

# **EXPERIMENTAL STUDY ON FIBRE REINFORCED CONCRETE REPLACED BY DEMOLISHED CONCRETE WASTE AS FINE AND COARSE AGGREGATE**

Submitted in partial fulfillment of the requirements for the award of  
Bachelor of Engineering degree in  
Civil Engineering

By

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**DEPARTMENT OF CIVIL ENGINEERING  
SCHOOL OF BUILDING AND ENVIRONMENT**

## **SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A++” by NAAC**

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**APRIL 2024**



# SATHYABAMA

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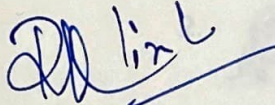
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### BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **K. LAKSHMAN KUMAR** (Register No: 40200712), **T. SUCHITH REDDY** (Register No: 40200014) who carried out the project entitled "**Experimental study on Fibre Reinforced Concrete replaced by Demolished concrete waste as Fine and Coarse aggregate**" under our supervision from June 2023 to April 2024.



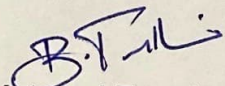
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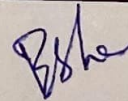


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## DECLARATION

We K. LAKSHMAN KUMAR (Register No: 40200712), T. SUCHITH REDDY (Register No:40200014) here by declare that the Project Report entitled "Experimental study on Fibre Reinforced Concrete replaced by Demolished concrete waste as Fine and Coarse aggregate" done by us under the guidance of Dr. R. NIRMALA mam is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

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## **ABSTRACT**

The construction industry generates a significant amount of demolished concrete waste, leading to environmental concerns and the need for sustainable waste management solutions. This experimental study investigates the feasibility of utilizing demolished concrete waste as both fine and coarse aggregates in fibre reinforced concrete (FRC). The research explores the mechanical properties, durability, and sustainability aspects of this alternative concrete mix.

The study involves various concrete mixes, including a control mix with conventional aggregates, and others with different percentages of demolished concrete waste replacement. To enhance the structural performance, steel or synthetic fibers are incorporated into the mixes. Mechanical tests such as compressive strength, tensile strength, and flexural strength of beams are conducted to evaluate the performance of these FRC mixes.

Furthermore, durability tests, including freeze-thaw resistance and chloride penetration resistance, are performed to assess the long-term sustainability and resistance to environmental factors. The results of this study provide valuable insights into the potential of using demolished concrete waste as a sustainable alternative in concrete production, reducing the environmental footprint of the construction industry while maintaining or improving concrete performance.

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## LIST OF SYMBOLS & ABBREVIATIONS

### SYMBOLS

### ABBREVIATIONS

Kg

Kilograms

MPa

Mega pascals

%

Percentage

Mm

Milli metre

M<sup>2</sup>

Metre Square

N

Newton

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 GENERAL**

Fine aggregate, commonly referred to as sand in construction, is an essential constituent of concrete mixtures. Its significance lies in its ability to fulfill multiple crucial roles in creation of durable and workable concrete structures. Fine aggregate primarily comprises small particles with diameters typically less than 4.75 millimeters (0.1875 inches). These particles will fill in between the larger coarse aggregates, contributing to the dense composition of the concrete.

Moreover, fine aggregate significantly influences the workability and consistency of the concrete mix, determining its ability to be appropriately placed and finished. Proper grading of the fine aggregate is vital, as it directly impacts various properties of the concrete, including water demand, workability, and strength.

Coarse aggregate is a fundamental component of concrete and plays a pivotal role in the construction industry. These larger-sized particles, typically exceeding 4.75 millimeters (0.1875 inches) in diameter, are responsible for several essential functions in concrete mixtures. Firstly, coarse aggregates provide structural integrity to the concrete by enhancing its compressive strength. They distribute loads and resist external forces, ensuring that the concrete can withstand the stresses it may encounter in various construction applications.

Secondly, coarse aggregates contribute to the durability of concrete. They help reduce shrinkage and cracking by providing internal support and reinforcement within the concrete matrix. This enhanced durability ensures that concrete structures maintain their integrity over time, even in harsh environmental conditions.

## **1.2 FIBRE REINFORCED CONCRETE**

Fiber reinforced concrete (FRC) is an innovative construction material that enhances the properties and performance of traditional concrete. It incorporates various types of fibers, such as steel, synthetic, or natural fibers, into the concrete mix to impart specific benefits.

Firstly, FRC significantly improves the tensile strength and ductility of concrete. While traditional concrete is strong in compression, it tends to be weak in tension, making it prone to cracking. The addition of fibers helps restrain crack formation and propagation, increasing the overall durability and toughness of the concrete.

Secondly, FRC enhances resistance to impact and fatigue. The embedded fibers act as a reinforcement mesh, absorbing energy and reducing the likelihood of surface spalling or fragmenting when subjected to dynamic loads or impacts. This makes FRC suitable for applications in high-traffic areas and structures exposed to harsh conditions.

Moreover, FRC offers superior resistance to shrinkage cracking and temperature-induced stresses. These benefits make it an excellent choice for applications such as pavements, bridge decks, and industrial flooring, where minimizing cracking and maintenance is crucial.

In summary, fiber reinforced concrete is a versatile and high-performance material that addresses several limitations of traditional concrete. Its ability to improve tensile strength, durability, and resistance to various stresses makes it a valuable choice in modern construction, contributing to the longevity and reliability of infrastructure projects.

### 1.3 TYPES OF FIBRE REINFORCED CONCRETE

- **Steel Fiber Reinforced Concrete (SFRC)**

SFRC incorporates short, discrete steel fibers into the concrete mix. These fibers improve the concrete's tensile strength, ductility, and resistance to cracking. SFRC is commonly used in industrial floors, pavements, and tunnel linings.

- **Polymer Fiber Reinforced Concrete (PFRC)**

PFRC incorporates synthetic polymer fibers, such as polypropylene or nylon, into the mix. These fibers enhance the concrete's durability, impact resistance, and resistance to freeze-thaw cycles. PFRC is often used in precast concrete products and structures exposed to harsh environmental conditions.

- **Glass Fiber Reinforced Concrete (GFRC)**

GFRC utilizes thin glass fibers within the concrete mix. It is known for its lightweight and high flexural strength. GFRC is commonly used in architectural elements, decorative panels, and cladding due to its ability to create intricate and lightweight designs.

- **Natural Fiber Reinforced Concrete (NFRC)**

NFRC incorporates natural fibers like jute, coir, or sisal into the concrete. While not as commonly used as synthetic fibers, NFRC can provide some reinforcement and is used in eco-friendly or sustainable construction practices.

- **Carbon Fiber Reinforced Concrete (CFRC)**

CFRC employs high-strength carbon fibers to enhance the concrete's strength and durability. It is particularly useful in applications requiring exceptional strength, such as in the construction of high-performance bridges and buildings.

- **Basalt Fiber Reinforced Concrete (BFRC)**

BFRC utilizes fibers made from basalt rock. These fibers offer good resistance to high temperatures and aggressive chemical environments. BFRC finds applications in industries such as petrochemical and marine construction.

- **Hybrid Fiber Reinforced Concrete**

In some cases, a combination of different fiber types, known as hybrid FRC, is used to achieve a balance of properties. This approach allows engineers to tailor the concrete mix to meet specific project requirements.

## 1.4 NEED OF THE PROJECT

The need for the study on fiber reinforced concrete (FRC) replaced by demolished concrete waste as fine and coarse aggregate arises from several important considerations:

**Sustainability:** The construction industry generates a significant amount of demolished concrete waste, which often ends up in landfills, contributing to environmental issues. Finding sustainable ways to reuse this waste material in concrete production is essential for reducing its environmental impact and conserving natural resources.

**Resource Conservation:** The extraction of natural aggregates (sand and gravel) for concrete production can lead to habitat destruction and resource depletion. By replacing these natural aggregates with recycled demolished concrete waste, the conservation of valuable resources and reduce the environmental footprint of concrete production.

**Waste Reduction:** Recycling demolished concrete waste as aggregate reduces the need for disposal in landfills, which can be costly and environmentally detrimental. Repurposing this waste as a construction material addresses waste management challenges.

**Performance Assessment:** It is crucial to evaluate the mechanical properties, durability, and sustainability of concrete when incorporating demolished concrete waste as aggregate. This experimental study allows for a systematic assessment of how this substitution impacts the concrete's performance.

**Structural Applications:** Understanding the feasibility of using demolished concrete waste as fine and coarse aggregate in fiber reinforced concrete is particularly important for structural applications. FRC offers enhanced mechanical properties and durability, making it suitable for a wide range of construction projects.

**Innovation:** Such research endeavors contribute to the development of innovative and sustainable construction practices, aligning with the growing global emphasis on environmentally friendly building materials and construction techniques.

## 1.5 SCOPE OF THE PROJECT

The scope of study on fiber reinforced concrete (FRC) replaced by demolished concrete waste as fine and coarse aggregate is broad and encompasses various aspects, including:

**Material Characterization:** Investigating the physical, chemical, and mechanical properties of the demolished concrete waste, including particle size distribution, shape, and composition, to understand its suitability as aggregate replacement.

**Mix Design:** Developing and optimizing concrete mixtures by incorporating different percentages of demolished concrete waste as fine and coarse aggregate. This includes selecting an appropriate type and dosage of fibers (e.g., steel, synthetic) to enhance concrete performance.

**Mechanical Properties:** Conducting comprehensive mechanical tests to assess the impact of the aggregate replacement on properties such as compressive strength, tensile strength, flexural strength, and modulus of elasticity. These tests help determine the structural integrity of the FRC.

**Durability Testing:** Evaluating the resistance of FRC mixes to environmental factors like freeze-thaw cycles, chloride penetration, and chemical attack. This provides insights into the long-term durability of the concrete.

**Workability and Rheology:** Studying the workability of FRC mixes to ensure they can be adequately placed and finished on construction sites. This involves assessing properties like slump and flow.

**Fiber Dispersion and Bonding:** Investigating the dispersion and bonding of fibers within the FRC matrix, which directly influence crack control, ductility, and toughness.

**Sustainability Analysis:** Conducting a life cycle assessment to compare the environmental impact of FRC mixes with demolished concrete waste against conventional concrete mixes, considering factors such as energy consumption and carbon emissions.

**Cost Analysis:** Assessing the economic feasibility of using demolished concrete waste as aggregate in FRC, considering factors like material costs, construction practices, and maintenance savings.

**Structural Performance:** Evaluating the structural performance of FRC in real-world applications, such as through the construction of test specimens or small-scale structural elements, to assess its viability for various construction projects.

**Optimization:** Identifying the optimal mix proportions, fiber types, and aggregate replacement percentages that strike a balance between sustainability, cost-effectiveness, and performance.

**Guideline Development:** Providing recommendations and guidelines for the use of FRC with demolished concrete waste as aggregate in construction projects, ensuring safe and efficient implementation.

**Case Studies:** Analyzing real-world case studies or pilot projects where FRC with demolished concrete waste has been used, showcasing its practical applications and performance.

## **1.6 OBJECTIVES OF THE PROJECT**

- To determine the feasibility and sustainability of using Demolished Concrete waste as a substitute for conventional aggregates in Fibre Reinforced Concrete.
- To evaluate the mechanical properties of Fibre Reinforced Concrete when replaced with demolished concrete waste as fine and coarse aggregates.

## CHAPTER 2

### LITERATURE SURVEY

#### 2.1 GENERAL

The various research works on fibre reinforced concrete using different types of fibres (both natural and artificial fibres) has been reviewed and summarized in this chapter.

#### 2.2 REVIEW OF THE LITERATURES

**Danying et al. (2023)**, The study included the execution of three-point bending experiments on 40 notched beam samples to assess the flexural behaviour and damage evolution of recycled coarse aggregate concrete reinforced with steel fibers (SFRCAC). The results suggest that higher water-cement ratios and increased replacement of recycled coarse aggregate lead to reduced residual flexural tensile strength and flexural toughness in SFRCAC. Moreover, the addition of steel fibers has been demonstrated to improve both the residual flexural tensile strength and flexural toughness of SFRCAC.

**Gopinath et al. (2023)**, A study was carried out to examine the feasibility of using recycled coarse aggregate (RCA) obtained from demolished concrete in place of natural coarse aggregate (NCA), along with the addition of waste plastic fibers, in the fabrication of M40 grade concrete. The objective of the research was to evaluate the strength properties of concrete through the partial replacement of natural coarse aggregate with recycled coarse aggregate (RCA).

**Harish et al, (2023)**, The study investigated the effectiveness of two different fibers in the RAC50 mixture regarding cube and cylinder compressive strengths, as well as split and flexural strengths. Additionally, the research included an examination of a reference mixture (NAC) without fiber additives to compare strength outcomes. To offset the strength decrease observed in the RAC50 mixture, fibers were added, and their performance was evaluated by comparing it with that of the reference mixture (NAC).

**Jie Xu et al (2023)**, The strength of green concrete, which integrates waste tire rubber particles to partially replace natural fine aggregate, faces limitations due to its inherent weakness. However, incorporating steel fibers has been identified as

an effective solution to this challenge. The fracture mechanisms of three concrete variations during four-point bending tests were observed through the application of acoustic emission (AE) technique.

**Manu and Nitin Verma (2023)**, Combining epoxy resins and glass fibers represents a novel approach to improving the characteristics of waste aggregates, an aspect not explored in prior research. The unreinforced reclaimed aggregate concrete exhibited lower compressive strength compared to the controlled concrete during testing. This suggests that these materials could serve as viable alternatives to natural aggregates, thus advancing sustainable construction practices.

**Mathew (2023)**, The study investigated the shear performance of reinforced concrete beams constructed using treated recycled coarse aggregate (RCA) and augmented with three varying volume fractions of hook-end steel fibers: 1.0%, 0.5%, 1%, and 1.5%. To strengthen recycled aggregate concrete (RAC), a method involving pre-soaking recycled aggregates in a slurry of cement and fly ash was employed. The replacement percentage of treated RCA remained consistent at 50% throughout the experiment.

**Saha and Mohanty (2023)**, The study included a comparison of all characteristics between jute fiber and ferrochrome slag (FSA) based concrete and conventional concrete, with the goal of developing an efficient, technically sound, and environmentally friendly construction material. This research highlights the utilization of waste ferrochrome slag as a partial replacement for coarse aggregate to improve the mechanical properties of cement concrete, along with the performance of non-destructive tests.

**Zahid et al, (2023)**, The increasing accumulation of inevitable waste rubber and the dismantling of aged concrete structures have emerged as significant environmental sustainability issues. Introducing crumb rubber and recycled concrete into the fresh concrete mixture is poised to foster eco-conscious methodologies. Fifteen reinforced concrete (RC) beams were fabricated, incorporating recycled concrete aggregate (RCA) ranging from 0% to 50%, crumb rubber as fine aggregate from 0% to 10%, and polypropylene (PP) fiber fractions from 0% to 1%.

**Danying et al. (2022)**, The research focused on analyzing the shear behavior of steel fiber-reinforced concrete beams that incorporated recycled fine aggregate and recycled coarse aggregate. These aggregates were obtained from demolished buildings and were incorporated into the concrete mixes at replacement rates of 0%, 50%, and 100%. The impact of recycled fine aggregate, recycled coarse aggregate, and steel fibers on the shear performance of the concrete beams was evaluated separately using linear equations.

**Sathish, Palanikumar and Karthick (2020)**, In this study, concrete waste sourced from demolished structures was gathered and utilized to produce fresh concrete, with the optimal percentage of coarse aggregate incorporated. The research aimed to assess the concrete strength by partially substituting natural aggregate with recycled coarse aggregate. Various percentages of fibers were introduced relative to the weight of cement during the experimental investigation.

**Zahid et al, (2023)**, The increase in both unavoidable waste rubber and the demolition of old concrete structures poses challenges to environmental sustainability. Introducing crumb rubber and recycled concrete into the new concrete mixture is expected to encourage eco-friendly approaches. Fifteen reinforced concrete (RC) beams were fabricated, incorporating recycled concrete aggregate (RCA) ranging from 0% to 50%, crumb rubber as fine aggregate from 0% to 10%, and polypropylene (PP) fiber fractions from 0% to 1%.

## **2.3 INFERENCE FROM THE LITERATURES**

- The recycled coarse aggregate (RCA) can be effectively used as a partial replacement for natural coarse aggregate (NCA) in M40-grade structural concrete.
- The incorporating waste ferrochrome slag (FSA) in concrete, along with jute fibers, results in an environmentally compatible and technically acceptable construction material.
- Utilizing a pre-soaking method with cement and fly ash slurry, alongside the incorporation of hook-end steel fibers at varying volume fractions (0.5%, 1%, and 1.5%), has shown significant enhancement in the shear characteristics of reinforced concrete beams using recycled coarse aggregate (RCA).

- A novel strategy integrating epoxy resins and glass fibers has been discovered to enhance the attributes of waste aggregates. This innovative approach demonstrates concrete compressive strength comparable to, or even exceeding, conventional concrete.
- The addition of steel fibers notably enhances the flexural performance of recycled coarse aggregate concrete (RAC). It has been observed that as the water-cement ratio and the replacement ratio of recycled coarse aggregate increase, the residual flexural tensile strength and flexural toughness of SFRCAC tend to decrease.
- Growing concerns surrounding environmental sustainability, particularly regarding the escalating volumes of unavoidable waste rubber and the demolition of aging concrete structures, necessitate attention.
- The challenge with green concrete containing waste tire rubber particles lies in its inherent weakness. Nevertheless, the incorporation of steel fibers has emerged as a viable solution to overcome this drawback.
- Evaluating the impact of incorporating fibers into the RAC50 mix to offset potential strength reduction, the performance of this fiber-reinforced RAC50 mix is compared against a reference mix (NAC) devoid of fibers.
- Repurposing concrete waste from demolished structures and utilizing the coarse aggregate derived from this waste to partially substitute natural aggregate in fresh concrete is an environmentally conscious practice.
- Analyzing the influence of recycled fine aggregate, recycled coarse aggregate, and steel fibers on the shear behavior of concrete beams across different replacement ratios (0%, 50%, and 100%) is crucial for understanding their impact on shear performance.

## CHAPTER 3

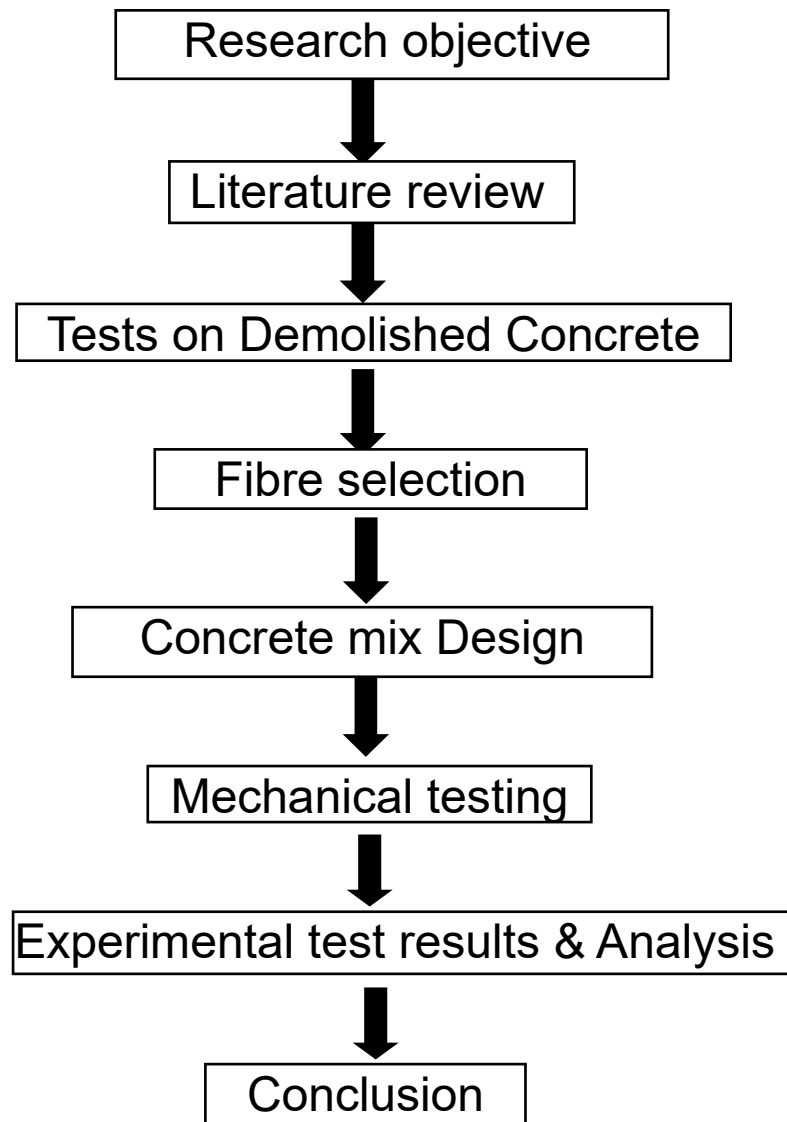
### METHODOLOGY AND MATERIALS

#### 3.1 GENERAL

Methodology is the systematic framework for conducting research, encompassing the design, data collection, analysis and ethical considerations to achieve research objectives.

#### 3.2 METHODOLOGY

The methodology of the experimental study is shown in the below figure 3.1.



**Fig.3.1 Methodology**

### **3.3 TESTS ON DEMOLISHED CONCRETE**

#### **Aggregate Gradation Test:**

This test determines the particle size distribution of the crushed concrete. It assesses whether the aggregates meet specified gradation requirements for both fine and coarse aggregates. Proper gradation is essential for concrete workability and performance.

#### **Aggregate Crushing Value (ACV) Test:**

The ACV test measures the resistance of the recycled aggregates to crushing under a compressive load. It provides an indication of the aggregates' strength, which is crucial for determining their suitability for use in concrete.

#### **Specific Gravity and Absorption Test:**

This test determines the specific gravity and water absorption capacity of the recycled aggregates. It helps evaluate the aggregates' ability to bond with cement paste and their propensity to absorb water, which can affect concrete properties

#### **Los Angeles Abrasion Test:**

The Los Angeles Abrasion test assesses the abrasion resistance of the recycled aggregates. It simulates the wear and tear that aggregates may experience during handling, transportation, and in concrete mixes, providing insights into their durability

### **3.4 MATERIALS USED**

The raw materials used in this experiment were locally available and these included ordinary Portland cement as binding agent, Demolished Concrete waste used as Fine and Coarse Aggregate, Steel fibre and super plasticizer. Potable tap water was used for mixing and curing throughout the entire investigation.

- **DEMOLISHED FINE AGGREGATE**

Demolished fine aggregate, also known as recycled fine aggregate, is a type of aggregate material obtained from the demolition of existing structures or from construction waste. When buildings or infrastructure are demolished, the resulting concrete rubble is often crushed and processed to produce recycled aggregates, including both fine and coarse fractions.

Demolished fine aggregate consists of fine particles of crushed concrete, typically smaller than 5mm in size. These particles can be used as a substitute for natural sand in concrete mixtures. Utilizing demolished fine aggregate in concrete production also helps to mitigate the accumulation of construction waste in landfills and promotes sustainable construction practices.



**Fig:3.2 Demolished fine aggregate**

- **DEMOLISHED COARSE AGGREGATE**

Demolished coarse aggregate, also known as recycled coarse aggregate, is a type of aggregate material obtained from the demolition of existing structures or from construction waste. When buildings or infrastructure are demolished, the resulting concrete rubble is often crushed and processed to produce recycled aggregates, including both coarse and fine fractions.

Demolished coarse aggregate consists of larger particles of crushed concrete, typically ranging from 5mm to 20mm or more in size. These particles can be used as a substitute for natural coarse aggregates in concrete mixtures



**Fig:3.3 Demolished Coarse Aggregate**

- **STEEL FIBER**

Steel fiber, also known as steel fiber reinforcement, is a material used in concrete to enhance its structural integrity and durability. It consists of small, discrete, and evenly distributed fibers made of steel. When added to concrete mixtures, steel fibers help control cracking, improve toughness, increase resistance to impact and fatigue, and enhance the overall performance of the concrete in various applications such as pavements, industrial floors, tunnel linings, and precast elements.

- **SUPER PLASTICIZER**

A superplasticizer is a type of chemical additive used in concrete mixtures to improve its workability and reduce the amount of water needed for proper hydration without compromising the strength of the concrete. Superplasticizers are typically high-range water reducers, meaning they can significantly decrease the water-to-cement ratio while maintaining or even enhancing the flowability and rheological properties of the concrete mix. This allows for the production of high-strength, durable concrete with improved workability, making it easier to place and finish. Superplasticizers are commonly employed in high-performance concrete, self-consolidating concrete, and other applications where superior workability and strength are required.

- **WATER**

Water plays a vital role in papercrete by actively participating in chemical reactions with cement. Its presence is crucial for mortar preparation, cement concrete mixing, and the curing processes involved in construction. The quality and quantity of water have a significant impact on the strength of mortar and cement concrete in construction projects. Therefore, it is essential that the water used for mixing and curing is clean and free from harmful substances such as alkalis, acids, oils, salts, sugars, organic matter, vegetable growth, and other materials that could negatively affect bricks, stone, concrete, or steel. Typically, potable water is considered suitable for mixing purposes.

- **CEMENT**

The investigation utilized Ordinary Portland Cement of 53 Grade, manufactured by Ultra Tech Company, which was sourced from the local market. Measures were taken to ensure procurement from a single batch, stored in airtight containers to shield it from atmospheric influences. The obtained cement underwent physical testing per IS: 169-1989 and chemical testing per IS: 4032-1988 to verify its compliance with respective standards.



**Fig:3.4 Cement**

### **3.5 TEST ON CEMENT**

Material inspection is a crucial aspect of civil engineering, as the durability of structures relies heavily on the quality of materials utilized. The following tests must

be conducted to assess the quality of cement.

- Consistency of Cement
- Fineness of Cement
- Initial and Final setting time of Cement

**Table 3.1 Test on Cement**

| Properties           | Values                     | Requirements As Per I.S. Codes                   |
|----------------------|----------------------------|--------------------------------------------------|
| Specific Gravity     | 3.12                       | IS 2720 part 3 (3.15 is generally assumed)       |
| Normal Consistency   | 29%                        | IS 4031-part 4                                   |
| Initial Setting Time | 65min                      | Not less than 30 minutes as per IS 4031-part 5   |
| Final Setting Time   | 275min                     | Not more than 600 minutes as per IS 4031- part 5 |
| Fineness             | 330 kg/m <sup>2</sup>      | Not>10% as per IS 4031- part 1                   |
| Soundness            | 2.5mm                      | Not>10mm as per IS 4031-part 3                   |
| Bulk Density         | 830-1650 kg/m <sup>3</sup> |                                                  |

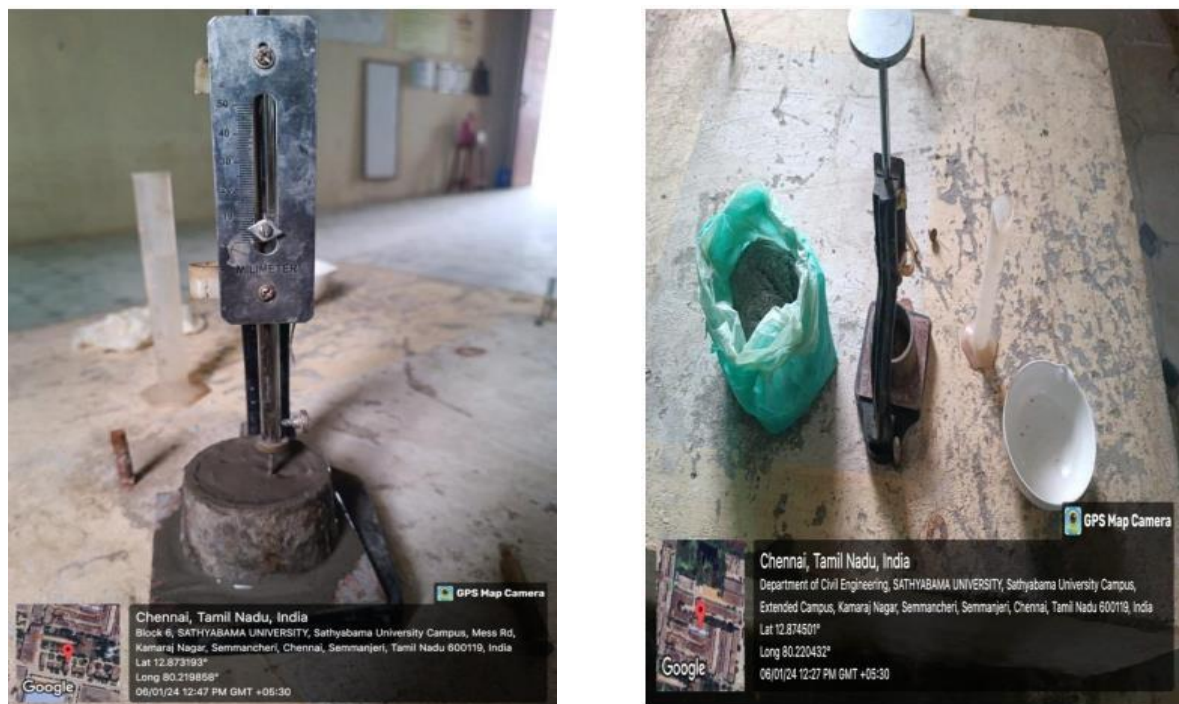
- **CONSISTENCY OF CEMENT**

**Purpose:**

Typically, this test is conducted to determine the amount of water needed to achieve the standard consistency of cement. Standard consistency refers to the point where the Vicat plunger penetrates 5 to 7mm into the Vicat mold during testing. The results are presented in Table 3.2.

**Table 3.2 Consistency of Cement**

| S.NO | PERCENTAGE OF WATER | HEIGHT OF PLUNGER |
|------|---------------------|-------------------|
| 1    | 25%                 | 35mm              |
| 2    | 26%                 | 32mm              |
| 3    | 27%                 | 26mm              |
| 4    | 28%                 | 16mm              |
| 5    | 29%                 | 12mm              |
| 6    | 30%                 | 8mm               |



**FIG 3.5 Consistency of Cement**

### • FINENESS OF CEMENT

The fineness of cement is determined by sieving it using a standard sieve. This process determines the proportion of cement particles with grain sizes larger than the specified mesh size.

**Observation:**

Empty weight of pan,  $w_1 = 310$  gms

Pan + Cement Sample  $w_2 = 410$  gms

Weight of Cement  $w_1 = w_2 - w_1 = 410 - 310 = 100$  gms

After sieving weight of pan + Retain of Cement  $w_3 = 317$  gms

Retain of Cement  $(w_3 - w_1) = 317 - 310 = 7$  gms

$$F = \frac{R}{P} \times 100$$
$$= \frac{7}{100} \times 100 = 7 \%$$

Fineness of cement is measured in percentage is 7%.

- **INITIAL AND FINAL SETTING TIME OF CEMENT**

**Aim:**

Determination of initial and final setting time of cement and determine whether the values satisfy IS standards.

Quantity of Cement = 500gm

$$\begin{aligned}\text{Quantity of water} &= 0.85 \times P \\ &= 0.85 \times 30 \\ &= 25.5 \\ &= \frac{500 \times 25.5}{100} \\ &= 128 \text{ ml}\end{aligned}$$

Initial Setting Time = 110 min

Final Setting Time = 290 min

**3.6 TESTS ON NATURAL FINE AGGREGATE (RIVER SAND)**

As per IS 2386 - Part I & Part III 1963, the tests was carried out for Natural Fine Aggregate.

## Sieve Analysis

As per IS 2386 - Part I 1963, the sieve analysis was carried out with 200g of NFA in sieve analysis method.



**Fig 3.6 Sieve Analysis**

**Table 3.3 Data and Observation for Sieve Analysis of NFA**

| S.NO | IS Sieve (mm) | Weight of sample retained in (gm) | Percentage retained in % | Cumulative percentage retained (N) in % | Percentage Finer (100-N) in % |
|------|---------------|-----------------------------------|--------------------------|-----------------------------------------|-------------------------------|
| 01   | 4.75          | 52                                | 5.11                     | 5.11                                    | 94.89                         |
| 02   | 2.36          | 101                               | 9.92                     | 15.03                                   | 84.87                         |
| 03   | 1.18          | 363                               | 35.66                    | 50.69                                   | 49.31                         |
| 04   | 0.6           | 274                               | 26.92                    | 77.61                                   | 22.39                         |
| 05   | 0.3           | 140                               | 13.92                    | 91.63                                   | 8.64                          |
| 06   | 0.15          | 71                                | 6.97                     | 98.33                                   | 1.67                          |
| 07   | 0.075         | 11                                | 1.08                     | 99.41                                   | 0.59                          |
| 08   | PAN           | 06                                | 0.58                     | 99.99                                   | 0.01                          |
|      |               |                                   |                          | $\Sigma = 537.8$                        |                               |

### Fineness Modulus

As per IS 2386-Part III 1963, the larger the value of fineness modulus, the coarser is the material.

Calculation:

$$\begin{aligned}\text{Fineness Modulus} &= \frac{\text{cumulative \%}}{100} \\ &= \frac{537.8}{100}\end{aligned}$$

Therefore, Fineness modulus of natural fine aggregate (River sand) = 5.378

### Grading of sand

As per IS 383, the Grading of Natural Fine Aggregate was carried out and tabulated in table 3.4.

**Table 3.4 Data and Observation for Grading of NFA**

| S. No | IS Sieve Size in mm | Zone I   | Zone II  | Zone III | Zone IV  |
|-------|---------------------|----------|----------|----------|----------|
| 01    | 10                  | 100      | 100      | 100      | 100      |
| 02    | 4.75                | ✓ 90-100 | ✓ 90-100 | ✓ 90-100 | ✓ 95-100 |
| 03    | 2.36                | 60-95    | ✓ 75-100 | ✓ 85-100 | ✓ 95-100 |
| 04    | 1.18                | ✓ 30-70  | ✓ 55-90  | 75-100   | 90-100   |
| 05    | 600                 | 15-34    | ✓ 35-59  | 60-79    | 80-100   |
| 06    | 300                 | ✓ 5-20   | ✓ 8-30   | ✓ 12-40  | ✓ 15-50  |
| 07    | 150                 | ✓ 0-10   | ✓ 0-10   | ✓ 0-10   | ✓ 0-15   |

The Natural Fine Aggregate (River sand) lies in the zone-II

### Specific Gravity of Fine Aggregate

As per IS: 2386 (Part III)-1963, the specific gravity test was carried out by using pycnometer and the test result is tabulated in the table 3.5.

**Table 3.5 Data and Observation for Specific Gravity of NFA**

| S. No | Determination                     | Notation | Mass in(g) |
|-------|-----------------------------------|----------|------------|
| 01    | Mass of pycnometer                | $M_1$    | 603        |
| 02    | Mass of pycnometer+ Sand          | $M_2$    | 1101       |
| 03    | Mass of pycnometer + Sand + Water | $M_3$    | 1743       |
| 04    | Mass of pycnometer + Water        | $M_4$    | 1441       |

Calculation:

$$\begin{aligned}\text{Specific Gravity, } G &= \frac{(M_2 - M_1)}{(M_2 - M_1) - (M_3 - M_4)} \\ &= \frac{(1101 - 603)}{(1101 - 603) - (1743 - 1441)}\end{aligned}$$

$$G = 2.54$$

Therefore, the specific gravity of NFA,  $G = 2.54$

### Surface Moisture

As per IS: 2386 (Part III)-1963, the surface moisture of the NFA was found out. This test also carried out by using the pycnometer method.

Calculation:

$$\begin{aligned}\text{Water content, } w &= \left[ \frac{(M_2 - M_1)}{(M_3 - M_4)} \left( \frac{G - 1}{G} \right) - 1 \right] \times 100 \% \\ &= \left[ \frac{(1095 - 598)}{(1760 - 1450)} \left( \frac{2.657 - 1}{2.657} \right) - 1 \right] \times 100 \%\end{aligned}$$

Therefore, water content,  $w = 0.8\%$

### **3.7 TESTS ON RECYCLED FINE AGGREGATE (DEMOLITION CONCRETE WASTE)**

#### **Sieve Analysis**

According to IS 2386 Part I 1963, sieve analysis was conducted, and the outcomes are detailed in Table 3.6. The distribution of particle sizes across various sieve sizes conforms to Indian standards. The experiment involved 200 g of Recycled Fine Aggregate in the sieve analysis method. Fineness Modulus (FM) is a calculated value obtained by summing the percentages of aggregate retained on specified sieves, divided by 100. Fine Aggregates typically range from an FM of 2.00 to 4.00. Tests for grain size or sieve analysis of aggregates are performed to ascertain their particle size distribution and fineness modulus.

**Table 3.6 Data and Observation for Sieve Analysis of RFA**

| S. No | IS Sieve (mm) | Weight of sample retained (g) | Percentage retained in % | Cumulative Percentage retained (N) in % | Percentage Finer (100 – N) in % |
|-------|---------------|-------------------------------|--------------------------|-----------------------------------------|---------------------------------|
| 01    | 4.75          | 09                            | 0.87                     | 0.87                                    | 99.13                           |
| 02    | 2.36          | 277                           | 26.97                    | 27.34                                   | 72.16                           |
| 03    | 1.18          | 321                           | 31.26                    | 59.10                                   | 40.9                            |
| 04    | 0.6           | 138                           | 13.44                    | 72.54                                   | 27.46                           |
| 05    | 0.3           | 99                            | 9.63                     | 82.17                                   | 17.83                           |
| 06    | 0.15          | 140                           | 13.63                    | 95.8                                    | 4.2                             |
| 07    | 0.075         | 36                            | 3.53                     | 99.33                                   | 0.67                            |
| 08    | PAN           | 07                            | 0.67                     | 100                                     | 0                               |
|       |               | Σ = 1027                      |                          | Σ = 537.65                              |                                 |

### Fineness Modulus

According to IS 2386 - PART III 1963, a higher fineness modulus indicates a coarser material. Fine aggregate, categorized as coarse sand, medium sand, and fine sand, is classified based on its fineness modulus.

Calculation:

$$\begin{aligned}
 \text{Fineness Modulus} &= \frac{\text{Cumulative \%}}{100} \\
 &= \frac{537.65}{100} \\
 &= 5.376
 \end{aligned}$$

Therefore, Fineness modulus of RFA (Demolition waste) = 5.376

### Grading of RFA

As per IS 383, the Grading of Natural Fine Aggregate was carried out and tabulated in table 3.7.

**Table 3.7 Data and Observation for Grading of RFA**

| S. No | IS Sieve size in mm | Zone I   | Zone II  | Zone III | Zone IV  |
|-------|---------------------|----------|----------|----------|----------|
| 01    | 10                  | ✓ 100    | ✓ 100    | ✓ 100    | ✓ 100    |
| 02    | 4.75                | ✓ 90-100 | 90-100   | ✓ 90-100 | ✓ 95-100 |
| 03    | 2.36                | 60-95    | ✓ 75-100 | ✓ 85-100 | ✓ 95-100 |
| 04    | 1.18                | ✓ 30-70  | 55-90    | 75-100   | 90-100   |
| 05    | 600                 | ✓ 15-34  | 35-59    | 60-79    | 80-100   |
| 06    | 300                 | ✓ 5-20   | 8-30     | 12-40    | 15-50    |
| 07    | 150                 | ✓ 0-10   | ✓ 0-10   | ✓ 0-10   | ✓ 0-15   |

The Recycled Fine Aggregate (River sand) lies in the zone-I

### Specific Gravity of Recycled Fine Aggregate

As per IS: 2386 (Part III)-1963, the specific gravity test was carried out by using pycnometer and the test result is tabulated in the table 3.8.

**Table 3.8 Data and Observation for Specific Gravity of RFA**

| S. No | Determination                     | Notation       | Mass in(g) |
|-------|-----------------------------------|----------------|------------|
| 01    | Mass of pycnometer                | M <sub>1</sub> | 598        |
| 02    | Mass of pycnometer+ Sand          | M <sub>2</sub> | 1102       |
| 03    | Mass of pycnometer + Sand + Water | M <sub>3</sub> | 1689       |
| 04    | Mass of pycnometer + Water        | M <sub>4</sub> | 1399       |

Calculation:

$$\begin{aligned}
 \text{Specific Gravity, G} &= \frac{(M_2 - M_1)}{(M_2 - M_1) - (M_3 - M_4)} \\
 &= \frac{(1102 - 598)}{(1102 - 598) - (1689 - 1399)} \\
 &= 2.36
 \end{aligned}$$

Therefore, the sp.gr of RFA, G = 2.36

#### **Surface Moisture of RFA**

As per IS: 2386 (Part III)-1963, the surface moisture of the NFA was found out. This test also carried out by using the pycnometer method.

Calculation:

$$\begin{aligned}
 \text{Water content, w} &= \left[ \frac{(M_2 - M_1)}{(M_3 - M_4)} \left( \frac{G - 1}{G} \right) - 1 \right] \times 100 \% \\
 &= \left[ \frac{(1115 - 598)}{(1780 - 1478)} \left( \frac{2.40 - 1}{2.40} \right) - 1 \right] \times 100 \%
 \end{aligned}$$

Therefore, w = 0.8%

### 3.8 TESTS ON NATURAL COARSE AGGREGATE

As per IS 2386 Part I, Part III – 1963 & IS 383 - 1970, the test was carried out on Natural Coarse aggregate.

#### Water absorption test

Aggregate was weighed for 1000g and then immersed in water for about 24 hours. The surface dried sample was dried in a oven and then the dry weight was noted as per IS 2386 (Part III) – 1963.

Calculation:

Weight of aggregate after soaked in water ( $W_1$ ) = 500g

Weight of aggregate after heated in dry oven ( $W_2$ ) = 494g

$$\begin{aligned}\text{Water absorption in \%} &= \frac{W_1 - W_2}{W_1} \times 100 \\ &= \frac{500 - 494}{500} \times 100\end{aligned}$$

Water absorption of coarse aggregate in % = 1.2%

#### Impact strength

Impact strength for natural coarse aggregate passing 12.5mm and retained on 10mm. The sieved sample was filled in cylinder by three layers. Each layer was tampered for 25 times. The impact load was given as 15 blows falling from the height of 380 mm and the load was 137 kN.

Calculation:

Empty weight of cylinder mold ( $W_1$ ) = 545g

Aggregate passed through the 2.36 mm sieve ( $W_3$ ) = 85 g

$$\begin{aligned} \text{Impact strength in \%} &= \frac{W_3}{W_2 - W_1} \times 100 \\ &= \frac{85}{1000 - 545} \times 100 \\ \text{Impact strength of coarse aggregate in \%} &= 15.52 \% \end{aligned}$$

### Specific Gravity of Natural Coarse Aggregate

Sieve analysis was conducted on the coarse aggregate following IS 2386 (part 1) -1963 guidelines, and the findings are depicted in Table 3.9. The experiment involved 1000g of coarse aggregate in the sieve analysis method.

**Table 3.9 Data and Observation for Specific Gravity test of Natural Coarse Aggregate**

| S. No | Determination                  | Notation       | Mass in (g) |
|-------|--------------------------------|----------------|-------------|
| 01    | Empty weight of pycnometer     | M <sub>1</sub> | 602g        |
| 02    | Pycnometer + Coarse aggregate  | M <sub>2</sub> | 1109g       |
| 03    | Pycnometer + aggregate + water | M <sub>3</sub> | 1748g       |
| 04    | Pycnometer + water             | M <sub>4</sub> | 1435g       |

$$\begin{aligned} \text{Specific gravity, } G &= \frac{(M_2 - M_1)}{(M_2 - M_1) - (M_3 - M_4)} \\ &= \frac{(1109 - 602)}{(1109 - 602) - (1748 - 1435)} \end{aligned}$$

$$\text{Specific gravity, } G = 2.61$$

### Surface Moisture of NCA

As per IS: 2386 (Part III)-1963, the surface moisture of the NCA was found out. This test also carried out by using the pycnometer method.

Calculation:

$$w = \left[ \frac{M_2 - M_1}{M_3 - M_4} \left( \frac{G-1}{G} \right) - 1 \right] \times 100$$

$$= \left[ \frac{1231 - 599}{1872 - 1475} \left( \frac{2.689 - 1}{2.689} \right) - 1 \right] \times 100$$

$$= [1.59(0.63) - 1] \times 100 = 0.17\%$$

$$w = 0.17\%$$

### Sieve Analysis of Natural Coarse Aggregate

Sieve analysis was conducted on recycled coarse aggregate following the guidelines of IS 2386 (part 1) -1963, and the outcomes are displayed in Table 3.10. The experiment utilized 1000g of coarse aggregate in the sieve analysis method.

**Table 3.10 Data and observation sheet for the sieve analysis**

| S. No | IS sieve size in (mm) | Weight of aggregate retained in (g) | % Retained | Cumulative % retained(N) | % Finer (100 -N) |
|-------|-----------------------|-------------------------------------|------------|--------------------------|------------------|
| 01    | 20                    | 0                                   | 0          | 0                        | 100%             |
| 02    | 16                    | 472                                 | 51.87      | 51.87                    | 48.13%           |
| 03    | 12.5                  | 398                                 | 43.74      | 95.61                    | 4.39%            |
| 04    | 10                    | 40                                  | 4.39       | 100                      | -                |
|       |                       | $\Sigma=910g$                       |            | 247.48                   |                  |

### Fineness Modulus of Natural Coarse Aggregate

As per IS 2386 – PART III 1963, the larger the value of fineness modulus, the course is the material.

$$\text{Fineness Modulus} = \frac{\text{cumulative \% retained}}{100}$$

$$= \frac{247.48+500}{100}$$

$$= \frac{747.48}{100}$$

∴ Fineness Modulus of NCA = 7.47

### **Elongation Index of Natural Coarse Aggregate**

The elongation index of aggregates indicates the weight percentage of particles where their greatest dimension (length) exceeds 1.8 times their mean dimension. The test outcomes are provided in Table 3.15 below.

**Table 3.11 Data and Observation for Elongation Index of Natural Coarse Aggregate**

| <b>S. No</b> | <b>Sieve fraction</b> | <b>Weight in each fraction</b> | <b>Weight in each fraction of total weight Y</b> | <b>Weight of elongated aggregate in each fraction(g)</b> | <b>Weight of elongated aggregate as a fraction X</b> | <b>% Weight of elongated aggregate XY</b> |
|--------------|-----------------------|--------------------------------|--------------------------------------------------|----------------------------------------------------------|------------------------------------------------------|-------------------------------------------|
| 01           | 25-20                 | 1573                           | 0.4583                                           | 217                                                      | 0.1379                                               | 6.32                                      |
| 02           | 20-16                 | 953                            | 0.2776                                           | 356                                                      | 0.3755                                               | 10.32                                     |
| 03           | 16-12.5               | 534                            | 0.1555                                           | 280                                                      | 0.5243                                               | 8.15                                      |
| 04           | 12.5-10               | 116                            | 0.0745                                           | 168                                                      | 0.6563                                               | 4.89                                      |

Elongation index =  $\sum XY$  = 8.18%

### Flakiness Index of NCA

The flakiness index of an aggregate represents the weight percentage of particles with a least dimension (thickness) less than 0.6 of their dimensions. The test results are presented in Table 3.12 below.

**Table 3.12 Data and Observation for Flakiness Index of Natural Coarse Aggregate**

| S. No | Sieve Fraction | Weight in each fraction | Weight in each Fraction of Total weight Y | Weight of Flaky Aggregate in each Fraction (g) | Weight of Flaky Aggregate as a Fraction of Each Fraction X | % Weight of Flaky Aggregate XY |
|-------|----------------|-------------------------|-------------------------------------------|------------------------------------------------|------------------------------------------------------------|--------------------------------|
| 01    | 25-20          | 1573                    | 0.4583                                    | 175                                            | 0.1112                                                     | 5.096                          |
| 02    | 20-16          | 953                     | 0.2776                                    | 135                                            | 0.1416                                                     | 3.931                          |
| 03    | 16-12.5        | 534                     | 0.1555                                    | 40                                             | 0.0749                                                     | 1.165                          |
| 04    | 12.5-10        | 256                     | 0.0337                                    | 46                                             | 0.1749                                                     | 1.34                           |

$$\text{Flakiness index} = \sum XY = 24.9\%$$

### 3.9 TESTS ON RECYCLED COARSE AGGREGATE (DEMOLISHED CONCRETE WASTE)

As per IS 2386 Part I, Part III – 1963 & IS 383 -1970, the test was carried out on RCA.

### Water absorption test of RCA

Aggregate was weighed for 1000g and then immersed in water for about 24 hours. The surface dried sample was dried in a oven and then the dry weight was noted and calculations was done, as per IS 2386 (Part III) – 1963.

Calculation:

Weight of RCA after soaked in water for 1 hour ( $W_1$ ) = 500g

Weight of RCA after heated in dry oven for 1 hour ( $W_2$ ) = 480g

$$\begin{aligned}\text{Water absorption in \%} &= \frac{W_1 - W_2}{W_1} \times 100 \\ &= \frac{500 - 480}{500} \times 100\end{aligned}$$

Water absorption of RCA in % = 4%

### Impact strength of RCA

Impact strength for RCA was carried out for aggregate passing 12.5 mm and retained on 10 mm. The result was tabulated in the table 3.13.

**Table 3.13 Data and Observation for Impact Strength test of RCA**

| S. No | Details of sample                                             | Trial I |
|-------|---------------------------------------------------------------|---------|
| 01    | Weight of sample filling cylinder mold (W)                    | 1372    |
| 02    | Weight of sample weighing in cylinder ( $W_1$ )               | 538     |
| 03    | Weight of aggregate passing 2.36mm ( $W_2$ )                  | 141     |
| 04    | Aggregate Impact value A.I.V = $\frac{W_2}{W_1} \times 100\%$ | 26.21   |

$$\text{Mean} = \frac{538 \times 100}{141}$$

∴ The Impact value for RCA = 26.21 %

### Specific Gravity of RCA

Specific gravity is carried out for the coarse aggregate passing 20mm and retained on 4.75mm. AS per IS: 2386 (Part III)-1963 the test was carried out. The result was tabulated in the Table 3.14.

**Table 3.14 Data and observation for Specific Gravity test of RCA**

| S. No | Description              | Notation | In (g) |
|-------|--------------------------|----------|--------|
| 01    | Weight of pycnometer     | $W_1$    | 598    |
| 02    | Pycnometer + RCA         | $W_2$    | 1104   |
| 03    | Pycnometer + RCA + water | $W_3$    | 1716   |
| 04    | Pycnometer + water       | $W_4$    | 1432   |
| 05    | Specific gravity         | G        | 2.28   |

Calculation:

$$\begin{aligned} \text{Specific gravity, } G &= \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)} \\ &= \frac{1104 - 598}{222} \end{aligned}$$

The specific gravity of RCA,  $G = 2.28$

### Surface Moisture of NCA

As per IS: 2386 (Part III)-1963, the surface moisture of the NCA was found out. This test also carried out by using the pycnometer method.

Calculation:

$$w = \left[ \frac{M_2 - M_1}{M_3 - M_4} \left( \frac{G-1}{G} \right) - 1 \right] \times 100 = \left[ \frac{1112 - 600}{1796 - 1476} \left( \frac{2.67-1}{2.67} \right) - 1 \right] \times 100$$

$$= [1.6(0.63) - 1] \times 100\%$$

$$w = 0.8\%$$

### Sieve Analysis of RCA

The sieve analysis on recycled coarse aggregate was carried out as per IS 2386 (part I) -1963 and the results are presented in Table 3.15. The Experiment was carried out with 1000g of Coarse Aggregate in sieve analysis method.

**Table 3.15 Data and observation for Sieve Analysis of RCA**

| S. No | IS Sieve (mm) | Weight of sample retained (g) | Percentage retained in % | Cumulative Percentage retained (N) in % | Percentage Finer (100 – N) in % |
|-------|---------------|-------------------------------|--------------------------|-----------------------------------------|---------------------------------|
| 01    | 40            | 16                            | 0                        | 0                                       | 100                             |
| 02    | 20            | 125                           | 1.49                     | 1.49                                    | 98.51                           |
| 03    | 16            | 237                           | 11.66                    | 13.51                                   | 86.85                           |
| 04    | 12.5          | 330                           | 22.10                    | 35.25                                   | 64.75                           |
| 05    | 10            | 196                           | 30.78                    | 66.03                                   | 33.97                           |
| 06    | 6.3           | 196                           | 13.63                    | 81.34                                   | 15.69                           |
| 07    | 4.75          | 146                           | 18.28                    | 97.33                                   | 4.06                            |
| 08    | PAN           | 22                            | 13.61                    | 99.33                                   | 2.08                            |
|       |               | $\Sigma = 1027$               |                          | $\Sigma = 298.15$                       |                                 |

### Fineness Modulus of RCA

As per IS 2386 – Part III 1963, the larger the value of fineness modulus, the course is the material.

Calculation:

$$\text{Fineness Modulus} = \frac{\text{cumulative \% retained}}{100}$$

∴ Fineness Modulus of RCA = 2.98

### Elongation Index of RCA

The elongation index on aggregates is the percentage by weight of particles whose greatest dimension (length) is greater than 1.8 times their mean dimension.

The results of the test are as given below in Table 3.16.

**Table 3.16 Data and Observation for Elongation Index and Flakiness Index of RCA**

| S. No | Sieve Size mm |          | Weight of sample(g) (A) | Weight of sample on tk Gauge (B) | Weight of sample Pass through tk (C) | Weight of sample Retained on length gauge (D) |
|-------|---------------|----------|-------------------------|----------------------------------|--------------------------------------|-----------------------------------------------|
|       | Passing       | Retained |                         |                                  |                                      |                                               |
| 01    | 20            | 16       | -                       | -                                | -                                    | -                                             |
| 02    | 16            | 12.5     | -                       | -                                | -                                    | -                                             |
| 03    | 12.5          | 10       | 422                     | 372                              | 50.00                                | 32                                            |
| 04    | 10            | 6.3      | 266                     | 221                              | 45.00                                | 24                                            |
| 05    | Total         |          | 688                     | 593                              | 95                                   | 56                                            |

$$\text{Elongation Index EI} = \frac{D}{B} \times 100 = 9\%$$

### Flakiness Index of RCA

The flakiness index of an aggregate indicates the weight percentage of particles within it with a thickness less than 0.6 times their dimensions.

Flakiness Index  $FI = C/A \times 100$  = 14%

FI&EI Combined = 23%

### Aggregate Crushing Value of RCA

The Aggregate Crushing Value (ACV) provides a relative indication of an aggregate sample's resistance to crushing under a gradually applied compressive load. The test results are presented in Table 3.17 below.

**Table 3.17 Aggregate Crushing Value of Recycled Aggregate**

| S. No | Description of Item                                | Trail/Test Number |           |       |
|-------|----------------------------------------------------|-------------------|-----------|-------|
|       |                                                    | 1                 | 2         | 3     |
| 01    | Weight of dry Sample Passing 12.5mm (g)-W1         | 400               | 405       | 403   |
| 02    | Weight of Fraction passing 2.36mm sieve-W2         | 102               | 94        | 97    |
| 03    | Weight of Fraction retained on 2.36mm sieve        | 298               | 311       | 306   |
| 04    | Aggregate Impact Value = $(W2/W1) \times 100$ in % | 25.50             | 23.2<br>1 | 24.07 |
| 05    | Average                                            | 24.47%            |           |       |

The aggregate crushing value of the given coarse aggregate is = 24.47%

## **CHAPTER 4**

### **EXPERIMENTAL INVESTIGATION**

#### **4.1 GENERAL**

Mix design involves the selection of appropriate concrete ingredients and determining their optimal proportions with the aim of achieving concrete with specified minimum strength and durability, while also being as cost-effective as feasible.

#### **4.2 MIX DESIGN**

At this juncture, it's advantageous to reexamine the interaction between aggregate and paste, the fundamental components of concrete. The ease of handling the mixture is facilitated by the lubricating effect of paste, which is influenced by its degree of dilution. The strength of concrete is primarily dictated by the strength of paste, as mineral aggregates generally surpass it in strength, with few exceptions. The permeability of concrete largely hinges on the quality and continuity of the paste, as water infiltration through aggregates, whether due to pressure or capillarity, is minimal. Moreover, the primary contributor to drying shrinkage in concrete is the paste. Given that the properties of concrete are significantly shaped by the paste, it's advantageous to delve deeper into its composition. Fresh paste consists of a suspension, not a solution, of cement in water. A more diluted paste leads to greater spacing between cement particles, consequently weakening the overall paste structure. Holding other variables constant, in workable mixes, the concrete's strength diminishes inversely with the water-to-cement ratio. Hence, reducing the water content to form the least amount of paste is essential, underscoring the importance of precise measurement.

#### **TYPES OF MIXES:**

##### **Nominal Mixes:**

Historically, concrete specifications outlined the ratios of cement, fine aggregates, and coarse aggregates. These fixed ratios, known as nominal mixes, ensure sufficient strength and provide simplicity in mixing. Typically, nominal mixes have a strength margin higher than what is specified under normal conditions.

## **Standard Mixes**

Nominal mixes with fixed cement-aggregate ratios (by volume) exhibit significant variability in strength and can lead to either under or over-rich mixes. To address this issue, many specifications include minimum flexural strength requirements, terming these mixes as standard mixes. IS 456-2000 classifies concrete mixes into several grades such as M10, M15, M20, M25, M30, M35, and M40. In this classification, the letter M denotes the mix, while the number indicates the specified 28-day cube strength of the mix in N/mm<sup>2</sup>. The grades M10, M15, M20, and M25 roughly correspond to mix proportions of (1:3:6), (1:2:4), (1:1.5:3), and (1:1:2) respectively.

## **FACTORS AFFECTING THE CHOICE OF MIX PROPORTIONS:**

### **Compressive Strength**

Flexural strength is a critical property of concrete, impacting numerous other characteristics of hardened concrete. The mean flexural strength needed at a particular age, typically at 28 days, establishes the nominal water-cement ratio of the mixture.

### **Workability**

The necessary level of workability is influenced by three key factors: the dimensions of the concrete section, the quantity of reinforcement, and the compaction technique to be employed.

### **Durability**

Concrete durability refers to its ability to withstand harsh environmental conditions. Typically, high-strength concrete exhibits greater durability compared to low-strength concrete.

### **Maximum Nominal size of Aggregate**

IS 456:2000 and IS 1343:1980 recommend that the nominal size of the aggregate should be as large as possible.

#### **4.3 MIX PROPORTIONS:**

##### **Grade designation: M30**

Type of Cement: Ordinary Portland cement (OPC) :43 grade

Fine Aggregate: zone-2

Water- cement ratio: 0.45 parts (adjust based on the water-cement ratio)

Minimum cement content: 320 kg/m<sup>3</sup> (IS-456, table-3)

Maximum nominal size of aggregate: 20mm.

Exposure condition – severe (IS:456, table-3)

Workability in terms of slump – 100mm (IS-456-CI.7.1)

Maximum cement content - 450kg/m<sup>3</sup> (IS-456: CI.8.2.4.2)

##### **• STEPS INVOLVED IN MIX DESIGN:**

1. Determination of target strength
2. Selection of water/cement ratio
3. Selection of water content
4. Calculation of cement content
5. Calculation of coarse aggregate content
6. Calculation of fine aggregate content
7. Calculation of water content
8. Calculation of the mix proportion

- **TARGET STRENGTH:**

$f'_{ck} = f_{ck} + 1.65 s / f_{ck} + x$ , whichever is higher

Where,

$f'_{ck}$  = target average compressive strength at 28 days,

$f_{ck}$  = characteristics compressive strength at 28 days,

$s$  = standard deviation.

$x$  = factor based on grade of concrete as per table-1

$s = 5.0 \text{ N/mm}^2$  (IS-10262:2019, Table-2)

$x = 6.5 \text{ N/mm}^2$  (IS-10262:2019, Table-1)

$f'_{ck} = 30 + 1.65 \times 5 = 38.25 \text{ N/mm}^2$

$f'_{ck} = 30 + 6.5 = 36.5 \text{ N/mm}^2$

hence,  $F'_{ck} = 38.25 \text{ N/mm}^2$

- **WATER – CEMENT RATIO**

Exposure – Severe (IS-456-2000, Table-3&5)

Water cement ratio – 0.45

- **WATER CONTENT**

IS-10262, Table- 4

20mm aggregate – 186kg (for 50mm slump) for every 25mm- add 3% (IS-10262-Cl.5.3)

for 125mm,  $186 + 6\% \text{ of } 186 = 191.58 \text{ kg/m}^3$

Water content =  $191.58 \text{ kg/m}^3$

- **CALCULATION OF CEMENT CONTENT**

Water cement ratio = water content / cement content

cement content = water content / water cement ratio

$$= 191.58 / 0.45 = 425.73 \text{ kg / m}^3$$

For durability check with the minimum cement required. Minimum cement for M30 – 320kg/ m<sup>3</sup>,

$$425.73 \text{ kg/ m}^3 > 320 \text{ kg/ m}^3$$

Cement Content = 425.73 kg/ m<sup>3</sup>

- **AGGREGATE PROPORTION BETWEEN C.A & F.A**

I S- 10262, Table-5, Cl.5.5.1

zone – 2 – 0.62 [ w/c ratio – 0.5]

Every 0.05 decrease, increase 0.01 [w/c ratio – 0.45]

$$0.45 - 0.4 = -0.05$$

$$0.62 + 0.01 = 0.63$$

For concrete Cl5.5.2(10% reduction)

$$0.63 \times 0.9 = 0.567 \text{ m}^3$$

For 1 m<sup>3</sup>, volume Coarse aggregate = 0.567 m<sup>3</sup>

Volume of Fine Aggregate = 1- 0.567 = 0.433 m<sup>3</sup>

- **MIX CALCULATION**

Volume of concrete = 1 m<sup>3</sup>

volume of cement = (mass / sp.gravity) x (1/1000) = 425.73 / (3.15x1000) = 0.138 m<sup>3</sup>

Volume of Cement = 0.138 m<sup>3</sup>

Volume of Water (c) = (Mass/ Sp.gravity) X (1/1000) = 192 / (1x1000)

Volume of water = 0.192 m<sup>3</sup>

- **VOLUME OF ALL IN AGGREGATES**

$$1 - (b + c) = 1 - (0.134 + 0.192) = 0.674 \text{ m}^3$$

- **MASS OF COARSE AGGREGATE**

$$(\text{Vol. of all in Aggregate}) \times (\text{Vol. of C.A}) \times (\text{Sp. Gravity of C.A}) \times (1000)$$

$$= 0.674 \times 0.63 \times 2.73 \times 1000$$

$$= 1143 \text{ kg}$$

$$\text{Mass of Coarse Aggregate} = 1143 \text{ kg}$$

- **MASS OF FINE AGGREGATE**

$$(\text{Vol. of all in Aggregate}) \times (\text{Vol of F. A}) \times (\text{Sp. gravity of F.A}) \times (1000)$$

$$0.674 \times 0.37 \times 2.46 \times 1000 = 697.2 \text{ kg}$$

$$\text{Mass of fine aggregate} = 697.2 \text{ kg}$$

### **Summary**

$$\text{Cement} = 425.73 \text{ kg/m}^3$$

$$\text{Water} = 191.58 \text{ kg/m}^3$$

$$\text{Fine Aggregate} = 697.2 \text{ kg/m}^3$$

$$\text{Coarse Aggregate} = 1102 \text{ kg/m}^3$$

$$\text{Water Cement Ratio} = 0.45$$

$$\text{Steel Fibre} = 4.26 \text{ kg/ m}^3$$

$$\text{Main Reinforcement} = 12\text{mm } \emptyset \text{ bars}$$

$$\text{Secondary reinforcement} = 8\text{mm } \emptyset \text{ bars @ } 150\text{mm c/c}$$

$$\text{Dimension of Beam} = 0.23 \times 0.15 \times 1.8 \text{ m}$$

## PROPORTION:

Therefore, the mix proportions for casting = **1:1.64:2.59**

## 4.4 PREPARATION OF SPECIMENS

**Table 4.1 Proportion of Materials**

| Description           | Fine Aggregate (%) | Coarse Aggregate (%) | Demolished Concrete as Fine Aggregate (%) | Demolished concrete as Coarse Aggregate (%) |
|-----------------------|--------------------|----------------------|-------------------------------------------|---------------------------------------------|
| Conventional concrete | 100                | 100                  | 0                                         | 0                                           |
| Specimen-1            | 0                  | 0                    | 100                                       | 100                                         |

**Table 4.2 Number of test specimens**

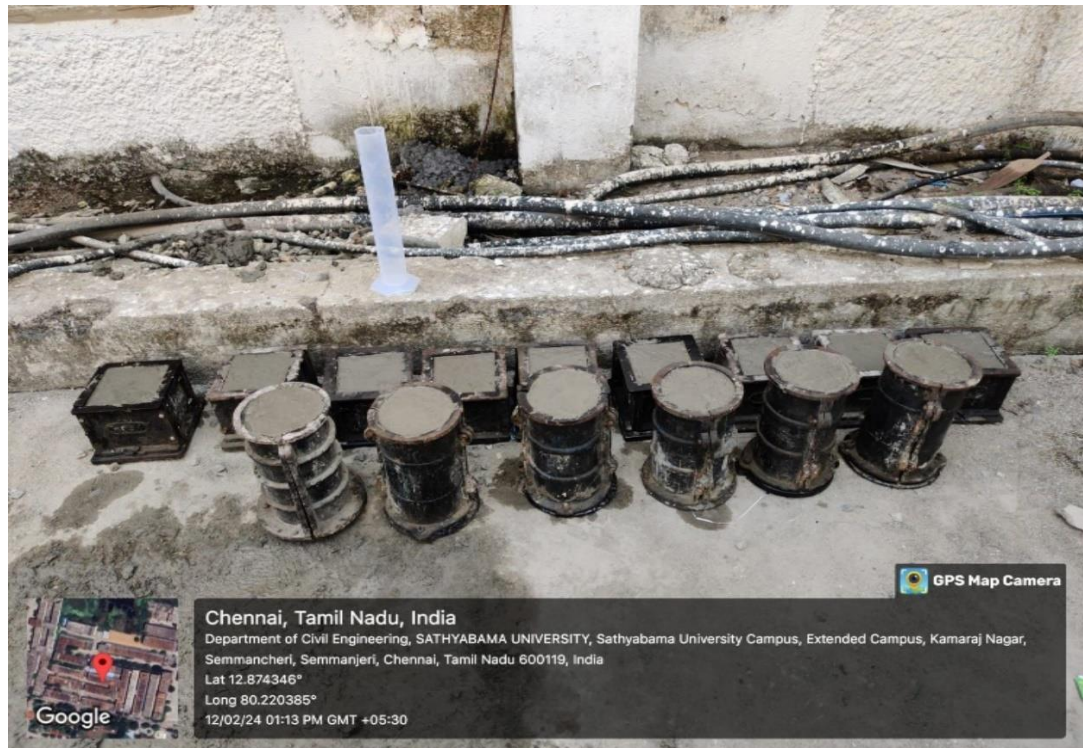
| Description           | Cube |    |    | Cylinder |    |    | Beam |    |    |
|-----------------------|------|----|----|----------|----|----|------|----|----|
| Number of days Curing | 7    | 14 | 28 | 7        | 14 | 28 | 7    | 14 | 28 |
| Conventional concrete | 3    | 3  | 3  | 2        | 2  | 2  | 0    | 0  | 0  |
| Specimen-1            | 0    | 0  | 1  | 0        | 0  | 1  | 0    | 0  | 1  |

1. Gathering Tools and Materials: Gather the necessary tools and materials, including moulds for the blocks, cement, sand, and water.
2. Mixing the Ingredients: Combine the ingredients according to the specified proportions of 1:1.64:2.59, along with water.

3. Casting of Cubes, Cylinders, and Beams: Remove and clean the cube, cylinder, and beam moulds, ensuring all bolts are securely tightened.
4. Manual Compaction and Casting: Fill the moulds for cubes, cylinders, and beams in three layers, compacting each layer using a vibrator.
5. Curing: Place the casted cubes, cylinders, and beams in a sheltered area with minimal vibration. Maintain a temperature range of 22 to 33 degrees Celsius.
6. Marking: Clearly mark the cubes, cylinders, and beams after the initial curing period. Submerge the specimens in clean water for 7 or 28 days after removing them from the moulds at the end of 24 hours.



**Fig:4.1 Mixing of Concrete**



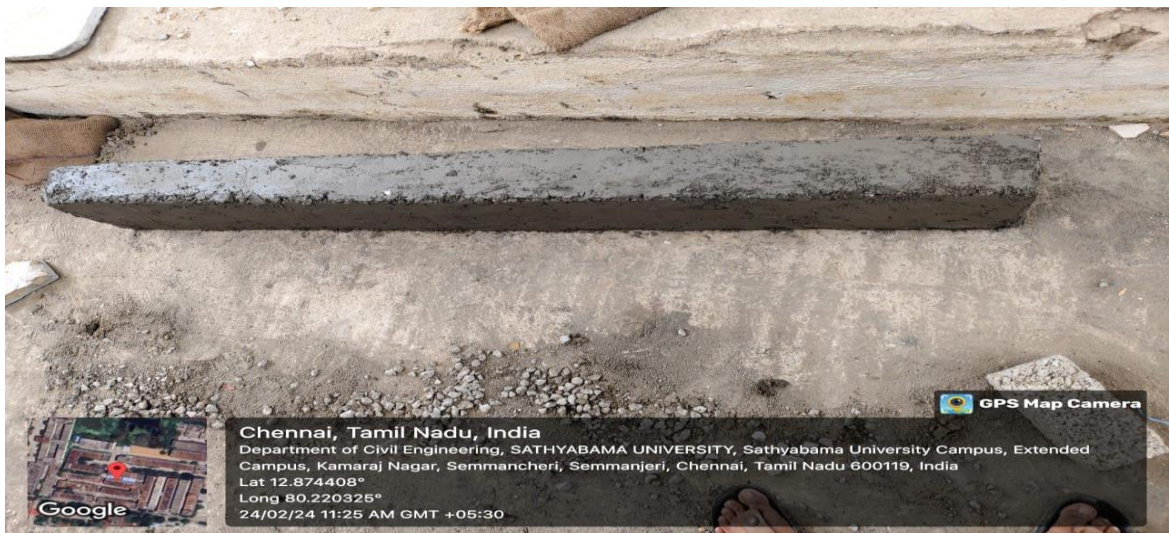
**Fig: 4.2 Casting of Cubes & Cylinders**



**Fig 4.3 Shuttering Plates for Beam Casting**



**Fig 4.4 Casting of Beam**



**Fig 4.5 After Removal of Shuttering Plates**



**Fig 4.6 Curing of Beam**

## 4.5 TESTING OF SPECIMENS

- **Compressive Strength Test**

The compressive strength test evaluates the concrete's ability to resist compression forces, ensuring it meets structural requirements and safety standards for construction projects.

- **Split Tensile Strength Test**

The split tensile strength test measures the tensile strength of concrete, crucial for assessing its ability to resist cracking and endure tensile stresses, ensuring structural durability in construction applications.

- **Flexural Strength Test**

The flexural strength assessment examines a material's capacity to withstand bending forces, essential for evaluating its structural integrity and longevity, especially in scenarios where bending loads are prevalent, like beams and slabs in construction projects.

### 4.5.1 COMPRESSIVE STRENGTH TEST

The compressive strength of concrete is impacted by several elements, including the ratio of water to cement, the strength of the cement itself, the quality of the concrete ingredients, and the level of quality control during production. Compressive strength denotes a material or structure's ability to withstand loads on its surface without developing cracks or deformations. Concrete cubes underwent curing periods of 7, 14, and 28 days, respectively, before undergoing testing. Following the testing of concrete cubes using a compression testing apparatus, the average compressive strength for each hydration period was measured and documented.

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{Maximum load}}{\text{Area of cross section}} = \frac{P}{A}$$

The specimens are subjected to compression testing using a compression test apparatus following curing periods of 7, 14, and 28 days. Load is gradually applied at a rate of 140 kilograms per square centimeter per minute until the specimen

reaches failure. Compressive strength is calculated by dividing the load at failure by the cross-sectional area of the specimen. Cubic specimens with standard dimensions of 150 mm x 150 mm x 150 mm are subjected to compressive loading, and three trials are conducted with identical specimens. Mean values are recorded in the table.  $FC = P/A$

Where, FC= Compressive strength (N/mm<sup>2</sup>)

P = Ultimate load (N) or Breaking Load

A = Loaded area (150 mm X 150 mm) = 22500 mm<sup>2</sup>

### **Apparatus required**

The sand utilized in the test must adhere to the standards outlined in IS: 650-1966. Additionally, the equipment required includes a Vibration Machine, Poking Rod, Cube Mold with dimensions of 70.6 mm conforming to IS: 10080-1982, Balance, Gauging Trowel, Stopwatch, Graduated Glass Cylinders, and other necessary tools.

### **Procedure**

- Position the cube centrally on the lower plate of the compression testing machine to ensure that the load is evenly distributed to opposite sides, aligning with its original casting orientation rather than the top and bottom surfaces.
- Ensure accurate alignment of the specimen's axis with the center of the thrust of the spherically seated platen. Avoid the use of any packing material between the test specimen and the steel platen.
- Gradually and smoothly apply the load at a rate of approximately 140 kg/cm<sup>2</sup> per minute until the specimen fails under the increasing load, while recording the maximum load applied



**Fig:4.7 Compressive Strength Test**

**Table:4.3 Compressive Strength Test of Conventional Concrete Cubes**

| Number of Days | Compressive Strength Test (N/mm <sup>2</sup> ) |        |        |         |
|----------------|------------------------------------------------|--------|--------|---------|
|                | Cube 1                                         | Cube 2 | Cube 3 | Average |
| 7 Days         | 17.7                                           | 18.4   | 22.2   | 19.43   |
| 14 Days        | 18.2                                           | 13.33  | 18.6   | 16.7    |
| 28 Days        | 13.5                                           | 13.11  | 17.7   | 14.76   |

#### **4.5.2 SPLIT TENSILE STRENGTH TEST**

The tension strength of concrete refers to its ability to withstand tensile stresses. This is evaluated through the split tensile test conducted on cylindrical concrete specimens. Tensile strength in concrete specimens is characterized by the tensile stresses generated when subjected to compressive loads.

The expression for calculating the split tensile strength  $T_{sp}$  of the concrete.

$$T_{sp} = \frac{2P}{\pi DL}$$

Here, the term

$P$  is applied load on the concrete

$D$  is cylindrical specimen diameter

$L$  is cylindrical specimen length

#### **Apparatus required**

**Testing Machine:** The testing machine can be of any trustworthy variety, with adequate capacity for the tests and capable of applying the load at the specified rate in section 5.5. The allowable error should not exceed 2 percent of the maximum load. **Cylinders:** The cylindrical mold should have a diameter of 150 mm and a height of 300 mm, conforming to IS: 10086-1982. **Weights and weighing device, tools, containers for mixing, and tamper** (square in cross-section) are required for the testing process.



**Fig:4.8 Tensile Strength Test**

### Procedure

- **Sampling of Materials:** Aggregate samples for each concrete batch should match the desired grading and be in a state of air drying. Upon arrival at the laboratory, cement samples need to undergo thorough dry mixing, either manually or with an appropriate mixer, to ensure optimal blending and uniformity.
- **Proportioning:** The proportions of materials, including water, in concrete mixes used for assessing material suitability, must closely resemble those intended for actual construction.

- **Weighing:** Cement, aggregate sizes, and water quantities for each batch should be determined by weight, with an accuracy of 0.1 percent of the total batch weight.
- **Mixing Concrete:** Concrete should be mixed by hand or, preferably, in a laboratory batch mixer to prevent loss of water or material. Each batch should have approximately 10 percent excess after moulding the required number of test specimens.
- **Mould:** Cylindrical moulds should conform to S: 10086-1982 and have a diameter of 150 mm and a height of 300 mm.
- **Compacting:** Test specimens should be promptly made after mixing to achieve full compaction without segregation or excessive laitance.
- **Curing:** Test specimens should be stored in a vibration-free area with moist air at a minimum of 90 percent relative humidity and a temperature of  $27^{\circ} \pm 2^{\circ}\text{C}$  for 24 hours  $\pm$  1 hour from the addition of water to the dry ingredients.
- **Placing the Specimen in the Testing Machine:** Clean the bearing surfaces of the supporting and loading rollers, ensuring removal of any loose sand or debris from the specimen surfaces where they contact the rollers. Additionally, provide two bearing strips of nominal thickness (1/8 in or 3.175 mm), approximately 25 mm wide, and slightly longer than the specimen's length for each specimen.

**Table:4.4 Tensile Strength Test Values**

| <b>Number of Days</b> | <b>Tensile strength of Cylinder (N/mm<sup>2</sup>)</b> |                   |                |
|-----------------------|--------------------------------------------------------|-------------------|----------------|
|                       | <b>Cylinder 1</b>                                      | <b>Cylinder 2</b> | <b>Average</b> |
| <b>7 Days</b>         | 2.83                                                   | 2.76              | 2.79           |
| <b>14 Days</b>        | 2.76                                                   | 2.97              | 2.86           |
| <b>28 days</b>        | 2.83                                                   | 2.68              | 2.75           |

#### **4.5.3 FLEXURAL STRENGTH TEST**

The flexural test assesses the tensile strength of concrete indirectly by evaluating its ability to resist failure under bending. Results from the flexural test are expressed as a modulus of rupture (MR) in MPa or psi.

This test can be conducted using either the three-point load test (ASTM C78) or the center-point load test (ASTM C293), with the configurations outlined in Figure-2 and Figure-3 respectively. The test method described in this article follows ASTM C78 guidelines.

## **APPARATUS**

Steel, iron cast, or other non-absorbent material moulds, Tamping rods: ASTM specifies both large rods and small rods. A testing machine capable of applying loads uniformly without shocks interruption, Scoop, Trowel, Balance with an accuracy of 10, Power-driven concrete mixer, Table vibration for compacting concrete in moulds if vibration is used.

## **PROCEDURE**

- The specimen underwent testing immediately upon removal from the curing environment to prevent surface dehydration, which could diminish flexural strength.
- Positioning the specimen on the loading points ensured that the hand-finished surface didn't make contact with them, maintaining proper alignment.
- The loading system was centered relative to the applied force, and the force-applying block was brought into contact with the specimen surface at the loading points. Loads ranged from 2 to 6 percent of the calculated ultimate load.
- Feeler gauges of 0.10 mm and 0.38 mm were used to detect any gaps between the specimen and the load-applying or support blocks over a length of 25 mm or more.
- Gaps exceeding 0.10 mm were rectified using leather shims (6.4 mm thick and 25 to 50 mm long) spanning the entire width of the specimen. For gaps surpassing 0.38 mm, capping or grinding was considered.
- Load application proceeded steadily until failure, without abrupt shocks, following the specified rate outlined by Indian standards (400 Kg/min for 150 mm specimen and 180 kg/min for 100 mm specimen) or British standards (stress increase rate of  $0.06 \pm 0.04 \text{ N/mm}^2.\text{s}$ ).

**Table 4.5 Load and Deflection Value**

| Load<br>(N)  | Experimental Deflection<br>(mm) |        |       | Average<br>deflection<br>(mm) | Theoretical<br>Deflection (mm) |                        |
|--------------|---------------------------------|--------|-------|-------------------------------|--------------------------------|------------------------|
|              | Left                            | Centre | Right |                               | $\frac{5PL^3}{162EI}$          | $\frac{23PL^3}{648EI}$ |
| <b>2000</b>  | 0.11                            | 0.13   | 0.11  | 0.11                          | 0.05                           | 0.06                   |
| <b>4000</b>  | 0.28                            | 0.31   | 0.29  | 0.29                          | 0.11                           | 0.13                   |
| <b>6000</b>  | 0.45                            | 0.52   | 0.52  | 0.49                          | 0.17                           | 0.20                   |
| <b>8000</b>  | 0.91                            | 0.42   | 0.56  | 0.63                          | 0.23                           | 0.27                   |
| <b>10000</b> | 1.01                            | 0.57   | 0.71  | 0.76                          | 0.29                           | 0.34                   |
| <b>12000</b> | 1.17                            | 0.77   | 0.89  | 0.94                          | 0.35                           | 0.40                   |
| <b>14000</b> | 1.07                            | 1.11   | 1.02  | 1.06                          | 0.41                           | 0.47                   |
| <b>16000</b> | 1.26                            | 1.32   | 1.26  | 1.28                          | 0.47                           | 0.54                   |
| <b>18000</b> | 1.45                            | 1.50   | 1.40  | 1.45                          | 0.53                           | 0.61                   |
| <b>20000</b> | 1.68                            | 1.78   | 1.64  | 1.7                           | 0.59                           | 0.68                   |
| <b>22000</b> | 1.90                            | 2.05   | 1.88  | 1.94                          | 0.65                           | 0.74                   |
| <b>24000</b> | 2.16                            | 2.34   | 2.15  | 2.21                          | 0.71                           | 0.81                   |
| <b>26000</b> | 2.40                            | 2.62   | 2.40  | 2.47                          | 0.76                           | 0.88                   |
| <b>28000</b> | 2.60                            | 2.86   | 2.63  | 2.69                          | 0.82                           | 0.95                   |
| <b>30000</b> | 2.84                            | 3.12   | 2.89  | 2.95                          | 0.88                           | 1.02                   |
| <b>32000</b> | 3.10                            | 3.44   | 3.19  | 3.24                          | 0.94                           | 1.08                   |
| <b>34000</b> | 3.35                            | 3.73   | 3.47  | 3.51                          | 1.0                            | 1.15                   |
| <b>36000</b> | 3.61                            | 4.01   | 3.76  | 3.79                          | 1.06                           | 1.22                   |
| <b>38000</b> | 3.92                            | 4.38   | 4.12  | 4.14                          | 1.12                           | 1.29                   |
| <b>40000</b> | 4.34                            | 4.89   | 4.60  | 4.61                          | 1.18                           | 1.36                   |



**Fig 4.9 (a) Flexural strength test**



**Fig: 4.9 (b) After applying load**

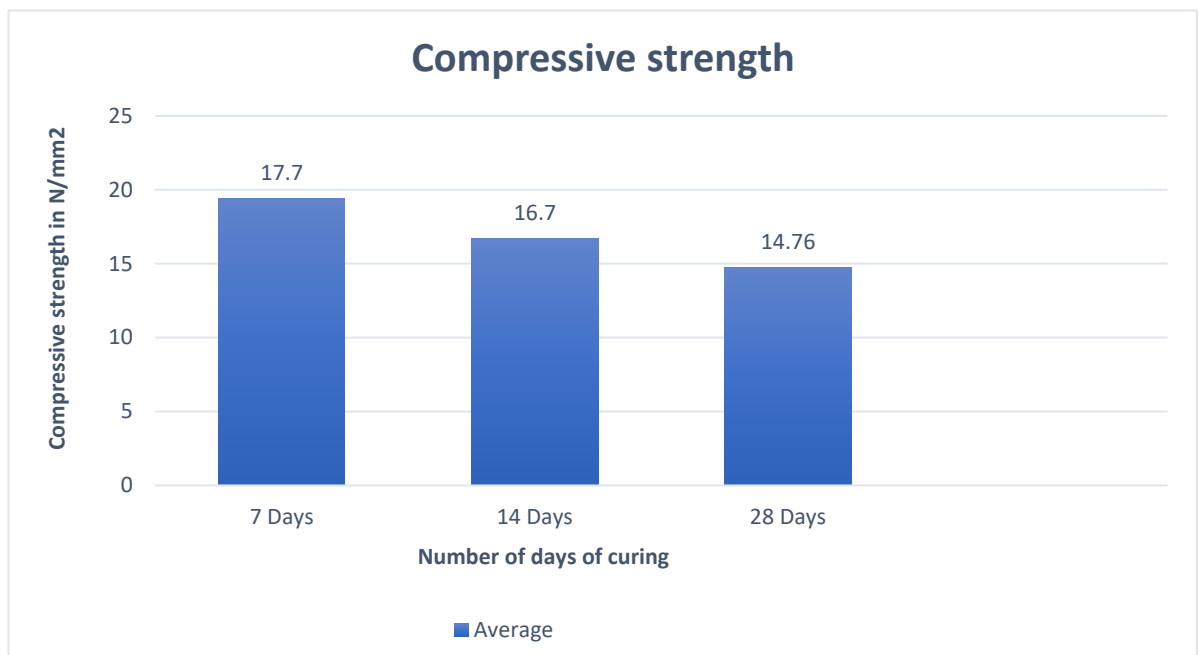
## CHAPTER 5

### RESULTS AND DISCUSSION

#### 5.1 GENERAL

In this chapter the results of Compressive strength test, Split Tensile Strength test, Flexural Strength test was shown in graphical form.

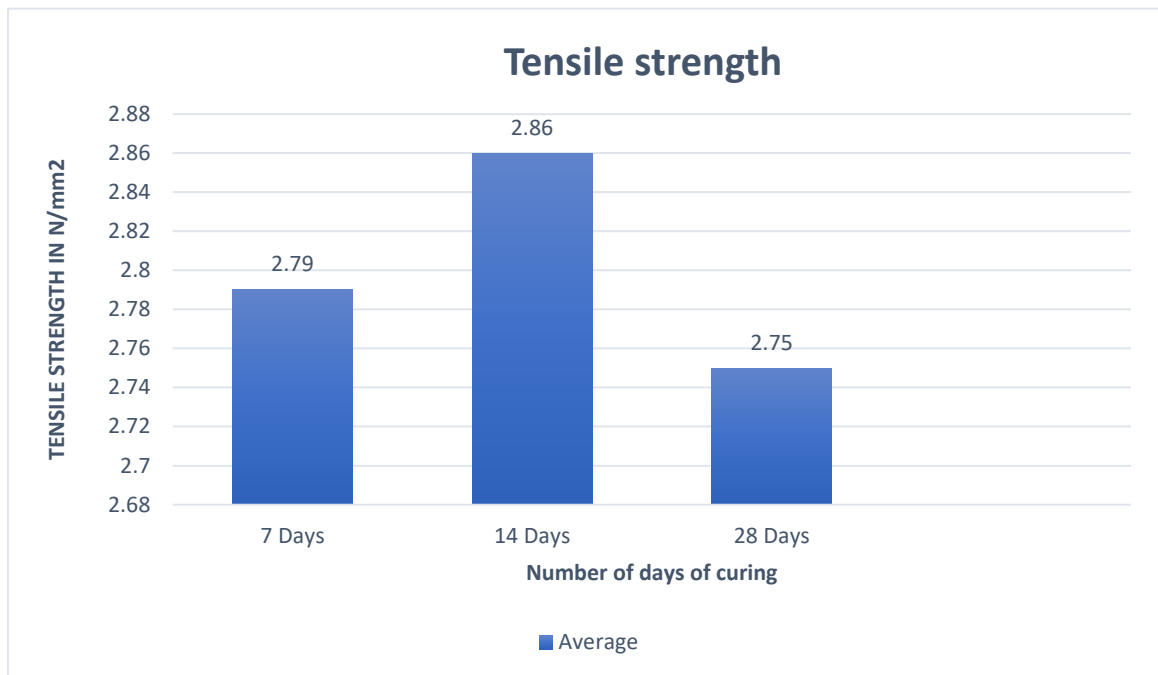
#### 5.2 COMPRESSIVE STRENGTH TEST



**Fig:5.1 Compressive Strength Test values of Fibre Reinforced Concrete**

From the above graph observed that for 7 days cured cubes average Compressive strength value is 17.7 N/mm<sup>2</sup>, for 14 days cured cubes average Compressive strength value is 16.7 N/mm<sup>2</sup> and for 28 days cured cubes average Compressive Strength value is 14.76 N/mm<sup>2</sup>.

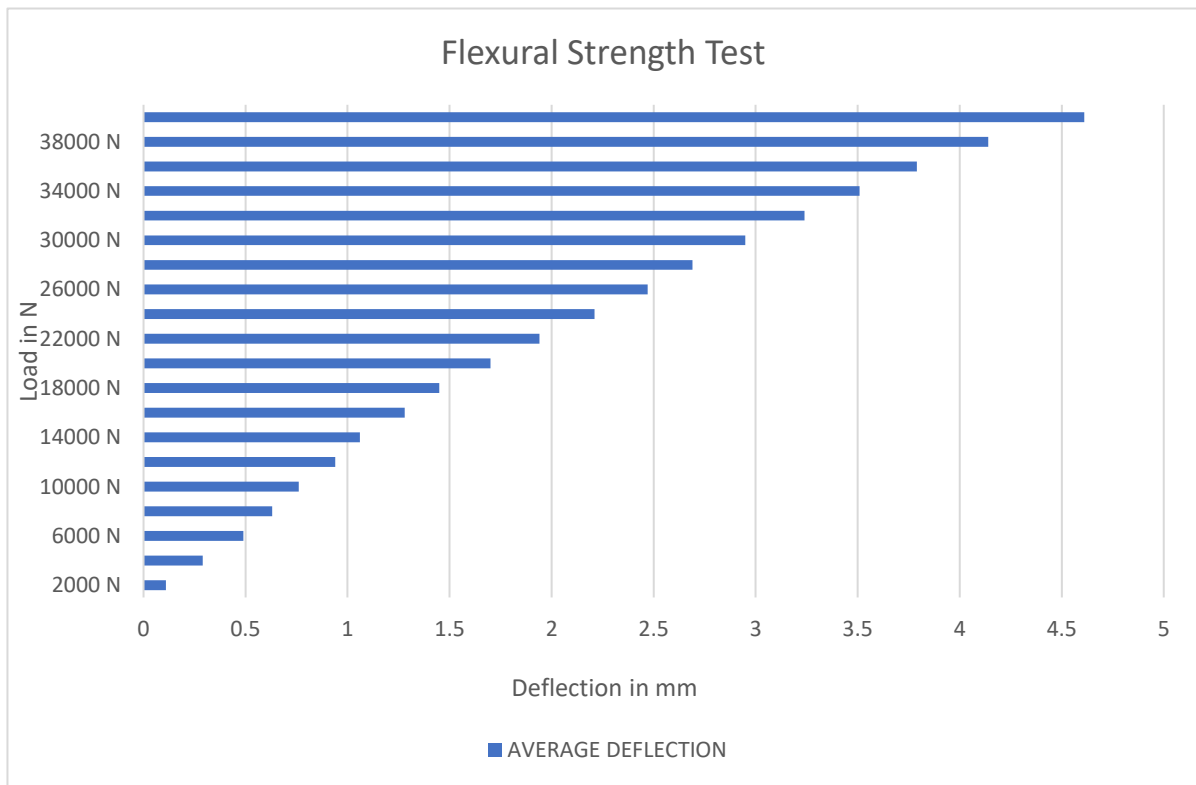
### 5.3 TENSILE STRENGTH TEST



**Fig: 5.2 Tensile Strength test values of Fibre Reinforced Concrete**

From the above graph observed that average Tensile strength value of 7 days cured cylinders are 2.79 N/mm<sup>2</sup>, average Tensile strength value of 14 days cured cylinders are 2.86 N/mm<sup>2</sup> and average Tensile strength value of 28 days cured cylinders are 2.75 N/mm<sup>2</sup>.

## 5.4 FLEXURAL STRENGTH TEST



**Fig 5.3 Deflection values**

From the above graph observed that when load is applying gradually the deflection of beam is increasing. The maximum deflection occurred is 4.61mm at load 40KN.

## CHAPTER 6

### CONCLUSION

Based on the experimental study on Fiber Reinforced Concrete with Demolished Concrete Waste as Fine and Coarse aggregate, the following conclusions were drawn:

- From the Compressive Strength Test results, it was observed that the maximum compressive strength of concrete is  $17.7 \text{ N/mm}^2$  after 7 days of curing, while the minimum compressive strength is  $14.76 \text{ N/mm}^2$  after 28 days of curing.
- From the Split Tensile Strength test results, it was noted that the maximum tensile strength value is  $2.86 \text{ N/mm}^2$  after 14 days of curing, with the minimum value being  $2.75 \text{ N/mm}^2$  after 28 days of curing.
- From the Flexural Strength Test results, it was found that the maximum deflection is 4.51 mm at a load of 40 kn.
- The experimental results suggest that natural fine and coarse aggregates can be entirely replaced by demolished fine and coarse aggregates.

#### **Future Scope:**

- It involves scaling up the implementation across various construction projects to promote sustainability and reduce reliance on natural resources.
- Research into innovative applications and technologies for utilizing demolished aggregates in other construction materials and infrastructure projects.

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