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Subject # Steel Structure

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Ans; sol; **Column;**

Given data;

Dead compression load = 60K
Live compression load = 110K
$K_x L_x$ = 36 ft
$K_y L_y$ = 18 ft
Column is supported "pin" at the top and bottom in Both direction.

Using AISC/LRFD Method;

Sol;

Required capacity = (1.2×60)+(1.6×110)
= 248K.

Enter design strength table of material with K_L = 18 ft and P = 248K

Some possible sections are;

$W_{14} \times 61$ P = 364K r_x/r_y = 2.44
$W_{12} \times 53$ P = 320K r_x/r_y = 2.11
$W_{10} \times 49$ P = 301K r_x/r_y = 1.71
$W_{8} \times 58$ P = 300K r_x/r_y = 1.74

(02)

Now;

$$K_x l_x / K_y l_y = \frac{36}{18} = 2$$

Try;

$W_{12 \times 53}$ $\quad r_x / r_y = 2.11$

$$r_x / r_y > \frac{K_x l_x}{K_y l_y}$$

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

$$K_x l_x / r_x = \frac{36 \times 12}{5.23} = 82.6$$

$$K_y l_y / r_y = \frac{18 \times 12}{2.48} = 87.09$$

$$KL/r = 87.09.$$

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

$$= \frac{87.09}{\pi} \sqrt{36/29{,}000}$$

$$= 0.97 < 1.5$$

Now;

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

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

$$F_{cr} = 24.28$$

$$P_n = A_g F_{cr}$$

$$= 15.6 \times 24.28$$

$$P_n = 378.78\,k$$

$$\phi P_n = 0.85 \times 378.78$$

$$= 321.96 > 248\,k$$

Okay;

So;

Use; **W12x53**

: Required W-shape column.

"Ansior": "Beam;"

Given Data;

Dead load = 1.5 Kips
Live load = 4.5 Kips
Simple Span = 52-ft
Live load deflection = 1/360 (of span)
F_y = 36 ksi

Required;

- Lightest W-Section of Beam = ?
- Using AISC/ASD method.

Sol; The maximum moment due to concentrated loads;

$= 1.5 + 4.5$

$= 6$ Kips.

As;

$$M = 1\frac{1}{2}(6)(26) - 6(13)$$

$$M = 156 \text{ ft}\cdot\text{kips}.$$

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

$$\text{eq ①} \Rightarrow \quad I = \frac{5}{48} \times \frac{ML^2}{E\Delta} \times 0.95$$

$$I = \frac{5/48\,(156 \times 12)(52 \times 12)^2}{29{,}000\,(52/360 \times 12)}$$

$$I = 1510.51\ in^4 \times 0.95 = \boxed{I = 1434.98\ in^4}$$

Try $W_{24} \times 62$ $\quad I_x = 1550\ in^4$

$b_f = 7.04\ in \quad d/A_F = 5.72$

$$L_c = \frac{76\,b_f}{\sqrt{F_y}} \Rightarrow \frac{76 \times (7.04)}{\sqrt{36}} = 89'' = 7.41'$$

$$L_c = \frac{20{,}000}{F_y \frac{d}{A_F}} \Rightarrow \frac{20{,}000}{36 \times 5.72} = 97.12'' = 8.09'$$

$L > L_c$ from Table 5.2

$c_b = 1.13$

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

$$\sqrt{\frac{510,000\,c_b}{F_y}} = \sqrt{\frac{510,000 \times 1.13}{36}} = 127$$

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

Condition

$$\sqrt{\frac{102,000\,c_b}{F_y}} \le L/r_T \le \sqrt{\frac{510,000\,c_b}{F_y}}$$

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 $= 62\ lb/ft$

$= 0.062\ k/ft$

$$M = wL^2/8 = 1/8 (0.062)(52)^2$$

$$M = 20.95 \text{ kft}$$

Total $M = 156 + 20.95$

$$M = 176.95$$

$S_x = 131$

$$F_b = M/S_x = \frac{176.95 \times 12}{131}$$

$$= 16.2 \text{ ksi}$$

$f_b < F_b$

OK

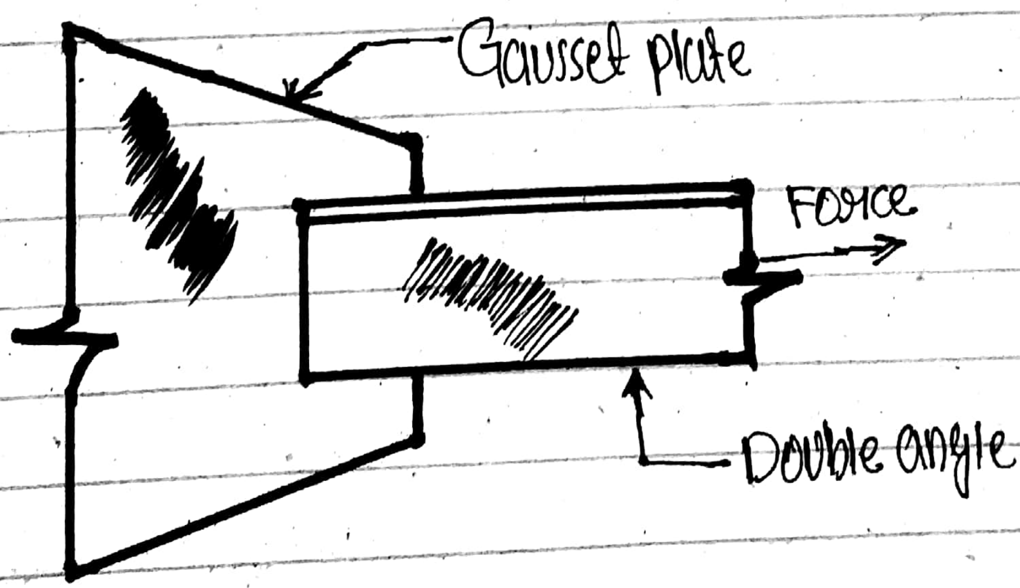
Use $W_{24 \times 62}$

Ans; 03:

Given Data:

- Dead load = 50k
- Live load = 150k
- A-36 double angle Tension member "18ft" long.?
- The connection is Bearing type with A325 Bolts with 3/4 in diameter
- Use two lines of Bots.

※ Using ASD Method;



※ Solution;

Total load = D.L + L.L

= 50 + 150

= 200k or 100k/angle

- For yielding at the gross area allowable stresses are;

$$0.6F_y = 0.6(36)$$

$$\boxed{= 22 ksi}$$

- For fracture at the net area allowable stresses are;

$$0.5F_u = 0.5(58)$$

$$\boxed{= 29 ksi.}$$

- Since the connection is Bolted so $A_g \neq A_n$

Now;

$$A_e = 0.85A_n$$

For yielding;

$$A_g \times 22 = 100$$

$$A_g = 100/22$$

$$\boxed{A_g = 4.54 in^2}$$

- For Fracture;

$$29 \times A_e = 100$$

$$\boxed{A_e = 3.44 \, in^2}$$

$$A_n = \frac{A_e}{0.85} = 3.44/0.85$$

$$\boxed{A_n = 4.04 \, in^2}$$

- Assume 15% Deduction in Gross Area for holes;

So;

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

$$\boxed{A_g = 4.76 \, in^2}$$

- For $L4 \times 4 \times \frac{5}{8}$; $A_g = 4.61 \simeq 4.76$ okay.

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

$$\frac{L}{r_{min}} = \frac{18 \times 12}{1.20} = 180 \leq 300 \text{ K} \quad : \text{Okay}$$

- "**Bolts Design**";

Using A325 Bolts with threads Included in shear plane.

As; dia $= 3/4''$

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

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

- Allowable Bolts shear $= 21$ ksi.

Since Bolts are in double shear so
Allowable ~~stress~~ shear per Bolt $= 2 \times 21 \times 0.44$
$= 18.58$ k.

Allowable Bolt Bearing stress $= 1.2 F_u$
$= 1.2(58)$
$= 69.6$ ksi

Allowable Bearing on two $\frac{5}{8}''$ thick angle

$$\text{Long legs} = 69.6 \times 2 \times \frac{5}{8} \times 0.75$$
$$= 65.25 > 18.5$$

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

Use 10 bolts

Design of gusset palate:

Bearing Stress = 1.2 Fu

= 1.2×58 = 69.6ksi

Now

Allowable bearing = 69.6×10×75×t

= 200

t = 0.38in

Use 3/4" G.P

checking various limit state

Yielding = 0.6 Fy Ag

= 0.6×36×(8×0.75)

= 129.6K < 200K

Not OK

Try $L\,4 \times 4 \times \frac{1}{2}$ $A_g = 5.25$

$r_x = 2.25$ $r_y = 1.11$ With $\frac{3}{8}$ G.P

$l/r_{min} = \frac{18 \times 12}{1.11}$ $194.59 \leq 300K$

"OK"

Allowable bearing on two $\frac{1}{2}$" thick angle

Long legs $= 69.6 \times 2 \times \frac{1}{2} \times 0.75$

~~52.2~~

$52.2 > 18.5$

Checking various unit States.

⇒ Yielding $= 0.6\,F_y\,A_g$

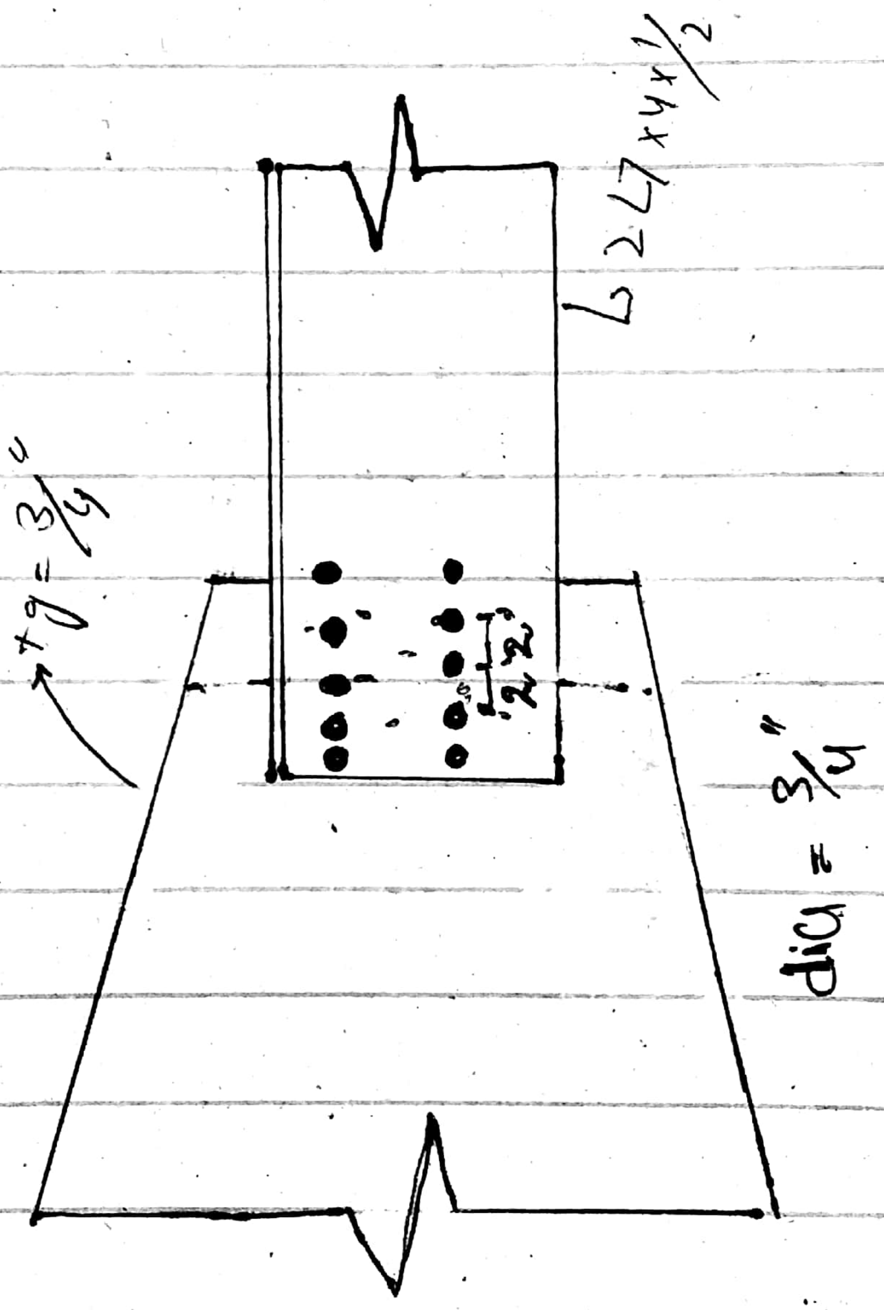
$= 0.6 \times 36 \times (14 \times 0.75)$

$= 226.8 > 200K$ "OK"

⇒ Fracture $= 0.5 \times F_u \times A_e$

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

$= 231\,K > 200\,K$ "OK"


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

check for tearing failure

$$L_e = 2P / F_u t$$

$$1.25 = 2P / 58 \times 0.5$$

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

$$P = 18.125 \text{ K}$$

$$L = 2P / F_u t + d_h / 2$$

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

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

$$116.1 - 0.375 = 2P$$

$$115.72 = 2P$$

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

Capacity

Since 10 bolts per row

$$2 \times 18.25 + 8 \times 57.86 = 499.13\text{K} > 200\text{K}$$

okay.