EXPERIMENTAL INVESTIGATION ON FLEXURAL BEHAVIOUR OF GLASS FIBRE REINFORCED CONCRETE MEMBER

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ABSTRACT

In present world construction of very challenging and complicated structures are done by civil engineers. Concrete is most widely used construction material in the world which possesses very high strength and sufficient workability. Fiber reinforced concrete (FRC) is a concrete in which small and discontinuous fibers are dispersed uniformly. Researches all over the world are attempting to develop the high performance concrete by using fiber and other admixtures in concrete up to certain proportions.

In this project glass fibers are used to produce Fiber reinforced concrete and to evaluate its performance under compression, tension and flexure types of loading. Based on I.S.10262:2009 Code method of mix design, proportion of different ingredients was obtained to get M40 grade concrete. Samples were prepared by varying the volume fraction of fibers from 0 to 1% of fibers and then the optimum percentage of fibers was obtained.

Total 24 different types of FRC matrices were considered for performance evaluation. The experimental test results demonstrated that addition of glass fiber at 0.75% showed considerable gain of strength of 54.12 N/mm^2 at 28 days.

For phase I, the properties of materials studied, Compressive strength of Conventional cement concrete and Glass fibers are evaluated. The compressive strength of fiber reinforced concrete is compared with reference mix design.

KEY WORDS

Fiber Reinforced Concrete, Conventional Cement Concrete, Coarse aggregate and Glass Fiber Reinforced Concrete.

INTRODUCTION

Concrete is a homogeneous material with high compressive strength and low tensile strength with little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete. Reinforcing bars are used to improve the tensile strength.

Fiber reinforced polymer composite materials have been successfully used in the construction of new structures and in rehabilitation of existing structures. This experimental program is to gain a better understanding of the performance of these fibers in the structural elements. The term 'Fiber Reinforced Concrete' (FRC) is made up with cement, various sizes of aggregates, which incorporate with discrete and discontinuous fibers.

APPLICATION OF FIBRE REINFORCED CONCRETE

- Floors, driveway and walks to reduce shrinkage and cracking problems are desirable
- Increase of toughness in fibre-reinforced concrete is ideal for buildings and pavements subject to shatter, impact, abrasion, and shear.
- Its use in crack control and shrinkage for water retaining and reservoir structures to reduce the permeability and freeze-thawing conditions.
- Its replacement for temperature steel in sanitary sewer tunnels prevents corrosion and improves ductility.
- Runways are made more resistant to fuel spills with less permeable and shatter resistant fibre-reinforced concrete.
- Pumped concrete project gets easy and safe with fibre, making concrete more cohesive and prevent segregation.

OBJECTIVE

The following point is considered as an objective of this project work.

- To investigate the chemical and physical properties of materials.
- To comparing the results of Conventional concrete and Glass fibers reinforced concrete in strength aspect an element is casted and tested.

LITERATURE REVIEW

Kolli Ramujee, et al.(2002), reported the strength properties of glass fibre reinforced concrete. The compressive strength, splitting tensile strength of concrete samples made with different fibers amount varying from 0%, 0.5%, 1%, 1.5%, and 2% were studied. The Reduction of slump was noticed with increase in fibre content, especially beyond 1.5% dosage, the mix became fibrous which resulted in difficulty in handling. The Compressive strength and splitting tensile strength tests revealed that , the strengths were increased proportionately with the increase in volume ratios of glass Fibers with reference to the controlled mix without fibers and the samples with added glass fibers of 1.5% showed better results with 34% increase in compressive strength and 40% increase in split tensile strength.

Chandramouli.K, et al. (2010), conducted a study to investigate the mechanical properties of alkali resistant glass fibre reinforced concrete for M20, M30, M40 and M50 grades of concrete. The study concluded that the addition 0.03% of glass fibers by volume of concrete increased the compressive strength for various grades of concrete from 20 to 25%. Also this showed an increase in flexural and split tensile strength for 28days from 15 to 20% and addition of glass fibers lead to reduction in bleeding, which improves the surface integrity of concrete and also improves its homogeneity and reduces the probability of cracks.

Patodi.S.C, et al.(2012), reported the experimental investigation on different volume fractions of Recron 3S fibers (polyester fibers) and continuously crimped steel fibers to produce HFRC and gives its performance under compression, tension, flexure, shear and impact types of loading. The optimum fiber ratio of Recron and steel fibers for HFRC matrix was found to be 0.3: 0.7 for overall better performance in terms of strength and post-peak ductility. This ratio also indicated the best resistance against impact and toughness. RS37 specimens (having 0.3% of Recron fibers and 0.7% of steel fibers) followed closely with increase in compressive strength by 21.91%. A maximum increase of 69.02% of split tensile strength was indicated by RS37 matrix

whereas RS01 samples indicated an increase of 53.80%. This is because in fibrous matrix when it cracks, the presence of fibers caused the load to be transferred from the cementitious composite to the fibers at the crack interface, thereby increased the tensile load carrying capacity of the fibrous matrix.

Tamilselvi.M, et al (2013)., studied the strength of concrete cubes, cylinders and prisms cast using M30 grade concrete reinforced with steel and polypropylene fibers. Also, hybrid fibers with crimped steel and polypropylene were used in concrete matrix to study its improvement in strength and durability properties. The steel, polypropylene and hybrid polypropylene and steel fibers of various proportion i.e., 4% of steel fibre, 4% of polypropylene fibre and 4% of hybrid polypropylene and steel fibers each of 2% by volume of cement were used in concrete mixes. Besides cubes, cylinders of 150 mm x 300 mm of M30 grade concrete were cast with 4% of steel fibre and polypropylene fibre, respectively, by volume of cement. The rapid chloride permeability test and water absorption test were conducted on 7, 28, 56 and 90 days and the test results showed that the addition of steel and polypropylene fibers to concrete exhibited better performance. Totally 160 specimens were cast and tested including conventional concrete for comparison. The test results show that use of steel fibre reinforced concrete improves compressive strength and split tensile strength. In addition to this, concrete with shorter fibre has better workability as compared to longer fibre.

Dr. P. Srinivasa Rao, et al.(2014), conducted durability studies on glass fiber reinforced concrete. The alkali resistant glass fibers were used to find out workability, resistance of concrete due to acids, sulphate and rapid chloride permeability test of M30, M40 and M50 grade of glass fiber reinforced concrete and ordinary concrete. The durability of concrete was increased by adding alkali resistant glass fibers in the concrete. The experimental study showed that addition of glass fibers in concrete gives a reduction in bleeding. The addition of glass fibers had shown improvement in the resistance of concrete to the attack of acids.

Avinash Gornale, et al.(2014), studied the strength aspect of glass fiber reinforced concrete. The study had revealed that the increase in compressive strength, flexural strength, split tensile strength for M20, M30 and M40 grade of concrete at 3, 7 and 28 days were observed to be 20% to 30%, 25% to 30% and 25% to 30% respectively after the addition of glass fibers as compared to the plain concrete.

Kavita Kene, et al.(2014), conducted experimental study on behavior of steel and glass Fiber Reinforced Concrete Composites. The study conducted on Fiber Reinforced concrete with steel fibers of 0% and 0.5% volume fraction and alkali resistant glass fibers containing 0% and 25% by weight of cement of 12 mm cut length, compared the
result.

Yogesh Murthy, et al.(2014), studied the performance of Glass Fiber Reinforced Concrete. The study revealed that the use of glass fiber in concrete not only improves the properties of concrete and a small cost cutting but also provide easy outlet to dispose the glass as environmental waste from the industry. From the study it could be revealed that the flexural strength of the beam with 1.5% glass fiber shows almost 30% increase in the strength. The reduction in slump observed with the increase in glass fiber content.

METHODOLOGY

Introduction

This chapter describes the methodology of this project, the main topics included in this chapter are study of material, testing of materials, mix design, experimental investigation, mechanical properties, compressive strength for conventional and glass fiber, observation for both conventional and glass fiber reinforced concrete and the last thing is the results and discussions.

STUDY OF MATERIAL

Study of material is about the gaining of general ideas and knowledge about the materials using in this project. It also includes study of the terms involved in the project. It consists of the general study about Cement, fine aggregate , coarse aggregate ,water, glass fiber and super plasticizer - Conplast-sp 430.

MATERIALS TESTING

The following materials are tested,

Cement, fine aggregate ,coarse aggregate ,water and glass fiber

TESTING RESULT

S.NO	PHYSICAL PROPERTY	RESULT
1.	Standard consistency	31 %
2.	Initial setting time	38 min
3.	Final setting time	520 min
4.	Specific gravity of cement	3.15
5.	Specific gravity of C.A	2.67
6.	Specific gravity of F.A	2.62
7.	Water absorption	0.5%
8.	Fineness of cement	2.2
9.	Fineness modulus of F.A	3.45
10.	Fineness modulus of C.A	7.81

MIX DESIGN

The required characteristic compressive strength of concrete in the field after 28 days of curing is 40 N/mm². The maximum size of the aggregate to be used is 20mm. The degree of workability and quality control is good with compacting factor 0.9. Type of exposure is moderate for design purpose.

Mix Proportion Ratio

Water (liter/m³)	Cement (Kg/m³)	Fine Aggregate (Kg/m³)	Coarse aggregate (Kg/m³)
160	400	631.57	1249.39
0.40	1	1.57	3.12

TESTS ON FRESH CONCRETE

1. **Workability - Slump Cone Test**

   Slump value of concrete = 4.5 cm

2. **Compaction Factor Test**

   Compacting factor= 0.9

TESTS ON HARDENED CONCRETE

1. **Compressive Strength Test**

The cube compressive strength results at the various ages such as 7 days and 28 days for different addition levels such as 0%, 0.5%, 0.75% and 1.00% (mix designations as CCC, GF01, GF02, GF03) of percentage of fibers to volume of concrete and cement.

For cube compression testing of concrete, 150mmX150mm cubes were used. All the cubes were tested in saturated condition after wiping out the surface moisture. For each mix combination three cubes were tested at the age of 7 days and 28 days of curing.

Compressive strength = P/A

Where,

P = Maximum load in N applied to the specimen

A = Cross sectional area of the specimen in m^2

EXPERIMENTAL INVESTIGATIONS

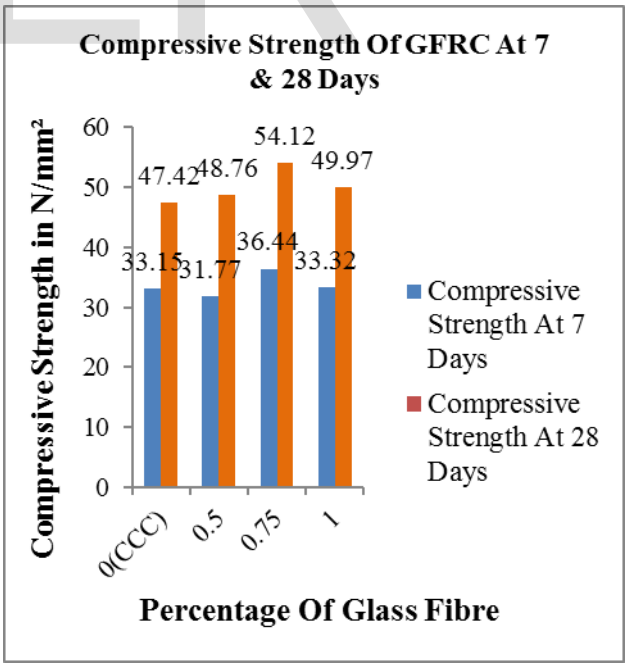
INTRODUCTION

This chapter presents the details of experimental investigations carried out on the test specimen to study the workability and strength-related properties of high strength concrete. To produce high strength concrete a substantial reduction in water cement ratio is required. The reduction of water cement ratio less than 0.3 will greatly improve the qualities of transition zone .The strength-related properties such as compressive strengths are studied. Minimum three specimens were tested for each mix for each test. The entire tests were conducted as per specifications required.

RESULTS AND DISCUSSIONS

1.Compressive Strength Of CCC and GFRC At 7 And 28 Days

PERCENTAGE OF GLASS FIBRE	AVERAGE COMPRESSIVE STRENGTH IN N/mm²	
	At 7 DAYS	At 28 DAYS
0(CCC)	33.15	47.42
0.50	31.77	48.76
0.75	36.44	54.12
1.00	33.32	49.97



CONCLUSION

From this Phase-I report, I concluded that all the properties of materials used in this project are studied thoroughly and Compressive strength of Conventional Cement concrete and Glass fibers reinforced concrete are evaluated.

1. The average Compressive Strength for conventional cement concrete at 7 and 28 Days are 33.15 and 47.42 N/mm^2.
2. The average compressive strength result at 7 days for different addition levels such as 0%, 0.50%, 0.75% and 1.00% of glass fiber is 31.77, 36.44 and 33.32 N/mm^2 respectively.
3. The average compressive strength result at 28 days for different addition levels such as 0%, 0.50%, 0.75% and 1.00% of glass fiber is 48.76, 54.12 and 49.97 N/mm^2 respectively.
4. The maximum compressive strength is achieved with 0.75% of fiber volume fraction.

FUTURE WORK

In the next phase of work the following parameters of flexural members with Glass fiber for the optimum mixes will be determined

1. Flexural strength test

2. Split tensile test

REFERENCES

1. Chandramouli K., Srinivasa Rao P. Pannirselvam N. Seshadri Sekhar T. and Sravana P. " Strength Properties Of Glass Fiber Concrete",*ARPN Journal of Engineering and Applied Sciences*, Vol. 5,No.4,April 2010.

2. Abhishek Kumar Singh, Anshul Jain and Deependra Singh, "Evaluation Of Mechanical Properties For Polypropylene And Steel Fibre Reinforced Concrete " *International Journal of Engineering Research & Technology*, Vol. 2, pp.2278-0181.

3. Avci, H. Arikan, A. Akdemir [25 August 2003] "Fracture behavior of glass fiber reinforced polymer composite", *Cement and Concrete Research* 34 (2004), pp. 429-434.

4. A Kavita S. Kene, B Vikrant S. Vairagade and C Satish Sathawane (2012),Experimental study on behavior of steel and glass fiber Reinforced concrete composite, *Bonfring International Journal of Industrial Engineering and Management studies*, Vol. 2, No-4.

5. Patodi.S.C and Kulkarni.C.V, 'Perfomance Evaluation Of Hybrid Fibre Reinforced Concrete Matrix', *International Journal of Engineering Research and Application*, Vol.2, No.5, PP.1856-1863, 2012.

6. Perumal.P and Thanukumari.B, 'Seismic Performance Of Hybrid Fibre Reinforced Beam - Column Joint', *International Journal Of Civil And Structural Engineering*, Vol.1, No.4, 2012.

7. Srinivasa Rao and Seshadri Sekhar T. 2005. Strength and Durability Properties of Glass Fibre Reinforced Concrete. Proceedings of the *International Conference on Recent Advances in Concrete and*

Construction Technology. December 7-9, SRMIST, Chennai.