

EXPERIMENTAL STUDY ON STRENGTH & WORKABILITY OF GLASS FIBRE REINFORCED CONCRETE

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ABSTRACT

Fiber Reinforced Concrete is a composite material consisting cement, fine aggregate, coarse aggregates & discrete, discontinuous, uniformly dispersed suitable fibers such as glass fibers. Fiber is a small piece of reinforcing material possessing glass fiber is an additional material to concrete and added as percentages by the weight of cement certain characteristics properties. Alkali resistant glass fiber is extracted from the malleability of the waste glass material. Glass fiber is used in concrete for improving the strain properties as well as crack resistance, ductility and toughness. Now-a-day's glass fiber is most used in the construction of buildings and pavements. In this experiment, the glass fiber is added in concrete & mortar cement at 0%, 1%, 2%, 3%, 4% and 5% by the weight of cement. In this study, M20 grade concrete is used. Concrete cubes & cylinder are tested for compressive strength & split tensile strength at the age of 7 days and 28 days. Glass Fiber, Fine Aggregate, Coarse Aggregate, Compressive Strength, Split Tensile Strength. This research investigates the influence of varying glass fiber content on the mechanical strength and workability of both cement concrete and cement mortar. An experimental study was conducted, involving the preparation of mixes with incremental additions of glass fibers. Standardized testing procedures were employed to assess compressive, a tensile strength, as well as workability through slump tests. Results indicate a general trend of enhanced strength properties with increasing fiber inclusion, particularly in tensile capacities. However, a corresponding reduction in workability was observed. The study concludes by identifying an optimal range of glass fiber content that balances strength improvements with acceptable workability, offering valuable insights for practical applications of glass fiber reinforced cementitious materials in construction.

Keywords: *Glass Fiber, Fine Aggregate, Coarse Aggregate, Compressive Strength, Split Tensile Strength, fiber reinforced concrete.*

INTRODUCTION

One of the most important building materials is concrete and its use has been ever increasing in the entire world. The reasons being that it is relatively cheap and its constituents are easily available, and has usability in wide range of civil infrastructure works. However, concrete has certain disadvantages like brittleness and poor resistance to crack opening and spread. Concrete is brittle by nature and possess very low tensile strength and therefore fibers are used in one form or another to increase its tensile strength and decrease the brittle behavior. With time a lot of experiments have been done to enhance the properties of concrete both in fresh state as well as hardened state. The basic materials remain the same but super plasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength.

Concrete & Mortar: -

Concrete: -

- **Composition:** A mixture of cement, water, and aggregates (sand, gravel, crushed stone).
- **Use:** Foundations, structural elements, pavements, and any application requiring high strength and durability.
- **Characteristics:** Strong in compression, relatively weak in tension. Often reinforced with steel to improve tensile strength.

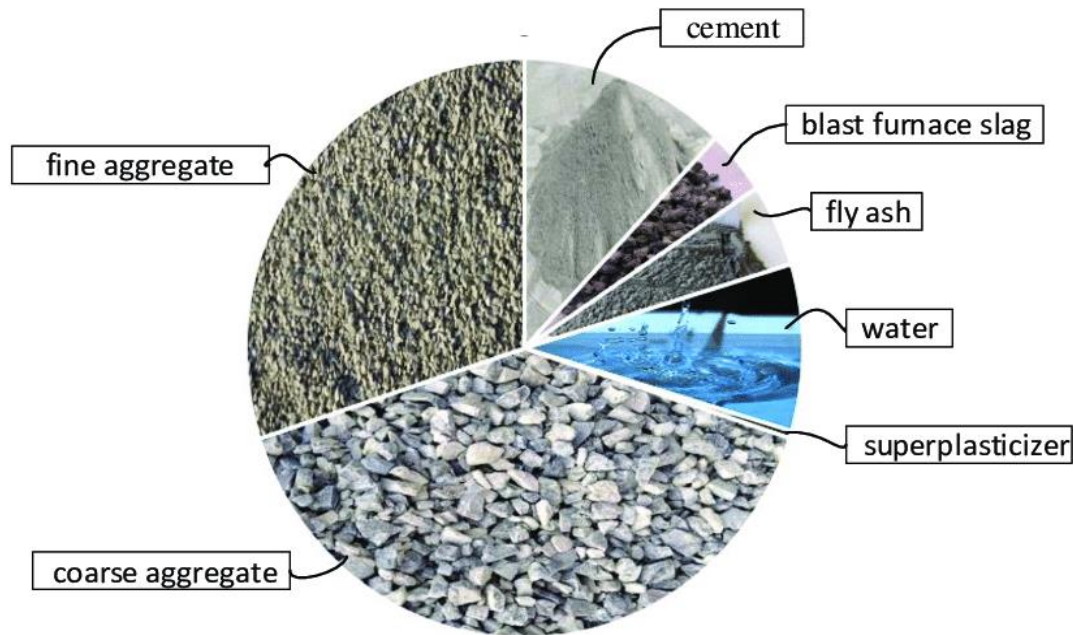


Fig 1 Concrete Composition

Need of GFRC:

- GFRC is significantly lighter than traditional concrete, making it easier to work with and reducing the load on the structure.
- This is especially important for high-rise buildings, where the weight of the structure can be a major concern.

Materials

Cement: - Ultra-Tech Ordinary Portland cement of grade 43 is used for all concrete mixes. The cement used is fresh, uniform in colour grey with light greenish shade and had no lumps and irregularities. It was stored in a dry place free from moisture content so that it does not lead to degradation in case of moisture. Tests conducted on cement were initial setting time, final setting time, standard consistency, compressive strength and specific gravity.

Table 1. Shows the physical properties of Cement

S.No.	Test Performed	Result	Specified Limits	References
1	Specific gravity	3.12	3.1-3.15	IS 2363(Part III) - 1963
2	Consistency Test of Cement	30%	26% to 33%	I S 4031 (Part 4)- 1988
3	Initial Setting Time Test	35 min	30 to 60 min	IS 4031 (Part V) - 1988
4	Final Setting Time Test	09 hour	06 to 10 hour	IS 4031 (Part V) - 1988
5	Fineness Test of Cement	2% Retained	<10%	IS 4031 (Part I) - 1988

Glass Fiber: - Fibre is a natural or synthetic string or used as a component of composite materials, or, when matted into sheets, used to make products such as paper, papyrus, or felt. Concrete is brittle by nature and is weak in flexure as well as direct tension therefore in order to improve this properties fibres are added to concrete. Fibres may be short discrete or in forms of rods or may be even in form of textile fibres or woven mesh fibres. Various types of fibres have been added to concrete some have high modulus of elasticity some have low modulus of elasticity each category can improve certain properties of concrete. In our case short discrete glass fibres were used and as glass fibre is susceptible to alkali we used alkali resistant glass fibres. A fiber is a material made into a long filament with a diameter generally in the order of 10 μ m. The main functions of the fibers are to carry the load and provide stiffness, strength, thermal stability, and other structural properties in the FRC.



Fig. 2 Glass Fiber

Aggregates

Coarse aggregates: - IS:383-1970 defined the Aggregate which is retained on 4.75mm IS sieve and containing only so much finer material as is permitted by is termed as coarse aggregate. We have taken 10mm and 20mm Sizes of coarse aggregate for the experiment

Table 2 Shows the physical properties of coarse aggregates

S.NO.	Properties of material	Coarse aggregates
1	Type	Crushed
2	Shape	Angular
3	Size	20 mm & 10 mm
4	Specific gravity	2.64
5	Fineness modulus	6.89
6	Bulk density (kg /m ^3)	1426
7	Source	Crushed basalt stone
8	Water Absorption	0.8%

Fine aggregates: - IS:383-1963 defined the fine aggregate is the aggregate most of which will passes 4.75mm IS sieve and retained on 0.075mm IS sieve is known as fine aggregate. Nearby available stream sand, which is obtained from Narmada River, having a lower size of about 0.075mm was used as a fine aggregate in concrete.

Table 3 shows the physical properties of fine aggregates

S.NO.	Properties of material	Fine aggregate
1	Type	Natural
2	Shape	Spherical
3	Size	> 4.75 μ
4	Specific gravity	2.65
5	Fineness modulus	2.72

6	Bulk Density (Kg/m ³)	1570
7	Source	Narmada river sand
8	Water Absorption	0.6%



Fig. 3 Coarse Aggregate



Fig. 4 Fine Aggregate

Experimental Results

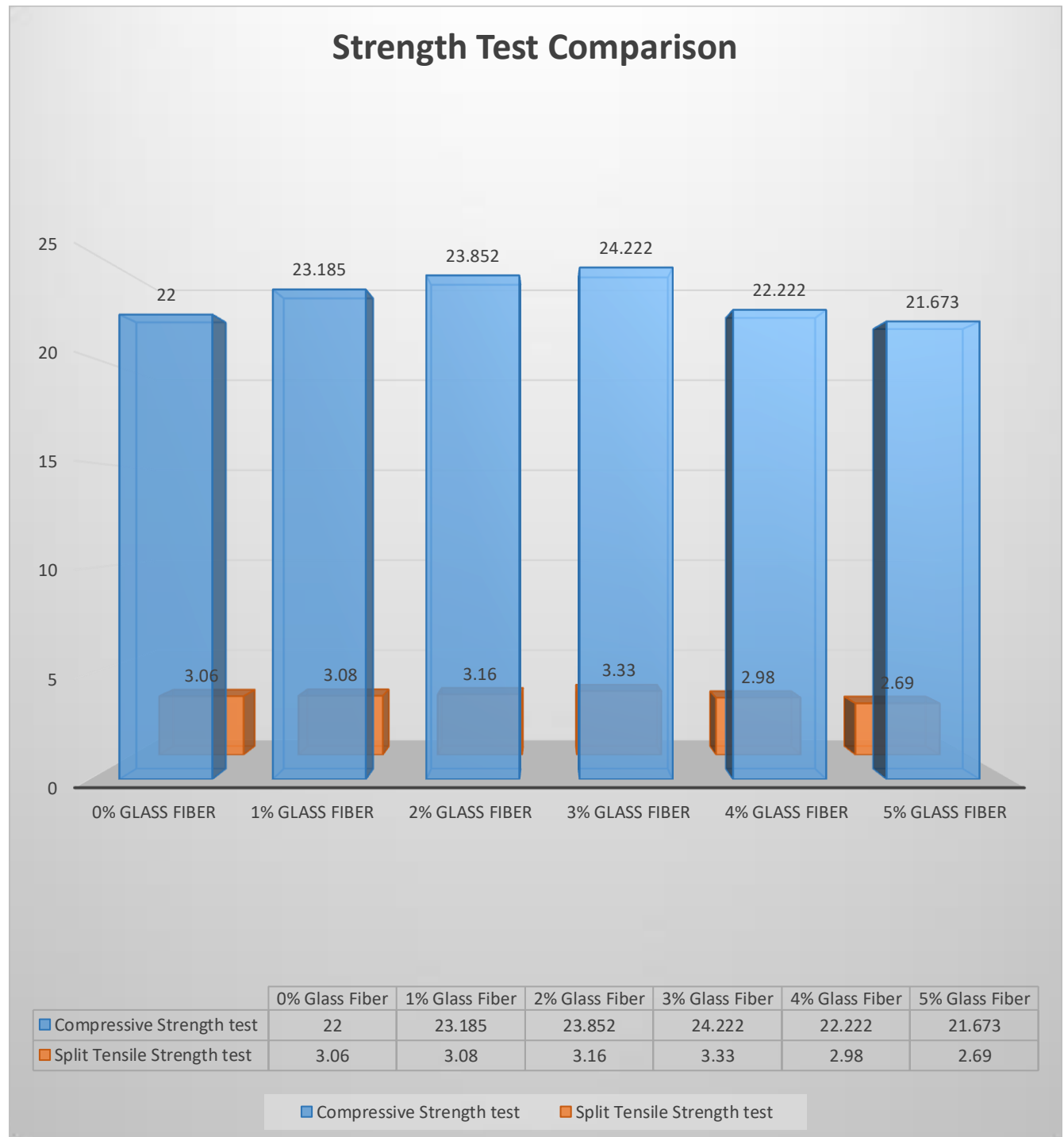


Fig. 5 Strength Test Comparision

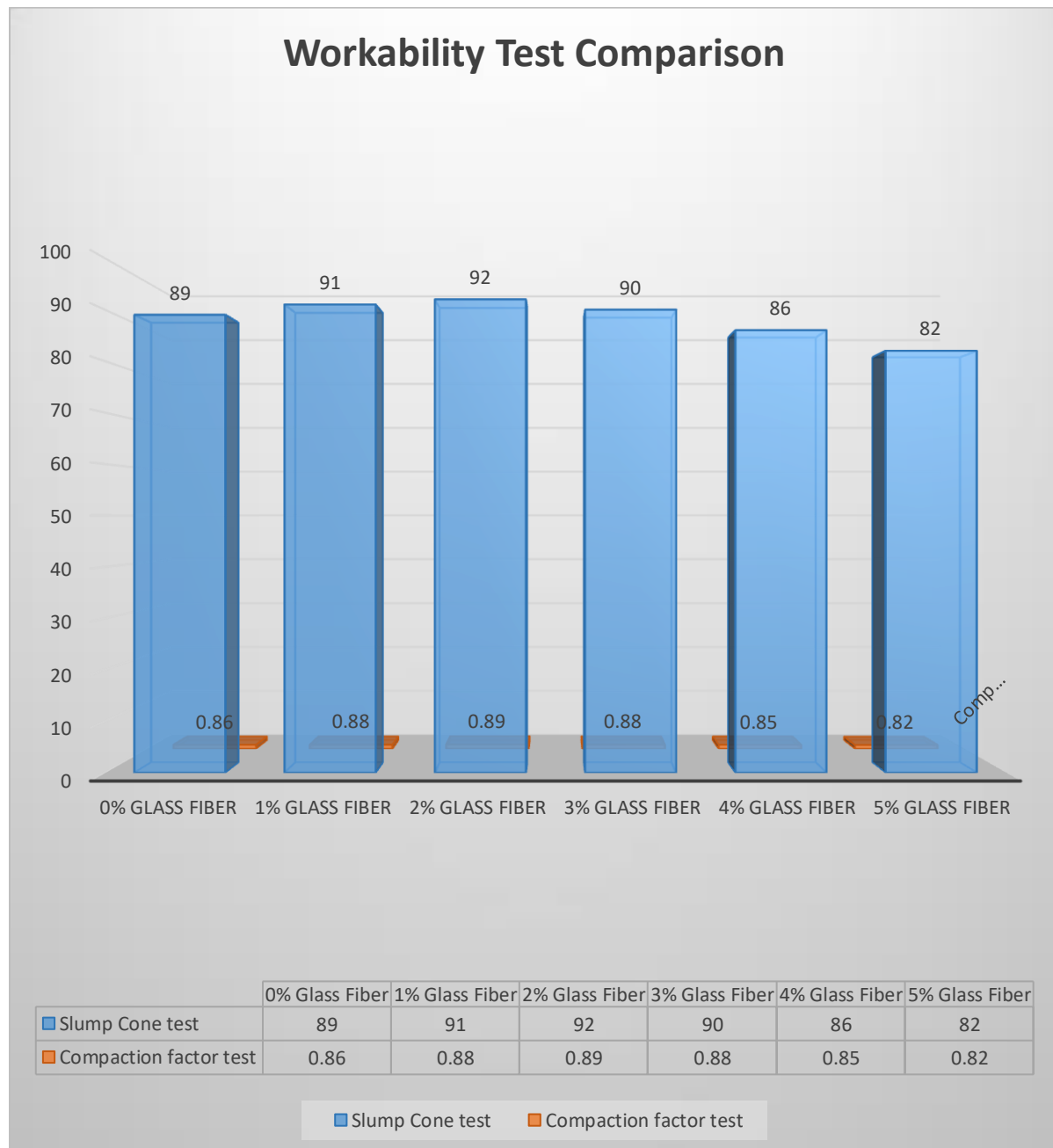


Fig. 6 Workability Test Comparison

Conclusion: -

1. As a result, alkali-resistant glass fibre may effectively employed ordinary concrete as reinforcement, resulting in concrete that are lighter and stronger.
 2. This study investigated the effects of incorporating glass fibers on the strength and workability of cement concrete. The results indicated that the addition of glass fibers generally improved the tensile strength and compressive strength of concrete. The workability of the mixes tended to increase and then decrease with increasing fiber content.
 3. Maximum compressive strength was achieved by adding 3 percent glass fiber by weight to the total concrete mix; subsequent increases resulted in a small deviation from the maximum strength.
 4. It has been also observed that there is gradual increase in the workability also up to 3% glass fiber after which workability decreases.
 5. Glass fibre is a cost-effective and acceptable approach for achieving high strength of concrete, may be made with little material and are quite strong.
 6. Optimal fiber content is crucial to balance strength gains with acceptable workability. A Reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks.
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- **Fiber Optimization:** Explore different fiber lengths, diameters, and surface treatments to optimize performance.
 - **Mix Design:** Study the influence of different mix proportions and admixtures on the properties of glass fiber-reinforced composites.
 - **Applications:** Explore specific applications (e.g., thin-walled structures, precast elements) and their performance.
 - **Sustainability:** Investigate the use of recycled glass fibers.

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