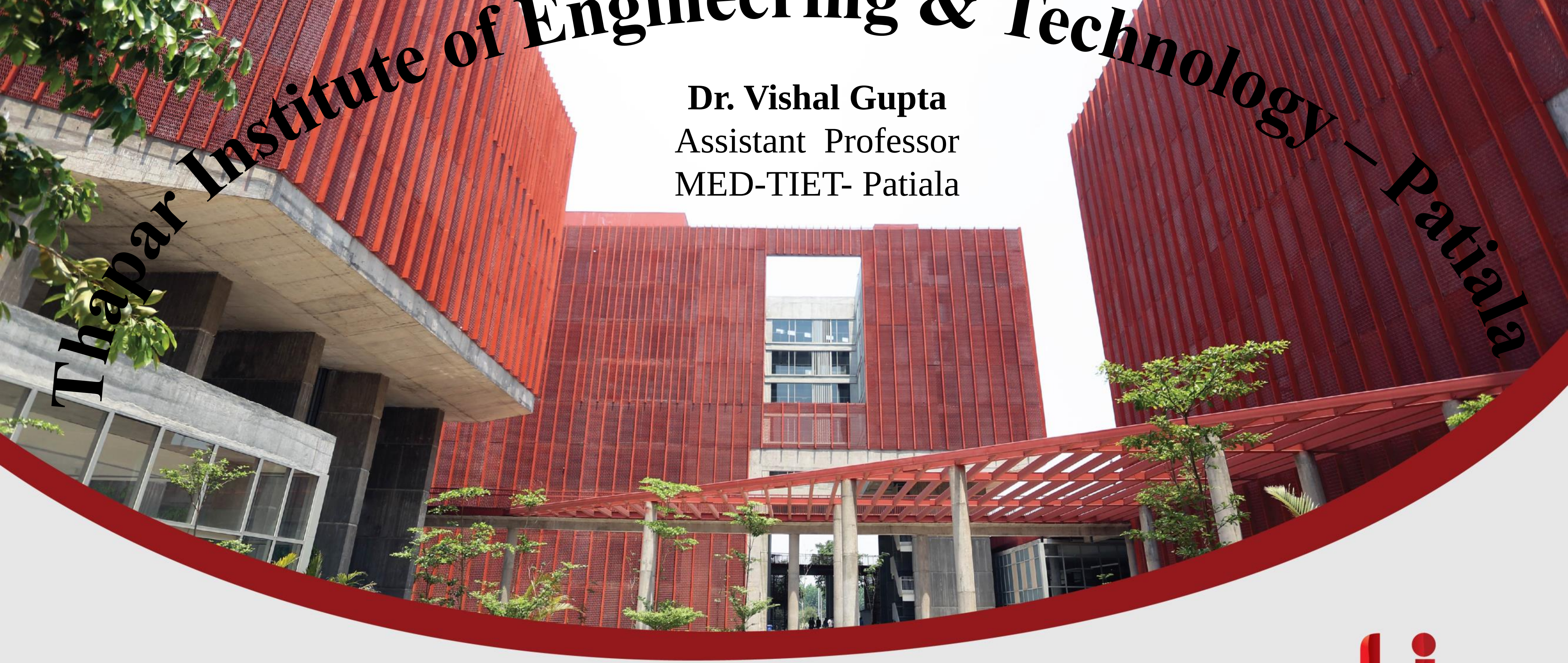

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THAPAR INSTITUTE
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(Deemed to be University)

Overview of the course

Mechanical Engineering Department

Course coordinator
Dr. Vishal Gupta
Assistant Professor
Mechanical Engineering Department

Course Co-coordinator
Dr. Sachin Singh
Assistant Professor
Mechanical Engineering Department

Electronics and Communication Engineering Department

Course Coordinator
Dr. Poonam Verma
Assistant Professor
Electronics and Communication Engineering Department

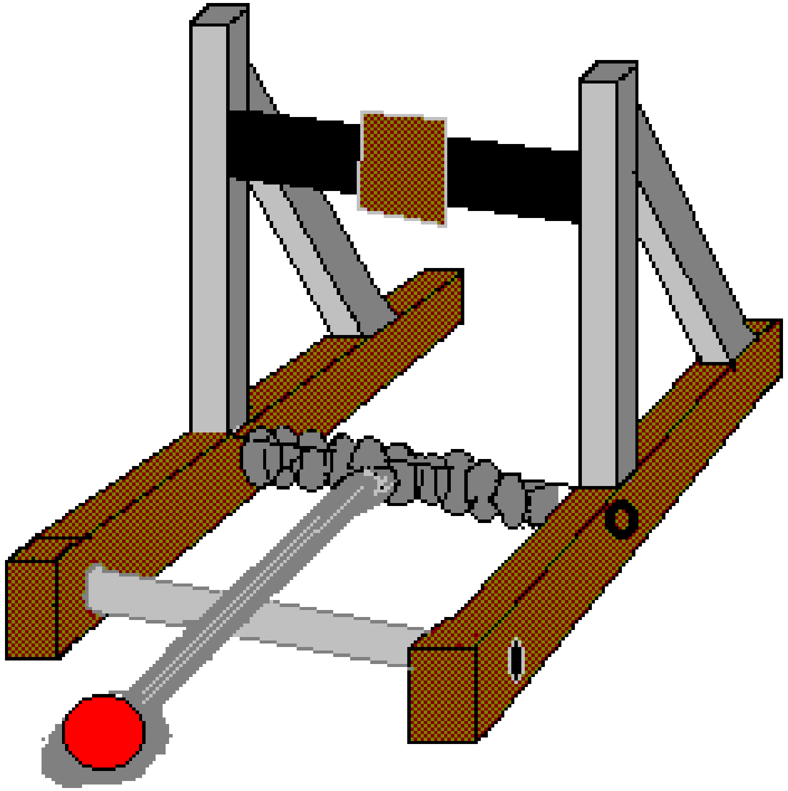
ENGINEERING DESIGN PROJECT-I
UTA016

Lecture - 4

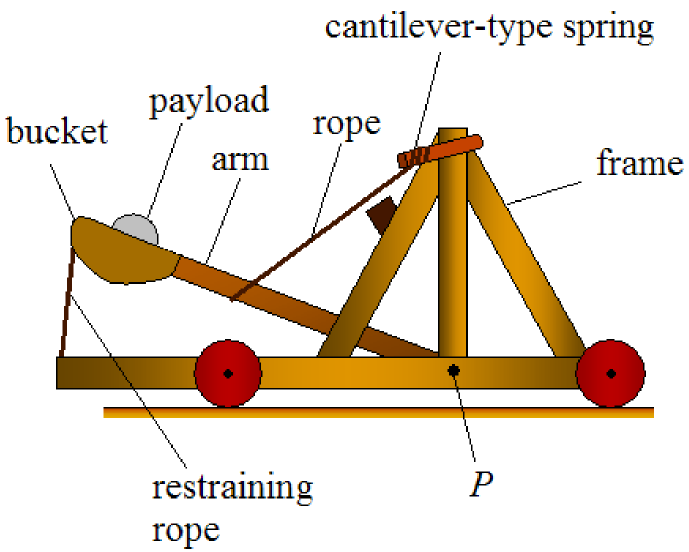
Dynamics of Mangonel

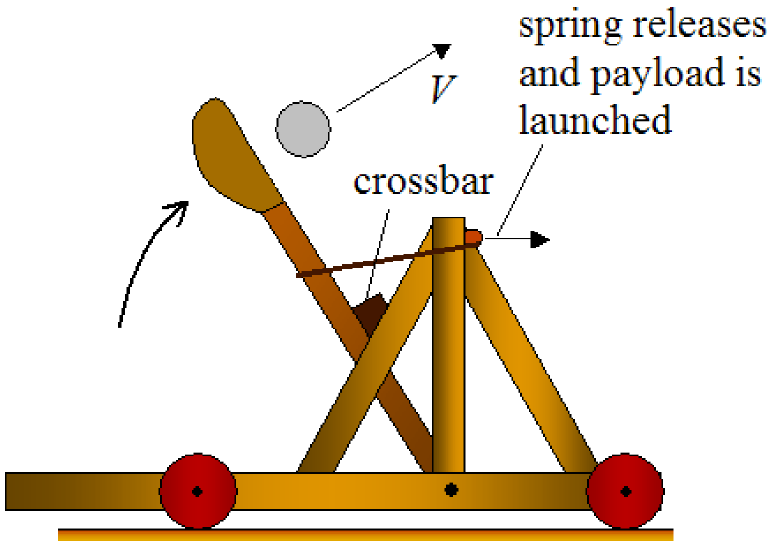
Instructional objective

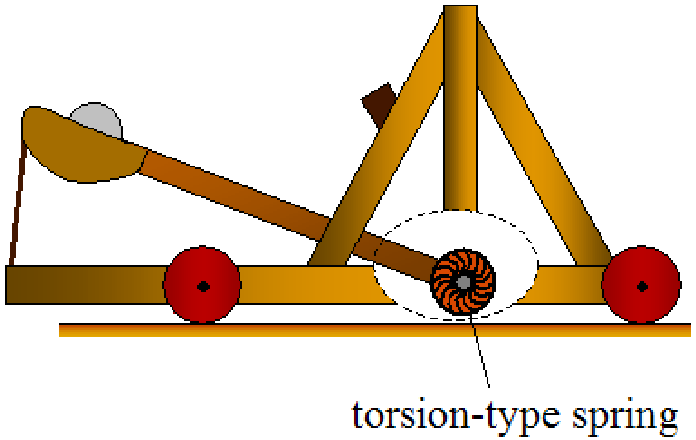
- Failure of Materials
- Different forces
- Static stress analysis
- Dynamic stress analysis

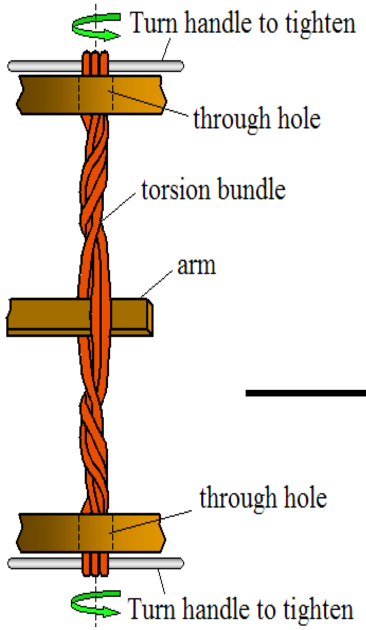



By V Ryan

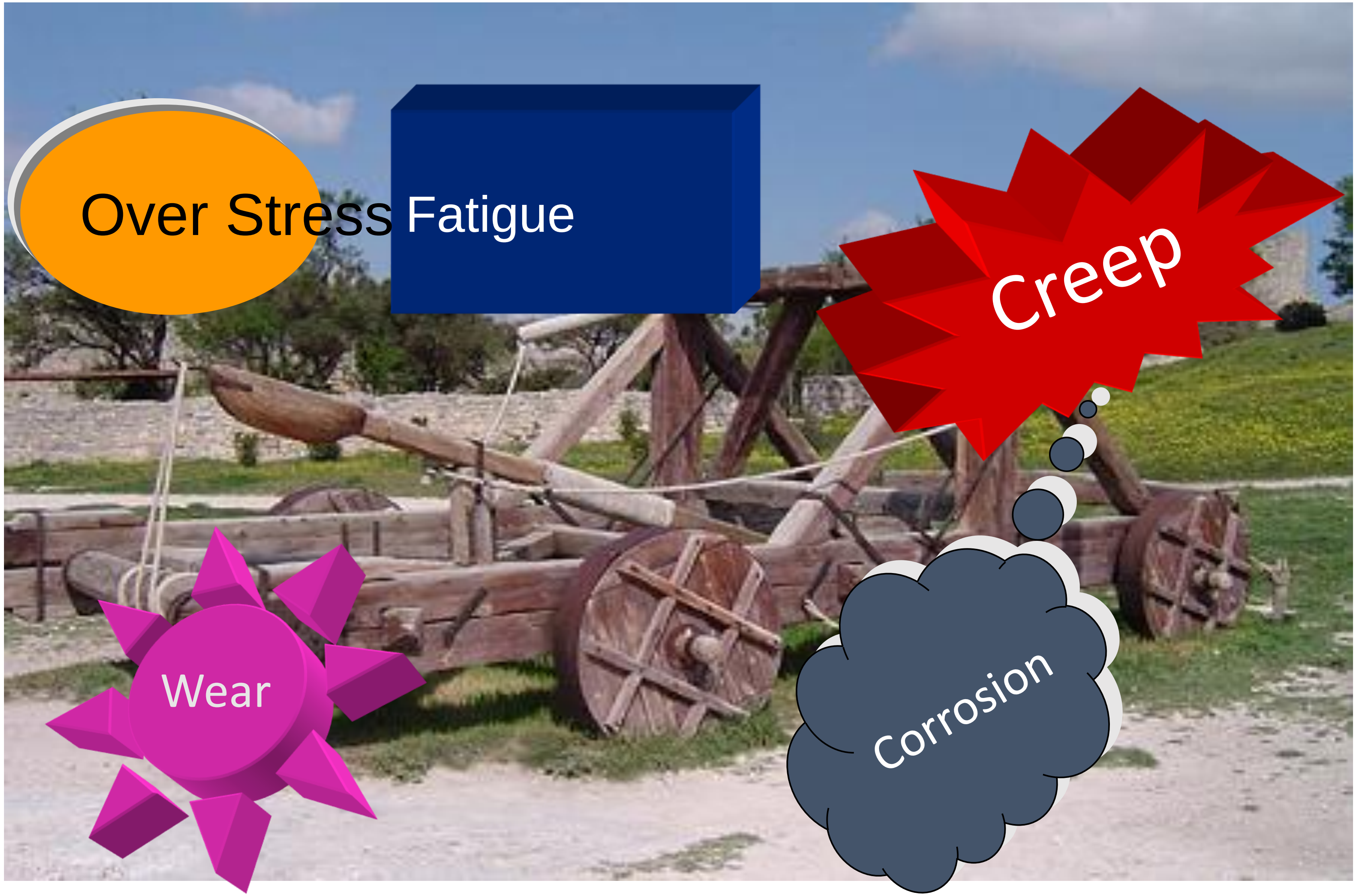

cantilever-type spring
payload
bucket
rope
arm
frame
restraining rope
P


spring releases and payload is launched
V
crossbar


torsion-type spring


Turn handle to tighten
through hole
torsion bundle
arm
through hole
Turn handle to tighten

Failure of Materials



Different forces

Static Force- Load is applied slowly (Time required for application of load is less than the time period of natural frequency)

Dynamic Force (Time varying)

Gradually applied load

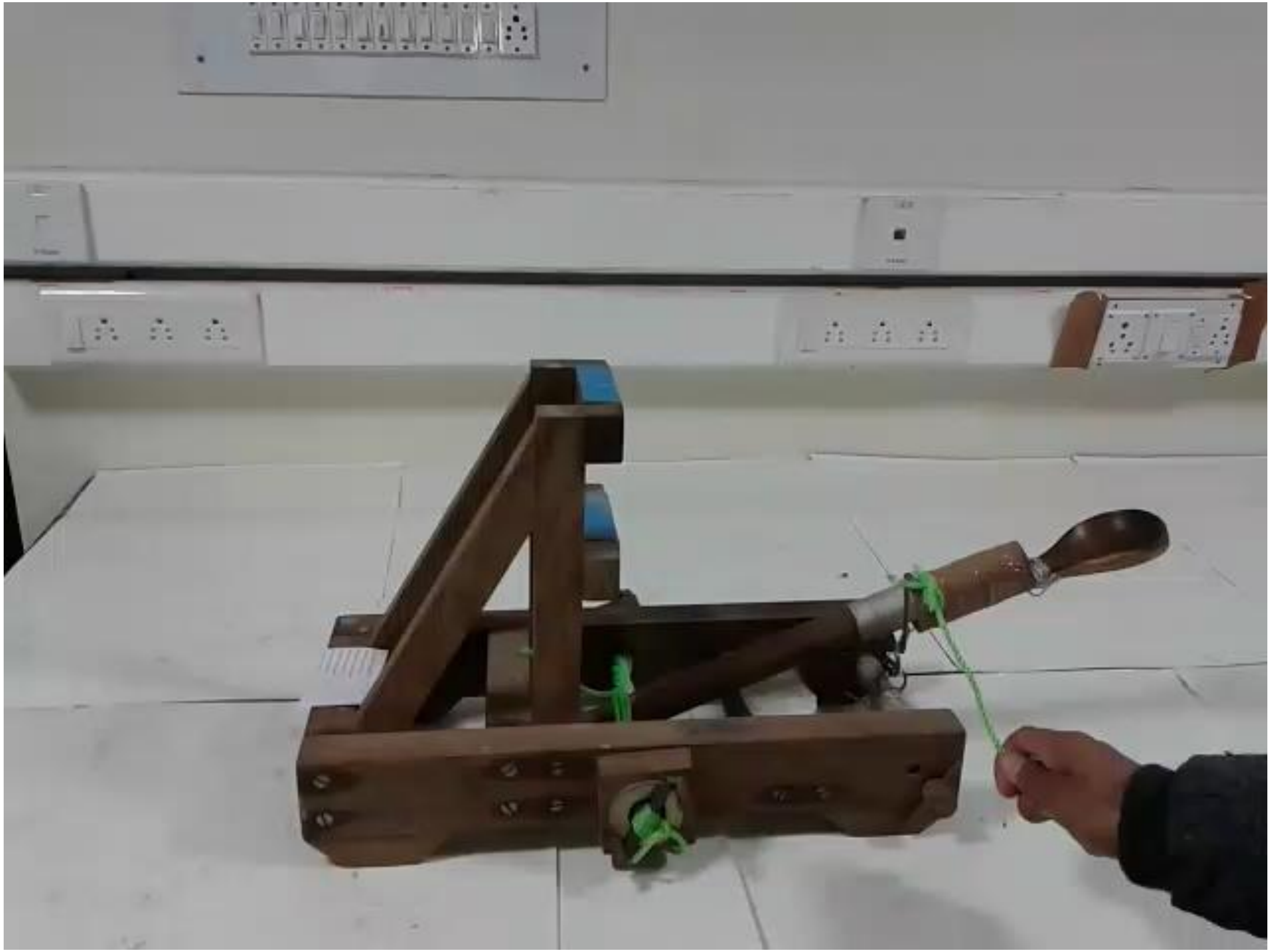
- People walking on floor
- Vehicles on road

Suddenly applied load without velocity (Force Impact)

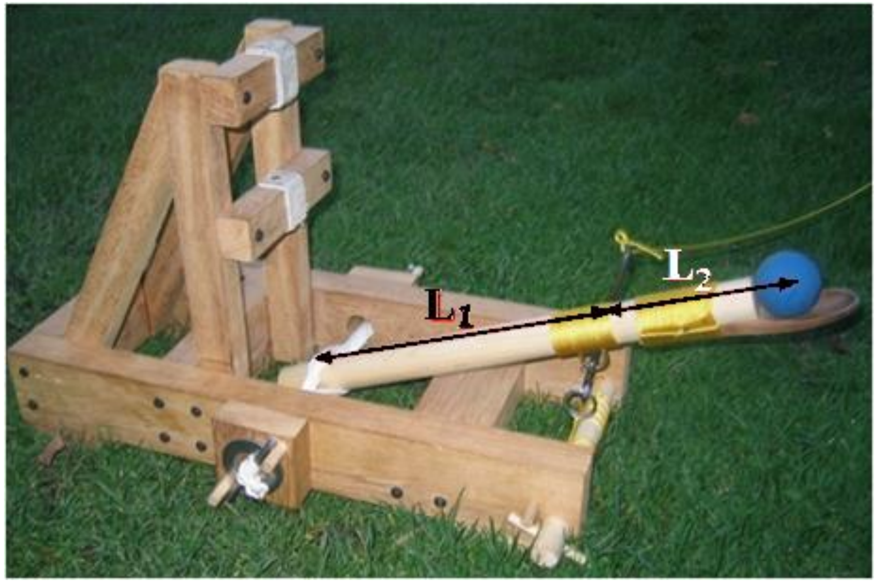
- Clutch, brake
- A person slowly sitting on a chair
- Placing a television on a table.
- Placing a bundle of books on a table

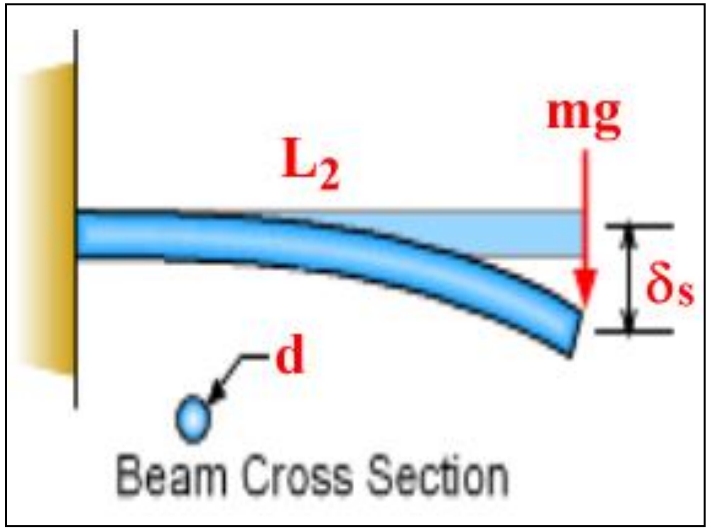
Suddenly applied load with velocity (Striking Impact)

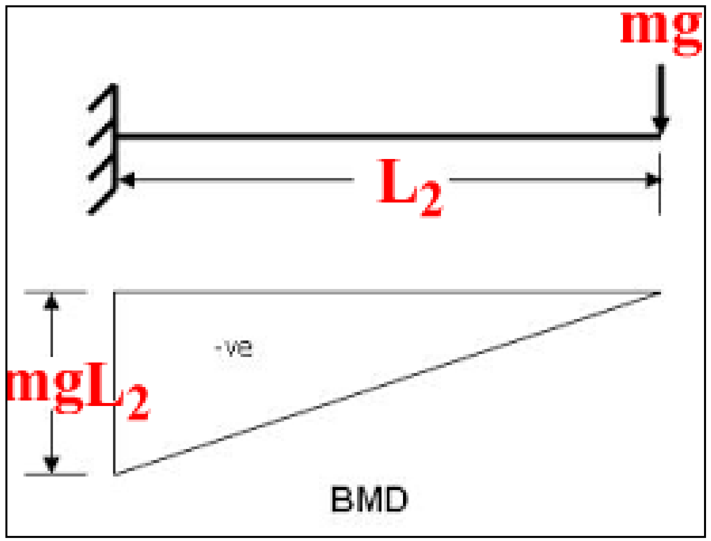
- Piston of IC engine
- Crashing between two cars
- hammering is another example of impact load
- Striking ball with the bat is impact load
- Falling of an object from the hand and striking the foot is impact load.



Static stress analysis L2





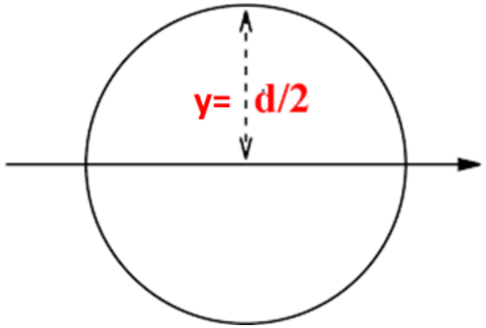


$$m = m_{\text{ball}} + m_{\text{spoon}} + m_{\text{beam}}$$

$$m_{\text{beam}} = \frac{\pi d^2}{4} L_2 \rho$$

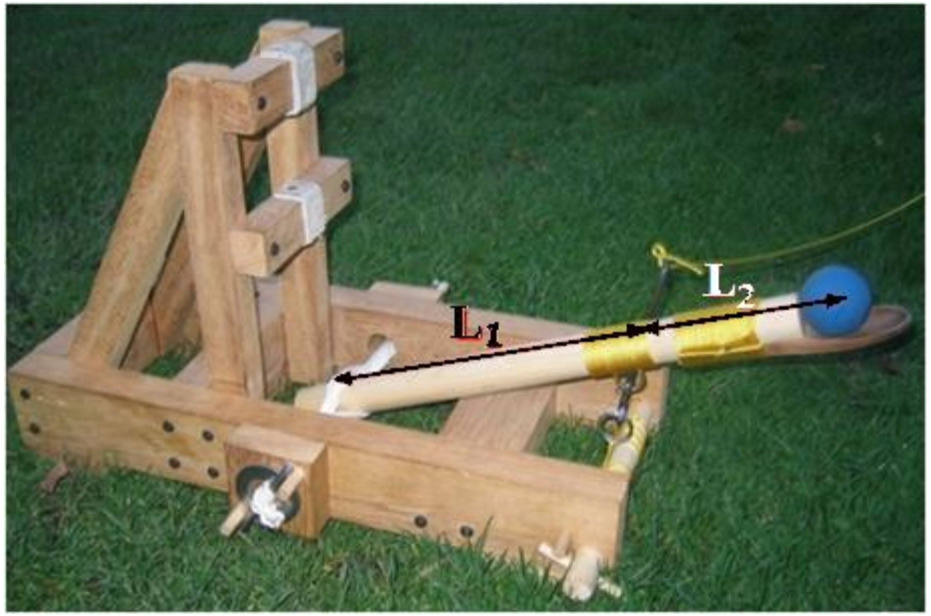
Neglecting mass of ball and spoon

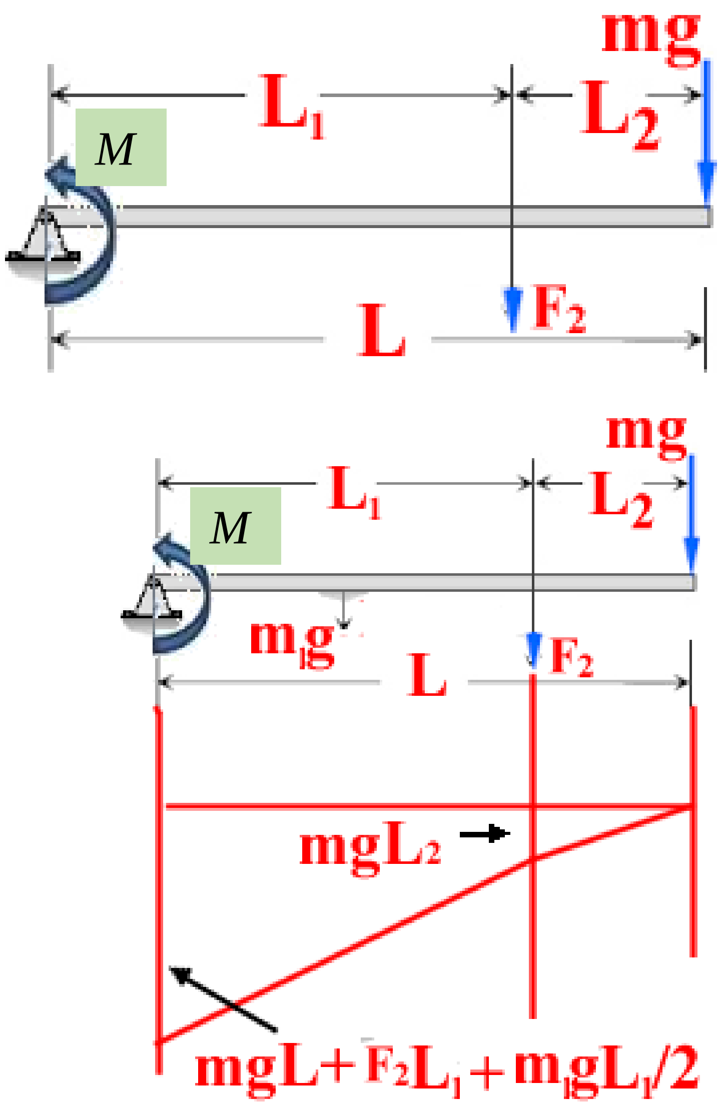
For Mehogany wood, $\rho = 700\ \text{kg/m}^3$



$$\frac{\sigma_s}{y} = \frac{M}{I} \quad \Rightarrow \sigma_s = \frac{My}{I} \quad \Rightarrow \sigma_s = \frac{(mgL_2)(d/2)}{(\pi d^4/64)} \Rightarrow \sigma_s = \frac{4\rho g L_2^2}{d}$$

Static stress analysis

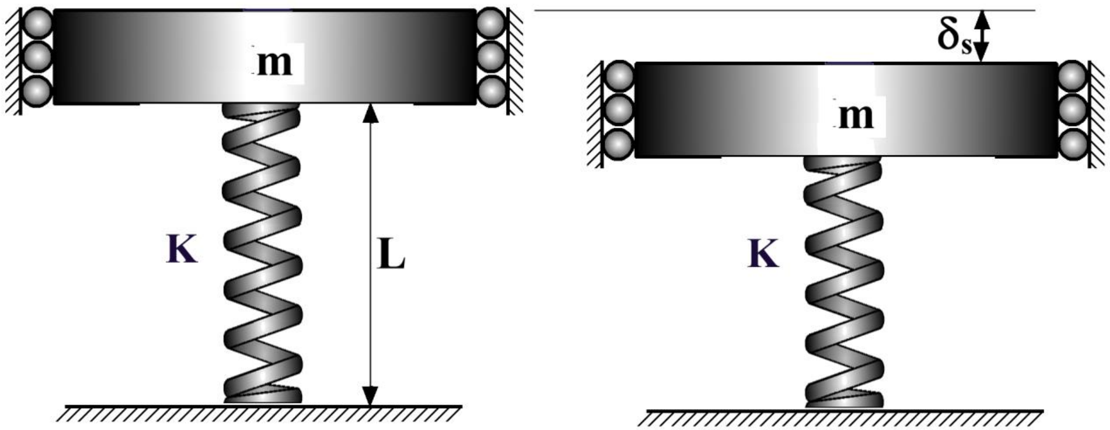




$$M = mgL + F_2 L_1 + \frac{m_1 g L_1}{2}$$

$$\sigma_s = \frac{(M)(d/2)}{\left(\pi d^4/64\right)}$$

Dynamic stress analysis



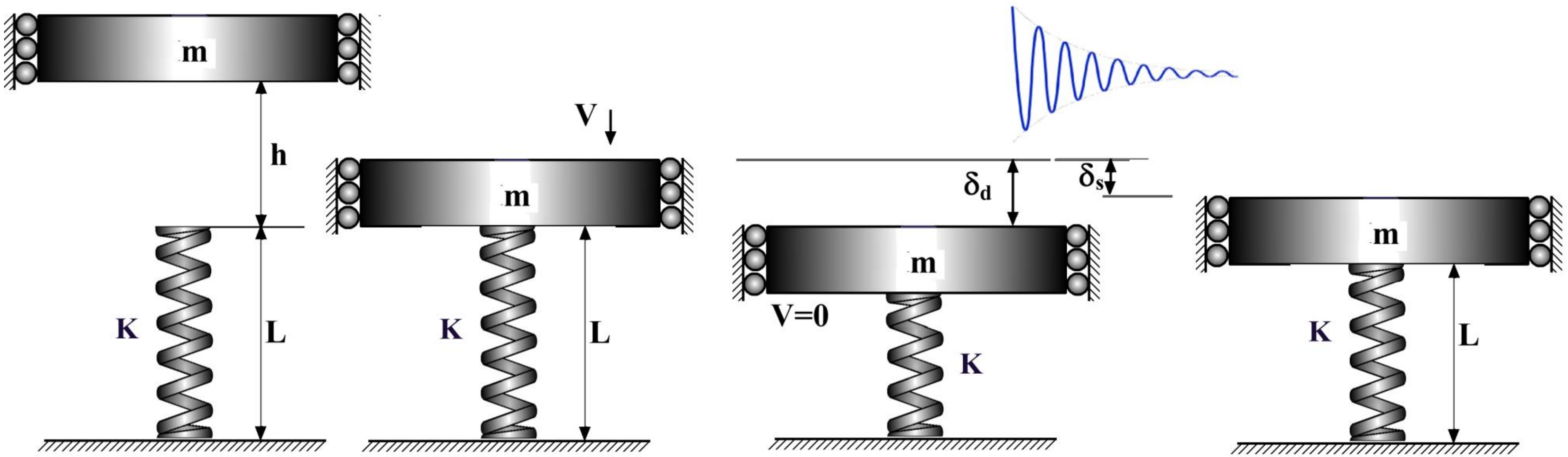
From Hooke's law: $F_s = K\delta_s$

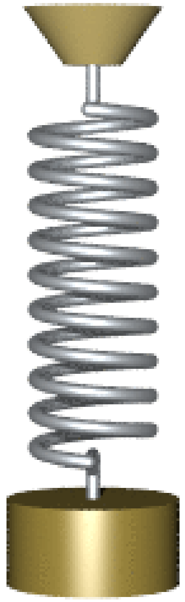
$F_s = mg$ $\quad$ $\delta_s < \delta_d$ $\quad$ $F_d = K\delta_d$

$$\mathrm{DMF} = \frac{F_d}{F_s} = \frac{\delta_d}{\delta_s}$$

Dynamic magnification factor = Dynamic force/Static force

Impact load





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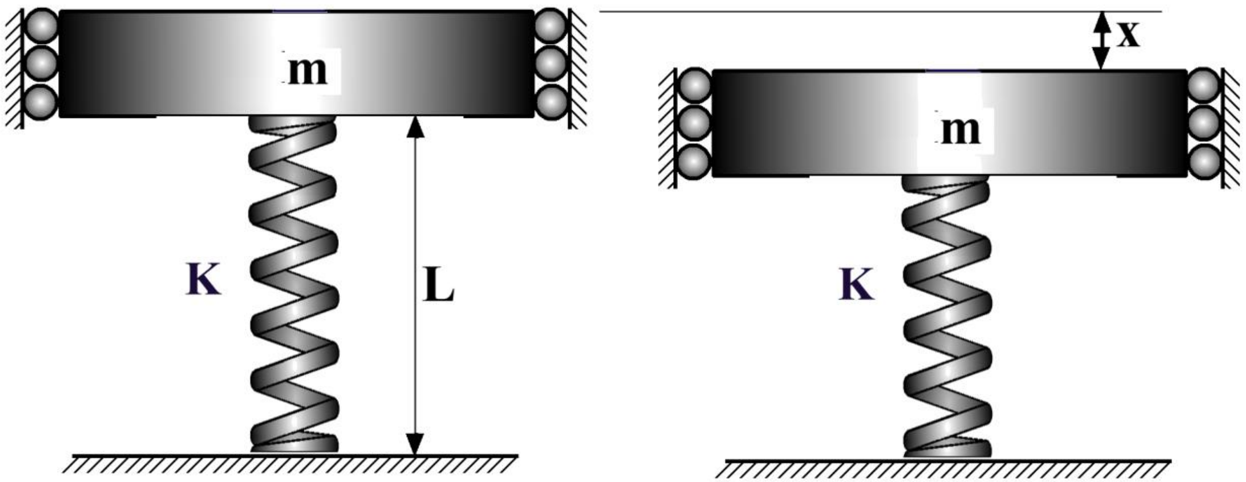
Energy stored in spring and mass



From Hooke's law: $F_s = Kx$

$F_s = mg$

$W = \int F_s \, dx$

$W = \int Kx \, dx$

Energy stored in the spring

$$W = K\int_0^{\delta} x\,dx = K\left|\frac{x^2}{2}\right|_0^{\delta} = \frac{K\delta^2}{2}$$

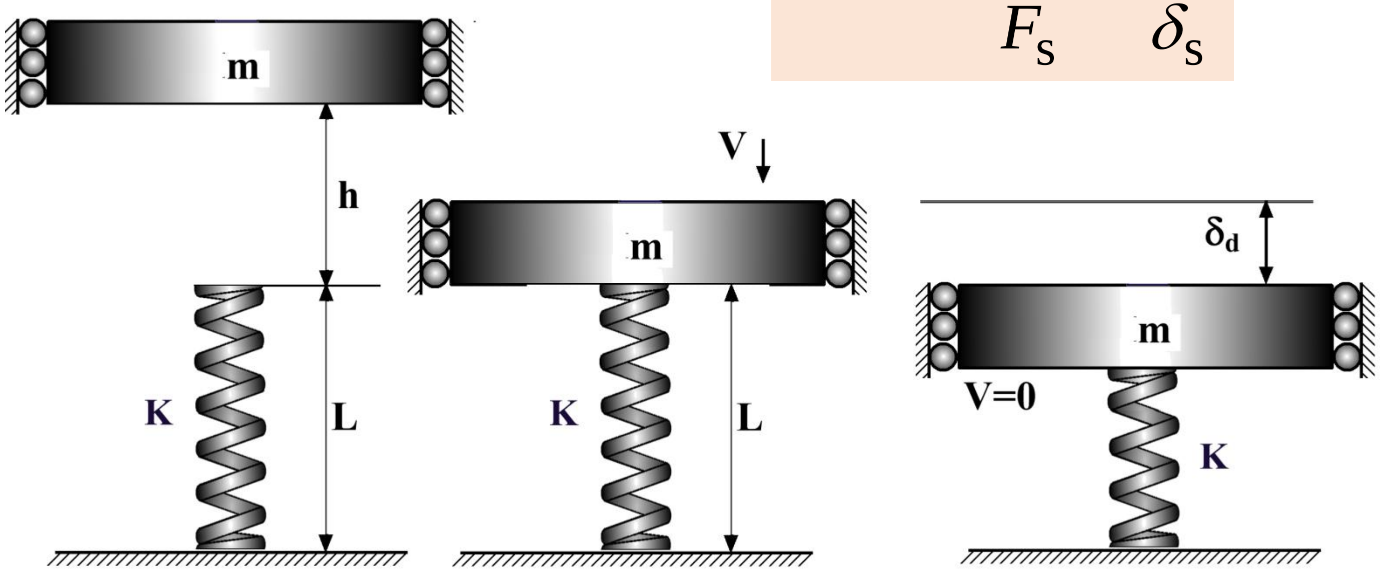
$F = ma$

Energy due to movement

$$W_{KE} = \int ma\,dx = m\int \frac{dv}{dt}\,dx = m\int_0^{V} v\,dv = m\left|\frac{v^2}{2}\right|_0^{V} = \frac{mV^2}{2}$$

Energy method

$$\mathrm{DMF}=\frac{F_\mathrm{d}}{F_\mathrm{s}}=\frac{\delta_\mathrm{d}}{\delta_\mathrm{s}}$$



$$E_\mathrm{Initial}=E_\mathrm{Final}$$

$$mg(h+L)=mg(L-\delta_\mathrm{d})+\frac{1}{2}K\delta_\mathrm{d}^2$$

$$mgh=-mg\delta_\mathrm{d}+\frac{1}{2}K\delta_\mathrm{d}^2$$

$$2h=-2\delta_\mathrm{d}+\frac{K}{mg}\delta_\mathrm{d}^2$$

$$2h=-2\delta_\mathrm{d}+\frac{1}{\delta_\mathrm{s}}\delta_\mathrm{d}^2$$

$$\frac{2h}{\delta_\mathrm{s}}=-2\frac{\delta_\mathrm{d}}{\delta_\mathrm{s}}+\frac{\delta_\mathrm{d}^2}{\delta_\mathrm{s}^2}$$

$$(\mathrm{DMF})^2-2(\mathrm{DMF})-\frac{2h}{\delta_\mathrm{s}}=0$$

$$\mathrm{DMF}=\frac{2\pm\sqrt{4+\frac{8h}{\delta_\mathrm{s}}}}{2}$$

$$\mathrm{DMF}=1+\sqrt{1+\frac{2h}{\delta_\mathrm{s}}}$$

$$\mathrm{DMF}=\frac{F_\mathrm{d}}{F_\mathrm{s}}=2 \text{ if } h=0$$

$$\mathrm{mg}h=\frac{mV^2}{2}$$

$$\mathrm{DMF}=\frac{\sigma_\mathrm{d}}{\sigma_\mathrm{s}}=1+\sqrt{1+\frac{V^2}{g\delta_\mathrm{s}}}$$

$$\boxed{\mathrm{DMF}=1+\sqrt{1+\frac{V^2}{g\delta_\mathrm{s}}}}$$

3:42 PM

$$\mathrm{DMF} = 1 + \sqrt{1 + \frac{V^2}{g\delta_s}}$$

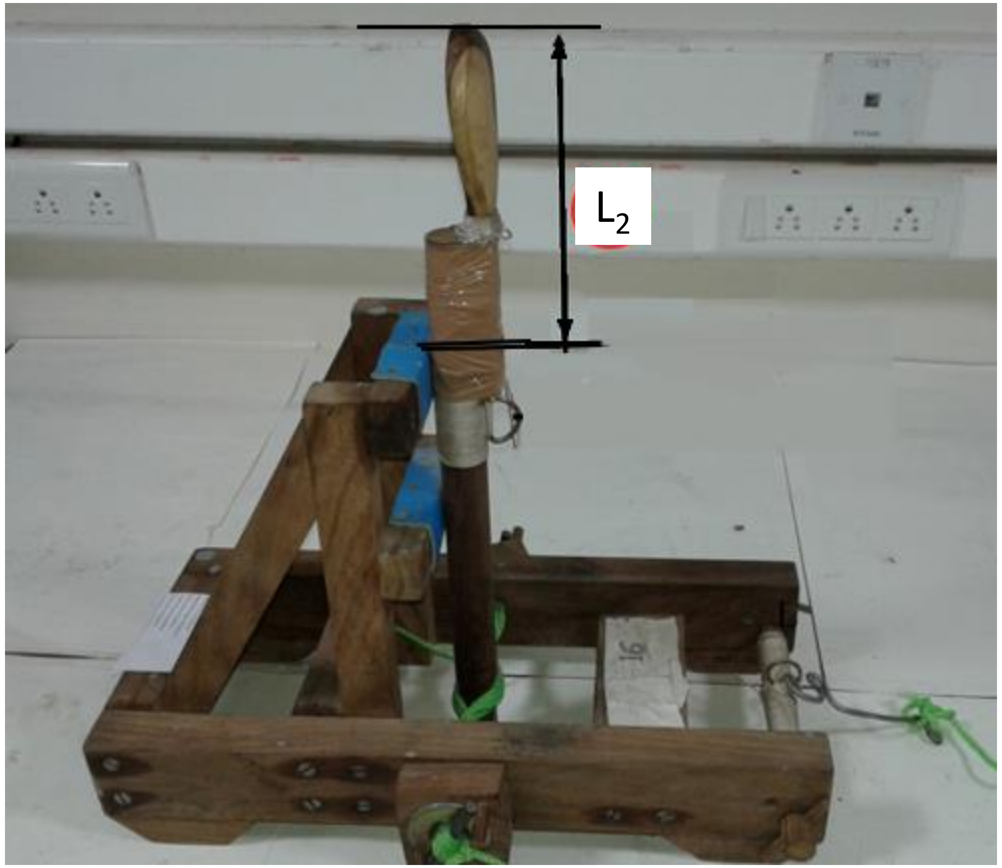
$$\delta_s = \frac{F_s L_2^3}{3EI} = \frac{16\rho L_2^4 g}{3Ed^2}$$

$$\mathrm{DMF} = \frac{F_d}{F_s} = \frac{\delta_d}{\delta_s}$$

$$F_s = \frac{\pi d^2}{4} L_2 \rho g$$

$$\sigma_d = \left(1 + \sqrt{1 + \frac{V^2}{g\delta_s}}\right)\sigma_s$$

$$\sigma_d = \left(1 + \sqrt{1 + \frac{3Ed^2V^2}{16\rho L_2^4 g^2}}\right) \times \frac{4\rho g L_2^2}{d}$$



Thanks for attending this lecture

Save Tree Save World