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Experimental Study on the Behaviour Of Glass Fibre Reinforced Concrete

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Abstract— **The purpose of this project is to study the behaviour of the glass fibre reinforced concrete. Tests on hardened concrete such as compressive strength, split tensile strength. initial surface absorption. The various Glass fibre combinations used in concrete mixes are 0.0%, 0.2%, 0.45%, 0.7%, 0.8%, 1.0%, 1.5%, 2.0% were conducted. Concrete specimen with various percentage of glass fibre gives the behaviour of concrete of different properties on different percentages compared with other combinations.**

Keywords— **concrete, Glass fibre, GFRP, compressive strength, split tensile strength , concrete behaviour.**

I. INTRODUCTION

Glass fibre reinforced concrete is defined as a concrete meeting special combination of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. Glass fibre reinforced concrete (GFRC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make these specially designed concretes that must meet a combination of performance requirements. Special mixing, placing, and curing practices may be needed to produce and handle Glass Fibre reinforced concrete.

Glass fibre reinforced concrete almost always has a higher strength than normal concrete. However, strength is not always the primary required property. For example, a normal strength concrete with very high durability and very low permeability is considered to have high performance properties. By using by-products such as silica fume with super plasticizer we can achieve high workability, high strength, and high modulus of elasticity, high density, high dimensional stability, low permeability and resistance to chemical attack.

Super plasticizers are used in these concrete to achieve the required workability; moreover different kinds of cement replacement materials are usually added because low porosity and permeability are desirable. Silica fume is the one of the most popular pozzolnas, whose addition to concrete mixtures results in lower porosity, permeability and bleeding because their oxides (SiO_2) react with and consume calcium hydroxides, which is produced by hydration of ordinary Portland cement. The main results of pozzolanic reactions are: lower heat liberation and strength development; lime-consuming activity; smaller pore size distribution. Researches shows that the optimum percentage of cement replaced by silica fume is 10% for achieving maximum compressive split tensile, initial surface absorption.

Griffiths (2000) carried out the study to investigate the mechanical properties of glass fibre reinforced polyester polymer concrete. It was found that the modulus of rupture of polymer concrete containing 20% polyester resin and about 79% fine silica aggregate is about 20 MPa. The addition of about 1.5% chopped glass fibres (by weight) to the material increases the modulus of rupture by about 20% and the fracture toughness by about 55%. Glass fibres improve the strength of the material by increasing the force required for deformation and improve the toughness by increasing the energy required for crack propagation.

Rao (2012) studied the effect of glass fibres on the mechanical properties of M20 and M30 grades of concrete. It was found that the addition of the glass fibres that there is increase in the compressive strength up to 1% by volume at higher fibre percentages and the strength decreases if the fibre content is increased significantly.

Nili and Afroughsabet (2011) studied long-term compressive strength and durability properties of concrete specimens produced by incorporating polypropylene fibers and silica fume. Silica fume, a cement replacement, was used at 8% (by weight of cement) and the volume fractions of the polypropylene fibers were 0%, 0.2%, 0.3% and 0.5%. Water-binder ratios were 0.46 and 0.36.Results shows that the inclusion of fiber and particularly silica fume into the specimens led to an increased long-term compressive strength. Electrical resistance of the silica fume specimens improved remarkably, but decreased slightly due to the fiber inclusion. Water absorption of the fiber–silica fume specimens was decreased as compared to the reference samples. Inclusion of fiber and silica fume into the specimens had no considerable effect on the dynamic frequency results.

Mahmoud Nili et al (2011) studied that the early- and later-stage compressive strength, the electrical resistivity, the water absorption and the dynamic frequency of the specimens made with silica fume were examined when silica fume was used as a cement replacement, it was found that it enhanced the effectiveness of added steel fibre on the properties of concrete. Three different steel fibres were used at 0.0%, 0.5% and 1.0% by volume of concrete. Silica fume was introduced at 8% by weight of cement into the concrete mixtures that were made with water–cement ratios of 0.46 and 0.36. It was observed that the inclusion of steel fibre in silica fume specimens led to the highest long-term compressive strength and the lowest resistivity. Furthermore, an improvement in the dynamic frequency and a decrease in water absorption were attained in 1% steel fibre silica fume specimens. Using silica fume as a partial replacement for cement decreased the density of the mixtures. Adding steel fibre to concrete increases the compressive strength of the concrete by approximately 4–17%, and inclusion of 1.0% steel–fibre volume fractions, in both water–cement ratio specimens, led to a higher compressive strength. The higher volume of fibres led to a higher compressive strength. The maximum compressive strengths of 64.4 MPa and 85.2 MPa were attained at 1 year when silica fume was introduced into the 1% steel–fibre specimens. It was observed that fibre inclusion, particularly in silica fume specimens, led to a slight increase in the dynamic frequency. Incorporation of glass fibers and silica fume in the mixtures led to a decrease in the water absorption.

II. METHODOLOGY

Selection of each material likes Cement, Aggregates, Admixtures and water of appropriate quality is very crucial to find strength studies on cement concrete.

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 recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture.

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.

Coarse Aggregate: Locally available crushed blue granite stones conforming to graded aggregate of nominal size 12.5 mm as per IS: 383 – 1970. Its specific gravity is 2.75.

Admixture: Super plasticizer CONPLAST SP 430 is a chloride free workability retention admixture based on selected organic polymers. Designed to provide workability retention where rapid workability loss is caused by high ambient temperatures or to compensate for delays in transportation. It is particularly suited to concrete mixes containing micro silica. Silica fume was used as a mineral admixture. It acts as a filler material, and gives the early strength to the concrete.

Fibre: The glass fibres used are of Cem-FIL Anti-Crack HD with 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.

Water - Potable water as per IS 456-2000.

The mix design was done for M25 grade concrete based on the Asian Journal of Civil Engineering vol.15, no.3(2014).

TABLE 1
NOMINAL MIX PROPORTION

MIX	OPC%	SILICA FUME %	GLASS FIBRE %
M1	90%	10%	0.0 %
M2	90%	10%	0.2 %
M3	90%	10%	0.45 %
M4	90%	10%	0.7 %
M5	90%	10%	0.8 %
M6	90%	10%	1.0 %
M7	90%	10%	1.5 %
M8	90%	10%	2.0 %

cement content is replaced by glass powder in three proportions as follows. 10% of silica fume and Super plasticizer CONPLAST SP 430 is added 1.875% to the weight of binder. The identification, mix proportion and quantity of material taken for one meter cube of Glass fiber reinforced concrete mixes are given in Table 2.

MIX	Cement Kg/ M^3	W/B	SF Kg / M^3	Water	Fine Agg Kg/ M^3	Coarse Agg 10 MM	Coarse Agg 20 MM	Fibre	Sp %
M1	360	0.4	40	160	649	416.4	624.6	0.0%	1
M2	360	0.4	40	160	649	416.4	624.6	0.2%	1
M3	360	0.4	40	160	649	416.4	624.6	0.45 %	1
M4	360	0.4	40	160	649	416.4	624.6	0.7%	1
M5	360	0.4	40	160	649	416.4	624.6	0.8%	1
M6	360	0.4	40	160	649	416.4	624.6	1.0%	1
M7	360	0.4	40	160	649	416.4	624.6	1.5%	1. 25
M8	360	0.4	40	160	649	416.4	624.6	2.0%	1. 25

Concrete cubes of size 150mm x 150mm x 150mm and cylinders of size 150mm diameter and 300mm height were casted for the above proportions of concrete to test the compressive strength, the split tensile strength and flexural strength.

III. RESULTS AND DISCUSSIONS

The slump values were analysed for different combinations and result shows the decrease in slump value with increase in percentage of glass Fibre

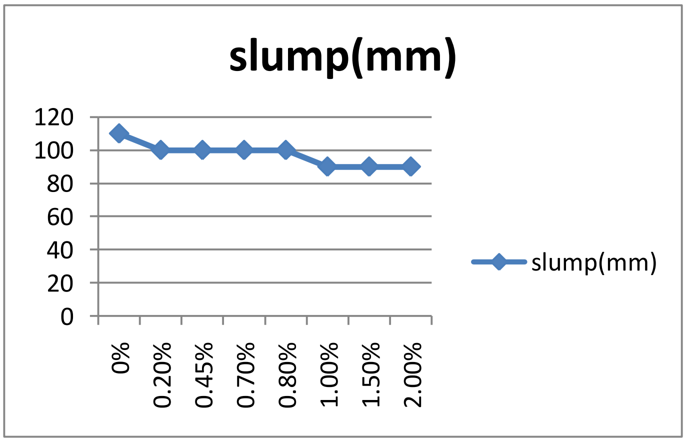

Fig 1. Slump Value for Various Mixes

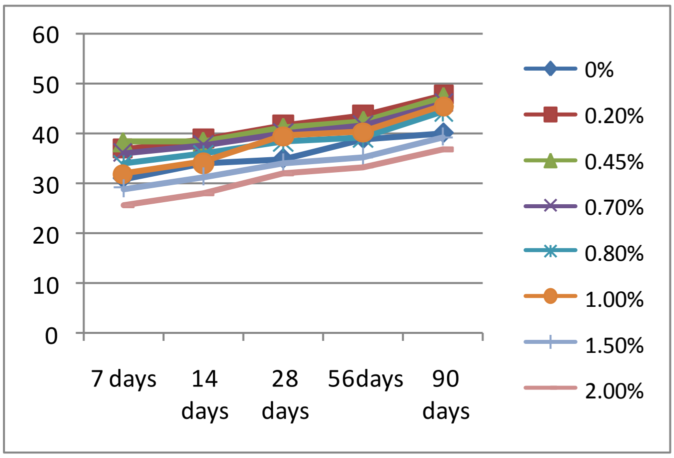

Fig 2. Compressive Strength results

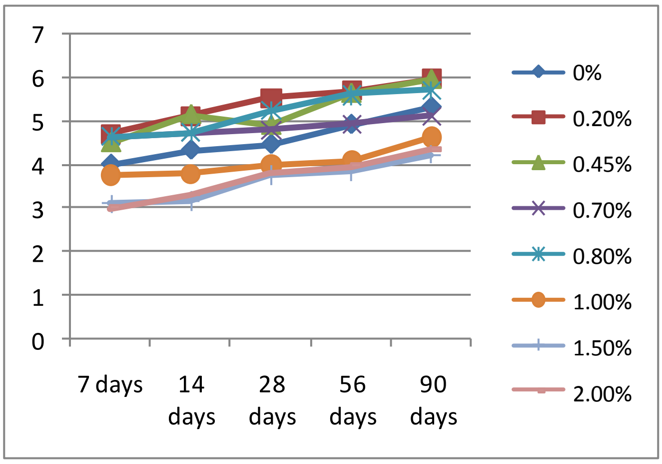

Fig 3. Split Tensile Strength Results

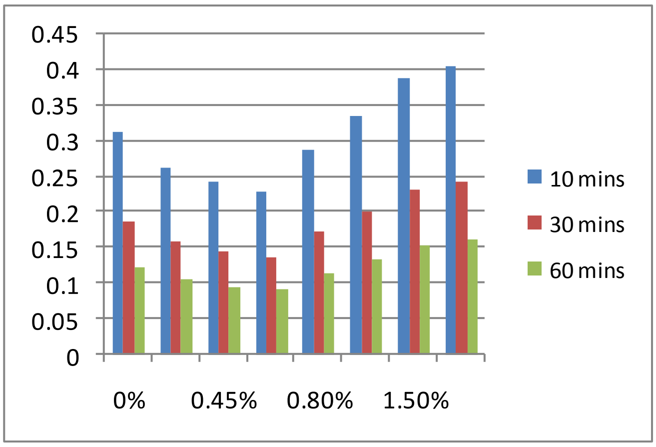

Fig 4.1 Initial surface abrorption test for 56 days

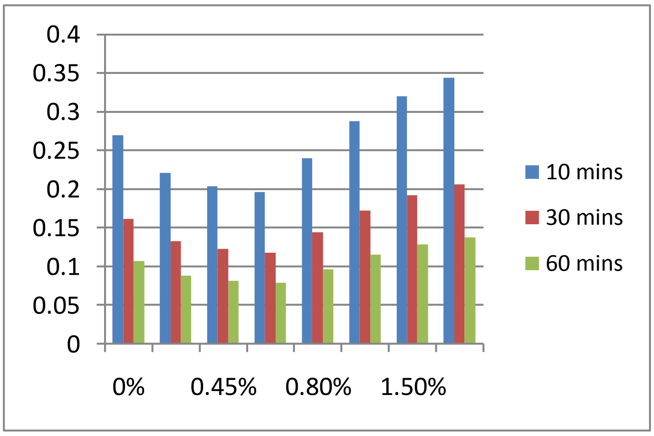

Fig 4.2 Initial surface absorption test for 90 days

The test results exhibit the increase in the behaviour of concrete. When compared with the nominal mix the other mixes shown increase in strength at the end of 90 days.

IV. CONCLUSION

Addition of Glass fibre leads to a increase in compressive strength, Split tensile and Flexural strength .Maximum compressive strength, Split tensile strength develop in M25grade glass fibre reinforced concrete by adding varying percentage of glass fibres.

a. Reduction in bleeding is observed by addition of glass fibres in the glass fibre concrete mixes.

It was observed that as the addition of glass fibres to concrete mix increases, the workability of concrete mix was found to decrease as compared to control mix.

At optimum dosage of GF the increase of 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 from 15 to 20% for 0.2% GF by weight of binder.

Addition of 0.2% by weight of cement of glass fibres shows maximum increase in Compressive strength & Flexural strength by 18% to 20%, & 15% to 20% respectively with respect to PC mix without fibres at 28 days of curing

It can be observed that addition of the glass fibres strands tested 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.

With an increase in glass fibers content from 0.0% to 0.2% by weight of cement, the compressive strength, splitting tensile strength and flexural strength were enhanced.

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