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# FLEXURAL RESPONSE OF HYBRID FRC BEAMS

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*Abstract*—***Now a days, repairing and rejuvenation of Structures Cost high as much as the Construction of New Structures. The main reason for repairing of RC Structures are cracks which are induced due to flexural failure of RC Structure. So as to improve the flexural strength, we had found that the addition of fibers especially Hybrid fibers are suitable for flexural failure issue. In this paper flexural behavior of hybrid fiber reinforced concrete beams was investigated. Combination of steel and glass fibers was used as hybrid fibers. In order to obtain benefits of both fibers. The Hybrid concrete beams of concrete were casted as per IS 10262:2009. The Hybrid fibers are added to concrete by 2% of its total volume. Fibers are Hybridized with proportions of (25%S-75%G, 50%S-50%G, 75%S-25%G). Hybrid FRC and control concrete beams were casted and tested.***

***Keywords— Fiber Reinforced concrete, Hybrid Fiber Reinforced Concrete, Hybrid fibers, Steel fibers, Glass fibers, Flexural response.***

## INTRODUCTION

Concrete is one of the most widely used construction material in the world, it is usually associated with Ordinary Portland Cement (OPC) as the main component for making concrete. In Past, a lot of experimental work was carried out on fiber reinforced concrete having different types of fibers to study their improved engineering properties in compressive strength, tensile strength, flexural strength etc. The fibers are able to prevent surface cracking through bridging action leading to an increased impact resistance of concrete. Most of the fibers used in practice contain one type of fiber or more than one type of fiber. Recent years have seen considerable interest in the fiber hybridization particularly combinations of metallic and non-metallic fibers. For optimal behavior, different types of metallic and non-metallic fibers are to be combined. The mechanical properties such as compressive strength, flexural strength and flexural toughness etc. of Hybrid Fiber Reinforced Concrete(HFRC) are to be investigated by different investigators.

## OBJECTIVES

The project started with objective of achieving the following,

- ✓ To determine the optimum percentage combination of Hybrid FRC.
- ✓ To compare the strength of concrete cube containing hybrid fibers with fixed 2% proportions of volume of the concrete with normal concrete beams.
- ✓ To study the effect of steel fibre and Glass fibre in different proportions in hardened properties of concrete.

## MATERIALS USED

In this experimental study cement, fine aggregate, coarse aggregate, steel fibres and glass fibres are to be used.

*Cement:* Ordinary Portland cement of 53 grade was used inthis experimentation conforming to IS 12269: 1987

*River Sand:* Clean and dry river sand available locally wasused. Sand passing through IS 4.75 mm sieve and as per IS: 383:1970 was used for all the specimens.

*Coarse aggregates:* Locally available, aggregate passingthrough 20 mm sieve and retained on 12.5 mm sieve and as given in IS: 383 – 1970 is used for all the specimens.

*Water:* Potable water was used for the experimentation.

*Steel Fibres:* End Hooked Steel fibres with an aspect ratio of65 are to be used.

*Glass Fibres*: ALKALI glass fibers with an aspect ratio of40 are to be used.

**Table 1 Properties of Cement**

| Property | Values |
|---|---|
| Fineness of Cement | 7.5% |
| Grade of Cement | 53 |
| Specific Gravity | 3.15 |
| Initial Setting time | 30 min |
| Final Setting Time | 600 min |

**Table 2 Properties of Coarse Aggregate**

| Property | Values |
|---|---|
| Specific Gravity | 2.70 |
| Size Of Aggregates | 20 mm |

**Table 3 Properties of River Sand**

| Property | Values |
|---|---|
| Specific Gravity | 2.47 |
| Zone of Passing | Zone II |

**Table 4 Properties of Steel Fibre**

| Specification | Values |
|---|---|
| Length(mm) | 35 |
| Modulus of Elasticity(GPa) | 200 |
| Specific gravity | 7.48 |

**Table 5 Properties of Glass Fibre**

| Specification | Values |
|---|---|
| Length(mm) | 12 |
| Modulus of Elasticity(GPa) | 72 |
| Specific gravity | 2.68 |

## MIX PROPORTION

Mix design has been adopted from IS 10262:2009 to design for $M_{30}$ grade of concrete.

**Table 6 Quantities of Materials Used**

| Materials | By weight Kg/m$^3$ | By Proportion |
|---|---|---|
| Cement | 320 | 1 |
| Fine aggregate | 798.66 | 1.18 |
| Coarse aggregate | 920.8 | 2.2 |
| Water | 165 | 0.4 |

## EXPERIMENTAL WORK

### *METHODOLOGY*

*A.COMPRESSION STRENGTH TEST*

For compressive strength test, cube specimens of dimensions 150 mm x 150 mm x 150 mm were casted for M30 grade of concrete. The moulds were filled with hybrid fibre concrete. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 28 days. These specimens were tested in compression testing machine. The load was applied as per IS 516-1964. Compression testing machine having 1000kN is used for loading. In each category, three cubes were tested and their average value is reported by using following formulae.

Compressive strength = Load / Area (MPa)

*B.SPLIT TENSILE TEST*

For tensile strength test, cylinder specimens of dimension 150mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value is reported. Tensile strength was calculated as follows as split tensile strength. Tensile strength (MPa) = $2P / \pi DL$, Where P = failure load, D = diameter of cylinder, L = length of cylinder.

*C. FLEXURAL STRENGTH TEST*

The flexural strength of concrete prism was determined based on IS: 516 –1959.Beam specimens of size 1200 mm x 120 mm x 150 mm were casted. The samples were demoulded after 24 h from casting and kept in a water tank for 28 days curing. The specimens were placed in UTM and tested for flexural strength.

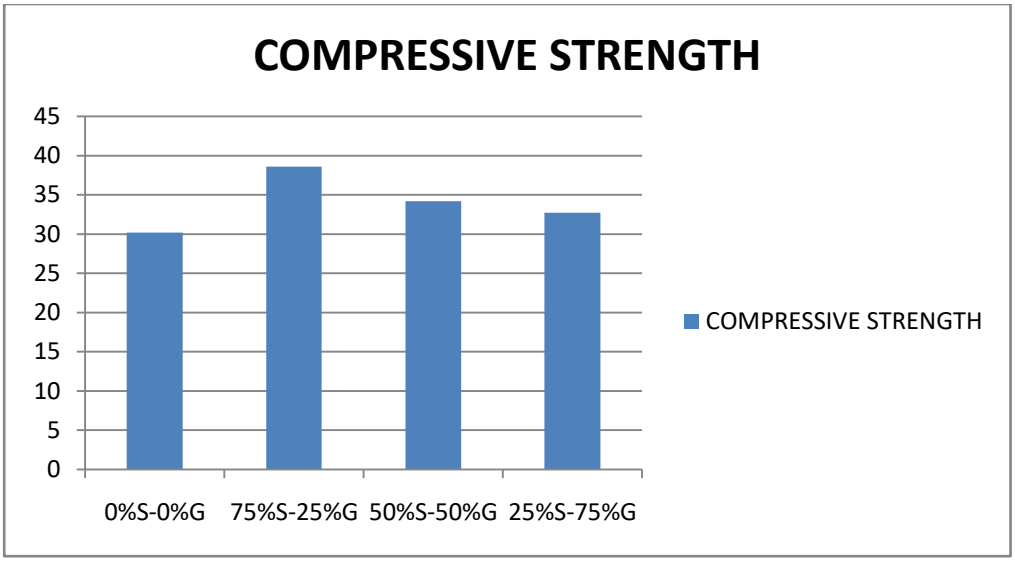
## TEST RESULTS

Results of Compressive strength, split tensile strength and flexural strength for $M_{30}$ grade of concrete on specimen without fibers and with fibers are shown in table and graph below.
And The Compressive Strength of the cubes was 31 N/mm2 is found out by using the loading frame.

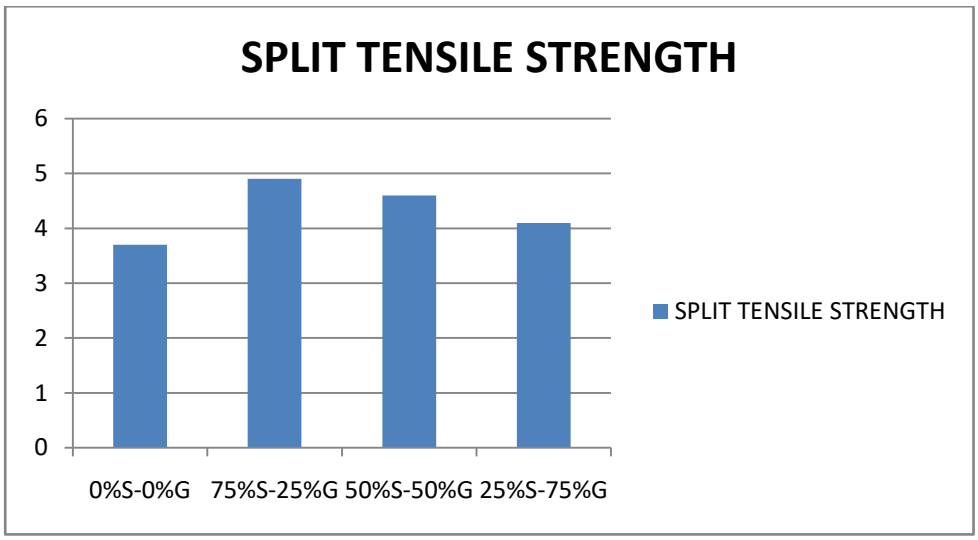
**Table 7 Results of Compressive Strength, Split Tensile Strength and Flexural Strength**

| TEST MIX | Average compressive strength at 28 days(MPa) | Average split tensile strength at 28 days(Mpa) | Average flexural strength at 28 days(MPa) |
|---|---|---|---|
| Control mix 0%S-0%G | 31.2 | 3.7 | 26.4 |
| Hybrid mix 75%S-25%G | 38.6 | 4.9 | 38.9 |
| Hybrid mix 50%S-50%G | 34.2 | 4.6 | 32.6 |
| Hybrid mix 25%S-75%G | 32.7 | 4.1 | 31.2 |

GRAPH 1 COMPRESSIVE STRENGTH RESULTS




GRAPH 2 SPLIT TENSILE STRENGTH RESULTS




GRAPH 3 FLEXURAL STRENGTH OF BEAMS

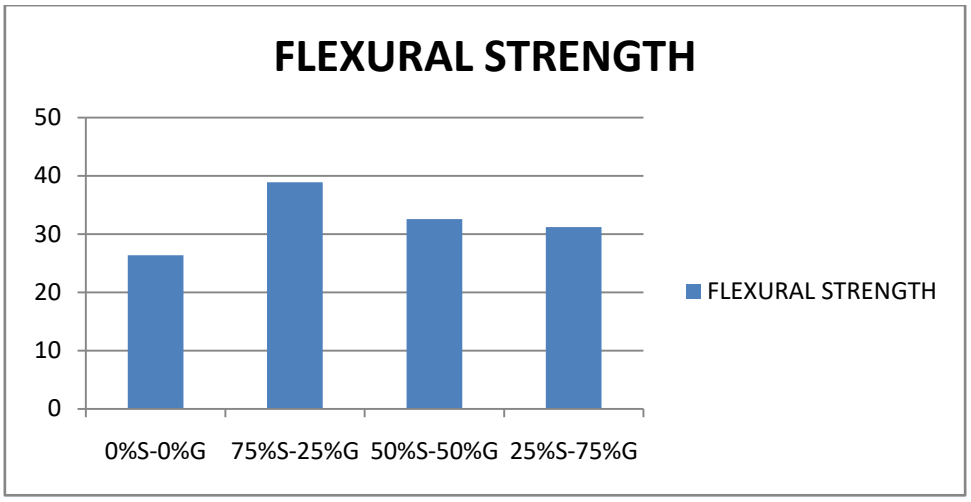


FIG1 TESTING OF BEAM

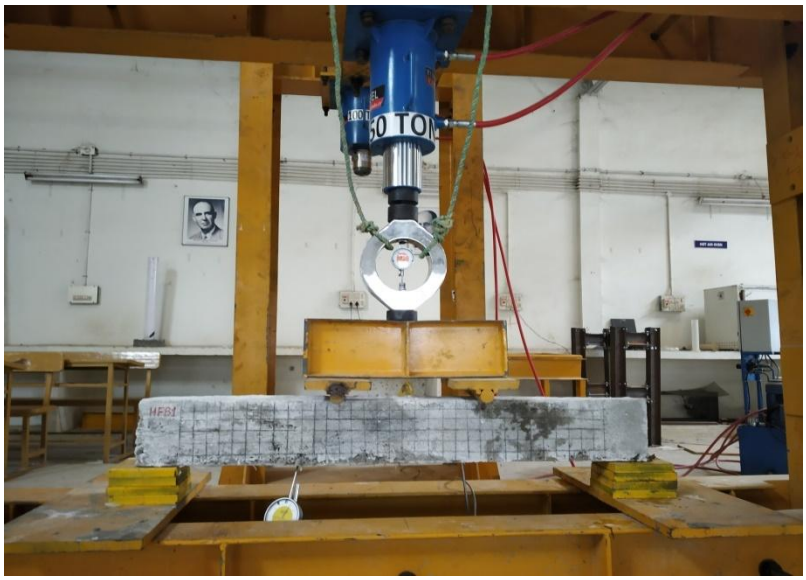
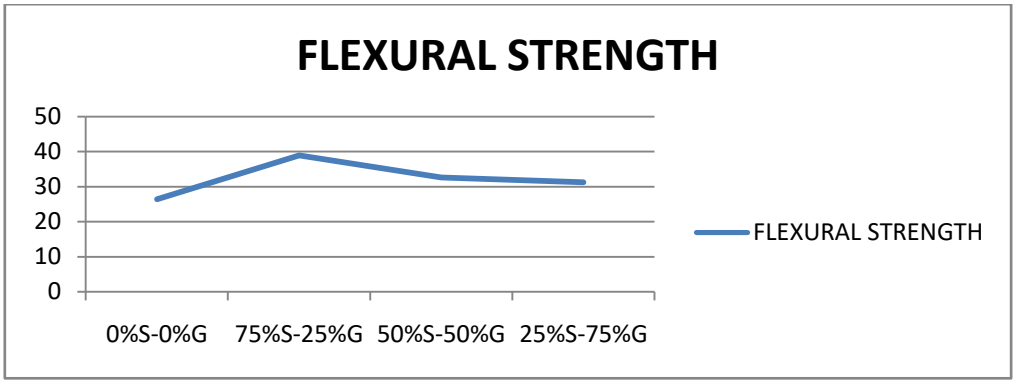


FIG 2 DEFLECTION IN BEAMS

GRAPH 4 DEFLECTION IN BEAMS



## CONCLUSIONS

From the experimental results, the following conclusions can be made:

- The workability decreases as the fiber content increases, both in steel fiber and glass fiber reinforced concrete mixes.
- At 28 days, the addition of hybrid fibers enhanced the compressive strength, the split tensile strength and flexural strength, compared to control concrete.
- Ultimate load is increased with increase in fiber content, maximum load was 30.15kN attained by the beam (75%S-25%G) specimen.
- Deflection ductility is increased with increase in fiber content , maximum values were obtained by 2% volume hybridization 75%S-25%G combination specimen.

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