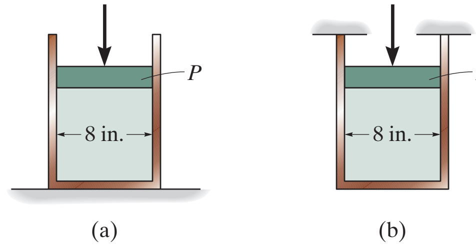
© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–3. The thin-walled cylinder can be supported in one of two ways as shown. Determine the state of stress in the wall of the cylinder for both cases if the piston *P* causes the internal pressure to be 65 psi. The wall has a thickness of 0.25 in. and the inner diameter of the cylinder is 8 in.



Case (a):

$$\sigma_1 = \frac{pr}{t}; \qquad \sigma_1 = \frac{65(4)}{0.25} = 1.04 \text{ ksi}$$ **Ans.**

$$\sigma_2 = 0$$ **Ans.**

Case (b):

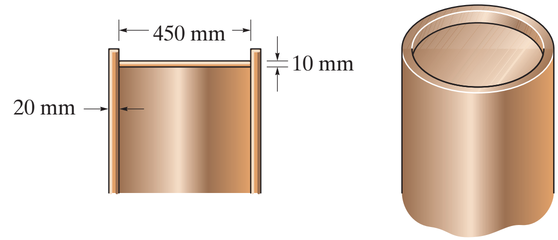
$$\sigma_1 = \frac{pr}{t}; \qquad \sigma_1 = \frac{65(4)}{0.25} = 1.04 \text{ ksi}$$ **Ans.**

$$\sigma_2 = \frac{pr}{2t}; \qquad \sigma_2 = \frac{65(4)}{2(0.25)} = 520 \text{ psi}$$ **Ans.**

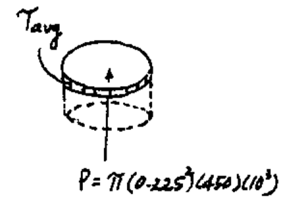
Ans:
(a) $\sigma_1 = 1.04$ ksi, $\sigma_2 = 0$,
(b) $\sigma_1 = 1.04$ ksi, $\sigma_2 = 520$ psi

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

***8–12.** A pressure-vessel head is fabricated by gluing the circular plate to the end of the vessel as shown. If the vessel sustains an internal pressure of 450 kPa, determine the average shear stress in the glue and the state of stress in the wall of the vessel.



$$+\uparrow \Sigma F_y = 0; \quad \pi(0.225)^2 450(10^3) - \tau_{avg}(2\pi)(0.225)(0.01) = 0;$$



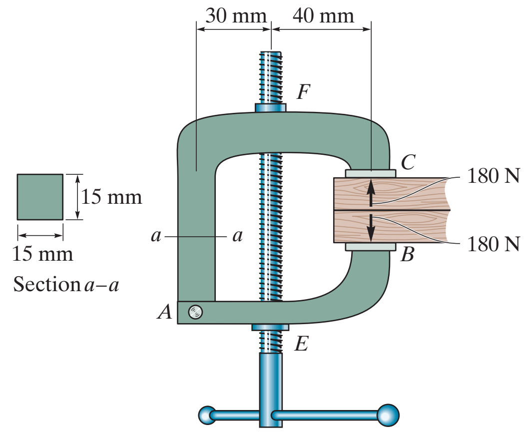
$\tau_{avg} = 5.06$ MPa **Ans.**

$$\sigma_1 = \frac{p\,r}{t} = \frac{450(10^3)(0.225)}{0.02} = 5.06 \text{ MPa}$$ **Ans.**

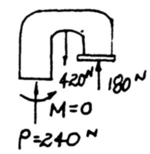
$$\sigma_2 = \frac{p\,r}{2\,t} = \frac{450(10^3)(0.225)}{2(0.02)} = 2.53 \text{ MPa}$$ **Ans.**

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–23. The clamp is made from members AB and AC, which are pin connected at A. If it exerts a compressive force at C and B of 180 N, sketch the stress distribution acting over section a–a. The screw EF is subjected only to a tensile force along its axis.



There is no moment in this problem. Therefore, the compressive stress is produced by axial force only.

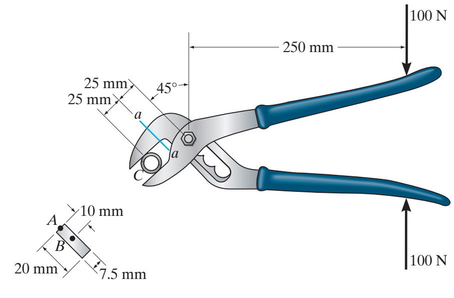


$$\sigma_{\text{const}} = \frac{P}{A} = \frac{240}{(0.015)(0.015)} = 1.07\ \text{MPa}$$

Ans:
$\sigma_{\text{const}} = 1.07\ \text{MPa}$

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–30. The rib-joint pliers are used to grip the smooth pipe C. If the force of 100 N is applied to the handles, determine the state of stress at points A and B on the cross section of the jaw at section $a-a$. Indicate the results on an element at each point.



Support Reactions: Referring to the free-body diagram of the handle shown in Fig. a,

$\circlearrowleft + \Sigma M_D = 0; \qquad 100(0.25) - F_C(0.05) = 0 \qquad F_C = 500 \text{ N}$

Internal Loadings: Consider the equilibrium of the free-body diagram of the segment shown in Fig. b,

$\Sigma F_{y'} = 0; \qquad 500 - V = 0 \qquad V = 500 \text{ N}$

$\circlearrowleft + \Sigma M_C = 0; \qquad M - 500(0.025) = 0 \qquad M = 12.5 \text{ N} \cdot \text{m}$

Section Properties: The moment of inertia of the cross section about the centroidal axis is

$$I = \frac{1}{12}(0.0075)(0.02^3) = 5(10^{-9}) \text{ m}^4$$

Referring to Fig. c, Q_A and Q_B are

$$Q_A = 0$$

$$Q_B = \bar{y}'A' = 0.005(0.01)(0.0075) = 0.375(10^{-6}) \text{ m}^3$$

Normal Stress: The normal stress is contributed by bending stress only. Thus

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

For point A, $y = 0.01$ m. Then

$$\sigma_A = -\frac{12.5(0.01)}{5(10^{-9})} = -25 \text{ MPa} = 25 \text{ MPa (C)} \qquad \textbf{Ans.}$$

For point B, $y = 0$. Then

$$\sigma_B = 0 \qquad \textbf{Ans.}$$

Shear Stress: The shear stress is contributed by transverse shear stress only. Thus,

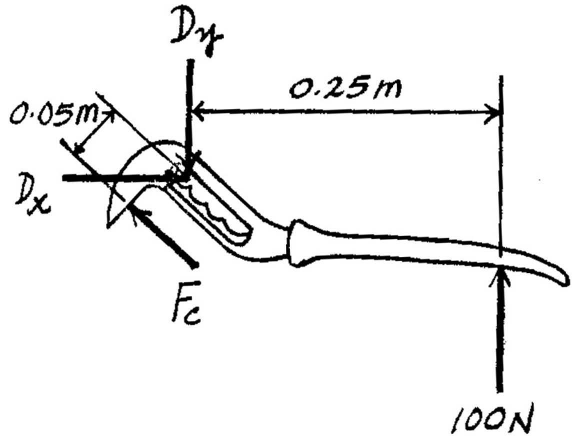
$$\tau_A = \frac{VQ_A}{It} = 0 \qquad \textbf{Ans.}$$

$$\tau_B = \frac{VQ_B}{It} = \frac{500[0.375(10^{-6})]}{5(10^{-9})(0.0075)} = 5 \text{ MPa} \qquad \textbf{Ans.}$$

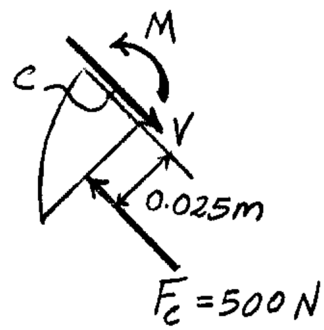
The state of stress of points A and B are represented by the elements shown in Figs. d and e respectively.

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

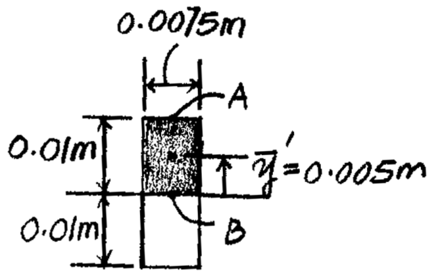
8–30. Continued



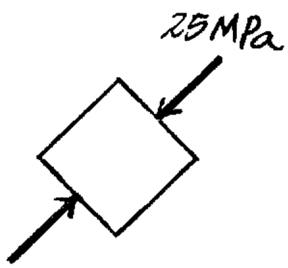
(a)



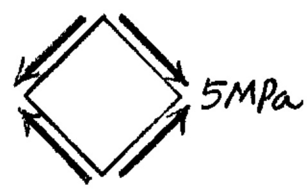
(b)



(c)



(d)

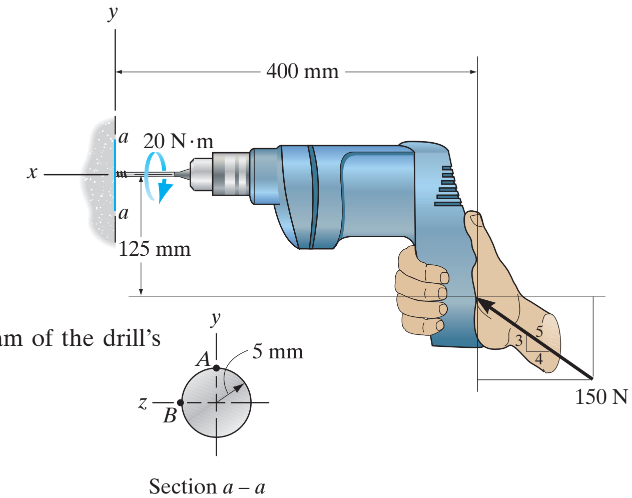


(e)

Ans:
$\sigma_A = 25$ MPa (C), $\sigma_B = 0$,
$\tau_A = 0$, $\tau_B = 5$ MPa

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–37. The drill is jammed in the wall and is subjected to the torque and force shown. Determine the state of stress at point B on the cross section of drill bit, in back, at section a–a.



Internal Loadings: Consider the equilibrium of the free-body diagram of the drill's right cut segment, Fig. a,

$$\Sigma F_x = 0;\quad N - 150\left(\frac{4}{5}\right) = 0 \qquad N = 120\ \text{N}$$

$$\Sigma F_y = 0;\quad 150\left(\frac{3}{5}\right) - V_y = 0 \qquad V_y = 90\ \text{N}$$

$$\Sigma M_x = 0;\quad 20 - T = 0 \qquad T = 20\ \text{N}\cdot\text{m}$$

$$\Sigma M_z = 0;\quad -150\left(\frac{3}{5}\right)(0.4) + 150\left(\frac{4}{5}\right)(0.125) + M_z = 0$$

$$M_z = 21\ \text{N}\cdot\text{m}$$

Section Properties: The cross-sectional area, the moment of inertia about the z axis, and the polar moment of inertia of the drill's cross section are

$$A = \pi\left(0.005^2\right) = 25\pi\left(10^{-6}\right)\text{m}^2$$

$$I_z = \frac{\pi}{4}\left(0.005^4\right) = 0.15625\pi\left(10^{-9}\right)\text{m}^4$$

$$J = \frac{\pi}{2}\left(0.005^4\right) = 0.3125\pi\left(10^{-9}\right)\text{m}^4$$

Referring to Fig. b, Q_B is

$$Q_B = \bar{y}'A' = \frac{4(0.005)}{3\pi}\left[\frac{\pi}{2}\left(0.005^2\right)\right] = 83.333\left(10^{-9}\right)\text{m}^3$$

Normal Stress: The normal stress is a combination of axial and bending stress. Thus,

$$\sigma = \frac{N}{A} - \frac{M_z y}{I_z}$$

For point B, $y = 0$. Then

$$\sigma_B = \frac{-120}{25\pi\left(10^{-6}\right)} - 0 = -1.528\ \text{MPa} = 1.53\ \text{MPa (C)} \qquad \textbf{Ans.}$$

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–37. Continued

Shear Stress: The transverse shear stress developed at point B is

$$\left[\left(\tau_{xy}\right)_V\right]_B = \frac{V_y Q_B}{I_z t} = \frac{90\left[83.333\left(10^{-9}\right)\right]}{0.15625\pi\left(10^{-9}\right)(0.01)} = 1.528 \text{ MPa}$$

The torsional shear stress developed at point B is

$$\left[\left(\tau_{xy}\right)_T\right]_B = \frac{Tc}{J} = \frac{20(0.005)}{0.3125\pi\left(10^{-9}\right)} = 101.86 \text{ MPa}$$

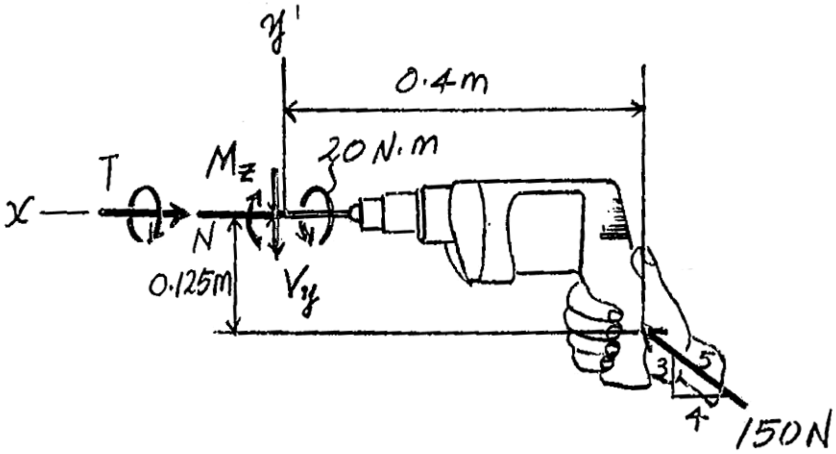
Thus,

$$\left(\tau_{xy}\right)_B = 0$$ **Ans.**

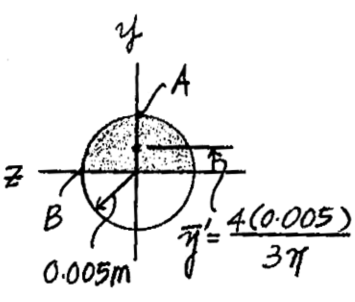
$$\left(\tau_{xy}\right)_B = \left[\left(\tau_{xy}\right)_T\right]_B - \left[\left(\tau_{xy}\right)_V\right]_B$$

$$= 101.86 - 1.528 = 100.33 \text{ MPa} = 100 \text{ MPa}$$ **Ans.**

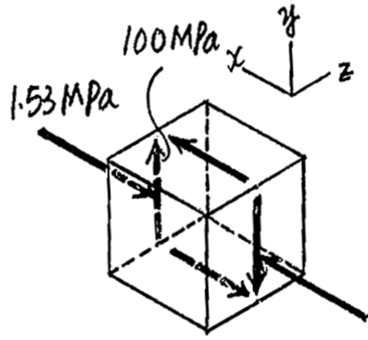
The state of stress at point B is represented on the element shown in Fig. *d*.



(a)



(b)

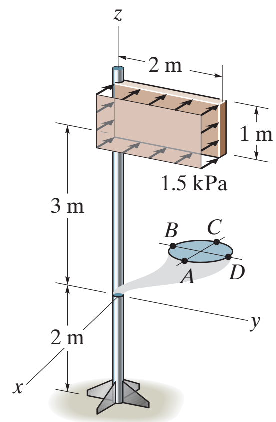


(d)

Ans:
$\sigma_B = 1.53$ MPa (C), $\tau_B = 100$ MPa

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

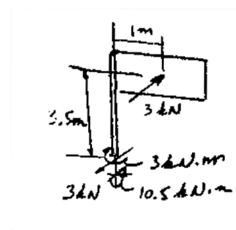
8–57. The sign is subjected to the uniform wind loading. Determine the stress components at points A and B on the 100-mm-diameter supporting post. Show the results on a volume element located at each of these points.



Point A:

$$\sigma_A = \frac{Mc}{I} = \frac{10.5(10^3)(0.05)}{\frac{\pi}{4}(0.05)^4} = 107 \text{ MPa (T)}$$ **Ans.**

$$\tau_A = \frac{Tc}{J} = \frac{3(10^3)(0.05)}{\frac{\pi}{4}(0.05)^4} = 15.279(10^6) = 15.3 \text{ MPa}$$ **Ans.**

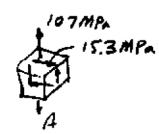


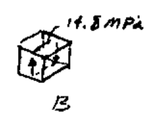
Point B:

$$\sigma_B = 0$$ **Ans.**

$$\tau_B = \frac{Tc}{J} - \frac{VQ}{It} = 15.279(10^6) - \frac{3000(4(0.05)/3\pi))(\frac{1}{2})(\pi)(0.05)^2}{\frac{\pi}{4}(0.05)^4(0.1)}$$

$$\tau_B = 14.8 \text{ MPa}$$ **Ans.**

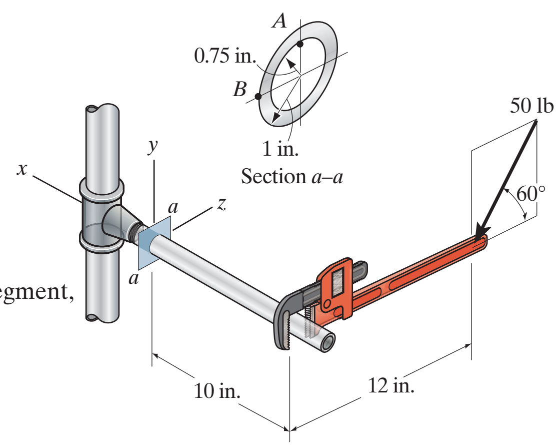




Ans:
$\sigma_A = 107$ MPa (T), $\tau_A = 15.3$ MPa,
$\sigma_B = 0$, $\tau_B = 14.8$ MPa

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–66. Determine the state of stress at point B on the cross section of the pipe at section a–a.



Internal Loadings: Referring to the free-body diagram of the pipe's right segment, Fig. *a*,

$\Sigma F_y = 0;\quad V_y - 50\sin 60° = 0 \qquad V_y = 43.30 \text{ lb}$

$\Sigma F_z = 0;\quad V_z - 50\cos 60° = 0 \qquad V_z = 25 \text{ lb}$

$\Sigma M_x = 0;\quad T + 50\sin 60°(12) = 0 \qquad T = -519.62 \text{ lb}\cdot\text{in}$

$\Sigma M_y = 0;\quad M_y - 50\cos 60°(10) = 0 \qquad M_y = 250 \text{ lb}\cdot\text{in}$

$\Sigma M_z = 0;\quad M_z + 50\sin 60°(10) = 0 \qquad M_z = -433.01 \text{ lb}\cdot\text{in}$

Section Properties: The moment of inertia about the y and z axes and the polar moment of inertia of the pipe are

$$I_y = I_z = \frac{\pi}{4}\left(1^4 - 0.75^4\right) = 0.53689 \text{ in}^4$$

$$J = \frac{\pi}{2}\left(1^4 - 0.75^4\right) = 1.07379 \text{ in}^4$$

Referring to Fig. *b*,

$$\left(Q_z\right)_B = 0$$

$$\left(Q_y\right)_B = \bar{y}_1' A_1' - \bar{y}_2' A_2' = \frac{4(1)}{3\pi}\left[\frac{\pi}{2}\left(1^2\right)\right] - \frac{4(0.75)}{3\pi}\left[\frac{\pi}{2}\left(0.75^2\right)\right] = 0.38542 \text{ in}^3$$

Normal Stress: The normal stress is contributed by bending stress only. Thus,

$$\sigma = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

For point B, $y = 0$ and $z = -1$. Then

$$\sigma_B = -0 + \frac{250(-1)}{0.53689} = -465.64 \text{ psi} = 466 \text{ psi (C)} \qquad \textbf{Ans.}$$

Shear Stress: The torsional shear stress developed at point B is

$$\left[\left(\tau_{xy}\right)_T\right]_B = \frac{T\rho_C}{J} = \frac{519.62(1)}{1.07379} = 483.91 \text{ psi}$$

© 2014 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected under all copyright laws as they currently exist. No portion of this material may be reproduced, in any form or by any means, without permission in writing from the publisher.

8–66. Continued

The transverse shear stress developed at point B is

$$\left[(\tau_{xz})_V\right]_B = 0$$

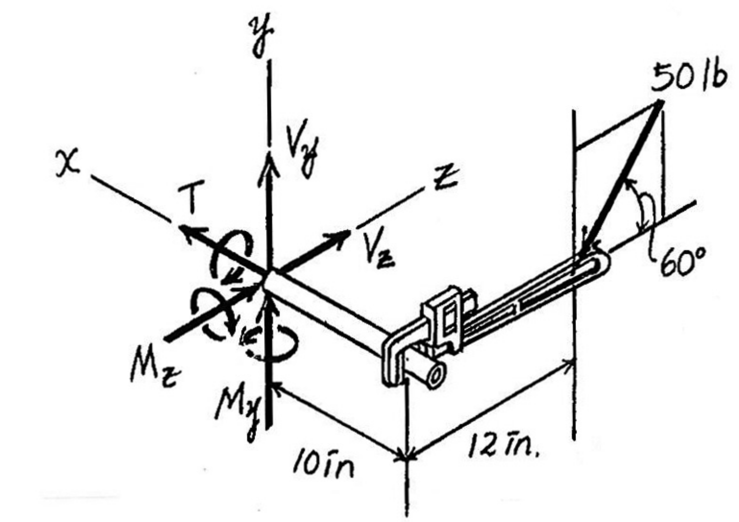
$$\left[(\tau_{xy})_V\right]_B = \frac{V_y(Q_y)_B}{I_z t} = \frac{43.30(0.38542)}{0.53689(2 - 1.5)} = 62.17 \text{ psi}$$

Combining these two shear stress components,

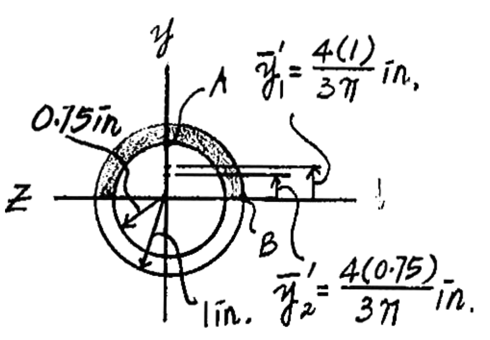
$$(\tau_{xy})_B = \left[(\tau_{xy})_T\right]_B - \left[(\tau_{xy})_V\right]_B$$

$$= 483.91 - 62.17 = 422 \text{ psi}$$ **Ans.**

$$(\tau_{xz})_B = 0$$ **Ans.**



(a)



(b)

Ans:
$\sigma_B = 466$ psi (C), $\tau_B = 422$ psi