International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Experimental study on strength comparison ofthe glass fiber reinforced concrete (GFRC) andconventional concrete (M30 grade)

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International Journal of Science and Research Archive, 2023, 09(01), 462–467

Publication history: Received on XX September 2023; revised on 11 June 2023; accepted on 14 June 2023

Article DOI: https://doi.org/10.30574/ijsra.2023.9.1.0152

Abstract

This is a comparatively recent advancement in construction technology. This saves money in the construction process because it is light weight. The use of glass fiber to replace steel in reinforced concrete structures helps reduce corrosion and structural damage. Many alternatives have been investigated to increase concrete's strength, durability, shrinkage characteristics, and serviceability while considering global environmental factors. As a consequence, glass fiber has been employed as an additive, and trials with various percentages of 1%, 2 %, and 3% cement have been carried out. When considering this material, concepts such as glass fiber, light weight, cost-effective, ecologically friendly, and compressive strength must be considered.

GFRC is a cement matrix made up of cement, sand, water and admixtures, and contains short glass fibers. Facade panels, pipes and channels are examples of non-structural elements that have been extensively used. Light weight (which lowers dead load), fire resistance, an attractive appearance, and tensile strength are just a few of the benefits of GFRC. Trial tests for concrete with and without glass fiber are conducted using cubes, beams, and cylinders to measure the differences in compressive strength, flexural strength, and split tensile strength. Because glass fiber may be molded and sculpted in a number of ways, its demand is growing in India due to rising building activity and other causes. Compared to other reinforcing materials, it is a more affordable and cost-effective solution.

Keywords: Glass fiber; Lightweight; Economic; Eco-friendly; Compressive strength

1. Introduction

Glass fibers are round and straight, with diameters ranging from 0.005mm to 0.015mm. Glass fibers are readily available in a wide range of lengths, diameters, and aspect ratios. Alkali- resistant glass fibers were used in all of the investigations in this study. By varying the number of fibers, this study contrasts some of the characteristics of two concrete classes. The goal of this study was to determine whether incorporating glass fiber into concrete enhances its strength.

1.1. Objectives of the project

The objectives of the project are as follows:

- Cost-effect data analysis
- Analysis and design steps of glass-fiber reinforcement
- Fully organized strength

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1.2. Role of fiber-glass reinforcement

The main tensile load-carrying component of GFRC is alkali-resistant glass fibers. The concrete matrix connects the fibers and transfers loads from one fiber to the next by causing shear stress in the matrix. Concrete fiber reinforcement is commonly misunderstood and feared. The CCI has published articles on fiber reinforcement ordinary concrete. The relevance of structural fiber dose and orientation, on the other hand, will be investigated further.

Fiber reinforcement is a typical approach for improving the mechanical characteristics of a material. Many engineers, who are interested in material sciences, have received education on the subject. Fiber glass is the most prevalent and well known type of fiber reinforcement.

1.3. Important contents

SiO_2	:50-60
Al_2O_3	:1-11
ZrO_2	:4-10
ZnO	:0.5-7
GroupIAOxide	:10-19
GroupIIAOxide	:3-15

Alkali resistance is conferred by zirconia in the glass. The more zirconia there is, the more alkali- resistant it is. AR glass fibers are also resistant to acids.

Finally, the direction of the fibers was crucial. The randomness of the orientation increases as the number of threads required to bear the load increases. This is because only a small number of randomly oriented fibers are oriented in the correct direction.

1.4. Mandatory study

GFRC's strength comes from a high dosage of AR glass fiber. Although GFRC has high compressive strength, it also has extra-ordinarily high flexural and tensile strength, making it a better choice than conventional concrete. Higher fiber doses effectively transmit tensile loads and make the material more flexible while preventing it from breaking. Facades are commonly composed of large light-weight panels manufactured using GFRC. As a result, the overall cost of the materials used gets reduced. We must explore its qualities to make the most of its superior structural features and reduce cost while maintaining its high strength.

2. Material and methods

Concrete is a freshly mixed material that can be formed into nearly any shape. Concrete, unlike other construction materials, is made on site and, with the exception of cement, can vary widely in quality, features and performance owing to the use of natural ingredients. Material properties are crucial for making concrete workable and long-lasting.

The materials used in the study are as follows:

Table 1 List of materials to be used in the study

Cement:	**OPC**
Fine aggregate	Local available sand
Coarse aggregate	Aggregates that have passed through a20mmsieve
Glass fiber	5cm of long chopped fibers
Water:	Potable water as per IS code 456:2000

2.1. Demand of fiber glass

The method may be used to replace asbestos. High quality alkali-resistant glass fibers with a high proportion of zirconia, increases the alkali resistance of cement composites. Strand lengths andsizes are available in a variety of lengths and sizes to fulfill specific applications and processing demands. AR glass fiber is available through a variety of local agencies in Saudi Arabia, France, the United States, Russia, Thailand, Singapore and the United Arab Emirates.

Table 2 Composition of AR glass fiber

S. no.	Compound	Composition(Parts by Weight)
1.	SiO_2	50-60
2.	Al_2O_3	1-11
3.	ZrO_2	4-10
4.	ZnO	0.5-7
5.	Group IA Oxide	10-19
6.	Group IIA Oxide	3-15

Table 3 Compressive strength of concrete at various ages

S. no.	Age	Strengthpercent
1.	1	16%
2.	3	40%
3.	7	65%
4.	14	90%
5.	28	99%

3. Results and Discussion

Table 4 Test results of conventional concrete cube

S. No.	LOAD		Compressive Strength	
	7Days	28Days	7Days	28Days
1.	350	570	15.55	25.33
2.	345	585	15.33	26
3.	360	565	15.98	25.11
Average			15.62	25.48

Table 5 Test results of fiber reinforced concretecube

S. no.	% glass fiber	Load (KN)		Compressive strength		Average	
		7 days	28 days	7 days	28 days	7 days	28 days
1.	1 %	505	685	22.44	30.44	22.14	30.14
		490	670	21.77	29.77		
		500	680	22.22	30.22		

2.	1.5 %	535	725	23.77	32.22	23.25	32.22
		515	720	22.88	32		
		520	730	23.11	32.44		
3.	2 %	485	670	21.55	29.77	21.18	9.55
		470	660	20.88	29.33		
		475	665	21.11	29.55		

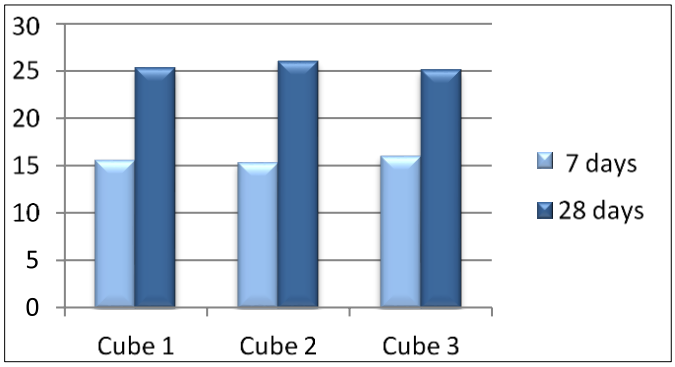

Figure 1 Conventional cube compressive strengthchart

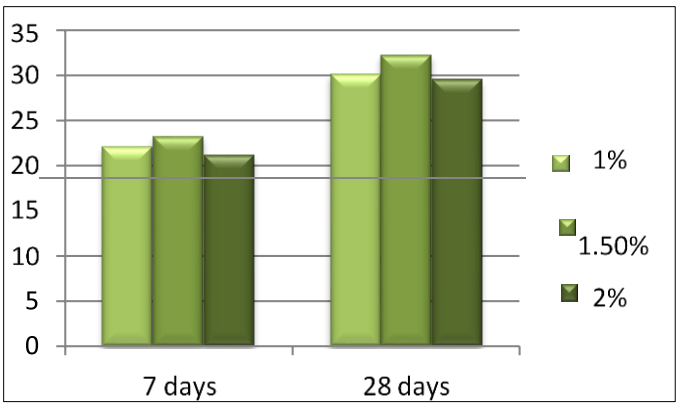

Figure 2 GFRC cube compressive strength chart

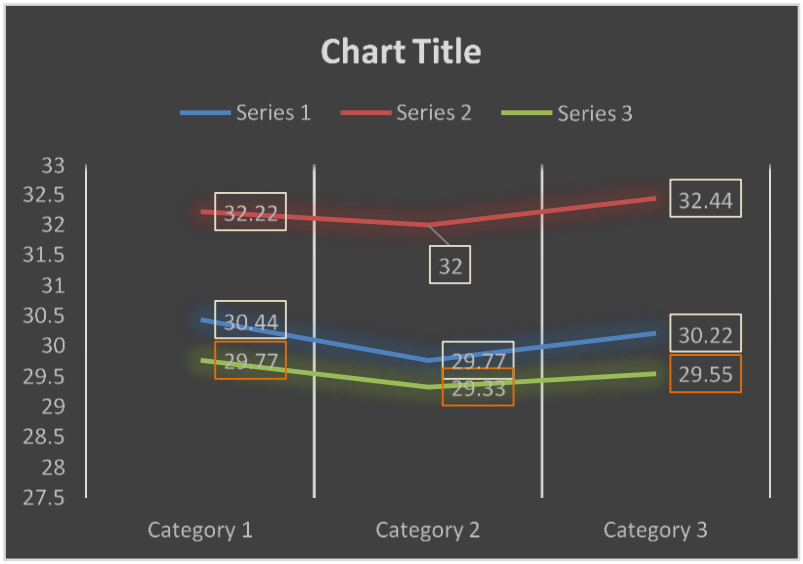

Figure 3 Compressive strength comparison

Graphical representation of Cube Compressive Strength of Natural Aggregate Concrete (NAC), replacement of natural aggregate were in proximity while 100% replacement has a low compressive strength.

4. Conclusion

From the results of the experiments, the following conclusions can be drawn:

- The highest compressive strength was attained by adding 1.5% of glass fiber by weight, to the entireconcrete mix. Successive additions resulted in a minor divergence from the maximum strength.
- Adding 1.5% of glass fiber by weight, to the entire concrete mix increased the compressive strength ofconcrete by 26%.
- When it comes to achieve high strength, glass fiber is a cost- effective and suitable option. Concretepanels are sturdy and can be manufactured with little material.
- As a result, alkali resistant glass fiber can be used as reinforcement in regular concrete, resulting inighter, smaller and stronger panels.

Compliance with ethical standards

Acknowledgments

I would like to express my profound gratitude to my co-authorsMr. Iliyas khaleel for their insightful advice provided in the composition of this article.

Disclosure of conflict of interest

The authors declared no interests.

Statement of informed consent

The goal of the study was explained to the respondents, and the researcher promised them that the information they provided would be kept private. The researcher assured the respondents that their information would only be utilized for scholarly purposes. Respondents chose to participate voluntarily, and there were no incentives.

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