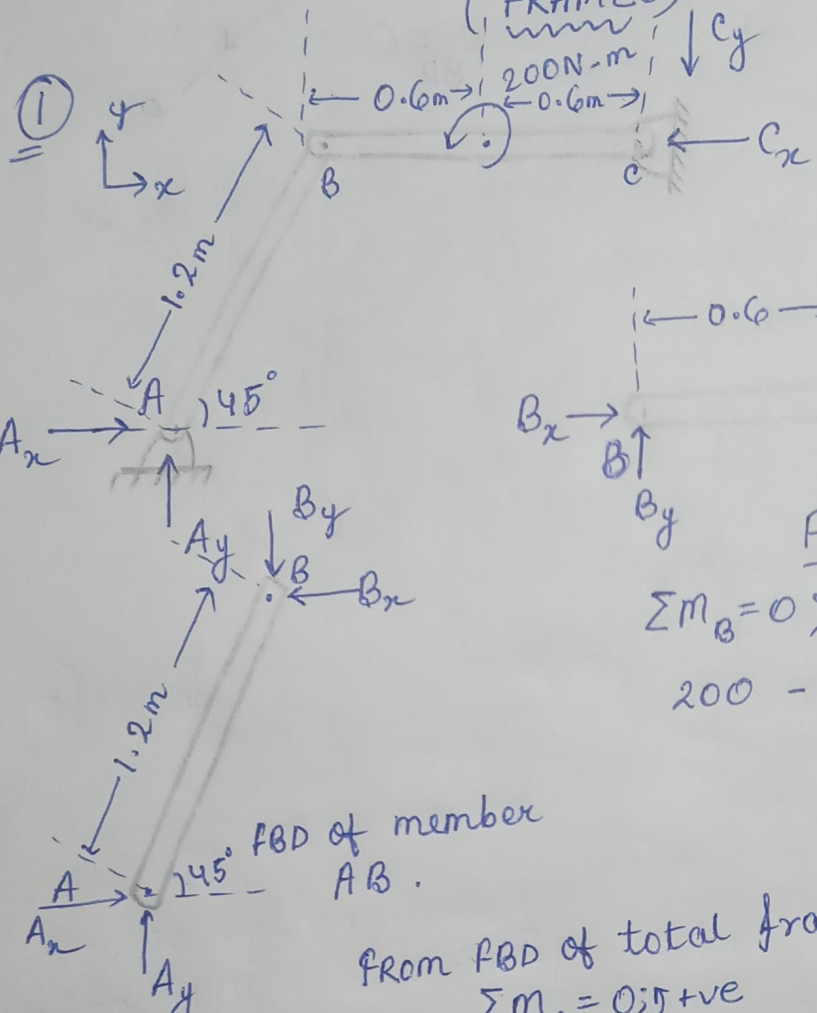
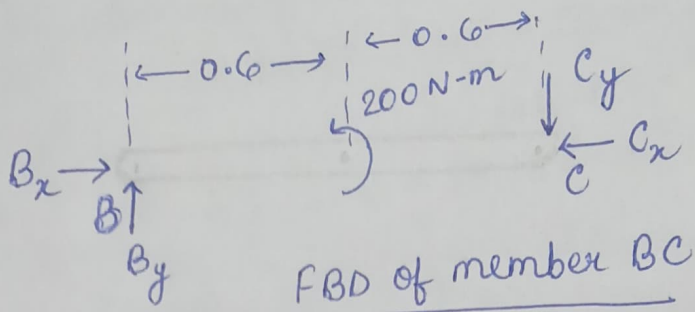
SHEET : 4.

(FRAMES)

① 



FBD of member BC :-

$\Sigma M_B = 0$; ↻ +ve.

$200 - C_y \times 1.2 = 0$

$C_y = 166.67\ N$

FBD of member AB.

From FBD of total frame :-

$\Sigma M_A = 0$; ↻ +ve

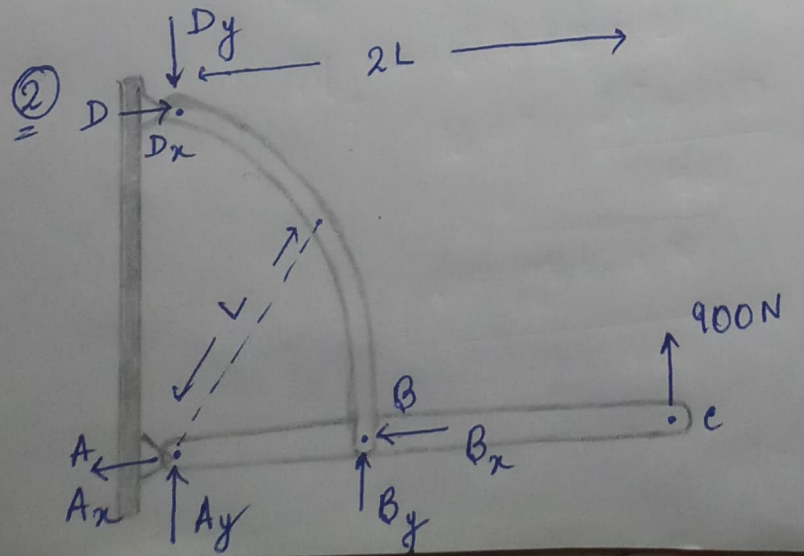
$-C_y \times (1.2 + 1.2\cos 45°) + 200 + C_x (1.2 \sin 45°) = 0$

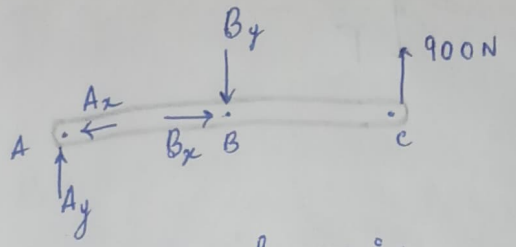
$C_x = 166.67\ N$

∴ Pin reaction at C :-

$C = \sqrt{C_x^2 + C_y^2} = 235.7\ N.$

$C \simeq 236\ N$

② 



FBD of member ABC.

$\Sigma M_A = 0$; ↺ +ve

$900 \times 2L - B_y \times L = 0$.

$B_y = 1800\ N$

$\Sigma F_y = 0$; $A_y + 900 - B_y = 0$

$A_y = 1800 - 900$

$\therefore A_y = 900\ N$.

From entire frame :-

$\Sigma M_D = 0$; ↺ +ve

$900 \times 2L - A_x \times L = 0$

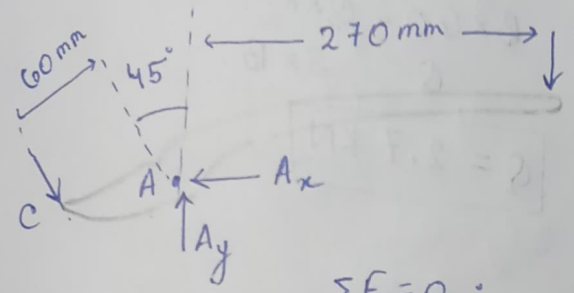
$A_x = 1800\ N$

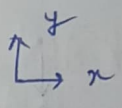
$\therefore$ Pin reaction at $A = \sqrt{A_x^2 + A_y^2}$

$= \underline{2012.46\ N}$

$\therefore A = 2.012\ KN$.

③





$\Sigma M_A = 0$; ↺ +ve

$100 \times 270 - C \times 60 = 0$

$C = 450\ N$

$\Sigma F_x = 0$;

$C \sin 45° - A_x = 0$

$A_x = \frac{450}{\sqrt{2}}$

$\Sigma F_y = 0$;

$A_y - C\cos 45° = 0$

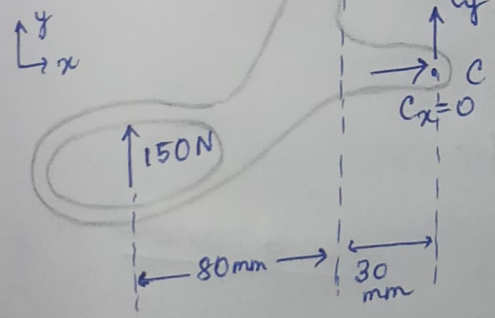
$A_y - 100 = 0$

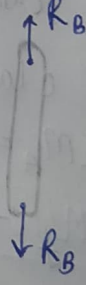
$A_y = 418.19\ N$.

$A = \sqrt{A_x^2 + A_y^2}$

$\boxed{A = 525.5\ N}$

④

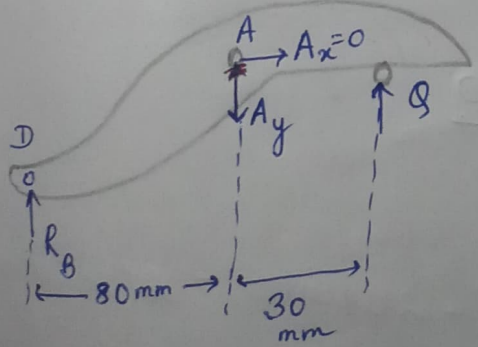




$\Sigma M_C = 0$

$150\,(80+30) - R_B \times 30 = 0$

$R_B = 550\ N$.



$\Sigma M_A = 0$;

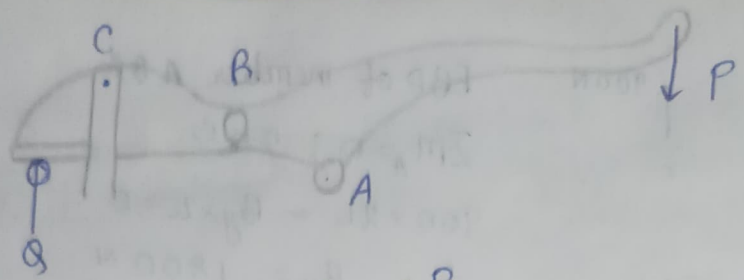
$R_B \times 80 - Q \times 30 = 0$

$Q = \frac{550 \times 80}{30}$

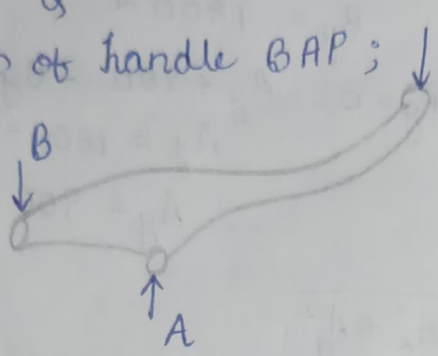
$Q = \underline{1467\ N}$ (Ans)

Cutting force $\underline{P = 1467\ N}$.

(5)



FBD of handle BAP ;



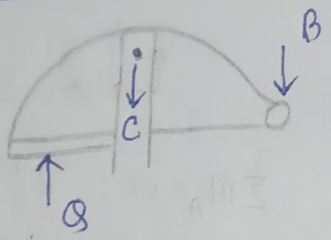
Taking $\Sigma M_A = 0$; ↻ +ve

$P \times 180 - B \times 30 = 0$

$B = \frac{150 \times 180}{30}$

$B = 900\,N$

FBD of QCB :-



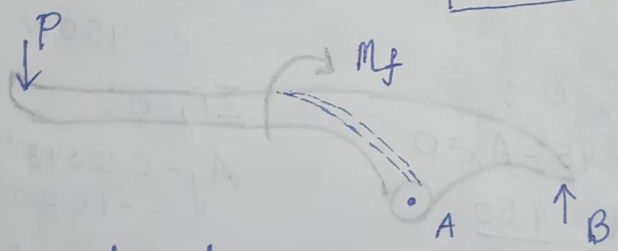
$\Sigma M_C = 0$; ↻ +ve

$B \times 60 - Q \times 20 = 0$

$Q = 3 \times B$.

$\boxed{Q = 2.7\,KN}$

(6)



The spring force acting will form a ~~coup~~ moment about A (M_f)

(i) When clamp is released, $B = 0$.

$\therefore \Sigma M_A = 0$; ↻ +ve

$M_f - P \times 110 = 0$

$M_f = 25 \times 110\,N$

(ii) When $P = 0$;

$M_A = 0$; ↻ +ve

$M_f - B \times 40 = 0$

$B = \frac{25 \times 110}{40}$

$\therefore \boxed{B = 68.8\,N}$

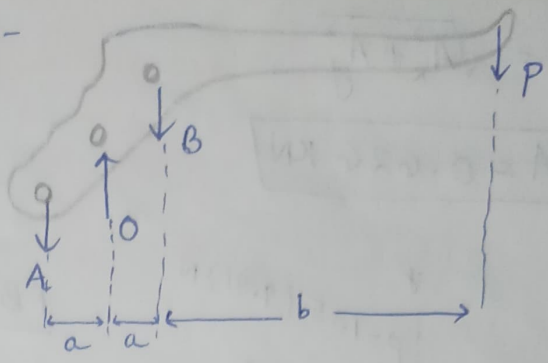
(7) For FBD of handle :-

$\Sigma M_o = 0$; ↻ +ve

$P \times b + B \times \frac{b}{a} - A \times a = 0$

$P \times b = (A - B) a$

↳ (i)



For FBD of Jaw :-

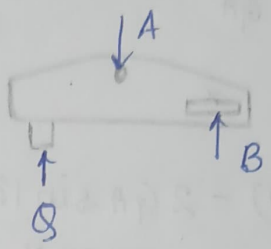
$\Sigma F_y = 0$;

$Q = A - B$ → (ii)

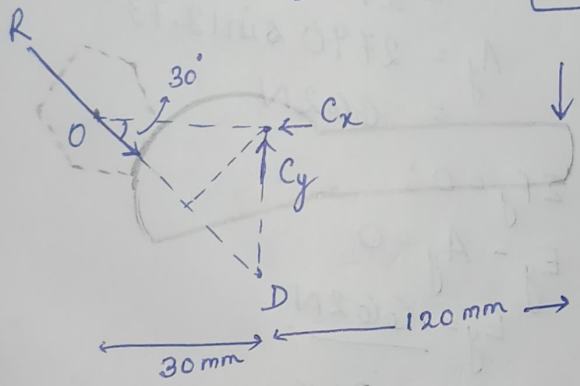
∴ from (i) & (ii)

$Pb = Qa$

$P = Q \frac{a}{b}$ or $\boxed{Q = P \frac{b}{a}}$



(8)



P = 160 N

$\Sigma M_o = 0$;

$30 C_y - 150(P) = 0$

$C_y = 800 N$

$\Sigma M_D = 0$;

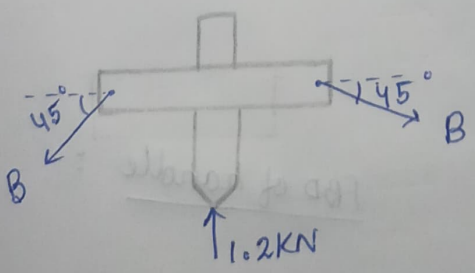
$(30 \tan 30°) C_x - 120 \times 160 = 0$

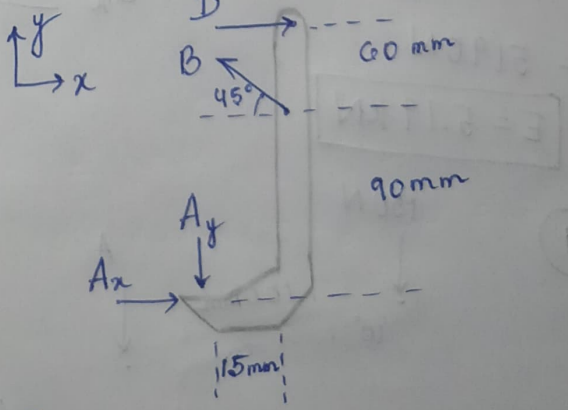
$C_x = 1109 N$

$C = \sqrt{C_x^2 + C_y^2}$

$C = 1367 N$

(9)





(upper bar & screw)

$\Sigma F_y = 0$; $-2B \sin 45° + 1.2 = 0$

(ABD)

$B = 0.849$ KN

$\Sigma M_A = 0$; $(150) D - 0.849 \cos 45° (90) - 0.849 \sin 45° (15) = 0$

$D = 0.420$ KN

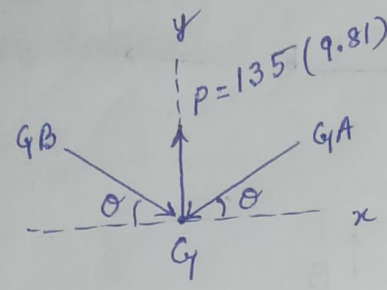
$\Sigma F_x = 0$; $A_x - 0.849 \cos 45° + 0.420 = 0$; $A_x = 0.1800$ KN

$\Sigma F_y = 0$; $-A_y + 0.849 \sin 45° = 0$; $A_y = 0.6$ KN

$$A = \sqrt{A_x^2 + A_y^2}$$

$$\therefore \boxed{A = 0.626\ KN}$$

(10)



FBD of Pin G :-

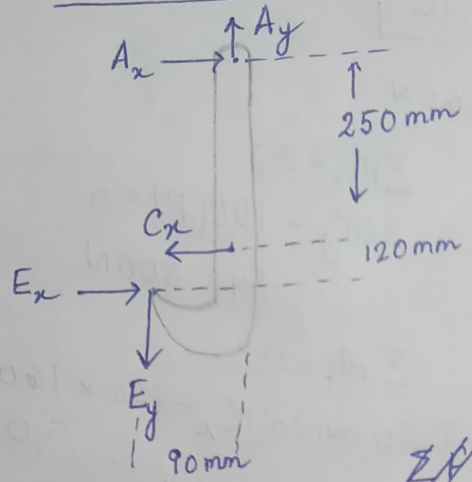
$$\theta = \cos^{-1}\left(\frac{340}{350}\right)$$

$$= 13.73^\circ$$

$$\Sigma F_y = 0; \quad 135(9.81) - 2\,G_A \sin 13.73^\circ = 0$$

$$G_A = G_B = 2790\ N$$

FBD of ACE :-



$$A_x = 2790 \cos 13.73^\circ$$
$$= 2710\ N$$

$$A_y = 2790 \sin 13.73^\circ$$
$$= 662\ N$$

$$\Sigma F_y = 0;$$
$$E_y - A_y = 0$$
$$E_y = \underline{662\ N}$$

$$\Sigma M_C = 0; \quad \text{2 +ve}$$

$$2710\,(250) - 662\,(90) - E_x(120) = 0$$

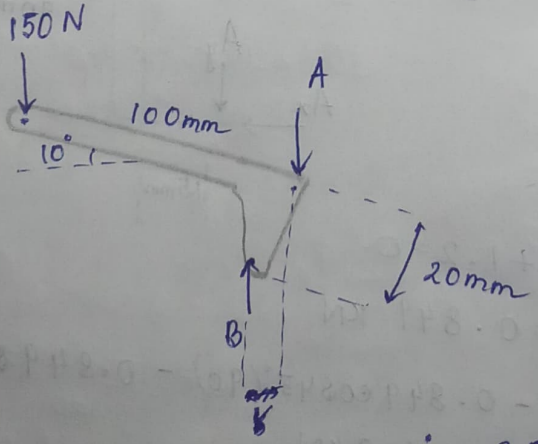
$$E_x = \underline{5150\ N}$$

$$E = \sqrt{E_x^2 + E_y^2}$$

$$= 5190\ N$$

$$\boxed{E = 5.19\ KN}$$

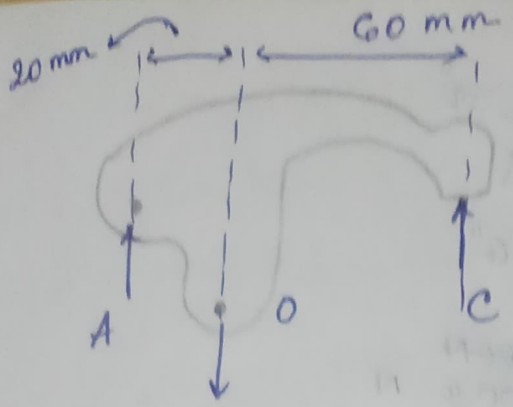
(11)



FBD of handle :-

$$\Sigma M_B = 0; \quad P(100\cos 10^\circ - 20\sin 10^\circ) - A(20\sin 10^\circ) = 0$$

$$A = 4103\ N$$



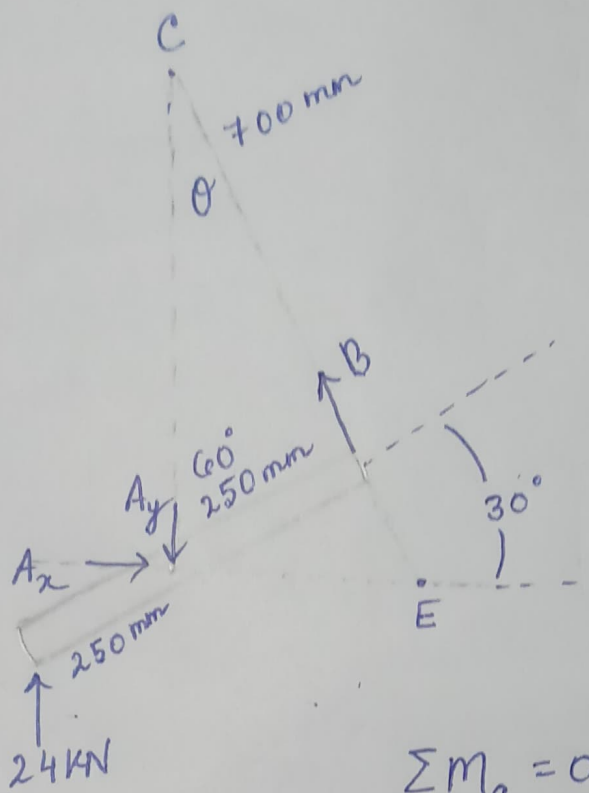
FBD of Jaw :-

$\Sigma M_o = 0$;

$60C - 20(4103) = 0$;

$\boxed{C = 1368\ N}$

(12)



$\frac{700}{\sin 60^\circ} = \frac{250}{\sin\theta}$;

$\theta = \sin^{-1}(0.3093)$

$\theta = 18.02^\circ$

$\cos\theta = 0.9510$,

$\tan\theta = 0.3252$.

$\bar{AC} = 700(0.9510) + 250(0.5) = 791\ mm$

$\Sigma M_C = 0$;

$24(250)(0.866) - 791 A_x = 0$

$A_x = 6.57\ kN$

$\bar{AE} = \bar{AC}\tan\theta = 791(0.3252)$

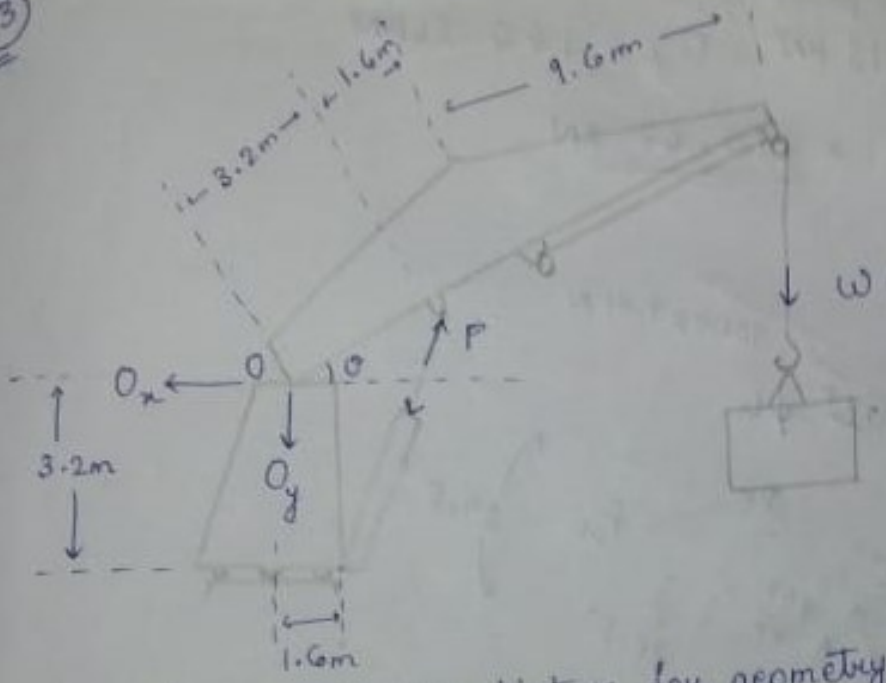
$= 257\ mm$

$\Sigma M_E = 0$; $A_y(257) - 24(250 \times 0.866 + 257) = 0$

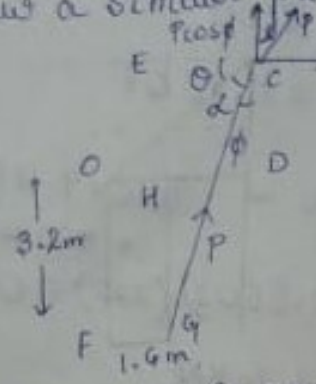
$A_y = 44.2\ kN$

$A = \sqrt{A_x^2 + A_y^2} \Rightarrow \boxed{A = 44.7\ kN}$

(13)



if a draw a similar picture for geometry :



In Δ OCD,
OC = 3.2m
∠COD = θ = 30°
∴ CD = OC sinθ
= 1.6 m
OD = OC cosθ
= 2.771 m

In Δ GEC, ∠ECG = θ + α

$$\tan(\theta+\alpha) = \frac{GE}{CE} = \frac{GH+HE}{DH}$$

$$= \frac{GH+CD}{OD-OH}$$

$$\therefore \quad \theta+\alpha = \tan^{-1}\left(\frac{3.2+1.6}{2.771-1.6}\right)$$

$$\theta+\alpha = 76.29° \rightarrow (i)$$

$(\theta+\alpha)+\phi = 90°, \quad \phi = 13.71°$

$\Sigma F_x = 0; \quad O_x = P\sin\phi \rightarrow (i)$

$\Sigma F_y = 0; \quad O_y + 4000 \times 9.81 = P\cos\phi \rightarrow (ii)$

$\Sigma M_o = 0;$

$P\sin\phi \times 1.6 + 4000 \times 9.81 \times (14.4\cos 30°) = P\cos\phi \times 2.771 \rightarrow (iii)$

∴ after solving,

$P = 211.546$ KN

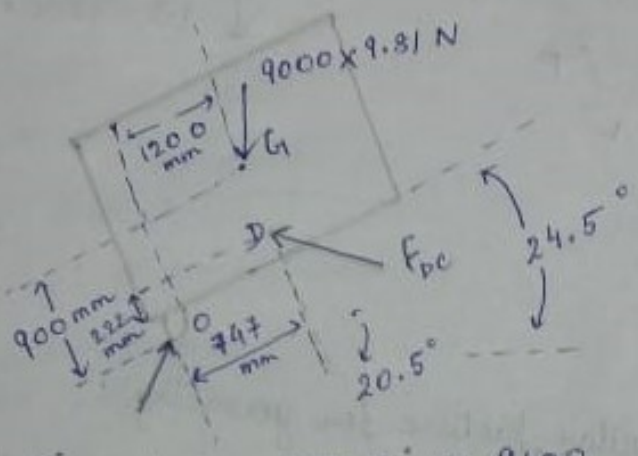
$P \approx 211$ KN

from eq (i) & (ii),

$O_x = 50.13$ kN , $O_y = 166.28$ kN

$O = \sqrt{O_x^2 + O_y^2} = \underline{173.67 \text{ kN}}$

(14)



$\sin 24.5^\circ = 0.4147$, $\cos 24.5^\circ = 0.9100$

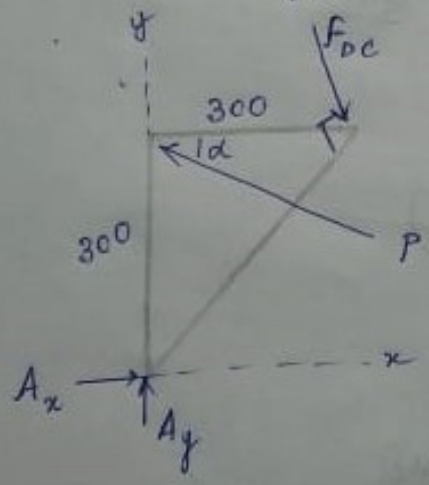
$\sin 20.5^\circ = 0.3502$, $\cos 20.5^\circ = 0.9367$

$\Sigma M_o = 0$;

$(9000 \times 9.81)(0.9100)\,1200 - 9000 \times 9.81 (0.4147) \times 900 \text{ mm}$

$- F_{DC}(0.9367)\,747 - F_{DC}(0.3502)(222) = 0$

~~F_{DC}~~ $F_{DC} = 81.6$ kN



$\alpha = \tan^{-1}\left(\frac{300}{1200}\right)$

$= 14.04^\circ$

$\sin\alpha = 0.2425$

$\cos\alpha = 0.9701$

$\Sigma M_A = 0$;

$(0.9701)\,P(300) - F_{DC}\left(\frac{300}{12\sqrt{2}}\right) = 0$

~~$P = 4.78$ kN~~

$\boxed{P = 119.5 \text{ kN}}$

$\Sigma F_x = 0$;

$A_x + F_{DC}/\sqrt{2} - P(0.9701) = 0$

$A_x = 57.4$ kN

$\Sigma F_y = 0$; $A_y + P(0.2425) - F_{DC}/\sqrt{2} = 0$

$A_y = 29.12$ kN

$\boxed{A = 64.3 \text{ kN}}$