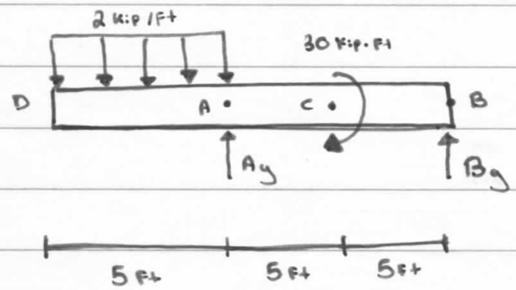
EXAMPLE 6.11

Draw the shear and moment diagrams for the beam

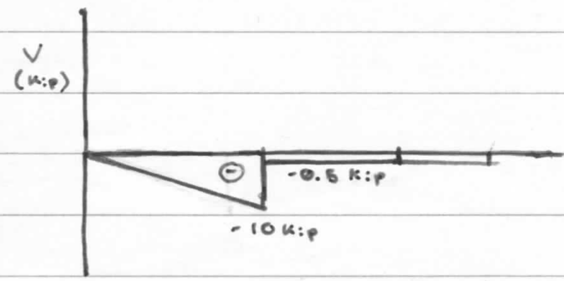


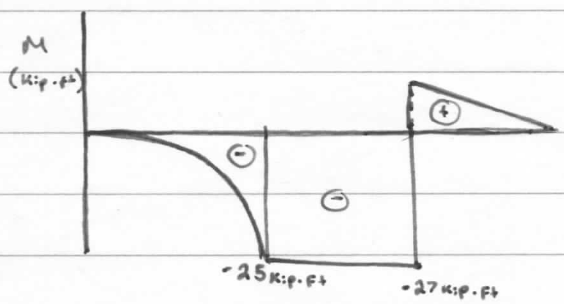
$\circlearrowleft + \Sigma M_B = (-30 \text{ kip}\cdot\text{ft}) + A_y(10) - (2)(5)(10.5)$

$A_y = 9.5$ kip

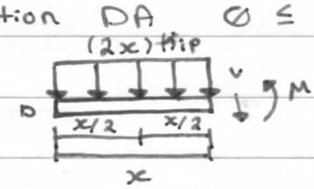
$\uparrow \Sigma F_y = 0 \Rightarrow -10 + 9.5 + B_y$

$B_y = 0.5$ kip





Section DA $\quad 0 \le x\ 5$



$+\uparrow \Sigma F_y = 0 \Rightarrow -(2)(x) - V$

$V = -2x \rightarrow 0 \ ; \ x = 0$

$\quad \rightarrow -10 \text{ kip} \ ; \ x = 5$

$+\circlearrowleft \Sigma M_o = 0 \Rightarrow (2)(x)(x/2) + M$

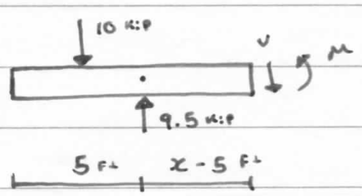
$M = -x^2 \rightarrow 0 \ ; \ x = 0$

$\quad \rightarrow -25 \text{ kip} \ ; \ x = 5$

$\quad \rightarrow -4 \text{ kip} \ ; \ x = 2$

use 3 points (second order)

Section AC $\quad 5 \le x < 10$



$+\uparrow V = -10 + 9.5 - V$

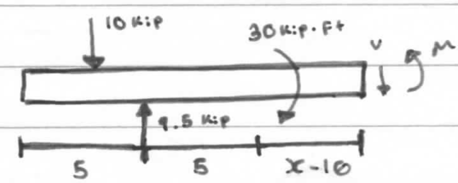
$V = -0.5$

$+\circlearrowleft M = -(9.5)(x-5) + (10)(x-2.5) + M = 0$

$M = -0.5x - 22.5 \rightarrow -25 \text{ kip}\cdot\text{ft} \ ; \ x = 5$

$\quad \rightarrow -27.5 \text{ kip}\cdot\text{ft} \ ; \ x = 10$

Section CB $\quad 10 \le x < 15$



$+\uparrow \Sigma F_y = 0 \Rightarrow -10 + 9.5 - V$

$V = -0.5$

$+\circlearrowleft \Sigma M = 0 \Rightarrow M - 30 - 9.5(x-5) + 10(x-2.5)$

$M = -0.5x + 7.5 \rightarrow 2.5 \ ; \ x = 10$

$\quad \rightarrow 0 \ ; \ x = 15$

EXAMPLE 6-13

SOLUTION Z-AXIS:

a) $I_z = \frac{bh^3}{12} \Rightarrow \frac{b_o h_o^3}{12} - \frac{b_i h_i^3}{12}$

$\Rightarrow \frac{(6)(6.5)^3}{12} - \frac{(5.75)(6)^3}{12}$

$I_z = 137.3125 - 103.5$

$I_z = 33.8 \text{ in}^4$

$(24 \text{ ksi}) = \frac{M(3.25 \text{ in})}{(33.8 \text{ in}^4)}$

$M = 249.6 \text{ kip·in}$

$\sigma_{allow} = 24 \text{ ksi}$

$\sigma_z = \frac{My}{I}, \quad \sigma_y = \frac{Mz}{I}$

b) $I_y = \frac{hb^3}{12} \Rightarrow \frac{h_o b_o^3}{12} - \frac{h_i b_i^3}{12}$

$\Rightarrow \frac{(6.5)(6)^3}{12} - \frac{(6)(5.75)^3}{12}$

$I_y = 117 - 95.0547$

$I_y = 21.9 \text{ in}^4$

$(24 \text{ ksi}) = \frac{M(3 \text{ in})}{(21.9 \text{ in}^4)}$

$M = 175.2 \text{ kip·in}$

EXAMPLE 6-12

$\sigma = \frac{My}{I_z}$

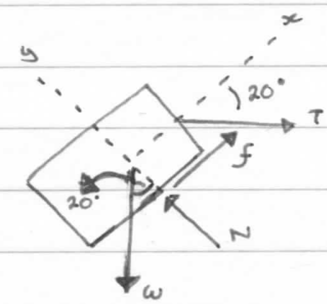
$\bar{y} = \frac{(5 \cdot 1 \cdot 0.5) + (1 \cdot 3 \cdot 0.5) + (1 \cdot 8 \cdot 0.5)}{(5 \cdot 1) + (8 \cdot 1) + (3 \cdot 1)}$

$\bar{y} = 4.438 \text{ in}$

$I_z = (1/12)(5)(1)^3 + (\ldots$

$I_z = 200.27 \text{ in}^4$

[Should be $72.063 \cdot 10^3$ lb·ft
$I = 9.008 \text{ in}^4$
by parallel axis theorem.]



$$\Sigma F_x = 0$$

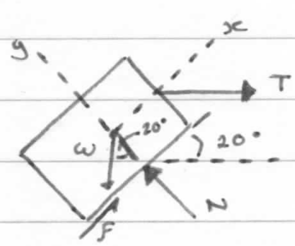
$$f + T(\cos 20°) - w(\sin 20°) = 0$$

$$f = -T(\cos 20°) + w(\sin 20°)$$

$$= -400(\cos 20°) + 800(\sin 20°)$$

$$f \Rightarrow 102.3\,N$$

b)



$$\Sigma F_y = N - T(\sin 20°) - w(\cos 20°) = 0$$

$$N = T(\sin 20°) + 800(\cos 20°)$$

NOTE:

N is max when T is max and the crate is at the verge of sliding.

$$\Sigma F_x = -f_{max} + T(\cos 20°) - w(\sin 20°) = 0$$

$$f_{max} = T(\cos 20°) - 800(\sin 20°)$$

$$\ldots (0.4)(T\sin 20° + 800\cos 20°)$$

$$\Rightarrow T\cos 20° - 800\sin 20°$$

$$T(\cos 20 - 0.4\sin 20)$$

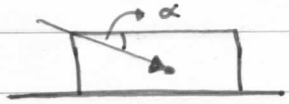
$$= 0.4 \cdot 800(\cos 20°) + 800(\sin 20°)$$

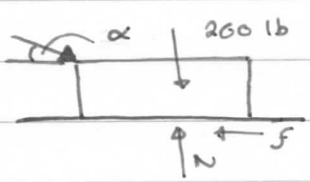
$$T = 714.3\,N$$

Q4 A man pushes a 200-lb box of food across the floor. The coefficient of kinetic friction is $\mu_k = 0.15$.

a) if he exerts the force F at $\alpha = 25°$ what is the magnitude of the force he must exert to slide the box across the floor.

b) if he bend his knees and exert the force at an angle $\alpha = 10°$, what is the magnitude of the force he must exert.





a) $\alpha = 25°$; $F = 35.6\,lb$

b) $\alpha = 10°$; $F = 31.3\,lb$

$$\Sigma F_x = F\cos\alpha - f = 0$$

$$\Sigma F_y = N - 200\,lb - F\sin\alpha = 0$$

Dec 1/16

Chapter 7 - Transverse Shear

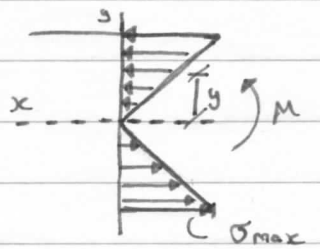
$M \sim \sigma$

$V \sim \tau$

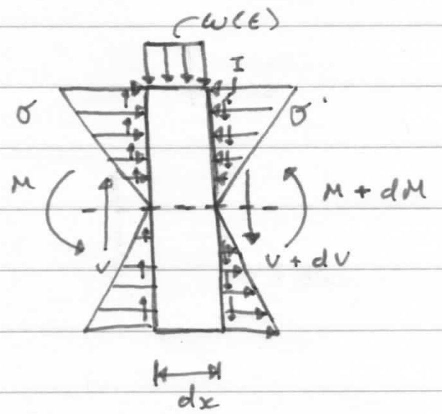
Flange members

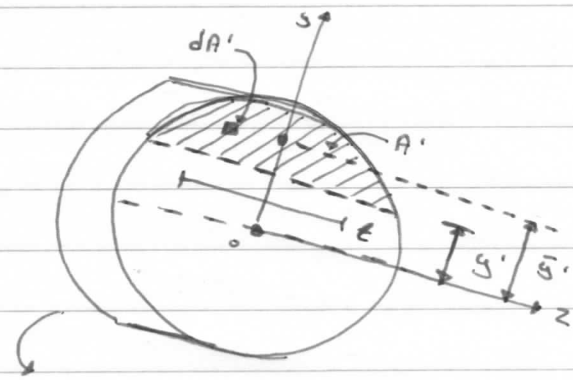
()

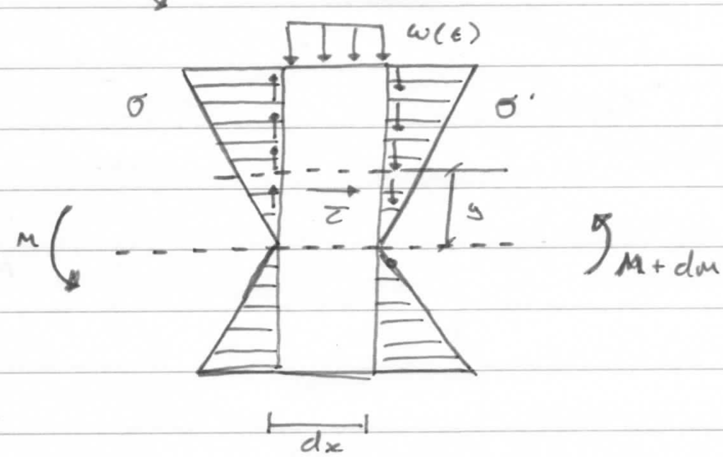
$\tau \sim$ deformation



$$\left(\sigma = -\frac{My}{I} \right)$$





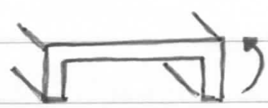


t = width of the member's cross-section.

A' = area of the sectioned part.

I = moment of inertia about the neutral axis

y' = location for t calculation w/ respect to neutral axis

 } → considered Friday

$\overset{+}{\leftarrow} \sum F_x = 0$

$+\int \sigma' dA' - \int \sigma \, dA' - \tau(t\,dx) = 0$

$$-\int \frac{(M+dM)\cdot y'}{I}\,dA - \int \frac{-M\cdot y}{I}\,dA' - \tau(t)\,dx = 0$$

$$-\int \frac{My'}{I}\,dA' - \int \frac{(dM)\,y'}{I}\,dA' + \int \frac{My'}{I}\,dA' - \tau t\,dx = 0$$

$$-\frac{dM}{I}\int y'\,dA' = \tau t\,dx$$

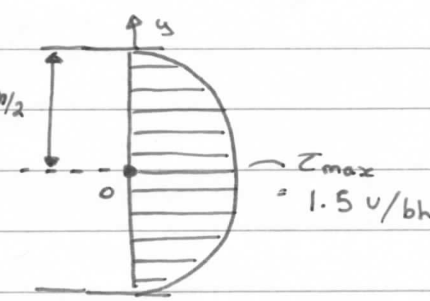
$$\tau = -\frac{dM}{dx}\,\frac{1}{It}\int y'\,dA' = \frac{V}{It}\int y'\,dA'$$

$$\int y'\,dA' = \bar{y}' \times A'$$

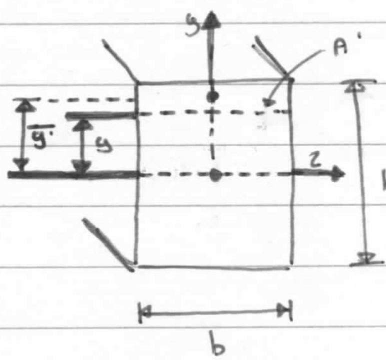
where $\bar{y}'$ = distance from the centroid of the upper area (A') to the neutral axis.

$$\tau = \frac{V\cdot \underbrace{\bar{y}'\cdot A}_{Q}}{I\cdot t} \Rightarrow \tau = \frac{V\cdot Q}{I\cdot t}$$

$$Q = \bar{y}'\cdot A'$$



EXAMPLE 7-1 (IN TEXTBOOK 7.21)



SOLUTION:

$$\tau = \frac{VQ}{It}$$

$I = \frac{1}{12}bh^3$

$t = b$

$Q = \bar{y}'A'$

$A = \left[\left(\frac{1}{2}\right)h - y\right]\cdot b$

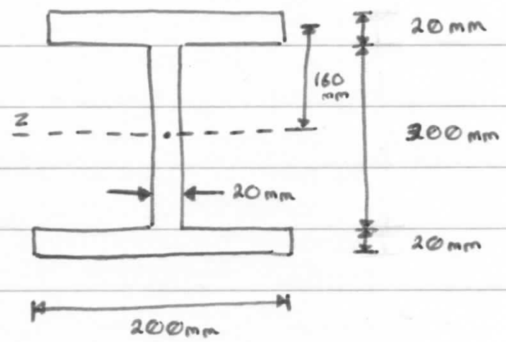
$$\bar{y}' = y + \frac{h/2 - y}{2} = \frac{h}{4} + \frac{y}{2}$$

$$\tau = \frac{V\left(h/4 + y/2\right)\left(h/2 - y\right)\cdot b}{(1/12)\,bh^3\cdot b}$$

$$\tau = \frac{6V}{bh^3}\left(\frac{h^2}{4} - y^2\right) = \begin{cases} 0 ; & y = h/2 \\ 1.5\,V/bh ; & y = 0 \\ 0 ; & y = -h/2 \end{cases}$$

EXAMPLE (7-2)

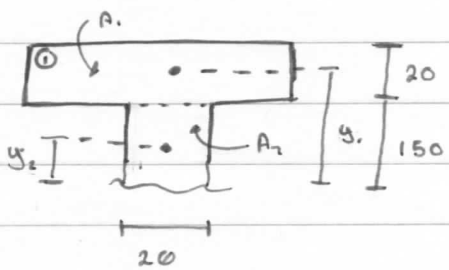
SOLUTION



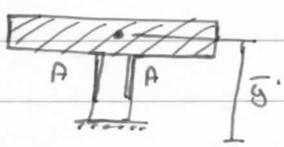
$$t = 0.02\,m$$

$$I = 2\left[(1/12)(0.2)(0.02)^3 + (0.16)^2(0.2)(0.02)\right] + \tfrac{1}{12}(0.02)(0.3)^3$$

$$I = 0.250 \times 10^{-3}\,m^4$$



$$Q = Q_1 + Q_2$$
$$= A_1\bar{y}_1 + A_2\bar{y}_2$$
$$= (0.2 \cdot 0.02)\cdot 0.16 \;\cdots$$
$$\cdots + (0.15 \cdot 0.02)\cdot(0.15/2)$$
$$= 0.64 \times 10^{-3}\,m^3$$



$$\tau_{max} = \frac{(20 \cdot 10^3\,N)(0.64 \times 10^{-3}\,m^3)}{(0.250 \cdot 10^{-3})(0.02)}$$
$$= 2.56 \cdot 10^6\ pa$$

$$\tau_A^L = \frac{VQ}{It} = 0.02$$

$$\tau_A^U = \frac{VQ}{It} = 0.02$$