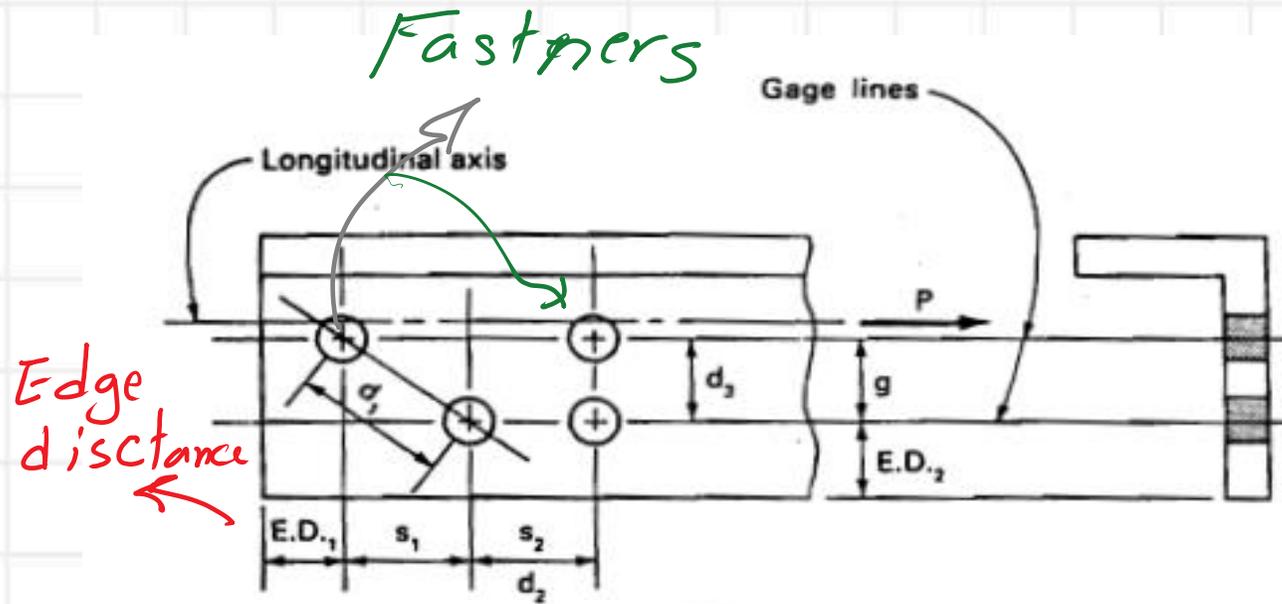


Solved problem 3.4.2 SALMON.

Net Area For an angle bolted in different gauge lines.
Unequal.

Solved problem 3.50 McCormac

Net area For C Channel bolted in different gauge lines.



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

S in the direction of Loading
g \perp er to the Loading direction

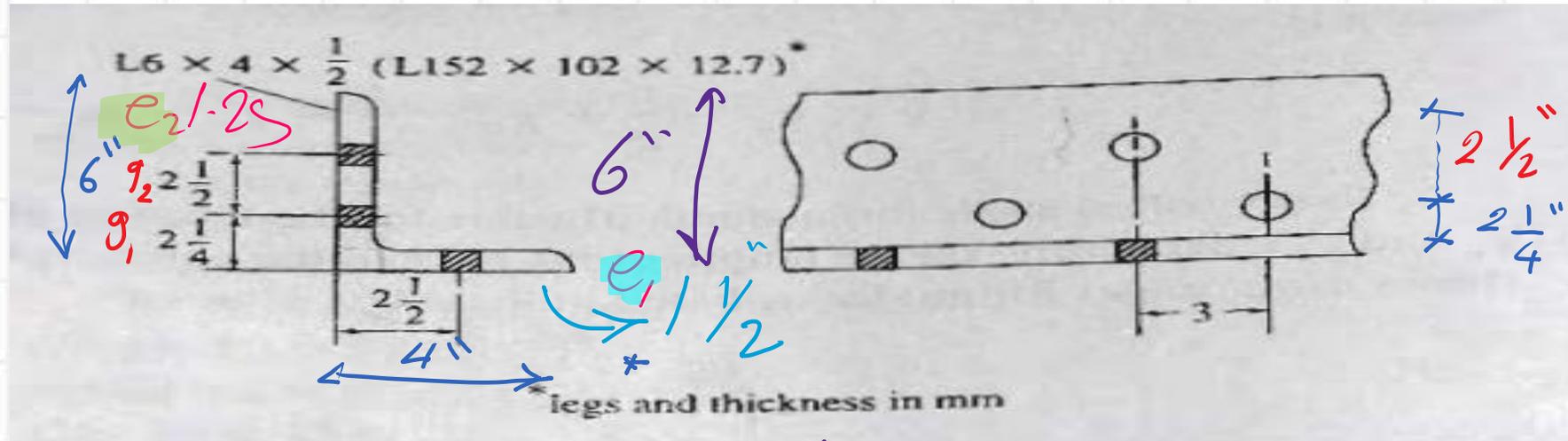
Gauge Line - 1
 Gauge Line - 2

\downarrow *g*

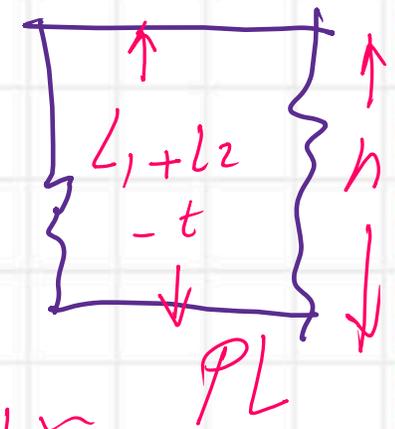
Figure 2-3 shows a tension member composed of a single steel angle with a 4-bolt connection. The tensile load P is assumed to be applied parallel to and coincident with the longitudinal axis of the member. The bolt holes are located on *gage lines* that are also parallel to the longitudinal axis. The 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.

3-4-2

Determine the net area For the shown angle
 Where $15/16$ dia holes are used.



(SALmon)



Solution For staggered route

$$A_{nt} = A_g - \sum A_h + \frac{s^2}{4g} t$$

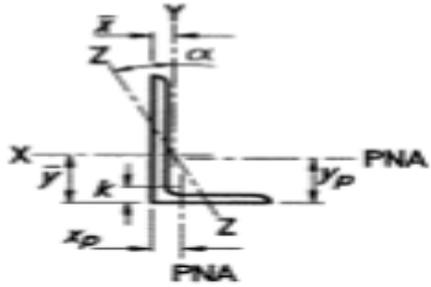
$L 6 \times 4 \times \frac{1}{2}$

$L_1 = 6$, $t = \frac{1}{2}$ g distance = $6 + 4 - \frac{1}{2} = 9.50$

$L_2 = 4$ $e_1 = 4 - 2.5 = 1.50$

$e_2 = 1.25$

Prepared by Eng. Maged Kamel.



**Table 1-7 (continued)
Angles
Properties**

$L 6 \times 4 \times \frac{1}{2}$

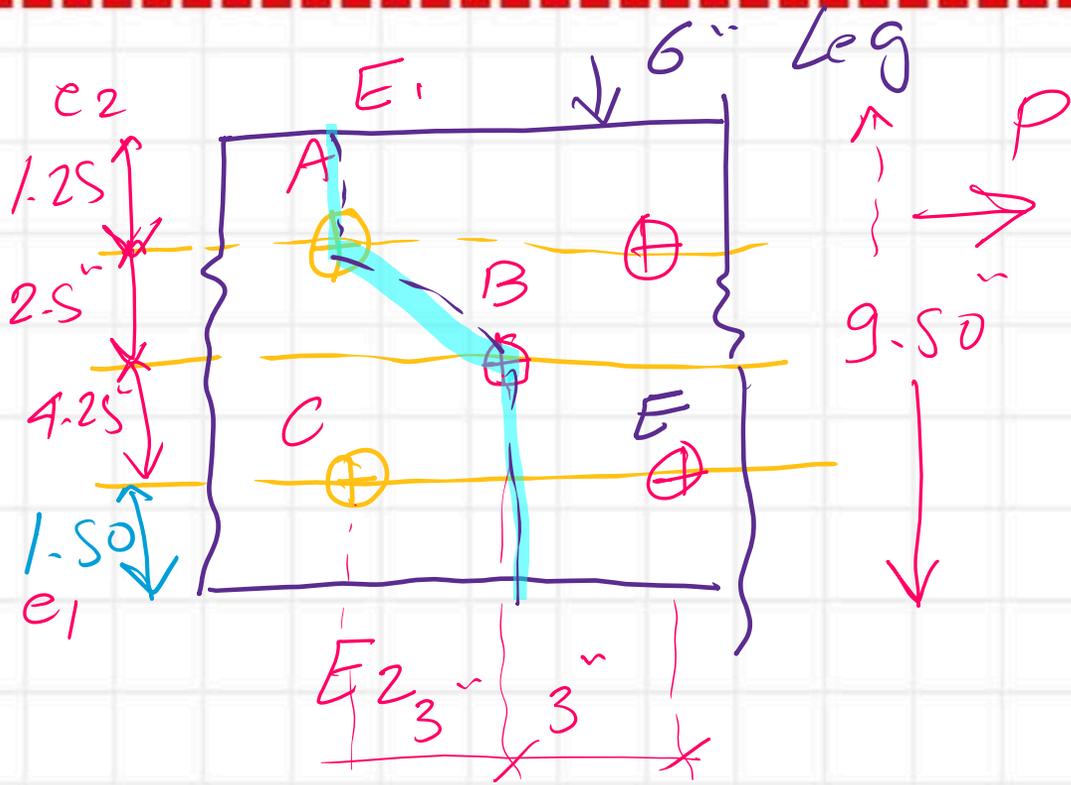
Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties		
				I	S	r	\bar{y}	Z	y_p	J	C_w	\bar{T}_o
				in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ⁶	in.
L6×4× $\frac{7}{8}$	1 $\frac{3}{8}$	27.2	8.00	27.7	7.13	1.86	2.12	12.7	1.43	2.03	4.04	2.82
× $\frac{3}{4}$	1 $\frac{1}{4}$	23.6	6.94	24.5	6.23	1.88	2.07	11.1	1.37	1.31	2.64	2.85
× $\frac{5}{8}$	1 $\frac{1}{8}$	20.0	5.86	21.0	5.29	1.89	2.03	9.44	1.31	0.775	1.59	2.88
× $\frac{9}{16}$	1 $\frac{1}{16}$	18.1	5.31	19.2	4.81	1.90	2.00	8.59	1.28	0.572	1.18	2.90
× $\frac{1}{2}$	1	16.2	4.75	17.3	4.31	1.91	1.98	7.71	1.25	0.407	0.843	2.91
× $\frac{7}{16}$	1 $\frac{5}{16}$	14.3	4.18	15.4	3.81	1.92	1.95	6.81	1.22	0.276	0.575	2.93
× $\frac{3}{8}$	1 $\frac{7}{8}$	12.3	3.61	13.4	3.30	1.93	1.93	5.89	1.19	0.177	0.369	2.94
× $\frac{5}{16}$	1 $\frac{3}{16}$	10.3	3.03	11.4	2.77	1.94	1.90	4.96	1.15	0.104	0.217	2.96

**Table 1-7 (continued)
Angles
Properties**



Find A_g
= 4.75 in²

Shape	Axis Y-Y						Axis Z-Z				Q_s $F_y = 36$ ksi
	I	S	r	\bar{x}	Z	x_p	I	S	r	Tan α	
	in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ³	in.		
L6×4× $\frac{7}{8}$	9.70	3.37	1.10	1.12	6.26	0.667	5.82	2.91	0.854	0.421	1.00
× $\frac{3}{4}$	8.63	2.95	1.12	1.07	5.42	0.578	5.08	2.51	0.856	0.428	1.00
× $\frac{5}{8}$	7.48	2.52	1.13	1.03	4.56	0.488	4.32	2.12	0.859	0.435	1.00
× $\frac{9}{16}$	6.86	2.29	1.14	1.00	4.13	0.443	3.93	1.92	0.861	0.438	1.00
× $\frac{1}{2}$	6.22	2.06	1.14	0.981	3.69	0.396	3.54	1.72	0.864	0.440	1.00
× $\frac{7}{16}$	5.56	1.83	1.15	0.957	3.24	0.348	3.14	1.51	0.867	0.443	0.973
× $\frac{3}{8}$	4.86	1.58	1.16	0.933	2.79	0.301	2.73	1.31	0.870	0.446	0.912
× $\frac{5}{16}$	4.13	1.34	1.17	0.908	2.33	0.253	2.31	1.10	0.874	0.449	0.826



Path E1 - A - C - E2

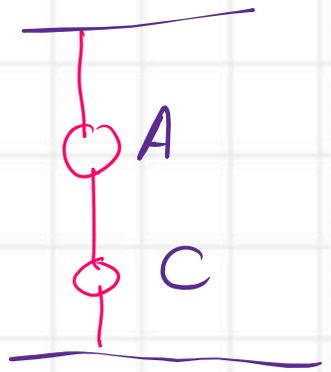
$$d_b = \frac{15}{16} + \frac{1}{16} = 1''$$

$$t_L = \frac{1}{2}''$$

$$A_g = 4.75 \text{ inch}^2 \text{ from Table}$$

$$A_h = n d_h \cdot t = 2(1)\left(\frac{1}{2}\right) = 1 \text{ inch}^2$$

$$A_n = A_g - A_h = 4.75 - 1 = 3.75 \text{ inch}^2$$



Check Path E1 - A - B - E2

$$s = 3''$$

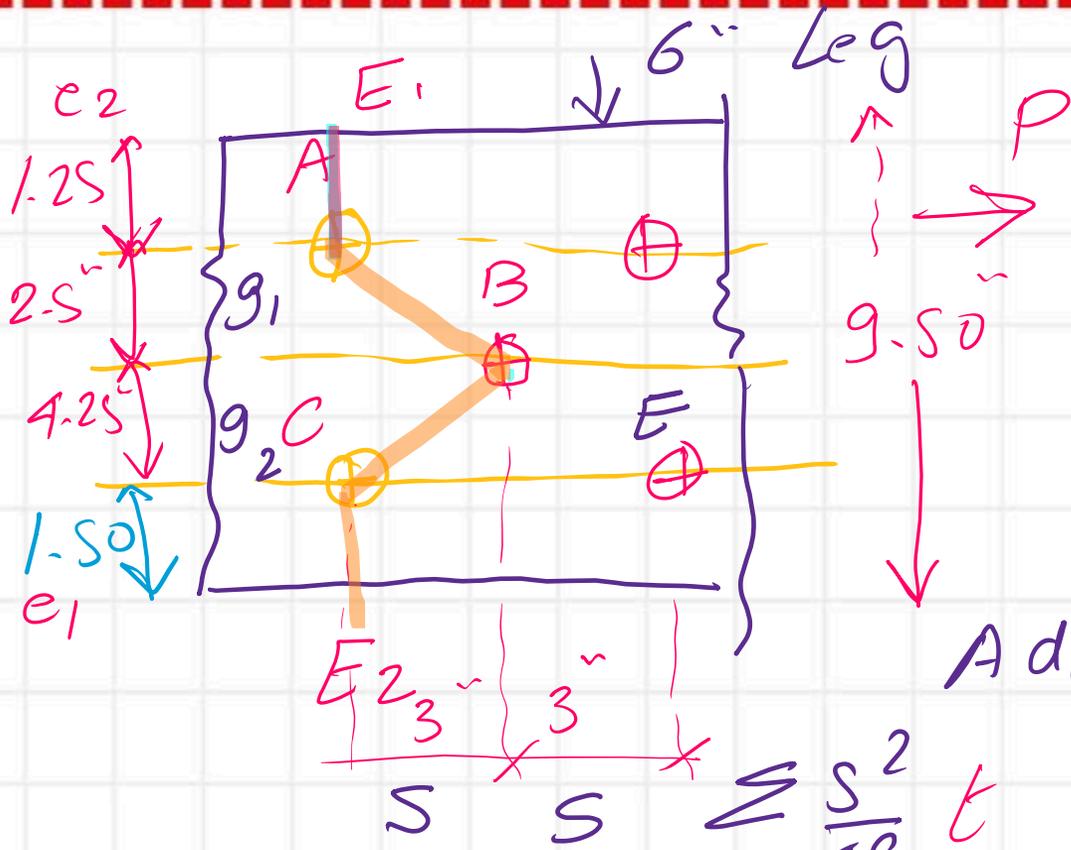
$$g = 2.5''$$

Two holes

$$A_h = 2(1)\left(\frac{1}{2}\right) = 1 \text{ inch}^2$$

$$\text{Add } \frac{s^2 t}{4g} = \frac{(3)^2}{4(2.5)} \frac{1}{2} = \frac{9}{20} \Rightarrow$$

$$A_n = 4.75 - 1.00 + \frac{9}{20} = 4.20 \text{ inch}^2$$



Path E1 - A - B - C - E2
 same \rightarrow E1 A B E E2

$A_g = 4.75 \text{ inch}^2$ from Table

$$A_h = n d_h \cdot t = 3(1)\left(\frac{1}{2}\right) = 1.5 \text{ inch}^2$$

$$\text{Add } \frac{s^2}{4g_1} t + \frac{s^2}{4g_2} t = \frac{3^2}{4(2.5)} \frac{1}{2} + \frac{3^2}{4(4.25)} \left(\frac{1}{2}\right)$$

$$\begin{aligned} & \frac{s^2}{4g} t \\ &= \frac{9}{20} + \frac{9}{34} = +0.715 \text{ inch}^2 \end{aligned}$$

$$A_n = A_g - A_h + \sum \frac{s^2}{4g} t = 4.75 - 1.5 + 0.715 = 3.96 \text{ inch}^2$$

$$\text{Final } A_n = \min(3.75, 4.2, 3.96) = 3.75 \text{ inch}^2 \rightarrow \underline{E1 A B E2}$$

Example 3-5

Determine the net area along route *ABCDEF* for the C15 × 33.9 ($A_g = 10.00 \text{ in}^2$) shown in Fig. 3.8. Holes are for $\frac{3}{4}$ -in bolts.

McCormac.

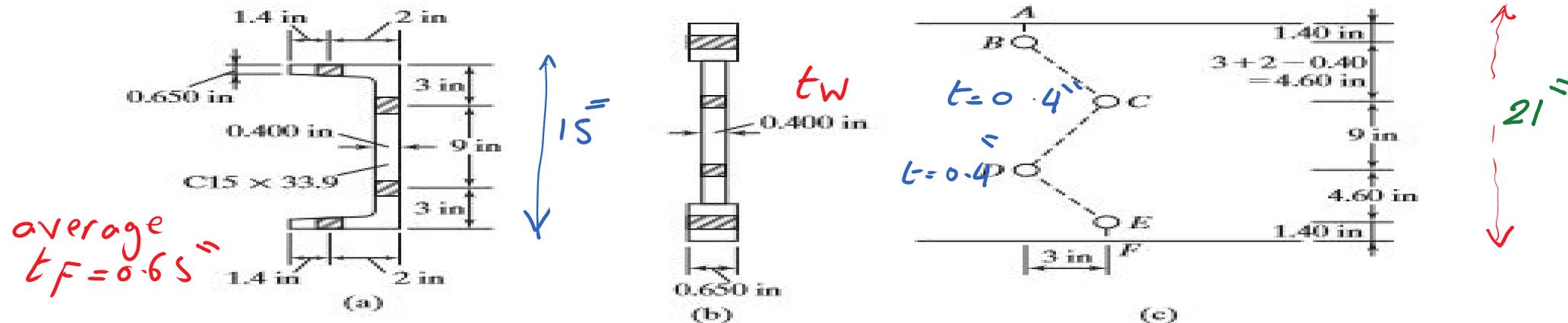


FIGURE 3.8

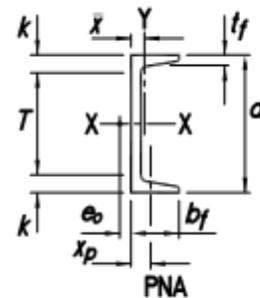
$B_F = 3.4''$

Solution $A_g = 10.00 \text{ inch}^2$ From table

Sum of External Lengths
 $= 3.40(2) + 15 = 21.80''$

Deduct $2t_w = 0.80''$

Route ABCD

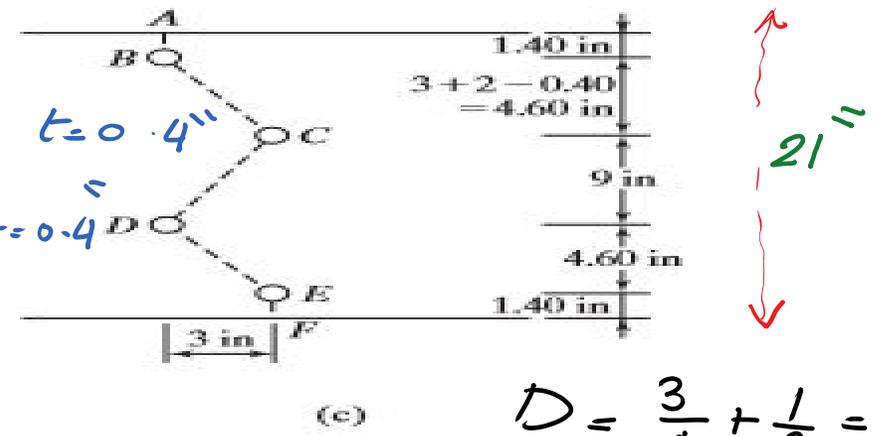
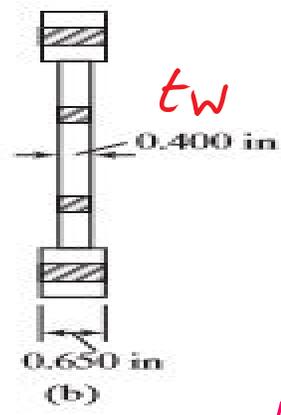
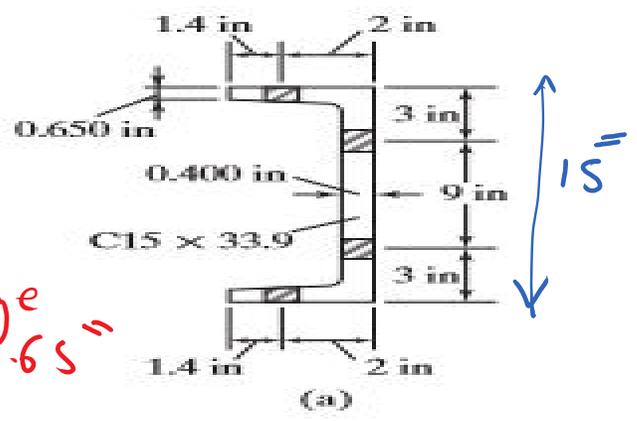


**Table 1-5
C-Shapes
Dimensions**

Shape	Area, A in. ²	Depth, d in.	Web		Flange		Distance			r_{ts} in.	h_o in.				
			Thickness, t_w in.	$\frac{t_w}{2}$ in.	Width, b_f in.	Average Thickness, t_f in.	k in.	T in.	Workable Gage in.						
												in.	in.	in.	in.
C15×50	14.7	15.0	15	0.716	$\frac{11}{16}$	$\frac{3}{8}$	3.72	$3\frac{3}{4}$	0.650	$\frac{5}{8}$	$1\frac{7}{16}$	$12\frac{1}{8}$	$2\frac{1}{4}$	1.17	14.4
×40	11.8	15.0	15	0.520	$\frac{1}{2}$	$\frac{1}{4}$	3.52	$3\frac{1}{2}$	0.650	$\frac{5}{8}$	$1\frac{7}{16}$	$12\frac{1}{8}$	2	1.15	14.4
×33.9	10.0	15.0	15	0.400	$\frac{3}{8}$	$\frac{3}{16}$	3.40	$3\frac{3}{8}$	0.650	$\frac{5}{8}$	$1\frac{7}{16}$	$12\frac{1}{8}$	2	1.13	14.4

Example 3-5

Determine the net area along route *ABCDEF* for the C15 × 33.9 ($A_g = 10.00 \text{ in}^2$) shown in Fig. 3.8. Holes are for $\frac{3}{4}$ -in bolts.



average $t_f = 0.65 \text{ in}$

FIGURE 3.8

$B_F = 3.4 \text{ in}$

$d_b = \frac{3 \text{ in}}{4}$

Two holes in Flange
Two holes in web

$D_h = \frac{3}{4} + \frac{1}{8} = \frac{7}{8} \text{ in}$

Solution $A_g = 10.00 \text{ inch}^2$

① deduct holes Diameters $\Sigma D \cdot t$

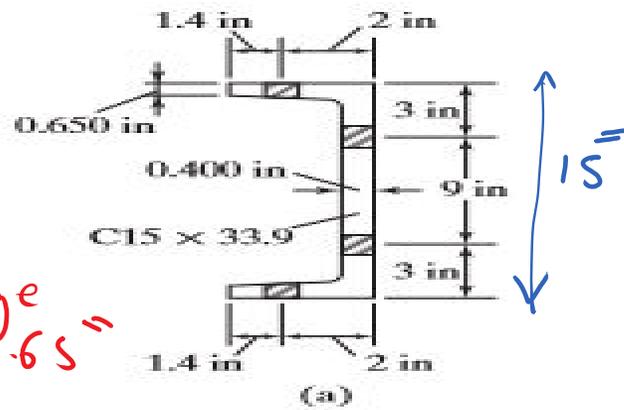
$$= 2 \left(\frac{7}{8} \right) (0.65) = 2 \left(\frac{7}{8} \right) (1.05)$$

$$2 \left(\frac{7}{8} \right) (0.40) = 1.838 \approx 1.84 \text{ inch}^2$$

Example 3-5

Determine the net area along route $ABCDEF$ for the $C15 \times 33.9$ ($A_g = 10.00 \text{ in}^2$) shown in Fig. 3.8. Holes are for $\frac{3}{4}$ -in bolts.

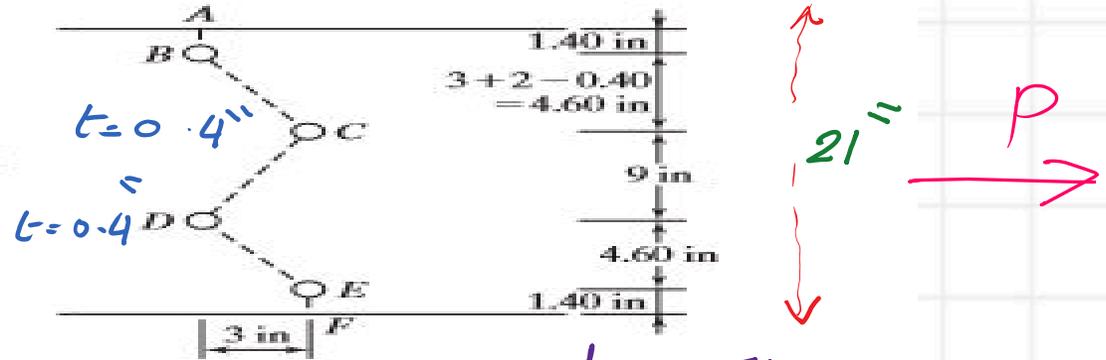
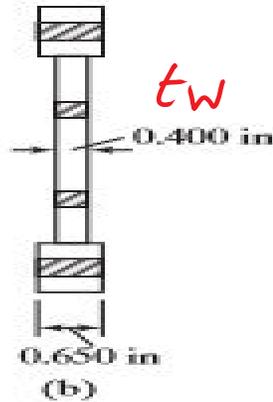
Mccormac.



average $t_f = 0.65 \text{ in}$

FIGURE 3.8

$B_F = 3.4 \text{ in}$



$S = 3 \text{ in}$ (c)

$d_h = 7/8 \text{ in}$

$g_1 = 4.60 \text{ in}$

$g_2 = 9 \text{ in}, g_3 = 4.60 \text{ in}$

$t = \frac{1}{2}(0.65 + 0.40) = \frac{1.05}{2} = 0.525 \text{ in}$

② Add $(S^2/4g)t$ For BC
 DE

data = $g = 4.60$
 $S = 3 \text{ in}$ } $N_o = 2$

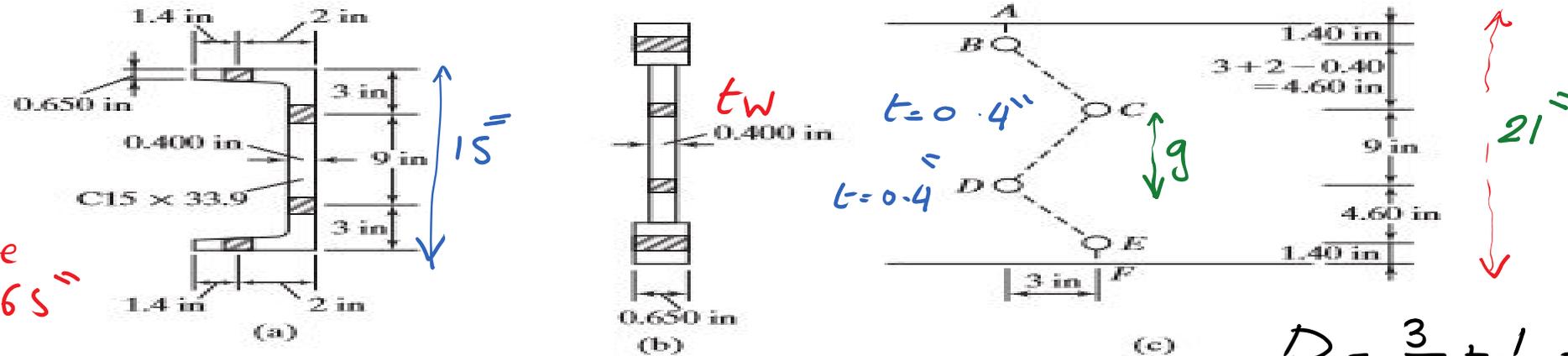
③ Add $(\frac{S^2}{4g})t$ For CD

data: $t = 0.40 \text{ in}$
 $g = 9 \text{ in}, S = 3 \text{ in}$ } $N_o = 1$

McCormac.

Example 3-5

Determine the net area along route *ABCDEF* for the C15 × 33.9 ($A_g = 10.00 \text{ in}^2$) shown in Fig. 3.8. Holes are for $\frac{3}{4}$ -in bolts.



average $t_f = 0.65 \text{ in}$

FIGURE 3.8

$B_F = 3.4 \text{ in}$

$A_g = 10.00 \text{ inch}^2$, $A_h = 1.84 \text{ inch}^2$

$D = \frac{3}{4} + \frac{1}{8} = \frac{7}{8} \text{ in}$

Solution Finally $A_{net} = A_{gross} - \sum D \cdot t + \sum \frac{s^2}{4g} t$

$A_{net} = 10 - 1.84 + [2][0.525] \left[\frac{(3)^2}{4(4.6)} \right] + 1 \left[\frac{3^2}{4(9)} \right] [0.40]$

$= 10 - 1.84 + 0.514 + 0.10 = 8.774 \text{ inch}^2$

- 3-18. Determine the effective net cross-sectional area of the C12 × 25 shown in Fig. P3-18. Holes are for 3/4 in \varnothing bolts.

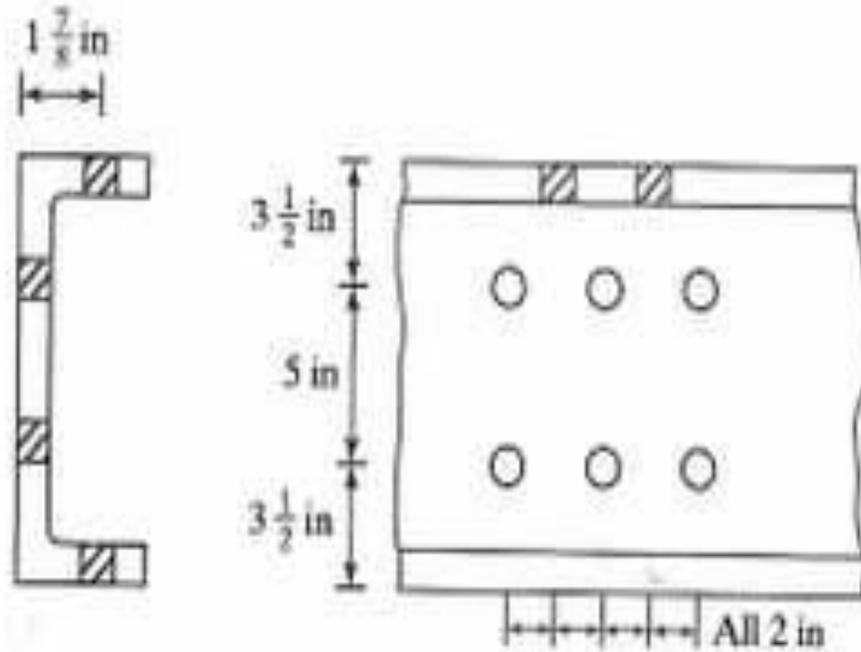


FIGURE P3-18

FIGURE P3-18

$$b_f = 3.05", t_f = 0.501", t_w = 0.387", d = 12"$$

Prepared by Eng. Maged Kamel.