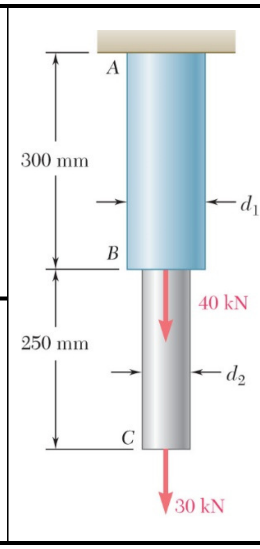
In the Name of GOD

Problem 1-1 Two solid cylindrical rods *AB* and *BC* are welded together at *B* and loaded as shown. Knowing that the average normal stress must not exceed 175 MPa in rod *AB* and 150 MPa in rod *BC,* determine the smallest allowable values of d_1 and d_2.

Answer: $d_1 = 22.6$ mm $d_2 = 15.96$ mm

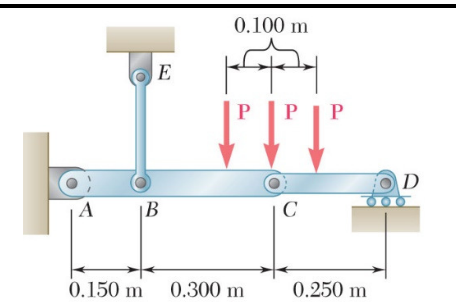
Problem 1-2 Two solid cylindrical rods *AB* and *BC* are welded together at *B* and loaded as shown. Knowing that $d_1 = 50$ mm and $d_2 = 30$ mm, find the average normal stress at the midsection of (a) rod *AB*, (b) rod *BC*.

Answer: (a) 35.7 MPa (b) 42.4 MPa



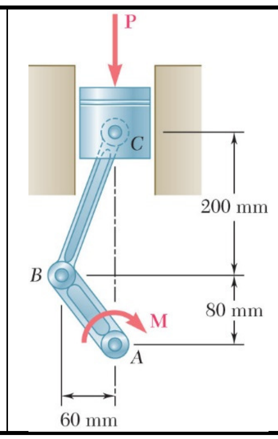
Problem 1-3 Three forces, each of magnitude $P = 4$ kN, are applied to the mechanism shown. Determine the cross-sectional area of the uniform portion of rod *BE* for which the normal stress in that portion is 1100 MPa.

Answer: 285 mm^2

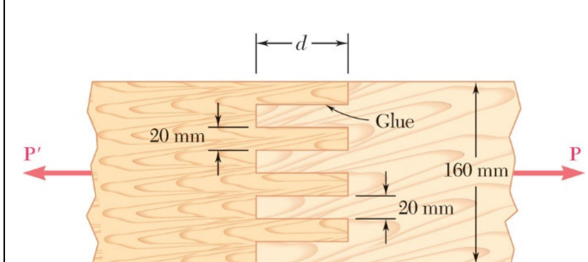


Problem 1-4 A couple M of magnitude 1500 N.m is applied to the crank of an engine. For the position shown, determine (a) the force P required to hold the engine system in equilibrium, (b) the average normal stress in the connecting rod *BC*, which has a 450 mm^2 uniform cross section.

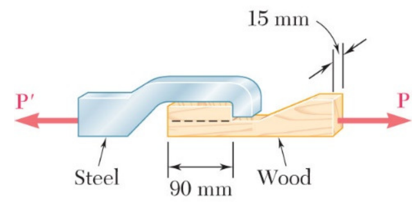
Answer: (a) 17.86 kN (b) -41.4 MPa



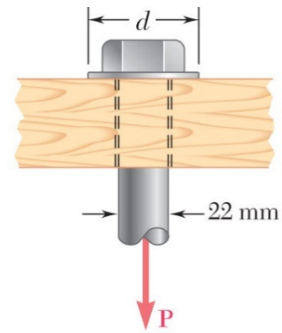
Problem 1-5 Two wooden planks, each 22 mm thick and 160 mm wide, are joined by the glued mortise joint shown. Knowing that the joint will fail when the average shearing stress in the glue reaches 820 kPa, determine the smallest allowable length d of the cuts if the joint is to withstand an axial load of magnitude $P = 7.6$ kN. **Answer:** 60.2 mm



Problem 1-6 When the force P reached 8 kN, the wooden specimen shown failed in shear along the surface indicated by the dashed line. Determine the average shearing stress along that surface at the time of failure. **Answer:** 5.93 MPa

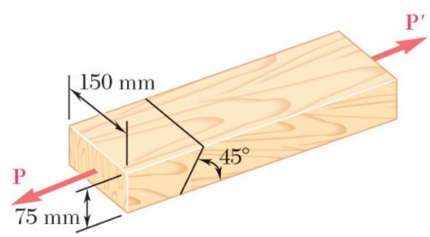


Problem 1-7 The load P applied to a steel rod is distributed to a timber support by an annular washer. The diameter of the rod is 22 mm and the inner diameter of the washer is 25 mm, which is slightly larger than the diameter of the hole. Determine the smallest allowable outer diameter d of the washer, knowing that the axial normal stress in the steel rod is 35 MPa and that the average bearing stress between the washer and the timber must not exceed 5 MPa. **Answer:** 63.3 mm



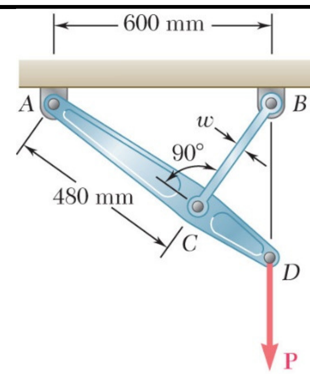
Problem 1-8 Two wooden members of uniform rectangular cross section are joined by the simple glued scarf splice shown. Knowing that the maximum allowable shearing stress in the glued splice is 620 kPa, determine (a) the largest load P that can be safely applied, (b) the corresponding tensile stress in the splice.

Answer: (a) 13.95 kN (b) 620 kPa

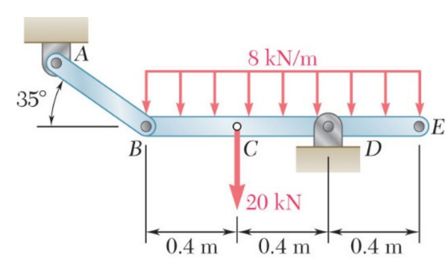


Problem 1-9 Link *BC* is 6 mm thick, has a width $w = 25$ mm, and is made of a steel with a 480 MPa ultimate strength in tension. What is the safety factor used if the structure shown was designed to support a 16 kN load P?

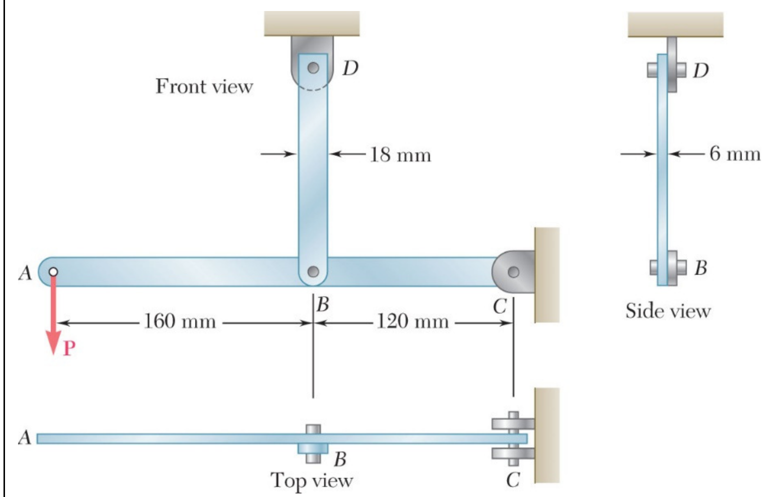
Answer: 3.60



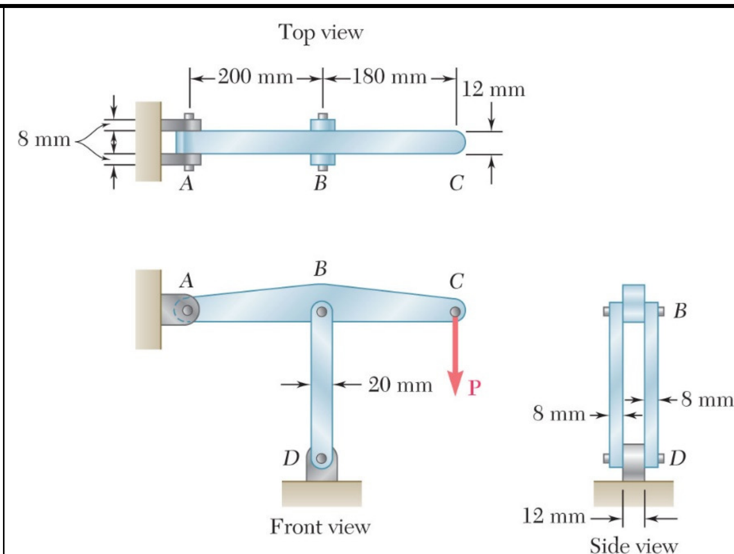
Problem 1-10 Link *AB* is to be made of a steel for which the ultimate normal stress is 450 MPa. Determine the cross-sectional area of *AB* for which the factor of safety will be 3.50. Assume that the link will be adequately reinforced around the pins at *A* and *B*. **Answer:** 168.1mm^2



Problem 1-11 In the steel structure shown, a 6-mm-diameter pin is used at *C* and 10-mm-diameter pins are used at *B* and *D*. The ultimate shearing stress is 150 MPa at all connections, and the ultimate normal stress is 400 MPa in link *BD*. Knowing that a factor of safety of 3.0 is desired, determine the largest load P that can be applied at *A*. Note that link *BD* is not reinforced around the pin holes. **Answer:** 1.683 kN



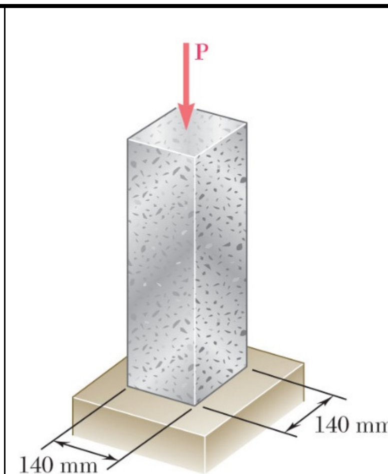
Problem 1-12 In the structure shown, an 8-mm-diameter pin is used at *A*, and 12-mm-diameter pins are used at *B* and *D*. Knowing that the ultimate shearing stress is 100 MPa at all connections and that the ultimate normal stress is 250 MPa in each of the two links joining *B* and *D*, determine the allowable load P if an overall factor of safety of 3.0 is desired. **Answer:** 3.72 kN



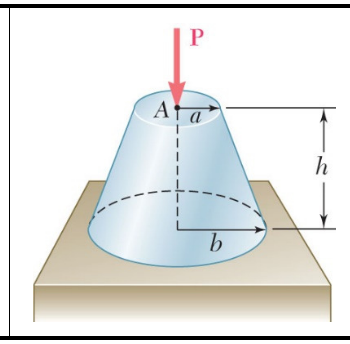
Problem 1-13 A centric load P is applied to the granite block shown. Knowing that the resulting maximum value of the shearing stress in the block is 18 MPa, determine (a) the magnitude of P, (b) the orientation of the surface on which the maximum shearing stress occurs, (c) the normal stress exerted on that surface, (d) the maximum value of the normal stress in the block.

Answer:

(a) 706 kN (b) $\theta = 45^{\circ}$ (c) 18.00 MPa (d) 36.0 MPa (compression)

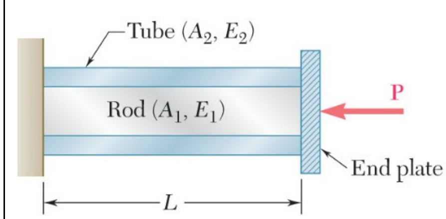


Problem 2-1 The vertical load P is applied at the center *A* of the upper section of a homogeneous frustum of a circular cone of height *h*, minimum radius *a*, and maximum radius *b*. Denoting by *E* the modulus of elasticity of the material and neglecting the effect of its weight, determine the deflection of point *A*. **Answer:** $\dfrac{Ph}{\pi Eab}\downarrow$



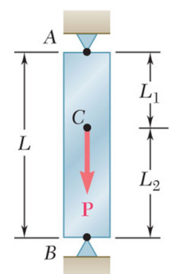
Problem 2-2 A rod of length *L*, cross-sectional area A_1, and modulus of elasticity E_1, has been placed inside a tube of the same length *L*, but of cross-sectional area A_2 and modulus of elasticity E_2 . What is the deformation of the rod and tube when a force P is exerted on a rigid end plate as shown?

Answer: $P_1 = \dfrac{A_1E_1P}{A_1E_1 + A_2E_2}$, $P_2 = \dfrac{A_2E_2P}{A_1E_1 + A_2E_2}$



Problem 2-3 A bar *AB* of length *L* and uniform cross section is attached to rigid supports at *A* and *B* before being loaded. What are the stresses in portions *AC* and *BC* due to the application of a load *P* at point *C* ?

Answer: $\sigma_1 = \dfrac{PL_2}{AL}$, $\sigma_2 = -\dfrac{PL_1}{AL}$

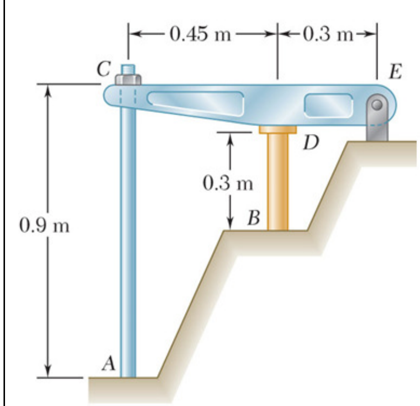


Problem 2-4 The rigid bar *CDE* is attached to a pin support at *E* and rests on the 30-mm diameter brass cylinder *BD*. A 22-mm-diameter steel rod *AC* passes through a hole in the bar and is secured by a nut which is snugly fitted when the temperature of the entire assembly is 20ºC. The temperature of the brass cylinder is then raised to 50ºC while the steel rod remains at 20ºC. Assuming that no stresses were present before the temperature change, determine the stress in the cylinder.

Rod *AC*: Steel $E = 200$ GPa , $\alpha = 11.7\times10^{-6}/{}^\circ\mathrm{C}$

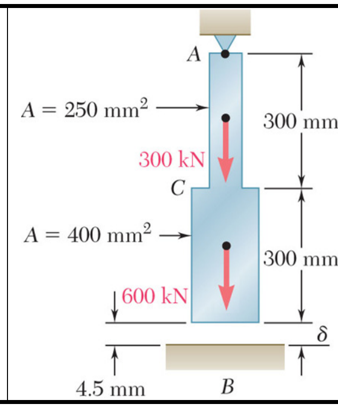
Cylinder *BD*: Brass $E = 105$ GPa , $\alpha = 20.9\times10^{-6}/{}^\circ\mathrm{C}$.

Answer: $\sigma_B = 44.8$ MPa



Problem 2-5 Determine the reactions at A and B for the steel bar assuming that a 4.50-mm clearance exists between the bar and the ground before the loads are applied. Assume $E = 200\ \text{GPa}$.

Answer: $R_A = 785\ \text{kN}$, $R_B = 115.4\ \text{MPa}$

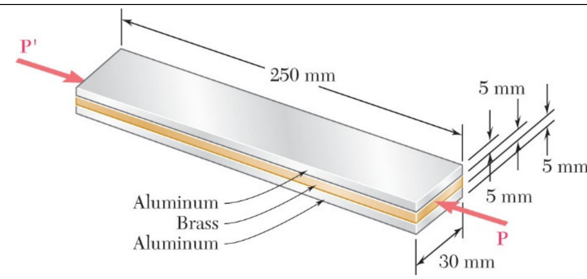


Problem 2-6 A 250-mm bar of 150×30-mm rectangular cross section consists of two aluminum layers, 5 mm thick, brazed to a center brass layer of the same thickness. If it is subjected to centric forces of magnitude $P = 30\ \text{kN}$, and knowing that $E_a = 70\ \text{GPa}$ and $E_b = 105\ \text{GPa}$, determine the normal stress (a) in the aluminum layers, (b) in the brass layer.

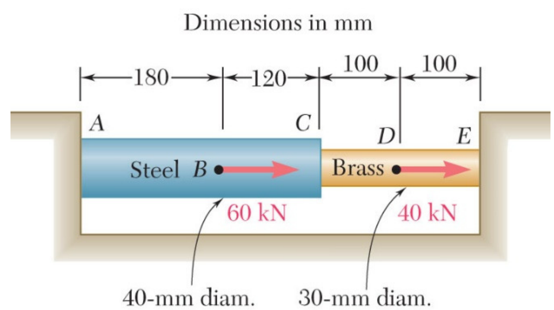
Answer: (a) $-57.1\ \text{MPa}$ (b) $-85.7\ \text{MPa}$

Problem 2-7 Determine the deformation of the composite bar if it is subjected to centric forces of magnitude $P = 45\ \text{kN}$.

Answer: -0.306 mm

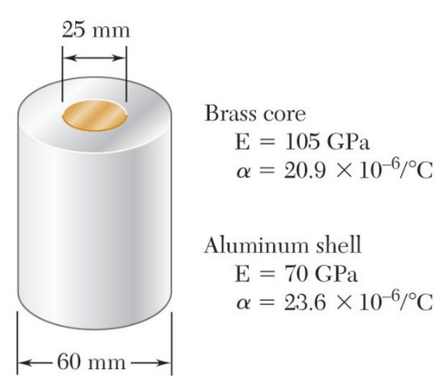


Problem 2-8 Two cylindrical rods, one of steel and the other of brass, are joined at C and restrained by rigid supports at A and E. For the loading shown and knowing that $E_s = 200\ \text{GPa}$ and $E_b = 105\ \text{GPa}$, determine (a) the reactions at A and E, (b) the deflection of point C. **Ans:** (a) $68.2\ \text{kN} \leftarrow$ at A; $37.2\ \text{kN} \leftarrow$ at E. (b) $46.3\ \mu\text{m}$



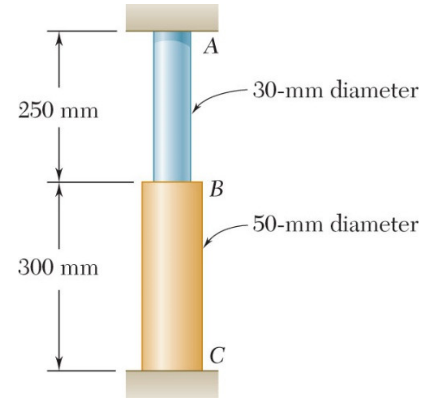
Problem 2-9 The aluminum shell is fully bonded to the brass core and the assembly is unstressed at a temperature of 15°C. Considering only axial deformations, determine the stress in the aluminum when the temperature reaches 195°C.

Answer: -8.15 MPa

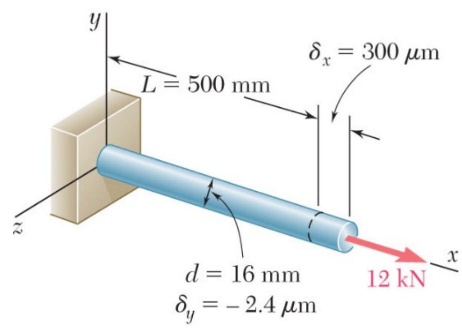


Problem 2-10 A rod consisting of two cylindrical portions *AB* and *BC* is restrained at both ends. Portion *AB* is made of steel (E_s = 200 GPa, $\alpha_s = 11.7\times10^{-6}/°\text{C}$) and portion *BC* is made of brass (E_b = 105 GPa, $\alpha_b = 20.9\times10^{-6}/°\text{C}$). Knowing that the rod is initially unstressed, determine the compressive force induced in *ABC* when there is a temperature rise of 50°C.

Answer: 142.6 kN

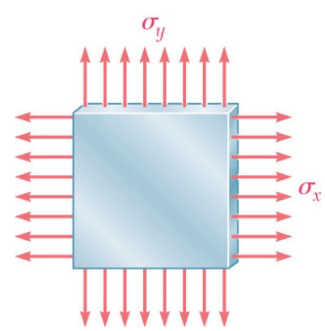


Problem 2-11 A 500-mm-long, 16-mm-diameter rod made of a homogenous, isotropic material is observed to increase in length by 300 mm, and to decrease in diameter by 2.4 mm when subjected to an axial 12-kN load. Determine the modulus of elasticity and Poisson's ratio of the material. **Answer:** $E = 99.5$ GPa , $\nu = 0.25$



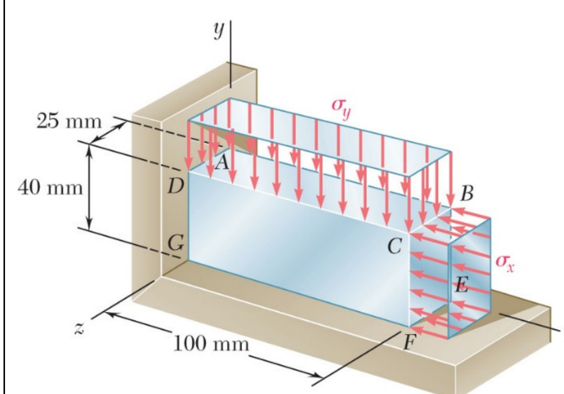
Problem 2-12 In many situations it is known that the normal stress in a given direction is zero. For example, $\sigma_z = 0$ in the case of the thin plate shown. For this case, which is known as plane stress, show that if the strains ε_x and ε_y have been determined experimentally, we can express σ_x, σ_y and ε_z as follows:

Answer: $\sigma_x = E\dfrac{\varepsilon_x + \nu\varepsilon_y}{1-\nu^2}$ $\quad \sigma_y = E\dfrac{\varepsilon_y + \nu\varepsilon_x}{1-\nu^2}$ $\quad \varepsilon_z = -\dfrac{\nu}{1-\nu}\left(\varepsilon_x + \varepsilon_y\right)$



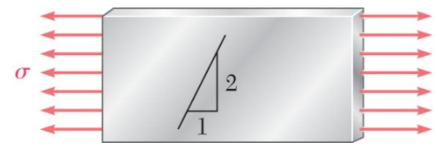
Problem 2-13 The block shown is made of a magnesium alloy for which (E = 45 GPa , ν = 0.35). Knowing that $\sigma_x = -180$ MPa, determine (a) the magnitude of σ_y for which the change in the height of the block will be zero, (b) the corresponding change in the area of the face *ABCD*, (c) the corresponding change in the volume of the block. **Answer:**

(a) -63.0 MPa, (b) $-13.50\ \text{mm}^2$, (c) $-540\ \text{mm}^3$

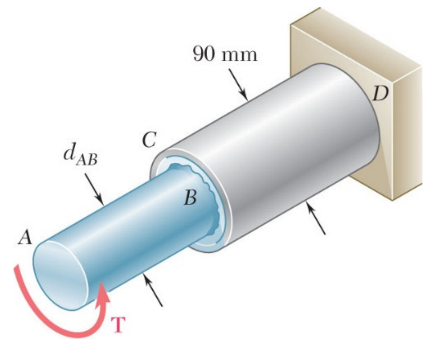


Problem 2-14 An aluminum plate ($E = 74$ GPa and $\nu = 0.33$) is subjected to a centric axial load that causes a normal stress σ. Knowing that, before loading, a line of slope 2:1 is scribed on the plate, determine the slope of the line when $\sigma = 125$ MPa.

Answer: 1.99551

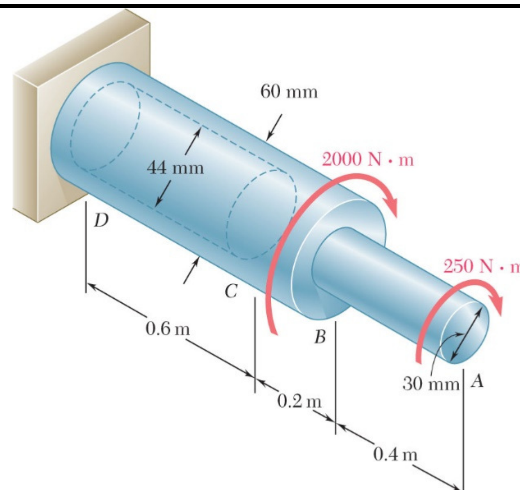


Problem 3-1 The solid rod *AB* has a diameter $d_{AB} = 60$ mm and is made of a steel for which the allowable shearing stress is 85 MPa. The pipe *CD*, which has an outer diameter of 90 mm and a wall thickness of 6 mm, is made of an aluminum for which the allowable shearing stress is 54 MPa. Determine the largest torque T that can be applied at *A*. **Answer:** 3.37 kN.m

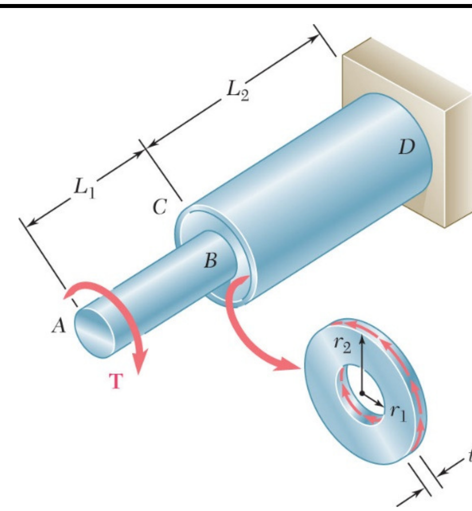


Problem 3-2 The horizontal shaft *AD* is attached to a fixed base at *D* and is subjected to the torques shown. A 44-mm-diameter hole has been drilled into portion *CD* of the shaft. Knowing that the entire shaft is made of steel for which $G = 77$ GPa, determine the angle of twist at end *A*.

Answer: $\phi_A = 2.31^{\circ}$

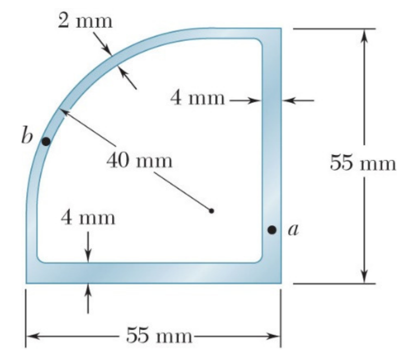


Problem 3-3 An annular plate of thickness *t* and modulus *G* is used to connect shaft *AB* of radius r_1 to tube *CD* of radius r_2. Knowing that a torque T is applied to end *A* of shaft *AB* and that end *D* of tube *CD* is fixed, (a) determine the magnitude and location of the maximum shearing stress in the annular plate, (b) show that the angle through which end *B* of the shaft rotates with respect to end *C* of the tube is $\phi_{BC} = \dfrac{T}{4\pi G t}\left(\dfrac{1}{r_1^2 - r_2^2}\right)$. **Answer:** (*a*) $\dfrac{T}{2\pi t r_1^2}$

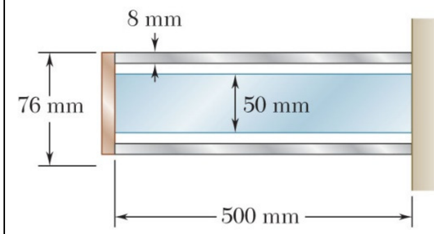


Problem 3-4 A 90-N.m torque is applied to a hollow shaft having the cross section shown. Neglecting the effect of stress concentrations, determine the shearing stress at points *a* and *b*.

Answer: 4.73 MPa at *a*; 9.46 MPa at *b*.

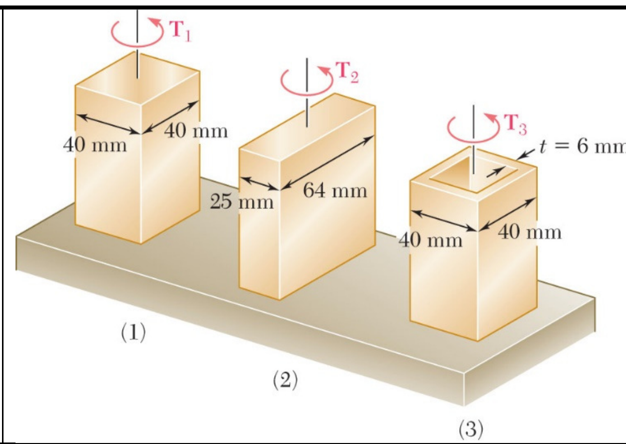


Problem 3-5 A steel shaft and an aluminum tube are connected to a fixed support and to a rigid disk as shown in the cross section. Knowing that the initial stresses are zero, determine the maximum torque T_0 that can be applied to the disk if the allowable stresses are 120 MPa in the steel shaft and 70 MPa in the aluminum tube. Use $G = 77$ GPa for steel and $G = 27$ GPa for aluminum. **Answer:** $T_0 = 6.325$ kN.m



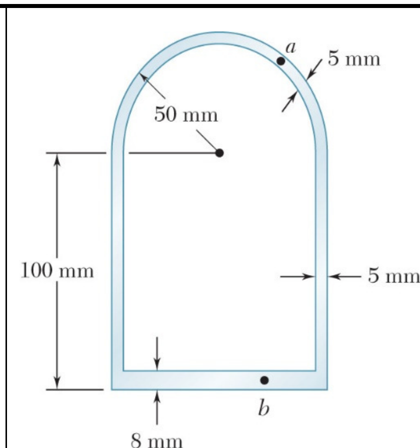
Problem 3-6 Using $\tau_{all} = 40$ MPa, determine the largest torque that may be applied to each of the brass bars and to the brass tube shown. Note that the two solid bars have the same cross sectional area, and that the square bar and square tube have the same outside dimensions. **Answer:**

$T_1 = 532$ N.m , $T_2 = 414$ N.m , $T_3 = 555$ N.m



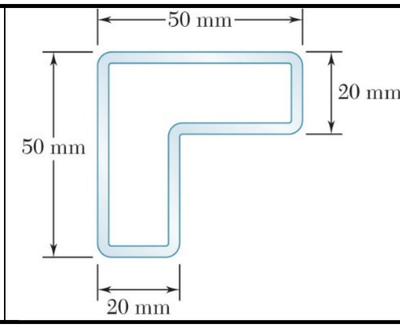
Problem 3-7 A 5.6 kN.m-torque is applied to a hollow shaft having the cross section shown. Neglecting the effect of stress concentrations, determine the shearing stress at points *a* and *b*.

Answer: 44.2 MPa at *a*; 27.6 MPa at *b*.



Problem 3-8 A hollow member having the cross section shown is formed from sheet metal of 2-mm thickness. Knowing that the shearing stress must not exceed 3 MPa, determine the largest torque that can be applied to the member.

Answer: 16.85 N.m

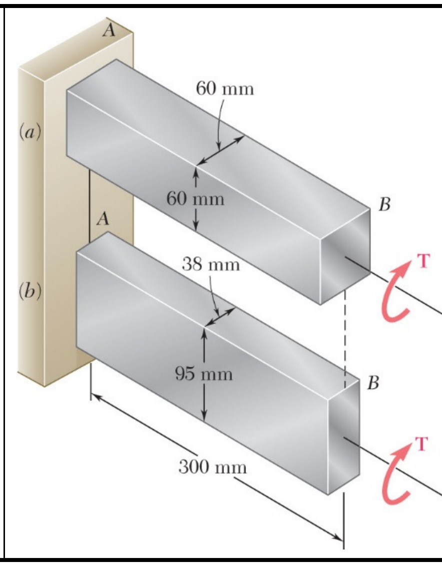


Problem 3-9 Each of the two aluminum bars shown is subjected to a torque of magnitude $T = 1800$ N.m. Knowing that $G = 26$ GPa, determine for each bar the maximum shearing stress and the angle of twist at *B*.

Answer: (*a*) 40.1 MPa; 0.653°. (*b*) 50.9 MPa; 0.917°.

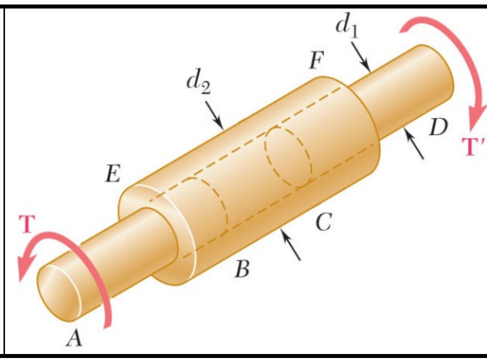
Determine the largest torque T that can be applied to each of the two aluminum bars shown and the corresponding angle of twist at *B*, knowing that $\tau_{all} = 50$ MPa and $G = 26$ GPa.

Answer: (*a*) 2.25 kN.m; 0.815°. (*b*) 1.770 kN.m; 0.901°.



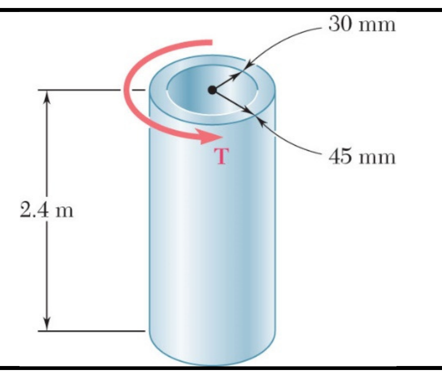
Problem 3-10 Two solid brass rods *AB* and *CD* are brazed to a brass sleeve *EF*. Determine the ratio d_2/d_1 for which the same maximum shearing stress occurs in the rods and in the sleeve.

Answer: 1.221



Problem 3-11 (a) Determine the torque T that causes a maximum shearing stress of 45 MPa in the hollow cylindrical steel shaft shown. (b) Determine the maximum shearing stress caused by the same torque T in a solid cylindrical shaft of the same cross-sectional area.

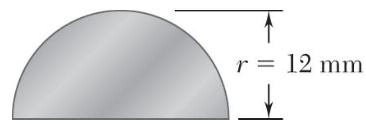
Answer: (*a*) 5.17 kN.m . (*b*) 87.2 MPa .



Problem 3-12 A solid shaft and a hollow shaft are made of the same material and are of the same weight and length. Denoting by n the ratio c_1/c_2, show that the ratio T_s/T_h of the torque T_s in the solid shaft to the torque T_h in the hollow shaft is (a) $\sqrt{(1-n^2)}/(1+n^2)$ if the maximum shearing stress is the same in each shaft, (b) $(1-n^2)/(1+n^2)$ if the angle of twist is the same for each shaft.

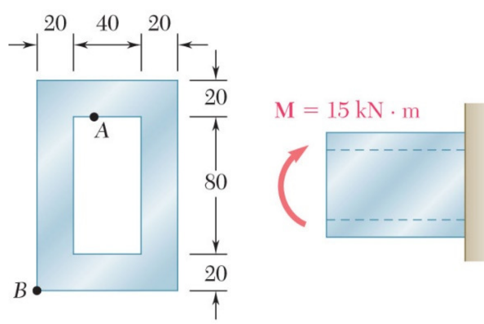
Problem 4-1 An aluminum rod with a semicircular cross section of radius $r = 12$ mm is bent into the shape of a circular arc of mean radius $\rho = 2.5$ m. Knowing that the flat face of the rod is turned toward the center of curvature of the arc, determine the maximum tensile and compressive stress in the rod. Use $E = 70$ GPa.

Answer: $\sigma_{\text{m}} = 193.4$ MPa , $\sigma_{\text{comp}} = -142.6$ MPa



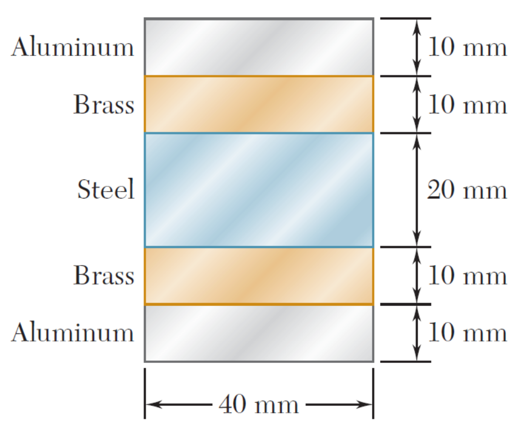
Problem 4-2 Knowing that the couple shown acts in a vertical plane, determine the stress at (a) point A, (b) point B.

Answer: (a) -61.6 MPa , (b) 91.7 MPa.



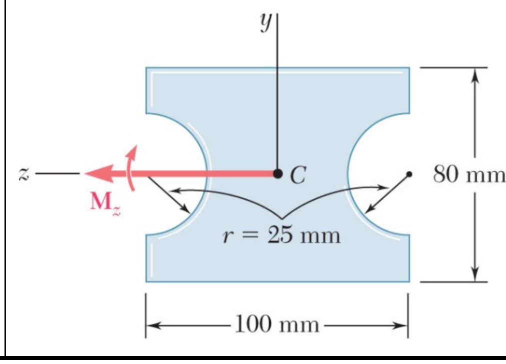
Dimensions in mm

Problem 4-3 Five metal strips, each 40 mm wide, are bonded together to form the composite beam shown. The modulus of elasticity is 210 GPa for the steel, 105 GPa for the brass, and 70 GPa for the aluminum. Knowing that the beam is bent about a horizontal axis by a couple of moment 1800 N.m, determine (a) the maximum stress in each of the three metals, (b) the radius of curvature of the composite beam. **Answer:** (a) (aluminum) 62.3 MPa; (brass) 62.3 MPa; (steel) 62.3 MPa; (b) 33.7 m



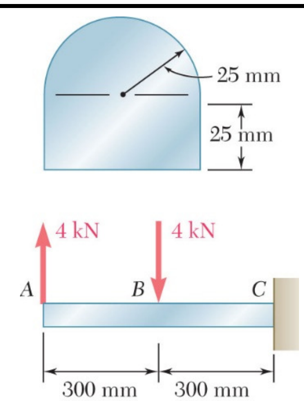
Problem 4-4 A nylon spacing bar has the cross section shown. Knowing that the allowable stress for the grade of nylon used is 24 MPa, determine the largest couple **M**z that can be applied to the bar.

Answer: 2.38 kN.m



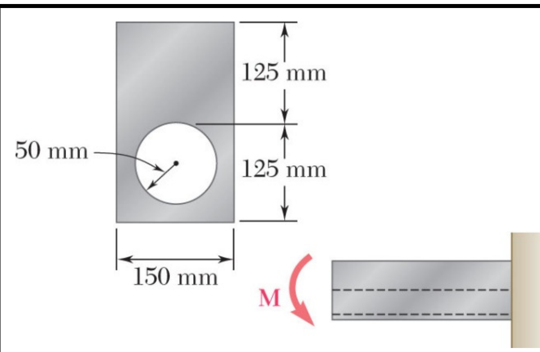
Problem 4-5 Two vertical forces are applied to a beam of the cross section shown. Determine the maximum tensile and compressive stresses in portion *BC* of the beam.

Answer: 67.8 MPa; -81.8 MPa .



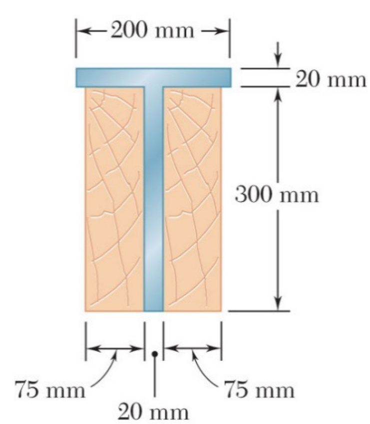
Problem 4-6 Knowing that for the extruded beam shown the allowable stress is 120 MPa in tension and 150 MPa in compression, determine the largest couple M that can be applied.

Answer: 177.8 kN.m



Problem 4-7 Two steel plates have been welded together to form a beam in the shape of a T that has been strengthened by securely bolting to it the two oak timbers shown. The modulus of elasticity is 12.5 GPa for the wood and 200 GPa for the steel. Knowing that a bending moment $M = 40$ kN.m is applied to the composite beam, determine (a) the maximum stress in the wood, (b) the stress in the steel along the top edge.

Answer: $\sigma_w = 4.57$ MPa , $\sigma_s = 43.8$ MPa

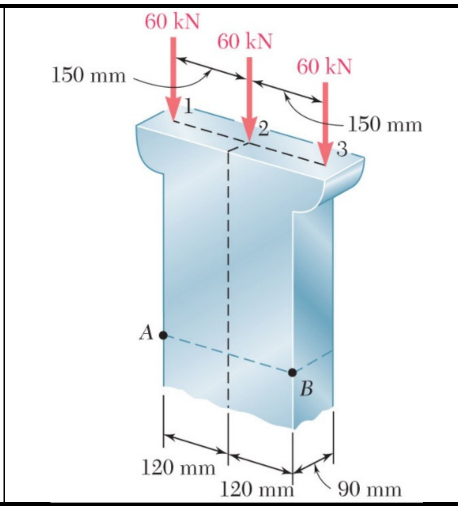


Problem 4-8 Determine the stress at points *A* and *B*, (a) for the loading shown, (b) if the 60-kN loads are applied at points 1 and 2 only.

Answer:

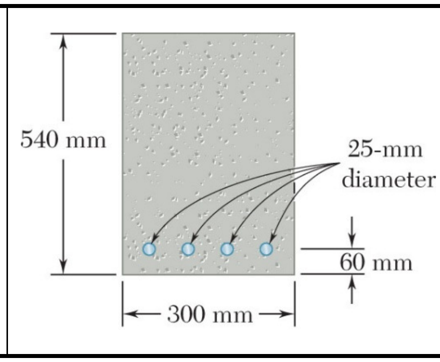
(*a*) (*A* and *B*) −8.33 MPa.

(*b*) (*A*) −15.97 MPa; (*B*) 4.86 MPa.



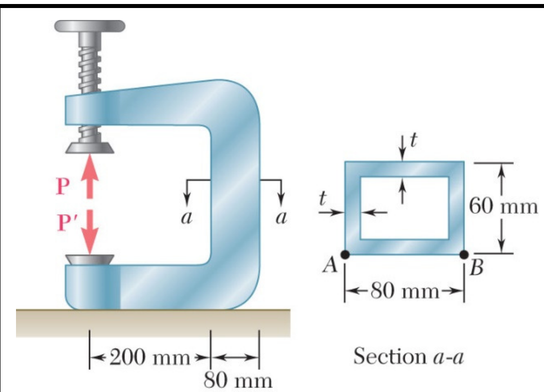
Problem 4-9 The reinforced concrete beam shown is subjected to a positive bending moment of 175 kN.m. Knowing that the modulus of elasticity is 25 GPa for the concrete and 200 GPa for the steel, determine (a) the stress in the steel, (b) the maximum stress in the concrete.

Answer: (*a*) 212 MPa. (*b*) −15.59 MPa.



Problem 4-10 The vertical portion of the press shown consists of a rectangular tube of wall thickness $t = 10$ mm. Knowing that the press has been tightened on wooden planks being glued together until $P = 20$ kN, determine the stress at (a) point *A*, (b) point *B*.

Answer: (*a*) 112.7 MPa. (*b*) −96.0 MPa.

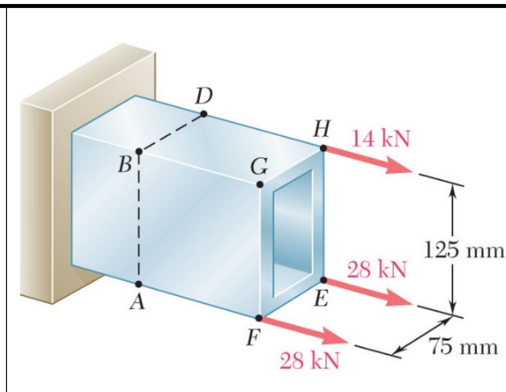


Problem 4-11 The tube shown has a uniform wall thickness of 12 mm. For the loading given, determine (a) the stress at points *A* and *B*, (b) the point where the neutral axis intersects line *ABD*.

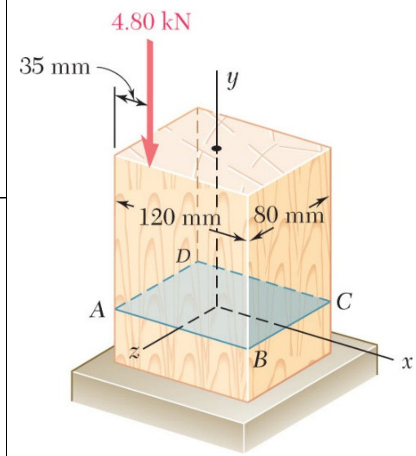
Answer:

(*a*) (*A*) 31.5 MPa; (*B*) −10.39 MPa

(*b*) 94.0 mm above point *A*.



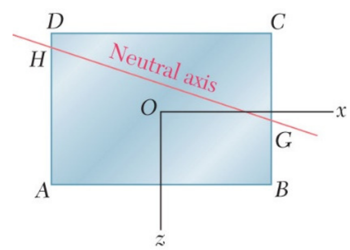
Problem 4-12 A vertical 4.80-kN load is applied as shown on a wooden post of rectangular cross section, 80 by 120 mm. (a) Determine the stress at points *A*, *B*, *C*, and *D*. (b) Locate the neutral axis of the cross section. **Answer:**



$\sigma_A = -2.625$ MPa , $\sigma_B = -1.375$ MPa

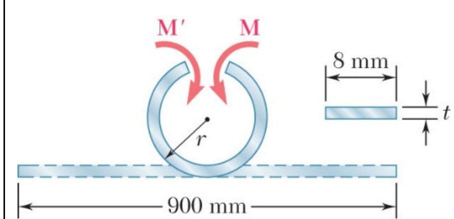
$\sigma_C = +1.625$ MPa , $\sigma_D = +0.375$ MPa

$BG = 36.7$ mm , $HA = 70$ mm

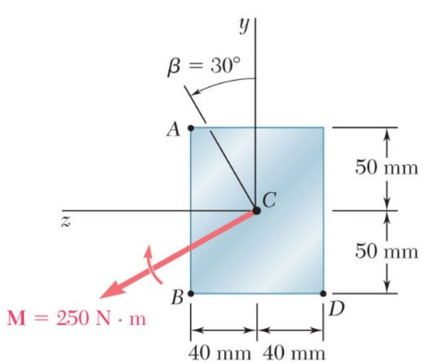


Problem 4-13 A 900-mm strip of steel is bent into a full circle by two couples applied as shown. Determine (a) the maximum thickness *t* of the strip if the allowable stress of the steel is 420 MPa, (b) the corresponding moment M of the couples. Use $E = 200$ GPa .

Answer: (*a*) 0.602 mm . (*b*) 0.203 N.m .



Problem 4-14 The couple **M** is applied to a beam of the cross section shown in a plane forming an angle *β* with the vertical. Determine the stress at (a) point *A*, (b) point *B*, (c) point *D*.

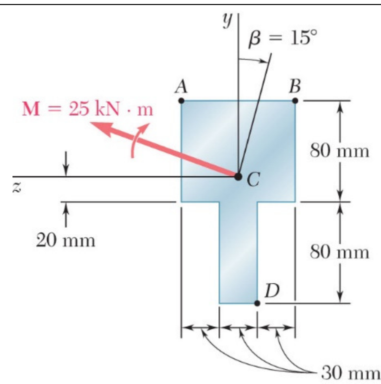


Answer:

(*a*) – 2.80 MPa.

(*b*) 0.452 MPa.

(*c*) 2.80 MPa.

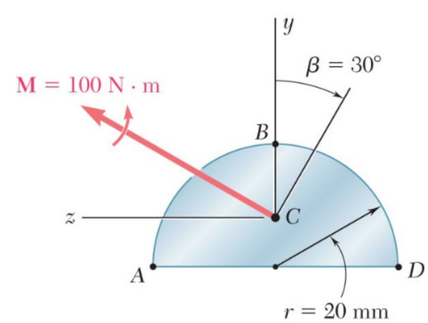


Answer:

(*a*) – 29.3 MPa.

(*b*) –144.8 MPa.

(*c*) –125.9 MPa.



Answer:

(*a*) 57.8 MPa.

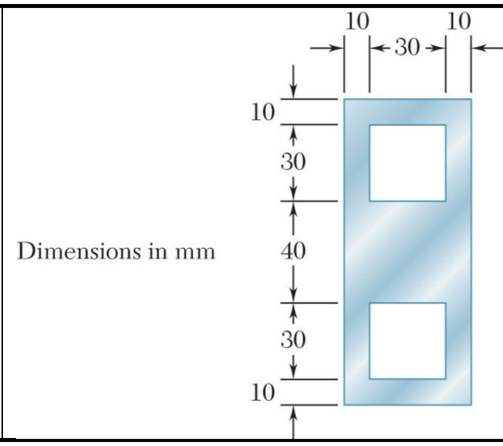
(*b*) – 56.8 MPa.

(*c*) 25.9 MPa.

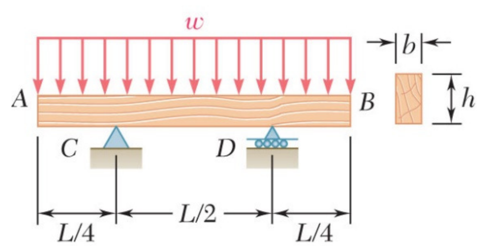
Problem 5-1 For a beam having the cross section shown, determine the largest allowable vertical shear if the shearing stress is not to exceed 60 MPa.

Answer:

120.3 kN.



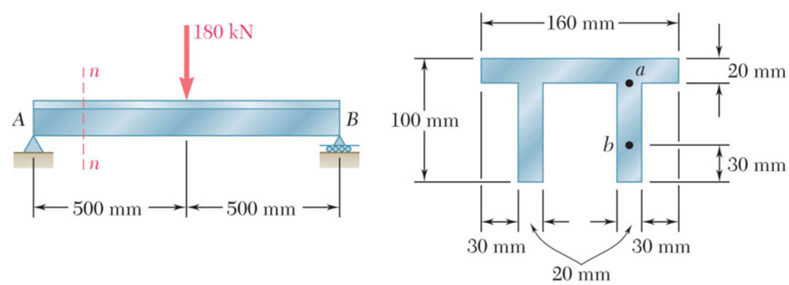
Problem 5-2 A timber beam *AB* of length *L* and rectangular cross section carries a uniformly distributed load *w* and is supported as shown. Show that the ratio τ_m/σ_m of the maximum values of the shearing and normal stresses in the beam is equal to $2h/L$, where *h* and *L* are, respectively, the depth and the length of the beam.



Problem 5-3 For the beam and loading shown, consider section *n-n* and determine the shearing stress at (a) point *a*, (b) point *b*. (c) the largest shearing stress in section *n-n*.

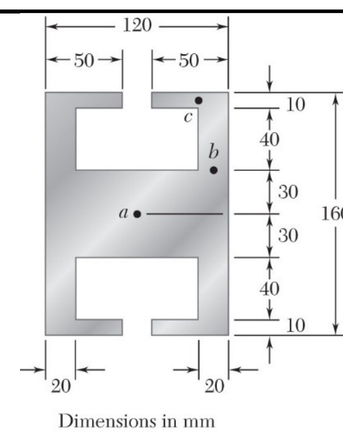
Answer:

(*a*) 31.0 MPa . (*b*) 23.2 MPa .
(*c*) 32.7 MPa .



Problem 5-4 Knowing that a given vertical shear **V** causes a maximum shearing stress of 75 MPa in an extruded beam having the cross section shown, determine the shearing stress at the three points indicated.

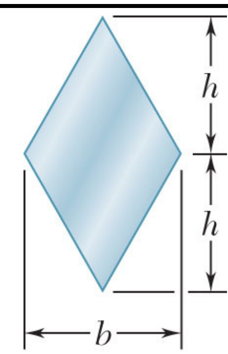
Answer: (*a*) 33.7 MPa . (*b*) 75.0 MPa . (*c*) 43.5 MPa .



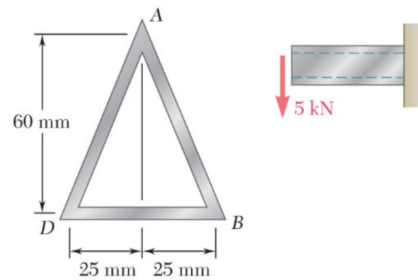
Problem 5-5 A beam having the cross section shown is subjected to a vertical shear V. Determine (a) the horizontal line along which the shearing stress is maximum, (b) the constant k in the following expression for the maximum shearing stress $\tau_{max} = kV/A$ where A is the cross-sectional area of the beam.

Answer:

(a) $h/4$ from neutral axis. (b) 1.125.



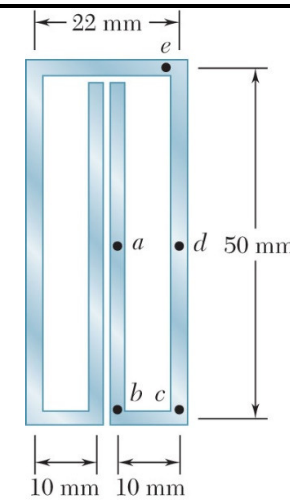
Problem 5-6 The thin-walled extruded beam shown is made of aluminum and has a uniform 3-mm wall thickness. Knowing that the shear in the beam is 5 kN, determine (a) the shearing stress at point A, (b) the maximum shearing stress in the beam. Note: The dimensions given are to lines midway between the outer and inner surfaces of the beam. **Answer:** $\tau_{max} = \tau_E = 18.54$ MPa



Problem 5-7 A plate of 2-mm thickness is bent as shown and then used as a beam. For a vertical shear of 5 kN, determine the shearing stress at the five points indicated.

Answer: (a) 10.76 MPa . (b) 0 MPa . (c) 11.21 MPa .

(d) 22.0 MPa . (e) 9.35 MPa .

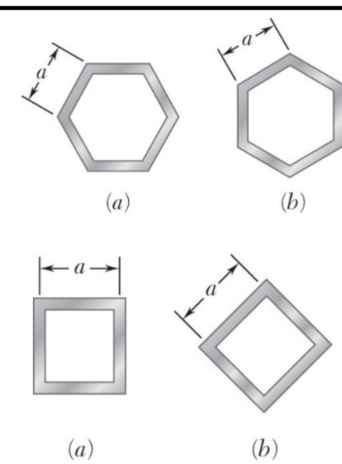


Problem 5-8 An extruded beam has a uniform wall thickness t. Denoting by **V** the vertical shear and by A the cross-sectional area of the beam, express the maximum shearing stress as $\tau_{max} = kV/A$ and determine the constant k for each of the two orientations shown.

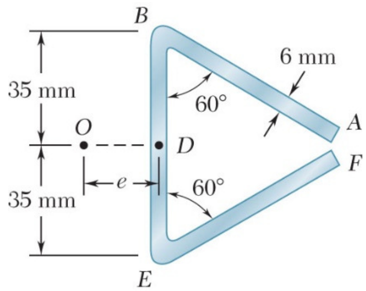
Answer:

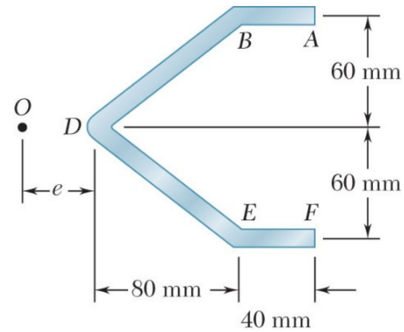
(a) 2.08 . (b) 2.10.

(a) 2.25 . (b) 2.12.



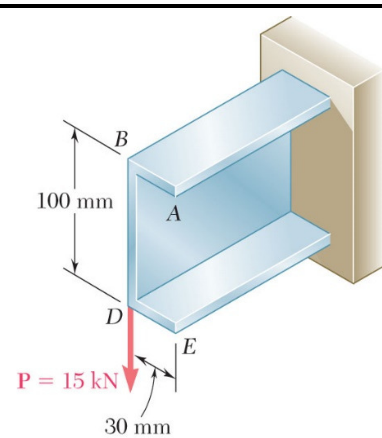
Problem 5-9 Determine the location of the shear center O of a thin-walled beam of uniform thickness having the cross section shown. **Answer:** $e = 20.2$ mm $e = 6.14$ mm





Problem 5-10 A steel plate, 160 mm wide and 8 mm thick, is bent to form the channel shown. Knowing that the vertical load P acts at a point in the midplane of the web of the channel, determine the maximum shearing stress in the channel caused by the load P.

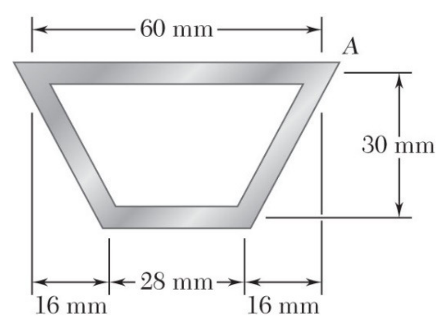
Answer: 65.9 MPa.



Problem 5-11 An extruded beam has the cross section shown and a uniform wall thickness of 3 mm. For a vertical shear of 10 kN, determine (a) the shearing stress at point A, (b) the maximum shearing stress in the beam. Also sketch the shear flow in the cross section.

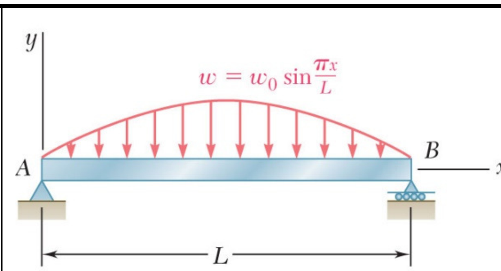
Answer:

(a) 50.9 MPa. (b) 62.4 MPa.

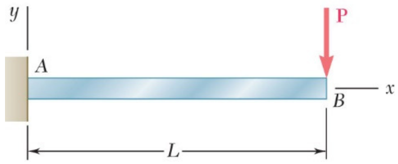


Problem 6-1 For the beam and loading shown, determine (a) the equation of the elastic curve, (b) the slope at end A, (c) the maximum deflection. **Answer:**

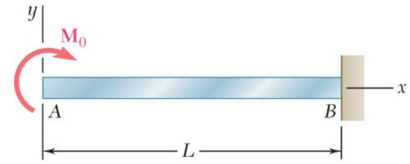
$$EIy = -w_0 \frac{L^4}{\pi^4} \sin \frac{\pi x}{L} \qquad \theta_A = \frac{w_0 L^3}{\pi^3 EI} \qquad y_{max} = \frac{w_0 L^4}{\pi^4 EI}$$



Problem 6-2 For the loading shown, determine (a) the equation of the elastic curve for the cantilever beam *AB*, (b) the deflection at the free end, (c) the slope at the free end.



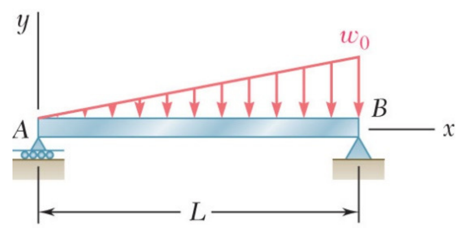
$$(a)\ y = -\frac{Px^2}{6EI}(3L - x).\quad (b)\ \frac{PL^3}{3EI}.\quad (c)\ \frac{PL^2}{2EI}.$$



$$(a)\ y = -\frac{M_0}{2EI}(L - x)^2.\quad (b)\ \frac{M_0L^2}{2EI}.\quad (c)\ \frac{M_0L}{EI}.$$

Problem 6-3 For the beam and loading shown, (a) express the magnitude and location of the maximum deflection in terms of w_0, L, E, and I.

Answer: $0.00652\dfrac{w_0L^4}{EI}$ at $x = 0.519L$.



Problem 6-4 For the beam and loading shown, determine (a) the equation of the elastic curve, (b) the slope at end *A*, (c) the deflection at the midpoint of the span.

Answer:

$$(a)\ y = w_0\frac{x^6 - 15L^2x^4 + 25L^3x^3 - 11L^5x}{360EIL^2}.$$

$$(b)\ \frac{11w_0L^3}{30EI}.\quad (c)\ 0.00916\frac{w_0L^4}{EI}.$$