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STRUCTURAL BEHAVIOUR OF HIGH PERFRMANCE FIBRE REINFRCEDED CONCRETE BEAM

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ABSTRACT

Tests on conventionally reinforced concrete beam specimens, containing steel fibres in 1.5% of volume fraction, have been conducted to establish load–deflection curves. An experimental program consisting of tests on HPFRC beams with conventional reinforcement and reinforced concrete beams was conducted under monotonic loading The various parameters, such as, first crack load, ultimate load, ductility factor, toughness and stiffness characteristics of beams with and without steel fibres have been carried out and a quantitative comparison was made on significant stages of loading. It was observed that HPFRC beams showed enhanced properties compared to that of RC beams. The various parameters were obtained in the experimental investigation of beams.The beams were cast with the following reinforcement details are 2 numbers of 10mm diameter rods was used as main reinforcement, 2 numbers at top and 2 numbers at bottom. 8mm diameter stirrups spaced at 100mm centre to centre were used as shear reinforcement.

1.INTRODUCTION

Extensive research in the field of concrete technology has lead to the development of special types of concretes which are capable of eliminating, to a great degree these basic deficiencies. For many applications, it is becoming increasingly popular to reinforce to the concrete with small, randomly distributed fibers. Plain cement concrete is weak in tension and has limited ductility and little resistance to cracking. Micro cracks are present in concrete and because of its poor tensile strength; the cracks propagate with the application of load leading to brittle fracture of concrete High Performance Concrete is used for concrete mixture which possess high workability, high durability, high modulus of elasticity, high density, high dimensional stability, low permeability and resistance to chemical attack. Reduction of w\c ratio will result in high strength concrete. But reduction in w\c ratio to less than 0.3 will greatly improve the qualities of transition zone to give inherent qualities expected in HPC.

1.1 FIBRE REINFORCED CONCRETE

Fiber reinforced concrete (FRC) is a concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres that character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities.

The characteristic of fibre reinforced concrete are changed by the alteration of quantities of concrete, fibre substances, geometric configuration, dispersals, direction and concentration. It is special type of concrete in which cement based matrix is reinforced with ordered or random distribution of fibers. The addition of fibres to the conventional concrete is varying from 1-2% by volume depending on the geometry of fibres and type of application. The inclusion of steel fibres in concrete is to delay and control tensile cracking of composite material.

1.2 NECCESITY OF HIGH PERFORMANCE FIBRE REINFORCED CONCRETE

High performance fiber reinforced concrete is developing quickly to a modern structural material with a high potential. FRC is containing fibrous material which increases its integrity. Fibre in the cement based matrix acts as a cracks arrester which restricts the growth of flaws in the matrix, preventing these from enlarging under load, into the cracks, which eventually cause failure. Fibers include steel fibers that the character of FRC changes with varying concretes, fiber materials, geometries, distribution, orientation and densities.

1.3 OBJECTIVE OF THE PROJECT

1. To study the load deformation behavior of RC beam with hybrid fibres as secondary reinforcement.
2. To determine the load carrying capacity, ductility and energy characteristic of RC beam.
3. To compare the behaviour of RC beams with and without fibres.
4. To study the influence of shapes and geometry of the fibre by conducting experiment.
5. To get the optimum fibre content for each type of fibre.
6. To study the influence of hybrid fibre in HPFR

2.LITERATURE REVIEW

2.1 REVIEW OF LITERATURE

Chote Soranakom et al (2009) concluded that flexural design of fiber reinforced concrete are The equations allow generation of flexural moment-curvature response of a rectangular beam section for use in structural analysis calculations in addition to design charts for strain softening fiber-reinforced concrete. To prevent sudden failure after flexural cracking and to control crack width, equations for minimum post-crack tensile strength are also proposed. The analytical tensile strain equations proposed for serviceability limit the average crack width of structural members.

Remigijus Salna et al (2010) concluded that the different models of estimation of fiber shape on the strength of SFRC are analyzed. The analysis shows, that the authors estimate this effect differently. Due to the analysis of models discussed, the pull-out test of four widely used steel fibers is made. The tests show that all specimens fail by straightening the hooks and waves of fibers.

Ramli et al (2011) concluded that the use of steel fiber at small volume fractions (0.5% volume fraction) has clear effects on the properties of high-strength flowable mortar. The use of 1.75% steel fiber as a volumetric fraction gives the highest increase, but beyond this percentage there is a slight decrease in this improvement. The toughness indices results illustrate that the inclusion of steel fiber leads to significant improvements in the ductility and the absorption capacity as the volume fraction of the steel fiber is increased.

3. EXPERIMENTAL INVESTIGATION

. A proportion of 70% hooked fibres and 30% crimpled fibres are adopted in this investigation.

The volume fraction of fibre is fixed as 1.5% for all the beams. An experimental Investigation have been carried out study and compare the behaviour of high performance concrete and high performance fibre reinforced concrete flexural members under monotonic loading. Where two different types of fibres crimpled steel fibre and hooked steel fibre are used in casting FRC beam separately and mixed together

The high strength concrete (HSC) of M60 mix with crimped and hooked end steel fibers were used in the present study. The ingredients of M60 mix HPFRC

.3.1 PHYSICAL PRPERTIES OF CEMENT

Table 3.1: Physical Properties of Cement

	Properties of cement	**Result**
1	Fines of cement	320kg/m^2
2	Grade of cement	53
3	Specific gravity of cement	3.15
4	Initial setting time	30 min
5	Final setting time	600min
6	Soundness	0.80%

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3.2 PROPERTIES OF CARSE AGGREGATE

Table 3.2 properties of coarse aggregate

S.no	Properties	Result
1	Specific gravity	2.75
2	Size of aggregate	10mm
3	Fineness modulus	4.82
4	Water absorption	0.7%
5	Impact test	15.2%

Table 3.3 SIEVE ANALYSIS FOR COARSE AGGREGATE

IS sieve size	Weight retained on each sieve (kg)	Cumulative weight retained (kg)	Cumulative % weight retained	Cumulative % passing
80mm	0	0	0	100
40mm	0	0	0	100
20mm	3.6	3.6	72	28
4.75mm	1.4	5	100	0
2.36mm	0	0	100	0
1.18mm	0	0	100	0
600µ	0	0	100	0
300µ	0	0	100	0
75µ	0	0	100	0
Total	5	0	673	0

Fineness modulus of CA = Cumulative percentage weight retained/10

= 671/100 = 6.71

3.3 STEEL FIBRES

3.3.1 BEHAVIOUR OF STEEL FIBRES

Steel fibres, the commonly used type, are produced by cutting round wires into short lengths. The typical diameters lie in the range of 0.25 to 0.75mm. Steel fibers having a rectangular cross-section produced by slitting the sheets about 0.25mm thick.

For improving the mechanical bond between the fibre and matrix, crimped and hook ended fibres are normally produced. The aspect

ratio of fibres which have been employed vary from about 30 to 250. Fibres made from mild steel drawn wire conforming to IS: 280-1976 with the diameter of wire varying from 0.3 to 0.5mm have been practically used in India.

Hooked End fibre and Crimpled fibre are used separately and mixed in the mix proportion of 70% - 30% by volume at a total volume fraction of 1.5%. The length of fibres are 30 and 38. The aspect ratios are 48.4 and 76. The diameter of the fibres are 0.62 and 0.55. the tensile strength are 110MPa and 400-600MPa respectively. The different types of steel fibres are shown in figure 3.1 and 3.2.

FIG3.1 HOOKED END FIBER

FIG3.2 CRIMPLED FIBER

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3.4 CUBE COMPRESSIVE STRENGTH

The aim of these experimental tests is to determine the maximum load carrying capacity of the test specimen. For each mix samples of 150x150x150 mm cube for compressive strength was prepared. After 24 hours sample was demoulded and curried for the period of 14 and 28 days. Samples of cubes were tested at the age of 14 and 28 days curing.

FIG3.3 COMPRESSIVE TEST

TABLE 3.4 CUBE COMPRESSIVE STRENGTH

S.NO	TYPE OF CONCRETE	COMPRESSIVE LOAD AT FAILURE (N)	COMPRESSIVE STRENGTH (N/mm^2)
1	B1 & B2	1352	60.4
2	B3	1573	69.91
3	B4	1574	69.65
4	B5	1450	64

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3.4.1 REINFORCEMENT DETAILS

The beams were cast with the following reinforcement details are 2 numbers of 10mm diameter rods was used as main reinforcement, 2 numbers at top and 2 numbers at bottom. 8mm diameter stirrups spaced at 100mm centre to centre were used as shear reinforcement. The dimensions of beam were 1200mm X 120mm X 80mm. The reinforcement details are shown in the fig 3.4

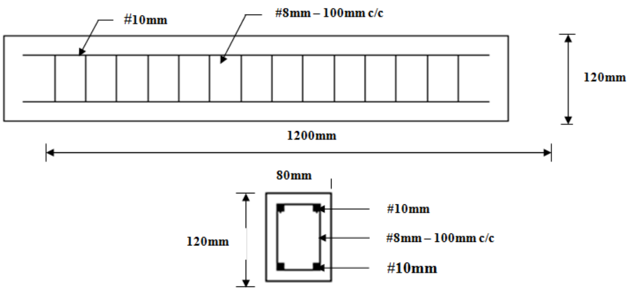
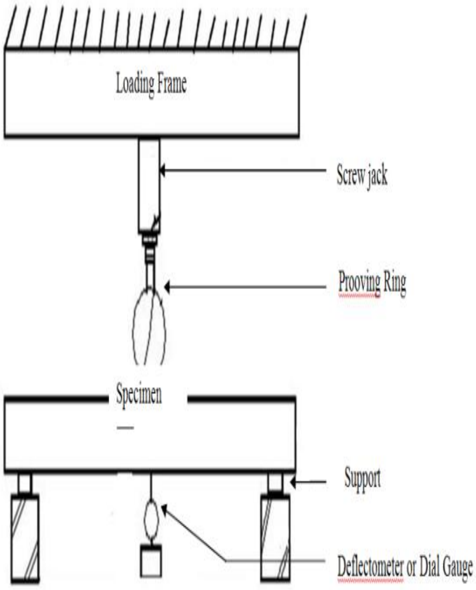


Fig 3.4 Reinforcement Details of Casted beam

EXPERIMENTAL SETUP

All beam specimens were tested under a loading frame of 500 kN capacity. Beams were simply supported over a span of 1200 mm. The load was applied through screw jack connected to manually operated. The load was distributed as symmetrical to centerline of beam on the top face. Loading arrangement for beam



specimens is shown in fig. 4.13

Fig 4.1 Experimental Setup

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Fig 4.2 Testing of beam

5. EXPERIMENTAL RESULTS AND DISCUSSIONS

5.1COMPARISON OF CUBE COMPRESSIVE STRENGTH

The compressive strength of HPC is found to be less than the HPFRC. Compressive strength of Hybrid HPFRC is found to be good. HPFRC-Hooked end have higher strength compare to HPFRC-Hooked end. The period of curing is 28 days

Table 5.1 Comparison of Cube Compressive strength

S.NO	TYPE OF CONCRETE	COMPRESSIVE LOAD AT FAILURE (N)	COMPRESSIVE STRENGTH (N/mm^2)
1	B1 & B2	1352	60.4
2	B3	1573	69.91
3	B4	1574	69.65
4	B5	1450	64

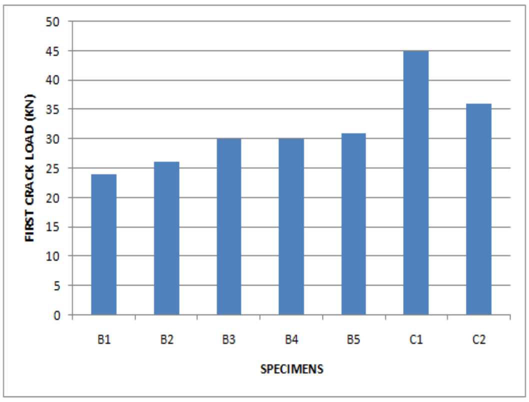

Fig 5.1 Comparison of First Crack Load

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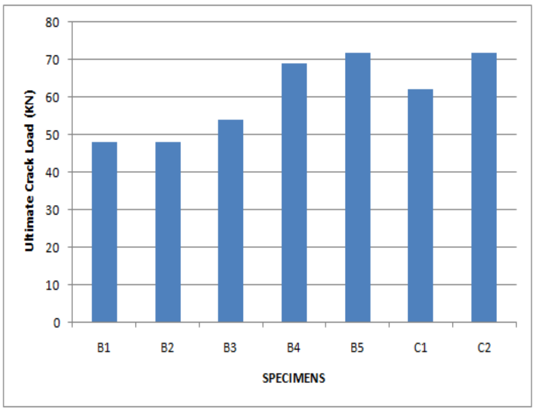


Fig 5.2 Comparison of Ultimate Crack Load

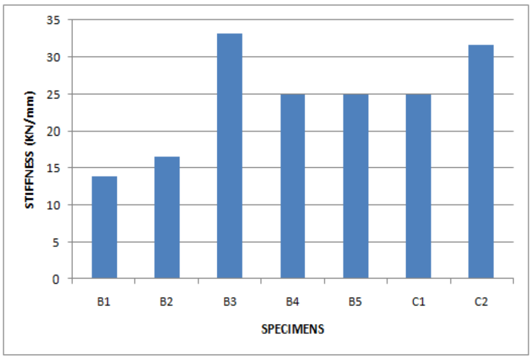


Fig 5.3 Comparison of Stiffness

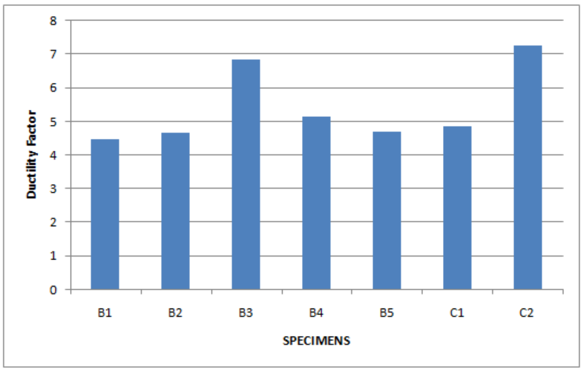
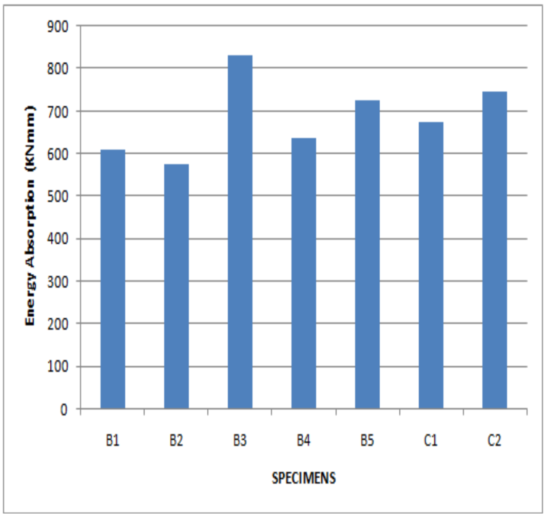
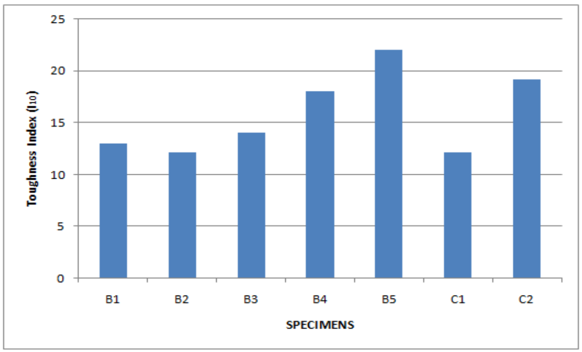


Fig5.4 Comparison of Ductility



Factor

Fig5.5 Comparison of Energy



Absorption

Fig 5.6 Comparison of Toughness Index (I_{10}

6. MODE OF FAILURE

S.NO	PARAMETER	B1	B2	B3	B4	B5	C1	C2
1	First Crack Load (kN)	24	26	30	30	31	45	36
2	Ultimate Crack Load (kN)	48	48	54	69	72	62	72
3	Stiffness (kN/mm)	13.73	16.43	33.33	25	25	25	31.66
4	Ductility Factor	4.48	4.65	6.84	5.15	4.7	4.85	7.25
5	Energy Absorption (kNmm)	610	575	830	635	725	675	745
6	Toughness Index (I_5)	4.6	4.8	6.41	8	8	4.69	8.63
7	Toughness Index (I_{10})	13	12.14	14	18	22	12.13	19.20

FIG.6.1 BEAM OF PARAMENTER

7.CONCLUSION

1. The stiffness for the hybrid fibre reinforced concrete beam was 2.427 times greater than that of conventional RC beam. The stiffness for hybrid, crimpled and hooked end beams are about 142%, 82% and 82% respectively more than that of conventional RC beam
2. The ductility value of hybrid fibre RC beam is about 1.526 times than that of conventional RC beam and 1.149 times than that of hooked end RC beams.
3. The energy absorption of hybrid fibre RC beam is about 1.36 times than that of conventional RC beam and 1.04 times than that of crimpled RC beams.
4. The first crack load for the hybrid fibre reinforced concrete beam was 1.25 times greater than conventional RC beam. The first crack load for hybrid, crimpled and hooked end beams are about 20%, 22.58% and 20% respectively more than that of conventional beam.
5. The ultimate load carrying capacity for the hybrid fibre reinforced concrete beam was 1.125 times greater than that of conventional RC beam. The ultimate load for hybrid, crimpled and hooked end beams are about 12.5%, 50% and 43.75% respectively more than that of conventional RC beam

The experimental investigation is carried out to study the behaviour of High Performance Fibre Reinforced Concrete Beam. The test results are compared with that of the Conventional high performance reinforced concrete beam. It based on study parameters such as first crack load, ultimate load, ductility factor, energy absorption, stiffness and toughness we compare all the beams with that of conventional concrete beam.

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