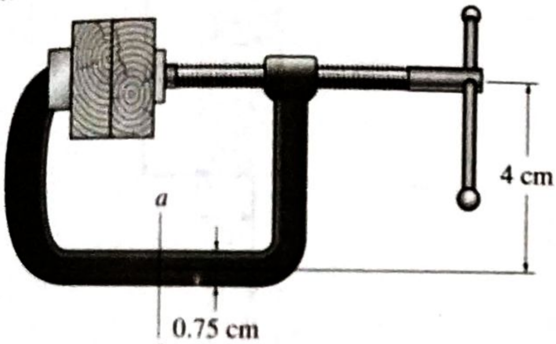
PROBLEMS

8-15. The screw of the clamp exerts a compressive force of 500 N on the wood blocks. Determine the maximum normal stress developed along section *a–a*. The cross section there is rectangular, 0.75 cm by 0.50 cm.

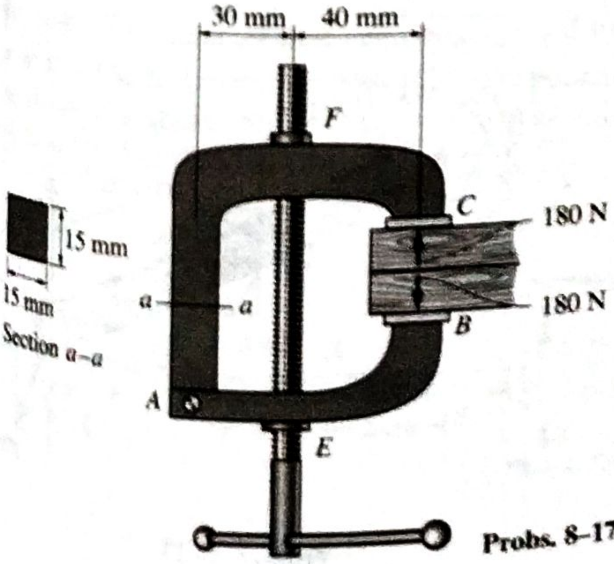
*8-16. The screw of the clamp exerts a compressive force of 500 N on the wood blocks. Sketch the stress distribution along section *a–a* of the clamp. The cross section there is rectangular, 0.75 cm by 0.50 cm.



Probs. 8–15/16

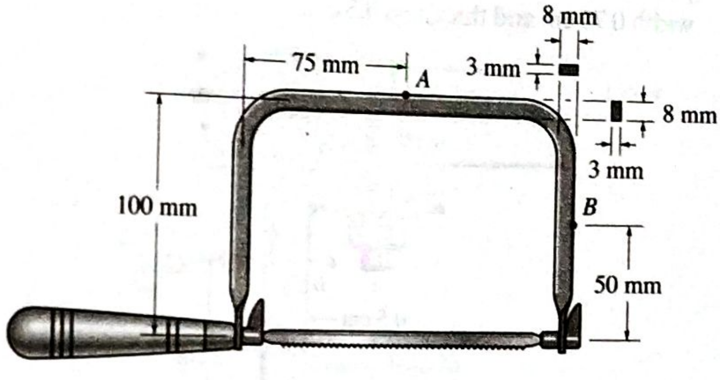
8-17. The clamp is made from members *AB* and *AC*, which are pin connected at *A*. If it exerts a compressive force at *C* and *B* of 180 N, determine the maximum compressive stress in the clamp at section *a–a*. The screw *EF* is subjected only to a tensile force along its axis.

8-18. 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.



Probs. 8–17/18

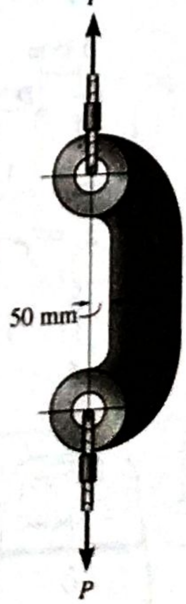
8-19. The coping saw has an adjustable blade that is tightened with a tension of 40 N. Determine the state of stress in the frame at points *A* and *B*.



Prob. 8–19

*8-20. The offset link supports the loading of $P = 30$ kN. Determine its required width *w* if the allowable normal stress is $\sigma_{allow} = 73$ MPa. The link has a thickness of 40 mm.

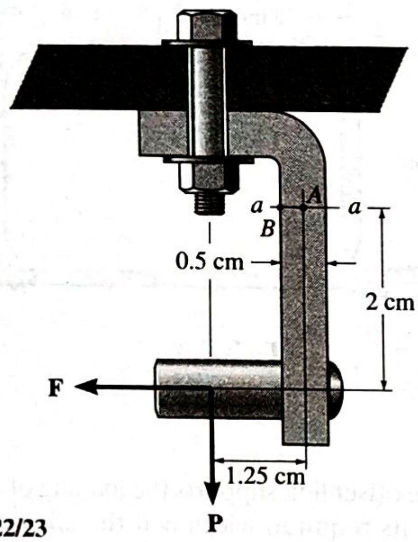
8-21. The offset link has a width of $w = 200$ mm and a thickness of 40 mm. If the allowable normal stress is $\sigma_{allow} = 75$ MPa, determine the maximum load *P* that can be applied to the cables.



Probs. 8–20/21

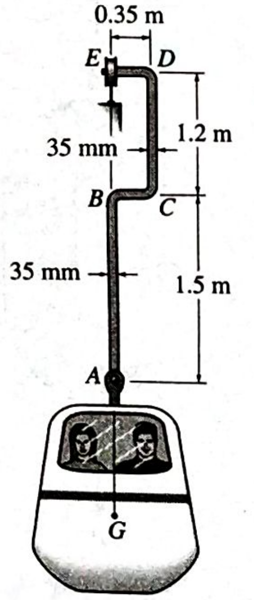
8-22. The joint is subjected to a force of $P = 80$ N, and $F = 0$. Sketch the normal-stress distribution acting over section a–a if the member has a rectangular cross-sectional area of width 2 cm and thickness 0.5 cm.

8-23. The joint is subjected to a force of $P = 200$ N and $F = 150$ N. Determine the state of stress at points A and B and sketch the results on differential elements located at these points. The member has a rectangular cross-sectional area of width 0.75 cm and thickness 0.5 cm.



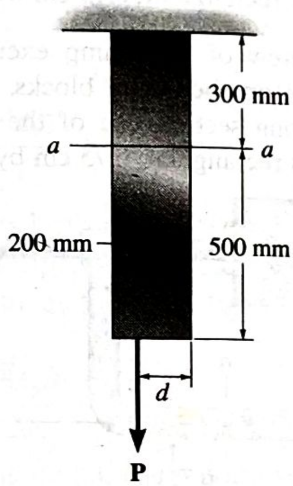
Probs. 8–22/23

***8-24.** The gondola and passengers have a weight of 7.5 kN and center of gravity at G. The suspender arm AE has a square cross-sectional area of 35 mm by 35 mm, and is pin connected at its ends A and E. Determine the largest tensile stress developed in regions AB and DC of the arm.



Prob. 8–24

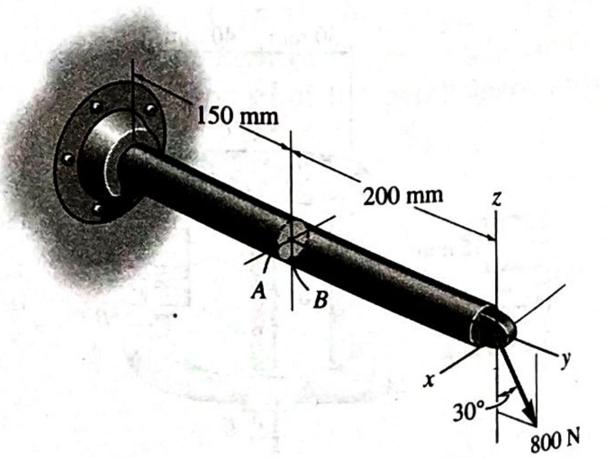
8-25. The vertical force **P** acts on the bottom of the plate having a negligible weight. Determine the shortest distance d to the edge of the plate at which it can be applied so that it produces no compressive stresses on the plate at section a–a. The plate has a thickness of 10 mm and **P** acts along the center line of this thickness.



Prob. 8–25

8-26. The bar has a diameter of 40 mm. If it is subjected to a force of 800 N as shown, determine the stress components that act at point A and show the results on a volume element located at this point.

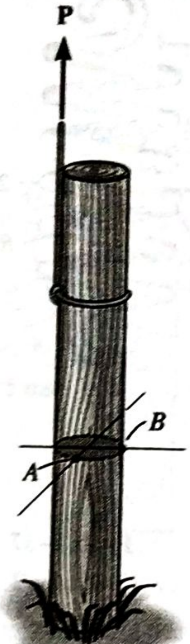
8-27. Solve Prob. 8–26 for point B.



Probs. 8–26/27

*8-28. The cylindrical post, having a diameter of 40 mm, is being pulled from the ground using a sling of negligible thickness. If the rope is subjected to a vertical force of $P = 500$ N, determine the stress at points A and B. Show the results on a volume element located at each of these points.

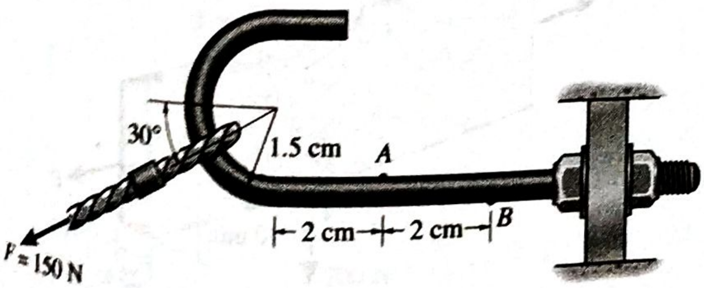
8-29. Determine the maximum load P that can be applied to the sling having a negligible thickness so that the normal stress in the post does not exceed $\sigma_{allow} = 30$ MPa. The post has a diameter of 50 mm.



Probs. 8–28/29

8-30. The $\frac{1}{2}$-cm-diameter bolt hook is subjected to the load of $F = 150$ N. Determine the stress components at point A on the shank. Show the results on a volume element located at this point.

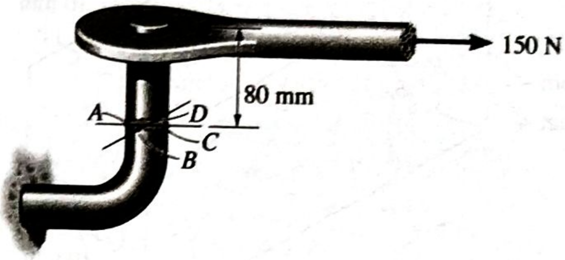
8-31. The $\frac{1}{2}$-cm-diameter bolt hook is subjected to the load of $F = 150$ N. Determine the stress components at point B on the shank. Show the results on a volume element located at this point.



Probs. 8–30/31

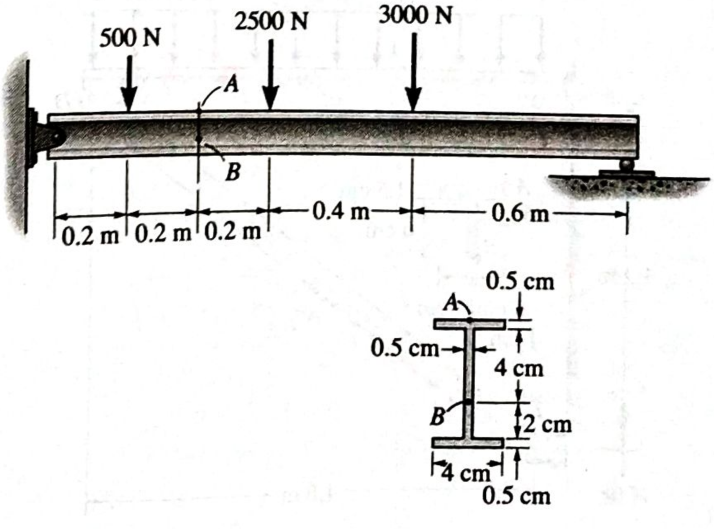
*8-32. The pin support is made from a steel rod and has a diameter of 20 mm. Determine the stress components at points A and B and represent the results on a volume element located at each of these points.

8-33. Solve Prob. 8–32 for points C and D.



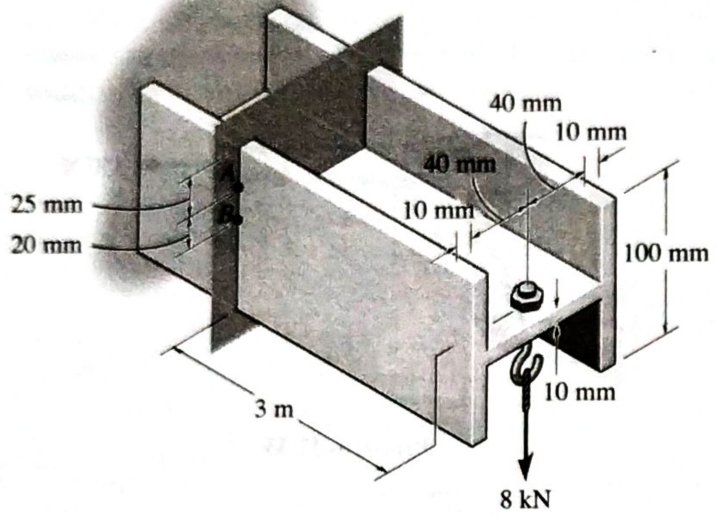
Probs. 8–32/33

8-34. The wide-flange beam is subjected to the loading shown. Determine the stress components at points A and B and show the results on a volume element at each of these points. Use the shear formula to compute the shear stress.



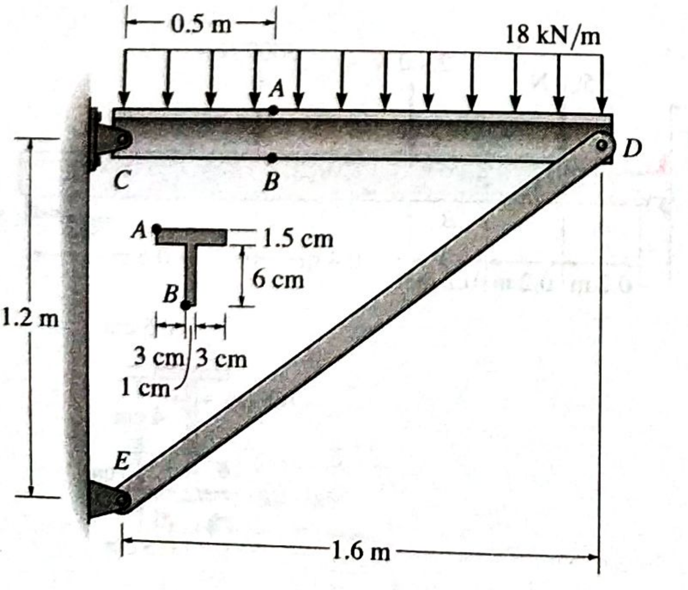
Prob. 8–34

8-35. The cantilevered beam is used to support the load of 8 kN. Determine the state of stress at points A and B, and sketch the results on differential elements located at each of these points.



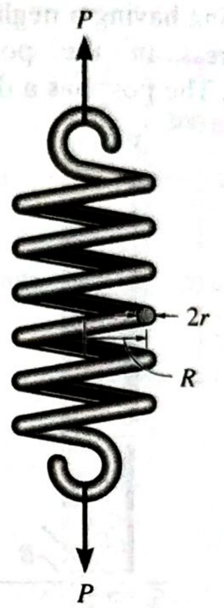
Prob. 8–35

***8-36.** The frame supports a centrally applied distributed load of 18 kN/m. Determine the state of stress at points A and B on member CD and indicate the results on a volume element located at each of these points. The pins at C and D are at the same location as the neutral axis for the cross section.



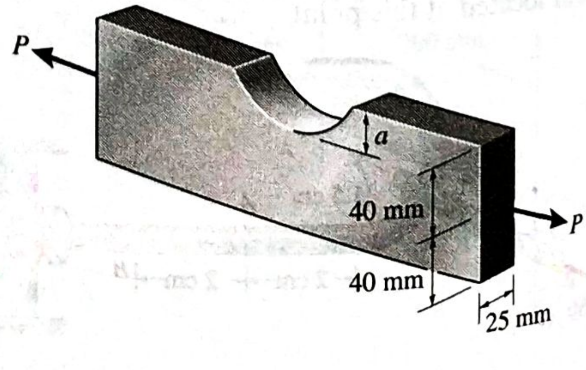
Prob. 8–36

8-37. The coiled spring is subjected to a force P. If we assume the shear stress caused by the shear force at any vertical section of the coil wire to be uniform, show that the maximum shear stress in the coil is $\tau_{max} = P/A + PRr/J$, where J is the polar moment of inertia of the coil wire and A is its cross-sectional area.



Prob. 8–37

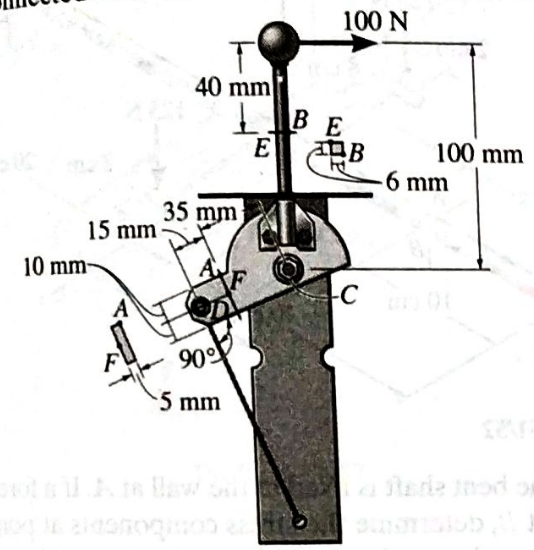
8-38. The metal link is subjected to the axial force of $P = 7$ kN. Its original cross section is to be altered by cutting a circular groove into one side. Determine the distance a the groove can penetrate into the cross section so that the tensile stress does not exceed $\sigma_{allow} = 175$ MPa. Offer a better way to remove this depth of material from the cross section and calculate the tensile stress for this case. Neglect the effects of stress concentration.



Prob. 8–38

8-39. The control lever is subjected to a horizontal force of 100 N on the handle. Determine the state of stress at points *A* and *B*. Sketch the results on differential elements located at each of these points. The assembly is pin-connected at *C* and attached to a cable at *D*.

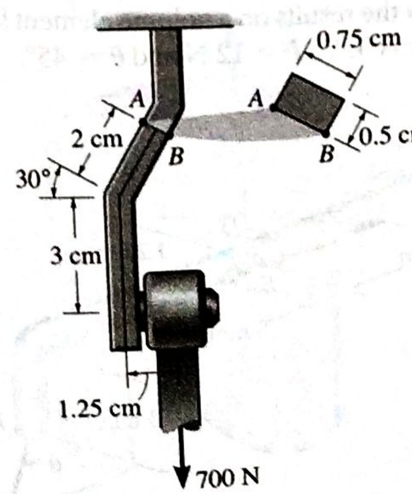
***8-40.** The control lever is subjected to a horizontal force of 100 N on the handle. Determine the state of stress at points *E* and *F*. Sketch the results on differential elements located at each of these points. The assembly is pin-connected at *C* and attached to a cable at *D*.



Probs. 8–39/40

8-41. The bearing pin supports the load of 700 N. Determine the stress components in the support member at point *A*. The support is 0.5 cm thick.

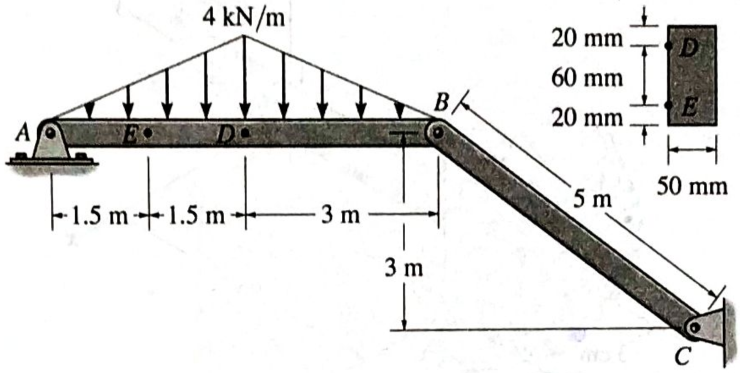
8-42. The bearing pin supports the load of 700 N. Determine the stress components in the support member at point *B*. The support is 0.5 cm thick.



Probs. 8–41/42

8-43. The frame supports the distributed load shown. Determine the state of stress acting at point *D*. Show the results on a differential element located at this point.

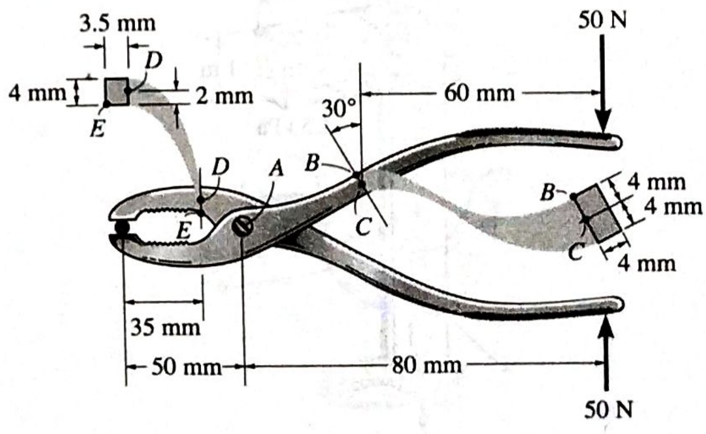
***8-44.** The frame supports the distributed load shown. Determine the state of stress acting at point *E*. Show the results on a differential element located at this point.



Probs. 8–43/44

8-45. The pliers are made from two steel parts pinned together at *A*. If a smooth bolt is held in the jaws and a gripping force of 50 N is applied at the handles, determine the state of stress developed in the pliers at points *B* and *C*. Here the cross section is rectangular, having the dimensions shown in the figure.

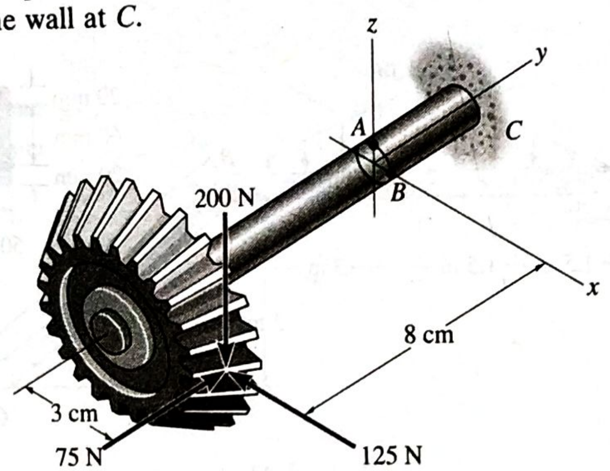
8-46. Solve Prob. 8–45 for points *D* and *E*.



Probs. 8–45/46

8-47. The beveled gear is subjected to the loads shown. Determine the stress components acting on the shaft at point A, and show the results on a volume element located at this point. The shaft has a diameter of 1 cm and is fixed to the wall at C.

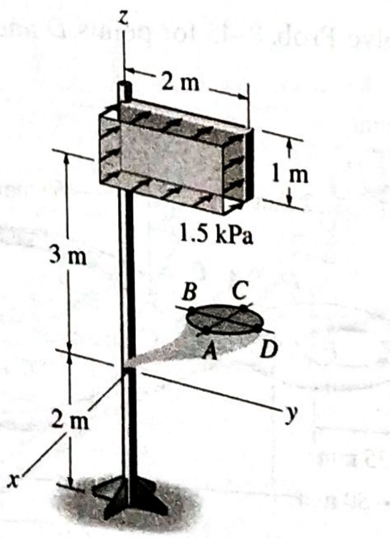
***8-48.** The beveled gear is subjected to the loads shown. Determine the stress components acting on the shaft at point B, and show the results on a volume element located at this point. The shaft has a diameter of 1 cm and is fixed to the wall at C.



Probs. 8–47/48

8-49. 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.

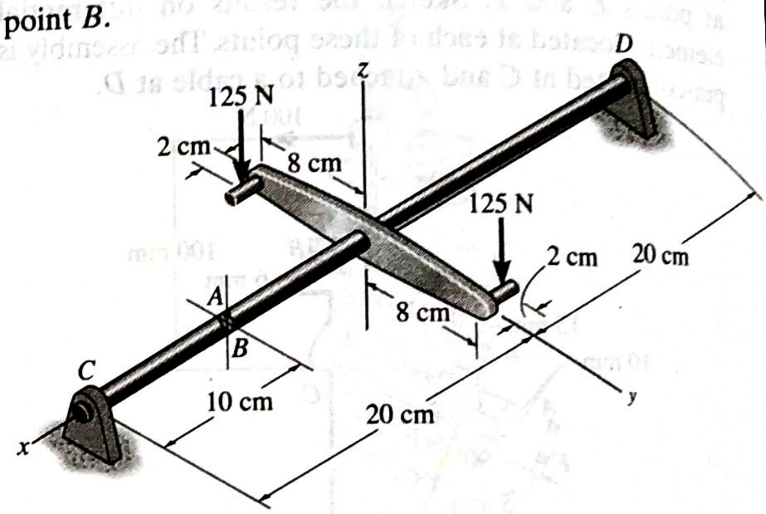
8-50. The sign is subjected to the uniform wind loading. Determine the stress components at points C and D on the 100-mm-diameter supporting post. Show the results on a volume element located at each of these points.



Probs. 8–49/50

8-51. The $\frac{3}{4}$-cm-diameter shaft is subjected to the loading shown. Determine the stress components at point A. Sketch the results on a volume element located at this point. The journal bearing at C can exert only force components $\mathbf{C}_y$ and $\mathbf{C}_z$ on the shaft, and the thrust bearing at D can exert force components $\mathbf{D}_x$, $\mathbf{D}_y$, and $\mathbf{D}_z$ on the shaft.

***8-52.** Solve Prob. 8–51 for the stress components at point B.

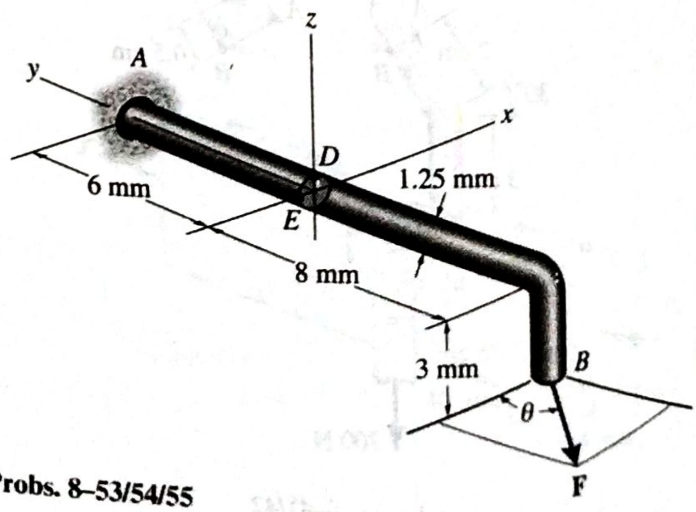


Probs. 8–51/52

8-53. The bent shaft is fixed in the wall at A. If a force $\mathbf{F}$ is applied at B, determine the stress components at points D and E. Show the results on a differential element located at each of these points. Take $F = 12$ N and $\theta = 0°$.

8-54. The bent shaft is fixed in the wall at A. If a force $\mathbf{F}$ is applied at B, determine the stress components at points D and E. Show the results on a differential element located at each of these points. Take $F = 12$ N and $\theta = 90°$.

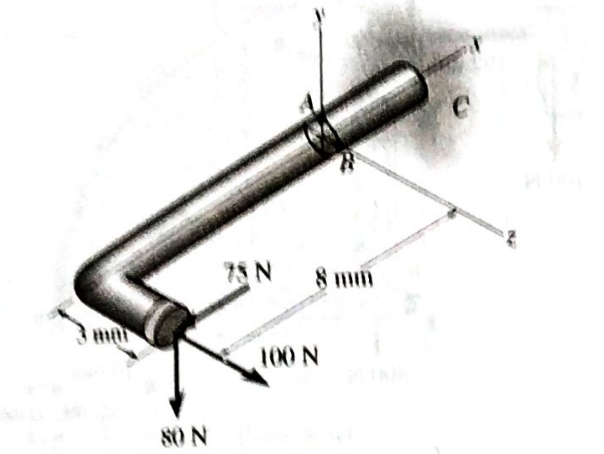
8-55. The bent shaft is fixed in the wall at A. If a force $\mathbf{F}$ is applied at B, determine the stress components at points D and E. Show the results on a volume element located at each of these points. Take $F = 12$ N and $\theta = 45°$.



Probs. 8–53/54/55

8-56. The 1-mm-diameter rod is subjected to the loads shown. Determine the state of stress at point A, and show the results on a differential element located at this point.

8-57. The 1-mm-diameter rod is subjected to the loads shown. Determine the state of stress at point B, and show the results on a differential element located at this point.



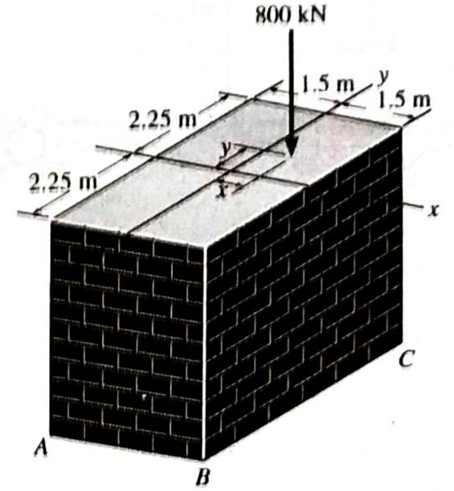
Probs. 8–56/57

8-58. The post has a circular cross section of radius c. Determine the maximum radius e at which the load can be applied so that no part of the post experiences a tensile stress. Neglect the weight of the post.

Prob. 8–58

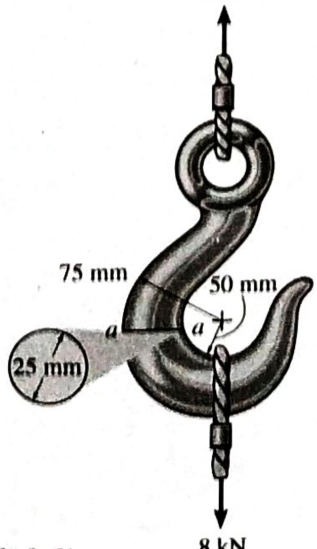
8-59. The masonry pier is subjected to the 800-kN load. For the range $y > 0$, $x > 0$, determine the equation of the line $y = f(x)$ along which the load can be placed without causing a tensile stress in the pier. Neglect the weight of the pier.

***8-60.** The masonry pier is subjected to the 800-kN load. If $x = 0.25$ m and $y = 0.5$ m, determine the normal stress at each corner A, B, C, D (not shown) and plot the stress distribution over the cross section. Neglect the weight of the pier.



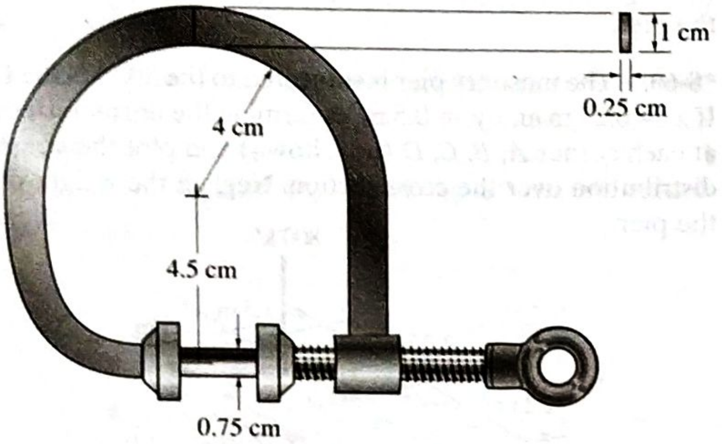
Probs. 8–59/60

8-61. The eye hook has the dimensions shown. If it supports a cable loading of 8 kN, determine the maximum normal stress at section a–a and sketch the stress distribution acting over the cross section.



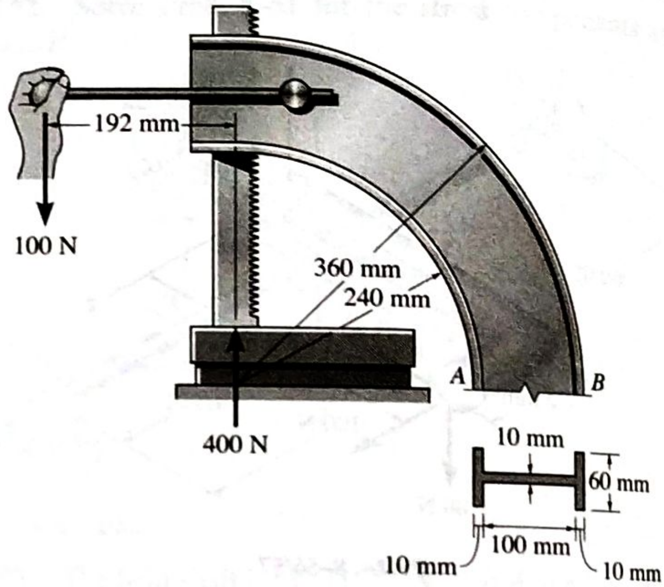
Prob. 8–61

8-62. The C-clamp applies a compressive stress on the cylindrical block of 80 N/cm^2. Determine the maximum normal stress developed in the clamp.



Prob. 8–62

8-63. The handle of the press is subjected to a force of 100 N. Due to internal gearing, this causes the block to be subjected to a compressive force of 400 N. Determine the normal stress acting in the frame at points along the outside flanges A and B. Use the curved-beam formula to compute the bending stress.

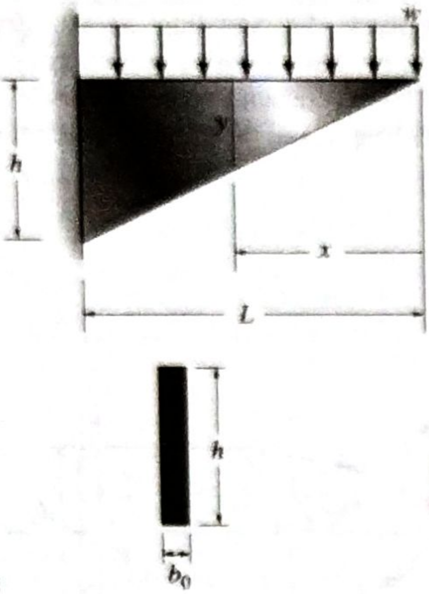


Prob. 8–63

CHAPTER REVIEW

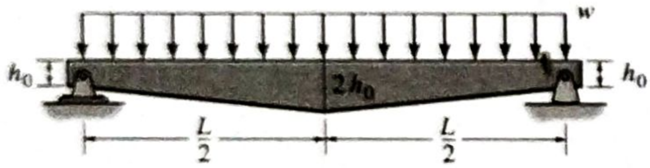
- A pressure vessel is considered to have a thin wall provided $r/t \geq 10$. For a thin-walled cylindrical vessel, the circumferential or hoop stress is $\sigma_1 = pr/t$. This stress is twice as great as the longitudinal stress, $\sigma_2 = pr/2t$. Thin-walled spherical vessels have the same stress within their walls in all directions so that $\sigma_1 = \sigma_2 = pr/2t$.
- Superposition of stress components can be used to determine the normal and shear stress at a point in a member subjected to a combined loading. To solve, it is first necessary to determine the resultant axial and shear force and the resultant torsional and bending moment at the section where the point is located. Then the stress components are determined due to each of these loadings. The normal and shear-stress resultants are then determined by algebraically adding the normal and shear-stress components.

11-35. The tapered beam supports a uniform distributed load w. If it is made from a plate that has a constant width b_0, determine the absolute maximum bending stress in the beam.



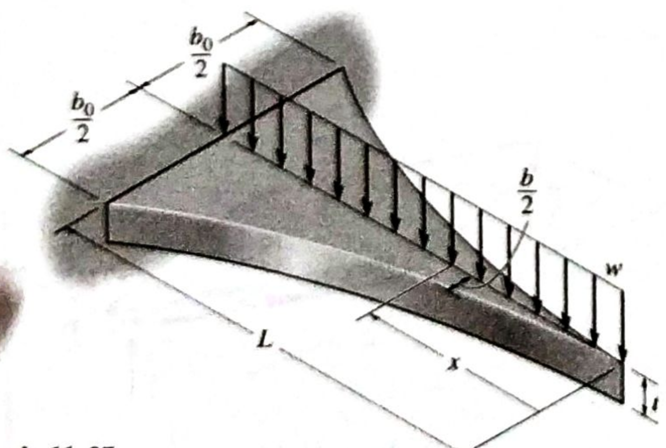
Prob. 11-35

***11-36.** The tapered beam supports a uniform distributed load w. If it is made from a plate and has a constant width b, determine the absolute maximum bending stress in the beam.



Prob. 11-36

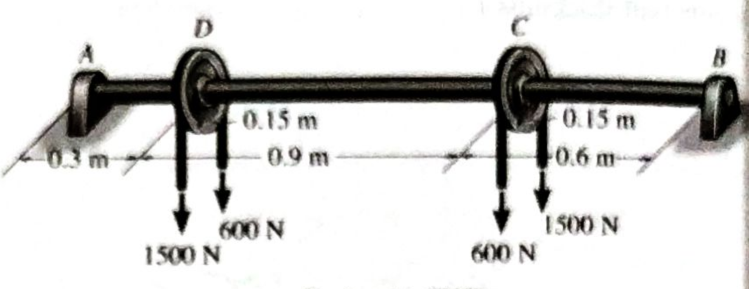
11-37. Determine the variation in the width b as a function of x for the cantilevered beam that supports a uniform distributed load along its centerline so that it has the same maximum bending stress σ_{allow} throughout its length. The beam has a constant depth t.



Prob. 11-37

11-38. The two pulleys attached to the shaft are loaded as shown. If the bearings at A and B exert only vertical forces on the shaft, determine the required diameter of the shaft to the nearest mm, using the maximum-shear-stress theory. $\tau_{allow} = 84$ MPa.

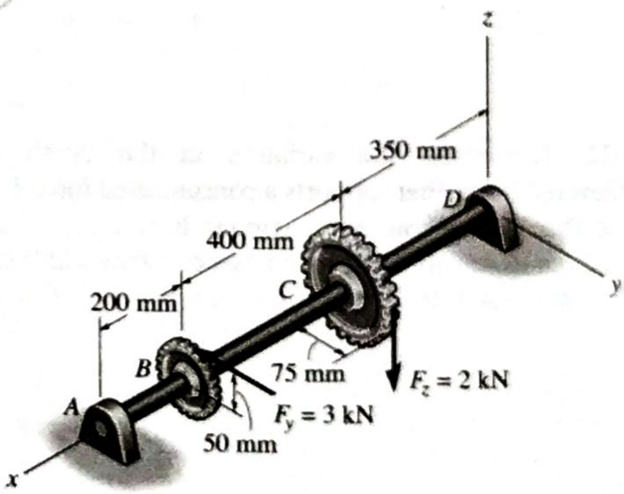
11-39. Solve Prob. 11–38 using the maximum-distortion-energy theory. $\sigma_{allow} = 470$ MPa.



Probs. 11–38/39

***11-40.** The bearings at A and D exert only y and z components of force on the shaft. If $\tau_{allow} = 60$ MPa, determine to the nearest millimeter, the smallest-diameter shaft that will support the loading. Use the maximum-shear-stress theory of failure.

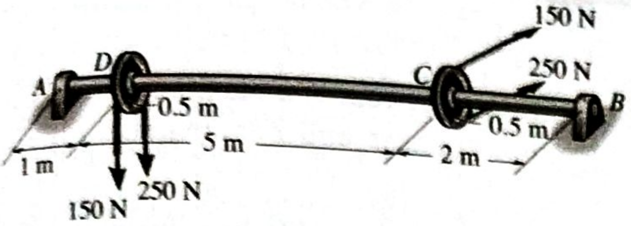
11-41. Solve Prob. 11–40 using the maximum-distortion-energy theory of failure. $\sigma_{allow} = 130$ MPa.



Probs. 11–40/41

11-42. The pulleys attached to the shaft are loaded as shown. If the bearings at A and B exert only horizontal and vertical forces on the shaft, determine the required diameter of the shaft to the nearest millimeter using the maximum-shear-stress theory of failure. $\sigma_{allow} = 85$ MPa.

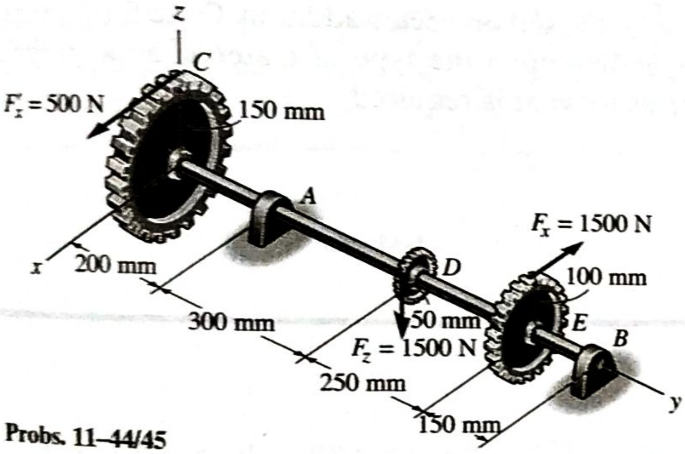
11-43. Solve Prob. 11–42 using the maximum-distortion-energy theory of failure, $\sigma_{allow} = 145$ MPa.



Probs. 11–42/43

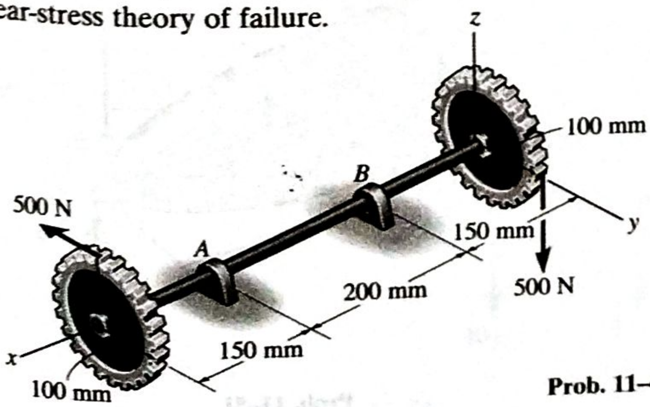
*11–44. The shaft is supported by bearings at A and B that exert force components only in the x and z directions on the shaft. If the allowable normal stress for the shaft is $\sigma_{allow} = 105$ MPa, determine to the nearest mm the smallest diameter of the shaft that will support the loading. Use the maximum-distortion-energy theory of failure.

11–45. Solve Prob. 11–44 using the maximum-shear-stress theory of failure. Take $\tau_{allow} = 42$ MPa.



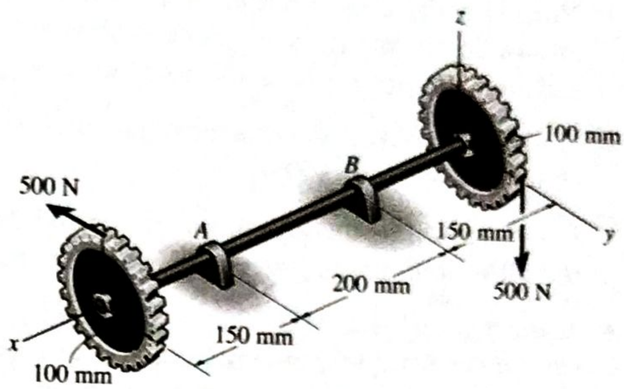
Probs. 11–44/45

■11–46. The tubular shaft has an inner diameter of 15 mm. Determine to the nearest millimeter its outer diameter if it is subjected to the gear loading. The bearings at A and B exert force components only in the y and z directions on the shaft. Use an allowable shear stress of $\tau_{allow} = 70$ MPa, and base the design on the maximum-shear-stress theory of failure.



Prob. 11–46

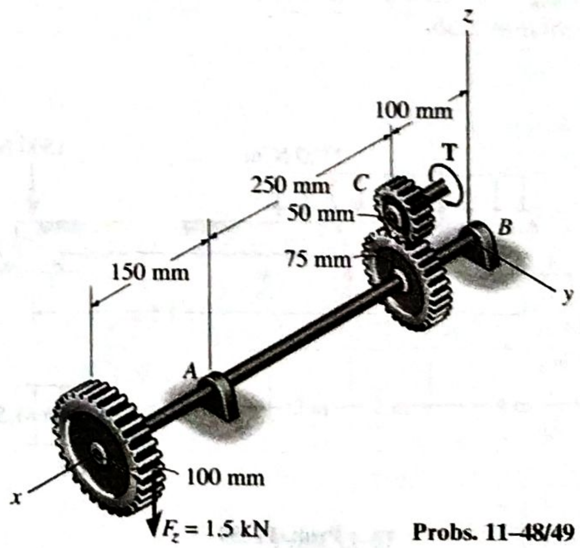
11–47. Determine to the nearest millimeter the diameter of the solid shaft if it is subjected to the gear loading. The bearings at A and B exert force components only in the y and z directions on the shaft. Base the design on the maximum-distortion-energy theory of failure with $\sigma_{allow} = 150$ MPa.



Prob. 11–47

*11–48. The end gear connected to the shaft is subjected to the loading shown. If the bearings at A and B exert only y and z components of force on the shaft, determine the equilibrium torque T at gear C, and then determine the smallest diameter of the shaft to the nearest millimeter that will support the loading. Use the maximum-shear-stress theory of failure with $\tau_{allow} = 60$ MPa.

11–49. Solve Prob. 11–48 using the maximum-distortion-energy theory of failure with $\sigma_{allow} = 80$ MPa.



Probs. 11–48/49