What is Stress and Strain?

Worksheet

Stress is force per unit cross-sectional area, = F/A (in Pa or MPa), and strain is the change in length divided by original length, = L/L (dimensionless).

$$\epsilon = \frac{\Delta L}{L_0}$$

Questions

1. A force of 50,000 N acts on a 500 mm cross-section. What is the stress?

A) 10 MPa
B) 100 MPa
C) 1000 MPa
D) 25 MPa

2. What is the unit of strain?

A) Pascal
B) Newton
C) Dimensionless
D) Newton-metre

3. On a stress-strain curve, what happens at the yield point?

A) The material fractures
B) Permanent (plastic) deformation begins
C) Stress becomes zero
D) The material becomes stiffer instantly

4. Young's modulus is defined as:

A) F A
B) / in the elastic region
C) L / L
D) F /

5. A steel rod with a cross-sectional area of 500 mm carries an axial force of 50,000 N. Find the normal stress.

6. A 2 m rod stretches by 4 mm under load. Find the strain.

7. A bolt with a cross-sectional area of 200 mm must not exceed a stress of 150 MPa. Find the maximum allowable force.

8. Define: What is the formula for stress?

9. Define: What is the formula for strain?

10. Define: What is the elastic region of a stress-strain curve?

Answer Key

1. B) 100 MPa - = F/A = 50000/500 = 100 MPa.
2. C) Dimensionless - Strain is a ratio of lengths (L/L), so it has no units.
3. B) Permanent (plastic) deformation begins - Beyond yield, deformation is no longer fully reversible.
4. B) / in the elastic region - E = / describes the slope of the linear elastic portion - the material's stiffness.
5. = F / A = 50000 / 500 = 100 N/mm = 100 MPa
6. = L / L L = 0.004 m, L = 2 m = 0.004 / 2 = 0.002 (0.2%)
7. = F / A F = A F = 150 N/mm 200 mm F = 30000 N = 30 kN
8. = F/A - applied force divided by cross-sectional area, measured in pascals (Pa) or megapascals (MPa).
9. = L/L - change in length divided by original length; it has no units.
10. The initial linear portion where stress is proportional to strain (Hooke's law) and the material returns to its original shape when unloaded.