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Mechanical Engineering - Mechanics of Materials

Topic: Mohr's Circle Analysis

Given:

- A Mohr's circle is depicted with various stress values.

Goal:

Determine the major principal stress, average normal stress, and maximum shear stress.

Step-by-Step Solution:

Step 1: Understand Mohr's Circle and Given Data

In Mohr's circle, the horizontal axis usually represents the normal stresses (σ), while the vertical axis represents the shear stresses (τ). The center of Mohr's circle represents the average normal stress, and the radius represents the maximum shear stress.

Given Data:

- The points on the Mohr circle at the x-axis are at 0 and 80 MPa.

Explanation and Supporting Statement for Step 1:

Mohr's circle provides a graphical representation of the state of stress on an element. The horizontal coordinates of Mohr's circle represent normal stresses, and the vertical coordinates represent shear stresses.

Step 2: Calculate the Center (Average Normal Stress)

The average normal stress (σ_avg) is the center of Mohr's circle and can be calculated as:

$$\sigma_{avg} = (\sigma_x + \sigma_y) / 2 = (0 + 80) / 2 = 40 \text{ MPa}$$

Explanation and Supporting Statement for Step 2:

The average normal stress is the normal stress at the center of Mohr's circle, calculated as the average of the normal stresses on the x-axis and y-axis.

Step 3: Calculate the Radius (Maximum Shear Stress)

The radius (R) of Mohr's circle represents the maximum shear stress (τ_max):

$$R = \tau_{max} = \sqrt{((\sigma_x - \sigma_y) / 2)^2 + \tau_{xy}^2}$$

Given that $\tau_{xy} = 0$:

$$R = (80 - 0) / 2 = 40 \text{ MPa}$$

Explanation and Supporting Statement for Step 3:

The radius of Mohr's circle is obtained by considering the difference between the normal stresses and dividing it by 2. This radius represents the maximum shear stress.

Step 4: Calculate the Principal Stresses

The principal stresses (σ_1 and σ_2) are:

$$\sigma_{1,2} = \sigma_{avg} \pm R$$

Thus:

$$\sigma_1 = 40 + 40 = 80 \text{ MPa}$$

σ_2 = 40 - 40 = 0 MPa

Explanation and Supporting Statement for Step 4:

Principal stresses are found by adding and subtracting the maximum shear stress from the average normal stress.

Final Solution:

- **Major Principal Stress (σ_1):** 80 MPa
- **Average Normal Stress (σ_{avg}):** 40 MPa
- **Maximum Shear Stress (τ_{max}):** 40 MPa

Explanation for Final Solution:

The major principal stress, average normal stress, and maximum shear stress were determined based on the positions of the points on Mohr's circle and the calculations derived from them.

Verify Answer Choices:

Given options:

1. 80, 50, -20
2. 80, -20, 50
3. 80, 30, 50

The correct option should be consistent with the values obtained for the major principal stress, average normal stress, and maximum shear stress. However, none of the given choices match correctly. Thus, the values in the problem might have been intended to align differently or calculation verification may be needed.

Explanation for Verification:

Careful comparison of the calculated values with the given choices ensures the selection of the correct answer.

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