Day: M T W T F S Date: __/__/__

NAME : Shah Sawar Khan

I.D # 7712

SECTION : A

Submitted To : Engr: Amjad Islam.

Date : 29-Sept-2020.

Q#01

Given Data:

Lightes W-Shape column of A-36 steel

DL = 60K , L.L = 110K

Pin Supported at top and bottom

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

AISC/LRFD Method

Sol:→ Required Capacity = (1.2x60) + (1.6x110)
= 248K

Enter design strength table of manual with KL = 18ft and P = 248K

Some possible Sections are

$W_{14} \times 61$	P = 364	$r_x/r_y = 2.44$
$W12 \times 53$	P = 320	$r_x/r_y = 2.11$
$W10 \times 49$	P = 301	$r_x/r_y = 1.71$
$W8 \times 58$	P = 300K	$r_x/r_y = 1.74$

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

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

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

$r_x = 5.23$, $r_y = 2.48$

$A = 15.6\ in^2$

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

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

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

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

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

$$= 0.97 < 1.5$$

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

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

$F_{cr} = 24.28$

$$P_n = A_g F_{cr}$$

$$= 15.6 \times 24.28$$

$P_n = 378.78K$

$\phi P_n = 0.85 \times 378.78$

$= 321.96 > 248K$

[okay]

So USE $W_{12} \times 53$

Q#02 Given Data:

Lightest W-section

D.L = 1.5K , L.L = 4.5K

(At each quater point)

Total length = 52'

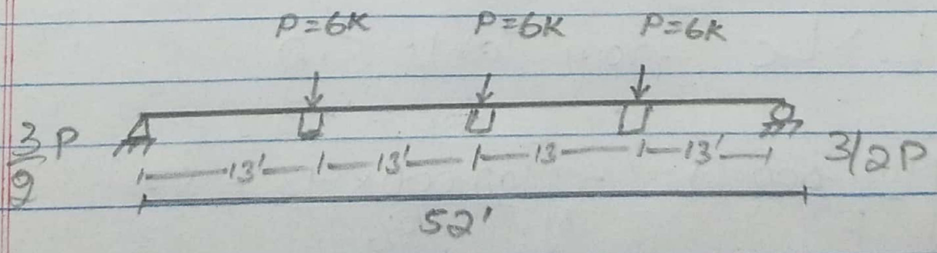
Live load deflection = $\frac{1}{360}$ of span

Δlim

Fy = 36 ksi

AISC/ASD method

Sol:-



Design load = 4.5 + 1.5 = 6K

P = 6K

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

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

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

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

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

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

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

$b_f = 7.04 \text{ in}$, $d/A_f = 5.72$

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

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

$L > L_c$ from table 5.2

$C_b = 1.13$

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

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

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

Condition

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

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 $= 62 \frac{lb}{ft} = 0.062$ K/ft

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

$M = 20.95$ K ft

Total $M = 156 + 20.95$

$M = 176.95$ $\therefore S_x = 131$

$$f_b = \frac{M}{S_x} = \frac{176.95 \times 12}{131} = 16.2 \text{ Ksi}$$

$f_b < F_b$ [okay]

So

USE $W_{24} \times 62$.

Q#03 **Given Data:**

D.L = 50K

L.L = 150K

Bolts Dia = 3/4"

Length = 18 ft

Connection type = Bearing

ASD Method

Required Data:

Design A36 Steel double angle tension member

Sol: Total load = D.L + L.L

= 50 + 150

= 200K or 100K/Angle

→ For yielding at gross area allowable stresses are

$0.6F_y = 0.6 \times 36$

$= 22$ 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 yielding

$A_g \times 22 = 100$

$$Ag = \frac{100}{22}$$

$Ag = 4.54\ in^2$

For fracture

$29 \times Ae = 100$

$Ae = 3.44\ in^2$

$An = Ae/0.85 \Rightarrow \frac{3.44}{0.85}$

$$\boxed{An = 4.04 in^2}$$

Assume 15% deduction in gross area for holes

So $Ag = \frac{An}{0.85} \Rightarrow Ag = \frac{4.04}{0.85}$

$$\boxed{Ag = 4.76 in^2}$$

For $L4 \times 4 \times \frac{5}{8}$ $Ag = 4.61 \cong 4.76$ OK

$r_x = 1.20$, $r_y = 1.20$ with $\frac{3}{8}$ in Gusset plate

$\frac{L}{r_{min}} = \frac{18 \times 12}{1.20} = 180 \leq 300$ K [OK]

Bolts Design: Using A325 bolts with threads included in Shear plane as dia = 3/4"

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

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

Allowable bolts Shear = 21 ksi

Since bolts are in double Shear So

Allowable Shear per bolt = 2x21x0.44

= 18.5K

Allowable bolt bearing Stress = 1.2Fu

= 1.2x58 = 69.6 ksi

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 groans

No. of bolts = $\frac{200}{18.5} = 10.81$

Use 10 bolts

Design of gusset plate

Bearing Stress = 1.2Fu

= 1.2x58 = 69.6 ksi

So

Allowable bearing = 69.6x10x0.75xt = 200

t = 0.38 in

Use $\frac{3}{4}$" G.P

Checking various limit States

yielding $= 0.6 F_y A_g$

$= 0.6 F_y A_g$

$= 0.6 \times 36 \times (8 \times 0.75)$

$= 129.6k < 200k$ [Not ok]

Try $L\, 7 \times 4 \times \frac{1}{2}$ $A_g = 5.25$

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

$\frac{L}{r_{min}} = \frac{18 \times 12}{1.11} = 194.59 \leq 300k$ [ok]

Allowable bearing on two $\frac{1}{2}$" thick Angle long legs $= 69.6 \times 2 \times 1/2 \times 0.75$

$52.2 > 18.5$

So Shear governs

Checking various limit States

yielding $= 0.6 F_y A_g$

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

$= 226.8 > 200k$ ok.

Fracture $= 0.5 \times F_u \times A_e$

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

$= 231K > 200K$ [okay]

Check for bearing failure

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

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

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

$$P = 18.125k$$

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

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

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

$$116.1 - 0.375 = 2P$$

$$115.72 = 2P$$

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

Capacity: Since 10 bolts & five bolts per row

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

$$499.13k > 200k \ [ok]$$

Day: M T W T F S Date: __/__/__