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Experimental Study on Behaviour of Steel Fibre Reinforced Concrete

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Abstract:

An experimental investigation of the behavior of concrete beams reinforced with conventional beams subjected to flexural loading is presented. An experimental program consisting of tests on steel fiber reinforced concrete (SFRC) beams with conventional reinforcement and reinforced concrete (RC) beams was conducted under flexural loading. SFRC beams include two types of beams containing beams with fully hybrid fibers and beams with fibers only in hinged zones. The cross-sectional dimensions and span of beams were fixed same for all types of beams. The dimensions of the beams were “80mm x 120mm x 2200mm”. Tests on conventionally reinforced concrete beam specimens, containing Steel fibers in different proportions, have been conducted to establish load deflection curves. The various parameters, such as, first crack load, ultimate load and stiffness characteristics, energy absorption, toughness index of beams with and without steel fibers have been carried out and a quantitative comparison was made on significant stages of loading. It was observed that SFRC beams showed enhanced properties compared to that of RC beam. Finally calculate the ultimate strength of the conventionally reinforced beams with steel fibers. The ultimate loads obtained in the experimental investigation were also compared for all types of beams

1.1 INTRODUCTION

Concrete is structural components exist in buildings and bridges in different forms. Understanding the response of these components during loading is crucial to the development of an overall efficient and safe structure. Different methods have been utilized to study the response of structural components. Experimental based testing has been widely used as a means to analyze individual elements and the effects of concrete strength under loading. It has now become the choice method to analyze concrete structural components. Concrete can withstand whatever compressive forces, more over its workable and durable material, can be formed to any shape, also it’s a cheap material. At the same time, it requires special care and precaution during casting otherwise it could cause cracks and failure. High performance fiber reinforced concrete is developing quickly to a modern structural material with a high potential. The results obtained was focused on the same as before also comparison of first cracking load, ultimate load, work-done in linear and nonlinear region, and load deflection nature between these different reinforcement ratios of the analytical beam. An experimental program conducted to study the flexural behavior and redistribution in moment of Reinforced high strength concrete (RHSC) continuous beams. Comparisons between experimental and predicted moment and load capacity show that the proposed model agrees very well with the test results, thus justifying the use of the proposed model for HSC and NSC in strengthened beams. Provides post-crack performance with Increased impact and abrasion resistance, load bearing capacity of concrete and Potential reduction of concrete beam depth to the Concrete retains load carrying capability after cracking has occurred in Increased durability and reduced maintenance costs with no requirement for crack control steel mesh, Concrete placement and crack control in one operation. Cost effective alternative to conventional steel mesh reinforcement no need to purchase and store additional material and no delays to fast track schedule with Easier positioning of joints to Reduced site labor requirement for on-site handling and cutting of steel reinforcement also no secondary steel mesh is required and reinforcement is automatically positioned Controls cracking which occurs in the hardened state even distribution of fibers throughout the concrete. A tougher surface with fewer bleed holes Enhanced load bearing capability which Improved flexural properties.

1.2 Properties and Behavior of Concrete

The Properties and strength development of concrete basically depends upon the characteristics of the hardened cement paste, aggregates and interface transition zone between the hardened cement paste and aggregates. It is an established fact that the strength of the hardening cement paste depends on the degree of porosity.

The concrete used in the mixture is of a usual type, although the proportions should be varied to obtain good workability and take full advantage of the fibers. If the cross section is not round, then the diameter of a circular section with the same area is used.

There is reduction in the total pore volume of concrete with the increase in the amount of hydrates. The proportions of hydrates can be increased by the use of high early strength cement or silica fume. Mineral additives with ultrafine particles are also used is HPC. Silica fume, blast furnace slag or fly ash and meta-kaolin are the commonly used mineral admixtures in the production of high-performance concrete. The replacement of the cement by silica fume can increase the strength remarkably. This is attributed to calcium silicate hydrates generated by ultra-fine particles. Silica fumes and calcium hydroxide around the aggregates improve the bond between the aggregates and the cement matrix.

1.3 Development of Fiber Reinforced Concrete

Fiber Reinforced Concrete is a concrete mix that contains short, discrete fibers that are uniformly distributed and randomly oriented. Fibers used are steel fibers, synthetic fibers, glass fibers, and natural fibers. The main function of the fibers in members is that of resisting the opening of the cracks due to micro cracking, increasing the ability of the member to with stand loads.

The characteristic of fiber reinforced concreteF is changed by the alteration of quantities of concrete, fiber substances, geometric configuration, dispersal, direction and concentration. It is a special type of concrete in which cement-based matrix is reinforced with ordered or random distribution of fiber.

Steel fiber reinforcement thus transfers an inherent unstable tensile crack propagation to slow controlled crack growth. This crack controlling property of fiber reinforcement delays the onset of flexure and shear cracking. It imparts extensive post cracking behavior and significantly enhances the ductility and energy absorption capacity of the composite.

1.4 Necessities Of SFRC

Improve mix cohesion, improving pumpability over long distances Improve freeze-thaw resistance and also Improve resistance to explosive spalling in case of a severe fire Improve impact resistance to plastic shrinkage during curing and improve structural strength Reduce steel reinforcement requirements Improve Ductility Reduce crack widths and control the crack widths tightly thus improve durability Improve impact & abrasion resistance Improve freeze-thaw resistance. Both concrete often used in construction of crimped and steel fibers are in order to combine the benefits of both products; structural improvements provided by steel fibers and the resistance to explosive spalling and plastic shrinkage improvements provided by polymeric fibers. In certain specific circumstances, steel fiber can entirely replace traditional steel reinforcement bar in reinforced concrete. There are increasing numbers of tunneling projects using precast lining segments reinforced only with steel fibers

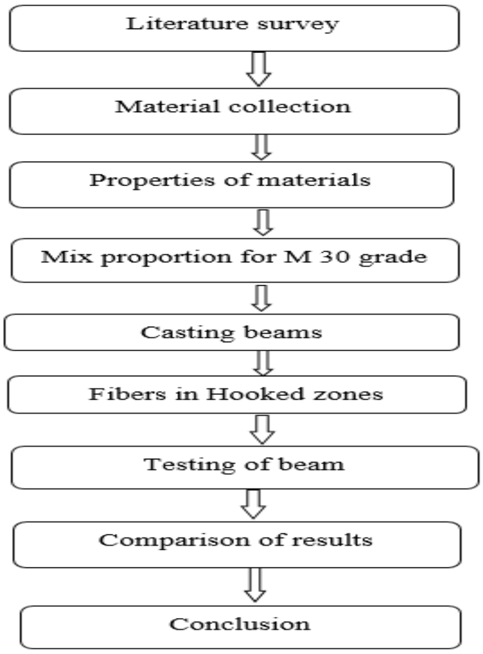
1.5 Need for The Present Study

Nowadays natural disaster such as earthquake, wind force etc. plays an important role in the construction industry. So, buildings and other construction work should be designed in good manner, which resist higher loads and seismic forces. Ductility and energy absorption capacity are the main requirement of the earthquake resistant structure. Fiber reinforced concrete possess high strength, improved ductility and enhancing energy absorption capacity. So, the study on the flexural behavior of beams with fibers under monotonic loading is needed

1.6 Scope & Objective

Conventional reinforced concrete develops microcracks and is weak under tension. Fibers are used as supplementary reinforcement to RCC to prevent the spread of microcracks, and it also enhances the mechanical qualities of concrete. This study will examine the effects of hybrid fibers in traditional RCC. In order to examine how FRC beams behave in the ultimate and post-ultimate regions, both fiber-containing and fiber-free beams must be evaluated under monotonic loading. to ascertain the RC beam's energy profile, ductility, and moment bearing capacity. to evaluate how RC beams, behave both with and without fiber.

1.7 METHODOLOGY



1.8 Materials Used

PPC cement of 53 grade is used for this experiment study. The cement has a specific gravity of 3.1

Silica fume is a byproduct in the Silicon and ferrosilicon industry was used as a mineral admixture in concrete mixes. It contains large proportion of silicon-di-oxide (sio2) which is about 90%of silica fume constituents. The fineness in silica fume in terms of specific surface area is around 20000cm2/g. Silica fume consists of ultra-fine (<1um) particles and increases the bond strength between cement paste and aggregate by making the interfacial zone denser.

Aggregates are the major ingredients of concrete. It acts as economical space filler. The IS 383 specifies the requirements of aggregate. They are inert and are broadly divided into two categories i.e., fine and coarse aggregate depending on their size. The crushed rock is used as coarse aggregate with specific gravity 2.66 and Zone II River sand preferred for fine aggregate.

Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials. Crushed stone aggregate of maximum size 12.5mm are used as coarse aggregate. Thus, have specific gravity value of 2.7 and fineness modulus of about 7. Fine aggregates shall not contain dust, lumps, soft or flaky materials, mica or other deleterious materials. Fine aggregates, having positive alkali-silica reaction shall not be used. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5

1.9 Crimped Fiber

The length of the fibre is 30 mm. The aspect ratio of fibre is 48.4. The diameter of hooked end fibres is 0.62mm. The tensile strength of the fibre is 1100Mpa. Fig 2.2 shows the view of the hooked end fibres

Fig 1.1 Hooked End Fibres

Portable water available in the laboratory is used for mixing and curing concrete. cero hyper plats a type of plasterer is used to increase the workability of concrete. It is a high range super plasticizing admixture. A dosage of 0.8 % by weight of binder is used for all the mixes. Steel of Fe415 grade with 2 nos of 8mm diameter bar provided at both top and bottom. 6mm diameter tor steel bars were used for stirrups.

1.10 Mix Proportioning

M30 grade concrete mix was designed as per IS 10262-2009. 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 1:1.2:2.2 and water cement ratio 0.3. Volume fractions of 1.5% fibers are used. Also 10 % of cement is replaced by silica fume intend to make HPC 70% end fiber combined with 30 % crimped fiber were mixed together in the required quantity of fibers.

1.11 Dimensions and Reinforcement Details

The beam mold was prepared by standard steel mould having cross section. It is used for casting the beams with and without fibers. Hence the size of the beam is of 80 x 120 x 2200mm.All the beams were cast with following reinforcement details. Four bars of 8mm diameter are used as main reinforcement 2 numbers at top and 2 numbers at bottom, 6mm diameter stirrups are spaced at 100mm c/c to act as shear reinforcement. The reinforcement details for the beam specimens shown in fig 1.2& 1.3

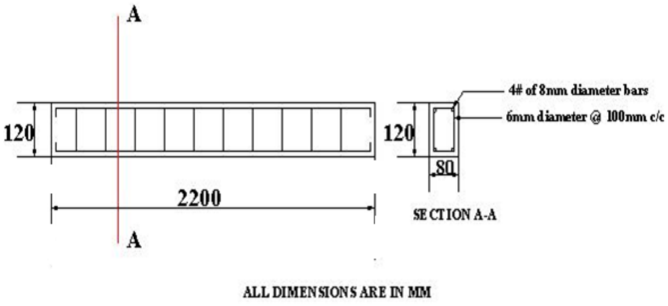


Fig 1.2 Reinforcement details.

Fig 1.3 Reinforcement details.

1.12 Casting of The Specimen

The exact quantities of materials for the specimen were weighted and kept separately before the mixing started. Machine mixing was adopted and the concrete mix was placed in mold layer by layer and compacted well. Hand mixing was adopted for convenient handling of steel fiber. Sand and cement with silica fume were mixed dry and kept separately. Then coarse aggregate was added and approximately quantity of water was sprinkled on the dry mix. In order to avoid the formation of lumps by gentle sprinkling the fibers were randomly oriented in the concrete mix. Beams casted with fully hybrid fibers and fibers only in hinged zone for flexural strength of plain concrete with and without fibers. Fig 1.4 shows the casting of beams.

FIGURE 1.4 CASTING OF BEAMS

1.13 Experimental Program Test Specimens

Test specimens consist of four conventional HPC beams with two different reinforcements with 10mm diameter main reinforcement and 8mm diameter as stirrups and 8mm diameter as main reinforcement and 6mm diameter as stirrups. Then the five SFRC beams are casted with one conventional beam and four SFRC containing 0.8% hybrid steel fibers by volume of concrete. The cross-sectional dimensions and span of beams were fixed same for all types of beams. The dimensions of the beams were 80mm x 120mm x 2200mm. Two types of SFRC beams specimens were cast using hybrid steel fibers for full length of beams with volume fractions of 1.5% with the described reinforcements. The ultimate tensile strength of steel fibers was 584.59 MPa. The aspect ratio of all fibers was kept constant at 75.

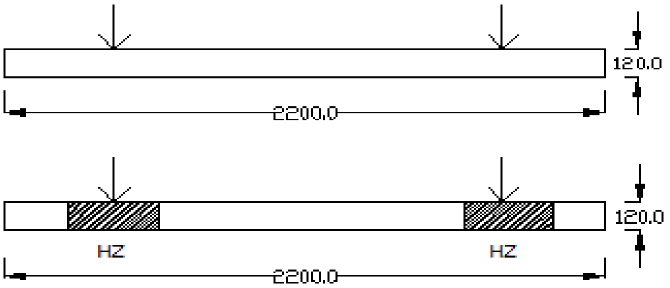


Fig 1.5 Experimental Specimen Setup.

1.14 Preparation of Test Specimens:

For the preparation of specimens, the concrete mix proportion was adopted was 1:1.2:2.2 by weight (cement: sand: coarse aggregate) with water cement ratio of 0.3. The concrete mix was designed to achieve strength of 60 MPa. A suitable dose of admixture named cerahipher plasticizer and silica fume was added in mixes to improve the workability of mixes. For casting of beams steel mould were used. Beams were filled in 4-5 layers, each of approximately 50mm deep, ramming heavily and vibrating the specimens on vibrating table till slurry appears at surface of the specimen. In this way concrete was very well compacted. The side forms of mould were stripped after 24 hours and then these beams were cured for 28 days in curing pond specially constructed for the investigation.

1.15 Loading Arrangement

All beam specimens were tested under a loading frame of 500 KN capacity. Beams were continuous over a span of 2200 mm. The load was applied through a screw jack which is connected with proving ring for applying manual loading. The load was distributed as two-point loads kept apart symmetrical to centerline of beam on the top face. An I section has been place over the beam for the application of two-point loading. Then three dial gauge on the loading point for normal deflection and dial three will be used to measure upward deflection. A proving ring of 10 Ton capacity was placed between test frame and load distributor placed on the test specimen. Gap between test frame and plate was filled by spacers. Loading arrangement for beam specimens is shown in Fig.1.6

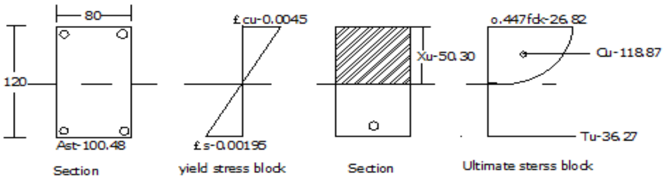
Fig.1.6. Experimental set up

1.16 Results & Discussion

The structural behavior of HPFRC beam has been studied in this project. Two types of beams namely HPC and HPFRC beams has been cast and tested under monotonic loading. Four conventional concrete beams are cast as high-performance concrete and in HPFRC beams were cast namely with fully hybrid fibers and fiber only in hinged zone and beam without fibers respectively. In hybrid fiber reinforced concrete beam, the specimen is incorporated with crimped fibers in the mix proportion of 70%-30% by volume at a total volume fraction of 1.5%. Then the eight beams are subjected to monotonic loading and eight beams are subjected to monotonic loading with the help of screw jack and the deflection is measured by using deflectometer. After testing, various parameters such as energy absorption, cumulative ductility, first crack load and ultimate load are compared with that of conventional concrete beam.

1.17 Behavior Of Continuous Beam Under Monotonic Loading

There are nine numbers of continuous beams were cast and tested. Five beam is made with conventional concrete, two is made with fully fiber and other two is made by adding fibers only in hinged zones. The beams were designated as follows for easy reference and presentations of the test result. Continuous beam with conventional concrete with 8mm diameter main reinforcement and 6mm diameter stirrups with curtailment BEAM- A.



Continuous beam with conventional concrete with 10mm diameter main reinforcement and 8mm diameter stirrups with curtailment BEAM- B. Continuous beam with conventional concrete with 10mm diameter main reinforcement and 8mm diameter stirrups without curtailment BEAM-C. Continuous beam with conventional concrete with 8mm diameter main reinforcement and 6mm diameter stirrups without curtailment BEAM- D.

Continuous beam with conventional concrete – CB

Continuous beams with two numbers of fully Hybrid fiber (1.5% Vf) – FH

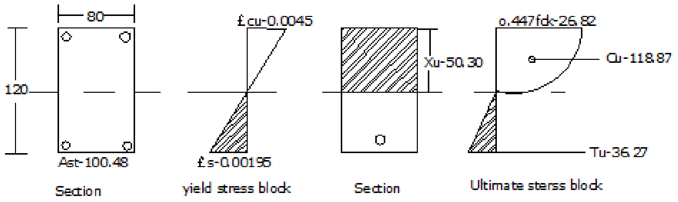
Continuous beam with two numbers of fibers in hinged zones only (1.5%Vf) – FHZ

Continuous beam with Hybrid fiber (+30% Crimped)

1.18 STRESS BLOCK:

The stress blocks determine the area of steel in tension and compression also used to determine the proper dimensions in the section with the compression and tension that applied in both the form of with and without fibers for both steel and concrete.

1.19 Stress block with fiber



1.20 Results and Discussion:

Totally nine specimens have been tested for their behavior under monotonic loading. In order to study the influence of fibers. The test results are discussed as below. The different parameters such load carrying capacity, stiffness, ductility, energy absorption capacity, toughness index etc. have been calculated for all beams re shown in Table.1 and 2.

Table.1 Test results

Parameter		BEAM			
		A	B	C	D
% Of fiber (Vf)		1.5	1.5	1.5	1.5
First crack load (KN)		75	78	84	84
Ultimate load (KN)		90	129	123	90
Stiffness (KN/mm)		66.67	100	100	66.67
Ductility factor		6.8	6	4.09	4.28
Energy Absorption (KN.mm)	Absolute	870	840	640	720
	Reality	1	0.96	0.73	0.94
Toughness Index (I5)		5.1	6	6.28	4.28
Toughness Index (I10)		10.4	13.44	14.55	11.9

Table.2 Test Results

Parameter		BEAM				
		FH1	FH2	FHZ1	FHZ2	CB
% Of fiber (Vf)		1.5	1.5	1.5	1.5	1.5
First crack load (KN)		75	57	55	60	39
Ultimate load (KN)		120	117	93	117	114
Stiffness (KN/mm)		66.6	57.5	66.67	66.67	50
Ductility factor		5.46	7	5.46	6.156	4.85
Energy Absorption (KN.mm)	Absolute	610	650	620	675	570
	Reality	1.24	1.22	1.08	1.24	1
Toughness Index (I5)		7.5	7.5	7.71	7.21	5.26

Toughness Index (I10)	13.75	13.45	14.375	13.87	10.24

1.21 Load Carrying Capacity:

The beams' ultimate load carrying capacity are displayed in figures 4.6.1 and 4.6.2. In order to select the reinforcement, Beam-A has the largest load carrying capability and Beam-D has the smallest load carrying capacity. When compared to a beam with fibers just in the hinged zone, the completely hybrid FH beam exhibits better resistance to load carrying capability. When compared to fully hybrid fiber beams and beams with fibers solely in the hinged zone, ordinary concrete beams without fiber will only be able to support a minimum amount of weight. Compared to the FHZ beam, the FH beam had a greater ultimate crack load. As the fiber concentration grew, so did the first crack load. A maximum ultimate load of 120kN is carried by the beam FH. Theoretical ultimate load for RC beams was calculated as per IS 456: 2000. The beam strength of control specimens was used to determine the ultimate load, stiffness, ductility, energy absorption and toughness index of RC beams tested under monotonic loading.

1.22 First Crack load:

The predominance in the load deflection curve at the beginning of loading was used to calculate the first crack load. The first crack load of all SFRC beams was much higher than that of reinforced concrete beams. When it comes to beams with 1.5 percent steel fibers, a typical concrete beam devoid of fibers will only be able to support a minimum amount of weight in comparison to fully hybrid fiber beams and beams with fibers located only in the hinged zone. Compared to the FHZ beam, the FH beam had a larger initial crack load. As the fiber concentration grew, so did the first crack load. A maximum first fracture load of 75kN is carried by the beam FH.

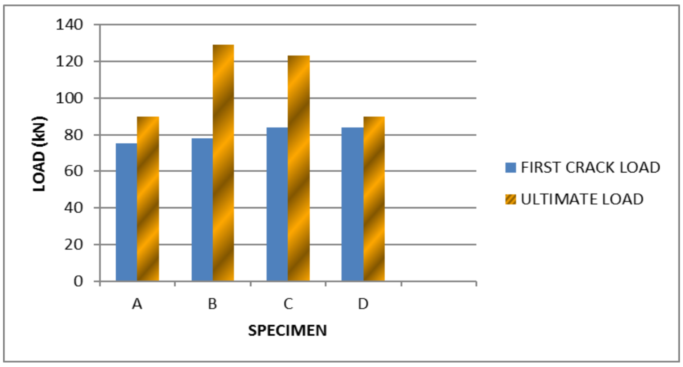


Fig. 1 First crack load and Ultimate load for without fiber

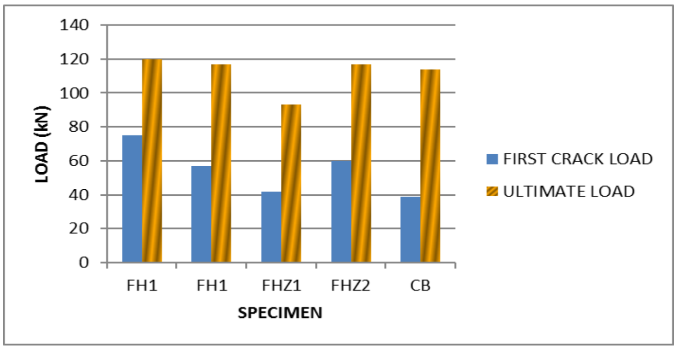


Fig. 2 First crack load and Ultimate load for with and without fiber.

4.7 Load deflection behavior

These investigations it is observed that the load deflection curve is linear up to the first crack load. Further increase in load, caused multiple cracks and the curve deviated from linearity in to a non-linear region. Comparisons of load deflection behavior for all the beams are shown in fig4.7.1, fig4.7.2, fig4.7.3, fig4.7.4. From the Beam-D which carries minimum load carrying capacity. From the comparisons the Beam FH (with fully hybrid fibers) carries a maximum load 120 KN. Then the specimen two of FH will carries 117 KN. Then these beams behave flexural cracks only. Then the other type of beam with fibers in hinged zone will carry load of 93 KN for specimen one and 117 KN for specimen two respectively. This beam also behaves only in flexural zone. These beams are compared to the conventional beam which carries 114 KN which behaves only in flexural zone. From the investigations all these beams behave only in flexure no shear cracks are occurred in any of these beams.

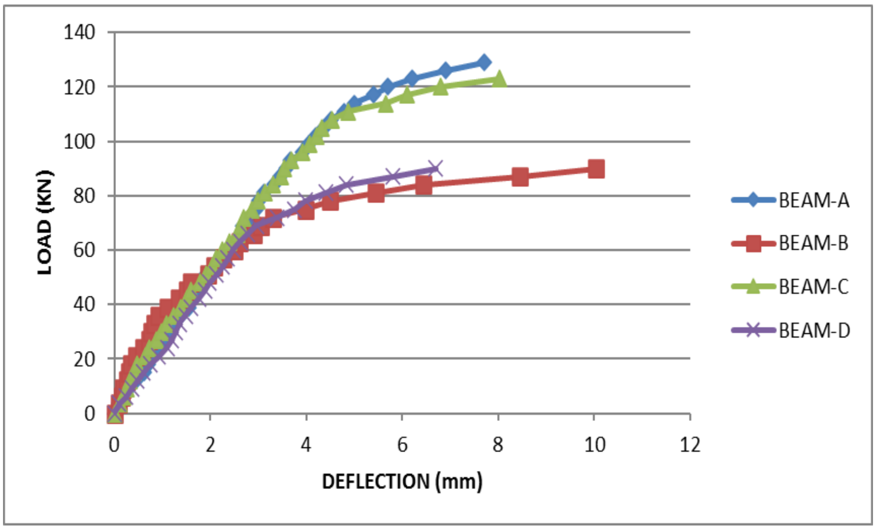


Fig.3 Comparison of Load deflection behavior for D1of all the beams WOF

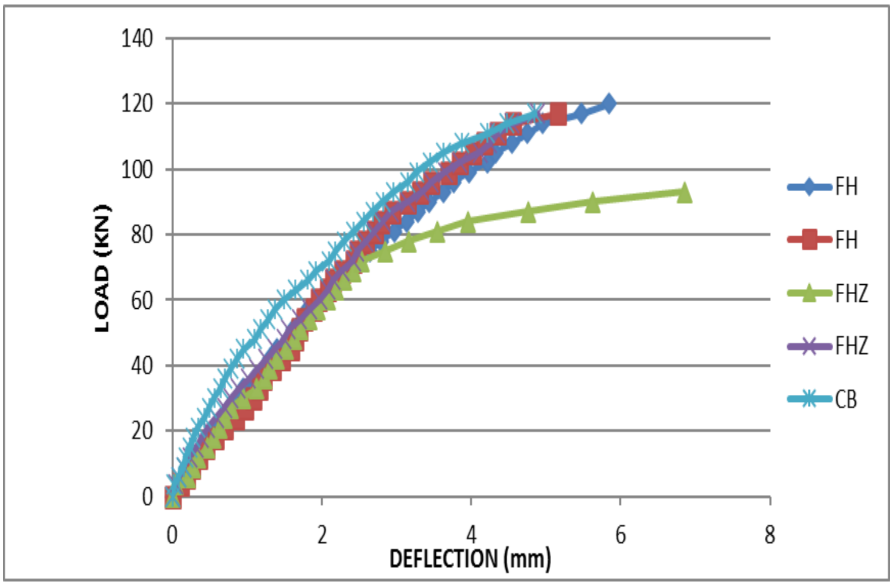


Fig.4 Comparison of Load deflection behavior for D1of all the beams WF

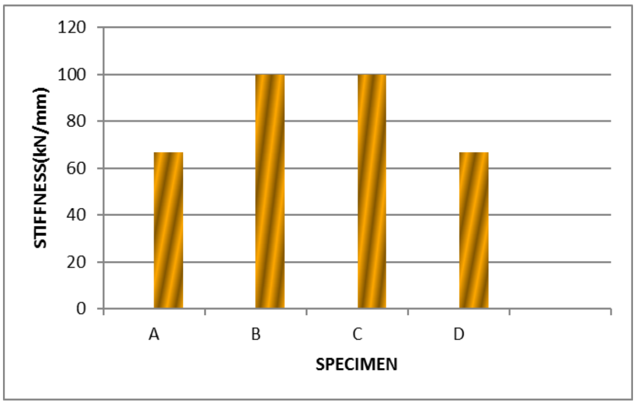


Fig.5 Comparison of Load deflection behavior for D2 of all the beams WOF

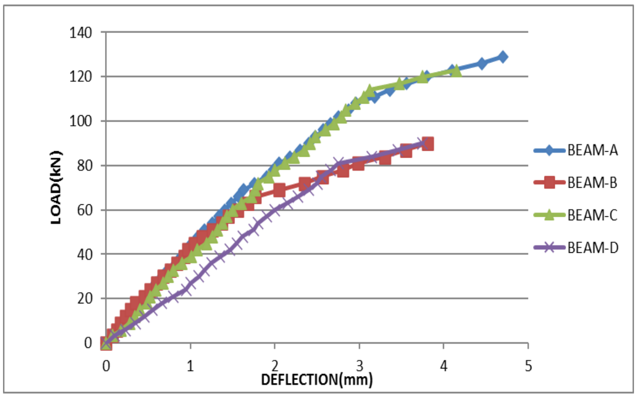


Fig.6 Comparison of Load deflection behavior for D2 of all the beams WF

4.8 Stiffness characteristics:

Stiffness is defined as the load required to cause unit deflection of the beam. The Deflection calculated in each beams gave the stiffness of the beam. The 1.5% volume fraction of fibers in HPFRC increased the stiffness of the beams. The beam is casted in two different forms one with fully hybrid fiber and fibers only in hinged zone as FH and FHZ. Each beam to calculate the deflection from continuous beams. From the values stiffness has been calculated. The stiffness of beam FHZ specimen one will be having more similar stiffness value. The specimen two of FHZ carries a maximum stiffness value in both dial one and dial two. The various of stiffness characteristics for all the beams are shown in figure.5. The beams FH and FHZ are almost similar in stiffness characteristic with 66.67kN/mm with FHZ slightly more consistent than FH based on stiffness characteristics.

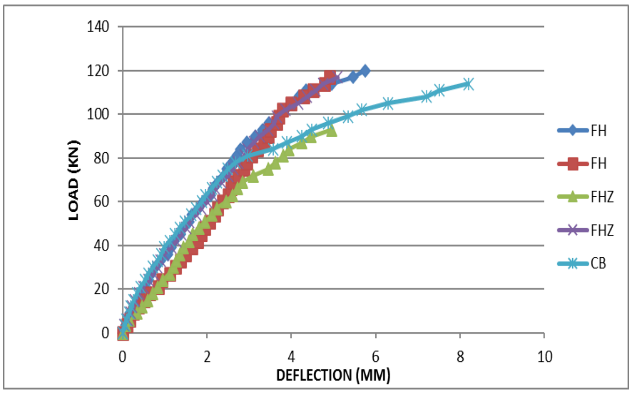


Fig.7 Comparison of Stiffness characteristics for all the beams WOF

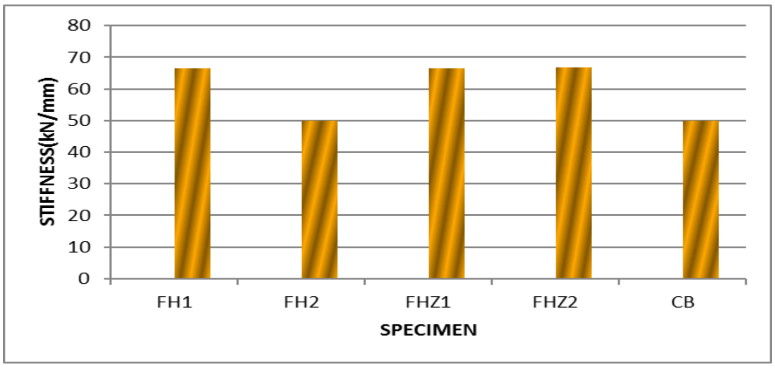


Fig.8 Comparison of Stiffness characteristics for all the beams WF

4.9 Ductility Factor:

It is defined as the ability of a member undergoes inelastic deformations beyond the yield deformations without significant loss in its load carrying capacity. The 1.5% volume fraction of fibers in HPFRC increased the ductility of the beams. The ductility of beam FH specimen two will be have a maximum at dial two values. At the same FHZ specimens has both dial one and two are almost equal. The specimen one of FHZ carries a minimum of ductility in both dials. The specimen two of FHZ is also minimum ductility. The various of ductility for all the beams is shown in figure.5. The beams FH are comparatively higher than FHZ. The beam FH has a maximum of 7. The ductility of a flexural member can be obtained from its load-deflection curve. The variations of ductility of all the five beams are shown in figure4.9.1 & 4.9.2.

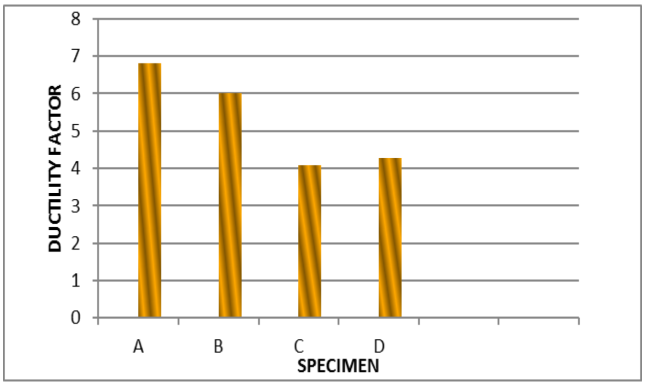


Fig.9 Comparison of Ductility for all the beams WOF

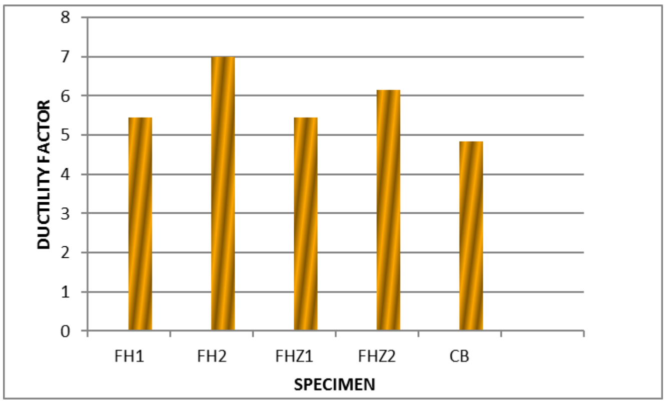


Fig.10 Comparison of Cumulative Ductility for all the beams WF

4.10 Energy absorption capacity:

The area under the load-deflection curve represents the energy absorption capacity of the whole specimen. The beam is casted in two different forms one with fully hybrid fiber and fibers only in hinged zone as FH and FHZ. The energy absorption of beam FH specimen one will be have a maximum at both dial values. The cumulative energy absorption capacity of FH beam was 710kNmm while that of FZH and CB beams have the values as 675kNmm, 570 kNmm respectively. The cumulative energy absorption capacity of FH (hybrid) beam was higher than that of other beams as shown in figure.4.10.2

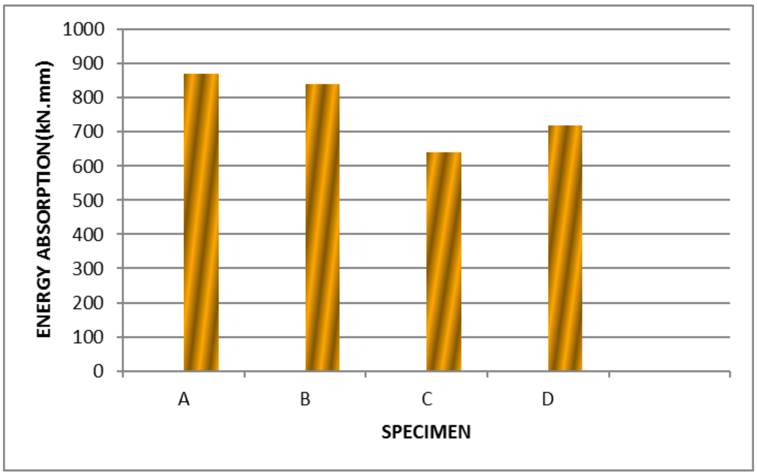


Fig.11 Comparison Energy absorption capacity for all the beams WOF

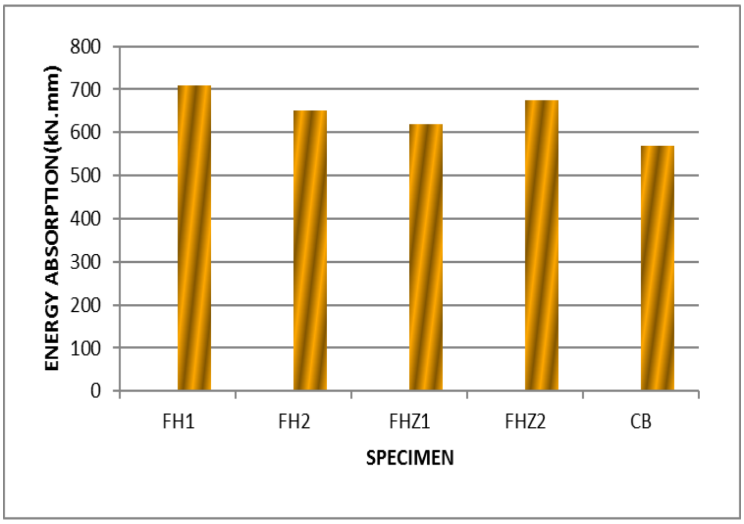


Fig.12 Comparison Energy absorption capacity for all the beams WF

4.11 Toughness index(I_5) & (I_{10})

The area under the load-deflection curve represents the energy absorption capacity of the whole specimen. The cumulative energy absorption capacity of FHZ beam was 7.71 while that of FZH and CHPC beams have the values as 7.5 and 5.26 respectively. The cumulative Toughness index(I5) capacity of FHZ (hybrid) beam was higher than that of other beams as shown in figure.8. The cumulative energy absorption of FHZ beam was 14.37 while that of FZH and CHPC beams have the values as 13.75 and 10.24 respectively in(I10). The cumulative Toughness index(I5) capacity of FHZ (hybrid) beam was higher than that of other beams as shown in figure.9.

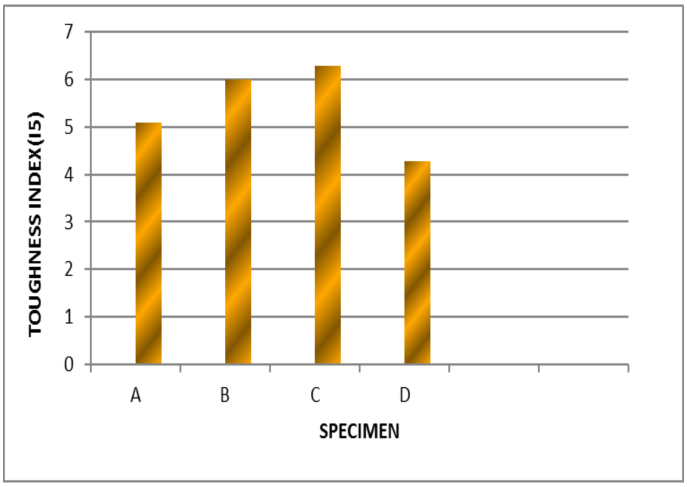


Fig.13 Comparison Toughness Index(I_5) for all the beams WOF

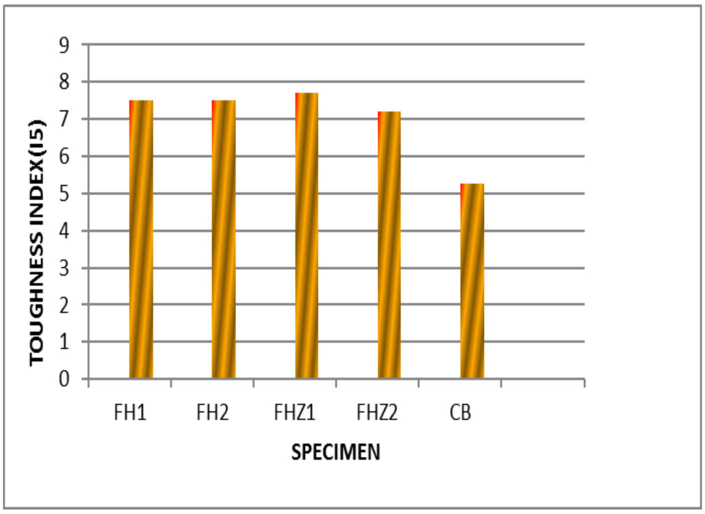


Fig.14 Comparison Toughness Index(I_5) for all the beams WF

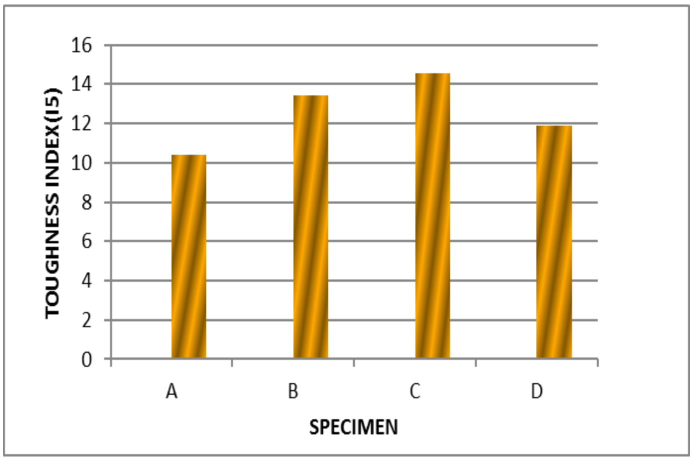


Fig.15 Comparison Toughness Index(I_{10}) for all the beams WOF

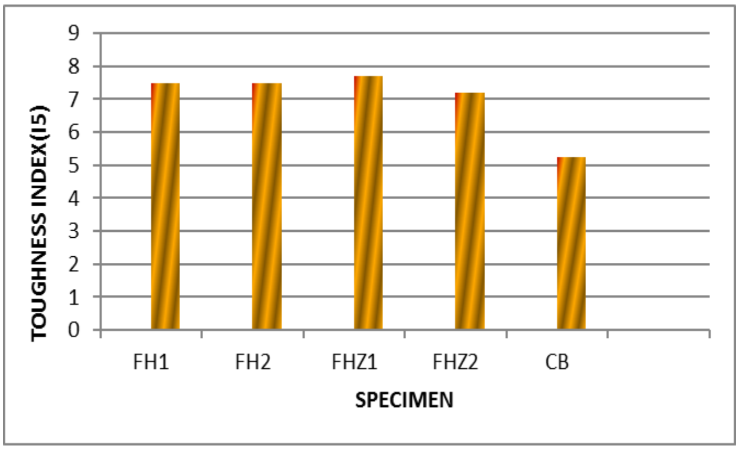


Fig.16 Comparison Toughness Index(I_{10}) for all the beams WF

4.12 Behavior and mode of failure

Every specimen saw an increase in loading, and more cracks started to show up in the beam. As the weight increased, more cracks appeared in the beams. Because steel fibers operate as crack arresting material during the initial stage of loading, their presence inside the beam will resist the growth of cracks by building a bridge over the cracks. Figure 8 displayed the tested specimens of the HPC and HPSFRC beams.

Fig.4.12 Failure pattern for all the beams.

5. CONCLUSION

The goal of the experimental investigation is to better understand how high-performance fiber-reinforced concrete beams behave. Comparing the test results to the conventional high performance reinforced concrete beam yields important insights. We compare each beam to a conventional concrete beam using study criteria such energy absorption, ductility factor, ultimate load, and first fracture load.

The following observation has been from the experimental programmed.

- The ultimate load for the FH fiber reinforced concrete beam was greater than that of both FHZ and conventional RC beam. The beam FH carries maximum Ultimate load of 120kN.
- The stiffness for the hybrid fiber reinforced concrete beam was greater than that of conventional RC beam with FH and FHZ are 66.67 KN/mm.
- The stiffness for FH and FHZ beams is almost similar. Both FH and FHZ are more than that of conventional RC beam.

- The ductility value of FH RC beam is maximum 7 which will be comparatively more than that of both FHZ and conventional RC beam.
- The energy absorption of capacity of FH beam was 710kNmm while that of FZH and CB beams have the values as 675kNmm, 570 KNmm respectively. The cumulative energy absorption capacity of FH (hybrid) beam was higher than that of CB and FHZ beams.
- The toughness index(I5) of FHZ beam was 7.71 while that of FH and CB have the values as 7.21 and 5.26 respectively. Therefore, the toughness index (I5) capacity of FHZ beam was higher than that of other beams.
- The toughness index(I10) of FHZ beam was 14.37 while that of FZH and CB beams have the values as 13.75 and 10.24 respectively. Therefore, toughness index(I10) of FHZ beam was higher than conventional beam.
- In general, the presence of hybrid fiber in full length of beam results in higher load carrying capacity in both stiffness and ductility as consider and beam carries only fiber in hinged zone carries higher values considering energy absorption and toughness index parameters calculated above.

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