Test Paper 2

1. State Hooke's law? 1

Ans. Hooke's law states that the extension produced in the wire is directly proportional to the load applied within the elastic limit
i.e. Acc to Hooke's law, Stress α Strain
Stress = E x Strain
E = Modulus of elasticity

2. What are ductile and brittle materials? 1

Ans. Ductile materials are those materials which show large plastic range beyond elastic limit.
Brittle materials are those materials which show very small plastic range beyond elastic limit.

3. An elastic wire is cut to half its original length. How would it affect the maximum load that the wire can support? 1

Ans. Since Breaking load = Breaking Stress x Area; so if cable is cut to half of its original length, there is no change in its area hence there is no effect on the maximum load that the wire can support.

4. Define modulus of elasticity and write its various types 2

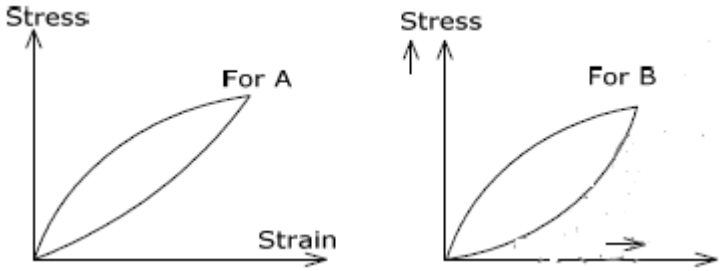
Ans. Modulus of elasticity is defined as ratio of the stress to the corresponding strain produced, within the elastic limit.
Types of modulus of elasticity

(*i*) *Young m*odulus $Y = \dfrac{Normal\ stress}{Longitudinal\ strain}$

(*ii*) *Bulk m*odulus $B = \dfrac{Normal\ stress}{Volumetric\ strain}$

(*iii*) $Modulus\ of\ rigidity\ \ \eta = \dfrac{Tangential\ stress}{Shearing\ strain}$

5. Two different types of rubber are found to have the stress – strain curves as shown in the figure stress 3



(a) In what ways do these curves suffer from the stress- strain curve of a metal wire?
(b) Which of the two rubbers A and B would you prefer to be installed in the working of a heavy machinery
(c) Which of these two rubbers would you choose for a car tyre ?

Ans. (a) Since for the above curves, Hooke's law is not obeyed as the curve is not a straight line Hence such type of curve are called as elastic hysteresis as the materials do not retrace curve during unloading.
(b) Rubber B is preferred because area of loop B is more than that of A which shows more absorption power for vibrations which is useful in machinery.
(c) Since hysteresis loop is a direct measure of heat dissipation, hence rubber A is preferred over B so to minimize the heating in the car tyres.

6. Which is more elastic rubber or steel? Explain. 2

Ans. *Let* l_r – *length of rubber*

l_s – *length of steel*

A_r – *Area of rubber*

A_s – *Area of steel*

Δl_r – *extension of rubber*

Δl_s – *extension of steel*

Now, $Y = \dfrac{Fl}{A\Delta l}$

$$Y_r = \frac{Fl_r}{A\Delta l_r}$$

$$Y_s = \frac{Fl_s}{A\Delta l_s}$$

As $\Delta l_r > \Delta l_s$

So, $Y_r < Y_s$

Hence more the modulus of elasticity more elastic is the material, so, steel is more elastic than rubber

7. The Young's modulus of steel is 2.0 x10^{11} N/m^2. If the inter-atomic spacing for the metal is 2.8 x 10^{-10}m, find the increase in the inter-atomic spacing for a force of 10^9 N|m^2 and the force constant? 2

Ans. *Given*: $Y = 2\times10^{11}\,Nm^{-2}$

$$l = 2.8\times10^{-10}$$

$$\frac{F}{A} = 10^9\,Nm^{-2}$$

To find: $\Delta l = ?$

$$K\left(=\frac{F}{\Delta l}\right) = ?$$

Sol^n:

$$Y = \frac{Fl}{A\Delta l}$$

$$2\times10^{11} = \frac{10^9\times2.8\times10^{-10}}{\Delta l}$$

$$\Delta l = 1.4\times10^{-12}\,m$$

Again $Y = \dfrac{Fl}{A\Delta l} = \dfrac{Fl}{l^2\Delta l}$

$$Y = \frac{K}{l} \qquad \left[\because K = \frac{F}{\Delta l}\right]$$

$$K = Yl = 2\times10^{11}\times2.8\times10^{-10} = 56\,Nm^{-1}$$