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Study of Glass Fibre Reinforced Concrete

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Abstract: *Plain concrete possess very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks. Fibers when added in certain percentage in the concrete improve the strain properties well as crack resistance, ductility, as flexure strength and toughness. Mainly the studies and research in fiber reinforced concrete has been devoted to steel fibers. In recent times, glass fibers have also become available, which are free from corrosion problem associated with steel fibers. The present paper outlines the experimental investigation conducts on the use of glass fibers with structural concrete. CEM-FILL anti crack, high dispersion, alkali resistance glass fiber of diameter 14 micron, having an aspect ratio 857 was employed in percentages , varying from 0.33 to1 percentage by weight in concrete and the properties of this FRC (fiber reinforced concrete) like compressive strength, flexure strength, toughness, modulus of elasticity were studied.*
Keywords: *CEM-FILL, Ductility , Flexural Strength , Micro cracks , Tensile Strength*

I. Introduction

Concrete is a composite material composed mainly of water, aggregate, and cement. Often, additives and reinforcements (such as rebar) are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Concrete is the most widely used material in the world after water. For thousands of years, concrete has been used for construction of landmark monuments. Most of these structures have suffered the ravages of war as well as the aggressiveness of the environment, and yet have withstood the test of time, owing to the versatility and durability of concrete. Concrete technology has progressed rapidly, especially since the 1950s, thanks to the advancement of materials science, particularly, material characterization techniques. Today, concrete is studied from an interdisciplinary viewpoint, where chemistry and materials science occupy equally important positions as civil engineering. Another aspect that has led to this progress is the development of additives for concrete. Concrete has great compressive strength but has less tensile strength. Various works have been done to improve the flexural strength of concrete. Various forms of additives and add mixtures are used. Addition of glass fibers provides concrete resistance to tension.

1.1Fibre Reinforced Concrete

Fibre reinforced concrete is a concrete reinforced with fibres i.e. fibres are embedded during the mix of concrete. Properties such as compressive strength, flexural strength, and various other properties are improved. 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.

1.2 Glass Fibre Reinforced Concrete

Glass-fibre reinforced concrete (GRC) is a material made of a cementations matrix composed of cement, sand, water and admixtures, in which short length glass fibres are dispersed It has been widely used in the construction industry for non-structural elements, like façade panels, piping and channels. GRC offers many advantages, such as being lightweight, fire resistance, good appearance and strength. In this study trial tests for concrete with glass fibre and without glass fibre are conducted to indicate the differences in compressive strength and flexural strength by using cubes of varying sizes.

1.3 Glass Fiber

The glass fibers 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 Recron 3s Glass Fibre of 6mm and 12mm diameter are used.

II. Literature Review

- GFRC is a material made of cementations matrix composed of cement sand, water and add mixtures with short glass fibers. Light weight, fire resistance, good appearance and strength. "ZIRCONIA" is used in the manufacture of glass fiber to make it alkali resistance.
- Compressive strength is maximum, when 1.5% of glass fiber by weight are used at lower or higher % the strength decreases as more % of glass fiber affects cohesiveness between particle of concrete which reduces comp. strength, flexural strength and tensile strength.
- For M60 mix a percentage of 2% give flexure strength of 6.15 Mpa which is 10% more than obtained at 1.5%.
- GFRC should not be mixed more than one minute in concrete otherwise it will break into tiny pieces and can't be worked with.
- Crimped fibers result in slightly higher slump values when compared with straight and hooked fibers.
- Glass fiber reduces bleeding which in turn improves surface integrity of concrete, homogeneity and reduces probability of cracks occurring where there is some restraint to settlement.
- Improvement in the resistance of concrete to the attack of acids.
- GFRC improves cost and provide easy outlet to dispose the glass as environmental waste from industry.
- Due to acid resisting property, it can be used for blast resisting structures, dams, hydraulic structures.

III. Methodology

3.1. Mix Design Of Conventional Concrete

The Design mix of M20 was prepared using IS code

3.2. Batching Up Of Materials

Appropriate quantity of materials were calculated by volume and mixed in following proportions:

Volume of cement = 09.20 kg
Volume of coarse aggregates = 23.66 kg
Volume of fine aggregates = 29.87 kg
Volume of water = 03.68 kg

The materials were mixed by hand mixing process and the workability of the mix was checked simultaneously by performing various workability tests such as Slump cone test and Compaction factor tests so as to ensure proper compaction, avoid bleeding of concrete and segregation of aggregate.

SLUMP CONE TEST: The test was performed on the concrete mix to guess its workability.

COMPACTION FACTOR TEST: As the slump is not the true guide for workability, so compaction factor test was also performed.

3.3. Casting Of Beams, Cubes And Cylinder

A total of three beams, 1 cylinder and three cubes were casted for conventional Concrete.

Dimension of beam= 50cmx10cmx10cm
Dimension of cylinder; r=10cm , h=15cm
Dimension of cube= 15cmx15cmx15cm

The molds were filled with concrete in three layers and each layer was tamed uniformly with tamping rod to prevent the formation of voids and provide better compaction.

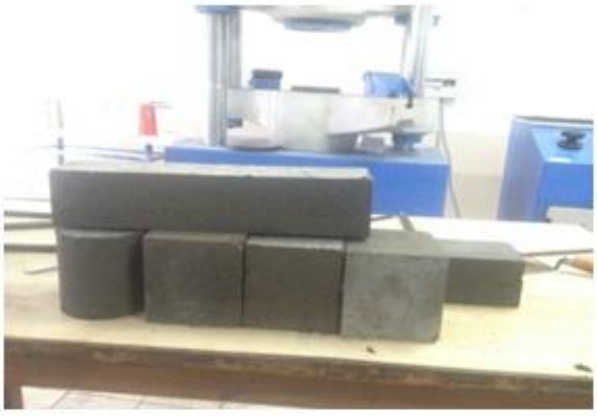

Fig. 1 – Beams, Cubes and a cylinder made up of conventional concrete.

3.4. Tests Performed On Conventional Concrete

COMPRESSION TEST: This test was performed on the cubes with the help of compression testing machine, and the compressive strength of the concrete was calculated. FOUR POINT LOADING FLEXURE TEST: This test was performed using flexure testing machine, so as to calculate the flexure strength of the beam, under 4 point loading.

3.5. Batching Up Of Materials For Glass Fibre Reinforced Concrete

The glass fibre "Recron 3s" was ordered from a supplier in Delhi, and the rest of material was assembles in the similar manner as for conventional concrete. The only difference was that the glass fibre was poured in the mixer one or two minutes before the machine was stopped. In this case the material was mixed using Concrete mixer. The aggregates, sand, cement, water was poured into the machine and it was run for about 5-8 minutes followed by the addition of glass fibre The Glass fibre before adding to the concrete was soaked in the water for minutes so that it doesn't break during mixing.

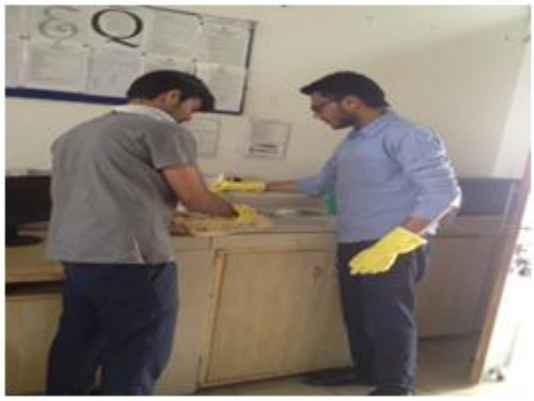

Fig-2 Handling and mixing of glass fibre.

IV. Results

4.1.Effect Of Glass Fibre On Workabilty Of GFRC

The workability of concrete of M20 was estimated in terms of compaction factor for addition of 0.03% glass fibre by weight of concrete. It was observed that the addition of glass fibre, the compaction factor of 0.91 was achieved.

Compaction Factor = Weight of partially compacted concrete

Weight of completely compacted concrete

4.2.Compressive Strength Of Ordinary Concrete And Glass Fibre Concrete Mixes

TABLE1 gives the compressive strength values of ordinary concrete and glass fibre reinforced concrete mixes and the value for M20 grade is 24.37 – 28.53 N/mm2for 28 days.

4.3.Flexural Strength Of Ordinary Concrete And Glass Fibre Concrete Mixes

TABLE1 gives the flexural strength values of ordinary concrete and glass fibre reinforced concrete mixes and the value for M20 grade is 2.98 – 3.43 N/mm2 for 28 days.

Table 1- Compressive and Flexural Strength of M20 Grade of Concrete.

Grade of concrete	No. of days	Compressive Strength (N/mm^2)		Flexural Strength (N/mm^2)	
		Without GF	With GF	Without GF	With GF
M20	28	24.37	28.53	2.98	3.43

IV. Conclusion

1. The modulus of elasticity of glass fibre reinforced concrete is increases 4.14% compared with conventional reinforced concrete.
2. The percentage increase of compressive strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed 37%.
3. The percentage increase of flexure strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed 5.19%.

4. Addition of glass fibre improves the toughness, flexural strength, ductility as well as compressive strength of concrete.
5. A very small volume of glass fibre is required upto 0.33 % of weight of cement content. Further addition may decrease the strength of concrete.

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