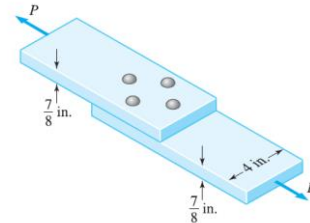


Exam 1
March 14, 2015
90 minutes

Problem 1 (20 Points)

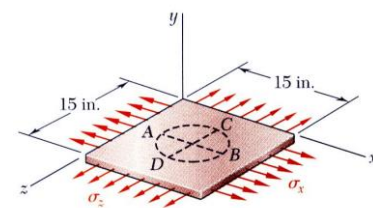
The two wooden boards are fastened together by four bolts of $\frac{3}{4}$ -in. diameter. Assume that the applied load is distributed evenly among the four bolts, and neglect friction between the plates. Using a factor of safety of 2, find the maximum load P that can be applied if the ultimate stresses are 28 ksi for the shear in the bolt and 36 ksi for bearing in the board.

**Problem 2 (25 Points)**

A circle of diameter $d = 9$ in. is scribed on an unstressed aluminum plate of thickness $t = 3/4$ in. Forces acting in the plane of the plate later cause normal stresses $\sigma_x = 12$ ksi and $\sigma_z = 20$ ksi.

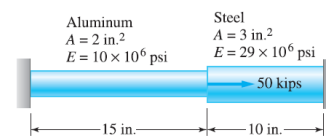
For $E = 10 \times 10^6$ psi and $\nu = 1/3$, determine the change in:

- the length of diameter AB ,
- the length of diameter CD ,
- the thickness of the plate, and
- the volume of the plate.

**Problem 3 (30 Points)**

The composite bar is firmly fixed at both ends. The bar is stress-free at $60^\circ F$.

- Compute the stress in each material after the 50-kip force is applied and the temperature is increased to $120^\circ F$. Use $\alpha = 6.5 \times 10^{-6}/^\circ F$ for steel and $\alpha = 12.8 \times 10^{-6}/^\circ F$ for aluminum.
- At what temperature will the aluminum and steel have stresses of equal magnitude after the 50-kip force is applied?

**Problem 4 (25 Points)**

The rigid bar $ABCD$ is supported by a pin at B and restrained by identical steel bars at C and D , each of area 250 mm^2 . If the temperature is increased by $80^\circ C$, determine the force P that will cause the bar at C to be stress-free. Use $E = 200 \text{ GPa}$ and $\alpha = 12 \times 10^{-6}/^\circ C$.

