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Strengthening of RC Element with Using Hybrid Fibre Reinforced System and Its Comparative Study on SFRC and GFRC Strengthening Systems

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ABSTRACT: The objective of this investigation to study about the behaviour of Hybrid Fibres Reinforced Concrete. Hybrid Fibre Reinforced concrete (HFRC) is formed from metallic, mineral and polymeric fibres. Specimens will be casted up to 2% of fibres partially replacement by weight of cement. This paper deals with the flexural behaviour of Hybrid Fibre. The material used are ordinary Portland cement 53 grade, fine aggregate and coarse aggregate. The concrete mix adopted was M25 grade with varying percentage of fibres. Casting and testing will is in hybrid fibre reinforced concrete specimens in different type of mixing percentage like 0-2 percentage. Five specimens namely RCC, GFRC, SFRC, HFRC1, HFRC2 and companion specimens will be cast and tested. The specimens are tested for 7 days, 14 days and 28 days strength and their behaviour are studied under compression and tension as per the method recommended by Indian Standards. The results provide comparison between control concrete, GFRC, SFRC and Hybrid fibre reinforced concrete.

KEYWORDS: Hybrid fibres, metallic fibres, mineral fibres, polymeric fibres, strengthening.

I. INTRODUCTION

In this Morden days Construction is a main part of developed and developing countries including India. In this type of construction work will be based on strength and lives of structures are very important. Concrete is the widely used material in construction. Plain cement concrete contain low tensile strength, to rectify this problems additional admixture will be added for improve the flexural strength of normal concrete. In this project will be contain Fibres to improve in the strength of concrete. This fibres helps to transfer the load without any micro cracks. In this projects will be tried using three types of fibres like metallic, mineral and polymeric.

Hybrid fibre reinforced concrete

Hybrid means that combination of two or more materials. Hybrid Fibre reinforced concrete is the combination of more than two fibres. In this concrete mix will contain Short, Discrete Fibres they are uniformly distributed and randomly deliver the load from the structure. Main aim of this hybrid fibre reinforced concrete is to improve the mechanical properties of concrete like compressive and flexural strength.

Role of fibre reinforced concrete

Fibres are used to rectify the mechanical damages like micro cracking. In Fibres are available in different shapes and size. They are classified into their properties like material, shape, mineral and elastic modulus. Hybrid

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fibres improve both flexural and impact capacity of normal concrete. In this fibres are discontinuous and distribute the load randomly after the harden stage.

II. MATERIALS AND METHODS

The FRC consist of three different type of fibres metallic, mineral and polymeric fibres in different percentages. The behaviour of such material has to be investigated under cyclic loading. In this research will be based on four types of beams like RCC, SFRC, HFRC1 and HFRC2. Steel Fibre Reinforced concrete (SFRC) consists of 1% of steel fibres in weight of cement. Hybrid Fibre reinforced concrete1 consist of 1% of steel and 0.2% of glass fibres by weight of cement. Hybrid Fibre Reinforced concrete2 will contain 1% of steel and 0.2% recron-3s fibres replacement by weight of cement. In this beams are tested under two point loading and subjected to cyclic loading.

Materials used

Ordinary Portland cement of 53 grade with specific gravity 3.15 was used for the preparation of test specimen. Silica fume was used as a mineral admixture in concrete mixes having an average diameter about 0.1 microns. Silica fume is added as partial replacement of cement at 7.5% by weight of cement in order to get high performance concrete. The specific gravity of fine aggregate used for concrete is determined and found to be 2.6. The specific gravity of coarse aggregates was found to be 2.6. The portable water from the tap is used for mixing and curing the concrete. Conplast SP- 430 is a high range super plasticizing admixture used to increase the workability of concrete. A dosage of 1.0% by weight of binder is used for all the mixes. The main reinforcement used for four beams were TMT bars of (Fe 415)10 mm diameter at both top and bottom. 6mm diameter mild steel bars were used for stirrups at 100mm spacing. The round crimped Steel fibers of 1% by volume of concrete having 0.6 mm diameter, 12mm length and aspect Ratio 60 was used in this work. The glass fibres used are of Cem-FILAnti-Crack high dispersion fibres. A fibre with Filament diameter 14 microns, length 12mm and aspect ratio of 857.1 was used. Recron-3s is used for improving the quality of construction in an optimum dosage of 0.3% by weight of cement.

Water

Potable water was used in the experimental work for both mixing and curing purposes.

Mix Proportioning

M25 grade concrete mix was designed as per IS 10262-2007. Proportion of concrete should be selected to make the most economical use of available materials to produce concrete of required quality. The mix ratio for casting the specimen used is 1:1.38:2.52 and water cement ratio of 0.4 is used.

Mould Details

The wooden beam mould of (100x170) mm in cross section and 1500mm long was selected for the casting of beam specimen.

III. EXPERIMENTAL INVESTIGATION

Reinforcement Details

All the four beams were cast with the following reinforcement details. Two numbers of 10mm diameter rods at both top and bottom & 6mm diameter stirrups spaced at 100mm centres as shear reinforcement grill before casting.

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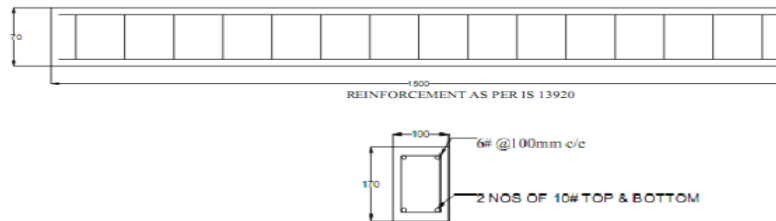


Fig 1 Reinforcement Details of Beam

Testing Of Beams

The beam specimen was placed on the loading frame. All the beams were tested under two-point loading condition. The forward and reverse cyclic load was applied by using screw jack. The beam was gradually loaded by increasing the load level in each cycle.



Fig 2 Casting of RC Beam.

The observed deflection at mid span was measured by using Dial gauge. At the end of each cycle, the load was released gradually and the deflection values for were also noted down

IV. RESULT

In this test results will be comparative study with Hybrid and Conventional reinforced concrete test results

COMPRESSIVE STRENGTH

From this above comparison of the compressive strength of the conventional concrete and the Hybrid fibre reinforced concrete (HFRC), it is clearly that HFRC-2 gives better result than the conventional concrete. It is clearly visible 1 percentage of steel fibre and 0.2 percentage of glass fibre required to attain maximum compressive strength. In this result comparison HFRC1 gives higher value compare to other three strengthening methods. Combination of metallic and mineral fibres is yield high compressive strength in 7days strength.

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Table. 1 Result Comparison of Compressive strength.

SL.NO	Property	Compressive strength (N/mm ²)		
		7 Days	14 Days	28 days
1	PCC	30.52	37.21	45.20
2	SFRC	35.20	43.21	54.52
3	HFRC1	36.52	45.35	61.30
4	HFRC2	35.78	44.52	58.25

SPLIT TENSILE STRENGTH

From the above results comparison gives the better results of split tensile strength based on three types of fibre dosages in different percentages. In the combination of steel and glass fibre gives better strength compare to other fiber mixes.

Table. 2 Result Comparison of Split Tensile strength.

SL.NO	Property	Split tensile strength (N/mm ²)		
		7 Days	14 Days	28 days
1	PCC	2.09	2.82	3.25
2	SFRC	2.53	3.02	3.82
3	HFRC1	2.35	3.15	4.10
4	HFRC2	2.75	3.08	3.75

3.3FLEXURAL STRENGTH

Flexural strength is important for framed structure like slab and beams. In this fibres main process is improve the tensile properties of concrete in elastic limit. From the above results combination of metallic and mineral fibres will yield high strength compare to other strengthening methods. In this increment of strength will improve the ductile and reduce the micro cracks in the horizontal members. In this discontinuous menders distribute the load uniformly throw the reinforcement steel bars.

Table. 3 Result Comparison of Flexural strength.

SL.NO	Property	Flexural strength (N/mm ²)		
		7 Days	14 Days	28 days
1	PCC	2.82	3.62	4.32
2	SFRC	3.25	4.25	5.63
3	HFRC1	3.52	4.96	6.75
4	HFRC2	3.46	4.87	6.23

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Therefore, addition of small percentage of such fibres in concrete mix will give more flexural strength. This result is illustrated as a comparative chart in the following pages, which shows the comparison of the compression strength, split tensile and flexural strength of the concrete and the increase in strength of the concrete in various stages of curing such as 7 days, 14 days and 28 days.

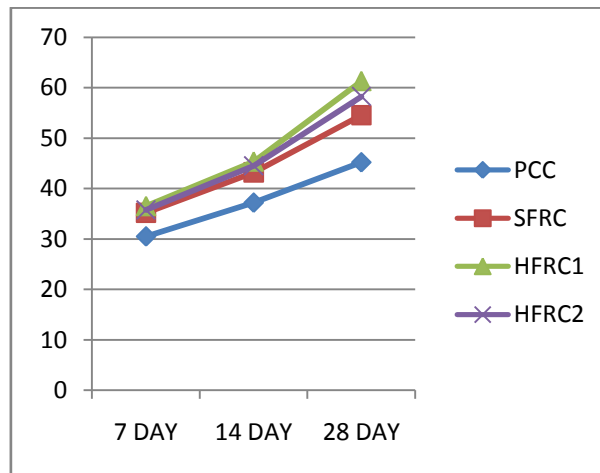


Fig 3 Result comparison of compressive strength of concrete.

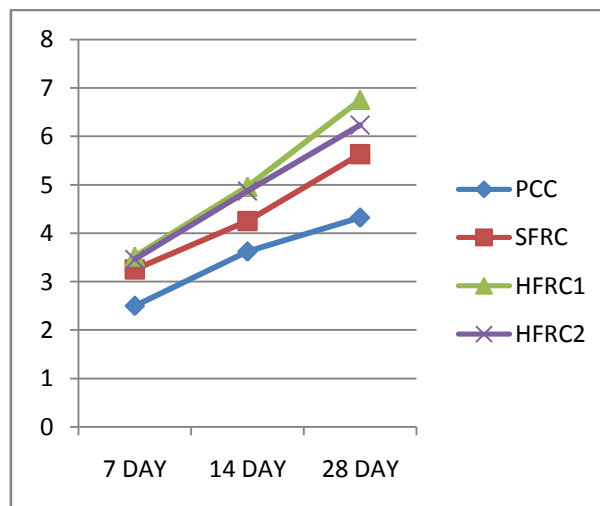


Fig 4 Result comparison of split tensile strength of concrete.

This chart shows the comparative strength of various type of concrete in different dosages of fibre. It will used to know the best performance hybrid fibres reinforced concrete.

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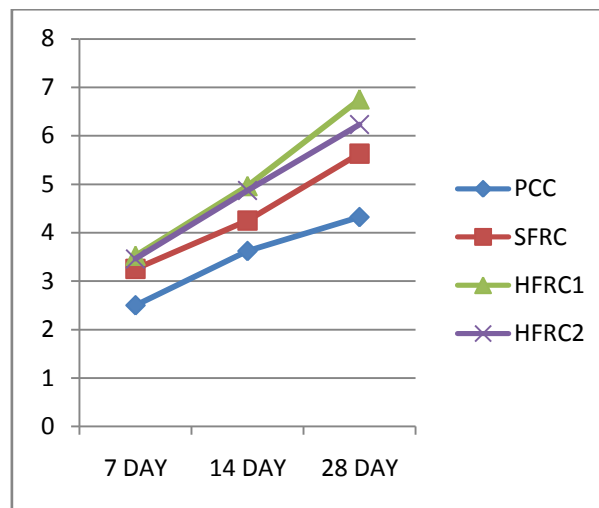


Fig 5 Result comparison of flexural strength of concrete.

V. CONCLUSION

In this project, the mix design for control concrete grade of M25 have been design as 1:1.38:2.52. Hybrid Fibre reinforced concrete is useful to improve flexural properties of concrete. This hybrid fibre reinforced concrete required have been arrived from the control concrete with addition of different types of three types of fibres by weight of cement. From the above results HFRC1 gives high flexural strength compare to other strengthening systems. In this systems contain fibre dosage of 1% of glass fibre and 0.2% of glass fibre

- Ultimate load carrying capacity of the HFRC1 is increased up to 40% compare to conventional concrete.
- Micro cracks will be controlled in this strengthening system.
- The compressive strength, split tensile strength and flexural strength for control concrete was lower than Hybrid Fibre Reinforced concrete.

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