Answer on Question#37869 – Physics – Mechanics | Kinematics | Dynamics

Find an expression for the energy density in terms of stress and strain?

Solution:

We know that when a material behaves elastically, the work done on straining it is stored as energy in it. We call this (elastic) strain energy. We can derive the strain **energy density (ρ_e)** in a material by calculating the area under its stress - strain graph. The definition of the density of energy is analogous to the definition of the density of mass. It is the energy stored per unit volume (how many joules are stored in $1\mathrm{m}^3$ of the material).

$$\rho_e = \frac{1}{2}(\text{stress})(\text{stain}) = \frac{1}{2}\sigma\varepsilon = \frac{1}{2}\frac{F \cdot e}{A \cdot l}$$

Where:

F is the applied force,

e is extension obtained at force F,

A is the area of the cross section of the object and

l is the length of the object

With the knowledge of ρ_e we can calculate the total energy stored in an object (i.e. that given by the area under the force - extension graph) if we know the volume of the object.