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EFFECTIVENESS OF GLASS FIBER-REINFORCED MORTAR FOR IMPROVING DURABILITY IN STRUCTURES

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Abstract

Enhancing the durability, usability, and effectiveness of structures is crucial in modern civil engineering. The aim of the study is to investigate how the properties of cement are altered by the addition of glass fibre (monofilament). In the study, the effectiveness of mortars with different amounts of glass fibre added (at concentrations of 1%, 2%, 3%, 4%, and 5% by weight of cement) is compared. Based on the results of the compressive strength tests, it can be shown that adding glass fibre to mortar mixtures typically increased their compressive strength at various ages for all mix proportions (1:3, 1:4, and 1:5). Glass fibre enhanced the compressive strength for the 1:3 mix percentage, with the 4 percent GF mix displaying the greatest strength values throughout all test time periods. The data for mortar mixtures of 1:3, 1:4, and 1:5 with varied amounts of glass fibre demonstrate that the inclusion of glass fibre often causes an increase in the rate of strength gain. The ideal glass fibre content, however, may change according to the particular curing time and application needs. The inclusion of glass fibre, particularly at proportions of 2 and 3 percent GF for 1:3 and 1:4 blends reduced drying shrinkage in mortar mixes. The findings show that the addition of fibres significantly changes a mixture's mechanical properties, whereas the effect is less pronounced when fibres are added to a less dense mixture. Overall, the results point to glass fibre-reinforced mortar as a potentially useful material for use in civil engineering applications because of its capacity to boost the durability and effectiveness of modern construction projects. Enhancing the durability, usability, and effectiveness of structures is crucial in modern civil engineering.

Keywords: Glass fibers; Reinforced mortar; compressive strength; water absorption; drying shrinkage**.**

1. INTRODUCTION

Mortar and plaster mixes with various cement to sand ratios are often used in construction in India. This time-tested pairing has long been a favourite among many people and is still in high demand. However, the development of new technologies and materials has led to a boom in the building sector in most developed nations. In developed nations, the strength and durability of construction materials are being improved through the use of fiber-reinforced cement composites more often. Due to these developments, construction materials are now less likely to shrink, crack, and experience typical job site wear and tear. Modern building techniques and materials are once again in demand as a result of

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India's extensive infrastructure initiatives. The durability and dependability of upcoming construction projects in India are anticipated to increase with the use of contemporary tools and materials.

Cement composites have been utilised in construction and civil engineering for a long time because of their outstanding strength and durability. However, even with these materials, over time, the impacts of physical processes like shrinkage and creep may result in cracks and a weaker structure. In recent years, it has become easier to find and less expensive to buy high-quality fibres. In order to create a more appealing composite material, fibres are increasingly being added to cement composites. Shrinkage is exacerbated by increased cement consumption and the use of early high-strength cements. As a result, the mortar can ultimately deteriorate and crack. However, the inclusion of fibres in the mortar mixture improves its ductility and resistance to cracking, so addressing this flaw. This article explores how cement composites with fibres may improve the strength and durability of construction materials.

Traditional mortar has had unexpected repercussions on the construction industry, including cracks in plaster and brickwork, the leaching of materials from the plaster surface, and other things. Other trash and fibres are added to the mortar mixture, along with other adjustments, to address these issues. These changes may result in a material that is more resistant to deterioration over time, such as cracking. For example, fibres can help distribute stress throughout the mixture, boosting strength and lowering the risk of cracking. Overall, these changes to the mortar composition may help to improve the robustness and lifetime of construction materials while lowering the risks connected with using regular mortar.

Physical factors like shrinkage and creep can cause bricks and blocks to crumble and lose their structural integrity over time. Fibers may be added to the mortar mixture to increase its ductility and resilience against breaking in order to prevent this. The cement mortar matrix's porous nature, which allows liquids and gases to pass through it, further reduces plaster's durability. Glass fibres improve mechanical strength and reduce permeability, prolonging the usable life of the material. Glass fibre is a well-liked fibre option for use in mortar mix due to its excellent strength and durability.

One type of fibre that may be used to dramatically increase the performance, strength, and longevity of mortar is glass fibre. In order to enhance the mechanical and physical qualities of cement-based mortars, researchers have looked at the effects of adding polypropylene and glass fibres. According to several studies, the addition of fibres can boost tensile and compressive strengths while lowering plastic shrinkage cracks.

2. LITERATURE REVIEW

An exciting investigation on the dynamic behaviour of cement mortars reinforced with glass and basalt fibres was given by Luigi Fenu et al. [21]. The study assessed the effectiveness of the two types of fiber-reinforced mortar and looked at how the fibres affected energy absorption and tensile strength at high strain rates. Waste dolomite powder (DP) was investigated by Xiang Chen, et al. [22] as an alternative to cement. The

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study demonstrated how the capacity of glass fibres to corrode in alkaline environments may limit the usage and durability of glass-fiber-reinforced cementitious composites (GFRCs). Fly ash was used in place of some of the fine aggregate in the glass fibre textile reinforced mortar (TRM) that Shaise K. Johna et al. examined. The tensile strength development rate dropped once the thickness of the TRM specimens reached 10mm, which also rose linearly with increasing thickness. By using the closest-packing approach to minimise alkalinity and enhance flexural performance, Qin Xiaochun et al. [25] demonstrate how alkaline-resistant glass fibre reinforced concrete may boost flexural strength and wear resistance in road pavements. In this study, Pshtiwan Shakor et al. [26] examine how additive manufacturing (AM) technology is used in the construction industry to create glass fibre reinforced mortar structures. In the study, mortar formulations with and without chopped glass fibre were extruded using a robotic arm at different speeds and layer counts. The results of the investigation showed that printed specimens with glass fibre had higher compressive strengths than specimens without the substance. In order to enhance the characteristics of the concrete, Chen Haiming et al. [27] looked into the usage of alkali-resistant (AR) glass fibre (GF) materials, such as GF and glass fibre powders (GFP). The findings demonstrated that the addition of GF enhanced the mortars' mechanical characteristics, notably their flexural strength, which rose by 57% after 28 days of curing when GF additions of 7.5 percent were made. While this was happening, AR-GFP proved successful in minimising the shrinkage of the mortars, with 40% autogenous shrinkage and 50% drying shrinkage minimised when 5% GFP was introduced.

Polypropylene fibres can improve compressive and tensile strengths and reduce plastic shrinkage cracks, according to Pey-Shiuan Song et al. (2014). Additionally, they claimed that greater fibre content results in lower flow values and greater compressive and tensile strengths. The compressive strength of concrete produced by switching out natural sand for manufactured sand and adding polypropylene fibre improves up to 60% before decreasing, according to Chaitra Patil et al. (2017). According to Divyeshkumar D. Paradava et al., a certain number of fibres enhances the compressive, splitting tensile strength, and water absorption capacity of fibre reinforced cement mortar (2014). According to Sadrmomtazi et al. (2009), employing a little proportion of polypropylene fibres improved compressive strength test results and water absorption. According to Cristiana Gonilho Pereira et al. (2011), waste fibres added to cement-based mortars explain how they behave. One of the best methods for enhancing performance behaviour, mechanical, shrinkage, expansion, and similar crack-causing processes has been suggested: fiber-reinforced mortars. Pardis Parto et al (2012) determined that a polypropylene fibre content of 0.2 percent is ideal for sand cement mortar that has been fibre reinforced. The results reveal that when polypropylene fibres are added to windblown sand-cement mortar, they are equally distributed throughout the matrix, reduce stress concentrations close to cracked ends, and enhance the mortar's mechanical properties. After examining the literature, Divyeshkumar et al. (2013) found that fibre addition is helpful in split tensile and flexural strength but has no influence on compressive strength. The strength of the brick bond in masonry, as well as the strength and permeability of the plaster, are all strengthened by the use of fibre mortar. Hua

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Zhanga et al. (2016) examined the dynamic characteristics and fundamental connectivity of polypropylene fibre mortar materials under compressive impact stress. They found that the mortar was stronger the lower the water to cement ratio was. They found that adding glass fibre to concrete increased its resistance to wear, freeze-thaw endurance, and dry shrinkage. In 2015, Annsingh Shermila G. et al. investigated how glass fibre affects compressive strength. The test findings show that compressive strength increases in the first percent of the fibre mix and decreases as the fibre percentage rises. Experimental research by Parameswararao Gairuboina et al. (2007) indicates that the use of glass fibre reinforcement improves the durability and strength of reinforced concrete. With a 1.0 percent addition of glass fibre, the maximum compressive, flexural, and split tensile strength may be achieved. In addition to the norm, Rasha Salah Mahdi (2014) chose to make glass fibre reinforced mortar mixtures with glass fibre contents of 1, 1.5, and 2% by weight of cement. According to the research, the mortar with 1% fibre content demonstrated greater compressive and flexural strength than the other mortars. She came to the conclusion that the workability of a mortar mix reduces as the concentration of glass fibre increases. Four different forms of fibre reinforced cement composites were tested by K. Kosa et al. in 1991. The results show that glass fibre mortar mix has the worst overall performance, whereas polypropylene mortar mix has the best overall performance. R.M. de Gutierrez et al. (2005) claim that fiber-reinforced materials, particularly those reinforced with steel, glass, or sisal fibres, have increased mechanical performance and durability. The effects of marble dust and glass fibre on the mechanical and physical properties of cement mortars exposed to high temperatures were examined by Oguzhan Kelestemur et al. in 2014. The results of the tests showed that as the amount of glass fibre in the mortar increased, so did its high temperature resistance.

The addition of fibres to concrete / mortar can improve compressive strength, water absorption, and durability characteristics such as heat resistance, acid attack, acoustic emission, and fracture resistance. This can lead to a stronger and more durable construction material.

3. EXPERIMENTAL DETAILS

The purpose of the study was to look into how glass fibre affected the mechanical properties and functionality of typical cement-sand mortar. Glass fibre (monofilament) was employed in five different concentrations—1 percent, 2 percent, 3 percent, 4 percent, and 5 percent by weight of cement—to achieve this. Three distinct mortar mixes of 1:3, 1:4, and 1:5 each received the glass fibre addition. 324 cubes in total and 54 tiny size beams were cast for the experiment. The cubes were used to gauge the mortars' compressive strength and water absorption. For each mix, three samples were evaluated, and the average value was calculated to assure precision. The water absorption test was done at 28 and 90 days after curing, whereas the compressive strength test was done at 7, 28, and 90 days. While the compressive strength and water absorption tests were being conducted, the beams were getting ready for the mortar shrinkage test. At 7, 35, 90, and 135 days, dry shrinkage tests were conducted on each mix fraction. This experiment was designed to measure how much the mortar shrank after being added with glass fibre.

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The overall goal of the study was to discover the ideal amount of glass fibre to add to cement-sand mortar in order to enhance its mechanical and performance properties. The specifics of the experiment offered useful information that may be used to judge if employing glass fibre in the manufacture of construction materials is appropriate.

4. MATERIALS

The primary binder ingredient for the mortar mix in this investigation was normal Portland cement, grade 43 (OPC). To make various mortar mix ratios, the cement was used in the usual ratio of 1, 3, 4, or 5 parts natural river sand to 1 part cement. Before being employed in the experiment, the natural river sand was filtered through a 4.75 mm sieve. When choosing the suitable sand to utilise in mortar mixes, it is vital to take into account the fineness modulus and specific gravity of the river sand, which were both 2.32 and 2.68, respectively.

In general, the manufacturing of mortar mixtures for construction uses conventional Portland cement and unprocessed river sand.

Glass Fiber: Glass fibre, commonly referred to as fibreglass, is a substance comprised of tiny glass strands that are woven or joined to form a durable and light-weight substance. Glass fibre is a less expensive choice since it is less brittle than carbon fibre and the raw ingredients are less expensive. Compared to many metals, glass fibre has a greater strength-to-weight ratio and is more easily moldable into a variety of forms.

Glass fibre that was easily accessible was employed in this investigation. The technical details for the glass fibre utilised in the study are listed in Table 1, which gives details on the fiber's stiffness, strength, and other crucial properties.

Table 1: Properties of glass fibers

	Particulars	Glass Fiber
1	Specific Gravity (g/cm3)	2.68
2	Tensile Strength (N/mm2)	1700
3	Young's Modulus (N/mm2)	72,000
4	Melting Point (oC)	860
5	Alkali resistance	High
6	Elongation (percentage)	2 - 4
7	Absorption	Nil
8	Fiber cut length (mm)	12 mm
9	Fiber cut diameter (um)	18
10	Form	Monofilament
11	Colour	Natural
12	Ignition Point (oC)	Incombustible

These measurements demonstrate that the glass fibre employed in the study has high Young's modulus and tensile strength, both of which are desired qualities to improve the mechanical characteristics of the mortar.

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5. MORTAR MIXES

Different cement to sand ratios were utilised in the study's mortar mixtures, and glass fibre was added as an extra ingredient. The various mortar mix ratios utilised in the study are listed below:

Mix 1:3 - The ratio of this mixture was 1 part cement to 3 parts sand.

Mix 1:4 - The ratio of this mixture was 1 part cement to 4 parts sand.

Mix 1:5 - The ratio of this mixture was 1 component cement to 5 parts sand.

Each mix also included varying weight percentages of glass fibre in addition to the cement and sand components. In the study, the impacts of introducing glass fibre at various weight percentages of the cement component—0, 1%, 2%, 3%, 4%, and 5%—were examined.

6. Experimental Testing: Tests were conducted to determine the compressive strength, water absorption, and drying shrinkage of the mortar mix in order to evaluate its properties at various curing stages.

6.1 Compressive Strength Test

A commonly used test to assess the toughness of concrete or mortar is the compressive strength test. In this study, cube specimens with dimensions of 70.6 mm x 70.6 mm x 70.6 mm were used to test the compressive strength of the mortar samples in accordance with Indian Standard IS:2250-1981.

The cube specimens were cast using mortar, demolded after 24 hours, and then allowed to cure for 7, 28, and 90 days in a curing tank. This is a typical curing time used to assess the concrete or mortar's compressive strength. By employing a compression testing equipment to apply a compressive force to the mortar samples after the curing period, the compressive strength of the samples was determined. The specimen's highest load before failing was recorded as the mortar's compressive strength.

6.2 Water Absorption Test

The water absorption test is a standard test used to determine the water tightness or resistance of concrete or mortar. In this study, the water absorption test was conducted on mortar cubes with dimensions of 70.6 mm x 70.6 mm x 70.6 mm, in accordance with the ASTM C642[20] standard. The water absorption test was performed after 7, 28, and 90 days of curing to determine the effect of glass fiber on the water absorption rate of the mortar.

The water absorption test involves immersing the mortar specimens in water for a specified period and then weighing them before and after immersion to determine the amount of water absorbed. The difference in weight before and after immersion is used to calculate the water absorption rate of the mortar. A water absorption rate of less than 10% is considered good for mortar mixtures.

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6.3 Drying Shrinkage

The shrinkage specimens were measured for their initial length and then put in a humidity chamber at a temperature of 27 2 °C and a relative humidity of 50%. After that, the specimens were periodically taken out of the chamber and their lengths were measured with a dial. The difference between the comparator reading and the specimen's reference bar reading, or CRD, was used to determine the length change. G is the gauge length, and Lx is the percentage change in length at any age (10 in. [250 mm]). Each mortar mix's drying shrinkage data was recorded, and any significant differences were studied.

The drying shrinkage test was conducted using ASTM C 596 and IS 4031 (part-10) 1988[19]. Under controlled conditions, the specimens were examined 7, 35, 90, and 135 days following casting. The original length of the shrinkage specimens was measured after 7 days before placing them in the humidity room. The formula Lx was used to estimate the length change.

$$\Delta l_x = \frac{\text{CRD} - \text{Initial CRD}}{\text{G}} * 100$$

Table 1 presents the water-cement (W/C) ratio, glass fibre percentage, and mortar mix proportions used in the study

Table 1: Mortar Mix proportions, percent of glass Fiber with W/C ratio

SN	Fiber (percentage of cement)	1:3 Mortar Mix Proportion		1:4 Mortar Mix Proportion		1:5 Mortar Mix Proportion	
		ID	W/C Ratio	ID	W/C Ratio	ID	W/C Ratio
1	0 % of cement	M 31	0.5	M 41	0.6	M 51	0.6
2	1 % of cement	MG 32	0.5	MG 42	0.6	MG 52	0.6
3	2 % of cement	MG 33	0.5	MG 43	0.6	MG 53	0.6
4	3 % of cement	MG 34	0.5	MG 44	0.6	MG 54	0.6
5	4 % of cement	MG 35	0.5	MG 45	0.6	MG 55	0.6
6	5 % of cement	MG 36	0.5	MG 46	0.6	MG 56	0.6

(SN: Serial number, ID: identification, GF: Glass Fiber, W/C Ratio: water cement ratio)

7. RESULTS AND DISCUSSION

The compressive strength, water absorption, and drying shrinkage test results of mortar mixes containing fibres at various ages are displayed in Figures 1 to 9.

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Compressive strength test result

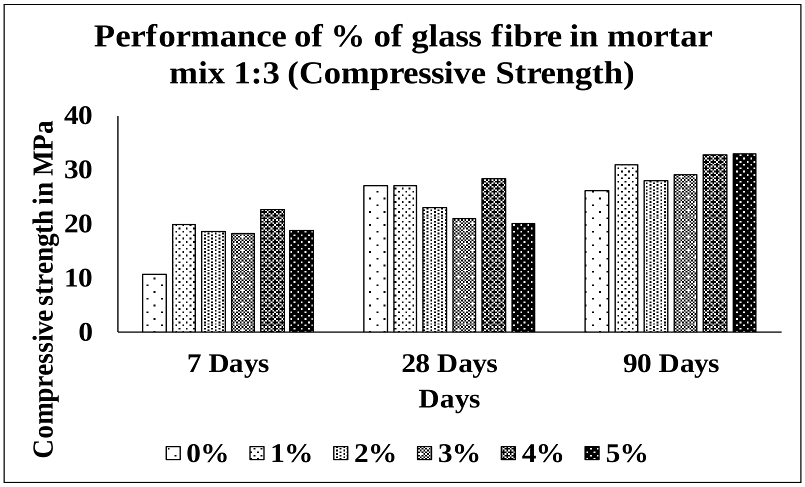

Figure 1: Performance of 1:3 mix mortar with varying percentage of glass fibre

Figure 1 shows that the compressive strength of the mortar mix 1:3 is typically increased by the inclusion of glass fibre. At 28 days (28.33 N/mm2) and 90 days (32.75 N/mm), the combination with 4 percent glass fibre showed the maximum compressive strength. Comparing the mix with 3 percent glass fibre to the mix without any glass fibre, there was a modest drop in compressive strength after 28 days. While the mix with 5% glass fibre had the best compressive strength at 90 days (33.00 N/mm2), the mix with 1% glass fibre displayed the highest compressive strength at 7 days (19.79 N/mm2).

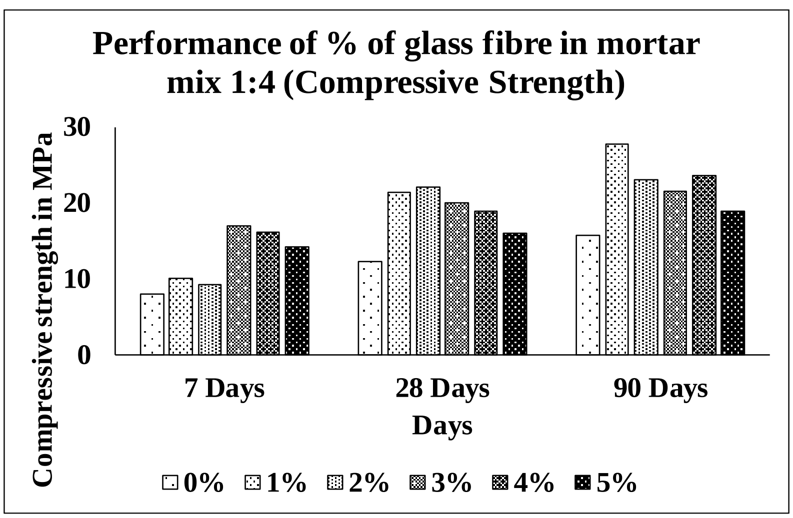

Figure 2: Performance of 1:4 mix mortar with varying percentage of glass fibre

As seen in figure 2, adding Glass Fibre (GF) to the mortar mixture increases the compressive strength for distinct GF percentages at particular curing durations. For instance, the compressive strength of the 1 percent GF mortar mix significantly increases after 28 and 90 days, whereas the 3 percent GF mix has the maximum compressive strength at 7 days.

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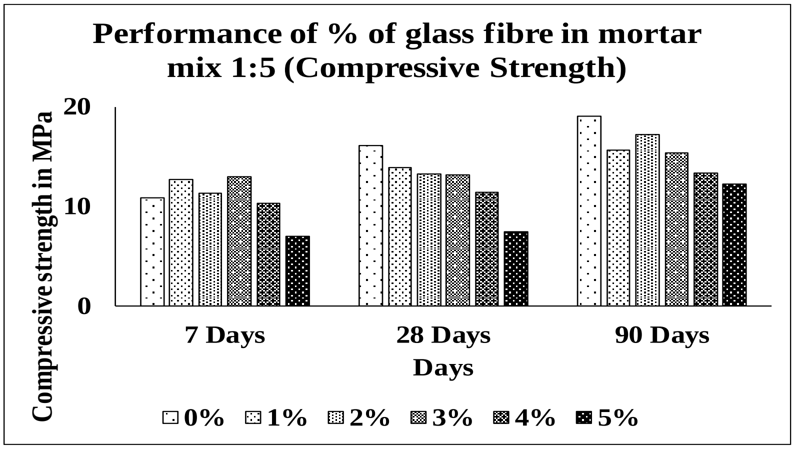

Figure 3: Performance of 1:5 mix mortar with varying percentage of glass fibre

As seen in figure 3, it can be seen that the compressive strength increases with the addition of glass fibre in the mortar mix up to a certain proportion, beyond which the strength begins to decline. During instance, for the 7 and 28 day curing periods, the compressive strength of the mortar mix with 1% glass fibre is better than that of the mix without glass fibre, however for the 90 day curing period, it is lower than the mix without glass fibre. Similar to the 3 percent glass fibre mixture, the mix with the maximum compressive strength during the 7-day curing time is not present at the 28-day or 90-day curing periods.

Overall, the findings imply that adding glass fibre to mortar mixtures can increase their compressive strength, but the amount of glass fibre must be carefully chosen.

Rate of gain in strength

Rate of gain in strength refers to the increase in strength of a material over a certain period. The rate of gain in strength depends on various factors such as the materials used, the proportion of the ingredients, the curing conditions, and the environmental factors such as temperature and humidity. It helps in determining the time required for the structure to reach the desired strength and to evaluate the suitability of the material for specific applications.

Table 2: Rate of gain in strength

ID	Glass Fibre	Rate of Gain in strength MPa/Day		
		0 to 7 Days	7 to 28 Days	28 to 90 Days
M 31	0% GF	1.51	1.29	0.42
G 32	1% GF	2.83	1.29	0.50
G 33	2% GF	2.67	1.10	0.45
G 34	3% GF	2.59	1.00	0.47
G 35	4% GF	3.23	1.35	0.53
G 36	5% GF	2.69	0.95	0.53

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The provided information illustrates the rate of strength increase in MPa (megapascals) per day for a 1:3 mortar mix with increasing amounts of glass fibre at various curing times. It can be seen that the pace at which the strength of the mortar mixtures increases typically increases with the addition of glass fibre. For instance, the rate of strength growth for the mortar mix containing 4% glass fibre is greater than that of the mix without glass fibre at the early curing period of 0 to 7 days. In a similar vein, the mix containing 5% glass fibre gains strength at the highest rate of all the mixes during the latter curing time of 28 to 90 days. It is crucial to remember that the rate of strength increase also varies depending on the curing time and glass fibre content. For instance, during the early curing time of 0 to 7 days, the mix containing 1% glass fibre gains strength more quickly than the mix without glass fibre, but at the later curing period of 28 to 90 days, there is no appreciable difference in the rates at which the two mixes grow strength. Overall, the findings indicate that adding glass fibre can accelerate the rate of strength growth for a 1:3 mortar mix, and the ideal amount of glass fibre may vary depending on the particular curing requirements and application needs.

Table 3: Rate of gain in strength for 1:4 mortar mix

ID	**Glass Fibre**	**Rate of Gain in strength MPa/Day**		
		0 to 7 Days	**7 to 28 Days**	**28 to 90 Days**
M 41	0% GF	1.15	0.58	0.25
G 42	1% GF	1.43	1.02	0.45
G 43	2% GF	1.32	1.05	0.37
G 44	3% GF	2.43	0.95	0.35
G 45	4% GF	2.31	0.90	0.38
G 46	5% GF	2.02	0.76	0.30

The table shows the strength increase rate in MPa per day for various glass fibre contents in a 1:4 mortar mix at different curing phases. The mix with a 4 percent glass fibre content (G45) has the highest rate of strength growth at 0.38 MPa/day throughout the latter phases of curing (28 to 90 days), whereas the mix with a 5 percent glass fibre content (G46) has the lowest rate of gain at 0.30 MPa/day.

Table 4: Rate of gain in strength for 1:5 mortar mix

ID	**Glass Fibre**	**Rate of Gain in strength MPa/Day**		
		0 to 7 Days	**7 to 28 Days**	**28 to 90 Days**
M 51	0% GF	1.54	0.77	0.31
G 52	1% GF	1.81	0.66	0.25
G 53	2% GF	1.62	0.63	0.28
G 54	3% GF	1.85	0.63	0.25
G 55	4% GF	1.47	0.54	0.21
G 56	5% GF	1.00	0.35	0.20

The table shows the strength increase rate in MPa per day for various glass fibre contents in a 1:5 mortar mix at different curing phases. The mix with 1% glass fibre content (G52) gains strength at the fastest rate during the first seven days of curing (1.81 MPa/day), whereas the mix with 5% glass fibre content (G56) gains strength at the slowest rate (1.00 MPa/day). The mix with 1% glass fibre content (G52) continues to have the highest rate

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of strength growth at 0.25 MPa/day during later stages of curing (28 to 90 days), whereas the mix with 5% glass fibre content (G56) has the lowest rate of gain at 0.20 MPa/day.

Water absorption test result

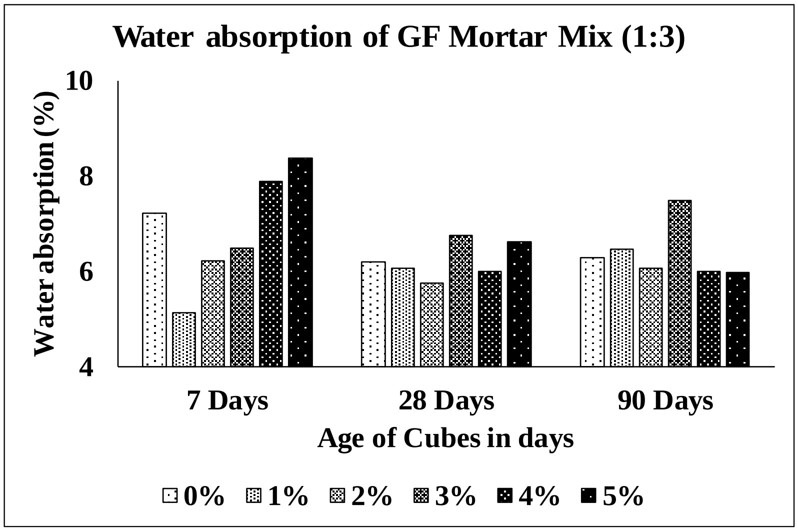

Figure 4: Water absorption of 1:3 mix mortar with varying percentage of glass fibre

Figure 4 shows the water absorption % of a 1:3 mortar mix with various glass fibre proportions at various curing times. It can be seen that the percentage of water absorption of the mortar mixes is not significantly affected by the inclusion of glass fibre.

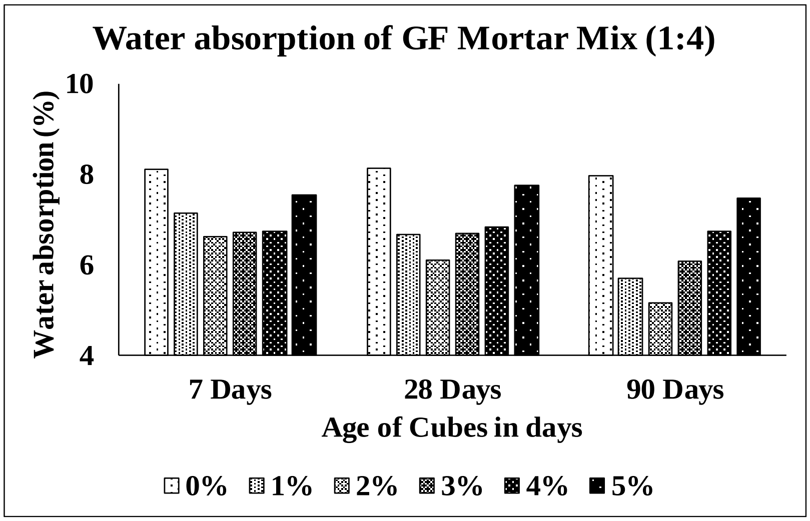

Figure 5: Water absorption of 1:4 mix mortar with varying percentage of glass fibre

Figure 5 displays the results of water absorption experiments performed on a 1:4 mortar mixture with various glass fibre contents at various curing times. The figure indicates that the water absorption for the mortar mixes typically decreases with the addition of glass

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fibre. Overall, the research indicates that adding glass fibre can increase the 1:4 mortar mix's water resistance.

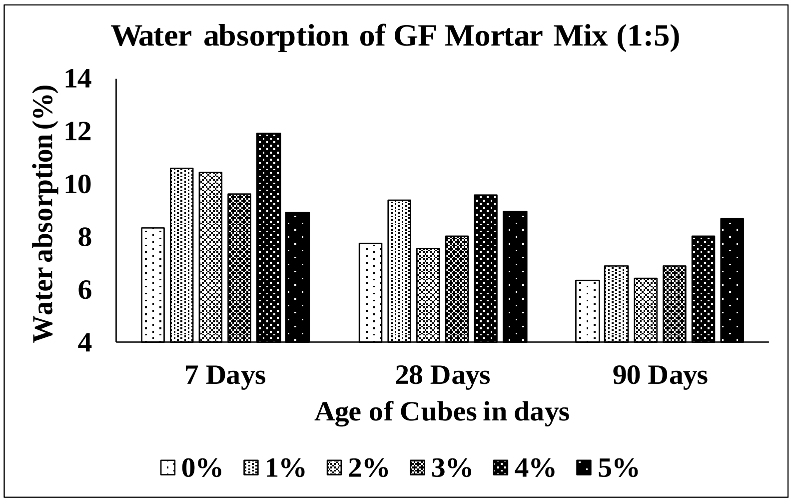

Figure 6: Water absorption of 1:5 mix mortar with varying percentage of glass fibre

The results of a water absorption test for various glass fibre (GF) percentages in a 1:5 mortar mixture are shown in Figure 6. The findings demonstrate that during 7 days, 28 days, and 90 days, respectively, the water absorption for the mortar mix without GF (M51) was 8.34%, 7.76%, and 6.37%. In some instances, but not always, the water absorption increased as the percentage of GF in the mix increased.

Final observation for comprehension: It can be seen that the inclusion of glass fibre typically results in an increase in water absorption for the 1:3 mortar mix. The inclusion of glass fibre often results in a reduction in water absorption for the 1:4 mortar mix. The water absorption behaviour is more complicated for the 1:5 mortar mixture. The amount of water absorbed varies depending on whether glass fibre is added; sometimes it rises, sometimes it reduces. Overall, glass fibre content, curing time, and mix ratio all have an impact on how quickly mortar mixtures absorb water. Depending on the precise mix percentage, adding glass fibre can have either good or negative effects on water absorption. The findings demonstrate that depending on the mix percentage, adding glass fibre to mortar mixtures can have a variety of impacts on water absorption. To get the best water absorption behaviour, it is crucial to carefully evaluate the particular mix proportions and curing time when adding glass fibre to mortar mixtures.

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Drying shrinkage test result

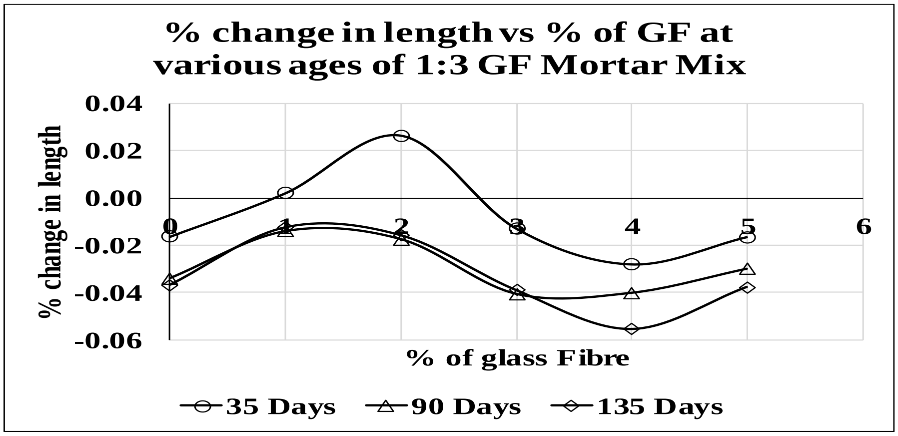

Figure 7: Percentage change in length of 1:3 mix mortar with percentage of glass fibre

The results demonstrated that the mix without GF (M31) saw negative drying shrinkage at each of the three time points, indicating that it was shrinking. The drying shrinkage behaviour changed as the amount of GF in the mixture increased.

For example, the mixes containing 2% GF (G33) and 4% GF (G35) both showed positive drying shrinkage at the 35-day point, suggesting expansion. However, the 3 percent GF (G34) mixture had negative drying shrinkage at the same time.

All of the mixtures showed negative drying shrinkage at 90 days and 135 days, indicating that they were shrinking. Depending on the GF %, the degree of shrinkage varied, with certain combinations exhibiting larger amounts of shrinkage than others.

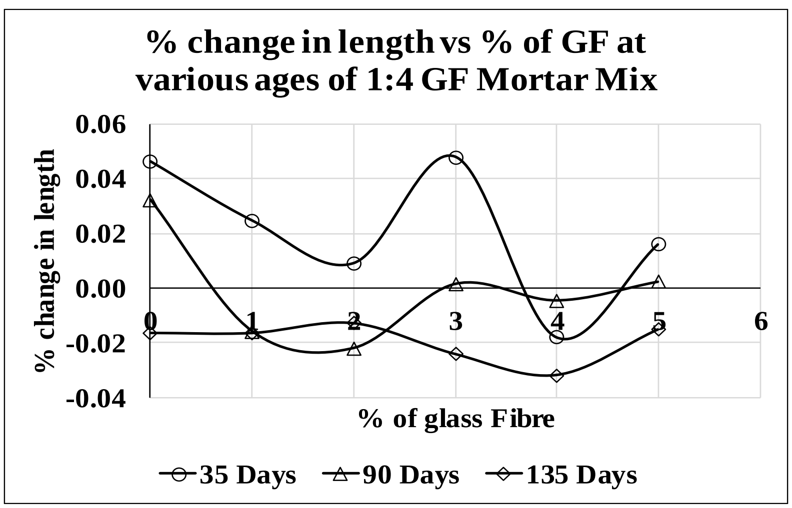

Figure 8: Percentage change in length of 1:4 mix mortar with percentage of glass fibre

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The table shows that there is often an increase in drying shrinkage when glass fibre is added. In contrast to the 0% GF mix, which has a negative drying shrinkage of -0.0164 percent at 35 days, the 1% GF mix has a positive drying shrinkage of 0.002 percent. The 0% GF mix has a negative drying shrinkage of -0.0367 percent at 135 days, compared to the 5% GF mix's negative drying shrinkage of -0.0377 percent.

However, not all blends exhibit the same drying shrinkage tendency. For instance, the 2 percent GF mix exhibits positive drying shrinkage after 35 days of 0.0264 percent but negative drying shrinkage at 90 days of -0.0174 percent.

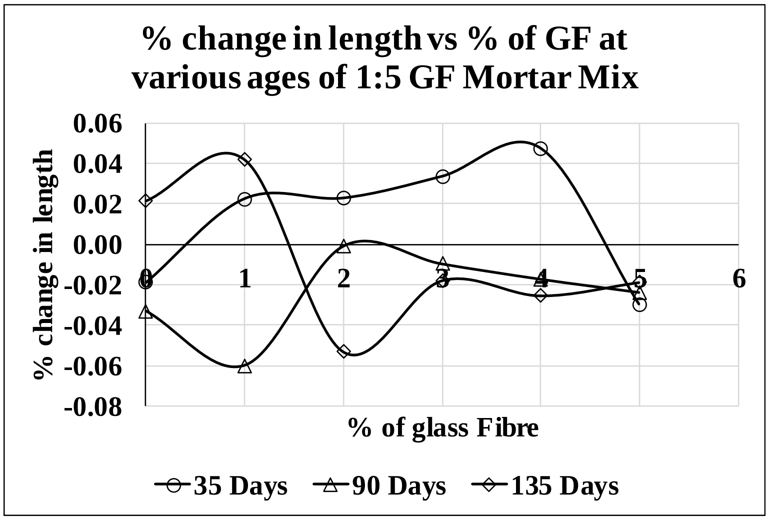

Figure 9: Percentage change in length of 1:5 mix mortars with percentage of glass fibre

As a consequence, the mix lacking GF (M51) showed negative drying shrinkage at 35 days but positive drying shrinkage at 90 days and 135 days, according to the data. The drying shrinkage behaviour changed as the amount of GF in the mixture increased.

For instance, the mix with 4 percent GF (G55) showed expansion at 35 days with positive drying shrinkage, but the other mixes showed negative drying shrinkage at this time. All of the mixtures showed negative drying shrinkage at 90 days and 135 days, indicating that they were shrinking.

Depending on the GF %, the degree of shrinkage varied, with certain combinations exhibiting larger amounts of shrinkage than others. For instance, for all three time periods, the drying shrinkage was greatest for the mix containing 4 percent GF (G55).

8. CONCLUSIONS

- Based on the results of the compressive strength tests, it can be shown that adding glass fibre to mortar mixtures typically increased their compressive strength at various ages for all mix proportions (1:3, 1:4, and 1:5). Glass fibre enhanced the compressive strength for the 1:3 mix percentage, with the 4 percent GF mix displaying the greatest strength values throughout all test time periods. The 3 percent GF mix had the best

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strength values at young ages (7 and 28 days) for the 1:4 mix percentage, whereas the 4 percent GF mix displayed the highest strength values at 90 days. Glass fiber's impact on compressive strength for the 1:5 mix ratio was less uniform, with some mixes exhibiting greater strength values with the addition of glass fibre while others exhibited lower values. Overall, the findings imply that adding glass fibre might improve mortar mixes' compressive strength, especially for mix ratios of 1:3 and 1:4, albeit the effect may vary depending on the exact mix ratio and glass fibre concentration.

- In conclusion, the data for mortar mixtures of 1:3, 1:4, and 1:5 with varied amounts of glass fibre demonstrate that the inclusion of glass fibre often causes an increase in the rate of strength gain. The ideal glass fibre content, however, may change according to the particular curing time and application needs. When choosing a mortar mix for building projects, it's crucial to take the rate of strength growth into account to make sure the mortar achieves its full strength within the needed amount of time. The findings for mortar combinations of 1:3, 1:4, and 1:5 with varying quantities of glass fibre show, in conclusion, that the pace at which strength increases is frequently accelerated by the addition of glass fibre. However, the optimal glass fibre content may vary depending on the specific curing requirements and application requirements.
- As the proportion of fibres in the mixture increases, so does its water absorption. On the 28th and 90th days, the water absorption of all the mixtures for the 1:3 mix is less than 8%. In a 1:4 mix proportion, the controlled mix absorbs more water than the other glass fibre blends. In a 1:5 mix proportion, the glass fibre mixes absorb more water than the controlled mix. All mixtures with different proportions absorb less water as they get older. It illustrates how including glass fibre into mortar mixtures enhances their ability to absorb water.
- In comparison to the mix without glass fibre, the inclusion of glass fibre typically reduced drying shrinkage for the 1:3 and 1:4 mortar mixes. The 2 percent and 3 percent GF mixes, which had the lowest drying shrinkage values across all time periods examined, were most affected by this impact. The drying shrinkage values for the 5 percent GF mix were somewhat lower than those for the 0 percent GF mix.
- The impact of glass fibre on drying shrinkage was less constant for the 1:5 mortar mixture. The drying shrinkage of the 2 percent GF mix was less than that of the 0 percent GF mix, but the drying shrinkage of the other mixes increased over time. The maximum drying shrinkage values were seen in the 4% and 5% GF mixes at 35 days, although the values reduced as time went on.

Overall, the findings imply that the inclusion of glass fibre, particularly at proportions of 2 and 3 percent GF for 1:3 and 1:4 blends, might reduce drying shrinkage in mortar mixes. However, for other mix proportions and longer time periods, the effect can be less predictable.

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