PHYSICS

NCERT - NCERT PHYSICS(GUJRATI)

MECHANICAL PROPERTIES OF SOLIDS

Examples

1. A structural steel rod has a radius of 10 mm and a length of 1.0 m. A 100 KN force stretches it along its length. Calculate a stress, (b)

elongation and (c) strain on the rod. Young's modulus of structural steel is $2.0 \times 10^{11} Nm^{-2}$.

2. A copper wire of length 2.2 m and a steel wire of length 1.6 m, both of diameter 3.0 mm, are connected end to end. When stretched by a load , the net elongation is found to be 0.70 mm. Obtain the load applied.

3. In a human pyramid in a circus, the entire weight of the balanced group is supported by the legs of a performer who is lying on his back (as shown in Fig. 9.5). The combined mass of all the persons performing the act, and the table, plaques etc. involved is 280 kg. The mass of the performer lying on his back at the bottom of the pyramid is 60 kg. Each thighbone (femur) of this performer has a length of 50 cm and an effective radius of 2.0 cm. Determine the amount by ehich each

thighbone gets compressed under the extra load.

4. A square lead slab of side 50 cm and thickness 10 cm is subject to a shearing force (on its narrow face) of $9.0 \times 10^4 N$. The lower edge is riveted to the floor How much will the upper edge be displaced ?

5. The average depth of Indian Ocean is about 3000 m. Calculate the fractional compression, $\Delta V/V$, of water at the bottom of the ocean, given that the bulk modulus of water is 2.2×10^9 N m^{-2}. (Take $g = 10$ m s^{-2})

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Exercises

1. A steet wire of length 4.7 m and cross - sectional area $3.0 \times 10^{-5} m^2$ stretches by the same amount as a copper wire of length 3.5 m and cross- sectional area of $4.0 \times 10^{-5} m^2$ under a given load. What is the ratio of the Young's modulus of steel to that of copper ?

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2. Read the following two statements below carefully and state, with reasons, if is true or

false.

(a) The Young's modulus of rubber is greater than of steel ,

(b) The stretching of a coil is determined by shear modulus.

3. The edge of an aluminium cube is 10 cm long. One face of the cube is firmly fixed to a vertical wall. A mass of 100 kg is then attached to the opposite face of the cube. The shear

modulus of aluminium is 25 Gpa. What is the vertical deflection of this face ?

4. Four identical hollow cylindrical columns of mild steel support a big structure of mass 50,000 kg. The inner and outer radii of each column are 30 and 60 cm respectively. Assuming the load distribution to be uniform, calculate the compressional strain of each column.

5. A piece of copper having a rectangular cross -section of 15.2 mm $\times$ 19.1 mm is pulled in tention with 44,500 N force, producing only elastic deformation. Calculate the resulting strain ?

6. A steel cable with a radius of 1.5 cm supports a chairlift at a ski area. If the

maximum stress is not to exceed 10^8 N m^{-2}, what is the maximum load the cable can support ?

7. A rigid bar of mass 15 kg is supported symmetrically by three each 2.0 m long. Those at each end is to copper and the middle one is of iron. Determine the ratios of their diameters if each is to have the same tension.

8. A 14.5 kg mass, fastened to the end of a steel wire of unstretched 1.0 m, is whirled in a vertical circle with an angular velocity of 2 rev/s at the bottom of the circle. The cross-sectional area of the wire is 0.065 cm^2. Calculate the elongation of the wire when the mass is at the lowest point of its path.

9. Compute the bulk modulus of water from the following staa , Initial volume = 100. 0 litre, Pressure increase = 100.0 atm (1 atm $= 1.013 \times 10^5$ Pa), Final volume = 100.5 litre. Compare the bulk modulus of water with that of air (at constant temperature). Explain in simple terms why the ratio is so large.

10. What is the density of water at a depth where pressure is 80.0 atm, given that its density at the surface is 1.03×103 kg m^{-3} ?

11. Compute the fractional change in volume of a glass slab, when subjected to a hydraulic pressure of 10 atm.

12. Determine the volume contraction of a solid copper cube, 10 cm on an edge, when subjected to a hydraulic pressure of 7.0×10^6 Pa.

13. How much should the pressure on a litre of water be changed to compress it by 0.10%

14. A mild steel wire of length 1.0 m and cross - sectional area 0.50×10^{-2} cm^2 is stretched, well within its elastic limit, horizontally between two pillars. A mass of 100 g is suspended from the mid - point of the wire. Calculate the depression at the mid point.

15. Two strips of metal are riveted together at their ends by four rivets, each of diameter 6.0 mm. What is the maximum tension that can be

exerted by the riveted strip if the shearing stress on the rivet is not to exceed 6.9×10^7 Pa ? Assume that each rivet is to carry one quarter of the load.

16. The Marina trench is located in the Pacific Ocean, and at one place it is nearly eleven km beneath the surface of water. The water pressure at the bottom of the trench is about 1.1×10^8 Pa. A steel trench. What is the

change in the volume of the ball when it reaches to the bottom ?