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Govt. polytechnic Vaidhali

Sub: - Engg. Mechanics (101204/02104)

Unit - 2 Equilibrium

Topic - 4

* Beam :-

A beam is a structural member used for bearing loads. It is typically used for resisting vertical loads, shear forces, and bending moments.

- for the beams the distance 'L' between the supports is called a span.

* Classification of beam :-

Beams can be classified in many types based on three main criteria.

① Based on geometry / cross-section:

a. Straight beam

b. Curved beam

c. Tapered beam

d. T-beam

e. T-beam

} based on cross-section.

② Based on equilibrium conditions:

a. statically determinate beam

b. statically indeterminate beam

③ Based on types of support:

a. simply supported beam

b. cantilever beam

c. overhanging beam

d. continuous beam

e. fixed beam

f. propped cantilever beam.

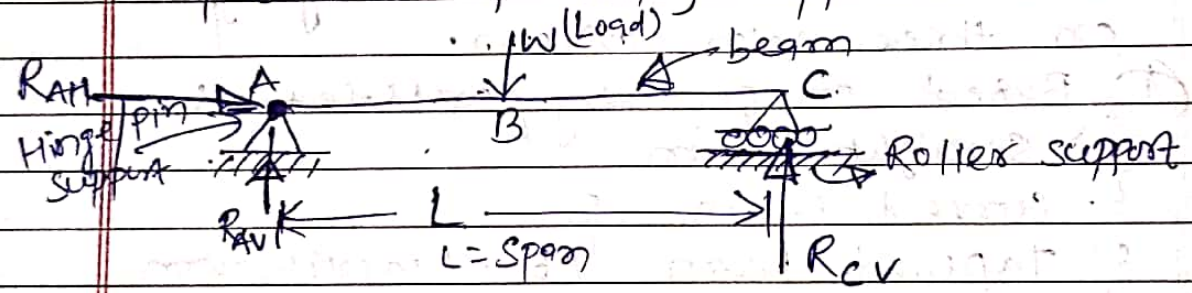
Types of beam: (According to syllabus)

1) simply supported beam:-

A simply supported beam is a type of beam that has pinned/hinge support at one end and roller support at the other end. depending on the load applied, it undergoes shearing and bending.

The horizontal distance between the support is called span.

Representation of simply supported beam:-



A beam is represented by -

- * longitudinal axis
- * Types of support or support reactions.
- * span
- * Load acting on it.

Here, $\sum H = 0$
 $\sum V = 0$
 $\sum M = 0$ } Static Equilibrium Equations

In this case,

No. of reaction = 3

No. of useful static equation = 3

Hence it is statically determinate beam

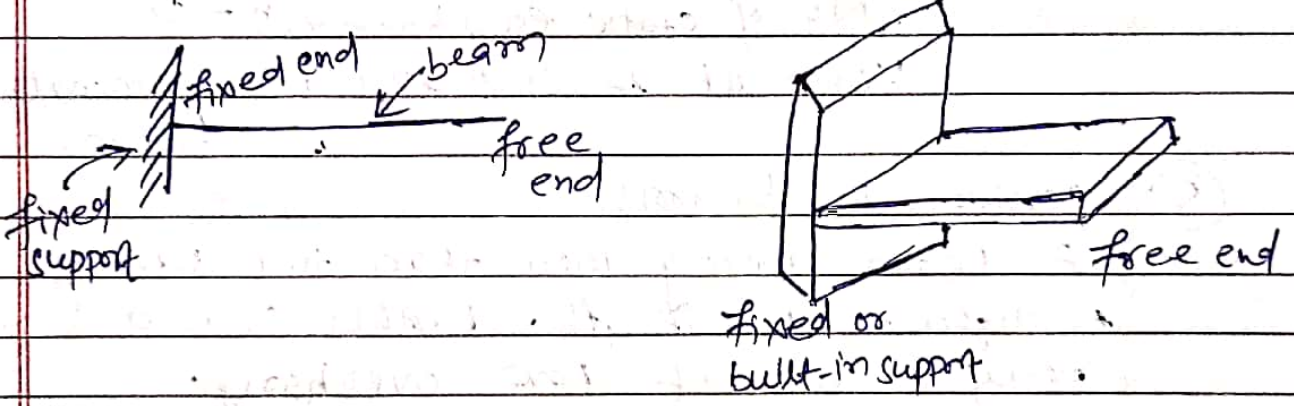
Note:- for statically determinate beam, equilibrium conditions alone can be used to solve reactions.

for statically indeterminate beam, equilibrium conditions are not enough to solve reactions.

2) Cantilever beam :-

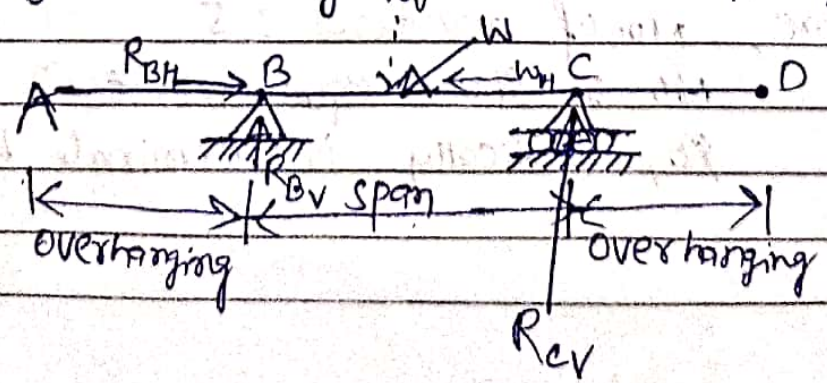
A beam having its one end fixed or built-in and the other end free to deflect. there is no deflection or rotation at the fixed end.

Representation :-



3) Overhanging beam :-

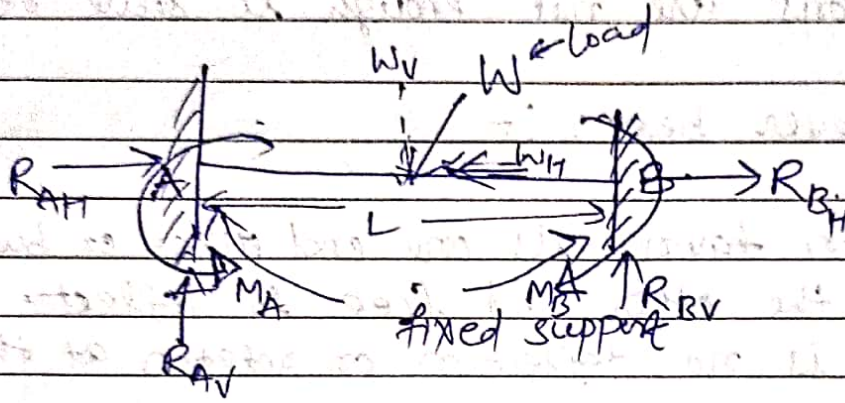
A beam having one or both ends extended over the supports. the end portion or portions extend in the form of cantilever beyond the supports. it may have any number of supports.





④ fixed beam:-

A beam having both of its ends fixed or built-in. this beam has maximum 6 reactions, 3 at each end.



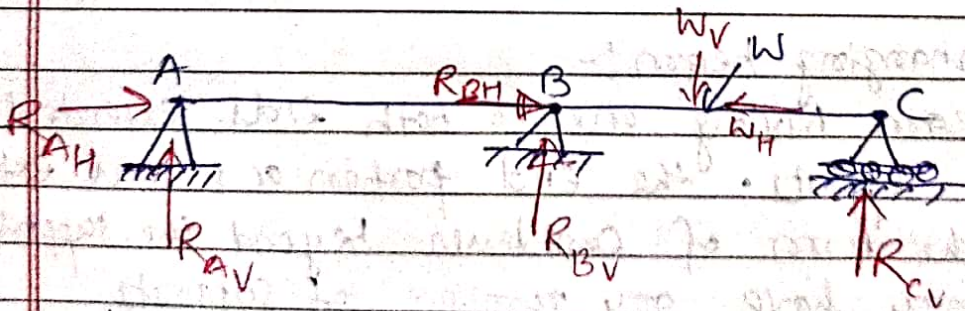
Here, No. of reactions = $3 + 3 = 6$

No. of static equilibrium eqⁿ = 3

Hence it is statically indeterminate beam.

⑤ continuous beam:-

A beam having more than two supports throughout its length. further such a beam may or maynot have overhang.



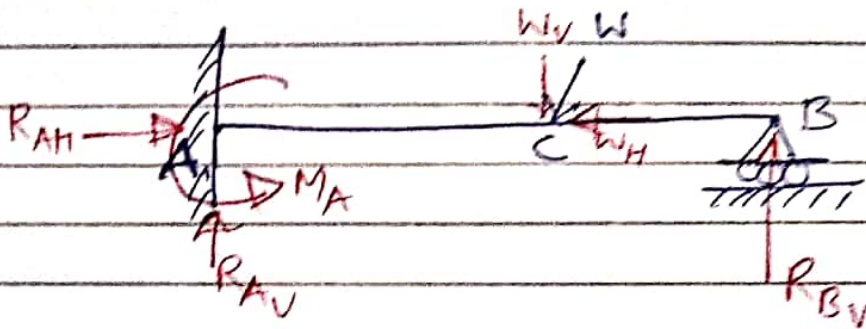
Hence, No. of reactions = 5

No. of static equilibrium eqⁿ = 3

So, statically indeterminate beam.

⑥ propped cantilever beam: -

if the free end of the cantilever beam is supported by a roller support, then it becomes a propped cantilever beam.



Here, No. of reactions = 4

No. of useful static equilibrium eqn = 3

∴, statically indeterminate beam.

Assignment:

Q ① Define Beam?

Q ② Write the types of beam with neat sketch?

Thank you * All the best *

Group - I (Mech + Electrical)

Sub - Engg. mechanics (01204/02104)

Unit - 2: Equilibrium

2.4 Beams:-

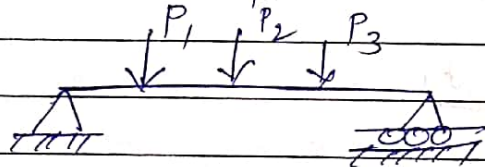
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Types of Load:-

1. Concentrated or point Load.
2. Distributed Load \rightarrow
 - ① Uniformly distributed load
 - ② Uniformly varying load.
3. Couple.

① Concentrated Load:-

The load acts at a point on the beam. This point load is applied through a knife edge.

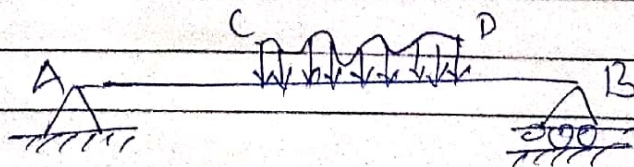


Load P_1 , P_2 & P_3 are point loads.

② Distributed Load:-

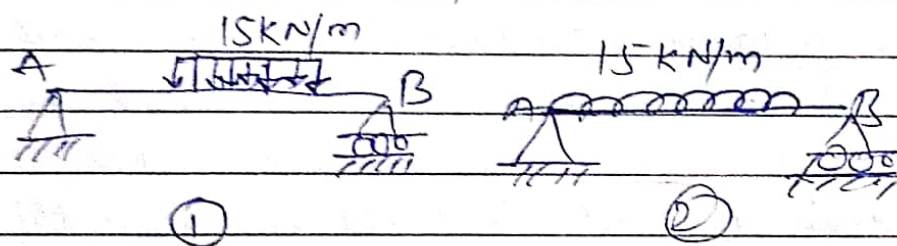
A load which acts over a finite length of the beam. It may be uniform over the length or it may vary uniformly or non-uniformly.

These loads are measured by their intensity which is expressed by force per unit distance along the axis of the beam.



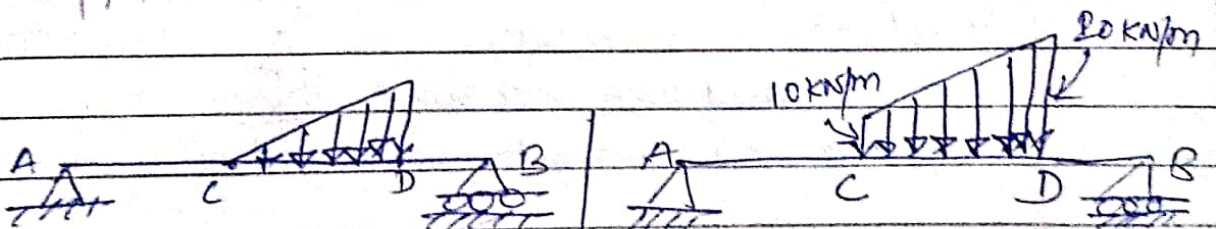
④ Uniformly distributed Load :-

the load is uniformly distributed over a part of the beam or the magnitude of the load remains uniform throughout the ~~the~~ beam. It is abbreviated as UDL. The total UDL is assumed to act at the centre of gravity of load. It is expressed as kN/m length of the beam



⑤ Uniformly varying load :-

The load whose intensity varies linearly along the length of the beam over which it is applied



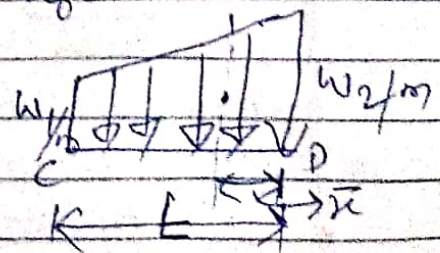
$$W = W_0 + Kx$$

W_0 = loading at reference point

here $W_0 = 0$, means load intensity at C = 0 and at D is max^m!

$$W = W_0 + Kx$$

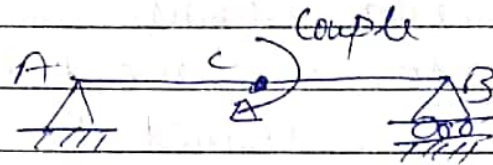
here $W_0 = 5 \text{ kN}$



$$\bar{x} = \frac{L}{3} \left(\frac{2W_1 + W_2}{W_1 + W_2} \right)$$

$$W = (W_1 + W_2) \times \frac{L}{2}$$

③ Couple: A beam may be loaded by a couple whose magnitude is expressed as $N\text{-m}$ or $KN\text{-m}$

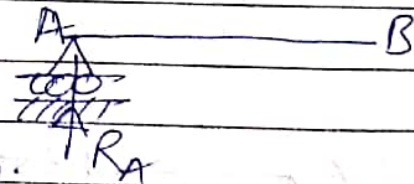


* Types of support: -

① Roller support: - In this case beam end is supported on rollers, in such cases reaction is always Normal to support, since rollers are free to roll along the supports. The ends are free to rotate also. There is no resistance to moment. This support can resist vertical loads only. Hence it has only one vertical reaction R_A .

It cannot resist horizontal load or a moment.

So it has not horizontal reaction or moment reaction.

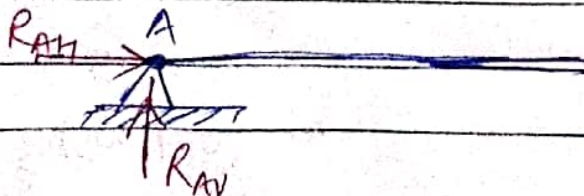


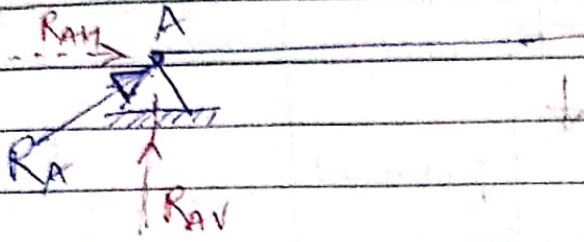
② Hinge or pin support: -

In this, the portion of the end of the beam is fixed but the end is free to rotate.

At such support the reaction can be in any direction which is normally represented by its components in mutually perpendicular dirⁿ.

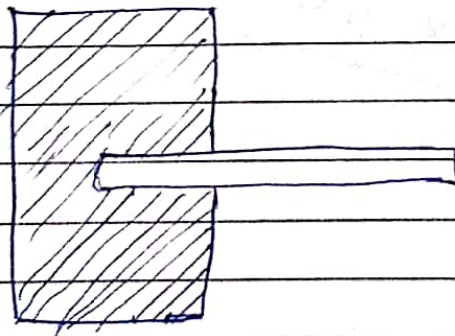
It permits rotation freely at the end.



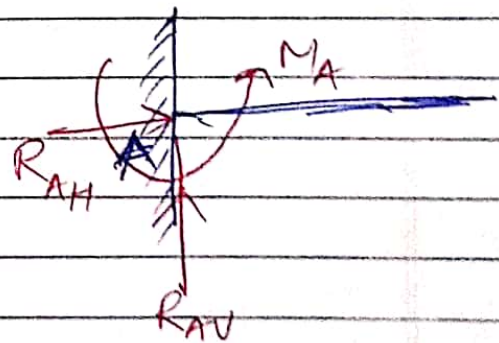


③ Fixed support:-

At fixed the end of the beam is neither permitted to move in any direction nor allowed to rotate. Hence support reactions are a force in any direction and the resisting moment. Reaction force in any direction is conveniently represented by its components in two mutually perpendicular directions.



represented as



Note

① Roller support }
Hinge/pin support } simple support

② No. of reactions at any support = No. of restricted motions by that support

Types of motion	axial motion	vertical motion	Rotation
Types of support			
① Roller support $R_V \checkmark$ $R_H = 0$ $M_R = 0$	permitted	Restricted	permitted
② Hinge support. $R_H \checkmark$ $R_V \checkmark$ $M_R = 0$	Restricted	Restricted	permitted
③ Fixed support. $R_H \checkmark$ $R_V \checkmark$ $M_R \checkmark$	Restricted	Restricted	Restricted

Assignment

- ① Explain the types of support reactions?
- ② How many types of load acting on a beam? explain with neat sketch?

Thank you