MECHANICAL ENGINEERING SCIENCE

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NUMERICALS

A circular rod of 12 mm diameter was tested for tension. The total elongation on a 300 mm length was 0.22 mm under a tensile load of 17 kN. Determine the value of E.

NUMERICALS

Solution:

Stress $$p = \frac{P}{A} = \frac{17 \times 10^3}{\frac{\pi}{4}(12)^2} = 150.31 \text{ N/mm}^2$$

Strain $$\varepsilon = \frac{\Delta L}{L} = \frac{0.22}{300} = 7.333 \times 10^{-4}$$

$$\therefore \quad E = \frac{\text{Stress}}{\text{Strain}} = \frac{150.31}{7.333 \times 10^{-4}} = 2.05 \times 10^5 \text{ N/mm}^2 = 210 \text{ kN/mm}^2$$

A mild steel specimen with an original diameter of 10 mm and gauge length of 50 mm was found to have an ultimate load of 60 kN and breaking load of 40 kN. The gauge length at rupture was 55 mm and diameter at rupture cross-section was 8 mm. Determine (i) the ultimate stress, (ii) breaking stress, (iii) true breaking stress, (iv) percentage elongation, and (v) percentage reduction in area.

Solution:

Given: l_g=50 mm, d_o=10 mm, $l_f = 55$ mm, P_{ult} =60 kN, $P_{break} = 40$ kN, and $d_f = 8$ mm.

$$A_o = \frac{\pi d_o^2}{4} = \frac{\pi \times 10^2}{4} = 78.53\,\text{mm}^2$$

$$A_f = \frac{\pi d_f^2}{4} = \frac{\pi \times 8^2}{4} = 50.26\,\text{mm}^2$$

(i) Ultimate stress, $\sigma_{ult} = \frac{P_{ult}}{A_o} = \frac{60 \times 10^3}{78.53} = 764.039\,\text{N/mm}^2$

(ii) Breaking stress, $\sigma_{brak} = \frac{P_{break}}{A_o} = \frac{40 \times 10^3}{78.53} = 509.359\,\text{N/mm}^2$

(ii) True breaking stress, $\sigma_{Tru_{break}} = \frac{P_{break}}{A_f} = \frac{40 \times 10^3}{50.26} = 795.861\,\text{N/mm}^2$

(iii) Percentage elongation $= \frac{l_f - l_o}{l_o} \times 100 = \frac{55 - 50}{50} \times 100 = 10\%$

(iv) Percentage reduction in area $= \frac{A_f - A_o}{A_o} \times 100 = \frac{78.53 - 50.26}{78.53} \times 100 = 35.9\%$

1. *Given two bars of the same material but different cross-sectional areas and lengths, how would the total deformation compare under the same axial load? Justify your reasoning using relevant formulas.*

2. *A cylindrical aluminum specimen has an original diameter of 12 mm and a gauge length of 60 mm. During a tensile test:*

    The maximum (ultimate) load recorded was 72 kN.

    The load at fracture (breaking load) was 50 kN.

After fracture, the gauge length increased to 66 mm, and the diameter at the necked region was found to be 9 mm.

Calculate:

Ultimate stress

Breaking stress

True breaking stress

Percentage elongation

Percentage reduction in area

THANK YOU

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