Structural System in Architecture
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Lecture No -40
Structural Detailing

Welcome to the NPTEL online certification course on Structural Systems in Architecture. This is the 40th lecture and this is the last lecture of the module 8 or the week 8 and also the course per se. And this lecture's topic is Structural Detailing.

Concepts Covered

- Introduction
- Detailing of Beam
- Detailing of Column
- Detailing of Foundation
- Detailing of Slab

Learning Objectives

- Introducing the needs for detailing.
- Outlining the general details of common structural elements.

Introduction

Detailing is the final stage that comes after the structural design. It incorporates the standard rules and procedure needed to be followed after the design of any structural element is completed.

The detail of reinforcement or rebar depends upon the following important factors:

- Strength of concrete and steel
- Condition of support system
- Types of loading types (static or dynamic)

- Bonding and development length
- Curtailment of reinforcement
- Standard of ductility in structural element

In India the "Handbook on Concrete Reinforcement and Detailing" (SP-34) is followed for RCC structures.

Necessity of Structural Detailing

- It provides a common benchmark to apply the design findings.
- It provides a common uniformity across a nation (region) to specify the design output in a standard form.
- It can bypass many more in depth calculations in design stage and reduce the effort of the design process.
- The details are printed in drawing sheets and send for execution.
- It is not possible to quantify the exact amount and cost of steel and concrete in the project without detailing of structural items.

Detailing of Beam

Spacing Between Main Reinforcement

Longitudinal Reinforcement

The following rule shall apply for the minimum distance between individual bars:

- The horizontal distance between two parallel bars shall be usually not less than the following:
  - Diameter of the bar, if the diameters are equal;
  - Diameter of the larger bar, if the diameters are unequal; and
  - 5mm more than the nominal maximum size of coarse aggregate.
- Where there are two or more rows of bars, the bars shall be vertically in line and the minimum vertical distance between bars shall be 15 mm or two-thirds the nominal maximum size of aggregate or the maximum size of the bar, whichever is greater.

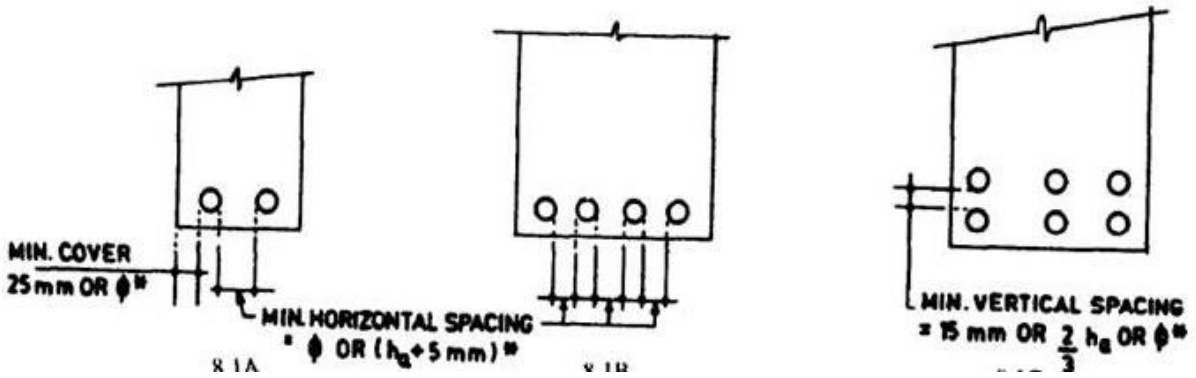


Figure 1 Spacing of reinforcements

Side Face Reinforcement

Where the depth of the web in a beam exceeds 750 mm side face reinforcement shall be provided along the two faces. The total area of such reinforcement shall be not less than 0.1 percent of the web area and shall be distributed equally on two faces at a spacing not exceeding 300 mm or web thickness whichever is less.

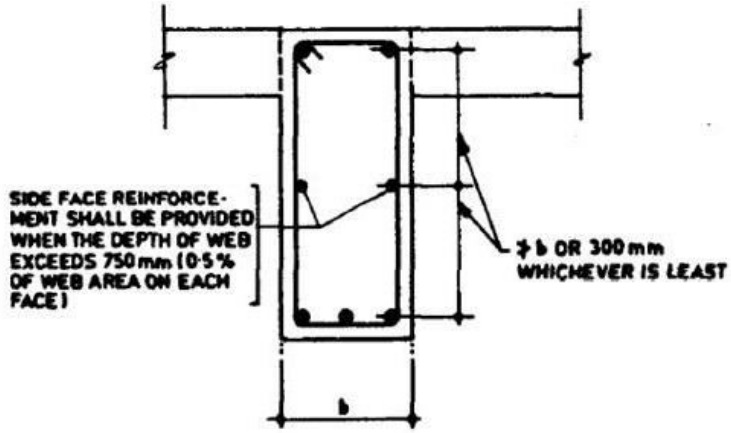


Figure 2 Side face reinforcement

Shear Reinforcement: Stirrups

- **Use Of Multi-Legged Stirrups**: Multi-legged stirrups are required from the consideration of shear stresses in the beam, or where restraint against the buckling of bars in compression is needed. The rules for stirrups reinforcing steel in compression are the same as those for columns. The vertical stirrups may be provided as two-legged stirrups, four-legged stirrups or six-legged stirrups at the same section according to actual

requirements. Open type stirrups may be used for beam-slab construction where the width of rib is more than 450 mm.

- **Maximum Spacing**: The maximum spacing of shear reinforcement measured along the axis of the member shall not exceed 0.75d for vertical stirrups and d for inclined stirrups at 45°, where d is the effective depth of the section under consideration. In no case shall it exceed 450 mm.

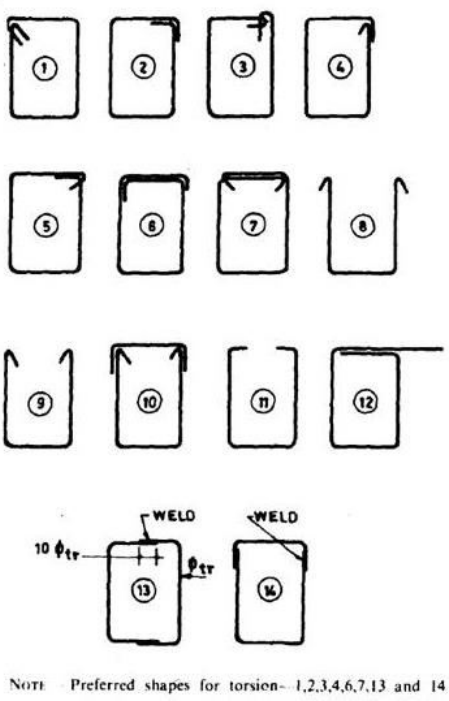


Figure 3 Different shapes of stirrups

Anchoring of Stirrups

A stirrup in the reinforced concrete beam shall pass around or be otherwise adequately secured to the outermost tension and compression reinforcement, and such stirrups should have both its ends anchored properly in any one of the fashion detailed in the following figure. In T-beams and I-beams, such reinforcement shall pass around longitudinal bars located close to the outer face of the flange.

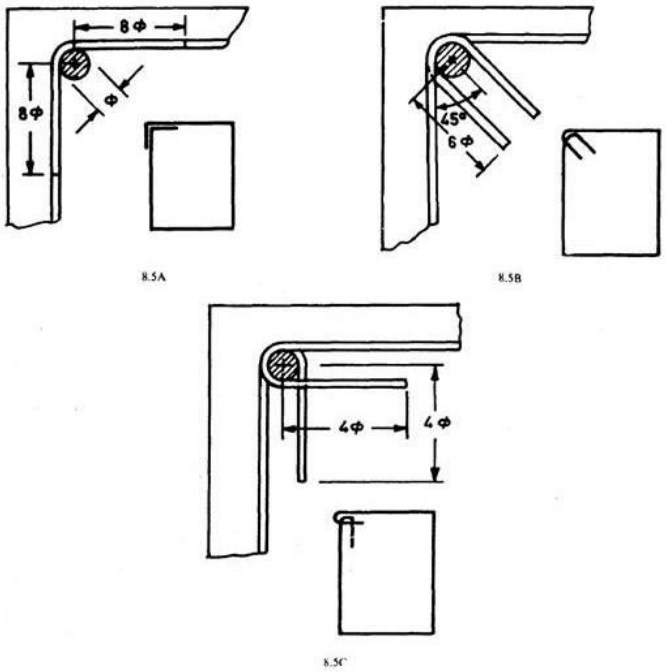


Figure 4 Different ways of anchoring ends of stirrups

Requirement of Reinforcement

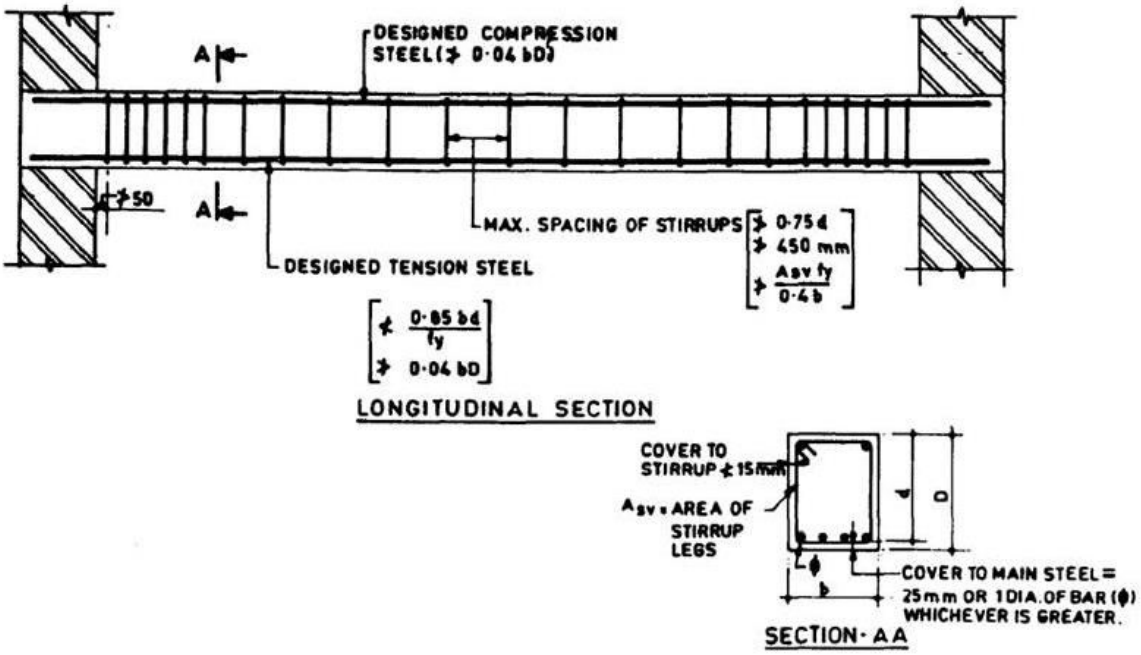
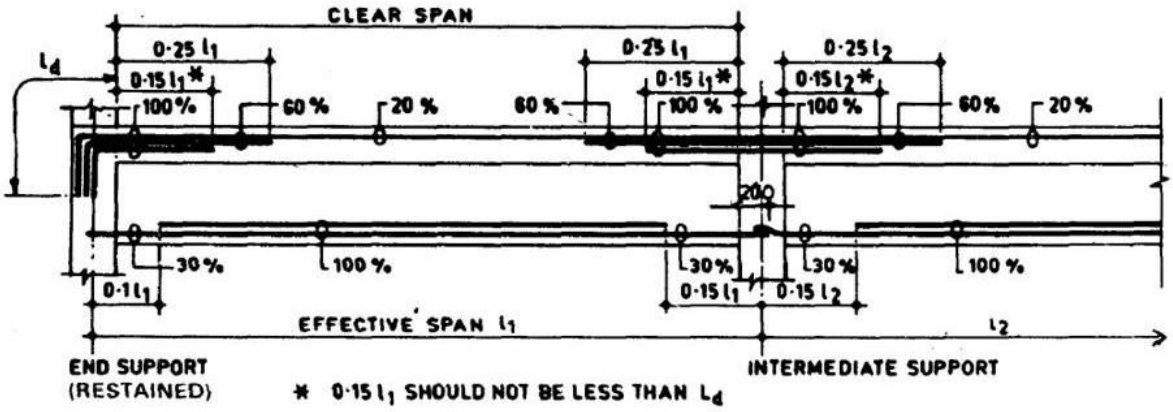


Figure 5 Reinforcement requirements for beams

Reinforcement Curtailment Rule



NOTE Applicable to continuous beams with approximately equal spans (not differing more than 15 percent) and subjected to predominantly U.D.L., and designed without compression steel.

Figure 6 Simplified curtailment rules for continuous beams

Detailing of Column

Reinforcement Spacing Requirement

Longitudinal Reinforcement

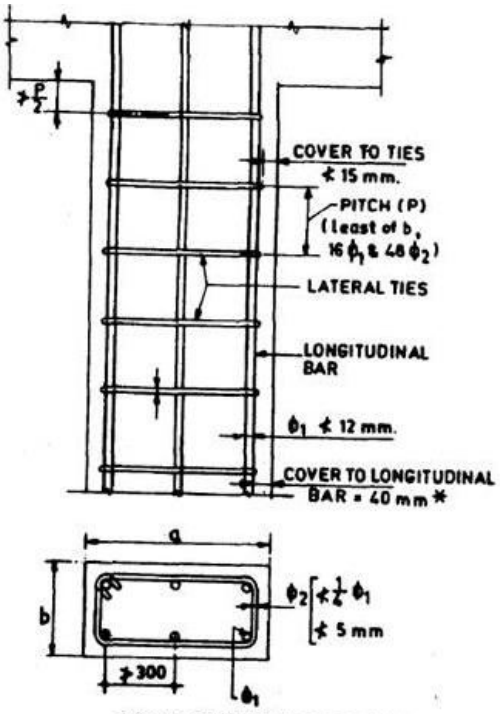
In a reinforced column, the area of longitudinal reinforcement shall not be less than 0.8% nor more than 6% of the gross cross-sectional area of the columns.

The area of longitudinal reinforcement should normally not exceed 4% of the gross cross-sectional area of the column. This percentage can be considered as the maximum from practical considerations.

However, where bars from one column have to be lapped with those of another column above, the total maximum percentage of 6% may be allowed at the lapping. Proper placing and compacting of concrete should be ensured at the place of lapping.

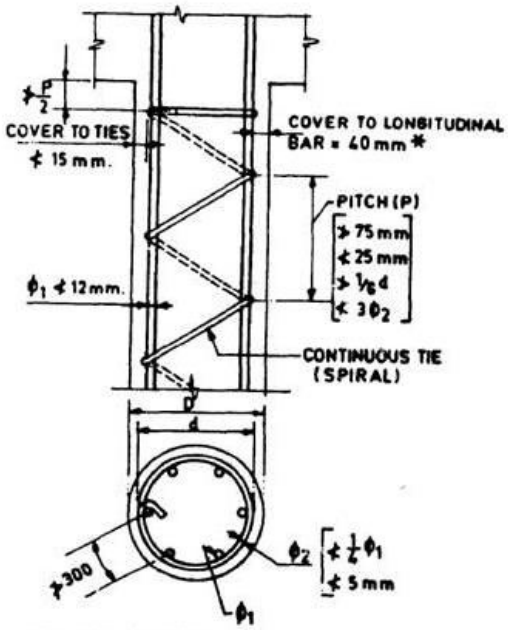
A minimum number of four bars shall be provided in a column and six bars in a circular column with helical reinforcement.

The bars shall be not less than 12 mm in diameter and spacing of the bars along the periphery of the column shall not exceed 300 mm.



7.6A RECTANGULAR COLUMN

*Cover can be reduced to 25mm when $a \leq 200$, $b \leq 200$ and $\phi = 12$.



7.6B CIRCULAR COLUMN

*Cover can be reduced to 25 mm when $D \leq 200$ and $\phi = 12$

Arrangement of Ties

Pitch and Diameter of Lateral Ties

Pitch: The pitch of the transverse reinforcement shall not be more than the least of the following distances:

- The least lateral dimension of the compression member.
- Sixteen times the smallest diameter of the longitudinal reinforcing bar to be tied, and
- 48 times the diameter of the transverse reinforcement.

Diameter: The diameter of the polygonal links or lateral ties shall not be less than one-fourth of diameter of the largest longitudinal bar, and in no case less than 5mm.

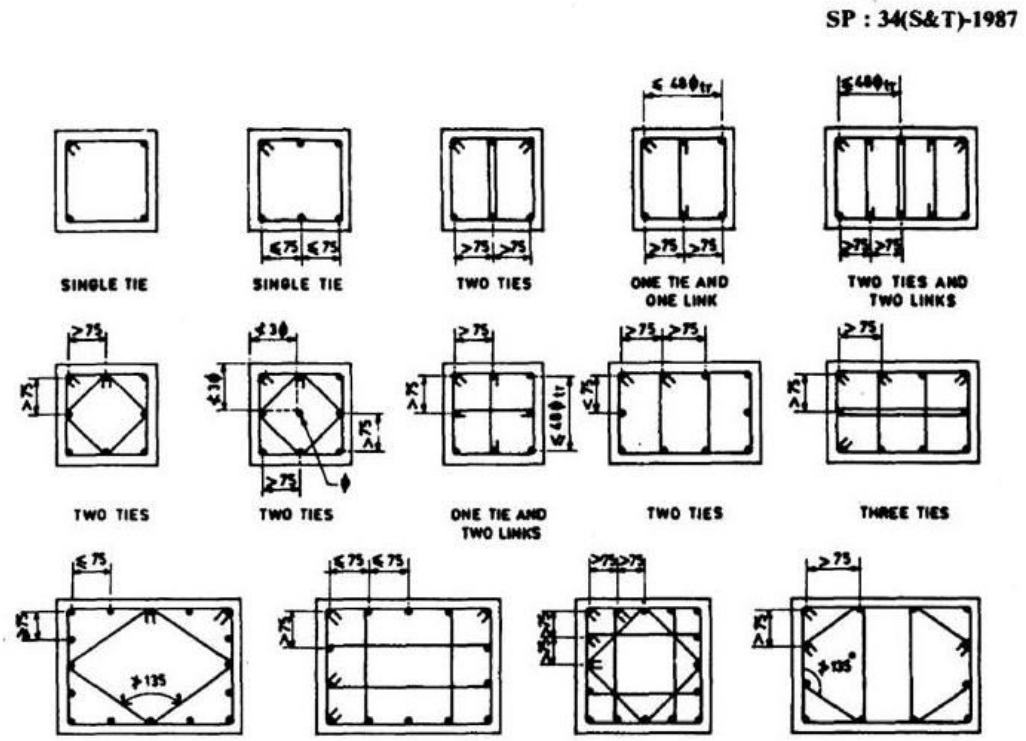


Figure 7 Pitch and diameter of lateral ties

Detailing of Foundation

Typical Detail of Isolated Footing

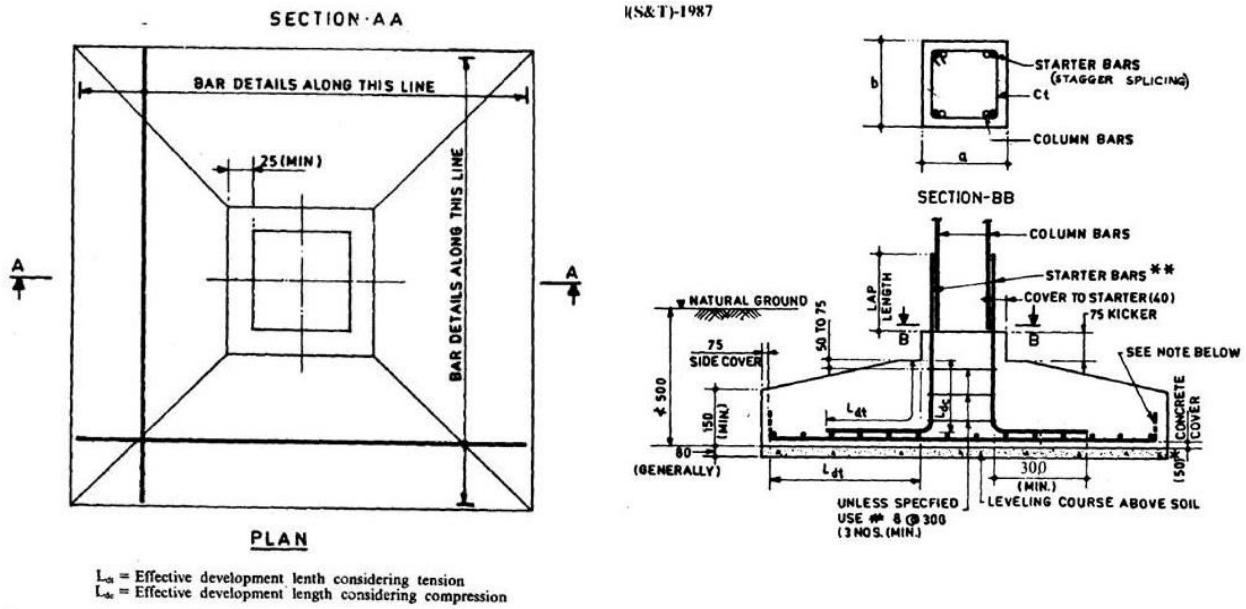
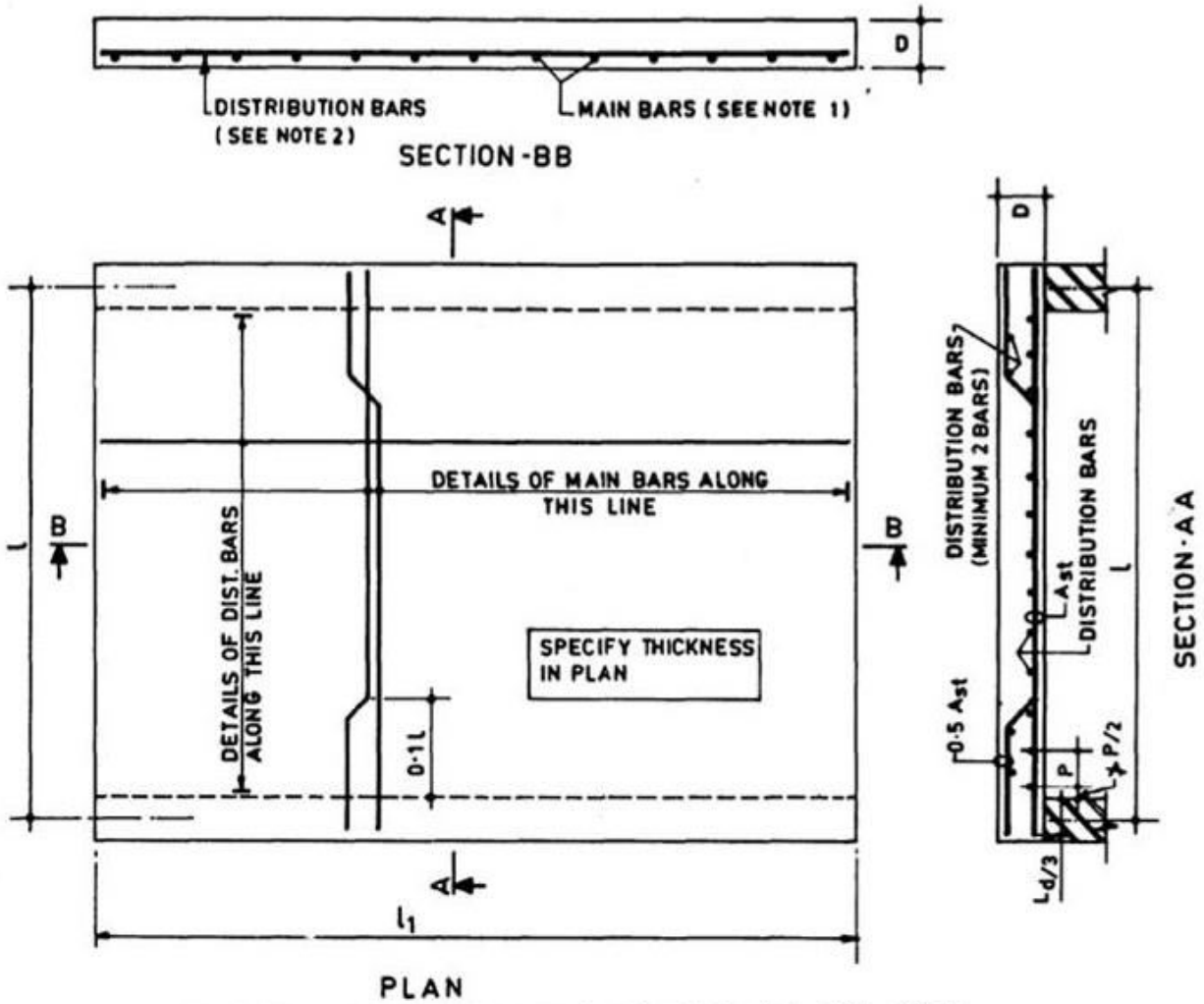


Figure 8 Typical detail of isolated footing

Detailing of Slab

Typical Detail of One way Slab



NOTE 1 — Diameter ≤ 8 mm for deformed bars; 10 mm for plain bars; Spacing ≥ 3d or 450 mm

NOTE 2 — Diameter ≤ 6 mm; Spacing ≥ 5d or 450 mm

Figure 9 Typical detail of one-way slab

Typical Detail of Two-way Slab

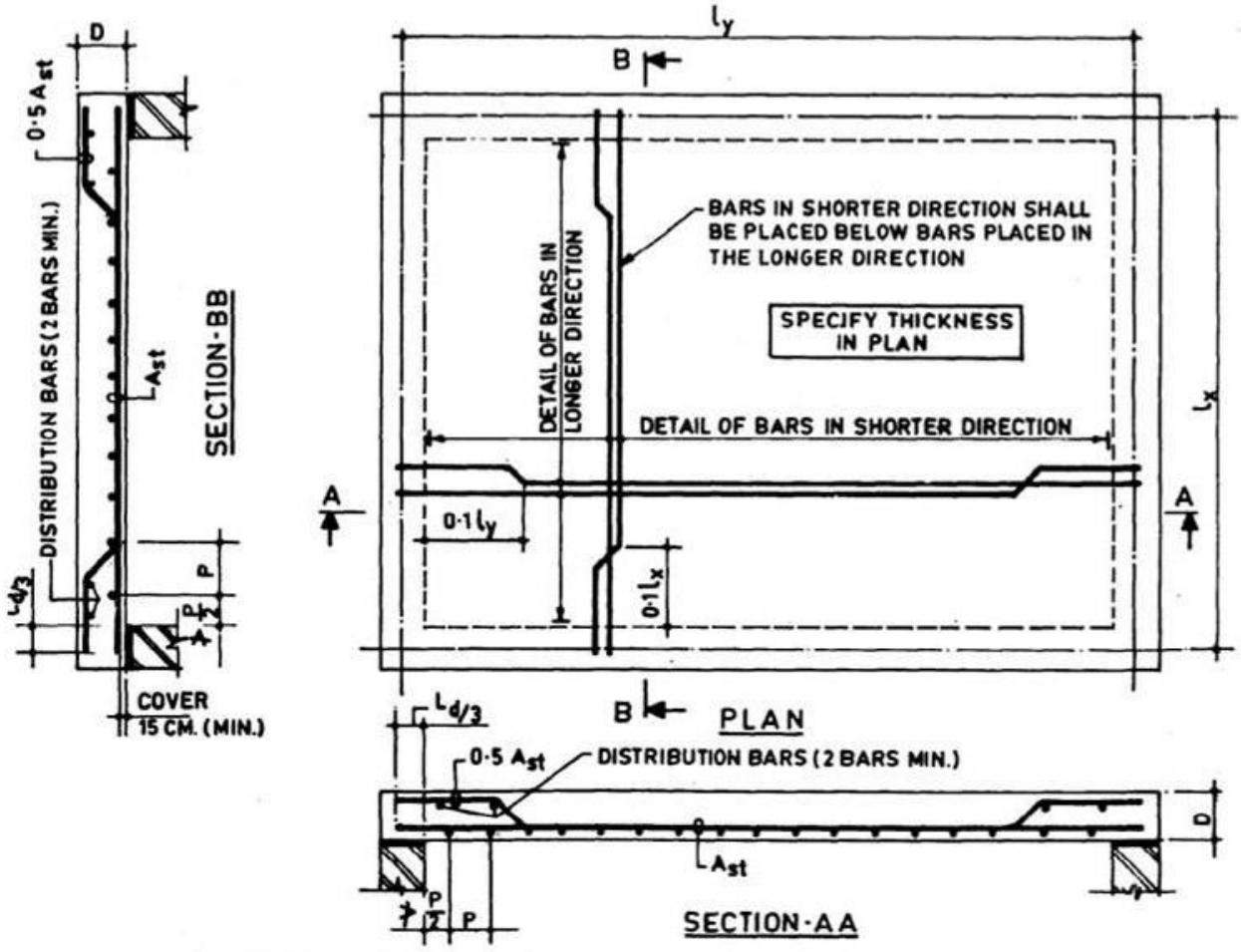


Figure 10 Typical detail of a two-way slab

References

- **Handbook on Concrete Reinforcement and Detailing" (SP-34), BIS**

Conclusion

Finally, I'd like to conclude with the following statements.

Detailing of structure is considered as the final stage of design process. It links the design output and the actual application at site. It is a very important stage; a structure may collapse due to good design but poor detailing.