

AN EXPERIMENTAL EVALUATION ON EFFECT OF CHOPPED GLASS FIBER IN CONVENTIONAL CONCRETE

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ABSTRACT

Chopped Glass Fibers are among the most versatile industrial materials known today. They are readily produced from raw materials from glass industries. Fibers when added in certain percentage in the concrete improve the strain properties, crack resistance, ductility, flexural strength and toughness. In the present experimental investigation, chopped glass fibers have been used to study the effect on compressive, split tensile and flexural strength on M 20 grade of concrete with varying percentage of glass fibers added to the concrete specimen. In this study Compressive Strength Test, Flexural Strength Test and Split-Tensile Strength Test is carried out for 7 and 28 days. The experimental results shows that with the addition of chopped glass fiber with varying percentages of 0.15%, 0.3% and 0.45% by weight. There is significant increase in compressive Strength, flexural strength and split-tensile strength of the conventional concrete.

Keywords: Chopped Glass fiber, Compressive strength, Flexural Strength and Split-Tensile Strength, M20 grade

I.INTRODUCTION

Today concrete is most widely used material in construction work, Fine aggregate, coarse aggregate, cement and water are the main constituents of concrete. Concrete have properties like high compressive strength, stiffness and durability under usual environmental factors. It is weak in tension and rich in compression but with reinforcement it gives ultimate tensile strength and to some extent by the inclusion of a sufficient volume of certain fibers. The use of fibers can make the concrete more homogenous and can improve the tensile properties. It also noticed that without any fiber concrete will develop the cracks due to drying shrinkage, plastic shrinkage and reasons of changes in volume of concrete. The addition of fibers in the plain concrete will control the cracking due to shrinkage

and also reduce the bleeding of water. The addition of glass fibers in plain concrete shows higher flexural strength than plain concrete. Environmental and economic considerations played a great role in the increase in use of mineral admixtures.

The use of fibers also alters the behaviour of the fiber-matrix composite after it has cracked, thereby improving its toughness. Toughness is defined as the area under a load-deflection (or stress-strain) curve. Addition of fibers to concrete greatly increases the toughness of the material. That is, fiber-reinforced concrete is able to sustain load at deflections or strains much greater than those at which cracking first appears in the matrix.

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, sand, aggregates and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber-reinforced normal concrete is mostly used for ground floors and pavements, but can be considered for a wide range of structural elements (beams, pliers, foundations etc) either alone or with hand-tied rebars. Concrete reinforced with fibers (which are usually steel, glass or plastic fibers) is less expensive than hand-tied rebar, while still increasing the tensile strength many times. Shape, dimension and length of fiber are important. A thin and short fiber, for example short hair-shaped glass fiber, will only be effective for the first hours after pouring the concrete (reduces cracking while the concrete is stiffening) but will not increase the concrete tensile strength. This is a composite material consisting of a matrix containing a random distribution or dispersion of small fibers, either natural or artificial, having a high tensile strength. Due to the presence of these uniformly dispersed fibers, the cracking strength of concrete is increased and the fibers acting as crack arresters. Fibers suitable of reinforcing concrete having been produced from steel, glass and organic polymers.

II.GLASS FIBERS

Glass Fiber is really made of glass, similar to windows or the drinking glasses used in the kitchen. The glass is heated until it is molten, then it is forced through superfine holes, creating glass filaments that are very thin. These threads can then be woven into larger swatches of material or left in the somewhat less structured although more familiar puffy substance used for insulation or soundproofing. This will depend on whether the extruded strands were made longer or shorter, and the quality of the fiberglass.

Glass fibre is a material consisting of numerous extremely fine fibres of glass". Glass fibres were found to be alkali reactive and the products in which they were used deteriorated rapidly. Alkali-resistant glass containing 16% zirconia was successfully formulated in the 1960s and by 1971, it was in commercial production in the UK. Alkali-resistant glass fibre is used in the manufacture of glass-reinforced cement (GRC) products, which have a wide range of applications. Glass fibre is available in continuous or chopped lengths. Fibre lengths of up to 35 mm are used in spray applications and 25 mm lengths in premix applications. Glass fibre has high tensile strength (2-4 GPa) and elastic modulus (70-80 GPa) but has brittle stress-strain characteristics (2.5-4.8% elongation at break) and low creep at room temperature. Claims have been made that up to 5% glass fibre by volume has been used successfully in sand-cement mortar without balling.

Glass fibre products exposed to outdoor environment have shown a loss of strength and ductility. It is suitable for use in direct spray techniques and premix processes and has been used as a replacement for asbestos fibre in flat sheet, pipes and a variety of precast products. GRC products are used extensively in agriculture; for architectural cladding and components; and for small containers.



III.TYPES OF GLASS FIBER

There are different types of glass fibers described below

A-glass – These are Alkali glass made with soda lime silicate. Used where electrical resistivity of E-glass is not needed. It is also known as soda lime glass. A-glass or soda lime glass is the predominate glass used for containers and windowpanes.

AR-glass – AR glass is known as Alkali Resistant glass. AR glass is the composition of zirconium silicates. Used in Portland cement substrates.

C-glass – Glass made with calcium borosilicates is known as Corrosive resistant or C-glass. Used in acid corrosive environments.

D-glass – These are the low dielectric constant glass made with borosilicates. Used in electrical applications.

E-glass – The highly electrically resistive glass made with alumina-calcium borosilicates is known as E- glass and free from alkalis. E-glass is known in the industry as a general-purpose fiber for its strength and electrical resistance. It is the most commonly used fiber in the fiber reinforced polymer composite industry.

ECR-glass – An E-glass with higher acid corrosion resistance made with calcium aluminosilicates. Used where strength, electrical conductivity and acid corrosion resistance is needed.

R-glass – A reinforcement glass made with calcium aluminosilicates used where higher strength and acid corrosion resistance is needed.

S-glass – Glass for the purpose of high strength made with magnesium aluminosilicates. Used where high strength, high stiffness, extreme temperature resistance, and corrosive resistance is needed.

S-2 glass – Glass similar to S- glass but with somewhat improved properties. “S-2” is a brand name originally created by Owens-Corning but spun off in 1998 and is now a registered trademark of AGY Holdings Corp.

IV.CEMICAL COMPOSITION &PROPERTIES OF GLASS FIBER

S. No.	Compositions	E- Glass	S- Glass
1	Silicone Dioxide	52 – 56%	64 – 66%
2	Calcium Oxide	16 – 25%	0 – .3%
3	Aluminum Oxide	12 – 16%	24- 26%
4	Boron Oxide	5 -10%	
5	Sodium Oxide & Potassium Oxide	0 – 2%	0 – .3%
6	Magnesium Oxide	0 – 5%	9 – 11%
7	Iron Oxide	.05 – .4%	0 – .3%
8	Titanium Oxide	0 – .8%	
9	Fluorides	0 -1.0%	

S. No.	Property	Value
1	Filament diameter	14μ
2	Ultimate Elongation	2.4 %
3	Specific Gravity	2.68
4	Length	12 mm
5	Density	2.6 T/m3
6	Elastic Modulus	73 MPa
7	Tensile Strength	1700 MPa
8	Number of fibres	220 million
9	Specific surface area	105 m2/kg

V.OBJECTIVES OF STUDY

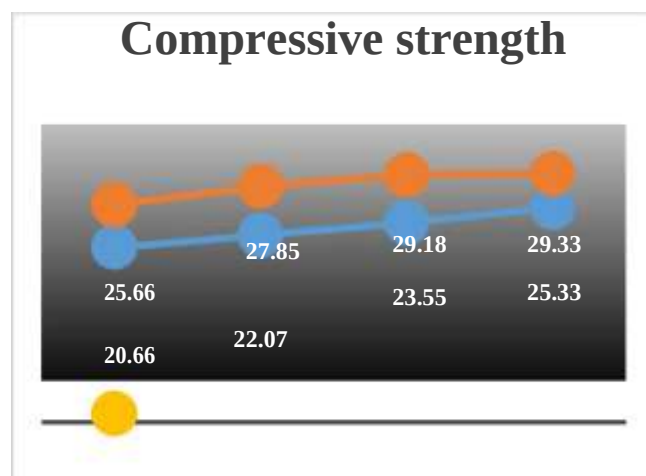
The versatility of glass as a fibre makes it a unique industrial material. Glass fibre in fabric form offers an excellent property to improve the concrete strength. Despite having numerous advantages, it does not reach to its paramount height due to its high cost. To overcome this limitation, glass fibre should be used as a cost-effective material to serve the construction sector. Replacing cement partially by chopped glass fibre would make it a superior material in applications where high strength and minimum weight are required. So this study includes a dual purpose of improving the compressive strength of the concrete as well as its tensile strength as compared to ordinary concrete. Moreover, using this material in the construction process will improve the material performance, its economics and flexibility.

VI.EXPERIMENTAL INVESTIGATION

1.1 Compressive strength

The test results of the compressive strength at 7 days of conventional concrete with 0 % addition of chopped glass fibre were obtained as 20.66 N/mm². The strength gradually increased with 0.15 % chopped glass fibre upon mixing was 22.07 N/mm² with 06.82 % increase of compressive strength. Later on with 0.30 % mix of chopped glass fibre, the compressive strength was obtained as 23.55 N/mm² with 13.98 % increase in strength. Lastly with 0.45 % of chopped glass fibre mix, the compressive strength was 25.33 N/mm² with 22.60 % increase in strength as compared to 0 % chopped glass fibre mix in conventional concrete.

The test results of the compressive strength at 28 days of conventional concrete were obtained as 25.66 N/mm². The strength was increased to 27.85 N/mm² with 0.15 % chopped glass fibre mix with its 08.53 % increase of the strength. Now with 0.30 % mix of chopped glass fibre, the compressive strength was obtained as 29.18 N/mm² with 13.71 % increase in its strength. And finally with 0.45 % of chopped glass fibre mix, the compressive strength was 29.33 N/mm² with 14.30 % increase in strength as compared to 0 % chopped glass fibre mix in conventional concrete.

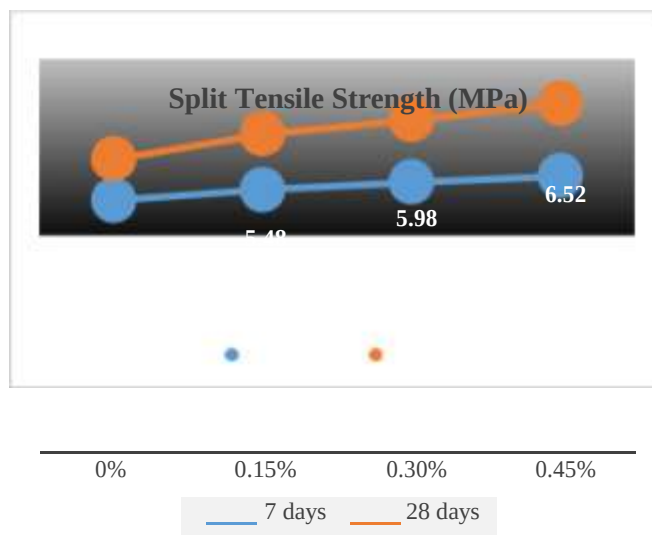


0% 0.15% 0.30% 0.45%

1.2 Split Tensile Strength

Split - Tensile strength increases with increasing percentage of glass fibers". The test results of the split-tensile strength at 7 days of conventional concrete which was obtained as 3.20 N/mm². The strength later on increases to 0.15 % chopped glass fiber upon mixing was 3.56 N/mm² with 11.25 % increase of split-tensile strength. Later on with 0.30 % mix of chopped glass fiber, the split-tensile strength was obtained as 3.82 N/mm² with 19.38 % increase in strength. Lastly with 0.45 % of chopped glass fiber mix, the split-tensile strength was 4.03 N/mm² with 25.93 % increase in strength as compare to 0 % chopped glass fiber mix in conventional concrete.

The test results of the split- tensile strength at 28 days of conventional concrete with 0 % addition of chopped glass fiber was obtained as 4.62 N/mm². The strength gradually was increased with 0.15 % chopped glass fiber upon mixing was 5.48 N/mm² with 18.61 % increase of split-tensile strength. Later on with 0.30 % mix of chopped glass fiber, the split-tensile strength was obtained as 5.98 N/mm² with 29.43 % increase in strength. Lastly with 0.45 % of chopped glass fiber mix, the split-tensile strength was 6.52 N/mm² with 41.12 % increase in strength as compare to 0 % chopped glass fiber mix in conventional concrete.



VII.CONCLUSIONS

1. A reduction in bleeding is observed by addition of glass fibres in the glass fibre concrete mixes.
2. A reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks.
3. The percentage increase of compressive strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed from 20 to 25%.
4. The percentage increase of flexural and split tensile strength of various grades of glass fibre concrete mixes compared with 28 days is observed from 15 to 20%.
5. Thus, it is observed that there is gradual increase in the strength of the concrete with increase of chopped glass fiber as compared to ordinary concrete.

REFERENCES

- [1.] Dr Srinivasa Rao. P and Seshadri Sekhar.T
- “Strength and Durability properties of glass fibre reinforced concrete” Proceedings of
 - International Conference on Recent Advances in Concrete and Construction Technology, 07-09 Dec 2005, SRMIST, India, P.P. 43-50.
- [2.] Ganesh Babu. K and Pavan Kumar. D. “Behaviour of Glass Fibre Reinforced Cement
- Composites”, ICFRC International Conference on Fibre Composites, High Performance Concretes and Smart Materials. 8-10 Jan. 2004, Chennai.
- [3.] V.R. Ramkumar, G.Murali and A. Parthiban
- “Influence of glass fibre on concrete structures”,
 - International Journal of Emerging trends in Engineering and Development, Issue 2, Vol.4 (May 2012), ISSN 2249-6149, page no.[627-630].
- [4.] Glassfibre reinforced concrete (grc) technical specification.
- [5.] Concrete Technology by M.S. Shetty (S.Chand publications).
- [6.] Marcus Hinzen, Wolfgang Brameshuber,
- “Improvement of serviceability and Strength of
 - Tensile Reinforced Concrete by using Short Fibres”, 4th Colloquium on Textile Reinforced Structures (CTRS4), p.p. 261-272.
- [7.] K. Jagannadha Rao, T. Ahmed Khan.
- “Suitability of Glass Fibers in High Strength
 - Recycled Aggregate Concrete-An Experimental
 - Investigation” Asian Journal of Civil
 - Engineering (Building and Housing), Volume 10, No.6, Dec., 2009, (ISSN 15630854) pp. 681-690
- [8.] IS 516 (1999), Indian standard methods of tests for strength of concrete, (Reaffirmed 1999), Bureau of Indian Standards, New Delhi.
- [9.] IS 5816 (1970), Method of tests for splitting tensile strength of concrete cylinders, Bureau of Indian Standards, New Delhi.
- [10.] IS 10262 (1982), Recommended guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi.