Name Zakir ullah

ID 7741

Subject steel structure

Teacher name SIR AMJID ISLAM SAIB

1

# QUESTION NO #01

## ANSWER

Given data :-

Eightest W-shape column

A 63 steel

D.L = 60K

pin suported at top and bottom

$K_x L_x = 36$ ft  $K_y l_y = 18$ ft

AISC/LRFD method

Solution :-

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

= 248 K

Enter design strength table of manual

with KL = 18ft and P = 248 K

Some possible section are

$W_{14} \times 61$  P = 364  $r_x/r_y$ = 2.44

$W_{12} \times 53$  P = 320  $r_x/r_y$ = 2.11

$W_{10} \times 49$ $P = 301$ $r_x/r_y = 1.71$

$W_8 \times 58$ $P = 300K$ $r_x/r_y = 1.74$

(2)

Now

$$\frac{K_x L_x}{K_y L_y} = \frac{36}{18} = 2$$

Try

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

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

$r_x = 5.23$ $r_y = 2.48$

$A = 15.6 \text{ in}^2$

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

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

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

(3)

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

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

~~= 0.97~~

$$= 0.97 < 1.5$$

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

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

$$F_{cr} = 24.28$$

$$P_n = A_g F_{cr}$$

$$= 15.6 \times 24.28$$

$$P_n = 378.78\,K$$

$$\phi P_n = 0.58 \times 378.78$$

$$= 321.96 > 248\,K$$

OK

So

use $W_{12} \times 53$

x — x — x — x

Question No # 02

ANSWER

Given data:-

(4)

lightest W = section

D.L = 1.5K

L.L = 4.5K

(At each quarter point)

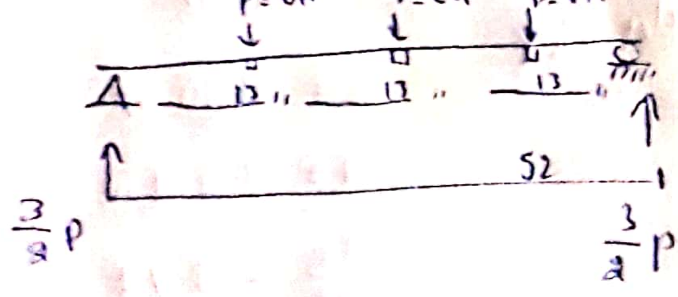
→ Total length = 52

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

$F_y$ = 36 Ksi

AISC/ASD

Solution :-



design load 4.5 + 1.5 = 6K

$P = 6K$

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

$\Delta$ by this equation is multiplied by the factor from table 5.4

(5)

$$M = \left(\frac{3}{2} \times 6 \times 26\right) - (6 \times 13)$$

$$= 156 \text{ K.ft}$$

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

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

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

$$I = 1434.98 \text{ in}^4$$

Try W24 X 62

$I = 1550 \text{ in}^4$

$b_f = 7.04 \text{ in}$

$$\frac{d}{A_F} = 5.79$$

$$LC = \frac{76 b_f}{\sqrt{F_y}}$$

$$= \frac{76\ (7.04)}{\sqrt{36}} = 89'' = 7.14'$$

(6)

$$LC = \frac{20000}{F_y \frac{d}{A_f}} \Rightarrow \frac{20000}{36 \times 5.72}$$

$$= 97.12'' = 8.09'$$

L > Lc from table 5.2

$$C_b = 1.13$$

$$\frac{\sqrt{102000\ C_b}}{F_y} = \frac{\sqrt{102\ 000 \times 1.13}}{36}$$

$$= 127$$

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

Condition

$$\frac{\sqrt{102000\, C_b}}{F_y} \le \frac{L}{r_T} \le \frac{\sqrt{510000\, C_b}}{F_y}$$

So

$$F_b = \left[\frac{2}{3} - \frac{F_y\left(\frac{L}{r_T}\right)^2}{1530\times10^3 \times C_b}\right] F_y$$

(7)

$$= \left[\frac{2}{3} - \frac{36\,(91.27)^2}{1530\times10^3\times 1.13}\right] F_y$$

$F_b = 17.76$ ksi allowable

The beam self wt

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

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

$M = 20.95$ K ft

Total

$M = 156 + 20.95$

Condition

$$\frac{\sqrt{102000 \cdot C_b}}{F_y} \leq \frac{L}{r_T} \leq \frac{\sqrt{102000\, C_b}}{F_y}$$

So

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

(7)

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

$F_b = 17.76$ Ksi allowable

The beam self wt

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

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

$M = 20.95$ K ft

Total

$$M = 156 + 20.95$$

$M = 176.95$

$F_b = \frac{M}{S_x} \Rightarrow \frac{176.95 \times 12}{131} = 16.2$ Ksi

$F_b < F_b$

OK

use $W_{24} \times W_{62}$

(8)

Question No #03

ANSWER

Given data

length, l = 18Ft

(9) D.L = 50K

L.L = 150K

bolts = A325, 3/4" dia

Connection type = Bearing

steel = A36

Threads not excluded

Required data :-

A36 Double angle tension = ?

Solution :-

Total load = DL + LL

= 50 + 150

= 200 Kips

100 Kip / angle

a. yeilding at gross area allowable

stress are 0.6 Fy = 0.6 × 36 => 22 ksi

For fracture at net area allowable stress are

$0.5 f_y = 0.5 \times 58$
$= 29 Ksi$

As connection is not bolted So

$A_g \neq A_n$

Now

$A_e = 0.85 \, An$

(10)

For yielding

$A_g \times 22 = 100$

$A_g = 100/22$

$A_g = 4.5 \text{ in}^2$

For Fracture

$29 \times A_e = 100$

$A_e = 100/29$

$A_e = 3.45 \text{ in}^2$

$A_n = A_e/.85 = 4.05 \text{ in}^2$

Assum 15% reduction in gross area for holes

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

$\Rightarrow A_g = \frac{4.05}{0.85}$

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

⇒ Allowable shear per bolt = 2 × 21 × 0.44

= 18.5 Kips

⇒ Allowable bearing on two 7/8" thick angle long legs = 69.6 × 2 × $\frac{7}{16}$ × 0.75

= 45.68 Kips > 18.5 Kips

So

(11)

shear governs.

Now

Number of bolts ⇒ $\frac{200}{18.5}$

⇒ 10.81

So we will use 11 bolts

Design of Gusset plate :→

Bearing stress = 1.2 fu

= 1.2 × 58

= 69.6 Ksi

6 × 4 × $\frac{1}{2}$ A = 4.75 in² ≈ 4.76 in²

$r_x$ = 1.91

$r_y$ = 1.15

Scanned with CamScanner

$$\frac{L}{r_{min}} = \frac{18 \times 12}{1.15}$$

$= 187.82$

$187.82 \leq 300$ OK

Design for bolts

Use $A_{325}$ bolt thread not exclude

(11) $A = 0.44 \ in^2$

dia $= 3/4''$

Allowable bolt shear = 21 Ksi → [Table 2.11 Gaylord]

Since

The bolt are in double shear

So

=> Allowable bolts shearing stress = 1.2 Fu

=> 1.2 × 58

=> 69.6 Ksi

X ———— X ———— X ———— X