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AN EXPERIMENTAL INVESTIGATION OF CONCRETE PROPERTIES M30 DUE TO INCORPORATION OF GLASS FIBERS

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Abstract: Many researches have been currently going to modify and improved the concrete properties by the addition of different types of materials. This paper represents the Optimum use of the fibres with the concrete mixture and will also help in achieving the desired results. This paper shows the investigation on M30 grade due to incorporation of Glass fibres . In this paper we used the Glass fibres of diameter 14 micron meter with aspect ratio 857.1 at various percentages as 0%,0.4%.0.8%,1.2%.1.6% by the weight of concrete on M30 grade of mix proportion (1:1.60:2.96) with water cement ratio 0.45. It can be concluded that the compressive strength of GFRC gets increased upto 26 % with 1.2% Glass fibres as compared to plain concrete. It is also observed that the Flexural strength of Glass fibre reinforced concrete gets increased upto 35 % as compared to plain concrete. It is also observed that during testing the specimens, the GFRC specimens does not collapse as compared to plain concrete. It is also observed that the Split Tensile strength of Glass fibre reinforced concrete gets increased increases up to 40 % with 1.2% Glass fibres as compared to plain concrete.

Keywords: Glass Fibres, Compressive Strength, Flexural Strength and Split Tensile Strength.

I. INTRODUCTION

For a long time concrete was considered to be a very durable material requiring a little or no maintenance. The assumption is largely true, except when it is subjected to highly aggressive environments. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments, harmful sub soil water in coastel areas and in many other hostile conditions where other materials of construction are found to be non-durable. The poor and unsatisfactory performance of conventional concrete under aggressive environmental conditions has necessitated the researchers and engineers to look for new concrete composites. The innovative use of concrete must contemplate explorations of areas , in use of new shapes, materials and technique of construction. Concrete is such a versatile material that such attempts of contemplation are quite possible. In modern age one cannot think of construction work without concrete. Plain concrete has two major deficiencies; a low tensile strength and allow strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks. Hence Fibers are generally utilized in concrete to manage the plastic shrink cracking and drying shrink cracking In FRC, thousands of small fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. That‟s why the addition of fiber with concrete improved the concrete properties such as workability, brittleness, strength, corrosion resistance and ultimately increased life of the structure. A major advantage of using fiber reinforced concrete besides reducing permeability and increasing fatigue strength is that fibers addition improves the toughness or residual load carrying ability after the first crack. This concrete is known as Glass fiber reinforced concrete (GFRC). Reinforcing capacity and proper functioning of fiber is based on length of fiber, diameter of fiber, the percentage of fiber and condition of mixing, orientation of fibers and aspect ratio. Aspect ratio is ratio of length of fiber to its diameter which plays an important role in the process of reinforcement. GFRC contains only less than 3% of fibers and aspect ratio below 100.

II. LITERATURE REVIEW

As we know the properties of concrete gets improved due to the incorporation of Glass fibre. Large no. of papers have being published which tells about the compressive strength, flexural strength and split tensile strength of concrete according to their opinion.

Alejandro Enfedaque Et. Al., [1].This paper is on the experimental studies made on the analysis of glass fiber reinforced cement (GRC) fracture surfaces. Glass fiber reinforced cement (GRC) is a composite material formed by the combination of cement mortar matrix and chopped glass fiber bonded fibre reinforced polymer sheets. The authors concluded that the strengthened beams exhibit higher load carrying capacity. Ms. K.Ramadevi1, Ms. R. Manju used the Polyethylene Terephthalate (PET) bottles for the reinforcement in concrete with dosage 1%, 2%, 4% and 6% . This paper proved that the replacement of fine aggregates with PET bottles reduces the quantity of river sand and also plastic fibres are proved to be more economical

Asokan.P Et. Al., [2].Research is carried out on Assessing the recycling potential of glass fiber reinforced plastic waste in concrete and cement composites. Presently, for the glass fiber reinforced plastic (GRP) waste the world wide recycling is very limited on account of its intrinsic thermoset properties,

Bing Chen Et. Al., [3].This paper presents an experimental study of mechanical properties of normal - strength concrete exposed to high temperatures at an early age. In this study, compressive and splitting tensile strengths of concretes for different curing periods and to high temperatures exposure are obtained.

Guneyisi Erhan Et. Al.,[4].Experimentally studied, the

effects of cement type, curing condition and testing age on the chloride permeability of concrete. The chloride permeability of concrete was held as estimated by rapid chloride permeability test (RCPT). In this research, varied cement types (i.e. plain and four-different blended cements) were used.

Scheffler.C. Et. Al.,[5].This paper reports on the interphase modification of alkali-resistant glass fibers and carbon fibers for textile reinforced concrete,fiber properties and durability. The sizings and coatings were considered to heal severe surface flaws of brittle alkali resistant glass (ARG) fibers.

Barluenga.G Et. Al.,[6].developed an experimental program by AR fiber producer, was conducted, to estimate the cracking control ability of alkali resistant (AR) glass fibers in standard concrete and SCC.

Ramakrishna.G Et. Al.,[7] This paper explain the results of difference in chemical composition and tensile strength of coir, sisal, jute and Hibiscus cannabinus when they are subjected to wetting and drying alternatively and continuous immersion for 60 days in three media (water, saturated lime and sodium hydroxide

Enrico Papa Et. Al., [8] shows the Experimental characterization and numerical simulations of a syntactic-foam/glass-fibre composite sandwich : A review on the results of an experimental and numerical investigations performed by the author on the mechanical behaviour of a composite sandwich initially designed for naval engineering applications.

III. MATERIALS USED

Materials required for making GFRC essentially consist of cement, fine sand, coarse aggregates and Glass fibre. These materials are described below-

CEMENT : Ordinary Portland cement of 43 grade has been used in this experimental work. OPC 43 grade of ULTRATECH cement has been used after investigate the strength of cement at 28 days as per IS 4031-1988. The various properties of the cement are described in Table No. 1.

Table No. 1. Characteristics Properties of Cement

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1	Consistency of cement (%)	33%	---
2	Specific gravity	2.98	3.15
3	Initial setting time (minutes)	35	>30 As Per IS 4031-1968
4	Final setting time (minutes)	282	<600 As per IS4031-1968
5	Compressive strength (N/mm2) (i) 3 days (ii) 7 days (iii) 28days	 27.56 40.57 48.96	 >23 >33 >43
6	Soundness (mm)	1.00	10
7	Fineness of Cement	5%	10% As Per IS 269-1976.

FINE AGGREGATES: Locally available river sand passed through 4.75mm IS sieve has been used in the preparation of GFRC . It confirms to IS 383-1970 which comes under Zone I. The physical Properties of sand like Fineness Modulus, Specific Gravity and water absorption are 3.25, 2.67 and 2.31% respectively.

COARSE AGGREGATES: The Coarse aggregate are obtained from a local quarry has been used. The coarse aggregate with a maximum size 20mm having a specific gravity 2.89. In this experimental work coarse gravel of 20mm and crushed aggregate of 10mm are mixed in 60:40. The physical Properties of coarse aggregates like Fineness Modulus, Specific Gravity are 2.31, 2.89 respectively

GLASS FIBRE: The glass fibres are of Cem-FIL Anti-Crack HD with Modulus of Elasticity 72 GPA, Filament diameter 14 microns, Specific Gravity 2.68, length 12mm and having the aspect ratio of 857. For 1 kilo gram, the number of fibres are 212 million. The various properties of the glass fiber are described in Table No. 2

Table No. 2: Properties Of Fibres Used

SR. NO	Tensile Strength	Young's modulus	Specific Gravity	Length of Fibre	Diameter of Fibre	Aspect Ratio
1	1700 Mpa	72 Gpa	2.68	12 mm	14 micron	857.1

WATER: - Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly, potable tap water was used for the preparation of all concrete specimens.

III. EXPERIMENTAL PROGRAMME

In this section, GFRC based specimens has been tested for the compressive strength, flexural strength and split tensile strength.

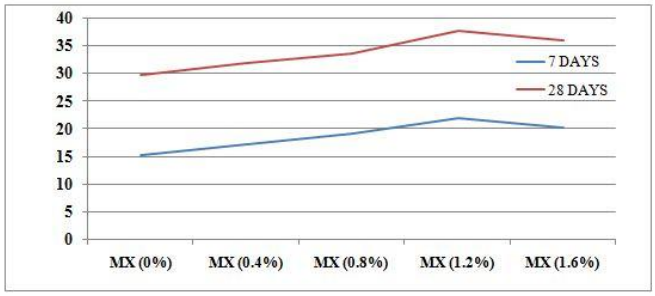
COMPRESSIVE STRENGTH TEST: To examine the compressive strength of GFRC, cube of 150mm×150mm×150mm has been used in this experimental work 30-40 cubes has been casted to determine the compressive strength. firstly cement and sand are mixed uniformly in dry condition . Secondly coarse aggregates are added in this mixture. Now Glass fibres also added according to mix proportion to get the resultant mixture of M30 grade. Required dosage of water was added in the course of mixing. The cube moulds were demoulded after 24 hours then they were placed in water tank containing portable water and were left for curing. After that the specimen are tested at 7 days and 28 days at compression testing machine (CTM) as per IS 516-1959. Compressive strength of concrete mixtures was measured at the ages of 7 and 28 days and shown in Table No. 3. There was an increase in compressive strength of cube concrete specimens produced with Glass fibres.

Fig. 1 CUBE UNDER COMPRESSION TESTING MACHINE (CTM)

Table No. 3: Compressive Strength Results

Mix Designation	7 Days (N/mm^2)	28 Days (N/mm^2)
MX(0 %)	15.40	29.85
MX(0.4%)	17.40	31.92
MX(0.8%)	19.33	33.66
MX(1.2 %)	22.07	37.77
MX (1.6%)	20.36	36.07

From the above results, we observe that compressive strength of concrete increases due to incorporation of Glass fibres. From the plot we can say that compressive strength of concrete increases upto 26 % with 1.2% Glass fibres.



Graph No. 1: VARIATION OF COMPRESSIVE STRENGTH AT DIFFERENT AGE

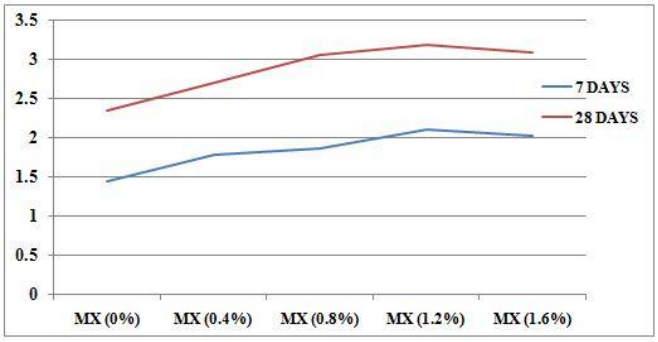
FLEXURAL STRENGTH TEST:- To examine the flexural strength of GFRC, cylinder of size 150mm×150mm×70mm has been used in this experimental work. 30-40 beams has been casted to determine the tensile strength. The beams specimens of different proportions were demoulded after 24 hours and transferred to the curing tank for 28 days . After that, beams were placed to the two point loading machine on which we apply the load manually. Note down the load value at which cracks starts developing on the beam. Table no. 4 shows the values of flexural strength of GFRC beams at different mix proportions. Graph 2 shows the variations of flexural strength at 7 and 28 days.

Fig. 2 TEST SET UP FOR BEAM

TABLE No. 4: Flexural Strength Results

Mix Designation	7 Days (N/mm^2)	28 Days (N/mm^2)
MX(0 %)	1.44	2.34
MX(0.4%)	1.77	2.69
MX(0.8%)	1.86	3.05
MX(1.2 %)	2.10	3.18
MX (1.6%)	2.02	3.08

The results obtained from the experiment showed that flexural strength of the GFRC increased upto 35 % as compared with plain concrete.



Graph No. 2 VARIATION OF FLEXURAL STRENGTH AT DIFFERENT AGE

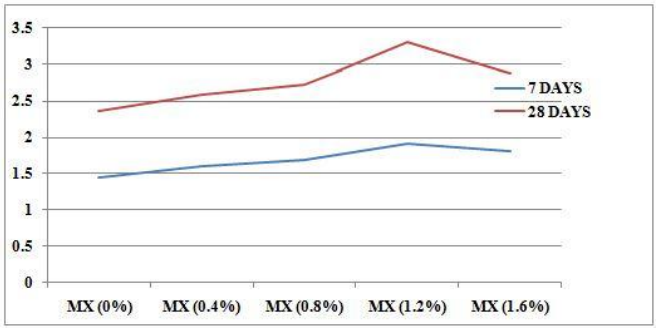
SPLIT TENSILE STRENGTH TEST:- To examine the tensile strength of GFRC, cylinder of size 150mm×300mm has been used in this experimental work . 30-40 cylinders has been casted. The cylinder moulds were demoulded after 24 hours and transferred to curing tank for 28 days. After that cylinders were tested horizontally under compression testing machine (CTM). The results shows that in general, there is an increase in splitting tensile strength of cylinder concrete specimens with the addition of fibres to the concrete at 28 days age.

Fig. 3 CYLINDER UNDER CTM

TABLE No. 5: Split Tensile Strength Results

Mix Designation	7 Days (N/mm^2)	28 Days (N/mm^2)
MX(0 %)	1.45	2.35
MX(0.4%)	1.60	2.58
MX(0.8%)	1.69	2.72
MX(1.2 %)	1.91	3.31
MX (1.6%)	1.80	2.88

From the above results, we observe that Split Tensile Strength of concrete increases due to incorporation of Glass fibres. From the plot we can say that Split Tensile strength of concrete increases upto 40 % with 1.2% Glass fibres as compared to plain concrete.



Graph No. 3 VARIATION OF SPLIT TENSILE STRENGTH AT DIFFERENT AGES

IV. CONCLUSION

The following conclusions could be drawn from the present investigation.

- The Experimental work shows that properties of concrete M30 gets improved due to incorporation of Glass fibres
- The Experimental work shows that workability of GFRC gets reduced as we increased the fibre amount.
- It can be concluded that the compressive strength of GFRC gets increased upto 26 % with 1.2% Glass fibres as compared to plain concrete. .
- It is observed that the compressive strength of Glass fibre reinforced concrete gets increased upto 1.2 % dosage amount after that it starts decreases.
- It is observed that the Flexural strength of Glass fibre reinforced concrete gets increased upto 35 % as compared to plain concrete.
- It can be concluded that Flexural strength of the GFRC gets increased continuously but after 1.2 % gets decreased.
- It is also observed that the Split Tensile strength of Glass fibre reinforced concrete gets increased increases up to 40 % with 1.2% Glass fibres as compared to plain concrete.
- While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two-piece geometry. But due to addition of Glass fibres in concrete cracks gets ceased which results into the ductile behaviour of GFRC.
- It is also observed that during testing the specimens, the GFRC specimens does not collapse as compared to plain concrete

V. FUTURE SCOPE OF THE STUDY

The present investigation has been carried out to investigate the behaviour of GFRC under compression, tension and flexure. My guide has suggested the optimum aspect ratio 857.1 of fibres and experiments were carried out for fibre content 0.4, 0.8, 1.2, 1.6 percent. it has been observed that the effect of fibre length, aspect ratio and the fibre content more than 3 % has not been considered therefore it can be suggested that further study may be undertaken to investigate:

- By change in length of glass fibre effect on compressive , tensile , flexural and other structural properties of GFRC.
- GFRC behaviour depend upon the aspect ratio.
- W/C ratio changes the structural behaviour of GFRC.
- GFRC formed at 1.2% is economical Hence we should not use the glass fibre after 1.2%.

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