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Experimental Investigation on Glass Fibre Reinforced Concrete

Abinaya P[1], Vanathi R[2], Vidhya J[3], Saravanan R[4]

[1]*PG Student, Dept. of Civil Engineering, Kaveri College of Engineering, Mecheri, Tamilnadu, India*
[2,3]*Asst. Professor, Dept. of Civil Engineering, Kaveri College of Engineering, Mecheri, Tamilnadu, India*
[4]*Professor, Dept. of Civil Engineering, Navodaya Institute of Technology, Raichur, Karnataka, India*

Abstract - *The aim of the work is to study the properties of the effect of glass fibres as admixtures in the concrete for different proportions from the research work which is already carried out by the researchers. Glass fibre is a material consisting of numerous extremely fine fibres of glass. Glass fibre is commonly used in Insulating material. It is also used as a reinforcing agent for many polymer products, to form a very strong and light fibre reinforced polymer (FRP) composite material called Glass-Reinforced Plastic (GRP), properly known as "fiberglass". Glass fibre has roughly comparable properties to other fibres such as polymer and carbon fibre. Although not as strong as rigid as carbon fibre, it is much cheaper and significantly less brittle.*

Key Words: GFRC, Compressive Strength, Split tensile strength, Flexural strength, Workability.

1. INTRODUCTION

Glass fiber reinforced concrete (GFRC) is a recent introduction in the field of civil engineering. So, it has been extensively used in many countries since its introduction two decades ago. This product has advantage of being light weight and thereby reducing the overall cost of construction, ultimately bringing economy in construction. Steel reinforcement corrosion and structural deterioration in reinforced concrete structures are common and prompted many researchers to seek alternative materials and rehabilitation techniques. So, researchers all over the world are attempting to develop high performance concrete using glass fibers and other admixtures in the concrete up to certain extent. In the view of global sustainable scenario, it is imperative that fibers like glass, carbon, aramid and poly-propylene provide very wide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, erosion resistance and serviceability of concrete.

2. LITERATURE STUDY

Gai-Fei Peng. et.al. (2006) carried out an investigation to explore the relationship between occurrence of explosive spalling and residual mechanical properties of fiber toughened high performance concrete exposed to high temperatures

Deepak Gouda. B & Balakrishna H B (2014) have done the experimental studies on the Flexural Behavior of Reinforced Concrete Beams by replacing Copper Slag as Fine Aggregate. The optimum level of replacement of copper slag was found to be 40% and the results were better than that of control Mix. The compressive strength gradually increases from 0%, 35%, 40% replacement of copper slag and decreases for 45% replacement of copper slag.

Krasnikovs & **Eiduks (2016)** presented the experimental work possibility to obtain high performance steel fiber reinforced concrete is under investigation. Investigation results are opening possibility to use this material in constructions subjected to bending forces without traditional reinforcement

3. MATERIALS

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. The properties of cement, coarse and fine aggregate were listed in Table 1.

Table -1: Properties of Materials

Property	Values
Grade of Cement	53 grade
Initial Setting time	40 mins
Final Setting time	392 mins
Soundness Test	3 mm (<10mm)
Consistency Test	27%
Specific Gravity of Cement	3.15
Aggregate crushing value	26.20%
Nominal maximum size of	20 mm
Specific gravity of CA	2.71
Specific gravity of FA	2.74
Grading of sand	Zone - III

The concrete mix proportions were found from the experimental investigations as 1: 0.45 : 2.33 : 4.27 was obtained and used to prepare the concrete specimens.

4. RESULTS AND DISCUSSIONS

The fresh and hardened concrete is tested to study their properties. The purpose of testing of hardened concrete is to confirm concrete used at site has developed the required strength. The results obtained from each tests are tabulated and graphically represented below.

4.1 Testing of Fresh Concrete

The properties of fresh concrete values were obtained from the experimental results and given in Table 2. Mix 1 refers conventional concrete and Mix 2 refers GFRC.

Table -2: Workability

Type of Mix	Slump Height
Mix 1	113
Mix 2	78

4.2 Testing of Hardened Concrete

In present study cube compression test on cubes, split tensile test on cylinder, flexural test on prism on conventional concrete and GFRC are carried out. The Table 3 shows the compressive strength of concrete.

Table -3: Comparison of Compressive Strength of Concrete

Mix	Compressive Strength (N/mm²)					
	7 days			28 days		
Mix 1	20.22	20.0	20.44	33.44	33.33	32.88
Mix 2	25.33	25.77	24.88	41.33	40.88	41.11

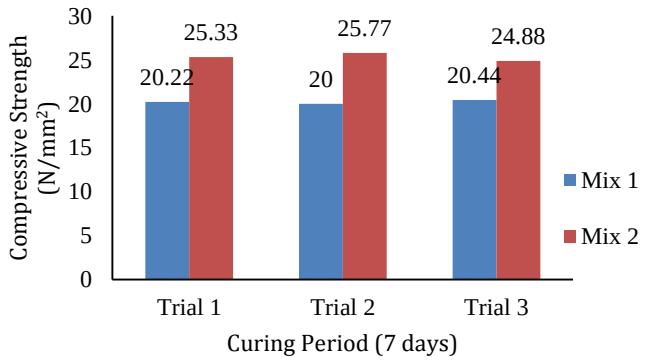

Fig -1: Comparison of compressive strength of concrete at 7 days

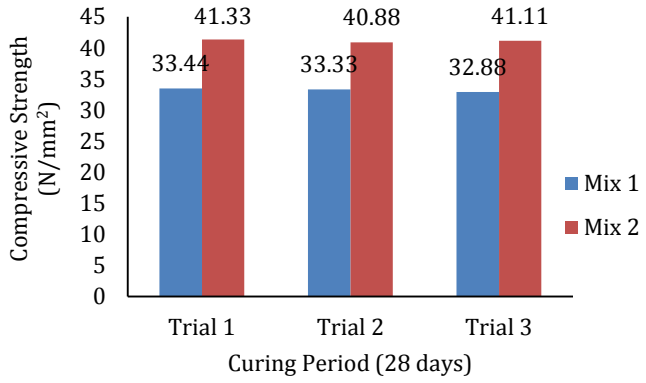

Fig -2: Comparison of compressive strength of concrete at 28 days

The Average compressive strength of the concrete at 7th day is 20.22N/mm² for Mix 1 and 25.33 N/mm² for Mix 2 and similarly at 28th day is 33.22 N/mm² and 41.10 N/mm² for Mix 1 and 2 respectively.

4.3 Split Tensile Strength test

A split tensile test is performed on standard cylinder of conventional concrete and GFRC with addition of fiber of specimen size 150mm diameter and 300 mm height after 7 and 28 days of immersion in water for curing. The Table 4 shows the split tensile strength of concrete.

Table -4: Comparison of Split Tensile Strength of Concrete

Mix	Split Tensile Strength (N/mm²)					
	7 days			28 days		
Mix 1	2.12	2.12	2.19	3.17	3.10	3.24
Mix 2	2.83	2.68	2.96	3.95	3.95	4.02

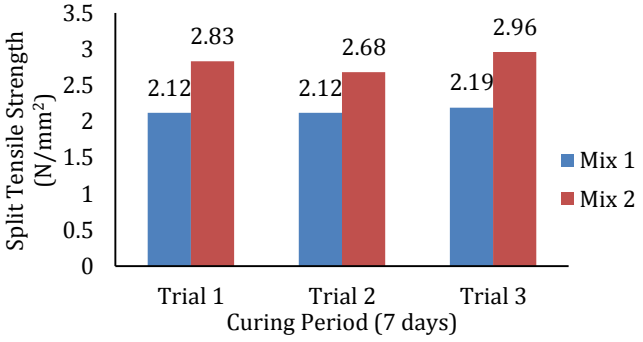

Fig -3: Comparison of split tensile strength of concrete at 7 days

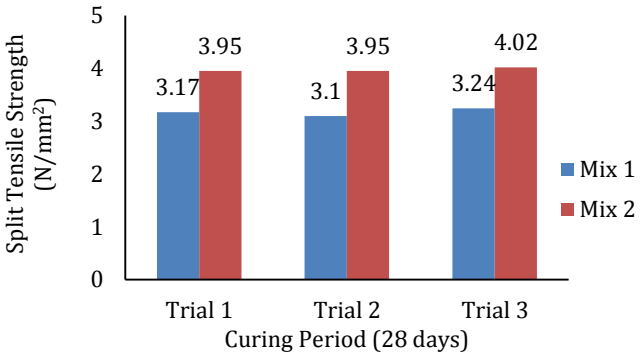

Fig -4: Comparison of split tensile strength of concrete at 28 days

The Average split tensile strength of the concrete at 7th day is 2.14 N/mm² for Mix 1 and 2.82 N/mm² for Mix 2 and similarly at 28th day is 3.17 N/mm² and 3.97 N/mm² for Mix 1 and 2 respectively.

4.4 Flexural Strength test

A flexural test is performed on standard prism of conventional concrete and GFRC with addition of fiber of size 100mm x 100mm x 500mm after 7 and 28 days of immersion in water for curing. The Table 5 shows the flexural strength of concrete.

Table -3: Comparison of Compressive Strength of Concrete

Mix	Flexural Strength (N/mm²)					
	7 days			28 days		
Mix 1	3.0	2.75	2.5	3.75	3.75	4.0
Mix 2	4.0	3.75	3.5	4.5	5.0	5.25

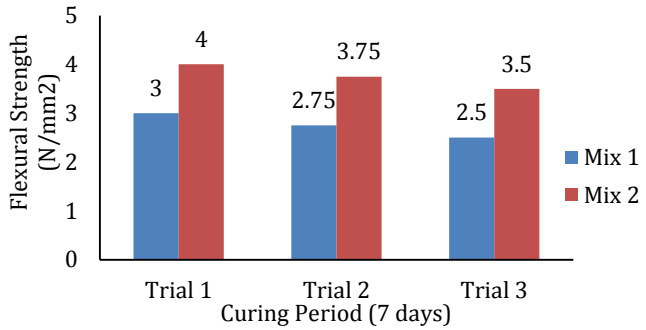

Fig -5: Comparison of flexural strength of concrete at 7 days

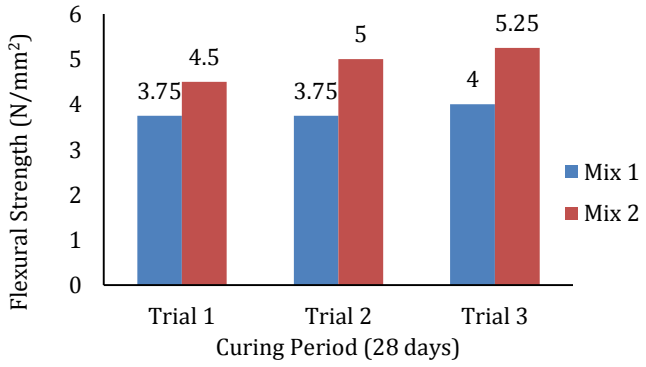

Fig -6: Comparison of flexural strength of concrete at 28 days

The Average flexural strength of the concrete at 7th day is 2.75 N/mm² for Mix 1 and 3.75 N/mm² for Mix 2 and similarly at 28th day is 3.83 N/mm² and 4.92 N/mm² for Mix 1 and 2 respectively.

5. CONCLUSIONS

- It is observed that Slump values of the concrete are decreasing as the fiber percentage increasing. The reduction in slump with the increase in the fiber will be attributed to presence of fibers which causes obstruction to the free flow of concrete.
- This study was to achieve the highest compressive, split tensile, flexural strength and to observe how these parameters changed with the variation of some factors like water to cement ratio will be decreased because of low permeability and shrinkage reduction in concrete.
- Though the initial cost is high the overall cost is greatly reduced because of the good properties of fiber reinforced concrete.
- The glass fiber reinforced concrete showed almost 20 to 25 % increase in compressive strength, flexural and split tensile strength as compared with 28 days compressive strength of plain concrete.
- Addition of glass fibers reduces bleeding and it improves the surface integrity of concrete. Also it increases the homogeneity and reduces the probability of cracks.
- So, the GFRC can be used for blast resisting structures, dams, hydraulic structures.
- This experimental investigation helps to know the properties and behavior of self-compacting concrete with fibers.

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