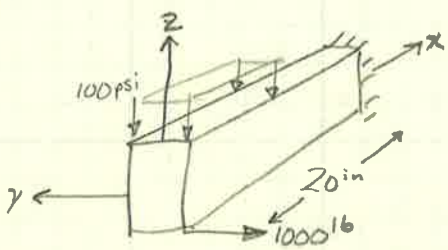
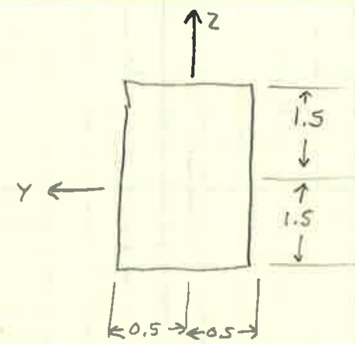
4.3





$I_{yy} = \frac{1}{12}(1)(3)^3 = 2.25 \text{ in}^4$

$I_{zz} = \frac{1}{12}3(1)^3 = 0.25 \text{ in}^4$

a)

$$P_x = \cancel{P_x(0)}^{0} - \int \cancel{p_x(x)}^{0} dx = 0$$

$$V_y(x) = \cancel{V_y(0)}^{1000} - \int \cancel{p_y(x)}^{0} dy = 1000^{lb}$$

be careful of the coordinate system!!

$$V_z(x) = \cancel{V_z(0)}^{0} - \int p_z(x)\,dx$$

$$p_z = -100^{lb/in} \quad 0 < x < +10$$

$$= 100x \quad 0 < x < 10 \quad [lb]$$

$$= 1000 \quad 10 < x < 20$$

$$M_x(x) = \cancel{M_x(0)}^{1500} - \int \cancel{m_x(x)}^{0} dx = 1500^{lb\,in}$$

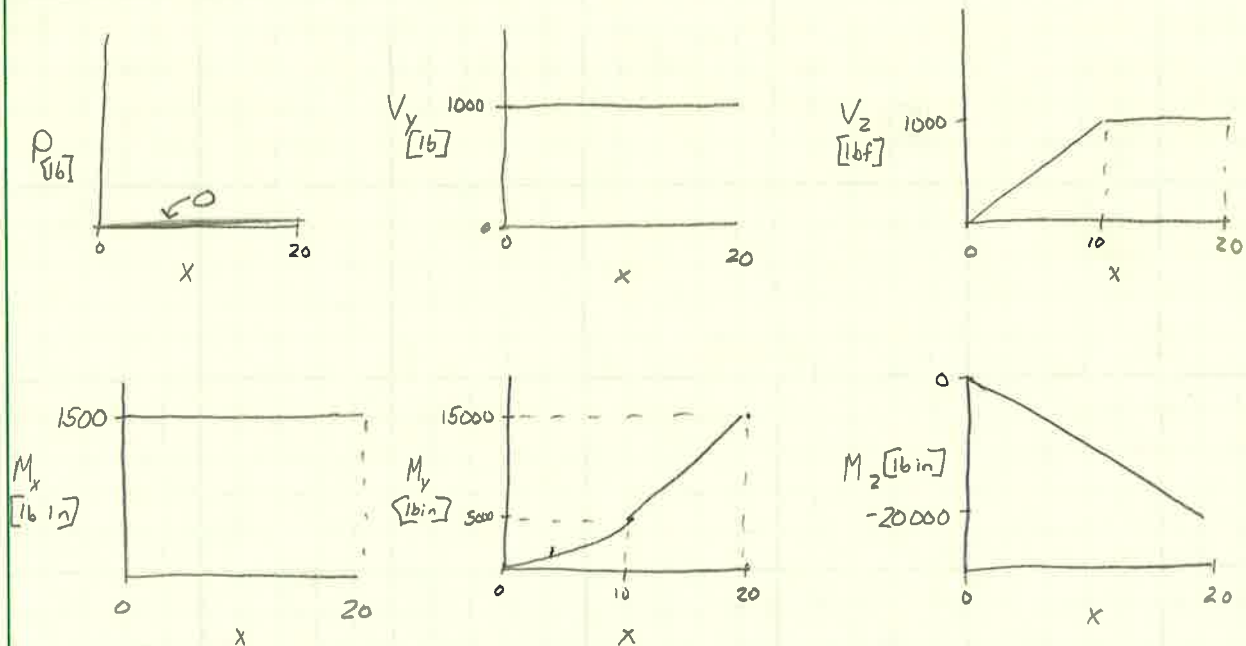
$$M_y(x) = \cancel{M_y(0)}^{0} - \int (\cancel{m_y(x)}^{0} - V_z(x))\,dx$$

$$= \frac{100}{2}x^2 \; [lb\,in] \quad 0 < x < 10$$

$$= -\frac{100}{2}(10)^2 + 1000x \; [lb\,in] = -5000 + 1000x \quad 10 < x < 20$$

$$M_z(x) = \cancel{M_z(x)}^{0} - \int \left(\cancel{m_z(x)}^{0} + V_y(x) \right) dx$$

$$= -1000x \text{ [lbin]} \qquad 0 < x < 20$$



b)

The change in temperature will not affect σ_{xx}.

$$\sigma_{xx} = \cancel{\frac{P}{A}}^{0} - \frac{M_z}{I_{zz}} y + \frac{M_y}{I_{yy}} z$$

for $0 < x < 10$

$$\sigma_{xx} = -\frac{(-1000x)y}{0.25 \text{ in}^4} + \frac{(50x^2)z}{2.25 \text{ in}^4} = \boxed{4000xy + 22.2x^2 z = \sigma_{xx} \text{ [psi]} \quad 0 < x < 10}$$

$10 < x < 20$

$$\sigma_{xx} = -\frac{(-1000x)y}{0.25} + \frac{(-5000 + 1000x)z}{2.25}$$

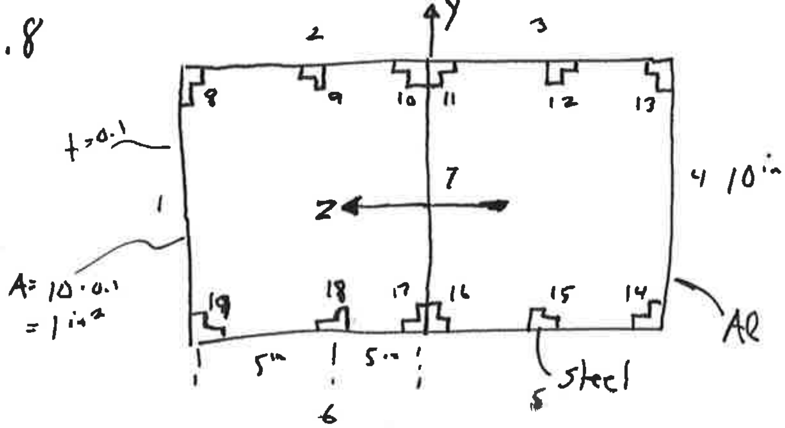
$$\boxed{\sigma_{xx} = 4000xy - 2222z + 444.4xz \quad 10 < x < 20}$$

c) $\sigma_{xx_{max}}$ would be expected to occur at $x, y, z = \begin{Bmatrix} 20 & 0.5 & 1.5 \\ 20 & -0.5 & -1.5 \end{Bmatrix}$

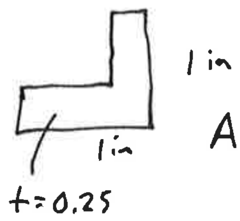
$$\sigma_{xx_{max}} = (4000)(20)(0.5) - 2222(1.5) + 444.4(20)(1.5)$$

$$\boxed{\sigma_{xx_{max}} = 50^{ksi}}$$

4.8



Determine the modulus weighted properties



$A = (2 - 0.25)(0.25)$

$= 0.4375 \text{ in}^2$

$E_{Al} = 10 \times 10^6 \text{ psi} = E_1$

$E_{steel} = 30 \times 10^6 \text{ psi}$

$$A^* = \sum \frac{E_i}{E_1} \int_A dA \qquad \bar{y}^* = \frac{1}{A^*} \sum_i \frac{E_i}{E_1} \bar{y}_i A_i \qquad \bar{z}^* = \frac{1}{A^*} \sum_i \frac{E_i}{E_1} \bar{z}_i A_i$$

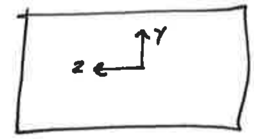
	part	E_i/E	A_i	$\bar{y}_i$	$\bar{z}_i$	$\frac{E_i}{E} A_i$	$\frac{E_i}{E_1} \bar{y} A_i$	$\frac{E_i}{E_1} \bar{z}_i A_i$
	1	1	1.0	0	10	1		
	2	1		5	5	1	(+)	
	3	1		5	-5	1		
#7	4	1		0	-10	1		Σ0
	5	1		-5	-5	1	(−)	
	6	1		-5	5	1		
	7	1	1.0	0	0	1		
	8	3	0.4375	≈ 5	10	1.31		
	9	3		5	5			
	10	3		5	0			
	11	3		5	0		+	
	12	3		5	-5			
#12	13	3		5	-10			Σ0
	14	3		-5	-10			
	15	3		-5	-5		−	
	16	3		-5	0			
	17	3		-5	0			
	18	3	0.4375	-5	5			
	19	3	0.4375	-5	10	1.31		
						22.75	0	0

$$\boxed{A^* = 22.75 \text{ in}^2}$$

Compute I_{yy}^* and I_{zz}^*

$$I_{yy}^* = \sum \frac{E_i}{E_1}\left(I_{y_0y_0} + \bar{z}_i^2 A_i\right) - \left(\bar{z}^*\right)^2 A^*$$

($I_{y_0y_0}$ ≈ 0 in some cases compared to $z^2 A$; $\bar{z}^* = 0$)



part	A	E_i/E_1	$\bar{z}_i$	$I_{y_0y_0}$	$I_{z_0z_0}$	$\bar{z}_i^2 A_i$	$\frac{E_i}{E_1}(\bar{z}_i^2 A + I_{y_0y_0})$	$\bar{y}_i$	$\bar{y}_i^2 A_i$	$\frac{E_i}{E}(\bar{y}_i^2 A + I_{z_0z_0})$
1	1	1	10	8.333	0			0		
2	1	1	5	≈0	8.333			5		
3	1	1	-5	0	8.333	Σ=300	300+25	5	Σ=100	133
4	1	1	-10	8.333				0		
5	1	1	-5	0	8.333			-5		
6	1	1	5	0	8.333			-5		
7	1	1	0	8.333				0		
8	0.4375	3	10					5		
9		3	5					5		
10		3	0					5		
11		3	0					5		
12		3	-5	≈0	≈0	Σ=218.75	656.25	5		
13		3	-10					5		
14		3	-10					-5		
15		3	-5					-5	Σ=131	393
16		3	0					-5		
17		3	0					-5		
18		3	5					-5		
19	0.4375	3	10					-5		

~~[illegible]~~
981.25 in⁴

526 in⁴

$I_{yy}^* = 981 \text{ in}^4$ $I_{zz}^* = 526 \text{ in}^4$

Exam #2 23rd March 2018 Friday

(week after spring break)

Will cover material upto ~~[illegible]~~ 4.4 and notes