



UNIT-I STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES

A structure is an arrangement of a number of components like slabs, beams, columns, walls, foundations and many others, which are in equilibrium. For this structure to exist, it has to satisfy the fundamental criteria of strength, stiffness, economy, durability and compatibility. It is generally classified into two categories for analysis, which are:

Determinate structures:

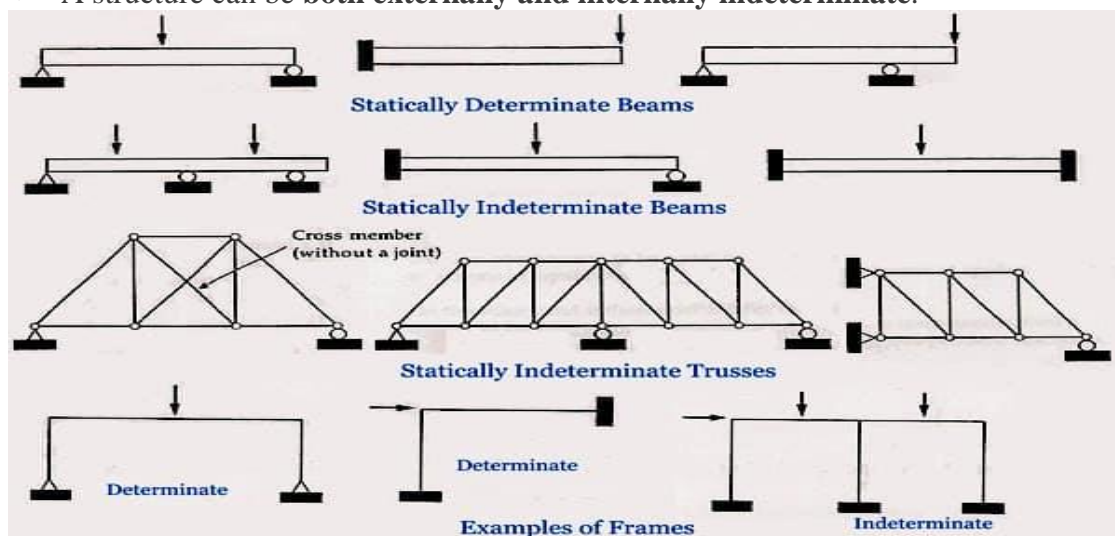
A structure is termed as statically determinate if it can be analyzed by the equilibrium equations alone, which are. After the unknown reactions are found, the further determination of stresses can be carried out. Examples of **determinate structures** are simply supported beams, cantilever beams, single and double overhanging beams, three hinged arches, etc.

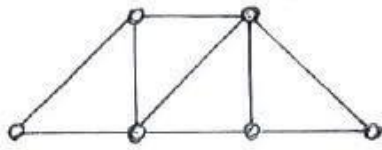
Indeterminate Structures (redundant structures):

A structure is termed as statically indeterminate, if it cannot be analyzed from equilibrium equations alone. Along with the basic equilibrium equations, some extra conditions are required to be used like compatibility conditions of deformations to get the unknown reactions for drawing bending moment and shear force diagrams. Examples of these structures are fixed arches or beams, continuous beams, two hinged arches, multistoried frames, etc.

A statically indeterminate structure may be classified as:

- **Externally indeterminate**
 - A structure is externally indeterminate or redundant if the reactions at the supports cannot be determined by using three equations of equilibrium.
- **Internally indeterminate**
 - In these structures, the reactions can be determined by the equations of equilibrium but the complete analysis is not possible due to internal redundancy.
- A structure can be **both externally and internally indeterminate**.



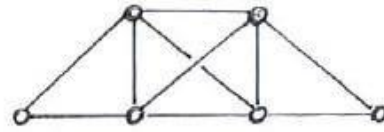


STATICALLY DETERMINATE

$$m = 9$$

$$2j = 12$$

$$m + 3 = 12 = 2j$$



STATICALLY INDETERMINATE

$$m = 10$$

$$2j = 12$$

$$m + 3 = 13 \neq 2j$$

Difference between Determinate and Indeterminate Structures

- In the case of determinate structures, equilibrium conditions alone are adequate to analyze the **structure** whereas this is not the same with indeterminate structures because there are more unknowns in the picture.
- Bending moment or shear force at any section of an indeterminate structure depends upon the material property and moment of inertia but is independent when talking about determinate structures.
- Temperature variations do not cause **stresses** in determinate structures but in case of indeterminate structures, they do cause the stress.
- Extra conditions like compatibility of displacements are required to analyze the structure for indeterminate structures along with equilibrium equations but these extra conditions are not needed for determinate structures.

Advantages of indeterminate structures over determinate structures

The stress generated by the indeterminate structures is lower than those in the determinate structures. When talking about stiffness, indeterminate structures generally have higher stiffness (which means small deformation) than those of determinate structures.

Disadvantages of indeterminate structures over determinate structures

- More complex analysis is required
- Stresses due to Support Settlements