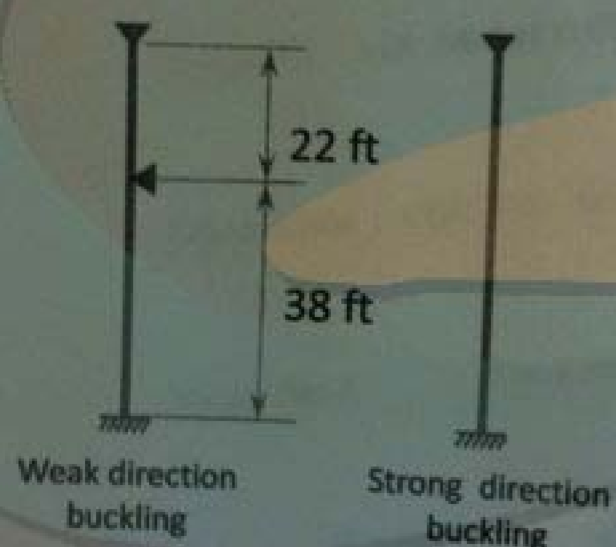
PROBLEM 3: (30 points)

A W14 x 82 is used as a column 60 ft in height to support a service load $P = D + L$ where the dead load is twice the live load. The column has full fixity at its base and is pinned at its top. A beam frames at mid-height of the column in the weak direction as shown in the figure. Use A992 steel. What is the maximum service load P that can be supported? Show all your calculations. Use LRFD.



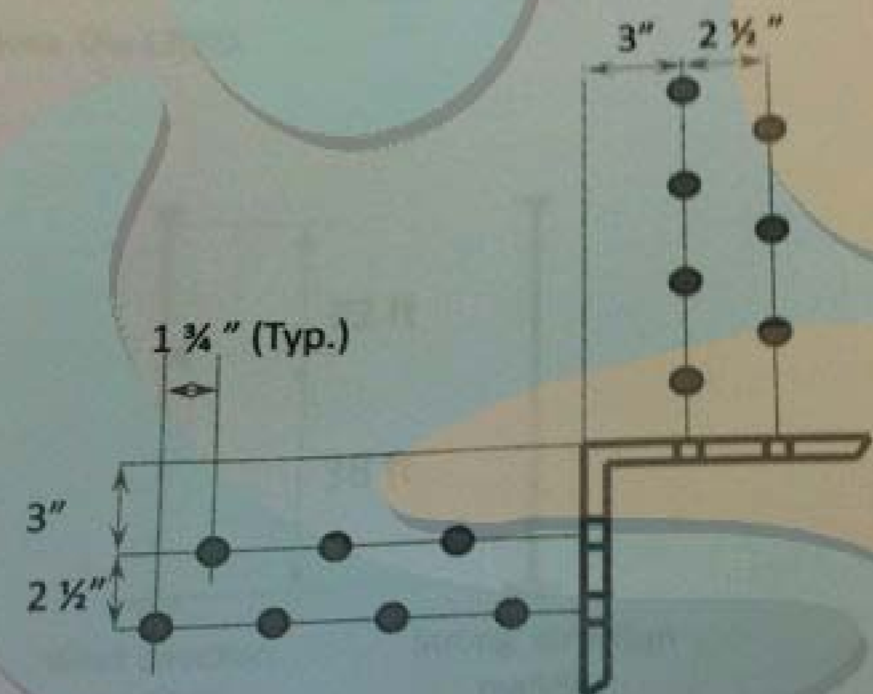
x-dir

0.8

0.8 1

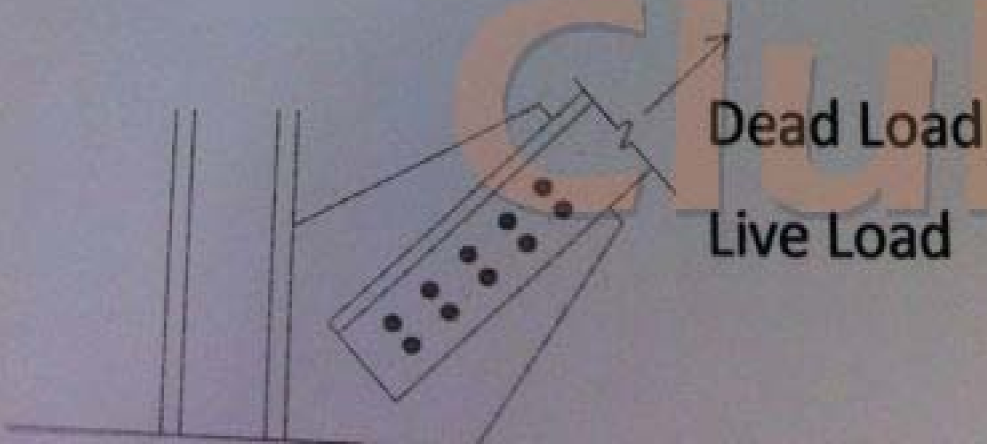
PROBLEM 1: (40 points)

Determine the design strength of an A36 steel member with a L 8 x 8 x ¾ section connected through each leg with 1 inch diameter bolts staggered as shown in the figure. Use LRFD. Provide a clear sketch on which you are basing your calculations and show all your work.

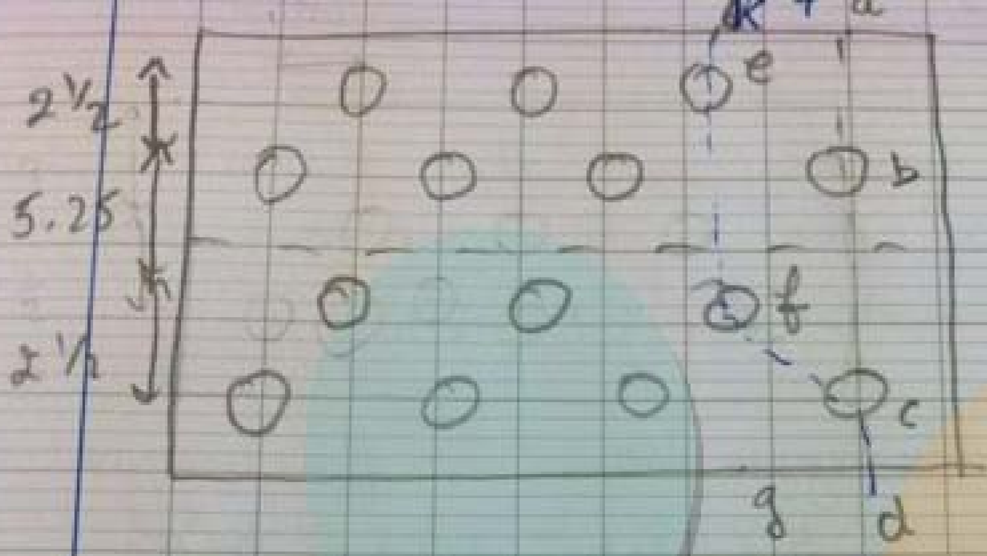


PROBLEM 2: (30 points)

An 18 ft long, A36 steel, truss member is subjected to a dead load of 30 kips and live load of 60 kips in tension. Select an unequal leg angle that you would connect through two rows of 5/8" diameter bolts as shown in figure. Show all your work.



$F_u = 58$ ksi



$d = 1 + \frac{1}{8} =$

$g = 3 + 3 - \frac{3}{4} = 5.25$ in

From table 1-7 Angles properties.

$\times \frac{3}{4}$: $A_g = 11.4 \text{ in}^2$

$\frac{1}{8} = 1.125$ in, The effective hole diameter is 1.1

For line abcd

$A_n = A_n - \Sigma t_w \times (d \cdot d')$

$= 11.4 - 0.75 \times 2 \times 1.25$

$A_n = 9.525 \text{ in}^2$?

For line ebcd

$A_n = 11.4 - 0.75 \times 1.125 - 0.75 (1.125$

$A_n = 9.09 \text{ in}^2$

For line K e b f c d:

~~$A_n = 11.4 - 0.75\times 1.125 - 0.75\left(\frac{1.75^2}{4}\right)$~~

$A_n = 11.4 - 0.75\times 1.125 - 0.75\left(1.125 - \frac{1.75^2}{4\times 2.5}\right) - 0.75\left(1.125 - \frac{1.75^2}{4\times 5.55}\right) - 0.75\left(1.125 - \frac{1.75^2}{4\times 2.5}\right)$

$A_n = 8.6\ in^2$

The last can control use $A_n = 8.6\ in^2$

Both legs of the angle are connected so, ~~$A_c = A$~~ $A_c = A_n = 8.6\ in^2$

The nominal strength based on fracture is:

$P_n = F_u A_e = 58\times 8.6 = 498.8$ kips

The nominal strength based on yielding

$P_n = F_y A_g = 36\times 11.4 = 410.4$ kips

The design strength based on fracture

$\phi_t P_n = 0.75\times 498.8 = 374.1$ kips

The design strength based on yielding

$\phi_t P_n = 0.9\times 410.4 = 369.36$ kips

design strength 369.36 kips

2) Problem 2:

$l = 18$ ft

A36 $F_u = 58$ ksi

$F_y = 36$ ksi

$D = 30$ kips , $L = 60$ kips

2 rows : $\frac{5}{8}$" ϕ , effective diameter $d = \frac{5}{8} + \frac{1}{8} = \frac{6}{8}$ in

LRFD : the factored load is

5 $P_u = 1.2 D + 1.6 L = 1.2 \times 30 + 1.6 \times 60$

$P_u = 132$ kips

5 Required $A_g = \frac{P_u}{\phi_t F_y} = \frac{132}{0.9 \times 36} = 4.07 \text{ in}^2$

5 Required $A_e = \frac{P_u}{\phi_t F_u} = \frac{132}{0.75 \times 58} = 3.03 \text{ in}^2$

The radius of gyration should be at least

5 $\frac{L}{300} = \frac{18 \times 12}{300} = 0.72$ in

starting at either end of the table, we find the the smallest area that is at least equal to 4.07 in^2

From the dimensions and properties table try $L\ 6 \times 3\frac{1}{2} \times \frac{1}{2}$, $A_g = 4.5 \text{ in}^2$, ~~[illegible]~~

$A_n = A_g - A_{holes}$

$= 4.5 - 2\left(\frac{5}{8} + \frac{1}{8}\right) \times \frac{1}{2}$

$A_n = 3.75 \text{ in}^2$

16

Problem 3:

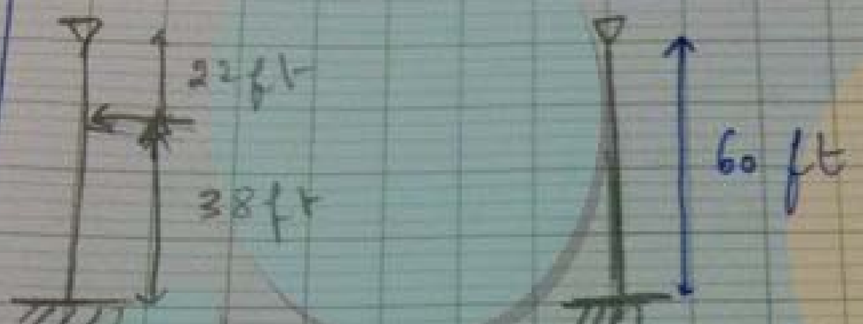
W 14x82 $\Rightarrow A = 24 \text{ in}^2$

$P = D + L$ $\quad\quad$ $D = 2L$

A 992 $\quad$ $F_y = 50 \text{ ksi}$

$F_u = 65 \text{ ksi}$

2



weak direction buckling $(k_y = 0.1)$ $\quad\quad$ strong direction buckling. $(k_x = 0.8)$

$$\frac{k_x L}{r_y} = \frac{0.8 \times 60 \times 12}{6.05} = 95.2 < 200$$

$$\frac{k_y L}{r_y} = \frac{1 \times 22 \times 12}{2.48} = 106.45 < 200$$

$$\frac{k_y L}{r_y} = \frac{0.8 \times 38 \times 12}{2.48} = 147.09 < 200$$

$$\frac{kL}{r} = 147.09$$ control the larger value

~~$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$~~

$$4.71\sqrt{\frac{E}{F_y}} = 4.71\sqrt{\frac{29{,}000}{50}} = 113.43$$

From table 4.22

$\frac{KL}{r}$	ϕF_a
147	10.5
148	10.3

show all your work of calculations

2

$\phi F_a = 10.48\,ksi$

$\phi_c P_n = \phi_c F_a A_g = 10.48 \times 24 = 251.52\,kips$

$\phi_c P_n = 1.2D + 1.6L$

$251.52 = 1.2D + 1.6(2D)$

$D = \frac{251.52}{4.4}$

2

$D = 57.163\,kips$

The maximum Service load $P = 3D = 3 \times 57.163$

$P = 171.48\,kips$

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