INDETERMINACY OF STRUCTURES

- **Statically determinate structures**

When the static equilibrium equations are sufficient for determining the internal forces and reactions on that structure.

For 2D

$\Sigma V = 0$

$\Sigma H = 0$

$\Sigma MA = 0$

- Example of determinate structures are: simply supported beams, cantilever beams, single and double overhanging beams, three hinged arches.etc

statically indeterminate structure

when the static equilibrium equations are insufficient for determining the internal forces and reactions on that structure.

1. Indeterminate

- <u>Static indeterminacy (DS)</u>

  DS = DSE+ DSI

- <u>External Static Indeterminacy (DSE):</u>

  It tells '*how many force's value cannot be found using with the available equilibrium equations.'*

  External Reactions - Equilibrium Equations available

<u>Internal static indeterminacy (DSI)</u>

It refers to the geometric stability of the structure .If after knowing the external reactions it is not possible to determine the all internal forces or reaction using static equilibrium equations alone .then the structure is said to be internally indeterminate.

<u>Kinematics determinacy.</u>

Kinematic determinacy is a term used in structural mechanics to describe a structure where material compatibility conditions alone can be used to calculate deflections.

- **Kinematic indeterminacy(K.I)**

  kinematic indeterminacy- when number of unknown displacement greater than number of compatibility equations

1. **Static indeterminacy**

   For beam

   2D
   DSE= (Re-3)
   DSI=(-Rr)

   For frame

2D	3D
DSE= (Re-3)	DSE=(Re-6)
DSI=(3C-Rr)	DSI=(6C-Rr)

   For truss

2 D	3D
DSE= (Re-3)	DSE=(Re-6)
DSI=(M-2J+3)	DSI=(M-2J+6)

2. **Kinematic indeterminacy**

   For beam

   2D
   K.I=(3J-Re-M'+Rr)

   For Frame

2 D	3 D
K.I=(3J-Re-M'+Rr)	K.I=(6J-Re-M'+Rr)

For truss

2D	3D
K.I=(2J-Re)	K.I=(3J-Re)

Rr = summation of (m"-1) for 2D
summation of 3(m"-1) for 3D

Notations

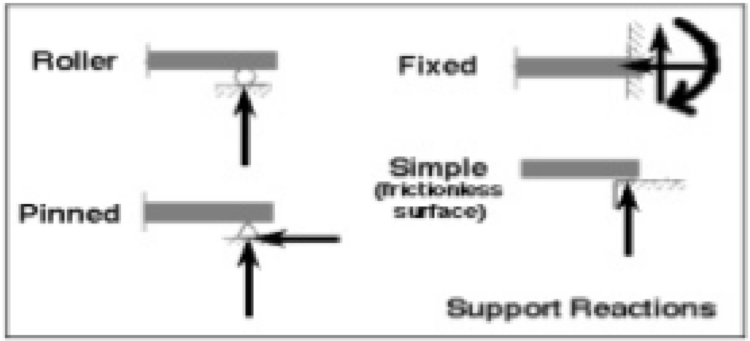
- Re= External reactions
- C = No.of closed loops
- M = No.of members
- J = No.of joints
- M' =No.of axially rigid members
- M"=No.of member connected at internal hinged location

- Equilibrium Equations

For 2D structure - 3 Equilibrium Equations are available

For 3D structure - 6 Equilibrium Equations are available

External reactions (Re)



Closed loop (C)

This exists only in frames and not for beams and trusses

Axially inextensible members (m')

Here m' represents number of axially rigid members

In the problem, if the beams alone are mentioned axially inextensible/rigid, then m' will be equal to number of beams in the structure

In the problem, if the columns alone are mentioned axially inextensible/rigid, then m' will be equal to number of columns in the structure

If it is mentioned all members are inextensible, then m' will be sum of all beams and columns

If nothing is mentioned in the question regarding the axial rigidity, then m' will take zero as its value