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An experiment on characteristic of concrete using glass fiber

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ABSTRACT

Extensive experimental investigation on glass fibre reinforced concrete was carried out by researchers. Glass fibre mesh is more effective in resisting bending and punching shear. Steel Fibres are most popular metallic fibres used for the production of Steel Fibre Reinforced Concrete particularly from the point of view of strength and ductility. Test results conducted by various researchers revealed that the use of non-metallic fibre like Nylon, Polythene, Organic fibres, Vegetable fibres etc. are more effective in resisting bending and punching shear. Usually, usage of fibres enhances the properties of concrete structures. Glass Fibres are used for the production of Glass fibres Reinforced Concrete in this study. Glass fibres of size 1mm dia. are available for industries. Fibre reinforced concrete is used for the construction of airport pavements to improve the properties of strength and toughness. So far, a very limited quantity of research work has been done on the application of glass fibres in structural concrete. Hence, the present research would lead to a stronger and durable Glass Fibre Reinforced Concrete, which can be recommended for applications like a construction of special building and shelters, slab panels, wall planes, special repair job work, rigid pavements etc. At present, research studies are made on various properties of glass fibre reinforced concrete by using AR-Glass fibres in concrete in various percentages. It is observed that studies showed Glass Fibre Reinforced Concrete mixes provide an improvement of high performance and high strength concretes. The present thesis would contribute to the efforts being made in the field of concrete technology towards the development of concretes possessing very much enhanced and special durable properties. Based on the study, valuable advice will be given to concrete structures. In the present experimental investigation, attempts are made to study on the various strength properties like compressive strength, split tensile strength, an also durability properties like Acid and Sulphate attack on both ordinary concrete and Glass Fibre Concrete, using alkali-resistant glass fibres at stipulated ages. Experiments were conducted for both Ordinary Concrete and Glass Fibre Concrete with different percentages of AR-Glass fibres. Studies were made on strength properties of Ordinary Concrete and Glass Fibre Concrete mixes. Studies were made on residual compressive strength, weight loss of Ordinary Concrete and Glass Fibre Concrete mixes. The experimental test was also held on Glass Fibre Reinforced Concrete and ordinary concrete.

Keywords— *GF, workability, compressive strength, split tensile strength, Acid and Sulphate attack*

1. INTRODUCTION

In the view of the global sustainable developments, it is imperative that fibres like glass, carbon, polypropylene and aramid fibres provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, corrosion resistance and serviceability of concrete. Fibre reinforced concrete (FRC) is a concrete made primarily of hydraulic cement, aggregates, and discrete reinforcing fibres. FRC is a relatively new material. This is a composite material consisting of a matrix containing a random distribution or dispersion of small fibres, either natural or artificial, having a high tensile strength. Due to the presence of these uniformly dispersed fibres, the cracking strength of concrete is increased and the fibres acting as crack arresters. Fibres suitable for reinforcing concrete having been produced from steel, glass, and organic polymers. Many of the current applications of FRC involve the use of fibres ranging around 1% by volume of concrete. Recent attempts made it possible to incorporate relatively large volumes of steel, glass and synthetic fibres in concrete. Results of tensile tests done on concretes with glass, polypropylene and steel fibres, indicate that with such large volume of aligned fibres in concrete, there is a substantial enhancement of the tensile load carrying capacity of the matrix. This may be attributed to the fact fibres suppress the localization of micro-cracks into macro-cracks and consequently the apparent tensile strength of the matrix increases

2. MATERIALS USED

2.1 Cement

Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement as determined from various tests 30 conforming to Indian Standard IS: 1489-1991(Part-1) are listed in Table 3.1. All the tests were carried out as per the recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture.

2.2 Course aggregate

Crushed angular granite metal from a local source was used as coarse aggregate. The specific gravity was 2.71, flakiness index of 4.58 percent and elongation index of 3.96.

2.3 Fine Aggregate

River sand was used as fine aggregate. The specific gravity and fineness modulus was 2.55 and 2.93 respectively. Crushed angular granite metal from a local source was used as coarse aggregate. The specific gravity was 2.71, flakiness index of 4.58 percent and elongation index of 3.96.

2.4 Glass Fiber

The glass fibres used are of Cem-FIL Anti-Crack HD with a modulus of elasticity 72 GPa, Filament diameter 14 microns, specific gravity 2.68, length 12 mm and having the aspect ratio of 857, the number of fibres per kg is 212 million fibres.

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

3.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure is given in chapter 3. w/b ratio was kept constant at 0.4 for all the concrete mixes. Super-plasticizer SP 430 was used to maintain the required slump. The dosage of super-plasticizer was varied from 1.0% to 1.25% by weight of binder depending upon the type of mix. The workability results of different concrete mixes were shown in Table 1.

Table 1: Workability values for different concrete mixes

Mix no.	Description	Superplasticizer (%) by weight of the binder	Slump (mm)
1	90%OPC+10%SF+0%GF	1.00	110
2	90%OPC+10%SF+0.2%GF	1.00	100
3	90%OPC+10%SF+0.45%GF	1.00	100
4	90%OPC+10%SF+0.7%GF	1.00	100
5	90%OPC+10%SF+0.8%GF	1.00	100
6	90%OPC+10%SF+1.0%GF	1.00	90
7	90%OPC+10%SF+1.50%GF	1.25	90
8	90%OPC+10%SF+2.0%GF	1.25	90

Table 1 shows that as the addition of glass fibres to concrete mix increases, the workability of the concrete mix was found to decrease as compared to the control mix. The addition of glass fibres into the concrete mix further decreases the workability. To achieve the required slump super plasticizer was added to the concrete mix. As a percentage of fibres increases the quantity of super plasticizer was increased. The lowest value of slump was obtained with mix 90%OPC+10%SF+2.0%GF and the highest value was obtained with 90%OPC+10%SF+0%GF. There is a decrease in workability of concrete with an increase in glass fibre content. The content of super plasticizer was increased to maintaining required slump value. Due to the high content of glass fibres it is very difficult to get required slump values without the addition of super plasticizer.

3.2 Compressive Strength

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, 28, 56 and 90 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 4.2. Variation of compressive strength of all the mixes cured at 7,14,28,56 and 90 days are also shown in Fig. 4.1. Fig. 4.1 shows the variation of compressive strength of concrete mixes w.r.t control mix (90%OPC+10%SF) after 7,14,28,56 and 90 days respectively.

Table 2: Compressive strength (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 days	14 days	28 days	56 days	90 days
1	90%OPC+10%SF+0%GF	31.00	34.00	35.00	39.00	40.20
2	90%OPC+10%SF+0.2%GF	37.00	39.00	41.60	43.90	47.80
3	90%OPC+10%SF+0.45%GF	38.30	38.40	41.20	42.60	47.40
4	90%OPC+10%SF+0.7%GF	36.20	37.80	40.10	41.60	46.10
5	90%OPC+10%SF+0.8%GF	34.10	35.90	38.50	39.30	44.30
6	90%OPC+10%SF+1.0%GF	32.00	34.20	36.50	38.40	41.50
7	90%OPC+10%SF+1.50%GF	29.00	31.30	34.20	35.20	39.40
8	90%OPC+10%SF+2.0%GF	25.60	28.00	32.00	33.40	36.80

Table 2 shows that addition of GF 0.2% to 1.0% by weight of OPC shows an increase in compressive strength of the concrete mixes compared with control mix of concrete. It can also be observed from the Figure 1 that the maximum compressive strength at7, 28 and 90 days of curing were obtained for a mix containing 90%OPC+10%SF with a fraction of fibres 0.2% by weight of the binder.

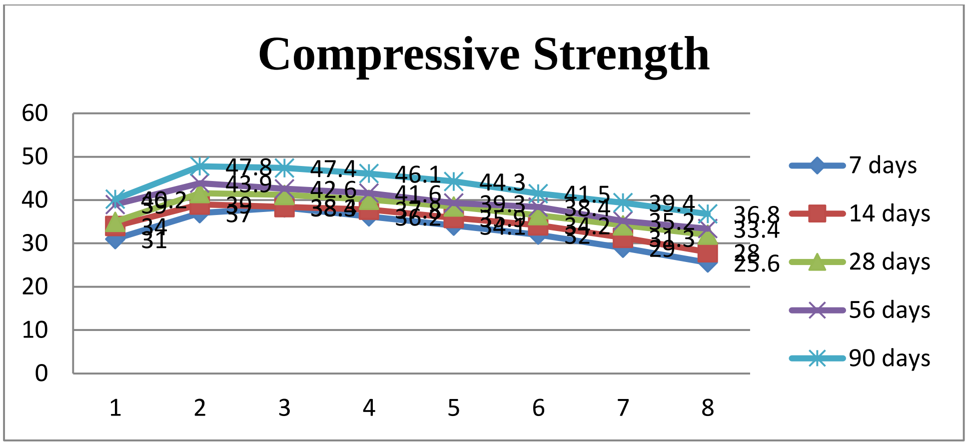

Fig. 1: Variation of compressive strength of concrete with age

3.3 Split tensile strength test results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 7, 14, 28, 56 and 90 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table 3. Variation of splitting tensile strength of all the mixes cured at7,14, 28,56 and 90 days is also shown in Figure 1. Figure 2 shows the variation of splitting tensile strength of concrete mixes w.r.t control mix (90%OPC+10%SF) after 7,14, 28,56 and 90 days respectively.

Table 3: Splitting tensile strength (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 days	14 days	28 days	56 days	90 days
1	90%OPC+10%SF+0%GF	4.00	4.33	4.46	4.92	5.32
2	90%OPC+10%SF+0.2%GF	4.71	5.11	5.54	5.72	5.98
3	90%OPC+10%SF+0.45%GF	4.50	5.15	5.31	5.64	5.69
4	90%OPC+10%SF+0.7%GF	4.65	4.75	4.81	4.93	5.12
5	90%OPC+10%SF+0.8%GF	4.65	4.75	5.24	5.6	5.71
6	90%OPC+10%SF+1.0%GF	3.76	3.80	4.00	4.10	4.63
7	90%OPC+10%SF+1.50%GF	3.11	3.16	3.76	3.83	4.22
8	90%OPC+10%SF+2.0%GF	3.00	3.30	3.81	3.96	4.34

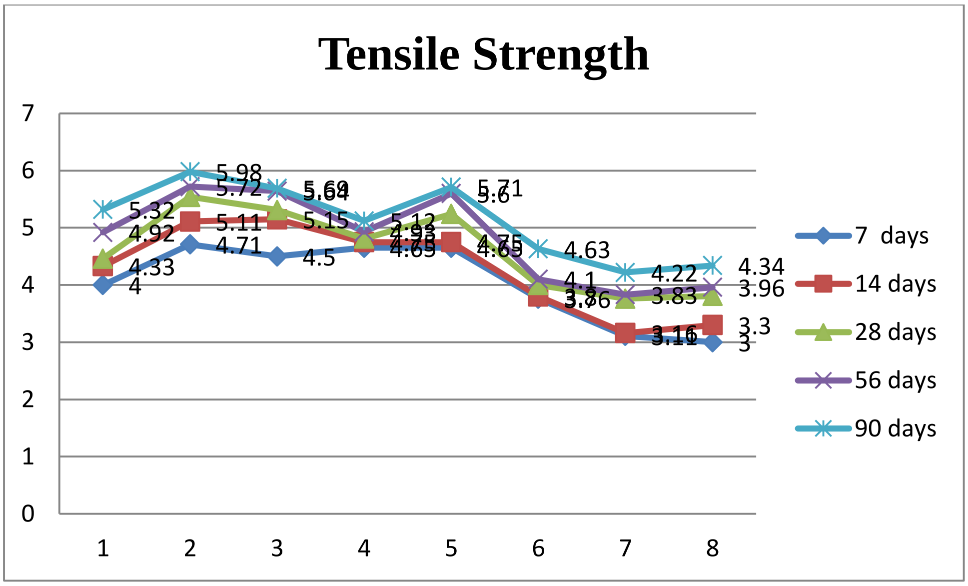

Fig. 2: Variation of compressive strength of concrete with age

4. DURABILITY

4.1 Acid and alkalinity resistance test

The concrete cubes of 150 mm size were cast for finding the mass loss due to the acid and base test. The prepared cubes were cured in water for 28 days and 90 days after which they were immersed in 1% H2SO4 and 5% NaOH solutions. The initial mass and the mass of concrete specimens after the immersion period of 28 days were measured for finding the mass loss due to the deterioration of concrete specimens. The average value of three specimens was considered for assessment. After 56 days of curing period of concrete in normal water the cubes were immersed in H_2SO_4 and NaOH solutions, the weights of cubes before and after immersion in solutions for 28 days were measured. Table 4 shows the effect of the acid attack on the compressive strength of concrete and Table 4 shows the effect of alkalinity attack on compressive strength of concrete. Figure 3 shows concrete specimen subjected to acid attack, compared with the normally cured specimen. Figure 3 shows concrete specimens subjected to alkalinity attack, compared with normally cured specimens**.**

Table 4: Durability test

S. No	Description	Before compressive strength	After compressive strength	% Percentage in compressive strength
1	M1	39	30.2	-22.56
2	M2	43.9	37.8	-13.8
3	M3	42.6	37.23	-12.6
4	M4	41.6	36.2	-12.9
5	M5	39.3	33.23	-15.44
6	M6	38.4	30.17	-21.64
7	M7	35.2	25.70	-26.82
8	M8	33.4	22.40	-32.00

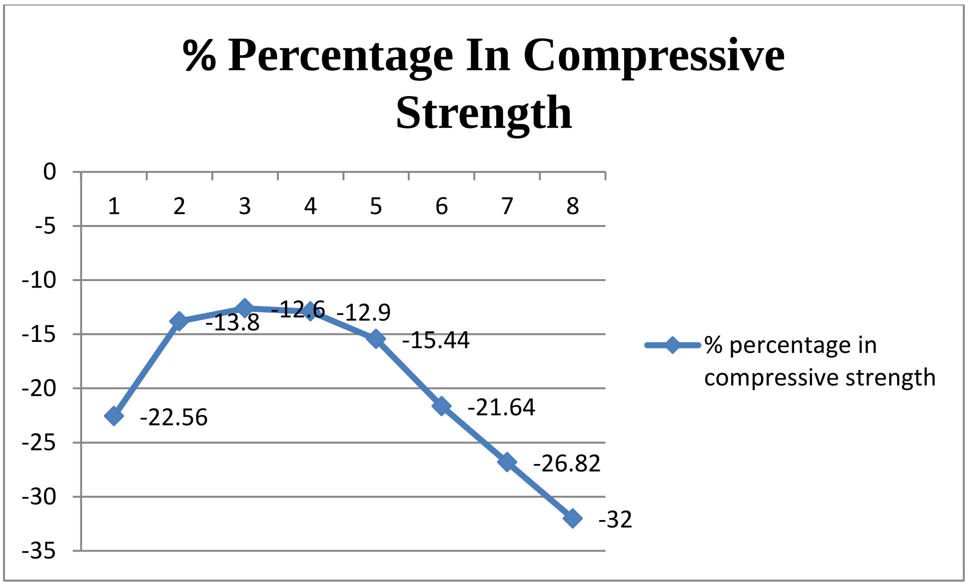

Fig. 3: Variation of Acid and Alkalinity Resistance Test with age

5. CONCLUSIONS

In the current investigation, glass fibres (GF) were used to examine the strength and acidity-alkalinity resistance test. The experimental data obtained has been analyzed and discussed in Chapter-4, to fulfil to the best of ability, the objectives set forth for the present investigation. This chapter gives the broad conclusions that are drawn from the investigation.

Based on the scope of work carried out in this investigation, the following conclusions are drawn:

- Reduction in bleeding is observed by the addition of glass fibres in the concrete mixes up to 2.0% by weight of cement.
- It was observed that as the addition of glass fibres to concrete mix increases, the workability of the concrete mix was found to decrease as compared to the control mix.
- At an optimum dosage of glass fibres the increase in compressive strength of glass fibre concrete mixes compared with control mix of concrete at 28 days compressive strength is observed from 18% to 20%.
- The percentage increase of split tensile strength of glass fibre concrete mixes compared with control mix at 28 days is observed varying from 15 to 20% for 0.2% GF by weight of the binder.
- The addition of glass fibres into the concrete mixture marginally improves the compressive strength at 28 days. It is observed from the experimental results and its analysis, that the compressive strength of concrete, splitting tensile strength of concrete increases with the addition of Percentage of glass fibers. The 0.2% and 0.45%addition of glass fibres into the concrete show a better result in mechanical properties and durability.
- Addition of 0.2% by weight of cement, glass fibres shows a maximum increase in Compressive strength and Flexural strength by 18% and 15% respectively with respect to PC mix without fibres at 28 days of curing.
- The durability of concrete from the aspect of resistance to acid attack on concrete increases by adding AR-glass fibres in concrete. The glass Fibres Bridge across the cracks causing interconnecting voids to be minimum.
- It was found that addition of the glass fibres strands improves the compressive strength, tensile strength, durability, load carrying capacity of ordinary reinforced cement concrete with small dosage levels of 0.2% & 0.45% by weight of cement

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