Name : Syed Waleed Shah
I.D : 7497
Subject : Steel Structure
Submitted to : Sir Amjad Islam
Semester : 11th

Problem # 01

Lightest w-shape column A36 steel

DL = 60k

L.L = 110k

Pin supported at top & bottom

$K_x L_x = 36$ ft $\quad K_y L_y = 18$ ft

AISC/LRFD Method

Solution:

Required capacity = $(1.2 \times 60) + (1.6 \times 110)$

$= 248$ k

Enter design strength table of manual with

$KL = 18$ ft and $P = 248$ k

Possible sections

$W_{14} \times 61$	$P = 364$	$r_x/r_y = 2.44$
$W_{12} \times 53$	$P = 320$	$r_x/r_y = 2.11$
$W_{10} \times 49$	$P = 301$	$r_x/r_y = 1.71$
$W_8 \times 58$	$P = 300$k	$r_x/r_y = 1.74$

Now

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

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

$$r_x/r_y > \frac{K_x L_x}{K_y L_y}$$

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

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

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

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

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

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

$$= 0.97 < 1.5$$

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

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

$$F_{cr} = 24.28$$

$$P_n = A_g F_{cr}$$

$$= 15.6 \times 24.28$$

$$P_n = 378.78k$$

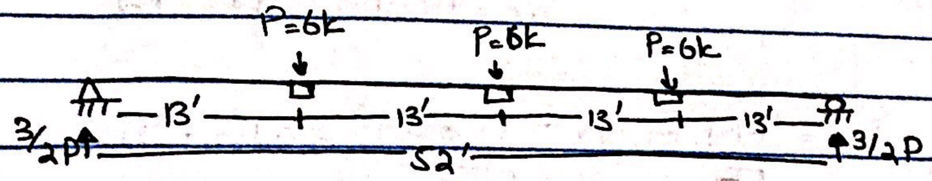
$$\phi P_n = 0.85 \times 378.78$$

$$= 321.96 > 248k$$

<u>ok</u>

So we use <u>$W_{12 \times 53}$</u>

Problem # 02



Lightest w-section

=> D.L = 1.5k L.L = 4.5k

(At each quater Point)

-> Total length = 52'

-> Live load deflection = $1/360$ of span
Δ_{lim}

-> $F_y = 36$ ksi

AISC/ASD method

Solution

Design load = 4.5 + 1.5 = 6k

P = 6k

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

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

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

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

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

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

Try $W_{24} \times 62$, $I_x = 1550 \text{ in}^4$
$b_f = 7.04 \text{ in}$, $d/A_f = 5.72$

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

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

$L > L_c$ 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:

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

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

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

$$M = 20.95\ k\cdot ft$$

Total $M = 156 + 20.95$

$$M = 176.95$$

$$f_b = M/S_x \Rightarrow \frac{176.95 \times 12}{131} = 16.2\ ksi$$

$f_b < F_b$

ok

Use $W_{24 \times 62}$

Problem # 03

Given

length = L = 18ft

dead load = D.L = 50k

Live load = L.L = 150 k

bolts = A_{325}, 3/4" dia

Connection Type = Bearing

Steel = A36

Threads not excluded

Required data:

A36 Double Angle Tension

Solution:

Total load = D.L + L.L

= 50 + 150

= 200 kips or 100 kips/angle

For Yielding at gross area allowable stresses are

$0.6\ F_y \Rightarrow 0.6 \times 36$

$= 22$ ksi

For Fracture at net area allowable stresses are

$0.5\ F_u = 0.5 \times 58$

$= 29$ ksi

As connection is not bolted so

$A_g \neq A_n$

Now

$A_e = 0.85\ A_n$

For yeilding

$A_g \times 22 = 100$

$A_g = 100/22$

$A_g = 4.5\ in^2$

Scanned with CamScanner

Date: / /

For Fracture

$$29 \times A_e = 100$$

$$A_e = 100/29$$

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

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

Assume 15% reduction in gross area for holes so

$$\rightarrow A_g = \frac{A_n}{0.85}$$

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

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

For $6 \times 4 \times 1/2$ $A = 4.75 \text{ in}^2 \approx 4.76 \text{ in}^2$

$$r_x = 1.91$$

$$r_y = 1.15$$

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

$$= 187.82$$

$$= 187.82 \le 300 \text{ ok}$$

Design For bolts:

Using A325 bolt threads not enclude

$A = .44 \text{ in}^2$

dia $= 3/4''$

Allowable bolt shear $= 21$ ksi $\rightarrow$ [Table 2.11 Gaylord]

Since

The bolts are in double shear so

Allowable bolts bearing stress $= 1.2 F_u$

$\Rightarrow 1.2 \times 58$

$= 869.6$ ksi

Date: / /

Allowable Shear/bolt $= 2 \times 21 \times 0.44$

$= 18.5$ kips

=> Allowable bearing on Two 7/16" Thick angle long legs $= 69.6 \times 2 \times 7/16 \times 0.75$

=> 45.68 kips > 18.5 kips

So

Shear governs

Now

number of bolts => $\frac{200}{18.5}$

=> 10.81

so we will use 12 bolts

Design of Gusset plate:

Bearing stress $= 1.2F_u$

=> 1.2×58

$= 69.6$ ksi