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Glass Fiber Reinforced Concrete & Its Properties

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Abstract:

Glass fiber reinforced concrete (GFRC) is a recent introduction in the field of civil engineering. So, it has been extensively used in many countries since its introduction two decades ago. This product has advantage of being light weight and thereby reducing the overall cost of construction, ultimately bringing economy in construction. Steel reinforcement corrosion and structural deterioration in reinforced concrete structures are common and prompted many researchers to seek alternative materials and rehabilitation techniques. So, researchers all over the world are attempting to develop high performance concrete using glass fibers and other admixtures in the concrete up to certain extent. In the view of global sustainable scenario, it is imperative that fibers like glass, carbon, aramid and poly-propylene provide very wide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. The present work is only an accumulation of information about GFRC and the research work which is already carried out by other researchers.

Introduction

Concrete is the most widely used construction material which has several desirable properties like high compressive strength, stiffness and durability under normal usual environmental factors. While at the same time concrete found to be brittle and weak in tension. It is well known that concrete mixed with other material was applied for resistance purpose.

Steel rebar has historically been used as an effective and cost efficient concrete reinforcement. While when the concrete is not subjected to chloride ion attack, steel reinforcement can last for decades without exhibiting any visible signs of deterioration.

Glass fiber reinforced concrete (GRC) is a composite material consisting of a mortar of hydraulic Portland cement and fine aggregate reinforced with alkali resistant glass fibers. The material properties, component design and method of manufacture of GRC products are interrelated with each other and it depend upon wide range of variables. These include method of manufacture, mix formulation, fiber product type, length, orientation and admixture used.

1.1 Types and properties of glass fibers

Glass fibers are available in continuous or chopped lengths. Glass fibers have large tensile strength and elastic modulus but have brittle stress-strain characteristics and low creep at room temperature. Glass fibers are usually are usually round and straight with diameters from 0.005 mm to 0.015 mm. They can be also bonded together to produce the bundle of glass fibers with diameter up to 1.3 mm.

1.2 Materials and methods

Cement: Ordinary Portland cement (OPC) of 53 grade confirming to IS: 8112 can be used. The cement to be used should be tested for various proportions as per IS: 4031-1988.

Water: The coarse aggregate to be chosen for GFRC should be typically angular in shape, well graded and smaller in maximum size that suited for conventional concrete.

Coarse aggregate & Fine aggregate: Coarse aggregate of around 20 mm size should be suitable for GFRC. The specific gravity fineness modulus should be noted. River sand can be used as fine aggregate. Aggregates sizes and properties should be in confirmation with IS 383:1970.

1. REVIEW OF LITERATURE

Concrete is the most widely used construction material and has several desirable properties like high compressive strength, stiffness and durability under usual environmental factors. Normally reinforcement consists of continuous deformed steel bars or pre-stressing tendons [2]. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementitious material, aggregate and water by adding some special ingredients. Therefore concrete can be considered as a suitable material for a wide range of application.

The experimental work was carried out by hand layup method [7], for that GFRP sheets were used, like E-class glass continuous filament mat and woven roving mat. From the experimental study on reinforced concrete beams it was found that cost of woven roving wrap was more as compared to single mat and double mat wrap but load carrying capacity also increased as compared single mat and double mat wrap. While it was also found that retrofitting was always affordable to strengthen the structure than replacement.

Glass fiber reinforced polymer (GFRP) has a very important role to play as reinforcement in concrete structures which is exposed to harsh environment conditions where traditional steel reinforcement could corrode [5]. It was found that the unique physical properties of GFRP that made it suitable for applications where conventional steel would be unsuitable.

The experimental work [8] dealt with the use of glass fiber in concrete which was obtained from the glass industry as a waste product. It was found that the compressive strength of concrete did not increase much but the flexural strength showed almost 30% increase in strength. The slump value found to be decreased with increase in fiber content. It was found that the use of fiber glass in concrete not only improved the properties of concrete but also small cost cutting.

With the Glass fiber reinforced concrete [6], building rehabilitation, more than its technique rehabilitation, either thermal and / or acoustic isolation, is also able to include a significant improvement in the architectural point of view of the intervention. GFRC found to be a suitable material in rehabilitation. It also found to be very economic when applied architectural items.

The experimental investigation was carried out on the alkali resistant glass fibers [1] to study the effect on compressive, tensile strength, split tensile and flexural strength on M20, M30, M40 and M50 grades of concrete. It was observed that percentage increase of compressive strength of various concrete grades of glass fiber concrete mixes compared with 28 days compressive strength observed from 20 to 25%. Also reduction in bleeding observed by addition of glass fibers in the glass fiber concrete mixes.

2. RESULTS AND COMPARISON

The comparison is done for adding varying amount of glass fibers, plain cement concrete with zero percent fiber with the same material. The results of the compressive strength, flexural strength and split tensile strength are as presented in the following table.

Table 1: Comparison of Compressive strength

Author	types of glass fiber	grade of concrete	no of days	compressive strength	
				with gf (MPa)	wiht out gf (MPa)
Yogesh murthy, et al	waste glass fiber (as replacement of aggregate)	M30	28	38.22 (0.5 %)	38
Chandramouli K, et al	AR glass fiber(as addition)	M30	28	48.56 (0.03 %)	41.5

Table 2: Comparison of Flexural strength

Author	types of glass fiber	grade of concrete	no of days	Flexural strength	
				with gf (MPa)	wiht out gf (MPa)
Yogesh murthy, et al	waste glass fiber (as replacement of aggregate)	M30	28	4.5 (0.5 %)	4.1
Chandramouli K, et al	AR glass fiber(as addition)	M30	28	4.78 (0.03 %)	4.12

Table 3: Comparison of Compressive strength & split tensile strength

Author	types of glass fiber	grade of concrete	no of days	compressive strength		Split tensile strength	
				with gf (MPa)	wihtout gf (MPa)	with gf (MPa)	wihtout gf (MPa)
kavita S Kene, et al	AR glass fiber (as addition % by weight of cement)	M20	28	35(0.5 %)	32	2.6 (0.5 %)	2.1
Chandramouli K, et al	AR glass fiber (as addi	M20	28	42.46 (0.03 %)	36.6	4.2 (0.03%)	3.62

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CONCLUSION

From the above results and comparison it can be stated that the alkali resistant glass fibers (Cem-FIL anti-Crack HD) shown good results as compared to other glass fibers. Compressive strength, flexural strength and split tensile strength for these AR glass fibers are more as compared to other glass fibers.

It can also be concluded that Flexural strength and split tensile strength shows almost 15 to 20% increase in strength as compared to 0% glass fibers. Also the percentage increase of compressive strength of glass fiber concrete mixes compared with 28 days compressive strength is found to be 20 to 25 %.

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