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Glass Fiber Reinforced Concrete

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***Abstract** - Glass-fiber reinforced concrete (GRC) is a material made of a cementitious matrix composed of cement, sand, water, and admixtures, in which short-length glass fibers are dispersed. It has been widely used for non-structural elements, like façade panels, piping, and channels. GRC offers many benefits, such as being lightweight, which will reduce dead load, fire resistance, good appearance, and tensile strength. In this study, trial tests for concrete with glass fiber and without glass fiber are conducted to indicate the differences in compressive strength, flexural strength, and split tensile strength by using cubes, beams, and cylinders. Various applications of GFRC shown in the study, the experimental test results, techno-economic comparison with normal concrete,*

The present work aims at evaluating the compressive strength, split tensile and flexural strength of glass fiber reinforced concrete of M25 grade for 12mm length of the fiber and varying dosages (0%, 0.03%, 0.06%, and 0.1%) by volume of the mould.

I. INTRODUCTION

Concrete is the most widely used construction material. In the last fifty-five years, there has been significant progress in concrete technology, mainly owing to the revival of the interest in supplementary cementing materials, as well because of the origin of new generation chemical additives for concrete. The concrete without any fiber will develop cracks due to plastic shrinkage, drying shrinkage, and other reasons for changes in the volume of concrete.

The development of these small cracks causes elastic deformation of concrete. Plain concrete is a brittle material and having the values of modulus of rapture and tensile capacity is low. The addition of fibers in the plain concrete will control the cracking due to shrinkage and also reduce the bleeding of water. Fibers help to improve the post-peak ductility performance and pre-crack tensile strength, fatigue strength, impact strength and eliminate temperature. GFRC is used to avoid corrosion in civil structures. Fiber-reinforced concrete is better suited to minimize cavitation/erosion damage in structures such as sluiceways, navigational locks, and bridge piers where high velocity flows are encountered. Glass fiber is available in continuous or chopped lengths.

Fiber lengths up to 35-mm are used in a spray application, and 25-mm lengths are used in premix applications. Glass fiber-reinforced concrete (GFRC) consists basically of a cementitious matrix composed of cement, sand, water in which short-length alkali-resistant glass fibers are dispersed.

II. LITERATURE REVIEW

Prof. S. S. Pimplikar, in this paper entitled "Glass fiber reinforced concrete used in construction "(2011)- GRC is a material made of a cementitious matrix composed of cement, sand, water, and admixture, in which short-length glass fiber are dispersed. It has been widely used in the construction industry for non – structural elements, like façade panels, piping, and channels. GRC offers many advantages, such as being lightweight, fire resistance, good appearance, and strength. In this study, trial tests for concrete with glass fiber and without glass fiber are conducted to indicate the differences in compressive strength and flexural strength by using cubes of varying sizes. Varies application of GFRC shown in the study, the experimental test results, techno-economic comparison with other types, as well as the financial calculation presented, indicate the tremendous potential of GFRC as an alternative construction material.

Prof. Ram Meghe et al. in this paper entitled "Glass fiber reinforced concrete & its properties (2013) – GFRC is a recent introduction in the field of civil engineering. So, it had been extensively used in many countries since its introduction in the field two decades ago. This product has the advantage of being lightweight and thereby reducing the overall cost of construction, ultimately bringing the economy to construction. Steel reinforcement corrosion and structural deterioration in reinforced concrete structures are common and prompted many researchers to seek alternative materials 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 a certain extent. In the view of a 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's, erosion resistance, and serviceability of concrete. The present work is only an accumulation of information about GFRC, and the research work is already carried out by other researchers.

Prof. M. B. Kumthekar, in this paper entitled "Strengthening of RCC Cubes and Cylinders-using Different Glass Fiber"(2013)-Worldwide, a great deal of research is currently being conducted concerning the use of fibers reinforced polymer wraps, laminates, and sheets in the repair and strengthening of reinforced concrete members. Fiber-reinforced polymer application is a very effective way to repair and strengthen structure that has become structurally weak over their life span. FRC repair systems provide an economically viable alternative to traditional repair systems and materials. Experimental data on load, deflection, and failure modes of each of the cubes and cylinders were obtained. The detailed procedure and application of GFRC layers and their orientation on ultimate load carrying capacity and failure mode of the beams are investigated.

Prof. Suresh Babu. R In this paper entitled "Strength and permeability characteristics of fiber reinforced concrete" (2013)-corrosion of reinforced steel due to chloride ingress is one of the most common environmental attacks that lead to deterioration of concrete structures. Corrosion related damage to concrete structures is a major problem. This durability problem has received widespread attention in recent years because of its frequent occurrence and associated high cost of repairs. The rate of chloride ion ingress into concrete is primarily dependent on the internal pore structure. The pore structure, in turn, depends on other factors such as the mix design, degree of hydration, curing conditions, use of supplementary cementitious materials, and construction practices. Researchers all over the world are attempting to develop high performance concretes by using fibers and other admixtures in concrete up to certain proportions. The present study concentrates on the behavior of fiber-reinforced concrete with varying concrete strength and different % of fiber additions.

III. EXPERIMENTAL PROGRAMME

MATERIALS USED:

Ordinary Portland cement:

In this experimental work, Ordinary Portland Cement (OPC) 43 grade conforming to IS: 8112-1989 was used. The cement used was ACC cement from the local distributors. The physical properties of tested cement are given in Table No.1

Table.1. Physical properties of cement

Sl.No.	Properties	Value
1	Specific Gravity	3.15
2	Setting time Initial Final	 46min 560min

Fine Aggregates:

River sand was used as fine aggregate. According to IS: 383-1970 specification sand used confirmed to grading zone -11. Sieve analysis of fine aggregate is given in Table No.2.

Table2: Sieve Analysis of Fine Aggregate

SL No.	Sieve size in mm	Weight retained in gm	Cumulative Weight retained, gm	Cumulative percentage retained	Cumulative percentage passing
1	4.75	40	2	3	97
2	2.36	80	4	7	93
3	1.18	380	19	26	74
4	0.60	960	48	74	26
5	0.30	440	22	96	4
6	0.15	60	3	99	1
7	0.075	10	0.5	99.5	0.5

Coarse Aggregate :

The crushed stone aggregate by the local quarry was purchased from the supplier. The coarse aggregates used in the experimentation were 20 mm and downsized aggregate and tested as per IS: 383-1970 and 2386 – 1963(I, II, and III) specifications. Sieve analysis of coarse aggregate is given below in table No.3.

Table3: Sieve Analysis of Coarse Aggregate.

SL No.	Sieve size in mm	Weight retained in gm	Cumulative Weight retained, gm	Cumulative percentage retained	Cumulative percentage passing
1	40	0	0	0	100
2	22.5	4360	43.6	43.6	56.4
3	16	3280	32.8	76.4	23.6
4	12.5	880	8.8	85.2	14.8
5	10	740	7.4	92.6	7.4
6	4.75	640	6.4	99	1
7	Pan	100	1	100	0

MIX PROPORTION:

Table.4.Mix Proportion

Mix designation	W/C ratio	Water (kg/m3)	Cement (kg/m3)	FA (kg/m3)	CA (kg/m3)	Glass fiber (kg/m3)
0	0.55	211.08	438	653.5	1121	0
0.03	0.55	211.08	438	653.5	1121	66.375
0.06	0.55	211.08	438	653.5	1121	132.75
0.1	0.55	211.08	438	653.5	1121	221.25

IV. RESULTS AND DISCUSSIONS

Workability Test:

In a fresh state, concrete is first tested for the slump and compaction factor, and the results for various samples have been displayed. It was observed that a sample of M25 grade concrete with replacement of glass fibers had shown good slump values and compaction factor. The overall results of workability of Glass Fiber Reinforced Concrete with different percentages of Fibers are tabulated below.

Table.6. Workability of Glass Fiber Reinforced Concrete with Different Percentage of Fibers

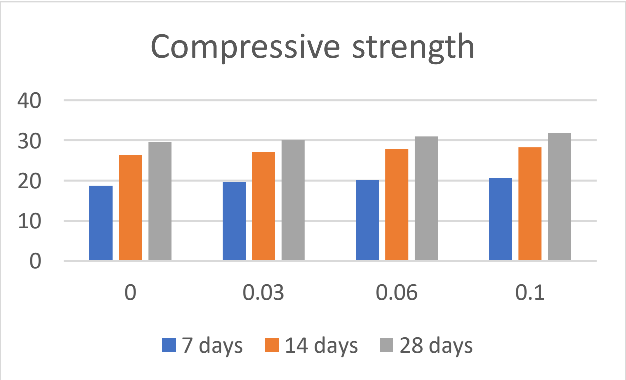
Percentage of Fibers	Slump (mm)	Compaction factor
0	70	0.80
0.03	60	0.89
0.06	75	0.90
0.1	80	0.90

Compressive Strength:

Compressive strength tests were performed using a compression testing machine on cube samples of M25 Grade concrete. Three samples per batch were tested with the average strength values reported in this paper. The 7-days, 14 days and 28 days compressive strength of GFRC shows an increasing trend in compressive strength as the percentage of glass fiber to the volume of concrete increases. The percentage increase in compressive strength of M25 7 days GFRC is 23.26%, M25 14 days GFRC is 22.20%, and M25 28 days is 20.22%.

For evaluating the compressive strength, specimens of dimensions 150×150×150mm have to be prepared. They have to be tested on a 3000kN capacity compression testing machine as per IS 516 – 1959.

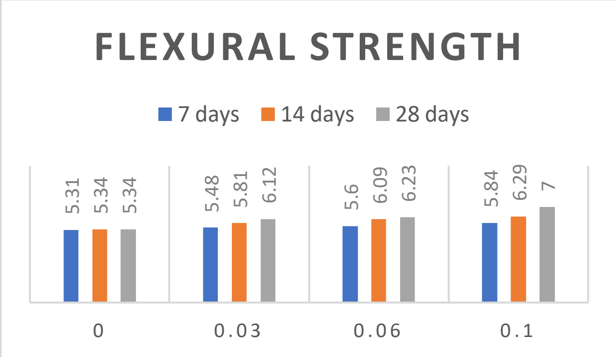
SI.NO	% of Fibers	Compressive strength (N/mm2)		
		7 days	14days	28days
1	0	18.65	26.34	29.60
2	0.03	19.74	27.14	30.02
3	0.06	20.12	27.86	30.96
4	0.1	20.67	28.31	31.81



Flexural Strength:

The flexural strength of GFRC increases with an increasing percentage of glass fibers. The percentage increase in flexural strength is maximum at 0.1% of glass fiber for 7 days,14 days, and 28 days curing of GFRC. The percentage increase in flexural strength of M25 7 days GFRC is 9.98%, M25 14 days GFRC is 13.94%, and M25 28 days GFRC is 20.68%. For evaluating the flexural strength, a beam of size 500×100×100mm have to be prepared. Flexural strength test has to be carried out on 3000kN capacity compression testing machine IS 516-1959

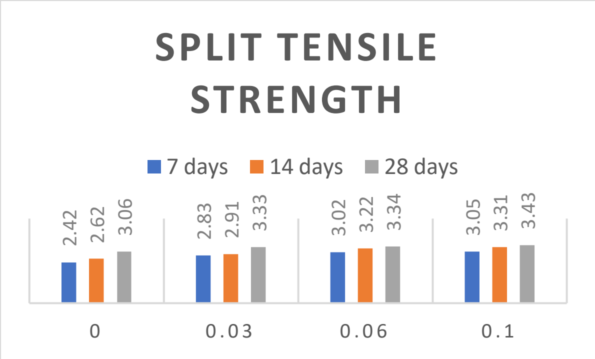
SI.NO	% of Fibers	Flexural strength(N/mm2)		
		7 days	14days	28days
1	0	5.31	5.52	5.80
2	0.03	5.48	5.81	6.12
3	0.06	5.60	6.09	6.23
4	0.1	5.84	6.29	7.00



Split-tensile strength:

The split tensile strength of GFRC increases with an increasing percentage of glass fibers. The percentage increase in tensile strength is maximum at 0.1% of glass fiber for 7 days, 14 days, and 28 days curing of GFRC. The percentage increase in tensile strength of M25 7 days GFRC is 26.03%, M25 14 days GFRC is 26.33%, and M25 28 days GFRC is 12.09%. For evaluating the split tensile strength, cylindrical specimens of diameter 150mm and length 300mm have to be prepared. Split tensile strength test has to be carried out on 3000kN capacity compression testing machine as per IS 5816 – 1999

SI.NO	% of Fibers	Split tensile strength(N/mm2)		
		7 days	14days	28days
1	0	2.42	2.62	3.06
2	0.03	2.83	2.91	3.33
3	0.06	3.02	3.22	3.34
4	0.1	3.05	3.31	3.43



V. CONCLUSION

- As this composite increases tensile strength, it may reduce the area of steel reinforcement required, minimizing the deterioration in marine environment's and hydraulic structures, if any, due to corrosion of steel reinforcements.
- There is a 20.22% increase in the compressive strength when 0.1% GFC compared with the control mix.
- There is a 12.09% increase in the split tensile strength when 0.1% GFC compared with the control mix.
- There is a 31.32% increase in the flexural strength when 0.1% GFC compared with the control mix

REFERENCES

[1] Avinash Gornale et al., in their paper Strength Aspects of Glass Fiber Reinforced Concrete., (2012).

[2] C. Selin Ravikumar and T.S. Thandavamoorthy, in their paper, Glass Fiber Concrete: Investigation on Strength and Fire Resistant Properties., (2013).

[3] Chandramouli K, et al. in their paper, STRENGTH PROPERTIES OF GLASS FIBER CONCRETE, (2010).

[4] Ir. Richard Sumners, in their paper, Glass Fiber Reinforced Concrete as a material, its properties, manufacture, and applications.

[5] J.D.Chaitanya Kumar, et al. in their paper, Experimental Studies on Glass Fiber Concrete,(2016).

[6] Komal Chawla and Bharti Tekwani, in their paper, Studies Of Glass Fiber Reinforced Concrete Composites,

[7] Pshtiwan N. Shakor and Prof. S. S. Pimplikar in their paper, Glass Fiber Reinforced Concrete Use In Construction,.(2011).

[8] Samadhan Garad and Prof.Navanath Phadtare, in their paper "EXPERIMENTAL ANALYSIS OF GLASS FIBER REINFORCED COMPOSITE BEAMS."

[9] Upendra Varma and A.D. Kumar(Oct 2013), in their paper " Glass Fiber Reinforced Concrete."

[10] V.R.Rathi et al. (March 2014), in their paper "Experimental Study on Glass Fiber Reinforced Concrete Moderate Deep Beam."

[11] J.D.Chaitanya Kumar et al. (2016), in their paper "Experimental Studies on Glass Fiber Concrete."

[12] Komal Chawla and Bharti Tekwani, in their paper "Studies Of Glass Fiber Reinforced Concrete Composites,"

[13] Pshtiwan N. Shakor and Prof. S. S. Pimplikar (March 2011) in their paper "Glass Fiber Reinforced Concrete Use In Construction." .

[14] Paul Paul Kraai, "Crack Control Methods: Welded-wire Fabric," vs. CFP Fibers, "Prepared for Fibermesh Co," Chattanooga, Tenn., 1985, "Crack Control Methods: Welded-wire Fabric vs. CFP Fibers," prepared for Fibermesh Co. Chattanooga, Tenn. 1985.