



FUNDAMENTALS OF CIVIL ENGINEERING

CE I I02

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INTRODUCTION TO STRUCTURAL ENGINEERING

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Content

- Equilibrium of rigid bodies (Free Body Diagrams, Loadings and Support Reactions)
- Constitutive Law of Materials
- Stresses and Stress Resultants (Axial forces and stresses, bending moments and stresses, shear forces and stresses)

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Learning Outcome

Draw free body diagrams and calculate stress resultants, stresses and strains.

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What Structural Engineers Do



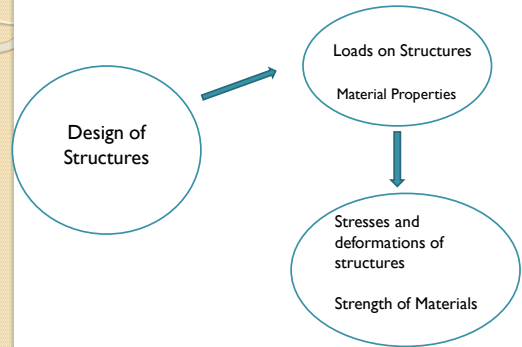
Responsible for strength and stability of a structure

Sizes of columns, beams and slab
Column, beam locations
Strength of concrete

Type and size of foundation

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What Structural Engineers Do



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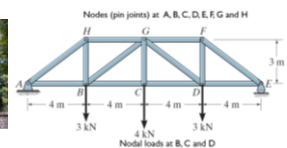
Structures

- What is a structure?
 - A system of connected parts used to support a load
- Civil Engineering structures
 - Buildings
 - Bridges
 - Towers

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Types of Structures

- Trusses
 - Slender members connected with pin joints at the end of members
 - Subjected to only axial internal forces
 - Loads are taken as nodal loads



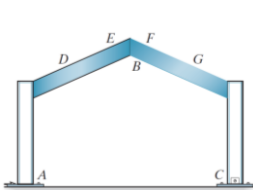
This is a truss bridge consists of two parallel trusses and a floor deck

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Types of Structures

Frames

- Consists of beams and columns connected by moment resisting joints (fixed connections)
- Some frame may have pin connections as well provided that other fixed connections in the frame are sufficient to ensure the stability

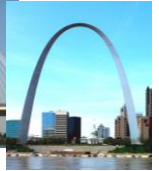


Few frames connected to make a warehouse

Types of Structures

Cables

- Support load in tension



Arches

- Support load in primarily in compression

Surface structures (plates and shells)

- Support load primarily in tension and compression



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Analysis of Structures

Before design any structure, the structure must be analyzed to determine the stresses and deformations which will be resulted due to the forces acting on the structure.

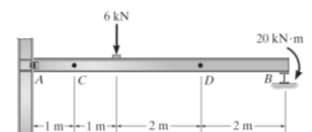
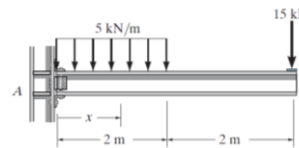
There are two types of forces;

- Loads (eg: weight of goods or people, water pressure, wind pressure etc.) – known values
- Support reactions (force generated due to resistance provided by the support) – Unknown values

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Loads

- Concentrated loads (Point loads)
- Distributed loads (uniformly distributed, triangular distribution etc.)
- Couple



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Supports

Types of Supports and Support Reactions

- Roller support



- Pin support



- Fixed support



Lecture 7 - Statics and Strength Theory

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Free Body Diagram (FBD)

- Diagram showing magnitudes and directions of all the forces (loads and reactions)



Equilibrium equations

- Necessary and sufficient conditions for equilibrium

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M_z = 0$$

Free body diagrams along with the equilibrium equations are used to find the unknown support reactions

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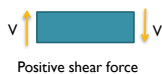
Internal Forces in Structural Members

Loads and support reactions are externally applied forces. However, there are internal forces as well.

- Normal force (axial)
- Bending moment
- Shear force



Positive normal force



Positive shear force



Positive bending moment

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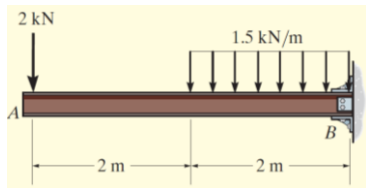
Example I

A 3 m long beam supported on two columns is carrying a uniformly distributed load of 1.8 kN/m. One support condition can be taken as pin support and the other as a roller. Draw the free body diagram and find the support reactions.

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Example 2

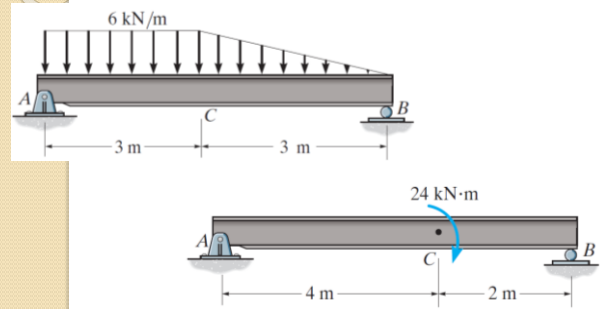
Draw the FBD and find the support reactions. B is a fixed support.



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Example 3

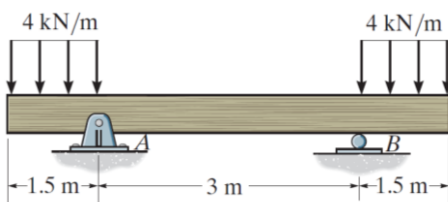
Draw the FBD and find the support reactions.



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Example 4

Draw the FBD and find the support reactions.



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References

- Hibbeler R.C., (2011), Mechanics of Materials, 8th Edition, Pearson Prentice Hall
- James M. Gere, (2004), Mechanics of Materials, 6th Edition, Thompson Learning Inc.
- Hearn, E.J. (1989), Mechanics of Materials, Volume I, Pergamon Press.

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