23CE503 :
STRUCTURAL ENGINEERING – I

Topic: I- UNIT :
Introduction of Structure - Components of structure

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Introduction to Structural Engineering

What is a Structure?

- Role of Structures in Construction
- Objectives of Structural Design

- **Components of a Structure**
- Foundation
- Columns
- Beams
- Slabs
- Walls
- Roofs
- Stairs

- **Types of Structures**
- Load Bearing Structures
- Framed Structures
- Shell Structures
- Suspension Structures
- Composite Structures

- **Basic Concepts: Equilibrium and Compatibility**
- Equilibrium: Sum of forces and moments equals zero.
- Compatibility: Deformation compatibility of structural components

Safety and Stability in Structures

- Factor of Safety (FoS)
- Structural Stability vs. Structural Strength

Types of Loads

- Dead Load (DL)
- Live Load (LL)
- Wind Load (WL)
- Earthquake Load (EL)
- Other Loads: Snow, Thermal, etc

Types of Forces in Structures

- Axial Force
- Shear Force
- Bending Moment
- Torsional Moment

What is Meant by Design?

- Process of creating safe, economic and efficient structures
- Involves analysis and detailing

Materials Used in Structures

- Reinforced Cement Concrete (RCC)
- Prestressed Concrete (PSC)
- Structural Steel

: Planning of Structural Elements

- Load Transfer Mechanism
- Arrangement and Sizing
- Selection of Materials

Concepts of RCC Design

- Composite Action of Concrete and Steel
- Durability and Serviceability

: Methods of Structural Design

- Working Stress Method (WSM)
- Limit State Method (LSM)

Load Combinations (as per LSM)

- 1.5(DL + LL)
- 1.2(DL + LL + WL/EL)
- 0.9DL + 1.5 WL/EL

Material Properties and Safety Factors

- Characteristic Strength of Materials
- Partial Safety Factors (γm, γf)

Properties of Concrete and Steel

- Concrete: Compressive Strength, Durability
- Steel: Yield Strength, Ductility

Stress Block Parameters (IS 456:2000)

- Neutral Axis Depth
- Limiting Moment of Resistance
- Stress Distribution in Concrete

Flexural Behavior of RC Sections

- Rectangular Sections
- T-Sections
- L-Sections

Singly and Doubly Reinforced Beams

- Singly Reinforced Beam: Tension reinforcement only
- Doubly Reinforced Beam: Tension + Compression reinforcement

Detailing of Reinforcement

- Lapping, Anchoring and Cover
- Bar Bending Schedule

Limit State Analysis and Design in Flexure

- Ultimate Limit State (ULS)
- Serviceability Limit State (SLS)
- Design Procedures for Flexure

Thank You..

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Topic: II- UNIT :
Design for Shear , Bond and Torsion

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Introduction to Shear, Bond, and Torsion Design

- Importance in RCC structures
- Preventing sudden failures
- Enhancing structural safety

Mechanism of Shear Failure

- Diagonal tension cracks
- Shear compression failure
- Critical in short spans and deep beams

Mechanism of Bond Failure

- Loss of adhesion between steel and concrete
- Slippage of reinforcement bars
- Inadequate anchorage length

Limit State Design for Shear

- Nominal shear stress (τ_v)
- Design shear strength of concrete (τ_c)
- Need for shear reinforcement when $\tau_v > \tau_c$
- Types of shear reinforcement (vertical stirrups, inclined bars)

Design for Bond Strength

- :
- Importance of bond in force transfer
- Basic development length (Ld)
- Design bond stress (τbd)
- Factors affecting bond: bar diameter, concrete grade, type of bar

Anchorage and Development Length of Bars

- Definition of development length (Ld)
- Formula: Ld = (φ × σs) / (4 τbd)
- Anchorage zones in tension and compression
- Curtailment and anchorage practices

Design of Sections for Torsion

- Types of torsion: primary and secondary
- Equivalent bending and shear moments
- IS 456:2000 torsion design guidelines
- Provision of closed stirrups and additional longitudinal bars

Detailing of Reinforcement for Shear, Bond, and Torsion

- Shear: closed stirrups with proper spacing
- Bond: adequate lap length and anchorage hooks
- Torsion: closed stirrups and longitudinal reinforcement placed at corners
- Importance of proper cover and spacing

Summary

- Shear, bond, and torsion critical for structural safety
- Design as per IS 456:2000 guidelines
- Proper detailing ensures effective load transfer

Thank You..

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Topic: **III- UNIT** :
Introductions of Codal Provisions of Slabs- One Way & Two Way Slabs

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Introduction to Slab Design

- Types of slabs in RCC structures
- Importance in load distribution
- Design philosophies: Safety & Serviceability

Types of Slabs

- One-Way Slab
- Two-Way Slab
- Continuous Slab
- Flat Slab

One-Way Slab Design

- Slab spanning in one direction (Lx/Ly > 2)
- Design steps:
  - Calculate bending moments using IS coefficients
  - Design for flexure and shear
  - Provide main and distribution reinforcement

Two-Way Slab Design with Different End Conditions

- End Conditions:
  - Simply supported on all sides
  - Continuous on one or more sides
  - Fixed or partially fixed supports
- Use of IS 456:2000 coefficients for moment calculation

IS Coefficients for Moment Calculation

- IS 456:2000 Moment Coefficients Table 26
- Moment Coefficients for
    - Simply supported slabs
    - Continuous slabs
    - Fixed-end slabs

Continuous Slab Design

- Analysis using moment coefficients
- Redistribution of moments (as per IS 456)
- Detailing for continuity at supports

Serviceability Limit States: Deflection Control

- Deflection limits as per IS 456:2000
  - Span/depth ratios
  - Modifications for tension reinforcement and concrete grade
- Checking for long-term deflection due to creep and shrinkage

Serviceability Limit States: Cracking Control

- Control of crack widths
- Minimum reinforcement requirements
- Bar spacing and cover as per codal provisions

Codal Provisions for Serviceability

- IS 456:2000 Guidelines:
  - Clause 23 for deflection
  - Clause 26.3.2 for minimum reinforcement
- Table 8 for crack control

Detailing of Slabs

- Placement of main and distribution bars
- Lapping and anchorage considerations
- Cover to reinforcement

Summary of Slab Design Process

- Determine slab type and end conditions
- Calculate design moments using IS coefficients
- Design reinforcement for flexure, shear, and torsion (if any)
- Check for serviceability (deflection and cracking)
- Proper detailing as per IS 456:2000

Thank You..