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# Replacement of Steel Reinforcement with Glass Fiber Reinforcement

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***Abstract*:- Concrete plays a vital role as construction material in this world. But, there are certain limitations for use of concrete material like brittleness, poor tensile strength, less resistance to impact strength, fatigue, ductility, durability. Although it has high compressive strength, and weak in tension and is due to micro cracks developed in it. If fibers are added to concrete at certain percentage, will increase strain properties like toughness, cracks resistance, flexural strength, ductility. Most research in fiber reinforced concrete (FRC) had been devoted to steel fibers. But in recent period, glass fiber also became available, which are free from corrosion problem associated with steel fibers. So the glass fiber reinforced concrete (GFRC) started as per public satisfaction and demands. Scientific studies and tests on the GFRC showed that the physical and mechanical propertied change depending on the accuracy of production techniques and quality of materials. As the technology get developed day by day, it is expected that the infrastructure if of our country should also get advanced and complex freeform with low cost. GRFC can be used where a light, strong, fire resistance, weather resistance material is needed. For the purpose of design, casting of concrete with fiber glass is carried out. As the result is compared w.r.t. strength, ductility, economy etc.**

***Keywords: Crack resistance, flexural strength, compression test, split tensile test.***

## 1. INTRODUCTION

Concrete is one of the most commonly used concrete materials. Fiber reinforced concrete (FRC) is relatively a new construction material developed through extensive research and development work during the last two decades. Incorporation of fiber in concrete has found to improve several properties like tensile strength, cracking resistance, impact and wear resistance, ductility and fatigue resistance. Glass fiber–reinforced concrete is (GFRC) basically a concrete composition which is composed of material like cement, sand, water, and admixtures, in which short length discrete glass fibers are dispersed. Inclusion of these fibers in these composite results in improved tensile strength and impact strength of the material. Fiber orientation and fiber length are the mechanical properties of fiber glass. There are some types of glass fiber as; **A-glass** i.e. alkali glass which is made up of soda lime silicate. **C-glass** corrosive resistance made up of calcium borosilicate. And **AR-glass** Alkali resistance glass made up of zir conium silicates. At the beginning age of the GFRC development, one of the most considerable problems was the durability of the glass fiber, which becomes more brittle with time, due to the alkalinity of the cement mortar. After some research, significant improvement has been made, and presently, the problem is practically solved with the new types of alkali-resistant (AR resistance) glass fibers and with mortar additives that prevent the processes that lead to the embrittlement of GFRC**.**

## 2. MATERIALS AND METHOD

### *2 (A). Materials*

### *2.1. Binders*

Binders or binding agent are fine, granular materials that form a paste when water is added to them. This paste hardens and encapsulates aggregates and reinforcement steel. Immediately after water is added, cement paste begins to harden through a chemical process called hydration. Hydration takes place at different rates according to the different properties of the binders and admixtures used the water-to-cement ratio, and the environmental conditions under which the concrete is placed. The ways in which binders affect concrete, mortar and similar products can vary with the chemical and physical properties of the source materials, the constituent materials, the mix design, and, to a lesser extent, the variations in the cement manufacturing process.

### *2.2. Cement*

Ordinary Portland Cement (OPC) 53grade used and is according to IS 12269:2013. The physical properties are as-

| | |
|---|---|
| Fineness | 8% |
| Specific gravity | 3.16 |
| Normal consistency | 26% |

### *2.3. Fine Aggregate or Crush Sand*

Sand, which is locally available on river are used. The physical properties are as-

| | |
|---|---|
| Water Absorption | 0.8% |
| Specific Gravity | 2.4 |

### *2.4. Coarse Aggregate*

These are the crushed aggregate of maximum 20mm. The physical properties are as-

| | |
|---|---|
| Abrasion Value | 14.5% |
| Specific Gravity | 2.6 |
| Impact Value | 11.2% |
| Crushing Value | 12.42% |

### *2.5. Water*

The quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work.

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The water used for construction working should be clean and free from injuries quantity of oil, sugar, alkali, organic, acids, salt or any other substances that may be harmful to bricks, concrete or steel. Portable water is generally considered as satisfactory. The pH value of water should not be less than 6.

*2.6. Glass Fiber*

The glass fiber is good at thermal expansion. The have low coefficient of thermal expansion and high thermal conductivity. Glass fiber thread has high strength-to-weight ratio. These threads are two times stronger than the steel wire. Fiber glass evaporates heat more quickly than the asbestos or organic fibers. High dialectical strength and relatively low dialectical constants male GF fabrics excellent for electrical insulation purposes.

Fig. No.1. Glass Fiber

The physical properties are as-

| | |
|---|---|
| Modulus of Elasticity | 72Gpa |
| Specific Gravity | 2.68 |
| Density | 2780kg/m3 |
| Tensile Strength | 2000Mpa |
| Diameter | 14micron |
| Length | 12mm |
| Aspect ratio | 851.2 |
| Elongation breaks | 3.6% |

*2 (B). Mix Design*

As per IS 1026:2009 –Guideline for concrete mix design. These is the table for quantity of materials as per proportions for M40 as suggested in IS Code and the water cement ratio 0.4

| Materials | Quantity (kg/m3) | Proportions |
|---|---|---|
| Cement | 400 | 1 |
| Coarse Aggregate | 595 | 1.5 |
| Fine Aggregate | 1150 | 2.9 |
| Water | 160 | 0.4 |

Table No. 1. Mix Proportion

## 3. RESULTS AND ANALYSIS

*3.1. Compressive Strength Test*

The compression test is carried out on specimens like cube. The cube specimen is of 15x15x15cm size. These specimens were tested for compressive strength as per IS 516-1959 using a calibrated compression testing machine of 2000KN capacity. After placing the specimen into the machine the compression load is applied, and due to load the specimen fails and the point at which it is failed is recorded. The compression test of the specimen is calculated by formula-

$$F_c = \frac{P}{A} \text{ N/mm2}$$

Where,
P = Total compression load applied on the specimen.
A = total area of the specimen
$F_c$ = Compression Stress in N/mm2

| Age / Types Of Concrete | 7 days N/mm2 | 14 days N/mm2 | 28 days N/mm2 |
|---|---|---|---|
| Regular concrete | 22.3 | 31 | 38.3 |
| 0.33% GF | 23.3 | 30.5 | 40.3 |
| 0.67% GF | 25.3 | 34.6 | 40.7 |
| 1% GF | 28.5 | 34.8 | 44.3 |
| 1.33% GF | 27.3 | 35.6 | 43.7 |
| 1.67% GF | 28 | 35.6 | 44.2 |
| 2% GF | 29.2 | 35.8 | 43 |

Table No. 2. Compressive Strength Test Results.

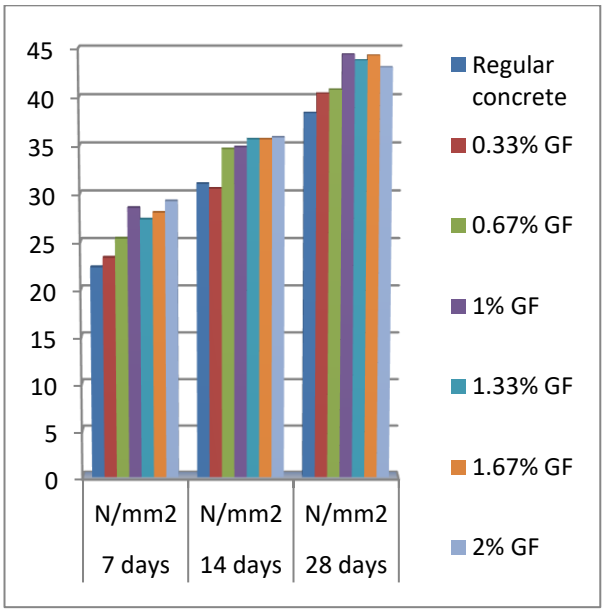


Chart No. 1. Analysis of Compressive Strength

*3.2. Flexural Strength Test*

Flexural strength is used to measure the tensile strength of concrete. It is measured by loading unreinforced beam of 100x100x500mm. 24hrs. after casting, the prism is demoulded and kept for curing in a tank for 7, 14, 28 days. The test is conducted as per IS 516-1959 using a calibrated flexural machine. The flexural strength of the specimen is calculated by formula-

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$$F_b = \frac{Pl}{bd2} \text{ N/mm2}$$

Where,
P = Load at which the specimen breaks.
L = Effective span in mm.
b = Breadth of the specimen in mm.
d = Depth of the specimen in mm.

| Age / Types Of Concrete | 7 days N/mm2 | 14 days N/mm2 | 28 days N/mm2 |
|---|---|---|---|
| Regular concrete | 5.4 | 5.92 | 6.27 |
| 0.33% GF | 5.8 | 6.02 | 6.6 |
| 0.67% GF | 5.8 | 6.2 | 6.68 |
| 1% GF | 5.3 | 5.6 | 6.8 |
| 1.33% GF | 4.7 | 5.3 | 5.68 |
| 1.67% GF | 4.4 | 4.8 | 5.45 |
| 2% GF | 4.1 | 4.4 | 4.9 |

Table No. 3. Flexural Strength Test Results.

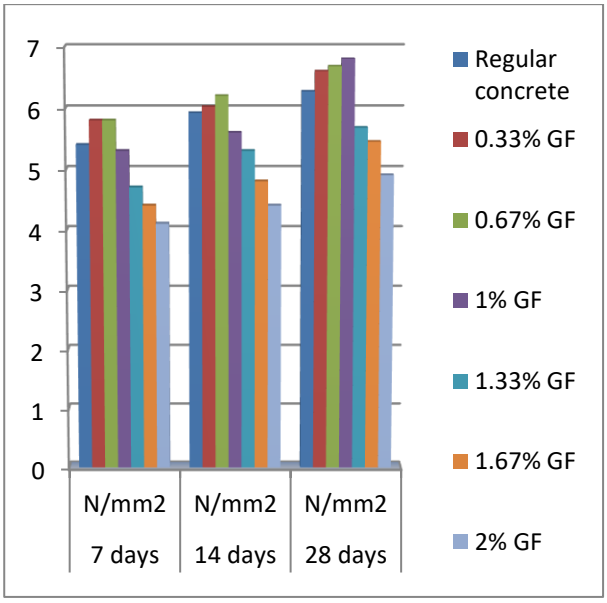


Chart No. 2. Analysis of Flexural Strength.

*3.3. Split Tensile Test*

The procedure split tensile test is almost same as of flexural test. The concrete specimen is casted in cylindrical mould as per IS 516-1959 and the test is conducted on Universal Testing Machine (UTM). The specimen is placed longitudinal in the machine, load is applied and the point, at which it is failed, is recorded. The Split tensile test on specimen is calculated as-

$$F_t = \frac{2p}{\pi dl} \text{ N/mm2}$$

Where,

P = Load at which the specimen breaks.
d = Length of the specimen
l = Diameter of specimen
$F_t$ = Tensile Strength.

| Age / Types Of Concrete | 7 days N/mm2 | 14 days N/mm2 | 28 days N/mm2 |
|---|---|---|---|
| Regular concrete | 4.7 | 5.26 | 6.36 |
| 0.33% GF | 4.87 | 5.6 | 6.6 |
| 0.67% GF | 4.92 | 6.6 | 7.32 |
| 1% GF | 5.09 | 6.2 | 6.97 |
| 1.33% GF | 4.8 | 5.59 | 6.01 |
| 1.67% GF | 3.9 | 4.7 | 5.25 |
| 2% GF | 3.1 | 3.88 | 4.8 |

Table No. 4. Split Strength Test Results.

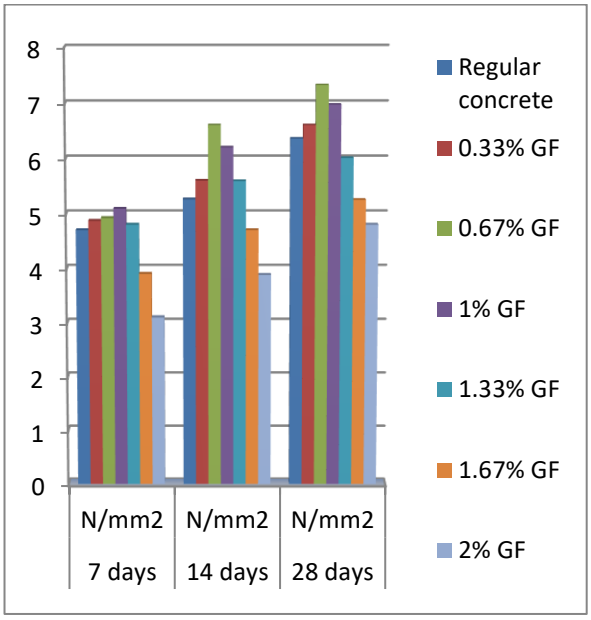


Chart No. 3. Analysis of Split Strength

## 4. CONCLUSION

As per the experiment conducted, addition of Glass fiber in plain concrete increases the strength, durability in the characteristics of the concrete.

Initially addition of Glass Fiber in the plain concrete the strength characteristics like compressive, flexural and split tensile strength is gradually increased. Finally certain percent addition of Glass Fiber attain that gradually decrease in strength.

Maximum compressive, flexural and split tensile strength is attaining in 1.0% addition of Glass Fiber. So adding Glass Fiber up to 1.0% only not exceeds the limit.

The durability characteristics gradually increased based on the addition of Glass Fiber.

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