To study the Mechanical Properties of M20 Concrete using glass fiber as an admixture

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Abstract – Concrete is the most commonly used material on the earth. It is extensively used in rigid pavements, buildings, dams, bridges etc. This experimental study is all about to use the glass fiber in M20 mix concrete as an admixture. Fiberglass is an immensely versatile material due to its light weight, inherent strength, weather-resistant finish and variety of surface textures. The purpose of this project is to study the mechanical properties of fiber-reinforced concrete by adding different proportions of glass fiber (E-glass fiber). There are multiple type of glass fibers but this experiment is based on E-glass fiber which is the glass wool generally used in the electrical appliances. The percentages of glass fiber were added as 0.03%, 0.06%, 0.09% and 0.12%. From the experiment, mechanical strength was increased from 7 to 28 days and the maximum strength was obtained as 38% whereas 27% of of split tensile strength was found after 28 days by the addition of 0.12% of glass fiber.

Key Words: Glass-fiber reinforced concrete, compressive strength, split tensile strength

1. INTRODUCTION

Glass fiber reinforcement concrete is cement mortar with countless strands of embedded glass fiber. It contains short discrete fibers that are uniformly distributed and randomly oriented. Based on the past research, it can control the plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability thus reduces bleeding of water. The composition of glass fiber used in GFRC as

Table -1: Composition of glass fiber

S.N.	Ingredients	Chemical composition
1	SiO_2	55%
2	CaO	16-25%
3	Al_2O_3	12-16%
4	B_2O_3	8-13%
5	MgO	0-6%
6	Na_2O	0-1%
7	K_2O	0-1%

1.2 TYPES OF GLASS FIBER

The following classification of glass fibers are:

1. **A-glass:** With regard to its composition, it is close to the window glass. In the Federal Republic of Germany, it is mainly used in the manufacturing of process equipment.
2. **C-glass:** This kind of glass shows better resistance to chemical impact.
3. **E-glass:** This kind of glass combines the characteristics of C-glass with very good insulation to electricity.
4. **AE-glass:** Alkali resistant glass. Generally, glass consists of quartz sand, soda, sodium sulphate, potash, feldspar and a number of refining and dying additives. The characteristics, with them the classification of the glass fibers to be made, are defined by the combination of raw materials and their proportions.

2. MATERIALS AND METHODOLOGY

2.1 Cement: The Ordinary Portland Cement of 43 grade was used in this study conforming to IS: 8112-1989. The specific gravity of cement was found out to be 3.12 and the standard consistency of cement was calculated as 29%

2.2 Coarse Aggregate: Coarse aggregates were obtained from local crusher were used in this study conforming to IS: 383-1970. The specific gravity of aggregates is 2.81 and water absorption of the aggregates is 2.49 and confirms the maximum size of the aggregate is 20mm.

2.3 Fine Aggregates: Locally available river sand was used as fine sand conforming to IS: 383-1970. The fineness modulus of sand 3.3 has been used which lies in **Zone II**

2.4 Glass Fiber: Glass fiber is a numerous material, it contains short discrete fibers that are uniformly distributed and randomly oriented. It is a versatile material due to its light weight, inherent strength, robust material, weather resistant properties and variety of surface textures. Its diameter is ranges from 9-25 micro meters. The physical properties of glass fiber are shown below:

Table -2: Physical properties of glass fiber

S.N.	Physical Properties	Value ranges
1	**Tenacity**	6.3-6.9 gms/den
2	**Density**	2.5 gms/cc
3	**Color**	White
4	**Elongation at break**	3%
5	**Resilience**	Excellent

2.5 Water: The potable water is generally considered satisfactory for mixing and curing of concrete. The water was taken from Arni University Civil Engineering Department. This was free from any detrimental contamination and was good potable quality.

Fig-1: Concrete moulds filled with glass fiber

3. TEST RESULTS AND DISCUSSIONS:

M20 grade of concrete mix was used for the different levels of glass fiber 0.03%, 0.06%, 0.09% and 0.12% with water-cement ratio 0.50 was added. As per IS: 456- 2000, there were total 45 concrete cubes, 45 cylinders and 45 beams were casted for different proportion of mix and their specimens were demoulded after 24 hours and curing was done. Their strength properties were tested on 7^{th} day, 14^{th} day and 28^{th} day. Here are the details of mix proportions of M20 Concrete

Table -3: Details of mix proportion of M20 Concrete

S.N.	Ingredients	Total Quantities
1	**Cement Content**	383.16 Kg/m^3
2	**Fine Aggregates**	480 Kg/m^3
3	**Coarse Aggregates**	1026 Kg/m^3
4	**Water-Cement ratio**	0.50
5	**Water**	191.6 lit/m^3

Table-4: Slump Cone Test results

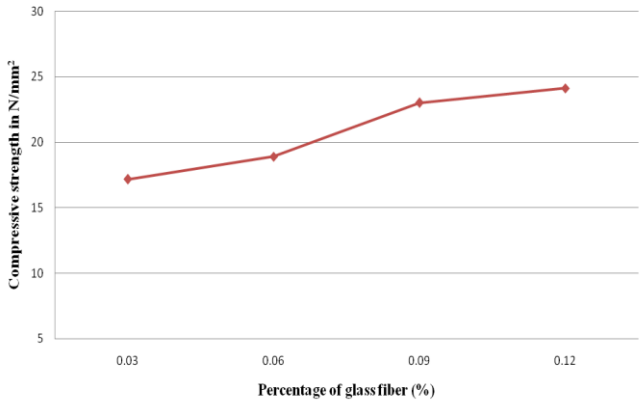
S.N.	% of glass fiber	W/C ratio	Slump values (mm)
1	0%	0.50	126
2	0.03%	0.50	126
3	0.06%	0.50	124
4	0.09%	0.50	123
5	0.12%	0.50	122

The above results shows that concrete is high workable.

The test results of compressive strength and split tensile strength are given below. These test results were obtained in the form of experimental study with the graph and discussion.

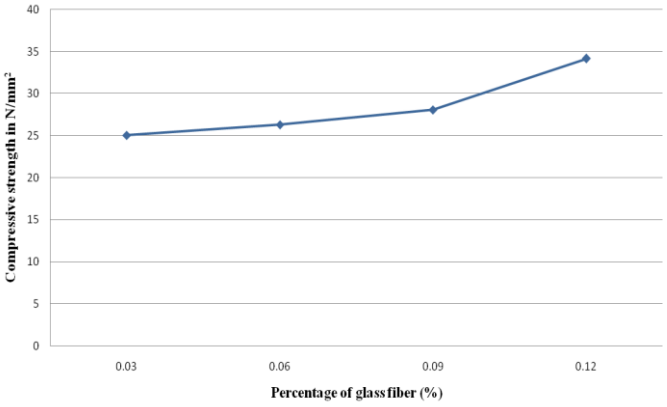
A. COMPRESSIVE STRENGTH FOR 7 DAYS

The compressive strength of cubes with filled with concrete using glass fiber as an admixture after curing for 7 days.



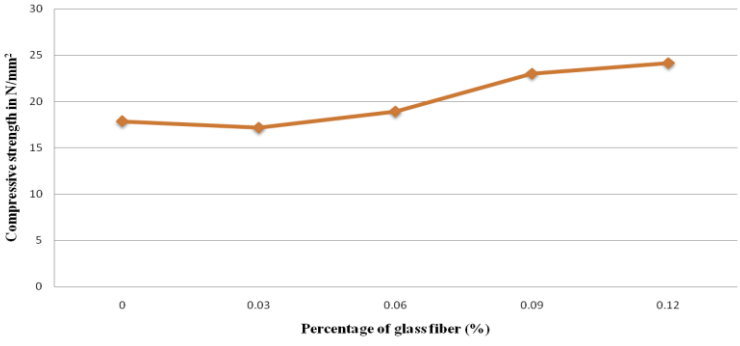
B. COMPRESSIVE STRENGTH FOR 28 DAYS

The compressive strength of cubes with filled with concrete using glass fiber as an admixture after curing for 28 days.



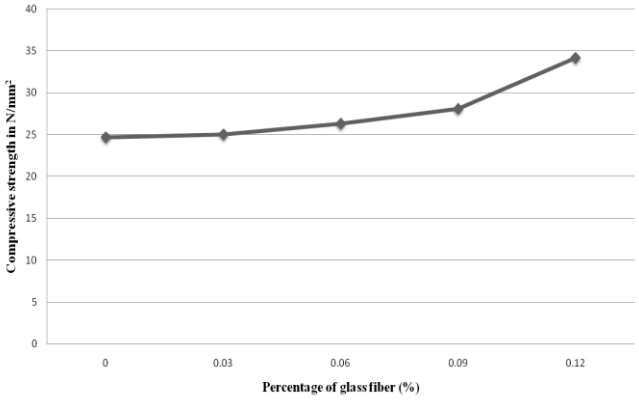
C. COMPRESSIVE STRENGTH AT 0% GLASS FIBER ADDITION AFTER 7 DAYS OF CURING

The compressive strength of cubes with filled with concrete using glass fiber as an admixture after curing for 7 days with respect to 0% glass fiber addition.



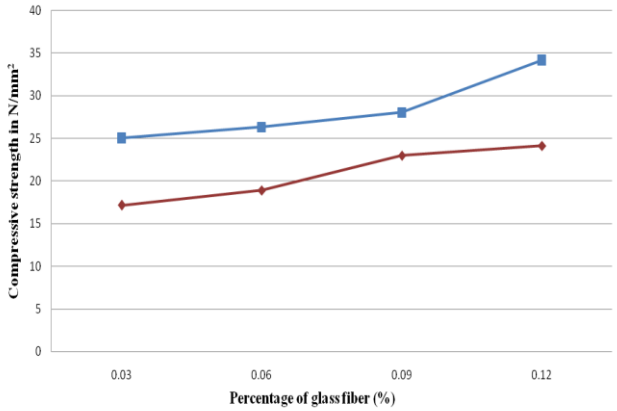
D. COMPRESSIVE STRENGTH AT 0% GLASS FIBER ADDITION AFTER 28 DAYS OF CURING

The compressive strength of cubes with filled with concrete using glass fiber as an admixture after curing for 7 days with respect to 0% glass fiber addition

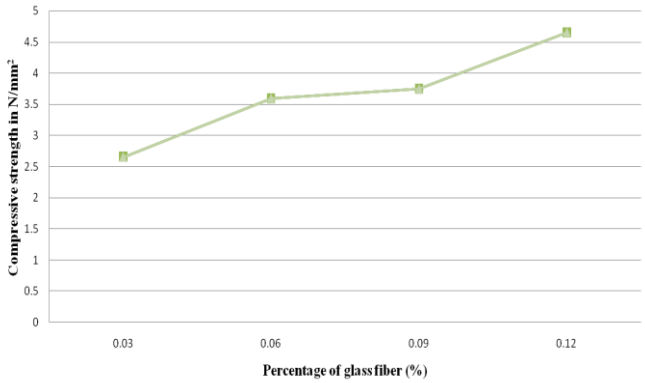


E. COMBINED INCREASE IN COMPRESSIVE STRENGTH AFTER 7 AND 28 DAYS OF CURING

This graph shows the combined increase in compressive strength of concrete using glass fiber as an admixture after 7 and 28 days of curing.



F. SPLIT TENSILE STRENGTH OF CYLINDERS FILLED WITH CONCRETE USING GLASS FIBER AFTER CURING FOR 28 DAYS



G. SPLIT TENSILE STRENGTH OF CYLINDERS FILLED WITH CONCRETE USING0 0% GLASS FIBER AFTER CURING FOR 28 DAYS

4. CONCLUSION

A. FOR COMPRESSIVE STRENGTH

1. The percentage increase of compressive strength of glass fiber concrete mixes compared with 28 days compressive strength is observed 38%.
2. The percentage decrease in compressive strength is found to be 3.8% after 7 days of curing by addition of 0.03% of glass fiber.
3. The percentage increase in compressive strength is found to be 5.8%, 28%, 35% for 0.06%, 0.09% and 0.12% respectively after 7 days of curing.
4. The percentage increase in compressive strength of fiber reinforced concrete are 1.4%, 6.6%, 13.7%, 38% for 0.03%, 0.06%, 0.09% and 0.12% of glass fiber respectively after 28 days of curing.
5. The highest compressive strength is found to be 38% after 28 days of curing with addition of 0.12% of glass fiber in M20 mix concrete.

B. FOR SPLIT TENSILE STRENGTH

1. The percentage increase of split tensile strength of glass fiber concrete mixes compared with 28 days split tensile strength is observed 27%.
2. The percentage decrease in split tensile strength of glass fiber concrete mixes is found to be 27%, 1.9% for 0.03% and 0.06% of glass fiber respectively after 28 days of curing.
3. The percentage increase in split tensile strength of glass fiber concrete mixes is found to be 2.2%, 27% for 0.09% and 0.12% of glass fiber respectively after 28 days of curing.
4. The highest split tensile strength is found to be 27% after 28 days of curing with addition of 0.12% of glass fiber in M20 mix concrete.

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