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# Improving Properties of M30 Grade of Concrete by Adding Glass Fibers

**Manoj Kumar[1], Er. Shashi Sharma[2], Er. Vikram[3]**

[1]M.Tech Scholar, [2]Assistant Professor, [3]Head of Department
[1, 2, 3]Department of Civil Engineering, JCDMCOE Sirsa, Haryana, India

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**ABSTRACT**

This Experimental work shows the investigation on M30 grade due to incorporation of glass fibers. In this Experiment, we used the glass fibers of Filament diameter 14 microns with aspect ratio 857.1 at various percentages as 0%, 0.4%, 0.8%, 1.2%, 1.6% by the weight of cement on M30 grade of mix proportion (1:1.60: 2.96) with water cement ratio 0.45. Hence, in this research the Experimental investigations and analysis of results were conducted to study the compressive, tensile and flexural behavior of composite concrete with varying percentage of such fibers added to it. The concrete mix adopted were M30 with varying percentage of fibers ranging from 0, 0.4, 0.8, 1.2 & 1.6% by weight of cement. On the analysis of test results, the concrete with straight glass fibers had improved performance as compared to the conventional concrete, which was readily available in market. From the experimental investigation, It has been found that optimum dosage amount of glass fiber of concrete is 1.2 % by weight of concrete because at this point the compressive strength of GFRC increased up to 17.36 % as compared to plain concrete while the flexural Strength increased up to 35% and Split Tensile Strength increased up to 40%. The common person in their regular constructions could easily adopt these sustainable improvements or modifications.

***Keywords:*** *Glass Fiber, Compressive Strength, Split tensile Strength, flexural Strength*

## I. INTRODUCTION

Fiber reinforced concrete specimens unlike plain concrete specimens which fall at the point of ultimate flexural strength of the first crack, do not fall immediately after the initiation of the first crack. After first crack, the load is transferred from the concrete matrix to the fibers. Hence, the role of fibers is essential to arrest advancing of crack by applying pinching forces at the crack tips, thus delaying their propagation across the matrix and creating a slow crack propagation stage. The ultimate cracking strain of the composite is thus increased by many times compared to that of unreinforced matrix. The introduction of small, closely spaced, randomly oriented fibers transfers an inherently brittle material with low tensile strength and impact resistance into a strong composite with superior crack resistance, improved ductility and distinctive post cracking behaviour prior to failure. A major advantage of using fiber reinforced concrete besides reducing permeability and increasing fatigue strength is that fibers addition improves the toughness or residual load carrying ability after the first crack. This concrete is known as glass fiber reinforced concrete (GFRC). Glass fiber is a recent introduction in making fiber concrete. Conventional concrete mixes are usually prone to plastic shrinkage during the curing phase and often lead to crazing and cracking. The addition of relatively small amounts of fibers can effectively eliminate this problem by controlling this early - age plastic shrinkage cracking. It also avoids the need for light crack - control steel -mesh with its attendant disadvantage of handling and positioning. Not only the fiber concrete is easy and cost effective to use, but also enables to produce a hardened concrete, which has improved surface quality, greater impact resistance and enhanced damaged resistance. Most importantly fiber restricts the growth of crack under load thereby arresting ultimate cracking Non metallic fibers like alkali resistant glass fiber and synthetic fibers provide resistance against chemicals. Reinforcing capacity and proper functioning of fiber is based on length of fiber, diameter of fiber, the percentage of fiber and condition of mixing, orientation of fibers and aspect ratio. Aspect ratio is ratio of length of fiber to its diameter which plays an important role in the process of reinforcement.

## II. Review of Literature

For a long time concrete was considered to be a very durable material requiring a little or no maintenance. The assumption is largely true, except when it is subjected to highly aggressive environments. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments, harmful sub-soil water in coastal areas and in many other hostile conditions where other materials of construction are found to be non-durable. Since, the use of concrete in recent years, has spread to highly harsh and hostile conditions, the earlier impression

that concrete is a very durable material is being threatened, particularly on account of premature failures of number of structures in the recent past. The published literature available so far various properties GFRC may be discussed as follows:-

**Muhammed İskender(2018)** In the 1940's, potential of glass as a construction material was realized and improvement continued with the addition of zirconium dioxide in 1960's for harsh alkali conditions. To enhance durability of materials, new generation of glass fibers directed to improvement process. In this way, glass fiber reinforced concrete (GFRC) was started to produce for the satisfaction of different demands. Scientific studies and tests on the GFRC have shown that the physical and mechanical properties of the GFRC change depending on the quality of the materials and the accuracy of the production methods. GFRC can be used wherever a light, strong, fire resistant, weather resistant, attractive, impermeable material is needed. As technology advances, it is possibly expected to build the whole building and complex freeform with low cost. In recent years, the effect of glass fibers in hybrid mixtures has been investigated for high-performance concrete (HPC), an emerging technology termed, which has become popular in the construction industry.

**Gaurav Tuli Et.Al..(2016)** 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

**S.Hemalatha(2016)** The Plain Concrete have brittle nature and low tensile strength. So placing of reinforcement bars to plain concrete to attain the tensile strength. Since Fiber Reinforced Concrete is most widely used construction materials. Fiber is easily available material. Due to the Glass Fiber Reinforced Concrete the Glass Fiber easily surrounded to the cementitious medium. The study work is focused on strength and durability characteristics of GFRC. As per IS 10262-2009 designed by M40 grade of Concrete and con plast as a super plasticizer and water cement ratio 0.40. The performance of Cement Concrete with varying percentage of Glass Fiber adding like 0.33%, 0.66%, 1%, 1.33%, 1.66%, 2%. The strength and durability properties of Glass Fiber Reinforced Concrete compared to Concrete.

## III. Methodology

The experimental programme included the following:

- Materials used in manufacturing of GFRC
- Testing properties of constituent materials.
- Development of concrete mix of desired strength by making trials
- Casting and curing of specimens.
- Compressive strength test on Glass Fiber Reinforced Concrete Mix
- Split tensile strength on Glass Fiber Reinforced Concrete Mix
- Flexural strength test on Glass Fiber Reinforced Concrete Mix

## IV. Test Result

### 1. COMPRESSIVE STRENGTH

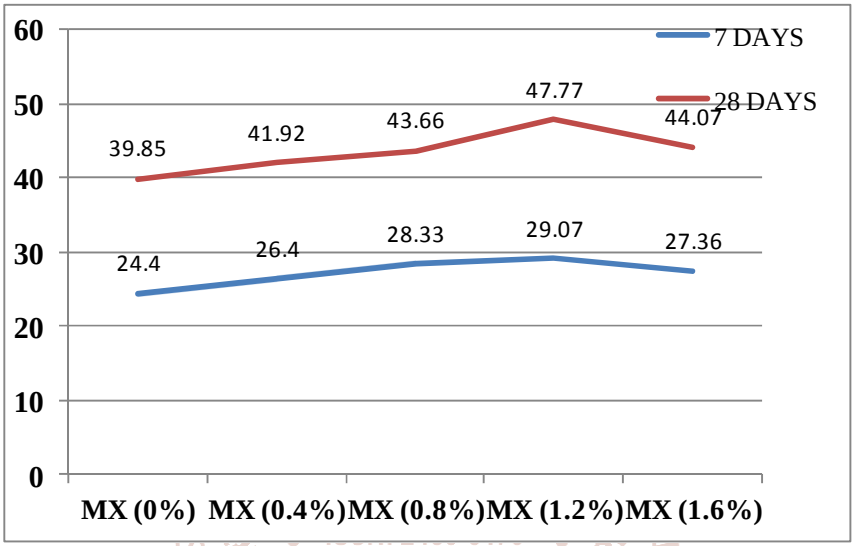
The compressive strength was conducted on various specimens as per the guidelines given in IS 516-1959. The specimens were surface dried before testing the same on Universal Testing Machine of 100 tonnes capacity. The compressive strength of plane mortar and GFRC for various percentages of fiber content has been illustrated in Table 4.1 and 4.2 which shows the compressive strength after 7 and 28 days respectively.. The compressive strength of plane mortar has been obtained as 39.85 Mpa after 28 days. This strength has been obtained as 41.92 Mpa, 43.66 Mpa, 46.77 Mpa, 44.07 Mpa for 0.4, 0.8, 1.2 and 1.6 percent fiber contents respectively in the case of Glass fiber reinforced concrete (GFRC). It has been observed that the compressive strength of GFRC is about 5.19, 9.56, 17.36 %and 10.58% higher than the compressive strength of plane concrete.. It has been found that compressive strength of the GFRC based specimens increased upto 17.36% with 1.2 % Glass fiber by weight of concrete.

**Compressive Strength after 7 Days**

| Mix Designation | Percentage of Glass Fiber | Compressive Load (KN) | Compressive Strength (N/mm²) | Average Compressive strength (N/mm²) |
|---|---|---|---|---|
| MX0 | 0 | 345<br>360<br>335 | 25.33<br>27.00<br>20.87 | 24.40 |
| MX1 | 0.4 | 370<br>460<br>345 | 26.44<br>28.44<br>24.32 | 26.40 |
| MX2 | 0.8 | 415<br>435<br>455 | 27.44<br>28.33<br>29.22 | 28.33 |
| MX3 | 1.2 | 505<br>510<br>475 | 29.44<br>30.62<br>27.15 | 29.07 |
| MX4 | 1.6 | 480<br>460<br>435 | 28.39<br>27.44<br>26.25 | 27.36 |

**Compressive Strength After 28 Days**

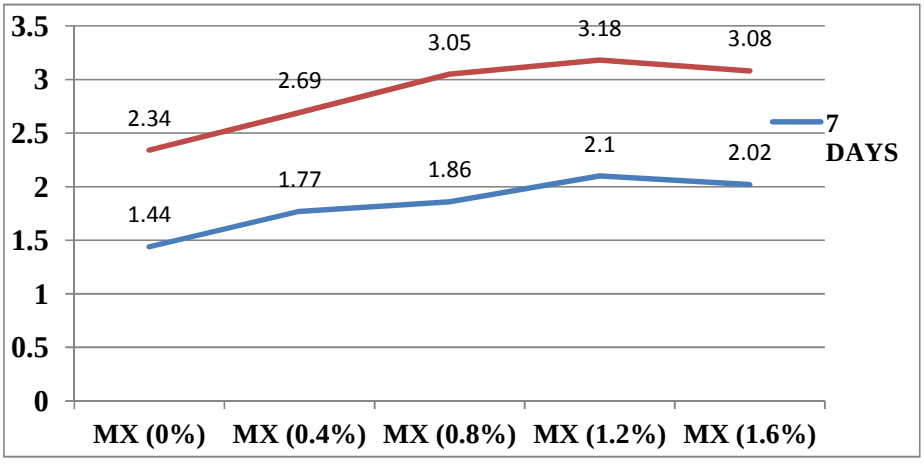
| Mix Designation | Percentage of Glass Fiber | Compressive Load (KN) | Compressive Strength (N/mm²) | Average Compressive strength (N/mm²) |
|---|---|---|---|---|
| MX0 | 0 | 680<br>675<br>660 | 41.29<br>39.26<br>39.00 | 39.85 |
| MX1 | 0.4 | 715<br>722<br>740 | 40.76<br>41.44<br>43.56 | 41.92 |
| MX2 | 0.8 | 780<br>785<br>730 | 44.32<br>45.54<br>41.12 | 43.66 |
| MX3 | 1.2 | 875<br>840<br>835 | 48.88<br>46.33<br>45.10 | 46.77 |
| MX4 | 1.6 | 820<br>790<br>825 | 44.24<br>42.31<br>45.66 | 44.07 |




**Graph: Variation Of Compressive Strength At Different Ages**

## 2. FLEXURAL STRENGTH

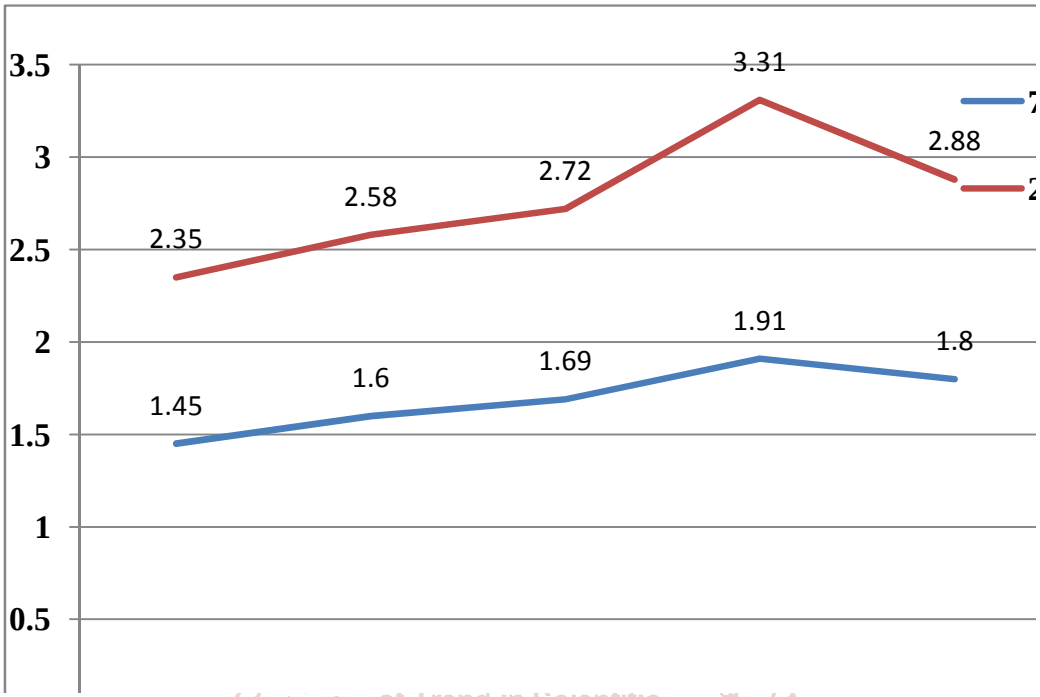
Flexural strength of plane mortar and GFRC has been investigated by testing beams of 150mm×150mm×700mm under two-point load because of small span between the supports. In this flexural strength , the effective length of the beam was 640 mm. The flexural strength of plane mortar and GFRC for various percentages of fiber content has been illustrated in Table 4.3 and 4.4, which shows the flexural strength after 7 and 28 days respectively. The flexural Strength has been obtained as 2.34 Mpa, 2.69 Mpa, 3.05 Mpa, 3.18Mpa and 3.08Mpa respectively for GFRC with 0, 0.4, 0.8, 1.2, and 1.6 percent of fiber content after 28 days. it has been observed that flexural strength of GFRC with 0.4, 0.8, 1.2, 1.6 percent of fiber content is about 1.15 , 1.30, 1.35 , 1.31 times more than that of plane mortar. This increase in strength however is about more in the case of 1.2 percent fiber contents of GFRC when compared with plane concrete.




**Graph: Variation Of Flexural Strength At Different Ages**

### 3. SPLIT TENSILE STRENGTH

Split tensile strength of plane mortar and GFRC has been investigated by testing cylinders of 300mm × 150mm under Compression Testing Machine of 100 tonnes capacity. The cylinders has been tested by placing the cylinder in horizontal position. The split tensile strength of plane mortar and GFRC for various percentages of fiber content has been illustrated in Table 4.5 and 4.6 which shows the split tensile strength after 7 and 28 days respectively. The flexural Strength has been obtained as 2.35 Mpa , 2.58 Mpa , 2.72Mpa, 3.31 Mpa and 2.88 Mpa respectively for GFRC with 0, 0.4, 0.8, 1.2, and 1.6 percent of fiber content after 28 days. it has been observed that flexural strength of GFRC with 0.4, 0.8, 1.2, 1.6 percent of fiber content is about 1.09, 1.15, 1.40 , 1.22 times more than that of plane mortar




**Graph: Variation Of Split Tensile Strength At Different Ages**

### V. CONCLUSIONS

From the results of the present investigation the following conclusion may be drawn:-

1. The Experimental work shows that properties of concrete M30 gets improved due to incorporation of Glass fibers.
2. The Experimental work shows that workability of GFRC gets reduced as we increased the fiber amount.
3. It can be concluded that the compressive strength of GFRC gets increased up to 17.36 % with 1.2% Glass fibers as compared to plain concrete.
4. It is observed that the compressive strength of Glass fiber reinforced concrete gets increased up to 1.2 % dosage amount after that it starts decreases.
5. It is observed that the Flexural strength of Glass fiber reinforced concrete gets increased up to 35 % as compared to plain concrete.
6. It can be concluded that Flexural strength of the GFRC gets increased continuously but after 1.2 % gets decreased.
7. It is also observed that the Split Tensile strength of Glass fiber reinforced concrete gets increased increases up to 40 % with 1.2% Glass fibers as compared to plain concrete.
8. While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two-piece geometry. But due to addition of Glass fibers in concrete cracks gets ceased which results into the ductile behaviour of GFRC.
9. It is also observed that during testing the specimens, the GFRC specimen does not collapse as compared to plain concrete.
10. Glass fiber reinforced concrete is very effective in resisting flexural tensile stresses as compared to compressive stresses.
11. From the experimental investigation, it has been found that the flexural strength of GFRC increases very much as compared to compressive strength.

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