2581-4575
International Journal For Recent Developments in Science & Technology
Crossref
A Peer Reviewed Research Journal

EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF ALKALI RESISTANT GLASS FIBER CONCRETE

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DOI: 10.48047/IJRDST/V04/I07/47

Abstract

Present day world is witnessing the enhancement and exigency in Construction Engineering. Through pioneering materials, Civil Engineers are creating worldwide significant infrastructure and creating wonders. It is mandatory to pioneer new materials and create innovative systems for the construction world. This is the right time to concentrate on amalgamation of new materials in concrete, as concrete is unavoidable due to its cost effectiveness when compared to rest of the materials used now a days in the construction industry. The addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack resist and would substantially improve its properties. This type of concrete known as fibre reinforced concrete. In this study, we use steel, AR Glass Fibres.. They can be added to concrete with different proportions as 0.5%, 1%, 1.5%, 2% and 2.5% in this study. Experiments were conducted to study the effect of steel fibre and polypropylene fibre in different proportions in hardened concrete. Compressive strength tests on cube and split tensile strength tests on cylinders were carried out to study the properties of hardened concrete. .

Keywords: Strength, Concrete, Mechanical Properties, AR Glass Fibre

1. INTRODUCTION:

One of the most important primary necessities for any human is shelter. In India, most of the construction activities are made with concrete, as is easily available and the mouldings can be done even by unskilled labour. Concrete is a composite material composed of cement, coarse aggregates, fine aggregates and water. It is most widely used man made material. Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fence sand poles and even boats. Concrete is used almost everywhere mankind has a need for infrastructure. Thus, concrete is becoming a very important materials for every human. In view of the extensive eco-friendly property of glass fibres, it is planned to investigate the efficiency for possible use in concrete. Recently, composite materials are replacing the conventional concrete new material for use in concrete are being developed so that we can improve the tensile properties of concrete as well as, which can be helpful in overcoming the need for providing more steel for a given load. It is very important to make concrete economical for rapid increase in use for construction. Concrete is one of the most widely recognized development material for the most part delivered by utilizing locally accessible ingredients. The development of concrete has brought about the essential need for additives both chemical and mineral to improve the performance of concrete. Hence varieties of admixtures such as fly ash, coconut fibre have been used so far. Hence an attempt has been made in the present investigation to study the behaviour of Alkali Resistance glass fibre in concrete. The present trend in concrete technology is towards increasing the strength and durability of concrete to meet the demands of the modern construction.

2. LITERATURE REVIEW:

Investigated And Studied the Effect Of Alkali Resistant (Ar) Glass Polymer Fibres In self Compacting, Self Curing concrete by Kannan et al (2010), The fibres are added at the percentages varying from 0.2% to 1.0% by weight of cement at intervals of 0.20%.To maintain a good workability, super plasticiser was added at the dosages of 0.8% by weight of cement. **Explained The Experimental Investigation On Tensile Strength And Hardness Property Of Woven Roving Samples, Random Layers Samples And Sandwich Composite (Woven Roving And Random) Samples by AL-Husain Emad (2007) ,** Finally it changed to 254 N/mm^2 after reinforcing with the two types of the fibres as a sandwich. In all the types the failure tensile load increased with increasing the number of layers except that it decreased in sandwich composite due to the high - volume fraction. The maximum value of Brinell hardness was 62.1 N/mm^2 for epoxy reinforced with (9 layers) of woven roving glass fibres when compared with the other types of composite.

Investigated the effect of adding steel fibers to concrete, on the mechanical behaviour of steel fiber concrete slabs by Ali Elloze et al (2010) , The compressive force of SFC improved up to 25% compared to plain concrete, while the splitting tensile strength tests showed an enhancement of up to 45% of the steel fibre concrete compared to plain concrete. **Explained experimental investigation Of Mechanical Properties Of Coal Ash Reinforced glass Fibre Polymer Matrix composites by Naresh Kumar et al. (2013), The** test results have shown that the addition of Coal ash increases the overall mechanical properties of the composite material as compared with the polymer composite materials 20% ash reinforced polymer composite was having a better result of tensile strength in comparison with other ash.

3. EXPERIMENTAL STUDIES & METHODOLOGY

3.1 PROGRAM OF EXPERIMENTAL WORK:

The experimental program consists of casting and testing of 24 cubes, 24 cylinders using AR-Glass fiber and 3 cubes and 3 cylinders without AR-glass fiber. The dimensions of cubes used for the tests were 150mmx150mmx150mm & that of cylinder was 150mmx300mm.The fibered concrete specimens in each category contains glass fiber at 0.5%,1%, 1.5% & 2% of each size 6mm & 12mm of fiber.

3.2 MATERIALS USED:

Different materials used in this investigation are

- 53 Grade Ordinary Portland cement
- Fine Aggregate
- Coarse Aggregate
- Water
- Alkali resistance glass fiber (ARGF)

3.1.1 CEMENT:

Cement used in the investigation was 53 Grade Ordinary Portland cement confirming to IS: 12269. Ordinary Portland cement is used for general constructions. The raw materials required for manufacture of Portland cement are calcareous materials, such as limestone or chalk and argillaceous materials such as shale or clay. The manufacture of cement consists of grinding the raw materials, mixing them intimately in certain proportions depending upon their purity and composition and burning them in a kiln at a temperature of about 1300^0C to 1500^0C at which temperature, the material sinters and partially fuses to form nodular shaped clinker. The clinker is cooled and ground to a fine powder with addition of about 2 to 3% of gypsum. The product formed by using the procedure is a "Portland cement".

3.1.1FINE AGGREGATE:

The fine aggregate conforming to Zone-II according to IS: 10262-2009 were used. The fine aggregate used was obtained from a nearby river source. Specific gravity of the sand is **2.47**. The sand obtained was sieved as per IS sieves (i.e. 4.75, 2.36, 1.18). Sand passing 4.75mm sieve were kept separately for use.

3.1.2 COARSE AGGREGATE:

The coarse aggregate was obtained from a local crushing unit having varying sizes. Those aggregates were sieved and 20mm retained aggregates were stacked separately for use. 20mm well graded aggregate according to IS: 383-1970 was used in this investigation. Specific gravity of the coarse aggregate is **2.65**.

4.1 TESTING OF CUBES AND CYLINDERS:

4.1.1 COMPRESSIVE STRENGTH TEST:

The cube specimens were tested on compression testing machine of capacity 3000kN. The bearing surface of the machine was wiped off clean and any loose sand or other material removed from the surface of the specimen. The specimen was placed in the machine in such a manner that the load was applied to opposite sides of the cubes as caste that is, not top and bottom. The axis of the specimen was carefully aligned at the center of the loading frame. The load applied was increased continuously at a constant rate of 5 KN/s until the resistance of the specimen to the increasing load breaks down and no longer sustained. Then maximum load applied on the specimen was recorded. The details of compressive strength results for M20 grade of all batches without and with AR Glass Fiber were compared. The figure 4.8 shows testing of cubes under direct compression.

Figure 4.1 Compressive Strength Test Of Cubes

4.1.2 Split Tensile Strength Test:

The cylinder specimens were tested on compression testing machine of capacity 3000 tons. The bearing surface of the machine was wiped off clean in case of cylindrical specimen the test was carried out by placing the specimen horizontally between the loading surfaces of the compression testing machine for split tensile strength and the axis of the specimen was carefully aligned at the centre of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to

the increasing load breaks down and no longer can be sustained. The maximum load applied on the specimen was noted.
The split Tensile Strength is obtained as
$2P/(\pi * LD)$ ………………………. (4.1)
Where,
P is the max load carried by the cylinder
L is the length of the cylinder
D is the diameter of cylinder

Figure 4.2 Testing Of Cylinder For Split Tensile Strength Test

5. TESTS AND RESULTS ON CONCRETE:

5.1 COMPRESSIVE STRENGTH RESULTS

The compressive strength values of M20 grade of concrete with and without ARGF are shown in table 5.5.

TABLE 5.2 Compressive Strength Values For 6mm ARGF

Sample No	% Fibre Volume	Compressive Strength (MPa) 28 days	Average Compressive Strength (MPa) 28 days
1	Conventional concrete	26.84	27.14
2		27.88	
3		27.70	
1	0.5% of ARGF	31.56	33.92
2		34.38	
3		35.83	
1	1.0% of ARGF	28.54	28.18
2		27.13	
3		28.88	
1	1.5% of ARGF	26.36	26.22
2		25.52	
3		26.78	
1	2.0% of ARGF	19.46	20.63
2		19.80	
3		22.62	

Table 5.2 Compressive Strength Values For 12mm Argf

Sample No	% Fibre Volume	Compressive Strength (MPa) 28 days	Average Compressive Strength (MPa) 28 days
1	Conventional concrete	26.84	27.14
2		27.88	
3		27.70	
1	0.5% of ARGF	29.80	29.70
2		28.52	
3		30.79	
1	1.0% of ARGF	27.61	27.74
2		26.92	
3		28.70	
1	1.5% of ARGF	24.58	24.13
2		24.10	
3		23.40	
1	2.0% of ARGF	20.81	21.00
2		21.29	
3		20.90	

5.2 DISCUSSION

Compressive strength values were obtained by dividing the loads the cubes can sustain by the area of cubes (15cmx15cm).From the table it is evident that compressive strength of specimen increase by 41% & 26% in 0.5%ARGF of 6mm &12mm compared to the conventional concrete (0% ARGF) specimen. After 0.5% of ARGF decrease in compressive strength is 19.4%, 24.2%, 54.1% for 1%, 1.5% & 2% respectively of 6mm and 10%, 12%, & 14% for 1%, 1.5% & 2% respectively for M_{20} grade of concrete. Among them the compressive is higher for the 6 mm.

It is evident that for M_{20} grade of concrete the maximum compressive strength is observed for 0.5% of ARGF. The values obtained showed that there is continuous decrease in Compressive strength with increase in percentage of glass fibre content for each mix of concrete. The comparison of actual f_{ck} obtained is as shown in figure 5.6

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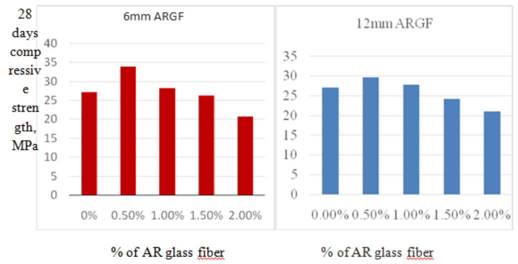

Figure 5.5 Comparison of F_{ck}

5.3 SPLIT TENSILE STRENGTH TEST RESULTS

The Split tensile strength values of M20 grade of concrete with & Without ARGF are shown in table 5.3

Table 5.3 SPLIT TENSILE STRENGTH VALUE FOR 6mm ARGF

Sample No	% Fibre Volume	Split Tensile Strength (MPa) 28 days	Average Split Tensile Strength (MPa) 28 days
1	Conventional concrete	2.65	2.47
2		2.44	
3		2.34	
1	0.5% of ARGF	3.43	3.50
2		3.58	
3		3.51	
1	1.0% of ARGF	2.88	2.95
2		3.05	
3		2.92	
1	1.5% of ARGF	2.89	2.22
2		1.62	
3		2.65	
1	2.0% of ARGF	1.70	1.73
2		1.63	
3		1.88	

Table 5.4 SPLIT TENSILE STRENGTH VALUE FOR 12mm ARGF

Sample No	% Fibre Volume	Split Tensile Strength (MPa) 28 days	Average Split Tensile Strength (MPa) 28 days
1	Conventional concrete	2.65	2.47
2		2.44	
3		2.34	
1	0.5% of ARGF	2.86	3.12
2		3.39	
3		3.11	
1	1.0% of ARGF	2.49	2.52
2		2.55	
3		2.52	
1	1.5% of ARGF	2.37	2.48
2		2.62	
3		2.47	
1	2.0% of ARGF	2.13	1.95
2		1.82	
3		1.91	

5.3.4 Discussion

The results from Split tensile strength test showed that the values are increasing with increase in percentage of ARGF content up to 0.5%. After that the split tensile strength is started to decreasing for 1%, 1.5% & 2% content of ARGF for both size of fiber i.e. 6mm & 12mm. For M_{20} grade the decrement is 24.20%, 40.05% and 73.75% for 1%, 1.5%,and 2% of ARGF content.

After comparing the values with compressive strength values it is observed that the percentage decrease in strength is more for split tensile test than compressive strength test. The comparison of actual fst values is as shown in figure 5.7

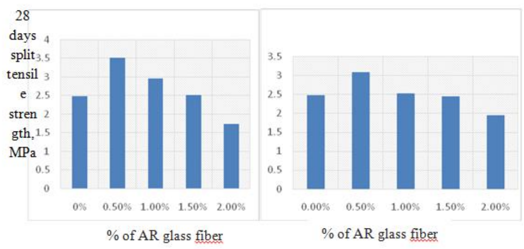

Figure 5.6 Comparison Of F_{ST}

6. Conclusion:

1. Compressive strength of the cubes and cylinders are increasing after adding of the ar glass fibre up to 0.5% compare to the conventional concrete. Further adding of the fibre lead to decrease the strength of the specimens.
2. Split tensile strength of the cubes and cylinder are also increasing after adding of the ar glass fibre up to 0.5% compare to the conventional concrete. And further adding of the fibre lead to decrease the split tensile strength of the specimen.
3. Among 6 mm & 12 mm of ar glass fibre, 6mm fibre gives more compressive strength and tensile strength as compare to the 12mm fibre.