Answers for Problems 3

3.1

Omitted.

3.2

(a) At $0 \le x \le L$, axial force and torsional moment are zero and bending moment is

$$Q = F, \quad M_x = F(x - L)$$

At $L \le x \le 2L$, axial force, shear force, bending moment and torsional moment are zero.

(b) The bar is rotated because the moments do not equilibrate.

(c) At $0 \le x \le L$, $T_x = -T$. The others are zero.

At $L \le x \le 2L$, every force and moment are zero.

(d) Shear force and bending moment are zero. $P_x = -P$. $T_x = -T$.

3.3

(a) $P = F/\sqrt{2}$, $Q = -F/\sqrt{2}$, $M = F(L - x)/\sqrt{2}$, $T = 0$

(b) $P = 0$, $Q = F$, $M = F(L - x)$, $T = FD/2$

3.4

(1) Normal force: $P = -F$, shear force : $Q = 0$

(2) Normal force: $P = -F$, shear force: $Q = 0$, bending moment: $M = -FD/4$

3.5

(1) Normal force: $P = -\sqrt{3}F/2$, shear force: $Q_y = 0$, $Q_z = -F/2$

(2) Bending moment: $M_y = 3FD/2$, $M_z = -\sqrt{3}FD/8$, torsional moment: $T = -FD/8$

3.6

(1) Normal force: $P = F$, shear force: $Q = 0$, bending moment: $M = 0$, torsional moment: $T = 0$

(2) Normal force: $P = F/2$, shear force: $Q = -\sqrt{3}F/2$, bending moment: $M = 3\sqrt{3}FL/2$, torsional moment: $T = 0$

3.7

(1) Normal force: $P = -F_1$, shear force: $Q = 0$, bending moment: $M = 2F_1L$, torsional moment: $T = 0$

(2) Normal force: $P = 0$, shear force: $Q = -F_2$, bending moment: $M = 3F_2L$, torsional moment: $T = 2F_2L$

3.8

(1) Normal force: $P = F\sin 30° = \frac{\sqrt{3}}{2}F$, shear force: $Q = -F\sin 30° = -\frac{1}{2}F$, bending moment:

$$M = -F\cos 30°\frac{D}{2} + F\sin 30°L = -\frac{\sqrt{3}}{2}F\frac{D}{2} + \frac{1}{2}FL = \frac{F}{4}\left(2L - \sqrt{3}D\right)$$

(2) Normal force: $P = 0$, shear force: $Q = 0$, bending moment: $M = 0$

3.9

(1) $P_0 = 0, \quad Q_1 = F, \quad Q_2 = 0$

(2) $M_1 = -Fa, \quad M_2 = 0, \quad T_0 = Fc$

3.10

(1) $P = \frac{F}{2}, \quad Q = \frac{\sqrt{3}F}{2}, \quad M = \frac{F}{4}\left\{2\sqrt{3}(b+c) - D\right\}, \quad T = 0$

(2) $P = 0, \quad Q = -\sqrt{3}F, \quad M = \frac{\sqrt{3}F}{2}(2b+c), \quad T = 0$