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Glass Fiber Reinforced Concrete as a Recent Construction Material

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Abstract – *After using glass fiber that improves the toughness, flexural strength, ductility as well as compressive strength of concrete. The usefulness of glass fiber reinforced concrete (GFRC) in various civil engineering applications is in disputable. To enhance durability of material, new generation of glass fibers used to improve the process. Glass fiber reinforced concrete change depending upon the quality of materials and the accuracy of the production methods.*
This study presents understanding strength of fiber ferroconcrete. Mechanical properties and sturdiness of fiber ferroconcrete.
Key Words*: Glass, Fiber, Reinforcement, Concrete, Synthetic Fiber***.**

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I. INTRODUCTION

Concrete occupies unique position among the fashionable construction materials, Concrete may be a material utilized in building construction, consisting of a tough, chemically inert particulate substance, referred to as an aggregate (usually made for various sorts of sand and gravel), that's bond by cement and water.
Materials are at the guts of the development industry.

They determine the standard of the top product and therefore the technology by which it's manufactured. Performance of engineering structures to an excellent extent depends on the characteristics of the materials used for his or her construction.
Innovation in construction is very linked with development of advanced construction materials and methods.

Concrete is that the most elementary element of for any quite construction work. regardless of what sort of building structure the concrete used should be sturdy and well compacted. the most reasons for compacting any sort of concrete are:

To ensure that the concrete used is fully contact with both the steel reinforcement and therefore the form work.

Concrete is that the most generally used construction material has several desirable properties like high compressive strength, stiffness and sturdiness under usual environmental factors.

At an equivalent time concrete is brittle and weak in tension. Plain concrete has two deficiencies, low lastingness and a coffee strain at fracture.

1.1 Fiber Reinforced Concrete:

Concrete containing cement, water, aggregate and discontinuous, uniformly dispersed or discrete fibers is named fiber ferroconcrete. It is a composite obtained by adding one type or a mix of fibers to the traditional concrete mix.

Fiber ferroconcrete (FRC) may be a new structural material which is gaining increasing importance. Addition of fiber reinforcement in discrete form improves many engineering properties of concrete.

Fibers are often in sort of steel fibers, glass fibers, natural fibers, synthetic fibers, etc.

1.2 How the Fibers Work?

GFRC uses alkali resistant glass fibers because the principle tensile-load carrying member. Typical GFRC mix uses a high loading of glass fibers to supply sufficient material cross-sectional area to resist the anticipated tensile loads. A loading of 5% fiber by weight of cementitious material can be used. So, for every 100 Kg of cementitious material in the GFRC mix, 5 Kg of glass fibers are added.

Finally, the orientation of the fibers is vital. If the more random the orientation will, then the more fibers are needed to resist the load. That's because on the average, only a little fraction of randomly oriented fibers is oriented within the right direction.

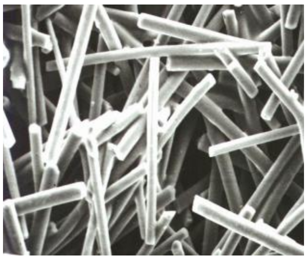


Fig.1 3D Fibers Fig.2 2D Fibers

1.3 Why we need Fiber Reinforced Concrete (FRC)?

Plain unreinforced concrete may be a brittle material with a coffee lastingness and low strain capacity .so once they are exposed to heavy load cracks appear and that they collapse. According to Griffith theory the concrete has low lastingness thanks to existence of cracks and that why the reinforced fiber helps in increasing the tensile strength of concrete by bridging the cracks with the fiber.

II. TYPES OF DIFFERENT FIBERS:

1. Steel Fiber
2. Glass Fiber
3. Synthetic Fibers
4. Polymer fibers
5. Acrylic polyesters
6. Metallic fibers
7. Carbon fibers
8. Natural Fiber


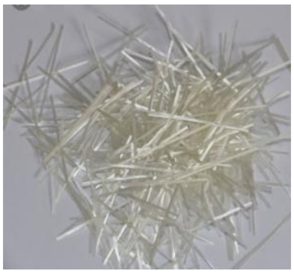

Fig.3. Steel Fibers Fig.4 Glass Fibers


Fig.5. Synthetic Fibers Fig.6 Polymer Fibers


Fig.7 Polystar Fibers Fig.8 Carbon Fibers

Fig.9 Natural Fibers

III. FACTORS AFFECTING FIBER REINFORCED CONCRETE.

Fiber ferroconcrete is that the material containing fibers within the cement matrix.
The factors are briefly discussed below:

3.1. Relative Fiber Matrix Stiffness:
The modulus of elasticity of matrix must be much less than that of fiber for efficient stress transfer. Low modulus of such as nylons and polypropylene greater degree of toughness and resistance.

3.2. Volume of Fibers:
The volume of fibers, increase approximately linearly, the lastingness and toughness of the composite. Use of upper percentage of fiber is probably going to cause segregation and harshness of concrete and mortar.

3.3. Aspect Ratio of the Fiber:
Another important factor which influences the properties and behavior of the composite is that the ratio of the fiber. It has been reported that up to ratio of 75, increase on the ratio increases the last word concrete linearly.

3.4. Workability and Compaction of Concrete:
Insufficient use of steel may cause decreases in workability.

3.5. Size of Coarse Aggregate:
Maximum size of the coarse aggregate can be of 10mm, to avoid appreciable reduction in strength of the composite.

3.6. Mixing:
Steel fiber content in quite |way over"> more than 2% by volume and ratio of more than 100 are difficult to combine.

IV. SELECTION OF FIBERS

Glass fiber ferroconcrete (GFRC) was first introduced to the building industry within the early 1970's within the uk. In our work, Cement-FIL anti-crack high dispersion Glass Fibers (GF) were used. Glass fiber ferroconcrete (GFRC) may be a material that's making a big contribution to the economics, technology and aesthetics of the development industry worldwide for over 40 years' is one among the foremost versatile building materials available to architects and engineers Compared to traditional concrete, it's complex properties due to its special structure. Different 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.

GFRC can be produced as thin as 6 mm weight is much less than traditional pre–cast concrete products. Progressing of 3D–printing technology with glass fiber reinforced ink can build a whole building and complex architecture forms with high reliability as well as the use of premix, spray–up, hybrid methods of GFRC.

Self–cleaning environmentally friendly panels for industrial construction are contributing to the GFRC both in terms of cost and recognition. The use of optical fiber within the High-Performance Concrete (HPC) class, being a category with extremely high mechanical performance, durability, workability and aesthetics, has gained momentum in recent years.

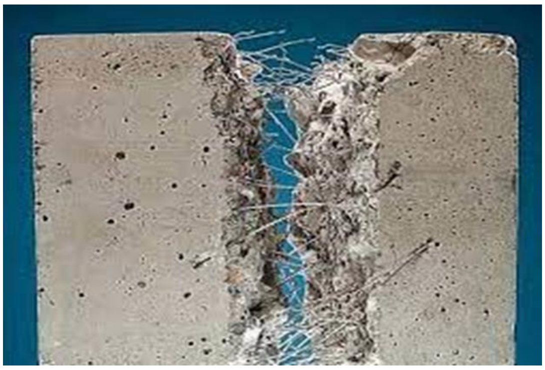

Fig.10: Glass Fiber Reinforced Concrete

V. MATERIALS USED FOR PREPARING GFRC

1. Ordinary hydraulic cement [OPC]: -

It includes OPC of 53grades. The dry powder or the wet slurry is then burnt during a rotary kiln at a temperature between 1400 degree C to 1500-degree C. the clinker obtained from the kiln is first cooled then passed on to ball mills where gypsum is added and it ground to the requisite fineness consistent with the category of product. The ingredients will mix with the proportion of two parts of calcareous materials to a minimum of one a neighborhood of argillaceous materials then crushed and ground in ball mills within a dry state or can be mixed in wet state.

2. Fine aggregates:

The fine aggregates are people who can easily undergo the IS Sieve 4.75 mm and will have finesse modulus 2.50-3.50 and silt contents should be restricted up to4%.

Sand is a crucial engineering material. In this work sand is used as a fine aggregate. Sand could also be a kind of silica (quartz) and will be of argillaceous, siliceous or calcareous according to its composition. Natural sands are formed from weathering of rocks (mainly quartzite) and are of various size or grades relying on the intensity of weathering. The sand grains should be of sharp angular or could also be rounded.

3 Coarse aggregates:

The coarse aggregates the aggregates which are retained on sieve of IS Sieve 4.75mm. It has to be hard, solid, thick, tough and clean. Coarse aggregates are an integral a part of many construction applications, sometimes used on their own, like a granular base placed under a slab or pavement, or as a component during a mix, like asphalt or concrete mixtures. Coarse aggregates are generally categorized as rock larger than a typical No. 4 sieve (3/16 inches) and fewer than 2 inches.

4.Water:

Water may be a crucial constituent of concrete; it should receive due attention in preparation and for control of concrete. Strength and other properties of concrete are developed as a results reaction of cement and water (hydration) and thus water plays a critical role. Quality of blending and curing water sometimes leads to distress and disintegration of concrete reducing the useful lifetime of the concrete structure. Water used or concrete mixture shouldn't contain substances which may have harmful effect on strength (i.e., on hydration process of cement) or durability of the concrete in commission.

5.Glass Fibers

There is one fiber that getting to "> we'll be going to use within the research work are: So, we are getting to use above materials for the research work. All folks know that cement may be a binding agent so we are using OPC of 53grade. Similarly, we are using angular coarse aggregate of two 0mm with the precise gravity of 2.65 and water absorption of 0.5%.

Fine aggregates are often named as very fine particles like the sand that we are using within the research work with the precise gravity of two .68 and water absorption of 1%.

6. Polymers

Polymers are utilized within the GFRC mix to supply toughness to the mixture and provides a curing effect to the mixture after hardening because of its high-water content.

7. Admixtures

Now every day altogether concrete construction admixtures is inevitable. within the GFRC also admixtures are used to a greater extent.

VI. MIXING PROCEDURE

1. The sand and cement are mixed dry then the water/admixture and polymer (if used) are added.
2. Generally, a two-speed slurry/fiber blender mixer is employed. With this type of mixer, the fast speed is supposed to form smooth creamy slurry.
3. This takes about one-two minutes. The mixer should be switched to slow speed and fiber within the type of chopped strand (minimum length13 mm) is added slowly.
4. The fiber is mixed into the combination for about 1 min. Once the combination is prepared, it's poured into the molds, which are vibrating employing a vibrating table.
5. the merchandise is left into the mold to line and is roofed with polythene sheet to stop moisture loss. the merchandise is demolded subsequent day. After demolding the products are cured under polythene sheets to take care of moist conditions for about 2 to 4 days.
6. Alternatively, a polymer curing compound are often used as described for the sprayed process. After mixing in fully pan mixer, the combination was cast in molds for every you look after fiber sufficient no of cubes and flexure beams were cast for testing at the ages of 28 days.

VII. CURING:

After molding, the specimens are stored on the site free from vibration under damp matting, sack or other similar material for 24 hours from the time of addition of water to the other ingredients. The temperature of place of storage was within the range of 220 c to 32o c.

After time of 24 hours cubes marked. After removing from the molds, cubes were stored in clean potable water at a temperature of 240 c to 300 c until they were transported to the testing laboratory.

In flexural test the beam specimen is placed in the machine in such a manner that the load is applied to the upper most surface as cast in the mold. All beams can be tested under two points in Universal testing machine of 60 tones capacity.

The load is applied at the rate of loading 10x10x50cm specimens. The load is increased until the specimen failed and therefore the failure load is recorded. The flexural strength is calculated by the given formula.

• Fb = PL/bd2
When 'a' is bigger than 20cms or Fb = 3Pa/bd2
When 'a' is a smaller amount than 20cms but greater than 17cms.

VIII. RESULTS & DISCUSSION

Grade Of Concrete	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregates (Kg)	Water (ltr)	W/C ratio	Glass Fibres
M 25	337.50	723.20	1135.00	186	0.48	0.025% by volume of concrete
M 30	415.5	662.00	1132.00	184	0.46	

Table 1. Quantities Of Materials Required Per 1 Cum Of Ordinary Concrete And Glass Fiber Concrete Mixes

CONCRETE MIX	COMPACTION FATOR	
	WIHOUT GF	WITH GF
M 25	0.965	0.970
M 30	0.930	0.910

Table 2. Values Of Compaction Factor For Different Concrete Mixes

Grade Of Concrete	Days Of Curing	Compressive Strength (N/mm²)		Flexural Strength (N/mm²)		Split tensile Strength (N/mm²)	
		WITHOUT GFRC	WITH GFRC	WITHOUT GFRC	WITH GFRC	WITHOUT GFRC	WITH GFRC
M25	28	30.15	39.50	14.22	18.65	3.15	4.12
M30	28	39.80	47.80	14.70	21.10	4.11	5.16

Table 3. Compressive, Flexural & Split Tensile Strength For Different Grades Of Concrete Mixes

IX. Properties Of Fiber Reinforced Concrete

a. Workability:
As the dosage of fiber increases then the workability reduced.

b. Compressive Strength:
The Steel mold of size 150 x 150 x 150 mm is well tightening and oiled thoroughly. They were allowed for curing during a curing tank for 28 days which they were tested in 200-tonnes electro hydraulic closed loop machine.

c. Flexural Strength:
The Steel mold of size 500 x 100 x 100 mm is well tightening and oiled thoroughly. They were allowed for curing during a curing tank for 28 days and that they were tested in universal testing machine.

d. Split Tensile Strength:
The 150mm diameter of cylindrical shape of specimen and 300 mm long is well tighten and oiled thoroughly and That can be allowed for curing in the curing tank for minimum 28days.
GFRC provides the design and feel of natural stone, architectural precast concrete, earthenware. wood or smooth panels. It allows the designer more freedom in shape, color and texture than any material in glass fiber reinforced concrete.

1.Naturally Friendly to the Environment
Glass fiber reinforced concrete includes a much lower environmental impact than conventional concrete, stone and other materials. Made with minerals: cement, aggregates, glass fibers and in some cases mineral pigments that is special polymers, GFRC is meant to be long lasting and earth friendly.

2. Disaster Resistant
Hurricanes, floods, fires and earthquakes are not any match for GFRC. Over the years it's proven itself both within the lab and within the world.

3. High strength
Compressive strength of M20 with optical fiber for 7 days and 28 days are 19.23N/mm2.

X. DIFFERENCE BETWEEN GFRC AND PRECAST CONCRETE:

Factor	**GFRC**	**Precast Concrete**
Elasticity	More elastic	Less elastic
Density	More dense	Less dense
Impact Strength	High impact strength	Low impact strength
Permeability	Low permeability	High permeability
Weight	Light weight	Considerably high
Environmentally friendly	Low impact on the environment	High impact on the environment
Durability	High durable	Moderately durable
Cost	Highly economical	Moderate

Table 4. Difference between GFRC and Precast Concrete:

XI. CONCLUSIONS

The efficient utilization of fibrous concrete involves improved static and dynamic properties like lastingness, energy absorbing characteristics, Impact strength and fatigue strength.
The optical fiber improves the toughness, flexural strength, ductility also as compressive strength of concrete.
GFRC is one among the foremost versatile building materials available to architects and engineers. It has contributed significantly to the economics, technology and aesthetics of the development industry.
It has been also observed that there is gradual increase in early strength for Compression and Flexural strength of Glass Fiber Reinforced Concrete as compared to Plain Concrete.
However, it's difficult to self–mix (requirement of special material). Its cost is above that of traditional concrete thanks to the fiberglass, addition of additives and acrylic co–polymer, but developing technology can substantially change this comparison.

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