Republic of Iraq
Ministry of Higher Education
Karbala University
College of Engineering
Department of Civil Engineering

Theory of Structure

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- Syllabus:-
- Introduction, Stability and Determinacy of Structures, Types of Trusses, Analysis of Trusses,
- Axial Force, Shear, and Bending Moment Diagrams for Frames and Arches,
- Influence Lines in Statically Determinate Structures,

- Syllabus:-
- Deflections of Statically Determinate Structures, Unit Load Method, Least Work Method, Conjugate-Beam Method,
- Deflections of Statically Indeterminate Structures, Approximate Analysis of Statically Indeterminate Structures, Consistence Deformation Method, Least Work Method, Moment Distribution Method, Slop Deflection Method, Stiffness Method.

- Text book: Structural Analysis by R.C Hibbeler
- Introduction:
- Structures

- A structure may be defined as an assembly of members.

- The main purpose of a structure is to resist external loads in an acceptable fashion.

Structural Members

Structural members are the smallest units into which structures can be divided. Several types of structural members exist depending on how the forces are transferred throughout them.

Classification of Structures

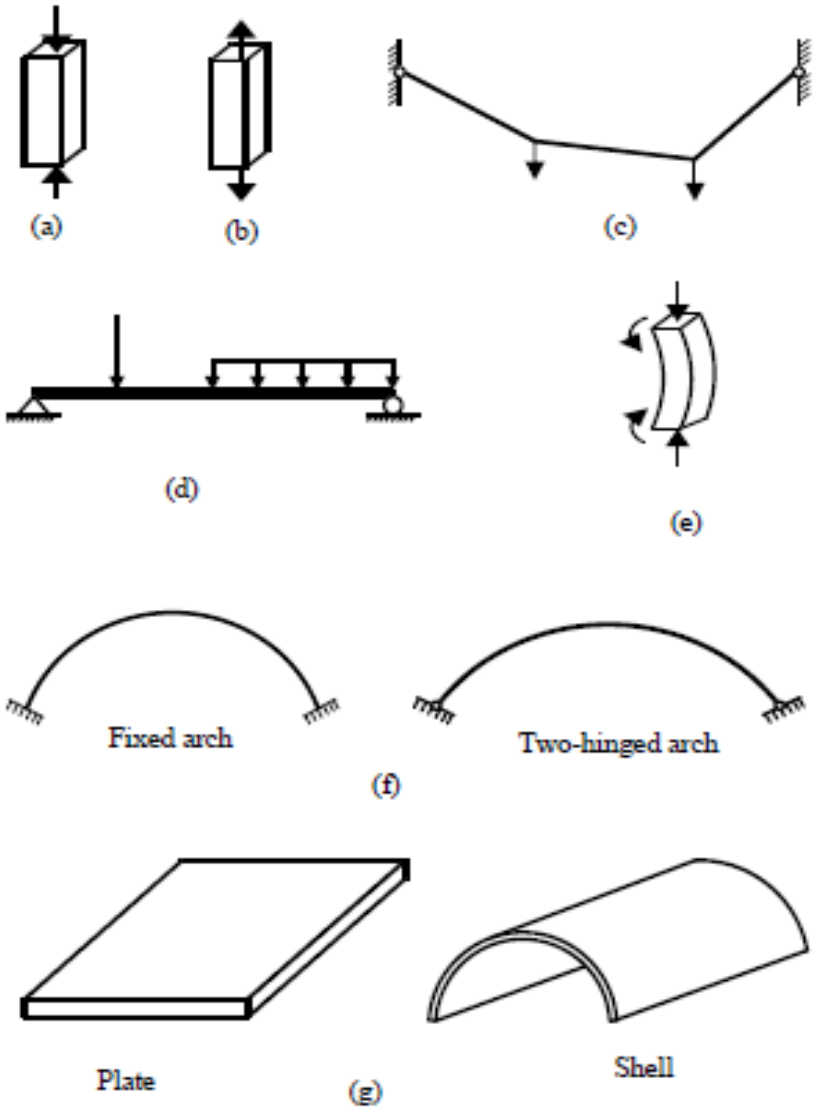
Structural elements

- Tie rods
- Beams
- Columns

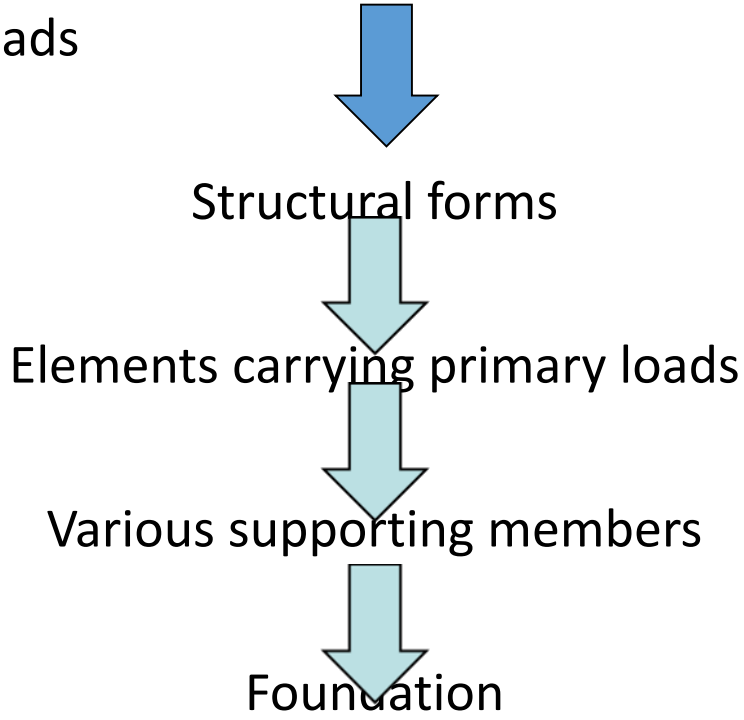
Types of structures

- Trusses
- Cables & Arches
- Surface Structures (Plates and Shells)
- Frame

- Types of structural members
- **(a) column, (b) tie,**
- **(c) cable,**
- **d) beam**
- **(e) beam-column,**
- **(f) arches,**
- **(g) plate and shell**



- Loads Loads


Structural forms
Elements carrying primary loads
Various supporting members
Foundation

Types of load

- **Dead loads**
- Weights of various structural members
- Weights of any objects that are attached to the structure
- **Live loads**
- Varies in magnitude & location
- **Traffic loads**
- Primary live loads are those due to traffic
- **Impact loads**
- Due to moving vehicles

- **Wind loads**
- wind depends on density & flow of air, angle of incidence, shape & stiffness of the structure & roughness of surface
- **Earthquake loads**
- Earthquake produce loadings through its interaction with the ground & its response characteristics
- **Hydrostatic & Soil Pressure**
- **Other natural loads(**blast, Temperature changes, Differential settlement of foundation)

Structural Analysis and Design

The primary function of a structure is to receive loads at certain points and transmit them safely. The selection of suitable sections to resist these forces such that the allowable stresses and specified displacements are not exceeded is called structural design.

Supports and Reactions

- Forces applied to a structure have internal and external effects. The external effects are the reactive forces (reactions). These reactions, which are exerted on the structure by the foundation, maintain the external equilibrium of the structure.

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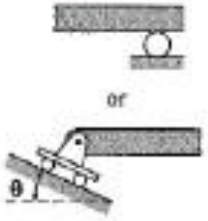
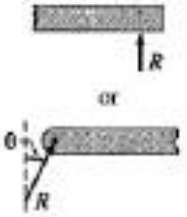
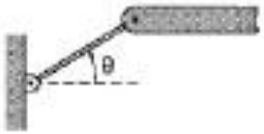
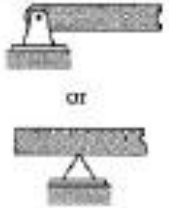
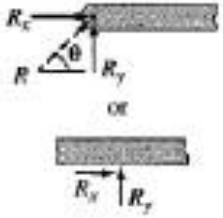
Types of supports

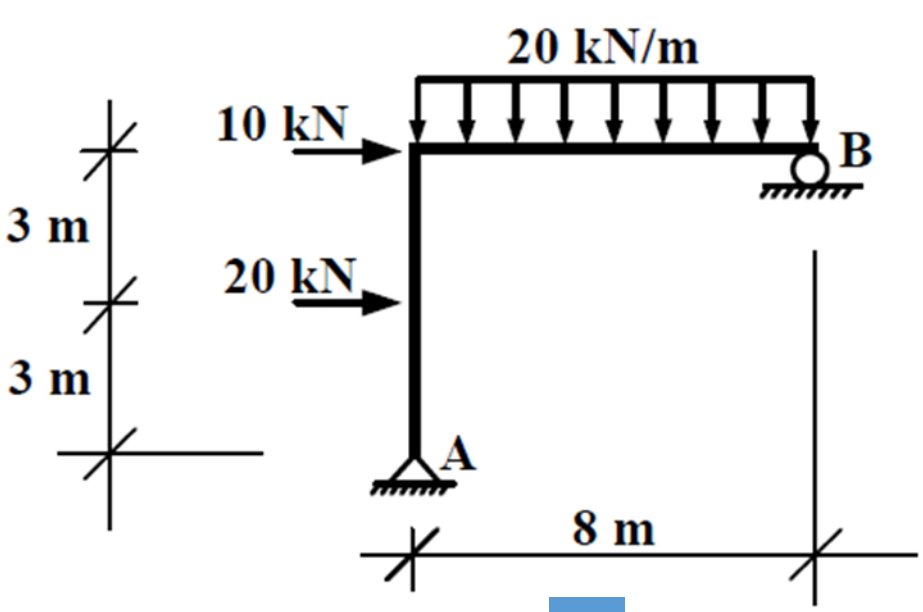
Category	Type of support	Symbolic representation	Reactions	Number of unknowns
I	Roller			1 The reaction force R acts perpendicular to the supporting surface and may be directed either into or away from the structure. The magnitude of R is the unknown.
	Rocker			
	Link			1 The reaction force R acts in the direction of the link and may be directed either into or away from the structure. The magnitude of R is the unknown.
II	Hinge			2 The reaction force R may act in any direction. It is usually convenient to represent R by its rectangular components, R_x and R_y. The magnitudes of R_x and R_y are the two unknowns.
III	Fixed			3 The reactions consist of two force components R_x and R_y and a couple of moment M. The magnitudes of R_x, R_y, and M are the three unknowns.

Computation of Reactions

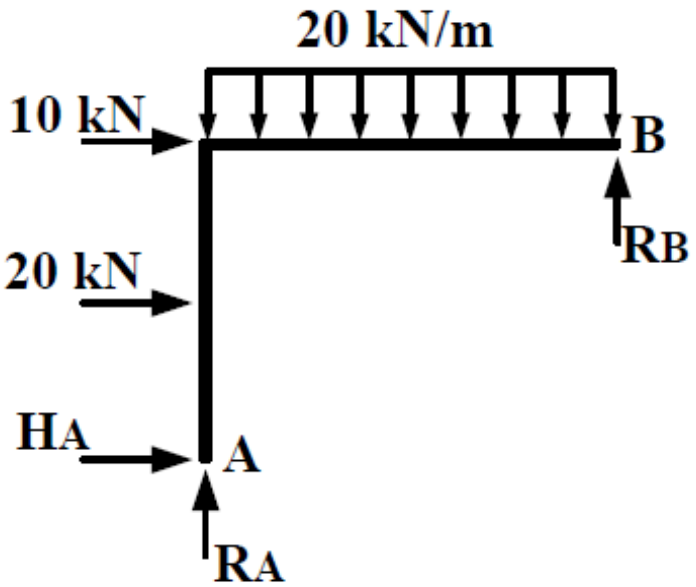
A body that is initially at rest and remains at rest when acted upon by a system of forces is said to be in a state of static equilibrium. The three following conditions must therefore be fulfilled simultaneously eqs. to remain in a state of static equilibrium:-

- $\Sigma F_x = 0$
- $\Sigma F_y = 0$
- $\Sigma M_z = 0$

Ex.1 Calculate the reactions for the frame shown in Fig.



a



b

- Solution:
- From Fig. (1) and using Eqs. (1) to (3), the reactions are

$$\sum F_x = 0 \xrightarrow{+} : \qquad 10+20+H_A=0$$

$$H_A = -30 \text{ kN} \leftarrow$$

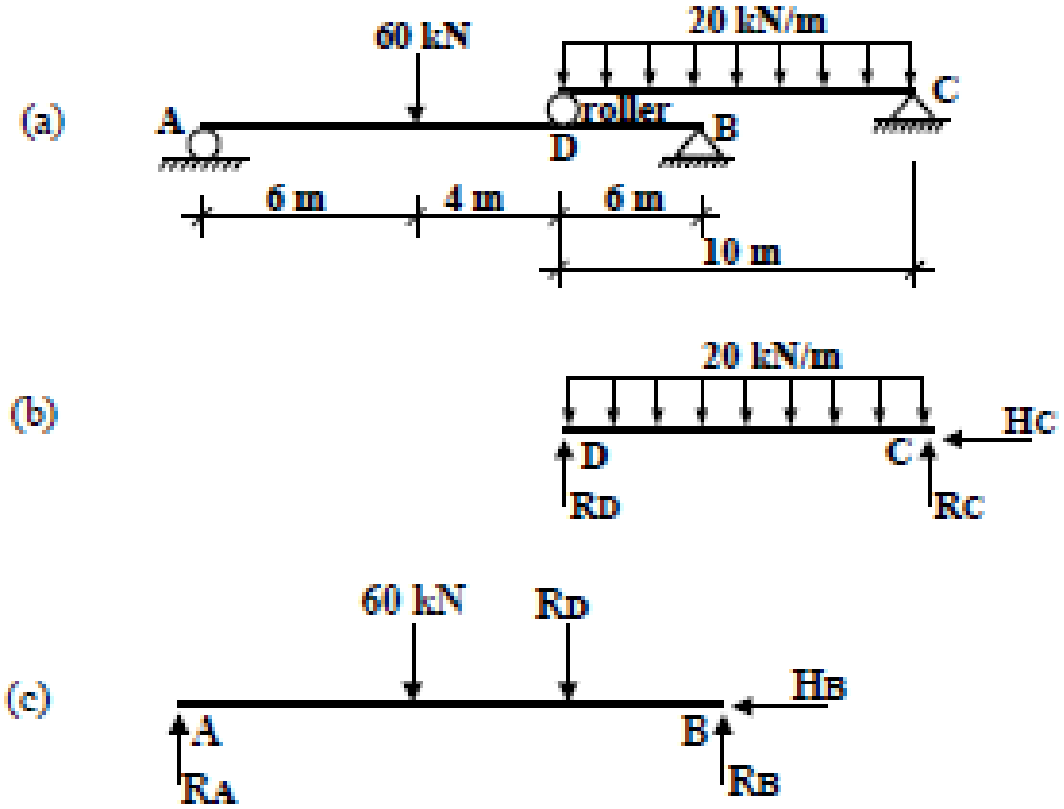
$$\sum M_A = 0 \ \text{+} \ 20 * 3 + 10 * 6 + 20 * 8 * \frac{8}{2} - R_B * 8 = 0$$

$$R_B = +95 \text{ kN} \uparrow$$

$$\sum F_y = 0 \ \uparrow + : \qquad R_A + R_B - 20 * 8 = 0$$

$$R_A = +65 \text{ kN} \uparrow$$

- Ex.2: Calculate the reactions for the beam shown in Fig.



- (a) Loaded beam, (b) free-body diagram for upper part, (c) free-body diagram for lower part

- Solution:
- From Fig. (2-b) and using Eqs. (1) to (3),

$$\sum F_x = 0 \quad \overset{+}{\leftarrow} : \qquad H_C = 0$$

$$\sum M_D = 0 \quad \overset{+}{\curvearrowleft} : \qquad R_C * 10 - 20 * 10 * \frac{10}{2} = 0$$

$$R_C = +100 \text{ kN} \uparrow$$

$$\sum F_y = 0 \quad \overset{+}{\uparrow} : \qquad R_D + R_C - 20 * 10 = 0$$

$$R_D = +100 \text{ kN} \uparrow$$

From Fig. (1.11-c),

$$\sum F_x = 0 \quad \overset{+}{\leftarrow} : \qquad H_B = 0$$

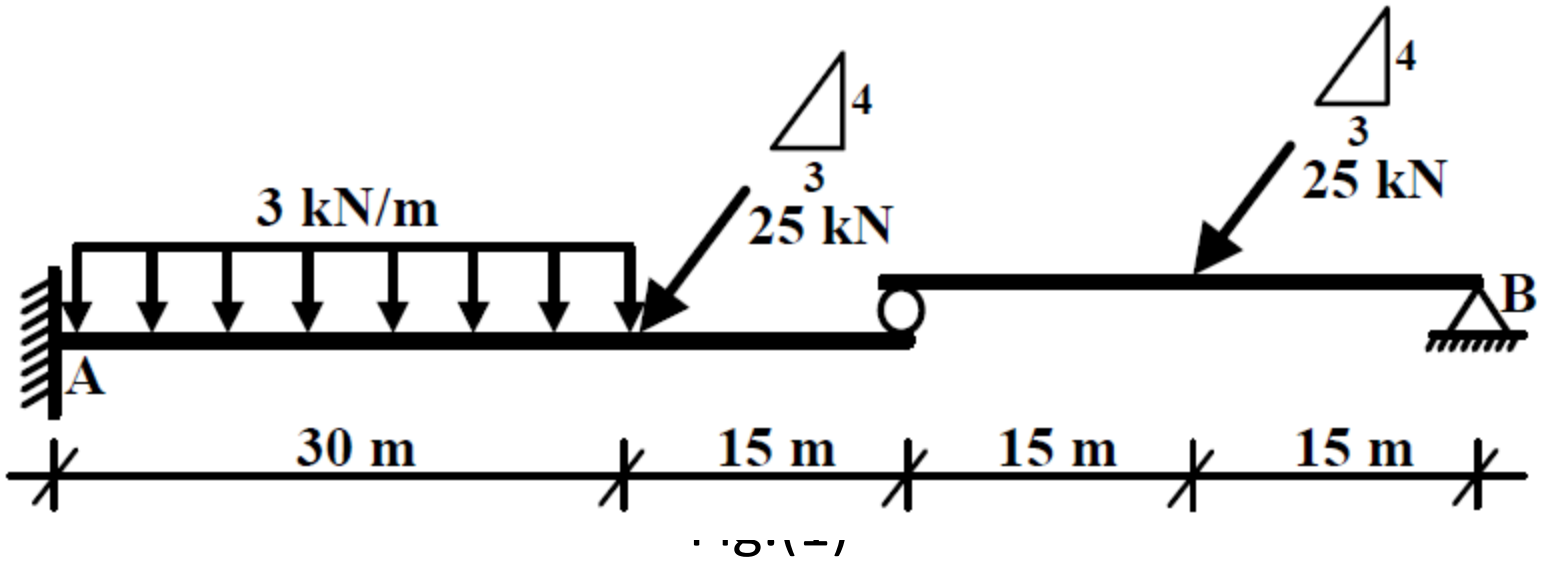
$$\sum M_B = 0 \quad \curvearrowleft + : \qquad R_A * 16 - R_D * 6 - 60 * 10 = 0$$

$$R_A = +75 \text{ kN} \uparrow$$

$$\sum F_y = 0 \quad \uparrow + : \qquad R_A + R_B - 60 - R_D = 0$$

$$R_B = +85 \text{ kN} \uparrow$$

- H.W:-
- 1 through 4: Determine the reactions at the supports for
- the structures shown.



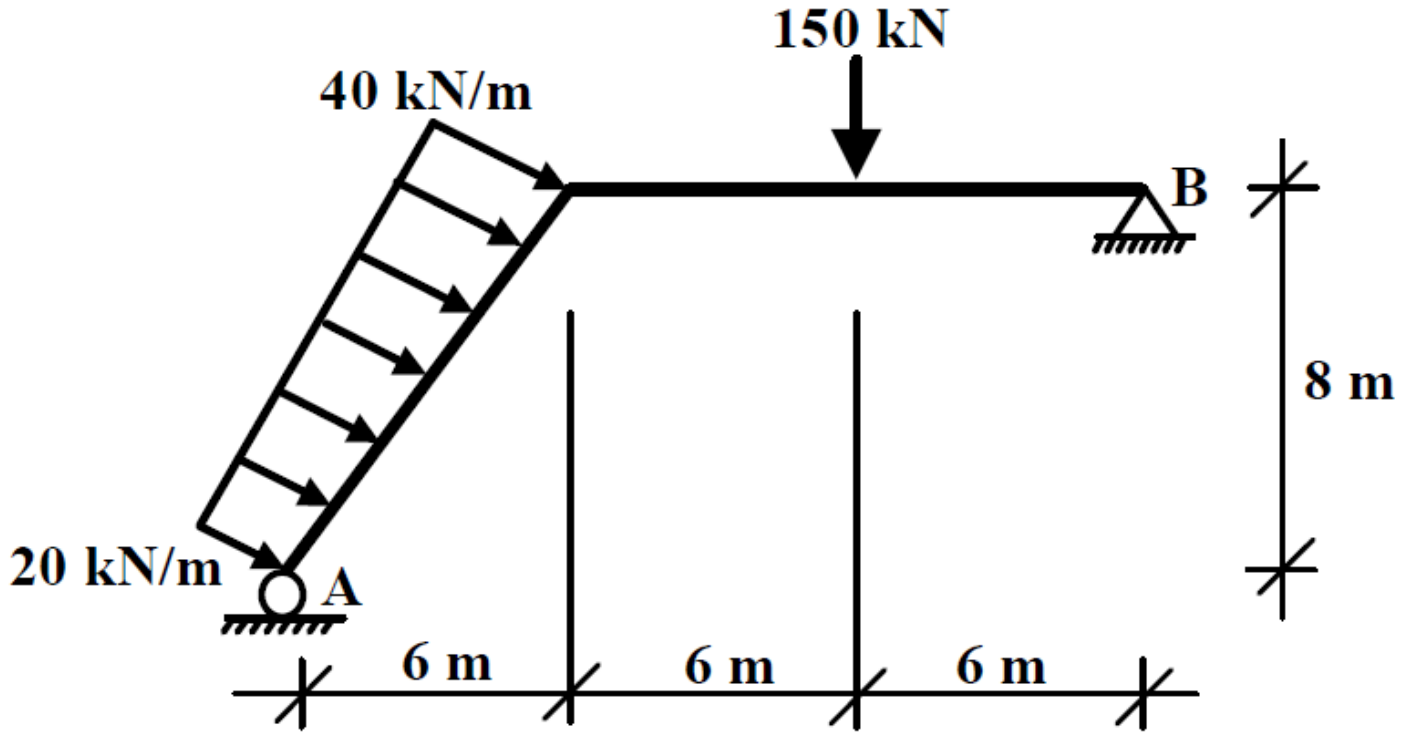


Figure P1.4

($R_A = 244.07$ kN ↑, $H_B = 240$ kN ←, $R_B = 85.93$ kN ↑)

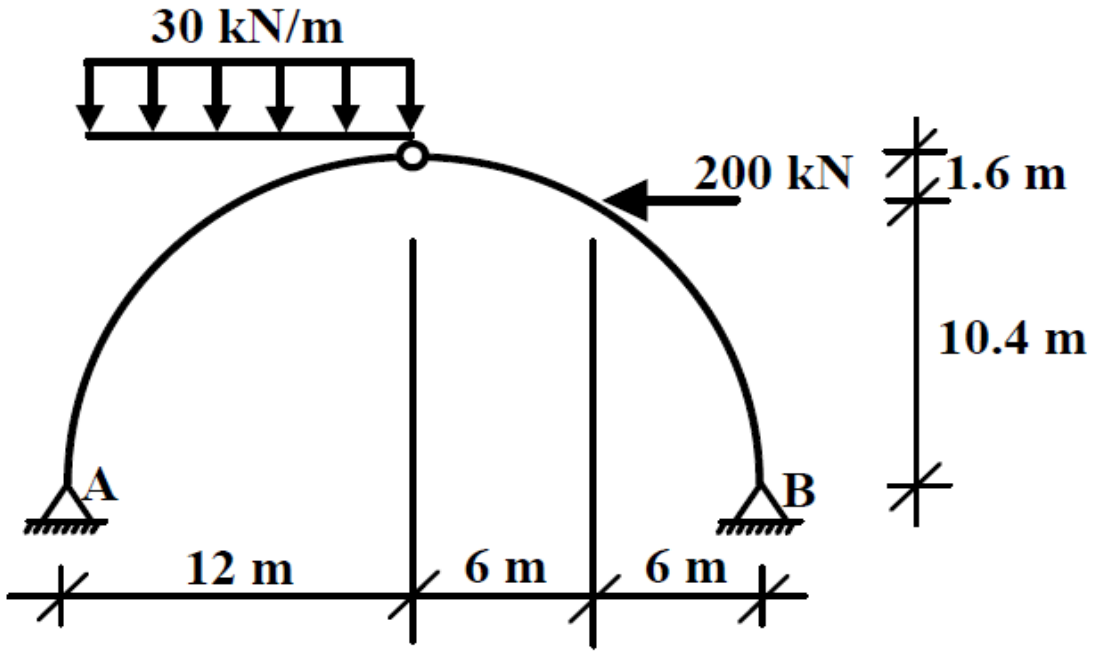
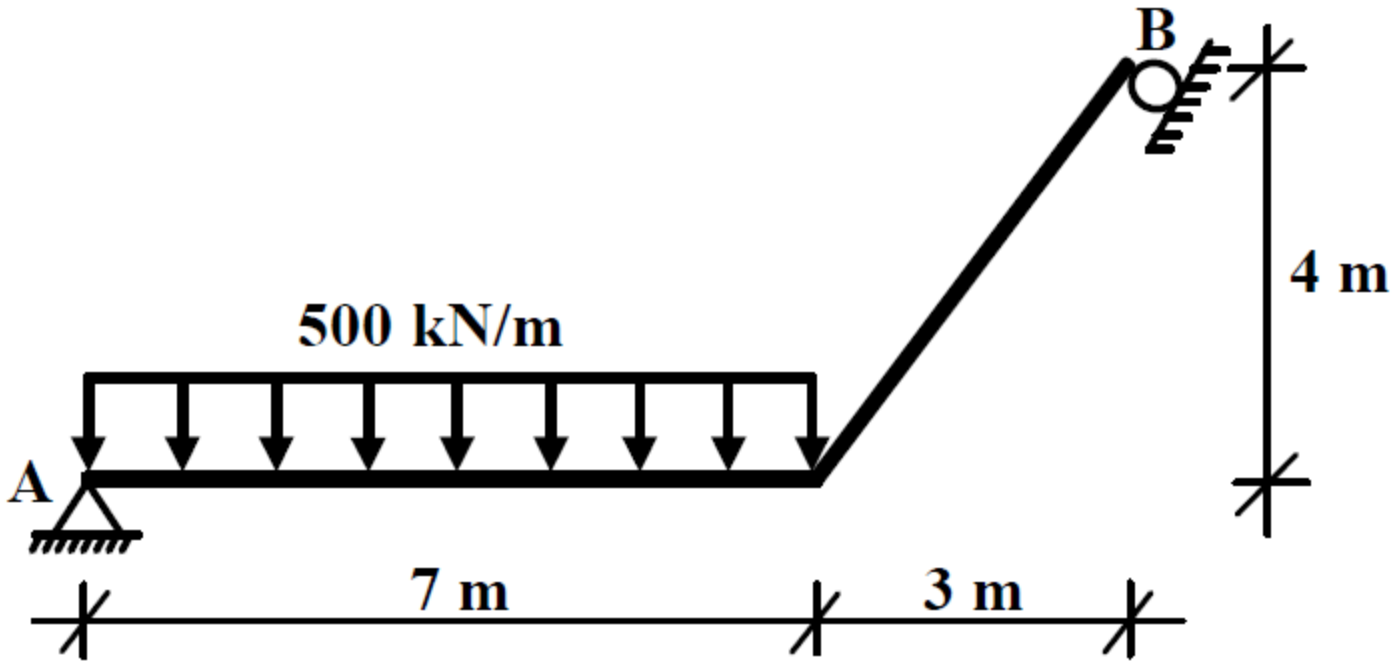


Figure P1.5

($H_A = 176.67$ kN ⟶ , $R_A = 356.67$ kN ↑ , $H_B = 23.33$ kN ⟶ ,
$R_B = 3.33$ kN ↑)


B
4 m
500 kN/m
A
7 m
3 m