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RESEARCH ARTICLE

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A STUDY ON DEVELOPMENT OF CONCRETE USING GLASS FIBRE

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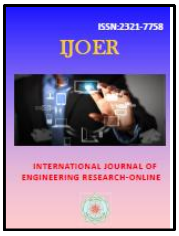

ABSTRACT

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 1 mm dia. are available for industries. Fibre reinforced concrete is used for the construction of airport pavements to improve the properties of strength and toughness.

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 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 from 15 to 20% for 0.2% glass fibres by weight of 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 addition of low Percentage of glass fibers. The 0.2%, 0.45% and 0.7% addition of glass fibres into the concrete shows better result in mechanical properties and durability.

Keywords— Glass fiber, concrete, OPC, concrete tests.

1. INTRODUCTION

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions.

Fibre reinforced concrete (FRC) is a concrete made primarily of hydraulic cements, 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 of 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 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

Following are the different type of fibres generally used in the construction industries.

1. Steel Fibre Reinforced Concrete.
2. Polypropylene Fibre Reinforced (PFR) cement mortar & concrete.
3. Glass-Fibre Reinforced Concrete.
4. Asbestos Fibres.
5. Carbon Fibres.
6. Organic Fibres.

2. Literature review

Toutanji (1999) studied mechanical properties of expansive-cement concrete containing silica fume and polypropylene fibers. Properties studied include those of the fresh mix properties, length change, rapid chloride permeability, compressive strength, flexural behaviour, and bond of hardened concrete. Silica fume content used was 5 and 10% and fiber volume fraction was 0.10, 0.30, and 0.50%. Results showed that the use of 5% silica fume combined with 0.30% fiber volume fraction results in optimum mixture design for repair applications from the standpoints of workability, bond, strength, length change and permeability.

3. EXPERIMENTAL PROGRAM

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control programme for concrete, which to achieve higher efficiency of the material used and greater assurance of the performance of the concrete with regards to both strength and durability. The test methods should be simple, direct and convenient to apply.

Table 3.1 properties of OPC

Characteristic Properties	Observed Value	Codal Requirements IS:8112-1989(Part 1)
Fineness (m^2/kg)	300	225 minimum
Standard consistency (%)	32	---------------
Initial Setting time (minutes)	62 minutes	30 Minimum
Final setting time (minutes)	270	600 Maximum
Specific gravity	3.15	--------------
Compressive strength (MPa) 3 days 7-days 28-days	 24.6 34.3 45.2	 23 Minimum 33 Minimum 43 Minimum

3.1 Coarse 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.

3.2 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.

3.3 Glass 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.

3.4. Admixtures

Water-reducing and set-retarding admixtures are permitted in order to increase the workability of the concrete and to extend the time of discharge from 60 to 90 minutes. These admixtures are permitted and often required for superstructure concrete. Chemical admixtures and mineral admixtures as defined by ASTM C 494 are as follows:

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.

3.5 Mix Design

Concrete mix was designed as per IS 10262-2009 and the design procedure was as follows;

1. Determine the mean target strength ft from the specified characteristic compressive strength at 28-day fck and the level of quality control. $f_t = f_{ck} + 1.65$ S, where S is the standard deviation obtained from the IS 10262- 2009.
2. Adopt the water cement ratio for the desired mean target strength using the Table 5 of IS 456 and water cement ratio so chosen is checked against the limiting water cement ratio.
3. Select the water content, for the required workability and maximum size of aggregates (for aggregates in saturated surface dry condition) using table 2 of IS 10262- 2009. Super plasticizer was used so water content was adjusted for the required workability.
4. Calculate the cement content from the water-cement ratio and the final water content as arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability, and greater of the two values is adopted.
5. Determine the proportion of coarse and fine aggregate in total aggregate by absolutevolume corresponding to the adjusted water cement ratio from IS 10262-2009.
6. From the quantities of water and cement per unit volume of concrete and theproportion of fine and coarse aggregates already determined in step 5 above, calculate the content of coarse and fine aggregates per unit volume of concrete from the following relations.
7. $V = \left[W + \frac{C}{S_C} + \frac{1}{P} + \frac{f_a}{Sa}\right] \times \frac{1}{1000}$

$$W = \left[W + \frac{C}{S_c} + \frac{1}{1-P}\frac{f_a}{S_{ca}}\right] \times \frac{1}{1000}$$

Where

V = absolute volume of concrete

= Gross volume ($1m^3$) minus the volume of entrapped air

Sc = specific gravity of cement

W = Mass of water per cubic metre of concrete, kg

C = mass of cement per cubic metre of concrete, kg

P = ratio of fine aggregate to total aggregate by absolute volume

fa, Ca = total masses of fine and coarse aggregates, per cubic metre of concrete respectively kg, and

S_{fa}, *Sca* = specific gravities of saturated surface dry fine and coarse aggregates, respectively

8. Determine the concrete mix proportions for the first trial mix.Prepare the concrete using the calculated proportions and cast three cubes of 100 mmsize and test them wet after 28-days moist curing and check for the strength.
9. Prepare trial mixes with suitable adjustments till the final mix proportions are arrived at.

Table 3.2 Mix details

MIX	OPC(%)	SILICA FUME (%)	GLASS FIBRE (%)
M1	90%	10%	0.00%
M2	90%	10%	0.20%
M3	90%	10%	0.45%
M4	90%	10%	0.70%
M5	90%	10%	0.80%
M6	90%	10%	1.00%
M7	90%	10%	1.50%
M8	90%	10%	2.00%

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Table 3.3 Mix proportion per m^3

MIX	CEMENT (Kg/m³)	W/B	SF(Kg/m³)	WATER(Kg/m³)	FINE AGG.(Kg/m³)	COARSE AGG. (Kg/m³)		FIBRE %	SP %
						10MM	20MM		
M1	360	0.4	40	160	694	416.4	624.6	0%	1
M2	360	0.4	40	160	694	416.4	624.6	0.20%	1
M3	360	0.4	40	160	694	416.4	624.6	0.45%	1
M4	360	0.4	40	160	694	416.4	624.6	0.70%	1
M5	360	0.4	40	160	694	416.4	624.6	0.80%	1
M6	360	0.4	40	160	694	416.4	624.6	1.00%	1
M7	360	0.4	40	160	694	416.4	624.6	1.50%	1.25
M8	360	0.4	40	160	694	416.4	624.6	2.00%	1.25

OBJECTIVES OF THE STUDY

The precise objectives of the study are follows.

- The objectives of the present investigation are to get the thoroughness with the existing mix design procedures for glass fiber reinforced concrete by varying the percentage addition of glass fibers in concrete mix.
- To carry out the literature review in the area of the study
- To carry out the study to check the hardened properties of the glass fibre reinforced concrete (compressive and split tensile strength).
- To carry out the study to check the long term durability properties of glass fibre reinforced concrete (ISAT, CSAT, UPV, Acid and Alkalinity resistance tests).

RESULTS AND DICUSSIONS

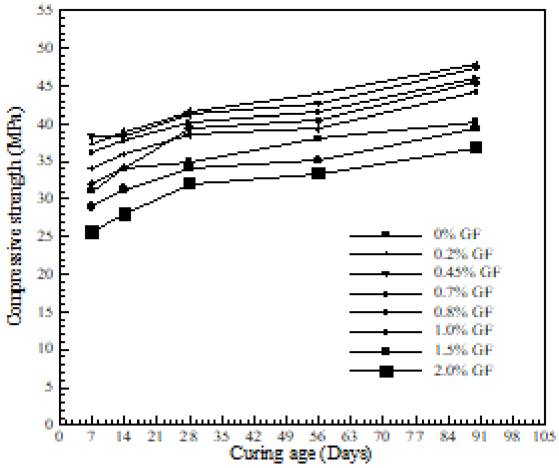
Workability of Concrete Mixes

Workability values for different concrete mixes

Mix no.	Description	Super plasticizer (%) by weight of 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

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



Variation of compressive strength of concrete with age

Split Tensile Strength Test Results

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

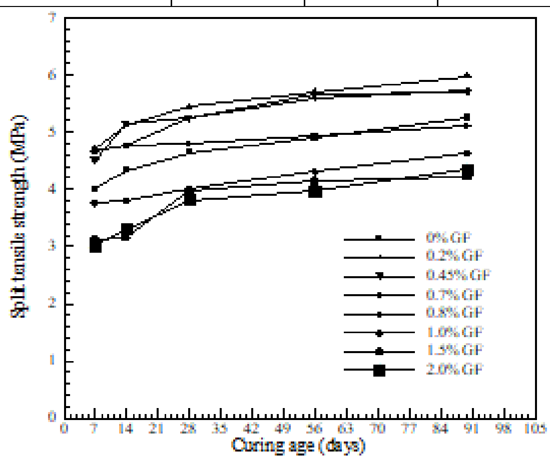


Fig. 2 Variation of split tensile strength of concrete with age

4 Initial Surface Absorption Test Results

Table 4 Initial Surface Absorption values in [ml/(m^2.Sec)] at 10 min.

Mix no.	Description	Initial Surface Absorption [ml/(m^2.Sec)] at 10 min.	
		56 days	90 days
1	90%OPC+10%SF+0%GF	0.312	0.2696
2	90%OPC+10%SF+0.2%GF	0.264	0.221
3	90%OPC+10%SF+0.45%GF	0.242	0.203
4	90%OPC+10%SF+0.7%GF	0.230	0.196
5	90%OPC+10%SF+0.8%GF	0.288	0.240
6	90%OPC+10%SF+1.0%GF	0.336	0.288
7	90%OPC+10%SF+1.50%GF	0.388	0.320
8	90%OPC+10%SF+2.0%GF	0.406	0.344

Table-5 Initial Surface Absorption values in [ml/(m^2.Sec)] at 30 min.

Mix no.	Description	Initial Surface Absorption [ml/(m^2.Sec)] at 30 min.	
		56 days	90 days
1	90%OPC+10%SF+0%GF	0.187	0.161
2	90%OPC+10%SF+0.2%GF	0.158	0.132
3	90%OPC+10%SF+0.45%GF	0.145	0.122
4	90%OPC+10%SF+0.7%GF	0.138	0.117
5	90%OPC+10%SF+0.8%GF	0.172	0.144
6	90%OPC+10%SF+1.0%GF	0.201	0.172
7	90%OPC+10%SF+1.50%GF	0.232	0.192
8	90%OPC+10%SF+2.0%GF	0.243	0.206

Table-6 Initial Surface Absorption values in [ml/(m^2.Sec)] at 60 min.

Mix no.	Description	Initial Surface Absorption [ml/(m^2.Sec)] at 60 min.	
		28 days	56 days
1	90%OPC+10%SF+0%GF	0.124	0.107
2	90%OPC+10%SF+0.2%GF	0.105	0.088
3	90%OPC+10%SF+0.45%GF	0.096	0.081
4	90%OPC+10%SF+0.7%GF	0.092	0.0784
5	90%OPC+10%SF+0.8%GF	0.115	0.096
6	90%OPC+10%SF+1.0%GF	0.134	0.115
7	90%OPC+10%SF+1.50%GF	0.155	0.128
8	90%OPC+10%SF+2.0%GF	0.162	0.137

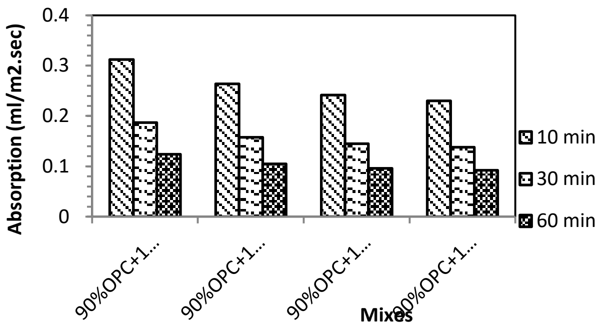


Fig. 3- ISAT at 56 days of curing for above mixes

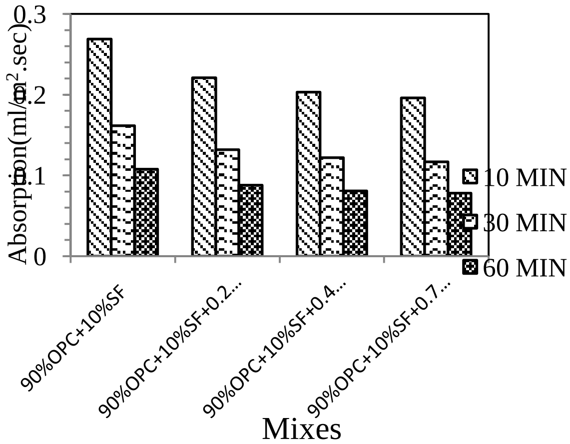


Fig. 4- ISAT at 90 days of curing for above mixes

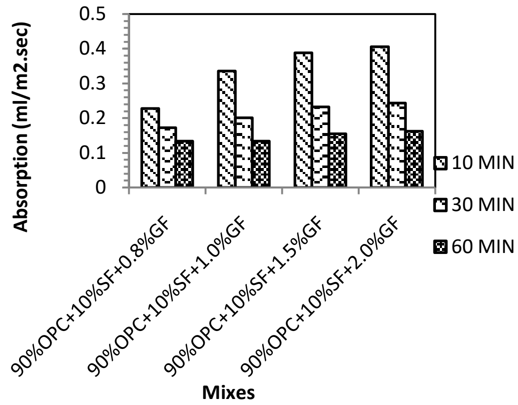


Fig.5 ISAT at 56 days of curing for above mixes

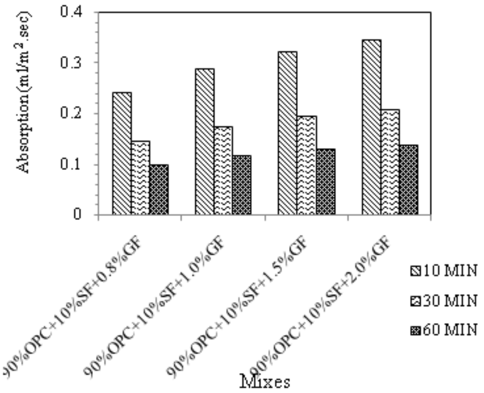


Fig. 6 ISAT at 90 days of curing for above mixes

6 Ultrasonic pulse velocity (UPV)Test Results

The results of the UPV tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The UPV test was conducted at curing ages of 56 and 90 days. The UPV test results of all the mixes at different curing ages are shown in Table 4.7 and 4.8.

Table 7 UPV values at 56 days of curing

Description	Distance (mm)	Transit time (µ sec)	Average pulse velocity (km/sec)	Quality of concrete
90%OPC+10%SF+0%GF	150	30.02	4.55	Excellent
90%OPC+10%SF+0.2%GF	150	30.47	4.80	Excellent
90%OPC+10%SF+0.45%GF	150	30.92	4.85	Excellent
90%OPC+10%SF+0.7%GF	150	30.95	4.84	Excellent
90%OPC+10%SF+0.8%GF	150	31.47	4.75	Excellent
90%OPC+10%SF+1.0%GF	150	31.37	4.35	Good
90%OPC+10%SF+1.50%GF	150	31.47	4.20	Good
90%OPC+10%SF+2.0%GF	150	32.40	4.12	Good

Table 8 UPV values at 90 days of curing

Description	Distance (mm)	Transit time (µ sec)	Average pulse velocity (km/sec)	Quality of concrete
90%OPC+10%SF+0%GF	150	30.45	4.79	Excellent
90%OPC+10%SF+0.2%GF	150	31.47	4.97	Excellent
90%OPC+10%SF+0.45%GF	150	31.92	5.10	Excellent
90%OPC+10%SF+0.7%GF	150	31.95	5.07	Excellent

90%OPC+10%SF+0.8%GF	150	31.47	5.01	Excellent
90%OPC+10%SF+1.0%GF	150	31.37	4.44	Good
90%OPC+10%SF+1.50%GF	150	31.47	4.32	Good
90%OPC+10%SF+2.0%GF	150	32.40	4.21	Good

7. Capillary Suction (Sorptivity) Test Results

Sorptivity is defined as the rate of movement of a waterfront through a porous material under capillary action. Sorptivity test differs from the ISAT as the former measures the rate of capillary suction as opposed to the bulk effect of capillary suction in the latter at a specified time. The lower the sorptivity value, the higher the resistance of concrete towards water absorption. Table 4.9 Average IRA (mm/Sec$^{1/2}$) at 56 and 90 days of curing

Mix no.	Discription	Average IRA (mm/Sec$^{1/2}$)	
		56 days	90 days
1	90%OPC+10%SF+0%GF	0.0130	0.0120
2	90%OPC+10%SF+0.2%GF	0.0096	0.0091
3	90%OPC+10%SF+0.45%GF	0.0082	0.0076
4	90%OPC+10%SF+0.7%GF	0.0085	0.0079
5	90%OPC+10%SF+0.8%GF	0.0121	0.0115
6	90%OPC+10%SF+1.0%GF	0.0140	0.0131
7	90%OPC+10%SF+1.50%GF	0.0165	0.0147
8	90%OPC+10%SF+2.0%GF	0.0210	0.0170

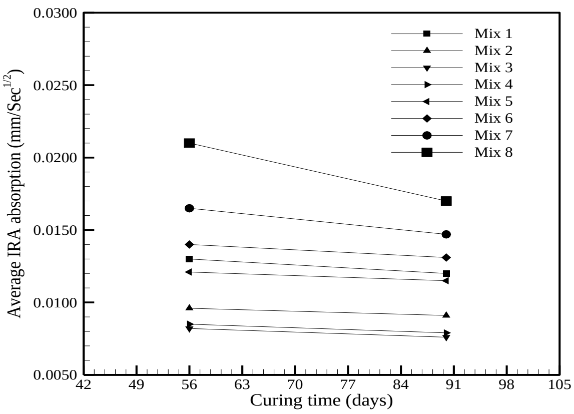


Fig.7- IRA graph at 56 and 90 days of curing

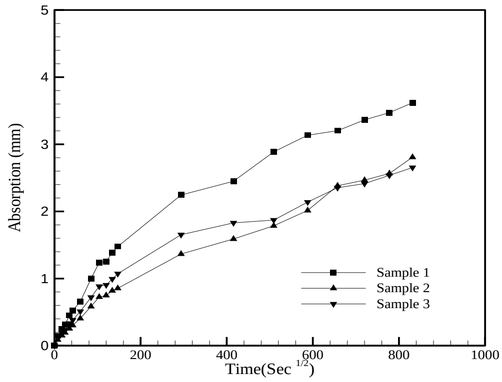


Fig. 8 Capillary suction test graph for Mix 1(90%OPC+10%SF+0%GF) at56 days of curing

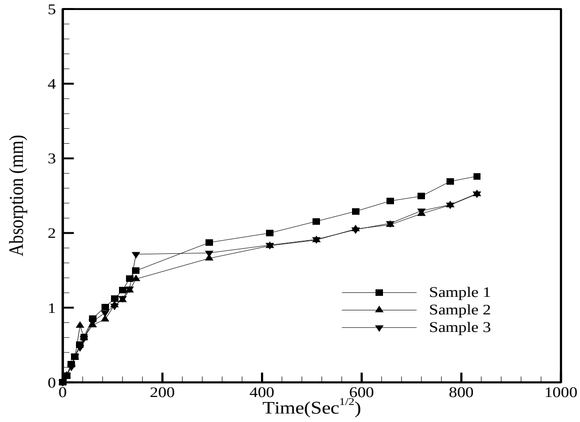


Fig. 9 Capillary suction test graph for Mix 2(90%OPC+10SF+0.2%GF) at 56 days of curing

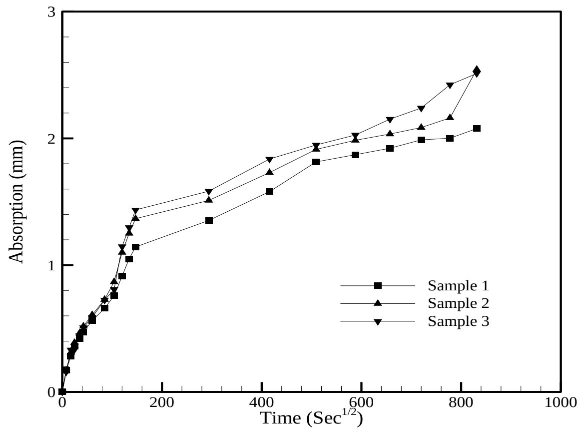


Fig. 10 Capillary suction test graph for Mix 3(90%OPC+10%SF+0.45%GF) at 56 days of curing

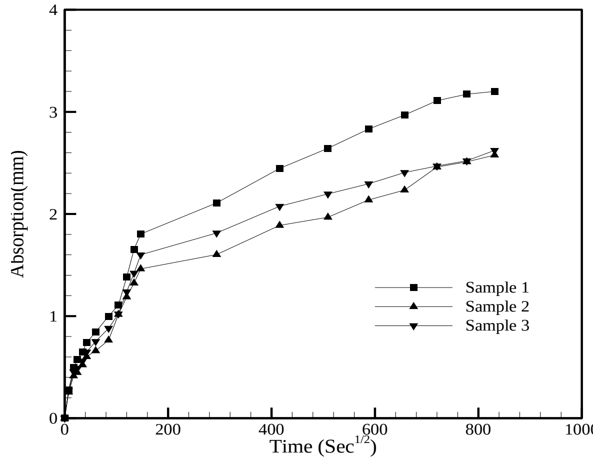


Fig. 11 Capillary suction test graph for Mix 4(90%OPC+10%SF+0.7%GF) at 56 days of curing

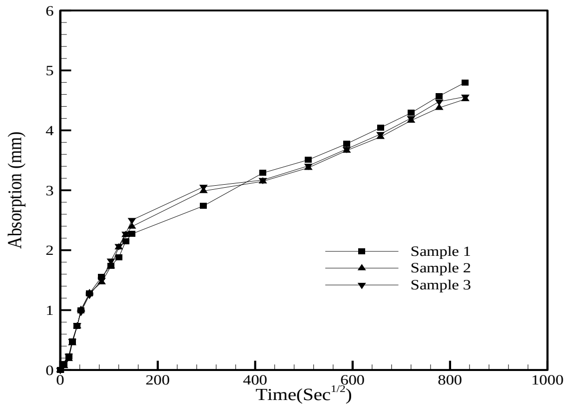


Fig.14 Capillary suction test graph for Mix 7(90%OPC+10%SF+1.5%GF) at 56 days of curing

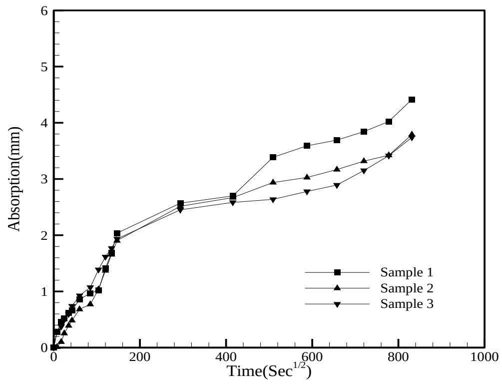


Fig. 12 Capillary suction test graph for Mix 5(90%OPC+10%SF+0.8%GF) at 56 days of curing

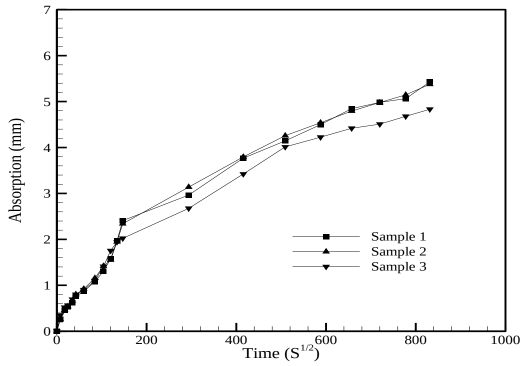


Fig. 15 capillary suction test graph for Mix 8(90%OPC+10%SF+2.0%GF) at 56 days of curing

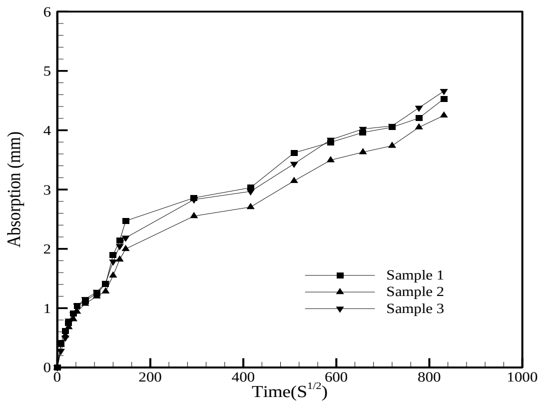


Fig. 13 Capillary suction test graph for Mix 6(90%OPC+10%SF+1.0%GF) at 56 days of curing

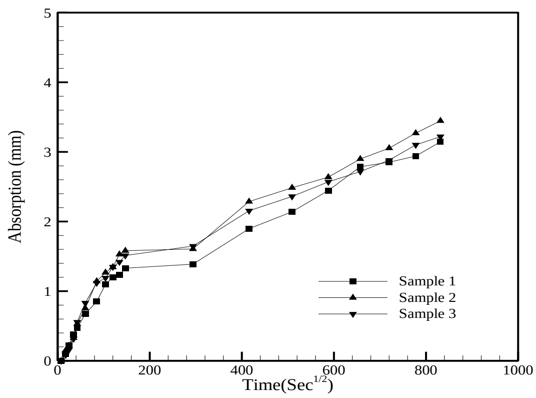


Fig. 16 Capillary suction test graph for Mix 1(90%OPC+10%SF+0%GF) at 90 days of curing

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Jan-Feb

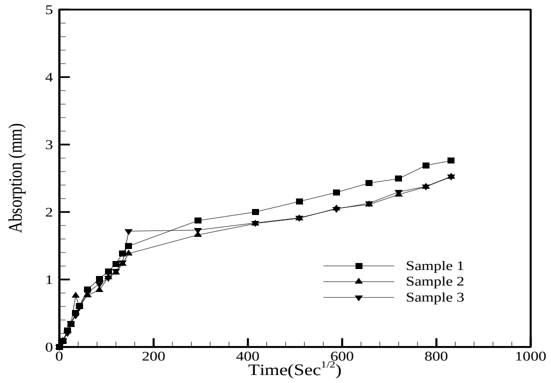

Fig. 17 Capillary suction test graph for Mix 2(90%OPC+10%SF+0.2%GF) at 90 days of curing

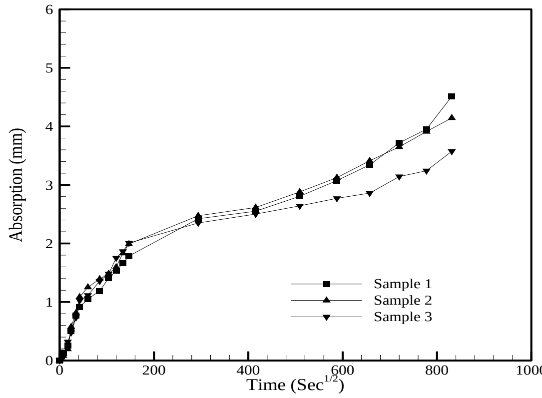

Fig. 20 Capillary suction test graph for Mix 5(90%OPC+10%SF+0.8%GF) at 90 days of curing

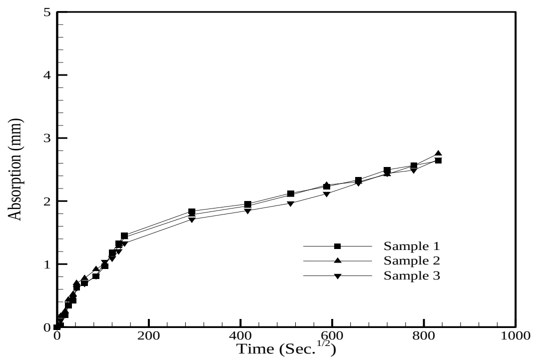

Fig. 4.18 Capillary suction test graph for Mix 3(90%OPC+10%SF+0.45%GF) at 90 days of curing

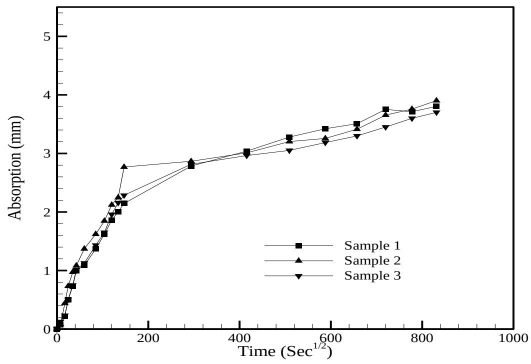

Fig. 4.21 Capillary suction test graph for Mix 6(90%OPC+10%SF+1.0%GF) at 90 days of curing

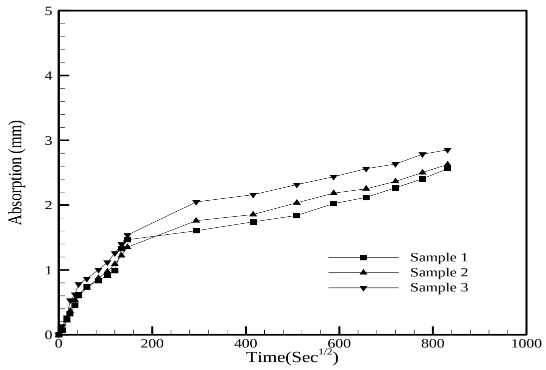

Fig. 4.19 Capillary suction test graph for Mix 4(90%OPC+10%SF+0.7%GF) at 90 days of curing

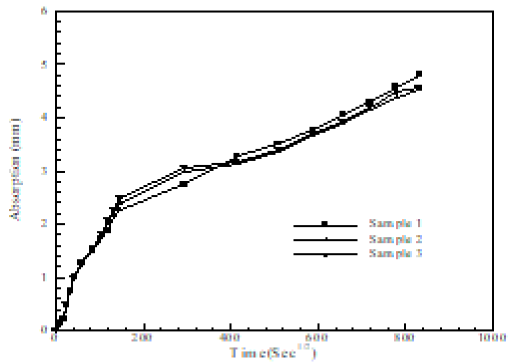

Fig. 4.22 Capillary suction test graph for Mix 7(90%OPC+10%SF+1.5%GF) at 90 days of curing

Acid and Alkalinity Resistance Test

Table 10 Effect of acid attack on compressive strength of concrete

Sl.No.	Mix Identity	Weight of cubes before and after immersion (Kg)		% Loss in weight	Compressive strength (N/mm^2)	Compressive strength after acid attack (N/mm^2)	% difference in compressive strength
		Before	After				
1	0% GF	8.452	8.312	1.66	39	30.2	22.56
		7.877	7.758	1.51			
2	0.2%GF	8.386	8.298	1.049	43.9	37.8	13.8
		8.356	8.251	1.25			
3	0.45% GF	8.419	8.345	0.87	42.6	37.23	12.6
		8.327	8.266	0.73			
4	0.7% GF	8.319	8.239	0.96	41.6	36.2	12.9
		8.336	8.256	0.95			
5	0.8% GF	8.173	8.061	1.37	39.3	33.23	15.44
		8.256	8.141	1.39			
6	1.0% GF	8.256	8.107	1.8	38.4	30.17	21.64
		8.342	8.219	1.67			
7	1.5%GF	8.274	8.055	2.64	35.2	25.7	26.82
		8.263	8.046	2.62			
8	2.0% GF	8.393	8.376	3.65	33.4	22.4	32
		8.396	8.475	3.75			

Table .11 Effect of alkalinity attack on compressive strength of concrete

Sl.No.	Mix Identity	Weight of cubes before and after immersion (Kg)		% increase in weight	Compressive strength (N/mm^2)	Compressive strength after alkalinity attack (N/mm^2)	% difference in compressive strength
		Before	After				
1	0% GF	8.434	8.497	0.74	39	36.7	5.89
		8.515	8.58	0.75			
2	0.2% GF	8.287	8.341	0.64	43.9	41.5	5.4
		8.266	8.325	0.7			
3	0.45% GF	8.435	8.485	0.58	42.6	40.8	4.22
		8.385	8.433	0.56			
4	0.7% GF	8.246	8.31	0.77	41.6	39.2	5.76
		8.287	8.33	0.75			
5	0.8% GF	8.247	8.31	0.75	39.3	36.1	8.14
		8.258	8.319	0.73			
6	1.0% GF	8.291	8.356	0.78	38.4	34.6	9.89
		8.312	8.387	0.89			
	1.5%GF	8.391	8.469	0.92	35.2	28.5	19
		8.267	8.338	0.85			

7	2.0% GF	8.372	8.468	1.13.	33.4	24.5	26.2
		8.342	8.44	1.16			

Table 12 Percentage increase in the resistance of glass fibre concrete against the weight losses in 1% H_2SO_4 solution comparison with ordinary concrete mixes

Type Mix	% of Glass fibre	% increase in resistance 28 days immersion period
M1	0.00%	-
M2	0.20%	0.41
M3	0.45%	0.79
M4	0.70%	0.69
M5	0.80%	0.7
M6	1.00%	-0.14
M7	1.50%	-0.98
M8	2.00%	-2.09

CONCLUSIONS

In the current investigation, glass fibres (GF) were used to examine the strength and water absorption characteristics using the Initial Surface Absorption Test as per BS-1881 208 and Capillary Suction test as per C 1585 – 04, acidity alkalinity resistance tests and UPV 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 may be drawn from the investigation.

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

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

b. 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.

c. At 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%.

d. 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 binder.

e. 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 addition of Percentage of glass fibers. The 0.2%and 0.45%addition of glass fibres into the concrete shows better result in mechanical properties and durability.

f. Addition of 0.2% by weight of cement, glass fibres shows 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.

g. 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.

h. 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.

i. UPV value found to behigher for concrete containing 0.45%GF by weight of cement. The value was 4.85 and 5.1 (km/sec.) at 56 and 90 days of curing respectively.

j. The concrete containing 0.45% and 0.7%GF by weight of binder shows lesser value of initial surface absorption.

k. The concrete containing 0.45% GF by weight of binder shows less capillary rise in concrete.

l. The durability of concrete from the aspect of resistance to acid attack on concrete increases by adding AR-glass fibres in concrete .The optimum value of AR-glass fibres for resistance to acid attack was 0.7% by weight of binder.

m. It was found that mix containing 0.7%GF by weight of binder showed higher resistance against weight loss in H2SO4 solution i.e.0.69% compared with control mix of concrete without glass fibres

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