Introduction to Prestressed Concrete

- Prestressed concrete (PSC) is concrete in which internal compressive stresses are introduced before external loading.
- Purpose: counteract tensile stresses, reduce cracking, improve durability and serviceability.
- Used in bridges, sleepers, tanks, silos and long-span buildings.

Historic Development

- 1886: Early concept by P.H. Jackson.
- 1928: Eugène Freyssinet developed practical prestressing using high-strength steel and high-strength concrete.
- After World War II PSC expanded rapidly for bridges and buildings.

Need for Prestressing

- Concrete is strong in compression but weak in tension.
- Prestressing introduces compression to minimize tensile stresses under service loads.
- Results in crack-free sections and higher load capacity.

General Principles

- Steel tendons are tensioned to induce compression in concrete.
- Prestress balances tensile stress due to external loads.
- Losses of prestress occur due to creep, shrinkage, relaxation and friction.

Pre-tensioning

- Steel is tensioned before casting concrete.
- After concrete gains strength, tendons are released and force is transferred by bond.
- Common for sleepers, poles and precast beams.

Post-tensioning

- Concrete is cast with ducts.
- Tendons are stressed after concrete hardens.
- Force is transferred through anchorages; ducts may be grouted.

Pre vs Post Tensioning

- Pre: factory production, bond transfer, no anchorages in member.
- Post: suitable for cast-in-situ work, uses ducts and anchorages, longer spans possible.

Advantages

- Longer spans with smaller sections.
- Excellent crack control and durability.
- Reduced deflection and dead load.
- Economical for repetitive construction.

Limitations

- Higher initial cost.
- Requires skilled supervision and special equipment.
- Quality control is essential.
- Repair is more difficult.

General Principles of PSC Design

- Concrete remains mainly in compression under service loads.
- Design considers transfer stage and service stage.
- Check stresses, deflection, cracking and ultimate strength.

Classification

- Internal and external prestressing.
- Bonded and unbonded tendons.
- Axial and eccentric prestressing.

Types of Prestressing

- Full prestressing: no tensile stress under service loads.
- Partial prestressing: limited tensile stress permitted.
- Linear and circular prestressing based on tendon profile.

High Strength Concrete

- Typical grade M40 and above.
- High compressive strength, low creep and shrinkage.
- Provides better bond and durability.

High Tensile Steel

- Available as wires, strands and bars.
- High tensile strength and good relaxation resistance.
- Essential for maintaining prestress.

Summary

- PSC improves strength, durability and economy.
- Understand methods, materials, advantages and limitations.
- Foundation for design and analysis of PSC members.