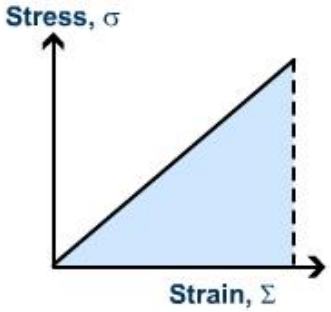
Evaluation of strain energy from stress - strain graph

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 (ρe)** 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 $1m^3$ of the material).



$$\rho_\varepsilon = \frac{1}{2}(stress)(strain) = \frac{1}{2}\sigma\varepsilon = \frac{1}{2}\frac{F}{A}\frac{e}{l}\ Jm^{-3}$$

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_ε 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.