

Chapter 1 Solutions

Problem 1.3-1

$$L = 14\text{ft} \quad q_0 = 12 \frac{\text{lbf}}{\text{ft}} \quad P = 50\text{lbf} \quad M_0 = 300\text{lbf}\cdot\text{ft}$$

Reactions

$$\Sigma F_x = 0 \quad B_x = \frac{3}{5} \cdot P = 30 \cdot \text{lbf}$$

$$\Sigma M_A = 0 \quad B_y = \frac{1}{L} \left[-M_0 + \left(\frac{1}{2} \cdot q_0 \right) \cdot L \cdot \left(\frac{2 \cdot L}{3} \right) + \frac{4}{5} \cdot P \cdot \left(L + \frac{L}{2} \right) \right] = 94.571 \cdot \text{lbf}$$

$$\Sigma F_y = 0 \quad A_y = \left(\frac{1}{2} \cdot q_0 \right) \cdot L + \frac{4}{5} \cdot P - B_y = 29.429 \cdot \text{lbf}$$

N, V and M at midspan of AB - LHFB is used below

$$N_{\text{mid}} = 0$$

$$V_{\text{mid}} = A_y - \frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} = 8.429 \cdot \text{lbf}$$

$$M_{\text{mid}} = -M_0 + A_y \cdot \frac{L}{2} - \frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} \cdot \left(\frac{1}{3} \cdot \frac{L}{2} \right) = -143 \cdot \text{lbf}\cdot\text{ft}$$

Problem 1.3-2

$$L = 4\text{m} \quad q_0 = 160 \frac{\text{N}}{\text{m}} \quad P = 200 \cdot \text{N} \quad M_0 = 380 \text{N}\cdot\text{m}$$

Reactions

$$\Sigma F_x = 0 \quad B_x = \frac{-3}{5} \cdot P = -120 \text{N}$$

$$\Sigma M_A = 0 \quad B_y = \frac{1}{L} \left[M_0 + \left(\frac{1}{2} \cdot q_0 \right) \cdot L \cdot \left(\frac{L}{3} \right) - \frac{4}{5} \cdot P \cdot \left(L + \frac{L}{2} \right) \right] = -38.333 \cdot \text{N}$$

$$\Sigma F_y = 0 \quad A_y = \left(\frac{1}{2} \cdot q_0 \right) \cdot L - \frac{4}{5} \cdot P - B_y = 198.333 \cdot \text{N}$$

N, V and M at midspan of AB - LHFB is used below

$$N_{\text{mid}} = 0$$

$$V_{\text{mid}} = A_y - \frac{1}{2} \cdot \left(\frac{q_0}{2} + q_0 \right) \cdot \frac{L}{2} = -41.667 \cdot \text{N}$$

$$M_{\text{mid}} = M_0 + A_y \cdot \frac{L}{2} - \frac{1}{2} \cdot q_0 \cdot \frac{L}{2} \cdot \left(\frac{2}{3} \cdot \frac{L}{2} \right) - \frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} \cdot \left(\frac{1}{3} \cdot \frac{L}{2} \right) = 510 \cdot \text{N}\cdot\text{m}$$

Check using RHFB

$$N_{\text{mid}} = B_x + \frac{3}{5} \cdot P = 0 \text{N} \quad V_{\text{mid}} = \frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} - B_y - \frac{4}{5} \cdot P = -41.667 \text{N}$$

$$M_{\text{mid}} = \frac{-1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} \cdot \left(\frac{1}{3} \cdot \frac{L}{2} \right) + B_y \cdot \frac{L}{2} + \frac{4}{5} \cdot P \cdot \left(\frac{L}{2} + \frac{L}{2} \right) = 510 \cdot \text{N}\cdot\text{m}$$

Problem 1.3-3

(a) APPLY LAWS OF STATICS

$$\Sigma F_x = 0 \quad C_x = 100 \text{ lb} - 50 \text{ lb} = 50 \text{ lb}$$

$$\text{FBD of } BC \quad \Sigma M_B = 0 \quad C_y = \frac{1}{10 \text{ ft}}(0) = 0$$

$$\text{Entire FBD} \quad \Sigma M_A = 0 \quad B_y = \frac{1}{20 \text{ ft}}(-100 \text{ lb-ft}) = -5 \text{ lb}$$

$$\Sigma F_y = 0 \quad A_y = -B_y = 5 \text{ lb-ft}$$

Reactions are $A_y = 5 \text{ lb}$ $B_y = -5 \text{ lb}$ $C_x = 50 \text{ lb}$ $C_y = 0$

(b) INTERNAL STRESS RESULTANTS N , V , AND M AT $x = 15 \text{ ft}$

Use FBD of segment from A to $x = 15 \text{ ft}$

$$\Sigma F_x = 0 \quad N = 100 \text{ lb} - 50 \text{ lb} = 50 \text{ lb}$$

$$\Sigma F_y = 0 \quad V = A_y = 5 \text{ lb}$$

$$\Sigma M = 0 \quad M = A_y 15 \text{ ft} = 75 \text{ lb-ft}$$

Problem 1.3-4

(a) APPLY LAWS OF STATICS

$$\Sigma F_x = 0 \quad A_x = 0$$

$$\text{FBD of } AB \quad \Sigma M_B = 0 \quad M_A = 0$$

$$\text{Entire FBD} \quad \Sigma M_C = 0 \quad D_y = \frac{1}{3} \text{ m} \left[200 \text{ N}\cdot\text{m} - \frac{1}{2} (80 \text{ N/m}) 4 \text{ m} \left(\frac{2}{3} \right) 4 \text{ m} \right] = -75.556 \text{ N}$$

$$\Sigma F_y = 0 \quad C_y = \frac{1}{2} (80 \text{ N/m}) 4 \text{ m} - D_y = 235.556 \text{ N}$$

$$\text{Reactions are} \quad \boxed{M_A = 0} \quad A_x = 0 \quad \boxed{C_y = 236 \text{ N}} \quad \boxed{D_y = -75.6 \text{ N}}$$

(b) INTERNAL STRESS RESULTANTS N , V , AND M AT $x = 5 \text{ m}$

Use FBD of segment from A to $x = 5 \text{ m}$; ordinate on triangular load at $x = 5 \text{ m}$ is $\frac{3}{4} (80 \text{ N/m}) = 60 \text{ N/m}$.

$$\Sigma F_x = 0 \quad N_x = -A_x = 0$$

$$\Sigma F_y = 0 \quad V = \frac{-1}{2} [(80 \text{ N/m} + 60 \text{ N/m}) 1 \text{ m}] = -70 \text{ N} \quad \boxed{V = -70 \text{ N}} \quad \text{Upward}$$

$$\Sigma M = 0 \quad M = -M_A - \frac{1}{2} (80 \text{ N/m}) 1 \text{ m} \left(\frac{2}{3} 1 \text{ m} \right) - \frac{1}{2} (60 \text{ N/m}) 1 \text{ m} \left(\frac{1}{3} 1 \text{ m} \right) = -36.667 \text{ N}\cdot\text{m}$$

(break trapezoidal load into two triangular loads in moment expression)

$$\boxed{M = -36.7 \text{ N}\cdot\text{m}} \quad \text{CW}$$

(c) REPLACE ROLLER SUPPORT AT C WITH SPRING SUPPORT

Structure remains statically determinate so all results above in (a) and (b) are unchanged.

Problem 1.3-5

(a) STATICS

FBD of AB (cut through beam at pin): $\sum M_B = 0 \quad A_y = \frac{1}{10 \text{ ft}}(-150 \text{ lb-ft}) = -15 \text{ lb}$

Entire FBD: $\sum M_D = 0$

$$C_y = \frac{1}{10 \text{ ft}} \left[\frac{4}{5} 40 \text{ lb}(5 \text{ ft}) + \frac{1}{2} (2.5 \text{ lb/ft}) 10 \text{ ft} \left(10 \text{ ft} + \frac{10 \text{ ft}}{3} \right) + \frac{1}{2} (5 \text{ lb/ft}) 10 \text{ ft} \left(10 \text{ ft} + \frac{2}{3} 10 \text{ ft} \right) - 150 \text{ lb-ft} - A_y 30 \text{ ft} \right] = 104.333 \text{ lb}$$

$$\sum F_y = 0 \quad D_y = \frac{4}{5} 40 \text{ lb} + \frac{1}{2} (5 \text{ lb/ft} + 2.5 \text{ lb/ft}) 10 \text{ ft} - A_y - C_y = -19.833 \text{ lb} \quad \text{so} \quad D_x = \frac{-D_y}{\tan(60^\circ)} = 11.451 \text{ lb}$$

$$\sum F_x = 0 \quad A_x = \frac{3}{5} 40 \text{ lb} - D_x = 12.549 \text{ lb}$$

$$\boxed{A_x = 12.55 \text{ lb}, A_y = -15 \text{ lb}, C_y = 104.3 \text{ lb}, D_x = 11.45 \text{ lb}, D_y = -19.83 \text{ lb}}$$

(b) USE FBD OF AB ONLY; MOMENT AT PIN IS ZERO

$$F_{Bx} = -A_x \quad F_{Bx} = -12.55 \text{ lb} \quad F_{By} = -A_y \quad F_{By} = 15 \text{ lb} \quad \boxed{\text{Resultant}_B = \sqrt{F_{Bx}^2 + F_{By}^2} = 19.56 \text{ lb}}$$

(c) ADD ROTATIONAL SPRING AT A AND REMOVE ROLLER AT C; APPLY EQUATIONS OF STATICAL EQUILIBRIUM

Use FBD of BCD $\sum M_B = 0$

$$D_y = \frac{1}{20 \text{ ft}} \left[\frac{1}{2} (2.5 \text{ lb/ft}) 10 \text{ ft} \left(\frac{2}{3} 10 \text{ ft} \right) + \frac{1}{2} (5 \text{ lb/ft}) 10 \text{ ft} \left(\frac{1}{3} 10 \text{ ft} \right) + \frac{4}{5} 40 \text{ lb} (15 \text{ ft}) \right] = 32.333 \text{ lb}$$

$$\text{so} \quad D_x = \frac{-D_y}{\tan(60^\circ)} = -18.668 \text{ lb}$$

$$\text{Use entire FBD} \quad \sum F_y = 0 \quad A_y = \frac{1}{2} (5 \text{ lb/ft} + 2.5 \text{ lb/ft}) 10 \text{ ft} + \frac{4}{5} (40 \text{ lb}) - D_y = 37.167 \text{ lb}$$

$$\sum F_x = 0 \quad A_x = \frac{3}{5} (40 \text{ lb}) - D_x = 42.668 \text{ lb}$$

$$\text{Use FBD of AB} \quad \sum M_B = 0 \quad M_A = 150 \text{ lb-ft} + A_y 10 \text{ ft} = 521.667 \text{ lb-ft}$$

$$\text{SO REACTIONS ARE} \quad \boxed{A_x = 42.7 \text{ lb}} \quad \boxed{A_y = 37.2 \text{ lb}} \quad \boxed{M_A = 522 \text{ lb-ft}} \quad \boxed{D_x = -18.67 \text{ lb}} \quad \boxed{D_y = 32.3 \text{ lb}}$$

RESULTANT FORCE IN PIN CONNECTION AT B

$$F_{Bx} = -A_x \quad F_{By} = -A_y \quad \boxed{\text{Resultant}_B = \sqrt{F_{Bx}^2 + F_{By}^2} = 56.6 \text{ lb}}$$

Problem 1.3-6

(a) STATICS

$$\Sigma F_y = 0 \quad R_{3y} = 20 \text{ N} - 45 \text{ N} = -25 \text{ N}$$

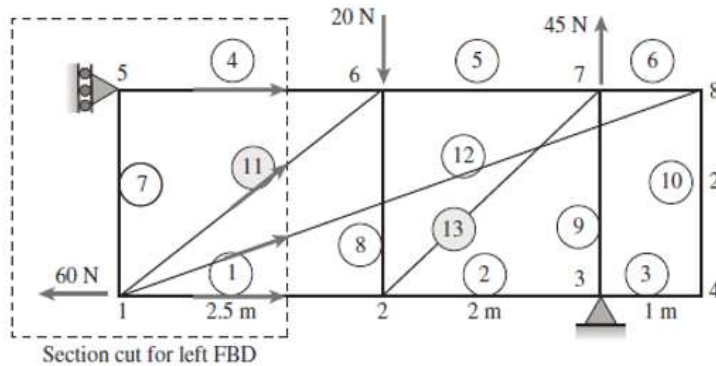
$$\Sigma M_3 = 0 \quad R_{5x} = \frac{1}{2 \text{ m}} (20 \text{ N} \times 2 \text{ m}) = 20 \text{ N}$$

$$\Sigma F_x = 0 \quad R_{3x} = -R_{5x} + 60 \text{ N} = 40 \text{ N}$$

(b) MEMBER FORCES IN MEMBERS 11 and 13

Number of unknowns: $m = 13 \quad r = 3 \quad m + r = 16$

Number of equations: $j = 8 \quad 2j = 16 \quad \text{So statically determinate}$



TRUSS ANALYSIS

- (1) $\Sigma F_V = 0$ at joint 4 so $F_{10} = 0$
- (2) $\Sigma F_V = 0$ at joint 8 so $F_{12} = 0$
- (3) $\Sigma F_H = 0$ at joint 5 so $F_4 = -R_{5x} = -20 \text{ N}$
- (4) Cut vertically through 4, 11, 12, and 1; use left FBD; sum moments about joint 2

$$F_{11V} = \frac{1}{2.5 \text{ m}} (R_{5x} - F_4) \quad \text{so} \quad \boxed{F_{11} = 0}$$
- (5) Sum vertical forces at joint 3; $F_9 = -R_{3y}$
 $F_9 = 25 \text{ N}$

(6) Sum vertical forces at joint 7 $F_{13V} = 45 \text{ N} - F_9 = 20 \text{ N} \quad \boxed{F_{13} = \sqrt{2} F_{13V} = 28.3 \text{ N}}$

Problem 1.3-7

(a) STATICS

$$\Sigma F_x = 0 \quad A_x = 0$$

$$\Sigma M_A = 0 \quad E_y = \frac{1}{20 \text{ ft}}(3 \text{ k} \times 10 \text{ ft} + 2 \text{ k} \times 20 \text{ ft} + 1 \text{ k} \times 30 \text{ ft}) = 5 \text{ k}$$

$$\Sigma F_y = 0 \quad A_y = 3 \text{ k} + 2 \text{ k} + 1 \text{ k} - E_y = 1 \text{ k}$$

(b) MEMBER FORCE IN MEMBER *FE*

Number of unknowns: $m = 11 \quad r = 3 \quad m + r = 14$

Number of equations: $j = 7 \quad 2j = 14 \quad \text{So statically determinate}$

TRUSS ANALYSIS

(1) Cut vertically through *AB*, *GC*, and *GF*; use left FBD; sum moments about *C*

$$F_{GFx}(15 \text{ ft}) - F_{GFy}(20 \text{ ft}) = A_y(20 \text{ ft}) = 20 \text{ ft-k} \quad F_{GFx} = F_{GF} \frac{10}{\sqrt{2^2 + 10^2}} \quad F_{GFy} = F_{GF} \frac{2}{\sqrt{2^2 + 10^2}}$$

$$\text{so } F_{GF} = \frac{A_y(20 \text{ ft})}{15 \text{ ft} \frac{10}{\sqrt{2^2 + 10^2}} - 20 \text{ ft} \frac{2}{\sqrt{2^2 + 10^2}}} = 1.854 \text{ k} \quad \text{and } F_{GFx} = F_{GF} \frac{10}{\sqrt{2^2 + 10^2}} = 1.818 \text{ k}$$

(2) Sum horizontal forces at joint *F* $F_{FEx} = F_{GFx} = 1.818 \text{ k} \quad F_{FE} = \frac{\sqrt{10^2 + 3^2}}{10} F_{FEx} = 1.898 \text{ k}$

$$\boxed{F_{FE} = 1.898 \text{ k}}$$

Problem 1.3-8

(a) STATICS

$$\Sigma F_x = 0 \quad F_x = 0$$

$$\Sigma M_F = 0 \quad D_y = \frac{1}{6 \text{ m}} [3 \text{ kN}(6 \text{ m}) + 6 \text{ kN}(3 \text{ m})] = 6 \text{ kN}$$

$$\Sigma F_y = 0 \quad F_y = 9 \text{ kN} + 6 \text{ kN} + 3 \text{ kN} - D_y = 12 \text{ kN}$$

(b) MEMBER FORCE IN MEMBER FE

$$\text{Number of unknowns:} \quad m = 11 \quad r = 3 \quad m + r = 14$$

$$\text{Number of equations:} \quad j = 7 \quad 2j = 14 \quad \text{So statically determinate}$$

TRUSS ANALYSIS

(1) Cut vertically through AB , GD , and GF ; use left FBD; sum moments about D to get $F_{GF} = 0$

(2) Sum horizontal forces at joint F $F_{FE_x} = -F_x = 0$ so $\boxed{F_{FE} = 0}$

Problem 1.3-9

$$c = 8 \text{ ft} \quad P = 20 \text{ kip}$$

$$a = \frac{\sin(60 \text{ deg})}{\sin(80 \text{ deg})} \cdot c = 7.035 \cdot \text{ft} \quad b = \frac{\sin(40 \text{ deg})}{\sin(80 \text{ deg})} \cdot c = 5.222 \cdot \text{ft}$$

$$\Sigma M_A = P \cdot \frac{c}{2} - P \cdot b \cdot \cos(60 \text{ deg}) - 2P \cdot b \cdot \sin(60 \text{ deg}) + B_y \cdot c = 0$$

$$B_y = \frac{P \cdot b \cdot \cos(60 \text{ deg}) + 2P \cdot b \cdot \sin(60 \text{ deg}) - P \cdot \frac{c}{2}}{c} = 19.137 \cdot \text{kip}$$

$$A_y = -B_y = -19.137 \cdot \text{kip}$$

$$A_x = 0$$

Joint A

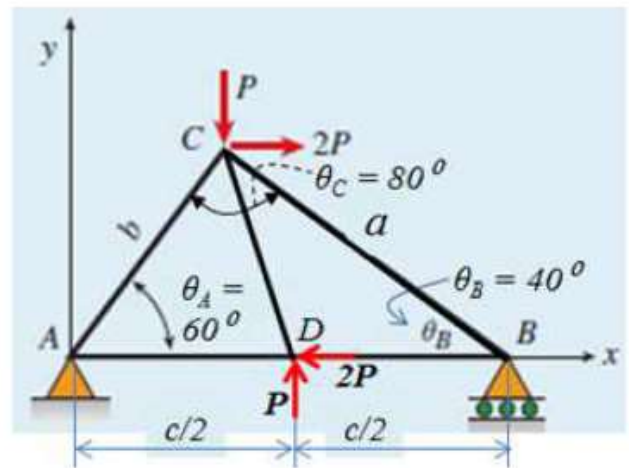
$$F_{AC} = \frac{-A_y}{\sin(60 \text{ deg})} = 22.098 \cdot \text{kip}$$

$$F_{AD} = -F_{AC} \cdot \cos(60 \text{ deg}) - A_x = -11.049 \cdot \text{kip}$$

Joint B

$$F_{BC} = \frac{-B_y}{\sin(40 \text{ deg})} = -29.772 \cdot \text{kip}$$

$$F_{BD} = -F_{BC} \cdot \cos(40 \text{ deg}) = 22.807 \cdot \text{kip}$$



$$CD = \sqrt{b^2 + \left(\frac{c}{2}\right)^2 - 2 \cdot b \cdot \frac{c}{2} \cdot \cos(60 \text{ deg})} = 4.731 \cdot \text{ft}$$

$$\text{ACD} = \text{asin}\left(\frac{\sin(60 \text{ deg}) \cdot \frac{c}{2}}{CD}\right) = 47.077 \cdot \text{deg}$$

Joint D

$$F_{DC} = \frac{-P}{\cos(90\text{deg} - 72.923\text{deg})} = -20.922 \cdot \text{kip}$$

$$180\text{deg} - 60\text{deg} - \text{ACD} = 72.923 \cdot \text{deg}$$

$$\frac{a \cdot \sin(\text{BCD})}{\sin(\text{ACD})} = 5.222 \cdot \text{ft}$$

$$\text{BCD} = \text{asin}\left(\frac{\sin(40\text{deg})}{\text{CD}} \cdot \frac{c}{2}\right) = 32.923 \cdot \text{deg}$$

$$\text{ACD} + \text{BCD} = 80 \cdot \text{deg}$$

Problem 1.3-10

Geometry $b = 3\text{ m}$ $P = 80\text{ kN}$

$$a = \sin(60\text{deg}) \cdot \left(\frac{b}{\sin(40\text{deg})} \right) = 4.042\text{ m}$$

$$L_{AB} = \sin(80\text{deg}) \cdot \left(\frac{b}{\sin(40\text{deg})} \right) = 4.596\text{ m}$$

$$L_{DB} = \sqrt{\left(\frac{b}{2} \right)^2 + L_{AB}^2 - 2 \cdot \left(\frac{b}{2} \right) \cdot (L_{AB}) \cdot \cos(60\text{deg})} = 4.06\text{ m}$$

$$\frac{L_{DB}}{\sin(60\text{deg})} = \frac{\frac{b}{2}}{\sin(\text{DBA})} \quad \text{so} \quad \text{DBA} = \text{asin} \left(\frac{\frac{b}{2}}{L_{DB}} \cdot \sin(60\text{deg}) \right) = 18.662\text{ deg}$$

$$\text{and} \quad \text{CBD} = 40\text{deg} - \text{DBA} = 21.338\text{ deg} \quad \text{ADB} = 180\text{deg} - 60\text{deg} - \text{DBA} = 101.338\text{ deg}$$

$$\text{CDB} = 180\text{deg} - \text{ADB} = 78.662\text{ deg}$$

Reactions

$$\Sigma F_x = 0 \quad A_x = -2 \cdot P + 2 \cdot P = 0\text{ N}$$

$$\Sigma M_A = 0 \quad B_y = \frac{1}{L_{AB}} \cdot \left[-2 \cdot P \cdot \left(\frac{b}{2} \cdot \sin(60\text{deg}) \right) + P \cdot (b \cdot \cos(60\text{deg})) + 2 \cdot P \cdot (b \cdot \sin(60\text{deg})) \right] = 71.329\text{ kN}$$

$$\Sigma F_y = 0 \quad A_y = P - B_y = 8.671\text{ kN}$$

MoJ to find member forces

$$\text{Joint A} \quad AD = \frac{-A_y}{\sin(60\text{deg})} = -10.013\text{ kN} \quad AB = -A_x - AD \cdot \cos(60\text{deg}) = 5.006\text{ kN}$$

$$\text{Joint D - sum forces normal to \& along line ADC} \quad DB = \frac{2 \cdot P \cdot \sin(60\text{deg})}{\cos(90\text{deg} - \text{CDB})} = 141.322\text{ kN}$$

$$DC = AD + 2 \cdot P \cdot (\cos(60\text{deg})) - DB \cdot \cos(\text{CDB}) = 42.204\text{ kN}$$

$$\text{Joint C} \quad CB = \frac{1}{\cos(40\text{deg})} \cdot (-2 \cdot P + DC \cdot \cos(60\text{deg})) = -181.319\text{ kN}$$

$$\text{Joint B} \quad \text{check} \quad -AB - DB \cdot \cos(\text{DBA}) - CB \cdot \cos(40\text{deg}) = 0\text{ N}$$

$$DB \cdot \sin(\text{DBA}) + CB \cdot \sin(40\text{deg}) + B_y = 0\text{ N}$$

Problem 1.3-11

Reactions $c = 8\text{ft}$ $P = 20\text{kip}$

$$A_x = 0 \quad A_y = -19.137\text{kip} \quad B_y = -A_y$$

AC: MoS - cut through AC and AD, use LHFB

$$\Sigma M_D = 0 \quad -A_y \frac{c}{2} - AC \cdot \sin(60\text{deg}) \cdot \frac{c}{2} = 0$$

$$AC = \frac{-A_y}{\sin(60\text{deg})} = 22.098 \cdot \text{kip}$$

BD: MoS - cut through BC andf BD, use RHFB

$$b = \frac{\sin(40\text{deg})}{\sin(80\text{deg})} \cdot c = 5.222 \cdot \text{ft}$$

$$\Sigma M_C = 0 \quad B_y \cdot (c - b \cdot \cos(60\text{deg})) - BD \cdot (b \cdot \sin(60\text{deg})) = 0 \quad BD = \frac{B_y \cdot (c - b \cdot \cos(60\text{deg}))}{b \cdot \sin(60\text{deg})} = 22.807 \cdot \text{kip}$$

Problem 1.3-12

Reactions $b = 3\text{m}$ $P = 80\text{kN}$

$$A_x = 0 \quad A_y = 8.671\text{kN} \quad B_y = 71.329\text{kN}$$

AB: MoS - cut through AD and AB, use LHFB

$$\Sigma M_D = 0 \quad AB \cdot \frac{b}{2} \cdot \sin(60\text{deg}) + A_x \cdot \frac{b}{2} \cdot \sin(60\text{deg}) - A_y \cdot \frac{b}{2} \cdot \cos(60\text{deg}) = 0$$

$$AB = \frac{-\left(A_x \cdot \frac{b}{2} \cdot \sin(60\text{deg}) - A_y \cdot \frac{b}{2} \cdot \cos(60\text{deg})\right)}{\left(\frac{b}{2} \cdot \sin(60\text{deg})\right)} = 5.006\text{kN}$$

DC: MoS - cut through DC and CB, use upper FBD $a = \sin(60\text{deg}) \cdot \left(\frac{b}{\sin(40\text{deg})}\right) = 4.042\text{m}$

$$DC_x = DC \cdot \cos(60\text{deg}) \quad DC_y = DC \cdot \sin(60\text{deg})$$

$$\Sigma M_B = 0 \quad -(-DC_x + 2 \cdot P) \cdot (a \cdot \sin(40\text{deg})) + (DC_y + P) \cdot (a \cdot \cos(40\text{deg})) = 0$$

$$-(-DC \cdot \cos(60\text{deg}) + 2 \cdot P) \cdot (a \cdot \sin(40\text{deg})) + (DC \cdot \sin(60\text{deg}) + P) \cdot (a \cdot \cos(40\text{deg})) = 0$$

Collect and simplify, solve for DC

$$DC = \frac{1.0 \cdot (80.0 \cdot \text{kN} \cdot \cos(40.0 \cdot \text{deg}) - 160.0 \cdot \text{kN} \cdot \sin(40.0 \cdot \text{deg}))}{\cos(60.0 \cdot \text{deg}) \cdot \sin(40.0 \cdot \text{deg}) + \sin(60.0 \cdot \text{deg}) \cdot \cos(40.0 \cdot \text{deg})} = 42.204 \cdot \text{kN}$$

Problem 1.3-13

(a) FIND REACTIONS USING STATICS $m = 3$ $r = 9$ $m + r = 12$ $j = 4$ $3j = 12$
 $m + r = 3j$ So truss is statically determinate

$$r_{AQ} = \begin{pmatrix} 4 \\ -3 \\ 0 \end{pmatrix} \quad r_{OA} = \begin{pmatrix} 0 \\ 0 \\ 5 \end{pmatrix} \quad e_{AQ} = \frac{r_{AQ}}{|r_{AQ}|} = \begin{pmatrix} 0.8 \\ -0.6 \\ 0 \end{pmatrix} \quad P_A = P e_{AQ} = \begin{pmatrix} 0.8P \\ -0.6P \\ 0 \end{pmatrix} \quad r_{OC} = \begin{pmatrix} 0 \\ 4 \\ 0 \end{pmatrix} \quad r_{OB} = \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$$

$\Sigma M = 0$

$$M_O = r_{OA} \times P_A + r_{OC} \times \begin{pmatrix} C_x \\ C_y \\ C_z \end{pmatrix} + r_{OB} \times \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = \begin{pmatrix} 4C_z + 3.0P \\ 4.0P - 2B_z \\ 2B_y - 4C_x \end{pmatrix} \quad \text{so} \quad \Sigma M_x = 0 \quad \text{gives} \quad C_z = \frac{-3}{4}P$$

$$\Sigma M_y = 0 \quad \text{gives} \quad \boxed{B_z = 2P}$$

$\Sigma F = 0$

$$R_O = P_A + \begin{pmatrix} O_x \\ O_y \\ O_z \end{pmatrix} + \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} + \begin{pmatrix} C_x \\ C_y \\ C_z \end{pmatrix} = \begin{pmatrix} B_x + C_x + O_x + 0.8P \\ B_y + C_y + O_y + -0.6P \\ O_z + \frac{5P}{4} \end{pmatrix} \quad \text{so} \quad \Sigma M_z = 0 \quad \text{gives} \quad \boxed{O_z = \frac{-5}{4}P}$$

METHOD OF JOINTS Joint O $\Sigma F_x = 0$ $O_x = 0$ $\Sigma F_y = 0$ $O_y = 0$

Joint B $\Sigma F_y = 0$ $B_y = 0$

Joint C $\Sigma F_x = 0$ $C_x = 0$

For entire structure $\Sigma F_x = 0$ gives $\boxed{B_x = -0.8P}$ $\Sigma F_y = 0$ $C_y = 0.6P - B_y = O_y$ $C_y = 0.6P$

(b) FORCE IN MEMBER AC

$$\Sigma F_z = 0 \quad \text{at joint C} \quad F_{AC} = \frac{\sqrt{4^2 + 5^2}}{5} |C_z| = \frac{3\sqrt{41}}{20} |P| \quad \boxed{F_{AC} = \frac{3\sqrt{41}}{20} P} \quad \text{tension} \quad \frac{3\sqrt{41}}{20} = 0.96$$

Problem 1.3-14

(a) FIND REACTIONS USING STATICS $m = 4$ $r = 8$ $m + r = 12$ $j = 4$ $3j = 12$

$m + r = 3j$ so truss is statically determinate

$$r_{OA} = \begin{pmatrix} 0 \\ 0 \\ 0.8L \end{pmatrix} \quad r_{OB} = \begin{pmatrix} L \\ 0 \\ 0 \end{pmatrix} \quad r_{OC} = \begin{pmatrix} 0 \\ 0.6L \\ 0 \end{pmatrix} \quad F_A = \begin{pmatrix} A_x \\ A_y \\ P \end{pmatrix} \quad F_B = \begin{pmatrix} 0 \\ B_y \\ B_z \end{pmatrix} \quad F_C = \begin{pmatrix} C_x \\ -2P \\ 0 \end{pmatrix} \quad F_O = \begin{pmatrix} O_x \\ O_y \\ O_z \end{pmatrix}$$

$$\Sigma M = 0$$

Resultant moment at O

$$M_O = r_{OA} \times F_A + r_{OB} \times F_B + r_{OC} \times F_C = \begin{pmatrix} -0.8A_yL \\ 0.8A_xL - B_zL \\ B_yL - 0.6C_xL \end{pmatrix} \quad \text{so} \quad \Sigma M_x = 0 \quad \text{gives} \quad A_y = 0$$

$$\Sigma F = 0$$

Resultant force at O

$$R_O = F_O + F_A + F_B + F_C = \begin{pmatrix} A_x + C_x + O_x \\ A_y + B_y + O_y - 2P \\ B_z + O_z + P \end{pmatrix}$$

METHOD OF JOINTS Joint O $\Sigma F_z = 0$ $O_z = 0$

so from $\Sigma F_z = 0$ $B_z = -P$ and $\Sigma M_y = 0$ $A_x = \frac{B_z}{0.8} = -1.25P$

Joint B $\Sigma F_y = 0$ $B_y = 0$

Joint C $\Sigma F_x = 0$ $C_x = 0$

(b) FORCE IN MEMBER AB

$$\Sigma F_z = 0 \quad \text{at joint } B \quad F_{AB} = \frac{\sqrt{(0.8L)^2 + L^2}}{0.8L} |B_z| \quad |B_z| = |P| \quad \frac{\sqrt{(0.8L)^2 + L^2}}{0.8L} = 1.601$$

$$F_{AB} = 1.601P \quad \text{tension}$$

Problem 1.3-15

(a) FIND REACTIONS USING STATICS $m = 3$ $r = 6$ $m + r = 9$ $j = 3$ $3j = 9$

$m + r = 3j$ So truss is statically determinate

$$r_{OA} = \begin{pmatrix} 3L \\ 0 \\ 0 \end{pmatrix} \quad r_{OB} = \begin{pmatrix} 0 \\ 4L \\ 0 \end{pmatrix} \quad r_{OC} = \begin{pmatrix} 0 \\ 2L \\ 4L \end{pmatrix} \quad F_A = \begin{pmatrix} -2P \\ A_y \\ A_z \end{pmatrix} \quad F_B = \begin{pmatrix} B_x \\ B_y \\ 3P \end{pmatrix} \quad F_C = \begin{pmatrix} C_x \\ C_y \\ P \end{pmatrix}$$

$$\Sigma M = 0$$

Resultant moment at O

$$M_O = r_{OA} \times F_A + r_{OB} \times F_B + r_{OC} \times F_C = \begin{pmatrix} 14LP - 4C_yL \\ 4C_xL - 3A_zL \\ 3A_yL - 4B_xL - 2C_xL \end{pmatrix} \quad \text{so} \quad \Sigma M_x = 0 \quad \text{gives} \quad C_y = \frac{14}{4}P$$

$$\Sigma F = 0$$

Resultant force at O

$$R_O = F_A + F_B + F_C = \begin{pmatrix} B_x + C_x - 2P \\ A_y + B_y + C_y \\ A_z + 4P \end{pmatrix} \quad \text{so} \quad \Sigma F_z = 0 \quad \text{gives} \quad \boxed{A_z = -4.0P}$$

METHOD OF JOINTS

$$\text{Joint A} \quad \Sigma F_z = 0 \quad F_{ACz} = -A_z = 4.0P \quad \text{so} \quad F_{ACy} = \frac{2}{4}F_{ACz} = 2.0P \quad F_{ACx} = \frac{3}{4}F_{ACz} = 3.0P$$

$$\Sigma F_x = 0 \quad F_{ABx} = -2P - F_{ACx} = -3.0P - 2P \quad \text{so} \quad F_{ABy} = \frac{4}{3}F_{ABx} = -4.0P - \frac{8P}{3}$$

$$\Sigma F_y = 0 \quad A_y = -(F_{ABy} + F_{ACy}) = \frac{8P}{3} + 4.0P + -2.0P \quad \boxed{A_y = 4.67P}$$

(b) FORCE IN MEMBER AB

$$F_{AB} = \sqrt{F_{ABx}^2 + F_{ABy}^2} \quad F_{AB} = -\sqrt{5^2 + \left(\frac{20}{3}\right)^2}P = -\frac{25P}{3} \quad \frac{25}{3} = 8.33$$

$$\boxed{F_{AB} = -8.33P} \quad \text{compression}$$

Problem 1.3-16

(a) FIND REACTIONS USING STATICS $m = 3$ $r = 6$ $m + r = 9$ $j = 3$ $3j = 9$
 $m + r = 3j$ so truss is statically determinate

$L = 2 \text{ m}$ $P = 5 \text{ kN}$

$$r_{OA} = \begin{pmatrix} 3L \\ 0 \\ 0 \end{pmatrix} \quad r_{OB} = \begin{pmatrix} 0 \\ 4L \\ 2L \end{pmatrix} \quad r_{OC} = \begin{pmatrix} 0 \\ 0 \\ 4L \end{pmatrix} \quad F_A = \begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix} \quad F_B = \begin{pmatrix} B_x \\ 0 \\ P \end{pmatrix} \quad F_C = \begin{pmatrix} C_x \\ C_y \\ -P \end{pmatrix}$$

$\Sigma F = 0$

Resultant force at O $R_O = F_A + F_B + F_C = \begin{pmatrix} A_x + B_x + C_x \\ A_y + C_y \\ A_z \end{pmatrix}$ so $\Sigma F_z = 0$ gives $A_z = 0$

RESULTANT MOMENT AT A

$$r_{AC} = \begin{pmatrix} -3L \\ 0 \\ 4L \end{pmatrix} \quad e_{AC} = \frac{r_{AC}}{|r_{AC}|} = \begin{pmatrix} -0.6 \\ 0 \\ 0.8 \end{pmatrix} \quad r_{AB} = \begin{pmatrix} -3L \\ 4L \\ 2L \end{pmatrix}$$

$$M_A = r_{AB} \times F_B + r_{AC} \times F_C = \begin{pmatrix} 40 \text{ kN}\cdot\text{m} - 8 \text{ C}_y \cdot \text{m} \\ 4 \text{ B}_x \cdot \text{m} + 8 \text{ C}_x \cdot \text{m} \\ -8 \text{ B}_x \cdot \text{m} - 6 \text{ C}_y \cdot \text{m} \end{pmatrix} \quad M_A e_{AC} = -6.4 B_x - 24.0 \text{ kN} \quad \text{so} \quad B_x = \frac{-24}{6.4} \text{ kN} = -3.75 \text{ kN}$$

(b) FORCE IN MEMBER AB

Method of joints at B $\Sigma F_x = 0$ $F_{ABx} = -B_x$ $F_{AB} = \frac{\sqrt{29}}{3} F_{ABx} = 6.73 \text{ kN}$

Problem 1.3-17

(a) APPLY LAWS OF STATICS $L_1 = 30$ in. $L_2 = 20$ in. $T_1 = 21000$ lb-in. $T_2 = 10000$ lb-in.

$$\Sigma M_x = 0 \quad \boxed{T_A = T_1 - T_2 = 11,000 \text{ lb-in.}}$$

(b) INTERNAL STRESS RESULTANT T AT TWO LOCATIONS

Cut shaft at midpoint between A and B at $x = L_1/2$
(use left FBD)

$$\Sigma M_x = 0 \quad \boxed{T_{AB} = -T_A = -11,000 \text{ lb-in.}}$$

Cut shaft at midpoint between B and C at $x = L_1 + L_2/2$
(use right FBD)

$$\Sigma M_x = 0 \quad \boxed{T_{BC} = T_2 = 10,000 \text{ lb-in.}}$$

Problem 1.3-18

(a) REACTION TORQUE AT A $L_1 = 0.75 \text{ m}$ $L_2 = 0.75 \text{ m}$ $t_1 = 3100 \text{ N}\cdot\text{m/m}$ $T_2 = 1100 \text{ N}\cdot\text{m}$

Statics $\Sigma M_x = 0$ $T_A = -t_1 L_1 + T_2 = -1225 \text{ N}\cdot\text{m}$ $T_A = -1225 \text{ N}\cdot\text{m}$

(b) INTERNAL TORSIONAL MOMENTS AT TWO LOCATIONS

Cut shaft between A and B
(use left FBD) $T_1(x) = -T_A - t_1 x$ $T_1\left(\frac{L_1}{2}\right) = 62.5 \text{ N}\cdot\text{m}$

Cut shaft between B and C
(use left FBD) $T_2(x) = -T_A - t_1 L_1$ $T_2\left(L_1 + \frac{L_2}{2}\right) = -1100 \text{ N}\cdot\text{m}$

Problem 1.3-19

(a) STATICS

$$\Sigma F_H = 0 \quad A_x = \frac{-1}{2}(90 \text{ lb/ft}) 12 \text{ ft} = -540 \text{ lb}$$

$$\Sigma F_V = 0 \quad A_y + C_y = 0$$

$$\Sigma M_{FBD BC} = 0 \quad C_y = \frac{500 \text{ lb-ft}}{9 \text{ ft}} = 55.6 \text{ lb} \quad A_y = -C_y = -55.6 \text{ lb}$$

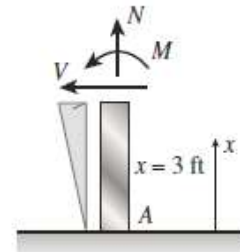
$$\Sigma M_A = 0 \quad M_A = 500 \text{ lb-ft} + \frac{1}{2}(90 \text{ lb/ft}) 12 \text{ ft} \left(\frac{2}{3} 12 \text{ ft}\right) - C_y 9 \text{ ft} = 4320 \text{ lb-ft}$$

(b) INTERNAL STRESS RESULTANTS

$$N = -A_y = 55.6 \text{ lb}$$

$$V = -A_x - \frac{1}{2} \left(\frac{3}{12} 90 \text{ lb/ft} \right) 3 \text{ ft} = 506 \text{ lb}$$

$$M = -M_A - A_x 3 \text{ ft} - \frac{1}{2} \left(\frac{3}{12} 90 \text{ lb/ft} \right) 3 \text{ ft} \left(\frac{1}{3} 3 \text{ ft} \right) = -2734 \text{ lb-ft}$$



Problem 1.3-20

(a) STATICS

$$\Sigma F_x = 0 \quad A_x = \frac{3}{5}(200 \text{ N}) + \frac{1}{2}(80 \text{ N/m}) 4 \text{ m} = 280 \text{ N}$$

$$\Sigma M_{BRHF} = 0 \quad D_y = \frac{1}{3 \text{ m}} \left[\frac{4}{5}(200 \text{ N})(1.5 \text{ m}) + \frac{1}{2}(80 \text{ N/m}) 4 \text{ m} \left(\frac{1}{3} 4 \text{ m} \right) \right]$$

$$= 151.1 \text{ N} < \text{ use right hand FBD (BCD only)}$$

$$\Sigma F_y = 0 \quad A_y = -D_y + \frac{4}{5}(200 \text{ N}) = 8.89 \text{ N}$$

$$\Sigma M_A = 0 \quad M_A = \frac{4}{5}(200 \text{ N})(1.5 \text{ m}) - \frac{3}{5}(200 \text{ N})(4 \text{ m}) - D_y 3 \text{ m} - \frac{1}{2}(80 \text{ N/m}) 4 \text{ m} \left(\frac{2}{3} 4 \text{ m} \right) = -1120 \text{ N}\cdot\text{m}$$

(b) RESULTANT FORCE IN PIN AT B

LEFT HAND FBD (SEE FIGURE)

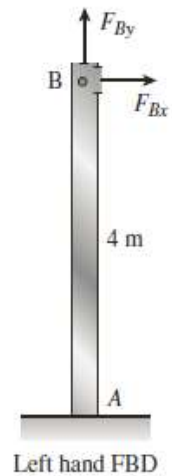
$$F_{Bx} = -A_x = -280 \text{ N} \quad F_{By} = -A_y = -8.89 \text{ N}$$

RIGHT HAND FBD

$$F_{Bx} = \frac{3}{5}(200 \text{ N}) + \frac{1}{2}(80 \text{ N/m}) 4 \text{ m} = 280 \text{ N}$$

$$F_{By} = \frac{4}{5}(200 \text{ N}) - D_y = 8.89 \text{ N}$$

$$\text{Resultant}_B = \sqrt{F_{Bx}^2 + F_{By}^2} = 280 \text{ N}$$



Problem 1.3-21

$$L = 14\text{ft} \quad q_0 = 12 \frac{\text{lbf}}{\text{ft}} \quad P = 50\text{lbf} \quad M_0 = 300\text{lbf}\cdot\text{ft}$$

$$\Sigma M_D = -M_0 + \frac{1}{2} \cdot q_0 \cdot L \cdot \frac{L}{3} - \frac{4}{5} \cdot P \cdot \frac{L}{2} + \frac{3}{5} P \cdot L - \frac{1}{2} \cdot q_0 \cdot L \cdot \frac{2L}{3} - A_y \cdot L = 0$$

$$A_y = \frac{-M_0 + \frac{1}{2} \cdot q_0 \cdot L \cdot \frac{L}{3} - \frac{4}{5} \cdot P \cdot \frac{L}{2} + \frac{3}{5} P \cdot L - \frac{1}{2} \cdot q_0 \cdot L \cdot \frac{2L}{3}}{L} = -39.429 \cdot \text{lbf}$$

$$D_y = -A_y + \frac{1}{2} \cdot q_0 \cdot L + \frac{4}{5} \cdot P = 163.429 \cdot \text{lbf}$$

$$D_x = \frac{-1}{2} \cdot q_0 \cdot L + \frac{3}{5} \cdot P = -54 \cdot \text{lbf}$$

$$V_{\text{midAB}} = A_y - \frac{1}{2} \cdot \frac{L}{2} \cdot \frac{q_0}{2} = -60.429 \cdot \text{lbf} \quad N_{\text{mid}} = 0$$

$$M_{\text{midAB}} = M_0 + A_y \cdot \frac{L}{2} - \frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} \cdot \frac{\frac{L}{2}}{3} = -25 \cdot \text{lbf}\cdot\text{ft}$$

Problem 1.3-22

$$L = 4\text{m} \quad q_0 = 160 \frac{\text{N}}{\text{m}} \quad P = 200\text{N} \quad M_0 = 380 \cdot \text{N}\cdot\text{m}$$

Reactions

$$\Sigma F_x = 0 \quad A_x = 2 \cdot \left(\frac{3}{5} \cdot P \right) - \frac{1}{2} \cdot q_0 \cdot L = -80\text{N}$$

$$\Sigma M_A = 0 \quad D_y = \frac{1}{L} \left[M_0 + \frac{4}{5} \cdot P \cdot \frac{L}{2} + \frac{4}{5} \cdot P \cdot \frac{3 \cdot L}{2} - \frac{1}{2} \cdot q_0 \cdot L \cdot \left(\frac{L}{3} \right) \right] = 308.333\text{N}$$

$$\Sigma F_y = 0 \quad A_y = -D_y + 2 \cdot \left(\frac{4}{5} \cdot P \right) = 11.667\text{N}$$

Column BD internal forces and moment at mid-height - cut through column, use lower FBD (D on your left)

$$N_{\text{mid}} = -D_y = -308.333\text{N} \quad V_{\text{mid}} = \frac{-1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} = -80\text{N} \quad M_{\text{mid}} = - \left(\frac{1}{2} \cdot \frac{q_0}{2} \cdot \frac{L}{2} \right) \cdot \left(\frac{1}{3} \cdot \frac{L}{2} \right) = -53.333 \cdot \text{N}\cdot\text{m}$$

Problem 1.3-23

$$L_{BC} = \frac{\frac{4}{5} \cdot 30 \text{ in}}{\frac{2}{\sqrt{5}}} = 26.833 \cdot \text{in} \quad L_{AC} = \frac{3}{5} \cdot (30 \text{ in}) + \frac{1}{\sqrt{5}} \cdot L_{BC} = 30 \cdot \text{in}$$

Part (a) - statics

$$\begin{aligned} \Sigma M_A = 0 \quad C_Y &= \frac{1}{L_{AC}} \cdot \left(200 \text{ lb} \cdot \frac{1}{2} \cdot \frac{3}{5} \cdot 30 \text{ in} \right) = 60 \text{ lbf} & C_X &= \frac{-1}{2} \cdot C_Y = -30 \text{ lbf} \\ \Sigma F_X = 0 \quad A_X &= -C_X = 30 \text{ lbf} & & \text{(resultant of } C_X \text{ and } C_Y \text{ acts along line of} \\ & & & \text{strut)} \\ \Sigma F_Y = 0 \quad A_Y &= 200 \text{ lb} - C_Y = 140 \text{ lbf} \end{aligned}$$

Part (b) - internal stress resultants N, V, M

distributed weight of door in -y dir. $w = \frac{200 \text{ lb}}{30 \text{ in}} = 6.667 \cdot \frac{\text{lb}}{\text{in}}$

components of w along and perpendicular to door

$$w_a = \frac{4}{5} \cdot w = 5.333 \cdot \frac{\text{lb}}{\text{in}} \quad w_p = \frac{3}{5} \cdot w = 4 \cdot \frac{\text{lb}}{\text{in}}$$

$$N_X = w_a \cdot (20 \text{ in}) - \frac{3}{5} \cdot A_X - \frac{4}{5} \cdot A_Y = -23.333 \text{ lbf}$$

$$V_X = -w_p \cdot (20 \text{ in}) - \frac{4}{5} \cdot A_X + \frac{3}{5} \cdot A_Y = -20 \text{ lbf}$$

$$M_X = -w_p \cdot (20 \text{ in}) \cdot \frac{20 \text{ in}}{2} - \frac{4}{5} \cdot A_X \cdot (20 \text{ in}) + \frac{3}{5} \cdot A_Y \cdot (20 \text{ in}) = 400 \cdot \text{lb} \cdot \text{in} \quad M_X = 33.333 \text{ lb} \cdot \text{ft}$$

$$\boxed{N_X = -23.3 \text{ lbf}}$$

$$\boxed{V_X = -20 \text{ lbf}}$$

$$\boxed{M_X = 33.3 \cdot \text{lb} \cdot \text{ft}}$$

Problem 1.3-24

(a) STATICS

$$\Sigma M_A = 0$$

$$10 \text{ kN}(6 \text{ m}) - 10 \text{ kN}\left(\frac{1}{\sqrt{2}}\right)(6 \text{ m}) + 90 \text{ kN}\cdot\text{m} + E_y(6 \text{ m}) - E_x(3 \text{ m}) = 6E_y \text{ m} - 3E_x \text{ m} + 150 \text{ kN}\cdot\text{m} - 30\sqrt{2} \text{ kN}\cdot\text{m}$$

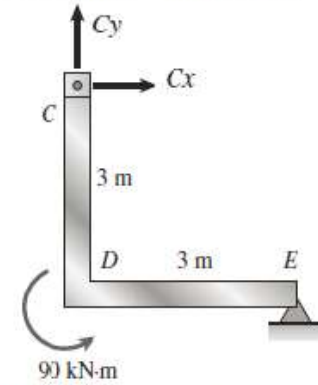
$$\text{so } 6E_y \text{ m} - 3E_x \text{ m} + 150 \text{ kN}\cdot\text{m} - 30\sqrt{2} \text{ kN}\cdot\text{m} = 0$$

$$\text{or } -E_x + 2E_y = \frac{-(150 \text{ kN}\cdot\text{m} - 30\sqrt{2} \text{ kN}\cdot\text{m})}{3 \text{ m}} = -35.858 \text{ kN}$$

$\Sigma M_{\text{CRHFB}} = 0$ < right hand FBD (CDE) - see figure.

$$(E_x + E_y)3 \text{ m} = -90 \text{ kN}\cdot\text{m} \quad E_x + E_y = \frac{-90 \text{ kN}\cdot\text{m}}{3 \text{ m}} = -30 \text{ kN}$$

$$\text{Solving } \begin{pmatrix} E_x \\ E_y \end{pmatrix} = \begin{pmatrix} -1 & 2 \\ 1 & 1 \end{pmatrix}^{-1} \begin{pmatrix} -35.858 \text{ kN} \\ -30 \text{ kN} \end{pmatrix} = \begin{pmatrix} -8.05 \\ -21.95 \end{pmatrix} \text{ kN}$$



$$E_x = -8.05 \text{ kN}$$

$$E_y = -22 \text{ kN}$$

$$\Sigma F_x = 0 \quad A_x = -E_x + 10 \text{ kN} - 10 \text{ kN}\left(\frac{1}{\sqrt{2}}\right) = 10.98 \text{ kN}$$

$$A_x = 10.98 \text{ kN}$$

$$\Sigma F_y = 0 \quad A_y = -E_y + 10 \text{ kN}\left(\frac{1}{\sqrt{2}}\right) = 29.07 \text{ kN}$$

$$A_y = 29.1 \text{ kN}$$

(b) RIGHT HAND FBD $C_x = -E_x = 8.05 \text{ kN}$ $C_y = -E_y = 22 \text{ kN}$

$$\text{Resultant}_C = \sqrt{C_x^2 + C_y^2} = 23.4 \text{ kN}$$