Name => Muhammad Zubair Khan

Paper => Steel Structure

ID => 7677

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QNO1 :→

Ans.→

Eigtest W-Shap Colum A36 Steel.

DL - 60K   L.L = 110K

Pin Supported at top and bottom $K_x l_x = 36ft$

$k_y l_y = 18ft$

AISC/LRFD method

Sol. Required Capacity = $(1.2 \times 60) + (1.6 \times 110)$

Enter design Strength table of mankal with KL - 18ft

and P = 248 K

Some possible sections are

W14x61	P = 364	$r_x/r_y = 2.44$
W_{12}x53	P = 320	$r_x/r_y = 2.11$
W_{10}x49	P = 301	$r_x/r_y = 1.71$
W_8x58	P = 300k	$r_x/r_y = 1.74$

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

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

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

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

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

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

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

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

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

$= 0.97 < 1.5$

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

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

$F_{cr} = 24.28$

$P_n = A_g F_r$

$= 15.6 \times 24.28$

$P_n = 378.78 K$

$P_n = 0.85 \times 378.78$

$= 321.967248 K$

So use $W_{12} \times 53$

Q No 2:-)

Ans :-) → Lightest W. Section

→ D.L = 1.5 K L.L = 4.5 K

(at each quater point)

→ Total length = 52'

→ Line load deflection $\frac{}{\delta lim} = \frac{1}{360}$ of Span

→ $F_y = 36ksi$ AISC/ASD method

So. design load = 4.5 + 1.5 = 6 K

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

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

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

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

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

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

Try W 24 × 62 $I_x = 1550 \text{ in}^4$

$b_f = 7.04$ in, $A_f = 5.72$

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

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

$L > L_c$ from table 5-2

$C_b = 1.13$

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

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

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

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

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

$$M = 20.95 \text{ k-ft}$$

Total $M = 156 + 20.95$

$M = 176.95$

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

$f_b < F_b$

Use W24x62

QNo3:→

Ans:→ Given data

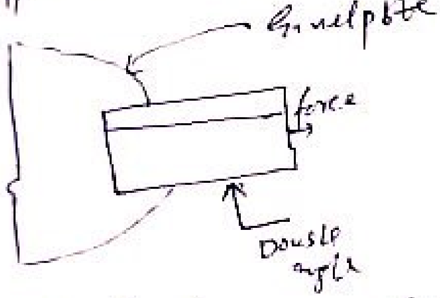
D.L = 50k

C.L = 150

Bcs = 3/4"

Length = 18ft

Connection type ⇒ Bearing type



Solution⇒ total load = D.L + live load

$\Rightarrow 50 + 150$

$\Rightarrow 200$ kips or 100kp/angle

For yielding at the gross allowable stresses are $0.6F_u = 0.6 \times 36$

$= 22$ ksi

For fracture at the net are allowable stresses are

$0.5F_t = 0.5 \times 58$

$= 29$ ksi

Since the connection is bolted so Ag + An

allow $A_e = 0.85 A_N$.

For yielding

$A_g \times 22 = 75$

$A_g = \frac{75}{22}$

$= 3.4\ in^2$

For fracture

$29 \times A_c = 75$

$\boxed{A_c = 2.59\ in^2}$

Assume 15% reduction in gross area for holes

So $A_g = A_n / 0.85 = 3.58\ in^2$

For $5 \times 3\frac{1}{2}'' \times \frac{7}{16}''$

$A = 3.53 \text{ in} \simeq 3.58 \text{ in}^2$ ok

$r_x = 1.59$ in & with 3/8 in G.P

$r_y = 1.47$ in

$\frac{L}{r_{min}} = \frac{18 \times 12}{1.47} = 146.93 \leq 300$

Design of Bolts =

Using A 325 bolts with threads included in sheer plane.

$A = 0.44 \text{ in}^2$ (dia $= \frac{3}{4}''$)

Allowable bolts are sheer = 21 ksi

(Table 2.11 Gay load)

Since the bolts are in double sheer so,

allowable sheer per bolts

$= 2 \times 21 = 0.44 = 18.5$ kips.

allowable bearing on two

7/16'' leg thick angle by $= 65.6 \times 2 \times \frac{7}{16} \times 0.75$

(7) $= 45r, 68$ kips 7 18.5 kips

Allowable bolts bearing stress

$= 1.2 F_u = 1.2 \times 58 \Rightarrow 65.6$ ksi

Now No of bolts =

$\frac{200}{18.5} = 10.81$

or 10 Bolts

=) Design of Gusset plates

Bearing stress = $1.2 F_u = 65.6$ ksi

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 $= 0.6 F_y A_g$.

$= 0.6 \times 36 \times (10 \times 0.75)$

$\Rightarrow 162$ kip $>$ 150 kips

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Fracture $= 0.5 \times F_u \times A_e$

$\Rightarrow 0.5 \times 58 \times .85 (10-(3/4)\times 2) \times \frac{3}{4}$

$\Rightarrow 157$ kips > 150 K

Check for tearing failure

$L_c = \frac{2P}{F_u t} \rightarrow 1.25 = \frac{2P}{58 \times 0.38}$

$P = 16.53$ kips

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

$2 = \frac{2P}{58 \times 0.38} + \frac{3}{4}/2$

$2 = \frac{2P}{22.04} + 0.37$

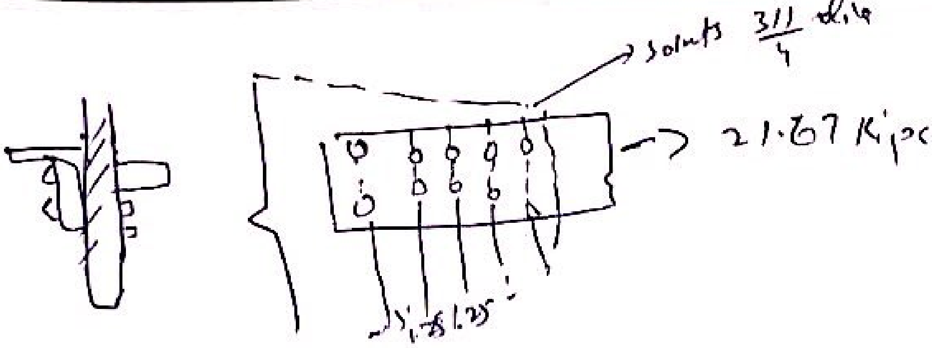
$2 \times 22.04 = 2P + 0.37$

$\frac{44.08}{2} = \frac{2P + 0.37}{2}$

$22.04 = P + 0.37$

$P = 21.67$ kip

(9)



t = 0.38
use two 3/4" C.P