25}$$

$$= 7.818 \text{ in.} \leftarrow$$

$$A_n = (7.818)\left(\frac{3}{4}\right) = 5.86 \text{ in.}^2$$

$$U = 1.0$$

$$A_e = U A_n = (1.0)(5.86) = 5.86 \text{ in.}^2$$

$$P_n = (58)(5.86) = 339.9 \text{ k}$$

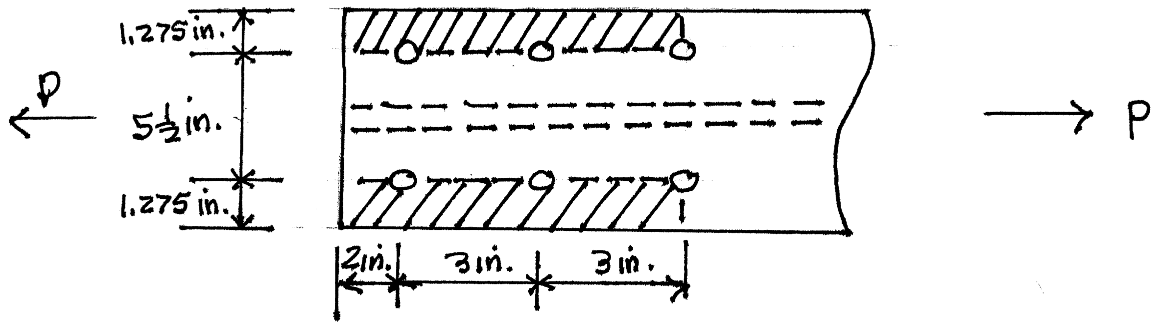
LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(339.9) = 254.9 \text{ k}$	$\frac{P_n}{\Omega_t} = \frac{339.9}{2.00} = 169.9 \text{ k}$

Answers **LRFD = 249.1 k** **ASD = 165.7 k**

✓ JCM[c]

PROB #3-35

7/8 Bolts



Using a W12 X 45 ($t_f = 0.575$ in., $b_f = 8.05$ in.)

$A_{gv} = (4)(8)(0.575) = 18.4 \text{ in.}^2$

$A_{nv} = (4)\left[8 - (2.5)\left(\frac{7}{8} + \frac{1}{8}\right)\right](0.575) = 12.65 \text{ in.}^2$

$A_{nt} = (4)\left[1.275 - \left(\frac{1}{2}\right)\left(\frac{7}{8} + \frac{1}{8}\right)\right](0.575) = 1.78 \text{ in.}^2$

$U_{bs} = 1.0$

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

$= (0.6)(70)(12.65) + (1.0)(70)(1.78) = 655.9 \text{ k}$

$< (0.6)(50)(18.4) + (1.0)(70)(1.78) = 676.6 \text{ k}$

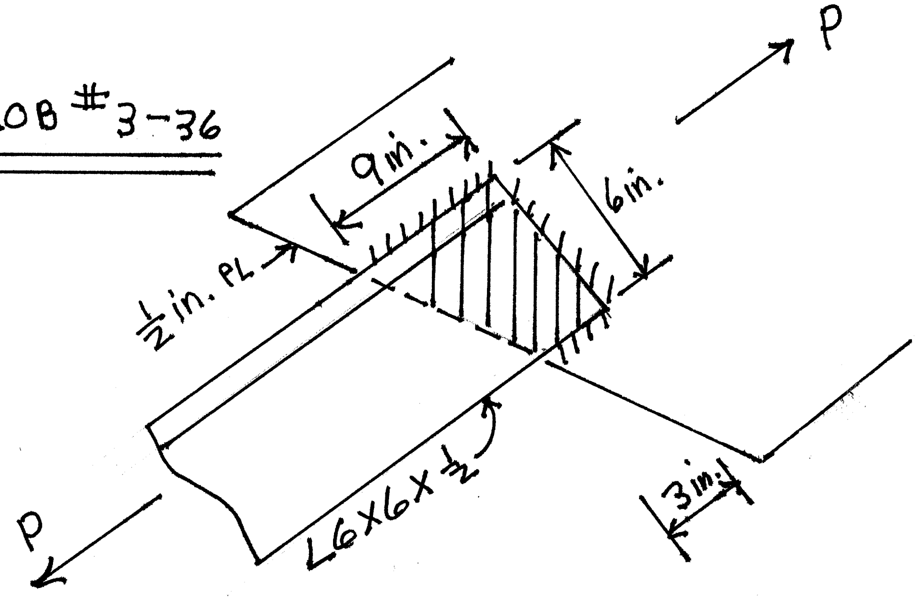
$\therefore R_n = 655.9 \text{ k}$

LRFD $\phi = 0.75$	ASD $\Omega = 2.00$
$\phi R_n = (0.75)(655.9) = 491.9 \text{ k}$	$\frac{R_n}{\Omega} = \frac{655.9}{2.00} = 327.9 \text{ k}$

ANSWRS. **LRFD = 491.9 k** **ASD = 327.9 k**

VJCMc

PROB #3-36



using one L6X6X$\frac{1}{2}$

$A_{gv} = (\frac{1}{2})(9+3) = 6.0 \text{ in.}^2$

$A_{nv} = (\frac{1}{2})(9+3) = 6.0 \text{ in.}^2$

$A_{nt} = (\frac{1}{2})(6) = 3.0 \text{ in.}^2$

$U_{bs} = 1.0$

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

$= (0.6)(65)(6.0) + (1.0)(65)(3.0) = 429 k$

$> (0.6)(50)(6.0) + (1.0)(65)(3.0) = 375 k \leftarrow$

$\therefore R_n = 375 k$

LRFD $\phi = 0.75$	ASD $\Omega = 2.00$
$\phi R_n = (0.75)(375) = 281.2 k$	$\frac{R_n}{\Omega} = \frac{375}{2.00} = 187.5 k$

ANSWRS. **LRFD = 281.2 k** **ASD = 187.5 k**

JCMc

PROB #3-37

Using a W16X31 ($A_g = 9.13$ in.^{2}, $d = 15.9$ in., $b_f = 5.53$ in., $t_f = 0.440$ in., $t_w = 0.275$ in., $\bar{x} = \bar{y}$ for WT 8X15.5 = 2.02 in.)

(a) Gross section yielding

$P_n = F_y A_g = (50)(9.13) = 456.5$ k

LRFD $\phi_t = 0.90$	ASD $\Omega_t = 1.67$
$\phi_t P_n = (0.90)(456.5) = 410.8$ k	$\frac{P_n}{\Omega_t} = \frac{456.5}{1.67} = 273.4$ k

(b) Tensile rupture strength

$A_n = 9.13 - (4)(\frac{7}{8} + \frac{1}{8})(0.440) = 7.37$ in.^{2}

$\bar{x} = \bar{y} = 2.02$ in. from table for WT 8X15.5

$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{2.02}{6} = 0.663$

But $b_f = 5.53$ in. $< (\frac{2}{3})(15.9) = 10.6$ in.

$\therefore U = 0.85$

$A_e = U A_n = (0.85)(7.37) = 6.26$ in.^{2}

$P_n = F_u A_e = (65)(6.26) = 406.9$ k

LRFD $\phi_t = 0.75$	ASD $\Omega_t = 2.00$
$\phi_t P_n = (0.75)(406.9) = 305.2$ k	$\frac{P_n}{\Omega_t} = \frac{406.9}{2.00} = 203.4$ k ←

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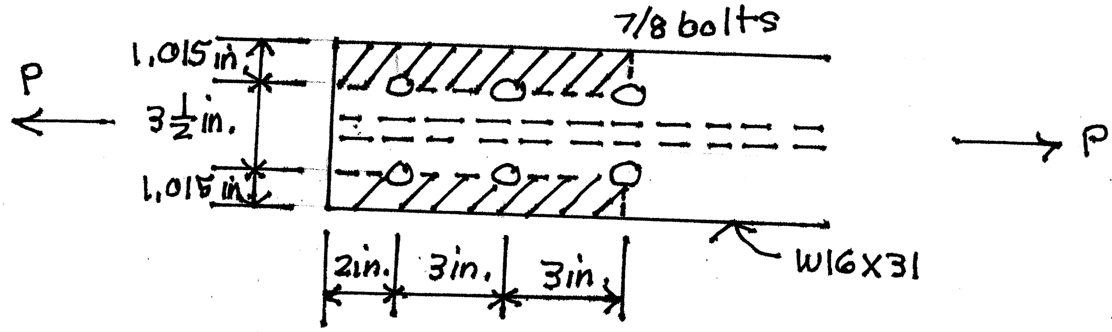
PROB # 3-37 CONTD.



$A_{gv} = (4)(8)(0.440) = 14.08 \text{ in.}^2$

$A_{nv} = (4)\left[8 - (2.5)\left(\frac{7}{8} + \frac{1}{8}\right)\right](0.440) = 9.68 \text{ in.}^2$

$A_{nt} = (4)\left[1.015 - \left(\frac{1}{2}\right)\left(\frac{7}{8} + \frac{1}{8}\right)\right](0.440) = 0.91 \text{ in.}$

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

$= (0.6)(65)(9.68) + (1.0)(65)(0.91) = 436.7k$

$< (0.6)(50)(14.08) + (1.0)(65)(0.91) = 481.5k$

$\therefore R_n = 436.7k$

LRFD $\phi = 0.75$	ASD $\Omega = 2.00$
$\phi R_n = (0.75)(436.7) = 327.5k$	$\frac{R_n}{\Omega} = \frac{436.7}{2.00} = 218.3k$

ANSWRS. **LRFD = 305.2k** **ASD = 203.4k**

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