NAME: MUHAMMAD
MUSTAFA
KHAN

SEC: A

ID: 7753

SUBJECT: STEEL STRUCTURE.

QUESTION # 1:

Given Data:

A36 steel

lightest W shape column

D.L = 60 K L.L = 110k

Pin supported at top and bottom

$K_xL_x = 36$ ft $K_yL_y = 18$ ft

AISC / LRFD method.

Solution:

Required capacity = (1.2×60) ~~+(1.6×~~ +(1.6×110)

= 248k

enter design strength table of manual with KL = 18ft and

P = 248k

Some possible sections are. ②

$W_{14\times61}$ $P = 364$ $r_x/r_y = 2.44$

$W_{12\times53}$ $P = 320$ $r_x/r_y = 2.11$

$W_{10\times49}$ $P = 301$ $r_x/r_y = 1.71$

$W_{8\times58}$ $P = 300k$ $r_x/r_y = 1.74$

Now

$$\frac{K_xL_x}{K_yL_y} = \frac{36}{18} = 2$$

try

$W_{12\times53}$ $r_x/r_y = 2.11$

$$r_x/r_y > \frac{K_xL_x}{K_yL_y}$$

$r_x = 5.23$ $r_y = 2.48$ $A = 15.6\ in^2$

$$\frac{K_xL_x}{r_x} = \frac{36\times12}{5.23} = 82.6$$

$$\frac{K_yL_y}{r_y} = \frac{18\times12}{2.48} = 87.09$$

$\frac{KL}{r} = 87.09$

$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{e}}$

$= \frac{87.09}{\pi}\sqrt{\frac{36}{29.000}}$

$= 0.97 < 1.5$

$F_{cr} = 0.658^{\lambda^2} \times F_y$

$F_{cr} = 0.658^{(0.97)^2} \times 36$

$F_{cr} = 24.28$

$P_n = A_g F_{cr}$ ||

$= 15.6 \times 24.28$

$P_n = 378.78k$

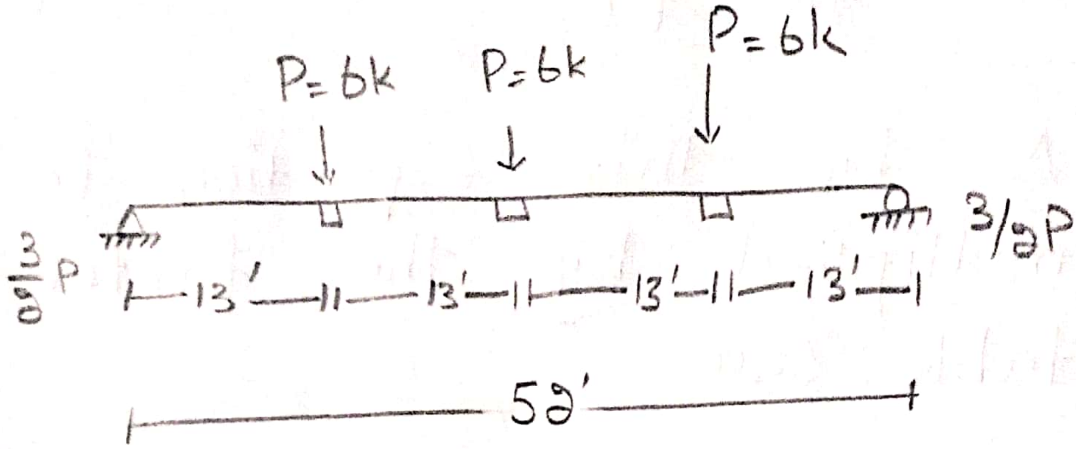
$\phi P_n = 0.85 \times 378.78$

$= 321.96 > 248k$

So OK

we use $W_{12 \times 53}$

QUESTION # 2:



Given Data:

→ lightest W-section

→ D.L = 1.5k   L.L = 4.5k

(At each quater point)

→ total length = 52'

→ live load deflection = $\frac{1}{360}$ of span

→ F_y = 36 ksi

AISC | LRFD

SOLUTION:

Design load = 4.5 + 1.5

= 6k

P = 6k

$$\Delta = \frac{5}{48}\frac{ML^2}{EI} \quad \text{— (1)}$$

Δ by this equation is multiplied by the factor from table 5.4

$$M = \left(\frac{3}{2} \times 6 \times 26\right) - (6 \times 13) = 156 \text{ K.ft}$$

$$\text{eq (1)} \Rightarrow I = \frac{5}{48} \times \frac{ML^2}{EI} \times 0.95$$

$$I = \frac{5}{48} \frac{(156 \times 12)(52 \times 12)^2}{29000\left(\frac{52}{360} \times 12\right)}$$

$I = 1510.51 \text{ in}^4 \times 0.95 \Rightarrow \underline{I = 1434.98 \text{ in}^4}$

Try W24x62

$I_x = 1550 \text{ in}^2$

$b_f = 7.04$ in

$d/A_f = 5.72$

$$L_c = \frac{76 b_f}{\sqrt{F_y}} \Rightarrow \frac{76 \times (7.04)}{\sqrt{36}} = 89''$$

$= 7.41'$

$$L_c = \frac{20000}{F_y \frac{d}{A_f}} \Rightarrow \frac{20000}{36 \times 5.72} = 97.12'' = 8.09'$$

$L > L_c$

From table 5.2
$C_b = 1.13$

$$\sqrt{\frac{102{,}000\,C_b}{F_y}} = \sqrt{\frac{102{,}000 \times 1.13}{36}} = 57$$

$$\sqrt{\frac{510\,000\,C_b}{F_y}} =$$

$$\Rightarrow \sqrt{\frac{510000 \times 1.13}{36}} = 127$$

$$\frac{L}{r_T} = \frac{13 \times 12}{1.71} = 91.22$$

Condition:

$$\sqrt{\frac{102{,}000\,C_b}{F_y}} < \frac{L}{r_T} < \sqrt{\frac{510{,}000\,C_b}{F_y}}$$

So

$$F_b = \left[\frac{2}{3} - \frac{F_y (L/r_T)^2}{1530 \times 10^3 \times C_b}\right] F_y$$

$$= \left[\frac{2}{3} - \frac{36\,(91.22)^2}{1530 \times 10^3 \times 1.13}\right] 36$$

$F_b = 17.76$ ksi allowable.

The beam self weight = 62 lb/ft
= 0.062 k/ft

$$M = \frac{WL^2}{8} = \frac{1}{8}(0.062)(52)^2$$

$M = 20.95$ k ft

total $M = 156 + 20.95$

$M = 176.95$

$S_x = 131$

$$f_b = \frac{M}{S_x} = \frac{176.95}{131} = 16.2 \text{ ksi}$$

$f_b < F_b$

OK

Use

$W_{24 \times 62}$

QUESTION #3

Given Data:

D.L = 50k

L.L = 150k

Bolts Dia = 3/4"

length = 18 ft

Connection type = Bearing

~~connecti~~ ASD methed

Required Data:

Design A36 steel double angle tension member

Solution:

Total load = D.L + L.L

= 50 + 150

= 200 k or 100k/Angl

→ For yeilding at the gross area allowable streses are

0.6 Fy = 0.6 x 36

= 22 ksi

→ For fracture at the net area allowable stresses are

$$0.5F_u = 0.5 \times 58$$
$$= 29\ ksi$$

→ Since the connection is bolted so $A_g \neq A_n$

Now

$$A_e = 0.85\ A_n$$

For yeilding

$$A_g \times 22 = 100$$
$$A_g = \frac{100}{22}$$
$$A_g = 4.54\ in^2$$

For Fracture

$$29 \times A_e = 100$$
$$A_e = 100/29$$
$$A_e = 3.44\ in^2$$

$$A_n = A_e/0.85 \Rightarrow 3.44/0.85 \Rightarrow A_n = 4.04$$

Assume 15% deduction in gross area for holes.

So, $A_g = \frac{A_n}{0.85} \Rightarrow A_g = \frac{4.04}{0.85}$

$A_g = 4.76 \text{ in}^2$

For $L4 \times 4 \times 5/8$ $A_g = 4.61$ or 4.76 Ok

$r_x = 1.20$ $r_y = 1.20$ with $3/8$ in Gusses plate.

$\frac{l}{r_{min}} = \frac{18 \times 12}{1.20} = 180 \leq 300$
Ok

Bolt Design:

using A325 bolts with threads included in shear plane as dia $= 3/4''$

$\text{Area} = \frac{\pi}{4}(d)^2 \Rightarrow \frac{\pi}{4}(0.75)^2$

$A = 0.441 \text{ in}^2$

Allowable bolts shear $= 21$ksi

Since bolts are in double shear so Allowable shear per bolt $= 2 \times 21 \times 0.44$
$= 18.5k$

Allowable bolt bearing stress $= 1.2F_u$

$= 1.2 \times 58$

$= 69.6k$

Allowable bearing on two $\frac{5}{8}$" thick angle

long legs $= 69.6 \times 2 \times \frac{5}{8} \times 0.75$

$= 65.25 > 18.5$

So shear Governs

Number of bolts $= \frac{200}{18.5} = 10.81$

Use 10 bolts.

Design a gusset plate:

Bearing stress $= 1.2F_u$

$= 1.2 \times 58 = 69.6ksi$

So

Allowable bearing $= 69.6 \times 10 \times 0.75 \times t$

$= 200$

$t = 0.38$ in

Use 3/4" G.P

Checking various limit states.

yielding $= 0.6\, F_y A_g$

$= 6.6 \times 36 \times (8 \times 0.75)$

$= 129.6\,k < 200k$

Not ok

Trying

$L_{7 \times 4 \times 1/2}$ $\quad A_g = 5.25$

$r_x = 2.25 \quad r_y = 1.11$ with $3/8''$ gusset plate

$$\frac{L}{r_{min}} = \frac{18 \times 12}{1.11} \quad 194.59 < 200k$$

Ok.

Allowable bearing on two $1/2''$ thick angle.

long legs $= 69.6 \times 2 \times 1/2 \times 0.75$

$= 52.2 > 18.5$

So shear governs

Checking various limit state

yielding $= 0.6 F_y A_g$

$= 0.6 \times 36 \times (14 \times 0.75)$

$= 226.8 > 200k$

Ok

Fracture $= 0.5 \times F_u$ ~~Ag~~ A_e

$= 0.5 \times 58 \times 0.85 \left[14 - \left(\frac{3}{4}\right) \times 2 \right] \frac{3}{4}$

$= 231k > 200k$

Ok

Check for tearing failure.

$L_e = \frac{2P}{F_u t}$

$1.25 = \frac{2P}{58 \times 0.5}$

$(1.25)(58 \times 0.5) = 2P$

$P = 18.125 k$,

$L = \frac{2P}{F_u t} + \frac{d_b}{2}$

$$2 = \frac{2P}{58 \times 0.5} + \frac{3/4}{2}$$

$$2 \times (58 \times 0.5) = 2P + 0.375$$

$$116.1 - 0.375 = 2P$$

$$2P = 115.72$$

$$P = 57.86 \text{ k}$$

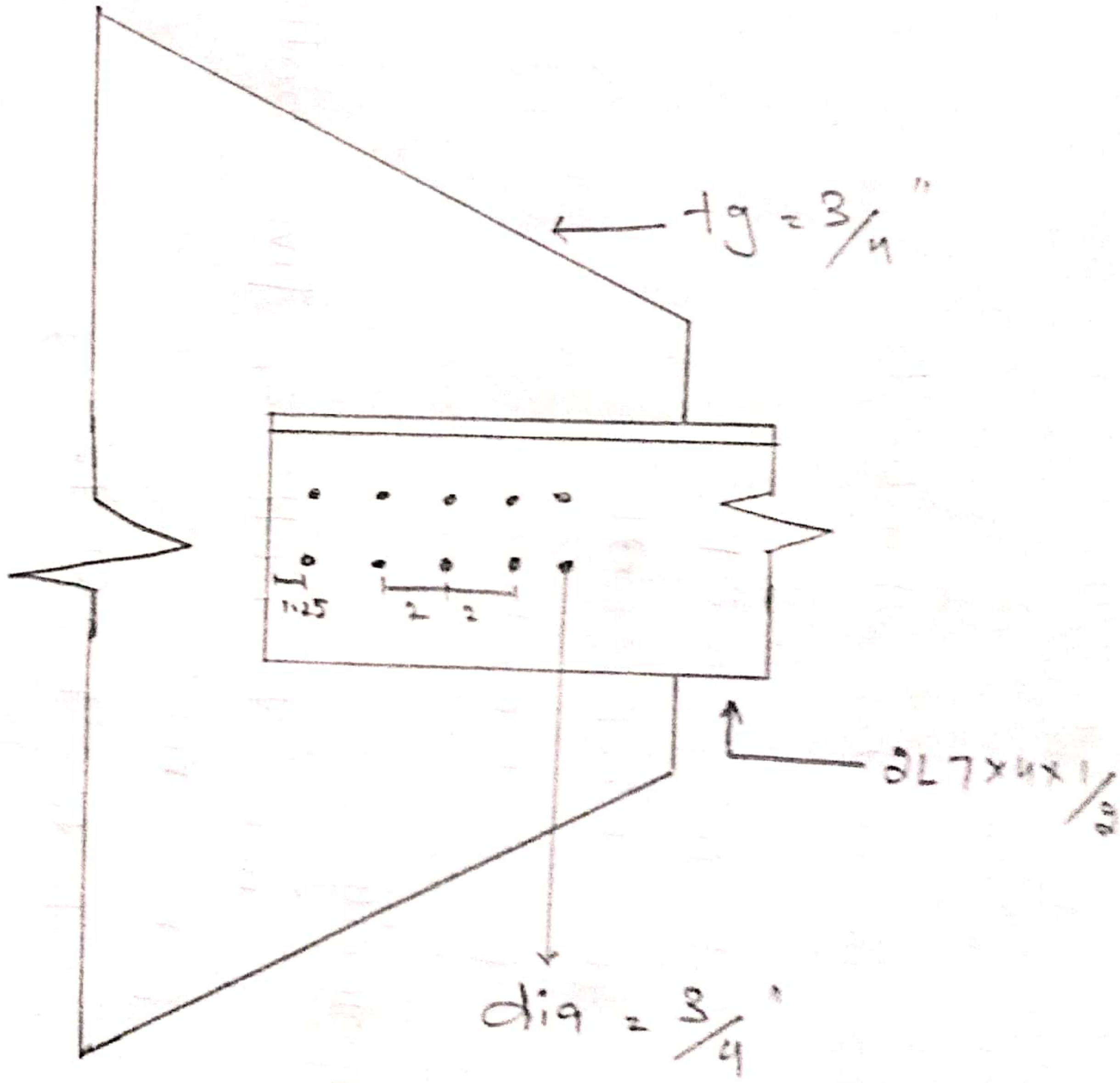
Capacity

Since 10 bolts & five bolts per row

$$2 \times 18.125 + 8 \times 57.86$$

$$499.13\text{K} > 200\text{K}$$

OK.


tg = 3/4"
2L7x4x1/2
1.25
2
2
dia = 3/4"