INTRODUCTION

PCC

- Plain cement concrete is a hardened mass obtained from a mixture of cement , fine aggregates , coarse aggregates and water in definite proportion.
- Hardening of this mixture is due to chemical action between cement and concrete.

RCC

- PCC is very strong in compression but very very weak in tension.
- To improve the tensile strength of PCC some sort of reinforcement is required which can take tensile stresses develop in structures.
- Cement concrete reinforced with steel bars is known as reinforced cement concrete (RCC).

USES OF RCC

- Beam , columns and slabs.
- Water retaining structure like water tanks.
- Highways , flyover and railway bridges.
- Power plants.
- Tunnels.
- Irrigation works.
- Retaining wall.

Advantages of RCC

- Strength
- Durability
- Economy
- Transportation
- Mouldability
- Fire resistance
- Aesthetics
- Permeability

Limitations of RCC

- Initial cost is high.
- Dead load of structures is increased.
- Require lot of site space and skilled workforce to handle it.
- RCC structures take time to attain its full strength.

Grades of cement

- 33 grade
- 43 grade
- 53 grade

Grades of concrete

- Ordinary concrete (M10 to M20)
- Standard concrete (M25 to M55)
- High strength concrete (M60 to M80)

Purpose of providing reinforcement

- Takes all tensile stresses.
- Increase strength of concrete section.
- Section becomes thinner as compared to PCC.
- Prevents propagation of cracks.

Characteristics of reinforcing material

- Should develop perfect bond with concrete.
- Should have high tensile strength.
- Should not react with other ingredients.
- Should be cheap and easily available.
- Should be easily workable.
- Should have high modulus of elasticity.
- Should be durable.

Forms of steel reinforcement

- Mild steel and medium tensile steel bars (IS: 432 – 1982)
- High strength deformed steel bars (IS: 1786 – 2008)
- Hard drawn steel wire fabric (IS:1566 – 1982)
- Structural steel (IS:2062 – 1992)

Types of Steel	Properties	Uses
Mild Steel	Soft and malleable steel is used for rolling into thin sheets	For making motor body, sheet metal, boiler plates, tin plates, structural steel etc
Medium Carbon Steel	Very soft and ductile steel used for drawing into wires	For making springs, tyres, stamping and pressing dies, rails
High Carbon Steel	Very hard and brittle steel used for making tools	For making chisels, hammers, saw, smithy tools, stone mason's tool, axes, drills, knives

HYSD BARS

Loading on structure

- Dead loads
- Live loads (superimposed loads)
- Wind loads
- Snow loads
- Seismic loads (earthquake loads)

Methods of RCC design

INTRODUCTION

- The main purpose of structural design is safety seviceability and economy of structure
- The structure should be safe under worst combination of loading conditions
- It should fulfill the purpose for which it has been designed during its whole life span
- All the structure should be economical with regard to its initial cost and

Methods of RCC design

- Working stress method
- Limit state method

- **The design of any RCC structure comprises of following–**

1. To decide the size the member and amount of steel reinforcement required
2. To check whether the designed structure will perform safely and satisfactorily during its life span

Comparison between Working Stress Method and Limit State Method

Sr. No.	Working Stress Method	Limit State Method
1	It is based on elastic theory. Concrete and steel are assumed to act together elastically and follow Hook's law (linear stress-strain relationship).	It takes into account actual nonlinear elasto-plastic stress-strain behavior of concrete and steel.
2	The stresses in the structural members are considered for normal working loads without considering the conditions existing at the time of failure.	The design is based on ultimate loads at failure (ultimate load = working load x Partial Safety Factor) Different partial safety factors are used for limit state of collapse and limit state of serviceability under different load combinations.
3	**Design Criteria:** i. Load carrying capacity > working load ii. Stresses in material (concrete or steel) < permissible stress in the material Permissible stresses = (characteristic cube strength of concrete or yield strength of steel/ Factor of Safety for concrete or steel respectively)	**Design Criteria:** (Load carrying capacity of material/ Partial safety factor for material) > Load combination comprising of Σ(load x corresponding partial safety factor for the load)

Sr. No.	Working Stress Method	Limit State Method
4	It does not give any idea about margin of safety available for loads to assess the extent of overloading without collapse.	It gives an idea about the excess load which a structure can carry beyond the working load without collapse.
5	The method follows a deterministic approach as it assumes that the loads, factor of safety and permissible stresses are accurately known.	The method follows a non-deterministic approach as it adopts probable loads and probable strength of materials as per actual or based on experience or observations depending upon the situation.
6	Material strengths are not fully utilized in designing the member.	Material strengths are fully utilized in designing the member.
	Merits / Demerits	
1	It is a simple method. (merit)	It is a somewhat complicated method involving more calculations. (demerit)
2	Due to its simplicity, it is still used for design of some complex structures such as Overhead water tanks, bunkers, silos etc. (merit)	The method is still evolving for the design of more complex structures. (demerit)

Sr. No.	Working Stress Method	Limit State Method
3	There is no need to check for serviceability requirement. The same is automatically satisfied as the working stresses are low and the method results in bigger sections.	The sections are required to be checked for serviceability criteria.
4	It assumes that stress-strain relationship for concrete is constant, which is not correct. (demerit)	It is a more realistic method which takes into account the actual non-linear stress-strain relationship for concrete. (merit)
5	It results in bigger section size in comparison to that obtained from Limit State Method, thus it gives uneconomical sections. (demerit)	It results in smaller section size in comparison to that obtained from Working Stress Method, thus it gives economical sections. (merit)
6	It is an old and conservative method which mainly concentrates on safety aspect.	It is a more rational method which not only takes into account safety and economy but also fitness of the structure throughout its service by controlling serviceability limits.

Axially loaded column

Column

- It is defined as a vertical compression member , the effective length of which exceeds three times the least lateral dimension.

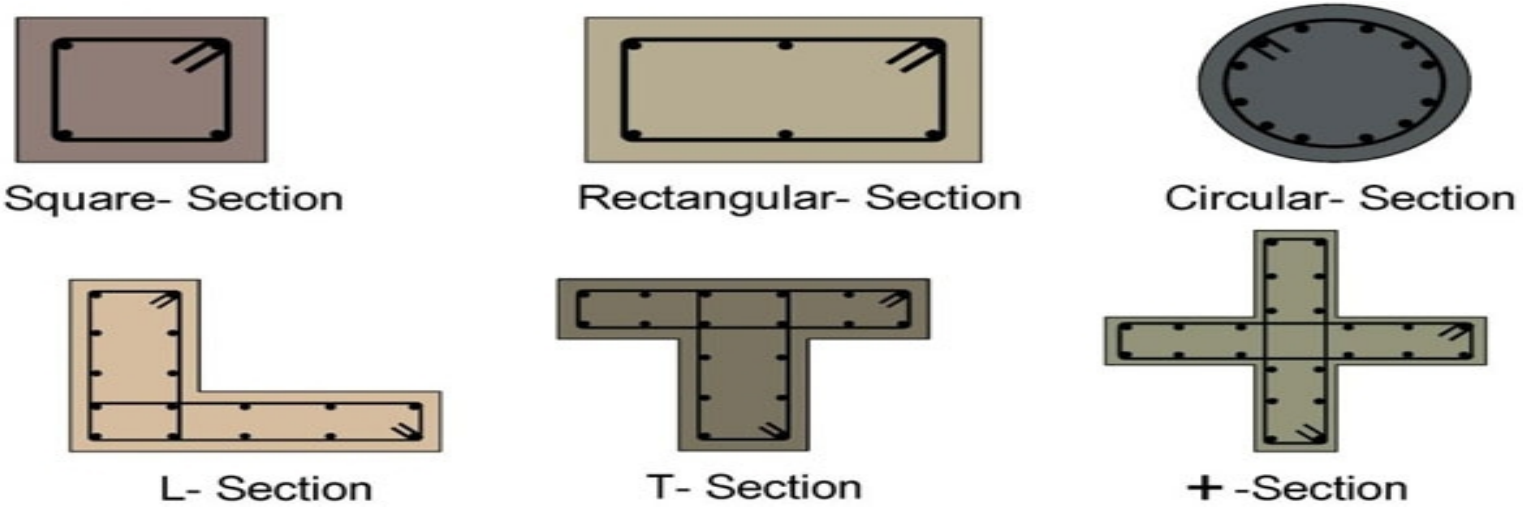
Classification of column

- On the basis of materials of construction

1. Timber columns
2. Masonry columns
3. Steel columns
4. RCC columns

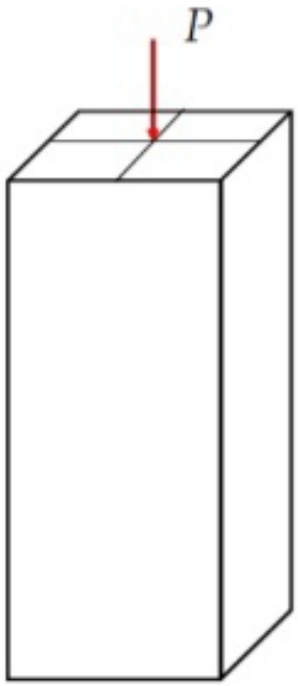
- On the basis of shape of columns

1. Square columns
2. Rectangular columns
3. Circular columns
4. Hexagonal columns

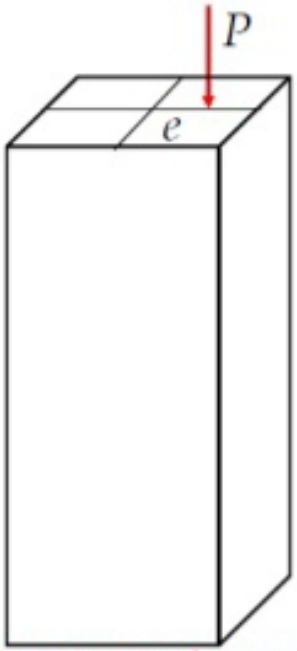


- On the basis of line of action of load

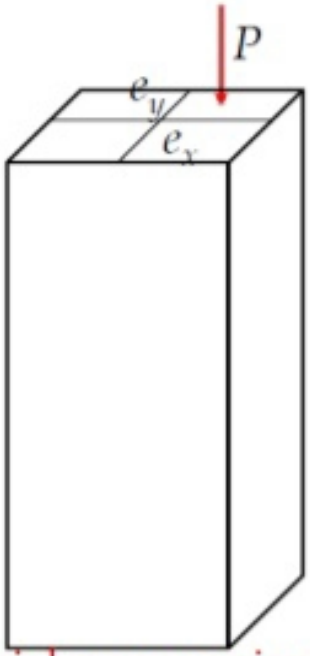
1. Axially loaded columns – columns in which line of action of load is along the centroid of the column.
2. Eccentrically loaded columns – columns in which the line of action of loads is away from the centroid of the column.



axial compression



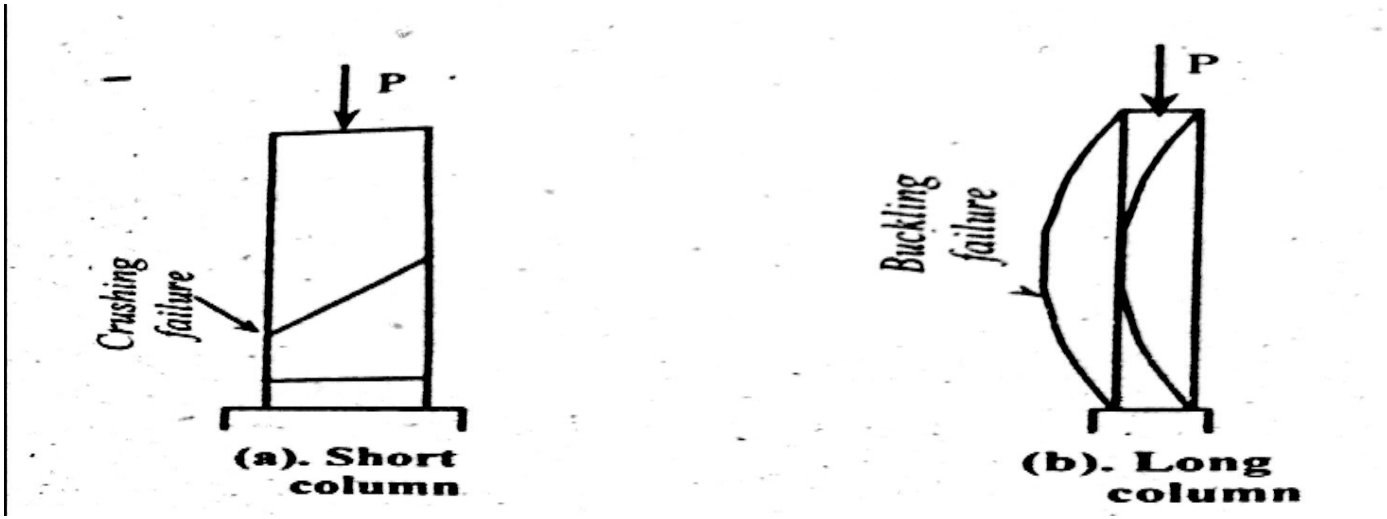
axial compression with uniaxial bending.



axial compression with biaxial bending.

- On the basis of length of column

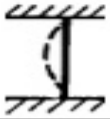
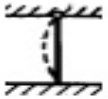
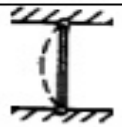
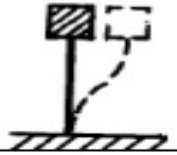
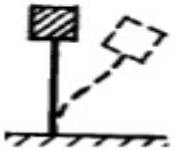
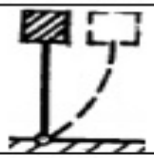
1. Short columns – when slenderness ratio is less than or equal to 12.
2. Long columns – when slenderness ratio is greater than 12.



Effective length of column

- It is defined as that length of the column which takes part in buckling under the action of loads.
- For the purpose of design only effective length of a column is considered.

Table.Effective length of compression member

Sl. No.	Degree of End Restraint of Compression Members	Figure	Theo. Value of Effective Length	Reco. Value of Effective Length
1	Effectively held in position and restrained against rotation in both ends		0.50 l	0.65l
2	Effectively held in position at both ends, restrained against rotation at one end		0.70 l	0.80l
3	Effectively held in position at both ends, but not restrained against rotation		1.0 l	1.0l
4	Effectively held in position and restrained against rotation at one end, and at the other restrained against rotation but not held in position		1.0 l	1.20l
5	Effectively held in position and restrained against rotation in one end, and at the other partially restrained against rotation but not held in position		-	1.5l
6	Effectively held in position at one end but not restrained against rotation, and at the other end restrained against rotation but not held in position		2.0 l	2.0l
7	Effectively held in position and restrained against rotation at one end but not held in position nor restrained against rotation at the other end		2.0 l	2.0l

Reinforcement in columns

- Longitudinal reinforcement – the steel bars provided longitudinally in a column .
- Transverse column – it is provided along the lateral direction of a column in the form of lateral ties or spirals enclosing the main steel.

Types of RCC columns on the basis of transverse reinforcement

- Columns with lateral ties
- Columns with helical reinforcement

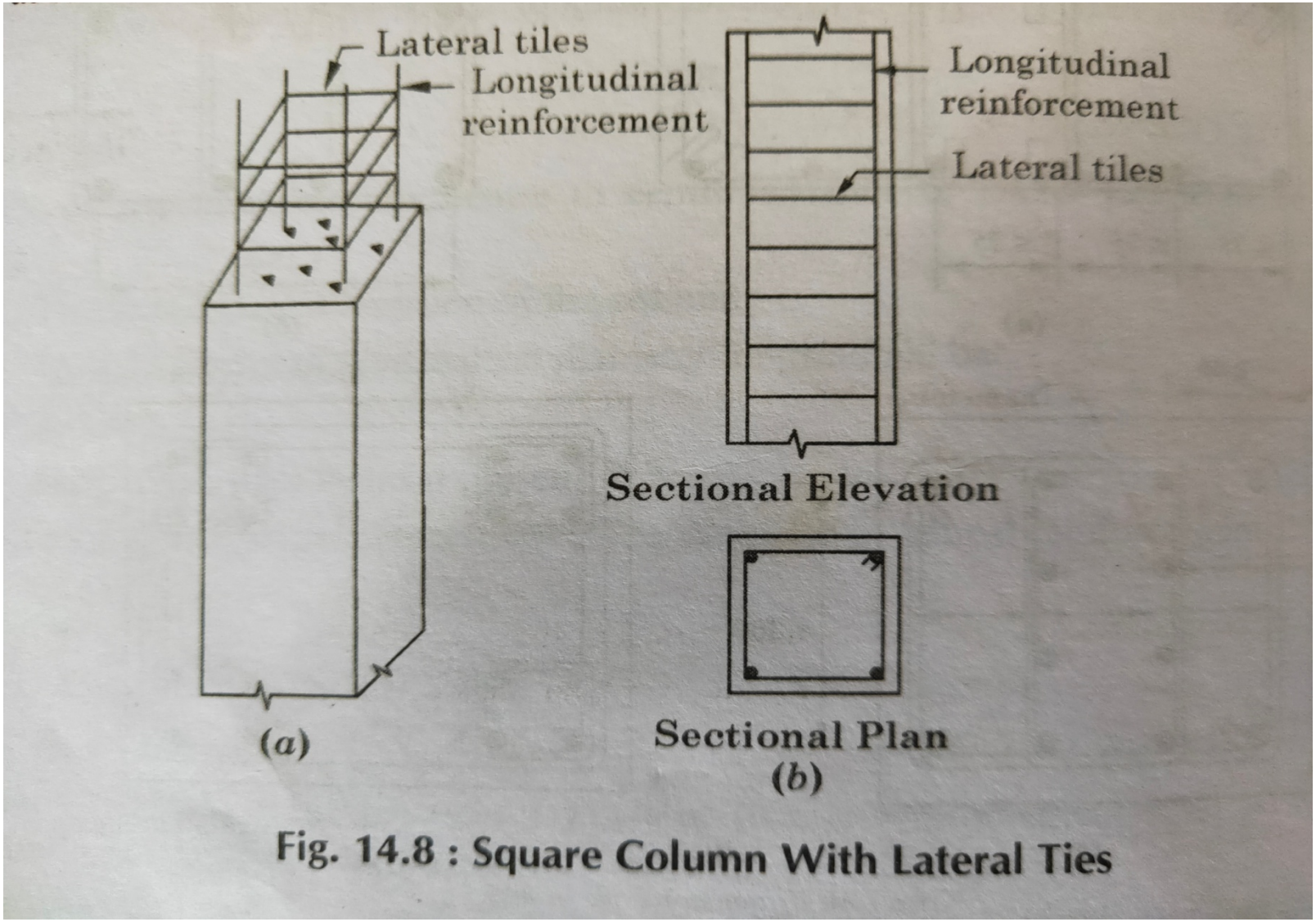
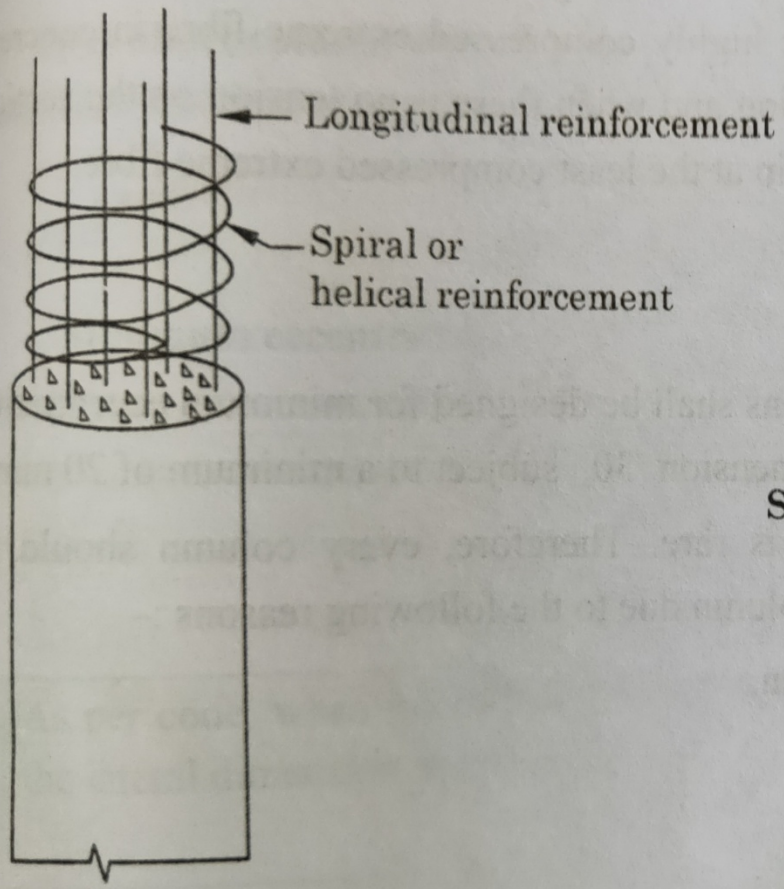
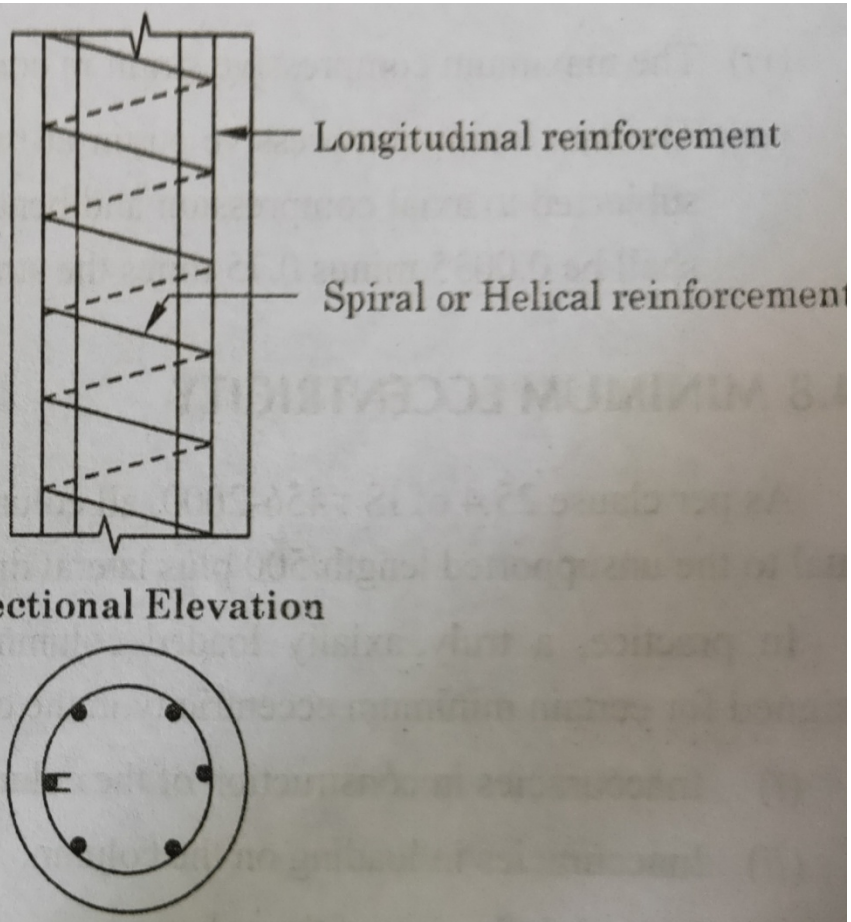


Fig. 14.8 : Square Column With Lateral Ties



(*a*)



Sectional Elevation

(*b*) **Sectional Plan**

Fig. 14.9 : Circular Column with Spiral or Helical Reinforcement

Design of RCC slab

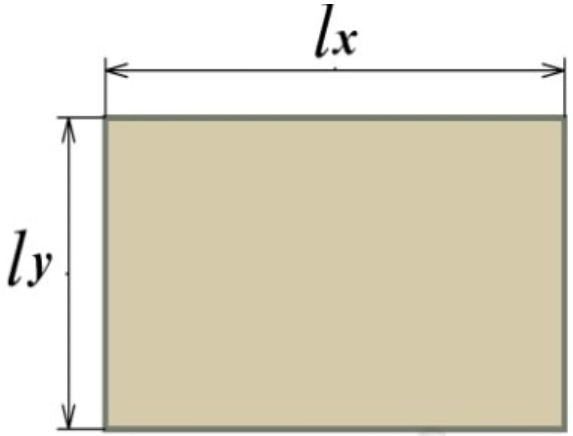
INTRODUCTION

- RCC slab are plane structural members which are used as floors and roof coverings to building.
- Slab support mainly transverse load and transfer these loads to supports by bending action in one or more directions.
- Thickness of slab is quite small as compared to its other dimensions.
- Slabs are designed as beams considering width 1 meter.

Classification of slab

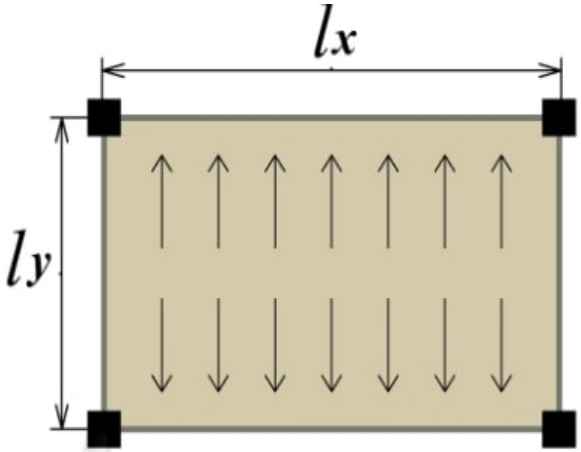
- One way slab
- Two way slab

- One way slab – the slabs in which the ratio of larger span to shorter span is greater tan or equal to 2 .
- Two way slab – the slabs which are supported on all the four edges and having ratio of larger span to shorter span less than 2 .

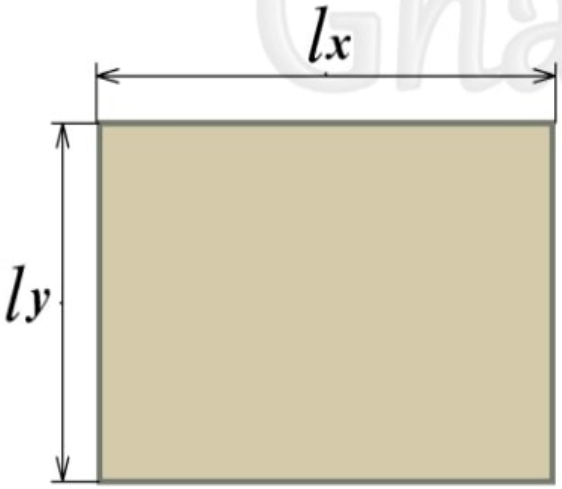


One-Way Slab

$\frac{lx}{ly} > 2$

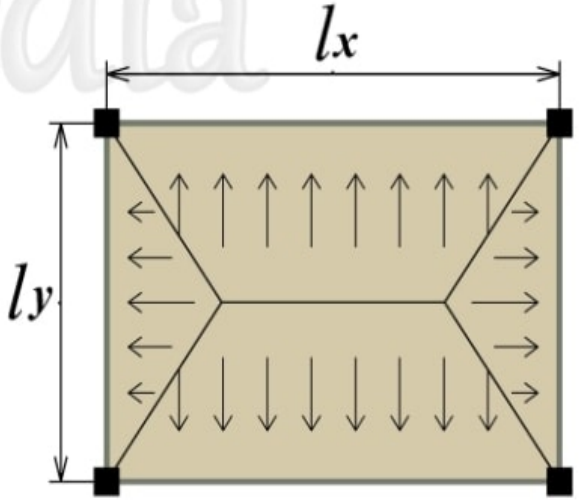


Load Transfer - One-way slab

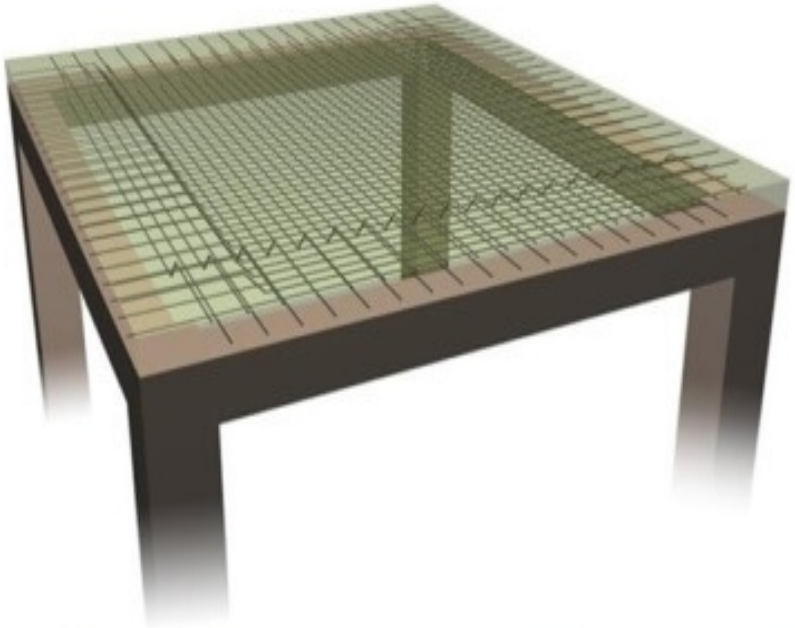


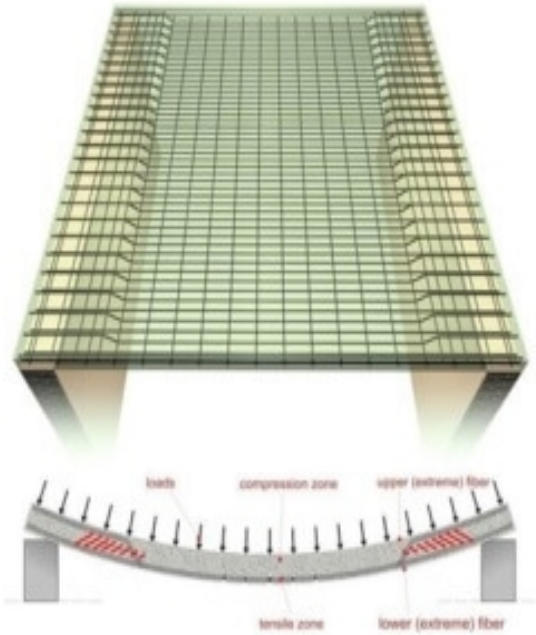
Two-Way Slab

$\frac{lx}{ly} \leq 2$



Load Transfer - Two-way slab





Difference Between One-Way Slab And Two-Way Slab

One Way Slab	Two Way Slab
One way slab is supported by beams in only 2 sides.	Two way slab is supported by beams in all four sides.
The ratio of longer span panel (L) to shorter span panel (B) is equal or greater than 2. Thus, L/B >= 2	The ratio of longer span panel (L) to shorter span panel (B) is less than 2. Thus, L/B < 2.
Main reinforcement is provided in only one direction for one way slabs.	Main reinforcement is provided in both the direction for two way slabs.

Prestressed concrete

Prestressed concrete

- It is that concrete in which internal stresses of suitable magnitude and distribution are introduced before the application of external loads such that the stresses resulting from the external forces can be counteracted to a desired degree.

Concept of prestressing

- The basic principle of prestressing is to introduce sufficient compressive stress in all those parts of concrete in which tensile stress would occur on the application of external force. Thus when prestress concrete member will be subjected to external force , the already induced compressive stress will be neutralized by the tensile stress due to application of external load.

Advantages of prestressed concrete

- Thinner and lighter than RCC section
- Thinner section results in lesser weight and hence overall economy.
- It is used for heavy loaded structures , long span bridges and flyovers.
- Less deflection
- Whole concrete area is effective in resisting loads.

- Since the concrete does not crack in PSC, rusting of steel is minimized
- PSC members can be produced in factories under controlled working condition
- PSC members can be tested before use
- PSC members gives sufficient warning before failure