CE 110 Sample Final Exam

Name: ________________________

Section: 1A, 1B, 1C, 1D or Springfield

Select the best (closest) answer.

	a	b	c	d	e	value
1.	O	O	O	O	O	3
2.	O	O	O	O	O	3
3.	O	O	O	O	O	3
4.	O	O	O	O	O	3
5.	O	O	O	O	O	3
6.	O	O	O	O	O	3
7.	O	O	O	O	O	4
8.	O	O	O	O	O	3
9.	O	O	O	O	O	3
10.	O	O	O	O	O	3
11.	O	O	O	O	O	3
12.	O	O	O	O	O	3
13.	O	O	O	O	O	3
14.	O	O	O	O	O	3
15.	O	O	O	O	O	3
16.	O	O	O	O	O	3

	a	b	c	d	e	value
17.	O	O	O	O	O	3
18.	O	O	O	O	O	3
19.	O	O	O	O	O	3
20.	O	O	O	O	O	3
21.	O	O	O	O	O	3
22.	O	O	O	O	O	3
23.	O	O	O	O	O	3
24.	O	O	O	O	O	3
25.	O	O	O	O	O	3
26.	O	O	O	O	O	3
27.	O	O	O	O	O	3
28.	O	O	O	O	O	3
29.	O	O	O	O	O	3
30.	O	O	O	O	O	3
31.	O	O	O	O	O	3
32.	O	O	O	O	O	3
33.	O	O	O	O	O	3

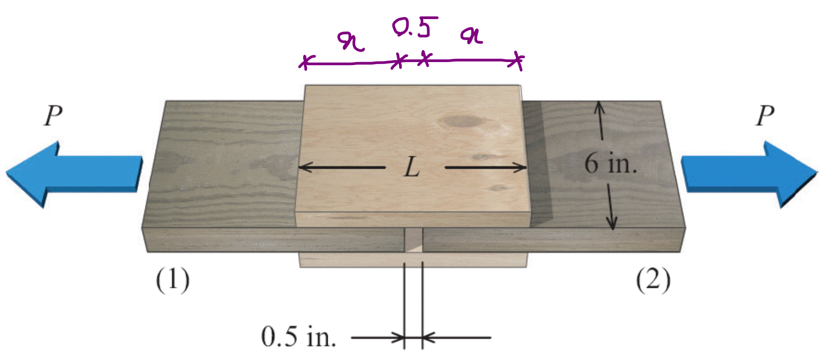
1. A stainless steel tube with an outside diameter of 70 mm and a wall thickness of 5 mm is used as a compression member. If the axial stress in the member must be limited to 340 MPa, determine the maximum load *P* that the member can support.

a. 398 kN
b. 170 kN
c. 268 kN
d. 448 kN
e. 347 kN

$$A = \frac{\pi}{4}(70^2 - 60^2)$$

$$P \leqslant A \times \sigma_{all} = A \times 340 = \boxed{347 \text{ kN}}$$

2. Two 6-in.-wide wooden boards are to be joined by splice plates that will be fully glued on the contact surfaces. The glue to be used can safely provide a shear strength of 120 psi. Determine the smallest allowable length *L* that can be used for the splice plates for an applied load of *P* = 15,000 lb. Note that a gap of 0.5 in. is required between boards (1) and (2).



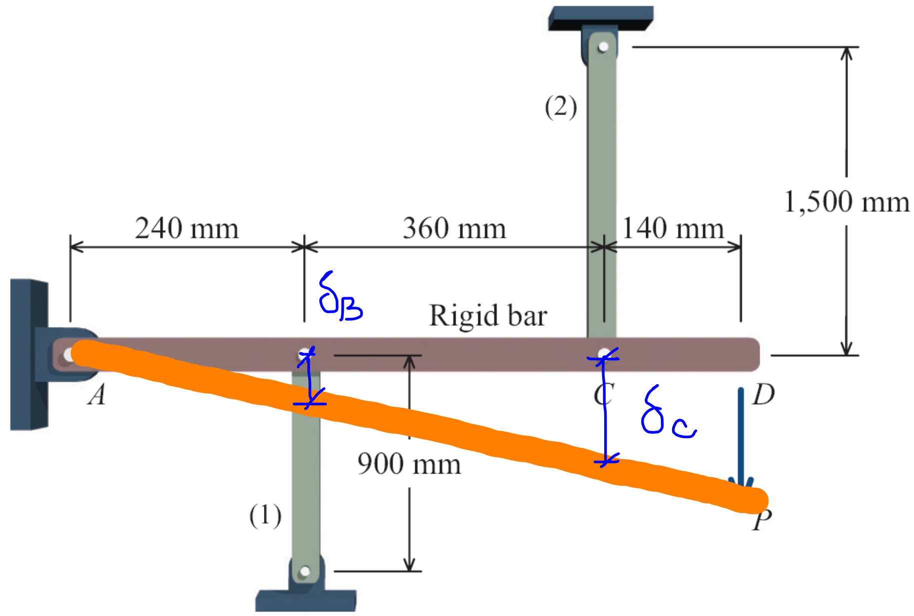
a. 19.7 in.
b. 15.7 in.
c. 24.3 in.
d. 21.3 in.
e. 11.6 in.

$$\tau = \frac{P}{2bx} = \frac{15{,}000 \text{ lb}}{2 \times 6 \times x} \leqslant \sigma_{all} = 120 \text{ mpa}$$

$$x \geqslant \frac{15{,}000}{2 \times 6 \times 120} = 10.41 \text{ in}$$

$$L = 2x + 0.5 = \boxed{21.3 \text{ in}}$$

3. A rigid bar *ABCD* is supported by two bars as shown in the figure. There is no strain in the vertical bars before load *P* is applied. After load *P* is applied, the normal strain in rod (1) is –1,400 μm/m. Determine the normal strain in rod (2).



a. 1650 με
b. 2400 με
c. 2850 με
d. 2100 με
e. 3150 με

$\delta = 1400 \times 10^{-6} \times 900 \text{ mm} = 1.26 \text{ mm}$

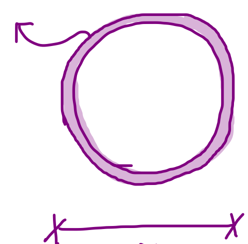
$\delta_2 = \frac{600}{240} \delta_1 = 3.15 \text{ mm}$

$\varepsilon_2 = \frac{\delta_2}{L_2} = \frac{3.15}{1500} = \boxed{2100 \times 10^{-6}}$

4. A large cement kiln has a length of 225 ft and a diameter of 8 ft. Determine the change in diameter of the structural steel [$\alpha = 6.5\times10^{-6}$/°F] shell caused by an increase in temperature of 250°F.

a. 0.195 in.
b. 0.156 in.
c. 0.328 in.
d. 0.273 in.
e. 0.410 in.

$P = \pi d = 25.13 \text{ ft} = 301.6 \text{ in}$



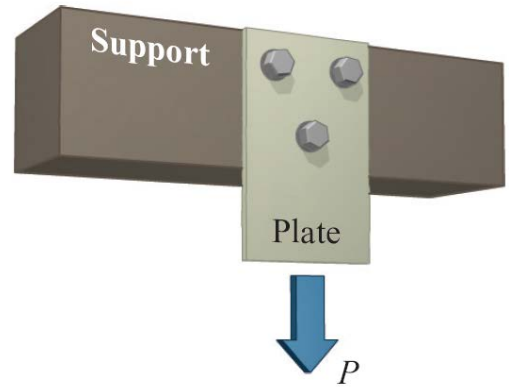
8 ft

$\delta = \alpha \Delta T P = 6.5 \times 10^{-6} \times 250 \times 301.6$

$\delta = 0.49 \text{ in}$

$P' = P + \delta = 302.1 \text{ in} \Rightarrow d' = \frac{P'}{\pi} = 96.15 \qquad d - d' = 96.15 - 96 = \boxed{0.159}$

5. A steel plate is to be attached to a support with three bolts. The cross-sectional area of the plate is 800 mm^2 and the yield strength of the steel is 250 MPa. The ultimate shear strength of the bolts is 475 MPa. A factor of safety of 1.67 with respect to yield is required for the plate. A factor of safety of 4.0 with respect to the ultimate shear strength is required for the bolts. Determine the minimum bolt diameter required to develop the full strength of the plate. Note: consider only the gross cross-sectional area of the plate – not the net area.



a. 25.9 mm
b. 20.7 mm
c. 19.0 mm
d. 24.5 mm
e. 17.2 mm

Maximum Force in plates

$$P = A \times \frac{\sigma_y}{SF} = 800 \times \frac{250}{1.67} = 119,800 \text{ N}$$

shear stress in bolts

$$\tau = \frac{P}{3A_b} \leq \frac{\sigma_{y,bolt}}{SF_{bolt}} \Rightarrow \frac{119,800 \text{ N}}{3 \times A_b} \leq \frac{475 \text{ MPa}}{4}$$

$$A_b \geq 336.2 \text{ mm}^2 \Rightarrow d \geq \sqrt{\frac{4 \times 336.2}{\pi}} = \boxed{20.7 \text{ mm}}$$

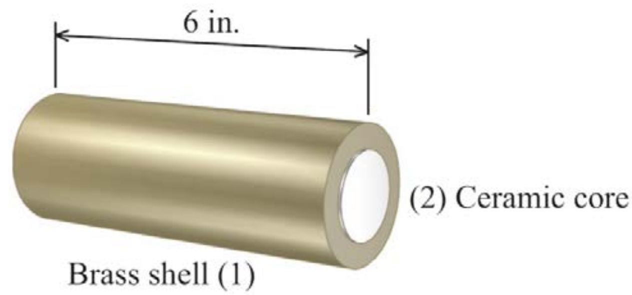
6. A steel [E = 200 GPa] rod with a circular cross section is 10-m long. Determine the minimum diameter D required if the rod must transmit a tensile force of 30 kN without stretching more than 5 mm.

a. 12.0 mm
b. 18.0 mm
c. 19.5 mm
d. 21.9 mm
e. 16.9 mm

$$\delta = \frac{PL}{EA} \leq 5 \text{ mm} \Rightarrow A \geq \frac{30 \times 10^3 \text{ N} \times 10,000 \text{ mm}}{200 \times 10^3 \text{ MPa} \times 5 \text{ mm}} = 300 \text{ mm}^2$$

$$d \geq \sqrt{\frac{4A}{\pi}} = \boxed{19.5 \text{ mm}}$$

7. The assembly shown consists of a brass shell (1) fully bonded to a ceramic core (2). The brass shell [E = 15,000 ksi, $\alpha = 9.8\times10^{-6}$/°F] has an outside diameter of 2.00 in. and an inside diameter of 1.25 in. The ceramic core [E = 42,000 ksi, $\alpha = 1.7\times10^{-6}$/°F] has a diameter of 1.25 in. At a temperature of 60°F, the assembly is unstressed. Determine the largest temperature increase that is acceptable for the assembly if the normal stress in the longitudinal direction of the brass shell must not exceed 29 ksi.



a. 244 °F
b. 320 °F
c. 410 °F
d. 372 °F
e. 282 °F

$$A_1 = \frac{\pi}{4}\left[2^2 - 1.25^2\right] = 1.914$$

$$A_2 = \frac{\pi}{4} \times 1.25^2 = 1.227$$

$$F = A_1 \sigma_1 = 1.914 \times 29 = 55.5 \text{ ksi}$$

$$\delta_{1F} + \delta_{1T} = \delta_{2F} + \delta_{2T}$$

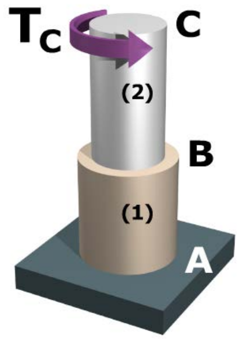
$$\frac{FL}{E_1 A_1} + \alpha_1 \Delta T L = \frac{-FL}{E_2 A_2} + \alpha_2 \Delta T L$$

$$\Delta T = \left(\frac{F}{E_2 A_2} + \frac{F}{E_1 A_1}\right) / (\alpha_1 - \alpha_2)$$

$$\Delta T = \left(\frac{55.5}{42{,}000 \times 1.227} + \frac{55.5}{15{,}000 \times 1.914}\right) / (9.8 - 1.7) \times 10^{-6}$$

$$\boxed{\Delta T = 371.6 \ °F}$$

8. A compound shaft consists of brass segment (1) and aluminum segment (2). Segment (1) is a solid brass shaft with an outside diameter of 0.875 in. and an allowable shear stress of 6,000 psi. Segment (2) is a solid aluminum shaft with an outside diameter of 0.65 in. and an allowable shear stress of 9,000 psi. Determine the magnitude of the largest torque T_C that may be applied at C.



a. 381.7 lb-in.
b. 555.6 lb-in.
c. 485.3 lb-in.
d. 606.1 lb-in.
e. 431.4 lb-in.

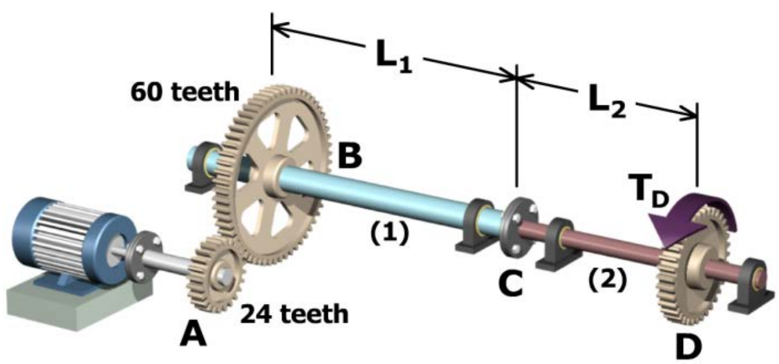
$$\tau = \frac{Tr}{J} \leq \tau_{all}$$

(1) $\rightarrow \dfrac{T \times 0.875/2}{\pi \times 0.875^4/32} \leq 6000 \text{ psi}$

$T = 789 \text{ lb\_in}$

(2) $\rightarrow \dfrac{T \times 0.65/2}{\pi \times 0.65^4/32} \leq 9{,}000 \text{ psi} \Rightarrow \boxed{T = 485 \text{ lb\_in}}$

9. A motor supplies 14 kW at 600 rpm to gear A of the drive system shown. Shaft (1) is a solid 50-mm-diameter aluminum [G = 28 GPa] shaft with a length of L_1 = 600 mm. Shaft (2) is a solid 40-mm-diameter steel [G = 80 GPa] shaft with a length of L_2 = 400 mm. Shafts (1) and (2) are connected at flange C, and the bearings shown permit free rotation of the shaft. Determine the rotation angle of gear D with respect to gear B.



a. 0.0748 rad
b. 0.0305 rad
c. 0.0628 rad
d. 0.0284 rad
e. 0.0523 rad

$$J_1 = \frac{\pi \times 50^4}{32} = 613 \times 10^3 \text{ mm}^4$$

$$J_2 = \frac{\pi \times 40^4}{32} = 251 \times 10^3 \quad ''$$

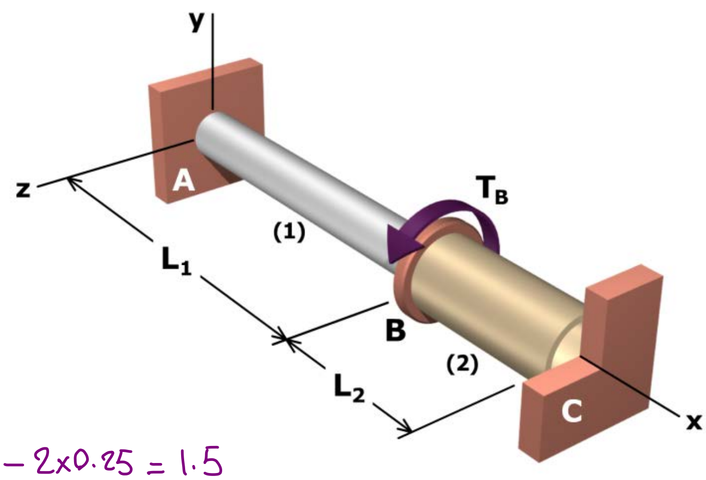
$$T_A = \frac{P}{\omega} = \frac{14{,}000 \text{ watt}}{600 \times \frac{2 \times 3.14}{60}} = 222.8 \text{ N.mm}$$

$$\phi = \frac{TL}{GJ}$$

$$T_B = \frac{60}{24} \times T_A = 557 \text{ N.m}$$

$$\phi = \phi_1 + \phi_2 = \frac{557 \times 10^3 \times 600}{28{,}000 \times 613 \times 10^3} + \frac{557 \times 10^3 \times 400}{80{,}000 \times 251 \times 10^3} = \boxed{0.0305 \text{ rad}}$$

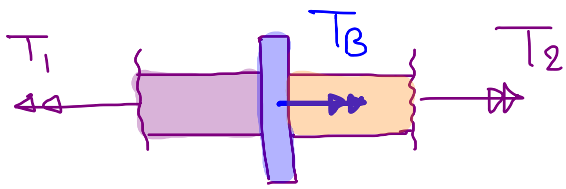
10. The composite shaft shown consists of a stainless steel tube (1) and a brass tube (2) that are connected at flange *B* and securely attached to rigid supports at *A* and *C*. Stainless steel tube (1) has an outside diameter of 2.00 in., a wall thickness of 0.250 in., a length of L_1 = 40 in., and a shear modulus of 12,500 ksi. Brass tube (2) has an outside diameter of 3.500 in., a wall thickness of 0.219 in., a length of L_2 = 20 in., and a shear modulus of 5,600 ksi. If a concentrated torque of T_B = 42 kip-in. is applied to flange *B*, determine the torque magnitude in tube (1).



a. 8.946 kip-in.
b. 6.894 kip-in.
c. 2.855 kip-in.
d. 4.652 kip-in.
e. 1.544 kip-in.

$d_1 = 2 - 2\times0.25 = 1.5$

$d_2 = 3.5 - 2\times0.219 = 3.06$



$$J_1 = \frac{\pi}{32}\left[2^4 - 1.5^4\right] = 1.07 \quad in^4$$

$$J_2 = \frac{\pi}{32}\left[3.5^4 - 3.06^4\right] = 6.12 \quad in^4$$

$$\phi = \frac{TL}{GJ}$$

$$\phi_1 = \phi_2 \implies \frac{T_1 L_1}{G_1 J_1} = \frac{T_2 L_2}{G_2 J_2}$$

$$T_1 = \frac{L_2}{L_1}\frac{G_1}{G_2}\frac{J_1}{J_2}T_2 = \frac{20}{40}\times\frac{12{,}500}{5{,}600}\times\frac{1.07}{6.12}\times T_2 = 0.195\ T_2$$

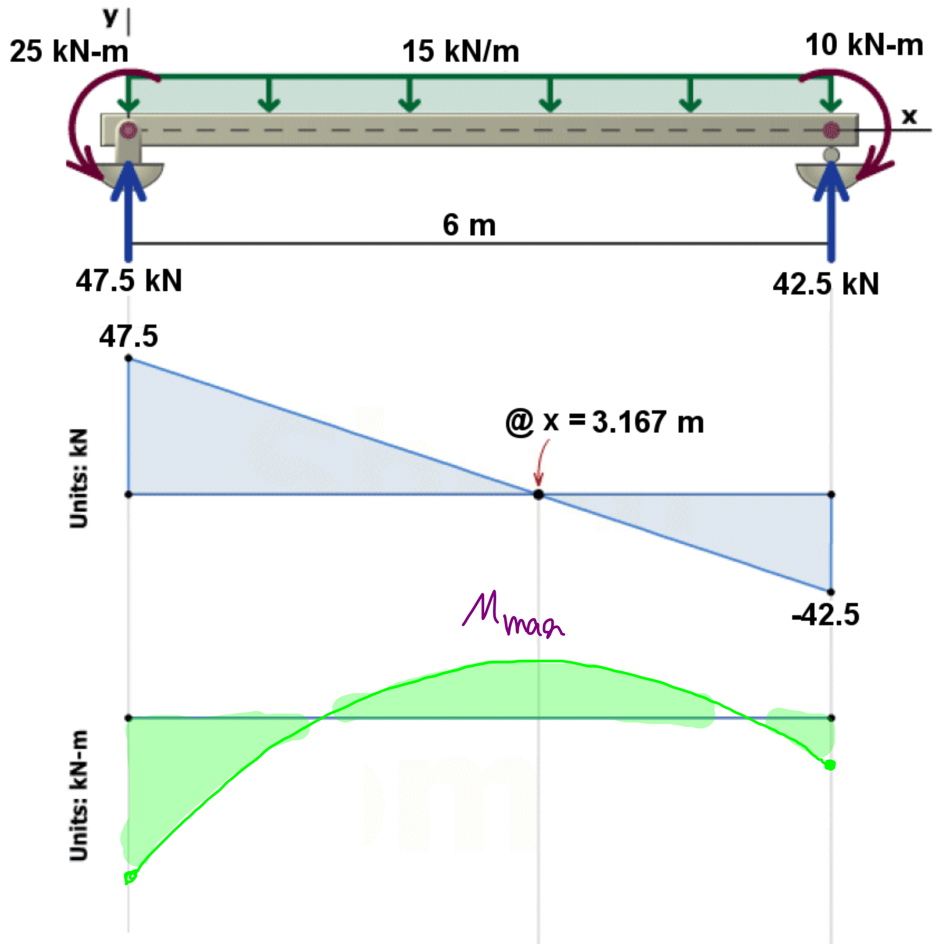
$$T_1 + T_2 = T_B \implies T_2 + 0.195\ T_2 = 42 \quad kips\text{-}in$$

$$T_2 = \frac{42}{1.195} = 35.1 \quad kip\text{-}in$$

$$T_1 = T_B - T_2 = \boxed{6.85 \quad kip\text{-}in}$$

11. Use the graphical method to construct the bending-moment diagram and identify the magnitude of the largest moment (consider both positive and negative). The ground reactions and shear-force diagram are shown.

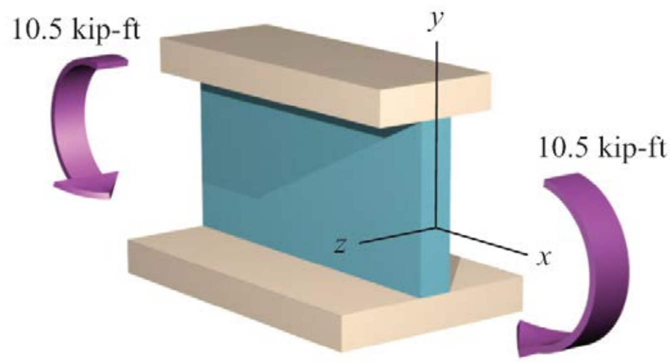
a. 46.8 kN-m
b. 40.5 kN-m
c. 65.6 kN-m
d. 58.7 kN-m
e. 50.2 kN-m



$$M_{max} = -25 + 42.5 \times \frac{3.167}{2}$$

$$= \boxed{50.2}$$

12. For a beam with the cross-section shown, find the magnitude of the bending stress at point *A*. The moment of inertia about the z axis is 862.7 in^4, and the centroid of the section is located 5.167 in from the bottom of the beam.



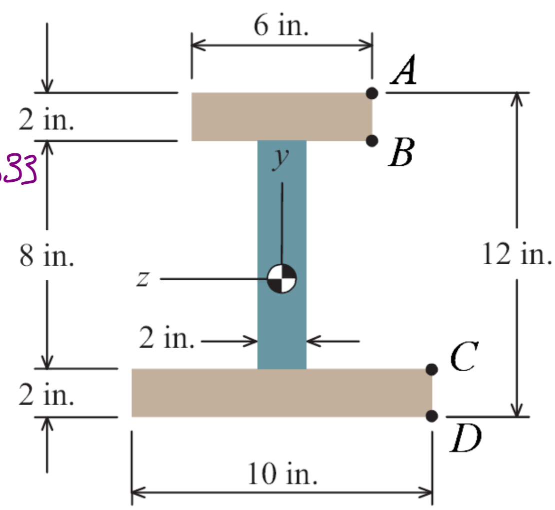
a. 998 psi
b. 706 psi
c. 463 psi
d. 658 psi
e. 755 psi

$$\sigma = \frac{MC}{I} = \frac{10.5 \times 12{,}000 \text{ lb-in} \times 6.833 \text{ in}}{862.7 \text{ in}^4}$$

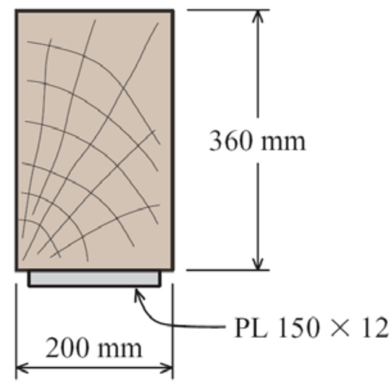
$$\boxed{\sigma = 998 \text{ psi}}$$

6.833

5.167

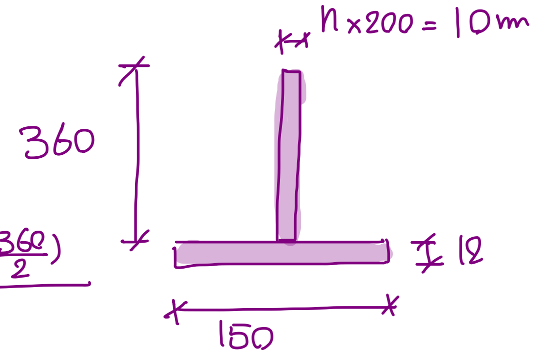


13. A composite beam is constructed of a Southern pine [E = 10 GPa] timber, 200 mm wide by 360 mm deep, that is reinforced on its lower surface by a steel [E = 200 GPa] plate that is 150 mm wide by 12 mm thick. Find the distance to the centroid of the *transformed* section from the bottom of the beam.



a. 130 mm
b. 134 mm
c. 140 mm
d. 145 mm
e. 149 mm

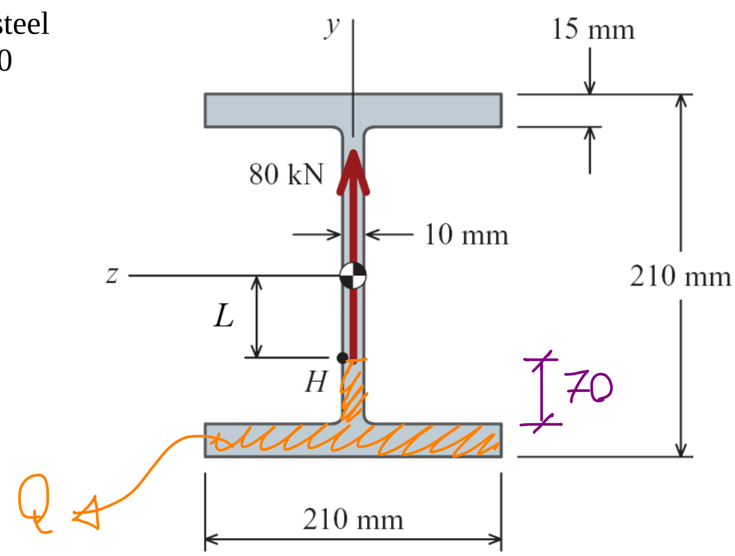
$$n = \frac{10}{200} = 0.05$$



$$\bar{y} = \frac{\sum A_i y_i}{\sum A_i} = \frac{150\times12\times6 + 360\times10\times(12+\frac{360}{2})}{150\times12 + 360\times10}$$

$$\boxed{\bar{y} = 130 \text{ mm}}$$

14. The internal shear force V at a certain section of a steel beam is 80 kN, and the moment of inertia is 64,900,000 mm^4. Determine the horizontal shear stress at point H, which is located L = 20 mm below the centroid.



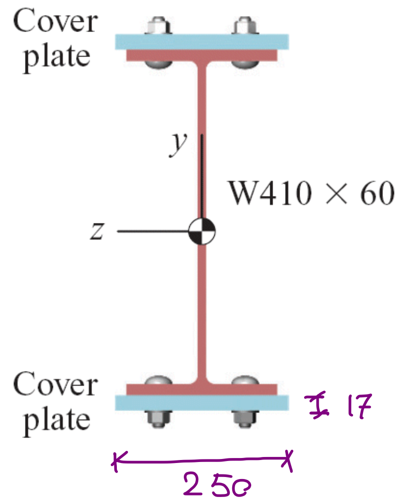
a. 40.6 MPa
b. 42.6 MPa
c. 38.9 MPa
d. 41.9 MPa
e. 43.7 MPa

$$Q = 210\times15\times\left(\frac{210}{2} - \frac{15}{2}\right) + 70\times10\times\left(20 + \frac{70}{2}\right)$$

$$Q = 345,600 \text{ mm}^3$$

$$\tau = \frac{VQ}{It} = \frac{80,000\times345,600}{64.9\times10^6\times10} = \boxed{42.6 \text{ MPa}}$$

15. A W410×60 shape is strengthened by adding two 250-mm wide by 17-mm thick cover plates to its flanges, as shown. Each cover plate is attached to its flange by pairs of 20-mm diameter bolts spaced at intervals of *s* along the beam span. Bending occurs about the z centroidal axis. If one were trying to find the maximum permissible spacing interval *s* for the bolts, what value of *Q* would one use?

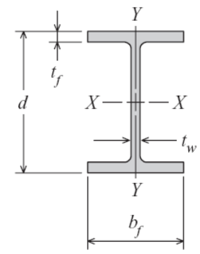


a. 735,000 mm^3
b. 680,900 mm^3
c. 954,000 mm^3
d. 789,400 mm^3
e. 898,900 mm^3

Q should be determined for Cover plate

$$Q = Ad = (17 \times 250) \times (406/2 + 17/2)$$

$$Q = \boxed{898{,}900 \text{ mm}^3}$$

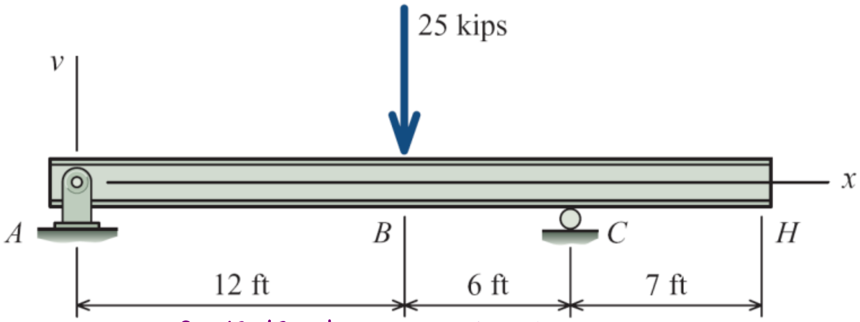


Designation	Area A	Depth d	Web thickness t_w	Flange width b_f	Flange thickness t_f	I_x	S_x	r_x	I_y	S_y	r_y
	mm^2	mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm
W410×85	10800	417	10.9	181	18.2	316	1510	171	17.9	198	40.6
410×75	9480	414	9.65	180	16.0	274	1330	170	15.5	172	40.4
410×60	7610	406	7.75	178	12.8	216	1060	168	12.0	135	39.9
410×46.1	5890	404	6.99	140	11.2	156	773	163	5.16	73.6	29.7

16. For the beam loaded as shown, use the method of superposition to determine the beam deflection at point *H*. Assume that $EI = 1.0 \times 10^7$ kips-in.^{2} is constant.

a. 0.7115 in.
b. 0.9305 in.
c. 0.4032 in.
d. 0.6048 in.
e. 0.3024 in.

$L = 18 \times 12 = 216$ in



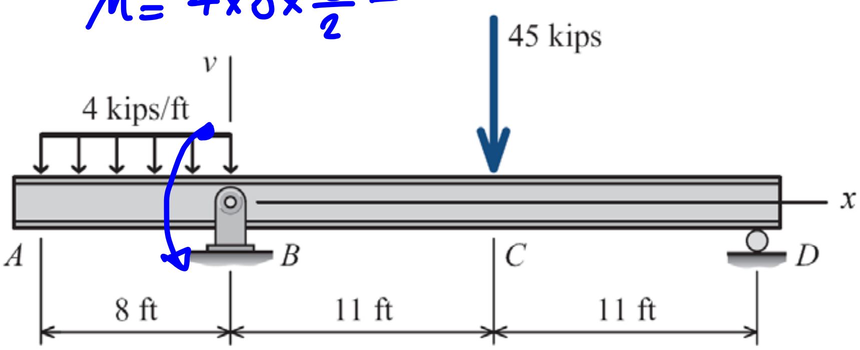
$a = 12 \times 12 = 144$ in $b = 6 \times 12 = 72$ in

$$\theta_C = \frac{Pa(L^2 - a^2)}{6LEI} = \frac{25 \times 144(216^2 - 144^2)}{6 \times 216 \times 1 \times 10^7} = 50 \times 10^{-6} \text{ rad}$$

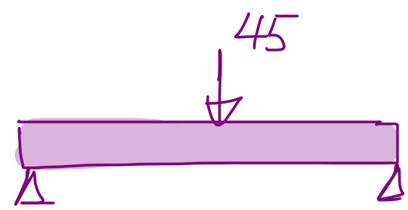
$$\delta_H = (7 \times 12 \text{ in}) \times \theta_C = \boxed{0.6048 \text{ in}}$$

$M = 4 \times 8 \times \frac{8}{2} = 128$

17. For the beam loaded as shown, use the method of superposition to determine the beam deflection at point *C*. Assume that *E* and *I* are constant. $E = 29{,}000$ ksi; $I = 600$ in.^{4}



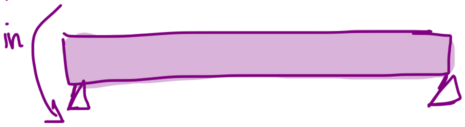
a. -0.7282 in.
b. -0.3734 in.
c. -0.6068 in.
d. -0.9103 in.
e. -0.4551 in.



1

$$\delta_1 = \frac{PL^3}{48EI} = \frac{45 \times (22 \times 12 \text{ in})^3}{48 \times 29{,}000 \times 600} = 0.991 \text{ in}$$

$M = 128$ kips-ft
$= 1536$ kips-in



2

$$\delta_2 = \frac{Mx}{6LEI}(2L^2 - 3Lx + x^2)$$

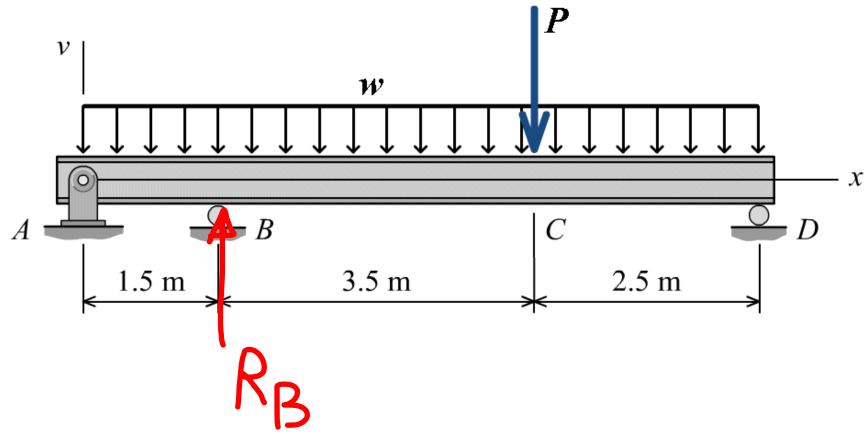
$x = 11 \times 12$ in $\Rightarrow$ $\delta_2 = \frac{1536 \times 132}{6 \times (22 \times 12) \times 29{,}000 \times 600}(2(22 \times 12)^2 - 3 \times 22 \times 12 \times 132 + 132^2)$

$x = 132$ in

$\delta_2 = 0.385$ in

$$\delta = \delta_1 - \delta_2 = \boxed{0.6068 \text{ in}}$$

18. The beam shown consists of a *W* 610×140 structural steel wide flange shape [E = 200 GPa; I = 1,120×10^6 mm^4]. Determine the magnitude of the reaction at *B* if w = 75 kN/m and P = 160 kN.



a. 516.7 kN
b. 584.7 kN
c. 686.6 kN
d. 832.8 kN
e. 799.6 kN

$$\delta_B = \delta_{B1} + \delta_{B2} + \delta_{B3} = 0$$

$$EI = 200\times10^3 \times 1120\times10^6 = 224\times10^{12}\ N.mm^2 = 224{,}000\ kN.m$$

$$\delta_{B1} = \frac{Pbx}{6EI}(L^2 - b^2 - x^2) = \boxed{0.00284\ m}$$

$x = 1.5$ m, $L = 7.5$ m, $b = 2.5$ m, $P = 160$ kN

$$\delta_{B2} = \frac{wx}{24EI}(L^3 - 2Lx^2 + x^3) = \boxed{0.00819\ m}$$

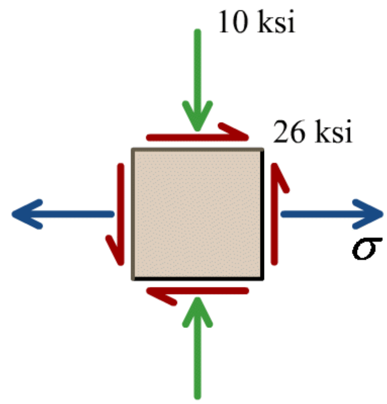
$x = 1.5$ m, $L = 7.5$ m, $W = 75$ kN/m

$$\delta_{B3} = \frac{Pa^2b^2}{3LEI} = \boxed{\frac{P}{62222}}$$

$a = 1.5$ m, $b = 6$ m, $L = 7.5$ m

$$\delta_{B1} + \delta_{B2} - \delta_{B3} = 0 \Rightarrow \boxed{P = 686\ kN}$$

19. Consider a point in a structural member that is subjected to plane stress. Normal and shear stresses acting on horizontal and vertical planes at the point are shown. If σ *(sigma)* = 15 ksi, determine the angle θ_s corresponding to the orientation of the maximum in-plane shear stress.



a. 66.7° or -23.3°
b. 60.7° or -29.3°
c. 77.2° or -12.8°
d. 56.7° or -33.3°
e. 54.0° or -36.0°

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2} = \frac{26}{(15+10)/2}$$

$$\theta_p = 32.2^\circ$$

$$\theta_s = \theta_p \pm 45^\circ = \boxed{77.1^\circ, -12.8^\circ}$$

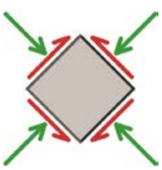
20. Determine the maximum in-plane shear stress and the average normal stress values acting at the point in the previous problem.

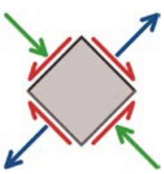
a. $\tau_{\text{in-plane max}}$ = 37.9 ksi; σ_{average} = 17.5 ksi
b. $\tau_{\text{in-plane max}}$ = 28.9 ksi; σ_{average} = 2.50 ksi
c. $\tau_{\text{in-plane max}}$ = 65.4 ksi; σ_{average} = 50.0 ksi
d. $\tau_{\text{in-plane max}}$ = 49.8 ksi; σ_{average} = 32.5 ksi
e. $\tau_{\text{in-plane max}}$ = 84.1 ksi; σ_{average} = 70.0 ksi

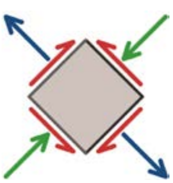
$$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2} = \frac{15-10}{2} = \boxed{2.5 \text{ ksi}}$$

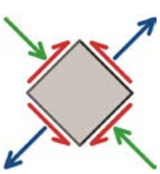
$$\tau_{inplane} = \sqrt{\left(\frac{15+10}{2}\right)^2 + 26^2} = \boxed{28.8 \text{ ksi}}$$

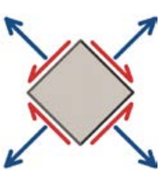
21. Identify the stress-element that best depicts the maximum in-plane shear stress and the average normal stress values found in the previous problem.


a.


b.

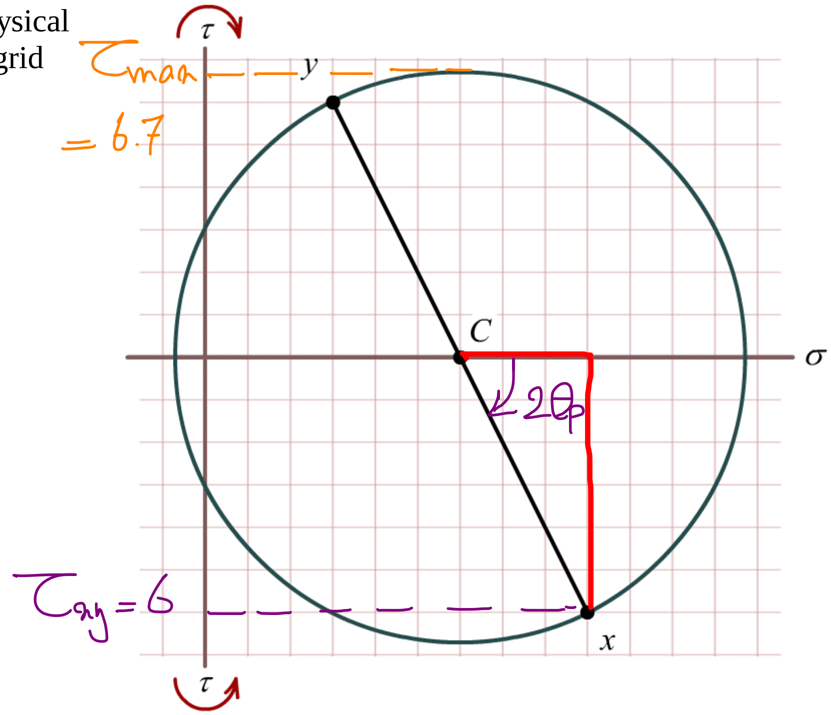

c.


d.


e.

The average normal stress is positive.

A Mohr's circle is shown for a point in a physical object that is subjected to plane stress. If 1 grid square = 1 ksi,



22. Determine the stress τ_{xy}.

a. 12 ksi
b. 30 ksi
c. 48 ksi
d. 6 ksi
e. 18 ksi

23. Determine the angle θ_p.

a. 76.7°
b. -13.3°
c. 63.4°
d. 31.7°
e. 13.3°

$\tan 2\theta_p = \frac{6}{3}$

$\boxed{\theta_p = 31.7^\circ}$

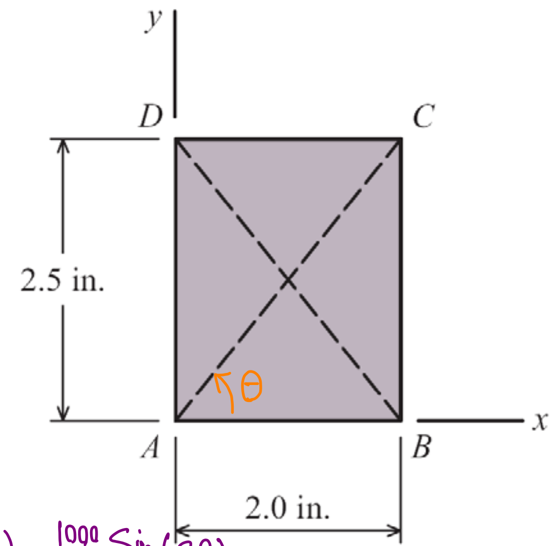
24. Determine the stress $\tau_{\text{in-plane max}}$.

a. 6.71 ksi
b. 20.12 ksi
c. 33.54 ksi
d. 53.67 ksi
e. 13.42 ksi

25. Determine the stress $\tau_{\text{absolute max}}$.

a. 6.71 ksi
b. 20.12 ksi
c. 13.42 ksi
d. 33.54 ksi
e. 53.67 ksi

26. The thin rectangular plate shown is uniformly deformed such that $\varepsilon_x = -475\ \mu\varepsilon$, $\varepsilon_y = +750\ \mu\varepsilon$, and $\gamma_{xy} = -1{,}000\ \mu\text{rad}$. Determine the normal strain ε_{AC} along diagonal AC of the plate.



a. 906.1 με
b. -215.9 με
c. -459.8 με
d. 759.8 με
e. -142.7 με

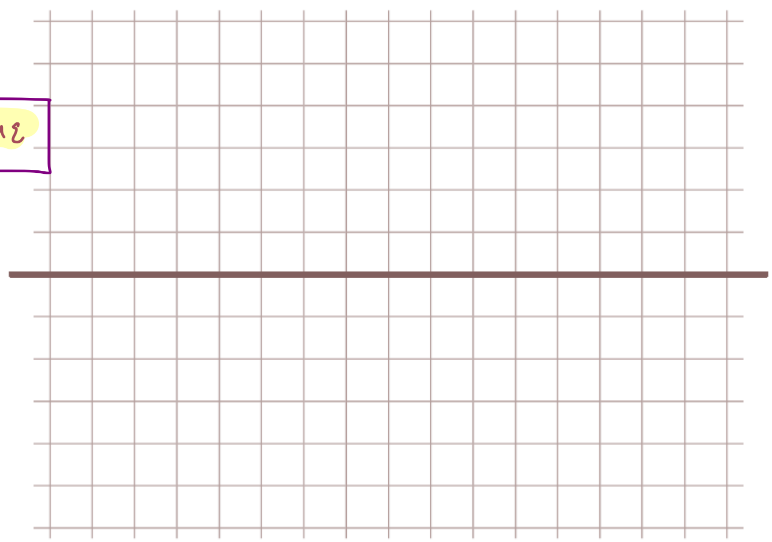
$$\tan\theta = \frac{2.5}{2} \Rightarrow \theta = 51.3^\circ$$

$$\varepsilon_{AC} = \varepsilon_n(\theta) = \frac{-475+750}{2} + \frac{-475-750}{2}\cos(2\theta) - \frac{1000}{2}\sin(2\theta)$$

$$\varepsilon_{AC} = \boxed{-215.8\,\mu\varepsilon}$$

The strain components $\varepsilon_x = -235\mu$, $\varepsilon_y = -835\mu$, and $\gamma_{xy} = 200\mu\text{rad}$ are given for a point in a body subjected to plane strain.

27. Determine the center ε_{center} of the corresponding in-plane Mohr's circle.



$$\varepsilon_c = \frac{\varepsilon_x + \varepsilon_y}{2} = \boxed{-535\,\mu\varepsilon}$$

a. -643μ
b. -583μ
c. -618μ
d. -535μ
e. -568μ

28. Determine the radius R of the in-plane Mohr's circle.

a. 286μ
b. 316μ
c. 244μ
d. 251μ
e. 282μ

$$R = \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

$$R = \boxed{316\,\mu\varepsilon}$$

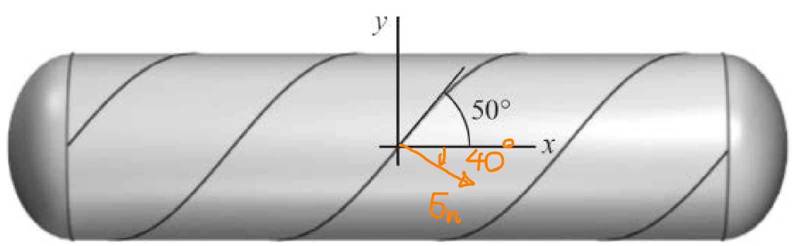
29. The normal strain measured on the outside surface of a spherical pressure vessel is 800 με. The sphere has an outside diameter of 54 in. and a wall thickness of 0.50 in., and it will be fabricated from an aluminum alloy [*E* = 10,000 ksi; *ν* = 0.33]. Determine the internal pressure in the vessel.

a. 506.9 psi
b. 281.6 psi
c. 394.3 psi
d. 337.9 psi
e. 450.6 psi

$\varepsilon_a = \frac{pr}{2tE}(1-\nu)$ $\quad d = 54 - 2\times0.5 = 53 \text{ in} \quad r = 53/2$

$$p = \frac{2tE}{r(1-\nu)}\varepsilon_a = \frac{2\times0.5\times10{,}000{,}000 \text{ psi}}{53/2\times(1-0.33)}\times 800\times10^{-6} = \boxed{450.6 \text{ psi}}$$

30. The pressure tank shown is fabricated from spirally-wrapped metal plates that are welded at the seams in the orientation shown. The tank has an inside diameter of 500 mm and a wall thickness of 6 mm. For a gage pressure of 2.0 MPa, determine the normal stress perpendicular to the weld.



a. 29.44 MPa
b. 88.32 MPa
c. 95.68 MPa
d. 58.88 MPa
e. 73.60 MPa

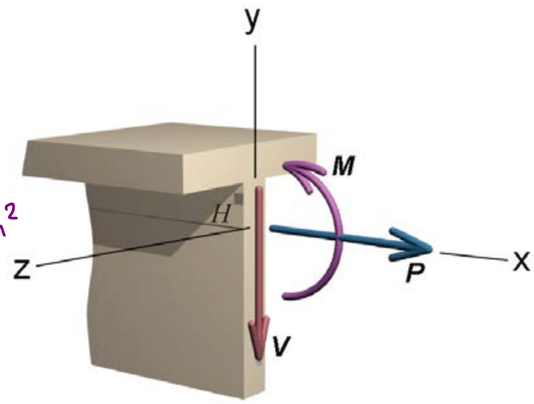
$$\sigma_x = \sigma_{long} = \frac{pr}{2t} = \frac{2\times250}{2\times6} = \boxed{41.7 \text{ MPa}}$$

$$\sigma_y = \sigma_{hoop} = 2\sigma_{long} = \boxed{83.3 \text{ MPa}}$$

$$\theta = 50 - 90 = -40^\circ$$

$$\sigma_n = \frac{\sigma_x+\sigma_y}{2} + \frac{\sigma_x-\sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta = \boxed{58.88 \text{ MPa}}$$

A tee-shaped flexural member is subjected to an internal axial force of P = 4,000 N, an internal shear force of V = 3,500 N, and an internal bending moment of M = 2,000 N-m, as shown. If the centroid is 95 mm above the bottom edge of the tee-shape and the moment of inertia about the z-axis is 8,840,000 mm^4, determine the following stresses at point H.

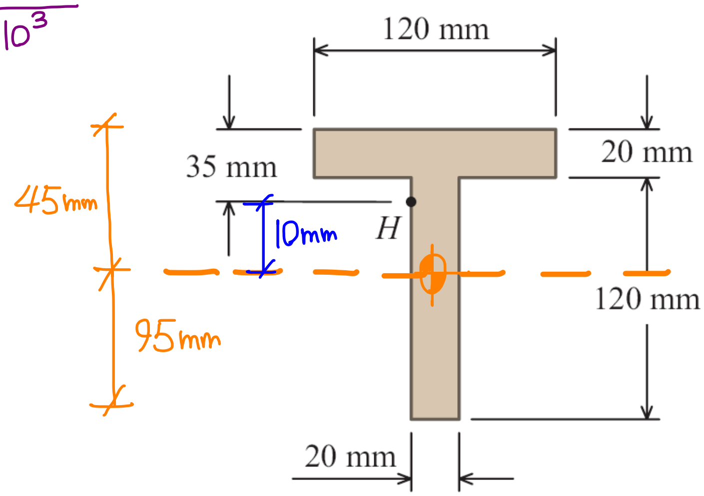


$$A = 2 \times 120 \times 20 = 4800 \text{ mm}^2$$

31. Normal stress σ_x.

a. 0.00 MPa
b. -1.99 MPa
c. -1.20 MPa
d. -1.66 MPa
e. -1.43 MPa

$$\sigma_x = \frac{P}{A} - \frac{MC}{I} = \frac{4000}{4800} - \frac{2000 \times 10^3 \times 10}{8840 \times 10^3} = \boxed{-1.429 \text{ mpa}}$$



32. Normal stress σ_y.

a. -1.99 MPa
b. -1.43 MPa
c. -1.20 MPa
d. 0.00 MPa
e. -1.66 MPa

$$\boxed{\sigma_y = 0}$$

33. Shear stress τ_{xy}.

a. -1.46 MPa
b. -2.32 MPa
c. -1.77 MPa
d. -1.01 MPa
e. -2.02 MPa

$$\tau_{xy} = \frac{VQ}{It} = \frac{3500 \times 90{,}250}{8840 \times 10^3 \times 20} = \boxed{1.787 \text{ mpa}}$$

$$Q = 120 \times 20 \times (45 - 10) + 25 \times 20 \times \frac{25}{2}$$

$$Q = 90{,}250 \text{ mm}^3$$

Key

1. e
2. d
3. d
4. b
5. b
6. c
7. d
8. c
9. b
10. b
11. e
12. a
13. a
14. b
15. e
16. d
17. c
18. c
19. c
20. b
21. e
22. d
23. d
24. a
25. a
26. b
27. d
28. b
29. e
30. d
31. e
32. d
33. c