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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF AR GLASS FIBER REINFORCED CONCRETE

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Abstract
The plain cement concrete have brittle in nature and low tensile strength. So placing of reinforcement bars to plain concrete to attain the tensile strength. Since AR glass Fiber is easily available material. Due to the AR Glass Fibre Reinforced Concrete the AR GlassFiber is easily surrounded to the cementitious medium. In this project trial test for concrete with AR glass fiber and without AR glass fiber are conducted to show the difference in compressive strength and split tensile strength by using concrete cubes and concrete cylinders. The different types of proportions have been taken for the casting of concretecubes and cylinders with different size of AR glass fiber strands used (6mm and 12mm) with proportions of 0.5%,0.75% and 1% compare the strength results of 28 days so that the highest strength of AR Glass Fiber Reinforced Concrete was obtained at 0.75%. Various application of AR GFRC as shown in the project, the experimental test result comparison with other type presented, finally indicate the tremendous potential of AR GFRC as an alternative construction material.

Key words: Concrete, Strength Properties, Fibers, Durability

1. Introduction:

Concrete is the most widely used man made construction material in civil engineering world. Due to specialty of being cast in any desirable shape, it has replaced the old construction techniques of stone and brick masonry. However, plain concrete possesses very low tensile strength, limited ductility and little resistance to cracking.The relatively low tensile strength of concrete is normally considered an unavoidable deficiency of the material. This deficiency has been eliminated by applying reinforcing and pre-stressing techniques. Throughout the development of reinforced concrete, however, the basic limitation of low tensile strength remains to be overcome.

This study presents a study on the strength of AR glass fiber reinforced concrete. Theparameters of investigation included compressive, flexural and split tensile strength in the concrete

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specimens. Specimens of cube mould 150x150 mm and cylinders of 150x300 mm for split tensile study.AR Glass Fibre Concrete with the ratio of (0.5% to 1.0%) by volume of fraction for M20 grades of concrete. The strength of AR glass fiber concrete specimens was compared with that of plain concrete.

Glass fiber reinforced concrete (GFRC) is a material that set ups a significant contribution for the economy, technologies of the construction industry worldwide is about from 40 years. GFRC is one of the most manifold building materials available to the architects and engineers. Compared to traditional concrete, it has complex characters because of its special structure. Many types of parameters such as water– cement ratio, porosity, composite density, inter filler content, fiber content, orientation and length, type of cure influence properties and behavior of GFRC as well as accuracy of production method

2. Literature Review:

Durability and Physical Properties of Glass Fiber Reinforced Concrete Subjected To Elevated Temperatures K. B Sankeerthan Reddy, J.S.R Prasad, Venu Malagavelli (11th September 2019) , From the experimental study, it is clear that the addition of fibers to the conventional concrete has enhanced the compressive, flexural, tensile properties of the concrete to great extent. Fibers in the concrete could induce tensile character to the concrete and would clog the spaces present in the concrete to increase the strength and also it prevents the corrosion of steel by blocking the small water pores. It could also be stated from the experiment that, addition of fibers to greater extent say for about greater than 2% would reduce the workability of the concrete. When these cubes of concrete having varied percentages of fiber content was exposed to high temperatures, they acted differently depending on the amount of fibers present in them. Investigation on Impact Strength of Fiber Reinforced Concrete Subjected To Elevated Temperature Alwyn Varghese, Anand. N, Prince Arulraj G (October 2020),The impact resistance of plain concrete and various fiber reinforced concretes of different grades with and without heat exposure are investigated. Based on the observations made from the investigation, the following results concluded.The addition of fiber enhanced the impact strength of concrete. The physical properties of fibers affect the impact resistance. The highest impact resistance is observed for concrete with CF. At elevated temperature all the specimens showed negligible variations in impact resistance due to the loss in bond with concrete, i.e. Specimen subjected to 90 minutes duration of heating. All the grades of concrete exhibited a similar trend in impact resistance for all the duration of heating. AF showed a drastic reduction in impact resistance

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with increase in temperature. Experimental Study on Behaviour of Steel Fiber Reinforced Concrete Prasad Karunakaran.R , Jegidha.K.J (October 2021), Addition of steel fibres to concrete increases the compressive strength of concrete marginally. The addition of steel fibres increases the tensile properties of concrete and improves resistance to cracking. Addition of steel fiber increase the flexural strength. Increase the volume of fraction of fiber and get good strength.

An experimental study on glass fibre reinforced concrete by r.A.Leema Rose (14^{th} apr 2016), ased on experimental investigation addition of Glass Fibre in plain concrete increases the strength and durability characteristics. Initially addition of GlassFibre in the plain concrete the strength characterstics like compressive, flexural and split tensile strength is gradually increased.Finally certain percentaddition of Glass Fibre attain that gradually decrease in strength. Maximum compressive, flexural and split tensile strength is attaining in 1.0% addition of Glass Fibre. So adding Glass Fibre upto 1.0% only not exceeds the limit. The durability characteristics gradually increased based on the addition of Glass Fibre. A Study On Fibre Reinforced Concrete By Dr.S.Mageswari, The study indicates the average experimental test results of impact failure energy of fibre reinforced concrete. Hence it enables researchers to present thenecessary impact strength. Therefore the hybrid reinforced concrete can also be used in hydraulic structures, airport runway pavements, industrial flooring,bridges , military building and railway traversers. It also plays an important role in place where the impact loads are heavier and therefore these types of concrete are in great demand in the construction. Furthermore, the impact resistance are also increased against the first visible crack, this means that theenergy absorption capacity in concrete with fibres in increased stage.

3. Methodology:

Compression test is most important test conducted on hardened concrete, partially because itis an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitively related to its compressive strength, the compression test is carried out on cube specimen of size 15x15x15 cm.

Standard concrete cube of 150x150x150 mm size were cast and test on 28 days. Addition ofAR glass fiber 0.5% to 1.0 % by the volume of content was tried in the control mix and the compressive strength of the adjusted mix proportions was studied and compared with the ordinary cement concrete cube of 150 x 150x150 mm size for the result of twenty eight days test.

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4. Materials:

4.1Cement:

A **cement** is a binder a substance used for construction that sets hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel produces concrete Concrete is the most widely used material in existence and is behind only water as the planet's most- consumed resource

The ordinary Portland cement was classified in to 3 grades, namely 33 grades, 43 grades, 53 grades depending upon the strength of the cement at 28 days when tested as per IS 4031 – 1988. If 28 days strength is not less than 53 N/mm^2, it is called 53 grade of cement. It is proposed to study the properties of high strength concrete of grade M20. Adopting 53 grade of cement for the study.

4.2Fine Aggregate:

In the Fine Aggregates**,** the grain-size lies between 4.75 mm and 0.15 mm. In other words, these pass-through from sieve with the mesh size of 4.75 mm and are retainedon a sieve of 0.15 mesh size. Sand is the most universally available natural Fine Aggregate. Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed Stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete.

The concrete or mortar mixture can be made more durable, stronger and cheaper if you made the selection of fine aggregate on basis of grading zone, particle shape and surface texture, abrasion and skid resistance and absorption and surface moisture.

4.3 Coarse Aggregate:

Coarse aggregate of size 20mm has been selected for the study. The physical properties will be tested as per IS 2386 (Part 1)-1963. The fineness modulus of sand is 5.94 with specific gravity around 2.72. Coarse-grained aggregates will not pass through a sieve with 4.75 mm openings Those particles that are predominantly retained on the 4.75 mm sieve and will pass through 3-inch screen, are called coarse aggregate**.** The coarser the aggregate, the more economical the mix. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements. Using aggregates larger than the maximum size of coarse aggregates permitted can result in interlock and form arches or obstructions within a concrete

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form. That allows the area below to become a void, or at best, to become filled with finer particles of sand and cement only and results in a weakened area.

4.4 Water:

Portable tap water available in the laboratory with pH value of 7.0 and conforming to the requirements of IS 456-2000 is used for making concrete and curing the specimen.

5. Concrete Testing

5.1 Test on Fresh Concrete

That property of freshly mixed concrete, plaster, or mortar which determines the ease and homogeneity with which it can be mixed, applied, compacted, spread, or finished; place ability. Workability of Fresh Concrete can be found by Slump Test and compaction factor test.

5.2 Tests on Hardened Concrete

5.2.1 Compressive Strength

It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other factor affecting the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of fully compacted concrete is inversely proportional to the water-cement ratio. The Compression Test is a laboratory test to determine the characteristic strength of the concrete but the making of test

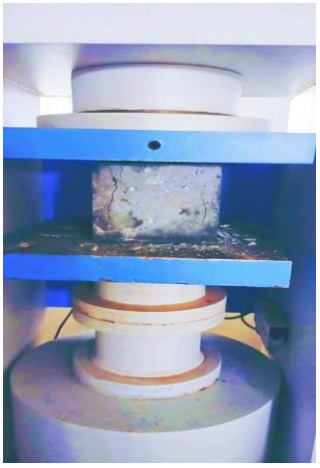

Figure 5.1 Compression strength testing

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TABLE 5.1 COMPRESSIVE STRENGTH VALUES FOR 6MM ARGF

Sample No	% Fibre Volume	Compressive Strength (MPa)28 days	Average Compressive Strength (MPa) 28 days
1	Conventional concrete	26.16	26.12
2		26.28	
3		25.92	
1	0.5% of ARGF	33.06	33.92
2		34.6	
3		34.1	
1	0.75% of ARGF	37.79	37.14
2		36.65	
3		37	
1	1% of ARGF	31.1	31.06
2		30.3	
3		31.8	

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	26.16	26.12
2		26.28	
3		25.92	
1	0.5% of ARGF	29.80	29.70
2		28.52	
3		30.79	
1	0.75% of ARGF	34.6	34.12
2		34.3	
3		33.45	
1	1% of ARGF	30.5	30.10
2		30.02	
3		29.8	

Compressive strength values were obtained by dividing the loads the cubes can sustain bythe

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area of cubes (15cmx15cm).From the table it is evident that compressive strength of specimen increase by 35% & 30% in 0.75% AR GFRC of 6mm &12mm compared to the conventional concrete (0% AR GFRC) specimen. After 0.75% of AR GFRC decrease in compressive strength is 16.4% for 1% of 6mm and 11.7% for 1% 0f 12mm for M20 grade of concrete. Among them the compressive is higher for the 6mm

5.2.2 Split Tensile Strength

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter.

The test is conducted in UTM machine as per IS518 (1959) and three specimens on dimensions 300mm length and 150mm diameter is tested as per the following procedure.

Figure 5.2 Split tensile strength testing

The maximum load at which the specimens fails was recorded and the appearance of the concrete for any unusual feature in the type of failure was noted and the split tensile strength are shown in the table.

Table 8.3 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	

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1	0.5% of ARGF	2.9	3.13
2		3.36	
3		3.13	
1	0.75% of ARGF	3.50	3.42
2		3.41	
3		3.36	
1	1% of ARGF	2.95	2.95
2		2.89	
3		2.97	

Table 8.4 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	2.97	2.98
2		2.96	
3		3.03	
1	0.75% of ARGF	3.28	3.24
2		3.12	
3		3.32	
1	1 1.0% of ARGF	2.84	2.84
2		2.79	
3		2.89	

The results from Split tensile strength test showed that the values are increasing with increasein percentage of AR GFRC content up to 0.75%. After that the split tensile strength is started to decreasing for 1% content of AR GFRC for both size of fiber i.e. 6mm & 12mm.

6. Conclusion:

Based on the results of this experimental investigation the following conclusions aredrawn:

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1. A detailed analysis of compressive strength and split tensile strength of concrete mixedwith AR glass fibers is done. The results are taken after 28 days of curing.
2. Among 6 mm & 12 mm of AR Glass fiber, 6mm AR glass fiber gives more compressive strength and split tensile strength as compare to the 12mm AR glass fiber.
3. The percentage increase of compressive strength of AR glass fiber concrete with 28 days compressive strength is 35%. The percentage increase of split tensile strength of AR glass fiber concrete with 28 days strength is 40%.
4. Based on the above observation it has been found that the maximum optimum value is obtained at **0.75% AR glass fiber content.** Further adding of the AR glass fiber lead to decrease the strength of the specimens.

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