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SECTION = 'A'

SUBJECT = STEEL STRUCTURE

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TEACHER = (Engr. Sir AMJAD-ISLAM)

EXAMINATION = FINAL TERM

#01

1) DATA = A-36, 36 ft, 60K (DL), 110K (LL),

$K_x L_x = 36$ ft & $K_y L_y = 18$ ft

USE AISC/LRFD Method :=

SOLUTION: Required Capacity

$= (1.2 \times 60) + (1.6 \times 10) = 248K$

Enter Design Strength Table of ~~[illegible]~~ with KL = 18 ft

& P = 248K.

Some possible sections are:

W14x61 $P = 364$ $r_x/r_y = 2.44$

W12x53 $P = 320$ $r_x/r_y = 2.11$

W10x49 $P = 301$ $r_x/r_y = 1.71$

W18x58 $P = 300K$ $r_x/r_y = 1.74$

Now

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

Try W12x53 $r_x/r_y = 2.11$

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

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

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

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

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

$$\lambda_c = \frac{Kl}{r\pi}\sqrt{Fy/e}$$

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

$$= 0.97 < 1.5$$

$$Fcr = 0.658^{\lambda_c^2} \times Fy$$

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

$$Fcr = 24.28$$

$$Pn = Ag\,Fcr$$

$$= 15.6 \times 24.28$$

$P_n = 378.78K$

$\phi P_n = 0.85 \times 378.78$

$= 321.96 > 248K$

OK

So use W12X53

Completed

Q#01

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- II ULTIMATE -

02/01

(Chap #02)

DATA / TAM

Load = 1.5 K

D.L = 4.5 K

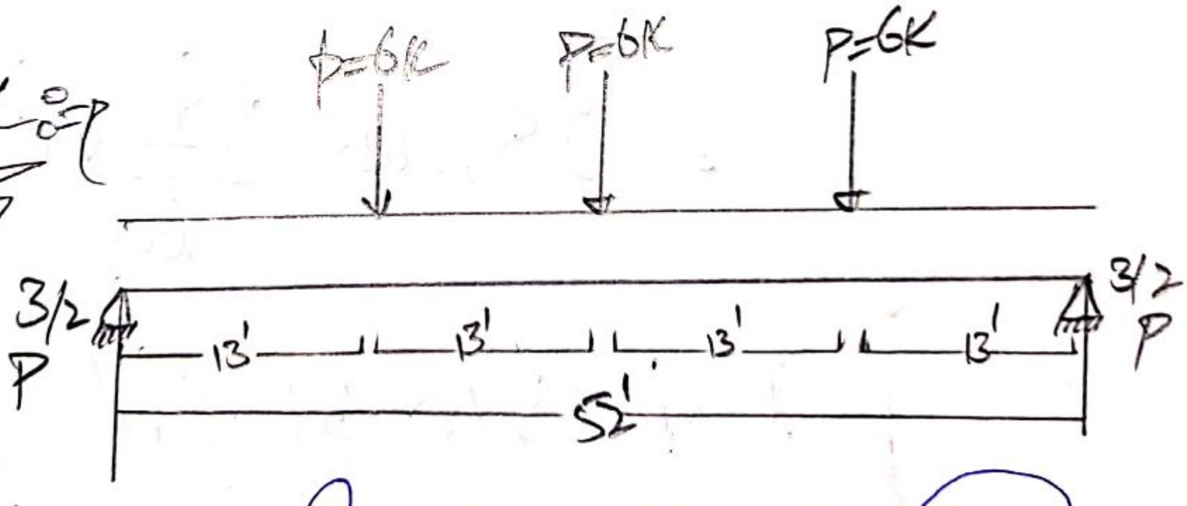
& Point = 52 ft

= 1/360

F_y = 36 KSI

USED = AISC/ASD Method

Solution



Design load = 4.5 + 1.5 = 6K (PD)

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

#02/02

Δ by This equation as multiplied by the factor from Table 5.4.

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

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

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

$$= 29{,}000\left(\frac{52}{360} \times 12\right)$$

$$I = 1510.51\ in^4$$

Try $W 24 \times 62$, $I_x = 1550\ in^4$

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

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

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

$L > L_c$ from Table 5.2

$C_b = 1.13$

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

$$= \sqrt{\frac{51,0000\ lb}{F_y}} = \sqrt{\frac{51,0000 \times 1.13}{36}} = \boxed{127}$$

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

Condition:

$$\sqrt{\frac{102{,}000\,lb}{F_y}} \le \frac{L}{r_T} < \sqrt{\frac{51{,}0000\,lb}{F_y}}$$

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:

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

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

$$= M = 20.95 \text{ K/ft}$$

Total $M = 156 + 20.95$

$M = 176.95$

$S_x = 131$

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

$\Rightarrow 16.2$ KSI

$f_b < F_b$ OK

Use W24X62

Completed Q#02 Page#02/05 to #02/05.

(Q No # 03)

DATA:→ A=36, 18 ft, 50 K, 150 K
A325, 3/4-in, . used ASD?

SOLUTION

Total load = D.L + L.L

= 50 + 150

⇒ 200 Kips or 100 Kip/Angle

For Yielding at the gross area allowable stresses are 0.6 Fy = 0.6 × 36

⇒ 22 KSI

For Fracture at the net are allowable Stresses are

03/02

$0.5 F_u = 0.5 \times 58$

$= 29$ ksi

Since the connection is bored so $A_g \neq A_n$

Now $A_e = 0.85 A_n$

For yielding:

$A_g \times 22 = 75$

$A_g = 75/22$

$= 3.04 \text{ in}^2$

For fracture:

$29 \times A_e = 75$

$A_e = 2.59 \text{ in}^2$

Scanned with CamScanner

Assume 15% reduction in gross Area for holes.

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

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

$A = 3.53 in \simeq 3.58 in^2$ OK

$r_x = 1.59 in$ & with 3/8 in Gap

$r_y = 1.47 in$

$$\frac{L}{r_{min}} = \frac{18 \times 12}{1.47} = 146.93 < 300 \text{ OK}$$

Design of Bolts:-

Using A 325 bolts with Threads Included in Shear plane.

$A = 0.44 \, in^2$ (dia = 3/4")

Allowable bolts are shear = 21 KSI

(Table 2.11 Gaylord)

Since the bolts are in double shear so

Allowable shear per bolts

= 2 × 21 = 0.44 = 18.5 Kips.

Allowable bearing on two 7/16" thick Angle

Long leg = 69.6 × 2 × 7/16 × 0.75

= 45.68 Kips > 18.5 Kips.

Allowable bolts bearing stress

= 1.2 Fu = 1.2 × 58 = 69.6 Ksi

Now No of bolts.

$\frac{200}{18.5}$ = 10.81 or 10 bolts

Design of Gusset plates

Bearing stress = 1.2 Fu.

= 69.6 Ksi

So Allowable bearing = ~~69.6~~ ×

= 69.6 × 10 × 0.75 × t

= 200

t = 0.38 in

Use 3/4" G.P

→ Checking various limit states:→

Yielding $= 0.6 F_y A_g$.

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

$= 162$ Kip > 150 Kips.

Fracture:→ $0.5 \times F_u \times A_e$

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

$\Rightarrow 157$ Kips > 150 K

→ Check for tearing failure.

$L_c = 2P / F_u t$

$1.25 = 2P / 58 \times 0.38 P$

$P = 16.53$ Kips

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

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

$$2 = \frac{2P}{22.04} + 3/4/2$$

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

$$2 \times 22.04 = 2P + 0.37$$

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

$$22.04 = P + 0.37$$

$$P = 21.67 \text{ Kips..}$$

$t = 0.38$..''

use Two 3/4'' G.P

Completed #03
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