SNS COLLEGE OF TECHNOLOGY

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COIMBATORE

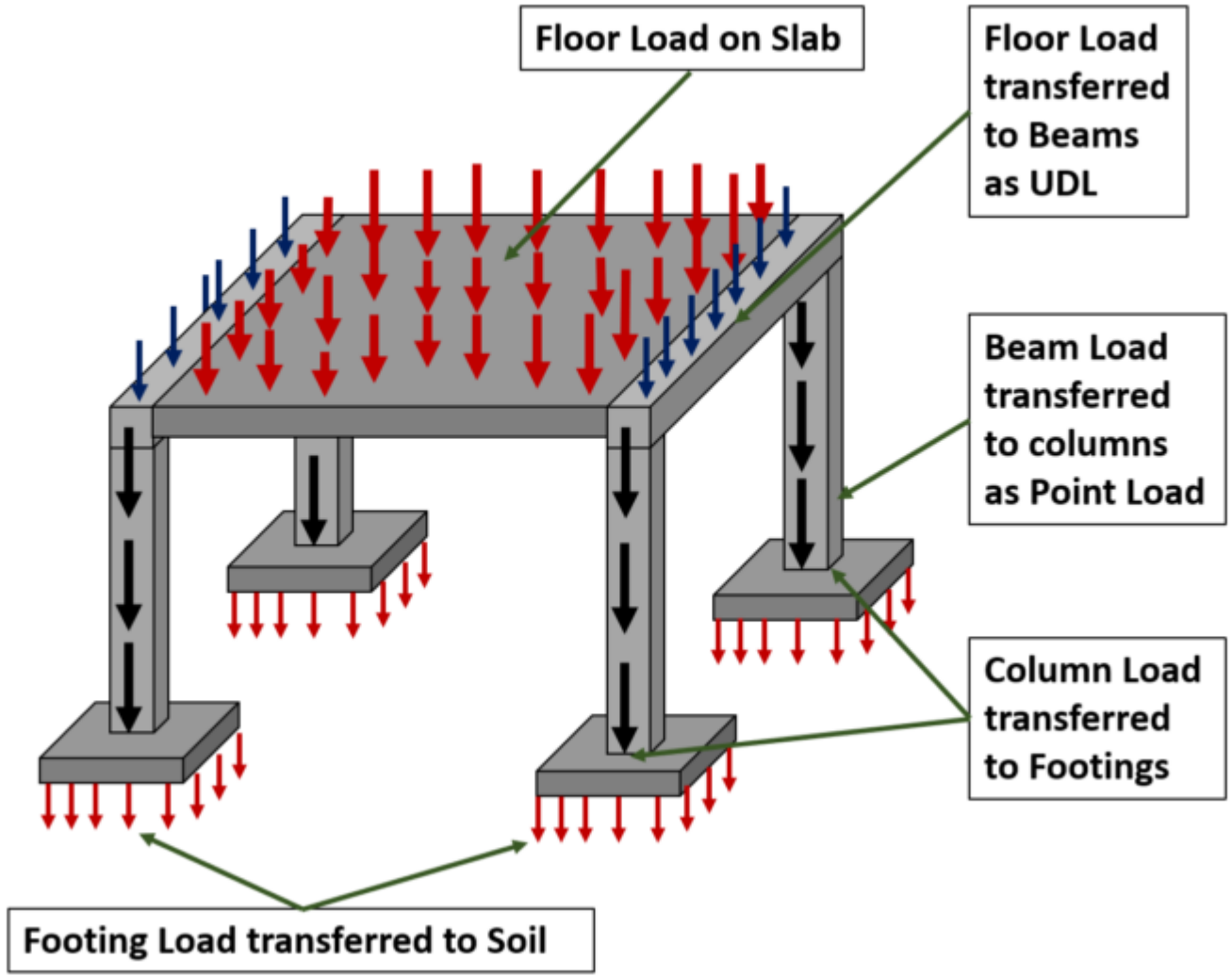
DEPARTMENT OF CIVIL ENGINEERING

19CET302-DESIGN OF RC STRUCTURAL ELEMENTS

III YEAR / V SEMESTER

Unit 2 : Limit state design of Beams

Introduction


Floor Load on Slab
Floor Load transferred to Beams as UDL
Beam Load transferred to columns as Point Load
Column Load transferred to Footings
Footing Load transferred to Soil

BEAM

- A Beam is an inevitable horizontal or sloping the structure.
- The main function of the beam is designed to resist the external or internal load such as wall, slab and floors of the building and distribute the load to the foundation through the column.
- The horizontal beam carries an only transverse (vertical) load and the sloping beams
- carry both transverse and axial load.

LIMIT STATE METHOD OF DESIGN

➢ The object of the design based on the limit state concept is to achieve an acceptable probability, that a structure will not become unsuitable in it's lifetime use for which it is intended.

 A structure with appropriate degree of reliability should be able to withstand safety.

 It should also be able to maintain the required structural integrity, during and after accident, such as fires, explosion & local failure. i.e. limit sate must be consider in design to ensure an adequate degree of safety and serviceability

 The most important of these limit states, which must be examine in design are as follows Limit state of collapse

- **Flexure**
- **Compression**
- **Shear**
- **Torsion**

This state corresponds to the maximum load carrying capacity.

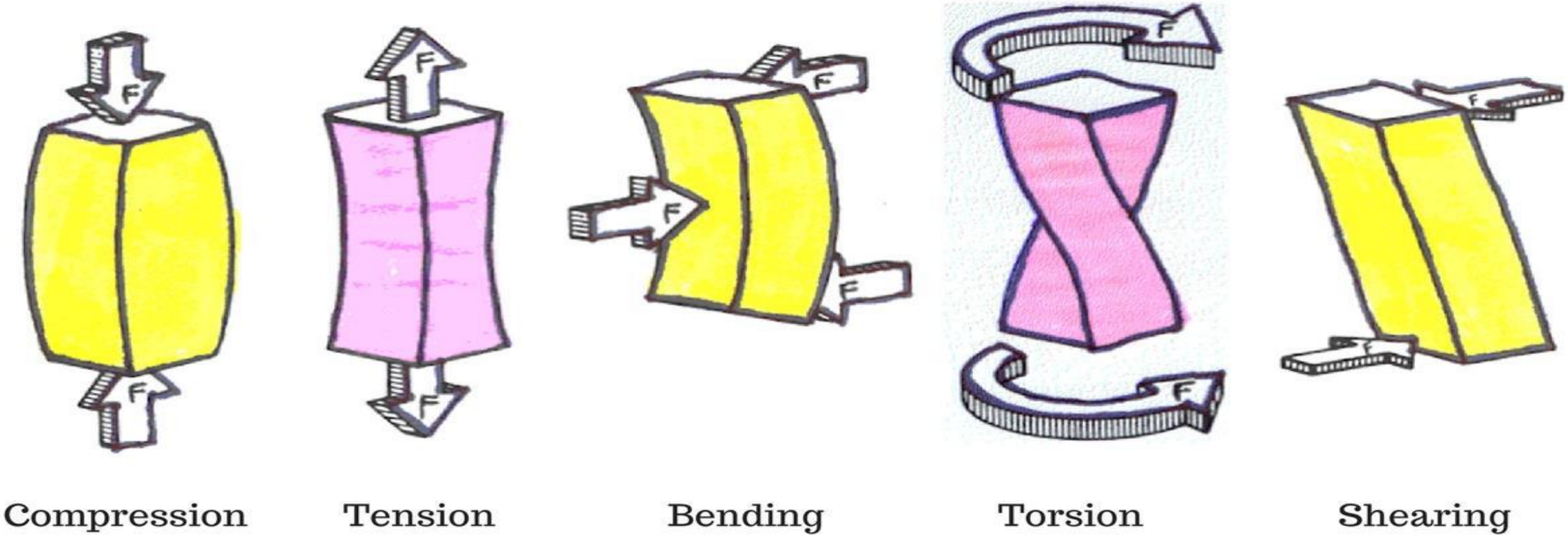


Fig. Types of stresses

Limit State :

The acceptable limit for the safety and serviceability requirements before failure occur.

Types of limit state

1. Limit state of **collapse or failure**:
   - ❑ Flexural (Bending)
   - ❑ Compression
   - ❑ Shear
   - ❑ Torsion

   } Based on *imaginary behaviour* of structure

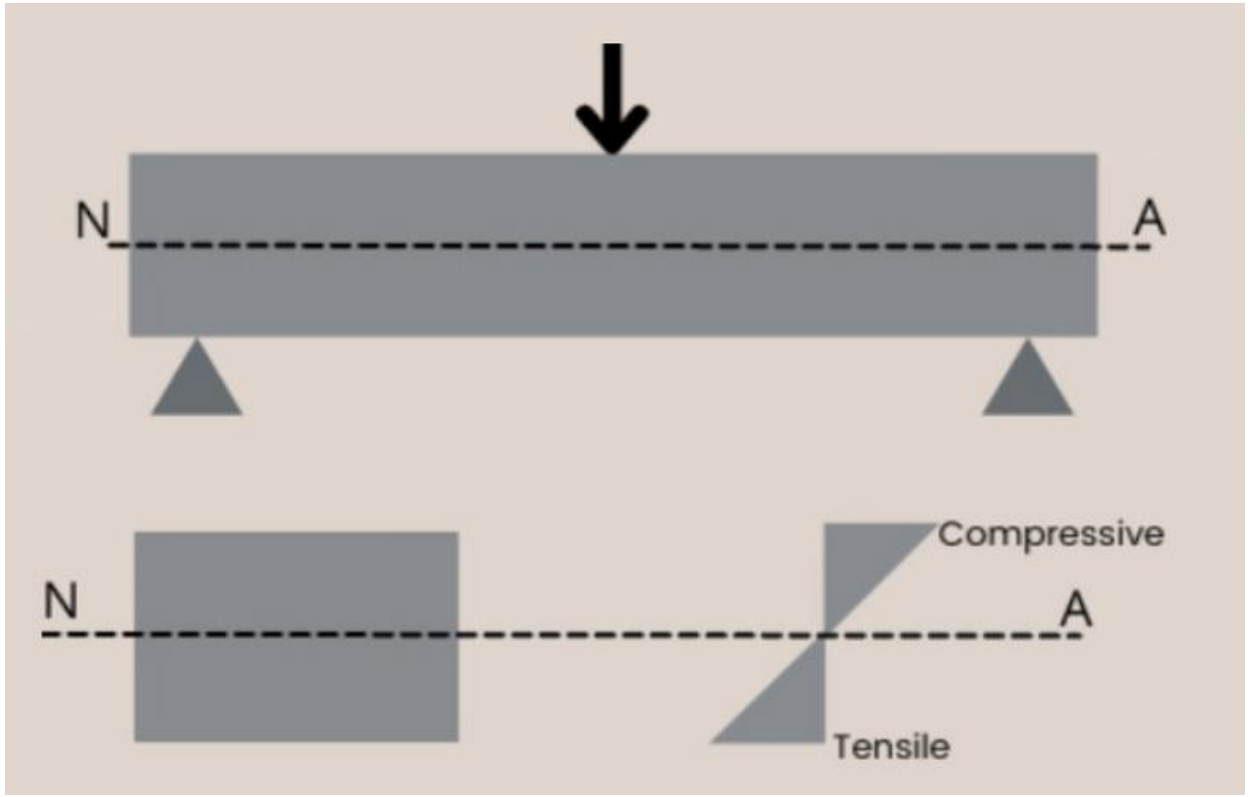
2. Limit state of **serviceability:**
   - ❑ Deflection
   - ❑ Cracking
   - ❑ Vibration
   - ❑ Fire resistance
   - ❑ Etc.

   } Based on *actual behaviour* of structure

Neutral Axis in Beam

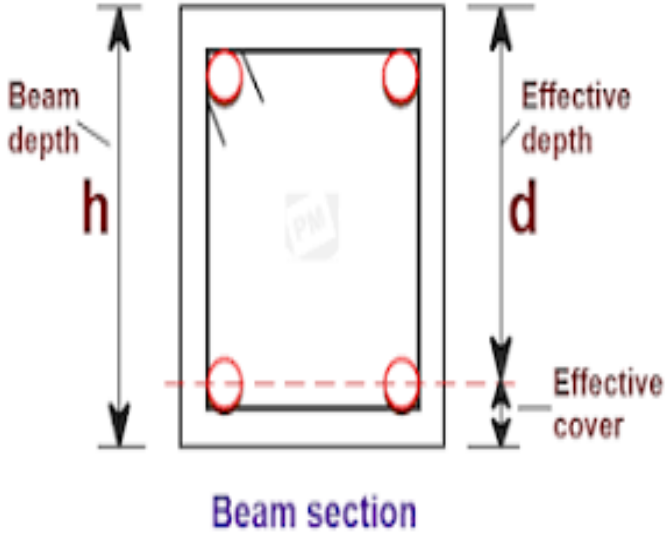
The **neutral axis of a beam** is the line that passes through the centroidal depth of the beam where no longitudinal stress either compressive or tensile stress or no strain exists. The neutral axis is represented by a dotted line.

From the neutral axis, the upper part of the beam is under compressive stress and the lower part of the neutral axis of the beam is under tensile stress. Hence the moment of area of any structure with respect to the neutral axis is always zero due to this from the neutral axis or centroidal axis for a beam subjected to the same simple bending moment.



Effective depth

Effective depth of a beam is the distance between the centroid of the area of tension reinforcement and the topmost compression fibre.



Beam section

WHAT IS EFFECTIVE COVER?

- Effective cover is taken as distance taken from bottom concrete fiber section from the center level of the reinforcement

Effective cover = overall depth – effective depth (OR) clear cover + (diameter of bar/2) .

WHAT IS CLEAR COVER?

 Clear cover is the distance measured from the exposed concrete surface (Without plaster and other finishes) to the nearest surface of the reinforcing bar.

WHY EFFECTIVE COVER IS PROVIDED?

- To protect the steel reinforcement bars (rebars) from environmental effects to prevent their corrosion;
- To provide thermal insulation, which protects the reinforcement bars from fire, and;
- To give reinforcing bars sufficient embedding to enable them to be stressed without slipping.

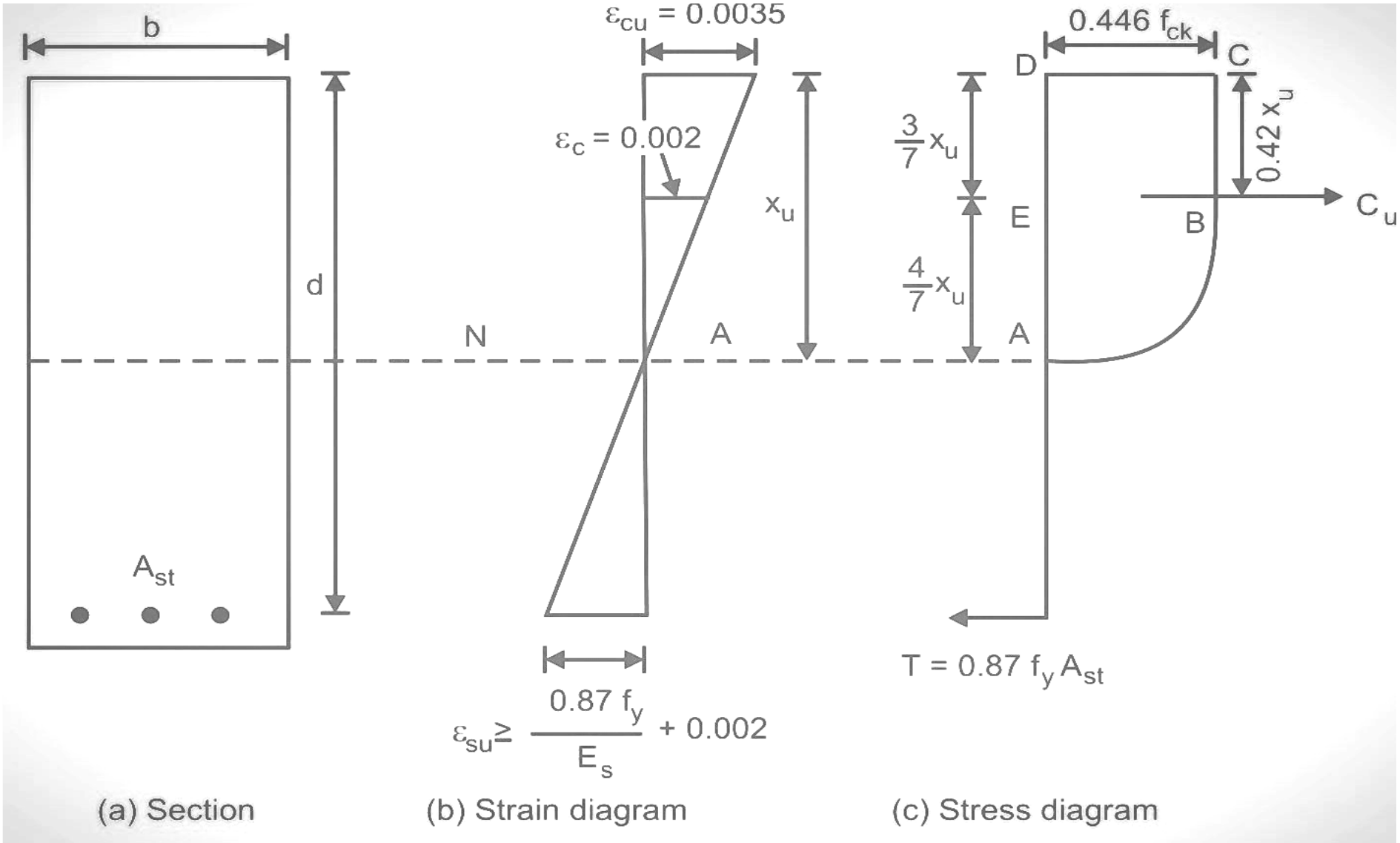


Fig . stress strain profile for beam

TYPES OF REINFORCED CONCRETE BEAMS

- Singly reinforced beam
- Doubly reinforced beam
- Singly or doubly reinforced flanged beams
- Continuous beams

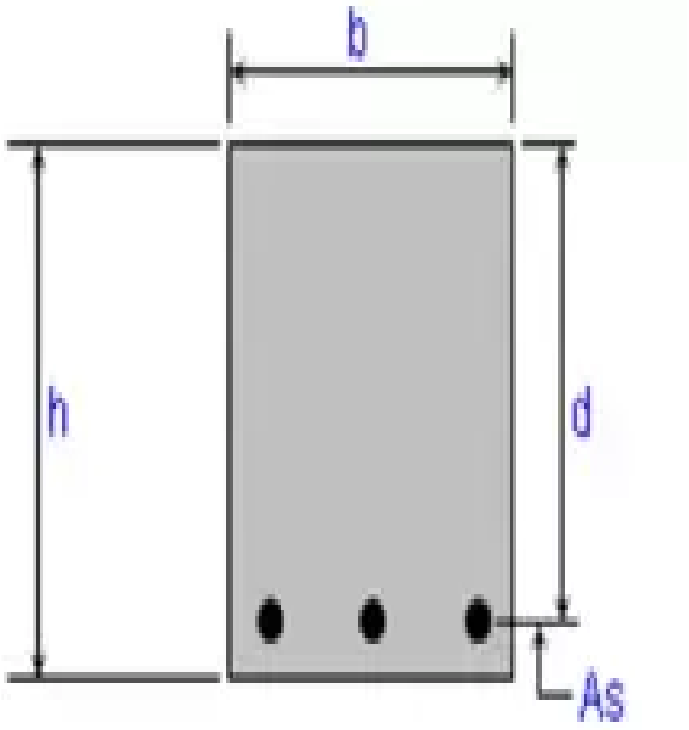
SINGLY REINFORCED BEAM

 The beam that is longitudinally reinforced only in tension zone, it is known as singly reinforced beam.

 In such beams, the final bending moment and the stress because of bending are carried by the reinforcement, while this compression is carried by the concrete.

 But it is not possible to provide reinforcement only in the tension zone, because we need to tie the stirrups.

 Therefore, two rebars/ holding bars are used in the compression zone to tie the stirrups, and the rebars act as false members only to hold the stirrups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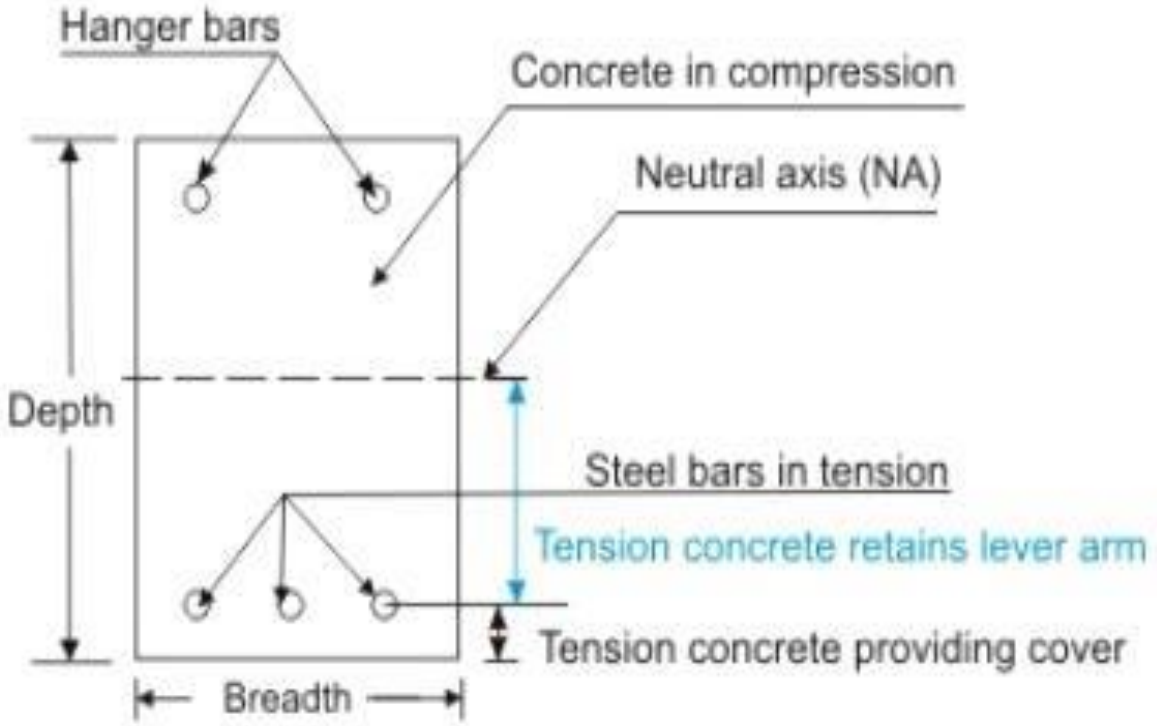
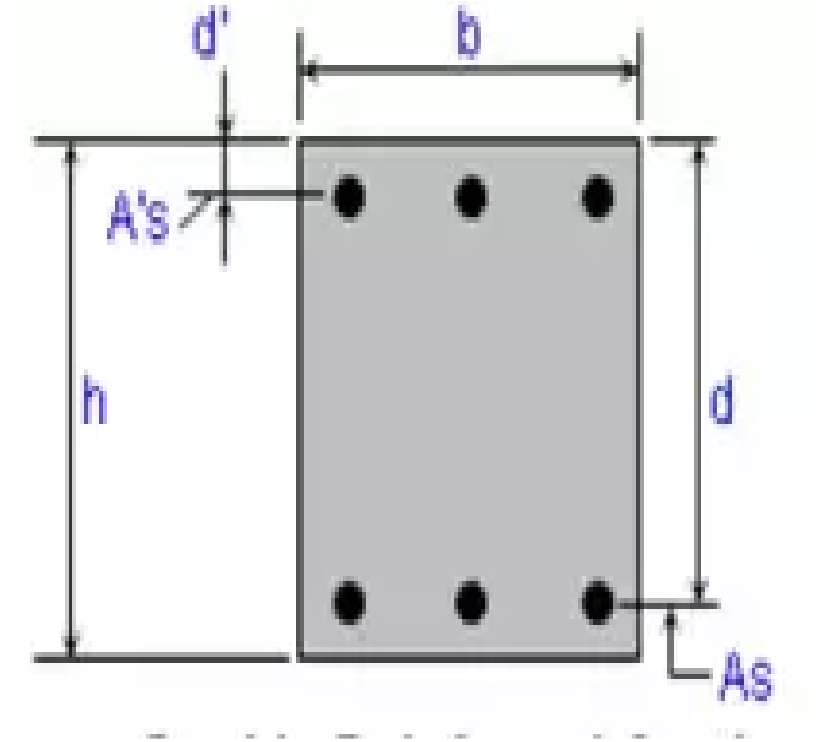

Hanger bars
Concrete in compression
Neutral axis (NA)
Depth
Steel bars in tension
Tension concrete retains lever arm
Tension concrete providing cover
Breadth

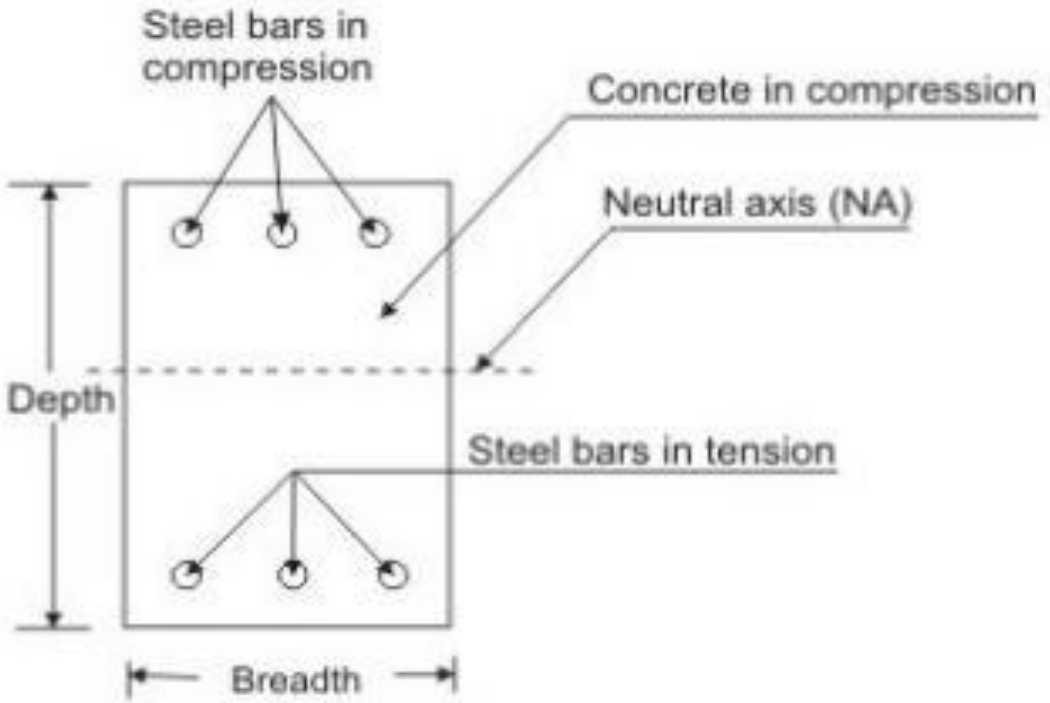
DOUBLY REINFORCED BEAM

 The beam that is reinforced with steel in the tension and compression zone is known as the doubly reinforced beam.

 The doubly reinforced beams have compression reinforcement in addition to the tension reinforcement, and this compression reinforcement can be on both sides of the beam (top or bottom face), depending on the type of beam, that is, simply supported or cantilever, respectively

DOUBLY REINFORCED BEAM





WHY A DOUBLY REINFORCED BEAM?

 This type of beam will be considered necessary when, due to the consideration of headroom or architecture, the depth of the beam is restricted.

 And when the singly reinforced section is insufficient to resist the bending moment on the section additional tension and compression reinforcement are designed based on steel beam theory.

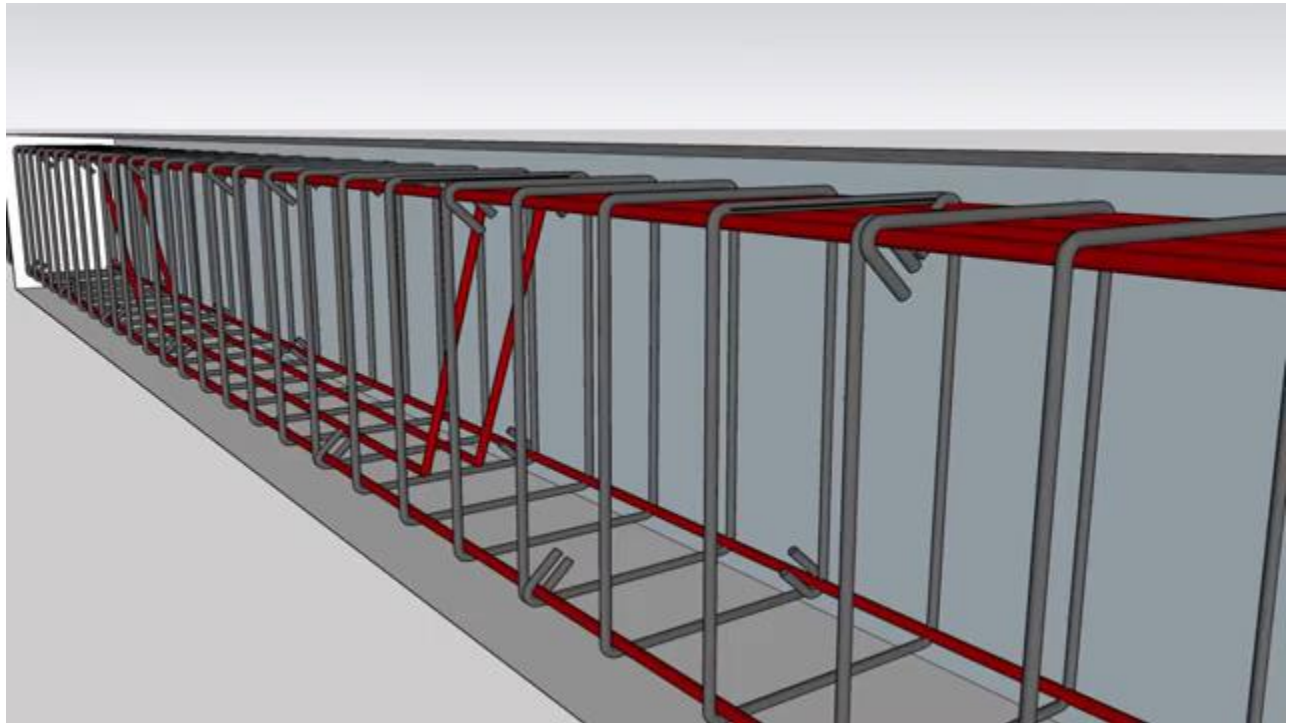
 The doubly reinforced beam (DRB) section is used where the span is more, where
cross section will also be increased.

 Depth can be reduced and the Ast can be increased.

 In DRB, the top and bottom reinforcement must be designed

Case study

Singly v/s Doubly Reinforced Beams



THANK YOU