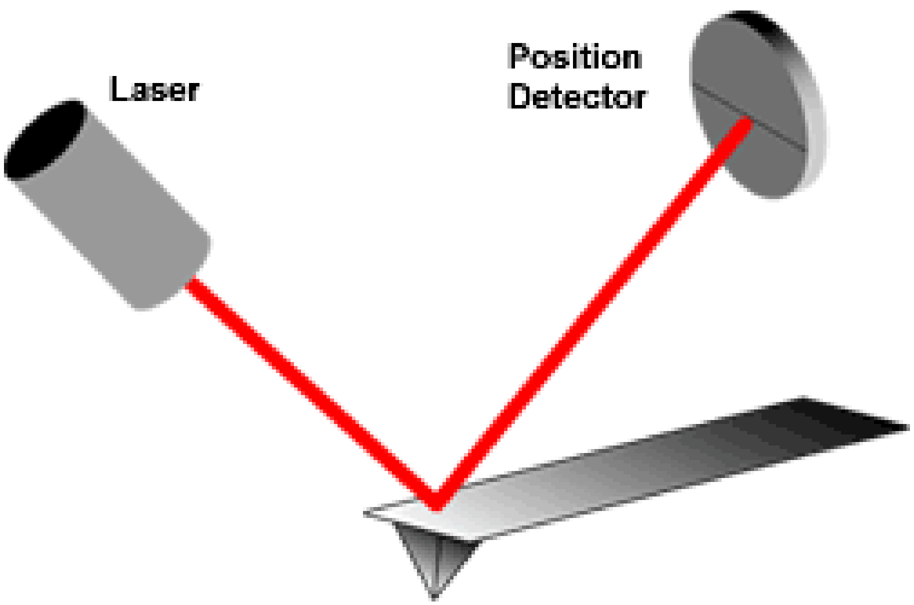
Mechanical Engineering ILAP

Beam Deflection Using Real-time Sensors

Beams at the small scale



Beams at the large scale

What parameters influence the beam deflection?

Cantilever beam

- Force
- Length
- Material
- Shape of Cross Section

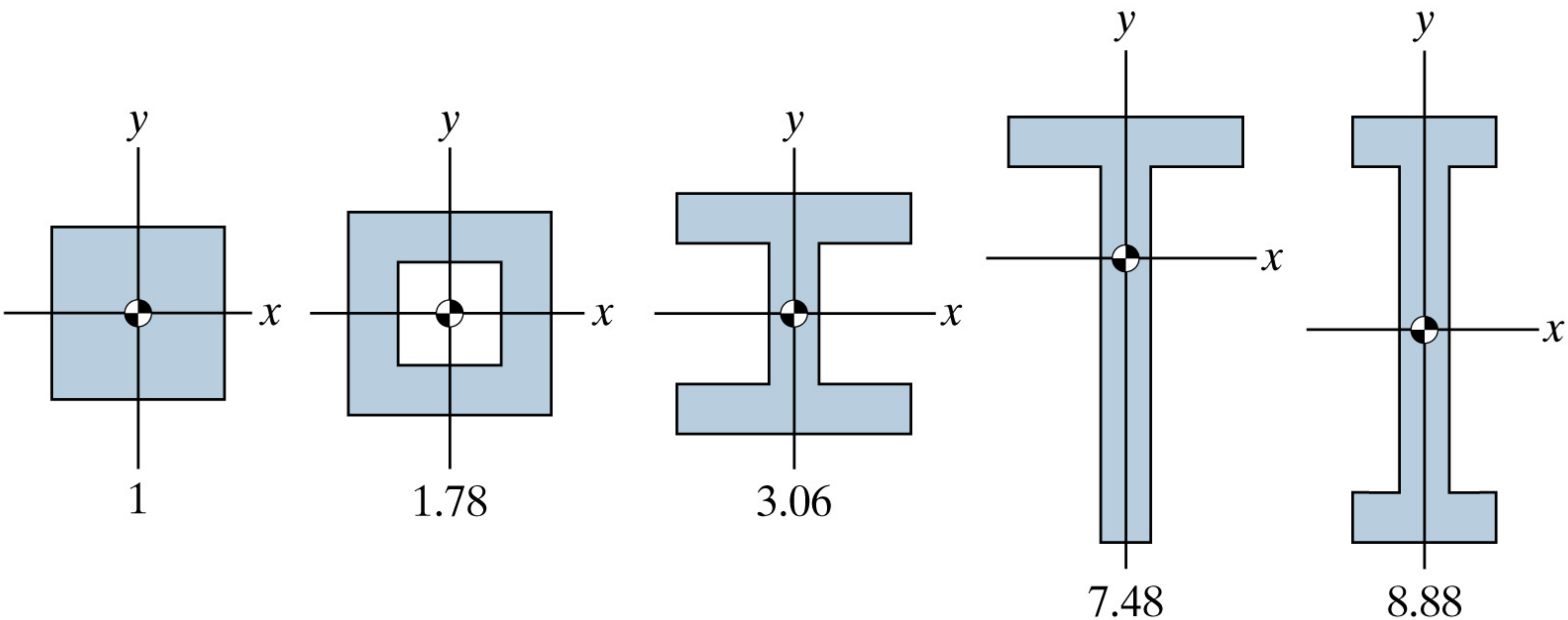
Modulus of Elasticity, E

Moment of Inertia, I

Modulus of Elasticity for Typical Materials

Material	Modulus of Elasticity GPa
Structural Steel	200
Aluminum	72
Timber, Ponderosa pine	9
Polystyrene	3.1
Polyester elastomer (rubber)	0.2

Typical Moments of Inertia



Typical Beam Cross Sections and the Ratio of I to the value for a solid square beam of equal cross-sectional area

Moment of Inertia

$$I_x = \int_A y^2 dA$$

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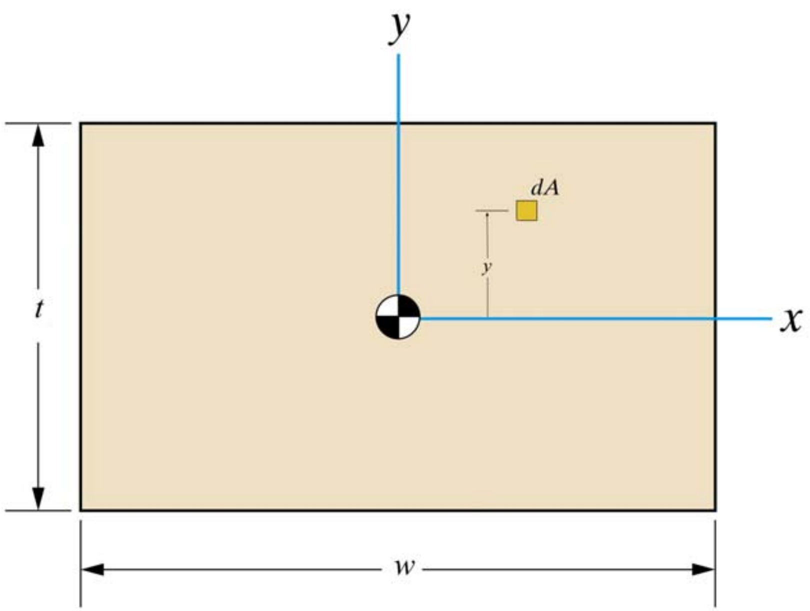
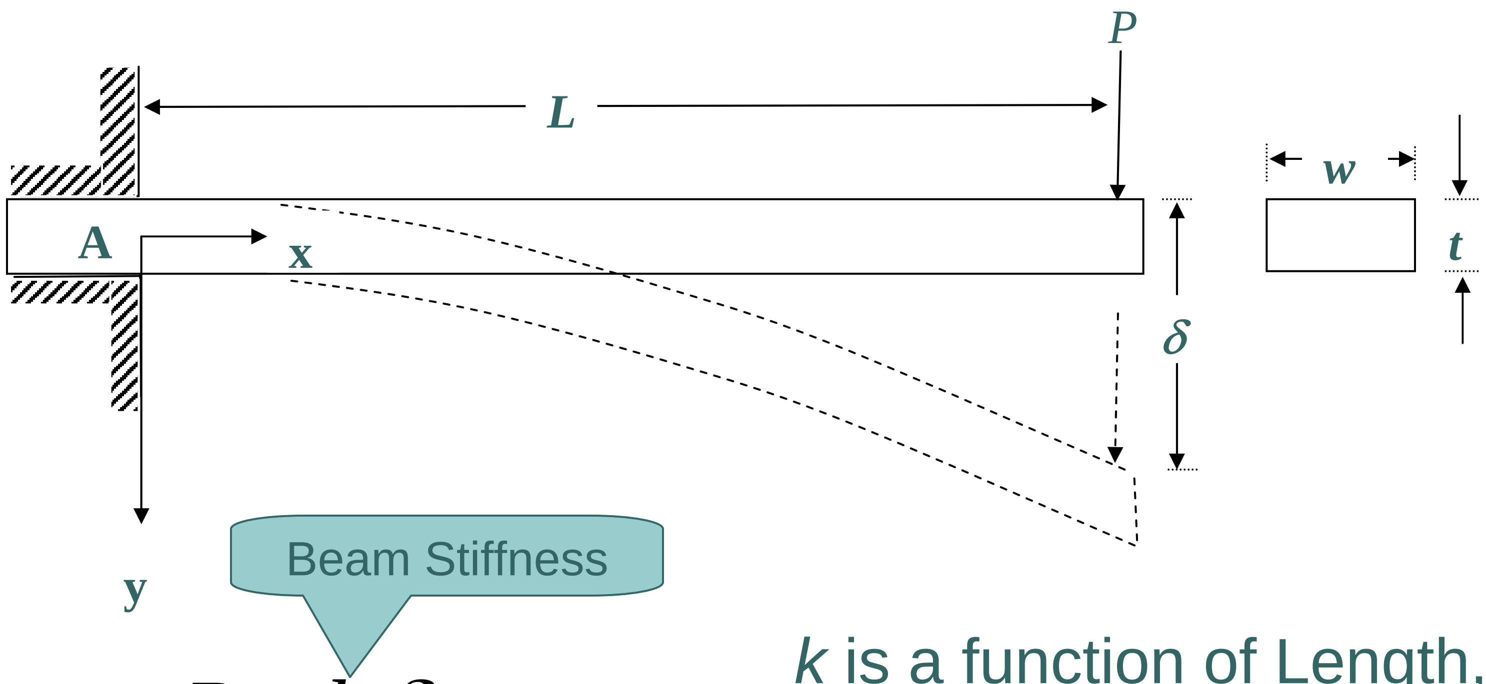


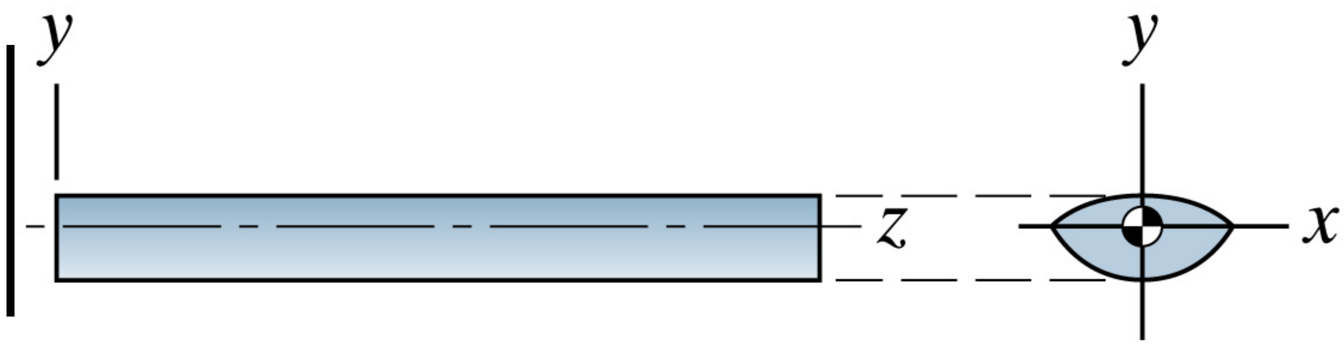
Relationship between load and tip deflection

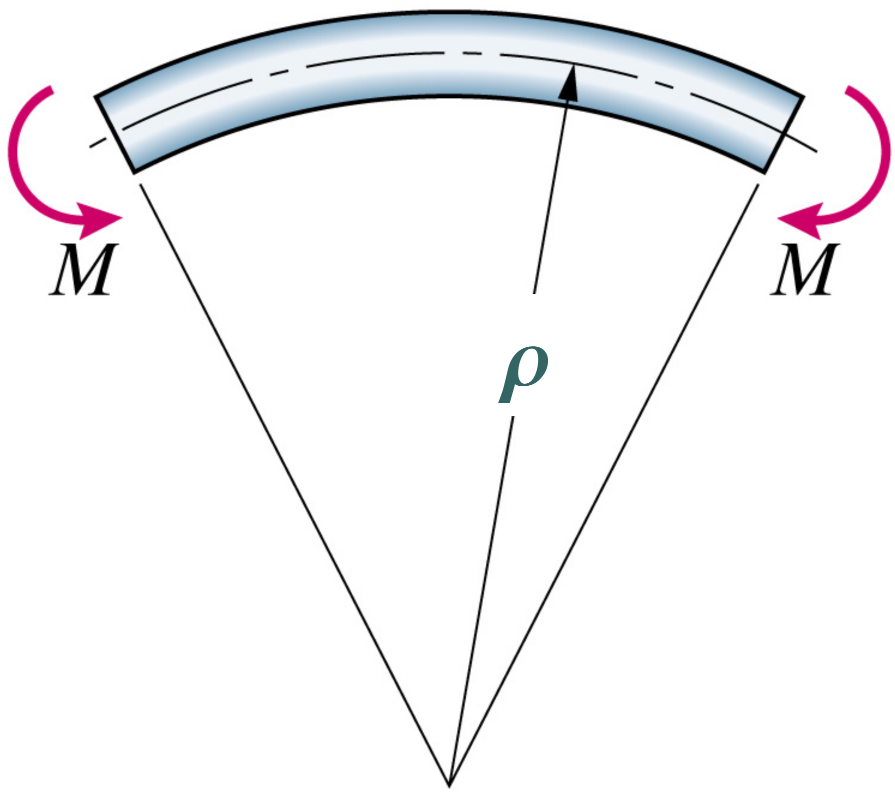


$$P = k\,\delta$$

k is a function of Length, Young's Modulus, and Moment of Inertia

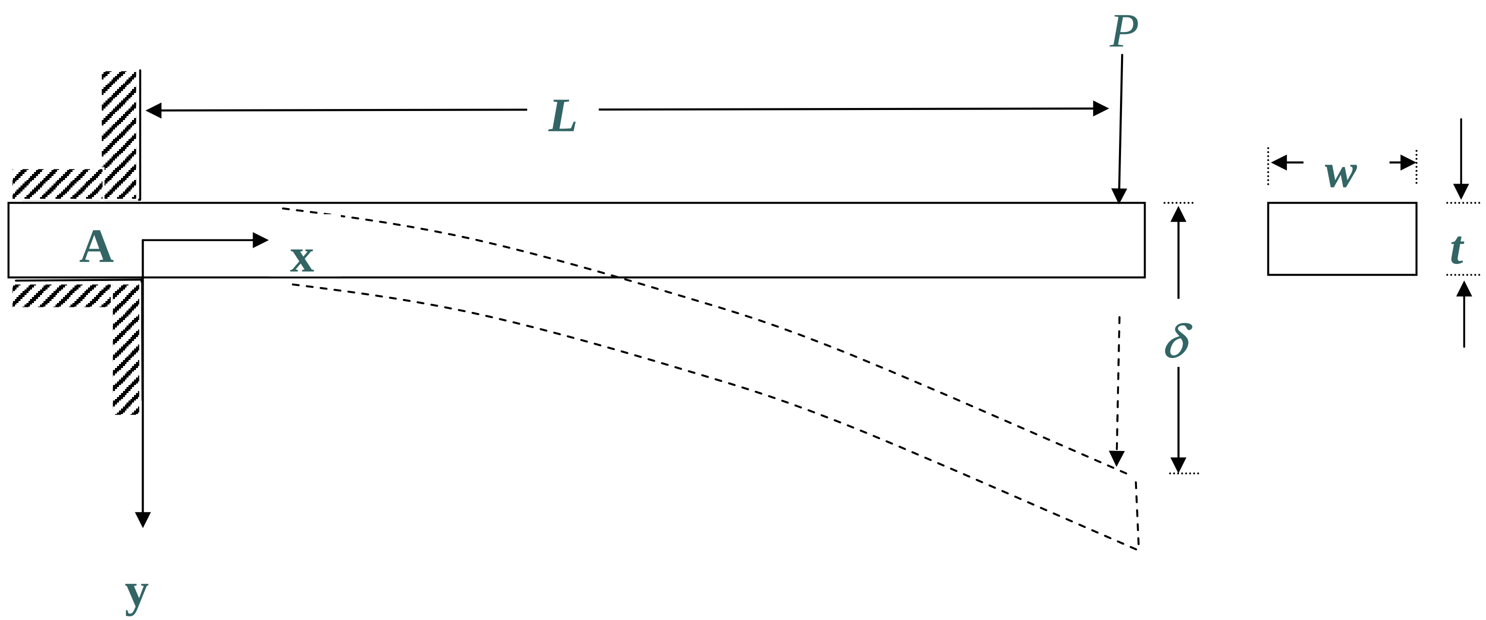
$$P = \left(a\ L^{b} E I\right)\delta$$





$$\rho = \frac{EI_x}{M}$$

Governing Equation



$$\frac{1}{\rho} = \frac{d^2 y}{dx^2} = \frac{M(x)}{EI} = \frac{P(L-x)}{EI}$$

Boundary Conditions?

$$y(0) = 0$$

$$\left.\frac{dy}{dx}\right|_{x=0} = 0$$

Evaluating Delta and Determining *E*

$$\delta = y(x = L)$$

•Compare Beam Stiffness for different beam lengths from experimental data with theoretical solution.

•Determine a best estimate of the Modulus of Elasticity of the Beam.