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Effects of Glass Fibre on Mechanical Propertices of Concrete

Prof. Shrikant S. Ingale[1], Pushkar S. Dige[2], Varun V. Patil[3], Tanishk P. Khot[4], Tanishq A. Patil[5], Sarang P. Tandale[6]

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[1]Professor, Department of Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India
[2,3,4,5,6]Diploma Student, Department of Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India

ABSTRACT:
This research delves into the impact of incorporating glass fiber into concrete to enhance its mechanical properties, such as strength and flexibility. Through rigorous testing and theoretical modeling, the study evaluates various factors including strength, flexural quality, and compressive strength, comparing the performance of glass fiber-reinforced concrete (GFRC) to conventional concrete. The results demonstrate that the addition of glass fiber improves the mechanical characteristics of concrete, particularly enhancing ductility and flexural strength. Moreover, GFRC exhibits resilience against environmental stressors like chemical attacks and freeze-thaw cycles, as evidenced by quick maturing tests and natural exposure simulations. By combining experimental data with finite element analysis (FEA), the study gains insights into the stress and strain distribution within GFRC, informing optimization strategies for maximizing its performance in different stacking scenarios.
In conclusion, this research contributes valuable insights into the application of glass fiber as a reinforcing material in concrete production. By showcasing the ability of GFRC to bolster the mechanical properties and durability of concrete structures, the study underscores its potential for creating robust and adaptable frameworks in the construction industry. These findings pave the way for leveraging GFRC technology to address the evolving needs of the development sector, offering promising avenues for future construction projects seeking enhanced performance and longevity.

Keywords: Glass fiber 1, concrete 2, mechanical properties 3, strength 4, flexibility 5, GFRC 6, durability 7, construction industry 8, development sector 9.

1. INTRODUCTION:

Concrete is considered a brittle material, primarily because of its low tensile strain capacity and poor fracture toughness. Reinforcement of concrete with short randomly distributed fibers can address some of the concerns related to concrete brittleness and poor resistance to crack growth. Fibers, used as reinforcement, can be effective in arresting cracks at both micro and macro-levels. At the micro-level, fibers inhibit the initiation and growth of cracks, and after the micro-cracks converts into macro-cracks, fibers provide mechanisms that abate their unstable propagation, provide effective bridging, and impart sources of strength gain, toughness and ductility. Concrete can be modified to perform in a more ductile form by the addition of randomly distributed discrete fibers in the concrete matrix.

Following are some reasons behind choosing this project: -

Because glass fiber have some very good properties that are very useful in construction like as follow

1. High tensile strength: Glass fibers exhibit high tensile strength, making them effective in reinforcing concrete other materials in the tensile strength
2. Lightweight: Compared to traditional reinforcing materials such as steel, fiberglass is lightweight, reducing the overall weight of the reinforced components and making them easier to handle and install
3. Corrosion resistance: Unlike steel reinforcement, fiberglass is non-metallic and corrosion resistant.
4. Chemical resistance: Glass fibers are resistant to a variety of chemicals, making them suitable for applications where exposure to harsh chemicals is a concern, such as wastewater treatment plants or locations manufacturers of medicines
5. Thermal insulation: Glass fibers are resistant to low temperatures, making them effective insulators. This property is useful where thermal insulation is required, such as building facades or insulation.
6. Non-combustible: Fiberglass is corrosion-resistant and highly fire-resistant, making it suitable for use in noncombustible materials and fireproof structures

That are some above properties that makes concrete more stronger and durable when we use glass fiber in concrete in replacement of cement in percentage. Also we know the concrete have a good compressive strength but it don't have any tensile strength, glass fiber helps to gain tensile strength in some percentages also it is very good material for repair and maintenance work.

1.1 Objective

- To prepare a mix design for M25 grade concrete
- To study the compressive strength of M25 grade concrete by replacing cement with Glass fiber up to 5%,10% & 15%.
- To study the strain energy absorption capacity of M25 grade concrete by replacing cement with Glass fiber up to 5%,10% & 15%.
- To improve the property of conventional concrete

1.2 Future Scope & Application

1. Improved Strength and Durability: Glass fibers reinforce concrete, increasing its tensile strength and durability. This can lead to longer-lasting structures with reduced maintenance requirements because reinforcement provided by the glass fiber.
2. Reduced Cracking & Insulation: Glass fibers can help control cracking in concrete especially in situations where temperature fluctuations and shrinkage are concerns. This can result in improved structural integrity, And It provides better thermal and sound insulation compared to traditional concrete.
3. Lightweight and Corrosion-Resistant: Glass fibers are lightweight and corrosion-resistant, making them suitable for applications in marine environments or in areas with aggressive chemical exposure.
4. Architectural Possibilities: The use of glass fibers in concrete can enable innovative and aesthetically pleasing designs in architecture, such as translucent or decorative panels.

1.3 Applications of glass fiber in concrete

1. Enhanced tensile strength: Concrete is strengthened by the use of glass fibers. Concrete is relatively weak in tension even if it is powerful in compression. Glass fibers are added to the concrete matrix to provide reinforcement, which helps to lessen this weakness.
2. Crack resistance: When shrinkage cracking is an issue, glass fibers can help prevent cracks in concrete. In order to distribute stress and stop cracks from spreading, the fibers serve as micro-reinforcement.

3. Enhancement of durability: Glass fibers can make concrete more resilient to environmental elements such chemical erosion, abrasion, and freeze-thaw cycles. Longer service life and lower maintenance costs are the results of this.
4. A flexural performance: Adding glass fibers to concrete can improve its flexural performance making it more resistant to bending and flexing forces. This is particularly beneficial in applications such as pavements, bridge decks, and industrial floors.
5. Fire Resistance: GFRC exhibits good fire resistance properties, making it suitable for applications where fire safety is a concern.
6. Insulation: It provides better thermal and sound insulation compared to traditional concrete.

2. TEST CONDUCTED ON MATERIALS:

➢ Fineness Modules:

To evaluate the particle size distribution of fine and coarse aggregates and make sure they satisfy the required grading standards for concrete mixtures, the fineness modulus is computed for each. This.is reason it matters for both fine and course aggregate. Here are some reasons why the fineness test is important:

1. Grading Assessment
2. Mix Design Optimization
3. Quality Control
4. Performance Prediction

- **Results:**

The fineness modulus of fine aggregate is typically between 2.4 to 3.1and for course aggregate it is between 5.0 to 8.0 but we conclude that the fineness modulus of fine aggregate is 2.99 and for course aggregate is 6.52

"Figure 1: Performing Fineness Modulus Test"

➢ Specific Gravity:

Aggregate density, or mass per unit volume, is measured using the specific gravity test and compared to the density of a reference material, typically water. This is the reason it matters. One of the most important

factors in determining the quality of aggregates used in building is their specific gravity. Here are some reasons why the ductility test is performed:

1. Material Identification
2. Density Determination
3. Purity Assessment
4. Mix Design
5. Quality Assurance in Manufacturing

- **Results:**

Average specific gravity of fine aggregate is typically between 2.5 to 3.0 N/mm^2 and for course aggregate it is between 2.5 to 3.0 N/mm^2 but we conclude that the specific gravity of fine aggregate is 2.61 N/mm^2 and for course aggregate is 2.72 N/mm^2

"Figure 2: Performing Specific Gravity Test"

➢ **Water Absorption:**

It is crucial to undertake water absorption tests on coarse and fine aggregates as this aids in evaluating their quality and functionality in concrete mixtures. The workability, strength, and durability of the concrete mix are affected by the amount of water required during the mixing process due to absorption rates. Through comprehension of these absorption rates, mix designers and engineers may make the necessary adjustments to ensure the long-term stability and performance of the concrete. Here are some reasons why the water absorption test is performed:

1. Material Porosity Evaluation
2. Moisture Content Determination
3. Quality Control in Manufacturing
4. Durability Prediction
5. Comparison of Material

- **Results:**

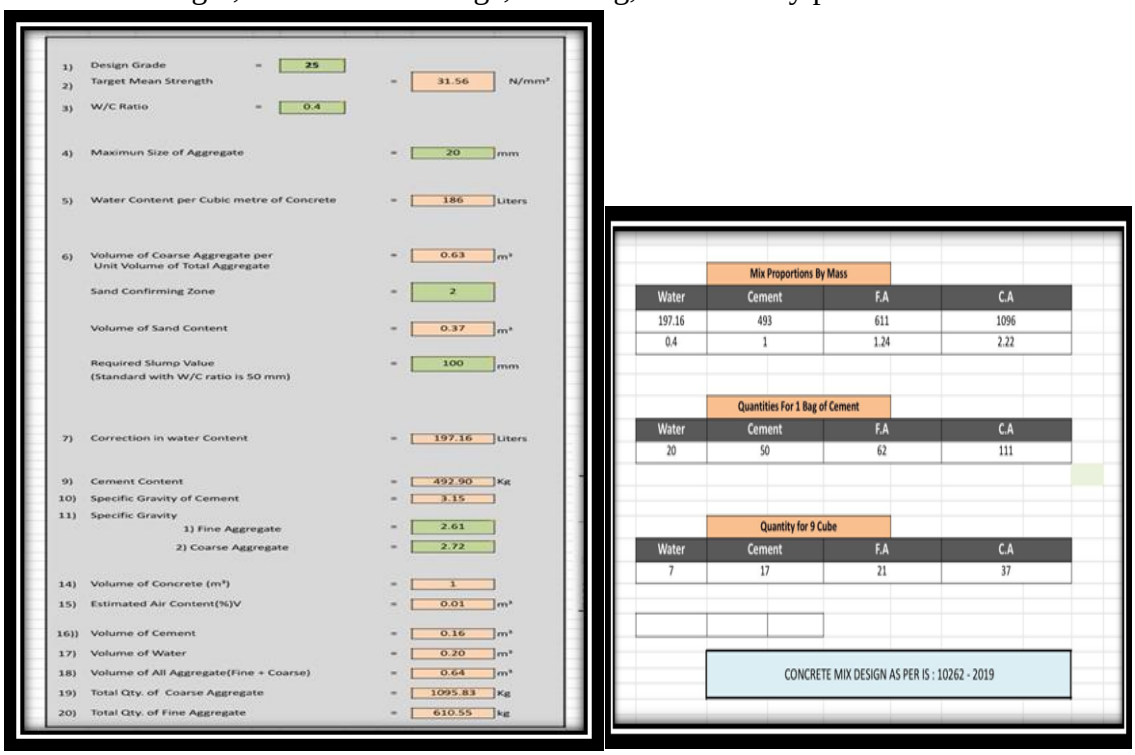
Average Water Absorption of fine aggregate is typically between 3% max and for course aggregate it is between 2% max but we conclude that the water absorption of fine aggregate is 1.39% and for course aggregate is 1.15%

"Figure 3: Performing Water Absorption Test"

2.1 MIX DESIGN OF CONCRETE

Before any concrete is actually made, a concrete mix design is created to make sure the finished product satisfies the project's performance requirements for strength, durability, workability, and other areas. Engineers can optimize a mix to obtain the desired properties by carefully balancing the proportions of cement, sand, aggregates & water, and admixtures. This allows them to take into account several elements, including the surrounding environment, construction methods, and economic concerns.

In order to produce concrete with the required properties, the best ratios and combinations of components must be found through laboratory testing and analysis. After the mix design is decided upon, it acts as a manual for creating dependable and uniform batches of concrete while building is underway. In the end, this proactive strategy ensures the quality and lifespan of the created infrastructure by preventing potential concerns like low strength, excessive shrinkage, cracking, or durability problems.



"Figure 4: Mix Design of Concrete"

- **Link of sheet:**
  https://docs.google.com/file/d/1xDH0ImfTQnB8jsEOthwQ4BsYE1YnzQr/edit?usp=docslist_api&filetype=msexcel

3. TESTING ON SEPCIMANS

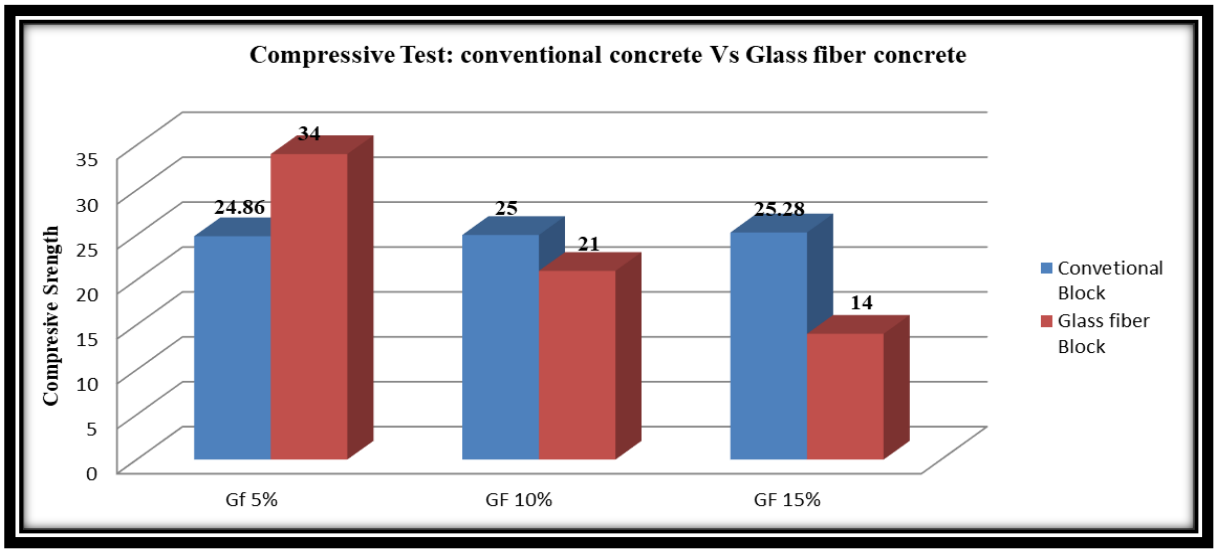
➢ Compressive strength test

The compressive test on concrete involves applying increasing force to a concrete specimen until it breaks. This measures the concrete ability to with stand compressive. Results help assess its quality for structural use, ensuring safety and performing in construction. Here are some reasons why the compressive test is performed:

1. Quality Control
2. Structural Integrity
3. Material selection
4. Cost Optimization
5. Safety Assurance

- **Results:**

As per the M25 grade we achieved very good compressive strength after the 28 days of curing period for Conventional concrete blocks is 25.04 N/mm2 and for 5% replacement of cement by glass fiber compressive strength is 34 N/mm2,10% it is 21 N/mm2,15% it is 1421 N/mm2. Below is the graph of conventional and glass fiber concrete.



"Figure 5: Compressive strength compression of conventional concrete Vs Glass fiber concrete"

➢ Impact test

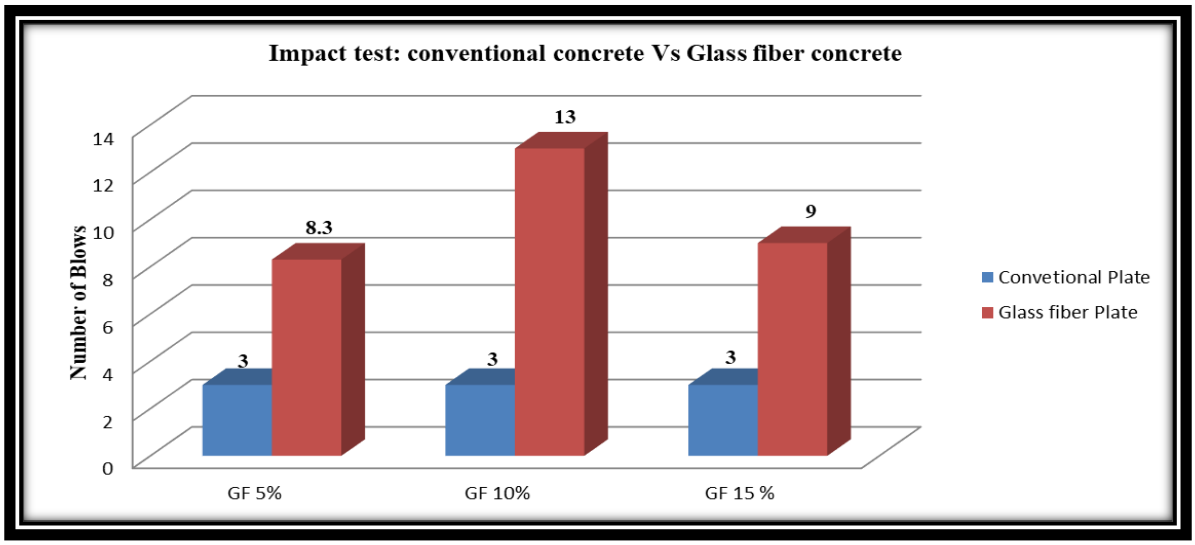
The impact test on concrete, also known as the Schmidt hammer test, measure the surface hardness and tensile strength of concrete by striking it with a rebound distance correlates with concrete strength, making it a rapid and non-destructive method for quality control and structural assessment. Here are some reasons why the impact test is performed:

1. Cost effective
2. Risk Mitigation

3. Quick Assessment
4. Safety Assurance

- **Results:**

As per the M25 grade we achieved very good tensile strength after the 28 days of curing period for Conventional concrete blocks is 3 blows and for 5% replacement of cement by glass fiber tensile strength is 8 blows, 10% it is 13 blows, 15% it is 9 blows. Below is the graph of conventional and glass fiber concrete.



"Figure 6: Impact test compression of conventional concrete plate Vs Glass fiber concrete plate"

4. CONCLUSION:

- We prepare a mix design for M25 grade concrete of by manually and also check it by software as per IS Code-10262-2019
- The compressive strength of M25 grade concrete is increase by 36% by replacing cement by 5% GFRC
- The compressive strength of M25 grade concrete is decrease by 16% by replacing cement by 10% GFRC
- The compressive strength of M25 grade concrete is decrease by 44% by replacing cement by 15% GFRC
- The normal M25 grade concrete have the capacity to absorbed strain energy upto 3 blows as per Drop –weight test
- For 5% replacement of glass fiber for m25 grade of concrete the capacity of absorbed strain energy increases up to 9 blows as pre drop-weight test .
- For 10% replacement of glass fiber for m25 grade of concrete the capacity of absorbed strain energy increases up to 13 blows as pre drop-weight test.
- For 15% replacement of glass fiber for m25 grade of concrete the capacity of absorbed strain energy increases up to 6 blows as pre drop-weight test .
- The compressive strength and impact strain of M25 grade concrete is improve after replacing the cement by glass fiber at 5%
- as the glass fiber up to 10% capacity of absorbed impact strain energy of M25 grade concrete is increased farther that it will be reduces

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