⑨

Shohan

mistake

Structure

QUESTION PAPER

1. Draw shear and Bending moment diagram

2. Truss Analysis

Ques paper solve

$v_1 \times 180 - H_1 \times 20 = 90 \times 30 + 100 \times 70 + 60 \times 110 + 120 \times$

$9v_1 - H_1 = 1715$

$9v_1 - 6H_1 = 840$

$54v_1 - \cancel{6H_1} - 9v_1 + \cancel{6H_1} = 1715 \times 6 - 840 = 92.50$

$v_1 \times 180$ [illegible] $- H_1 \times 20$ 2 4

$=$ [illegible] $90 \times 30 + 60 \times 70 + 60 \times 110 + 120 \times 150 = 0$

$\Rightarrow 9v_1 - 2H_1 = 135 + 350 + 330 + 700 = 1715 \longleftarrow$ (i)

$v_1 \times 90 - H_1 \times 60 = 60 \times 20 + 120 \times 60$

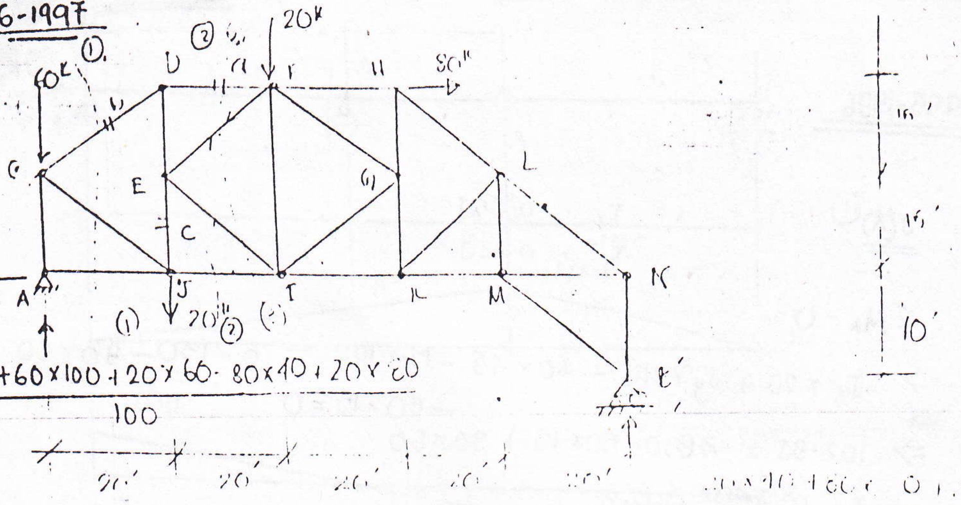
$9v_1 - 6H_1 = 840. \longleftarrow$ (ii)

$4H_1 = 875$

$H_1 = 218.75$

1996-1997

1



$$\frac{80\times 10+60\times 100+20\times 60-80\times 10+20\times 20}{100}$$

$= 64^k$

$$\frac{[illegible]\times 10+60\times 0+20\times 20}{100}$$

36^k

(1)-(1)

$\Sigma M_J = 0$

$$\Rightarrow \frac{F_b}{\sqrt{20^2+15^2}}\times 20\times 15+\frac{F_b}{\sqrt{20^2+15^2}}\times 15\times 20-(60-64)\times 20=0$$

$$\therefore F_b\times\frac{2\times 20\times 15}{\sqrt{20^2+15^2}}=-4\times 20$$

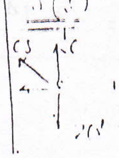
$$\boxed{\therefore F_b=-3.33^k=b}\ (c)$$

J (C)

$F_b = CJ$

$CJ = +3.33^k$ (T)

J (T)

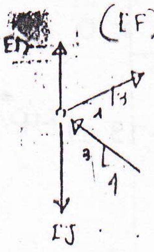


$\Sigma F_y = 0$

$$\therefore T_c+\frac{CJ}{\sqrt{15^2+20^2}}\times 15=20$$

$$\boxed{\therefore T_c = 18.002^k\ (T)}$$

$(EF)_x = (IJ)_x$



(2)-(2)

$\Sigma M_J = 0$

$$\Rightarrow F_a\times 30-60\times 20+64\times 20=0$$

$$\boxed{\therefore F_a=-2.667^k\ (c)}$$

③-③

$\Sigma M_I = 0$

$$\Rightarrow \frac{EF}{\sqrt{15^2+20^2}}\times 20\times 30+F_a\times 30-80\times 30+36\times 3\times 20=0$$

$\therefore EF = 13.33^k$ (T)

1995-1996

14

J(A)

$J_x = 0.55J$

$J_y = 0.83J$

$\Sigma M_A = 0$

$\Rightarrow J_x \times 20 + J_y \times 110 - 60\times 45 - 15\times 100 - 5\times 130 - 30\times 60 + 50\times 15 = 0$

$\Rightarrow 102.3J = 4850 + 50\times 15 + 30\times 60$

$\therefore J = 7400/102.3$

$= 72.33^K$

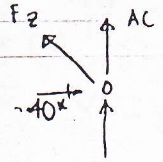
$J_x = 39.78^K = 40^K$ (←)

$J_y = 60^K$ (↑

$A_x = 40^K$ (→)

$A_y = (60 + 15 + 5 + 50 + 30 - 60)^K$

$= 100^K$ (↑



$$\frac{F_2}{\sqrt{5^2+3^2}} \times 3 = 40$$

$$\boxed{F_2 = 77.74^K \text{ (T)}}$$

①-①″

$$\frac{2F_y}{\sqrt{15^2+15^2}} \times 15 = 60+30+15+5-60$$

$$\boxed{F_y = 35.35^{\text{kip}}}$$

$\Sigma M_I = 0$

$$\Rightarrow \frac{MH}{\sqrt{5^2+10^2}} \times 10 \times 20 = 5 \times 3 \times 10$$

$\therefore MH = 8.38^K$

$\Sigma M_H = 0$

$$\Rightarrow \frac{NI}{\sqrt{15^2+10^2}} \times 10 \times 20 = -5 \times 3 \times 10$$

$\Rightarrow NI = -13.52^{\text{kip}}$

$\Sigma F_y = 0$

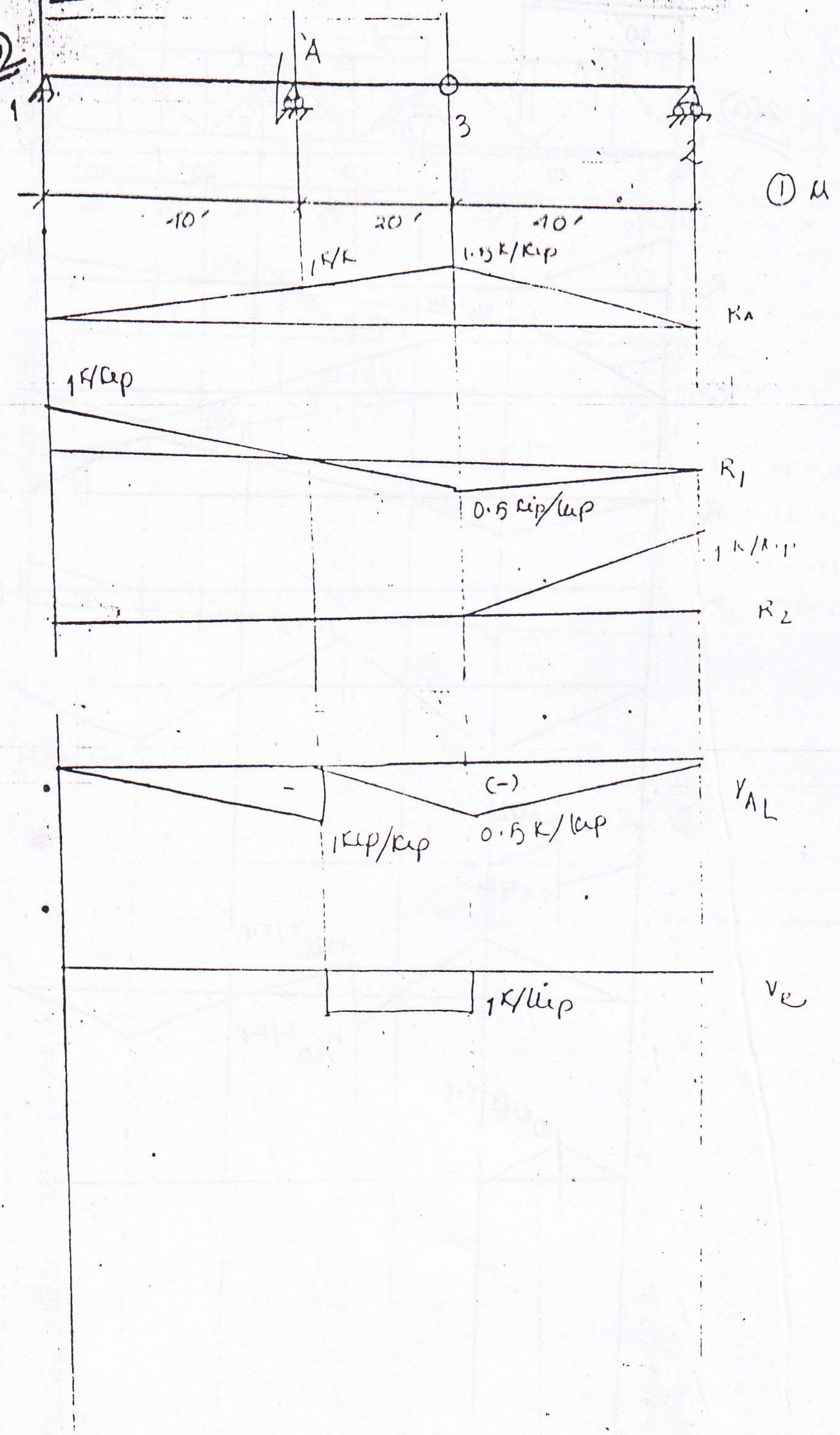
$$\Rightarrow F_x + \frac{MH}{\sqrt{5^2+10^2}} \times 5 + \frac{NI}{\sqrt{15^2+10^2}} \times 15 + 15 + 5 = 0$$

$\Rightarrow F_x + 3.74 + (-11.24) + 20 = 0$

$$\therefore \boxed{F_x = -12.5^K \text{ (C)}}$$

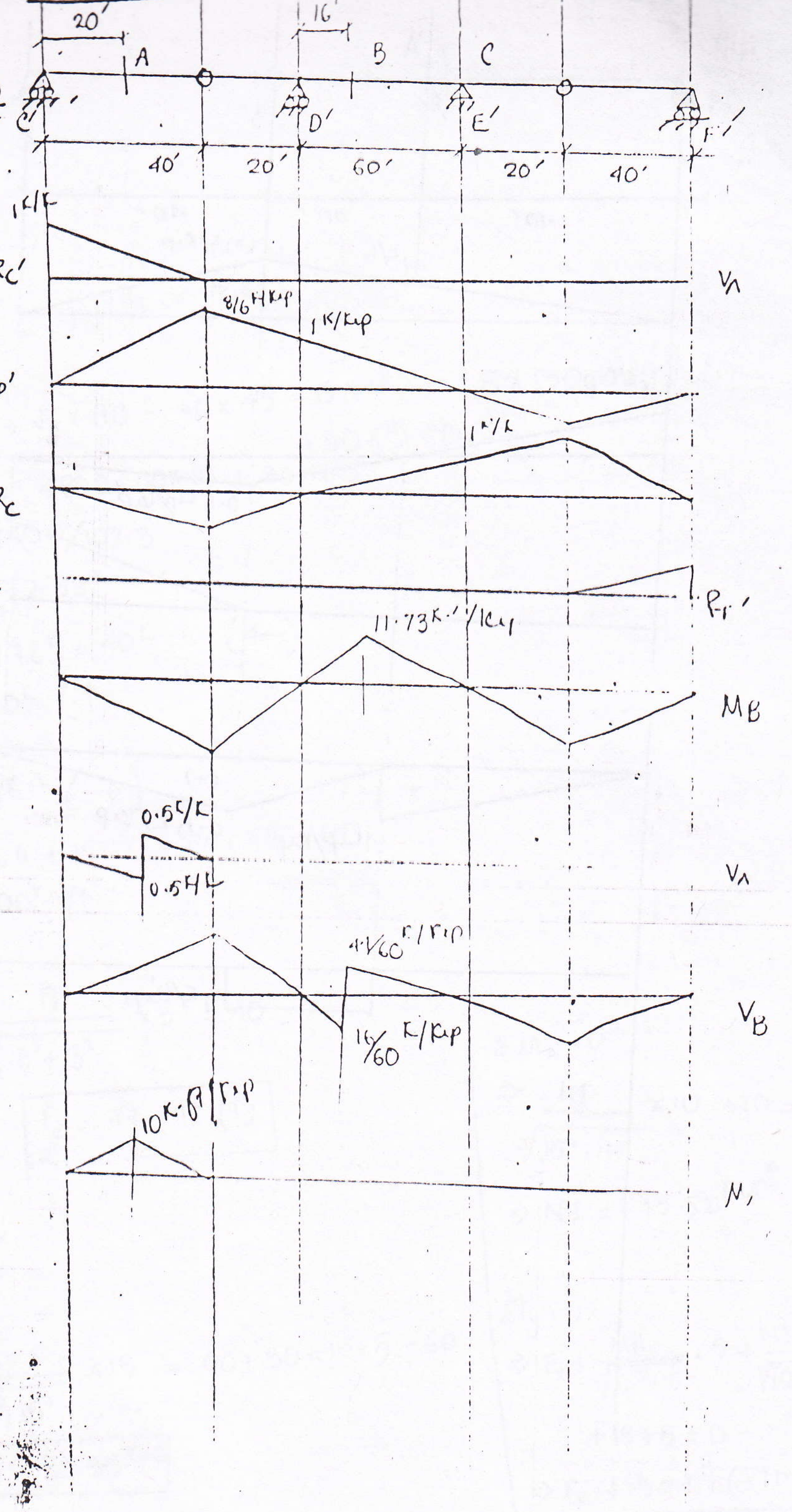
1987-1988

1(b)


A
1
3
2
① M
10'
20'
10'
1 K/K
1.5 K/Kip
R_A
1 K/Kip
R_1
0.5 kip/kip
1 K/Kip
R_2
-
(-)
V_AL
1 kip/kip
0.5 K/kip
V_e
1 K/kip

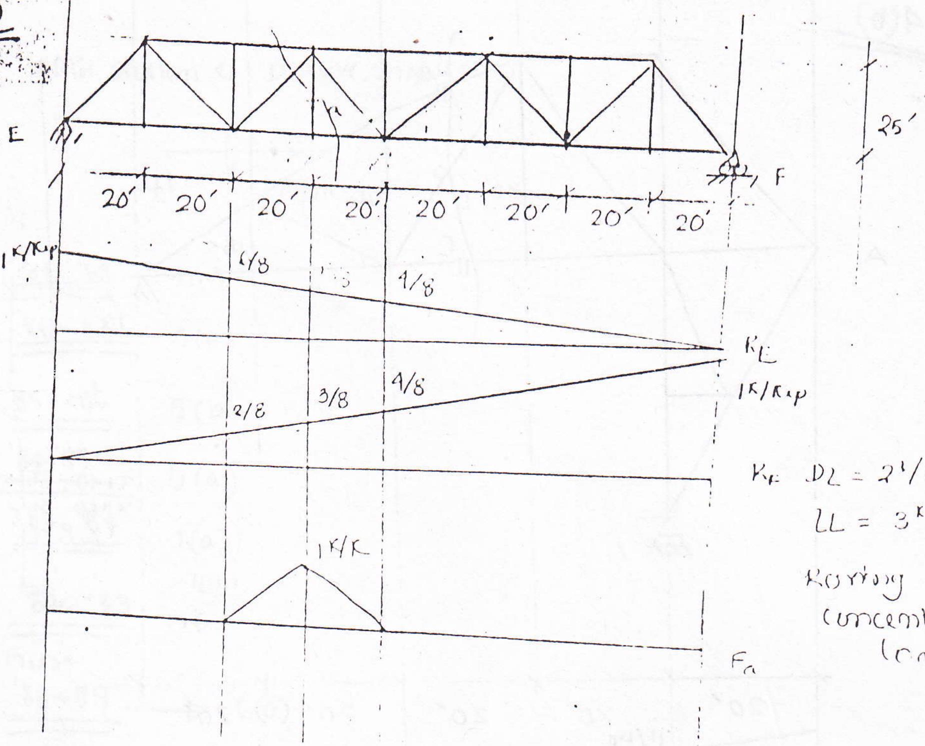
1987 -1988

2(a)


20'
A
16'
B
C
C'
D'
E'
F'
40'
20'
60'
20'
40'
1K/K
Rc'
VA
8/6 K/Kip
1K/Kip
RD'
1K/K
Rc
F
RF'
11.73K-'/Kip
MB
0.5K/K
0.5K/K
VA
4/60 K/Kip
16/60 K/Kip
VB
10K-ft/Kip
M1

1987-1988

2(b)



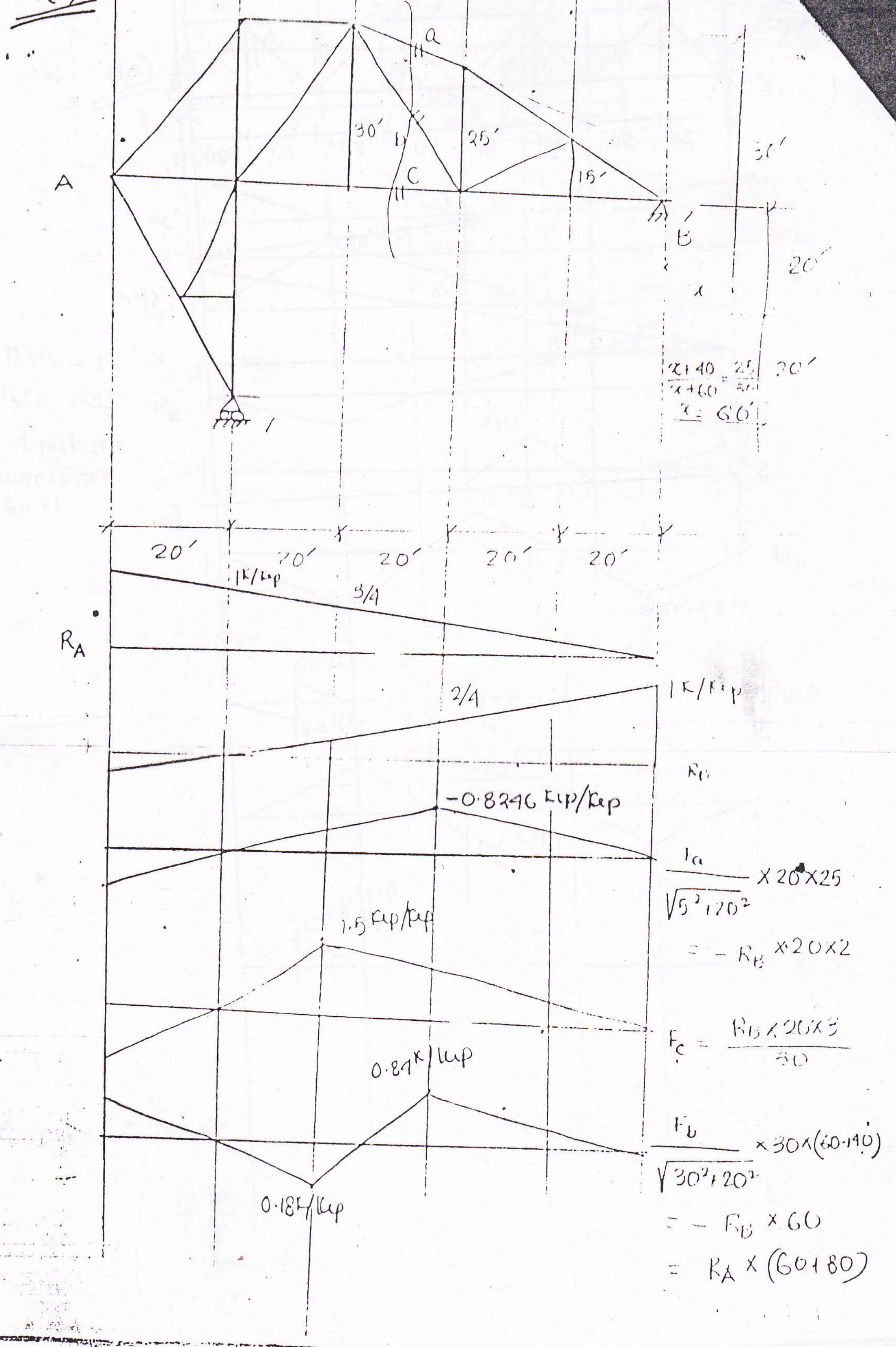
K_F $DL = 2^k/ft$
$LL = 3^k/ft$

Rolling concentrated load = 30^k

Maximu

1987-1988

4(b)



$$\frac{x+40}{x+60} = \frac{25}{30}$$

$$\underline{x = 60'}$$

$$\frac{F_a}{\sqrt{5^2+20^2}} \times 20 \times 25$$

$$= -R_B \times 20 \times 2$$

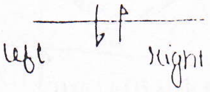
$$F_c = \frac{R_B \times 20 \times 5}{30}$$

$$\frac{F_b}{\sqrt{30^2+20^2}} \times 30 \times (60+40)$$

$$= -R_B \times 60$$

$$= R_A \times (60+80)$$

[illegible] section এ positive shear :



'87 '88	1(a)
'86 - '87	5(a)
'85- '86	5(a
'84-'85	5(a)
'83-'84	1(a)
'82- '83	1(b) 1(

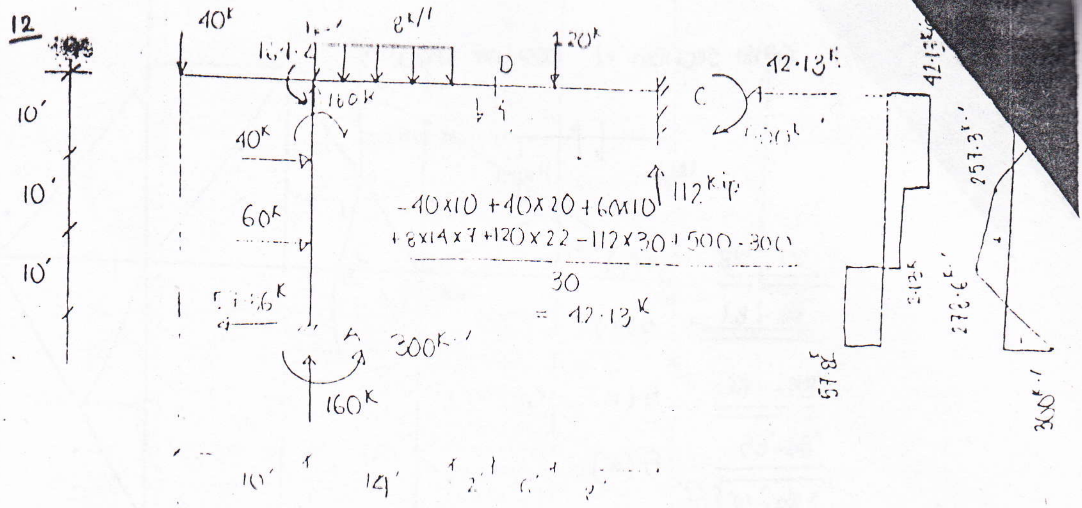
Truss

'88-'89 → 6(a)

1995-1996

SAY

12



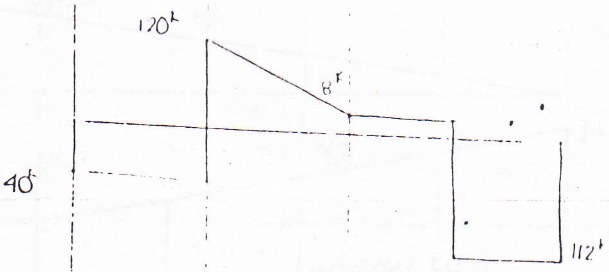
$$\frac{-40\times10+40\times20+60\times10+8\times14\times7+120\times22-112\times30+500-300}{30}$$

$= 42.13^K$

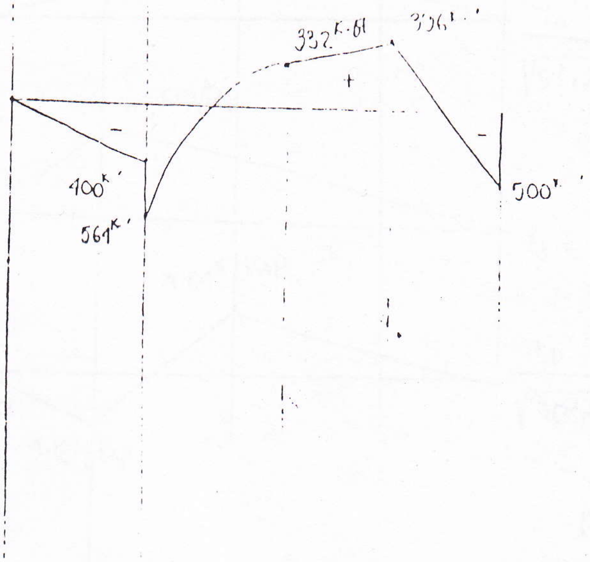
Moment at A = −300^k-ft

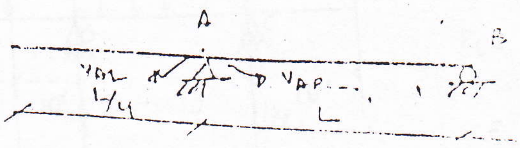
Shear at D = 18^kips

- Moment at C = −500^k-ft



Area − −ve
Moment −ve
concentrated moment
↻ +ve | left
↺ −ve |
left → ↺ −ve
right → ↻ −ve
Concentrated moment
.. put

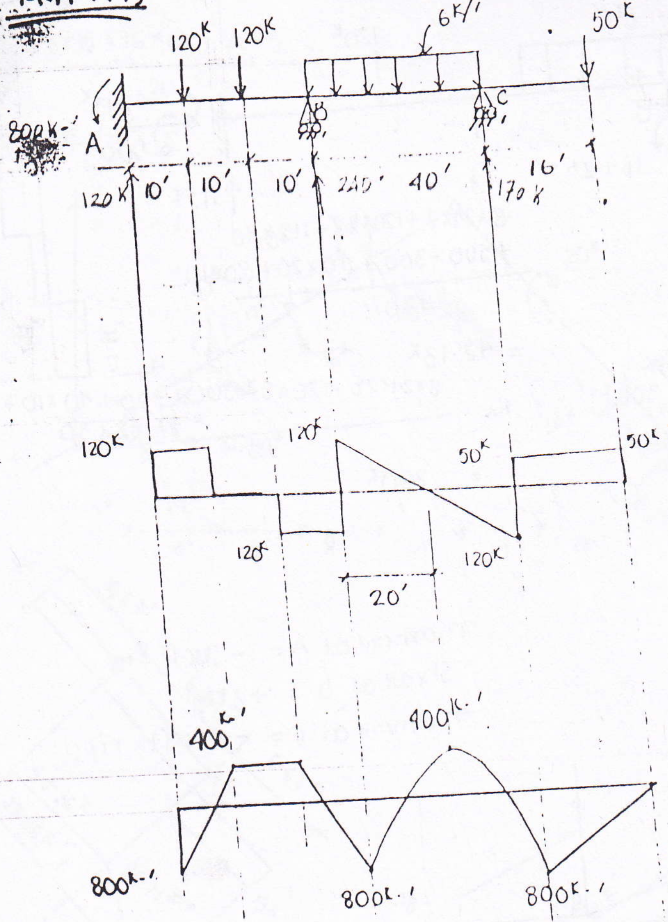




V_{AL} , V_{AR}

1994-1995

3



$$R_B = \frac{120 \times 10 + 120 \times 20 + 6 \times 40 \times 50 + 50 \times 86 - 170 \times 70 - 800}{30}$$

$= 210^K$

moment at A = $-300^K \cdot ft$

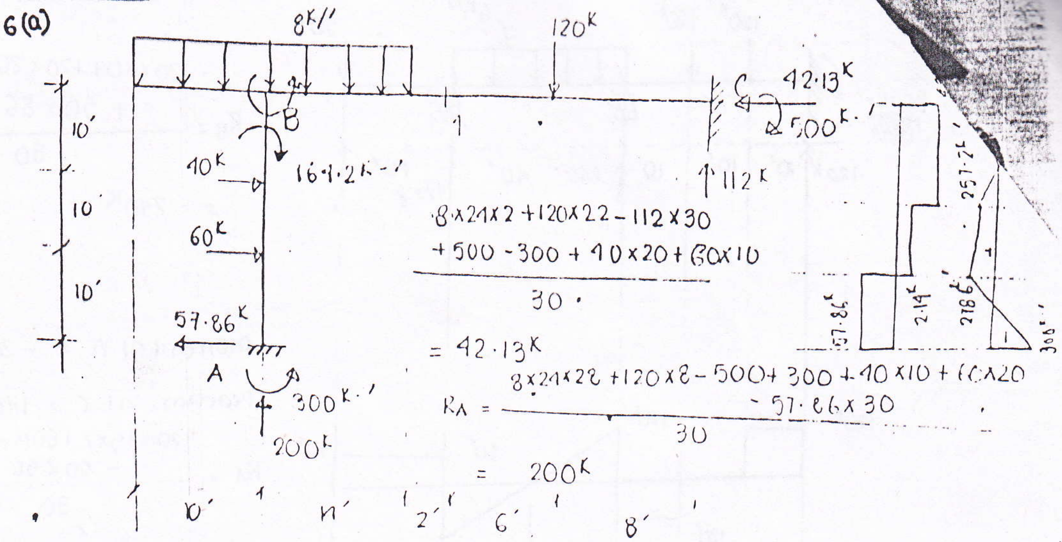
Reaction at C = $110^K \uparrow$

$$R_A = \frac{120 \times 15 \times 2 + 800 - 6 \times 40 \times 20 + 170 \times 40 - 50 \times 56}{30}$$

$= 120^K$

1993-1994

6(a)



$$\frac{8\times21\times2+120\times22-112\times30+500-300+10\times20+60\times10}{30}$$

$$=42.13^K$$

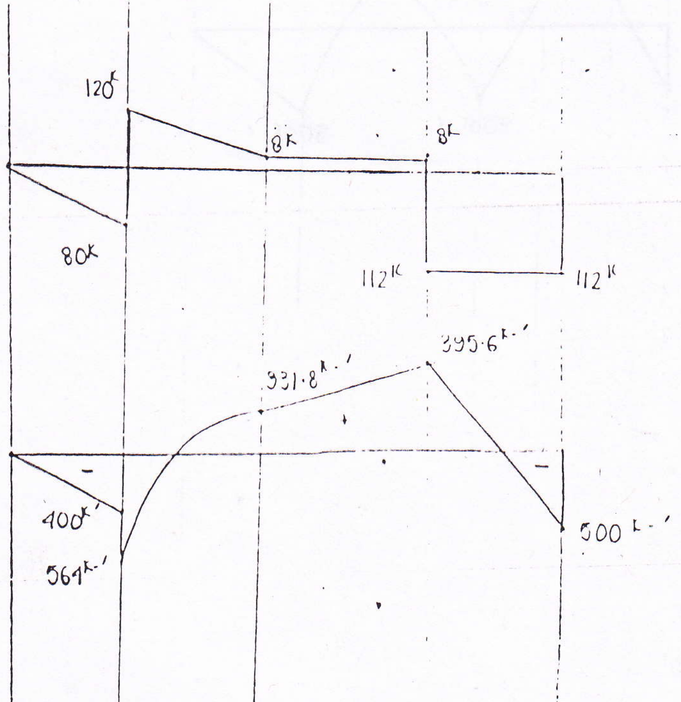
$$R_A=\frac{8\times21\times28+120\times8-500+300+10\times10+60\times20-57.86\times30}{30}$$

$$=200^K$$

moment at A = −300 ft kip

Shear at D = +8 kip

moment at C = −500 ft kip



1992-1993

6(a)

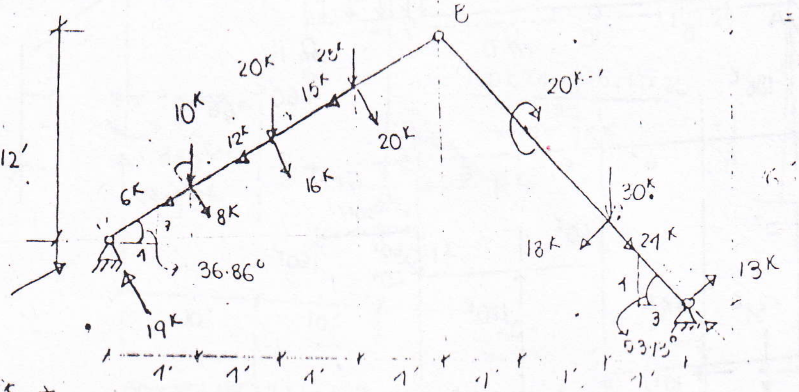
$$\frac{8\times15+16\times10+20\times5}{20}$$

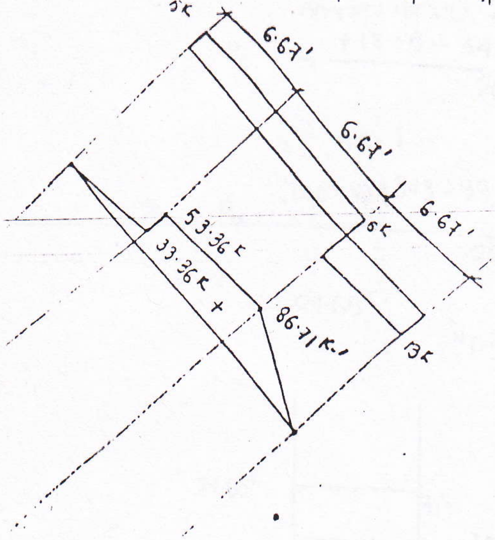
$= 19^K$

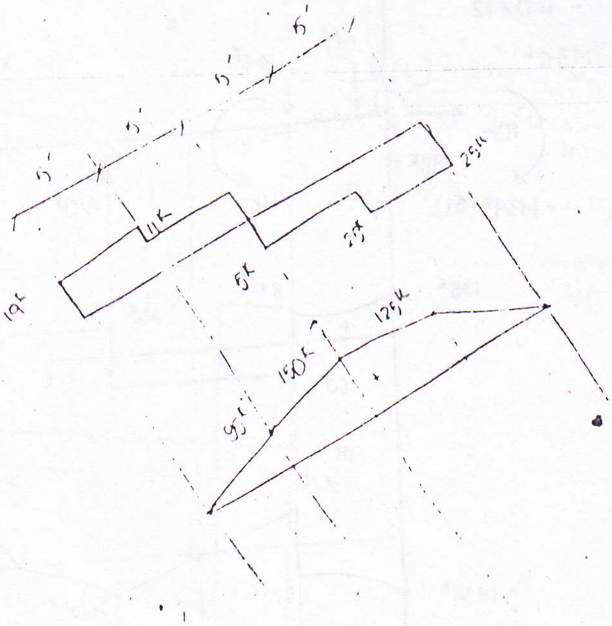
$$\frac{20+18\times6.67\times2}{6.67\times3}$$

$= 12.99^K$

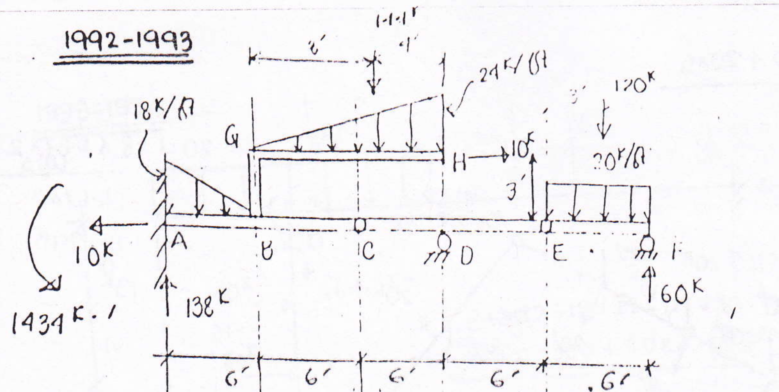
$= 13^K$

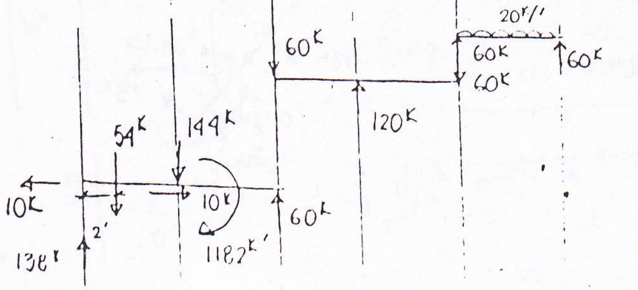




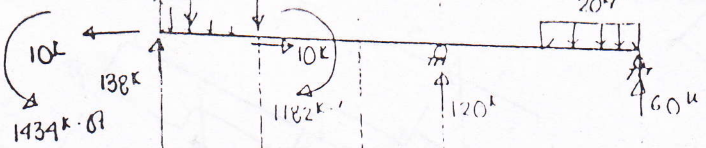


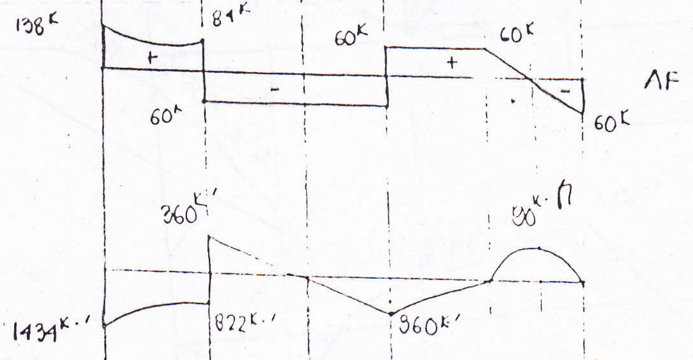
1992-1993

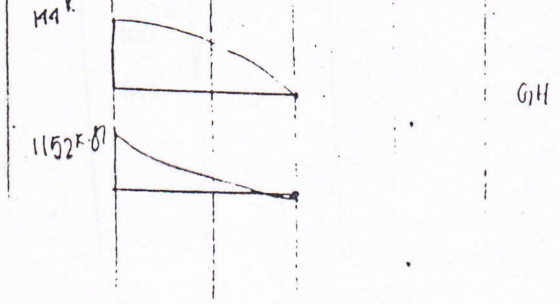




M
= 54x2 + 144x6 + 1182
- 60x12
= 1434k-'



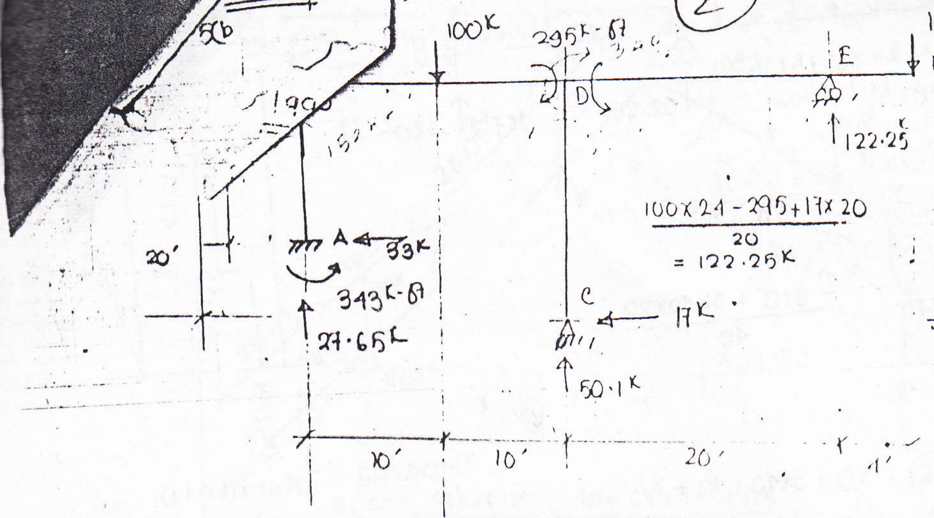




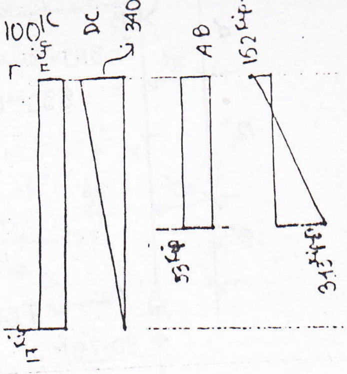
1988-1989

5(b)

②



$$\frac{100\times24-295+17\times20}{20}$$
$$=122.25^K$$



$$R_C=\frac{50\times15+100\times10-122.25\times40+100\times44+17\times5-343}{20}$$

$$=50.1$$

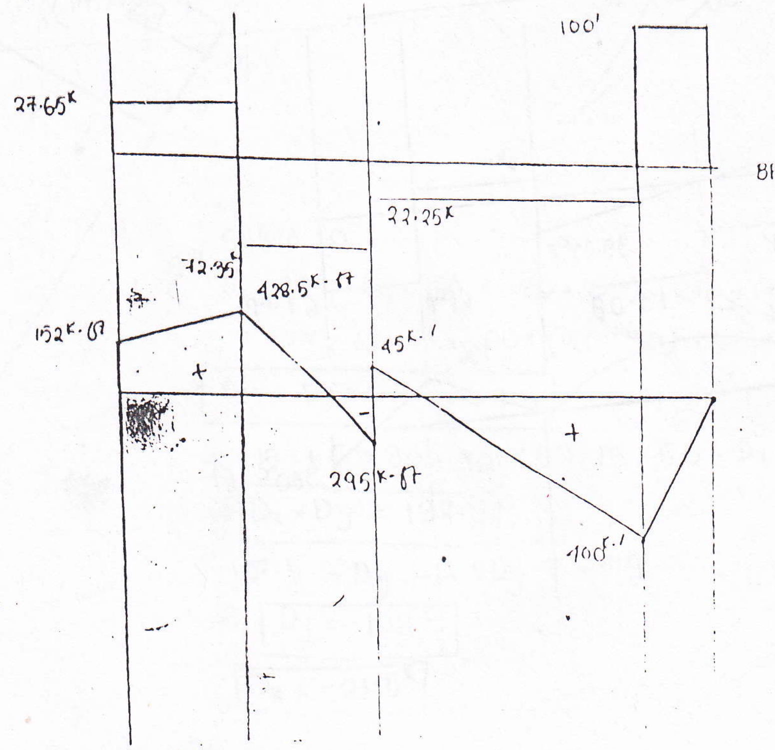
$$R_A=\frac{100\times10+343-33\times15-295}{20}$$

$$=27.65^K$$

Horizontal reaction at A = 33^k (← left)

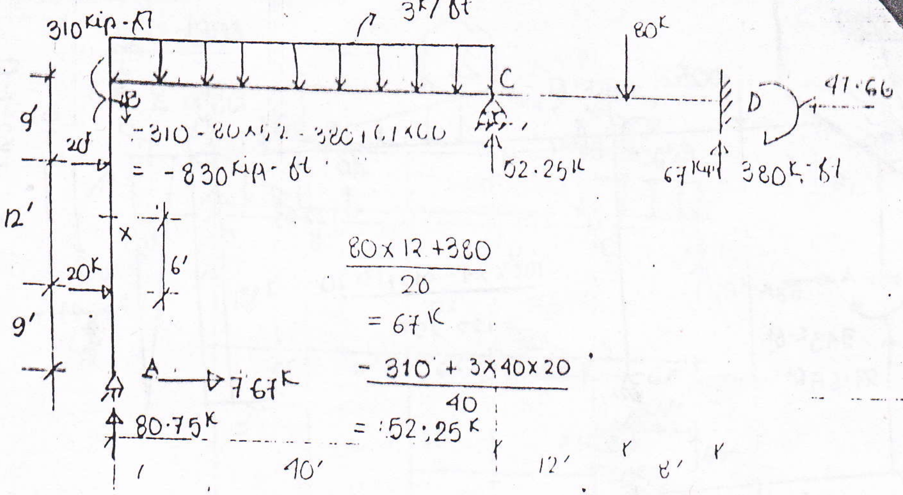
Bending moment, $M_{EF}=295^{k\text{-}ft}$ (tension on the top side)

Bending moment, $M_{AB}=343^{k\text{-}ft}$ (tension on the left side)



1441-1442

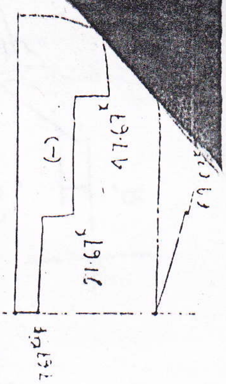
9



$-310-80\times52-380+67\times60$
$=-830$ kip-ft

$$\frac{80\times12+380}{20}$$
$=67^{K}$

$$\frac{-310+3\times40\times20}{40}$$
$=52.25^{K}$



$$\frac{-380+7.67\times30+3\times40\times40+80\times8+20\times9+20\times21-52.25\times20}{60}$$

$=80.75^{K}$

Bending moment at D
= −380^k-ft (tension at top)

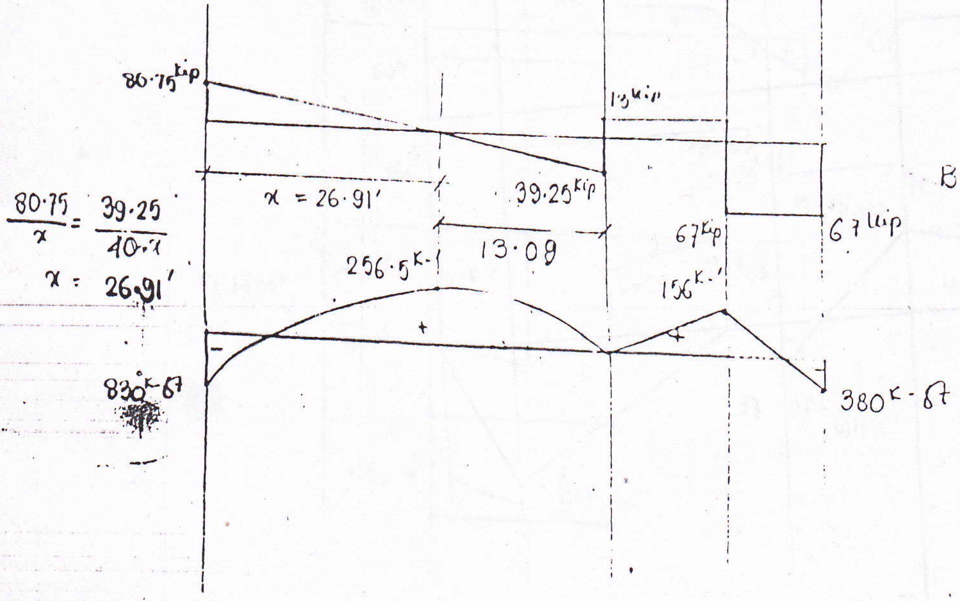
Bending moment at Mbc
= −310 k-ft (tension at top)

Shear force at x = 10.33 ft
(left side goes up gives positive shear)

$$\frac{-830+20\times9+20\times21}{30}=-7.67^{kip}$$

$$\frac{20\times9+20\times21+3\times40\times20-52.25\times40+80\times52-67\times60+380}{30}$$

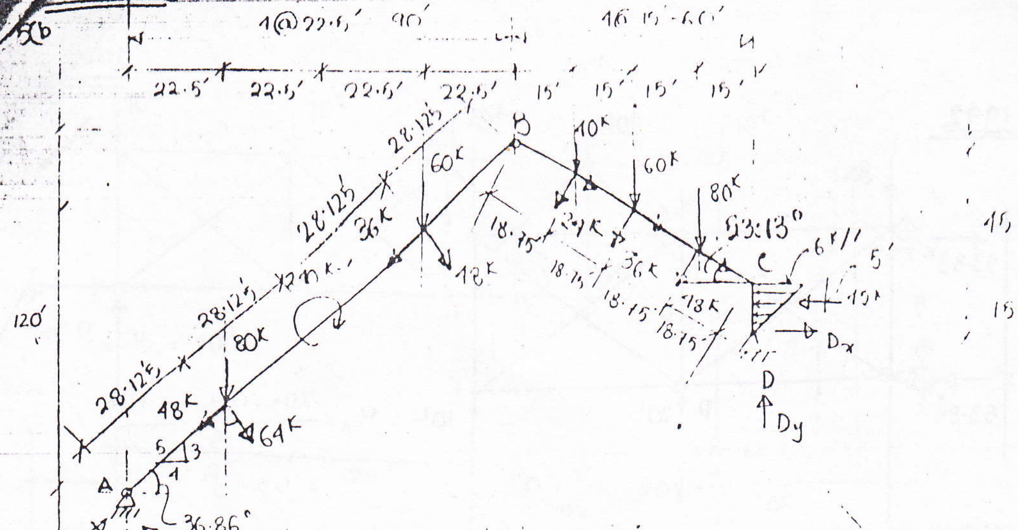
$=47.66^{kip}$



$$\frac{80.75}{x}=\frac{39.25}{40-x}$$
$x=26.91'$

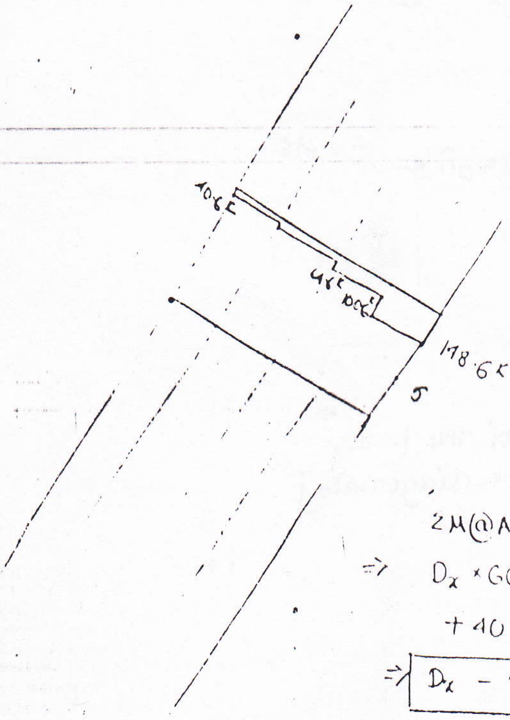
1988-1989

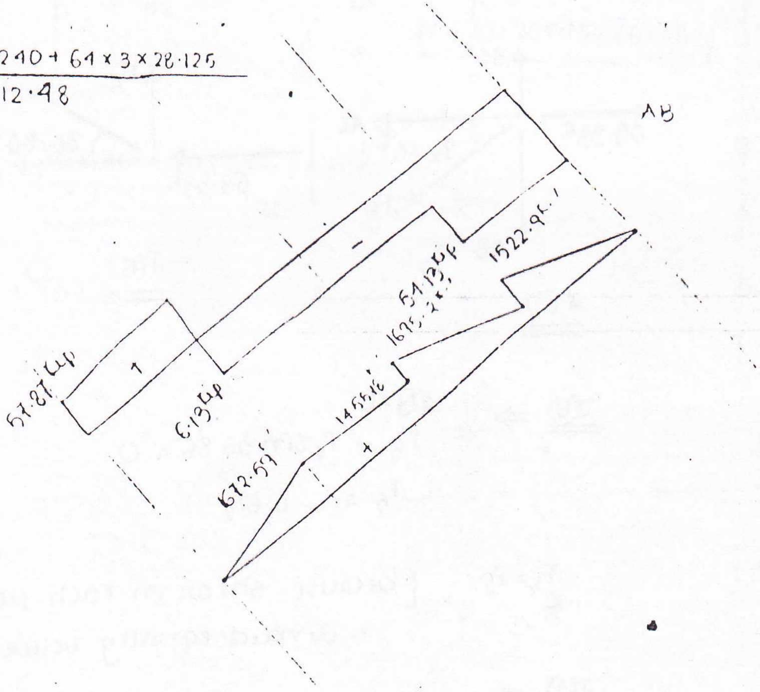
5b



$$R_A = \frac{48 \times 28.125 - 240 + 64 \times 3 \times 28.125}{112.48}$$

$$= 57.87^K$$





$\Sigma M@A = 0$

$\Rightarrow D_x \times 60 - D_y \times 150 + 80 \times 22.5 + 240 + 60 \times 3 \times 22.5$

$+ 40 \times (90+15) + 60 \times (90+30) + 80 \times (90+45) - 45 \times 70 = 0$

$\Rightarrow \boxed{D_x - D_y \times 2.5 = -419}$

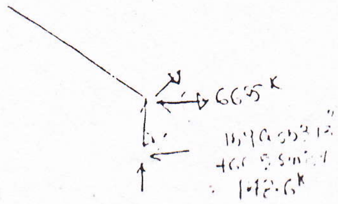
$40 \times 15 + 60 \times 30 + 80 \times 45 + 45 \times 50 - D_x \times 60 - D_y \times 60 = 0$

$\Rightarrow \boxed{D_x + D_y = 137.5}$

$137.5 - D_y - 2.5 D_y = -419$

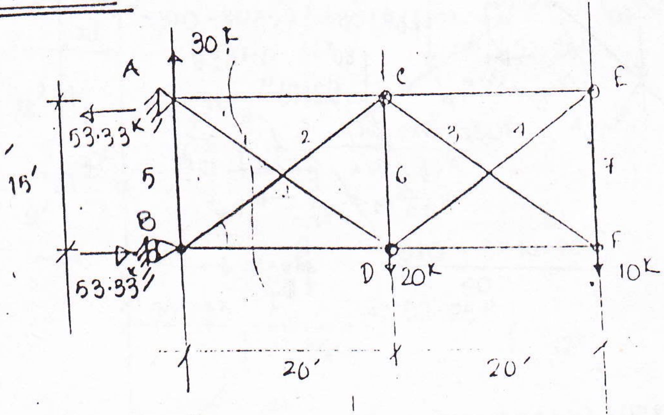
$\Rightarrow \boxed{D_y = 159^K}$

$\boxed{D_x = -21.5^K}$



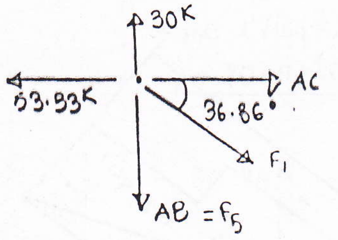
??

<u>1991 – 1992</u>

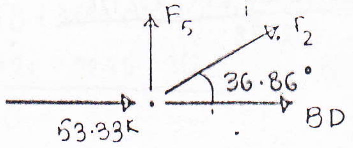


$$R_A = \frac{20\times20 + 10\times40}{15'}$$

$$= 53.33'$$



J(A)



J(B)

J(B) ⇒ $\Sigma F_y = 0$

$F_5 + F_2 \sin 36.86° = 0$

$\therefore F_5 = -0.6F_2$

$F_1 = F_2$ [Because shear in each panel of the truss is divided equally between the diagon

J(A) ⇒ $\Sigma F_y = 0$

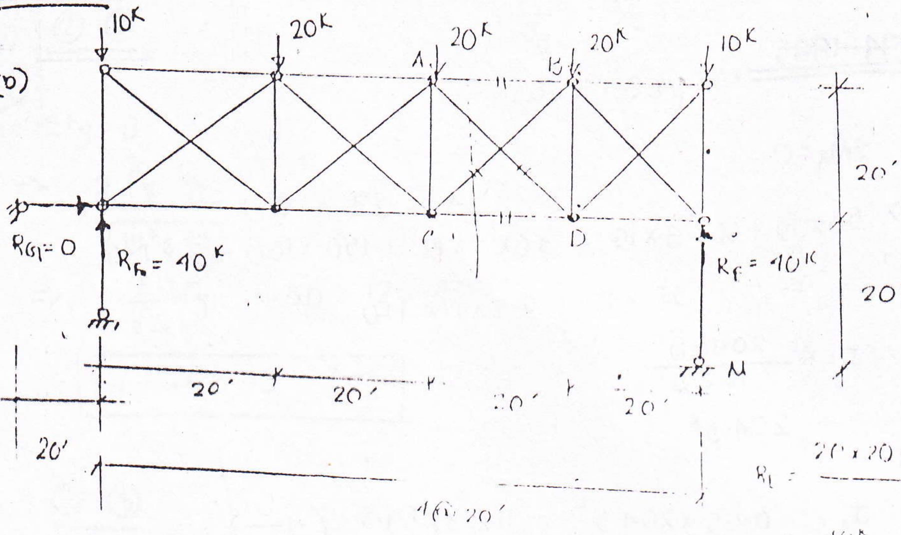
$\Rightarrow 30 - F_5 - F_1 \sin 36$

$\Rightarrow 30 - F_5$

$\Rightarrow$

1989 - 1990

2(b)



$$R_1 = \frac{20\times20+20\times40+20\times60}{80} + 10\times8$$

$$= 40^K$$

$$\Sigma M_M = 0 \Rightarrow R_G = \frac{30\times80 - 20\times60 - 20\times40 - 20\times20}{20}$$

$$= 0$$

$$\Sigma F_x = 0 \Rightarrow R_G = 0$$

1994-1995

7

check

$\Sigma M_A = 0$

$\Rightarrow 50 \times 15 + 60 \times 3 \times 15 + 30 \times 4 \times 15 + 150 \times 100 + 5 \times 130$

$= 0.55J \times 20 + 0.83J \times 110$

$\therefore J = \dfrac{20900}{102.3}$

$= 204.3^{k}$

$J_x = 0.55 \times 204.3^{k} = 112.37^{\text{kips}}$ (←)

$J_y = 0.83 \times 204.3^{k} = 169.6$ kips (↑)

$A_x = 112.37^{\text{kip}}$ (→)

$A_y = (60 + 50 + 30 + 150 + 5 - 169.6)$ kips

$= 125.4^{\text{kip}}$ (↑)

$\Sigma M_J = 0$

$\Rightarrow 30 \times 2 \times 15 + 60 \times 3 \times 15 + 50 \times 5 \times 15 + 112.37 \times 20$

$+ 150 \times 10 - 5 \times 20 = A_y \times 90$

$\therefore A_y = 122.19^{\text{kip}}$ (↑)

①-①′

ΣM @ $D = 0$

$\Rightarrow \dfrac{F_2}{\sqrt{30^2+30^2}} \times 30 \times 30 = 112.37 \times 50$

$$\therefore \boxed{\begin{aligned} F_2 &= 264.85^{K} \text{ (T)} \\ &= 265 \text{ kip (T)} \end{aligned}}$$

$$\frac{J_x}{J_y} = 3/2$$

$$J_x = 1.5 J_y$$

② - ②

$$\Sigma F_y = 0$$

$$\Rightarrow \frac{2 F_y}{\sqrt{15^2 + 15^2}} \times 15 = 50 - A_y$$

$$\Rightarrow \frac{2}{\sqrt{2}} F_y = 50 - 125.4$$

$$\therefore \boxed{F_y = -53.3^{k} \ (c)}$$

③ - ③

$$\Sigma M @ O = 0$$

$$\Rightarrow \frac{MP}{\sqrt{5^2 + 10^2}} \times 10 \times 20 = +5 \times 3 \times 10$$

$$\therefore \boxed{MP = +8.38^{\text{kip}} \ (T)}$$

$$\Sigma M @ M = 0$$

$$\Rightarrow \frac{NO}{\sqrt{15^2 + 10^2}} \times 10 \times 30 = -5 \times 4 \times 10 - 150 \times 10$$

$$\Rightarrow \boxed{NO = -102.15^{\text{kip}} \ (c)}$$

$$\Sigma F_x = 0$$

$$\frac{MP}{\sqrt{5^2 + 10^2}} \times 10 + \frac{F_x}{\sqrt{15^2 + 10^2}} \times 10 + \frac{NO}{\sqrt{15^2 + 10^2}} \times 10 = 0$$

$$\Rightarrow +0.749 + 0.055 F_x + (-5.66) = 0$$

$$F_x = 89.29$$

$$\Sigma F_y = 0$$

$$\frac{F_x}{\sqrt{15^2 + 10^2}} \times 15 - \frac{MP}{\sqrt{5^2 + 10^2}} \times 5 - \frac{NO}{\sqrt{15^2 + 10^2}} \times 15 - 150 + 5 = 0$$

$$\Rightarrow F_x * 0.83 - 3.74 + 84.9 - 145 = 0$$

$$F_x = 76.73^{K} \ (T)$$

1993-1994

7(a)

$\Sigma M_B = 0$

$\Rightarrow 90 \times 15 + 90 \times 4 \times 15 + 80 \times 5 \times 15 + 60 \times 6 \times 15 - 20 \times 6 + 20 \times 5 - 60 \times 2$
$- 80 \times 37 - 60 \times 32.5 = R_{Ay} \times 90$
$- 30 \times 15$

$\therefore R_{Ay} = 122.33$

$R_{Bx} = 130^K (\leftarrow)$

$R_{By} \times 90 = 20 \times 15 + 80 \times 15 + 90 \times 30 + 90 \times 75 - 130 \times 1$
$+ 60 \times 117 + 80 \times 129 + 60 \times 47.5 + 30 \times 30$

$R_{By} = 334.33^K$

$\Sigma F_y = 0$

$\Rightarrow R_{By} = -122.33 + 60 + 80 + 90 + 90 + 60 + 80$
$= 337.67^K (\uparrow)$

$\Sigma M_d = 0$

$$\Rightarrow \frac{F_a}{\sqrt{15^2 + 17.5^2}} \times 15 + 30 \times 0 + 20 \times 2 \times 15 = 0$$

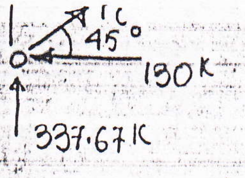
$$\boxed{\therefore F_a = -921.95^K (C)}$$

$$\frac{h+15}{17.5} = \frac{h+30}{20}$$

$$\boxed{h = 90'}$$

$\Sigma M_x = 0$

$\Rightarrow F_b = ?$



$$\Sigma F_x = 0$$

$$\Rightarrow \frac{F_c}{\sqrt{2}} = 130$$

$$\Rightarrow F_c = \sqrt{2} \times 130^k \quad (T)$$

$$\boxed{F_c = 183.847^k (T)}$$

1992 -1993

7(a)

$\Sigma M_A = 0$

$\Rightarrow \quad 12 \times (16+8) + 24 \times 20 = R_B \times 48$

$\therefore R_B = 16^k$

$R_X(x) = 24^K \; (\leftarrow)$

$\Sigma M_B = 0$

$\Rightarrow \quad 12 \times (16+8) + 24 \times 10 - 24 \times 30 = R_{A(y)} \times 48$

$\therefore R_{Ay} = -4^K \; (\downarrow)$

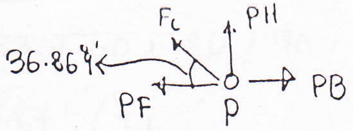
$\Sigma M_D = 0$

$\Rightarrow \quad F_a \times 6 = 16 \times 6$

$\therefore \boxed{F_a = 16^K \; (T)}$

② - ②

F_b

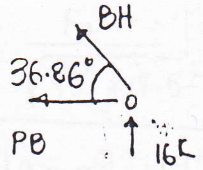


③ - ③

$\Sigma M_E = 0$

$\Rightarrow \; FP \times 12 + 12 \times 8 - 16 \times 32 = 0$

$\therefore FP = 34.667^K \; (T)$



$BH(\sin 36.86°) = -16$

$\therefore BH = -26.67^K \; (C)$

$PB + BH(\cos 36.86°) = 0$

$\Rightarrow PB = 26.67 \times 0.8$

$= 21.33^k \; (T)$

$F_c(\cos 36.86°) + PF - PB = 0$

$\Rightarrow \quad F_c \times 0.8 + 34.667 - 21.33 = 0$

$\therefore \boxed{F_c = -16.67^K \quad (C)}$

②-②

$$\Sigma M_p = 0$$

$$\Rightarrow F_a \times 12 + \frac{F_b}{\sqrt{8^2+6^2}} \times 8 \times 12 + 16 \times 16 = 0$$

$$\Rightarrow 192 + 9.6F_b + 256 = 0$$

$$\therefore \boxed{F_b = -46.67^k \ (C)}$$

1992 - 1993

1(b) $\Sigma M_A = 0$

$\Rightarrow -50 \times 20 + 10 \times 2 \times 20 + 40 \times 30 + 10 \times 20 = R_B \times 90$

$\Rightarrow R_B = \frac{800^k}{90}$

$\therefore R_B = 8.88^k \uparrow$

$\Sigma M_B = 0$

$\Rightarrow -40 \times 50 + 10 \times 50 + 10 \times 70 + 30 \times 90 + 50 \times 110 + 40 \times 20$

$= R_{Ay} \times 90$

⑦

$\Rightarrow \therefore R_{Ay} = 91.11^k (\uparrow)$

$R_{Ay} = 50 + 30 + 10 + 10 - 8.88$

$= 91.12^k$

①-①

$\Sigma M_F = 0$

$A_G \times 20 - 40 \times 20 + 50 \times 20 = 0$

$AG = 10^k$ (T)

$\Sigma M_G = 0$

$\Rightarrow \frac{FD}{\sqrt{10^2 + 20^2}} \times 20 \times 30 - 30 \times 20 + 91.1 \times 20 - 50 \times 40 = 0$

$\therefore FD = 1.29 \times \sqrt{10^2 + 20^2}$

$\boxed{FD = 28.84^k (T)}$

$= 30^k (T)$

$\Sigma F_y = 0$

$$\Rightarrow \frac{F_a}{\sqrt{20^2+20^2}} \times 20 - \frac{F_D}{\sqrt{10^2+20^2}} \times 10 - 30 - 91.1 - 50 = 0$$

$$\Rightarrow F_a \times 0.707 - 13.416 - 30 - 91.1 - 50 = 0$$

$$\therefore F_a = 184.516 / 0.707^K$$

$$= 260.9^K\ (T)$$

$$\boxed{F_a = 261^K\ (T)}$$

② - ②

$\Sigma M_G = 0$

$$F_b \times 30 - 30 \times 20 + 91.1 \times 20 - 50 \times 40 = 0$$

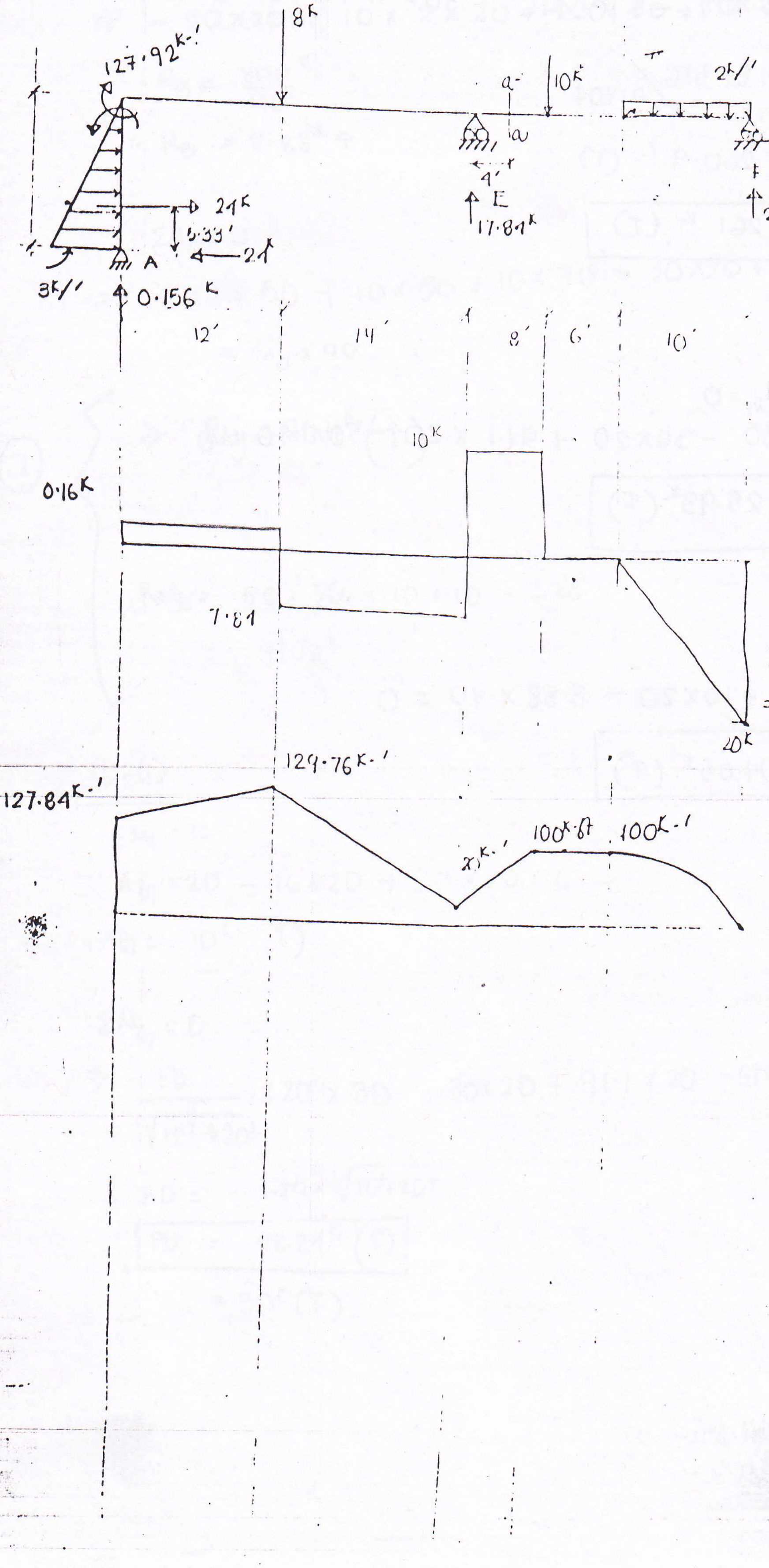
$$\boxed{F_b = 25.93^K (T)}$$

$\Sigma M_D = 0$

$$F_c \times 30 + 10 \times 20 - 8.88 \times 70 = 0$$

$$\therefore \boxed{F_c = 14.05^K\ (T)}$$

1982-1983



$-R_T + 20 + 10 = 10$

$R_F = 20^K$

$$R_E : \frac{24\times5.33+8\times12+10\times3 +20\times45-20\times50}{26}$$

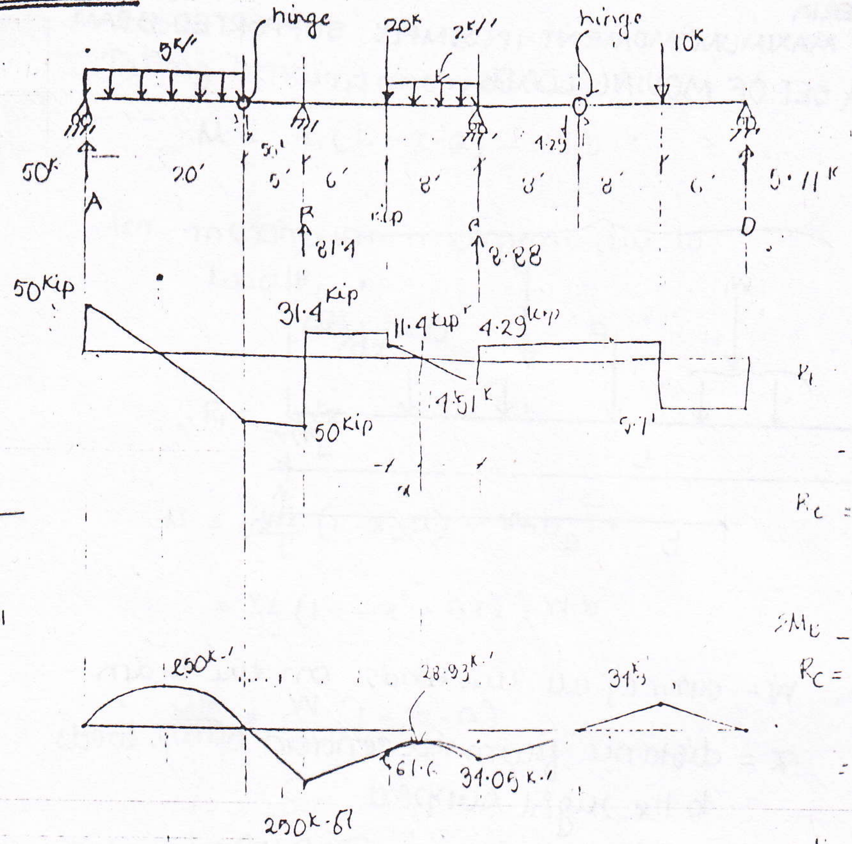
$= 17.84^{Kip}$

$\Sigma M_E = 0$

$$\Rightarrow R_{Ay} = \frac{8\times14-24\times10.67+24\times +10\times8+20\times19-20\times24}{26}$$

$= -0.156^K$

1982-1983



$$\frac{x}{8-x} = \frac{11.4}{4.51}$$

$$\frac{8-x}{x} = \frac{4.51}{11.4}$$

$$= \frac{8}{x} - 1$$

$$x = 5.73'$$

$$R_1 = \frac{-4.29 \times 8 + 16 \times 4 + 20 \times 8 + 50 \times 19}{14}$$

$$= 81.4$$

$$R_C = \frac{20 \times 6 + 16 \times 10 + 4.29 \times 22 - 50 \times 5}{14}$$

$$8.88^k$$

$$\Sigma M_D$$

$$R_C = \frac{-100 \times 15 + 50 \times 25 + 20 \times 6 + 16 \times 10 + 10 \times 30 - 5.71 \times 36}{14}$$

$$= 8.88^k$$

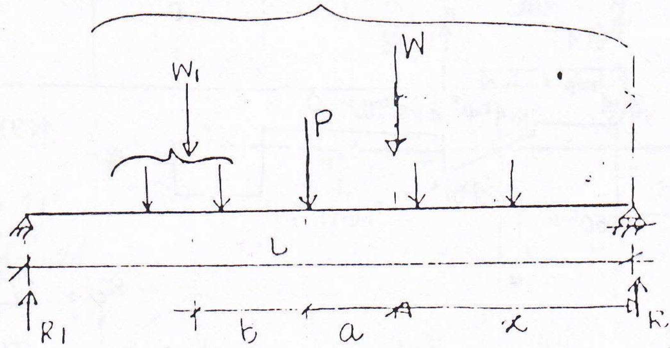
$$R_B = 50 - 100 - 20 - 16 - 8.88 - 10 + 5.71$$

$$= -81.4^k (\uparrow)$$

$$R_B = \frac{16 \times 4 + 20 \times 8 + 100 \times 20 - 50 \times 39 - 10 \times 16 + 5.71 \times 22}{14}$$

$$= 81.4^{kip} (\uparrow)$$

DERIVE THE CRITERIA FOR 'ABS MAXIMUM' MOMENT IN SIMPLY SUPPORTED BEAM DUE TO A SET OF MOVING LOADS:



In the figure, W = sum of all the loads on the beam

x = distance from the centroid of all loads to the right support

P = one of the loads on the beam and a its distance from c.g of all loads.

W_1 = sum of all loads to the left of P

b = distance from the centre of gravity of W_1 to P

R_1 = reaction at left support

R_2 = reaction at right support

Taking bending moment, at P,

$$M = R_1(L-x-a) - W_1 b$$

for maximum moment due to load P.

$$dM/dx = 0$$

$$R_1 = \frac{Wx}{L}$$

$$M = \frac{Wx}{L}(L-x-a) - W_1 b$$

$$= \frac{W}{L}(Lx - x^2 - ax) - W_1 b$$

$$\frac{dM}{dx} = \frac{W}{L}(L-2x-a)$$

$$= 0$$

$$L-2x-a=0$$

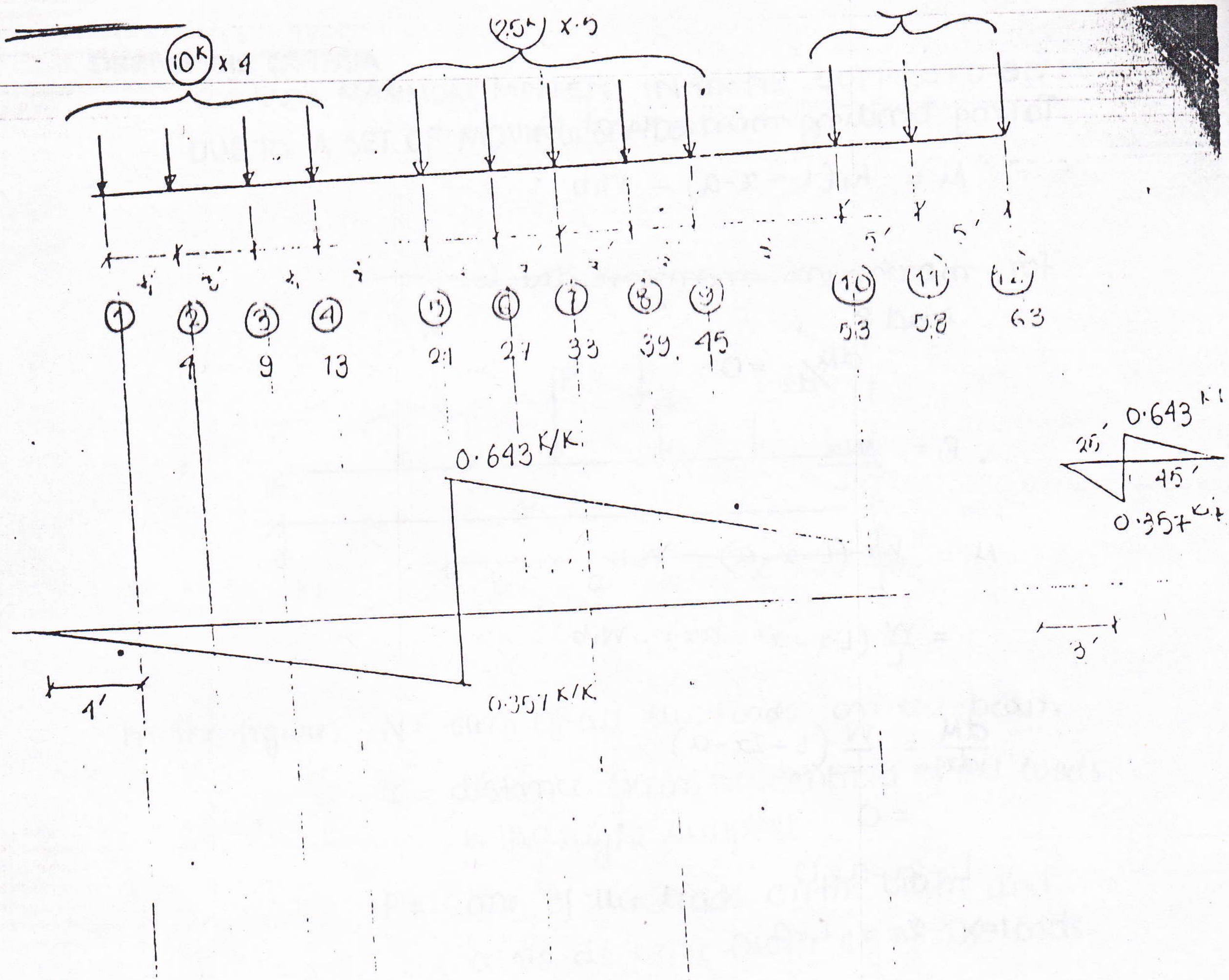
$$\Rightarrow 2x = L-a$$

$$\therefore x = L/2 - a/2$$

That is, the maximum moment under any load will occur when that load and the centre of gravity of all the loads on the beam are equidistant from the centre of the beam.

$$\boxed{x = L/2 - a/2}$$

Criteria for absolute maximum moment location for a load



$$\Delta V = \frac{\Sigma P d_1}{L} - P_1 + \frac{P_1 e_1}{L} + \frac{P_2 e_2}{L}$$

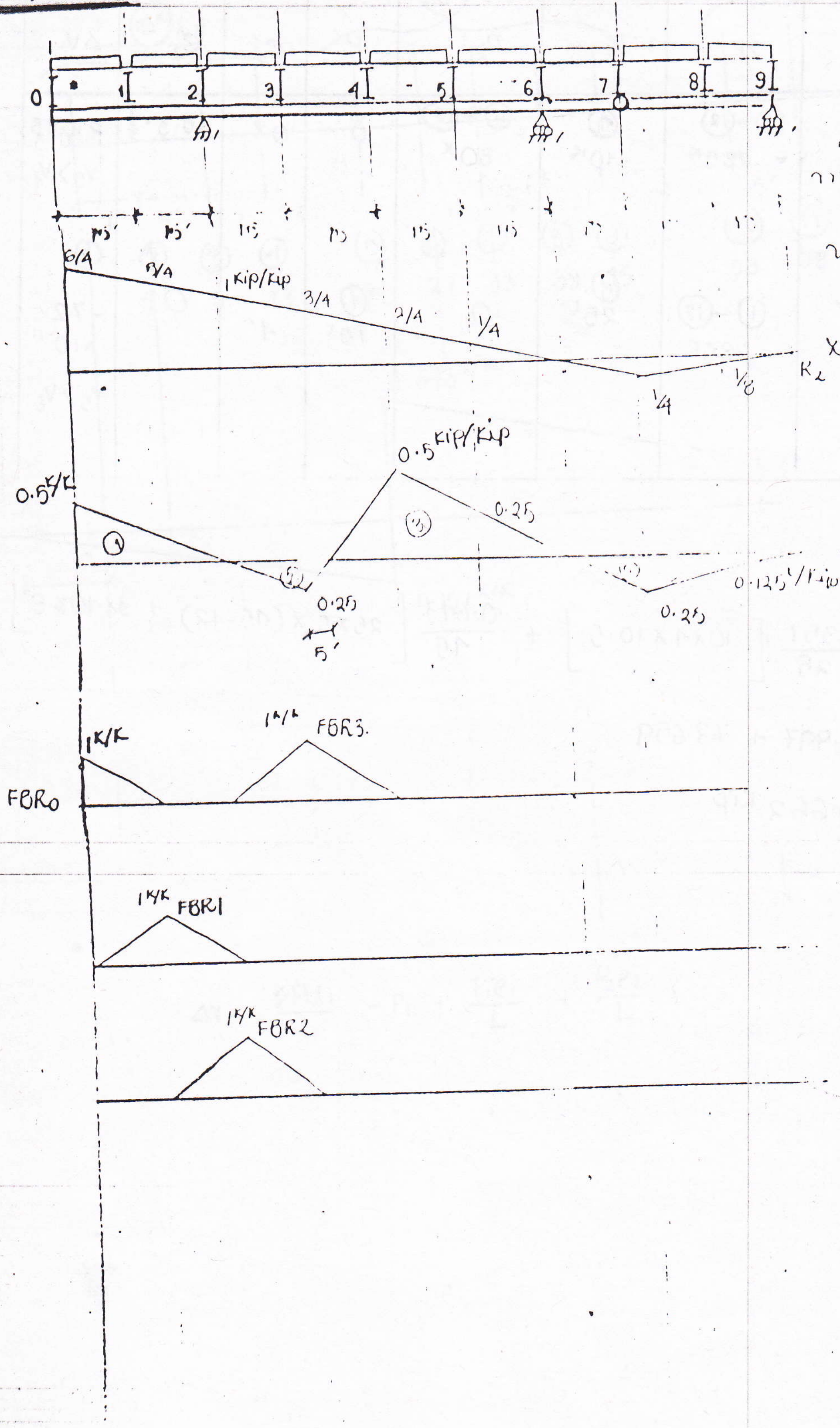
WHEEL POSITN	d_1	ΣP	P_1	P_2	P'	e'	e_2	ΔV
W_1 at C to W_5 at C	8'	① − ⑫ = 285^K	⑦ 10^K	⑪ + ⑫ 80^K	0	0	0.5'	28.85 $V_5 > V_1$
W_5 at C to W_6 at C	6'	① − ⑫ = 285^K	⑤ 25^K	0	① 10^K	-1'	0	-7.2×10^{-11} $V_5 > V_6$

$$V_{max} = -\frac{0.357}{25}\left[10 \times 1 \times 10.5\right] + \frac{0.613}{15}\left[25 \times 5 \times (15-12) + 3 \times 10 \times 8\right]$$

$$= -5.997 + 72.659$$

$$= 66.662 \text{ kip}$$

1982-1983



V_{3-4}

[illegible]

uniform moving
load = 3K/ft

Moving concentrated
load = 10K

V_{3-4} = R2 - FBR0 -
FBR1 - FBR3

uniform moving load —

maximum shear in panel 3-4

① = $\frac{1}{2} \times 0.5 \times 2 \times 15 = 7.5$

② = $\frac{1}{2} \times 0.25 \times (15+5) = 2.5$

③ = $\frac{1}{2} (10+30) \times 0.5 = 10$

④ = $\frac{1}{2} \times 0.25 \times 45 = 5.625$

$\frac{0.25}{x} = \frac{0.5}{15-x}$

$x = 5'$

$V_{max} = \cancel{(7.5 - 2.5 + 10 - 5.625) \times 3} + 0.5 \times 10$

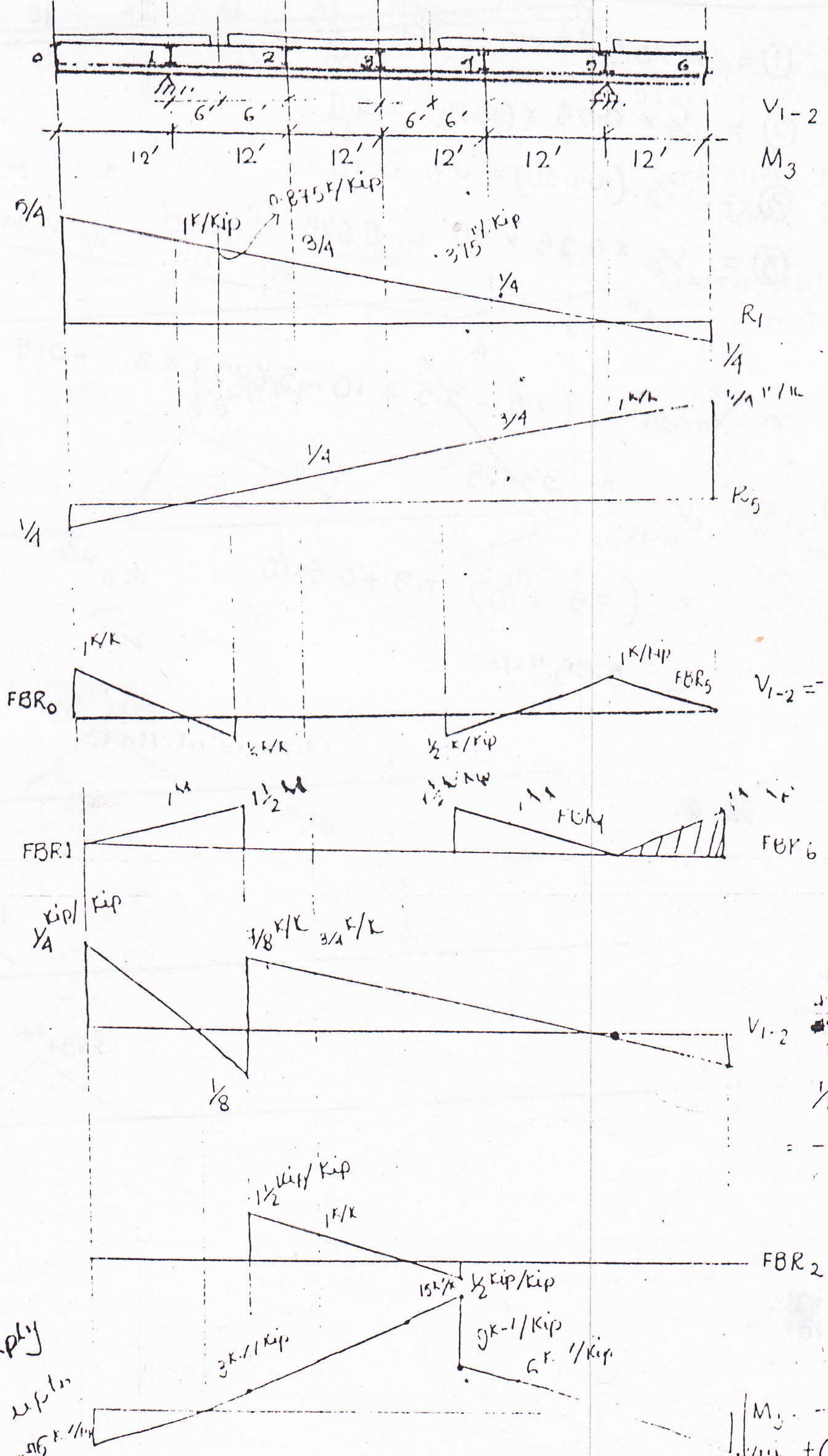
$= \cancel{33.125^K}$

$= (7.5 + 10) \times 3 + 0.5 \times 10$ ✓

$= 57.5$ kip

Alhamdulillah.

1982-1983



$V_{1-2} = -FBR_0 - FBR1 + R1$

$\frac{1}{8} + \frac{1}{2} - 1\frac{1}{2}$

$\frac{1}{8} - 1$

$= -\frac{1}{8}$

$(\frac{5}{4} - 0) \times \overset{6}{\cancel{24}} - 1 \times 36$

$= -6^k \cdot ft/kip$

$(0.875 - 1.5) \times 24 + 0.5 \times 36$

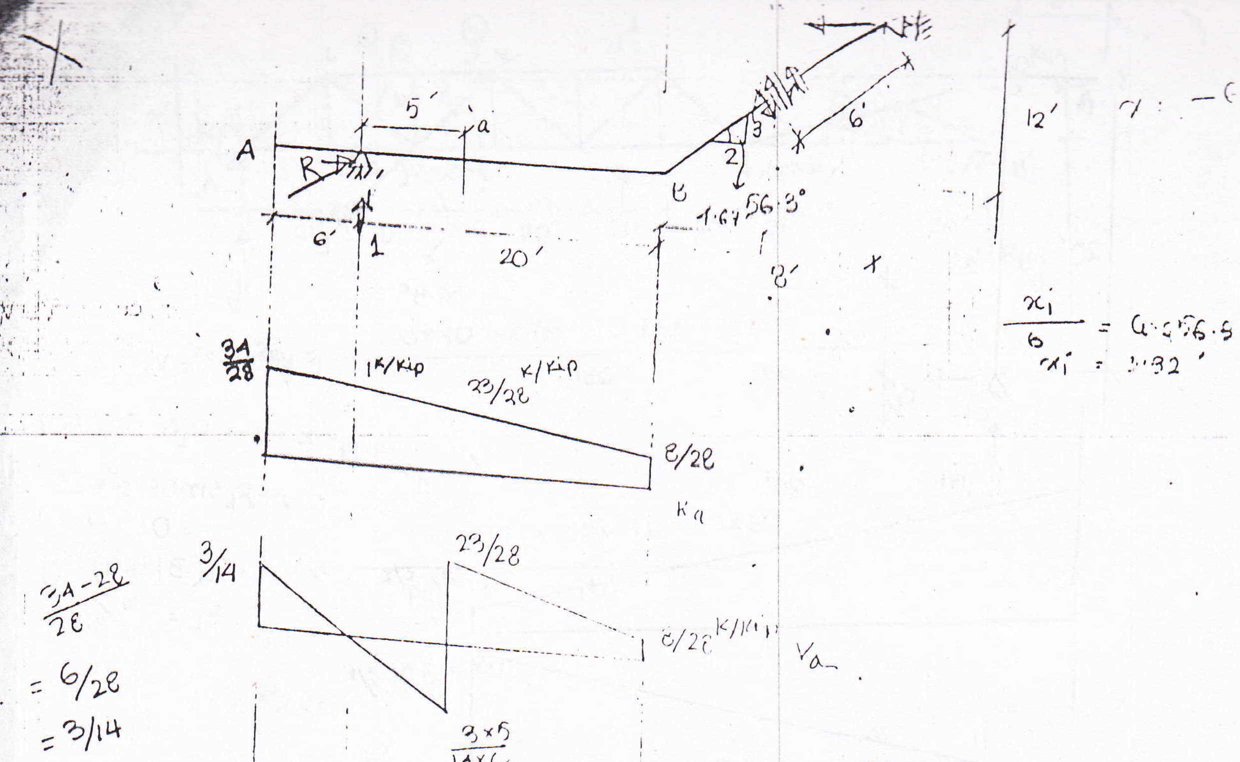
$= 3$

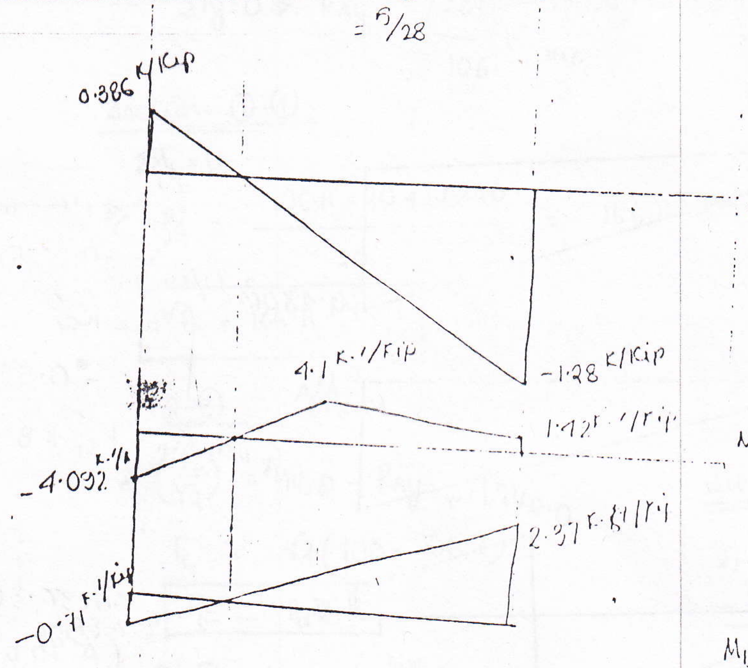
① overhang in between

② M_3 1.. 3 simply supported continue upto the overhang

$M_3 = -FBR_6 \times 36 + (FBR_5 - R_5) \times 24 - FBR_4 \times 12$

$M_3 \cdot -FBR_0 \times 36 + (R1 - FBR1) \times 24 - FBR2 \times 12$





A to a.

$V_a = -1+R_F$

a to B

$V_a = R_F$

V_b

$V_b \cos 56.3° = -1+R_F$

$V_b = \frac{-1+R_F}{\cos 56.3°}$

$M_a = 1.8(-1+R_1)$

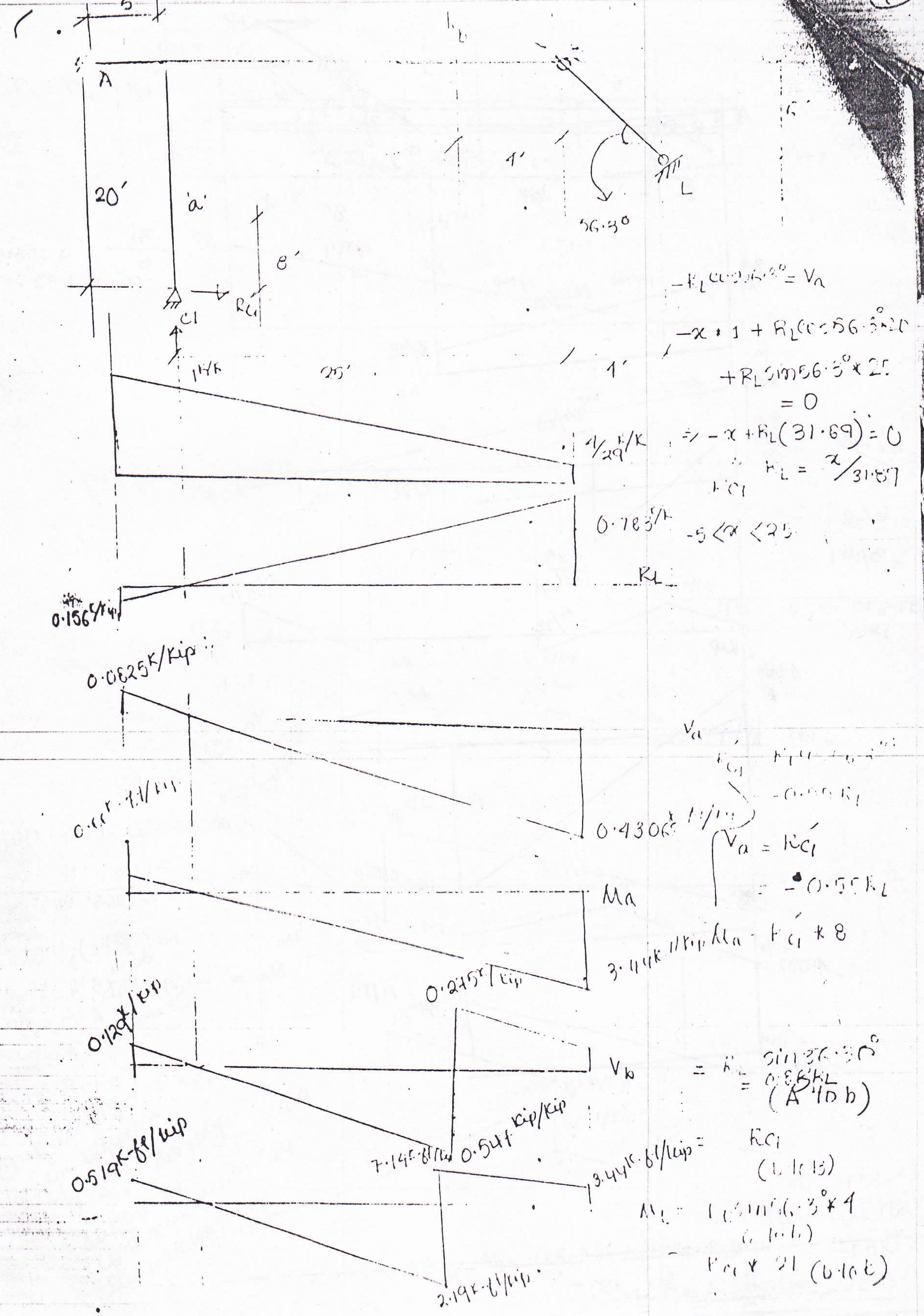
$M_a = -1(x)+R_F\times5$ (A to a)

$M_b = R_F\times5$ (a to B)

$M_b = -1(x+1.67)$
$+R_1\times(x+1.67)$

0 → 26

1982-1983



$-R_L\cos 56.3^\circ = V_a$

$-x \cdot 1 + R_L\cos 56.3^\circ \times 20 + R_L\sin 56.3^\circ \times 25 = 0$

$\Rightarrow -x + R_L(31.69) = 0$

$\therefore R_L = x/31.69$

$-5 < x < 25$

$V_a = R_{C1} = -0.55R_L$

$M_a = R_{C1} \times 8$

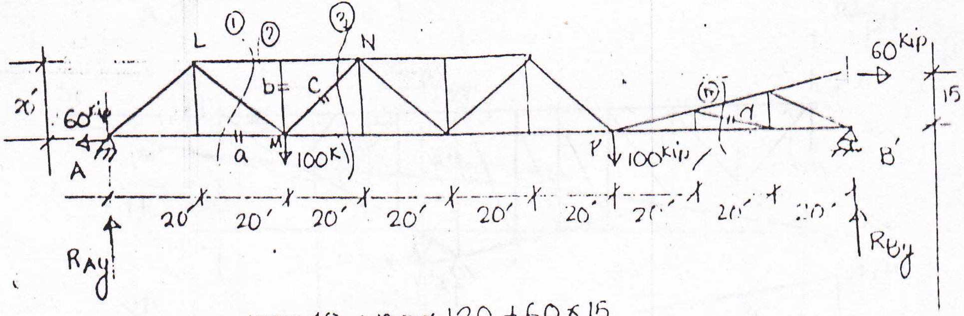
$V_b = R_L\sin 56.30^\circ = 0.83R_L$ (A 10 b)

$= R_{C1}$ (b 10 b)

$M_L = R_L\sin 56.3^\circ \times 4$ (b 10 b) $- R_{C1} \times 21$ (b 10 c)

⊛

1982-1989



$$R_{By} = \frac{100\times40 + 100\times120 + 60\times15}{180}$$

$$= 93.88^{K}$$

$$R_{Ay} = \frac{-60\times15 + 100\times140 + 100\times60}{180}$$

$$= 106.11^{kip}$$

$$\Sigma F_y = 0 \Rightarrow R_{Ay} = (200 - 93.88)^{C}$$

$$= 106.\ ^{kip}$$

Section ①-①

$\Sigma M_L = 0$

$$\Rightarrow F_a = \frac{106.11\times20 + 60\times20}{20} = 166.11^{kip}$$

$$\boxed{F_a = 166.11^{kip}}$$

③-③ Shear

$$\left(\frac{F_c}{\sqrt{2}}\right) = 100 - R_{Ay}$$

$$F_c = \sqrt{2}(100 - 106.2)$$

$$\boxed{F_c = 8.76^{K}}$$

②-②

$$F_b + \frac{F_c}{\sqrt{2}} = 100 - R_{Ay}$$

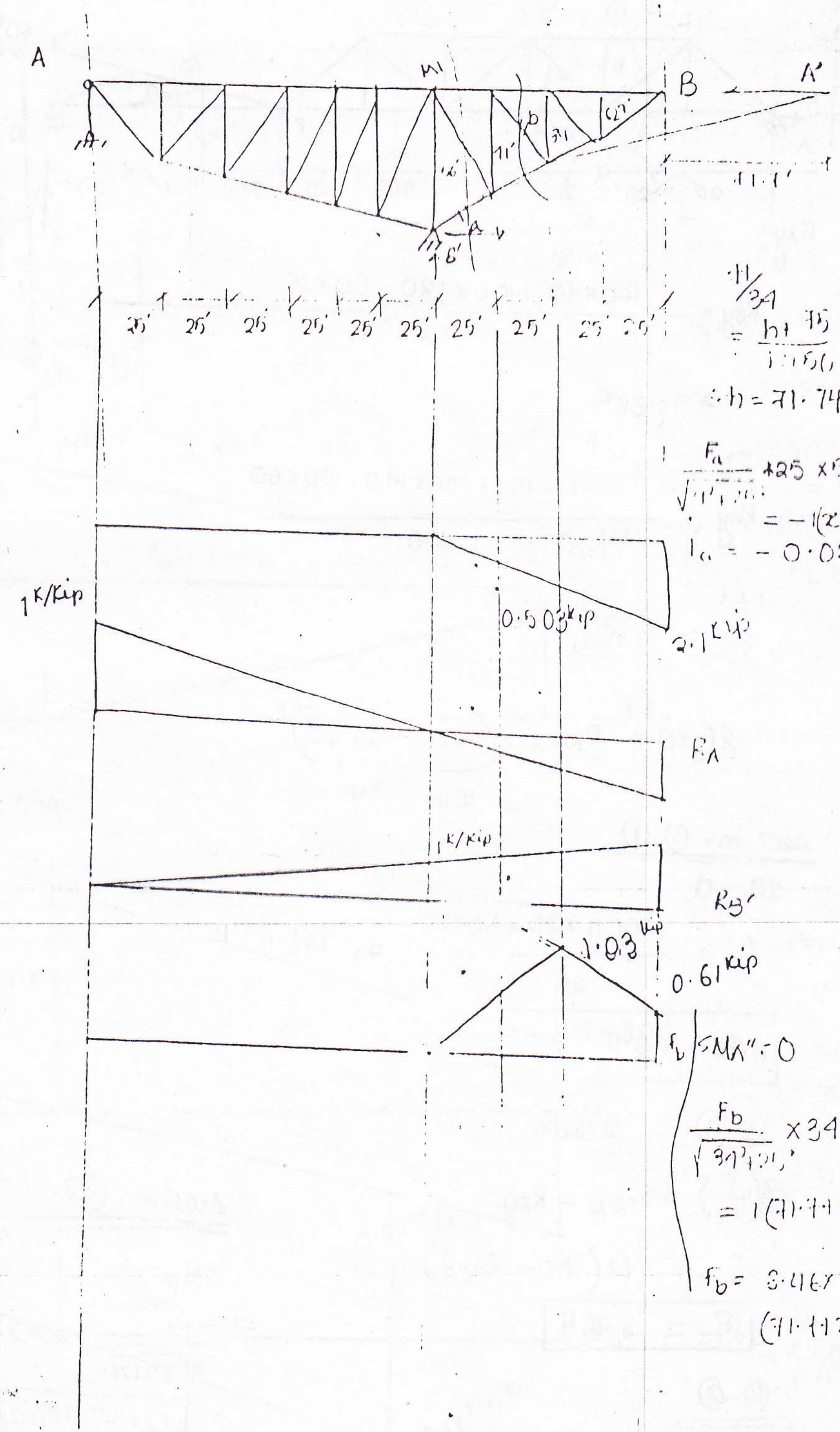
$$\boxed{F_b = 0}$$

Section (n) : n

ΣM_P

$$\Rightarrow \frac{-F_d}{\sqrt{2\,+20}} \times 20\times2 + 60 \times 15 - 93.8\times$$

$$\boxed{F_d = -2139.1 (c)}$$



$\frac{11}{34} = \frac{h+75}{1156}$

$\therefore h = 71.74'$

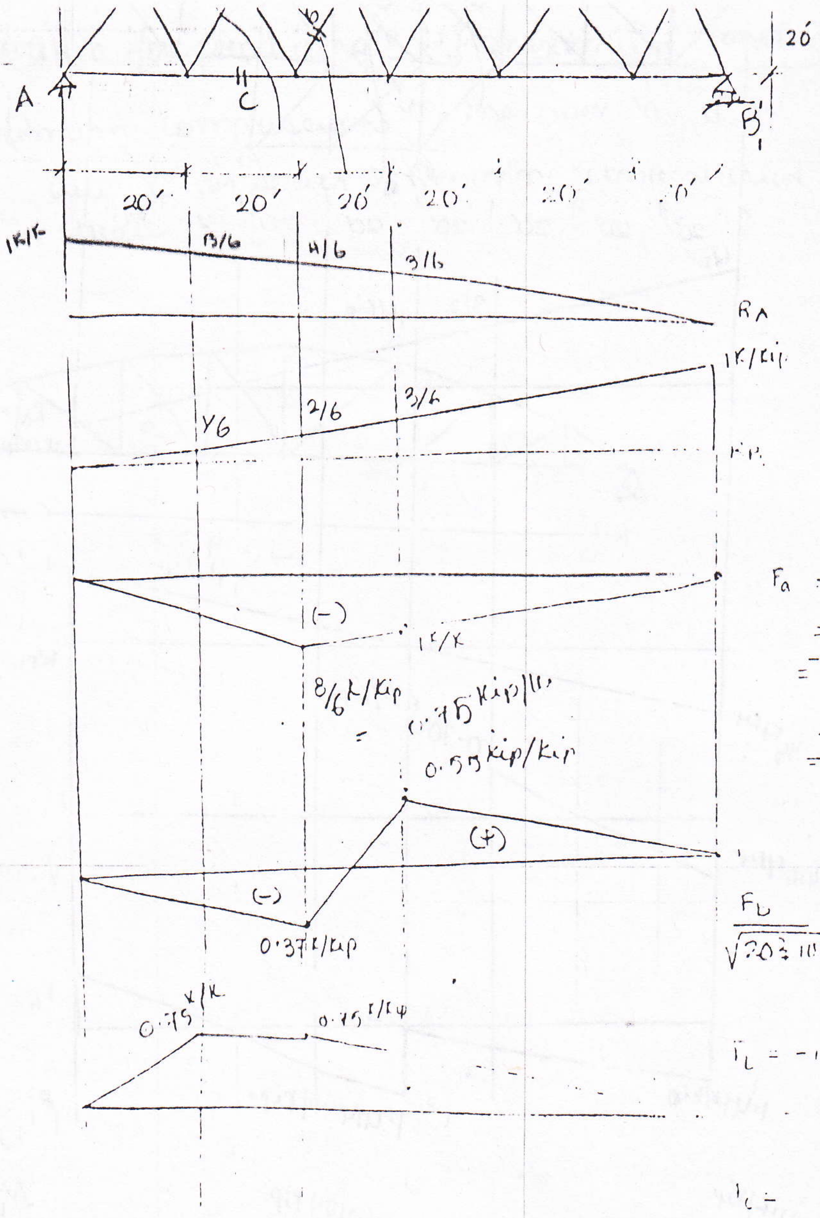
$\frac{F_a}{\sqrt{11^2+25^2}} \times 25 \times 50 = -1(x)$

$F_a = -0.0201\, x^{kip}$

$\Sigma M_{A''} = 0$

$\frac{F_b}{\sqrt{34^2+25^2}} \times 34 \times (71.7 + 175) = 1(71.74 + x)$

$F_b = 8.467 \times 10^{-3} (71.74 + x)$



$$F_a = \frac{-R_B \times 20 \times 4}{20}$$

$$= -R_B \times 4$$

$$= \frac{-R_A \times 20 \times 2}{20}$$

$$= -(R_A \times 2)$$

$$\frac{F_b}{\sqrt{20^2 + 100}} \times 20 = -R_B$$

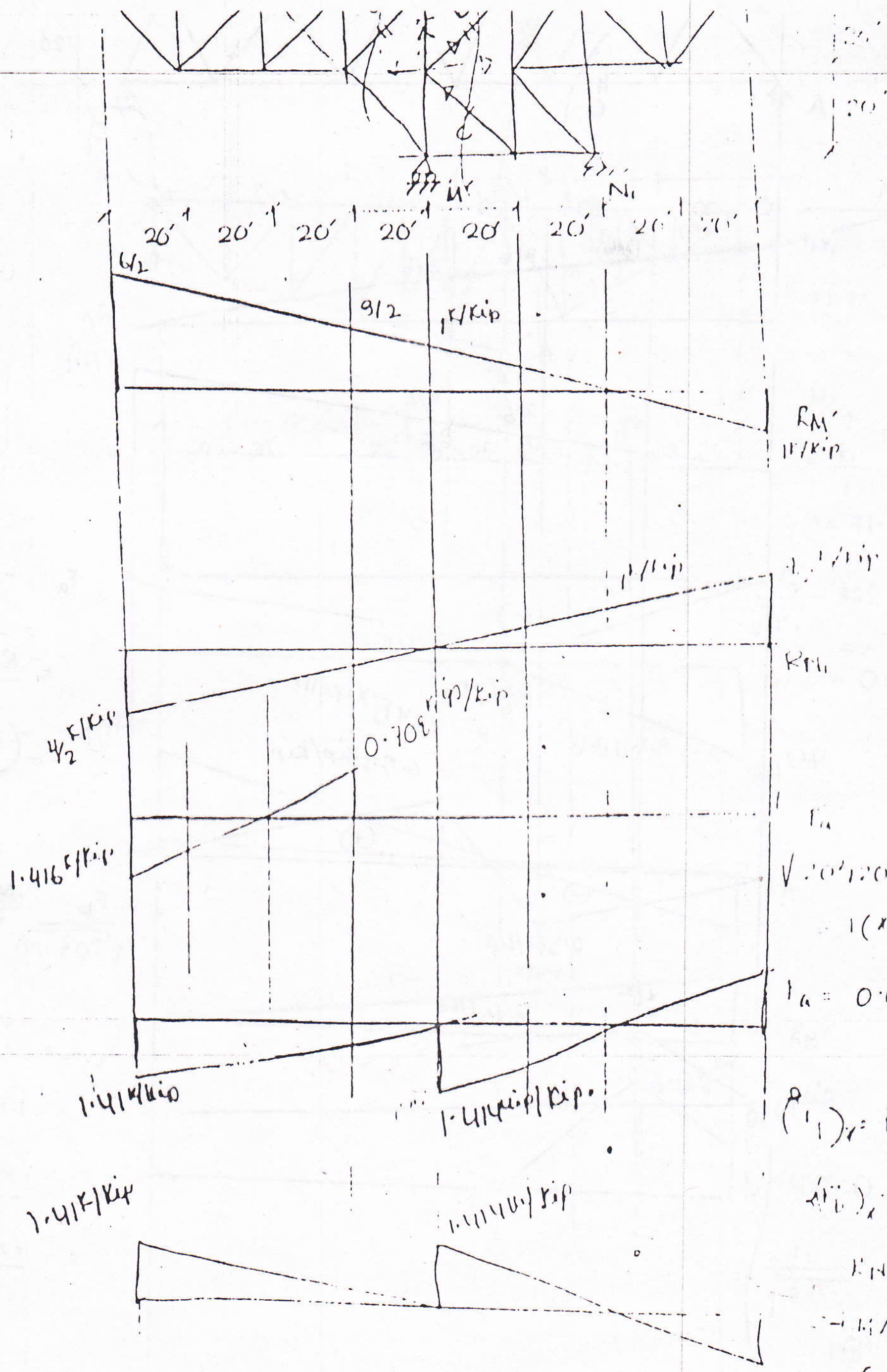
$$= -R_A$$

$F_c = -1.11 R_A$ [illegible]

$= 1.11 R_A$

$$F_c = \frac{R_A \times 20}{20}$$

$$= \frac{[illegible]}{[illegible]}$$

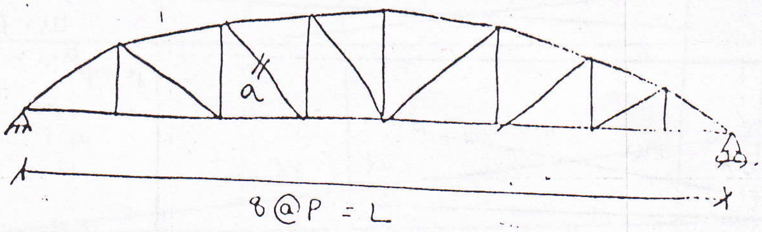


$F_a = 0.035x$

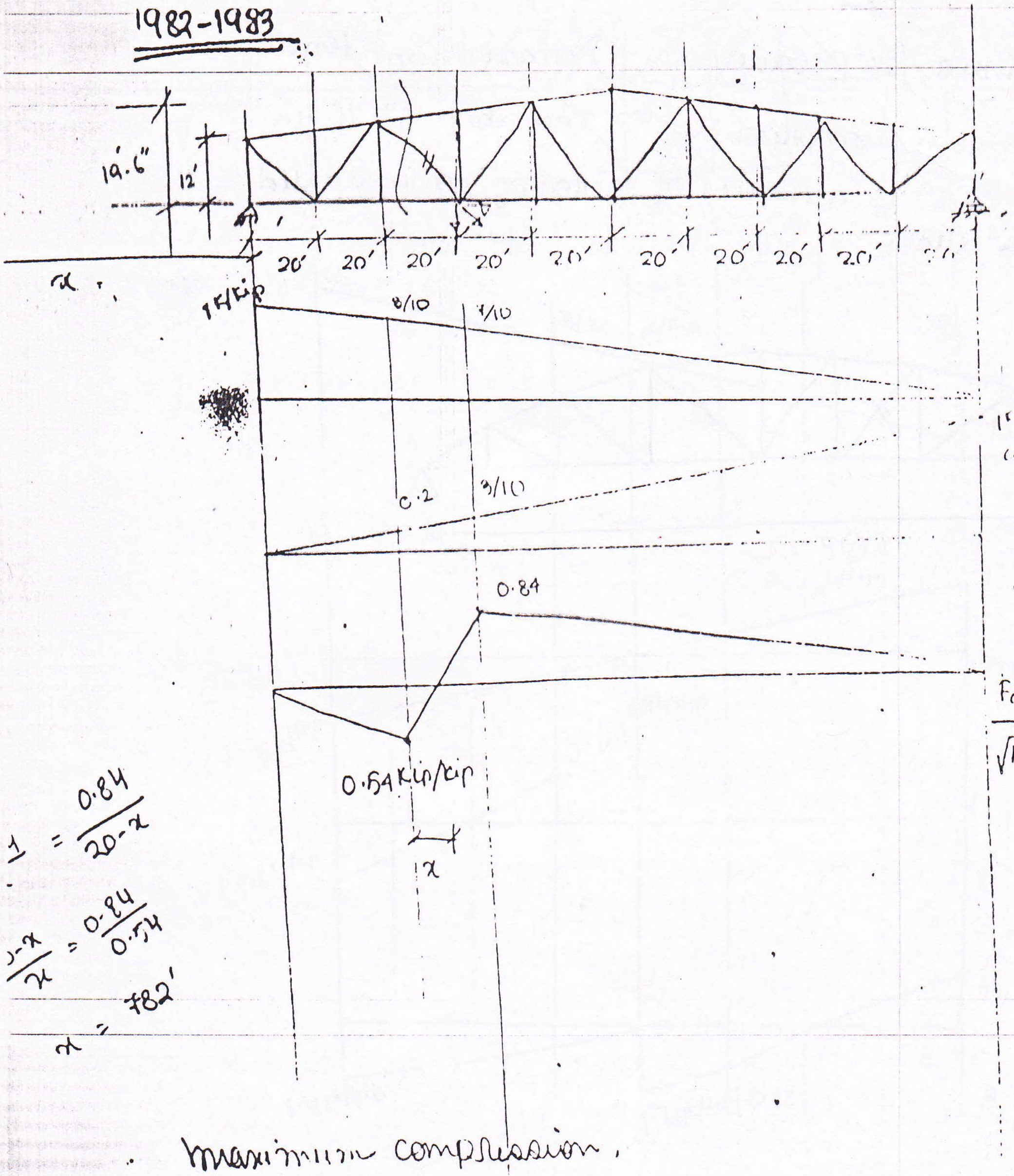
$F_b = (F_b)_x * \sqrt{2}$

$F_b = -F_c$

Develop criteria for producing i) maximum tension and ii) maximum compression in member 'a' of the truss sh. due to a series of moving concentrated loads from a train



1982-1983



$\frac{1}{x} = \frac{0.84}{20-x}$

$\frac{20-x}{x} = \frac{0.84}{0.54}$

$x = 7.82'$

1k 2k/1

ving

uniformly

distributed

loaded

19'-6

12

x =

$\frac{F_a}{\sqrt{15^2+20^2}} \times 15 \times 2$

=

=

F_a 4.51

×R

= 1.21

= -2.42

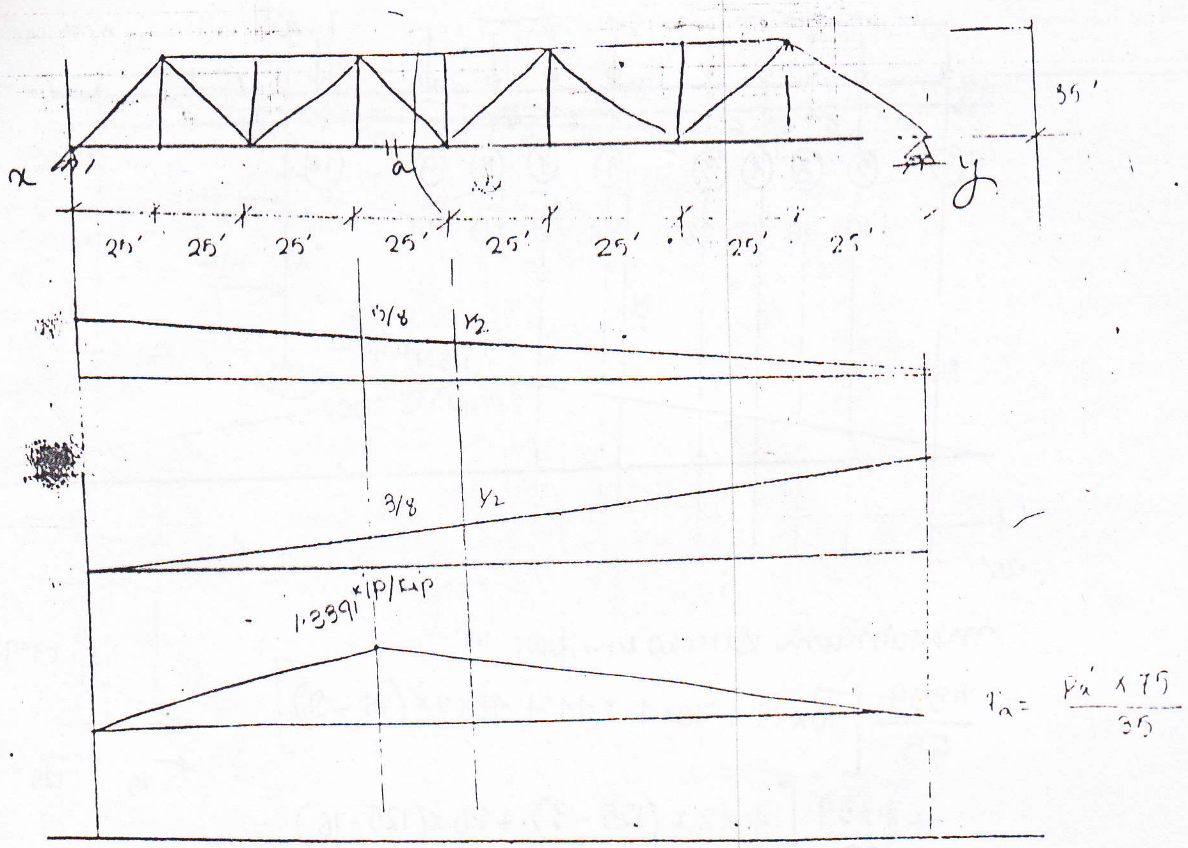
maximum compression,

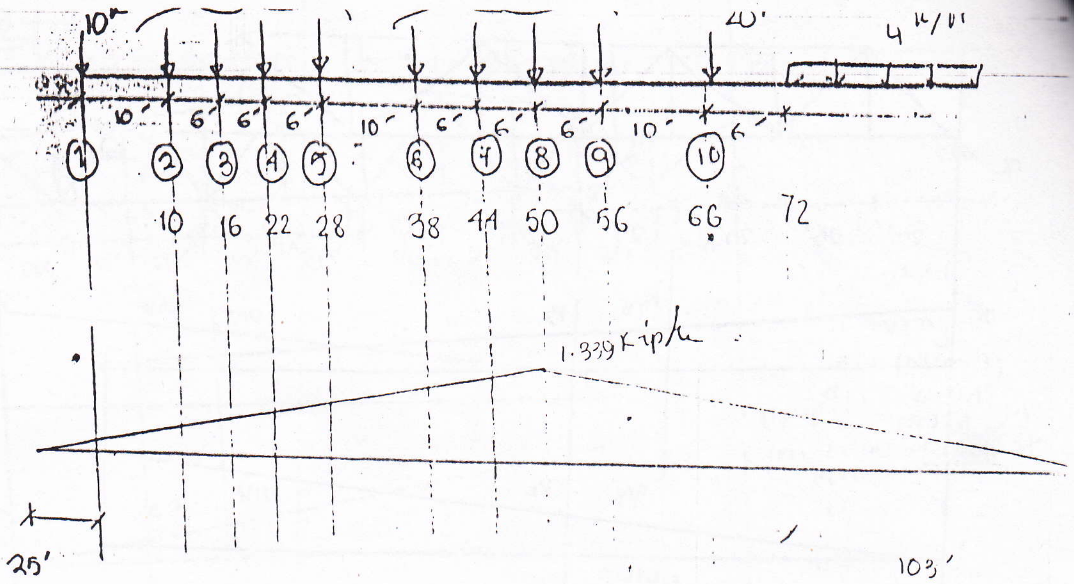
① = $\frac{1}{2} \times 0.54 \times (40 + 7.82) = 12.91$

② = $\frac{1}{2} \times 0.84 \times (140 + 20 - 7.82) = 69.91$

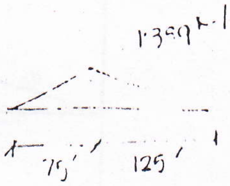
$F_{a\,max}$(compression = $-12.91(2+3) + 63.91$/6$(2) - 0.54 \times 40$

=


x
a
y
35'
25'
25'
25'
25'
25'
25'
25'
25'
5/8
1/2
3/8
1/2
1.3391 kip/kip
Y_a = Pa' × 75 / 35



maximum stress in bar 'n'

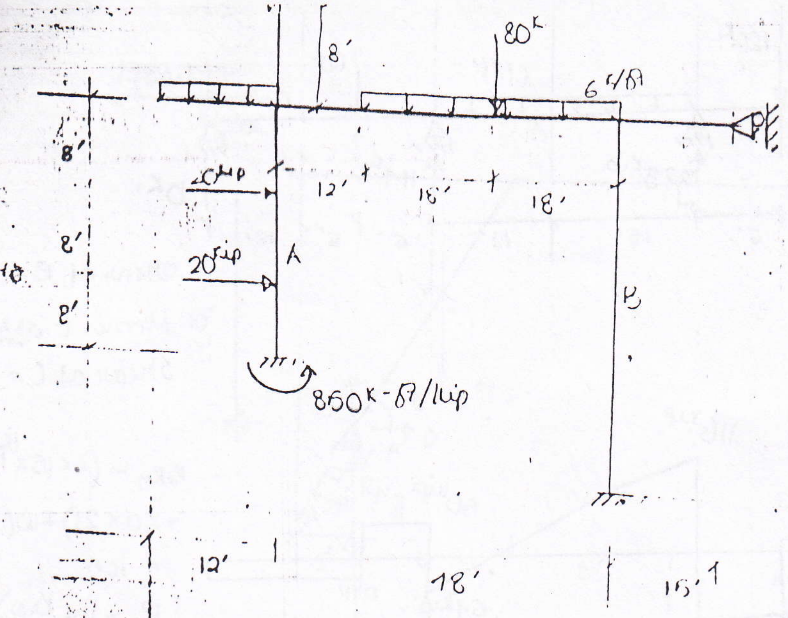


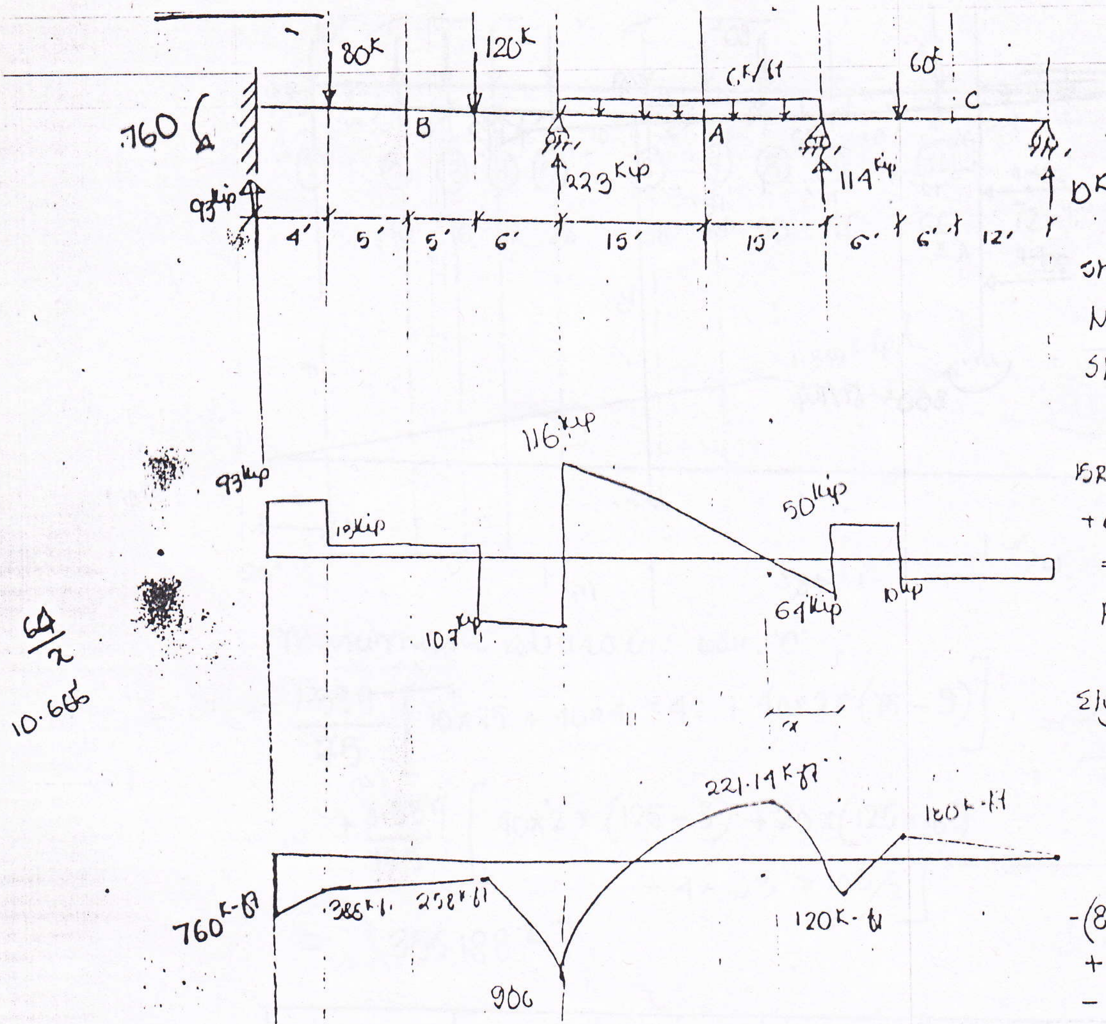
$$= \frac{1.339}{75}\left[10\times25 + 40\times4 \times 44 + 40\times2\times(75-9)\right]$$

$$+\frac{1.339}{125}\left[40\times2\times(125-3) + 20\times(125\cdot16) + 4\times103 \times 103/2\right]$$

$$= \quad 355.188^{k}$$

WHEEL POSITION	SIAIL	W_1/a	W/L		
ⓦ3 at c	K L	50/75 < 90/75	626/200		
W_5 at	R L	130/75 170/75	674/200 = 3.37		
W_6 at c	K L	170/75 210/75	714/200 = 3.57		
W_7 at	R L	210/75 250/75 = 3.33	738/200 = 3.69		
W_8 at c	K L	250/75 290/75 3.87 >	762/200 = 3.81		
W_9 at c	K L	290/75 330/75			


80^k
8'
6^k/ft
8'
20^kip
12'
18'
18'
8'
10'
20^kip
A
8'
B
850^k-ft/kip
12'
18'
15'



Shear at B = $+13^k$

Moment at A = $165^{k\cdot ft}$

Shear at C = -10^k

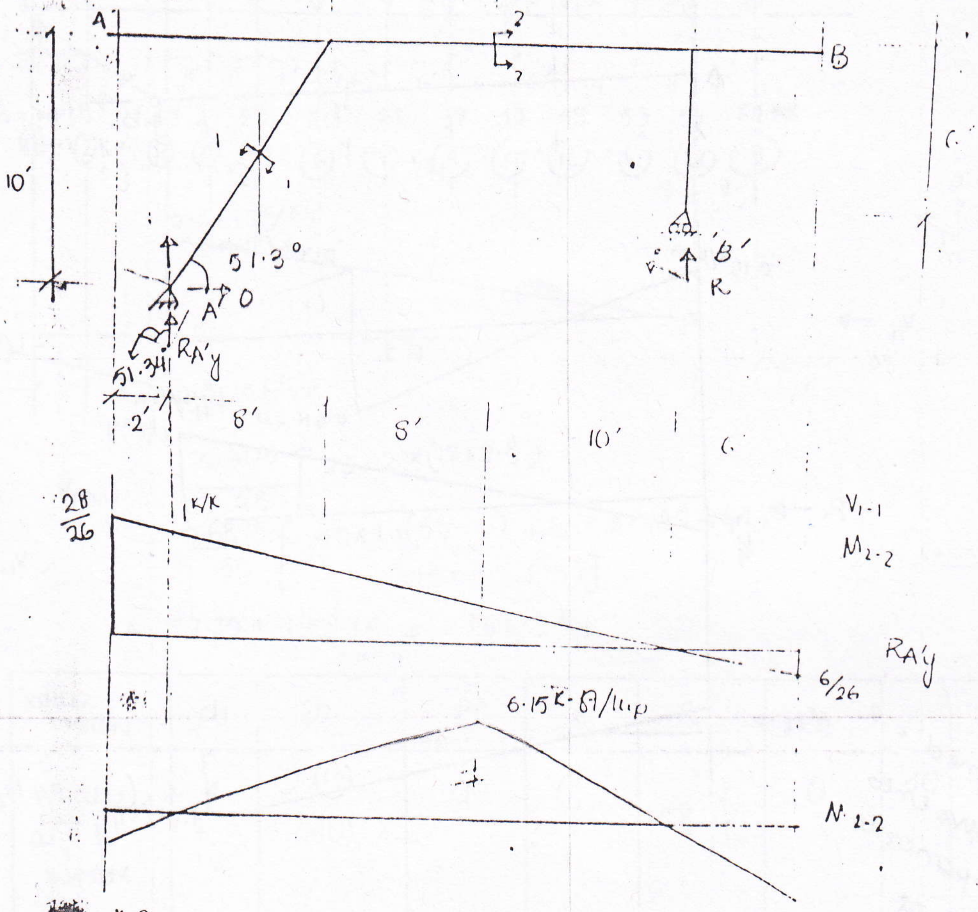
$15R_{11} - (6\times15\times 15/2$
$+60\times21) + 10(15+6+6+12)$
$= 165$
$R_{11} = 114$ kip

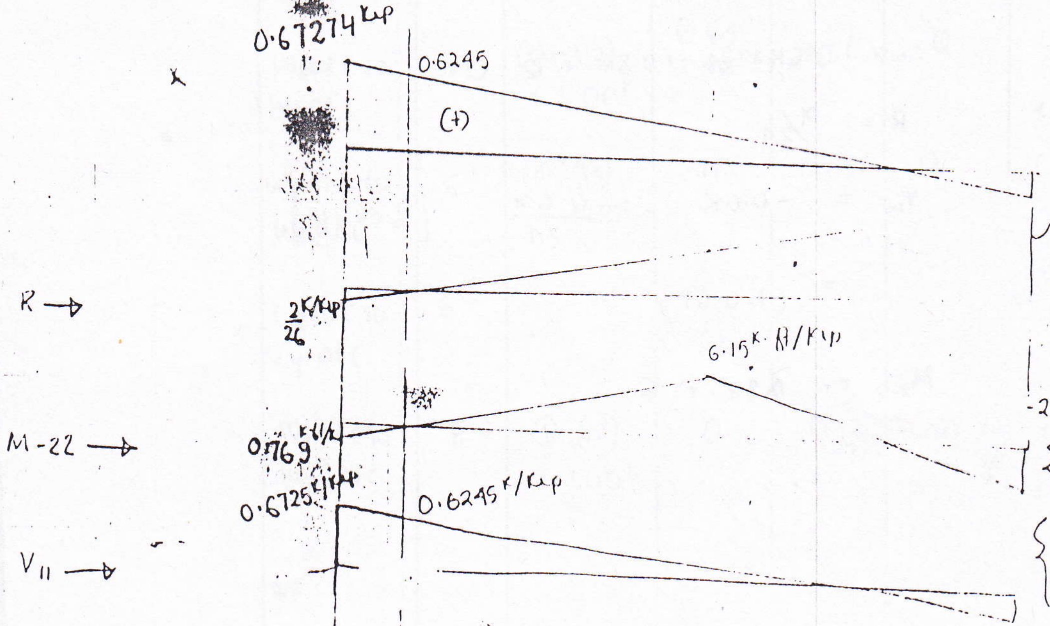
$\Sigma y = 93-20-120$
$-6\times30+114$
$-60+10$
$= -223$ kip

$-(80\times4+120\times14)$
$+223\times20$
$-6\times30\times35$
$+114\times50$
-60×56
$+10\times74$
$= -760^{k\text{-}ft}$

$-60\times18-6\times30\times39$
$+114\times24+223\times54$
$-120\times60-80\times70$
$+93\times74-$
760
$=0$

1983-1984





V1-1 = 0.6245 RA'y

26R − x = 0

$R = \frac{x}{36}$

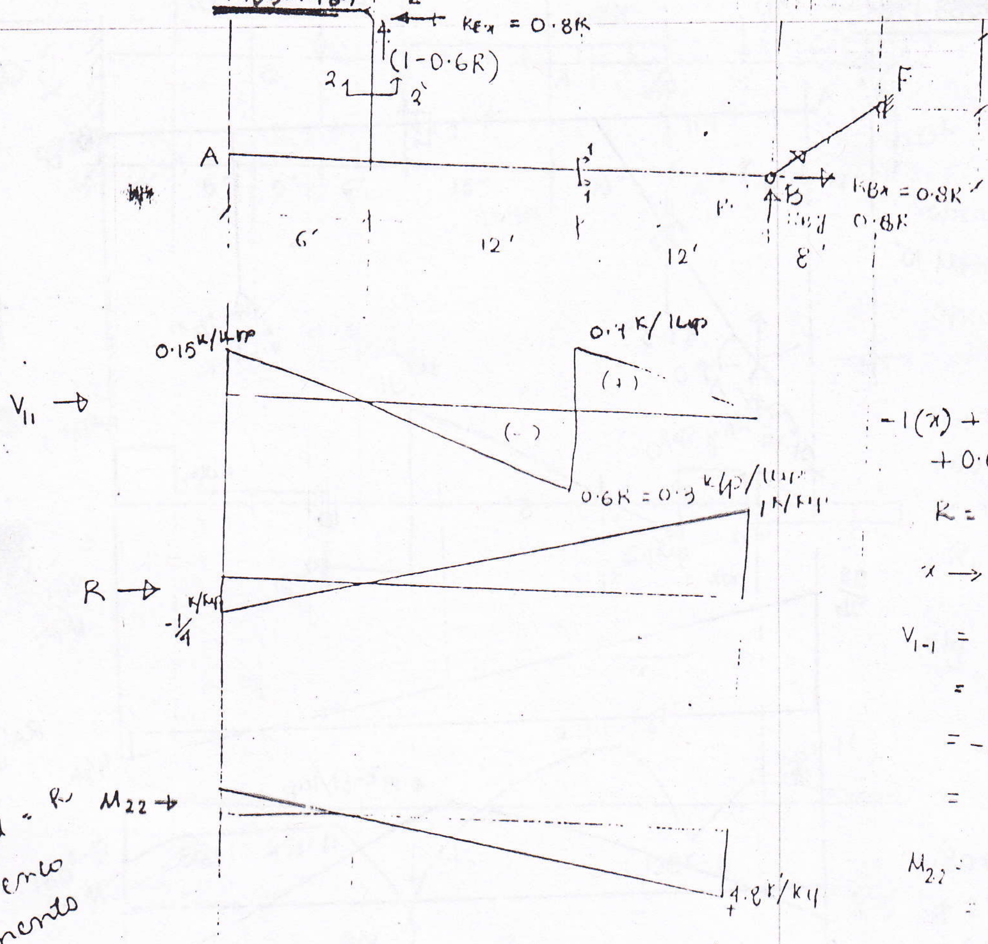
$-2 < x < 32$

$M_{2-2} = 10R$, $-2 < x < 16$

$M_{2-2} = (1-R)16$, $16 < x < 32$

$V_{1-1} = 0.6245(1-R)$

1983-1984



$V_{1\cdot1}$

M_2

$-1(x) + 0.8R \times 12$
$+ 0.6R \times 24 = 0$

$R = + x/24$

$x \rightarrow -6$ to 24

$V_{1-1} = R_{By}'$
$= R_{Ey}$
$= -(1-0.6R)$
$=$

$M_{22} = +0.8R \times 6$
$= 4.8R$

inclined = R
resolve into
components
[illegible] of
then
[illegible]
equation
and drawing

$-x + 0.6R \times 24 + 0.8R \times 12 = 0$

$R = x/24$

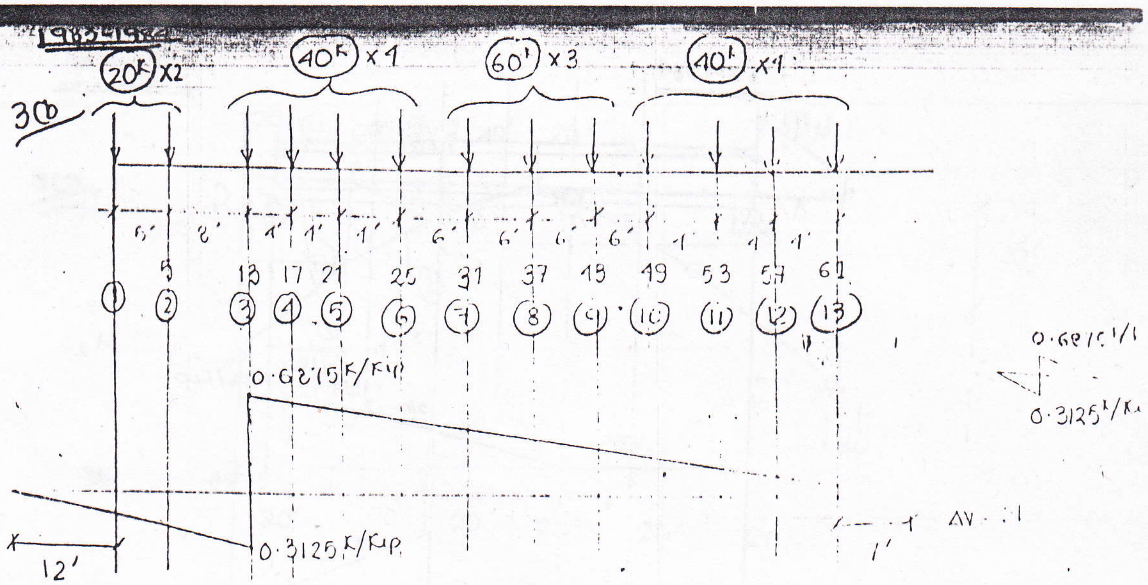
$V_{1-1} = -0.6R = -\frac{0.6x}{24}$ $[-6 < x < 12]$

$= (1-0.6R)$

$M_{2-2} = 0.8R \times 6$

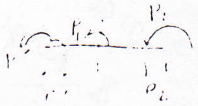
1983-1984

30b



$$V_{max} = -\frac{0.3125}{25}\left[20\times2\times(12+2.5)\right] + \frac{0.6875}{55}\left[40\times4\times(55-6)+60\times3\times(55-21) + 40\times4\times(13)\right]$$

$$= -7.25 + 193.75 = 186.5^{Kip}$$



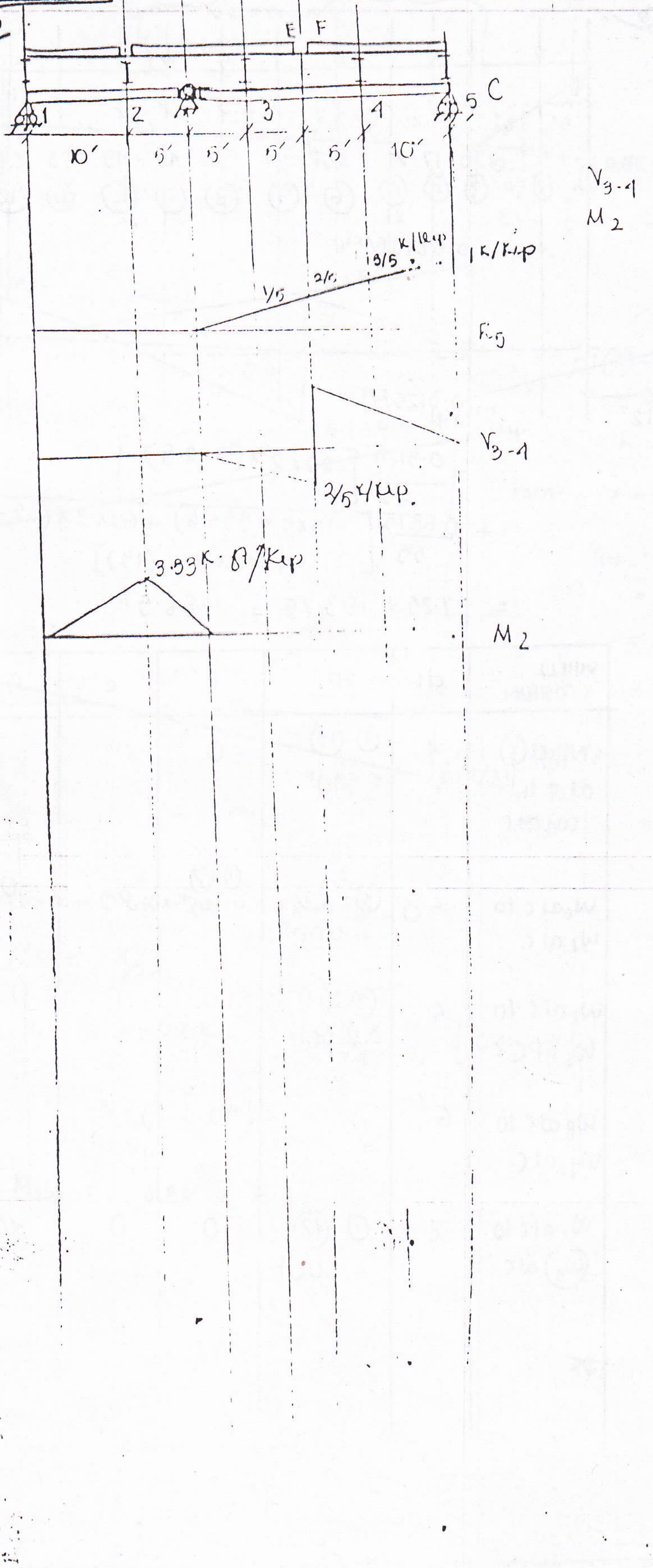
Axle Load

Wheel Load

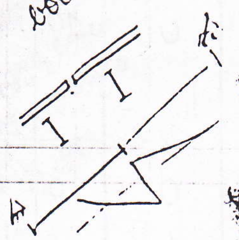
WHEEL POSITION	d1	ΣP	P'	e'	P_2	e_2	P_1	ΔV
Wheel ③ at c to W_4 at C	4	①-⑬ = 540K	0	0	0	0	40	-12 $V_3 > V_4$
W_6 at c to W_7 at C	6	③-⑬ = 500K	①+② = 40K	2.5'	0	0	40	-125
W_7 at C to W_8 at C	6	③-⑬ = 500K	0	0	0	0	60	[illegible]
W_8 at C to W_9 at C	6'							
W_2 at C to (W_3) at C	8	①-⑫ = 500K	0	0	10	7'	20	35.5 $V_3 > V_2$

1983-1984

4(b)

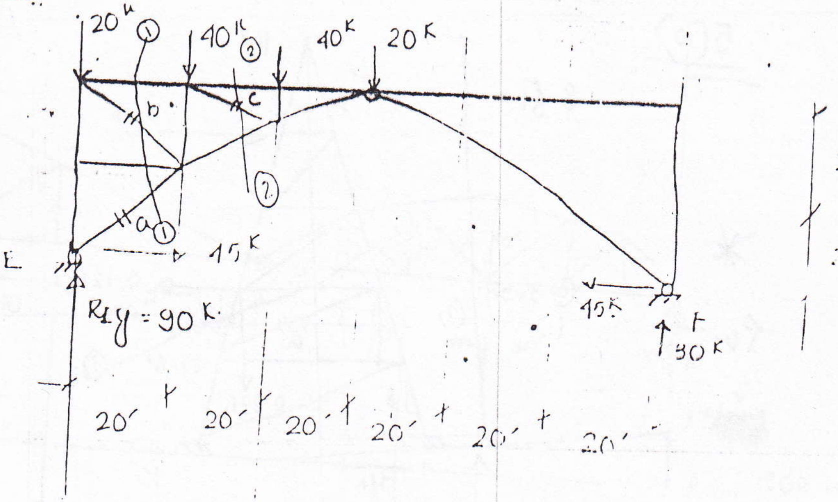


main girder
& hinge
and support
both



1983-1984

oca

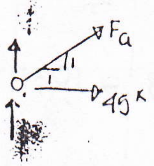


$$R_{Fy} = \frac{20\times60+40\times80+40\times100+20}{120} = 90^K$$

$$R_{Ey} = \frac{40\times20+40\times40+20\times60}{120} = 30^K$$

$$40\times20+40\times40+20\times60-90\times60+R_{Ex}\times40=0$$

$\Rightarrow R_{Ex} = 45^K$



$$\frac{F_a}{\sqrt{2}} = -45 \Rightarrow \boxed{F_a = -63.639^K\ (C)}$$

Section ①-①

$$\frac{F_b}{\sqrt{2}} - \frac{F_a}{\sqrt{2}} + 20 - 90 = 0$$

$$\Rightarrow \frac{F_b}{\sqrt{2}} + 45 + 20 - 90 = 0$$

$$\therefore \boxed{F_b = +35.355\text{kip}\ (T)}$$

Section ②-②

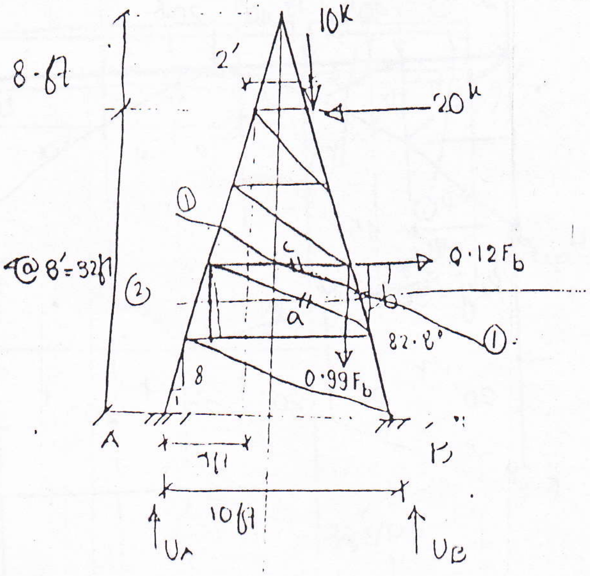
$$\frac{F_c}{\sqrt{10^2+20^2}}\times10\times40+40\times40+20\times60-90\times60+45\times40=0$$

$$\boxed{F_c = 11.721^K\ (T)}$$

5(b)

*

F_a



$0.99F_b \times 6 + 10\times 4 - 20\times 16 = 0$

$\boxed{F_b = 47.029^k\ (T)}$

$F_c \times 8\times 3 + 10\times 1 + 20\times 8 = 0$

$\Rightarrow \boxed{F_c = -7.083^k\ (C)}$

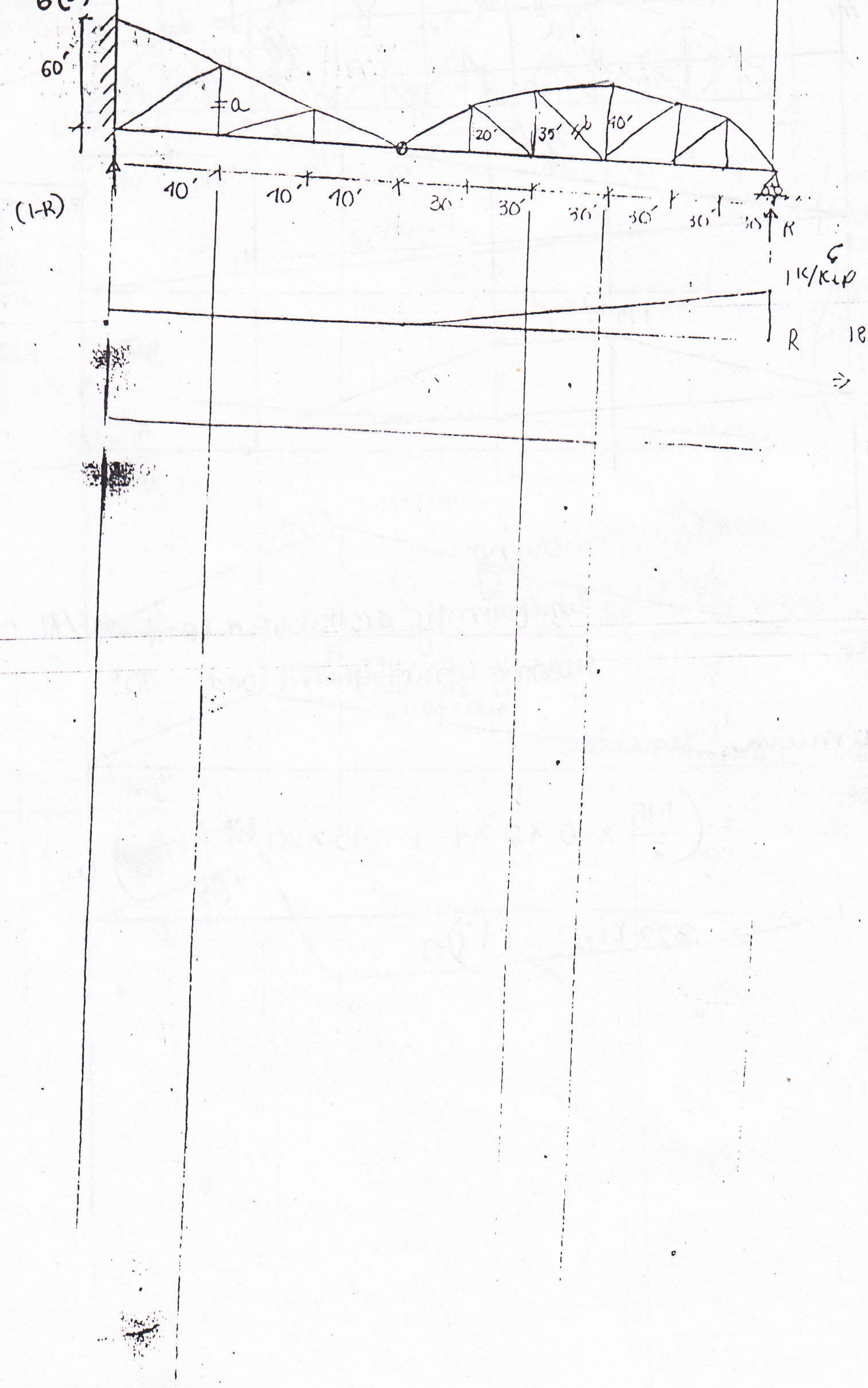
$\frac{F_a}{\sqrt{7^2+8^2}} \times 7\times 3\times 8 + \frac{F_a}{\text{[illegible]}} \times 8\times 3 - 10\times 1 - 20 * 8 = C$

$\frac{F_a}{\sqrt{7^2+8^2}} * 192 = 170$

$\therefore F_a = 9.413^k\ (T)$

1983-1984

6(a)

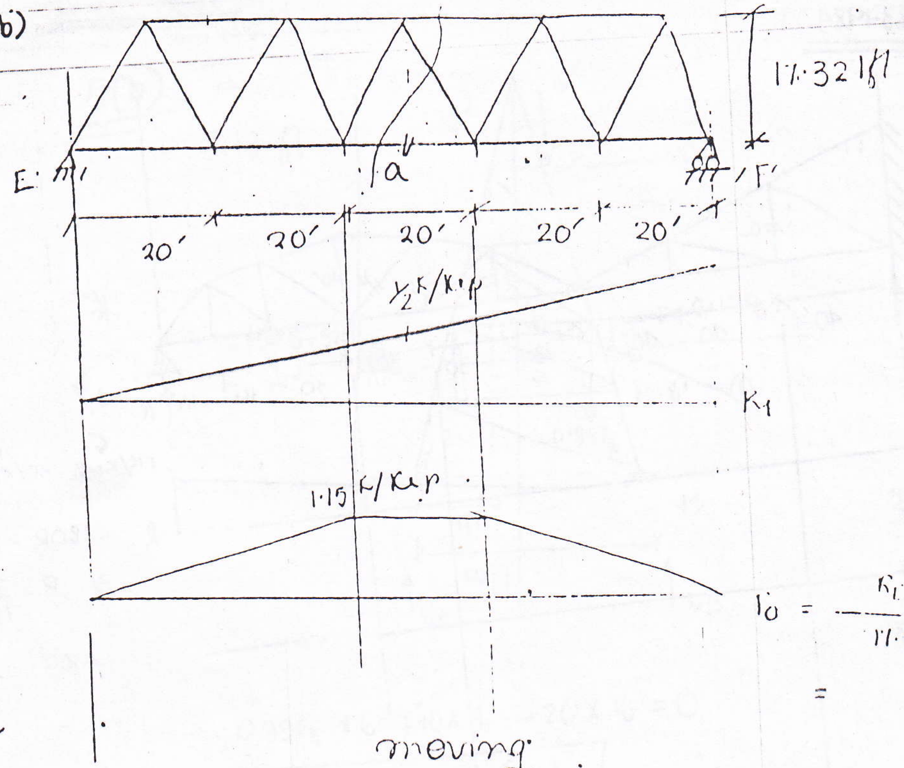


$180R - x = 0$

$\Rightarrow R = \frac{x}{120}$

x

6(b)



$$F_o = \frac{K_1 \times 50}{17.32}$$

$=$

moving

uniformly distributed load = 4 k/ft

moving concentrated load = 40 k

Maximum tension

$$= \left(\frac{1.15}{2} \times 40 \times 2 \times 4 + 1.15 \times 20 \times 4 + 1.15 \times 40 \right) \text{kip}$$

$= 322$ kip (T)

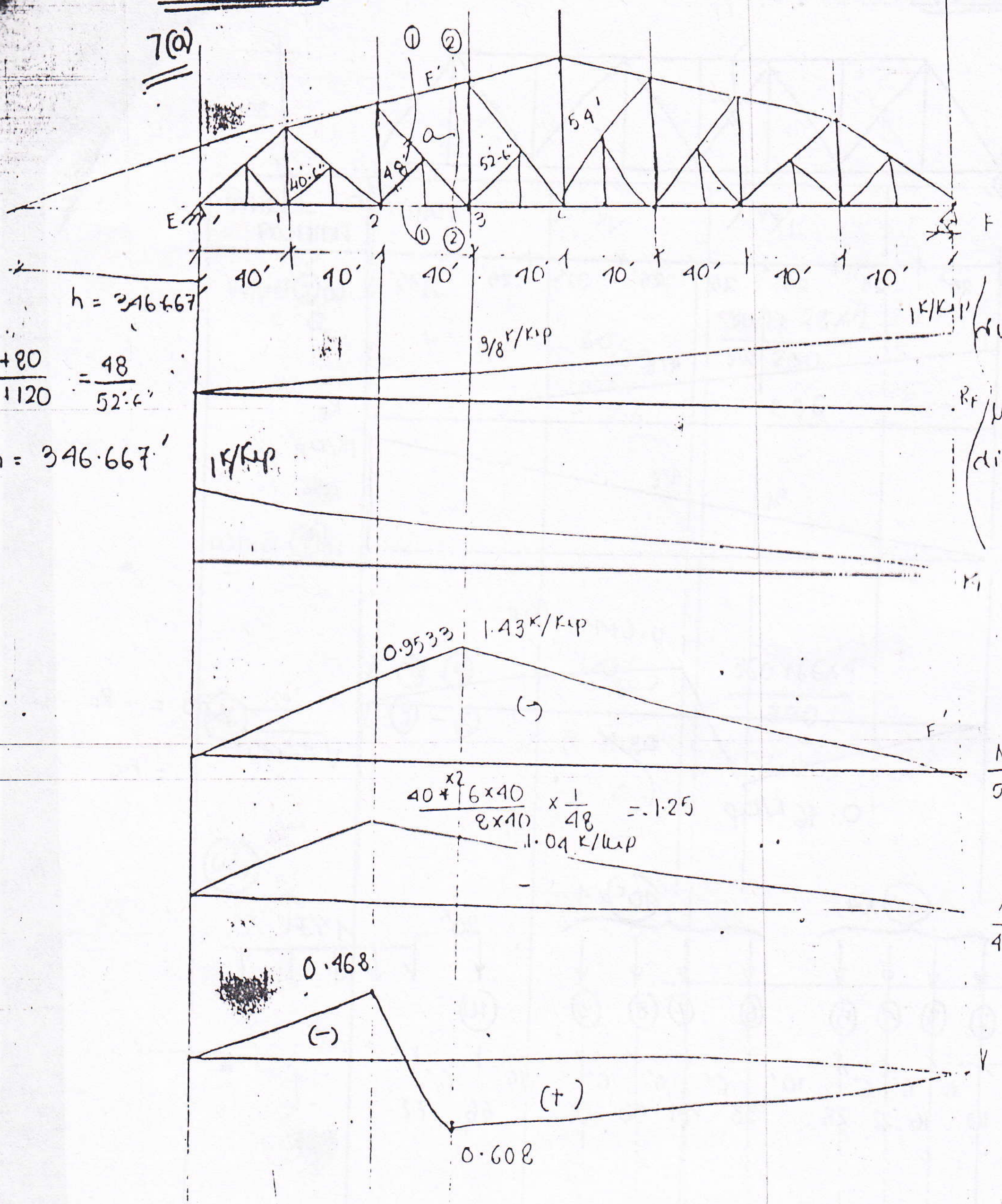
1983-1984

7(a)

h = 346.67

$$\frac{h+80}{h+120} = \frac{48}{52.6}$$

h = 346.667'



Uniformly distributed dead load - 3k/ft

Moving uniform distributed live load - 6k/ft

Moving concen load - 40'

$$\frac{M_3}{52.5} = F'_x$$

$$\frac{M_2}{48} = F'_x + F_{a_x}$$

$$\frac{F_{ax}}{40} \times \sqrt{48\times48+4} [illegible]$$

Fa

$F_{ax} = 0.64 F_a$

$F_a = 1.56 F_{a_x}$

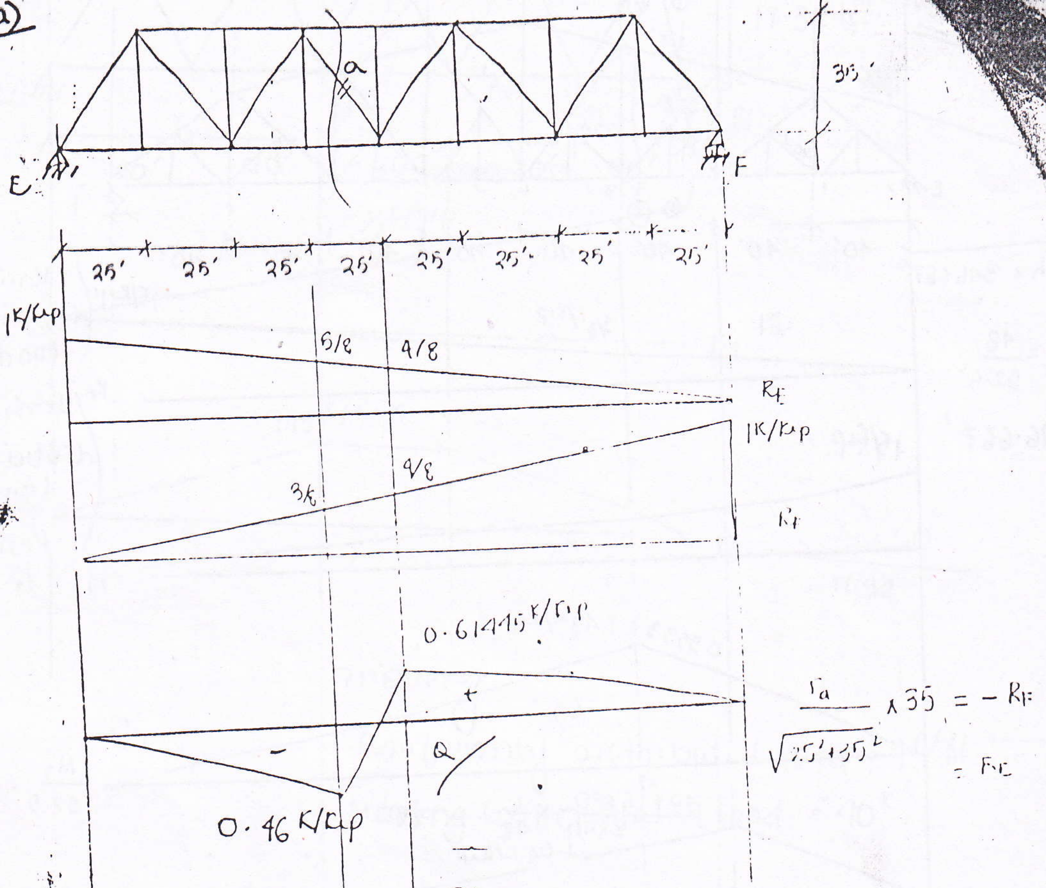
[illegible]

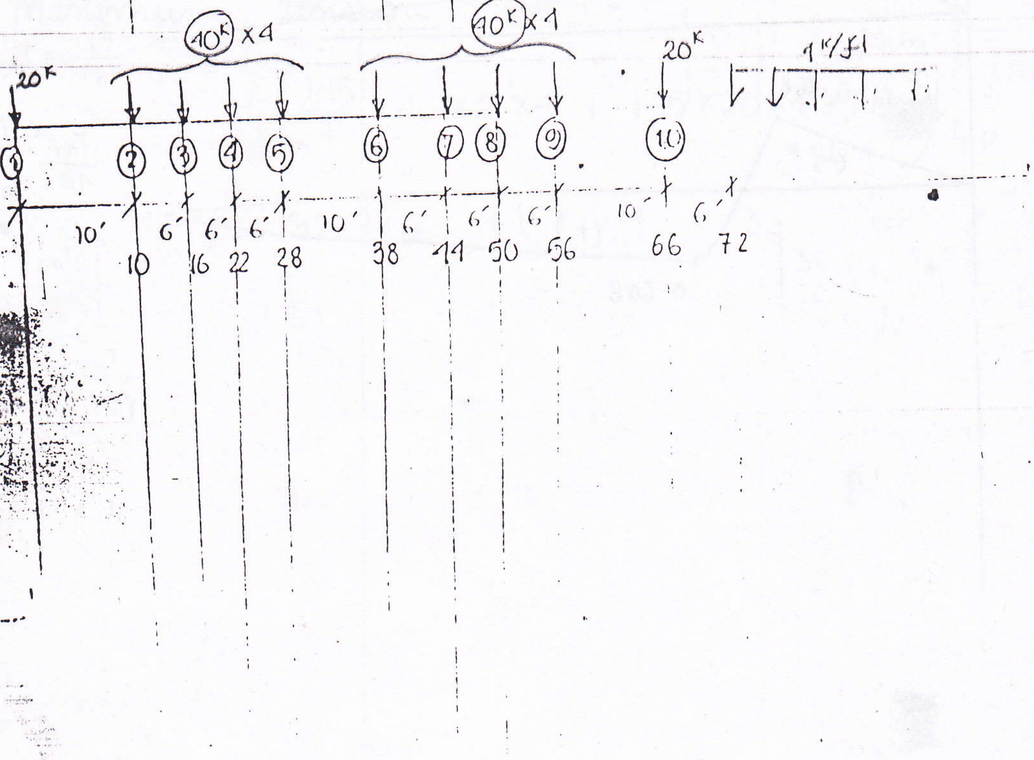
$$= \frac{120 \times [illegible]}{8\times 40}$$

F' = 1.13

1983-1984

8(a)

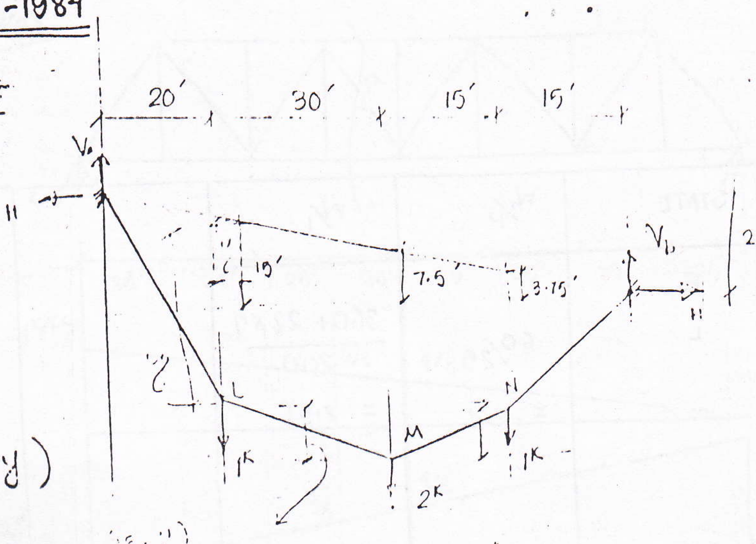

a
E
F
35'
25'
25'
25'
25'
25'
25'
25'
25'
1K/kip
5/8
4/8
RE
1K/kip
3/8
4/8
RF
0.61445 K/kip
+
−
Q
0.46 K/kip
Fa / √(25'²+35'²) × 35 = − RF
= FE


40K ×4
40K ×1
20K
20K
1K/ft
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
10'
6'
6'
6'
10'
6'
6'
6'
10'
6'
10
16
22
28
38
44
50
56
66
72

WHEEL POSITION	STATE	W_1/P	W/L		
Wheel ② at Q	R L	$60/25$ $= 2.4$	$\frac{360+28\times4}{200}$ $= 2.36$		
Wheel ① at					
(W6)	R ③ - ⑤ L ③ - ⑥	$120/25$ $= 4.8$ $\rightarrow 6.4$	$\frac{360+66\times4}{200}$ $= 3.12$		
(ω_7)					

1983-1984

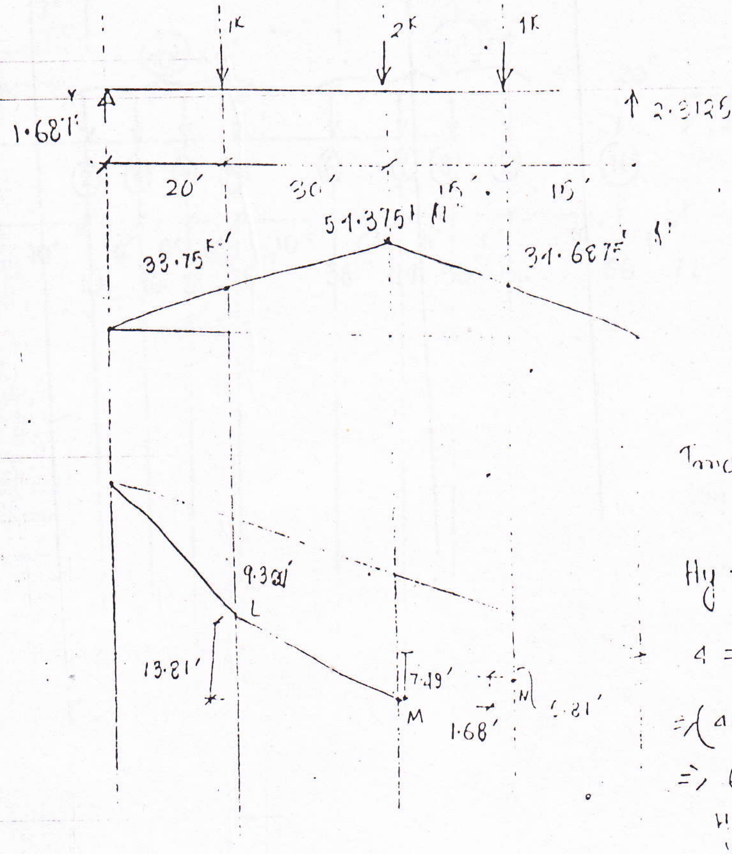
8(b)



$20-(15-y)$
$= 5+y$

$20\ (15-y)$

Determine the length of the cable required in the problem such that maximum tension in the cable will not exceed 4 kips.



$$T_{max} = \frac{H}{20}\sqrt{20^2+y^2}$$

$$Hy = 33.75$$

$$4 = \frac{H}{20}\sqrt{20^2+y^2}$$

$$\Rightarrow (4\times 20)^2 = H^2(20^2+y^2)$$

$$\Rightarrow 6400 = 400H^2 + (33.75)^2$$

$$H = 3.6266 \text{ Kip}$$

$$y = 9.30'$$

$Hy_M = 54.375$

$y_M = 1499'$

$Hy_N = 34.68$

$y_N = 9.56'$

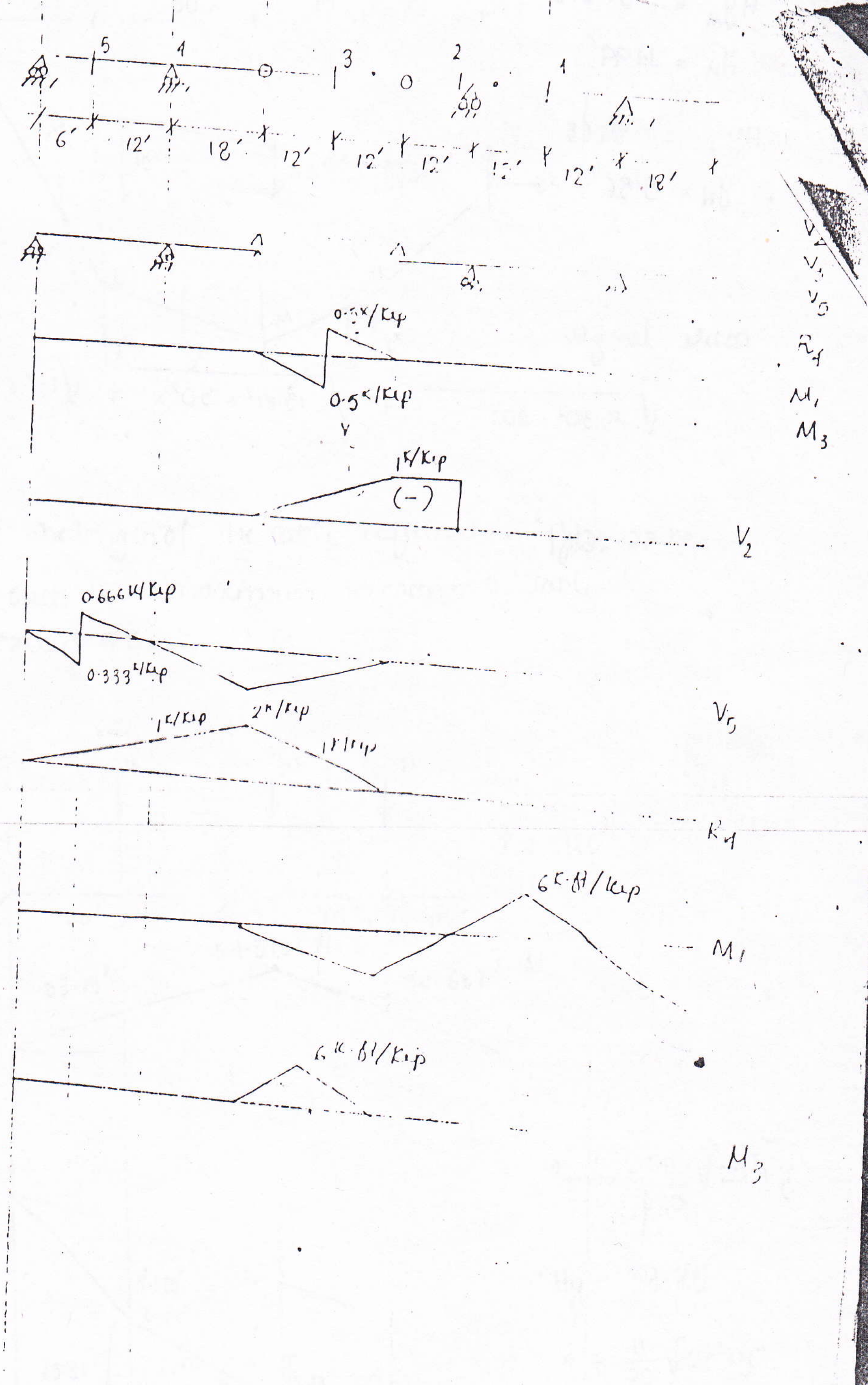
cable length

$$= \sqrt{9.30^2 + 20^2} + \sqrt{13.81^2 + 30^2} + \sqrt{1.68^2 + 15^2} + \sqrt{5.81 \times 5.81 + 15^2}$$

$= 86.262ft$

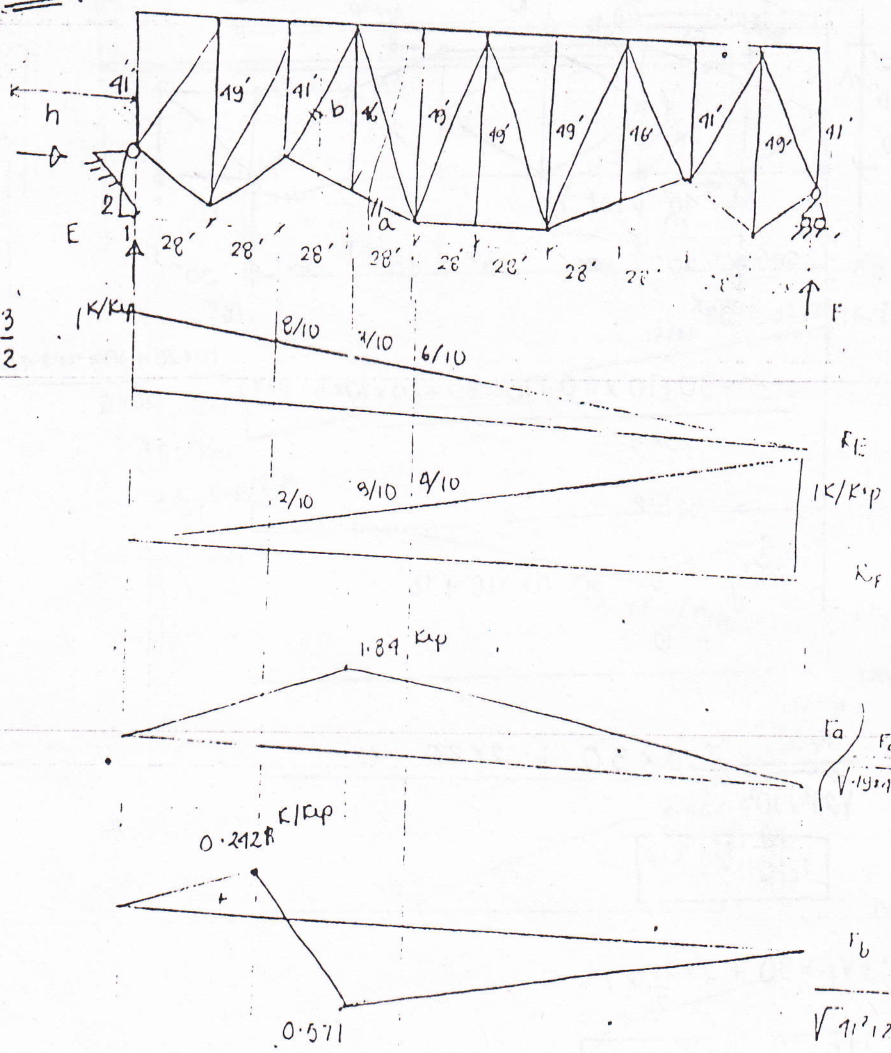
1985-1986

1(a)


5
4
3
2
1
6'
12'
18'
12'
12'
12'
12'
12'
18'
V4
V3
V5
R4
M1
M3
0.5k/kip
0.5k/kip
1k/kip
(−)
V2
0.6666k/kip
0.333k/kip
V5
1k/kip
2k/kip
1k/kip
R4
6k-ft/kip
M1
6k-ft/kip
M3

1985-1986

1(b)



$$\frac{46}{41} = \frac{h+28\times3}{h+28\times2}$$

$h = 173.6 ft$

$\frac{F_a}{\sqrt{19\times19+28\times28}} \times 28 \times 19 =$

$F_a = 1.84 Kip$

$\frac{F_b}{\sqrt{41^2+28^2}} \times 41 \times (173.6$

$= K_1 \times (173.6+28$

$- K_1 \times (173.6)$

$212.726 F_b$

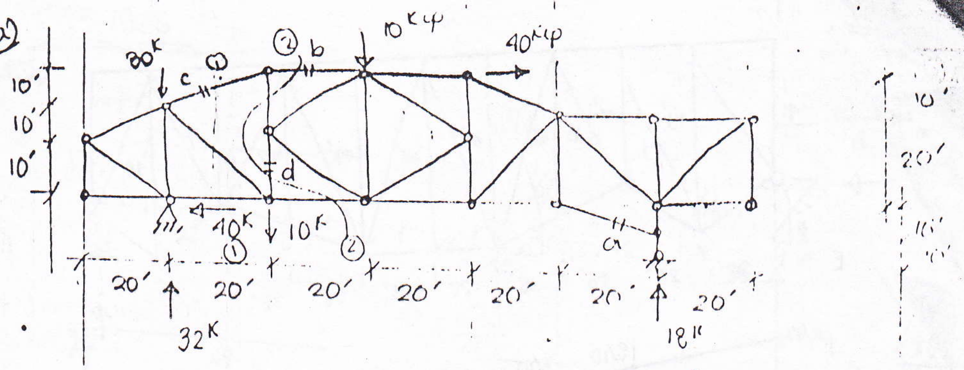
$= 257.6 F_1$

=

moving uniform load = 12k/'
moving concentrated load = 60k

1985-1986

2(a)



$$\frac{-40\times30+10\times60+10\times80+30\times20\times5}{20\times5}$$

$= 32^{kip}$

$$\frac{10\times20+10\times40+40\times30}{20\times5}$$

$= 18^{K}$

1a

ΣF_y $32-30-10-10+18$

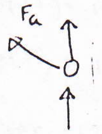
$= 0$

$$\frac{F_c}{\sqrt{20^2+10^2}}\times20\times30+2\times20=0$$

$\Rightarrow$ $\boxed{F_c = 1.49\ ^{kip}}$

$F_b\times30+2\times\frac{20}{2}\times2=0$

$\therefore$ $\boxed{F_b = -1.33\ kip}$

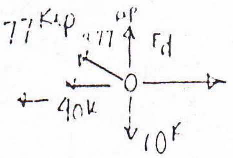


$\boxed{F_a = 0}$

Section ①

$$\frac{F_c}{\sqrt{10^2+20^2}}\times10-\frac{F'}{\sqrt{20^2+20^2}}\times20-30+32=0$$

$F' = 3.77^{kip}$

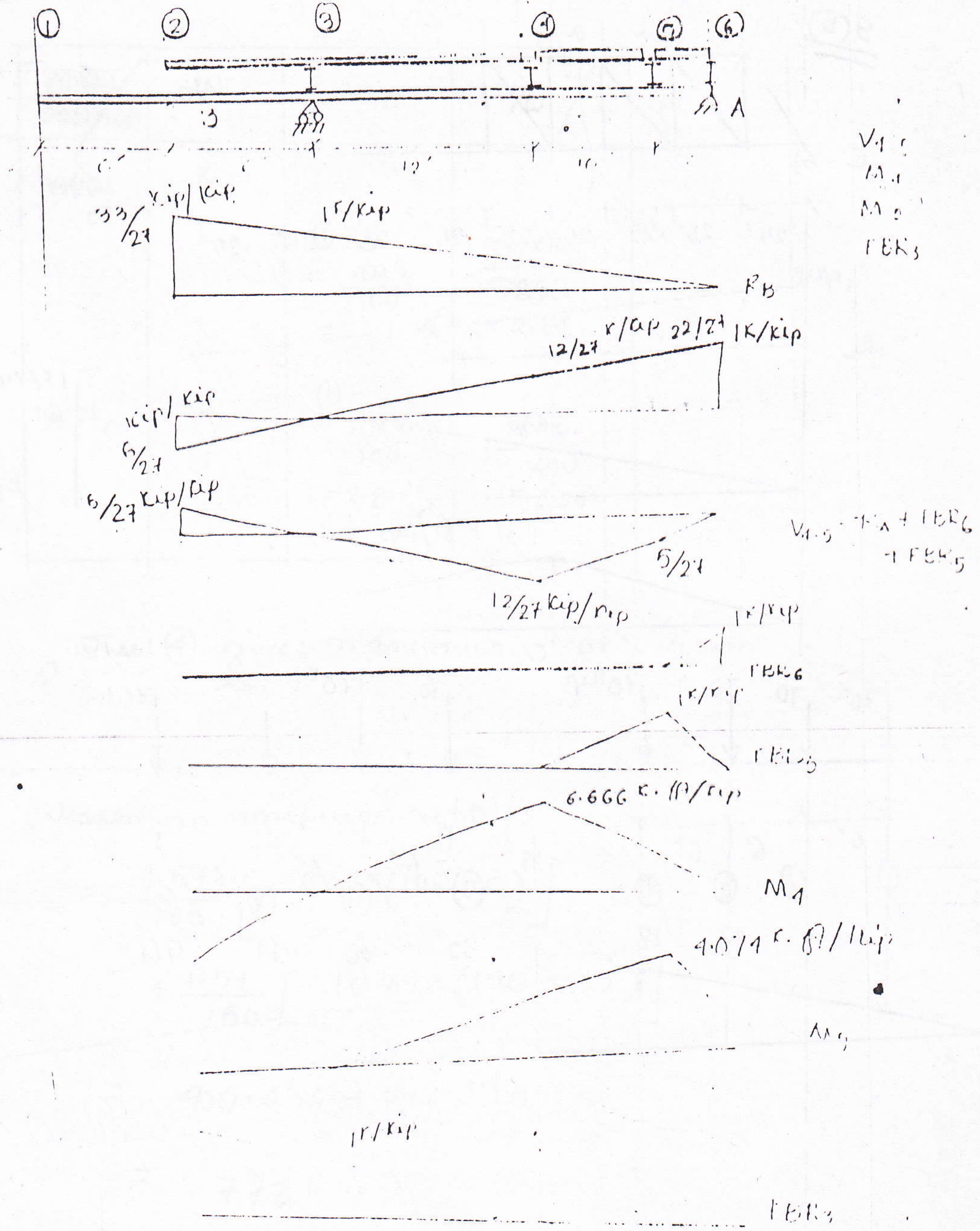


$$\frac{3.77}{\sqrt{2}}+F_d=10$$

$F_d = 7.333\ ^{kip}$

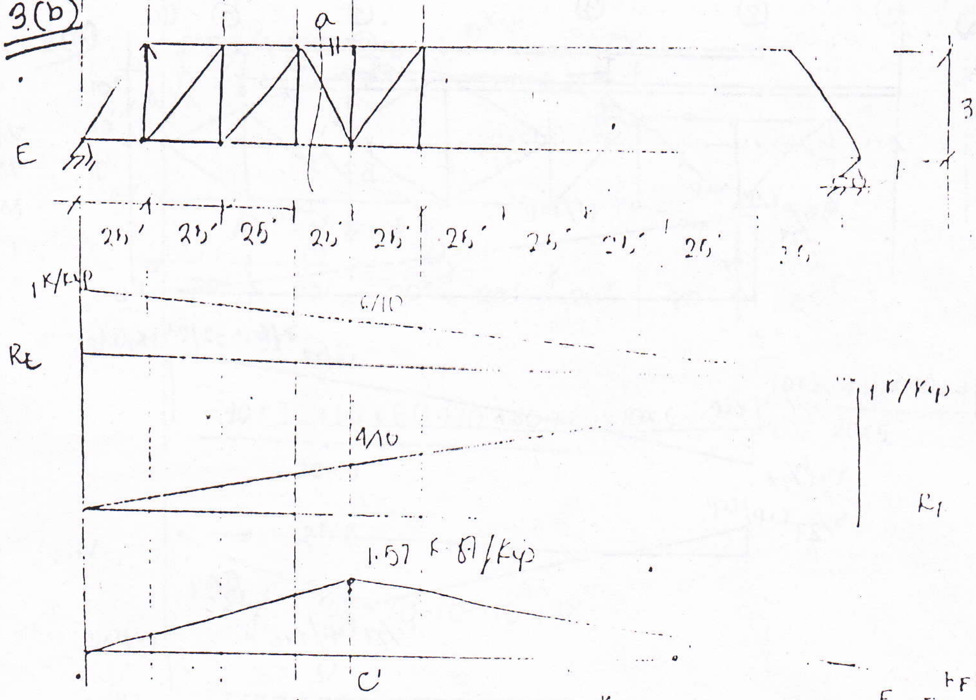
1985-1986

3(a)

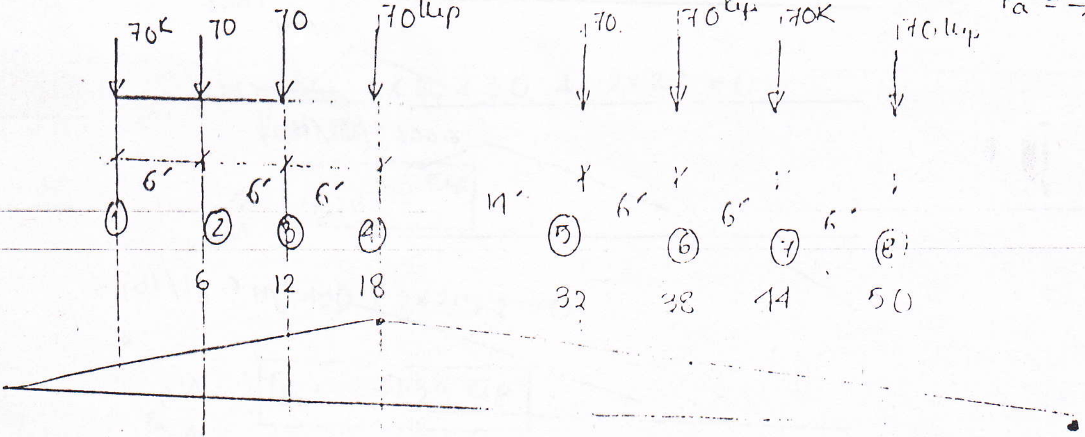

①
②
③
④
⑤
⑥
A
3
6'
12'
10'
V4-5
M4
M5
FBR3
33/27 kip/kip
1k/kip
RB
12/27 k/kip
22/27
1k/kip
kip/kip
6/27
6/27 kip/kip
V4-5 = RA + FBR6 + FBR5
5/27
12/27 kip/kip
1k/kip
FBR6
1k/kip
FBR5
6.666 k-ft/kip
M4
4.074 k-ft/kip
M5
1k/kip
FBR3

1985-1986

3(b)



$F_a = \frac{F_F \times 4 \times 25}{32}$



WHEEL POSITION	STATE	W_1/a	W/L
W_3 at C'	K L	①-③ $= \frac{70\times3}{100}$ $= 2.1 <$	$\frac{70\times8}{250}$ $= 2.24.$
W_4 at C'	K l	① - $\frac{70\times4}{100}$ $= 2.8 >$	$\frac{70\times8}{250}$ $= 2.24$

Wheel ④ gives maximum compression

Maximum compression force

$$= \frac{1.57}{100}\left[70\times4\times(100-9)\right]$$

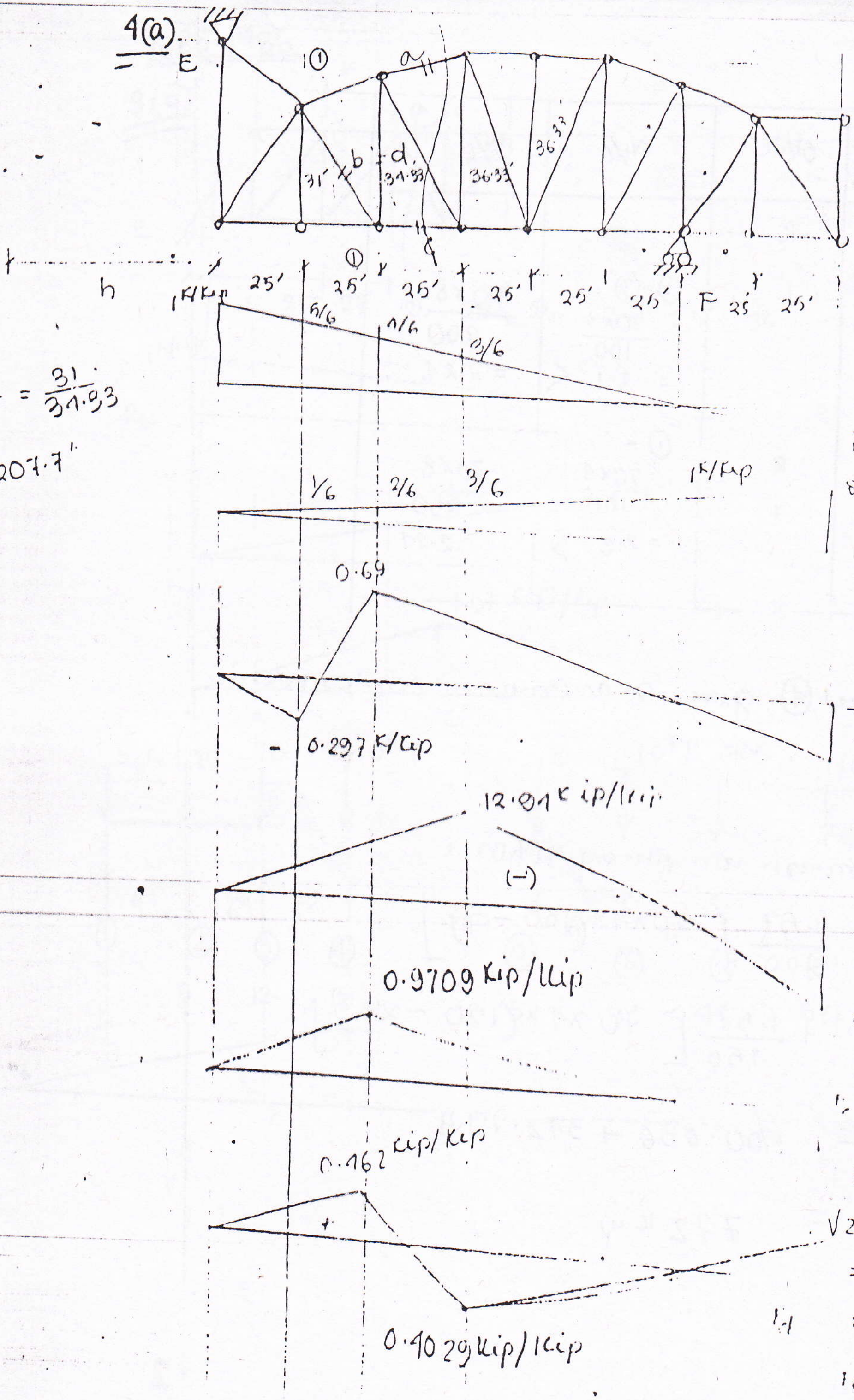
$$+ \frac{1.57}{150}\left[70\times4\times(150-23)\right]$$

$$= 400.036 + 372.194$$

$$= 772 \text{ kip}$$

1985-1986

4(a)



$\frac{25}{50} = \frac{31}{31.93}$

$= 207.7'$

R_E

8/6 K/K

R_F

$\frac{F_b}{\sqrt{31^2+25^2}} \times 31 \times (207.7+50)$

$= R_E \times 207.7$

$= -R_F \times (207.7$ [illegible]

$= 200.59 F_b$

$= 207.7 R_E$

$= -357.7 R_F$

$F_b = 1.035 R_E$

$F_b = -1.78 R_F$

$\frac{F_a}{\sqrt{2^2+25^2}} \times 2 \times 36.33$

$= -R_F \times 3 \times 25$

$F_d = -R_F \times 3 \times 25$

$F_c = \frac{-R_F \times 50}{34.33}$

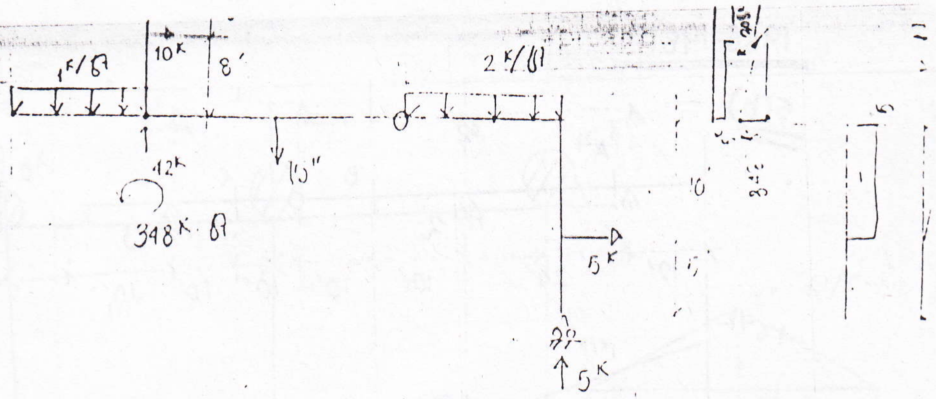
$F_d = \frac{R_E \times 207.7}{(207.7+50)}$

$= R_E \times (207.7$ [illegible]

([illegible]

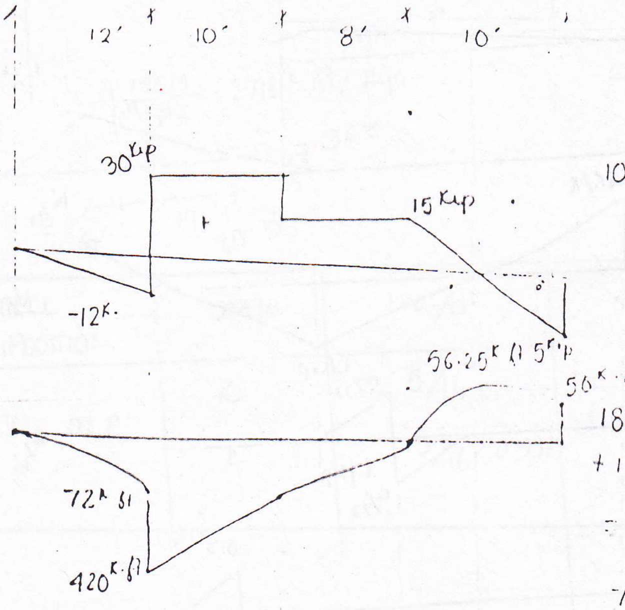
1985-1986

5(a)



$$\frac{2\times10\times\frac{10}{2} - 5\times10}{10}$$

$= 5^k$



$\frac{15}{5} = \frac{10-x'}{x'}$

$x' = 2.5'$

$10\times6 + 1\times12\times6 - 15\times10$
$- 2\times10\times2 + 5\times26$
$+ 5\times28 = M$
$= -188^k·ft$

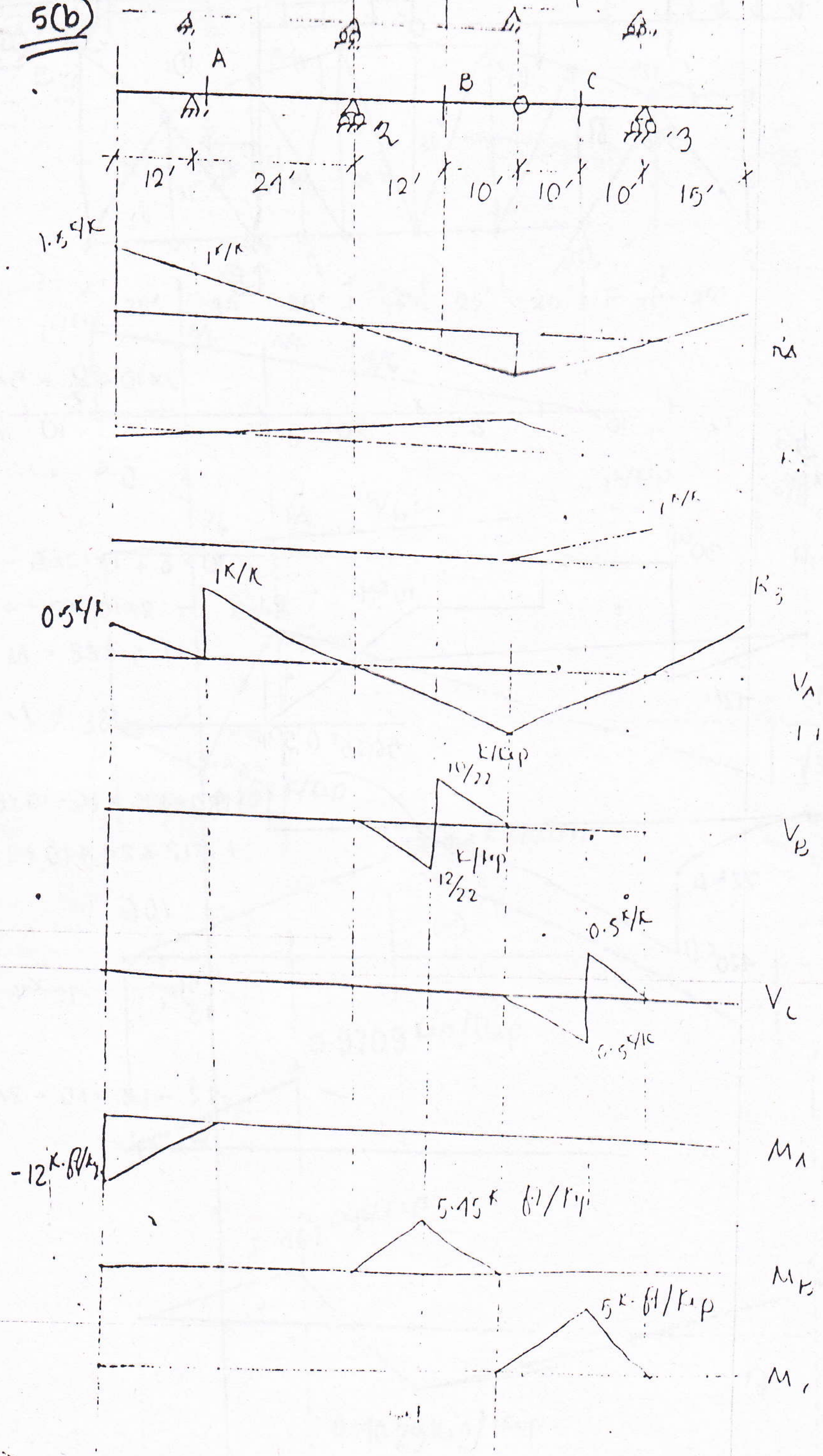
$188 + 15\times16 - 10\times8$
$+ 1\times12\times24 + 15\times8$
$= 156$

$\frac{756}{15}$ · 42^k

$42 - 12 - 15 - 2\times10 + 5$
$= 0$

1985-1986

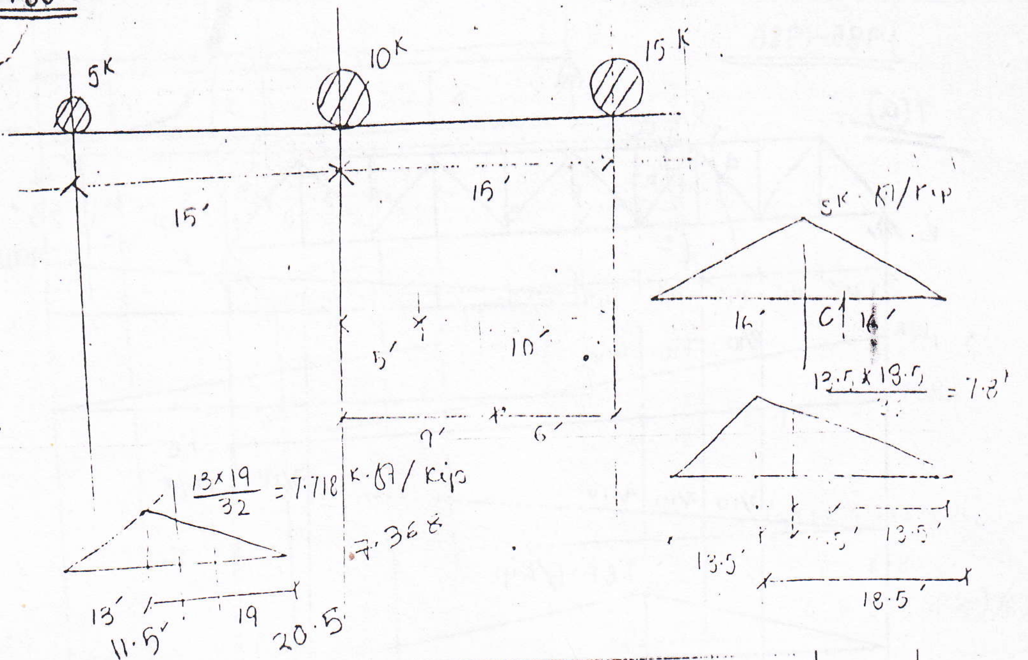
5(b)



A
B
C
2
3
12'
21'
12'
10'
10'
10'
15'
1.5^k/k
1^k/k
R_A
R_2
1^k/k
R_3
0.5^k/k
1^k/k
V_A
1 k/k
k/kip
10/22
12/22
k/kip
V_B
0.5^k/k
0.5^k/k
V_C
-12^k·ft/k
M_A
5.15^k ft/kip
M_B
5^k·ft/kip
M_C

1985-1986

6(c)



$$Cg = \frac{10\times15}{25} = 6'$$

Mmax

$$= 7.718\times10 + \frac{7.718}{19}\left[15\times(19-15)\right]$$

$$= 101.55$$

WHEEL POSITION	STATE	W_1/a	W/L
W_2 at C,	R	5/16	25/32
	L	15/16 = 0.9375 =	30/32 0.9375
	R		
	L	5/16 0.3125 <	15/32 = 0.46875

$$Cg = \frac{10\times15 + 5\times30}{10+15+5} = 10'$$

W_1/a = 0.74

W/L = 0.78

Maximum moment

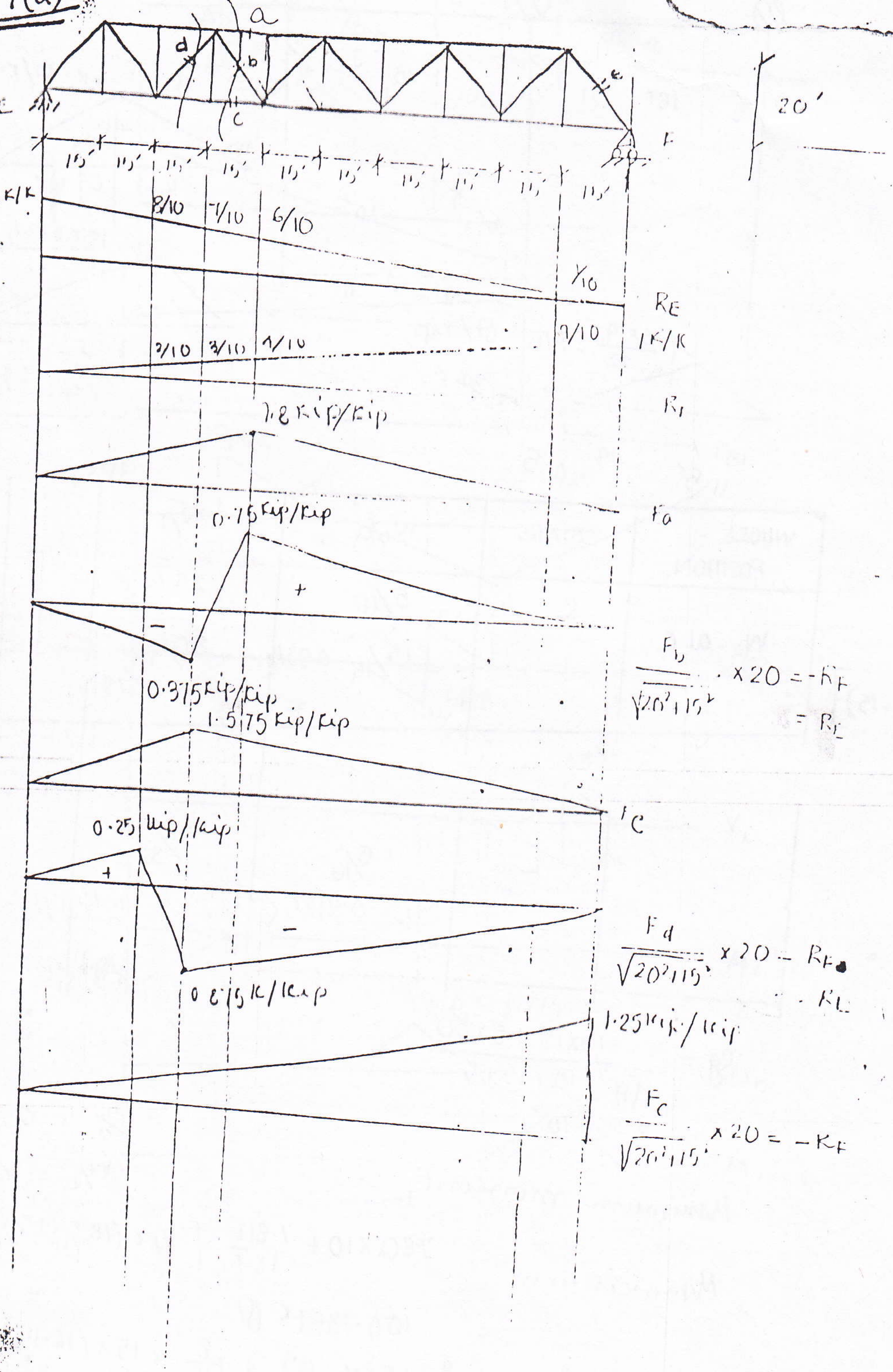
$$M_{maximum} = 7.80\times10 + \frac{7.80}{18.5}\left[15\times(18.5-15)\right]$$

$$= 100.1351^{K\text{-}ft}$$

$$M = 8\times10 + \frac{8}{16}\times5(16-15) + \frac{8}{16}\times15\times(16-15) = 90'$$

1985-1986

7(a)


a
b
c
d
e
E
F
15'
20'
1K/K
8/10
7/10
6/10
1/10
R_E
2/10
3/10
4/10
9/10
1K/K
R_F
1.8 kip/kip
F_a
0.75 kip/kip
+
−
0.375 kip/kip
F_b / √(20²+15²) · ×20 = −R_F = R_E
1.575 kip/kip
F_c
0.25 kip/kip
+
−
0.875 K/kip
F_d / √(20²+15²) ×20 = R_F = R_E
1.25 kip/kip
F_c / √(20²+15²) ×20 = −R_F

1985-1986

7(b)

$V_{3-1} = -R_5 + FBR_1$

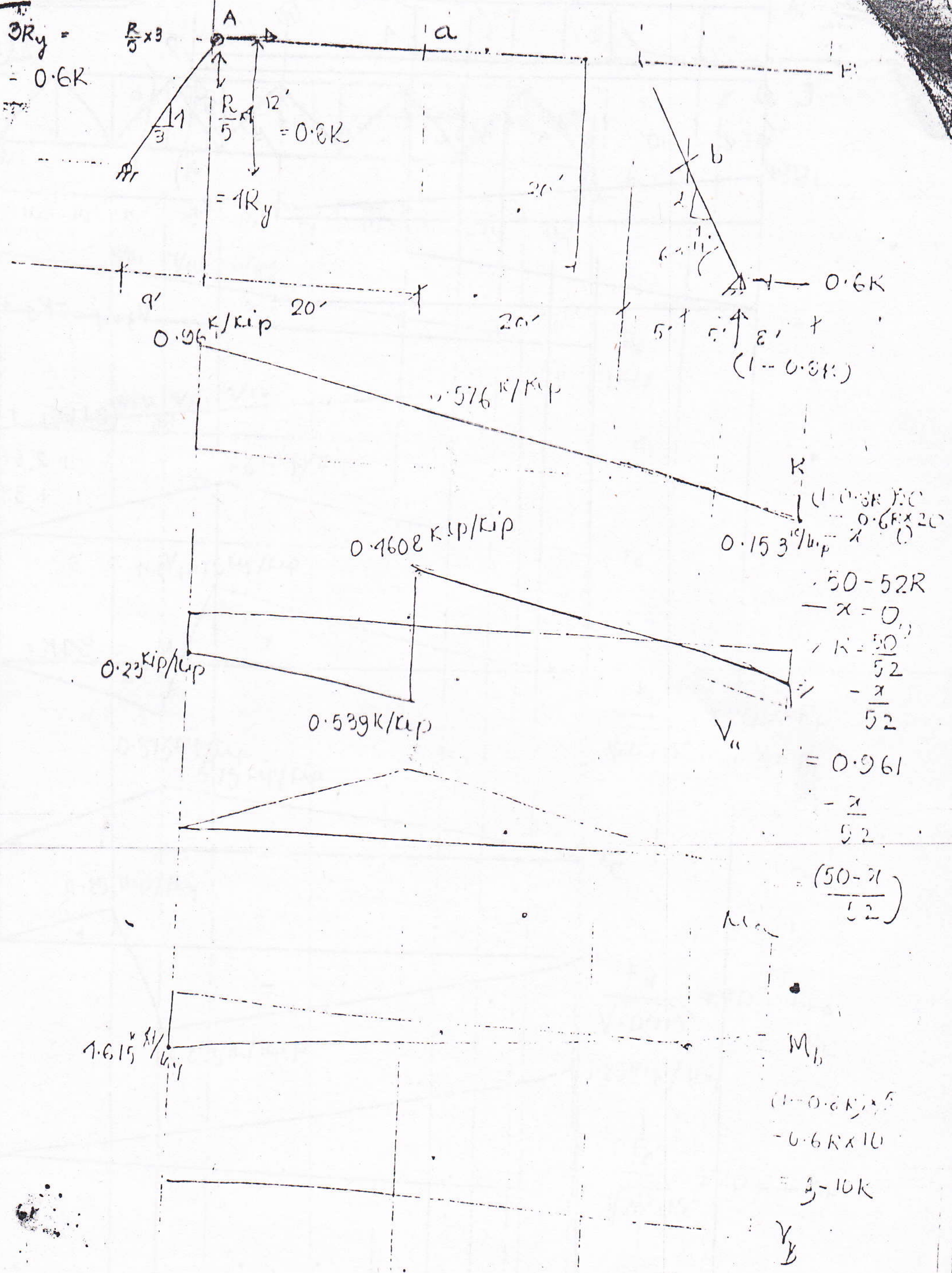
$R_5 = (8\,FBR_1 + 18\,FBR_2$
$+ 28\,FBR_3$
$+ 38\,FBR_4)/62$

$V_{3\cdot 1} =$

$M_3 = 34R_5 - 10\,FBR_1$

1985-1985

8(a)



(1 - 0.8K) 50 - 0.6K × 20 - x ()

= 50 - 52K - x = 0

∴ K = $\frac{50}{52}$ - $\frac{x}{52}$

= 0.961 - $\frac{x}{52}$

= $\left(\frac{50-x}{52}\right)$

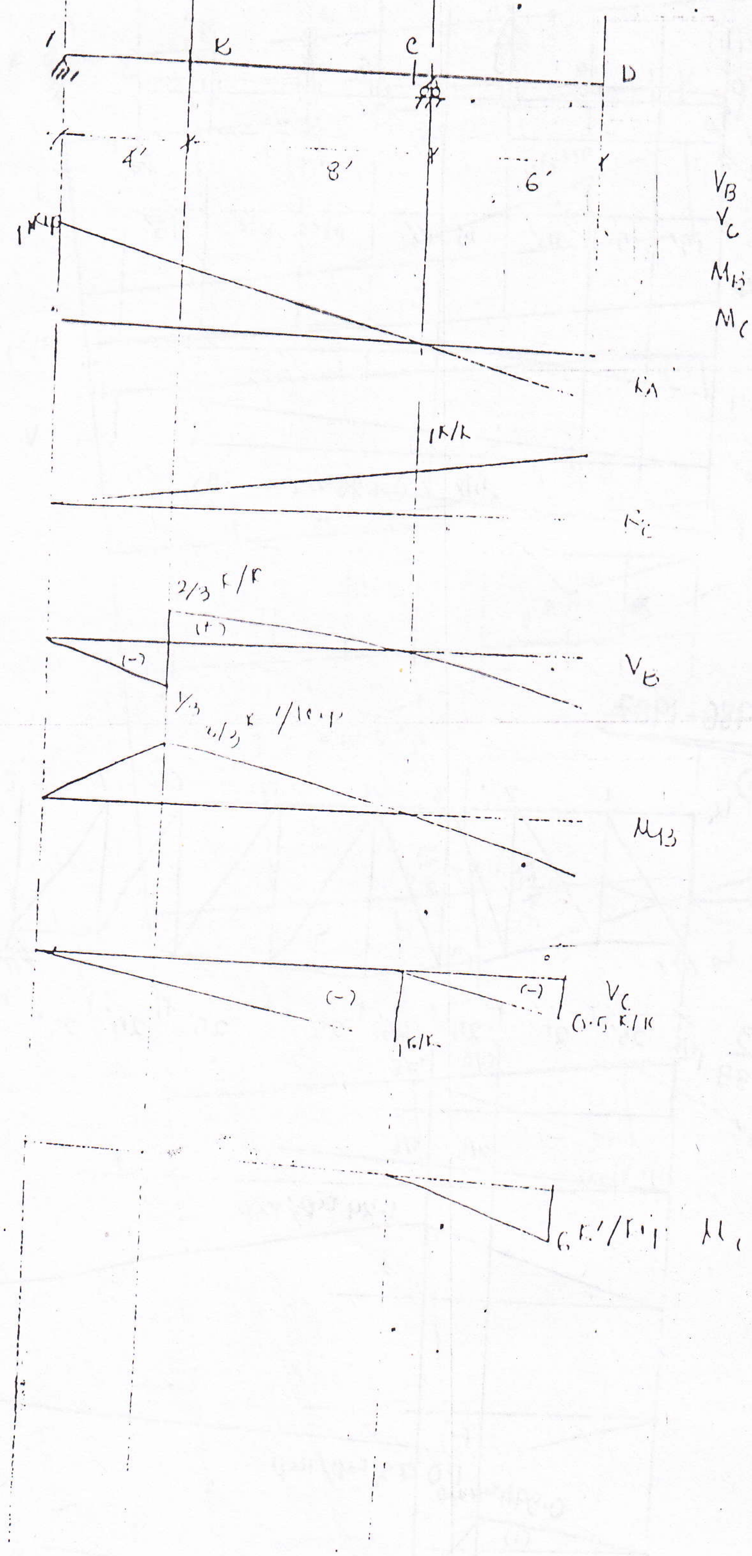
(1 - 0.6K) × 5 - 0.6K × 10

= 5 - 10K

(1 - 0.8K)

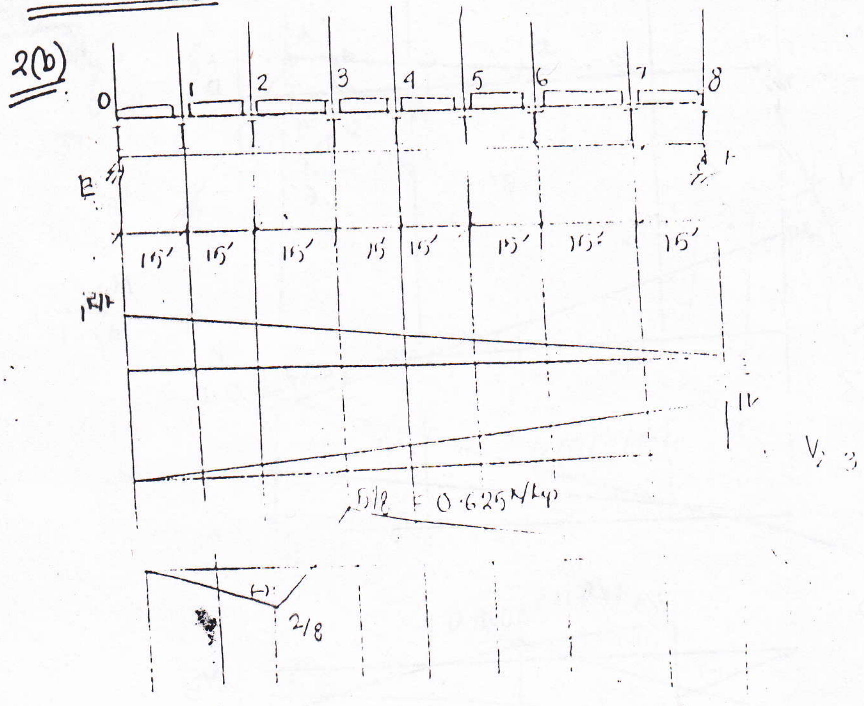
1986 - 1987

1(a).


A
B
C
D
4'
8'
6'
V_B
V_C
M_B
M_C
1 kip
R_A
1k/k
R_C
2/3 k/k
(+)
(-)
V_B
1/3
2/3 k
1/kip
M_B
(-)
(-)
V_C
0.5 k/k
1k/k
6 k'/kip
M_C

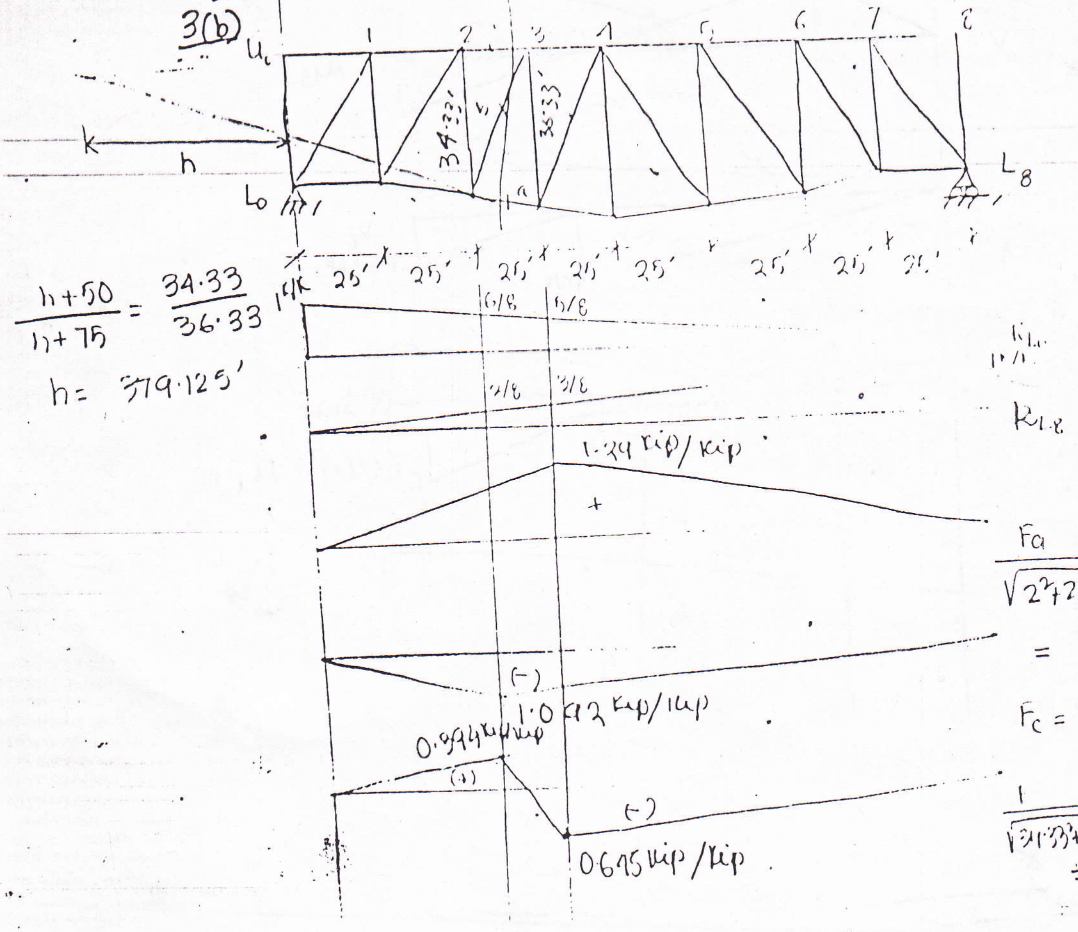
1986-1987

2(b)



1986-1987

3(b)



$$\frac{h+50}{h+75} = \frac{34.33}{36.33}$$

$h = 379.125'$

$$\frac{Fa}{\sqrt{2^2+25^2}} \times 25 \times 36.5$$

$$= \frac{3 \times 5 \times 25}{8}$$

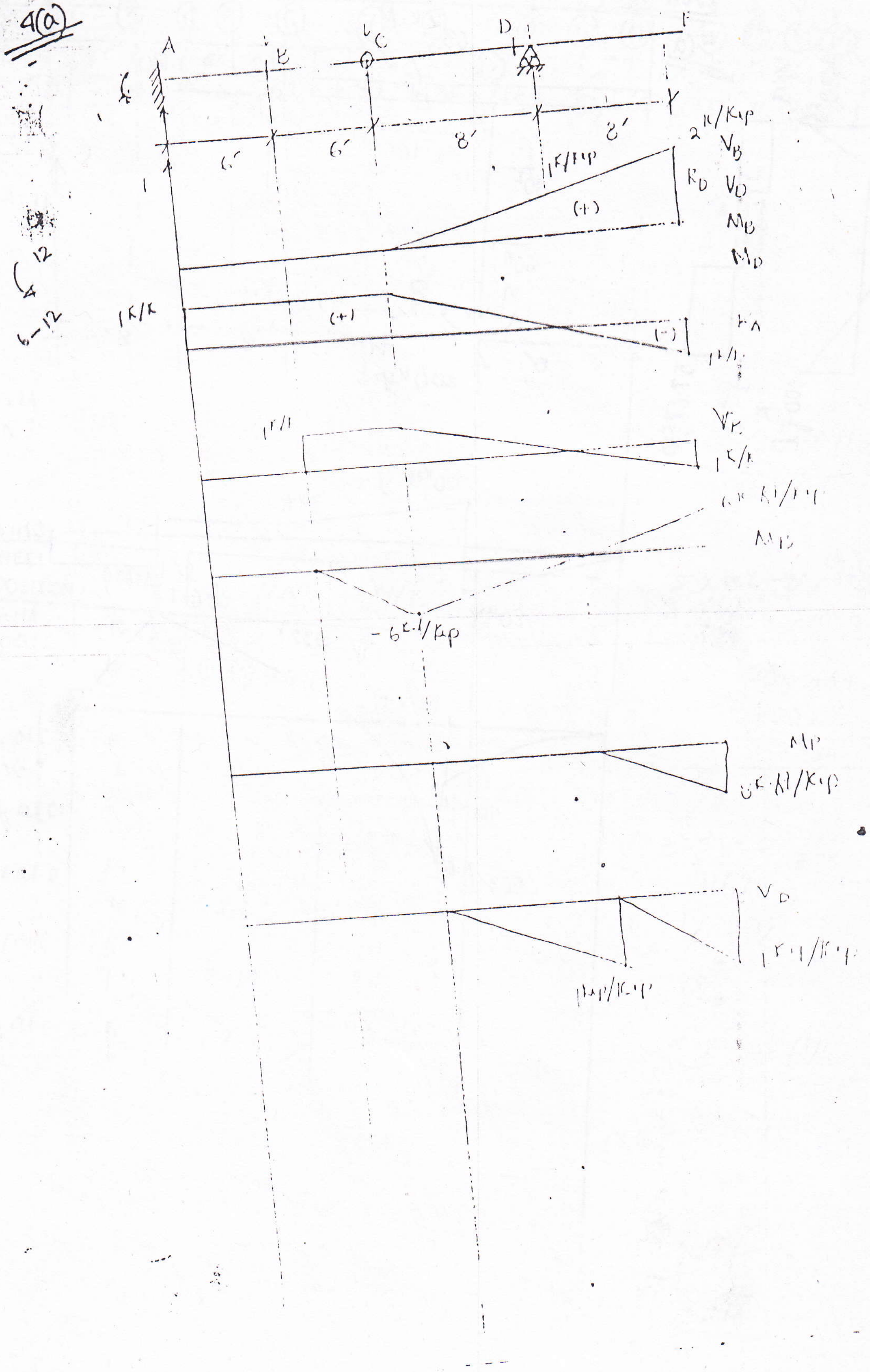
$$F_c = \frac{2 \times 6 \times 2 \times 5/8}{1.33}$$

$$\frac{1}{\sqrt{34.33^2+25^2}} \times 34.33 \times (379.125 + 75)$$

$$= +R_{L8} * (379.125 + 200) - R_{L0}(379.125)$$

1986-1987

4(a)


A
B
C
D
F
6'
6'
8'
8'
1
2 K/Kip
V_B
1K/Kip
R_D
V_D
M_B
M_D
(+)
12
6-12
1K/K
(+)
(-)
R_A
1K/K
1K/K
V_B
1K/K
6K-ft/Kip
M_B
-6K-ft/Kip
M_D
6K-ft/Kip
V_D
1Kip/Kip
1Kip/Kip

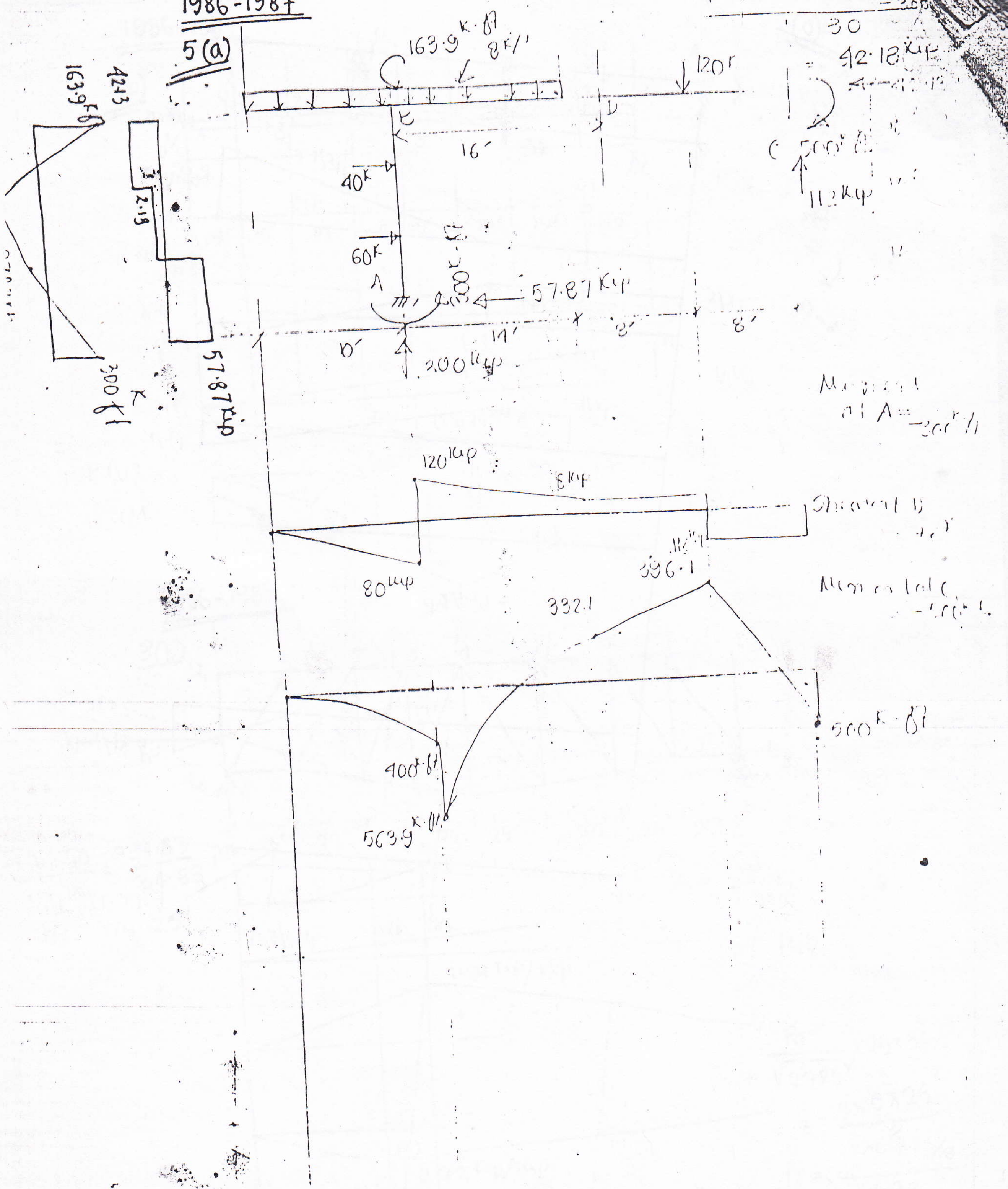
1986-1987

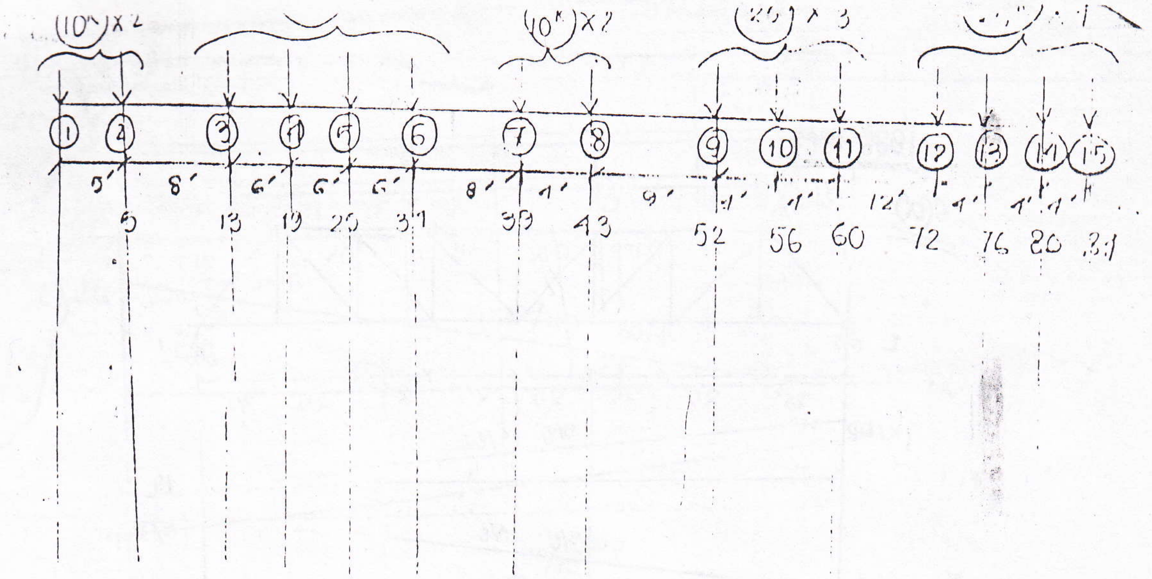
5(a)

60×10+40×20+8×24×

+120×22-112×30+

30





10^k 11

WHEEL POSITION	STATE	W_1/a	W/L	
W_3 at C	R			
	L	① ③ > 0.7	① ⑮ 2.21	
W_4 at C	R			
	L	1.15	2.21	
W_5 at C				
	—	1.6	2.21	
W_6 at C	R			
	L	2.05	2.21	
W_7 at C	R			
	L	2.174	2.21	
W_8 at C	R	2.3 >	2.21	
	L			

$25 \times 4 \times 6 + 25 \times 3 \times 28$

$+ 20 \times 13 + 36 \times 4 \times 62$

$+$ [illegible]

$20 + 36 \times 4$

$+ 20 + 25 \times$

[illegible]

$a = 11 - 3$ [illegible]

1.615

$x: L/2 - a/2$

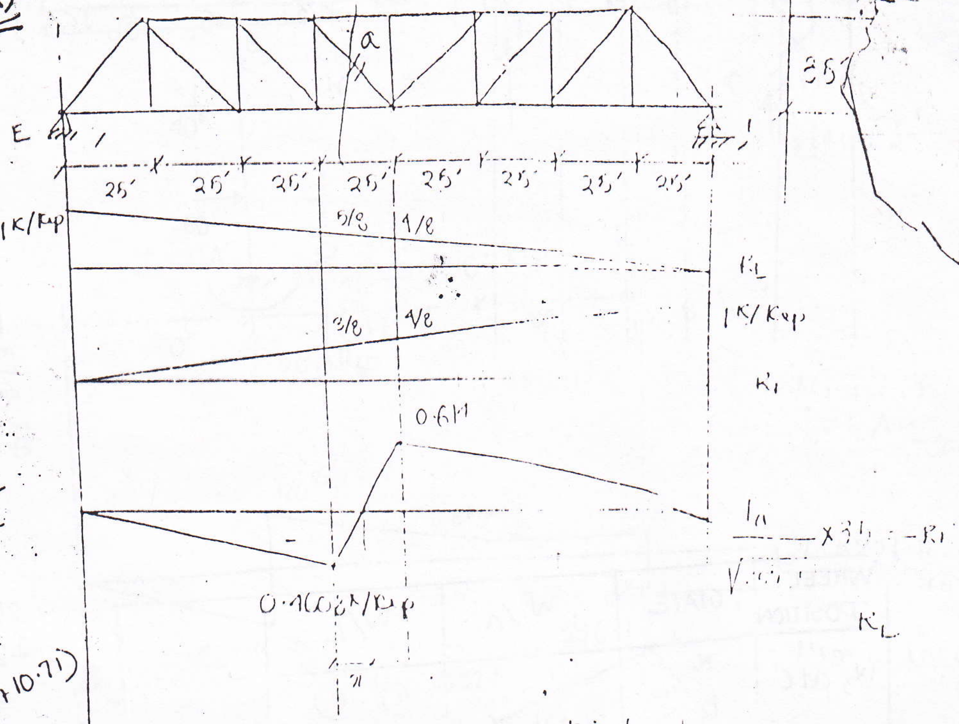
$= 78$ [illegible]

[illegible]

13.1625 30.9375

1986-1987

6(a)



$$\frac{0.4608}{0.614} = \frac{x}{25-x}$$

$x = 10.71'$

$\frac{1}{2} \times 0.4608 \times (75+10.71)$

$= 19.74$

$\frac{1}{2} \times 0.614 \times (100+25-10.71)$

$= 35.08$

DL = 11^k at each top chord joint

25^k at each bottom chord joint

LL = moving uniformly distributed load = 4/

a moving concentrated load = 40^k

maximum tension:

$$= -\frac{0.4608}{75}\left[(11+25)\times 3\times 25\right] + 0.614\times(11+25)$$

$$+ \frac{0.614}{100}\left[(11+25)\times 3\times 50\right] + 35.08\times 4 + 0.614\times 40$$

lud

maximum compression

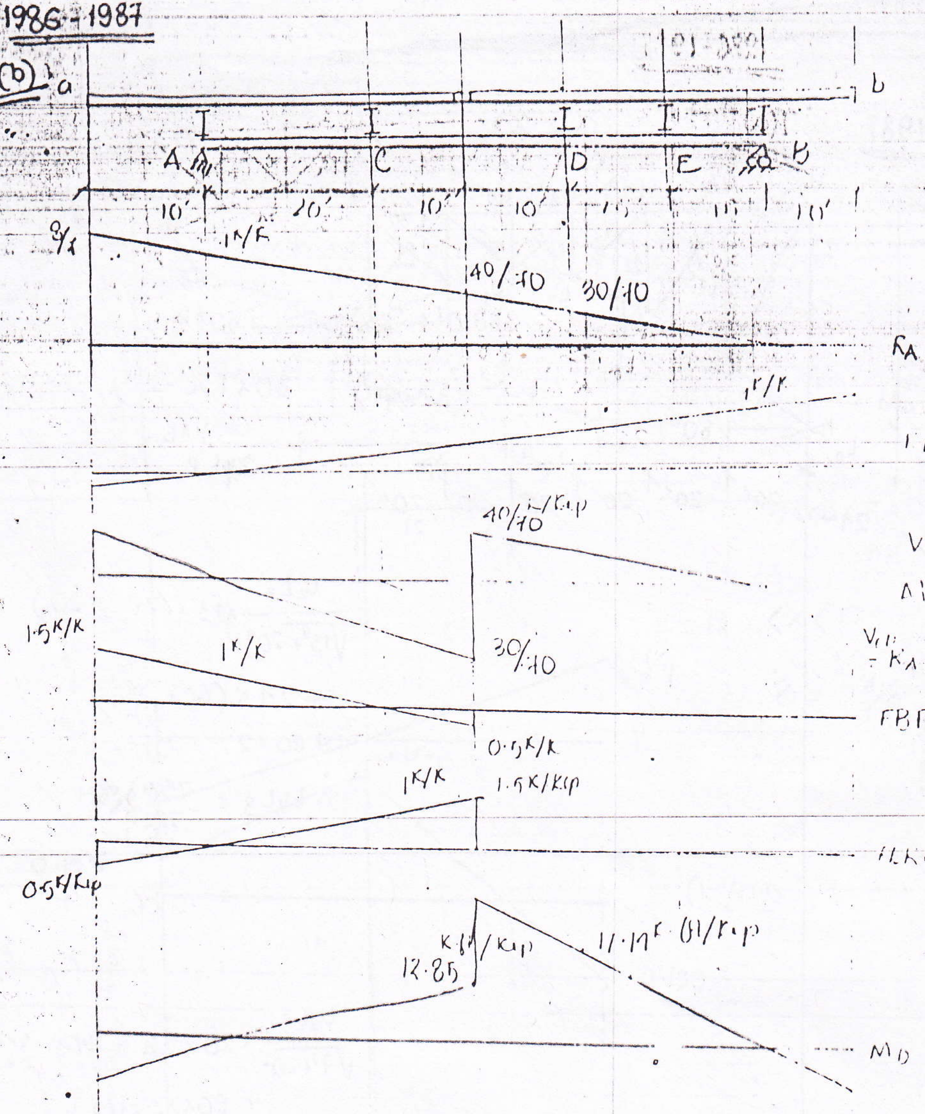
$$= -\frac{4608}{75}\left[(11+25)\times 3\times 25\right] + 0.614(11+5)$$

$$+ \frac{0.614}{100}\left[(11+25)\times 3\times 50\right] - 0.4608\times 40$$

$- 19.74$

1986-1987

6(b)



40/10 + 0.5 - 1.5

40/10 - 1

30/10 k/k

MD (RA FBRA)

× 10

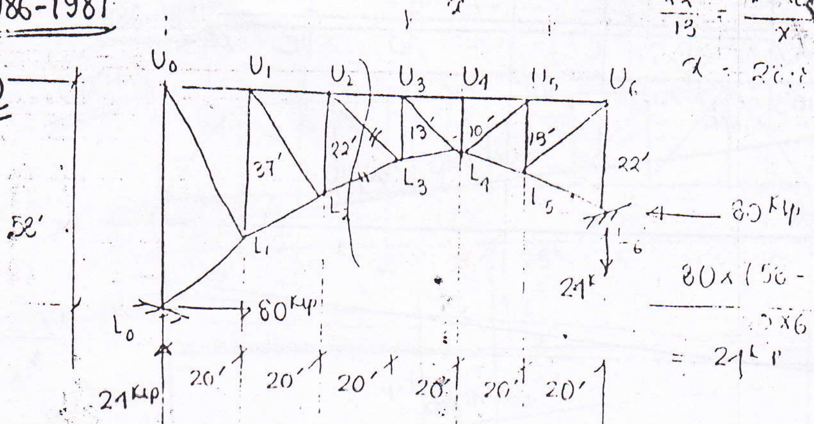
FBRC × 20

1986-1987

7(a)

$\frac{22}{13} = \frac{x+20}{x}$

$x = 28.88$



$\frac{80 \times (56-22)}{[illegible]\times 6}$

$= 21^{kip}$

$\frac{U_2L_3}{\sqrt{13^2+20^2}} \times 13 \times (28[illegible]+20)$

$+ 21 \times (60 - [illegible])$

$+ 80 \times 22 = 0$

$\therefore U_2L_3 = \frac{35028}{26[illegible]}$

$= 316.[illegible]^{k}$

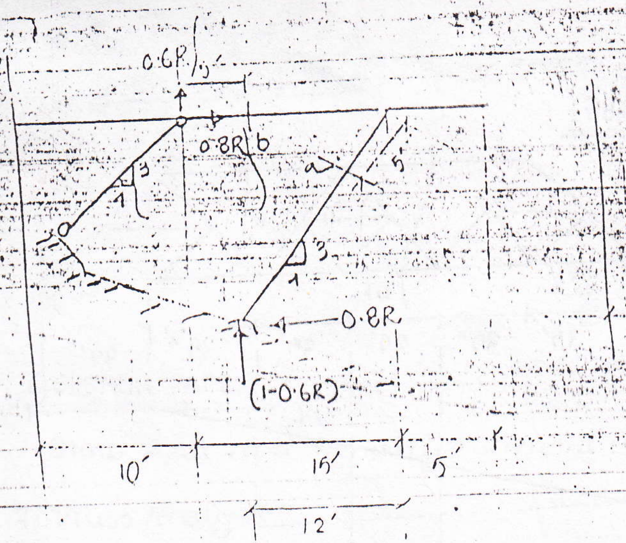
$\frac{L_2L_3}{\sqrt{9^2+20^2}} \times 20 \times 22 + 21 \times [illegible]4$

$+ 80 \times 22 = 0$

$L_2L_{3,} = \frac{3680}{20.06}$

$= 183.4476^{kip}$

1986-1987

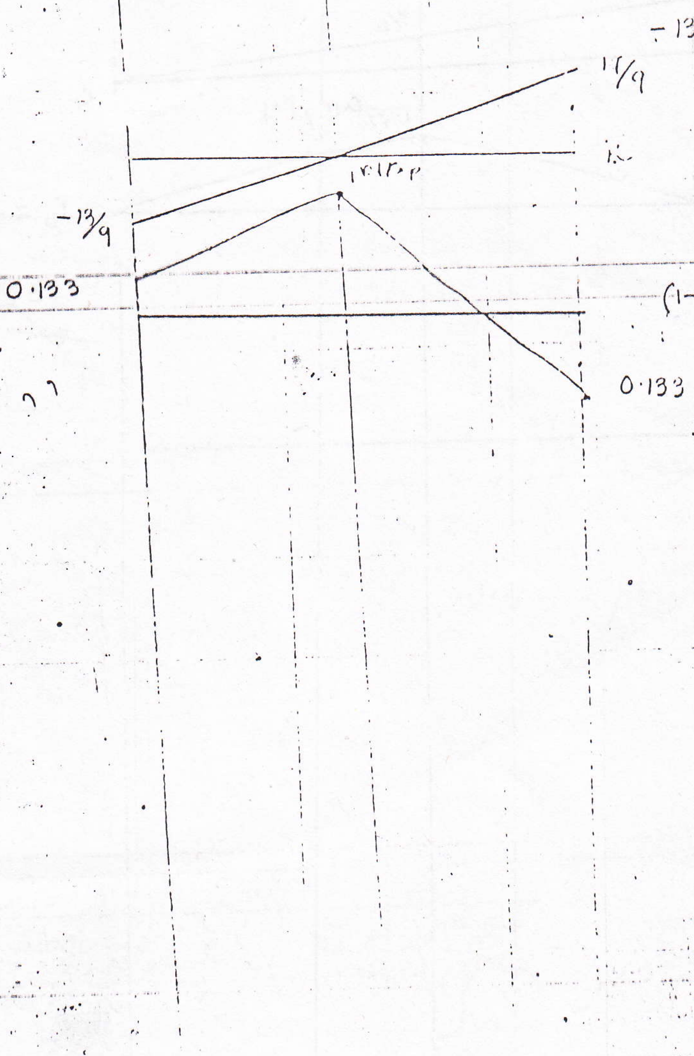


V_a
M_b

$0.6R \times 3 + 0.8R \times 9$
$- x = 0$

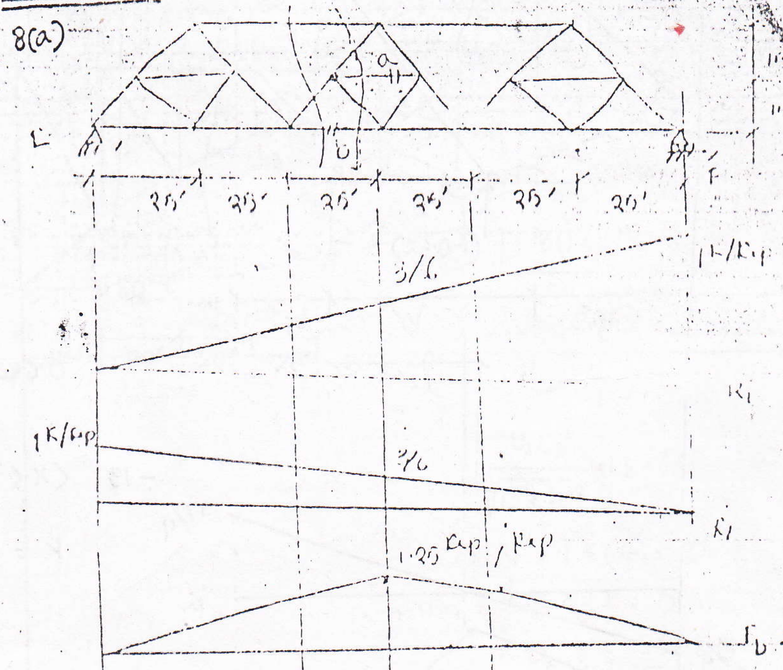
$-13 < x < 17$

$R = x/9$



1986-1987

8(a)



$$F_b = \frac{3/6 \times 3 \times 25}{30}$$

$$= 1.25 \text{ kip/kip}$$