Problem 11.1 (10 Points)

The elbow shown below is fixed to the ground at the center of the coordinate system. Two loads 75 N and 150 N are applied at the free end in the y and z directions, respectively. If the elbow has a circular cross-section with a diameter of 20 cm, find:

(a) The internal reactions at a cross-section perpendicular to the y-axis at point A (y = 1 m). Classify the forces as either axial or shear forces, and the moments as either bending or torsion.

(b) The stresses induced (magnitude and direction) in the stress elements M and N on the cross-section at A, shown in Fig. 11.1 (b), due to each reaction calculated in part (a). Use the three-dimensional stress elements in Fig. 11.1 (c).

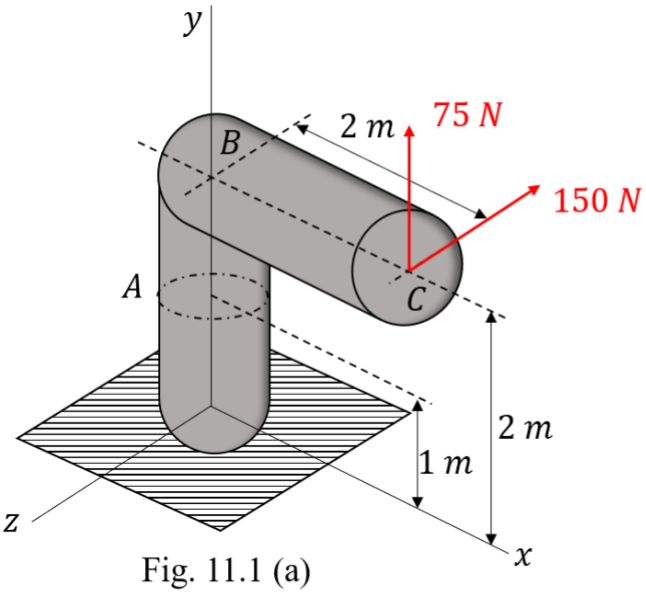


Fig. 11.1 (a)

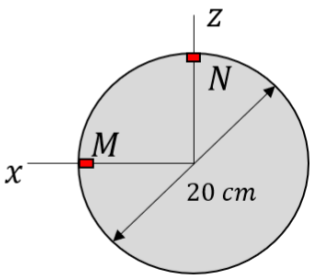


Fig. 11.1 (b)

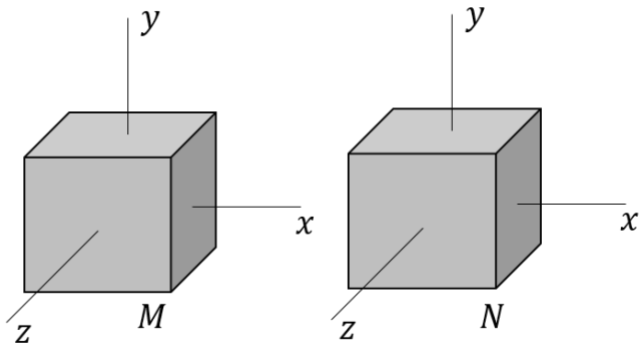


Fig. 11.1 (c)

Problem 11.2 (10 points): For the given stress states indicated in Fig. 11.2(a) and (b),

a) Sketch Mohr's circles for the stress states.
b) Determine the absolute maximum shear stress $\tau_{max,abs}$ from the Mohr's circle.

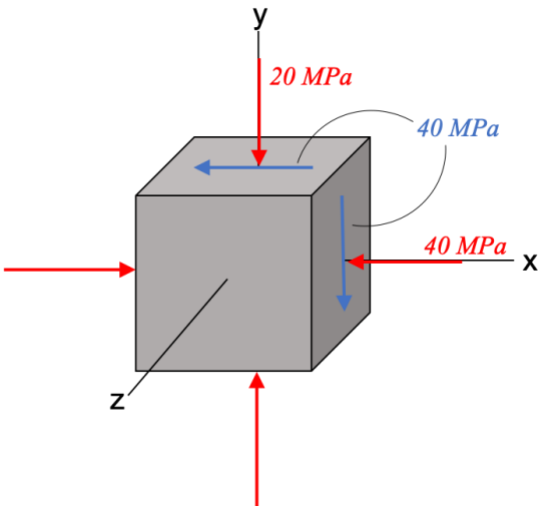


Fig. 11.2 (a)

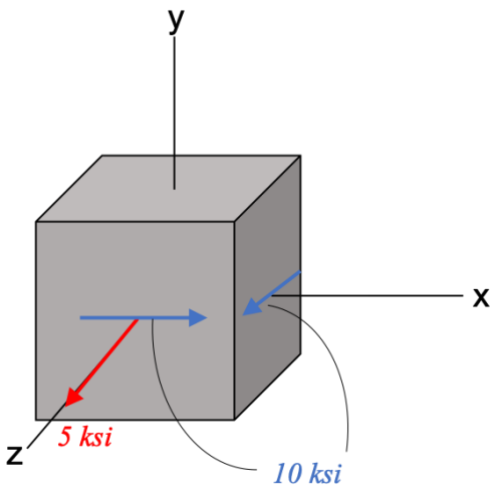


Fig. 11.2 (b)

Problem 11.3 (10 points): A rectangular bar is fixed on a wall and subjected to the loads shown in Figure 11.3(a) with values $P = -10\ kips$, $Q = 5\ kips$, $M_Z = 2\ kips \cdot in$, $M_y = 5\ kips \cdot in$.

a) Determine the stress at points A and B, as shown in Figure 11.3(b), and show the state of stress on stress elements in Fig 11.3(c). Indicate both magnitude, and direction of stresses.

b) Draw the Mohr's circle for the state of stress at points A and B, and determine the maximum shear stress $\tau_{max,abs}$.

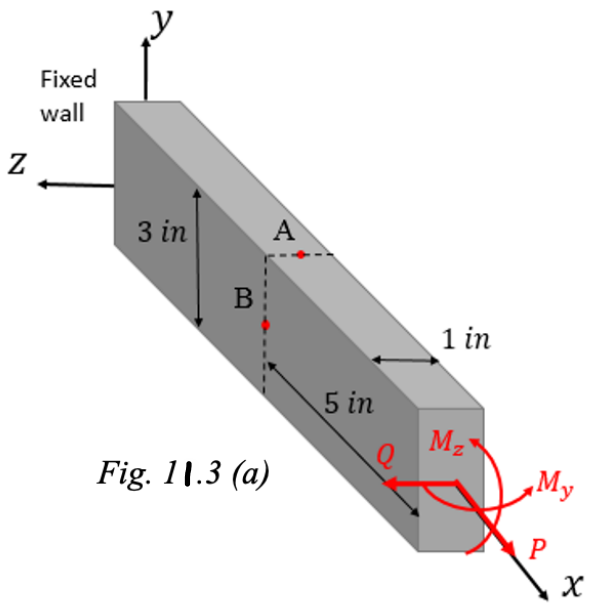


Fig. 11.3 (a)

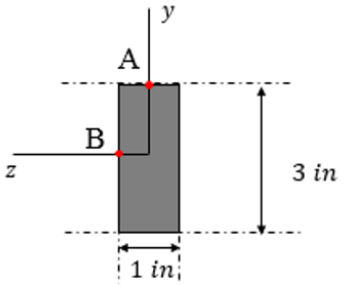


Fig. 11.3 (b)

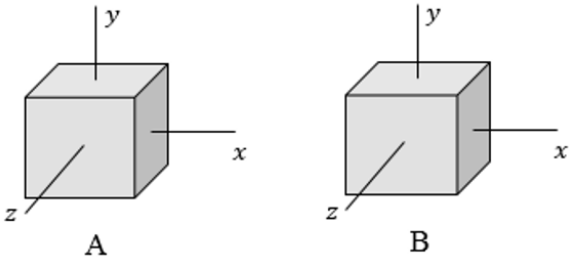
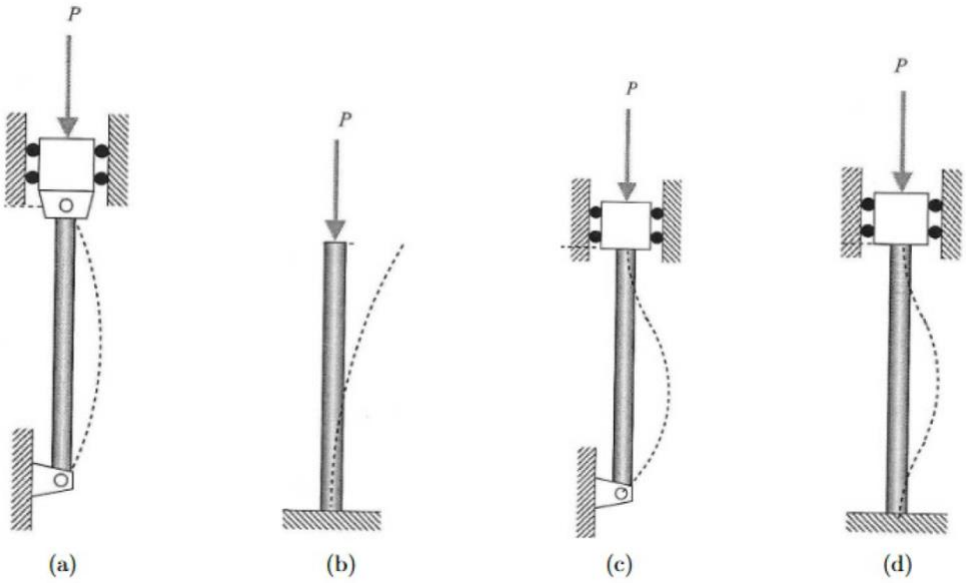


Fig. 11.3 (c)

Problem 11.4 (5 points): Cylindrical columns A, B, C, and D shown below. A compressive axial load P is applied to each column. Use the following properties for the columns:

A) Young's modulus E, radius R, length L
B) Young's modulus 4E, radius R/2, length L
C) Young's modulus 3E, radius R, length L/3
D) Young's modulus 4E, radius 2R, length L



The critical Euler's buckling loads $P_{cr}^{(a)}$, $P_{cr}^{(b)}$, $P_{cr}^{(c)}$, $P_{cr}^{(d)}$ columns A, B, C, and D, respectively, are such that:

1. $P_{cr}^{(a)} = P_{cr}^{(b)} > P_{cr}^{(d)} = P_{cr}^{(c)}$
2. $P_{cr}^{(a)} > P_{cr}^{(d)} > P_{cr}^{(b)} > P_{cr}^{(c)}$
3. $P_{cr}^{(c)} > P_{cr}^{(d)} > P_{cr}^{(a)} = P_{cr}^{(b)}$
4. $P_{cr}^{(a)} > P_{cr}^{(d)} > P_{cr}^{(b)} = P_{cr}^{(c)}$
5. None of the above