Analysis of Indeterminate Structures

Introduction:

Anything built by man by using mat and machines are called structures.

Ex: Building, bridges, Dam, Tunnel, Highway, ways, Harbour etc.,

Calculation of unknowns is called analy There are two types of unknowns:

a) Reactive unknowns
b) Displacement unknowns

Reactive unknowns are R_V, R_H, BM, SF, RS, T, σ, E, P_b, τ etc., and

Displacement unknowns are Slope (θ), D -tion (Δ), Settlement, sway etc.,

Equilibrium Equations:

(i) $\Sigma M = 0$; Body doesnot rotate in any direc
(ii) $\Sigma H = 0$; Body doesnot move in Horizontal
(iii) $\Sigma V = 0$; Body doesnot move in vertical di

Note: All structures are in equilibrium cond

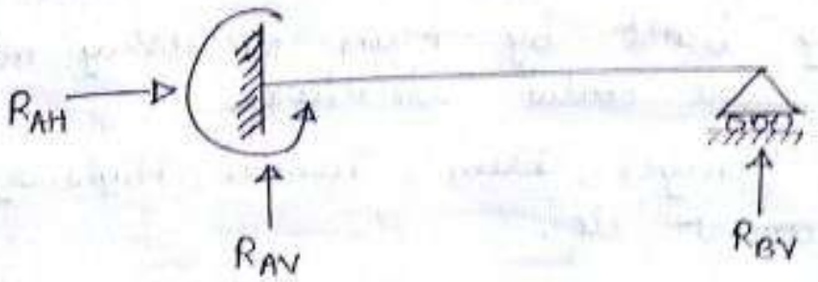
If the unknowns can be calcula making use of three equilibrium equations -ed determinate structure.

Ex: 

If the unknowns cannot be calculated by using the equilibrium equation is called indeterminate structure.

We need extra equation to calculate unknow

Ex:



No. of unknowns = 4

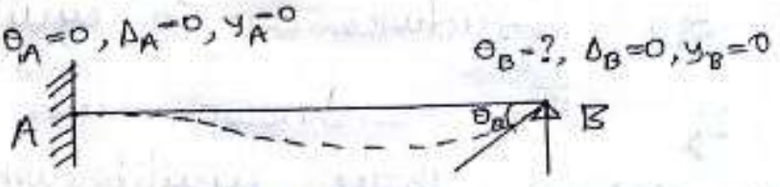
Equilibrium eq^{ns} = 3

4 − 3 = 1

Number of extra equations required to calculate unknown reactive components is called static Indeterminancy. It is also called as degree of redundancy (DOR).

Number of extra equations required to calculate unknown displacement components is called Kinematic Indeterminancy. It is also called as Degree of freedom (DOF).

Degree of freedom is defined as 'the possible movement of a structure at the support @ at the joints.'



DOF = θ_B

∴ DOF = 1

There are various methods to analyse statically Indeterminate structures:

1. Slope - Deflection method
2. Moment Distribution method

3. Kani's rotation method
4. Stiffness matrix method
5. Flexibility matrix method

Sign Convention :

*) ↑ +ve ↓ -ve

*) → +ve ← -ve

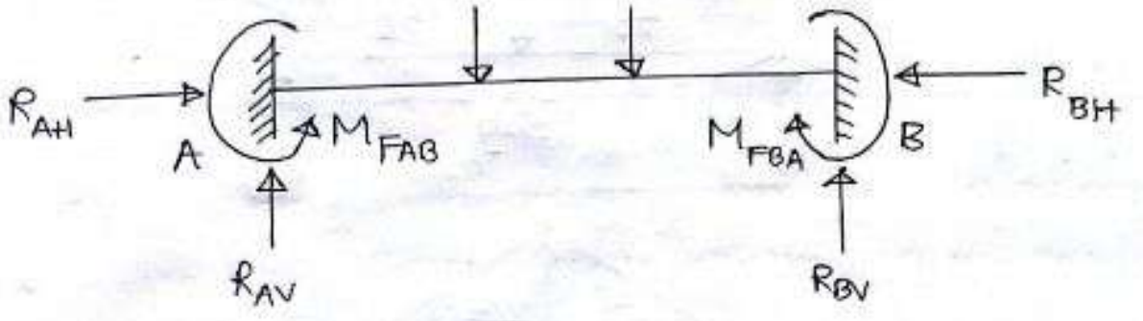
*) ↻ +ve ↺ -ve

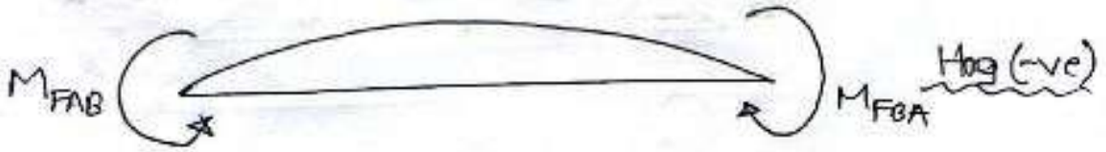
Imp *) Hogging '-ve' Sagging '+ve'

The moments which are developed at the support due to fixity end is called fixed end moment (FEM). The effect of fixed end moment is to 'Hog' the beam.

The moment developed at the centre called sagging bending moment @ free bending moment (FBM).

Eg :





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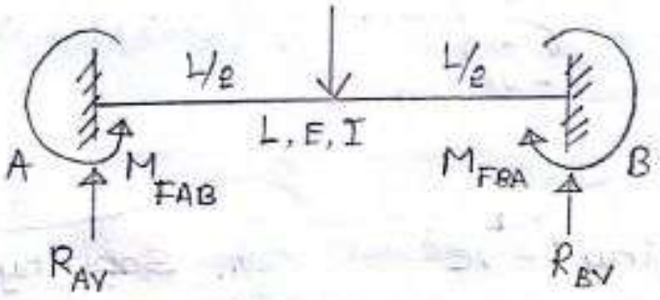
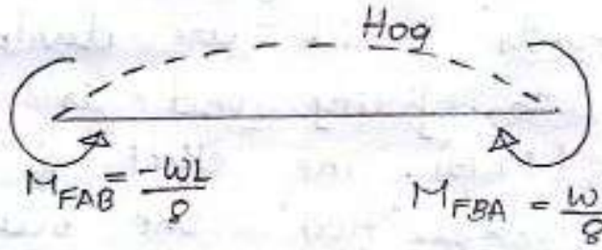
If the cross-section of the beam is uniform throughout is called "prismatic beam".

If the beam is made of same material throughout the length called "homogeneous", if elastic properties are same (E, G, K) called "isotropic".

Fixed end moments and free bending moments

1.





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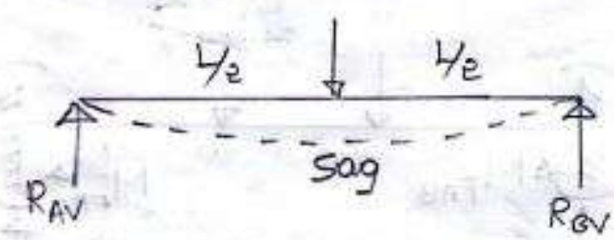

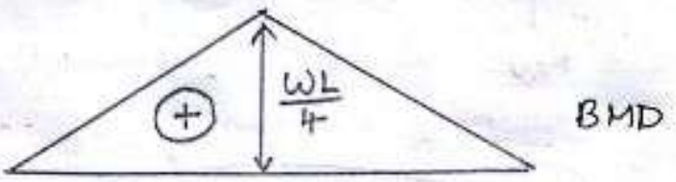

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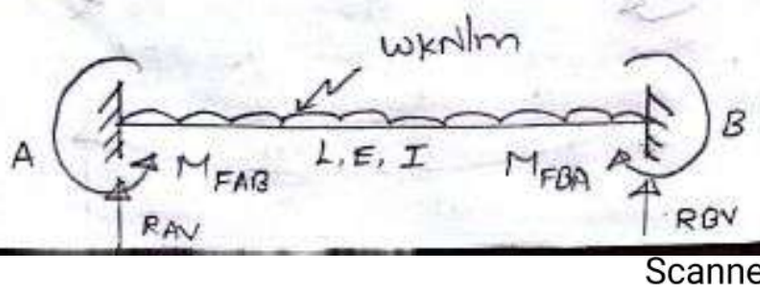

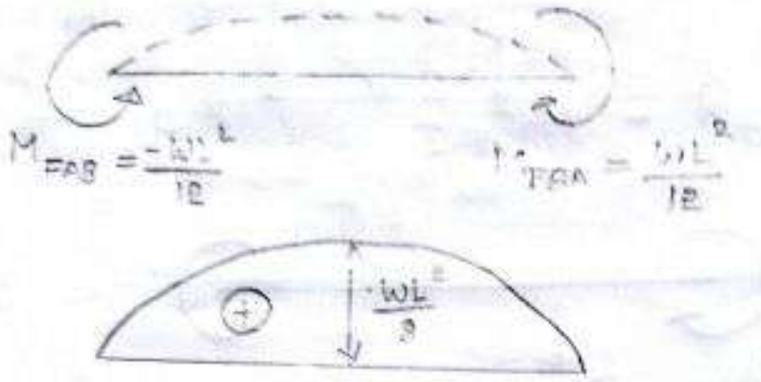

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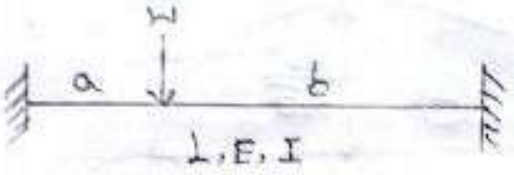

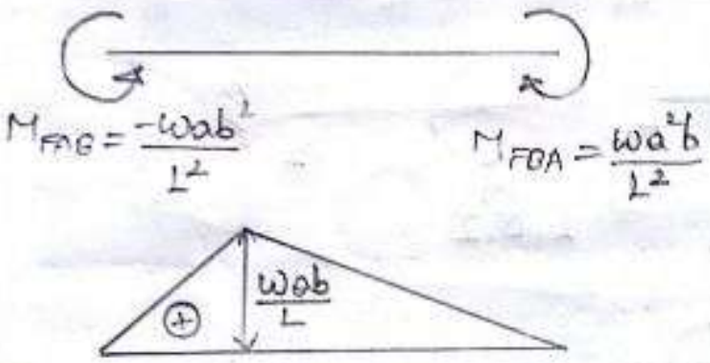

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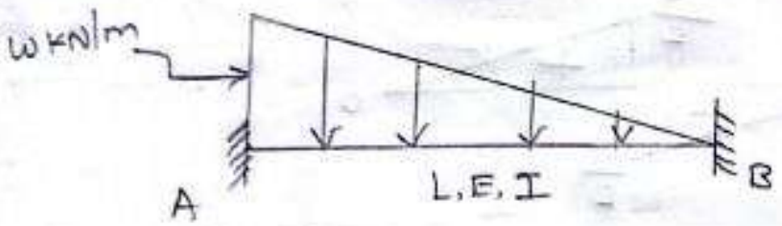

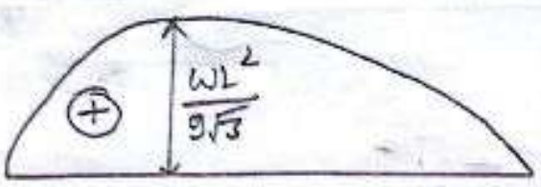

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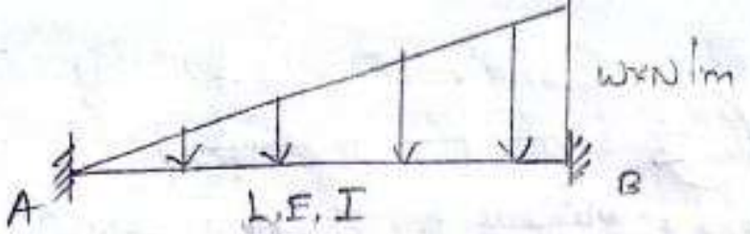
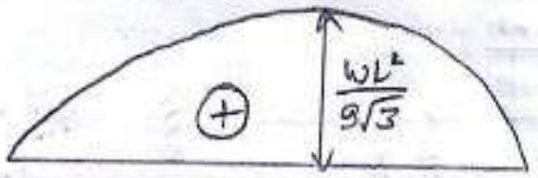


$M_{FAB} = \frac{-WL^2}{30}$ $\qquad$ $F_{FBA} = \frac{WL^2}{20}$



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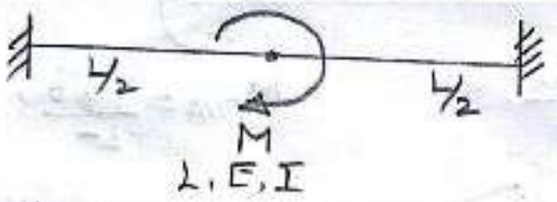
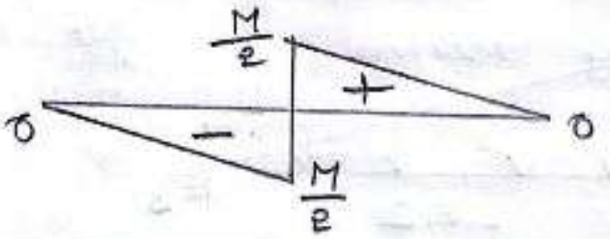
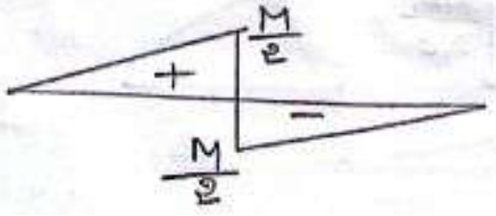


$M_{FAB} = \frac{M}{4}$ $\qquad$ $M_{FBA} = \frac{M}{4}$



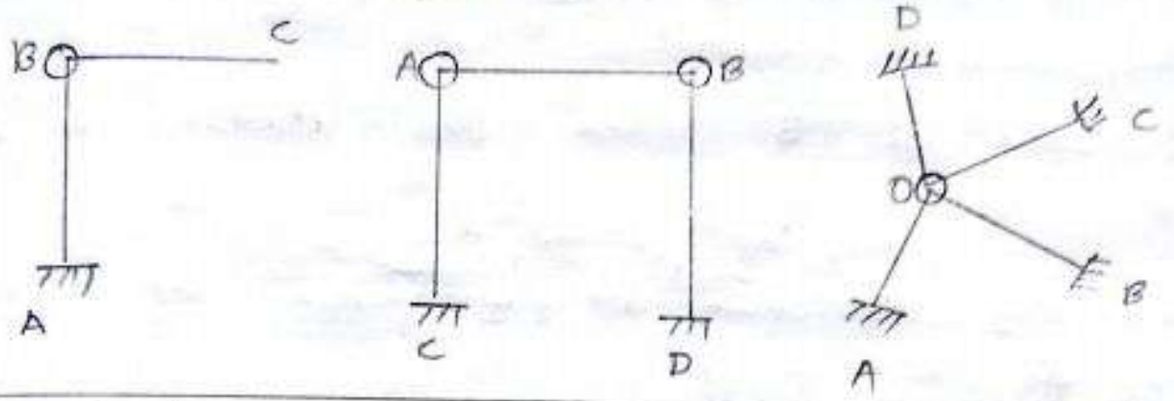
7.

$M_{FAB} = \frac{-M}{4}$ $\qquad$ $M_{FBA} = \frac{-M}{4}$



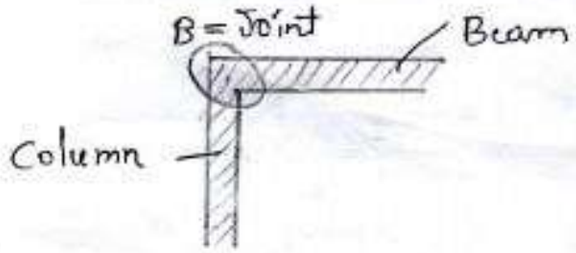
Joint :

Joint is a point where two or more than two members meet.

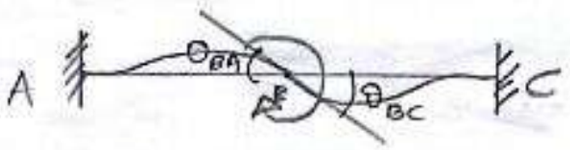


Characteristics of a joint :

1. Joint is monolithic and rigid.

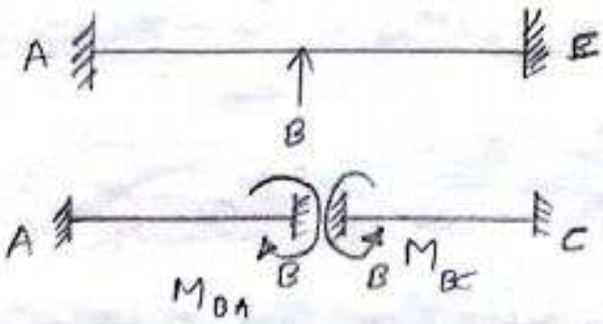


2. Rotation at the joint is constant.



$$\theta_{BA} = \theta_{BC} = \theta_B$$

3. Joints can be replaced by two fixed points.



$$M_{BC} = -M_{BA}$$

$$\therefore M_{BA} + M_{BC} = 0$$

4. Sum of the moments @ the joint is zero.

$$\Sigma M_B = 0$$

i.e. $M_{BA} + M_{BC} = 0$