LAB MANUAL

Course Name: RCC Structure
Course Code: P2415502

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LAB MANUAL

STATE BOARD OF TECHNICAL EDUCATION,BIHAR

Practical No: 01

1. **Practical Statement:-**
   To draw the cross-section, strain diagram, and stress diagram for a singly reinforced concrete (RCC) Section.
2. **Practical Significance:-**
   This experiment helps students to:
   - Understand behaviour of reinforced concrete under load
   - Visualize stress and strain distribution
   - Learn limit state theory concepts
   - Develop engineering drawing skills

3. **Relevant Theory:-**

Reinforced Cement Concrete (RCC)

RCC is a composite material made of concrete (good in compression) and steel (good in tension).

Singly Reinforced Section

A section in which steel reinforcement is provided only on the tension side (usually at the bottom).

Neutral Axis (NA)

The axis where strain is zero.

- Above NA → compression
- Below NA → tension

Strain Distribution

- Strain varies linearly from maximum at top to zero at neutral axis
- Concrete strain at extreme fiber = 0.0035 (limit state)

Stress Distribution

- Concrete resists compression only
- Steel resists tension
- Stress block is parabolic/rectangular (as per IS code)

Important Terms

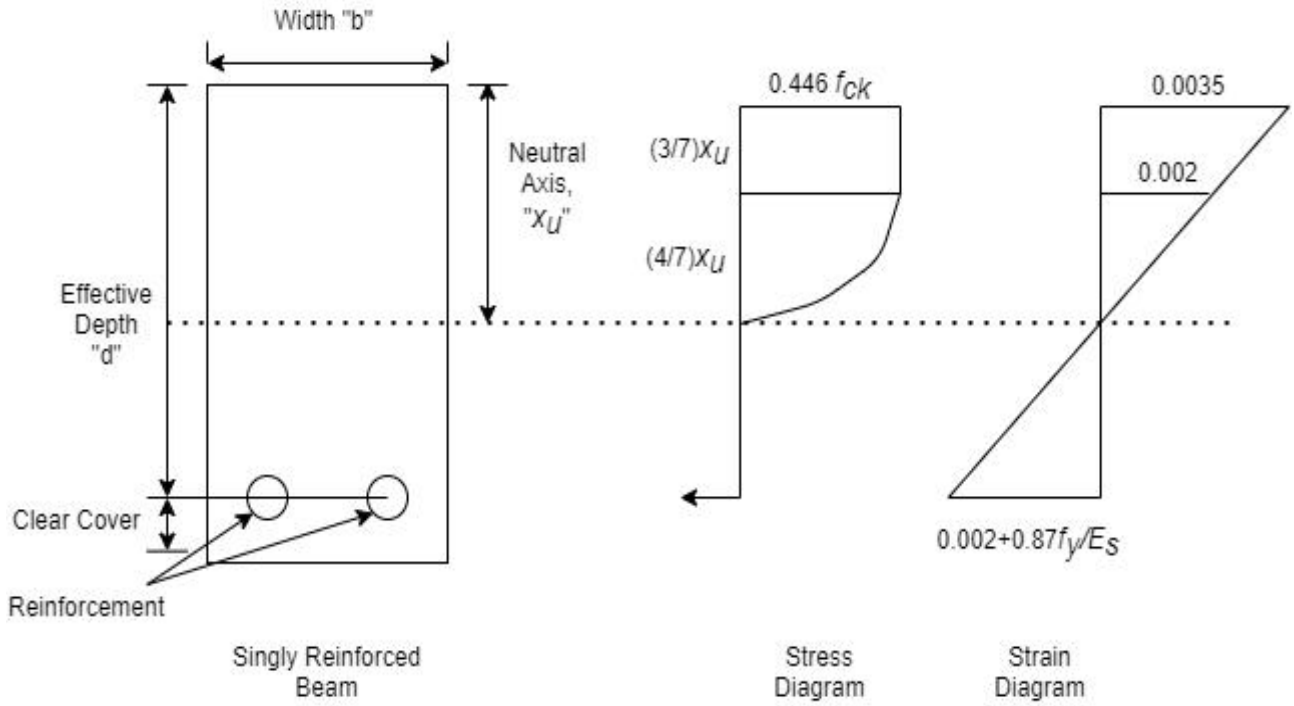
- Effective depth (d)
- Width of beam (b)
- Area of steel (Ast)
- Neutral axis depth (x_n)

4. **Relevant Course Outcome:-**
   Understand stress-strain behaviour of RCC sections under loading.

5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Draw RCC cross-section
   - Represent strain distribution
   - Represent stress distribution
   - Identify neutral axis

6. Experimental Setup:-

Cross Section, Strain and Stress of Singly Reinforced Beam



7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

a. Maintain proper proportions
b. Label all components clearly
c. Draw straight and neat lines
d. Indicate neutral axis correctly
e. Follow standard symbols

9. Suggested Procedure

a. Draw rectangular beam section
b. Mark:
- Width (b)
- Depth (d)

c. Draw steel reinforcement at bottom
d. Mark neutral axis
e. Draw strain diagram (linear variation)
f. Draw stress diagram:
- Compression block in concrete
- Tension in steel

g. Label all parts

10. Graphical Representation

Cross Section

- Show concrete section
- Indicate steel reinforcement

Strain Diagram

- Linear variation
- Zero at NA
- Maximum at top

Stress Diagram

- Compression (top)
- Tension (bottom steel)

11. Observations and Calculations

Observation Table

Parameter	Symbol	Value
Width	b	
Depth	d	
Area of steel	Ast	
Neutral axis	x_n	

12. Results:

- Cross section, strain, and stress diagrams were successfully drawn
- Behaviour of RCC section was understood

13. Interpretation of Results

- Concrete resists compression only
- Steel resists tension
- Neutral axis separates tension and compression zones

14. Practical Related Questions

a. What is RCC?
b. Define singly reinforced section
c. What is neutral axis?
d. Why steel is used in RCC?
e. Explain strain distribution
f. What is stress block?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 02

1. **Practical Statement:-**
   To draw the cross-section, strain diagram, and stress diagram for a doubly reinforced concrete (RCC) Section.
2. **Practical Significance:-**
   This experiment helps students to:
   - Understand behaviour of reinforced concrete under heavy load
   - Helps in design of beams with depth restriction
   - Learn limit state theory concepts
   - Develop engineering drawing skills
3. **Relevant Theory**

   Doubly Reinforced Section

   A section where steel is provided in:
   - Tension zone (bottom)
   - Compression zone (top)

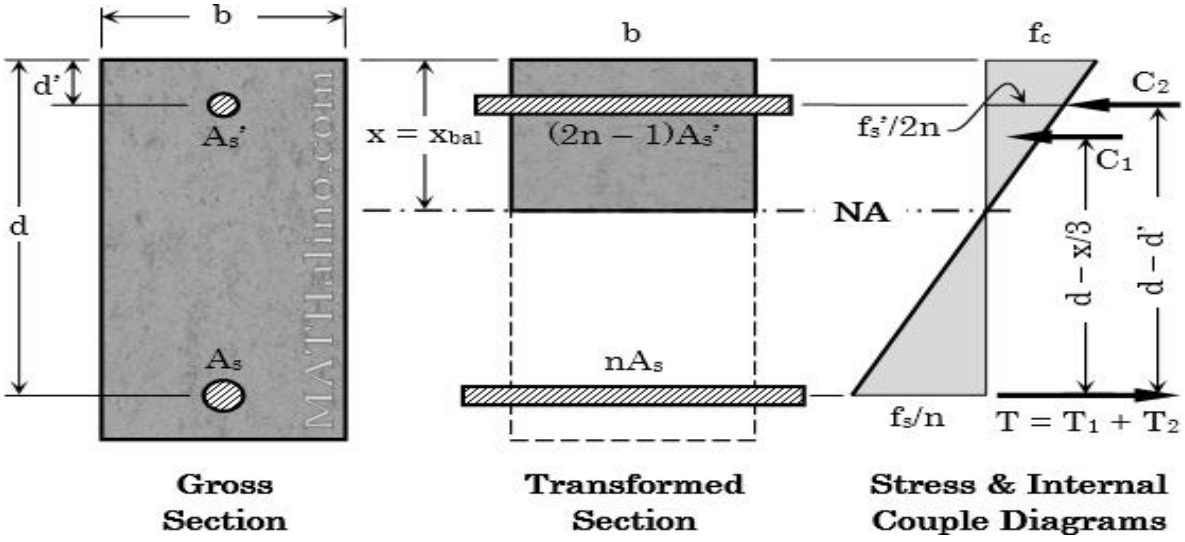
   Need
   - When moment exceeds limiting value
   - When depth is restricted

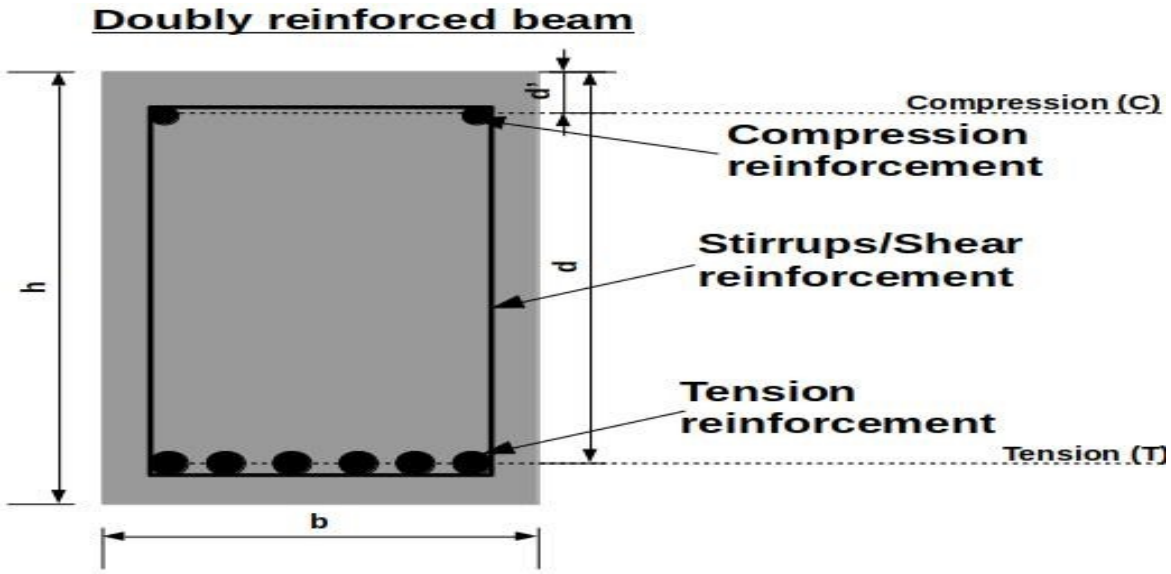
   Strain Diagram
   - Linear variation
   - Compression at top and tension at bottom

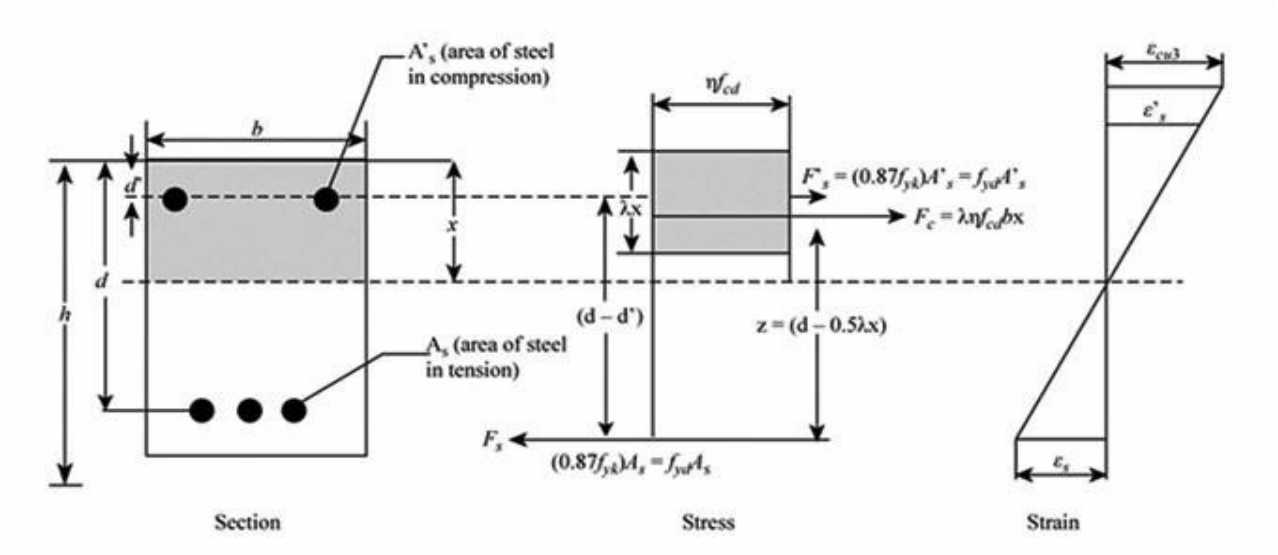
   Stress Diagram
   - Concrete → compression
   - Steel → both tension & compression
4. **Relevant Course Outcome:-**
   Understand stress-strain behaviour of RCC sections under loading.

5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Draw RCC cross-section
   - Represent strain distribution
   - Represent stress distribution
   - Identify neutral axis

6. **Experimental Setup:-**
   Cross Section, Strain and Stress of Singly Reinforced Beam







7. Resources Required

- Drawing sheet

- Pencil, scale, eraser
- IS code reference

8. Precaution

a. Maintain proper proportions
b. Label all components clearly
c. Draw straight and neat lines
d. Indicate neutral axis correctly
e. Follow standard symbols

9. Suggested Procedure

a. Draw rectangular beam section
b. Mark:
- Width (b)
- Depth (d)

c. Draw steel reinforcement at bottom and top
d. Mark neutral axis
e. Draw strain diagram (linear variation)
f. Draw stress diagram:
- Compression block in concrete
- Tension in steel

g. Label all parts

10. Graphical Representation

Cross Section
- Show concrete section
- Indicate steel reinforcement

Strain Diagram
- Linear variation
- Zero at NA
- Maximum at top

Stress Diagram
- Compression (top)
- Tension (bottom steel)

11. Observations and Calculations

Observation Table

Parameter	Symbol	Value
Width	b	
Depth	d	
Area of steel	Ast	
Neutral axis	x_n	

12. Results:

- Cross section, strain, and stress diagrams were successfully drawn
- Behaviour of RCC section was understood

13. Interpretation of Results

- Concrete resists compression only
- Steel resists tension
- Neutral axis separates tension and compression zones

14. Practical Related Questions

- What is doubly reinforced section?
- Why compression steel is provided?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 03

1. Practical Statement:-

To design a beam section for shear as per IS 456:2000.

2. Practical Significance:-

This experiment helps students to:

- Prevent shear failure in beams
- Ensure structural safety

3. Relevant Theory

Shear Stress

$$\tau_V = \frac{V}{b * d}$$

Shear Reinforcement

Stirrups are provided

Types:

- Vertical stirrups
- Inclined stirrups

4. Relevant Course Outcome:-

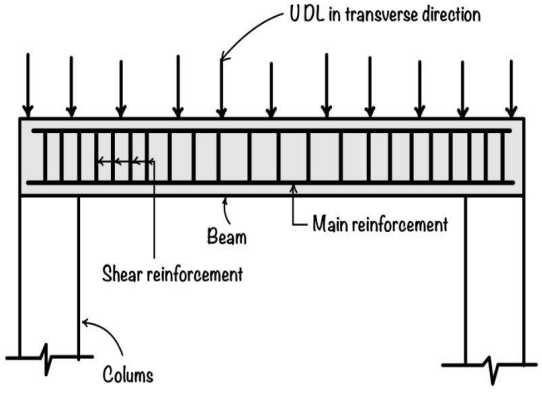
Understand shear reinforcement for a given beam section.

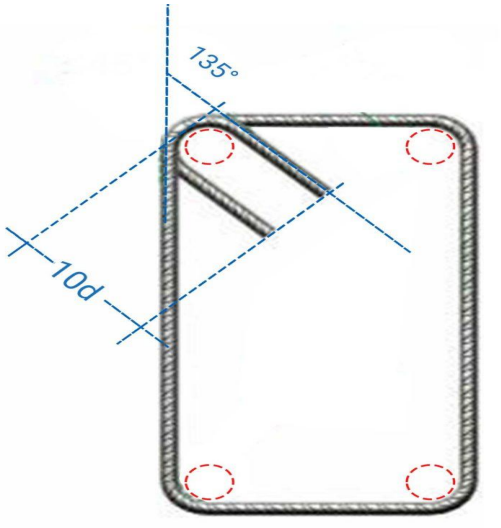
5. Lab Session Outcomes (LSOs):-

After completing this practical, students will be able to:

- Draw shear reinforcement detailing
- Represent stirrups
- Identify development length

6. Experimental Setup:-





7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

- Use correct formulas as per IS 456:2000.
- Ensure proper unit consistency.
- Refer to IS code tables for shear strength.
- Avoid calculation and rounding errors.
- Verify all steps carefully.

9. Suggested Procedure

a. Calculate shear force
b. Find shear stress
c. Compare with permissible value
d. Design stirrups

10. Graphical Representation

- Draw beam with loading and support conditions.
- Show shear force diagram (SFD).
- Sketch cross-section of beam showing stirrups.
- Indicate spacing and diameter of shear reinforcement.

11. Observations and Calculations

Given Data:

- Width of beam (b) = _____ mm
- Effective depth (d) = _____ mm
- Shear force (V) = _____ kN
- Grade of concrete = _____
- Grade of steel = _____

Observation Table

Parameter	Symbol	Value
Width of beam	b	
Effective depth	d	
Shear force	V	
Shear stress	τv	
Shear strength	τc	
Stirrup spacing	Sv	

12. Results:

- Cross section, shear reinforcement diagrams were successfully drawn

- Behaviour of development length was understood

13. Interpretation of Results

- The beam is checked for shear safety as per IS 456:2000.
- If required, shear reinforcement is provided to resist excess shear.
- Proper stirrup spacing ensures prevention of shear failure.
- The designed beam section is safe and structurally reliable.

14. Practical Related Questions

- What is shear failure?
- Why stirrups are provided?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 04

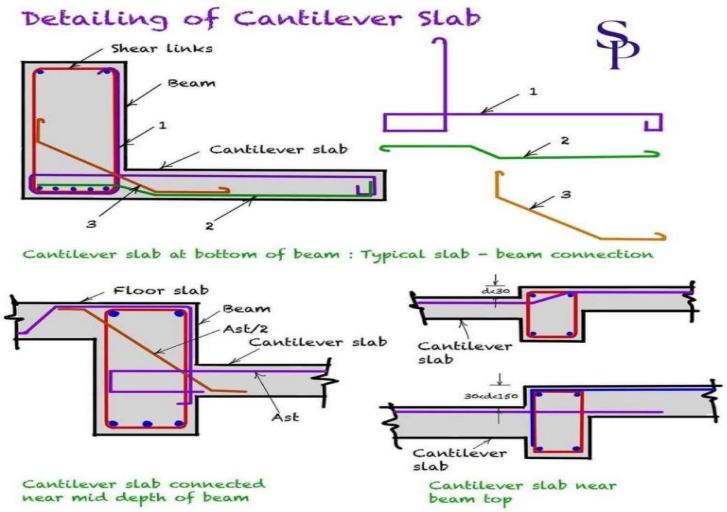
1. **Practical Statement:-**
   To design a cantilever slab from given data.
2. **Practical Significance:-**
   This experiment helps students to know Cantilever slab is:
   - Used as balconies, projections
   - Important for structural design
3. **Relevant Theory**

   Cantilever Slab
   - Fixed at one end
   - Free at other

   Maximum Moment

$$M = \frac{wL^2}{2}$$

4. **Relevant Course Outcome:-**
   - Apply structural design principles to cantilever elements.
   - Analyze bending moments and shear forces.
   - Design safe and economical slab sections.
5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Calculate loads acting on cantilever slab.
   - Determine bending moment and shear force.
   - Design reinforcement.
   - Check structural safety.
6. **Experimental Setup:-**



7. **Resources Required**
   - Drawing sheet
   - Pencil, scale, eraser
   - IS code reference

8. Precaution

a. Use correct units.
b. Follow IS code provisions.
c. Avoid calculation errors.
d. Ensure proper data interpretation.

9. Suggested Procedure

a. Calculate shear force
b. Find shear stress
c. Compare with permissible value
d. Design stirrups

10. Graphical Representation

- Sketch cantilever slab with support and free end.
- Draw load diagram.
- Draw bending moment and shear force diagrams.

11. Observations and Calculations

- Calculate dead load and live load.
- Find total load.
- Compute bending moment ($wL^2/2$).
- Design reinforcement.

Observation Table

Parameter	Symbol	Value
Span	L	
Load	w	
Moment	M	
Depth	d	
Steel Area	Ast	

12. Results:

- Cantilever slab reinforcement diagrams were successfully drawn

13. Interpretation of Results

- Slab is safe against bending and shear.
- Reinforcement is adequate.
- Design is economical and stable.

14. Practical Related Questions

- What is shear failure?
- Why stirrups are provided?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 05

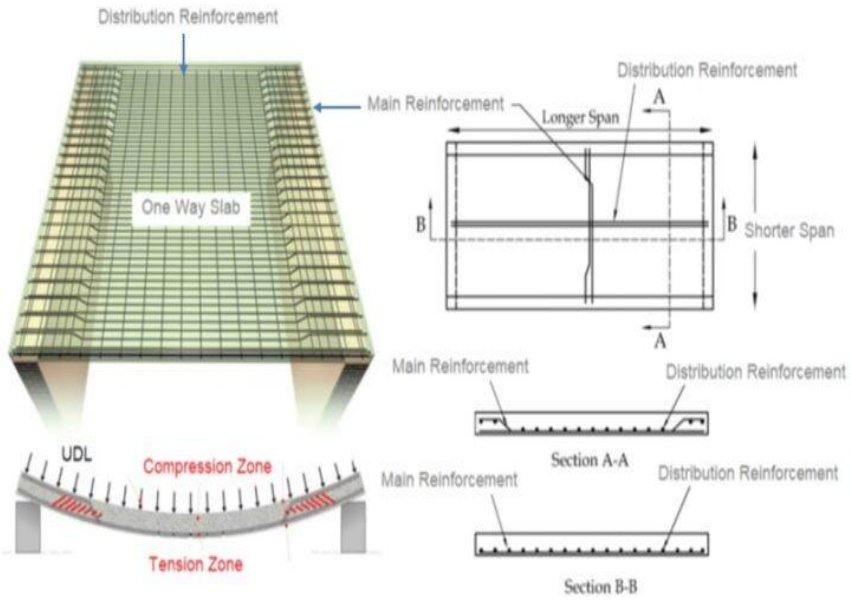
1. **Practical Statement:-**
   To design a one-way simply supported slab.
2. **Practical Significance:-**
   This experiment helps students to know one-way slab is:
   - Common in building floors
   - Easy and economical design
3. **Relevant Theory**
   One Way Slab

   - Load transferred in one direction
   - Condition: $L_y/L_x > 2$

4. **Relevant Course Outcome:-**
   - Understand behavior of one-way slabs.
   - Apply load distribution concepts.

5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Identify one-way slab behavior.
   - Calculate loads and moments.
   - Design reinforcement.

6. **Experimental Setup:-**



7. **Resources Required**
   - Drawing sheet
   - Pencil, scale, eraser

- IS code reference

8. Precaution

a. Maintain proper proportions
b. Label all components clearly
c. Draw straight and neat lines
d. Indicate stirrups correctly
e. Follow standard symbols

9. Suggested Procedure

a. Determine span
b. Calculate load
c. Calculate moment
d. Design reinforcement

10. Graphical Representation

- Sketch slab supported on two sides.
- Show load distribution.
- Draw bending moment diagram.

11. Observations and Calculations

- Calculate loads.
- Moment = $wL^2/8$
- Design reinforcement.

Observation Table

Parameter	Symbol	Value
Span	L	
Load	w	
Moment	M	
Depth	d	
Steel Area	Ast	

12. Results:

One way slab was designed successfully.

13. Interpretation of Results

- Load carried in one direction.
- Design satisfies safety requirements.

14. Practical Related Questions

- What is one way slab?
- Where reinforcement is provided?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

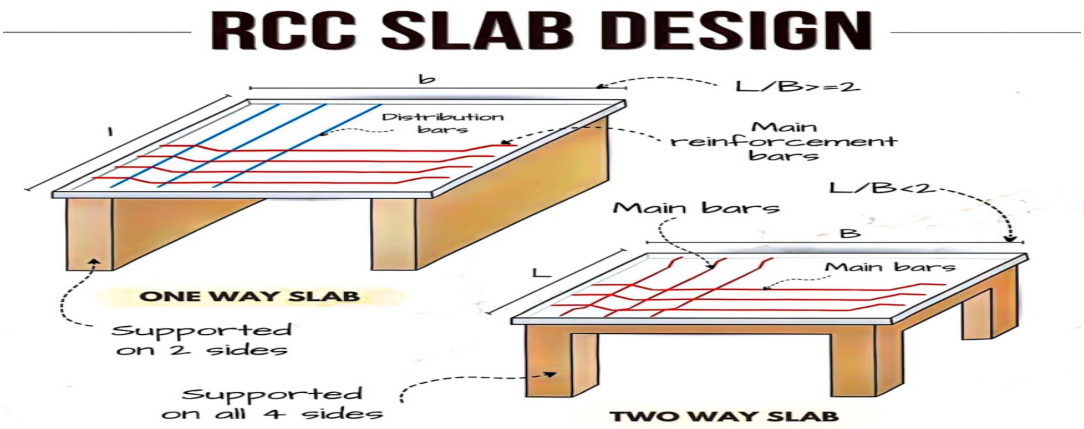
Practical No: 06

1. **Practical Statement:-**
   To design a two-way simply supported slab.
2. **Practical Significance:-**
   This experiment helps students to know two-way slab is:
   - Used in square slab
   - Load distributed in both direction
3. **Relevant Theory**
   Two Way Slab
   - Load transferred in two direction
   - Condition: $L_y/L_x \leq 2$

4. **Relevant Course Outcome:-**
   - Understand two-way slab action.
   - Apply moment distribution in both directions.

5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Identify two-way slab behavior.
   - Calculate moments in both directions.
   - Design reinforcement accordingly.

6. **Experimental Setup:-**



7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

a. Check aspect ratio.
b. Use correct coefficients.
c. Maintain accuracy.

9. Suggested Procedure

a. Determine span ratio
b. Calculate load
c. Use IS coefficients
d. Design reinforcement both directions

10. Graphical Representation

- Sketch slab supported on all sides.
- Show load distribution in both directions.

11. Observations and Calculations

- Calculate loads.
- Use moment coefficients.
- Design reinforcement in both directions.

Observation Table

Parameter	Symbol	Value
Short Span	Lx	
Long Span	Ly	
Load	w	
Moment	Mx/My	
Steel Area	Ast	

12. Results:

Two way slab was designed successfully.

13. Interpretation of Results

- Load distributed in two directions.
- Slab design is safe and efficient.

14. Practical Related Questions

- What is two way slabs?
- What is difference between one way slab and two way slabs?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 07

1. Practical Statement:-

To draw the reinforcement detailing for:

- Cantilever slab
- One way simply supported slab
- Two way simply supported slab

2. Practical Significance:-

This experiment helps students to know two-way slab is:

- Reinforcement detailing is essential for actual construction
- Helps in understanding placement of steel bars
- Ensures safety and durability of structure

3. Relevant Theory

Reinforcement Detailing

It is the process of showing:

- Size of bars
- Spacing of bars
- Position of bars

Key Concepts

Cantilever Slab

- Main reinforcement at top

One Way Slab

- Main reinforcement in short span direction
- Distribution bars in other direction

Two Way Slab

- Reinforcement in both directions

4. Relevant Course Outcome:-

- Understand reinforcement detailing practices.
- Interpret structural drawings.

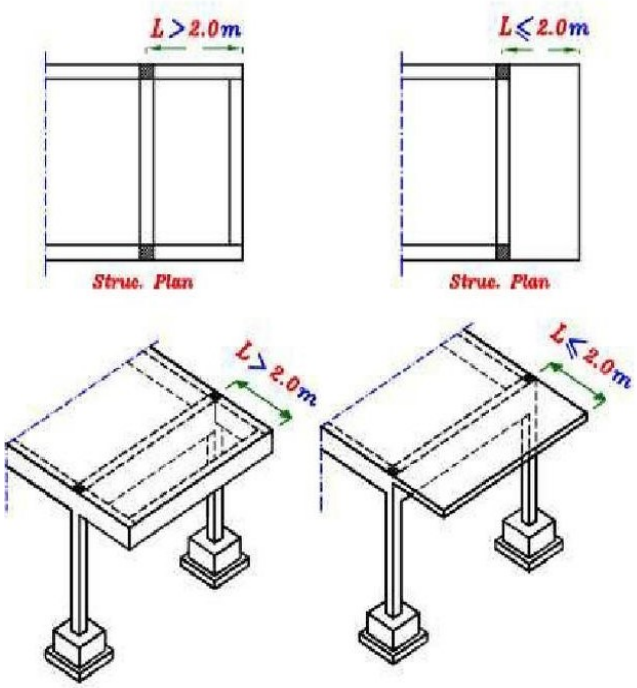
5. Lab Session Outcomes (LSOs):-

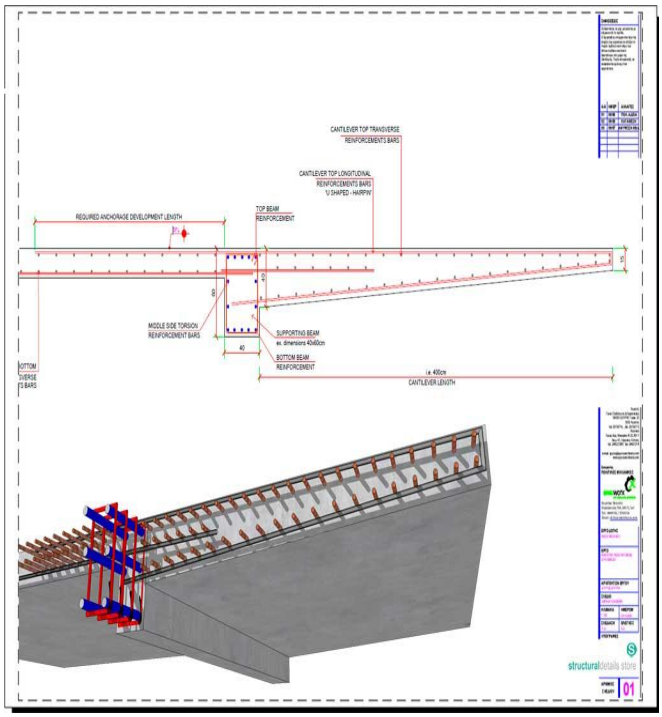
After completing this practical, students will be able to:

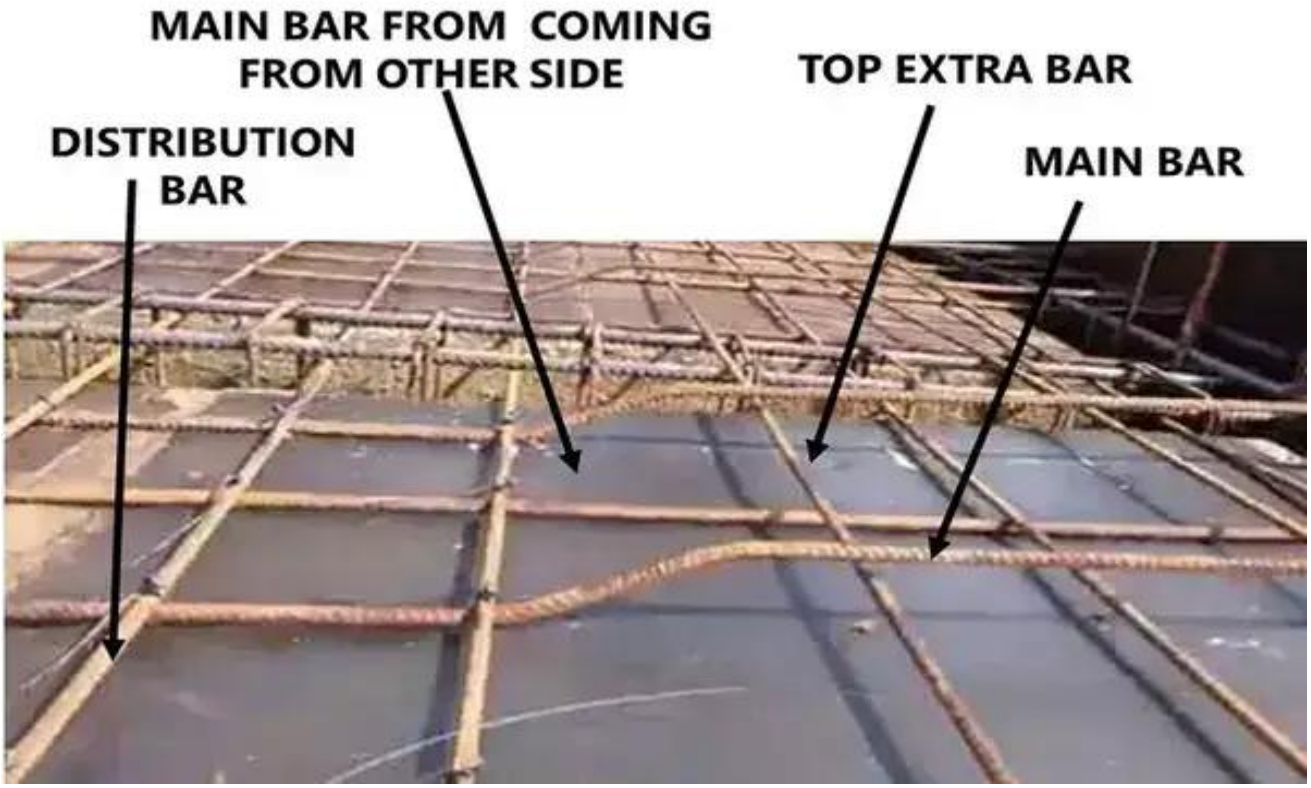
- Draw reinforcement layouts.
- Identify main and distribution steel.
- Understand bar spacing and placement.

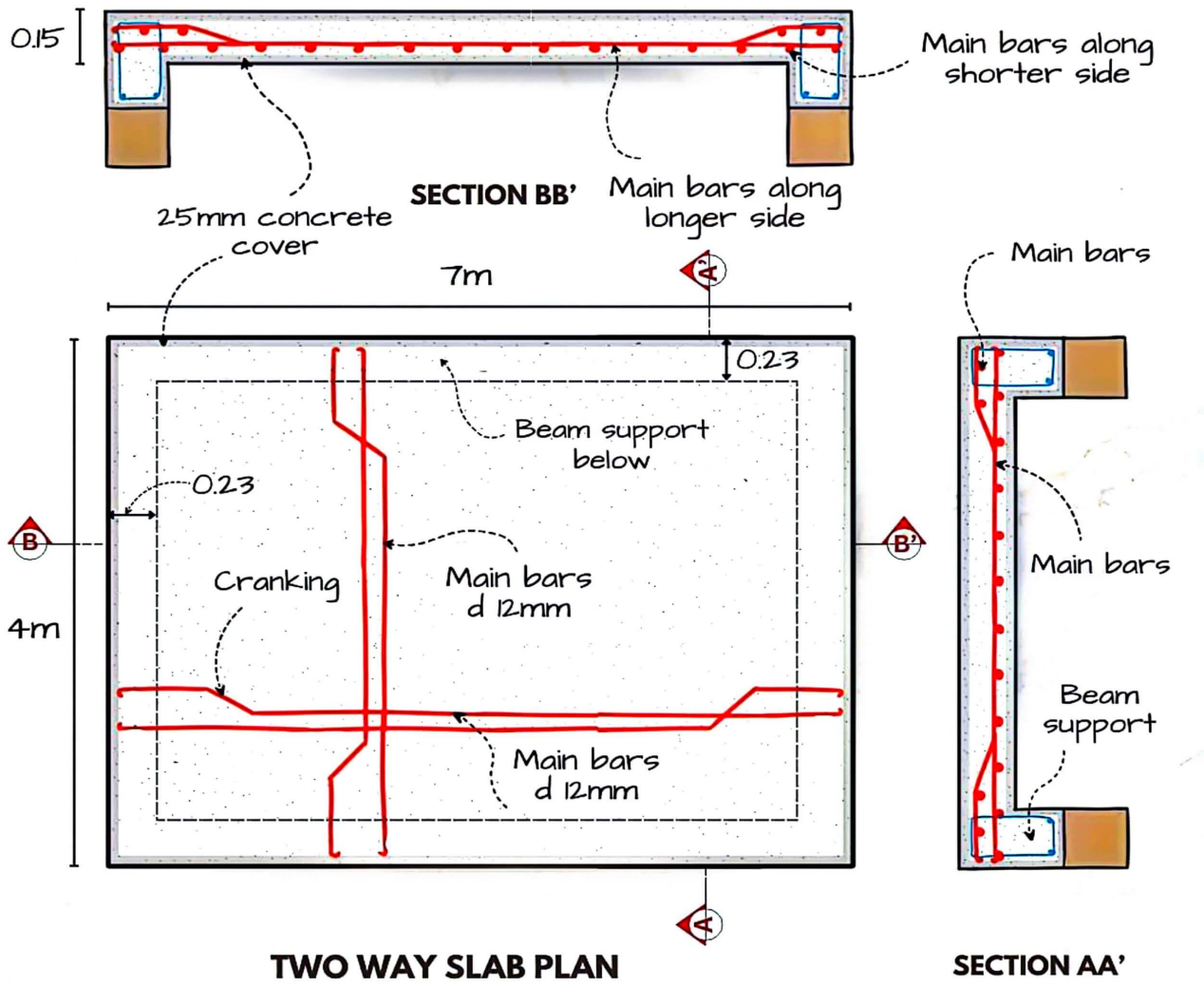
6. Experimental Setup:-

Cantilever Slab Reinforcement









7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

a. Use proper scale.
b. Clearly label reinforcement.
c. Maintain neatness.

9. Suggested Procedure

a. Identify slab type
b. Draw slab plan
c. Show reinforcement direction
d. Mark spacing and bar diameter
e. Label all details

10. Graphical Representation

- Draw reinforcement details for all three slabs.
- Show bar spacing, cover, and anchorage.

11. Observations and Calculations

Observation Table

Slab Type	Reinforcement Type	Details
Cantilever	Main Steel	Top side
One-way	Main Steel	Short span
Two-way	Main Steel	Both directions

12. Results:

Reinforcement detailing for all slabs are drawn successfully.

13. Interpretation of Results

- Reinforcement placement ensures strength.
- Proper detailing improves durability.

14. Practical Related Questions

- What is reinforcement detailing?
- Why top reinforcement is used in cantilever slab?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

Practical No: 08

1. **Practical Statement:-**
   To design an axially loaded short column from given data.
2. **Practical Significance:-**
   This experiment helps students to know two-way slab is:
   - Columns are primary load carrying members
   - Ensures safety of structure
   - Helps in understanding compression behavior
3. **Relevant Theory**

   Short Column

   A column where slenderness ratio is small

   $$\frac{L_e}{D} < 12$$

   Axial Load Capacity

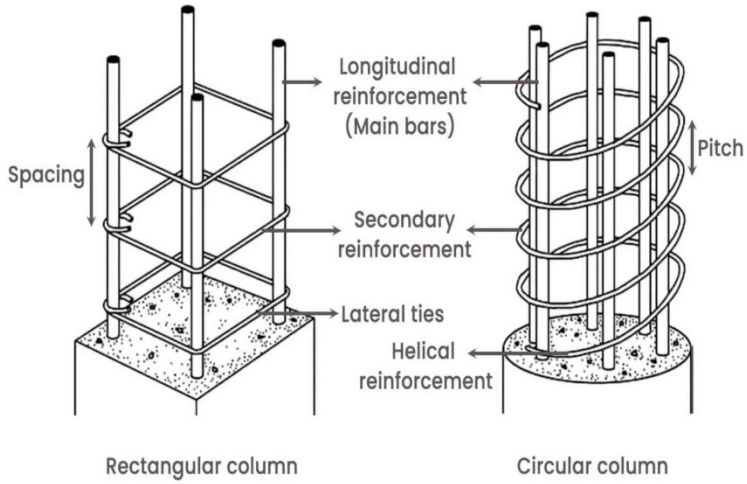
   $$P_u = 0.4fckAc + 0.67fyAs$$

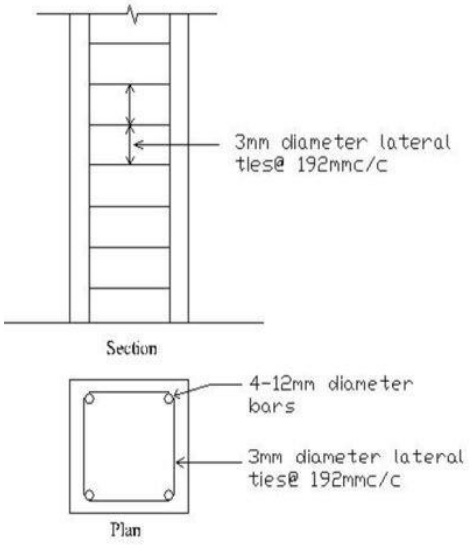
   Where:
   - Ac= Area of concrete
   - As= Area of steel

   Reinforcement
   - Longitudinal bars
   - Lateral ties (stirrups)
4. **Relevant Course Outcome:-**
   - Apply column design principles.
   - Understand axial load behavior.

5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Calculate axial load capacity.
   - Design column dimensions.
   - Determine reinforcement.

6. **Experimental Setup:-**





7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

- Follow IS code provisions.
- Ensure correct load values.
- Maintain calculation accuracy.

9. Suggested Procedure

a. Assume column size
b. Calculate load
c. Determine area of steel
d. Provide reinforcement
e. Check design

10. Graphical Representation

- Draw column cross-section.
- Show reinforcement layout.

11. Observations and Calculations

- Calculate axial load.
- Use column design formula.
- Determine steel area.

Observation Table

Parameter	Symbol	Value
Load	P	

Area	A	
Steel Area	Ast	

12. Results:

Axially loaded short column is designed successfully.

13. Interpretation of Results

- Column is safe under axial load.
- Reinforcement satisfies design criteria.

14. Practical Related Questions

- What is short column?
- What is difference between short and long column?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	

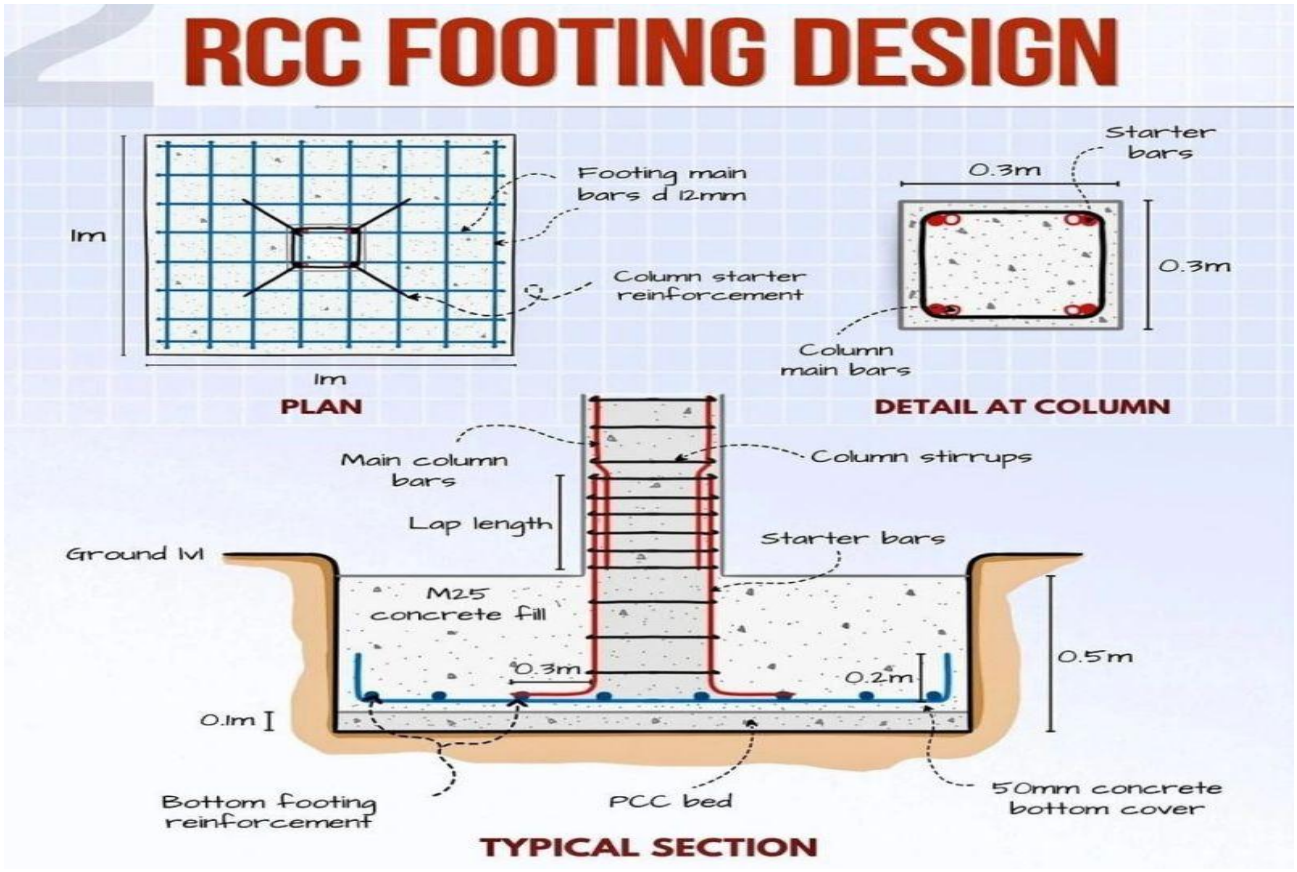
Practical No: 09

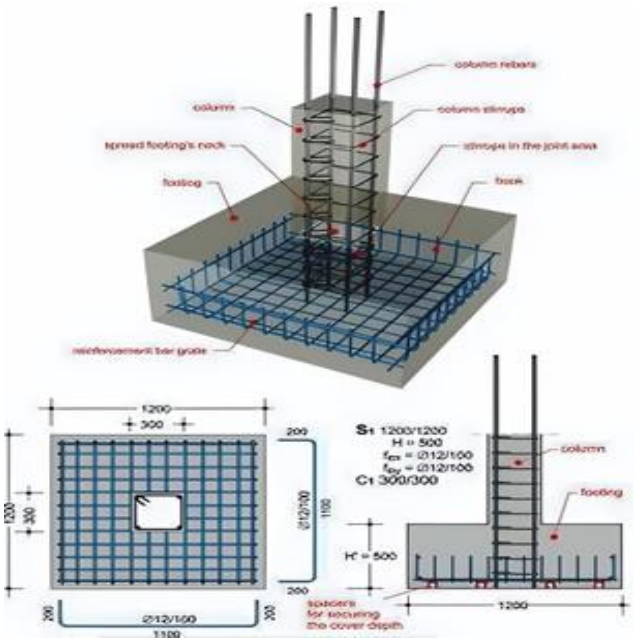
1. **Practical Statement:-**
   To draw sketches of different types of column footings**.**
2. **Practical Significance:-**
   This experiment helps students to know two-way slab is:
   - Footings transfer load safely to soil
   - Helps in understanding foundation systems
   - Important for structural stability
3. **Relevant Theory**

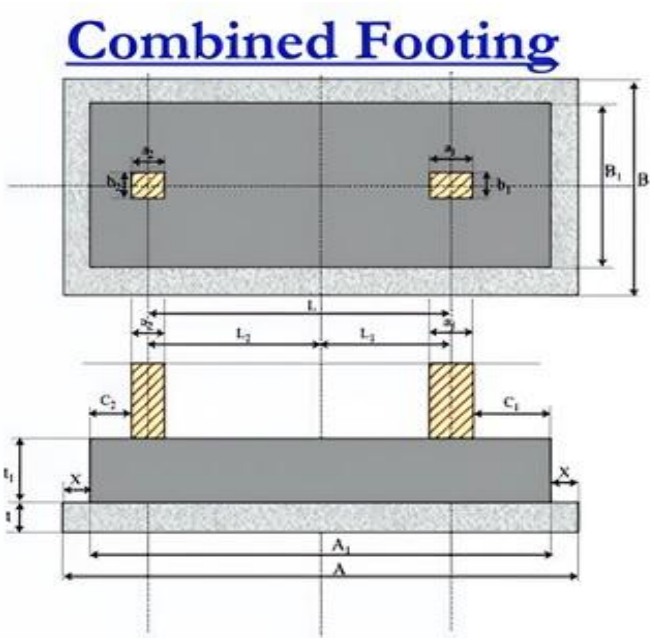
   Footing

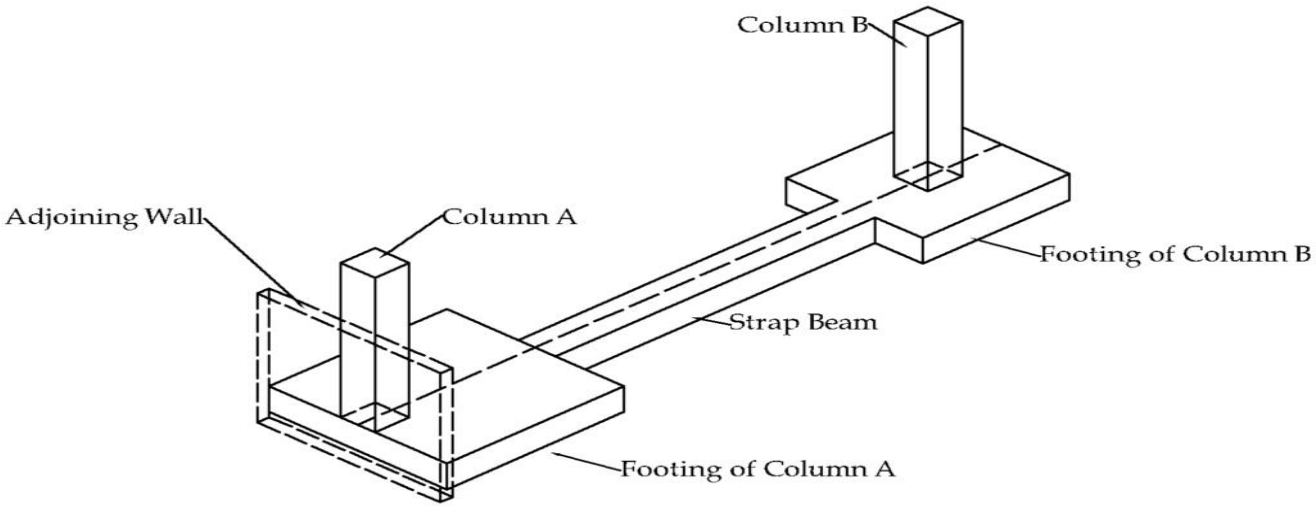
   A footing is a structural element that transfers load from column to soil.

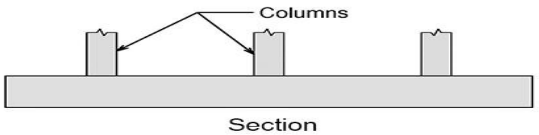
   Types of Footings
   - Isolated Footing
   - Combined Footing
   - Strap Footing
   - Raft Footing
4. **Relevant Course Outcome:-**
   - Understand foundation systems.
   - Identify different footing types.
5. **Lab Session Outcomes (LSOs):-**
   After completing this practical, students will be able to:
   - Draw different footing sketches.
   - Understand applications.
6. **Experimental Setup:-**

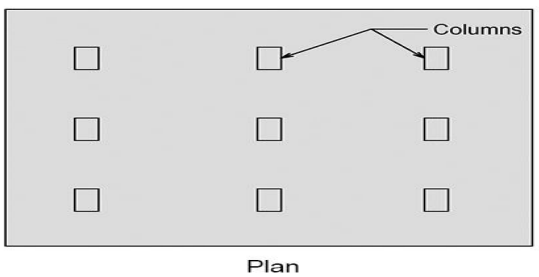


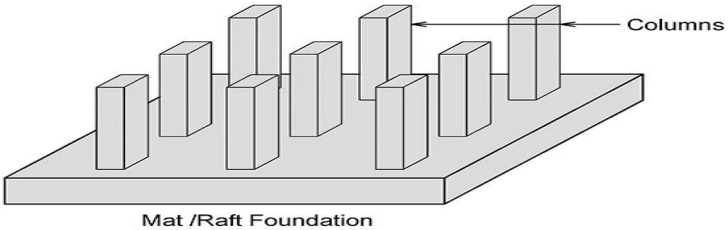












Raft Footing

7. Resources Required

- Drawing sheet
- Pencil, scale, eraser
- IS code reference

8. Precaution

a. Maintain proper proportions
b. Label all components clearly
c. Draw straight and neat lines
d. Follow standard symbols

9. Suggested Procedure

a. Identify type of footing
b. Draw plan view
c. Draw sectional view
d. Label all parts

10. Graphical Representation

- Draw isolated, combined, strap, raft, and pile footings.

11. Observations and Calculations

Observation Table

Type	**Use**	
Isolated	Single column	
Combined	Multiple columns	
Strap	Unequal loads	

12. Results:

Different types of footings were successfully drawn.

13. Interpretation of Results

- Footings vary based on soil and load.
- Proper selection ensures stability.

14. Practical Related Questions

- What is footing?
- Types of footing
- What is difference between isolated and combined footing?

15. Suggested Assessment Scheme/Rubrics (As per OBE Curriculum)

Process Assessment (45%)

- Drawing steps
- Neatness

Product Assessment (45%)

- Correct diagrams
- Proper labelling

Viva-Voce (10%)

- Conceptual clarity

List of Student Team Members

A. _____

B. _____

C. _____

D. _____

E. _____

Marks Obtained				**Dated Sign of Teacher**
Process Assessment (9)	**Product Assessment (9)**	**Viva-voce (2)**	**Total Marks (Out of 20)**	