PROBLEM 4.4

For the beam and loading shown, determine (a) the reaction at A, (b) the tension in cable BC.

SOLUTION

Free-Body Diagram:

(a) Reaction at A: \( \Sigma F_x = 0 \): \( A_x = 0 \)

\[ + \Sigma M_B = 0: \ (15 \text{ lb})(28 \text{ in.}) + (20 \text{ lb})(22 \text{ in.}) + (35 \text{ lb})(14 \text{ in.}) + (20 \text{ lb})(6 \text{ in.}) - A_y(6 \text{ in.}) = 0 \]

\[ A_y = +245 \text{ lb} \quad A = 245 \text{ lb} \uparrow \]

(b) Tension in BC: \( + \Sigma M_A = 0: \ (15 \text{ lb})(22 \text{ in.}) + (20 \text{ lb})(16 \text{ in.}) + (35 \text{ lb})(8 \text{ in.}) - (15 \text{ lb})(6 \text{ in.}) - F_{BC}(6 \text{ in.}) = 0 \]

\[ F_{BC} = +140.0 \text{ lb} \quad F_{BC} = 140.0 \text{ lb} \uparrow \]

Check: \( + \Sigma F_y = 0: \ -15 \text{ lb} - 20 \text{ lb} = 35 \text{ lb} - 20 \text{ lb} + A - F_{BC} = 0 \)

\[ -105 \text{ lb} + 245 \text{ lb} - 140.0 = 0 \]

\[ 0 = 0 \quad (\text{Checks}) \]
PROBLEM 4.7

A T-shaped bracket supports the four loads shown. Determine the reactions at A and B (a) if a = 10 in., (b) if a = 7 in.

SOLUTION

Free-Body Diagram:

\[ \sum F_x = 0: \quad B_x = 0 \]

\[ \sum M_B = 0: \quad (40 \text{ lb})(6 \text{ in.}) - (30 \text{ lb})a - (10 \text{ lb})(a + 8 \text{ in.}) + (12 \text{ in.})A = 0 \]

\[ A = \frac{(40a - 160)}{12} \]  

(1)

\[ \sum M_A = 0: \quad -(40 \text{ lb})(6 \text{ in.}) - (50 \text{ lb})(12 \text{ in.}) - (30 \text{ lb})(a + 12 \text{ in.}) - (10 \text{ lb})(a + 20 \text{ in.}) + (12 \text{ in.})B_y = 0 \]

\[ B_y = \frac{(1400 + 40a)}{12} \]

Since

\[ B_x = 0, \quad B = \frac{(1400 + 40a)}{12} \]  

(2)

(a) For a = 10 in.,

Eq. (1):

\[ A = \frac{(40 \times 10 - 160)}{12} = +20.0 \text{ lb} \]

A = 20.0 lb \downarrow

Eq. (2):

\[ B = \frac{(1400 + 40 \times 10)}{12} = +150.0 \text{ lb} \]

B = 150.0 lb \uparrow

(b) For a = 7 in.,

Eq. (1):

\[ A = \frac{(40 \times 7 - 160)}{12} = +10.00 \text{ lb} \]

A = 10.00 lb \downarrow

Eq. (2):

\[ B = \frac{(1400 + 40 \times 7)}{12} = +140.0 \text{ lb} \]

B = 140.0 lb \uparrow
PROBLEM 4.9

Three loads are applied as shown to a light beam supported by cables attached at B and D. Neglecting the weight of the beam, determine the range of values of $Q$ for which neither cable becomes slack when $P = 0$.

SOLUTION

Free-Body Diagram:

For $Q_{\text{min}}$, $T_D = 0$

\[ \sum M_B = 0: \quad (7.5 \text{ kN})(0.5 \text{ m}) - Q_{\text{min}}(3 \text{ m}) = 0 \]

\[ Q_{\text{min}} = 1.250 \text{ kN} \]

For $Q_{\text{max}}$, $T_B = 0$

\[ \sum M_D = 0: \quad (7.5 \text{ kN})(2.75 \text{ m}) - Q_{\text{max}}(0.75 \text{ m}) = 0 \]

\[ Q_{\text{max}} = 27.5 \text{ kN} \]

Therefore:

\[ 1.250 \text{ kN} \leq Q \leq 27.5 \text{ kN} \]
PROBLEM 4.14

For the beam and loading shown, determine the range of the distance \( a \) for which the reaction at \( B \) does not exceed 100 lb downward or 200 lb upward.

SOLUTION

Assume \( B \) is positive when directed ↑.

Sketch showing distance from \( D \) to forces.

\[
\sum M_D = 0: \quad (300 \text{ lb})(8 \text{ in.} - a) - (300 \text{ lb})(a - 2 \text{ in.}) - (50 \text{ lb})(4 \text{ in.}) + 16B = 0 \\
-600a + 2800 + 16B = 0 \\
a = \frac{(2800 + 16B)}{600} \quad (1)
\]

For \( B = 100 \text{ lb} \uparrow = -100 \text{ lb} \), Eq. (1) yields:

\[
a \geq \frac{[2800 + 16(-100)]}{600} = \frac{1200}{600} = 2 \text{ in.} \\
a \geq 2.00 \text{ in.} \quad \triangleleft
\]

For \( B = 200 \text{ lb} \uparrow = +200 \text{ lb} \), Eq. (1) yields:

\[
a \leq \frac{[2800 + 16(200)]}{600} = \frac{6000}{600} = 10 \text{ in.} \\
a \leq 10.00 \text{ in.} \quad \triangleleft
\]

Required range: \( 2.00 \text{ in.} \leq a \leq 10.00 \text{ in.} \)