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Experimental study on Glass, Steel and Hybrid Reinforced Concrete

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Abstract – *Concrete being widely used construction material in various civil engineering construction these days. This paper aims at project determining the properties of Fiber reinforced concrete (FRC) with M25 grade concrete using steel and glass fibers. With The main aim to Concrete is a widely used construction material for building of various civil engineering structures. The paper accounts for a project aimed at determining the properties of fibre Reinforced Concrete (FRC) M25 concrete by using steel, glass and hybrid fibres. The main aim was to test the ratios of these fibres, when mixed together and to determine which ratio provides best concrete properties in various conditions. Use of fibres is practiced for a while now and determining these ratios, if it could provide better results, is important so as to make concrete more economical and eco-friendlier. After finding out the most suitable ratio, an attempt is also made to identify the Young's modulus of concrete. Concrete is the most important product used in construction industry with cement as its base ingredient but production of cement causes environmental issues and a need to find its replacement is a priority. Though full replacement causes strength issues but successful experiments with partial replacements are being carried out regularly. This project is also based on such experiment.*

Key Words: Fibre, Steel, Glass, Concrete, Hybrid fiber, Young's modulus, Compression strength.

1. INTRODUCTION

As India is a one of the developing country construction industry plays an important role in it. For the construction of buildings and also for developing infra structures the most commonly used material is concrete. Concrete is a homogenous mix developed from mixing of various ingredients like cement ,coarse aggregates ,fine aggregates along with water .The variations in strength of concrete can be achieved by changing the proportions of ingredients appropriately during the mix along with some special characterized materials usually called as admixtures. Due to its high compressive strength, better durability characteristics along with low construction as well as maintenance cost it has been used in large amounts for various civil engineering applications. As we all know that concrete is very strong in compression but when it comes to the tensile property it is very weak and tends to fail because of its deficiencies such as low tensile strength, low strain at fracture. The weakness of concrete is due to the presence of micro cracks at mortar aggregate interface.

There are many experiments carried out so as to replace cement partially or fully in order to improve the properties of concrete as well as reduce the consumption of cement. For this purpose, many waste products are used like fly ash, plastic waste, silica fumes etc. One such experiment is introduction of fibres. Fibres like that of steel, glass, polypropylene, asbestos, carbon etc. are introduced in concrete by partial replacement of cement by weight and the concrete formed is known as Fibre Reinforced Concrete(FRC).

1.1 MATERIALS AND METHODS

Cement

This experimental study has been carried by using of ordinary Portland cement (OPC) 53 Grade of Birla company. The different properties of cement are given below in table 1

Table 1: cement properties

1 Specific Gravity	3.15
2 Initial setting time	40 Min
3 Final setting time	4hr 30min

Fine aggregate

Here manufactured sand has been used as fine aggregate and tested the same as per IS 2386-1963. The results are tabulated in Table 2.

Table 2: Physical properties of manufactured sand

1 Specific gravity	2.56
2 Water absorption (%)	3.8

Coarse aggregate

In this investigation 20mm downsize of coarse aggregate were used and they were tested as per IS 2386-1963. The results are shown in Table 3.

Table 3: Physical properties of Coarse aggregate

1 Specific gravity	2.62
2 Water absorption (%)	0.7
3 Impact value (%)	18.42
4 Crushing Value (%)	20.62
5 Flakiness index (%)	18.4
6 Elongation index(%)	19.26

In this investigation 12.5 mm downsize of coarse aggregate were used and they were tested as per IS 2386-1963. The results are shown in Table 3.1

Figure 1: Steel fibers

Table 4: Physical properties of Coarse aggregate

1 Specific gravity	2.66
2 Water absorption (%)	0.9
3 Impact value (%)	15.4
4 Crushing Value (%)	22.2
5 Fineness modulus	7.5

Steel fibers

Steel fibers were imported from Gujarat these fibers are zinc coated to be able to withstand corrosion.

Table 5: Physical properties of Steel fibers

Property	Value
Diameter	0.6
Length of Fibers	30
Aspect Ratio	50
Deformation	Hooked at both ends
Coating	Zinc

Glass fibers
Glass fibers were imported from Tamilnadu these are not coated fibers.

Table 5: Physical properties of Glass fibers

Property	Value
Diameter	0.14
Length of Fibers	6
Aspect Ratio	43
Deformation	Straight
Coating	No coating

Figure 2: Glass fibers

2. RESULTS AND DISCUSSIONS

28 days Compressive test was conducted on these mix and the results were as follows

Table 6: 28 Days compressive strength results

FIBER PERCENTAGE	STEEL FIBERS CONCRETE MIX	GLASS FIBER CONCRETE MIX	HYBRID FIBER CONCRETE MIX
DAYS	28 DAYS	28 DAYS	28 DAYS
0	31.29	31.53	31.1
0.5	37.83	35.06	36.5
1	42.3	36.4	39.73
1.5	48.03	34.5	46.4

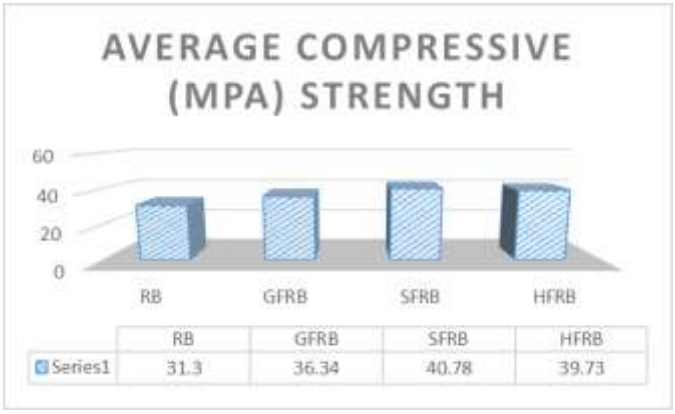

Chart 1: Average Compressive Strength

From the above chart it is clear that Steel fiber concrete can with stand more compressive strength of 30.28% more than ordinary cement when the fiber content of 1% was added to the concrete mix. Followed by hybrid with 26.93% increase in compressive strength and last glass fiber concrete with 16.1% increase in compressive strength.

Fresh concrete: slump cone test and compaction factor test are done on fresh concrete for knowing the workability of HFRC concrete and the values are plotted as follows.

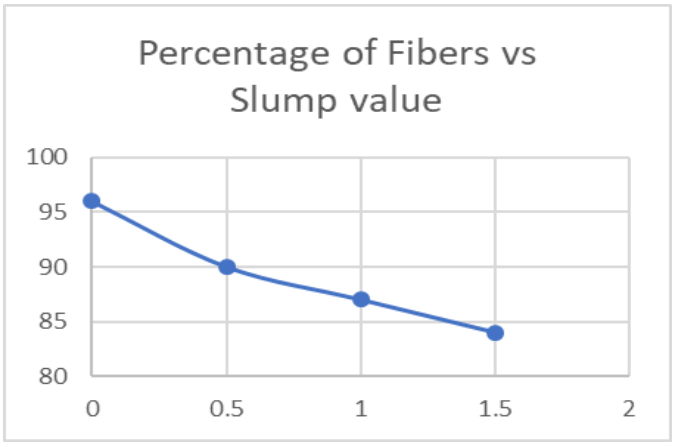

Chart 2: Percentage of fibers vs slump

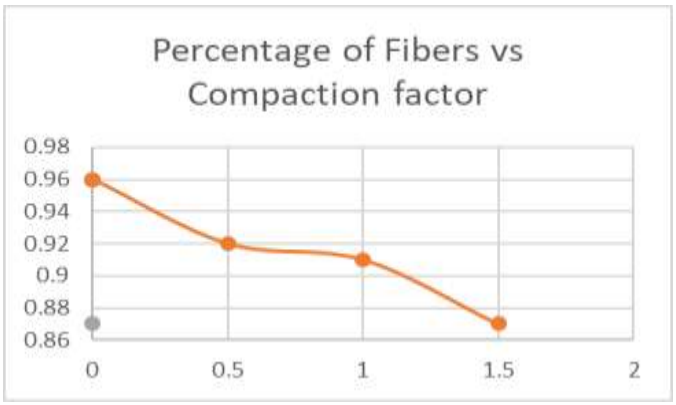

Chart 3: Percentage of fibers vs compaction factor value.

The above chart shows how there is reduction in both slump as well as compaction factor value upon increasing the fiber content in the concrete mix.

Density of the mix

Along with compression even density of the specimen was checked and the average density was found to be. Specimen with presence of steel having higher density with steel being the heavier of the fiber considered and the difference is not so much yet considerable.

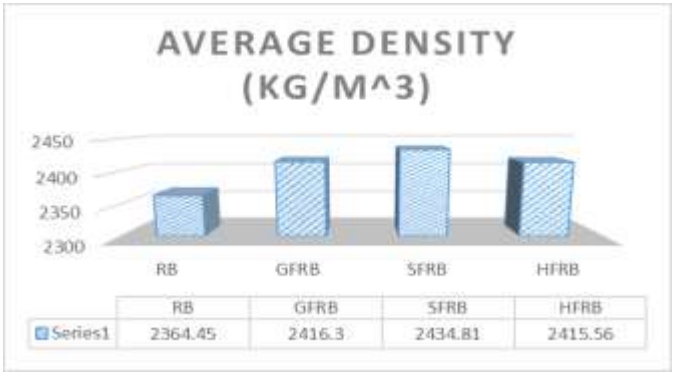

Chart 4: Average Density

The chart clearly indicated that the Steel fiber concrete as a density increase of 3% only compared to plain concrete followed by Glass and Hybrid with just 2% increase in density.

Young's modulus

The cylinders that were casted during casting of specimen were been tested at Bureau veritas laboratory and the results were obtained as below. Young's modulus is required with future part of the project so even though it served expensive to get it tested in the outside at commercial laboratory it was yet tested with steel fiber constituted mix showing highest modulus of elasticity. Slope was taken from the deformation readings obtained when the specimen was subjected to 40% its failure load according to ASTM codes. Three trails are conducted for each specimen.

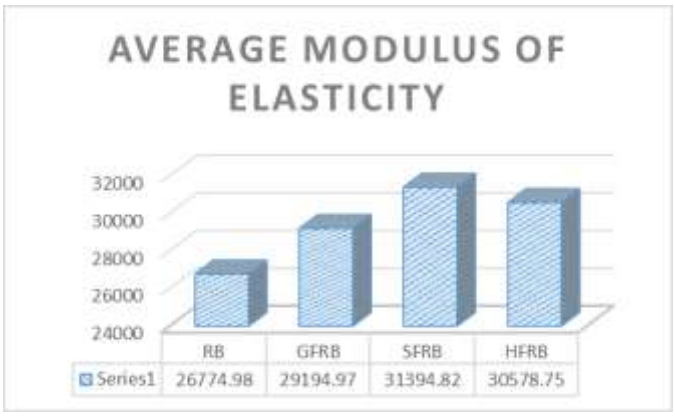

Chart 5: Average Modulus of Elasticity

From the Chart it can be drawn that Steel fiber concrete as more modulus of elasticity with just 1% addition of fiber it shows a increase by 17.25% followed by hybrid fiber by 14.2% and glass fiber by just 9% increase in elasticity.

3 CONCLUSIONS

1. As the fibers content in the mix increases there is a decrement in the workability of the concrete. The compressive strength is increased as the fiber content is increased .when the HFRC is compared with controlled concrete the percentage increase in compressive strength of 0.5%,1%1.5% addition is 10.96%, 14.84%, 17.25% respectively.

2. As the fiber content increase there is increase in compressive strength but in case of glass fibers as the fiber content increases beyond 1% there is a reduction in compressive strength.

3. Steel fiber concrete can with stand more compressive strength of 30.28% more than ordinary cement when the fiber content of 1% was added to the concrete mix. Followed by hybrid with 26.93% increase in compressive

strength and last glass fiber concrete with 16.1% increase in compressive strength.

4. Steel fiber concrete as more modulus of elasticity with just 1% addition of fiber it shows a increase by 17.25% followed by hybrid fiber by 14.2% and glass fiber by just 9% increase in elasticity.

5. Hybrid concrete as negligible difference in performance in comparison with the strength of these individual fibers like just 3.35% less compressive strength compared to sleet fiber concrete, just 2% more density compared to plain concrete which is negligible difference and 3% lesser modulus of elasticity compared to steel fibers.

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