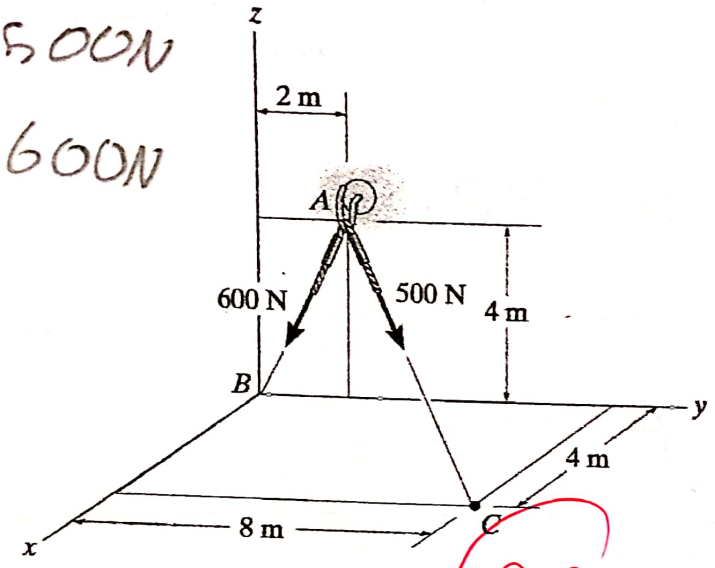
Q1 (20 marks): Determine the magnitude and coordinate direction angles of the resultant force.




$F_1 = 500N$

$F_2 = 600N$

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

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

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

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

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

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

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

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

20

$U_{rAC} = \left\{\dfrac{2}{\sqrt{17}}\hat{i} + \dfrac{3}{\sqrt{17}}\hat{j} - \dfrac{2}{\sqrt{17}}\hat{k}\right\} m$

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

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

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

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

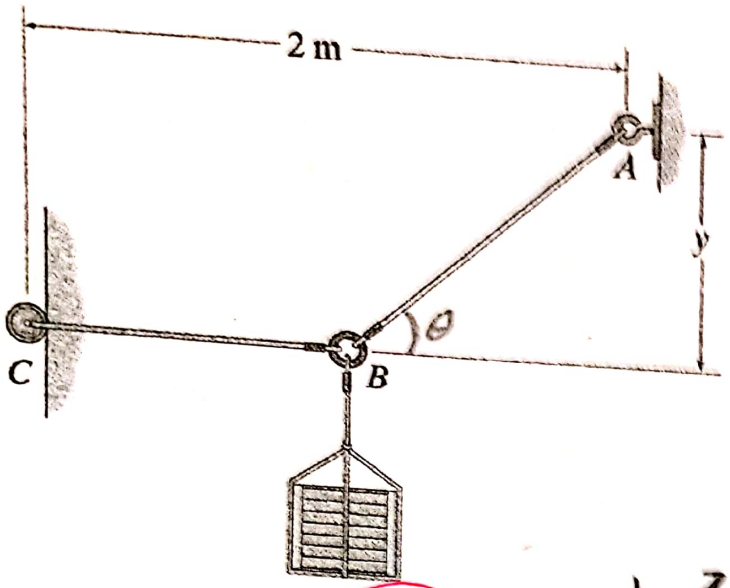
$F_{AB} = F_2 \cdot U_{AB} \rightarrow F_{AB} = \left\{-\dfrac{1200}{\sqrt{20}}\hat{j} - \dfrac{2400}{\sqrt{20}}\hat{k}\right\}$

$F_R = F_{AB} + F_{AC} \rightarrow F_R = \left\{\dfrac{1000}{\sqrt{17}}\hat{i} + 95.5\hat{j} - 779.2\right.$

Final answers

| | | | |
|---|---|---|---|
| $\alpha = 72.8^\circ$ | $\beta = 83.3^\circ$ | $\gamma = 161.5^\circ$ | $F_R = 821.6\ N$ |

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.




$L_{AB} = 1.5\,m$

$T_{max_{AB}} = 3500\,N$

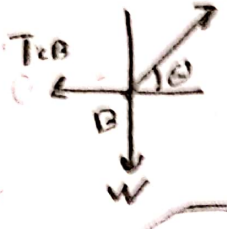
$T_{BC} = ?$

$m = 200\,kg$

$W = mg$

$W = 200 \times 9.81 \rightarrow W = 1962$

F.B.D at (B)




$+\rightarrow \sum F_x = 0$

$T_{CB} - T_{AB}\cos\theta = 0 \rightarrow T_{CB} = 3500\cos\theta$

$+\uparrow \sum F_y = 0$

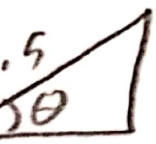
$T_{AB}\sin\theta - 1962 = 0 \rightarrow 3500\sin\theta = 1962$

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

$\theta = 34.1°$

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

$T_{CB} = 2898.4\,N, i-$




$\sin\theta = \sin\theta$

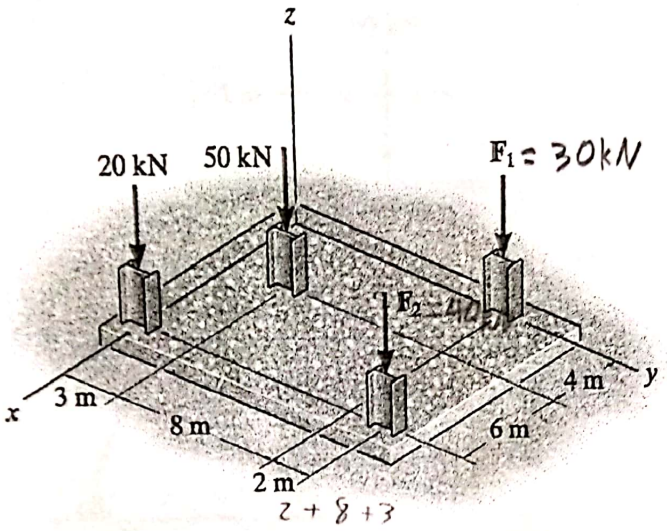
$\frac{y}{1.5} = \sin(34.1) \Rightarrow y = 1.5 \times \sin(34.1)$

$y = 0.84\,m$

Final answers

| | |
|---|---|
| $F_{BC}$ = 2898.4 N | $y$ = 0.84 m |

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 $F_1 = 30$ kN, $F_2 = 40$ kN.




$+\downarrow F_R = 30 + 40 + 20$

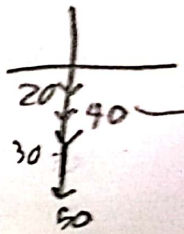
$F_R = 140$ kN, k-

assume position in

$(\overset{+}{x}, \overset{+}{y})$ x-positi

y-positi

F.B.D




$\sum M$ around x-axis $=$ $F_R \times y$

$140 \times y = (40 \times 13) + (50 \times 3) + (30 \times 11)$

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

20

$F_R \times X$

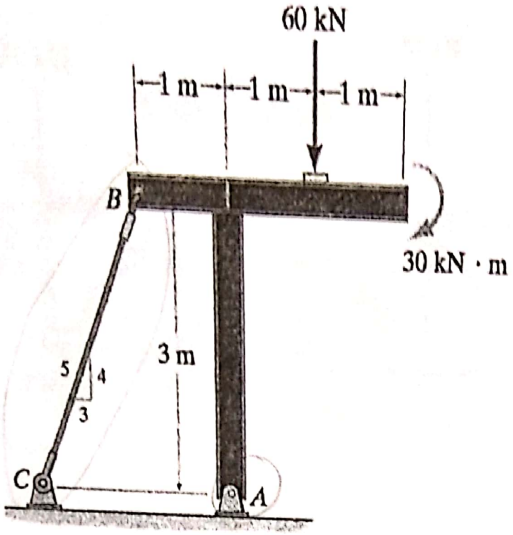
$+( \sum M$ around y-axis $\Rightarrow 140 \cdot X = (20 \times 10) + (50 \times 4) + (40$

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

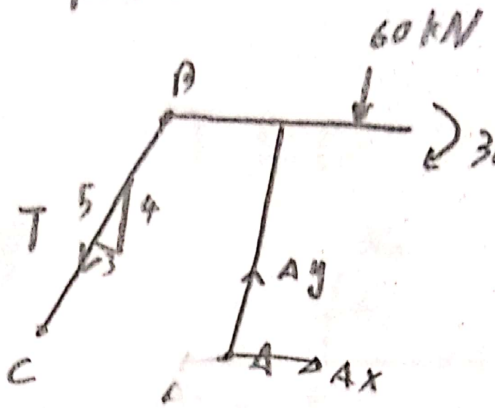
Final answers

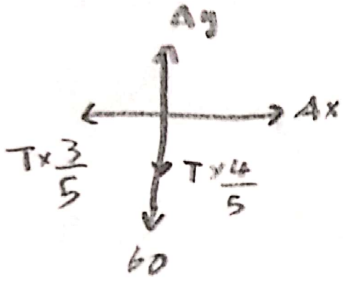
| | | |
|---|---|---|
| $F_R =$ 140 kN | $x =$ 5.72 m | $y =$ 7.14 m |

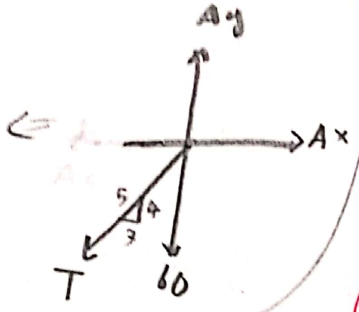
Q4 (20 marks): Determine the horizontal and vertical components of reaction at the pin *A* and t
tension developed in cable *BC* used to support the steel frame.




F.B.D




$\curvearrowleft \Sigma M_A = 0$

20

$+\curvearrowleft \Sigma M_A = 0 \Rightarrow \left(T \times \frac{3}{5} \times 3\right) + \left(T \times \frac{4}{5} \times 1\right) - 30 - (60 \times 1) = 0$

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

$\rightarrow \Sigma F_x = 0 \Rightarrow A_x - \left(34.62 \times \frac{3}{5}\right) \Rightarrow \boxed{A_x = 20.75\ kN, i+}$

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

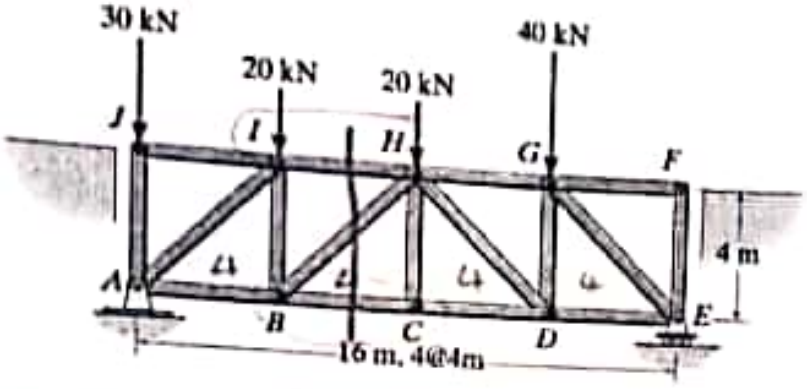
$A_y = 60 + \left(34.62 \times \frac{4}{5}\right)$

$\boxed{A_y = 87.70\ kN, j+}$

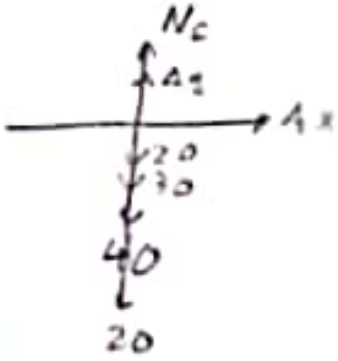
Final answers

| | | |
|---|---|---|
| $A_x = 20.75\ kN$ | $A_y = 87.70\ kN$ | $T_{BC} = 34.62\ kN$ |

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




$A_x = 0 \rightarrow \Sigma F_x = 0$

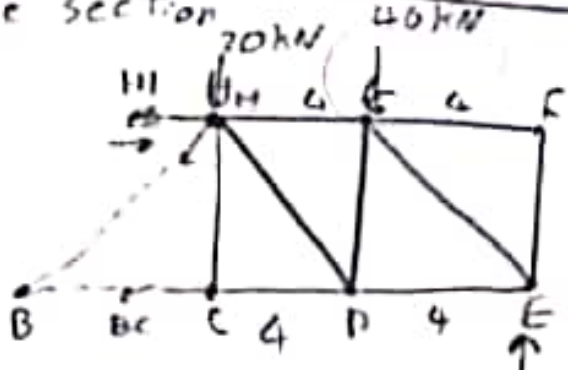
13

$+(\Sigma M_A = 0$

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

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

Now make section




$+(\Sigma M_B = 0$

$(HI \times 4) + (45\times 12) - (20\times 4)$

$-(40\times 8) = 0$

$HI = 20 + 320 - 540$

$(HI\times 4) + (45\times 8) = (20\times 4) + (40\times 8)$

$HI = -160\,kN \rightarrow$ IC

Final answer

| | |
|---|---|
| $F_{HI} = 165$ | $F_{BC} = 50\,kN, T$ |