Glass Fibre Reinforced Concrete: Design & Analysis

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ABSTRACT: Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Glass fiber reinforced concrete, also known as GFRC or GRC, is a type of fiber reinforced concrete. Glass fiber concretes are mainly used in exterior building façade panels and as architectural precast concrete.This paper describe the use of fibres which are of different shapes and sizes in different forms as all know the function of the fibre based concrete is to arrest cracks, fibre composites possess increased extensibility and tensile strength, both at first crack and at ultimate, particular under flexural loading; and the fibres are able to hold the matrix together even after extensive cracking.so the purpose of the paper is to show the various forms of fibres used in concrete and discuss about their properties and applications.

Key Words: GFRC, flexure strength, Compressive strength, Mechanical properties, Cracking, Workability.

1. INTRODUCTION:

Glass fibre–reinforced concrete is (GFRC) basically a concrete composition which is composed of material like cement, sand, water, and admixtures, in which short length discrete glass fibers are dispersed. Inclusion of these fibres in these composite resultsin improved tensile strength andimpact strength of the material.GFRC has been used for a period of 30 years in several construction elements but at that time it was not so popular, mainly in non-structural ones, like facingpanels (about 80% of the GRC production), usedin piping for sanitation network systems, decorativenon-recoverable formwork, and other products.

At the beginning age of the GFRC development, one of the most considerable problems was the durability of the glass fiber, which becomes more brittle with time, due to the alkalinity of the cement mortar. After some research, significant improvement have been made, andpresently, the problem is practically solved with the new types of alkali-resistant (AR resistance) glass fibers and with mortar additives that prevent the processes that lead to the

Figure 1-Glass Fibre

embrittlement of GFRC,some of them shown in the figure.1

The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mixture. Different types of fibers, such as those used in traditional composite materials can be introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. The fibres help to transfer loads at the internal micro cracks. Such a concrete is called fibre-reinforced concrete (FRC). The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

2. METHODOLOGY:

The study follows the following broad steps:

a. Laboratory investigations
b. Analysis of laboratory test results
c. Specific conclusions

As with any other type of concrete, the mix proportions for GFRC depend upon the requirements for a particular job, in terms of strength, workability, and so on. Several procedures for proportioning GFRC mixes are available, which emphasize the workability of the resulting mix. However, there are some considerations that are particular to GFRC.Commonly, to reduce the quantity of cement; up to 35% of the cement may be replaced with fly ash. In addition, to improve the workability of higher fibre volume mixes, water reducing admixtures and, in particular, superplasticizers are often used, in conjunction with air entrainment.

3. LABORATORY INVESTIGATIONS:

The work carried out in the laboratory is as follows:

1. Selection of materials and study of their properties i.e. Zoning of sand, Water absorbtion of sand & aggregates, etc.
2. Mix Design of Concrete using data obtained from above step.
3. Finding workability of designed Concrete mix using slump and compaction factor tests.
4. Casting of cubes, beams and cylinders of Concrete without fibers.
5. Finding workability of designed Concrete mix with different glass fiber volume fraction ranging from 0.25% to 1.0%..

4. STATIC MECHANICAL PROPERTIES

a. Workability :

   The workability tests were performed using standard sizes of Slump Moulds as per IS: 1199 - 1999 and Compaction Factor apparatus which was developed in UK and is described in IS: 1199 - 1999.

b. Compressive Strength:

The Steel mould of size 150 x 150 x 150 mm is well tighten and oiled thoroughly. They were allowed for curing in a curing tank for 28 days and they were tested in 200-tonnes electro hydraulic closed loop machine. The test procedures were used as per IS: 516-1979.

c. Flexural Strength:

The Steel mould of size 500 x 100 x 100 mm is well tighten and oiled thoroughly. They were allowed for curing in a curing tank for 28 days and they were tested in universal testing machine. The test procedures were used as per IS 516-1979.

d. Split Tensile Strength:

The specimens shall be cylinder with 150 mm in diameter and 300 mm long and is well tighten and oiled thoroughly. They were allowed for curing in a curing tank for 28 days and they were tested in universal testing machine. The test procedure were used as per IS 5816-1999.

5. RESULTS AND DISCUSSIONS

For the design mix values of concrete material required for per cubic meter is mentioned in table 1 and the Variation of Compressive strength, Flexural strength and Split tensile strength of Glass fibre reinforced concrete mixes compared with ordinary concrete mixes are shown in table 2 also the variation of compressive strength, flexure strength and split tensile strength graphically is shown in figure 2,3,4.

Table-1
QUANTITIES OF MATERIALS REQUIRED PER 1 CUM OF ORDINARY CONCRETE AND GLASS FIBRE CONCRETE MIXES

Grade Of Concrete	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregates (Kg)	Water (ltr)	W/C ratio	Glass Fibres
M 20	335.18	729.41	1125.42	186	0.55	0.05 % By volume of concrete
M 30	410.33	664.90	1132.33	186	0.45	
M 40	461.00	627.53	1115.95	186	0.40	

Table-2
COMPRESSIVE, FLEXURAL AND SPLIT TENSILE STRENGTH FOR DIFFERENT GRADES OF CONCRETE MIXES

Grade Of Concrete	Days Of Curing	Compressive Strength (N/mm^2)		Flexural Strength (N/mm^2)		Split tensile Strength (N/mm^2)	
		WITHOUT GF	WITH GF	WITHOUT GF	WITH GF	WITHOUT GF	WITH GF
M-20	03	12.10	20.10	6.20	10.90	1.48	1.97
	07	24.69	25.39	8.68	14.25	2.15	2.85
	28	30.15	38.97	14.39	18.85	3.12	4.19
M-30	03	16.88	27.65	8.97	12.30	2.15	2.69
	07	28.25	30.55	10.25	13.87	3.5	3.87
	28	40.36	49.15	15.59	20.15	4.19	5.29
M-40	03	22.20	30.87	10.70	13.50	2.54	3.55

	07	32.40	40.85	14.72	16.88	3.88	5.10
	28	49.55	61.28	16.73	21.65	4.36	5.68

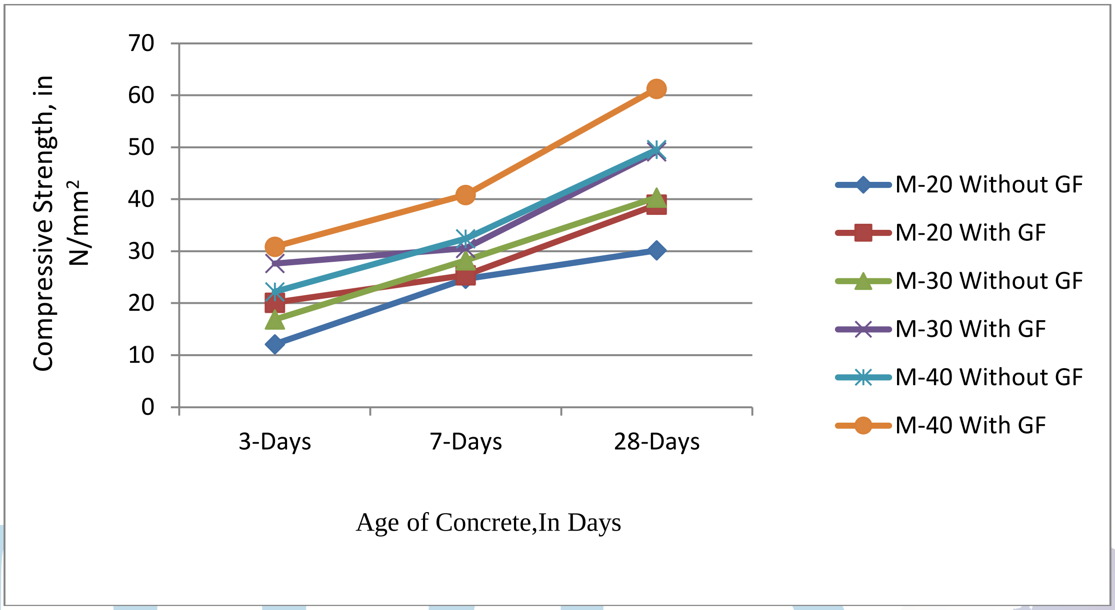

Figure 2
Variation of compressive strength of ordinary concrete and Glass fibre reinforced concrete with age in days.

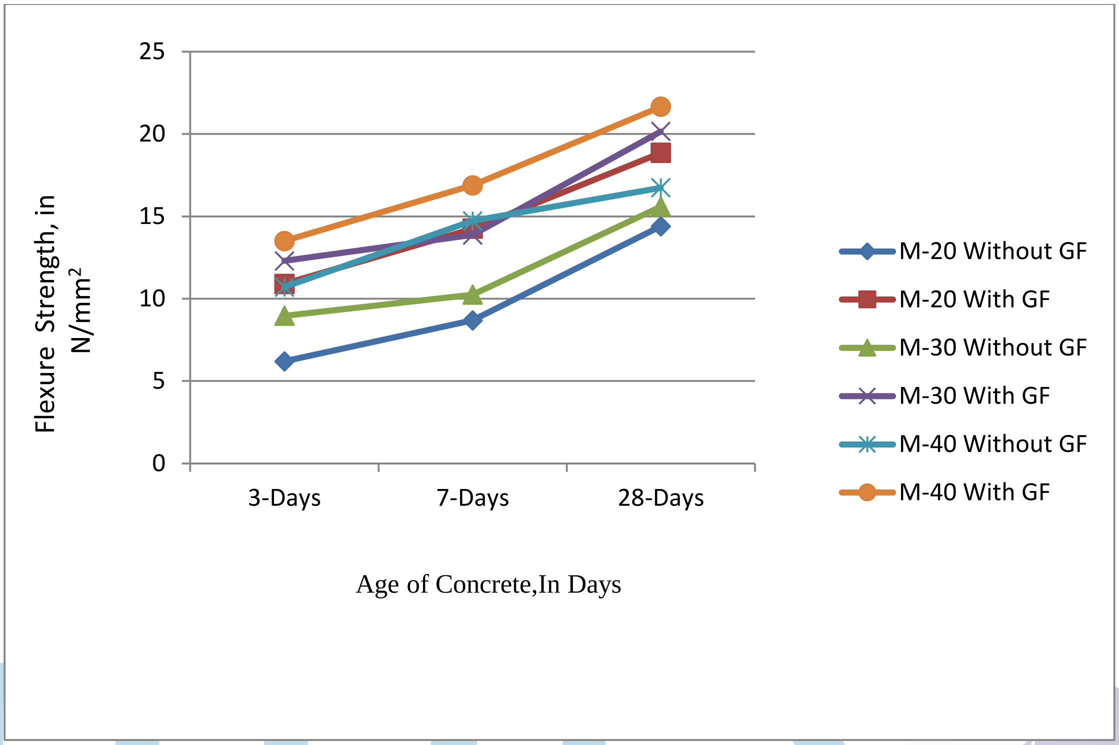

Figure 3
Variation of flexural strength of ordinary concrete and Glass fibre reinforced concrete with age in days.

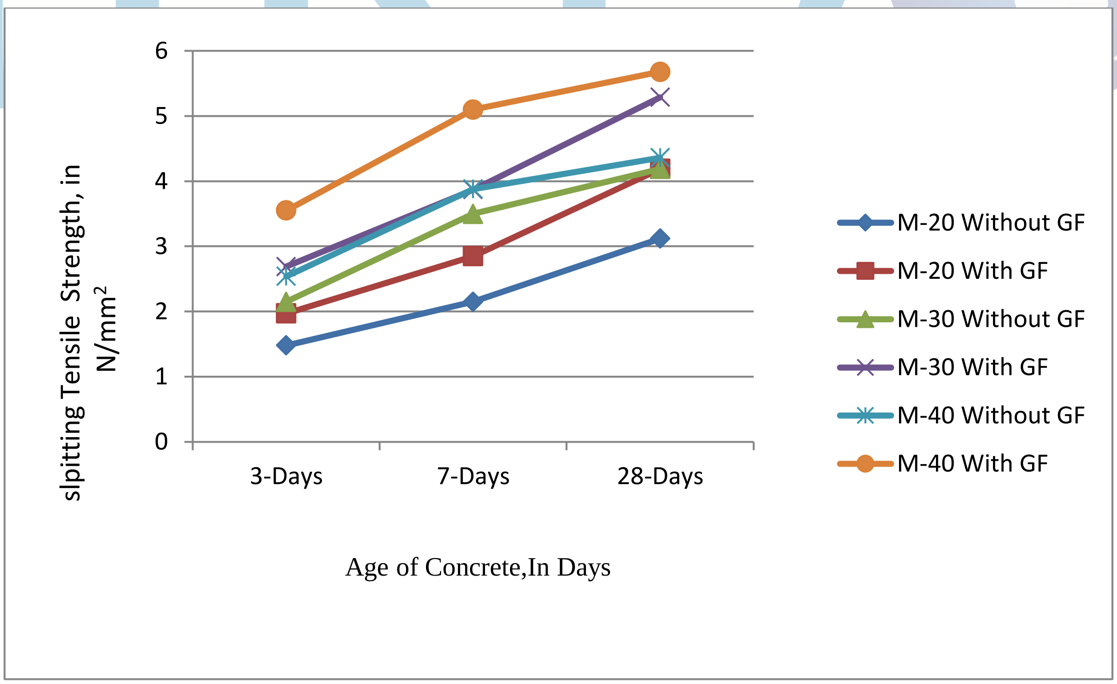

Figure 4
Variation of Split tensile strength of ordinary concrete and Glass fibre reinforced concrete with Age.

6. Conclusion

The study on the introduction of effect of steel fibers can be still promising as Glass fiber reinforced concrete is used for sustainable and long-lasting concrete structures. Glass Fibres are widely used as a fiber reinforced concrete all over the world. Lot of research work had been done on GFRC and lot of researchers work prominently over it.

It has been observed that the workability of concrete decreases with the addition of Glass Fibres. But this difficulty can be overcome by using plasticizers or super-plasticizers.

The increase in Compression strength, Flexural strength, Split tensile strength for M-20, M-30 and M-40 grade of concrete at 3, 7 and 28 days are observed to be 20% to 30%, 25% to 30% and 25% to30% respectively when compared with 28 days strength of Plain Concrete

It has been also observed that there is gradual increase in early strength for Compression and Flexural strength of Glass Fibre Reinforced Concrete as compared to Plain Concrete, and there is sudden increase in ultimate strength for Split tensile strength of Glass Fibre Reinforced Concrete as compared to Plain Concrete.

A reduction in bleeding is observed by addition of glass fibres in the glass fibre concrete mixes;

A reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks;

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