Practical Applications of Elasticity.

(i) The metallic parts of machinery are never subjected to a stress beyond elastic limit, otherwise they will get permanently deformed.

(ii) The thickness of the metallic rope used in the crane in order to lift a given load is decided from the knowledge of elastic limit of the material of the rope and the factor of safety.

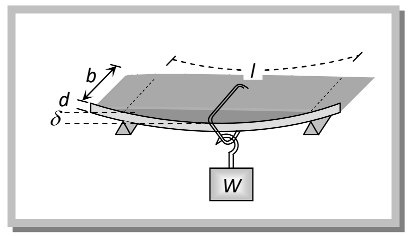
(iii) The bridges are declared unsafe after long use because during its long use, a bridge under goes quick alternating strains continuously. It results in the loss of elastic strength.

(iv) Maximum height of a mountain on earth can be estimated from the elastic behaviour of earth.

At the base of the mountain, the pressure is given by $P = h\rho g$ and it must be less than elastic limit (K) of earth's supporting material.

$K > P > h\rho g \quad \therefore \quad h < \frac{K}{\rho g} \quad$ or $\quad h_{max} = \frac{K}{\rho g}$

(v) In designing a beam for its use to support a load (in construction of roofs and bridges), it is advantageous to increase its depth rather than the breadth of the beam because the depression in rectangular beam.



$$\delta = \frac{Wl^3}{4Ybd^3}$$

To minimize the depression in the beam, it is designed as I-shaped girder.

(vi) For a beam with circular cross-section depression is given by $\delta = \frac{WL^3}{12\pi r^4 Y}$

(vii) A hollow shaft is stronger than a solid shaft made of same mass, length and material.

Torque required to produce a unit twist in a solid shaft $\tau_{solid} = \frac{\pi\eta r^4}{2l}$ ......(i)

and torque required to produce a unit twist in a hollow shaft $\tau_{hollow} = \frac{\pi\eta(r_2^4 - r_1^4)}{2l}$ .....(ii)

From (i) and (ii), $\frac{\tau_{hollow}}{\tau_{solid}} = \frac{r_2^4 - r_1^4}{r^4} = \frac{(r_2^2 + r_1^2)(r_2^2 - r_1^2)}{r^4}$ .....(iii)

Since two shafts are made from equal volume $\therefore \pi r^2 l = \pi(r_2^2 - r_1^2)l \Rightarrow r^2 = r_2^2 - r_1^2$

Substituting this value in equation (iii) we get, $\frac{\tau_{hollow}}{\tau_{solid}} = \frac{r_2^2 + r_1^2}{r^2} > 1 \quad \therefore \tau_{hollow} > \tau_{solid}$

i.e., the torque required to twist a hollow shaft is greater than the torque necessary to twist a solid shaft of the same mass, length and material through the same angle. Hence, a hollow shaft is stronger than a solid shaft.