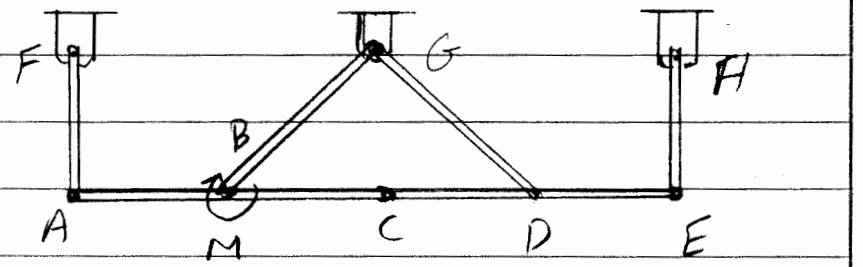
CE 201-9 (061)

Solution of HW # 10

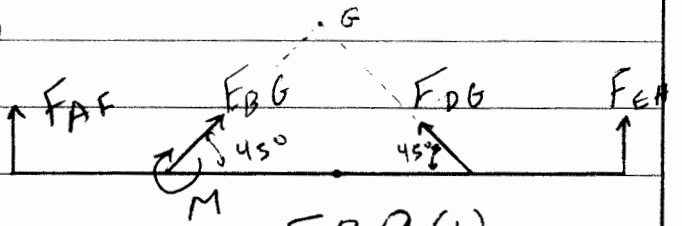
Problem # 1



Given: The system shown in the figure.

Required: The force in AF, BG, DG, and EH

Solution From the FBD(1)



FBD(1)

(Note: Four unknowns and three equations)

$$\Sigma M_C = 0 \Rightarrow +\circlearrowleft$$

$$-F_{AF} \times 2a - M + 2a \times F_{EH} = 0 \quad \text{---} \quad (1)$$

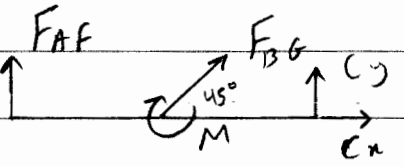
$$\Sigma F_x = 0$$

$$F_{BG}\cos 45 - F_{DG}\cos 45 = 0 \quad \text{---} \quad (2)$$

$$\Sigma F_y = 0$$

$$F_{AF} + F_{BG}\sin 45 + F_{DG}\sin 45 + F_{EH} = 0 \quad \text{---} \quad (3)$$

From FBD(2)



FBD(2)

$$\Sigma M_C = 0$$

$$-2a\,F_{AF} - M - a\sin 45\,F_{BG} = 0 \quad \text{---} \quad (4)$$

Solving equations (1) to (4) we get

$$\boxed{F_{AF} = -\frac{3M}{4a}} \text{ «C»} \qquad \boxed{F_{EH} = -\frac{M}{4a}} \text{ «C»}$$

$$\boxed{F_{DG} = F_{BG} = \frac{M}{\sqrt{2}a}} \text{ «T»}$$

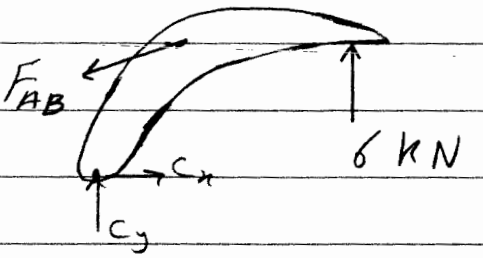
Problem # 2

Given: The system shown in Figure P2 in the HW sheet, with the weight of the roll is 2000 kg and 6 kN force is applied at the roll by arm CAF

Required: a) the force exerted by each cylinder
b) the force exerted at C on arm BCEH

Solution From FBD(1)

For the arm CAF



$$\sum M_C = 0 \quad +\circlearrowleft$$

$$\frac{600}{640.80} F_{AB} \times 0.6 - \frac{225}{640.80} F_{AB} \times 0.3 + 6 \times 1 = 0$$

$$\Rightarrow \boxed{F_{AB} = -13.14 \text{ kN}} \ (C)$$

$$\sum F_x = 0 \Rightarrow C_x - \frac{600}{640.8}(-13.14) = 0 \Rightarrow C_x = -12.3 \text{ kN}$$
("on CAF")

$\boxed{C_x = 12.3 \text{ kN}}$ "→" on BCEH

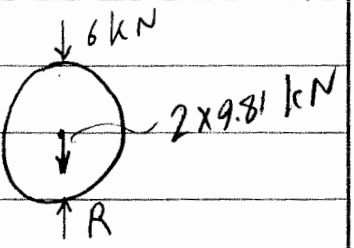
$$\sum F_y = 0 \Rightarrow C_y + 6 - \frac{225}{640.8}(-13.14) = 0 \Rightarrow$$

$C_y = -10.61$ kN on CAF

$\boxed{C_y = 10.61 \text{ kN}}$ "↑" on BCEH $\Rightarrow$ $C = 16.26$ kN, 40.8° from x

From FBD(2)

For the roll



$$\sum F_y = 0$$

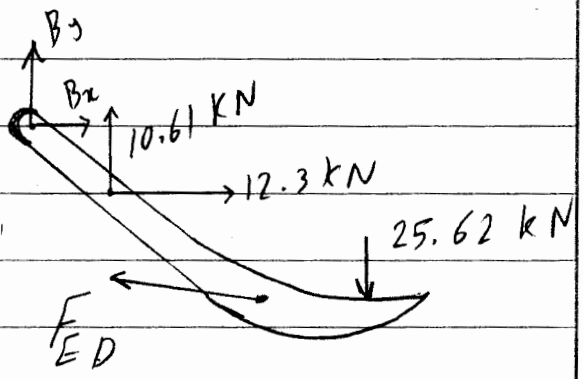
$$-6 - 2 \times 9.81 + R = 0$$

$$\Rightarrow R = 25.62 \text{ kN}$$

FBD(2)

Continue problem # 2

From FBD (3)
Sum around BCEH



$$\Sigma M_B = 0 \quad +\circlearrowleft \Rightarrow$$

$$-25.62 \times 1.3 - \frac{900}{934.08} F_{ED} \times 0.925 + \frac{250}{934.08} F_{ED} \times 0.9$$

$$+10.61 \times 0.3 + 12.3 \times 0.375 = 0$$

$$\Rightarrow \boxed{F_{ED} = -39.22 \text{ kN}} \ (C) \ \#$$

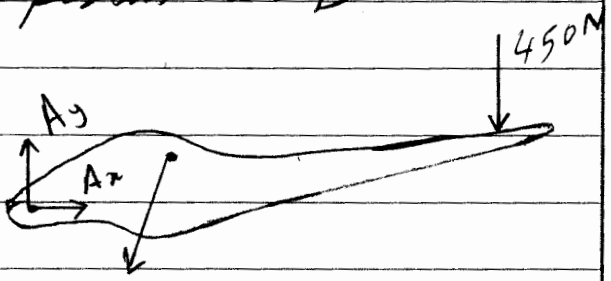
Problem # 3

Given: The system shown on Fig P3 in HW sheet.

Required: The force exerted in piston at D

Solution:

From the FBD



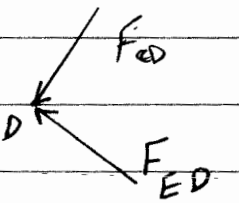
FBD

$$+\circlearrowleft \Sigma M_A = 0$$

$$-450 \times 0.33 + \frac{50}{78.102} F_{CD} \times 0.038 - \frac{60}{78.102} F_{CD} \times 0.1 = 0$$

$$\Rightarrow F_{CD} = -2829 \text{ N}$$

∴ at D there are two force exerted F_{CD} & F_{ED} and the values of these two force are equals because of the similarity and different directions.



The resultant of these two force are

$$2 \times 2829 \times \frac{50}{78.102} = 3622 \text{ N} \leftarrow$$

$$\therefore \boxed{F_D = 3622 \text{ N} \leftarrow} \quad \#$$

Problem # 4

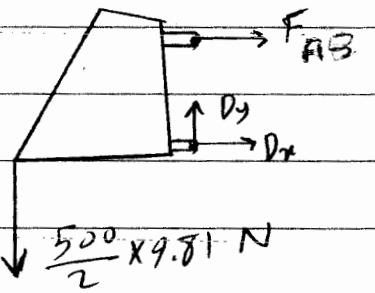
Given:

The system shown in Figure P4 in the HW sheet with the weight of the concrete is 500 kg.

Required: a) Force exerted by cylinder CD
b) Force exerted by cylinder FH

Solution:

a) From FBD (1) the bucket



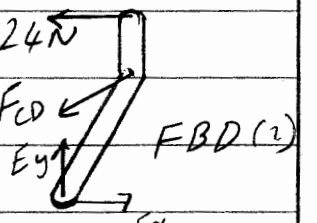
FBD (1)

$+\circlearrowleft \sum M_D = 0 \Rightarrow$

$-F_{AB} \times 0.5 + \frac{500}{2} \times 4.81 \times 0.8 = 0 \Rightarrow$

$F_{AB} = 3924$ N

From FBD (2) for the arm BCE



$+\circlearrowleft \sum M_E = 0 \Rightarrow$

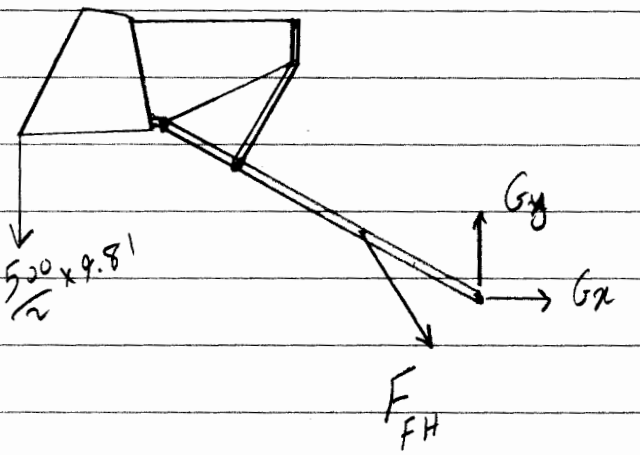
$3924 \times 0.65 + \frac{0.8}{0.89} F_{CD} \times 0.54 - \frac{0.39}{0.89} F_{CD} \times 0.35 = 0$

$\Rightarrow F_{CD} = -7682$ N

$\therefore \boxed{F_{CD} = 7682 \quad N}$ (C)

Continue problem # 4

b) From FBD (3)



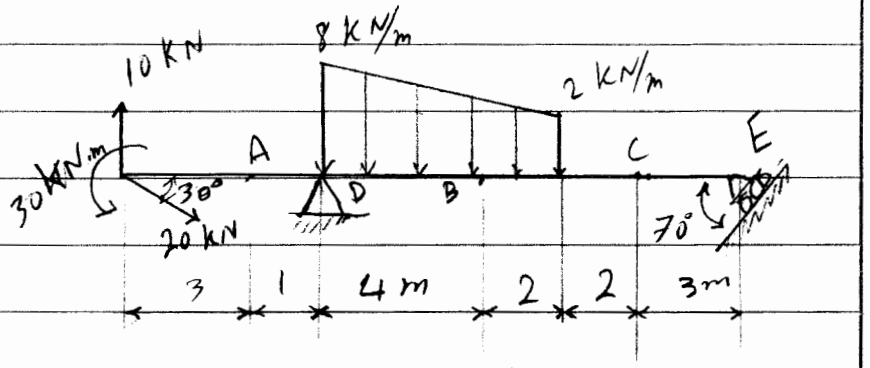
$\curvearrowleft \Sigma M_G = 0 \Rightarrow$

$$\frac{500}{2} \times 9.81 \times 2.5 - F_{FH} \cos 45 \times 0.2 + F_{FH} \sin 45 \times 0.6 = 0$$

$$\Rightarrow F_{FH} = -21677.2 \text{ N}$$

$$\therefore \boxed{F_{FH} = 21677.2 \text{ N}} \text{ « C »}$$

Problem #5

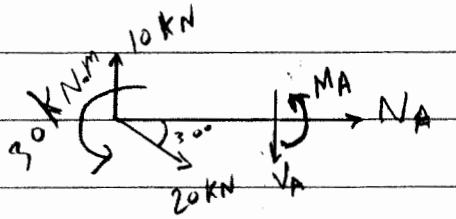


Given: The system shown in the figure.

Required: The internal force at A, B, & C.

Solution: at A we don't need to find the reactions.

From FBD(1)



FBD(1)

$\Sigma F_y = 0 \Rightarrow 10 - 20\sin 30 - V_A = 0$

$\Rightarrow \boxed{V_A = 0}$

$\Sigma F_x = 0 \Rightarrow 20\cos 30 + N_A = 0 \Rightarrow$

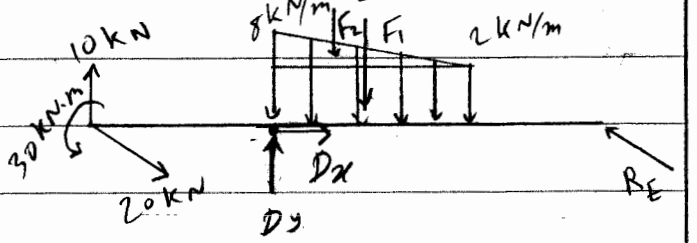
$\boxed{N_A = -17.32 \text{ KN}}$

$\Rightarrow \Sigma M_A = 0 \Rightarrow -10 \times 3 + 20\sin 30 \times 3 + 30 + M_A = 0$

$\Rightarrow \boxed{M_A = -30 \text{ KN.m}}$

For B and C we first find the reactions

From FBD(2)



FBD(2)

$F_1 = 2 \times 6 = 12 \text{ KN}$

$F_2 = 6 \times \frac{6}{2} = 18 \text{ KN}$ and exert 2m from D

Continue problem # 5

From FBD(2)

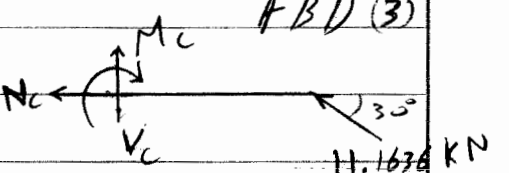
$\circlearrowleft \Sigma M_D = 0 \Rightarrow$

$R_E \cos 70 \times 11 - 12 \times 3 - 18 \times 2 + 30 - 10 \times 4 + 20 \sin 30 \times 4 = 0$

$\Rightarrow R_E = 11.1636 \text{ kN}$

Note: we don't need D_y or D_x

FBD (3)



∴ At C from FBD(3)

$\Sigma F_x = 0 \Rightarrow$

$-N_C - 11.1636 \cos 30 = 0 \Rightarrow \boxed{N_C = -9.668 \text{ kN}}$

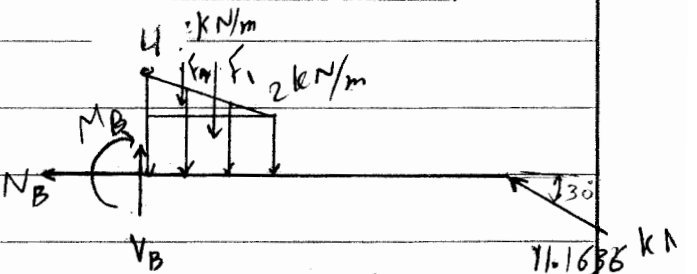
$\Sigma F_y = 0 \Rightarrow$

$11.1636 \sin 30 + V_C = 0 \Rightarrow \boxed{V_C = -5.5818 \text{ kN}}$

$\circlearrowleft \Sigma M_C = 0 \Rightarrow$

$11.1636 \sin 30 \times 3 - M_C = 0 \Rightarrow \boxed{M_C = 16.745 \text{kN}}$

At B F



$\Sigma F_x = 0 \Rightarrow$

$-N_B - 11.1636 \cos 30 = 0 \Rightarrow \boxed{N_B = -9.668 \text{ KN}}$ "opposite as shown"

$F_1 = 2 \times 2 = 4 \text{ kN}$

$F_2 = \frac{2 \times 2}{2} = 2 \text{ kN}$ and exert at $\frac{2}{3}$ m from B

$\Sigma F_y = 0 \Rightarrow 11.1636 \times \sin 30 - 4 - 2 + V_B = 0$

$\Rightarrow \boxed{V_B = 0.4182 \text{ KN}}$ "as shown"

$\circlearrowleft \Sigma M_B = 0 \Rightarrow$

$11.1636 \sin 30 \times 7 - 4 \times 1 - 2 \times \frac{2}{3} - M_B = 0$

$\Rightarrow \boxed{M_B = 33.739 \text{ kN.m}}$ "as shown"

Note: if you take the left part the result will be the same.