Problem Sheet: Mechanical Properties of Materials

Prerequisite for Metal Forming

1. A steel rod 6 mm in diameter is under the action of a tensile force of 800 Newtons. **Calculate the tensile** stress **in the bar.**

2. A 30-mm gauge length is marked on an aluminium test piece. The test piece is strained in tension so that the gauge length becomes 32.3 mm. **Calculate the strain.**

3. A steel wire, 0.5 mm^2 in cross-sectional area, and 10m long is extended elastically 1.68 mm by a force of 18 N. **Calculate the modulus of elasticity for the steel.**

4. A 200-mm-long strip of metal is stretched in two steps, first to 300 mm and then to 400 mm. Show that the total true strain is the sum of the true strains in each step; in other words, the true strains are additive. **Show that, in the case of engineering strains, the strains cannot be added to obtain the total strain.**

5. A paper clip is made of wire 0.7 mm in diameter. If the original material from which the wire is made is a rod 25 mm in diameter, **calculate the longitudinal engineering and true strains that the wire has undergone during processing.**

6. A steel rod having 0.1 mm diameter and 1.5 m length is subjected to an axial pull of 1 kN. Find (a) stress (b) strain and (c) elongation. Assume modulus of elasticity E = 205 x 10^6 kN/m^2.

The following data were obtained during the tensile test of a steel specimen having 30 mm diameter and 200 mm length.
Extension at a load of 50 kN = 0.1 mm
Load at elastic limit = 230 kN
Maximum load = 300 kN
Total extension = 50 mm, Diameter of rod at failure = 20 mm
Calculate (a) Young's modulus (b) percentage elongation (c) percentage decrease in area.

7. A short timber post of rectangular cross section has one side of section twice the other. When the timber post is subjected to compressive load of 10 kN it contracts by 0.0521 mm for 1 m length. If the modulus of elasticity of timber is 12 GPa, **calculate the dimensions of the post.**

8. A tensile test uses a test specimen that has a gage length of 50 mm and an area = 200 mm^2. During the test the specimen yields under a load of 98,000 N. The corresponding gage length = 50.23 mm. This is the 0.2 percent yield point. The maximum load = 168,000 N is reached at a gage length = 64.2 mm. **Determine: (a) yield strength Y, (b) modulus of elasticity E, and (c) tensile strength TS.**

9. A copper wire of diameter 0.80 mm fails at an engineering stress = 248.2 MPa. Its ductility is measured as 75% reduction of area. **Determine the true** stress **and true strain at failure.**

10. **List and explain the desirable mechanical properties of:**
(a) an elevator cable,
(b) a paper clip,
(c) a leaf spring for a truck,
(d) a bracket for a bookshelf,
(e) piano wire,
(f) a wire coat hanger,
(g) the clip for a pen, and
(h) a staple.