# USE OF GLASS FIBRE FOR STRENGTH ENHANCEMENT OF CONCRETE

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***Abstract***— Glass fiber GF is lightweight, strong and less feeble. 40 MPa design grade of concrete mix proportions is prepared according to the IS10262:2019 and during mixing , glass fiber added in the concrete of different percentage of 1%, 2%, 3%, 4% and 5%. The test results showing that the slump value of control mix is 82 mm while with the addition of glass fiber the slump value is increased up to 3% glass fiber. 100 mm slump value is observed as maximum in the glass fiber mix (GFM3). The slump value is ranges from 88mm to 100mm. The slump value is decreased after 3% of glass fiber due to the addition of more percentages of glass fiber. The mechanical strength results revealed that the compressive strength of GFC increased from 2.15% to 13.44% and 2.31% to 17.20% after 28 days and 56 days respectively. Maximum compressive strength achieved at 3% of glass fiber in the concrete mixes while minimum strength achieved at 5% of glass fiber and tensile strength increased 10% to 36% with the addition of glass fiber. Optimum percentage of glass fiber attained at 3% of glass fiber and observed as maximum in compressive strength and tensile strength. This study finally concludes that glass fiber improves the strength of concrete and it is helpful to increase the tensile strength of concrete.

**Keywords: Glass fiber, Concrete, Compressive strength, Tensile strength**

## 1. INTRODUCTION

Concrete holds a unique place among present-day development materials. Concrete is a structure material comprised of a hard, synthetically dormant molecule part called total (regularly comprised of a few kinds of sand and rock) that is bound along with concrete and water. The construction business relies heavily on materials. They determine the ultimate product's quality as well as the technology used to create it. The qualities of the materials used in the building of civil engineering developments fundamentally affect their presentation. India's infrastructure is ageing and deteriorating, putting a strain on the country's already scant public assets. The expense of supplanting Indian structures, extensions, and streets is relied upon to be around 77 billion dollars. India spends a great deal of cash on framework consistently, yet even at that rate, it can't stay aware of the excess of work that must be done on spans, yet foundation all in all. Indeed, even in troublesome financial occasions, public framework stays a significant spending need, and assets must be spent wisely and efficiently [13].

### 1.1Glass Fiber

GF has gotten a famous material used all through a few mechanical businesses like oil and gas, marine and compound, just to give some examples. Glass fiber additionally assumes a part in numerous mechanical protection cycles and final results like textures for high-temperature applications. A fiberglass is a kind of fiber-created plastic where glass fiber is the maintained plastic. This is the explanation potentially why fiberglass is by and large called glass created plastic or glass fiber maintained plastic. The glass fiber is regularly smoothed into a sheet, self-confidently designed or woven into a surface. As indicated by the use of the fiberglass, the glass strands can be made of various kinds of glass [14].

GF is lightweight, solid and less weak. The most stunning piece of fiberglass is its capacity to get outlined into different complex shapes. This essentially clarifies why fiberglass is all things considered utilized in showers, boats, plane, material, and different applications [1].

### 1.2 Glass Fiber Reinforce Concrete

FRC can be described as composite material containing mixes of cement, mortar or concrete and broken, discrete, reliably dissipated sensible fibers. Relentless cross sections, woven surfaces and long wires or reds are not seen as discrete fibers [11]. Strands incorporate steel filaments, glass filaments, engineered filaments and regular filaments. Concrete made with concrete has certain qualities: it is moderately solid in pressure however powerless in strain and will in general be fragile [10]. The weakness in pressing factor can be overpowered by the usage of conventional shaft support and to some degree by the joining of a sufficient volume of explicit strands. The utilization of strands additionally modifies the conduct of the fiber-lattice composite after it has broken, subsequently improving it's anything [12].

## 2. MATERIALS

All the materials were purchased from a nearby market. All the materials are available in the local market and this material are locally used in this current study.

### 2.1 Cement

A fresh OPC of 43 Grade adjusting to Indian standard IS 8112 utilized in the current examination (Table 2.1).

Table 2.1: Properties of cement

| S. No. | Property | Result |
|---|---|---|
| 1 | Standard Consistency | 31.3% |
| 2 | Initial Setting time | 160 min |
| 3 | Specific Gravity | 224 min |

### 2.2 Fine Aggregate

The fine total utilized in the current examination was locally accessible in the Delhi area. Fundamentally, GFC commonly contains such high substance of super fine cementitious material that the evaluating of the fine total utilized is generally insignificant. (Table 3.2).

Table 3.2: Properties of fine aggregate

| S. No | Property | Result |
|---|---|---|
| 1 | Specific Gravity | 2.53 |
| 2 | Fineness modulus | 2.28 |
| 3 | Grading zone | II |
| 4 | Water absorption | 0.8% |

### 2.3 Coarse Aggregate

Locally accessible squashed stones of maximum size 20 mm and 10 mm are utilized as coarse aggregate in the current examination. The specific gravity of 20mm and 10mm size aggregate is 2.72 and 2.78 respectively. The water absorption of coarse aggregate is observed as 0.26%. The crushing value and impact value of coarse aggregate is 19.22% and 12.97% respectively.

### 2.4 Glass Fiber

Cem-FIL hostileis used to break high scattering GF was utilized in this work. Glass fiber purchased from the local market available in Delh-NCR region. Four different percentages of glass fiber such as 1%, 2%, 3%, 4% and 5% of total weight of material added in the freshly concrete mix. The data about glass fiber showed in the Table 3.3 and figure shows in Fig. 2.1.

Table 3.3: Properties of glass fiber

| Characteristics | Values |
|---|---|
| Length (mm) | 12-28mm |
| Dia. | 0.015 |
| Density (gm/cc) | 2.5 |
| TS (MPa) | 2500-3500 |
| Colour | Whitish colour |
| Elongation | 3.5% |

Fig. 2.1: Glass fiber (GF) used in the study

### 2.5 Super Plasticizer

Cemwet SP-3000 superplasticizer (SP), based on polycarboxylic ether polymer was used for making of concrete. The superplasticizer scatters concrete particles and can keep up droop of cement for over two hours without influencing early improvement of solidarity. The superplasticizer was claimed to exhibit both water reduction and workability retention properties of concrete.

## 3. MIX PROPORTIONING

An M40 grade concrete mix designed as per IS 10262-2019 [4] using OPC was adopted for the study. Concrete mix proportions having no glass fiber termed as control mix (CM) and mix with fiber dosage of 1%, 2%, 3%, 4% and 5% called as GFM1, GFM2, GFM3, GFM4 and GFM5. According to the initial data of materials, design the concrete mix proportions and calculate the glass fiber addition in each mix. The quantity of cement, water, FA, CA, and superplasticizers is 394 kg/m$^3$, 150 kg/m$^3$, 733.62 kg/m$^3$, 1183 kg/m$^3$ and 8 kg/m$^3$ respectively. The total weight of the mix is 2469 kg in cubic meter. The quantity of GF is mixed in to the concrete mix by the weight of total concrete mix. Table 3.1 presents the concrete mix designation and glass fiber quantity which added in the concrete (Fig. 3.1).

Table 3.1: Concrete mix designation and fiber quantity

| Sr. No. | Concrete Mix | Weight of Fiber |
|---|---|---|
| 1 | Control mix (CM) | No Fiber |
| 2 | Mix with 1% GF (GFM1) | 24.69 |
| 3 | Mix with 2% GF (GFM2) | 49.38 |
| 4 | Mix with 3% GF (GFM3) | 74.07 |
| 5 | Mix with 4% GF (GFM4) | 98.76 |
| 6 | Mix with 5% GF (GFM5) | 123.45 |

Fig. 3.1: Cube specimen on vibrating table

## 4. RESULT AND DISCUSSION

### 4.1Workability Results

The workability of the concrete mixes was determined using slump cone as per IS 1199. An average slump value was observed for control mix and glass fiber mixes respectively are presented in Table 4.1. The slump values obtained for various concrete mixes follow a definite trend. Fig 4.2 shows the setup of slump cone.

As the results showing, the slump value of control mix is 82 mm while with the addition of glass fiber the slump value is increased up to 3% glass fiber. 100 mm slump value is observed as maximum in the glass fiber mix (GFM3). The slump value is ranges from 88mm to 100mm. The slump value is decreased after 3% of glass fiber due to the addition of more percentages of glass fiber. Higher amount of glass fiber increases the harshness of mixes which results as less value of slump. Even the higher amount of GF, changes the mix moderately dry. It concludes from the results that 3% addition ofGF shows good results as compared to control mix and other GF different mix.

**Table 4.1: Slump value of mixes**

| Sr. No. | Mixes | Slump Value (mm) |
|---|---|---|
| 1 | CM | 82 |
| 2 | GFM1 | 88 |
| 3 | GFM2 | 94 |
| 4 | GFM3 | 100 |
| 5 | GFM4 | 91 |
| 6 | GFM5 | 86 |

### 4.2 Compressive Strength

The compressive strength test results are presented in graphical representation are as shown Fig. 4.1. The strength of control mix is 27.2 MPa, 41.73 MPa and 47.61 MPa at 7, 28 and 56 days respectively. Highest strength have attained as 47.34 MPa and 55.8 MPa at 3% dosage of glass fiber however, less strength found at 4% and 5% addition as observed 44.68 MPa and 43.35 MPa at 28 days of glass fiber respectively. The strength has been increased with the addition of glass fiber as it may be bind the ingredients of concrete material. The strength of glass fiber increased up-to 3% addition of glass fiber then decrease the strength at 4% and 5% of glass fiber volume. The reason behind the low strength at higher percentage of GFC is the cohesiveness nature and also increases the porosity of concrete [2]. The concrete strength was increased at 28 days more as compared to 56 days. Slightly increment observed at 56 days in the GF concrete strength. This present study concludes that glass fibers increases the strength of concrete and can be used in construction industry.

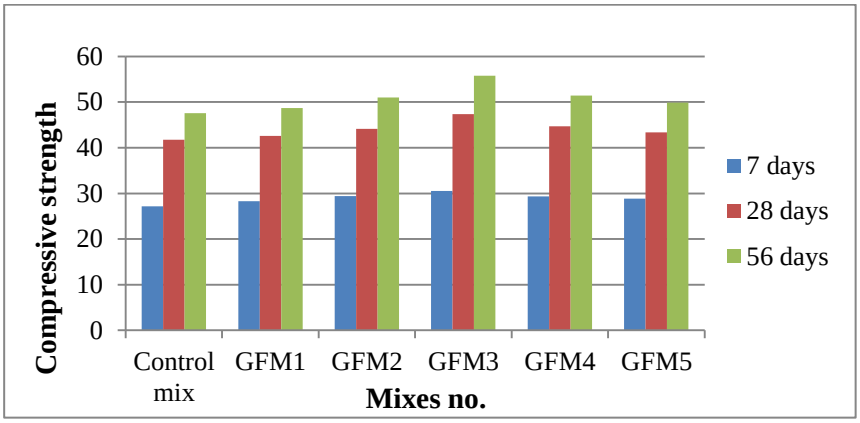


Fig. 4.1: Compressive strength of concrete mixes

### 4.3 Split Tensile Strength

The tensile strength of concrete mixes with different dosage of GF with graphical representation as shown in Fig. 4.2. As glass fiber content increased in the concrete mix so the tensile strength of GF concrete also increased. Tensile strength improved as 4.54 MPa to 5.61 MPa after 28 days from 1% GF to 3% GF while drop down in tensile strength was observed at different dosage of glass fiber such as 4% and 5%. Maximum tensile strength was observed as 5.61 MPa and 6.31 MPa at 28 and 56 days however minimum strength attained at 5% of GF (4.51 MPa and 4.88 MPa after 28 days and 56 days). Low strength achieved due to the porousness nature and balling of fiber in GFC. Inclusion of 3% of glass fiber showed best results as compared to control mix and other glass fiber concrete mixes. Fibers are more beneficial for improvement in tensile strength.

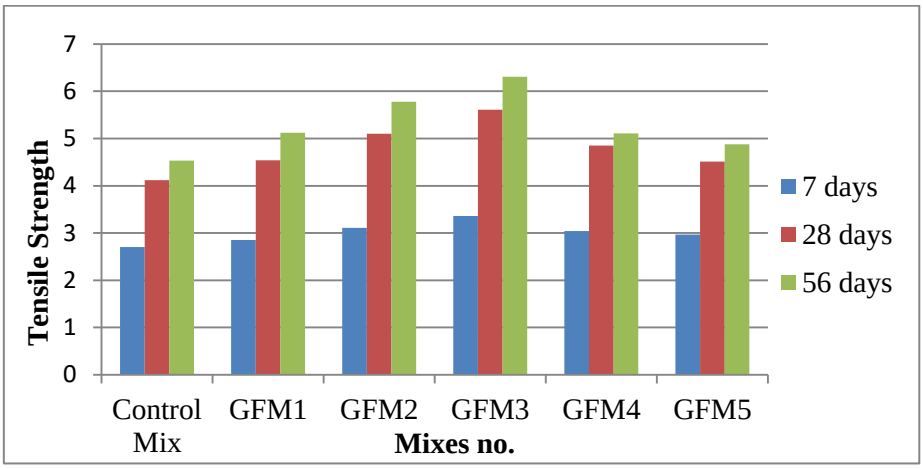


Fig. 4.2: Split tensile strength result of cylinders

## 5. CONCLUSIONS

The present research work was aimed at developing a glass fiber concrete strength. Different types of concrete specimens made with the above mixes have been made and tested for fresh and hardened concrete properties. The mechanical parameters tested were compressive strength and split tensile test. On the basis of the test results the following conclusions have been drawn and suggestions for future work has been proposed:

- The compressive strength of GFC increased from 2.15% to 13.44% and 2.31% to 17.20% after 28 days and 56 days respectively. Maximum compressive strength achieved at 3% of glass fiber in the concrete mixes while minimum strength achieved at 5% of glass fiber.
- Tensile strength is improved up to 10% to 36% (1% to 3% GF) however lower strength at 5% of GF (9.46%) after 28 days.
- Optimum percentage of glass fiber improves the compressive and tensile strength of concrete.
- The compressive and tensile strength improve upto 3% of glass fiber and observed as less at 4% and 5% of glass fibers.

- A fiber increases the tensile strength more as compared to compressive strength due to the ductile nature of fiber.

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