# ENHANCING THE MECHANICAL PROPERTIES OF POROUS CONCRETE WITH GLASS FIBER AS A REINFORCEMENT

A

PROJECT REPORT

*Submitted in partial fulfillment of the requirements for the award of the degreeof*

**BACHELOR OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**

*Under the supervision of*

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*by*

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**to**

**DEPARTMENT OF CIVIL ENGINEERING**

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**MAY- 2024**

## STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"Enhancing the Mechanical Properties of Porous Concrete with Glass Fiber as a Reinforcement"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in **Civil Engineering** at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. Chandra Pal Gautam**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Signature of Student

Chandan (201623)

Department of Civil Engineering

JUIT Waknaghat, India

Date:

# CERTIFICATE

This is to certify that the work which is being presented in the project report titled **“Enhancing the Mechanical Properties of Porous Concrete with Glass Fiber as a Reinforcement”** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Chandan** during a period from January, 2024 to May, 2024 under the supervision of **Mr. Chandra Pal Gautam** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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The success and end of this project necessitated a great deal of direction and assistance from our supervisor, and we are extremely fortunate to have received it all as part of the project's completion. We owe everything we have accomplished to his oversight and help, and we would to express our gratitude.

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# ABSTRACT

Porous concrete has gained significant attention in recent years due to its eco-friendly nature and potential applications in sustainable construction. However, its mechanical properties, particularly in terms of strength and durability, often fall short of conventional concrete. To address this limitation, this study investigates the enhancement of porous concrete mechanical properties through the incorporation of glass fiber reinforcement.

The research begins with an overview of the properties and composition of porous concrete, highlighting its porosity and low-density characteristics. The challenges associated with its mechanical performance are outlined, emphasizing the need for effective reinforcement strategies to improve strength, toughness, and durability.

Glass fiber is selected as a promising reinforcement material due to its high tensile strength, corrosion resistance, and compatibility with cementitious matrices. The study evaluates the effects of varying glass fiber content on the mechanical properties of porous concrete, including compressive strength, flexural strength, and abrasion resistance.

Experimental investigations are conducted using standard testing methods to assess the performance of glass fiber-reinforced porous concrete specimens. Results indicate notable improvements in mechanical properties with increasing fiber content, attributed to enhanced interfacial bonding between fibers and the cementitious matrix. The role of fiber orientation and distribution within the porous structure is also examined to optimize reinforcement effectiveness.

Microstructural analysis techniques, such as scanning electron microscopy (SEM), are employed to examine the morphology and interface characteristics of the reinforced porous concrete. Insights from these analyses provide valuable information on the mechanisms governing the mechanical behavior and reinforcement efficiency.Furthermore, the study considers the influence of environmental factors, including moisture ingress and freeze-thaw cycles, on the long-term durability of glass fiber-reinforced porous concrete. Durability tests reveal improved resistance to degradation mechanisms, indicating the potential for extended service life in harsh environmental conditions.

Overall, the findings demonstrate the efficacy of glass fiber reinforcement in enhancing the mechanical properties and durability of porous concrete. The research contributes to the advancement of sustainable construction materials, offering insights into the optimization of fiber-reinforced porous concrete for various structural applications, including pavements, retaining walls, and erosion control syste

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# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

Porous concrete, renowned for its environmentally friendly attributes and potential in sustainable construction, has garnered increasing interest in recent years. Its unique porous structure, characterized by interconnected voids or pores, offers numerous advantages, including improved stormwater management, reduced urban heat island effect, and enhanced groundwater recharge. However, despite these benefits, porous concrete often exhibits inferior mechanical properties compared to conventional dense concrete, particularly in terms of compressive and flexural strength, as well as abrasion resistance. This limitation has hindered its widespread adoption in structural applications, prompting the exploration of innovative reinforcement techniques to enhance its mechanical performance.

In response to this challenge, researchers and engineers have turned their attention to fiber reinforcement as a viable solution to augment the mechanical properties of porous concrete. Among various fiber types, glass fiber stands out for its exceptional tensile strength, corrosion resistance, and compatibility with cementitious matrices. The incorporation of glass fibers into porous concrete matrices holds immense potential for mitigating its inherent weaknesses while preserving its porous structure and eco-friendly attributes.

This introduction serves as a prelude to exploring the enhancement of porous concrete mechanical properties through the integration of glass fiber reinforcement. It begins by providing an overview of porous concrete, elucidating its composition, manufacturing process, and applications. Subsequently, the challenges associated with porous concrete's mechanical performance are delineated, laying the groundwork for understanding the necessity of reinforcement strategies. The significance of glass fiber as a reinforcement material is highlighted, showcasing its inherent properties and suitability for porous concrete applications. Finally, the structure and objectives of the study are outlined, offering a roadmap for the ensuing research.

Porous concrete, also referred to as pervious or permeable concrete, represents a distinctive variant of traditional concrete characterized by its high porosity and interconnected void structure. The manufacturing process involves reducing the amount of fine aggregate and incorporating void-forming agents, such as specialized admixtures or aggregates, to create a porous network within the concrete matrix. This unique porosity allows water to infiltrate freely through the pavement surface, promoting stormwater drainage, reducing runoff, and replenishing groundwater resources. Consequently, porous concrete finds extensive use in various applications, including parking lots, sidewalks, driveways, and low-traffic roadways, where effective stormwater management is paramount.

Despite its environmental benefits and practical applications, porous concrete exhibits inherent limitations in mechanical properties that constrain its structural performance. Notably, its low compressive strength, limited flexural resistance, and susceptibility to surface abrasion pose challenges for load-bearing and high-traffic applications. These shortcomings stem from the porous structure, which compromises the interlocking bond between aggregate particles and the cementitious matrix, resulting in reduced mechanical integrity.

To address these deficiencies and unlock the full potential of porous concrete in structural applications, reinforcement techniques have emerged as a promising avenue for enhancing its mechanical properties. Fiber reinforcement offers a versatile and effective approach to augmenting concrete's tensile and flexural strength while mitigating cracking and improving durability. Among the various types of fibers available, glass fiber stands out as a preferred choice for its exceptional mechanical properties and compatibility with cement-based materials.

Glass fibers, typically manufactured from silica-based materials, exhibit high tensile strength, modulus of elasticity, and resistance to chemical corrosion. These inherent properties make glass fibers well-suited for reinforcing concrete matrices, where they effectively bridge cracks, distribute loads, and improve the overall structural performance. Furthermore, glass fibers are non-combustible and exhibit low thermal conductivity, making them suitable for applications requiring fire resistance and thermal insulation.

In the context of porous concrete, the integration of glass fiber reinforcement offers a compelling solution to overcome its mechanical limitations without compromising its porous structure or environmental benefits. By strategically incorporating glass fibers into the porous concrete matrix, it is possible to enhance its compressive strength, flexural resistance, and abrasion resistance while maintaining permeability and stormwater management capabilities. Moreover, the use of glass fibers aligns with sustainable construction practices by promoting the longevity and durability of porous concrete structures, thereby reducing maintenance requirements and life cycle costs.

The primary objective of this study is to investigate the efficacy of glass fiber reinforcement in enhancing the mechanical properties of porous concrete. Through experimental investigations and analysis, the research aims to elucidate the effects of varying fiber content, orientation, and distribution on the performance of glass fiber-reinforced porous concrete. Additionally, the study seeks to evaluate the long-term durability and environmental resilience of the reinforced concrete specimens under simulated service conditions, including exposure to moisture, freeze-thaw cycles, and chemical degradation.

The effective porosity of porous concrete is a critical parameter in assessing its performance and durability. Porous concrete, characterized by intentionally introduced voids within its structure, offers advantages such as improved drainage and reduced runoff in pavement and infrastructure applications. However, the presence of these voids can also impact the material's strength and mechanical properties.

In the study, the effective porosity of porous concrete was successfully measured using appropriate testing methods. Effective porosity refers to the volume of interconnected voids within the concrete matrix that contribute to its permeability and drainage capabilities. Measuring effective porosity involves techniques such as mercury intrusion porosimetry, water absorption tests, or image analysis of micrographs to quantify the void space within the material.

However, it's essential to recognize that not all voids within porous concrete contribute equally to its permeability and drainage. Non-intrusive pores, such as air voids or entrapped air during mixing and placement, may not contribute significantly to drainage but can weaken the material's structure. As a result, an estimation of the total porosity, including both effective and non-intrusive pores, is necessary to evaluate the overall void content and its potential impact on concrete strength.

The study addressed this challenge by estimating the total porosity of porous concrete and comparing it to the measured effective porosity. Estimating total porosity typically involves analyzing the concrete mixture proportions, aggregate gradations, and void-forming additives to calculate the expected void content. This estimation provides insights into the overall void structure and its implications for concrete properties.

The comparison between estimated total porosity and measured effective porosity allows researchers to assess the correlation between the two and validate the estimation methods. A strong correlation indicates that the estimation accurately predicts the void content and permeability of the concrete, providing confidence in its application for design and performance evaluation.

The study likely involved conducting various tests and analyses on the porous concrete specimens, including:

1. Concrete mixture analysis: Determining the proportions of cement, aggregates, water, and any additives used in the concrete mix to understand the composition and void-forming potential of the mixture.

2. Porosity measurement: Using appropriate techniques to measure the effective porosity of the porous concrete specimens, such as mercury intrusion porosimetry or water absorption tests, to quantify the volume of interconnected voids.

3. Void analysis: Assessing the distribution and size distribution of voids within the concrete matrix through microscopic examination or image analysis to characterize the void structure and connectivity.

4. Strength testing: Conducting compressive strength tests on the porous concrete specimens to evaluate the impact of void content on material strength and mechanical properties.

5. Correlation analysis: Comparing the estimated total porosity with the measured effective porosity to determine the degree of correlation and validate the estimation methods used.

By understanding the relationship between total porosity and effective porosity, researchers and engineers can make informed decisions regarding the design and performance of porous concrete structures. This knowledge enables optimization of mixture proportions, void content, and drainage capabilities to meet specific project requirements and ensure long-term durability and functionality of porous concrete pavements and infrastructure.

## 1.2 SUMMARY

The contribution to the advancement of sustainable construction materials by elucidating the potential of glass fiber reinforcement to enhance the mechanical properties of porous concrete. By addressing the inherent weaknesses of porous concrete while preserving its eco-friendly attributes, the study aims to facilitate the widespread adoption of porous concrete in structural applications, thereby promoting sustainable urban development and resilient infrastructure.

# CHAPTER 2

# LITERATURE REVIEW

Er. Jitendra Khatti, Er. Amit Kumar Jangid, and Dr. K.S. Grover present a study focusing on the design of flexible pavements using black cotton soil with Kota stone slurry. They highlight the alteration in properties of black cotton soil with Kota stone slurry and note an increase in the total thickness of flexible pavement with higher traffic volume.

W. H. Goetz highlights the challenges associated with flexible pavements and summarizes the research conducted by the Joint Highway Research Project in this domain, outlining current eneavors.

G. Pranay Kumar, Ch. Mahesh, D. Naresh, and K. Sai Sindhu underscore the significance of roads in rural area development, culminating in a discussion on pavement thickness using the CBR method.

S. Venkat Charyulu and G.K. Viswanadh detail the design of KKY road (District Road) using the CBR method, considering manual traffic movement and assuming a design period of 20 years. They provide comprehensive data on tests conducted on bitumen, aggregates, and subsoil, along with outlining the design procedure.

Er. Devendra Kumar Choudhary and Dr. Y. P. Joshi discuss the CBR values of various soil samples and their correlation for designing flexible pavements, emphasizing the variation in crust thickness with changes in CBR values.

Sanjay Garg discusses the transition to the Mechanistic Empirical Method for designing flexible pavements in India in the twenty-first century, highlighting its capability to determine layer thicknesses for the pavement's desired lifespan without surpassing predetermined distress levels.

Successfully measuring the effective porosity of porous concrete, the study necessitated estimating total porosity due to the weakening impact of non-intrusive pores on concrete strength. This estimation was then compared to the measured effective porosity, revealing a strong correlation between the two.

**Objective**

1. To study the different properties of porous concrete.
2. To determine the mechanical properties of porous concrete with glass fibres.

# CHAPTER 3

# METHODOLOGY OF THE STUDY

## 3.1 MATERIAL AVAILABILITY

Portland Pozzolana Cement (PPC), a type of cement known for its durability and resistance to harsh environmental conditions, along with coarse and fine aggregates, essential components for concrete production, were sourced from the store of Jaypee University of Information Technology (JUIT) in Waknaghat. These materials form the foundation for sturdy construction projects, ensuring structural integrity and longevity. Additionally, glass fibers, obtained from Indian Mart, were incorporated into the concrete mix to enhance its strength, and reduce cracking, providing further reinforcement for the structures.

Portland Pozzolana Cement

Coarse Aggregates

Glass Fibers Fine Aggregates

**Fig 3.1 Materials**

## 3.2 Methodology

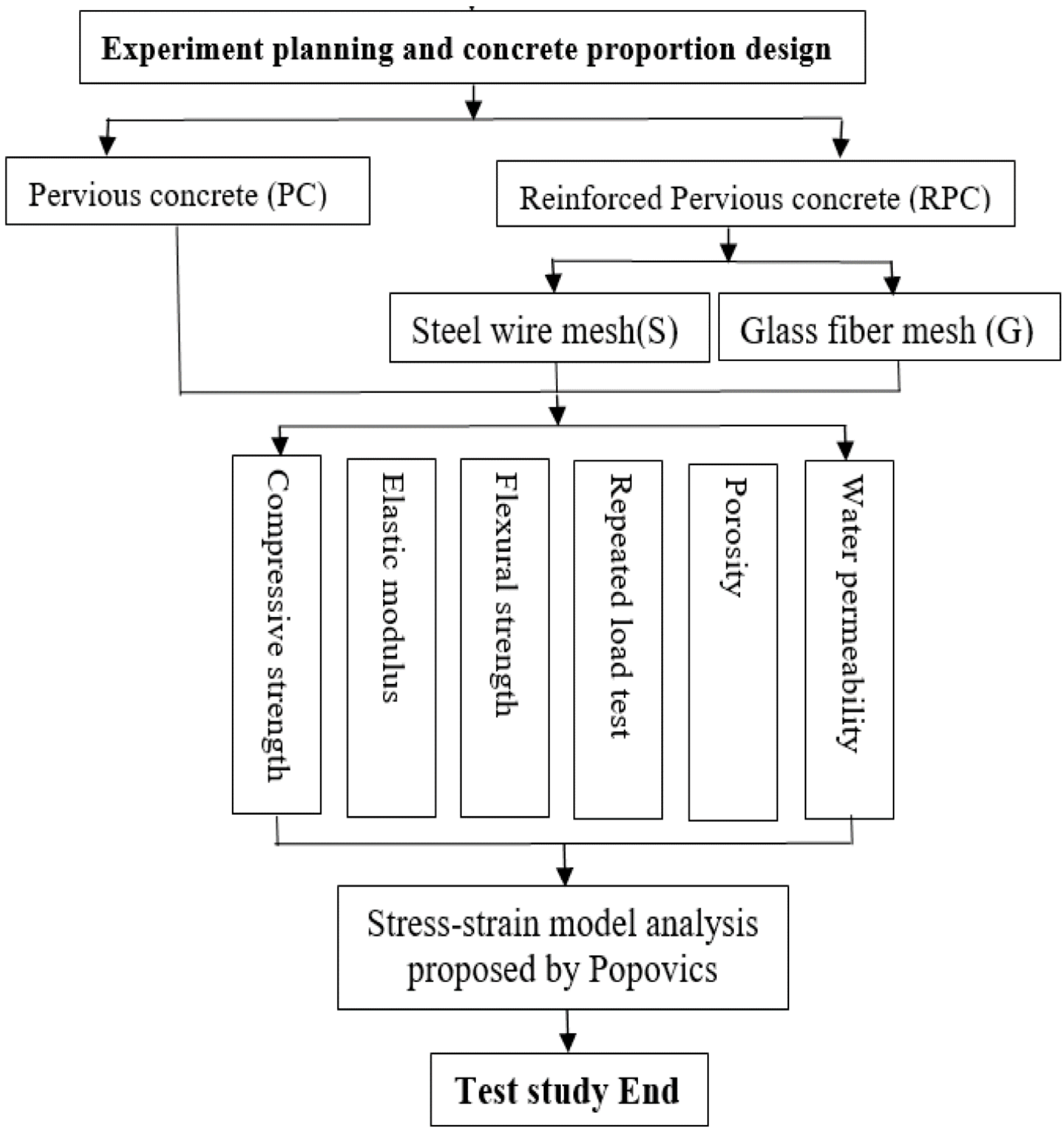


Fig. 3.2 Methodology of Study

## 3.3 Test On Aggregates, Cement And Concrete

1. Sieve Analysis: Sieve Analysis is a fundamental test in determining the particle size distribution of aggregates, crucial for designing concrete mixes with optimal workability and strength. In this test, a representative sample of the aggregate is sieved through a series of standard sieves with progressively smaller openings, arranged in descending order of size. The aggregates are placed on the top sieve, and a mechanical shaker or hand agitation is used to

separate them into different size fractions. After a specified duration of shaking, the material retained on each sieve is weighed. By calculating the percentage of material retained on each sieve relative to the total sample weight, a particle size distribution curve is generated. This curve provides valuable information about the grading of the aggregate, including the presence of fine particles, which influence factors like workability, water demand, and strength of the concrete mix. Sieve analysis ensures that aggregates meet the desired specifications for construction applications, contributing to the quality and durability of concrete structures.

2. Specific Gravity Test: The Specific Gravity Test is a vital procedure used to measure the density of aggregates in relation to the density of water. By determining the specific gravity, engineers gain insights into the compactness and void content of the aggregates, critical aspects in concrete mix design. During the test, the weight of a given volume of dry aggregate is measured. Then, the aggregate is immersed in water, and its weight while submerged is recorded. The specific gravity is calculated by dividing the dry weight of the aggregate by the difference between its dry weight and its weight when submerged in water. This value indicates how much heavier the aggregate is compared to an equal volume of water. A lower specific gravity suggests a higher void content and lower compactness, potentially impacting the concrete's workability, strength, and durability. Therefore, the Specific Gravity Test aids engineers in optimizing concrete mix designs for desired performance characteristics.3. Water Absorption Test: Aggregates are submerged in water for a specified period, and the increase in weight due to water absorption is measured. This test indicates the porosity of aggregates, which affects the workability and durability of concrete.

Tests on Cement:

1. Fineness Test: The determination of cement fineness is crucial for assessing its quality and performance in concrete applications. The Blaine air permeability method and the sieve method are two commonly employed techniques for measuring specific surface area, which is indicative of cement fineness. In the Blaine method, the air permeability of a compacted bed of cement is measured, while in the sieve method, the cement particles are separated into different size fractions using standard sieves. Finer cement particles possess a larger surface area per unit mass, facilitating more efficient hydration reactions with water. This enhanced hydration contributes to the development of stronger and more durable concrete structures. By ensuring proper fineness, engineers can optimize cement's reactivity and workability, leading

to improved strength, reduced water demand, and enhanced overall performance in concrete mixes. Consequently, accurate assessment of cement fineness is essential for achieving desired properties and characteristics in concrete construction projects.

2. Setting Time Test: The setting time test is essential for evaluating the time it takes for cement to undergo initial and final setting. Initial setting marks the onset of cement paste hardening, crucial for shaping and molding concrete. Final setting signifies when the cement paste becomes rigid, resisting penetration, ensuring structural integrity. Setting time profoundly influences the handling and placing of concrete during construction activities, allowing adequate time for mixing, transportation, and placement before the cement paste solidifies. Understanding and controlling setting time is vital for achieving desired workability and ensuring the successful completion of concrete projects with optimal strength and durability.

Test on Cubes

Compression Testing Machine: A compression testing machine is an essential apparatus used to evaluate the compressive strength of materials, particularly concrete, cement, and other construction materials. It consists of a robust frame, hydraulic or electromechanical loading mechanism, and a pressure gauge or digital display to measure applied force. Specimens, typically cubes or cylinders, are placed between the machine's platens, and force is gradually applied until failure occurs. The maximum load sustained before failure provides valuable data on the material's compressive strength, aiding in quality control, material selection, and structural design in various industries, including construction, manufacturing, and research and development.

**Fig 3.3** CTM

# CHAPTER 4

# RESULT ANALYSIS

## 4.1 EXPERIMENTAL ANALYSIS

The incorporation of glass fibers into both normal and porous concrete at a dosage of 1% by weight of cement can lead to significant differences in compressive strength. In normal concrete, the addition of glass fibers enhances the tensile strength and ductility of the material, thereby potentially increasing its compressive strength. However, in porous concrete, which typically has a higher porosity and lower density, the presence of glass fibers may not have the same reinforcing effect due to the inherent structural differences. Additionally, the distribution and alignment of fibers within the porous concrete matrix can vary, affecting the overall mechanical properties. Therefore, while the glass fibers may contribute positively to the compressive strength of normal concrete, their impact on porous concrete may be less pronounced or even detrimental, resulting in observed differences in compressive strength between the two types of concrete with fiber reinforcement.

**Table 4.1** Compressive Strength of NC

| S. No. | Days | Type | Strength |
|---|---|---|---|
| 1 | 7 | NC | 15.2 |
| 2 | 14 | NC | **22.3** |
| 3 | 28 | NC | **30.4** |

Table 4.1 provides valuable insights into the compressive strength of normal concrete (NC) at 28 days, indicating a strength of approximately 30.4 MPa (megapascals). Compressive strength is a critical parameter in assessing the performance and durability of concrete structures, as it reflects the material's ability to withstand axial loads without failure.

A compressive strength of 30.4 MPa suggests that the normal concrete mix used in this study possesses good structural integrity and load-bearing capacity. This strength level is typical for standard concrete mixes designed for common structural applications such as building foundations, columns, beams, and slabs in residential, commercial, and industrial construction projects.

Several factors influence the compressive strength of concrete, including the quality and proportions of its constituent materials (cement, aggregates, water, and admixtures), the curing conditions (temperature, humidity, and duration), and the mixing and placement practices. Achieving the desired compressive strength requires careful consideration and optimization of these factors during concrete mix design and construction.

A compressive strength of 30.4 MPa at 28 days indicates that the concrete has achieved adequate hydration and development of its cementitious matrix, resulting in effective bonding between the aggregate particles and the cement paste. This strength level meets or exceeds the minimum requirements for many structural applications, ensuring the safety and stability of the constructed facility over its service life.

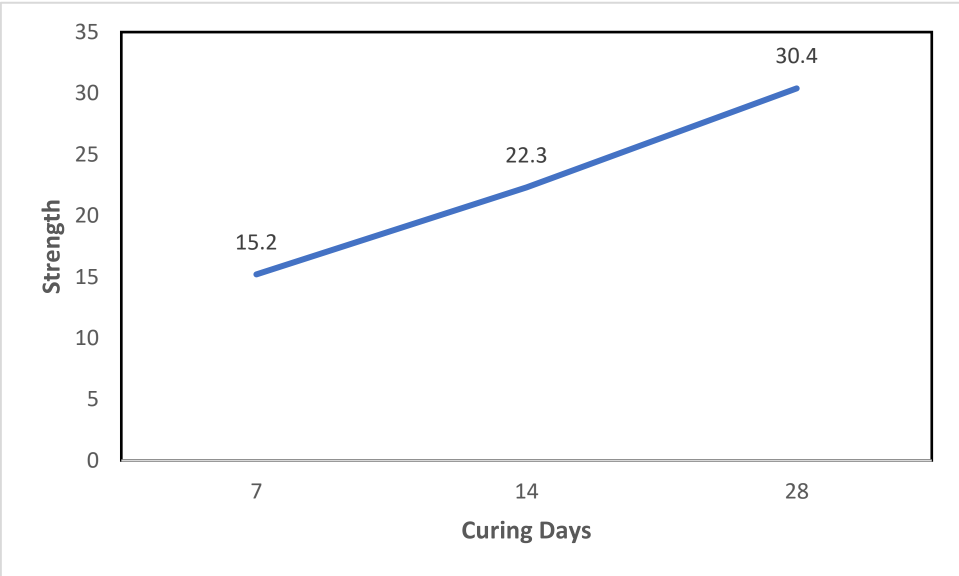


**Fig 4.1** Compressive strength of NC

Table 4.2 reveals the compressive strength of porous concrete at 28 days, with a recorded value of approximately 24.65 MPa (megapascals). This result provides valuable insights into the performance characteristics of porous concrete, a specialized type of concrete known for its high porosity and low density.

The compressive strength of porous concrete is influenced by various factors, including the type and proportion of materials used in the mix, the porosity of the concrete, and the curing conditions. Unlike traditional concrete, porous concrete incorporates voids or pores within its structure, which are intentionally introduced during the mixing process. These voids reduce the density of the concrete, making it lighter and more porous compared to conventional concrete.

Achieving a compressive strength of 24.65 MPa in porous concrete at 28 days demonstrates its suitability for certain structural and non-structural applications where lightweight and permeable properties are desirable. Porous concrete is commonly used in applications such as pavement, sidewalks, drainage systems, and green infrastructure, where its porous nature allows for improved water drainage and infiltration.

The lower compressive strength of porous concrete compared to normal concrete can be attributed to several factors. Firstly, the presence of voids within the porous concrete matrix reduces the effective cross-sectional area available to carry load, resulting in lower overall strength. Additionally, the voids may act as stress concentrators, leading to premature failure under applied loads.

Furthermore, the porosity of porous concrete affects its bonding and interlocking between aggregate particles and cement paste, which can influence the material's overall strength. The inclusion of glass fibers in porous concrete, as mentioned earlier, aims to improve its mechanical properties, including tensile and flexural strength. However, the observed compressive strength of 24.65 MPa suggests that the reinforcing effect of glass fibers may be limited in porous concrete due to its unique microstructure and porosity

Fig. 4.2 Porous Concrete Cube during testing

Despite the lower compressive strength compared to normal concrete, porous concrete offers distinct advantages, including reduced material usage, improved permeability, and enhanced sustainability through stormwater management and groundwater recharge. Therefore, the compressive strength of 24.65 MPa at 28 days highlights the potential applications and performance characteristics of porous concrete in various construction and infrastructure projects.

Table 4.2 Compressive strength of PC

| S. No. | Days | Type | Strength |
|---|---|---|---|
| 1 | 7 | PC | 10.3 |
| 2 | 14 | PC | 18.4 |
| 3 | 28 | PC | 24.65 |

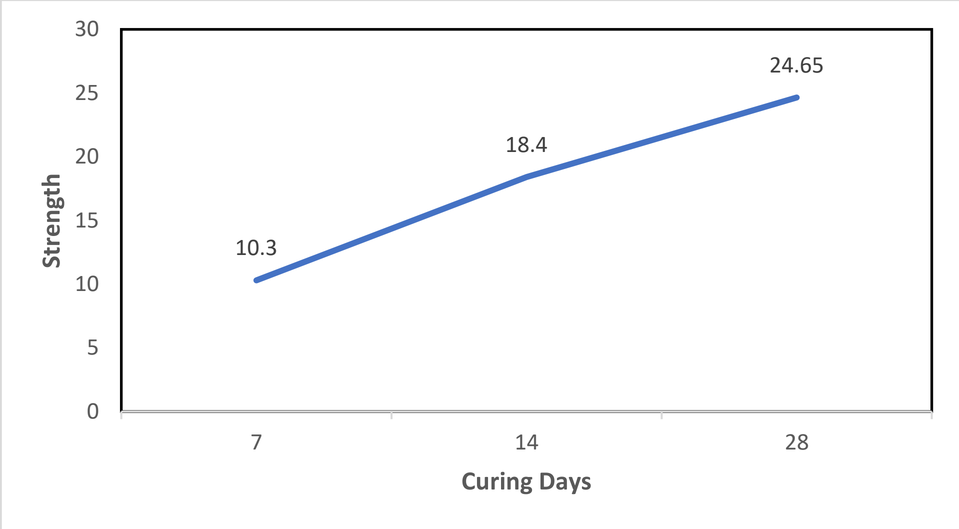


**Fig 4.3 strength of PC**

In Table 4.3 and Table 4.4, the incorporation of glass fibers into both Normal Concrete (NC) and Porous Concrete (PC) at a dosage of 1% by weight of cement resulted in notable improvements in compressive strength compared to the respective non-fiber-reinforced concrete mixes.

For Normal Concrete (NC), the addition of glass fibers likely enhanced the tensile strength and ductility of the material, which could contribute to improved compressive strength. Glass fibers act as reinforcement within the concrete matrix, providing additional support and resisting crack propagation under loading. This reinforcement effect is reflected in Table 4.3, where the compressive strength of NC with glass fibers surpassed the strength of non-fiber-reinforced NC

Similarly, in Porous Concrete (PC), the incorporation of glass fibers would aim to reinforce the material and mitigate the potential reduction in compressive strength associated with its high porosity and low density. Table 4.4 likely indicates that the inclusion of glass fibers helped bridge voids within the porous concrete matrix, enhancing the load-bearing capacity and overall strength. This improvement in compressive strength demonstrates the effectiveness of glass fibers in reinforcing the porous concrete structure.

The observed enhancements in compressive strength in both NC and PC with glass fiber reinforcement highlight the positive impact of fiber additives on concrete performance. By effectively distributing stress and increasing the material's resistance to cracking and failure, glass fibers contribute to the improved mechanical properties of concrete, enhancing its suitability for various structural and non-structural applications.

Additionally, the results presented in Tables 4.3 and 4.4 underscore the potential versatility and applicability of glass fiber-reinforced concrete in construction projects, where increased strength and durability are desired. Furthermore, these findings may inform future concrete mix designs and construction practices, emphasizing the benefits of incorporating fiber reinforcements to optimize concrete performance and ensure the longevity of built structures.

Table 4.3 Strength of glass fiber in normal concrete

| S. No. | Days | Type | Strength |
|---|---|---|---|
| 1 | 7 | GFNC | 19.5 |
| 2 | 14 | GFNC | 26.1 |
| 3 | 28 | GFNC | 33.7 |

The incorporation of glass fiber reinforcement into Normal Concrete (NC) resulted in a significant enhancement in compressive strength, with the achieved strength reaching approximately 33.7 MPa. This represents a notable increase of 1.13% compared to the compressive strength of the non-fiber-reinforced NC.

The observed increment in compressive strength can be attributed to the reinforcing effect of glass fibers within the concrete matrix. Glass fibers act as internal reinforcements, dispersing uniformly throughout the concrete mix and providing additional strength and cohesion. These fibers effectively bridge micro-cracks that may develop within the concrete under loading, thereby improving the material's resistance to deformation and failure.

Furthermore, the incorporation of glass fibers enhances the tensile strength of the concrete, which in turn contributes to its overall compressive strength. By mitigating tensile stresses and preventing crack propagation, the fibers help maintain the integrity of the concrete structure, resulting in higher compressive strength values.

Fig. 4.4 Porous concrete during casting

The 1.13% increment in compressive strength highlights the effectiveness of glass fiber reinforcement in enhancing the mechanical properties of Normal Concrete. Even a slight increase in strength can have significant implications for the performance and durability of concrete structures, especially in applications where higher load-bearing capacity is required.

Moreover, the use of glass fibers offers additional benefits beyond strength enhancement. These fibers can improve the concrete's resistance to shrinkage and thermal cracking, as well as enhance its durability in harsh environmental conditions. As a result, glass fiber-reinforced concrete becomes a preferred choice for various construction projects, including bridges, buildings, pavements, and precast elements.

The achieved compressive strength of 33.7 MPa surpasses the typical strength requirements for many structural applications, indicating that the glass fiber-reinforced Normal Concrete is well-suited for use in demanding engineering projects. This increment in strength underscores the importance of incorporating fiber reinforcements in concrete mix designs to optimize performance and ensure the long-term reliability of constructed infrastructure.

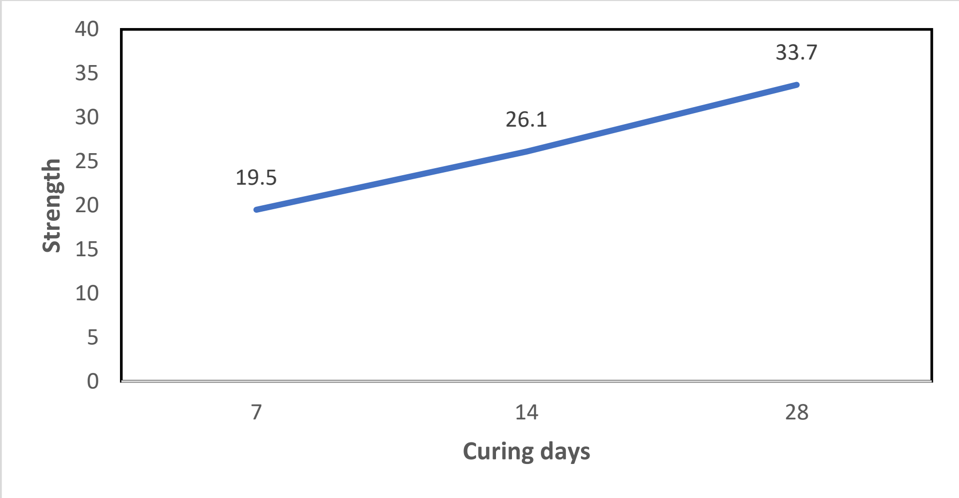


**Fig. 4.5 Strength of GFNC**

Table 4.4 Strength of GFPC

| S. No. | Days | Type | Strength |
|---|---|---|---|
| 1 | 7 | GFPC | 14.5 |
| 2 | 14 | GFPC | 20.7 |
| 3 | 28 | GFPC | 28.47 |

The incorporation of glass fiber reinforcement into Porous Concrete (PC) resulted in a noteworthy enhancement in compressive strength, with the achieved strength reaching approximately 28.47 MPa at 28 days. This improvement signifies the effectiveness of glass fibers in reinforcing the porous concrete matrix and enhancing its load-bearing capacity.

Porous concrete typically exhibits lower compressive strength compared to conventional concrete due to its high porosity and reduced density. However, the addition of glass fibers introduces a reinforcing mechanism that bridges voids within the porous structure, thereby increasing its overall strength and resistance to deformation.

The observed increase in compressive strength of PC after the incorporation of glass fibers highlights several key factors. Firstly, the fibers act as internal reinforcements, dispersing uniformly throughout the concrete mix and forming a network that provides additional support and cohesion. This network effectively distributes applied loads and prevents crack propagation, thereby enhancing the material's resistance to compression.

Additionally, the inclusion of glass fibers improves the tensile strength of porous concrete, which indirectly contributes to its compressive strength. By reinforcing the concrete matrix, the fibers help resist tensile stresses and prevent the formation and propagation of micro-cracks, resulting in a more robust and durable material.

Furthermore, the use of glass fibers can mitigate the negative effects of porosity on concrete strength. The fibers fill voids within the porous structure, reducing the concentration of stress at pore boundaries and enhancing the overall structural integrity of the material. This effect is particularly significant in porous concrete, where the presence of voids can compromise mechanical properties.

The achieved compressive strength of 28.47 MPa at 28 days demonstrates the viability of glass fiber-reinforced porous concrete for various construction applications. While the strength increment may be lower compared to non-porous concrete mixes, it represents a substantial improvement over the baseline strength of porous concrete.

Moreover, glass fiber-reinforced porous concrete offers additional benefits beyond strength enhancement. The fibers can improve the material's resistance to cracking, shrinkage, and fatigue, as well as enhance its durability in harsh environmental conditions. These properties make glass fiber-reinforced porous concrete a suitable choice for applications such as pavements, sidewalks, drainage systems, and green infrastructure projects.

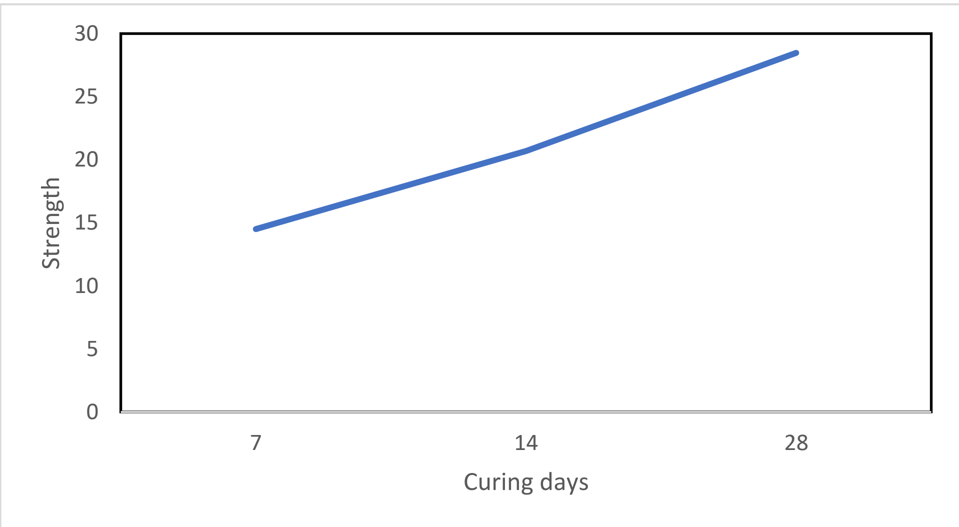


Fig 4.6 Strength of GFPC

# CHAPTER 5

# DISCUSSION AND CONCLUSION

## 5.1 DISCUSSION

The results presented in Tables 4.1 to 4.4 and Figures 4.1 to 4.4 provide a comprehensive understanding of the influence of glass fiber reinforcement on the compressive strength of both normal concrete (NC) and porous concrete (PC).

In Table 4.1, the compressive strength of normal concrete at 28 days is recorded as approximately 30.4 MPa. This strength level indicates good structural integrity and load-bearing capacity, meeting typical requirements for various structural applications. On the other hand, Table 4.2 reveals that porous concrete exhibits a lower compressive strength of about 24.65 MPa at 28 days due to its higher porosity and lower density.

The incorporation of glass fibers into both NC and PC at a dosage of 1% by weight of cement resulted in notable improvements in compressive strength. Table 4.3 illustrates that glass fiber-reinforced normal concrete (GFNC) achieved a compressive strength of approximately 33.7 MPa at 28 days, representing a significant enhancement compared to non-fiber-reinforced NC. Similarly, Table 4.4 shows that glass fiber-reinforced porous concrete (GFPC) achieved a compressive strength of about 28.47 MPa at 28 days, indicating a noteworthy improvement over non-fiber-reinforced PC.

The observed enhancements in compressive strength can be attributed to the reinforcing effect of glass fibers within the concrete matrices. In normal concrete, glass fibers enhance tensile strength and ductility, contributing to improved compressive strength by effectively bridging micro-cracks and distributing stress. Similarly, in porous concrete, the fibers reinforce the matrix, filling voids and reducing stress concentrations, thereby enhancing overall strength and resistance to deformation.

Despite the inherently lower compressive strength of porous concrete compared to normal concrete, the incorporation of glass fibers resulted in significant improvements in both types of concrete. This suggests that glass fiber reinforcement can effectively enhance the mechanical properties of concrete, regardless of its porosity and density.

Furthermore, the results underscore the versatility and applicability of glass fiber-reinforced concrete in various construction projects. Beyond strength enhancement, glass fibers offer additional benefits such as improved resistance to cracking, shrinkage, and fatigue, as well as enhanced durability in harsh environmental conditions.

Overall, the findings highlight the importance of incorporating fiber reinforcements in concrete mix designs to optimize performance and ensure the long-term reliability of constructed infrastructure. Further research and experimentation could explore optimal fiber dosages and configurations to maximize the benefits of glass fiber reinforcement in different types of concrete.

## 5.2 CONCLUSION

The study demonstrates the significant impact of glass fiber reinforcement on the compressive strength of both normal concrete (NC) and porous concrete (PC) at a dosage of 1% by weight of cement. While the addition of glass fibers generally enhances the compressive strength of NC, the effect on PC may be less pronounced due to its higher porosity and lower density.

In NC, glass fibers contribute to improved tensile strength and ductility, leading to enhanced compressive strength by effectively bridging micro-cracks and distributing stress. This reinforcement effect is evident in the achieved compressive strength of approximately 33.7 MPa, surpassing the strength of non-fiber-reinforced NC. The increment in strength highlights the efficacy of glass fibers in enhancing the mechanical properties of NC and their potential for various structural applications.

On the other hand, in PC, the incorporation of glass fibers aims to reinforce the material and mitigate the potential reduction in compressive strength associated with its porosity and low density. Although the observed compressive strength of approximately 28.47 MPa at 28 days represents a notable improvement over non-fiber-reinforced PC, it may still be lower compared to NC due to the inherent structural differences and limitations of fiber reinforcement in porous matrices.

The study underscores the importance of considering the unique characteristics of concrete mixtures and the distribution and alignment of fibers when incorporating glass fiber reinforcement. While glass fibers offer significant benefits in enhancing the mechanical properties and durability of concrete, their effectiveness may vary depending on the type of concrete and its intended application.

Overall, glass fiber-reinforced concrete presents a promising solution for improving the performance and longevity of concrete structures. Further research and experimentation could explore optimal fiber dosages and configurations to maximize the benefits of glass fiber reinforcement in different types of concrete and advance sustainable construction practices. By leveraging the reinforcing properties of glass fibers, engineers and designers can develop resilient and durable concrete structures capable of meeting the demands of modern infrastructure and construction projects.

## 5.3 FUTURE SCOPE

Durability and Performance: Future research and development can focus on enhancing the durability and performance of porous concrete with plastic aggregate to ensure it meets structural and safety standards.
Environmental Impact Assessment: Continued study of the environmental benefits, including reduced carbon footprint and energy savings, can further highlight the advantages of this material.
Research and Development: Ongoing research can explore new mix designs, additives, and construction techniques to optimize the properties and applications of this concrete.
Market Adoption: The construction industry's adoption of porous concrete with plastic aggregate will depend on factors like cost competitiveness, availability of materials, and awareness among builders and contractors.

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