# STRENGTH ASPECTS OF GLASS FIBRE REINFORCED CONCRETE WITH FLY ASH

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**ABSTRACT:**
The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient characteristics. Research all over the world are attempting to develop high performance concretes using fibres and other fibres like glass, polypropylene and aramid fibre provide improvements in the tensile strength, fatigue characteristics, durability, shrinkage characteristic impact, cavitation, erosion resistance and serviceability of concrete. In the present investigation, GFRC hasbeen produced with locally available aggregates and fly ash as the mineral admixture. Various fly ash based GFRC mixes were designed by absolute volume method.

**Key Words:** Fibre reinforced concrete (FRC), Glass fibres, Fly ash, Strength properties, Concrete.

**INTRODUCTION:**

Concrete is the most widely used man-made construction material in the world, and is second only to water as the utilized substances on the planet. During recent years here awareness is increased regarding environmental pollution due to domestic and industrial waste.

Glass Fibre Reinforced Concrete (GFRC) is concrete containing fibrous material which increases its structural integrity. GFRC is a form of concrete that uses cement, fine sand, water, fly ash and alkali resistant glass fires. Fibres suppress the localization of micro cracks into macro cracks and consequently the apparent tensile strength of the matrix increases.

Fly ash is a by-product of the thermal plants. It reduces permeability of concrete and dense calcium silicate hydrate (C-S-H). A preliminary test program has been carried out to study the mechanical characteristics of glass fibre reinforced concrete with the fly ash content 10%.The glass fibre content is vary from 0.5-2% by weight of cement.

**REVIEW OF LITERATURE:**

Rao [Apr-2010]conducted study to investigate the strength properties of glass fiber reinforced concrete with fly ash.Griffiths conducted study to investigate the mechanical properties of glass fiber reinforced polyester Polymer concrete. The author observed that the modulus of rupture polymer concrete containing 20% polyester resin and about 79% fine silica aggregate is about 20 MPa. The addition of about 1.5% chopped glass fibers (by weight) to the material increases the modulus of rupture by about 20% and the fracture toughness by about 55%. Glass fibers improve the strength of the material by increasing the force required for deformation and improve thetoughness by increasing theenergy required for crack propagation.

**MATERIALS AND METHODS**:

## Materials:

### Cement:

The cement used was Ordinary Portland Cement of 53-Grade Conforming to IS: 8112-1989.The cement should be fresh and of uniform consistency. Where there is evidence of lumps or any foreign matter in the material, it should not be used. The cement should be stored under dry conditions and for as short duration as possible.

**Coarse aggregate:**

Crushed angular granite metal from a local source was used as coarse aggregate. The specific gravity was 2.71, flakiness index of 4.58 percent and elongation index of 3.96.

**Fine aggregate:**

River sand was used as fine aggregate. The specific gravity and fineness modulus was 2.55 and 2.93 respectively. The fine aggregate used in the project work is 4.75 mm down grade.

**Glass fibre:**

Glass fibres used are of Cem-FIL Anti-Crack HD with modulus of elasticity 72 GPA Filament diameter 14 microns, specific gravity 2.68, length 12mm, the number of fibres per kg is 212 million fibres.

**Fly ash:**

Fly ash is a byproduct of the thermal power plants. Fly ash reduces the environmental pollution. It improves the workability and durability. Specific gravity of fly ash was 2.50.

Cement with Puzzolona like fly ash reduce the permeability of concrete and dense calcium silicate hydrate. Usually, class F fly ashes have a lower content of Cao and exhibit Puzzolonic properties.

Table -1. Quantities of materials required per 1 m3 of ordinary concrete mix.

## Methods:

**Workability:**

The workability tests were performed using standard sizes of slump moulds as per IS:1199-1999 and compaction factor apparatus which was developed in UK and is described in IS:1199-1999.

**Compressive strength:**

The steel mould of size 150X150X150 mm is well tighten and oiled thoroughly. They were allowed for curing in a curing tank for 28 days and they were tested in 200-tonnes electro hydraulic closed loop machine. The test procedures were used as per IS: 516-1979.

**Split tensile strength:**

The specimens shall be cylinder with 150 mm in diameter and 300 mm long and is well tighten and oiled thoroughly. They were allowed for curing in a curing tank for 28 days and they were tested in universal testing machine. The test procedure were used as per IS: 5816-1999.

## DISCUSSIONS OF TEST RESULTS:

**Analysis:**

A laboratory study were performed to determine the compressive strengths 20 cubes and 20 cylinders for 28 days of casting of different percentages of glass fibres are 0.5, 1.0, 1.5, 2.0 by weight of concrete and the fly ash is 10 percent. The various test results are analysed below.

**Compressive strength for ordinary concrete and glass fibre concrete mixes:**

| S.NO | Grades of concrete | Cement | Fine aggregate | Coarse aggregate | W/C ratio |
|---|---|---|---|---|---|
| 1. | M20 | 3.62 | 5.73 | 14.8 | 0.5 |
| 2. | M25 | 4.14 | 5.5 | 15.0 | 0.45 |
| 3. | M30 | 4.21 | 5.58 | 14.4 | 0.45 |
| 4. | M35 | 4.38 | 4.68 | 13.3 | 0.4 |

Table -2 give the compressive strength values of ordinary concrete and glass fibre concrete mixes and their values are observed to be varied from 32.2 to 45.5 N/mm2 for M20 grade and 41.51 to 44.8 N/mm2 for M25 grade and 46.8 to 49.1 N/mm2 for M30 grade and 47.3 to 51.2 N/mm2 for M35 grade at 28 days.
Compressive strength = compressive load/Cross Sectional area in N/mm2

**Split tensile strength of ordinary concrete an glass fibre concrete mixes:**

The split tensile strength values of ordinary concrete and glass fibre concrete mixes are observed from Table -2 varied from 1.93 to 2.689 N/mm2 for M20 grade and 2.017 to 2.793 N/mm2 for M25 grade and 2.44 to 2.79 N/mm2 for M30 grade and 2.56 to 2.82 N/mm2 for M35 grade at 28 days.

**Table -2: Determination of compressive and split tensile strength**

| Grade of concrete | % of glass fibre | % of fly ash | Compressive strength (N/mm2) | Split tensile strength (N/mm2) |
|---|---|---|---|---|
| M20 | 0.5 | 10% | 32.2 | 2.26 |
| | 1 | | 38.6 | 2.44 |
| | 1.5 | | 40.45 | 2.52 |
| | 2 | | 45.5 | 2.68 |
| M25 | 0.5 | 10% | 41.51 | 2.38 |
| | 1 | | 42.8 | 2.53 |
| | 1.5 | | 43.6 | 2.66 |
| | 2 | | 44.8 | 2.72 |
| M30 | 0.5 | 10% | 46.8 | 2.44 |
| | 1 | | 47.2 | 2.63 |
| | 1.5 | | 48.4 | 2.68 |
| | 2 | | 49.1 | 2.74 |
| M35 | 0.5 | 10% | 47.3 | 2.46 |
| | 1 | | 49.7 | 2.62 |
| | 1.5 | | 50.3 | 2.74 |
| | 2 | | 51.2 | 2.82 |

**Variation of compressive strength, split strength of the ordinary concrete and glass fibre concrete mixes compared with 28 days strength:**

The increase in compressive strength for all the grades of concrete like M20, M25, M30, and M35 are observed to be 20 to 25% when compared with 28 days strength. The split tensile strength for all the grades of concrete mixes are observed to be 20 to 25% when compared with 28 days strength.

**Variation of compressive strength, split strength of the ordinary concrete and glass fibre concrete mixes compared with ordinary concrete mixes:**

Table -3 gives the increase in compressive, split tensile strength of various grades of glass fibre concrete mixes were compared with ordinary concrete mixes of M20, M25, M30, M35. The variation in strength of glass fibre concrete is observed to be 15 to 20% when compared with ordinary concrete

Table -3: percentage increase of compressive, split tensile strength of glass fibre concrete in comparison with ordinary concrete mixes

| Grade of concrete | % of fly ash | No. of days | Compressive strength (N/mm2) | | Split tensile strength (N/mm2) | |
|---|---|---|---|---|---|---|
| | | | Without GF | With GF | Without GF | With GF |
| M20 | 10 | 28 | 27.02 | 47.3 | 2.07 | 2.56 |
| M25 | 10 | 28 | 33.3 | 49.58 | 2.12 | 2.62 |
| M30 | 10 | 28 | 38.23 | 50.3 | 2.14 | 2.74 |
| M35 | 10 | 28 | 40.43 | 51.2 | 2.22 | 2.82 |

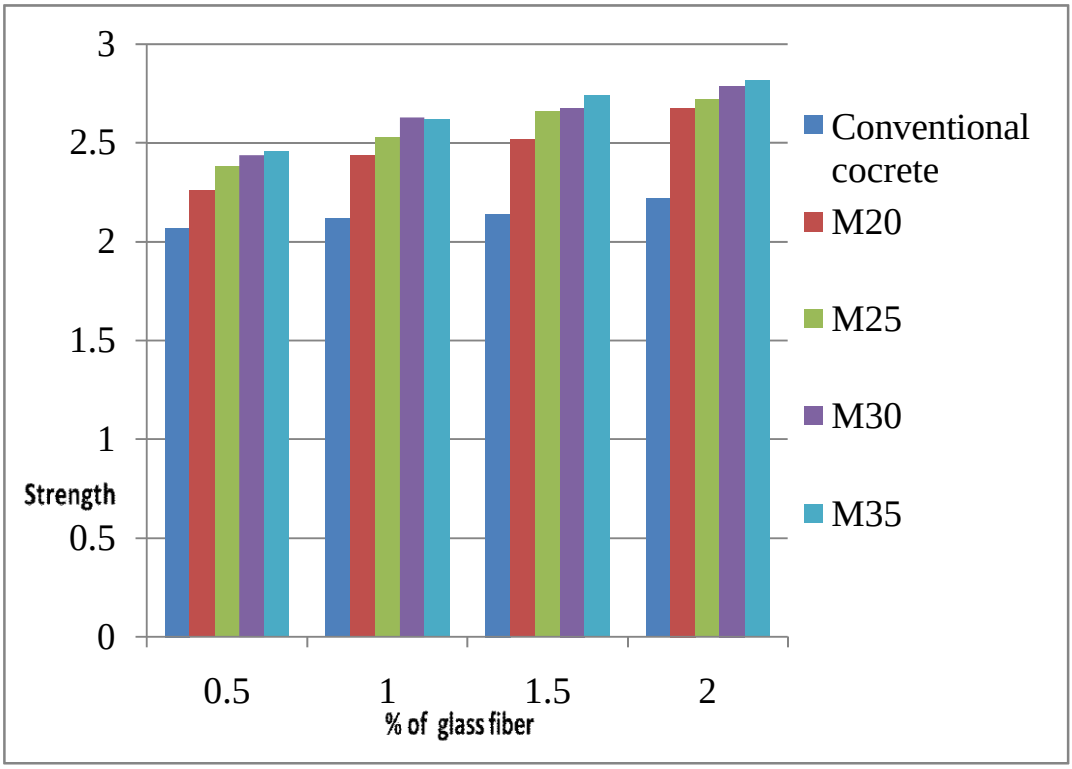


Fig 1: variation of compressive strength of glass fibre concrete with different % of glass fibre

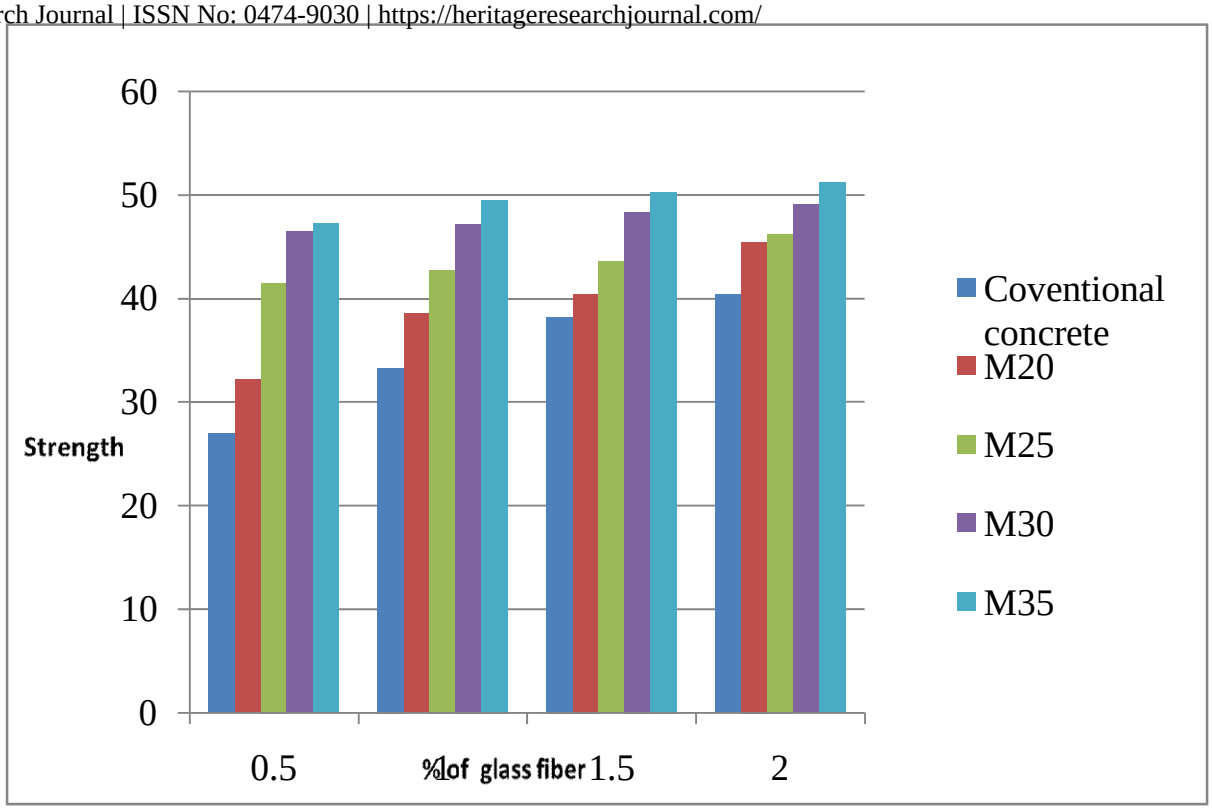


Fig 2: variation of split tensile strength of glass fibre concrete with different % of glass fibre

**CONCULSIONS:**

The addition of glass fibres into the fly ash concrete mixture marginally improves the compressive strength at 28 days. The study was conducted to evaluate the strength characteristics of concrete with fly ash and glass fibre. The concrete mix design was done for M20, M25,M30,M35 grade concrete. The following points are concluded from this study.

• The strength of concrete cubes at 28 days with 10% replacement of fly ash along with 0.5,1.0,1.5,and 2.0% of glass fibre shows an increase in compressive strength.

• Addition of glass fibre increases the tensile strength of the specimens. Reduces the workability of concrete which was overcome by the addition of fly ash to Glass fiber reinforcfed concrete.

• Experimental result showed that the addition of glass fibres resulted in decrease of the mechanical strength beyond 2% of Glass fibered reinforced concrete both in ambient curing and in heat curing at all ages.

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