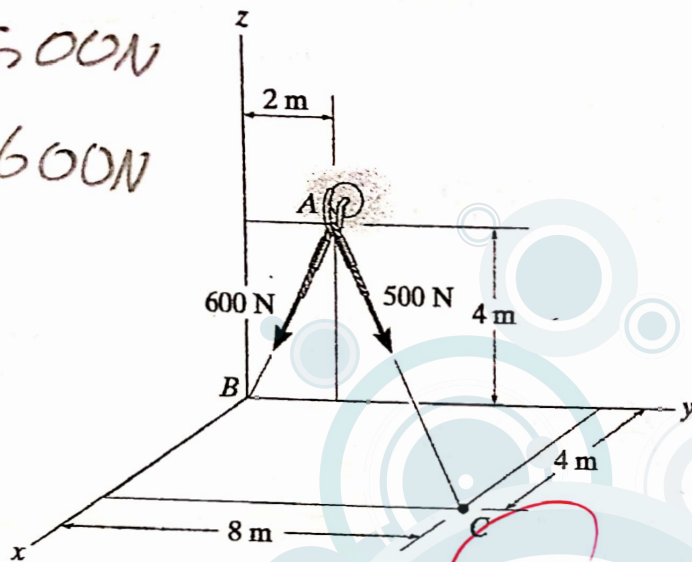


Q1 (20 marks): Determine the magnitude and coordinate direction angles of the resultant force.

$$F_1 = 500 \text{ N}$$

$$F_2 = 600 \text{ N}$$



$$C \rightarrow (4, 8, 0)$$

$$A \rightarrow (0, 2, 4)$$

$$B \rightarrow (0, 0, 0)$$

$$r_{AC} \rightarrow \langle 4, 6, -4 \rangle \text{ m}$$

$$r_{AC} = \{4\hat{i} + 6\hat{j} - 4\hat{k}\} \text{ m}$$

$$U_{AC} = \frac{r_{AC}}{|r_{AC}|}$$

$$|r_{AC}| = \sqrt{4^2 + 6^2 + 4^2}$$

$$|r_{AC}| = 2\sqrt{17}$$

$$U_{AC} = \left\{ \frac{2}{\sqrt{17}} \hat{i} + \frac{3}{\sqrt{17}} \hat{j} - \frac{2}{\sqrt{17}} \hat{k} \right\} \text{ m}$$

$$F_{AC} = F_1 \cdot U_{AC}$$

$$F_{AC} = \left\{ \frac{1000}{\sqrt{17}} \hat{i} + \frac{1500}{\sqrt{17}} \hat{j} - \frac{1000}{\sqrt{17}} \hat{k} \right\} \text{ N}$$

$$AB \rightarrow \langle 0, -2, -4 \rangle \Rightarrow r_{AB} = \{-2\hat{j} - 4\hat{k}\} \text{ m}$$

$$U_{AB} = \frac{r_{AB}}{|r_{AB}|}$$

$$|r_{AB}| = \sqrt{4 + 16} = \sqrt{20} \rightarrow U_{AB} = \left\{ \frac{-2}{\sqrt{20}} \hat{j} - \frac{4}{\sqrt{20}} \hat{k} \right\}$$

$$F_{AB} = F_2 \cdot U_{AB} \rightarrow F_{AB} = \left\{ \frac{-1200}{\sqrt{20}} \hat{j} - \frac{2400}{\sqrt{20}} \hat{k} \right\}$$

$$F_R = F_{AB} + F_{AC} \rightarrow F_R = \left\{ \frac{1000}{\sqrt{17}} \hat{i} + 95.8 \hat{j} - 779.2 \hat{k} \right\}$$

Final answers

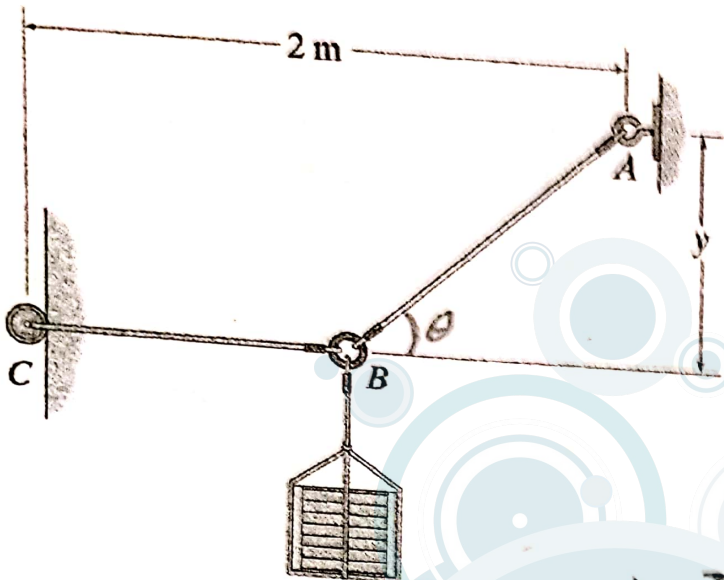
$$\alpha = 72.8^\circ$$

$$\beta = 83.3^\circ$$

$$\gamma = 161.5^\circ$$

$$F_R = 821.6 \text{ N}$$

Q2 (20 marks): If the 1.5-m-long cord AB can withstand a maximum force of 3500 N, determine the force in cord BC and the distance y so that the 200-kg crate can be supported.



$$L_{AB} = 1.5 \text{ m}$$

$$T_{AB} = 3500 \text{ N}$$

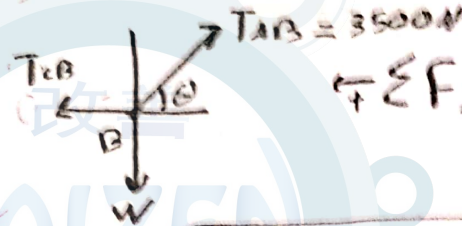
$$T_{BC} = ?$$

$$m = 200 \text{ kg}$$

$$W = mg$$

$$W = 200 \times 9.81 \Rightarrow W = 1962 \text{ N}$$

F.B.D at B



$$\sum F_x = 0$$

$$T_{BC} - T_{AB} \cos \theta = 0 \Rightarrow T_{BC} = 3500 \cos \theta$$

$$\sum F_y = 0$$

$$T_{AB} \sin \theta - 1962 = 0 \Rightarrow 3500 \sin \theta = 1962$$

$$\sin \theta = \frac{1962}{3500} \Rightarrow \theta = \sin^{-1} \left(\frac{1962}{3500} \right)$$

$$\theta = 34.1^\circ$$

$$T_{BC} = 3500 \times \cos(34.1)$$

$$T_{BC} = 2898.4 \text{ N}$$

$$\sin \theta = \frac{y}{1.5}$$

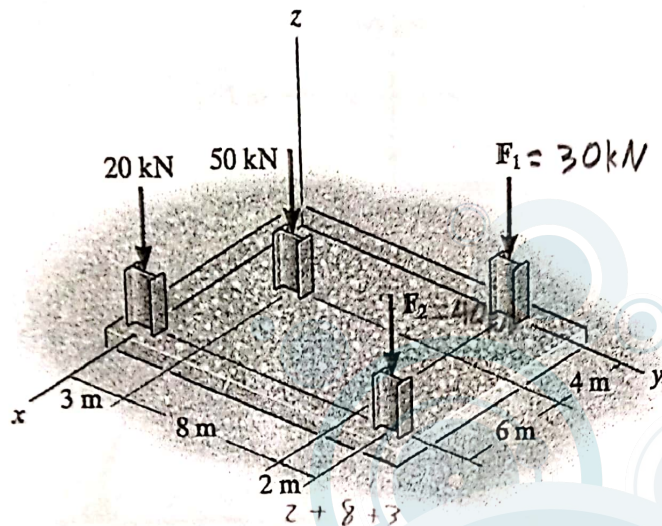
$$\frac{y}{1.5} = \sin(34.1) \Rightarrow y = 1.5 \times \sin(34.1)$$

$$y = 0.84 \text{ m}$$

Final answers

$F_{BC} = 2898.4 \text{ N}$	$y = 0.84 \text{ m}$
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Q3 (20 marks): The building slab is subjected to four parallel column loadings. Determine the equivalent resultant force and specify its location (x, y) on the slab. Take $F_1 = 30 \text{ kN}$, $F_2 = 40 \text{ kN}$.

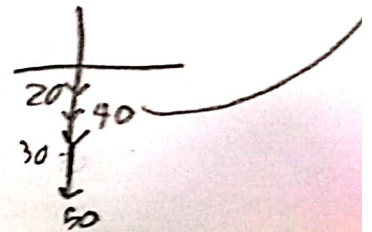


$$\uparrow \downarrow \bar{F}_R = 30 + 40 + 20$$

$$\bar{F}_R = 140 \text{ kN, k-}$$

assume position in
x-position
y-position
(x, y)

F.B.D



$$\sum M_{\text{around } x\text{-axis}} =$$

$$F_R \times y = (40 \times 13) + (50 \times 3) + (30 \times 11)$$

$$140y = 1000 \Rightarrow y = 7.14 \text{ m}$$

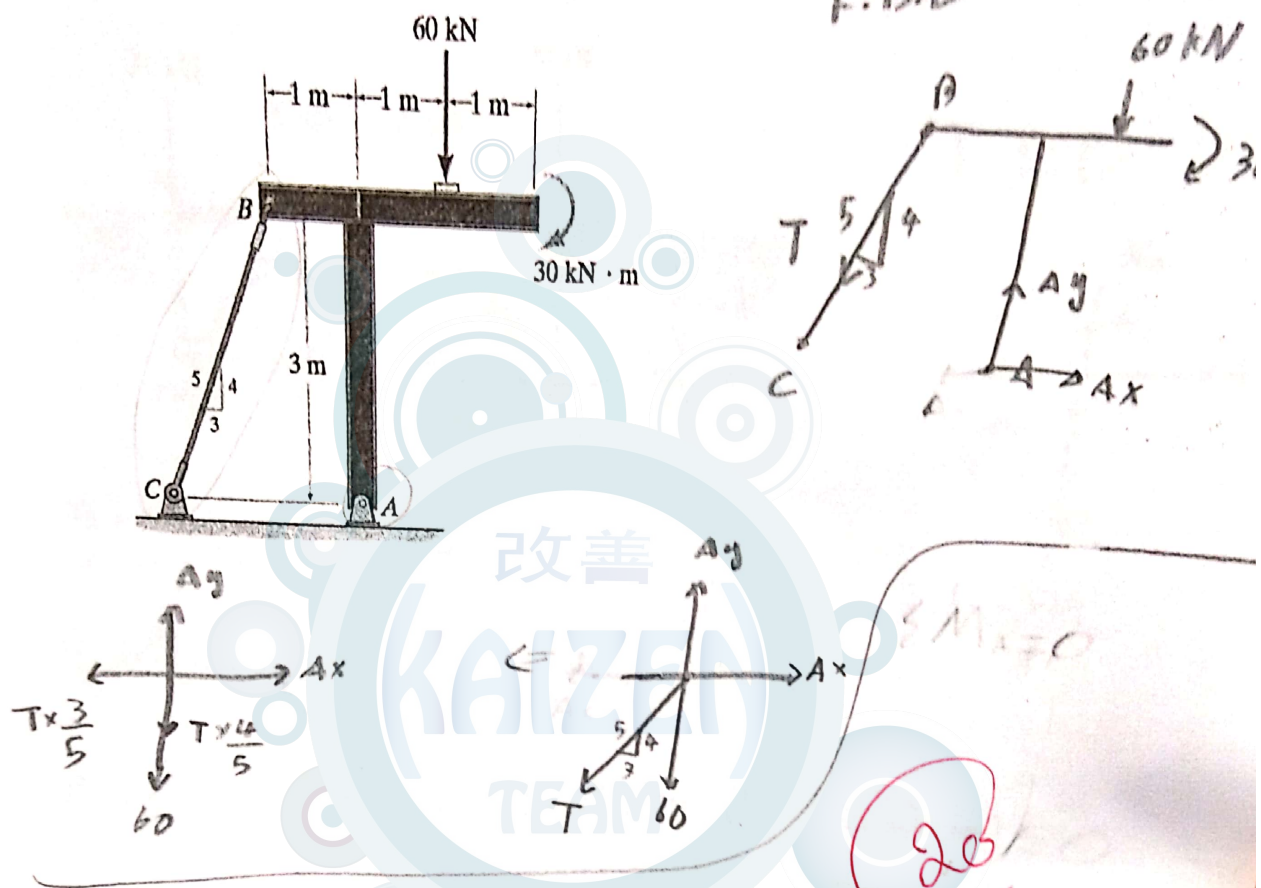
$$+ \sum M_{\text{around } y\text{-axis}} \Rightarrow F_R \times X = (20 \times 10) + (50 \times 4) + (40 \times 6)$$

$$140 \cdot X = 800 \Rightarrow X = 5.72 \text{ m}$$

Final answers

$F_R = 140 \text{ kN}$	$x = 5.72 \text{ m}$	$y = 7.14 \text{ m}$
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Q4 (20 marks): Determine the horizontal and vertical components of reaction at the pin A and tension developed in cable BC used to support the steel frame.



$$+\uparrow \sum M_A = 0 \Rightarrow (T \times \frac{3}{5} \times 3) + (T \times \frac{4}{5} \times 1) - 30 - (60 \times 1) = 0$$

$$\frac{13T}{5} = 30 + 60 \Rightarrow \frac{13T}{5} = 90 \rightarrow T = 34.62 \text{ kN}$$

$$+\rightarrow \sum F_x = 0 \Rightarrow A_x - (34.62 \times \frac{3}{5}) = 0 \Rightarrow A_x = 20.75 \text{ kN, } \delta +$$

$$+\uparrow \sum F_y = 0 \quad A_y - 60 - (34.62 \times \frac{4}{5}) = 0$$

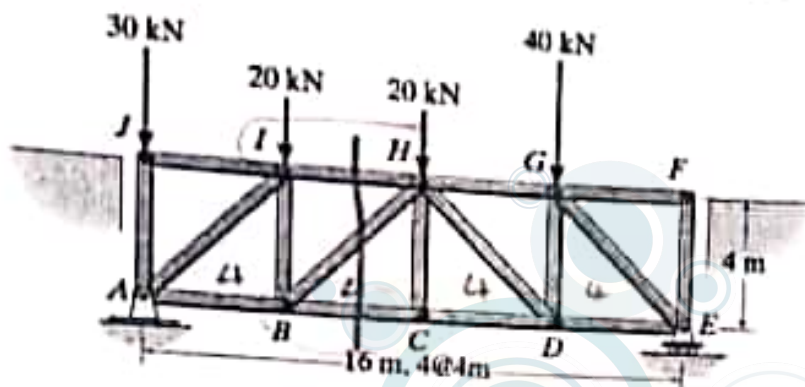
$$A_y = 60 + (34.62 \times \frac{4}{5})$$

$$A_y = 87.70 \text{ kN, } \delta +$$

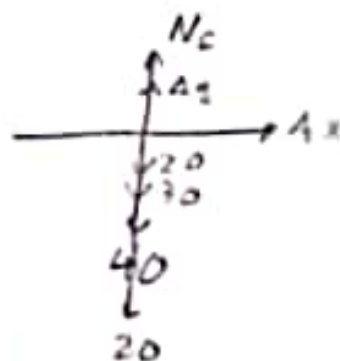
Final answers

$A_x = 20.75 \text{ kN}$	$A_y = 87.70 \text{ kN}$	$T_{BC} = 34.62 \text{ kN}$
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Q5 (20 marks): The Howe bridge truss is subjected to the loading shown. Determine the force in members HI and BC, and state if the members are in tension or compression.



F.B.D



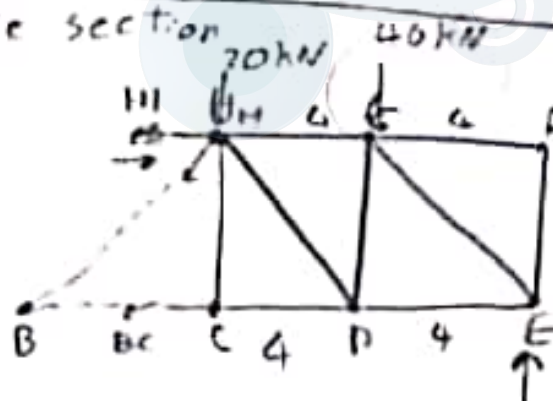
$$A_x = 0 \rightarrow \sum F_x = 0$$

$$+\circlearrowleft \sum M_A = 0$$

$$N_E \times 16 = (20 \times 8) + (40 \times 12) + (20 \times 4) = 0$$

$$N_E \times 16 = 720 \Rightarrow N_E = 45 \text{ kN, } \uparrow$$

Now make section



$$+\circlearrowleft \sum M_B = 0$$

$$(H_I \times 4) + (45 \times 12) - (20 \times 4) - (40 \times 8) = 0$$

$$H_I = 20 + 370 - 540$$

Final answer

$$F_{HI} = 165 \text{ kN, C}$$

$$F_{BC} = 50 \text{ kN, T}$$