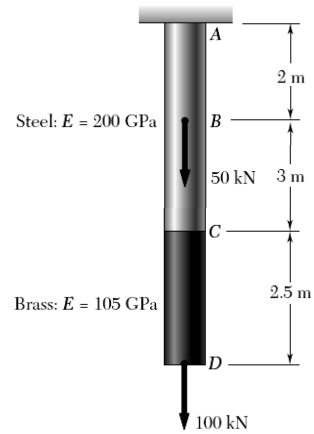
MECHANICS (ME10001)

Tutorial 7: Concept of Stress and Strain - II

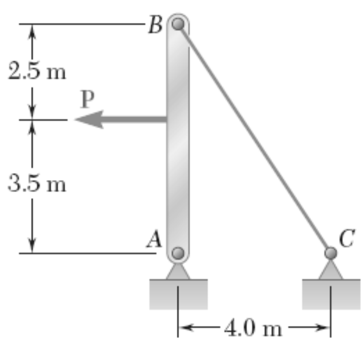
1. An 80-m-long wire of 5-mm diameter is made of a steel with E=200 GPa and an ultimate tensile strength of 400 MPa. If a factor of safety of 3.2 is desired, determine (a) the largest allowable tension in the wire, (b) the corresponding elongation of the wire. [(a) 2.45 kN, (b) 50 mm]

2. Two gauge marks are placed exactly 250 mm apart on a 12 mm diameter aluminum rod. Knowing that, with an axial load of 6000 N acting on the rod, the distance between the gage marks is 250.18 mm; determine the modulus of elasticity of the aluminum used in the rod. [73.68 GPa]

3. The 36-mm-diameter steel rod ABC and a brass rod CD of the same diameter are joined at point C to form the 7.5-m rod ABCD. For the loading shown, and neglecting the weight of the rod, determine the deflection of points C and D. [2.9474 mm, 5.2865 mm]

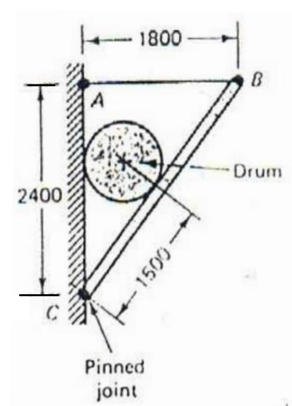


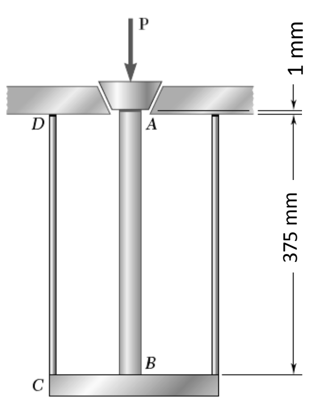
4. A square yellow-brass bar must not stretch more than 2.5 mm when it is subjected to a tensile load. Knowing that E=105 GPa and that the allowable tensile strength is 180 MPa, determine (a) the maximum allowable length of the bar, (b) the required dimensions of the cross section if the tensile load is 40 kN. [(a) 1.458 m, (b) 14.9071 mm]



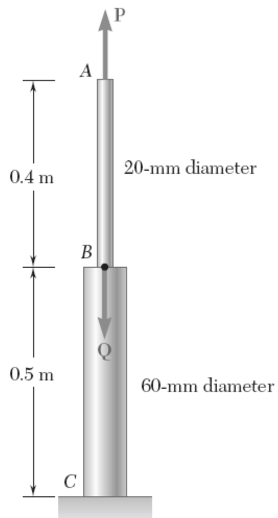
5. The 4-mm-diameter cable BC is made of a steel with E = 200 GPa. Knowing that the maximum stress in the cable must not exceed 190 MPa and that the elongation of the cable must not exceed 6 mm, find the maximum load P that can be applied as shown. [P=1.989 kN]

6. All the joints of the wall bracket may be considered as pin connected. Steel rod AB (E = 200 GPa) has a cross sectional area of 5 mm^2 and the member BC is a rigid beam. If a 1000 mm diameter frictionless drum of weight 5000 N is placed in the position shown, what will be the elongation of rod AB? [9.375 mm]



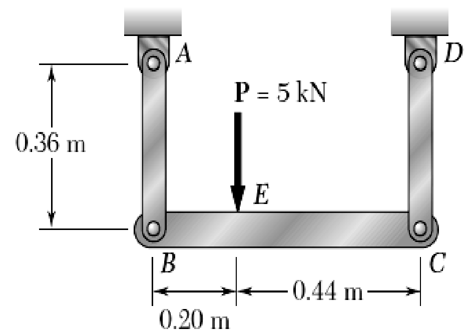


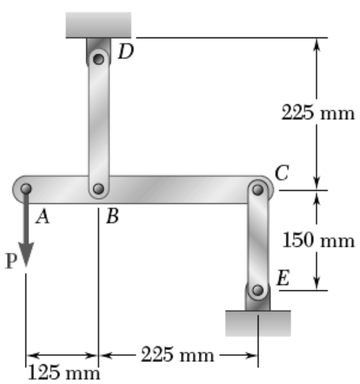
7. The brass tube AB (E = 105 GPa) has a cross-sectional area of 140 mm^2 and is fitted with a plug at A. The tube is attached at B to a rigid plate that is itself attached at C to the bottom of an aluminum cylinder (E = 72 GPa) with a cross-sectional area of 250 mm^2. The cylinder is then hung from a support at D. In order to close the cylinder, the plug must move down through 1 mm. Determine the force P that must be applied to the tube. [P=21.578 kN]



8. Both portions of the rod ABC are made of an aluminum for which E = 70 GPa. Knowing that the magnitude of P is 4 kN, determine (a) the value of Q so that the deflection at A is zero, (b) the corresponding deflection of B. [(a) 32.8 kN, (b) -0.0728 mm]

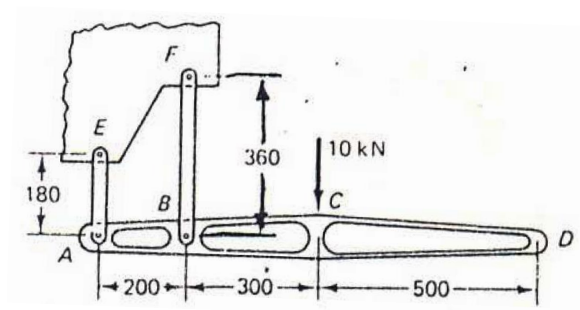
9. Each of the links *AB* and *CD* is made of aluminum of *E* =75 GPa and has a cross-sectional area of 125 mm^2. Knowing that they support the rigid member *BC;* determine the deflection of point *E*. [0.1095 mm]



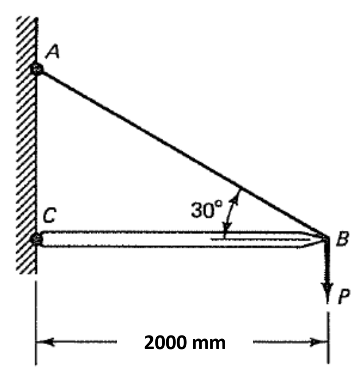


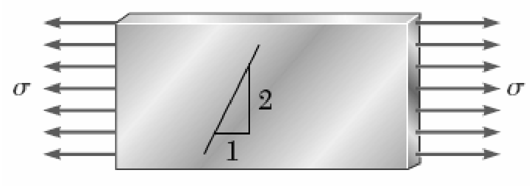
10. Link BD is made of brass (E = 105 GPa) and has a cross-sectional area of 240 mm^2. Link CE is made of aluminum (E = 72 GPa) and has a cross-sectional area of 300 mm^2. Knowing that they support rigid member ABC, determine the maximum force P that can be applied vertically at point A if the deflection of A is not to exceed 0.35 mm. [P=14.737 kN]

11. A rigid machine part AD is suspended by double hangers AE of cross sectional area of 50 mm^2 each and BF of cross sectional area of 100 mm^2 each respectively. The elastic modulus of hanger material is 180GPa and yield stress is 600MPa. Determine the deflection that would occur at D by applying a downward force of 10kN at C. Check hanger stress to assure that an elastic solution is applicable. [1.85 mm]



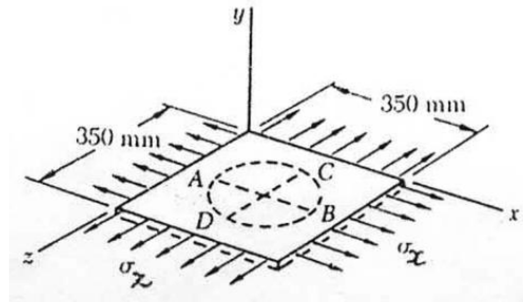
12. The jib crane shown in the figure has the cable AB of cross-sectional area of 300 mm^2 and the bar BC of cross-sectional area of 320 mm^2. (a) Determine the deflection vector at B caused by the application of a force P=16 kN. (b) Hence, estimate the vertical stiffness of the crane at point B. Take E=200 GPa. [(a) (-0.87i-3.9638j) mm, (b) 4036.53 N/mm]

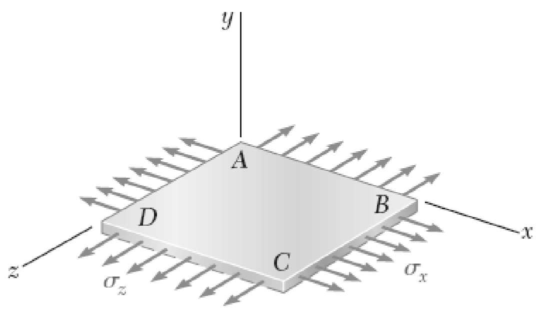




13. An aluminum plate ($E = 74$ GPa, $\nu = 0.33$) is subjected to a centric axial load that causes a normal stress σ. Knowing that, before loading, a line of slope 2:1 is scribed on the plate, determine the slope of the line when $\sigma = 125$ MPa. [1.9955]

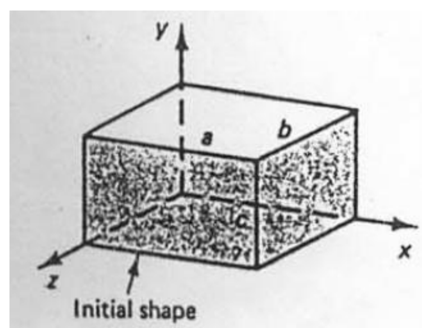
14. A circle of diameter 200mm is scribed on an unstressed aluminum plate of thickness 18 mm. Forces acting in the plane of the plate later causes normal stresses σ_x=85 MPa and σ_z=150 MPa. For E=70 GPa and $\nu = 0.33$, determine the changes in (a) the length of diameter AB, (b) the length of diameter CD, (c) the thickness of the plate and (d) the volume of the plate. [(a) 0.1014 mm, (b) 0.3484 mm, (c) -0.01994 mm, (d)=2516.6547 mm^3]

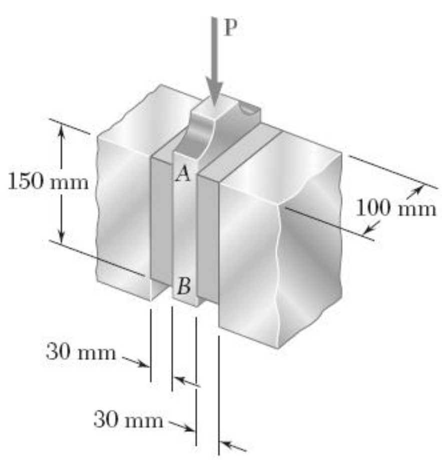




15. The homogeneous plate ABCD is subjected to a biaxial loading as shown. It is known that $\sigma_z = k$ and that the change in length of the plate in the x direction must be zero, that is, $\varepsilon_x = 0$. If the modulus of elasticity is E and Poisson's ratio is ν, determine (a) the required magnitude of σ_x, (b) the ratio k/ε_z. [(a) νk, (b) $E/(1-\nu^2)$]

16. A rectangular steel block has the following dimensions: a=50 mm, b=75 mm and c=100 mm. The faces of this block are subjected to uniformly distributed forces of 180 kN (tension) in the x-direction, 200 kN (tension) in the y-direction and 240 kN (compression) in the z-direction. Determine the magnitude of a single system of forces acting only in the y-direction that would cause the same deformation in the y-direction as the initial forces. Consider ν =0.25. [222.49 kN]





17. A vibration isolation unit consists of two blocks of rubber bonded to a rigid metal plate AB and to rigid supports as shown. Knowing that a force of magnitude P =25 kN causes a deflection d = 1.5 mm of plate AB in the downward direction, determine the modulus of rigidity of the rubber used. [16.67 MPa]