Chapter 9: Fresh Concrete – Mixing, Transporting, Placing, Compaction, Finishing

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Introduction

Fresh concrete is a plastic, workable, and cohesive mixture of cement, water, fine aggregate, coarse aggregate, and sometimes admixtures, before it sets and hardens. Its properties in this fresh state critically determine the ease of handling and the quality of the hardened concrete. The operations of mixing, transporting, placing, compacting, and finishing are collectively known as *concreting*. These steps must be executed with precision to achieve desired strength, durability, and finish in the final structure.

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1. Mixing of Concrete

1.1 Objectives of Mixing

- Achieve uniform distribution of ingredients.
- Ensure coating of all aggregates with cement paste.
- Facilitate hydration reactions between cement and water.

1.2 Types of Mixing

(a) Hand Mixing

- Used for small works.
- Carried out on a watertight platform.
- Requires mixing dry components first and then water.
- Quality control is difficult.

(b) Machine Mixing

- Suitable for large-scale concrete works.
- Performed in mixers (batch or continuous).
- Types:
  - **Tilting Drum Mixers**
  - **Non-Tilting Drum Mixers**
  - **Pan Mixers**
- Uniformity and speed of mixing are superior to hand mixing.

1.3 Duration of Mixing

- Typically, 1.5 to 2 minutes for machine mixing.
- Over-mixing should be avoided as it leads to segregation and reduced workability.

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2. Transporting of Concrete

2.1 Considerations

- Avoid segregation and loss of materials.
- Prevent premature setting.
- Ensure speed and continuity.

2.2 Methods of Transporting

(a) Manual Transport (Head Pans, Wheelbarrows)

- Suitable for small sites.
- Risk of segregation if not handled carefully.

(b) Concrete Buggies and Power Buggies

- Used for horizontal transportation over longer distances.

(c) Dumpers and Trucks

- Used when concrete needs to be transported over longer distances, e.g., from batching plant to site.

(d) Belt Conveyors

- Used for continuous concrete placement.
- Can cause segregation if improperly handled.

(e) Pumps

- Most efficient method for vertical and horizontal transport.
- Used in high-rise construction.
- Requires controlled slump (workability).

(f) Cranes and Buckets

- Used for vertical lifting in constrained areas.

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3. Placing of Concrete

3.1 Basic Guidelines

- Concrete should be placed as near to its final position as possible.
- Avoid dropping concrete from a height >1.5 meters to prevent segregation.
- Place continuously to avoid cold joints.
- Concrete should be placed within 30 minutes of mixing (if no retarders are used).

3.2 Methods of Placing

(a) Direct Discharge

- Used for foundations and ground slabs.

(b) Chutes and Troughs

- Helps control flow of concrete and reduce segregation.

(c) Conveyor Belts and Pumps

- Ensure continuous flow and placement, especially for tall structures.

(d) Tremie Method

- Used for underwater concreting.
- A tremie pipe prevents direct contact with water, minimizing cement washout.

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4. Compaction of Concrete

4.1 Objectives

- Remove entrapped air.
- Achieve full compaction to ensure strength and durability.
- Reduce permeability and improve bond with reinforcement.

4.2 Methods of Compaction

(a) Hand Compaction

- Tools: Rods, tamping bars.
- Suitable for low-workability concrete or small works.

(b) Vibration

- Most efficient method.
- **Internal (Needle) Vibrators** – inserted into concrete mass.
- **External Vibrators** – used for precast elements.
- **Surface Vibrators** – used for slabs and pavements.
- Proper duration is essential to avoid segregation or laitance.

(c) Centrifugation

- Used in factory-made spun concrete poles, pipes.

(d) Shock Waves and Pressure Techniques

- Specialized methods used in advanced applications.

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5. Finishing of Concrete

5.1 Purpose

- Achieve desired surface texture.
- Provide aesthetics and functionality (e.g., slip resistance).
- Prepare surface for further treatments (like flooring).

5.2 Finishing Operations

(a) Floating

- Removes imperfections.
- Initial finishing done after bleeding water disappears.

(b) Troweling

- Provides smooth surface.
- Performed with steel or power trowel.

(c) Brooming

- For non-slip surfaces (e.g., roads and sidewalks).
- Surface is brushed before it sets.

(d) Edging and Jointing

- Rounds off slab edges and introduces control joints to prevent random cracking.

5.3 Timing of Finishing

- Critical to avoid disturbing setting process.
- Should be coordinated with bleeding and setting times of concrete.

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6. Precautions During Concreting

- Do not allow concrete to dry out before finishing and curing.
- Use proper workability (slump) for the method of placing and compaction.
- Avoid delays between batches.
- Protect concrete from direct sun or rain during setting.
- Clean equipment after each use to prevent contamination.

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7. Testing of Fresh Concrete (Related)

While not a part of actual concreting steps, it's common to test the fresh concrete during the process:

- **Slump Test** – for workability.
- **Compacting Factor Test** – for low-workability concrete.
- **Vee-Bee Consistometer Test** – for stiff concrete.
- **Flow Table Test** – for very fluid mixes.

These tests help verify that the concrete will behave appropriately during mixing, transport, and placement.

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8. Workability of Fresh Concrete

8.1 Definition

Workability is the property of fresh concrete that determines the ease with which it can be mixed, transported, placed, compacted, and finished without segregation or bleeding.

8.2 Factors Affecting Workability

- **Water Content:** More water increases workability but reduces strength.
- **Aggregate Size and Shape:**
  - Rounded aggregates → higher workability.
  - Angular aggregates → lower workability.
- **Cement Content:** Higher cement increases cohesion and workability.
- **Admixtures:**

  - Plasticizers and superplasticizers improve workability without adding water.
- **Grading of Aggregates:** Well-graded aggregates improve packing and reduce voids, enhancing workability.
- **Temperature:** High temperatures accelerate setting and reduce workability.

8.3 Measurement of Workability

- **Slump Test** (for medium workability concrete)
- **Compacting Factor Test** (for low workability concrete)
- **Vee-Bee Consistometer Test** (for very dry concrete)
- **Flow Table Test** (for very high workability concrete, such as in self-compacting concrete)

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9. Segregation and Bleeding in Fresh Concrete

9.1 Segregation

The separation of coarse aggregates from the cement paste and fine aggregates.

Causes:

- Poor mix design (excess water or coarse aggregates).
- Improper handling or dropping from height.
- Over-vibration.

Effects:

- Honeycombing.
- Loss of strength and durability.
- Uneven surface finish.

Prevention:

- Use well-graded aggregates.
- Maintain proper water-cement ratio.
- Avoid excessive vibration and dropping concrete from a height.

9.2 Bleeding

Upward movement of water in fresh concrete after placing, due to settlement of heavier particles.

Effects:

- Formation of laitance on top surface.
- Weak bond between aggregate and cement paste.
- Surface cracks after finishing.

Prevention:

- Use finer cement and blended cements.
- Add pozzolanic materials (fly ash, silica fume).
- Avoid excessive water in mix.

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10. Retempering of Concrete

Definition:

Retempering is the addition of water to partially set concrete to regain workability.

Why It's a Problem:

- Weakens final strength.
- Delays setting.
- Increases porosity.

Important Note (as per IS 456): Concrete should be placed within 30 minutes of mixing. Retempering is not recommended unless approved admixtures are used under controlled conditions.

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11. Use of Admixtures in Fresh Concrete

Admixtures are materials added to concrete during mixing to modify its properties.

11.1 Types of Admixtures Relevant to Fresh Concrete

- **Plasticizers / Superplasticizers:** Improve workability without increasing water content.
- **Retarders:** Delay setting time (used in hot weather concreting).
- **Accelerators:** Speed up setting and early strength gain.
- **Air-Entraining Agents:** Improve workability and freeze-thaw resistance.
- **Water-Reducing Agents:** Reduce water requirement while maintaining slump.

11.2 Dosage and Mixing

- Dosage should follow manufacturer's guidelines.
- Uniform mixing is essential for consistent effects.

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12. Environmental Considerations During Concreting

12.1 Hot Weather Concreting

Problems:

- Accelerated setting.
- Rapid moisture loss → cracking.

Precautions:

- Use chilled water or ice.
- Dampen aggregates.
- Use retarders.
- Work during cooler times of the day.

12.2 Cold Weather Concreting

Problems:

- Delayed setting and strength gain.
- Freezing of water in mix.

Precautions:

- Use warm mixing water.
- Add accelerators.
- Protect concrete with thermal blankets or enclosures.

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13. Formwork Considerations Related to Fresh Concrete

13.1 Pressure Exerted by Fresh Concrete

- Acts like a fluid; lateral pressure is maximum at the base.
- Depends on rate of placing, height, and temperature.

13.2 Formwork Quality

- Should be watertight and strong.
- Should resist bulging under fresh concrete pressure.
- Must not absorb water from concrete (causes loss of workability).
