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CHAPTER 1: INTRODUCTION TO BUILDING STRUCTURES

WEIGHTAGE & TIPS (INTRODUCTION TO BUILDING STRUCTURES)

Please refer to the weightage of this topic (Chapter 1: Introduction to Building Structures of Book 4) from GATE 2012 to GATE 2021 tabulated below;

GATE YEAR	WEIGHTAGE (Marks)
2021	0
2020	0
2019	0
2018	0
2017	0
2016	0
2015	0
2014	0
2013	0
2012	0
Average	**0 Marks**

Students are advised to remember the following points, before you start studying this Chapter:

- This chapter might not have a huge weightage for GATE exam; but it is very important to clearly understand the basic concepts discussed in this chapter.
- Only by understanding the basics discussed in this Chapter, the scoring areas of Structures will become easy to understand.
- Understanding the concepts of Stress and Strain is very important.
- Have a special emphasis on the measurement units of various terms discussed, as it can be important in solving numerical questions of future chapters.
- Even though the above listed table shows zero marks weightage, there are instances where this chapter has a weightage of 4 marks (like in GATE 2006).

1.1 BASICS OF STRUCTURAL SYSTEMS

1.1.1 Introduction

The structure of a building (or other object) is the part which is responsible for maintaining the shape of the building under the action of the gravitational & environmental loads. It is important that the structure as a whole (or any part of it) does not fall down, break or deform to an unacceptable degree when subjected to such forces or loads. It should safely transmit the resulting forces to the supporting ground. It should maintain the integrity and serviceability of the built form.

Any structure is made up of STRUCTURAL ELEMENTS (Beams, Columns, Slab, and Trusses) and NON-STRUCTURAL ELEMENTS (Partition wall, false ceilings, Windows, Doors, Parapet). The STRUCTURAL ELEMENTS, put together, constitute the STRUCTURAL SYSTEM.

Structural configuration or system is governed by nature of loading (concentrated heavy moment wind seismic); structural material (brick, RCC, steel, ductile or brittle); support system (simply supported, cantilever, continuous, flexible) – structural behaviour (stable, shear, bending, buckling, deflection, crack)

Types of Structural Systems include; Frames, Trusses, Space Frame, Arch, Vault, Shell Structure, Dome, Tensile, and Plate structures.

Basic objectives of Structural Engineering are discussed below;

- Safety: Strength to resist the various stresses induced in different structural elements. Sufficient margins of safety to have an acceptable low risk of collapse under possible overloads during its designed life.
- Stability: To prevent overturning, sliding, or buckling of the structure, or parts of it, under action of different loads.
- Serviceability: To ensure satisfactory performance under service load conditions and to contain deflections, crack-width, story drift, vibration within the acceptable limit.
- Durability: Providing impermeability, corrosion resistance, control of creep and shrinkage, by using high performance materials. The materials used must be resistant to corrosion, spalling (pieces falling off), chemical attack, rot or insect attack.
- Economy: Efficiency and economy of structures are important parts of structural engineering. Many buildings have been built under strict financial constraints. The need for selecting an efficient structural system is essential to keep the cost of project under control.
- Ease of maintenance
- Fire resistance
- Aesthetics: Structural systems and structural components designed by the engineer plays a major role in the aesthetic appearance of structures. The visual appearance of buildings mainly depends on the conceptual composition of three dimensional forms. A well composed form provides a unique and easy structural solution.
- It is indeed a challenge, and a responsibility for the structural designer to design a structure that is not only appropriate for the architectural purpose, but also strikes the right balance between safety and economy.

Mechanics deals with study of forces and their effects on any object or body in rest or under motion.

Engineering Mechanics: It deals with mechanics of rigid body and study of external forces and their effects on rigid body.

Statics: Deals with the study of forces on a body which is at rest.

$$\sum F_x = 0$$

$$\sum F_y = 0$$

Dynamics: Deals with study of motion and forces on a body which is in motion.

Solid Mechanics: It deals with internal resisting forces developed in a deformable body under the action of external forces.

$$\text{Stress}, \sigma = \frac{P}{A}$$

$$\text{Modulus of Elasticity}, E = \frac{\sigma}{\epsilon}$$

The concepts like stress, strain and modulus of elasticity are discussed in detail under 'Basics of Strength of Materials'

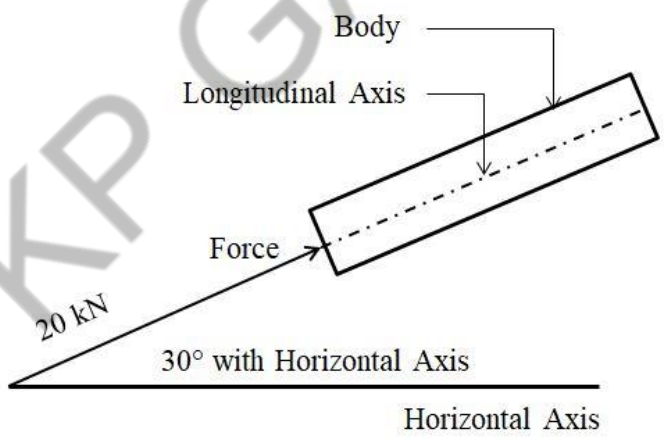
Fluid Mechanics: It deals with mechanics of compressive forces on the fluid & fluid particles.

1.1.2 Understanding Force

Force is an action that tends to change the state of inertia (rest or motion) of a rigid body, i.e., an action that tends to change the shape of an elastic body.

Characteristics of a Force

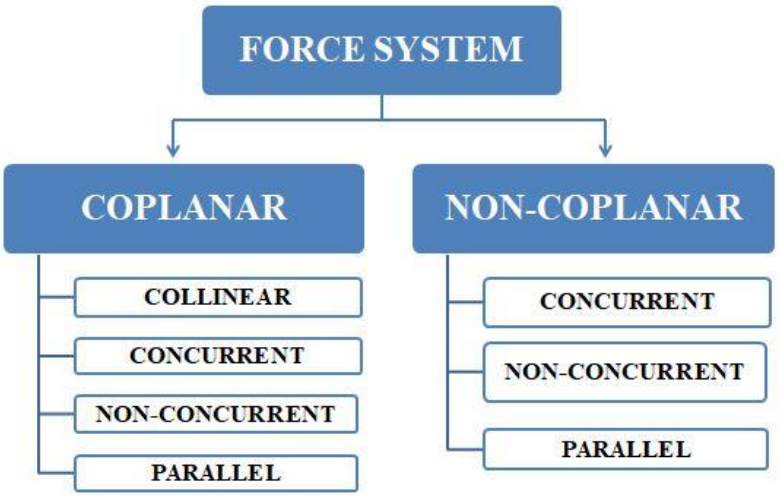
1) Magnitude: 20 kN
2) Direction: 30° with Horizontal Axis
3) Point of application: Point A
4) Line of Action: Longitudinal Axis of the Body



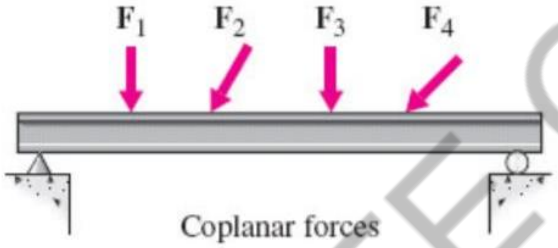
System of Forces:

If more than one force acting on a body or a group of bodies, then it is called a 'FORCE SYSTEM'. The force system is classified based on the direction and orientation of the lines of action of the forces.

Classification of systems of forces is shown below;

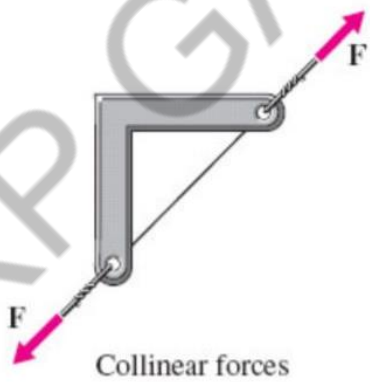


COPLANAR FORCES: Coplanar Forces are forces where the lines of action of all forces lie on the same plane.

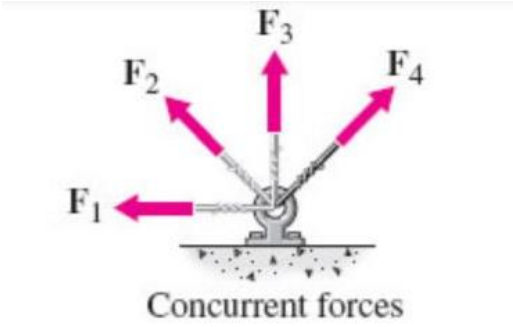


Various types of coplanar forces are discussed below. Example for each type is also given;

Collinear Forces: The line of action of the entire force system is in the same direction.

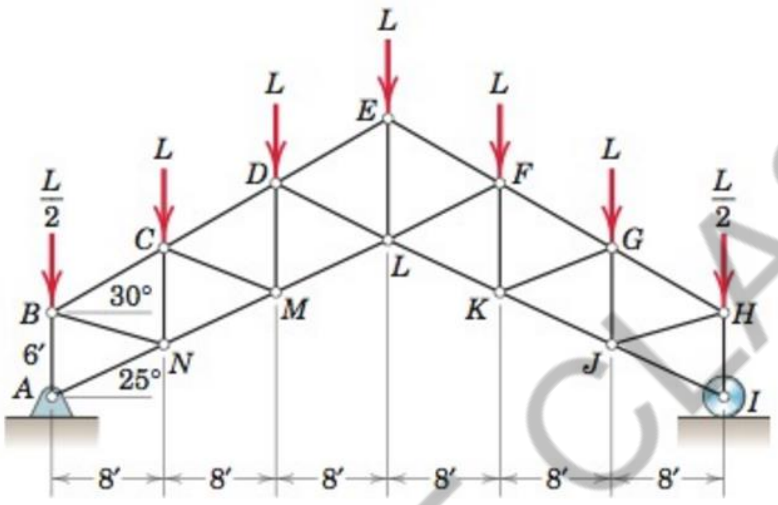


Concurrent Forces: The line of action of all forces passing through a single point.

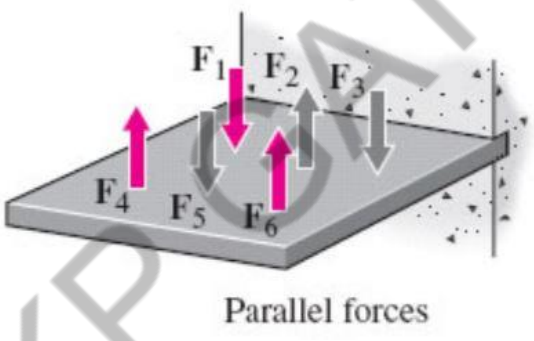


Concurrent forces

Non-concurrent Forces: The line of action of all forces does not pass through a single point. Force system shown acting on the truss below is non-concurrent coplanar force system;



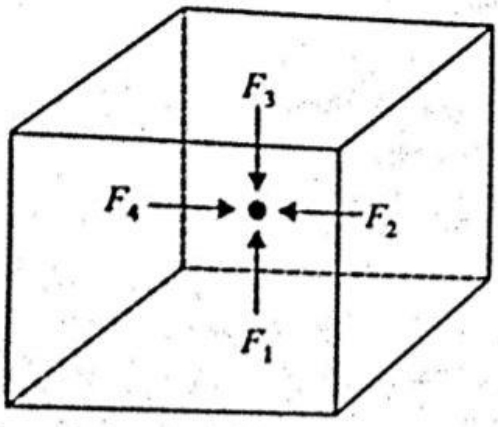
Parallel Forces: The lines of actions of all forces are parallel to each other.



Parallel forces

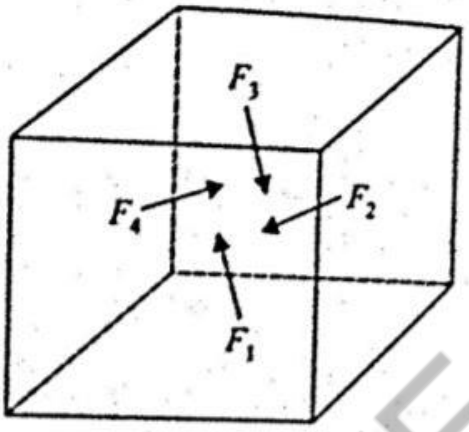
NON-COPLANAR FORCES: Non-coplanar Forces are forces where the lines of action of all forces lie on different planes.

Concurrent Forces: The line of action of all forces passing through a single point.



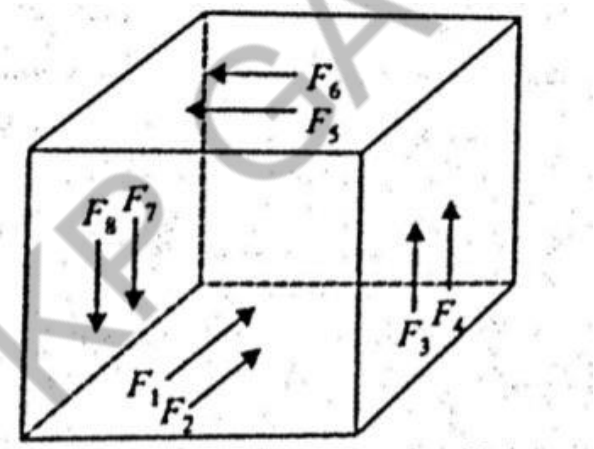
Non-coplanar concurrent system of forces

Non-concurrent Forces: The line of action of all forces does not pass through a single point.



Non-coplanar non-concurrent system of forces

Parallel Forces: The lines of action of all forces are parallel to each other.



Non-coplanar parallel system of forces