# Study of Strength Properties of Glass Fibre Reinforced Concrete

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*Abstract*— Glass Fibre Reinforced concrete (GFRC) is a recent introduction in the field of concrete technology. It has been extensively used in over 100 countries since its introduction in 1980's. This product is covered by international standards and has been practiced all over the world. Glass Fibre Reinforced concrete (GFRC) has advantage of being light weight and thereby reducing the overall cost of construction there by bringing economy in construction. Glass Fibre Reinforced concrete (GFRC) derives its strength from a high dosage of Alkali resistant glass fibers and a high dosage of acrylic polymer. While compressive strength of Glass Fibre Reinforced concrete (GFRC) can be quite high due to low water to cement ratios and high cement contents, it is the very high flexural and tensile strengths that make it superior to ordinary concrete. While the structural properties of GFRC itself are superior to unreinforced concrete, properly designed steel reinforcing will significantly increase the strength of objects cast with either ordinary concrete or GFRC. This is important when dependable strength is required, such as with cantilever overhangs, and other critical members where visible cracks are not tolerable. GFRC does not replace reinforced concrete when true load carrying capacity is required. It's best used for complex, three dimensional shells where loads are light. While the weight savings due to reduced thickness is maintained, the effort of forming, mixing and casting are similar or the same In present investigation concrete with addition of glass fiber and various proportions is studied to find the optimum dosage of Glass fiber for concrete. The results of Glass fiber reinforced specimens with various dosages of glass fiber are compared with control specimens to study the behavior of glass fiber reinforced concrete properties.

***Key words:*** Glass Fibre Reinforced Concrete, GFRC

## I. Objectives of the Study

- To investigate the effect of addition of glass fiber on strength properties of concrete
- To find the optimum values of addition of glass fiber to concrete
- The present experiment is carried out to investigate strength properties of concrete mixes of M25 grade in which Glass Fibre is added along with Cement in the concrete mixture by percentage of weight of cement with variations of 0.25%, 0.5%, 0.75% and 1%

## II. Literature Review

1) Cement, when reinforced with glass fibre, produces precast elements much thinner— typically 10 mm— than would be possible with traditional steel-reinforced precast concrete, where 30mm or more concrete cover to the steel is essential as protection against corrosion. Thinner sections are also made possible by the low water: cement ratio of the material, the lack of coarse aggregate, and its low permeability. As a result, panels of equal strength and function of precast concrete can be produced with thinner sections and therefore less weight [1].
2) Special methods have been suggested to reduce the sensitivity to poor and non-uniform water curing. The addition of polymer latex has been reported to be effective in eliminating the adverse effects of lack of water curing. It has been suggested that for ARGRC, the addition of 5% polymer solids by volume, without any moist curing, may replace the recommended practice of seven days curing in a composite without the polymer [2].
3) The tests conducted on GFRC in laboratory have shown good resistance for fire, since the major use of GFRCs is for architectural building panels. In these buildings, fire resistance becomes an important factor in design [3].
4) When cement, mortar or concrete is splashed or otherwise brought into contact with window glass, etching occurs. This is because the alkali in cement attacks some of the silicates that are used in glass manufacture. The stock used in making glass fibres has better alkali resistance than window glass because zirconia is used as one of the constituents [4].

## III. Experimental Program

### A. Materials

Building Ordinary Portland cement (Ultra Tech Cement) of 53 grade confirming to IS: 12269 – 1987 was used. It was tested for its physical properties as per IS 4031 (part II) – 1988.The locally available river sand was used as fine aggregate in the present investigation. The sand was free from clayey matter, salt and organic impurities. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386 – 1963. The fine aggregate was conforming to standard specifications. Machine crashed angular granite metal of 20mm nominal size from the local source was used as coarse aggregate. It was free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with IS 2386 – 1963. .

### B. Specimen Details

The tests were done on Concrete cubes of 150mm x 150mm x 150mm for compressive strength, cylinders of 150mm dia and 300mm length for split tensile strength and beams of 100mmx100mmx500mm for flexural strengths. There were 5 series of specimens having glass fiber addition at 0%, 0.25%, 0.5%, 0.75% & 1%.

 

### *C. Testing Procedure*

The specimens have been tested for compressive, split tensile & flexural strengths as per IS 516(1959) for 7 and 28 day strengths.

Fig. 1: Testing Procedure

## IV. RESULTS AND DISCUSSION

### *A. Compressive Strength*

To study the effect of addition of AR Glass fiber to the concrete, cubical specimens were casted and tested. The results obtained for the specimens tested for compressive strength for 7 Days and 28 Days were reported in the tables. The comparison of compressive strength at 7 days and 28 days with specimens containing different percentages is shown in graphical format below

| Mix Designation | Percentage Addition | Average Compressive Strength ($N/mm^2$) – 7 Days | Average Compressive Strength ($N/mm^2$) – 28 Days |
|---|---|---|---|
| M1 | 0 | 21.04 | 36.07 |
| M2 | 0.25 | 29.04 | 42.07 |
| M3 | 0.5 | 25.19 | 38.96 |
| M4 | 0.75 | 24.44 | 36.74 |
| M5 | 1 | 24.15 | 34.37 |

Table 1: Compressive Strength

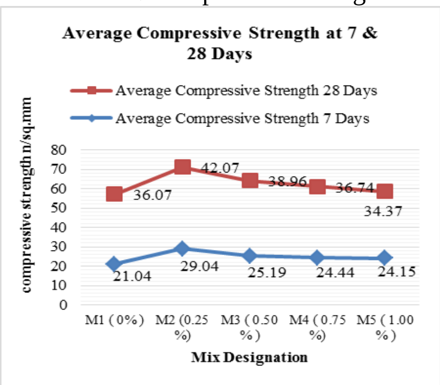


Fig. 2: Graph Compressive Strength

Fig. 3: Specimens tested for compressive strength for 7 Days and 28 Days

### *B. Split Tensile Strength*

To study the effect of addition of AR Glass fiber to the concrete cylinder specimens were casted and tested. The results obtained for the specimens tested for split tensile strength for 7 Days and 28 Days were reported in the tables. The comparison of split tensile at 7 days and 28 days with specimens containing different percentages is shown in graphical format below

| Mix Designation | Percentage Addition | Average Split Tensile Strength ($N/mm^2$) – 7 Days | Average Split Tensile Strength ($N/mm^2$) – 28 Days |
|---|---|---|---|
| M1 | 0 | 2.48 | 3.03 |
| M2 | 0.25 | 2.51 | 3.07 |
| M3 | 0.5 | 2.62 | 3.34 |
| M4 | 0.75 | 3.02 | 3.39 |
| M5 | 1 | 2.97 | 3.32 |

Table 2: Split Tensile Strength

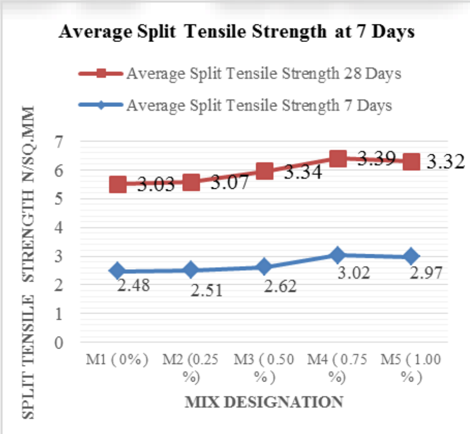


Fig. 4: Graph Split Tensile Strength

Fig. 5: Specimens tested for Split Tensile Strength for 7 Days and 28 Days

### C. Flexural Strength

To study the effect of addition of AR Glass fiber to the concrete beam specimens were casted and tested. The results obtained for the specimens tested for flexural strength for 7 Days and 28 Days were reported in the tables. The comparison of compressive strength at 7 days and 28 days with specimens containing different percentages is shown in graphical format below

| Mix Designation | Percentage Addition | Average Flexural Strength (N/mm$^2$) – 7 Days | Average Flexural Strength (N/mm$^2$) – 28 Days |
|---|---|---|---|
| M1 | 0 | 3.92 | 4.66 |
| M2 | 0.25 | 4.22 | 5.15 |
| M3 | 0.5 | 4.46 | 5.69 |
| M4 | 0.75 | 4.41 | 4.95 |
| M5 | 1 | 4.17 | 4.66 |

Table 3: Flexural Strength

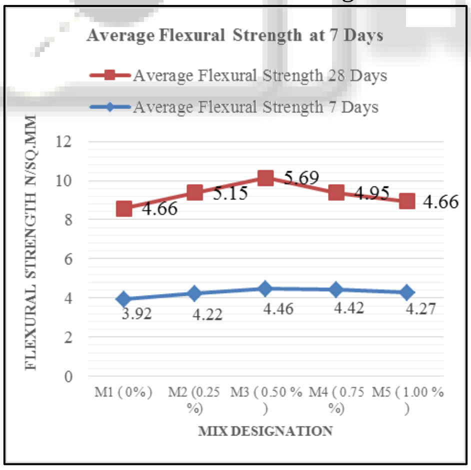


Fig. 6: Graph Flexural Strength

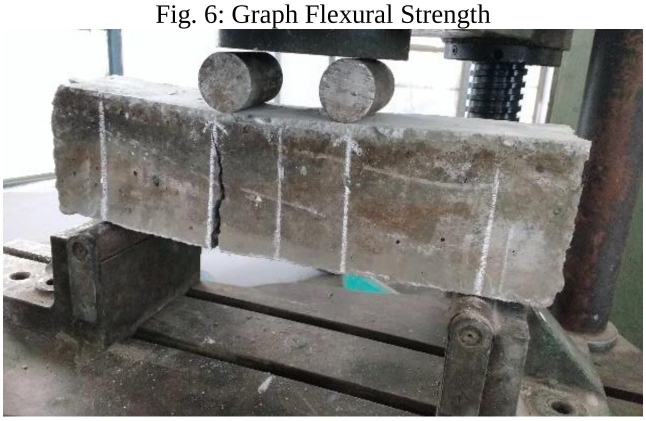

Fig. 7: Specimens tested for Flexural Strength for 7 Days and 28 Days

## V. Conclusions

1) The Compressive strength of the specimens tested have increased for an addition of Glass fiber at 0.25% and 0.5%, however the strength recorded showed a decrease when gone for higher addition of 0.75% and 1%. For mix containing 0.25% and 0.5% the compressive strength at 28 Days was increased by 16.66% and 8.01% when compared to the control mix.
2) The Split Tensile strength of the specimens tested have increased for an addition of Glass fiber at 0.5% and 0.75%, however the strength recorded showed a decrease when gone for higher addition of 1%. For mix containing 0.5% and 0.75% the compressive strength at 28 Days was increased by 10.23% and 11.88% when compared to the control mix.
3) The Flexural strength of the specimens tested have increased for an addition of Glass fiber at 0.25% and 0.5%, however the strength recorded showed a decrease when gone for higher addition of 0.75% and 1%. For mix containing 0.25% and 0.5% the compressive strength at 28 Days was increased by 10.53% and 22.11% when compared to the control mix.
4) The Compressive strength shall reach optimum when the fiber addition is at 0.25%. The Split tensile shall reach optimum when fiber addition is at 0.75%. The flexural strength shall reach optimum when fiber addition is at 0.5%.

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