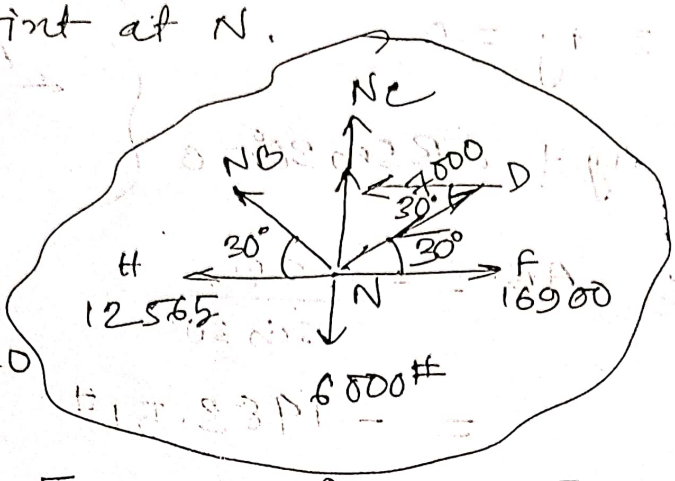
TRUSS

(337) consider joint at N.



$\Sigma fx = 0$

$\Rightarrow NF + ND\cos 30° - NH - NB\cos 30° = 0$

$\Rightarrow NB\cos 30° = 16900 + 7000\cos 30° - 12565$

$\Rightarrow NB = -1994.37$

$\Rightarrow NB = 1994.37^{\#}$ (C)

$\Sigma fy = 0$

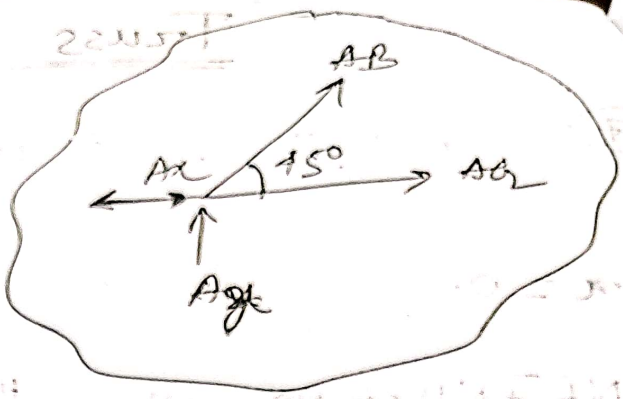
$NC - ND\sin 30° + NB\sin 30° - 6000 = 0$

$\Rightarrow NC = 7000\sin 30° + 6000 - NB\sin 30°$

$= 7000\sin 30° + 6000 - (-1994.37\sin 30)$

$= 10497.185^{\#}$

(338) Joint at A



$\Sigma F_y = 0$

$\Rightarrow A_y + AB \sin 30° = 0$

$\Rightarrow AB = -\frac{1000}{\sin 30°}$

$= -1483.51\#$

$= 1483.51\#$ (C)

$\Sigma F_x = 0$

$\Rightarrow AG + AB \cos 45° - Ax = 0$

$\Rightarrow AG = Ax - AB \cos 45°$

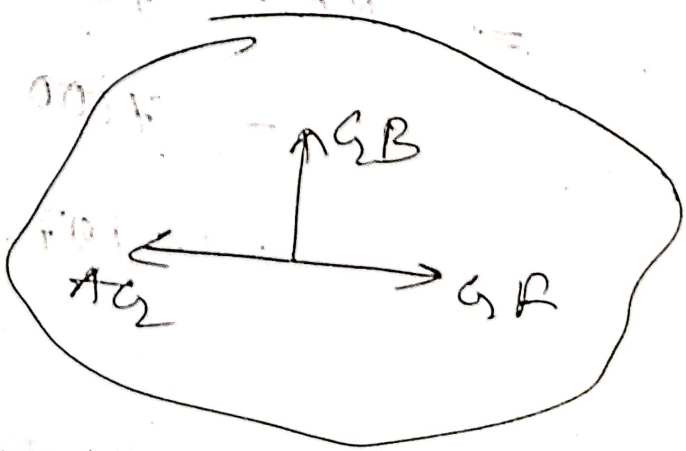
$= 1000 - (-1483.51 \cos 45°)$

$= 2049\#$

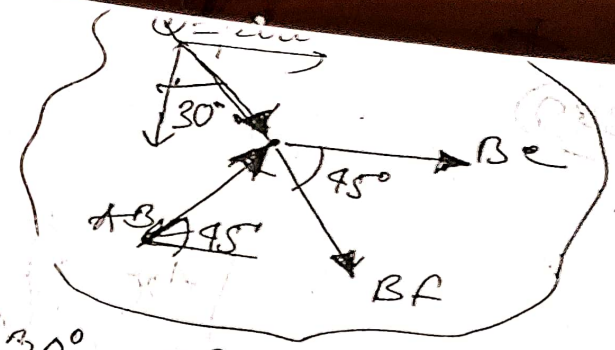
Joint G

$\Sigma F_y = 0$

$\Rightarrow GB = 0.$



Joint B



$\Sigma F_y = 0$

$\Rightarrow AB \sin 45° - Q \cos 30° - BF \sin 45° = 0$

$\Rightarrow BF \sin 45° = -1483.57 \sin 45° + 2000 \cos 30°$

$\Rightarrow BF = -965.98\#$

$= 965.98\#$ (C)

$\Sigma F_x = 0$

$\Rightarrow 2000 \sin 30° + BC + AB \cos 45° + BF \cos 45° = 0$

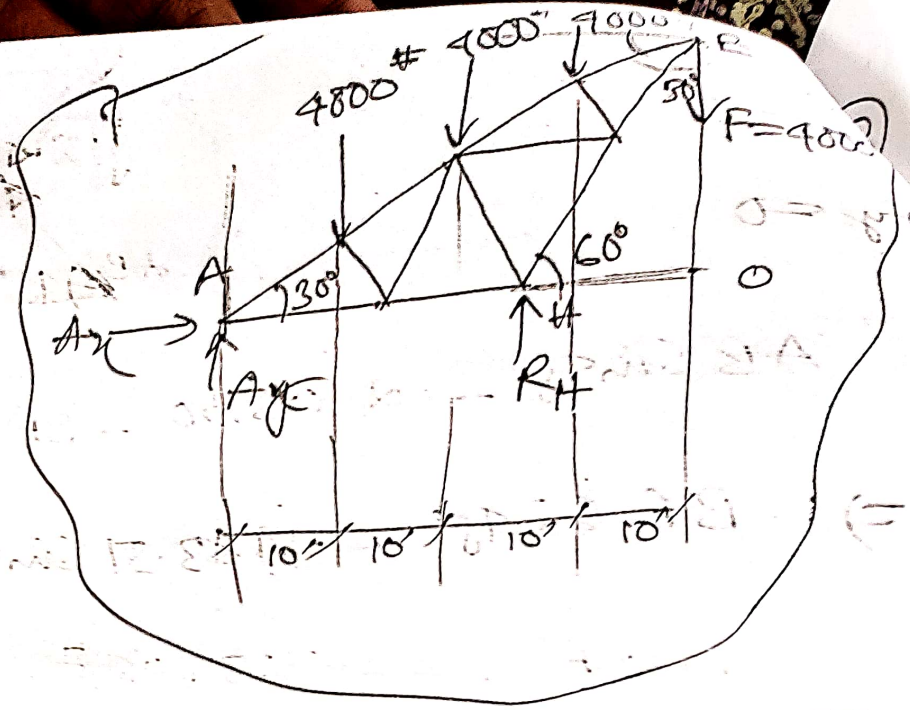
$\Rightarrow BC = -BF \cos 45° - 2000 \sin 30° - 1483.57 \cos 45°$

$= 965.98 \cos 45° - 2000 \sin 30° - 1483.57 \cos 45°$

$= -1365.95\#$

$\Rightarrow BC = 1365.95\#$ (C).

339



$\Sigma M_A = 0$

$\Rightarrow$

$\Rightarrow 4800 \times 10 + 4000 \times 20 + 4000 \times 30 + 4000 \times 40 - R_H \times (40 - 13.33)$

$\Rightarrow R_H = 14999.98$ #

$= 15000$ #

$\Sigma F_x = 0$

$A_x =$

$\Sigma F_y = 0$

$A_y =$

$AH = 40 - OH$

$= 40 - 18.33$

$\Rightarrow$

ΔOAE ন্য

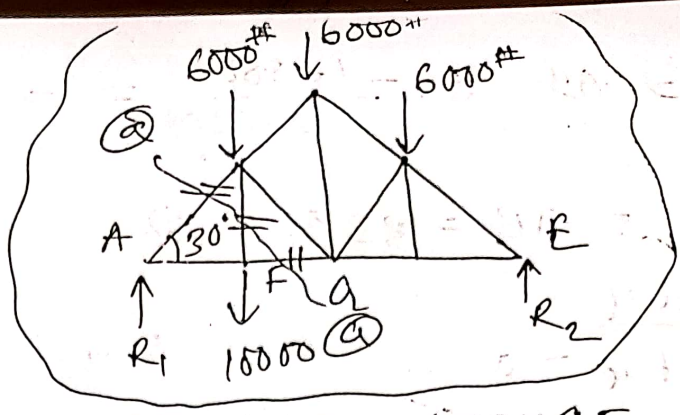
$\tan 30° = \frac{OE}{40}$

$\Rightarrow OE = 23.094$

ΔOHE থেকে

$\tan 60° = \frac{OE}{OH}$

$\Rightarrow OH = \frac{23.094}{\tan 60°} = 18.3$



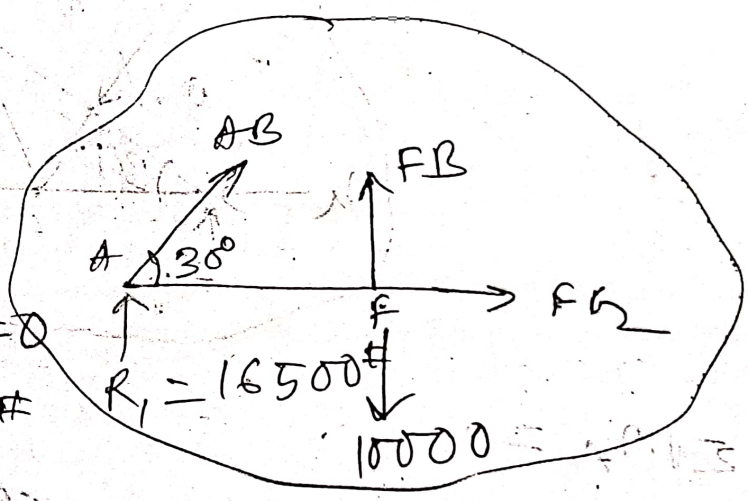
$\Sigma M_E = 0$

$\Rightarrow R_1 \times 60 - 6000 \times 15 - 6000 \times 30 - 6000 \times 45 - 10000 \times 45^a = 0$

$\Rightarrow R_1 = \frac{990000}{60}$

$= 16500^{\#}$

Section a–a



$\Sigma M_A = 0$

$\Rightarrow -FB \times 15 + 10000 \times 15 = 0$

$\Rightarrow FB = 10,000^{\#}$

$\Sigma F_y = 0$

$\Rightarrow R_1 + FB + AB \sin 30^\circ - 10000 = 0$

$\Rightarrow AB \sin 30^\circ = 10000 - 10000 - 16500$

$$\Rightarrow AB = \frac{-16.580}{\sin 30^\circ} = -33000$$

$$\therefore AB = 33000 \text{ (C)}$$

Again

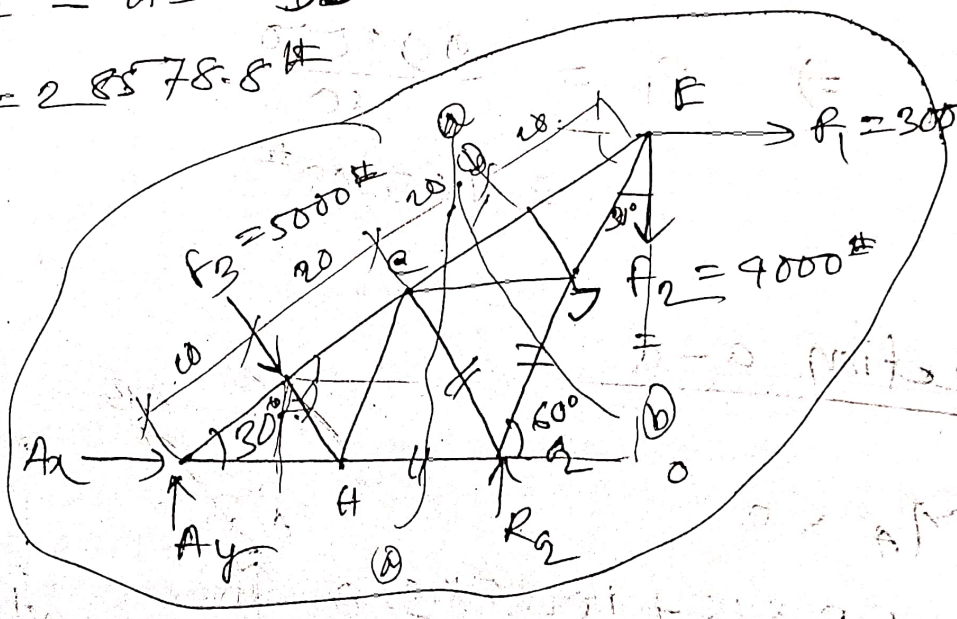
$\Sigma F_x = 0$

$\Rightarrow AB \cos 45^\circ + R_2 = 0$

$\Rightarrow R = -AB \cos 30^\circ$

$= 28578.8^{\#}$

(341)



$\Sigma M_A = 0$

$\Rightarrow 5000 \times 20 + 3000 \times 80 \sin 30^\circ + 4000 \times 80 \cos 30^\circ - R_2 \times (69.28 - 23.09) = 0$

$\Rightarrow R_2 = 10762.97^{\#}$

$\sin 30^\circ = \frac{OE}{80}$

$\Rightarrow OE = 40'$

$\tan 60^\circ = \frac{OE}{OC}$

$\Rightarrow OC = 23.09$

$OA = 80 \cos 30^\circ = 69.28$

$\Sigma F_x = 0$

$\Rightarrow -A_x + 5000 \cos 60° + 3000 = 0$

$\Rightarrow A_x = -5500\ \#$

$= 5500\ \#\ (\leftarrow)$

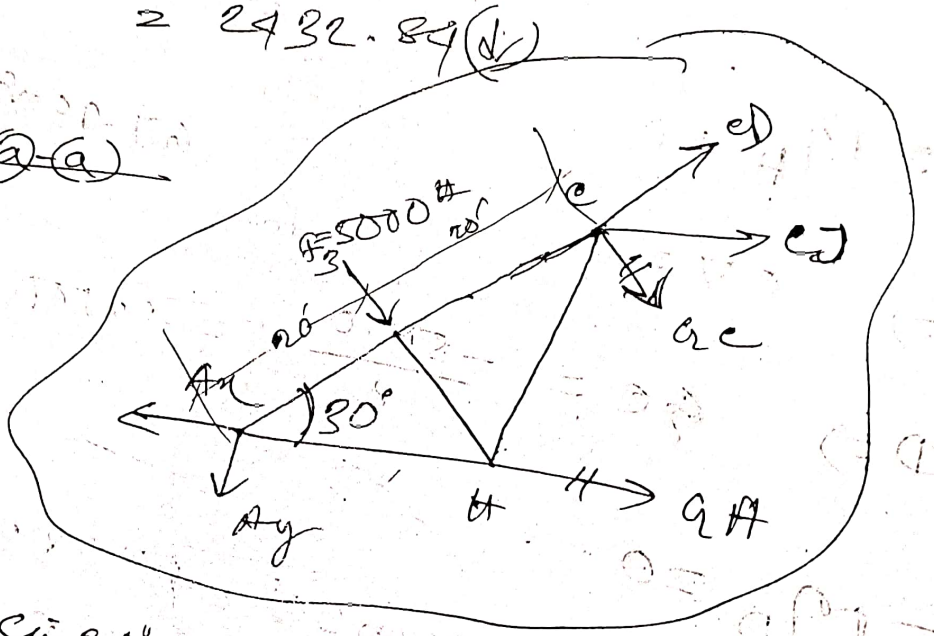
$\Sigma F_y = 0$

$\Rightarrow -A_y - 5000 \sin 60° + 10762.97 - 4000 = 0$

$\Rightarrow A_y = -2432.84\ \#$

$= 2432.84\ \#\ (\downarrow)$

Section (a)-(a)



$\Sigma M_C = 0$

$\Rightarrow A_x \times 40 \sin 30° - 5000 \times 20 - A_y \times 40 \cos 30° - Q_H \times 40 \sin 30° = 0$

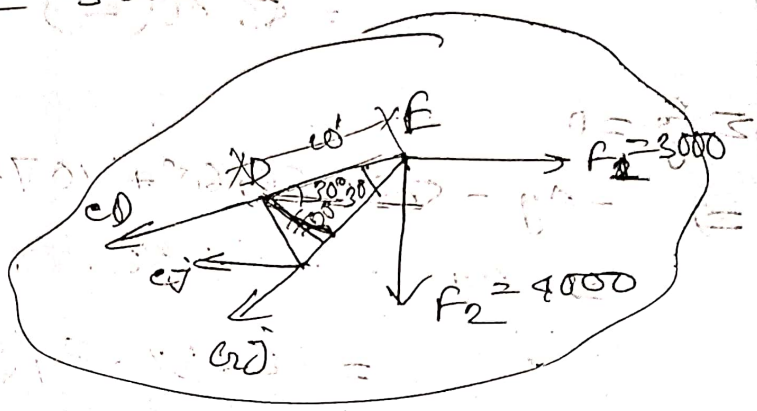
$\Rightarrow Q_H = -3713.8\ \# = [-]$

$= 3713.8\ \#$ (C)

$\Sigma M_A = 0$

$\Rightarrow 5000 \times 20 + C_1 e \times 40 + c_2 \vec{j} \times 40 \sin 30^\circ = 0$

$\Rightarrow 2c_1 e + c_2 \vec{j} = -5000$ ——— (1)



$\Sigma M_E = 0$

$\Rightarrow c_2 \vec{j} = 0$ — $c_2 \vec{j}$ এর মান বসিয়ে

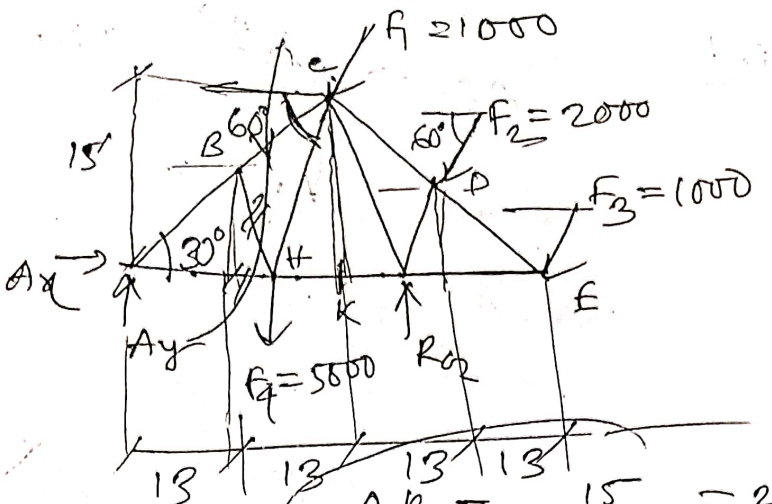
(1) $\Rightarrow c_1 e = \frac{-5000}{2} = -2500 = 2500$ (T)

$\Sigma M_D = 0$

$\Rightarrow 3000 \times 20 \sin 30^\circ + 4000 \times \cos 30^\circ + c_2 \vec{j} \times 20 \sin 30^\circ = 0$

$\Rightarrow f_{c_2 \vec{j}} = -99.2^{\#}$

$= 99.2^{\#}$ (T)



$\Sigma M_A = 0$

$AK = \frac{15}{\tan 30^\circ} = 26$

$AE = 2AK = 52'$

$AH = HG = GH = \frac{52}{3}$

$= 17.33$#

$\Rightarrow 5000 \times 17.33$

$+ 1000 \cos 60^\circ \times 15'$

$+ 1000 \sin 60^\circ \times 26$

$+ 2000 \sin 60^\circ \times (13 \times 3) - 2000 \cos 60^\circ \times 13 \tan 30^\circ$

$+ 1000 \sin 60^\circ \times 52 - R_E \times 34.66 = 0$

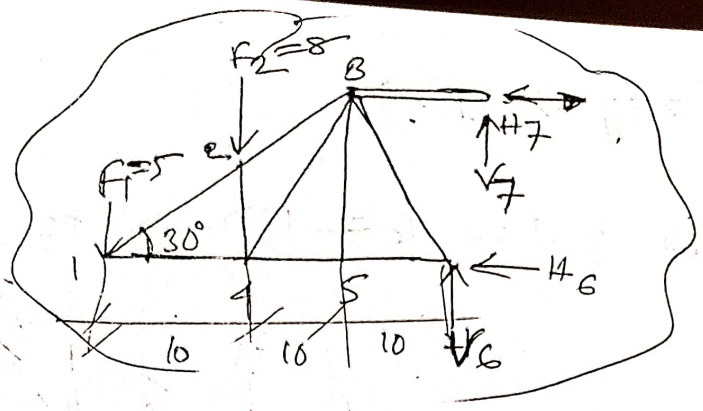
$\Rightarrow R_E = 5965.09$#

$\Sigma F_x = 0$

$\Rightarrow A_x = 2000$#

$\Sigma F_y = 0$

$\Rightarrow A_y = 2499$#



$\Sigma M_7 = 0$

$\Rightarrow \quad H_6 \times 20 \sin 30° - 8 \times 10 + 5 \times 30 = 0$

$\Rightarrow \quad H_6 = 26.84 \text{ kip} \ (\leftarrow)$.

$\Sigma F_x = 0$

$\Rightarrow \quad H_7 - H_6 = 0$

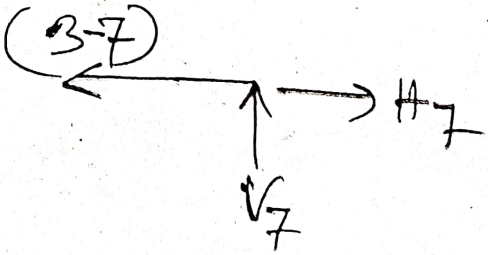
$\Rightarrow \quad H_7 = 26.84 \text{ K} \ (\rightarrow)$

$\Sigma F_y = 0$

$\Rightarrow \quad V_6 - 5 - 8 + V_7 = 0$

$\Rightarrow \quad V_6 + V_7 = 13 \quad \text{---------} \ (1)$

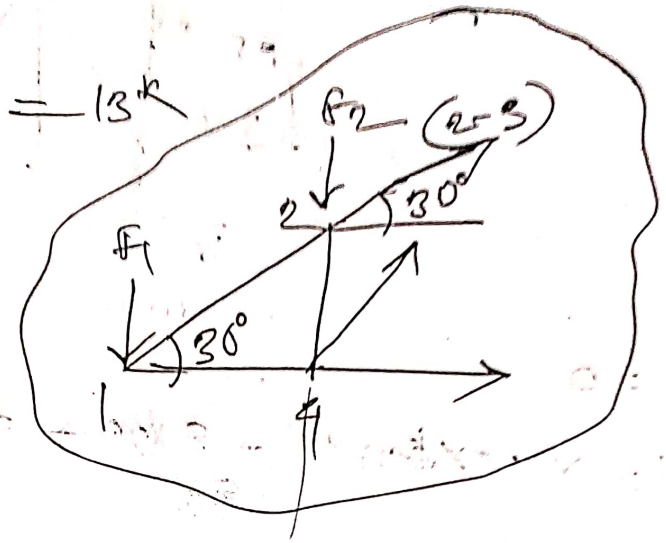
Joint 7



$\Sigma F_x \Rightarrow H_7 = (3\text{-}7) = 26.84$

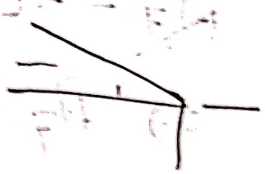
$\Sigma F_y \Rightarrow V_7 = 0$:

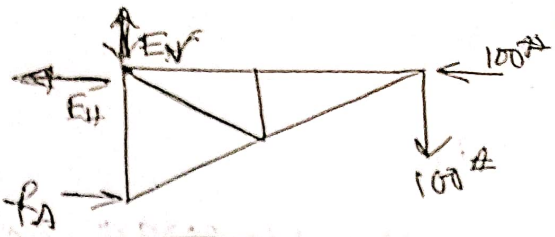
$\Rightarrow \forall ① \Rightarrow V_6 = 13^K$



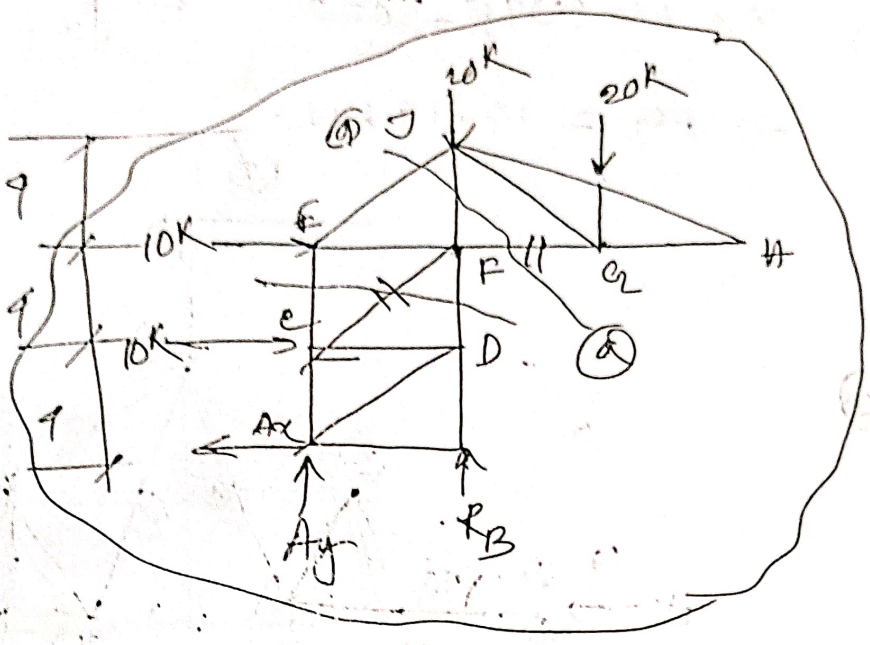
$\Sigma M_4 = 0$

$\Rightarrow$





35)



$\Sigma F_x = 0$

$\Rightarrow A_x = 20K$

$\Sigma M_A = 0$

$\Rightarrow R_B = 90\ K$

$\Sigma F_y = 0$

$\Rightarrow A_y + R_B - 20 - 20 = 0$

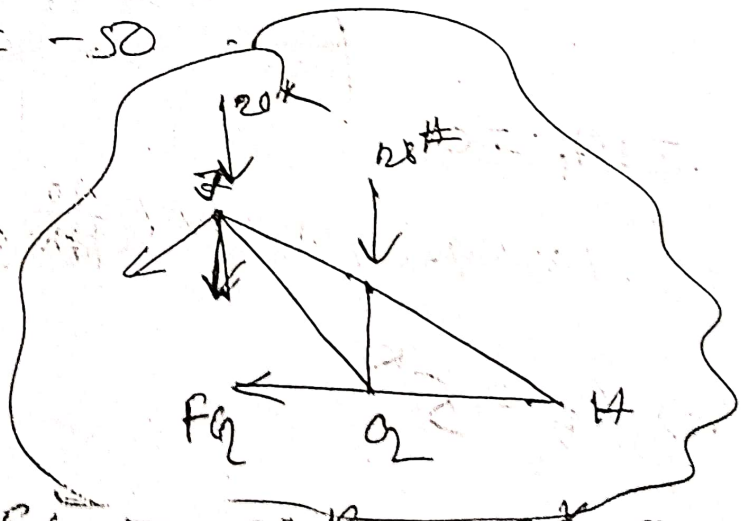
$\Rightarrow A_y = 40 - 90 = -50$

$\Rightarrow A_y = 50$ ↓

Section @-@

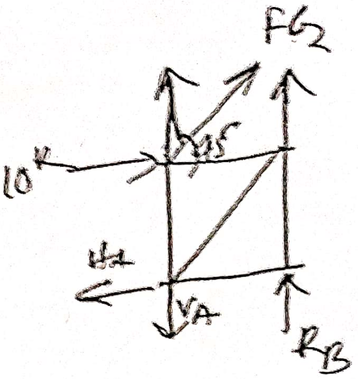
$\Sigma M_J = 0$

$\Rightarrow F_G \times 4 + 20 \times 4 = 0$



$\Rightarrow F_G = -20K = 20K$ ↓

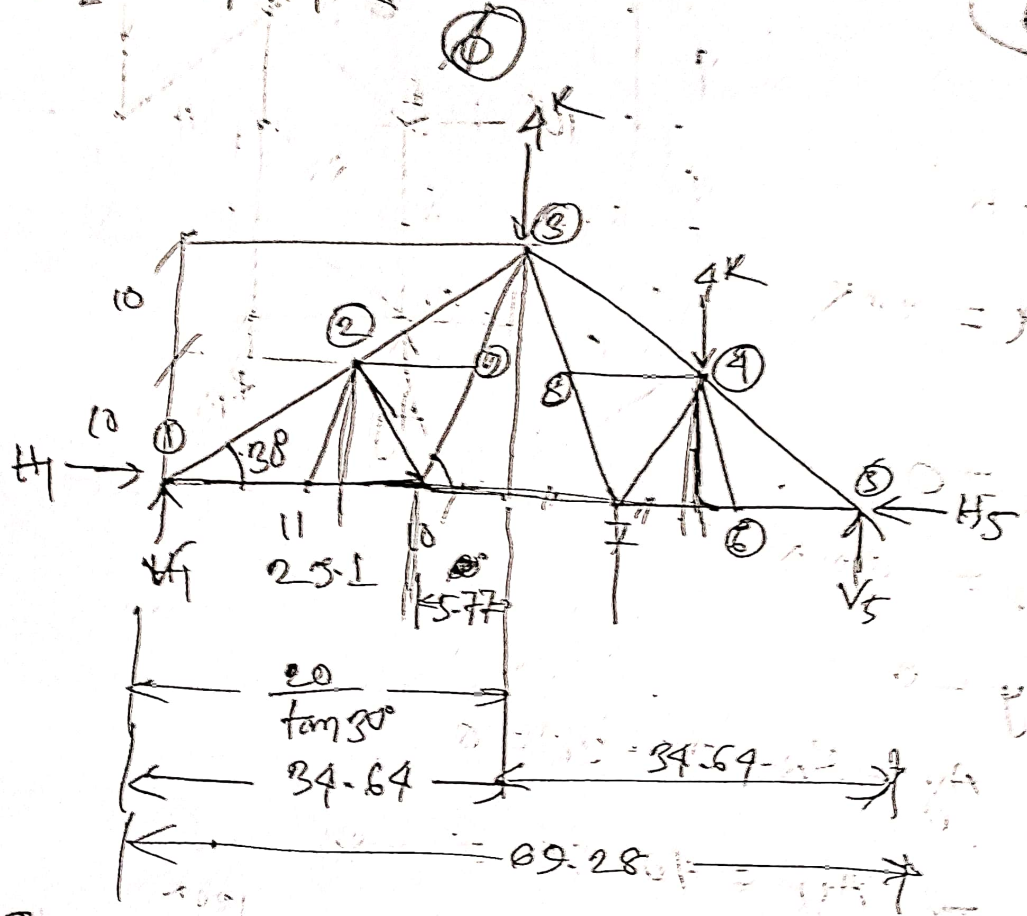
section ① - ①



$\Sigma F_x = 0$

$\Rightarrow 10 + FG \cos 45° - 20 = 0$

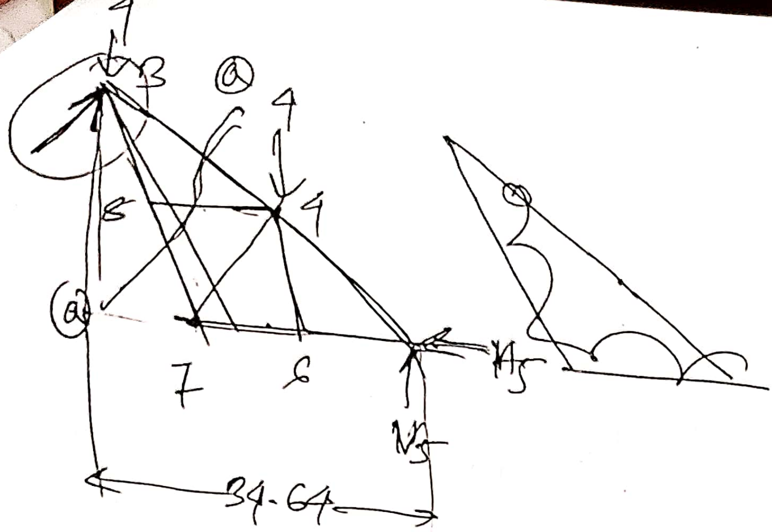
$\Rightarrow FG = 14.14\ KN$



$\Sigma M_1 = 0$

$\Rightarrow 4 \times 34.64 + 4 \times \left(\frac{20}{\tan 30°} + \frac{10}{\tan 30°}\right) - V_5 \times 69.28 = 0$

$\Rightarrow V_5 = 5^K$

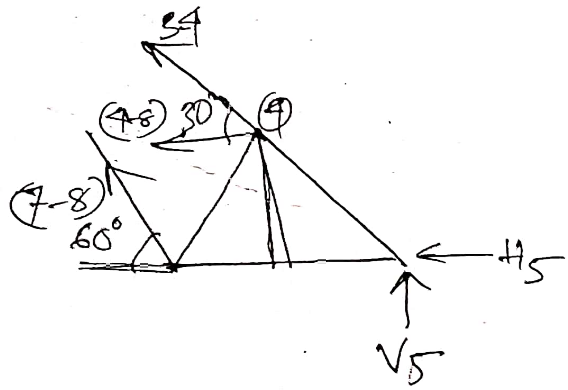


$\Sigma M_3 = 0$

$\Rightarrow 4 \times \frac{10}{\tan 30^\circ} + H_5 \times 20 - V_5 \times 34.64 = 0$

$\Rightarrow H_5 = 5.2^k$

See ⓐ-ⓐ



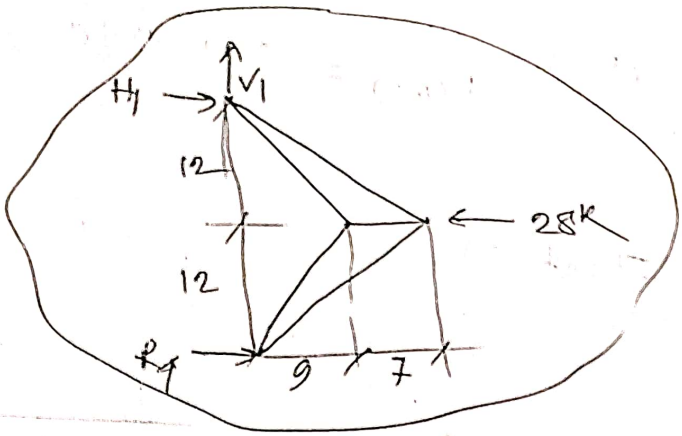
$\Sigma M_4 = 0$

$H_5 \times 10 - V_5 \times \frac{10}{\tan 30^\circ} + (7\text{-}8) \cos 60^\circ \times 10 + (7\text{-}8) \sin 60^\circ \times 2.31 - \frac{10}{\tan 30^\circ} = 0$

$\Rightarrow (7\text{-}8) = 3.46^k$

$M_1 = 0$

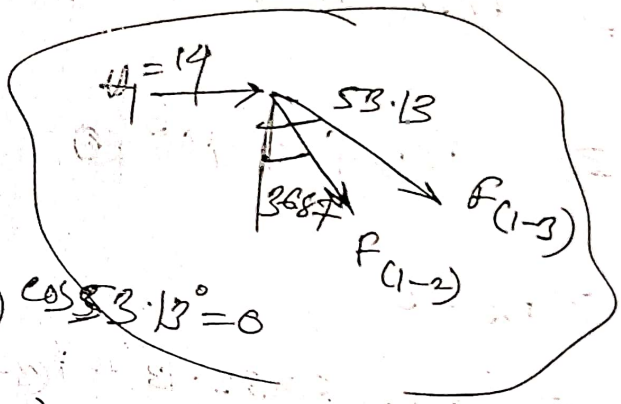
$\Rightarrow R_4 = 14^K$



$\Sigma F_x = 0$ | $\Sigma F_y = 0$

$H_1 = 14^K$ | $V_1 = 0$

Joint ①



$\Sigma F_y = 0$

$\Rightarrow F_{(1-2)} \cos 36.87^\circ + F_{(1-3)} \cos 53.13^\circ = 0$

$\Rightarrow F_{(1-2)} = -0.75\, F_{(1-3)}$ ——— ①

$\Sigma F_x = 0$

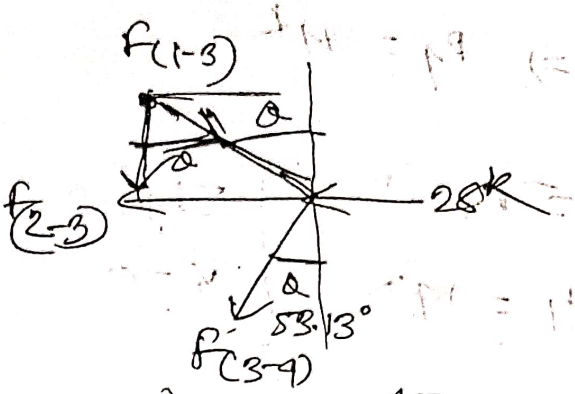
$\Rightarrow 14 + F_{(1-2)} \sin 36.87^\circ + F_{(1-3)} \sin 53.13 = 0$

$\Rightarrow 14 - 0.75 \times \sin 36.87^\circ F_{(1-3)} + F_{(1-3)} \sin 53.13^\circ = 0$

$\Rightarrow F_{(1-3)} = -40^K = 40^K$ (C)

$\Rightarrow$ $F_{(1-2)} = 0.75 \times 40 = 30^K$ (T).

Joint (3)



$\Sigma F_y = 0$

$\Rightarrow F_{(1-3)} \cos 53.13° + F_{(3-4)} \cos 53.13 = 0$ $\quad \theta = \tan^{-1}\left(\frac{1.5}{1.2}\right) = 53.13°$

$\Rightarrow F_{(3-4)} = 40^K$ (C)

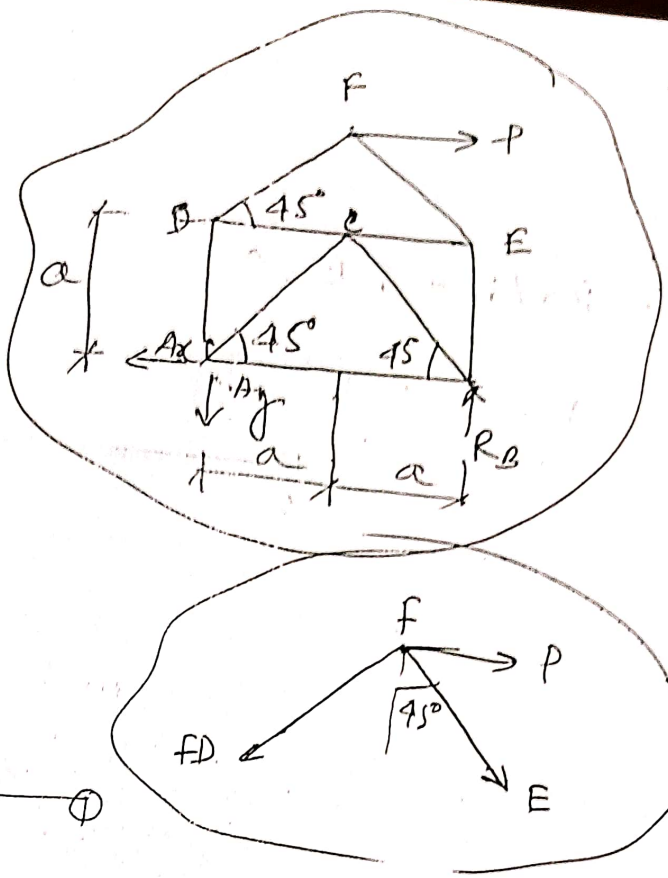
$\Sigma F_x = 0$

$\Rightarrow F_{(1-3)} \sin 53.13 - F_{(3-4)} \sin 53.13 - F_{(2-3)} - 28 = 0$

$\Rightarrow F_{(2-3)} = 36^K$ (T)

Joint 4

Put,
$AD = a$



$\Sigma M_A = 0$

$\Rightarrow P \times 2a - R_B \times 2a = 0$

$\Rightarrow R_B = P$

Joint f

$\Sigma F_y = 0$

$\Rightarrow FD = -FE$ ——— ①

$\Sigma F_x = 0$

$\Rightarrow P + EF \sin 45° - FD \cos 45° = 0$

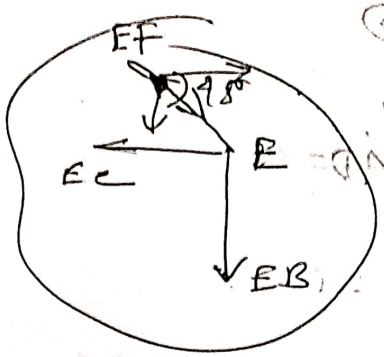
$\Rightarrow FD \cos 45° - EF \sin 45° = P$

$\Rightarrow -FE \cos 45° - FE \sin 45° = P$

$\Rightarrow FE \; 2 \times \frac{1}{\sqrt{2}} = -P$

$\Rightarrow FE = -\frac{P}{\sqrt{2}}$

Joint E

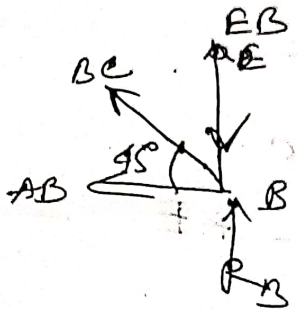


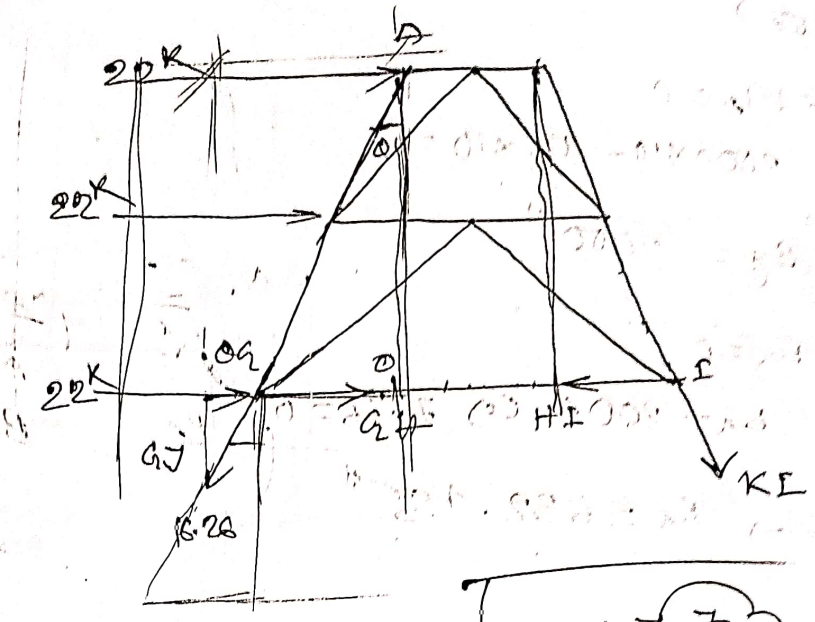
$\Sigma F_y = 0$

$\Rightarrow EF \sin 45° + EB = 0$

$\Rightarrow EB = -EF \frac{1}{\sqrt{2}}$

$= -\frac{P}{2}$!





$\theta = \tan^{-1}\left(\frac{7}{24}\right)$

$= 16.26°$

$\tan 16.26 = \frac{QO}{OA}$

$\Rightarrow QO = 16 \times \tan 16.26$

$= 4.68K$

$\sum M_I = 0$

$\Rightarrow 22 \times 8 + 22 \times 16 - GJ \cos 16.26 \times (8 + 24) = 0$

$\Rightarrow GJ \cos 16.26° \times 17.84 = 528$

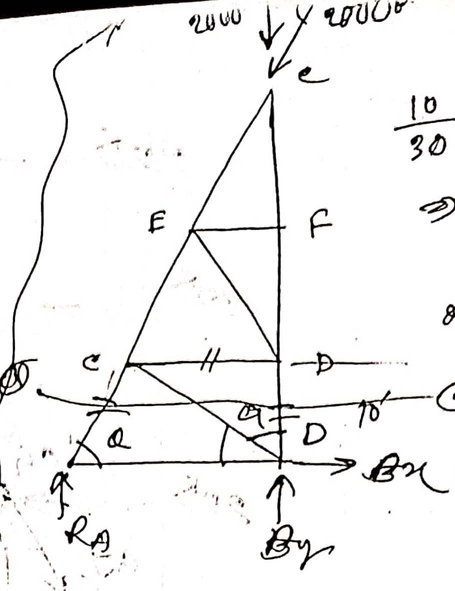
$\Rightarrow GJ = 31.72K$ (T)

(387)

$\Sigma M_A = 0$

$\Rightarrow 2000 \times 10 - B_y \times 10 = 0$

$\Rightarrow B_y = 2000$ #



$\frac{10}{30} = \frac{CD}{CD}$

$\Rightarrow CD = \frac{20}{3}$

$= 6.67$

$\theta_1 = \tan^{-1} \frac{6.67}{10}$

$= 33.70$

$\theta = \tan^{-1}\left(\frac{30}{10}\right)$

$= 71.56°$

$\Sigma F_x = 0$

$\Rightarrow B_x - 2000 \cos 71.56 = 0$

$\Rightarrow B_x = 632.455$ #

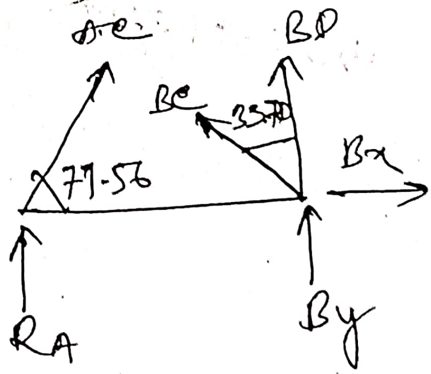
$\Sigma F_y = 0$

$\Rightarrow R_A + B_y - 2000 - 2000 \sin 71.56° = 0$

$\Rightarrow R_A = 2000 + 2000 \sin 71.56° - 2000$

$= 1897.31$ #

Section ⓐ-ⓐ



$\Sigma M_A = 0$

$\Rightarrow R_A \times 18 + AC \sin 71.56 \times 18 = 0$

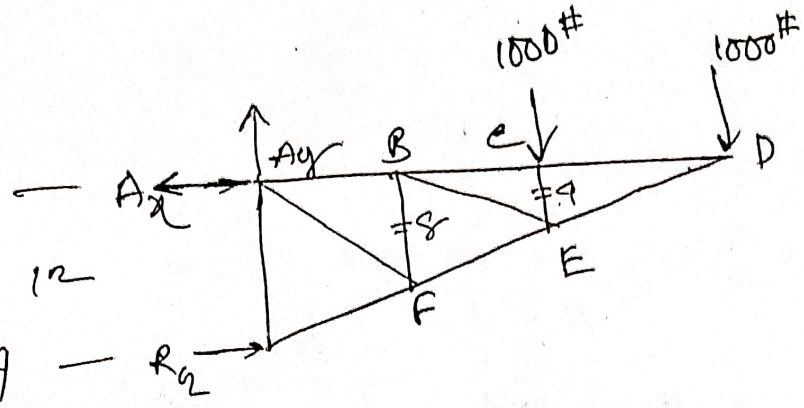
$\Rightarrow AB = -\frac{1879.31}{\sin 71.56°}$

$= -2000$ #

$= 2000$ Ⓒ

$\Sigma F_x =$

(388)



$\Sigma M_A = 0$

$\Rightarrow 1000 \times 16 + 1000 \times 24 - R_q \times 12 = 0$

$R_q = 3333.33^{\#}$

$\Rightarrow$

$\Sigma F_x = 0$

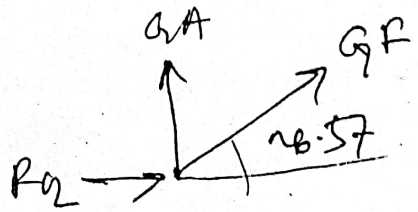
$\Rightarrow R_q - A_x = 0$

$\Rightarrow A_x = 3333.33^{\#}$

$\Sigma F_y = 0$

$\Rightarrow A_y = 2000^{\#}$

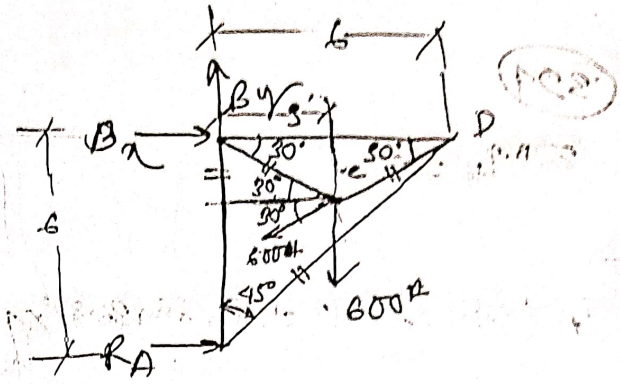
Joint at q



$\theta = \tan^{-1}\left(\frac{12}{24}\right)$

$= 26.57$

(589)

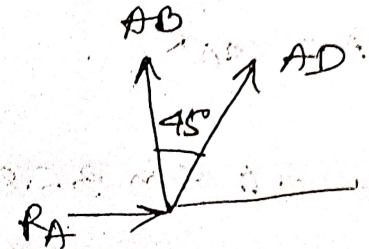


$\Sigma M_B = 0$

$\Rightarrow 600 \times 3 + 600 \cos 30° \times 3 \tan 30°$

$+ 600 \sin 30° \times 3 - R_A \times 6 = 0$

$\Rightarrow R_A = 600\#$



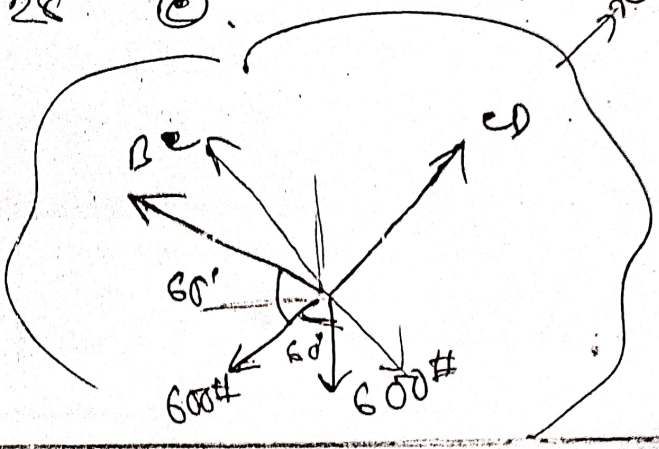
Joint at A

$\Sigma F_x = 0$

$\Rightarrow R_A + AD \sin 45° = 0$

$\Rightarrow AD = \frac{-600}{\sin 45°} = -848.528\#$

$\therefore AD = 848.528\#$ (C).



Joint at E

$\Sigma F_y = 0$

$\Rightarrow BE \sin 60° - 600 \sin 60° = 0$

$\Rightarrow BE = 600\#$

$\Sigma F_x = 0$

$\Rightarrow C - 600 - BC \cos 60° - 600 \cos 60° = 0$

$\Rightarrow C = 600 + 2 * 600 \cos 60°$

$= 1200$ (T)

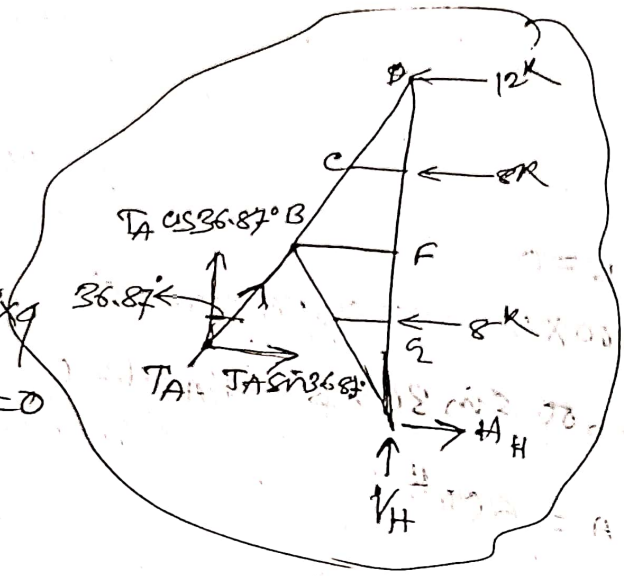
(394)

$\Sigma M_H = 0$

$\Rightarrow$

$T_A \cos 36.87° \times 12 + T_A \sin 36.87° \times 9 - 8 \times 6 - 8 \times 18 - 12 \times 24 = 0$

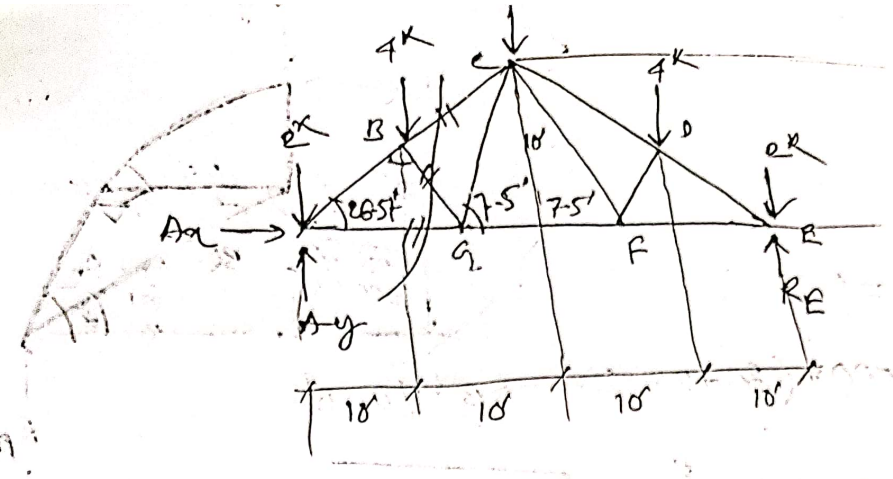
$\Rightarrow T_A = 40\ K$



(22)

$H_A = 40 \sin 36.87° = 24K$

$V_A = 40 \cos 36.87° = 32K$

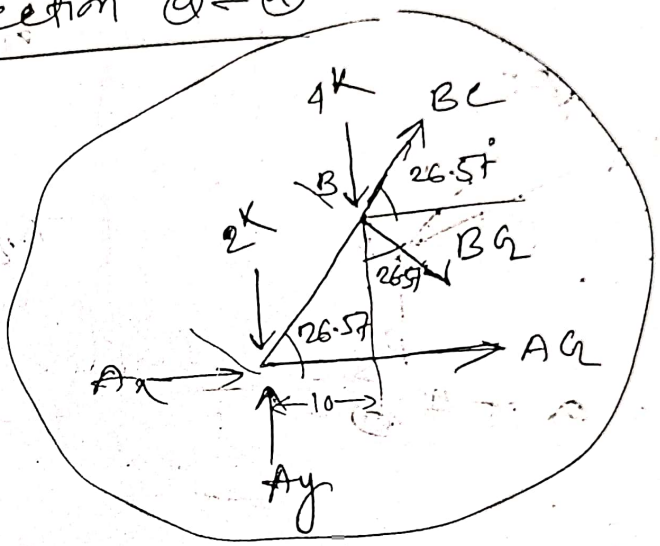


$\Sigma M_E = 0$

$A_y = 8^K$

$A_x = 0$

considering the section @ - ①



$\Sigma M_A = 0$

$\Rightarrow 4 \times 10 + BG \times 11.18 = 0$

$\Rightarrow BG = -3.58^{\#}$

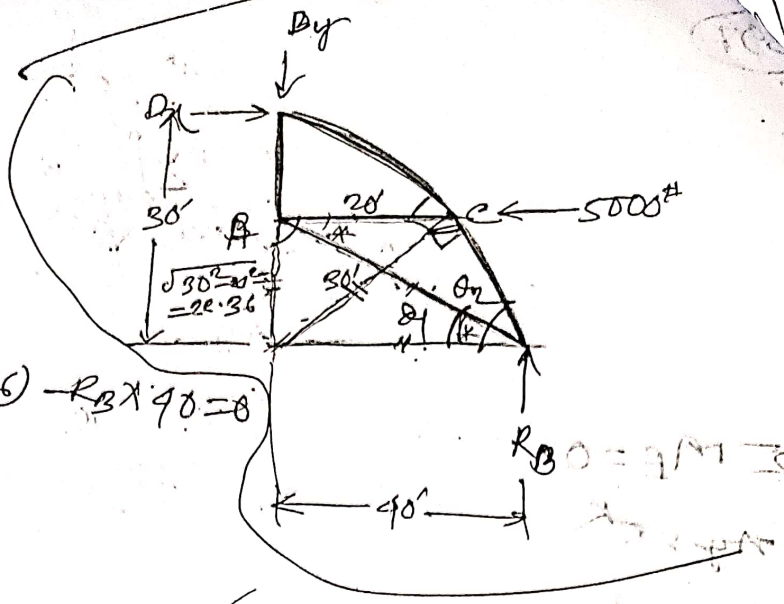
$= 3.58^{\#}$ ⊕.

$AB = \frac{10}{\cos 26.57}$

$= 11.18$

$\Sigma F_y = 0$

(308)

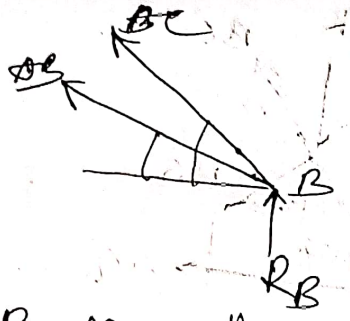


$\Sigma M_D = 0$

$\Rightarrow 5000 \times (30 - 22.36) - R_B \times 40 = 0$

$\Rightarrow R_B = 955^{\#}$

Joint at B



$AB = 955^{\#}$ (C)

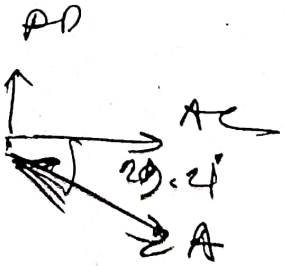
$\theta_1 = \tan^{-1}\left(\frac{22.36}{40}\right)$

$= 29.2^\circ$

$\theta_2 = \sin^{-1}\left(\frac{30}{40}\right)$

$= 48.59^\circ$

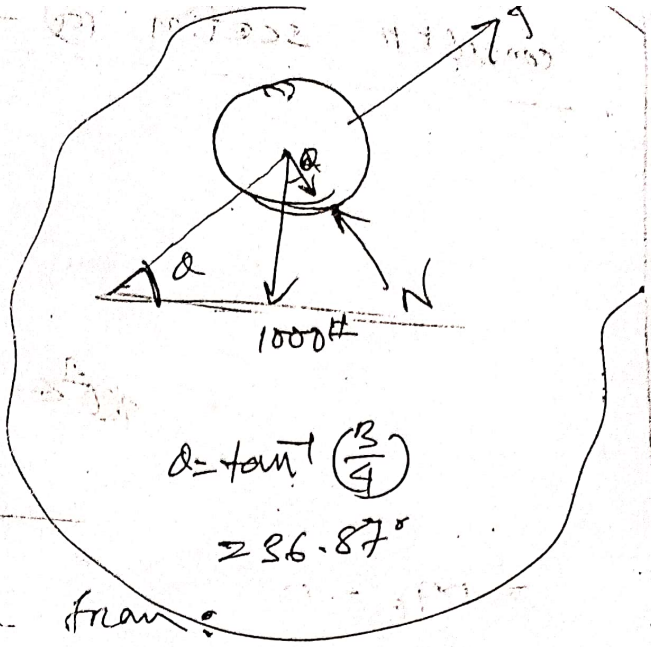
Joint A



$\Sigma F_y = 0$

$N = 1000 \cos 36.87°$

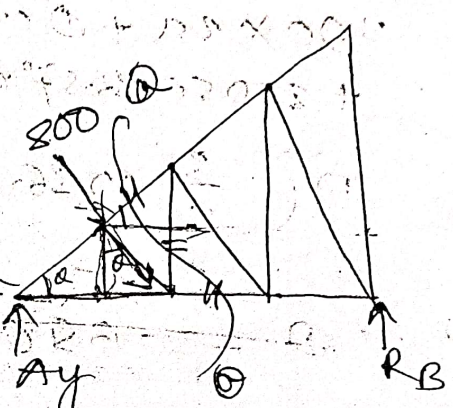
$= 800\ \#$



$\theta = \tan^{-1}\left(\frac{3}{4}\right)$

$= 36.87°$

Whole free body of the frame:



$\Sigma M_B = 0$

$\Rightarrow A_y \times 4a + 800 \sin 36.87° \times a - 800 \cos 36.87° \times 3a = 0$

$\frac{3a}{4a} \times a - 800 \cos 36.87° \times 3a = 0$

$\Rightarrow A_y \times 4 = 800 \times 3 \times \cos 36.87° - 800 \times \frac{3}{4} \times \sin 36.87°$

$= 1560\ \#$

$\Rightarrow A_y = 1560/4 = 390\ \#$

ΣF_x

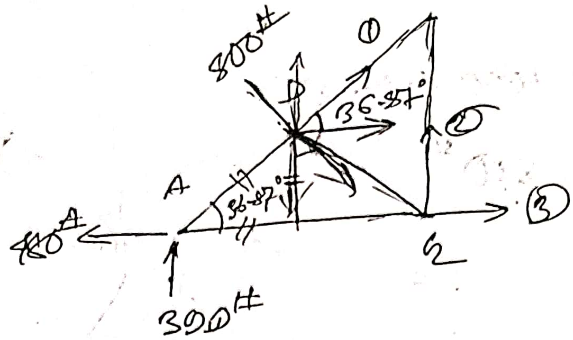
$\Rightarrow A_x = 800 \sin 36.87°$

$= 480\ \#$

$A_x = 480\ \#$

$A_y = 390\ \#$

consider section ⓐ-ⓐ



$\Sigma M_C = 0$

$\Rightarrow 390 \times 2a + ① \cos 36.87° \times \frac{3a}{4a} \times a + ① \sin 36.87° a$
$+ 800 \sin 36.87° \times \frac{3a}{4a} \times a - 800 \cos 36.87° \times a = 0$

$\Rightarrow ① \left(\frac{3}{4} \cos 36.87° + \sin 36.87° \right) = -390 \times 2$
$+ 800 \cos 36.87° - \frac{800 \times 3}{4} \sin 36.87°$

$\Rightarrow$ ~~① = -650#~~ $① = -416.67^{\#}$

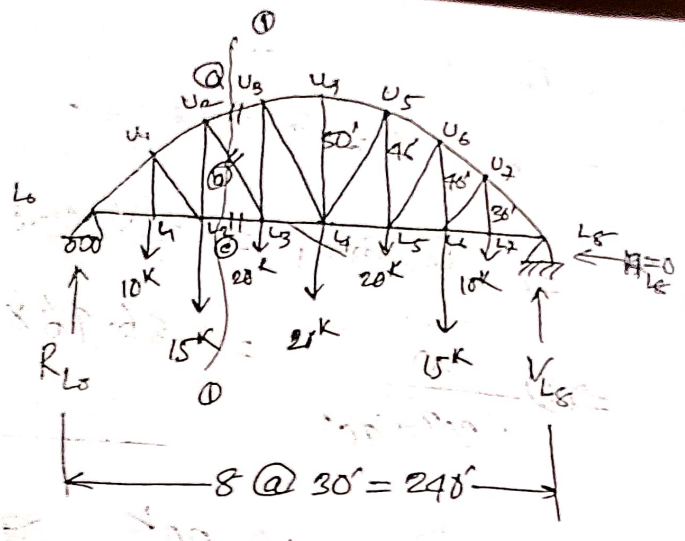
~~= 650# ©~~ $= 416.67^{\#}$ ©

$\Sigma M_A = 0$

$\Rightarrow 800 \times \frac{a}{\cos 36.87°} - ② \times 2a = 0$

$\Rightarrow ② = 500^{\#}$

$\Sigma F_x = 0$ $416.67^{\#}$
$-$ ~~650~~ $\times \cos 36.87° + 800 \sin 36.87° + ③$
$- 480 = 0$ $\Rightarrow ③ = 333.33^{\#}$ ⓣ



$\Sigma M_{L_0} = 0$

$\Rightarrow V_{L_8} = 55^K$

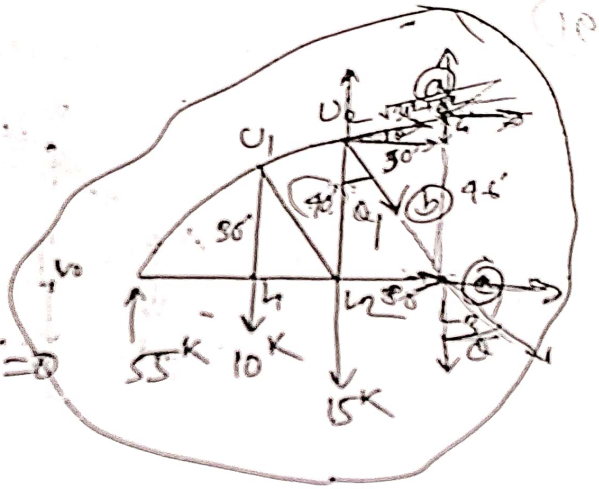
$\Sigma f_y = 0$

$\Rightarrow R_{L_0} = 55^K.$

$\Sigma f_x = 0$

$\Rightarrow H_{L_8} = 0.$

Section ① - ①



$\Sigma M_{U_2} = 0$

$\Rightarrow 55 \times 60 - 10 \times 30 - ⓒ \times 40' = 0$

$\Rightarrow ⓒ = 75^K$ (T)

$\Sigma M_{L_3} = 0$

$55 \times 90 - 10 \times 60 - 15 \times 30 + a \cos\theta \times 46 = 0$

$\Rightarrow ⓐ \times 46 \times \frac{30}{\sqrt{30^2 + 40^2}} = -3450$

$\Rightarrow a = -86.46^K$

$= 86.46^K$ (C).

$\Sigma F_x = 0$

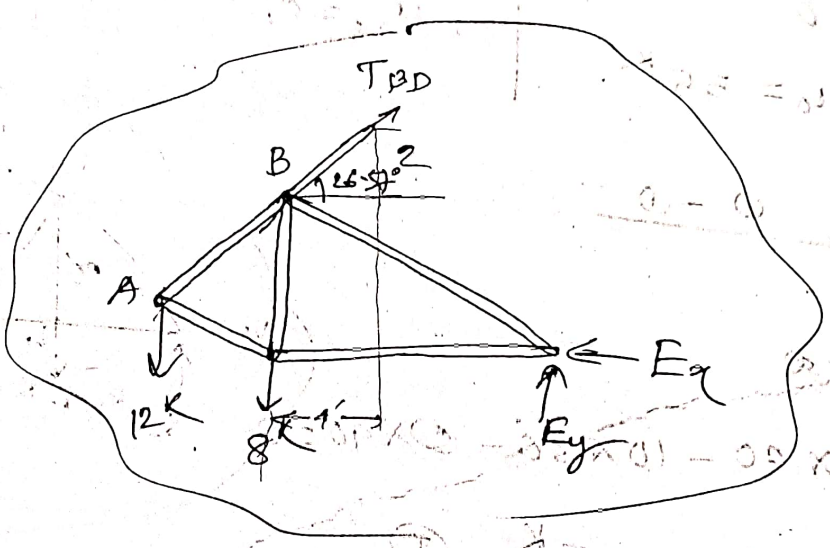
$\Rightarrow$ ⓑ $\sin\theta_1 \pm$ ⓐ $\cos\theta + \text{ⓒ} = 0$

$\Rightarrow$ ⓑ $\sin\theta_1 =$ ⓐ $\cos\theta -$ ⓒ

$\Rightarrow$ ⓑ $\dfrac{30}{\sqrt{30^2+90^2}} = 86.96 \times \dfrac{30}{\sqrt{30^2+6^2}} - 75$

$\Rightarrow$ ⓑ $= 16.30^K$

S91



$\Sigma M_E = 0$

$\Rightarrow T_{BD} \cos 26.57° \times 4 + T_{BD} \sin 26.57° \times 8 - 8 \times 8$

$- 12 \times 12 = 0$

$\Rightarrow T_{BD} = 29.1^K$

$\Sigma F_x = 0$

$\Rightarrow T_{BD} \cos 26.57° - E_x = 0$

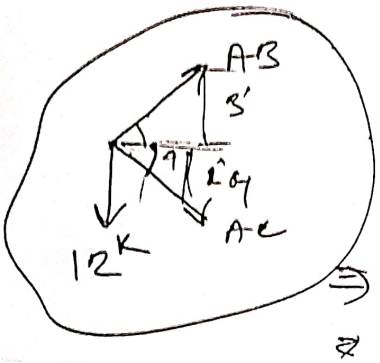
$\Rightarrow E_x = 28.03\#$

$\Sigma F_y = 0$

$\Rightarrow E_y + T_{BD} \sin 26.57° - 12 - 8 = 0$

$\Rightarrow E_y = 20 - 29.1 \sin 26.57°$

$= 6.98\#$



$\Sigma F_x = 0$

$\Rightarrow AB \cos\theta = -AC \cos\theta$

$\Rightarrow AB \cdot \frac{4}{\sqrt{4^2+3^2}} = -AC \frac{4}{\sqrt{4^2+1^2}}$

$\Rightarrow AB = -\frac{5}{\sqrt{17}} AC.$

$\Sigma F_y = 0$

$\Rightarrow AB \sin\theta - AC \sin\theta - 12 = 0$

$\Rightarrow -\frac{5}{\sqrt{17}} \times AC \times \frac{3}{\sqrt{4^2+3^2}} - AC \cdot \frac{1}{\sqrt{4^2+1^2}} - 12 = 0$

$\Rightarrow AC = -16.49\# = 16.49\#$ (C).