

# 1.050 Engineering Mechanics

II. Stresses and Strength  
Examples: Beam Statistics

# Program 9<sup>th</sup> Lecture

## 1-050 CONTENT

- I. Dimensional Analysis:
- II. **Stresses & Strength**
  2. **Stresses and Equilibrium**
    1. Discrete Model
    2. Continuum Model
    3. **Beam Model**
  3. Strength Models
- III. Deformation and Strain
  4. How Strain Gages work?
- IV. Elasticity
  5. Elastic Model
  6. Variational Methods in Elasticity
- V. How Things Fail? And How to avoid it.



### TODAY:

1. Review: Beam Stress Model
2. **Formulation of a Beam Boundary Value Problem**
3. **Statically Determined vs. Statically Indetermined Beam Structures**
4. **Closure: Stresses & Equilibrium**

Goal: Appreciate Force-Moment Beam Model for solving beam problems

# Review: Beam Model

1. Scales in Structural Mechanics

$$o\left(d\Omega_{\text{REV}}^{1/3}\right) \ll (h, b) \ll \ell$$

REV                      Section Dimension                      Beam length

2. **Reduction Formulas:**  
(from stresses to section forces and section moments)

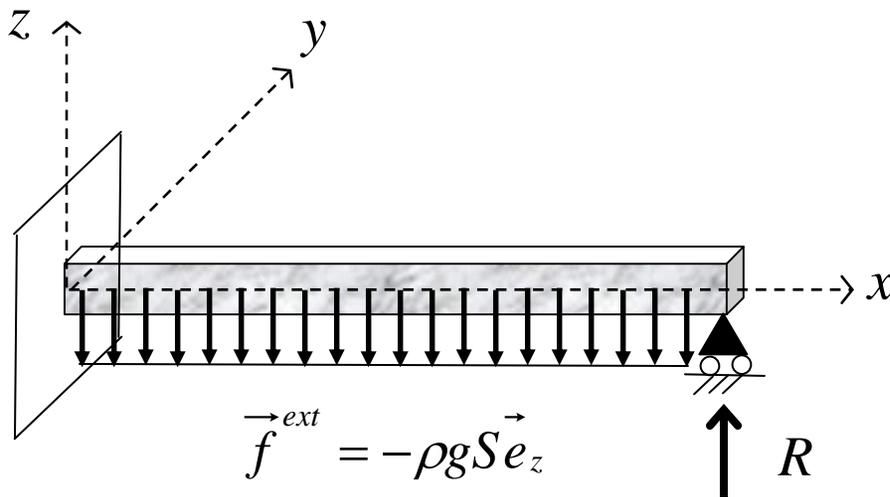
$$\vec{F}_S = \int_S \boldsymbol{\sigma} \cdot \vec{e}_x dS$$
$$\vec{M}_S = \int_S \vec{x} \times (\boldsymbol{\sigma} \cdot \vec{e}_x) dS$$

3. **Equilibrium:** along beam axis, differential equilibrium of forces and moments

$$\frac{d\vec{F}_S}{dx} + \vec{f}^{ext} = 0$$
$$\frac{d\vec{M}_S}{dx} + \vec{e}_x \times \vec{F}_S = 0$$

# Formulation of a Beam Boundary Value Problem

- Example



- Force and Moment Boundary Conditions
- Sum of all forces and Moments along  $x$  is zero
- Differential Equilibrium of
  - Section forces
  - Section moments

# Stresses & Equilibrium

	Discrete System	Continuum System	Beam System
Elementary System			
Internal "Stresses"			
Boundary Condition			
Continuity Condition			
Diff. Force Equilibrium			
Diff. Moment Equilibrium			