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LONG TERM CHARACTERIZATION OF FIBRE REINFORCED CONCRETE

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ABSTRACT

The present paper outlines the investigation conducts on the use of glass fibres with structural concrete. Plain concrete has very low tensile strength, limited ductility and low resistance to cracking.Internal micro cracks are innately present in concrete. Fibres when added in different proportions in the concrete improve the strain properties as well as crack resistance, ductility, as flexure strength and toughness properties. In recent times, glass fibres have also become available, which are free from corrosion problem associated with steel fibres which provide us with added advantages. GFRC is a combination of cement, glass fibres, and polymers. Alkali resistance glass fibre, having an some aspect ratio was employed in percentages, varying by percentage by weight in concrete and the properties of this FRC (fibre reinforced concrete) like compressive strength, tensile strength are studied.

Keywords:- Glass fibre, Superplasticizer, Compressive strength, Slump value, Concrete (M35)

1.Introduction

GFRC is a form of concrete that uses fine sand, cement, polymer (usually an acrylic polymer), water, other admixtures and alkali-resistant glass fibres. Glass Fibre Reinforced Concrete (GFRC) is a type of fibre reinforced concrete.

Glass fibres can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths. Glass fibres have large tensile strength and elastic modulus but have brittle stress strain characteristics and low creep at room temperature. The Glass fibres are usually round and straight with diameters from 0.005 mm to 0.015 mm.

The basic applications of Glass Fibre Reinforced Concrete includes, exterior building facade panels and as architectural precast concrete. This material is good in developing the façade of any building. It can be effectively used to create facade wall panels, fireplace surrounds, vanity tops and concrete countertops due to its unique properties and higher tensile strength. Glass fibres were first used to reinforce cement and concrete in Russia. However they were corroded by the highly alkaline Portland cement matrix. Therefore, alkali resistant glass fibres have been subsequently developed in UK and other countries.

Glass fibre reinforced concrete is basically concrete material that utilizes glass fibres for the reinforcement, as a substitute of steel. It is normally cast in thin sections. As the fibres are not rusted like steel, protecting concrete coat is not necessary for the prevention of rust. The weight of thin and hollow products produced by GFRC is considerably lesser than the conventional pre-cast concrete. The material characteristics will be influenced by the concrete reinforcement spacing, and the concrete reinforcement mesh.

2. MATERIALS USED AND THEIR PROPERTIES

Various tests on materials like, cement, fine aggregate, coarse aggregate and water have been conducted to confirm their suitability to use in concrete making as per the procedures laid down in IS Codes. It is observed that all the materials satisfy the relevant provisions of IS Code of practice.
Glass fibre: A variety of Chemical composition are commercially available common glass fibre are silica based [50-60% SiO2] and a host of other oxides of calcium, Iron, sodium and Iron and they are designated as E, C, S glass. Glass fibre is the cheapest among the high performance fibre and hence more than 95% of the composite made today are glass fibre as the reinforcement by drawing mother glass into fibres form.

Table 1 - Properties of Glass Fibre

Parameter	**Properties**
Fiber Type	AR Glass fiber
Fiber Orientation	Randomly oriented
Electrical Conductivity	Very low
Specific Gravity	2.68 g/cm3
Softening point	860°C – 1580°F
Chemical Resistance	Very high
Modulus of elasticity	72 GPa – 10 x 106 psi
Tensile Strength	1000–1700 MPa – 145–250 x 103 psi
Length of fibre	18mm
Filament Diameter	18 μm

Fig.1 AR Glass Fibre

Cement: Pozzolana Portland cement is used in the research work

Coarse Aggregate : The locally available crushed granite has been used as coarseaggregate in thisresearchFor the mix design it is necessary to know the properties of material i.e., Sieveanalysis, Specific gravity and water absorption. The testshave been carried out as per the procedure given in IS Codes and it is observed that it satisfies the relevant provisions of IS Code of practice.

Fine Aggregate : River sand was used as fine aggregate of size 4.75 mm down grade.

Water : Normal tap water available in the concrete laboratory, fit for drinking, was used to cast concrete samples.

Superplasticiser: Auramix 400, a high performancesuperplasticiseris used as High Range Water Reducer.

3. Actual Casting Schedule

The total no. of 48 cubes were casted. Mix design M-35 is used in casting the cubes.

S. No.	**Fibre Content in %**	**No. of Cubes**
1	0	12
2	5	12
3	6	12
4	7	12

4. Experimental Result of Fresh Concrete

Concrete slump test –

The concrete slump test measures the consistency of fresh concrete before it sets. The results of Slump test M-35 grade of concrete without and with Glass Fibre are given below table-

% of Glass fiber	Concrete slump value
0	25mm
5	15mm
6	12mm
7	08mm

From the experimental results it was observed that on the adding Glass Fibres to concrete there was substantial amount of loss in the slump. Hence, the workability decreases with the increase in volume of fibres.

Cubes Result -

Table gives the increase in Compressive strength with variation in glass fibre percentage concrete mixes were compared with ordinary concrete mix of M-35.

Name			F0	F5	F6	F7
Compressive Strength on Given Day in kN/mm2	7	specimen 1	21.33	21.78	23.56	23.56
		specimen 2	21.78	22.44	21.33	24.44
		specimen 3	20.67	20.44	23.11	24.89
		Average	21.26	21.55	22.67	24.3
	28	specimen 1	29.33	31.11	32	34.67
		specimen 2	30.22	30.67	32.22	32
		specimen 3	30.67	32	32.89	33.78
		Average	30.07	31.26	32.27	33.48
	60	specimen 1	32	37.55	36.45	32.44
		specimen 2	31.11	39.11	38.67	35.56
		specimen 3	31.56	37.78	33.78	36.89
		Average	31.56	38.15	36.3	34.96
	90	specimen 1	38.67	40	37.78	37.78
		specimen 2	34.22	40.89	39.56	37.82
		specimen 3	37.33	37.78	38.22	36.00
		Average	36.74	39.56	38.52	37.20

5.DISCUSSION OF RESULTS

Workability

Slump test was carried out conforming to ASTM C143 on each mix to ascertain workability of GFRC as well as control mixtures. The results of slump tests are plotted in figure 2

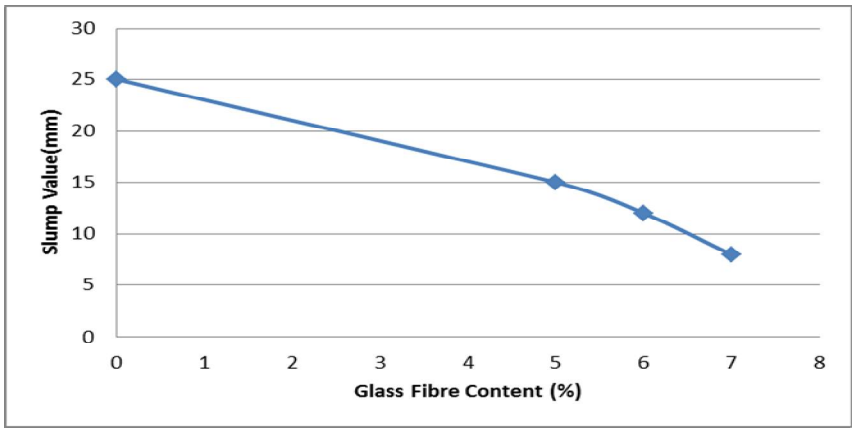

Fig 2 Slump value vs Glass Fibre content

Gradual decrease in the slump values with an increase in GF dose, indicates that addition of GF content is associated with an increase in water demand. Thus some water reducing admixtures may be used to get required workability of concrete without compromising on strength.

Cubes were tested at the age of 7, 28, and 60 days. Results are plotted in figure 3 represents the change in compressive strength values as compared to control specimen.

Fig 3 shows the change in compressive strength with respect to time for F0(M 35 with 0% fibre content).

- At 7 days: 59% of characteristic strength is achieved,
- At 28 days: the strength increase rapidly but after it the increase in compressive strength become gradually.

In Fig.3 compressive strength vary with time for F5(M 35 with 5% of glass fibre). At 7 days 1.3% more strength obtains as compare to F0. Till 28th days the increase in compressive strength is rapidly, at 60th days the change in compressive strength has some downfall as compare to 28th days.

Fig.3 shows the change in compressive strength with time for F6 (M 35 with 6% glass fibre). At 7th days the strength is obtain 6.6% more than the pilot F0. In F6 the gain of compressive strength in first phase (28th days) is more than the 2nd (60th days) and 3rd phase (90th days).

Compressive strength vary with time for F7(M 35 with 7% of glass fibre). At 7 days 15.8% more strength obtains as compare to F0. Till 28th days the increase in compressive strength is rapidly, at 60th days the change in compressive strength has a large downfall as compare to 28th days.

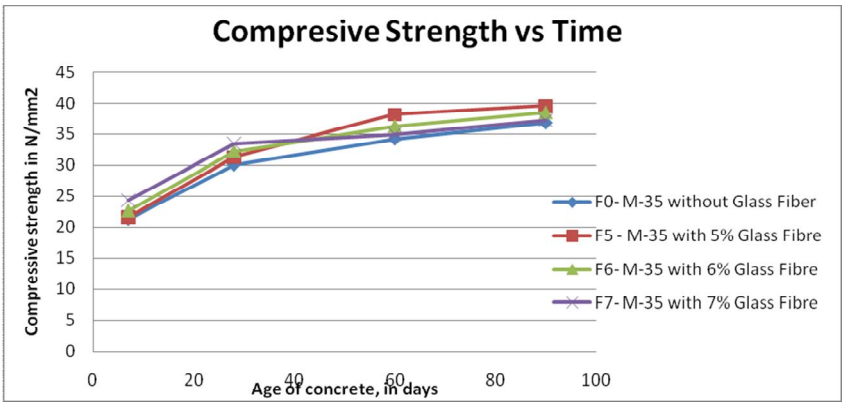

Fig 3 Compressive Strength vs % of Glass fibre

Results shows as the fibre content increase the compressive strength at 7 days and 28 days also increase but at 60 days with increase fiber content above 5% of cementious material compressive strength decrease as shown in figure 4. Result also shows there is marginal change in compressive strength for with and without fibre (F0 & F5) at 7 days is 1.3% ,at 28th days it is 3.95% but at 60th days it is 20.89% that is maximum at 60th days.

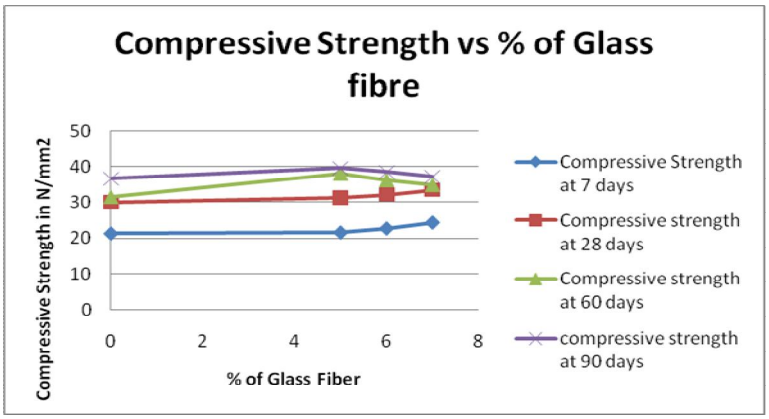

Fig 4 Compressive Strength Vs Time

Figure 4 shows that as age of concrete increase, compressive strength of concrete with or without glass fibre(F0,F5,F6,F7) also increase rapidly till 28^{th} days but at 60^{th} days postive change in compressive strength become gradually except F5, F5 continuous increase rapidly at 60^{th} days.

6. CONCLUSION

The following conclusions are formed from the experimental investigation.

1. Workability of GFRC decreases by increasing glass fiber content. Thus some water reducing admixtures (Superplasticizer) were used to get required workability of concrete without compromising on strength.
   GFRC is a combination of cement, glass fibres, and polymers.
2. The earlier strength, the characteristic strength, the later strength and the long term strength of F5 got 1.3%, 3.87%, 20.88% and 7.67% respectively more than as compare to the strength of F0.
3. The earlier strength, the characteristic strength, the later strength and the long term strength of F6 got 6.6%, 9.4%, 15.01% and 4.8% respectively more than as compare to the strength of F0.
4. The earlier strength, the characteristic strength, the later strength and the long term strength of F7 got 14.2%, 11.34%, 10.77% and 1.25% respectively more than as compare to the strength of F0.
5. The results shows that design mix M-35 with 5 % glass fibre by cement weight get maximum compressive strength at long term (90^{th} days).
6. As due to CTM is not calibrated the result is not achieved as better as expected.
7. Since the materials have a fibre coating, they are unaffected by the environmental effects, corrosion attacks, and other harmful affects, thereby proving to be vital material for concrete.

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