Deformation of Solids

- Tensile stress
- Compressive stress

Hooke's law

The law is directly proportional to the extension, up to the limit of proportionality

$$F = kx$$

- $\mathbf{F}$ → Force
- $\mathbf{k}$ → Spring constant
- $\mathbf{x}$ → Extension length

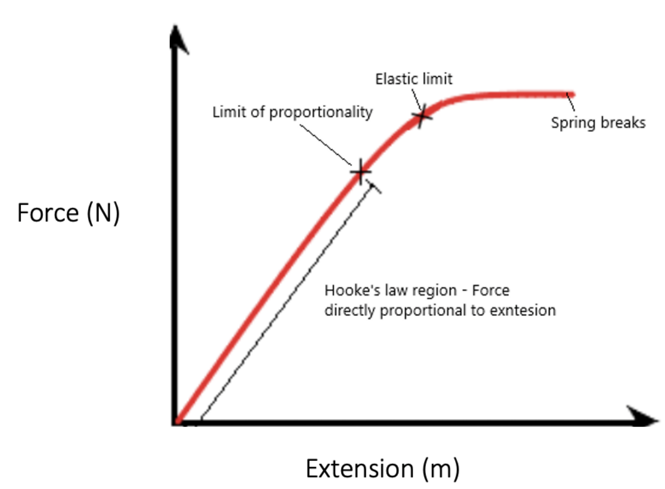
Spring Constant

Load per unit extension (Nm^{-1})
The spring constant is dependent on :

1. Material of the spring
2. Dimensions
    - Thickness
    - Diameter
    - Length

Limit Of Proportionality

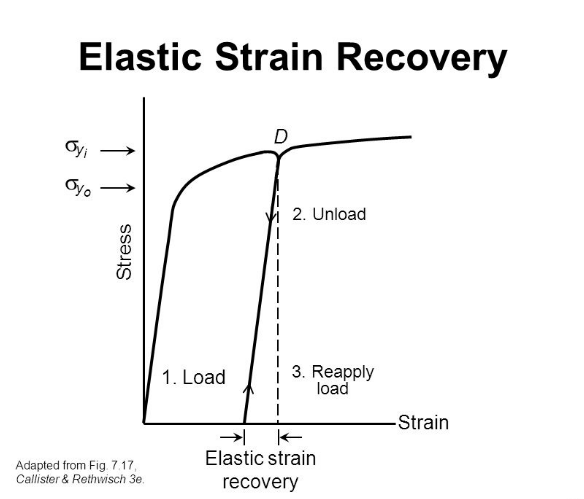
The final point to which hooke's law is applied



Elastic Limit

Past the limit of proportionality but still elastic (Not yet Deformed)
Elastic deformation : the object can be restored after load is removed
Plastic deformation : the object is permanently deformed, even after removal of the load

- Unloading past the Elastic Limit

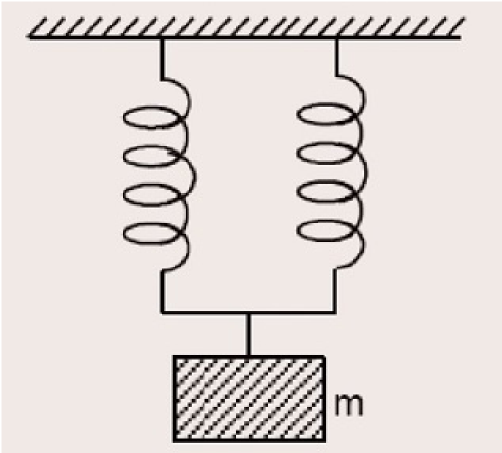


Springs in Series

If the 2 springs are identical are placed in series the extension is $\mathbf{2x}$ and the spring constant is $\frac{1}{2}\mathbf{k}$

Springs in Parallel

If the 2 identical springs are placed in parallel the extension is $\frac{1}{2}\mathbf{k}$ and the spring constant is $\mathbf{2x}$

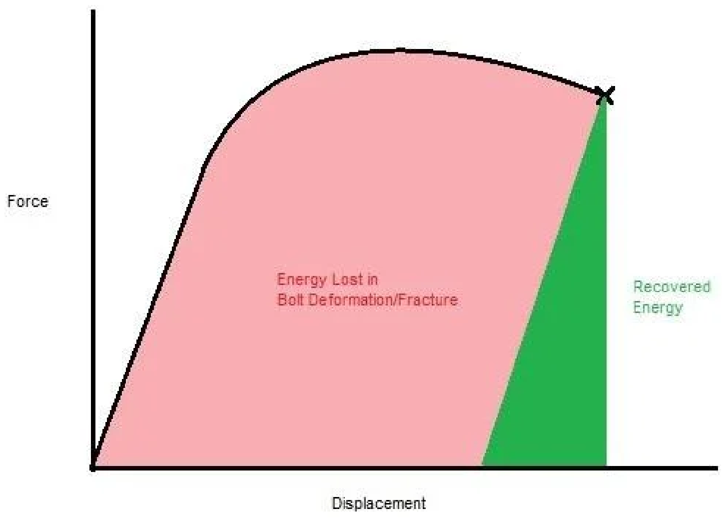


Graph

- Area Under the graph → Strain energy stored

$$E_{\text{strain}} = \frac{1}{2}Fx$$

$E_{\text{strain}} = \frac{1}{2}kx^2$
$F = kx$
$E_{\text{strain}} = \frac{1}{2}\frac{F^2}{k}$



- Energy Recovered
- Energy Lost
    - Work done to do Plastic (Permanent) Deformation

Stress

Force per unit Area
Stress = $\frac{F}{A}$ Pascal

Strain

extension ÷ original length

Strain = $\frac{\Delta x}{x}$ Unitless

Young modules (E)

Stress per unit strain

- Used to eliminate the need for dimensions

- Related to only the material
  $\times 10^9 Pa \leq E \leq \times 10^{11} Pa$

$$E = \frac{\text{stress}}{\text{strain}}$$

  Stress / Strain graph
- Area under the graph → Force done per unit volume