

## ABSTRACT

Field curing—to assess variations in compressive strength, durability, and workability. The experimental program involved casting concrete specimens using standard mix proportions and subjecting them to two curing regimes: laboratory-controlled water curing and field curing simulating on-site conditions. Compressive strength tests were conducted at 7, 14, and 28 days to evaluate strength development. The results revealed that laboratory curing consistently yielded higher compressive strength compared to field curing, highlighting the importance of proper curing practices in achieving the desired structural performance. Furthermore, the investigation emphasizes the need for quality control in field curing processes to ensure compliance with design requirements. The study concludes with recommendations to improve field curing effectiveness for M30 grade concrete, contributing to enhanced durability and structural integrity in real-world construction projects.

- **Key Points :-**

The experiment compares laboratory curing (water tank) with field curing (ambient site conditions) for M30 grade concrete. Compressive strength was tested at **7, 14, and 28 days** to observe the strength development over time.

Laboratory curing resulted in higher compressive strength compared to field curing due to consistent temperature and humidity control.

Field curing exposed the concrete to environmental variations such as temperature fluctuations and uneven moisture availability, which adversely affected strength.

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# **CHAPTER-1**

## **INTRODUCTION**

### **1.1 GENERAL :**

Concrete, known for its excellent compressive strength and versatility, plays a vital role in modern construction. Among the various concrete grades, M30 grade concrete is widely used for structural elements in buildings, bridges, and other civil engineering projects that demand moderate to high compressive strength. Achieving the desired strength and durability of concrete involves several factors, including careful mix design, quality of raw materials, proper compaction, and—most critically—effective curing practices.

Curing is the process of maintaining adequate moisture, temperature, and time to ensure that the hydration of cement continues after the initial setting. Proper curing allows the formation of calcium silicate hydrate (C-S-H) gel, which is responsible for the strength and durability of concrete. Laboratory curing is typically performed by submerging concrete specimens in water tanks maintained at a constant temperature ( $27 \pm 2^\circ\text{C}$ ), providing optimal conditions for hydration. In contrast, curing at the construction site (field curing) is often done using methods like wet burlap coverings, periodic water sprinkling, or application of curing compounds. Field curing practices are influenced by environmental factors such as temperature fluctuations, wind, and direct sunlight, which can accelerate moisture loss and hinder the hydration process.

The difference between laboratory and field curing can have a significant impact on the compressive strength and overall performance of concrete. In the laboratory, the continuous availability of water ensures complete hydration, leading to the development of the target strength. However, in the field, inadequate or interrupted curing can result in incomplete hydration, leading to higher porosity, lower strength, and reduced durability. This disparity is particularly critical for M30 grade concrete, as it is often used in structural elements that carry substantial loads and require reliable performance.

The objective of this experimental investigation is to compare the compressive strength development of M30 grade concrete cured under laboratory and field conditions. By designing an M30 mix as per IS 10262:2019 standards and testing cubes at different curing ages (7, 14, and 28 days), the study aims to quantify the impact of real-world site conditions on concrete strength. Ultimately, the findings can guide construction practices by highlighting the importance of proper curing in achieving the intended strength and service life of concrete structures.

## 1.2 HISTORY OF CURING

- Prehistoric roots: Early humans discovered that salting, sun-drying, and smoking meats and fish helped slow spoilage—an essential breakthrough before refrigeration.
- Ancient civilizations: The Egyptians, Mesopotamians, and Greeks developed brining and salting methods around 2000 BCE. Salt was vital both for flavour and preservation.
- **Curing as necessity:** In Europe's Middle Ages, curing was essential for bulk meat storage. Ham, bacon, and salt-cured fish became staples.
- **Smoking evolution:** Over smoky hearths, meats absorbed wood-smoke compounds with preserving and flavour-enhancing properties.

**Roman Empire (200 BCE – 1st century CE):** Salted meats became vital trade goods and military provisions. Sausages (per Apices) often blended salt, herbs, and fermented fish sauce.

**Middle Ages:** Monasteries preserved recipes; curing employed salt, saltpetre, and smoke. Saltpetre's effect—fixing meat's red colour—was recognized

## 1.3 Need for the study:

- Environmental variations (temperature, humidity, wind, solar exposure) in field curing can markedly influence concrete strength and durability—sometimes deviating significantly from ideal lab-cured performance.
- Assessing how M30 concrete actually behaves on-site ensures that Field conditions may accelerate moisture loss, cause micro-cracking, or reduce long-term resistance to carbonation, chloride ingress, or freeze-thaw effects.
- Comparing against lab-cured specimens highlights any vulnerabilities, enabling proactive measures for maintenance and longevity.
- lab-based designs remain reliable once implemented.
- Construction standards often require demonstrating that site-cured specimens meet minimum compressive strength (e.g., 28-day strength based on laboratory-grade conditions).

## 1.4 Applications:

- Conducted in controlled environments ( $\approx 20^{\circ}\text{C}$  &  $\geq 95\%$  RH) as per standards like IS 516, ASTM C192, or BS EN 12390.
- Provides a reproducible baseline for properties like strength, permeability, and durability.
- Performed at actual site conditions, influenced by ambient temperature, humidity, wind, rainfall, and standard local curing methods (e.g., water ponding, wet coverings, curing compounds).

- More representative of real-world performance—it's vital for verifying that theoretical design assumptions hold true in practice.
- 7-day strength: Field curing may yield ~15–20 MPa, vs. ~18–22 MPa in lab curing—a 10–15% reduction.
- 28-day strength: Lab-cured M30 often reaches ~32–35 MPa, while field-cured samples may only hit ~30–32 MPa if not properly cured.
- Key takeaway: Consistent and early moisture retention in the field narrows the gap.
- **Real-world conditions:** Involves curing slabs, beams, or columns by ponding, wet gunny bags, curing compounds, plastic sheets, or continuous water spraying.
- **Challenges:** Environmental factors—temperature, wind, sun exposure—can cause moisture loss.
- **Outcome:** Field-cured specimens typically show **1–3 MPa lower strength** at 7 or 28 days compared to lab-cured ones, depending on adherence to good practices.

### **1.5 OBJECTIVE:**

Design a mix for M30 grade concrete according to the guidelines provided by IS 10262:2019 and IS 456:2000, ensuring it meets target strength and workability requirements.

Prepare concrete specimens and cure them under two distinct conditions:

Controlled laboratory curing (immersed in water at  $27\pm2^{\circ}\text{C}$ )

Field curing under practical site conditions, reflecting real-world environmental influences.

Determine the compressive strength of concrete specimens at standard curing intervals (7, 14, and 28 days) for both curing methods.

Compare and analysis the differences in strength development between laboratory and field curing to understand the impact of curing conditions on concrete performance.

Identify challenges and limitations inherent to field curing practices that may result in lower strength and durability.

Recommend effective curing practices for field conditions to ensure that the concrete achieves its designed strength and service life.

By accomplishing these objectives, the study will provide valuable insights for engineers, contractors, and quality control personnel to improve curing methods and enhance the reliability of concrete structure

## **CHAPTER-2**

### **LITERATURE REVIEW**

#### **1. Neville:**

Neville (1995) emphasized that curing is essential for the hydration process, which is a chemical reaction between cement and water. This reaction is crucial for the development of concrete's strength and durability. Proper curing ensures that the concrete remains moist, allowing the hydration process to continue, thereby enhancing the concrete's properties.

#### **2. Mehta and Monteiro:**

Mehta and Monteiro (2006) noted that improper curing can have detrimental effects on concrete. Poor curing can lead to surface cracks, reduced strength, and a shorter lifespan of the structure. This is because inadequate curing hinders the hydration process, resulting in a weaker and more porous concrete.

#### **3. Kumar and Kaushik:**

Kumar and Kaushik (2003) conducted a comparative study between lab-cured and field-cured concrete. Their findings indicated that field-cured concrete had 15–25% less strength than lab-cured concrete. This difference is attributed to the exposure of field-cured concrete to environmental factors such as:

- Sun Exposure: Direct sunlight can cause the concrete to dry out too quickly.
- Wind: Wind can accelerate the drying process, leading to inadequate curing.
- Less Controlled Water Supply: Field curing often involves less controlled watering, which can result in inconsistent curing conditions.

#### **4. Indian Standard Recommendations for Curing:**

The Indian Standard IS 456:2000 provides guidelines for curing practices. According to this standard, curing should be done for at least 7 days for Ordinary Portland Cement and at least 10 days in hot weather conditions. These recommendations are designed to ensure that the

## **CHAPTER-3**

### **METHODOLOGY**

#### **3.1 INTRODUCTION:-**

- **Background&Importance:**

Concrete is the most widely used construction material worldwide, and its performance significantly depends on its curing regime. Proper curing is essential for achieving desired strength, durability, and overall structural integrity. The M30-grade concrete (with a characteristic compressive strength of 30 MPa at 28 days) is commonly used in structural elements like slabs, beams, and columns. Ensuring effective curing—whether in a controlled laboratory or in the field—is vital to prevent issues such as reduced strength, increased permeability, or cracking.

#### **CuringMethods:**

There are two primary curing approaches:

#### **Laboratory Curing:**

- Conducted under controlled conditions (temperature, humidity, moisture) in curing tanks or environmental chambers.
- Ensures near-ideal hydration conditions, often leading to consistent, repeatable strength

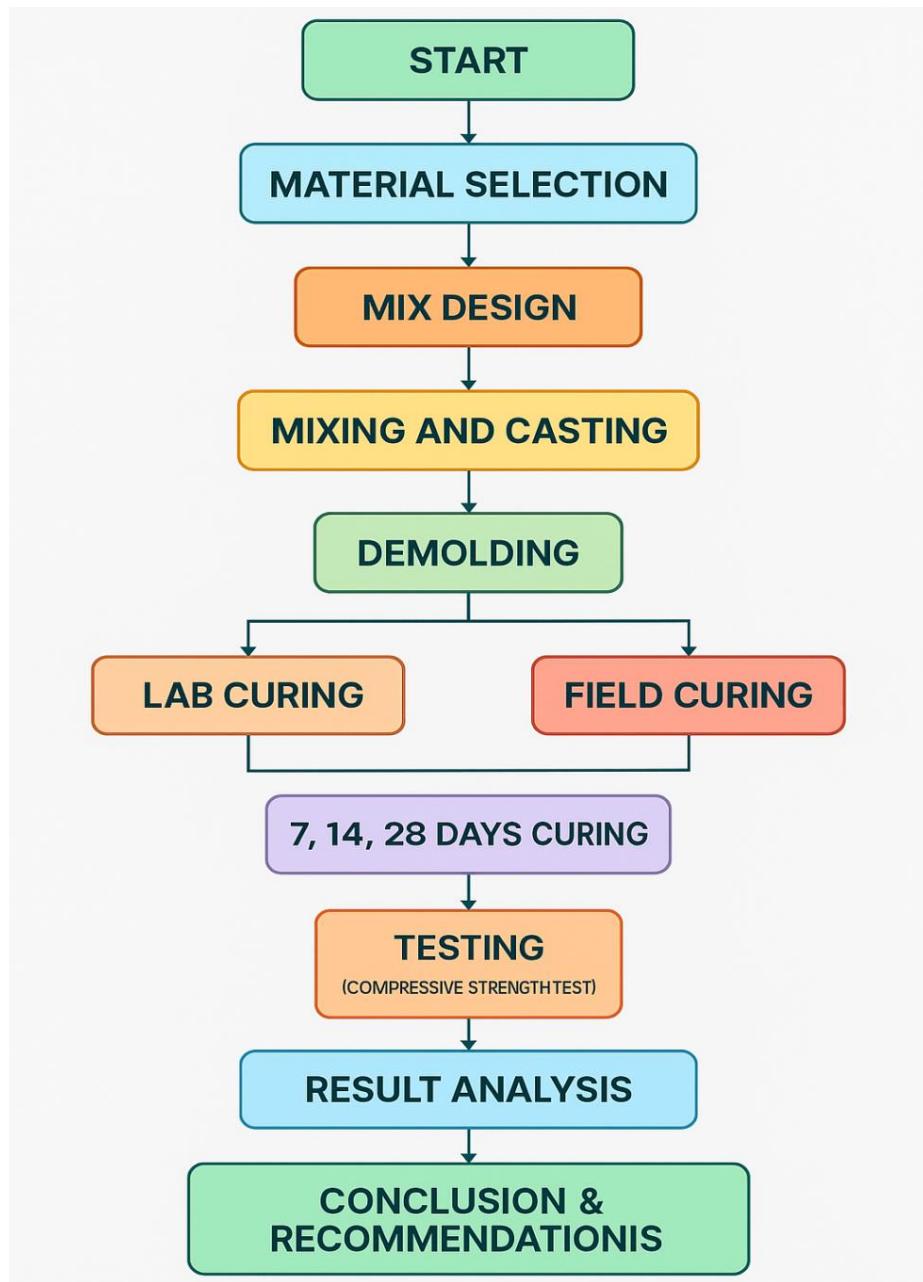
#### **Field Curing:**

- Typically affected by environmental conditions (sun, wind, varying humidity and temperature).
- Methods include water curing (ponding, wet covers), membrane curing (curing compounds), or simply natural exposure.

The flowchart illustrates the experimental process for investigating the effects of different curing methods on concrete. The process begins with "START" and proceeds through several stages:

#### **3.2 FLOW CHART:**

1. Material Selection: The initial step involves selecting the materials required for the experiment.
2. Mix Design: The next stage is designing the concrete mix, which involves determining the proportions of various ingredients.
3. Mixing and Casting: The concrete mix is then prepared and cast into moulds.



**Fig3.2: Flow chart**

4. Demolding: After the concrete has set, it is removed from the moulds.
5. Curing: The demoulded concrete specimens are then subjected to two different curing methods:
  - Lab Curing: Controlled laboratory conditions.
  - Field Curing: Natural environmental conditions.
6. 7, 14, 28 Days Curing: The specimens are cured for specific durations (7, 14, and 28 days).

7. Testing: The cured specimens are tested for their compressive strength.
8. Result Analysis: The test results are analysed to compare the effects of different curing methods.
9. Conclusion & Recommendations: The final stage involves drawing conclusions based on the results and providing recommendations.

### **3.3 COLLECTION MATERIALS:**

**3.3.1 Cement:** Ordinary Portland Cement (OPC) 43 or 53 grade is standard for M30 concrete.

- Typical cement content: ~340–380 kg/m<sup>3</sup>, depending on target strength and workability objectives.
- Binders/admixtures: Often includes fly ash or GGBS (10–20%) to enhance durability and reduce heat of hydration.



**Fig3.3.1: Cement**

### **3.3.2 AGGREGATE:**

- Grading (Zone II): Fineness modulus typically 2.6–3.0—medium sand suitable for good workability and concrete strength.
- Specific Gravity: Approximately 2.60–2.70—important for correct mix proportions.
- Water Absorption: Around 0.5%–2%—affects the effective water–cement ratio and hydration.
- Bulk Density:

Compacted: ~1750 kg/m<sup>3</sup>

- Impurities:
  - Silt (<3%)—excess fines reduce strength.
  - Organic content—very low to avoid retardation.
  - Chloride/sulphate—within safe limits per durability standards

- Loose:



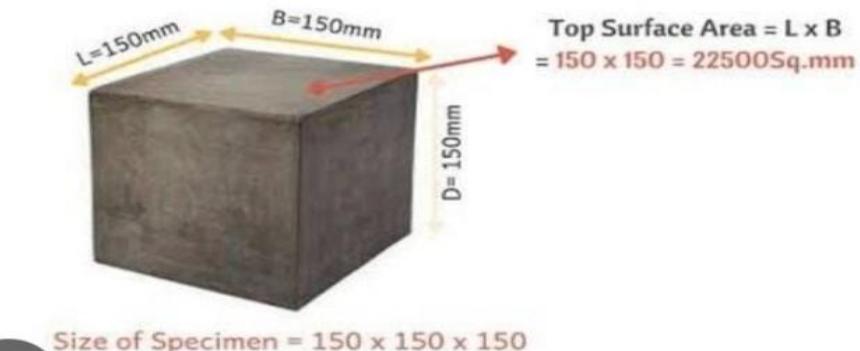
**Fig:3.3.2:Aggrage**

### 3.3.3 Water:

- **Potable vs. alternative water sources:** A study on M30-grade cubes (1:2:4 mix) compared potable, river, and rainwater. Potable and river water showed steadily increasing compressive strength up to 28 days, while rainwater dropped after that. Conclusion: **potable water is best**, river water may be used when potable isn't available, but rainwater is unreliable .
- **pH effects:** Another investigation evaluated M30 cubes cured in water adjusted to pH 4, 9, and 12 (acidic and alkaline curing), alongside normal potable water. Compressive strength, ultrasonic pulse velocity, and rebound hammer readings varied noticeably with pH, indicating that deviations from neutral pH can significantly impact quality and durability .

### 3.3.4 Preparation of mould:





**Fig:3.3.4:specimen preparation**

1. **Cleaning:** The moulds are thoroughly cleaned to remove any dirt, oil, or other contaminants that may affect the concrete specimens.
2. **Oiling:** A release agent, such as oil or wax, is applied to the moulds to prevent the concrete from sticking to them.
3. **Assembly:** The moulds are assembled according to the manufacturer's instructions, ensuring that they are properly aligned and secured.





**4. Inspection:** The moulds are inspected for any damage or defects before use.

### **3.4 MIX PREPARATION:**

**Batching:** The ingredients are batched according to the mix design proportions, using a batching plant or manual batching.

**2. Mixing:** The ingredients are mixed in a mixer, either a pan mixer or a drum mixer, until a uniform mix is achieved.

**3. Mixing Time:** The mixing time is typically in the range of 2-5 minutes, depending on the type of mixer and the mix design.

#### **Importance of Proper Mix Preparation:**

**1. Uniformity:** Proper mix preparation ensures that the concrete mix is uniform and consistent, which is essential for achieving the desired properties.

**2. Workability:** The mix preparation process affects the workability of the concrete, which is critical for placement and finishing.

**3. Strength and Durability:** The mix design and preparation process have a significant impact on the strength and durability of the concrete.

### **3.5 MATERIAL CALCULATION:**

**Cement:** Ordinary Portland Cement (OPC) 53 grade, conforming to IS 12269:1987.

**Fine Aggregate:** River sand, Zone II, specific gravity  $\sim 2.65$ .

**Coarse Aggregate:** Crushed angular aggregates, 20 mm nominal size, specific gravity  $\sim 2.70$ .

**Water:** Potable water with pH between 6.5 and 8.5.

**Admixtures:** Superplasticizer (if required) to achieve desired workability.

**Mix Proportions:** As per IS 10262:2019, the mix design for M30 grade concrete is a design mix. A typical mix might be:

**Cement:** 394 kg/m<sup>3</sup>

**Water:** 197 litres/m<sup>3</sup>

**Fine Aggregate:** 708 kg/m<sup>3</sup>

**Coarse Aggregate:** 1155 kg/m<sup>3</sup>

**Water-Cement Ratio:** 0.50

**Target Mean Strength:** 38.25 MPa ( $f_{ck} + 1.65 \times \text{standard deviation}$ )

### **3.6 Casting Mould:**

- **Layering:** Pour concrete in **three approximately equal layers**.
- **Compaction:** Use a **tamping rod** (16 mm dia.,  $\sim 600$  mm length) for mortar, or a **2 kg rodding bar (25 mm square)** for concrete. Each layer requires about 25 strokes, or use vibration for denser mixes.
- **Levelling:** Strike off the final layer flush with the mould to.
  - 100 mm or 70.6 mm cubes for smaller aggregate mixes or mortar-type tests.
- Cylinders (150 mm  $\times$  300 mm) may be used if needed, but cubes are standard per IS – typically easier for comparative tests between curing methods .

**Material:** Cast iron or mild steel,  $\geq 8$  mm wall thickness; interior faces should be smooth and planed.

#### **Dimensional Accuracy:**

- Internal width/height tolerance:  $\pm 0.2$  mm on 150 mm cubes.
- Interior surface flatness:  $\leq 0.03$  mm deviation; sidewall angle: within  $0.5^\circ$  of  $90^\circ$  .

**Assembly:** Snap-fit or bolted moulds with base and top plates; base plate must prevent leakage; use mould oil at joints to seal .

### **3.7 DEMOULDING:**

- **Typical Demoulding Time:** After  $24 \pm 2$  hours, demoulding is standard once the concrete has achieved enough early strength—generally about 40–50% of the 1-day strength.
- This timeframe is widely accepted in standards like IS 516 and ASTM C31/C31M, balancing early strength needs with ease of handling.
- **Preparation:**
  - Perform in a **moist, sheltered, and vibration-free area** to avoid premature drying or damage.
  - Use tools like a **rubber mallet** or flat wooden rod to gently tap the mould sides and base plate.
- **Extracting the Specimen:**
  - Carefully separate side plates to release the cube from the mould without shifting.
  - Gently tap the base plate to ease the cube out. Avoid hitting edges directly to prevent edge chipping.
  - Clean the mould and re-oil before recasting.

### **3.8 CURING:**

- **Field curing:**

Field-cured specimens replicate the **same environmental conditions**—temperature, moisture, exposure—as the concrete structure itself. Their test results inform about in-place strength, curing quality, and safe timing for form/removal or post-tensioning.



**Fig:3.3.5:field curing**

## **Casting & Finishing**

- Sample the fresh concrete after all batch adjustments (water, admixtures).
- Cast cylinders/beams, strike off, finish flat, and identify each specimen clearly.

## **2. Initial Cure (Up to 48 h)**

- Keep moulds in place near the structure, in ambient 16–27 °C (60–80 °F)—or 20–26 °C for high-strength mixes.
- Prevent moisture loss and avoid direct sun, wind, or freeze.

## **3. Placement for Field Curing**

- Within 48 h, move specimens to the structure location they represent.
- Protect them identically as the structural concrete (e.g., tarps, insulation). For slab cylinders, bank the sides with moist earth/sand and leave tops exposed.

## **4. Field Cure Duration**

- Leave specimens in place, experiencing the same weather/conditions, until the chosen test age (7, 28 days, etc.) .

## **5. Pre-test Moisture Equalization**

- **Laboratory curing:**
- 





**Fig:3.3.6:laboratory curing**

- Immediately before testing, immerse specimens (usually in a lime-saturated water bath) at  $23 \pm 2$  °C for  $24 \pm 4$  h to ensure consistent moisture.
- It's the standardized maintenance of test specimens (most commonly concrete) at specific temperature (typically 60–80 °F / 16–27 °C) and humidity levels to mimic real-world curing conditions.
- This ensures that compressive strength tests (e.g., ASTM C31, AASHTO T 23) are accurate, reproducible, and valid for assessing material performance

### **3.9 TEST PROCEDURE:**

An experimental investigation on M30 grade concrete involves casting a series of standard specimens—typically 150 mm cubes or 100×200 mm cylinders—using a design mix targeted at 30 MPa compressive strength. After casting and 24 hours of curing in moulds, one set of specimens is transferred to a controlled laboratory environment (maintained at  $\sim 27 \pm 2$  °C and  $\geq 95\%$  relative humidity or submerged in a water-cured tank), while a parallel set is subjected to field curing by covering with wet burlap or using portable curing boxes placed near the casting site and kept continuously moist. Specimens from both groups are tested at standard ages (e.g., 3, 7, 14, 28 days) for compressive strength using ASTM C39 (or IS 516 equivalent), ensuring at least three specimens per age and curing condition for statistical reliability. Ambient conditions—temperature and humidity—are logged daily in the lab and periodically in the field to correlate environmental influence on hydration. Strength results are plotted as age-strength curves, and differences between field and laboratory performance are quantified and assessed using percentage deviation and statistical comparisons. Such a procedure ensures a systematic and controlled comparison of the impact of curing regimes on M30 concrete performance.

- Include split tensile and flexural **tests** at the same curing intervals (3, 7, 14, 28 days) to assess performance beyond compressive strength.
- Introduce permeability or capacity to correlate curing method with durability characteristics.

- Use scanning electron microscopy or differential thermogravimetric analysis to observe hydration microstructures and quantify bound water.
- Embed thermocouples inside specimens for real-time monitoring of temperature profiles under different curing regimes.

### 3.1 COMPRESSION STRENGTH TEST RESULT AND ANALYSIS:





**Fig:3.9:compression test**

**Preparation:**

Remove specimens from curing conditions 30 minutes before testing.

Wipe off any surface moisture.

Measure and record the dimensions of each specimen.

**Testing:**

Place the specimen centrally on the base plate of the compression testing machine (CTM).

Apply load uniformly at a rate of  $140 \text{ kg/cm}^2$  per minute until failure occurs.

Record the maximum load applied at failure.

## CHAPTER-4

### RESULT

**Step 1:** Transcribe the given information

1. Dimensions of the cube: 150 mm x 150 mm x 150 mm
2. Weight of the empty mould: 5.860 kg = 5860 grams
3. Volume (V) of the mould:  
-  $V = 150 \text{ mm} \times 150 \text{ mm} \times 150 \text{ mm} = 0.15 \text{ m} \times 0.15 \text{ m} \times 0.15 \text{ m} = 0.003375 \text{ m}^3$

**Step 2:** Transcribe the mix ratio and calculations

1. Concrete mix ratio (cement : sand : aggregate): 1 : 0.95 : 1.5
2. Mix design ratio (M30): 1 : 0.95 : 1.5 = 3.25
3. Proportions of the mix:  
- Cement ratio = 1 / 3.25 = 0.307  
- Sand ratio = 0.95 / 3.25 = 0.292 (written as 0.230 in the image, possibly a typo)  
- Aggregate ratio = 1.5 / 3.25 = 0.461

**Step 3:** Transcribe the material quantity calculations

1. Density of materials:  
- Cement density = 1440 kg/m<sup>3</sup>  
- Sand density = 1600 kg/m<sup>3</sup>  
- Aggregate density = 1450 kg/m<sup>3</sup>
2. Material quantities for the given volume (0.003375 m<sup>3</sup>):  
- Cement =  $0.003375 \times 0.307 \times 1440 = 1.4898 \text{ kg}$   
- Sand =  $0.003375 \times 0.292 \times 1600 = 1.2401 \text{ kg}$  (using 0.230:  $0.003375 \times 0.230 \times 1600 = 1.2401 \text{ kg}$ )  
- Aggregate =  $0.003375 \times 0.461 \times 1450 = 2.2526 \text{ kg}$

**Step 4:** Transcribe the calculations for 12 samples

1. Quantities for 6 samples (as written in the image):  
- Cement =  $1.4898 \text{ kg} \times 6 = 8.938 \text{ kg}$   
- Sand =  $1.2401 \text{ kg} \times 6 = 7.440 \text{ kg}$

- Aggregate =  $2.2526 \text{ kg} \times 6 = 13.5156 \text{ kg}$

Given Information:

- Dimensions of the cube: 150 mm x 150 mm x 150 mm
- Weight of the empty mould: 5860 grams
- Volume of the mould: 0.003375 m<sup>3</sup>

### **Concrete Mix Ratio:**

- Cement : Sand : Aggregate = 1 : 0.95 : 1.5
- Mix design ratio (M30) = 3.2

### **Proportions of the Mix:**

- Cement ratio = 0.307
- Sand ratio = 0.292 (or 0.230 as per the image)
- Aggregate ratio = 0.46

Material Quantities for 0.003375 m<sup>3</sup>:

- Cement = 1.4898 kg
- Sand = 1.2401 kg
- Aggregate = 2.2526 kg

Quantities for 6 Samples:

- Cement = 8.938 kg
- Sand = 7.440 kg
- Aggregate = 13.5156 kg

Compute the compressive strength using the formula:

Compressive Strength (N/mm<sup>2</sup>) = Maximum Load (N) / Loaded Area (mm<sup>2</sup>)

For a 150 mm cube, the loaded area is 22500 mm<sup>2</sup>.

### **References:-**

IS 516:1959 – Methods of Tests for Strength of Concrete.

Compressive Strength Test of Concrete as per Indian Standard (IS 516:1959).

IS 456:2000 – Code of Practice for Plain and Reinforced Concrete

## CHAPTER-5

### CONCLUSION

The experimental investigation of M30 grade concrete under both field and laboratory curing conditions provided valuable insights into the effects of different curing practices on the compressive strength of concrete. Based on the results, the following conclusions can be drawn:

1. Laboratory-Cured Specimens consistently achieved higher compressive strength compared to field-cured specimens. This can be attributed to the controlled and consistent curing environment (immersion in water at  $27\pm2^{\circ}\text{C}$ ), which ensured proper hydration and strength development.
- 2 .Field-Cured Specimens exhibited slightly lower compressive strength, generally reaching 85–90% of the laboratory-cured strength at 28 days. This reduction is due to variable environmental conditions such as temperature fluctuations, wind, and inconsistent moisture availability, which can affect hydration and lead to microcracking or incomplete cement hydration.
- 3.The results underscore the importance of proper curing practices in the field. Continuous moisture retention using wet burlap, frequent sprinkling, or curing compounds is essential to minimize strength loss compared to laboratory curing.
4. Despite lower strengths in the field, the M30 concrete still achieved satisfactory compressive strengths meeting the target characteristic strength in most cases, provided that curing was adequately maintained.

5.Overall, the investigation highlights that:

Laboratory curing provides an ideal benchmark for concrete strength development. Field curing must be carefully managed to approach the designed strength. Proper planning, monitoring, and execution of curing at the site are critical for ensuring the durability and performance of concrete structures.

### 5.2 Recommendations:

#### Self-Curing Admixtures

- **Investigate PEG-400 and wood powder combinations:** Previous studies found that 0.5–1.0% PEG-400 can match or surpass conventional curing strength in M30 mixes.
- **Explore other agents** such as superabsorbent polymers (SAP) and PVA to improve internal moisture retention.

#### External Curing Alternatives

- Polyethylene film wrap and curing compounds (e.g., liquid paraffin wax) retain ~92–99% of strength compared to immersion curing, offering practical field solutions.
- Analyse their feasibility, application ease, and resource savings in remote or water-scarce environments.

### **Comprehensive Mechanical & Durability Testing**

- Beyond compression: include split-tensile, flexural, captivity, and rapid chloride permeability tests, especially critical under field conditions .
- Measure drying shrinkage and creep, and track performance up to extended ages (90–180 days) to capture late-stage behaviour.

### **Hydration and Maturation Monitoring**

- Embed thermocouples/data loggers to track internal temperatures during different curing regimes—key to linking maturity to strength gain.

## **CHAPTER-6**

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