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Research Article

STUDY THE MODULUS ELASTICITY OF HFRC

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ABSTRACT

This paper research and experimental investigation carried out on hybrid fiber reinforced concrete (combination of hooked end steel fiber and polyolefin) with a volume fraction of 0.5%, 1% and 1.5% which was prepared using normal mixing, compaction and curing conditions. Here the cylindrical specimen with a diameter of 150 mm and height of 300 mm was casted. The experiment shows the modulus elasticity of samples increase with the amount of steel fibers in the concrete mix. Steel fiber and polyolefin fiber are used as Hybrid fibers. Tested were conducted to study the effect of steel fiber and polyolefin fiber in different proportions in hardened concrete. The research was also aimed to evaluate the potential of bottom ash as a fine aggregate in concrete. Fiber addition was seen to enhance an increase in compressive strength and ductility, respectively. The fine aggregate is replaced by 10% of bottom ash. Compressive strength of concrete is checked by compressive testing machine and compressive properties of cylinder samples were studied by using two point bending tests method. As results it shows that, the percentage of hybrid fibers gives better performance as compared to conventional concrete. The fine aggregate is replaced by 10% of bottom ash. Result shows the percentage of hybrid fiber which shows the maximum performance of the concrete. Addition of hybrid fibers generally contributed towards the energy absorbing and increases the strength value. The modulus of elasticity of concrete is a very important parameter reflecting the ability of concrete to deform elastically.

INTRODUCTION

From the ancient age concrete is the second largest consumption material. Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibers. Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Within these different fibers that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities. Fiber-reinforcement is mainly used in Shot-concrete, but can also be used in normal concrete. By the 1960s, steel, glass (GFRC), and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

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Modulus of elasticity increases as well as the strength of concrete. The same parameters that influence the compressive strength of concrete are responsible for elastic modulus as well. Hence, most of the empirical formulations express modulus of elasticity as a function of compressive strength. Fiber reinforced concrete is increasingly being used day by day as a structural material. The complete stress–strain curve of the material in compression is needed for the analysis and design of structures.

Polyolefin fiber reinforced concrete is similar to steel fiber reinforced concrete. A specimen containing polyolefin fibers can increase its flexural strength by up to 13% and reduce the growth or propagation of cracks by up to 70%, compared to control specimens.

(Misba Gul, *et al*., 2014) experimented and found that modulus of elasticity is essentially a measurement of the stiffness of a material. Modulus of elasticity of concrete is a key factor for estimating the deformation of buildings and members, as well as a fundamental factor for determining modular ratio.

(Han Zhao, 1992) researched study on testing techniques for concrete like materials under compressive impact loading has used split Hopkinson pressure test bar to explain the problems in testing of concrete. The study showed that the wave dispersion, correction and exact time shifting are indispensable and a good estimate of stress strain curve was obtained by the use of conventional formula to assess impact.

(Mathiraja, 2013) N. Banthia Fiber matrix bond strength plays an important role in Impact strength of FRC. High strength fiber matrix results in stiffer bond. The fibers used were three polymeric fiber and one steel fiber. The study revealed that with high bond stiffening with impact loading, steel fibers showed the best peak loads for small inclination compared to aligned load. The study showed that the crack opening displacement associated with peak loading is inversely proportional to loading rate thereby proving the stiffness of fiber matrix bonding. The quasi static and impact rates of loading in case of high strength matrix reduces the strength of the fiber-matrix bond. The study concluded that the fiber, that pull out totally during impact is the best studied of high strength concrete.

(Bayasi, *et al*., 1993) the research regarding the effect of different shapes of steel fibers in concrete and found that hooked fibers are more effective than straight and wavy fibers on the compressive strength.

(Swami, 2006; Vikrant, 2012) in their experimental investigation the effect of addition of mono fibers and hybrid fibers on the mechanical properties of concrete mixture is studied in the present investigation. Steel fibers of 1% and polypropylene fibers 0.036% were added individually to the concrete mixture as mono fibers and then they were added together to form a hybrid fiber reinforced concrete. Mechanical properties such as compressive, split tensile and flexural strength were determined. The results show that hybrid fibers improve the compressive strength marginally as compared to mono fibers. Whereas, hybridization improves split tensile strength and compressive strength noticeably.

MATERIALS USED

In this experimental study cement, fine aggregate, coarse aggregate, both end steel fiber, polyolefin fiber and super plasticizer were used.

Cement

Ordinary Portland Cement (Brand-Chettienad Cement OPC 53 grade) conforming to IS 12269: 1987. Test results are given in Table 1 (Fig. 1 and 2).

Fine aggregate

Clean and air dry river silica grained sand locally available was used. Sand passing through IS 4.75 mm sieve [IS: 383:1970] was used as sample specimens. The test result on FA is presented in Table 2.

Coarse aggregate

Locally available crushed granite stone of 12.5 mm is used for this experiment. Test results on coarse aggregate are given in Table 3.

Polyolefin fiber

Good quality of material supplied by "Elkam materials, Nevi Mumbai, India was used. The various properties of Polypropylene fiber are given in Table 4.

Both end bend steel fiber

Properties of steel fiber are presented in Table 5.

Bottom ash

Thermal industrial waste material bottom ash was collected from "Ennore Thermal Plant, Chennai, India. Properties of bottom ash are shown in Table 6.

Table 1. Properties of cement

Properties	Value
Fineness (%)	3.46
Sp. Gravity	3.10
Soundness (mm)	2
Consistency (%)	32
Initial setting Time (Minute)	40
Final setting Time(minute)	300

Fig. 1 Cube sample in CTM.

Fig. 2 Column specimen fix for testing.

Table 2. Properties of FA

Properties	Value
Sp Gravity	2.65
FM	3.45
Zone	III
Moisture Content	6%
Bulk Density	1.625

Table 3. Properties of CA.

Properties	Value
Sp Gravity	2.69
FM	7.2
Bulk Density($^{grm}/_{cm^3}$)	1.635
Impact Strength (%)	26.32

Water

Portable drinking water for mixing & curing, having pH 7.5. For this experiment tap water is used for both mixing and curing.

Super plasticizer

ConPlast SP 430 is used for this experiment. Sp. Gravity is 1.20.

MIX DESIGN

A design mix has been adopted as per IS10262:2009 for M25 grade concrete. Mix proportion is in Table 7 Material consumption details are shown in Table 7.

EXPERIMENTAL METHODOLOGY

For the compressive strength cube having 150 mm × 150 mm × 150 mm was casted and for modulus of elasticity cylinder having 150 mm × 300 mm were casted. After that harden concrete was allowed for submersed curing in a water tank in room temperature (Fig. 3).

Compressive strength test

It is determined by using the compressive testing machine as specified IS 516-1959. Cubes of 150 mm size were subjected to a uniformly rated compressive load of 140 Kg/cm^2 per minute until failure at ageof 28 days. Average of three is taken. The compressive strength of concrete is 57 mpa (Tables 8 and 9).

Stress and strain behaviour

For generate the complete stress strain curve experimentally for High Strength Fiber Reinforced Concrete of grade M25 using steel and polyolefin fibers compressive strength (Table 10).

Table 4. Properties of polyolefin fiber

Properties	Value
Length (mm)	20
Diameter (mm)	03
Sp. Gravity	0.90
Density g/cm^3	0.87 - 0.97
Water absorption	Nil
Elongation after break	15%
Tensile strength	274MPa

Table 5 Properties of steel fiber

Properties	Value
Length (mm)	50
Diameter (mm)	1
Tensile strength MPa	1000 -1050
Water absorption	Nil

Table 6. Properties of bottom ash

Properties	Value
Sp Gravity	2.45
FM	3.30
Moisture Content	10%
Bulk Density (Kg/m^3)	900

Table 7. Mix proportion

Particulars	Value
Cement (Kg) per Cum	270
FA (Kg) per Cum	265
CA (Kg) per Cum	546
Water (Lit) per Cum	140
w/c	0.35%
Ratio (C:FA:CA)	1:0.98:2.02

Fig. 3 Cylinder specimen after failure.

Table 8. Specimen

Plain Specimen				
Sl. no	**Name of the specimen**	**Vol. fraction**	**Steel Fiber**	**Polyolefin Fiber**
1	PC1	0	0	0
2	AC1	0.5	0.5	0
3	SPC1	0.5	0.4	0.1
4	SPC2	0.5	0.3	0.2
5	SC2	1	1	0
6	SPC3	1	0.3	0.7
7	SPC4	1	0.6	0.4
8	SC3	1.5	1.5	0
9	SPC5	1.5	1.2	0.3
10	SPC6	1.5	0.9	0.6

RESULTS AND DISCUSSION

This investigation deals about the compressive strength and stress strain behavior of high strength hybrid fiber reinforced concrete. If the fibers are sufficiently strong, sufficiently bonded to material, and permit the FRC to carry significant stresses over a relatively large strain capacity in the post-cracking stage. The test results were averaged over all the types of fibers to derive the compressive stress-strain relationship; the evaluation and definition of the stress-strain relationship of concrete are required. It is also known to most investigators that this is due to the fact that stress-strain relationship greatly influenced by a number of factors. In this work compression tests was carried out on fiber reinforced concrete using steel and polyolefin fibers with the replacement of 10% with bottom ash and the stress-strain relationship is studied (Fig. 4 and 5).

CONCLUSION

From the compression tests carried out it shows that optimum10%of bottom ash, though the strength does not increase with that of the control mix with hybrid fibers but its possess acceptable compressive strength. Because of the hybrid fibers added the compressive strength varies with different combinations of fibers, the modulus of elasticity of steel fiber reinforced concrete is observed to increase the strength of concrete. it was observed that the

Table 9. 10% Bottom ash

Sl. no	Name of the specimen	Vol. fraction	Steel Fiber	Polyolefin Fiber
1	PC2	0	0	0
2	BSC1	0.5	0.5	0
3	BSPC1	0.5	0.4	0.1
4	BSPC2	0.5	0.3	0.2
5	BSC2	1	1	0
6	BSPC3	1	0.3	0.7
7	BSPC4	1	0.6	0.4
8	BSC3	1.5	1.5	0
9	BSPC5	1.5	1.2	0.3
10	BSPC6	1.5	0.9	0.6

Table 10. Calculating Young's modulus

Specimen name	Stress N/mm^2	Strain	Young's Modulus N/mm^2
PC1	8.48	0.0002	42400
AC1	8.48	0.00021	40380
SPC1	8.48	0.00024	35533
SPC2	9.90	0.00026	38076
SC2	8.46	0.00024	35071
SPC3	8.48	0.00026	44631
SPC4	8.48	0.00025	38076
SC3	8.48	0.00019	40381
SPC5	8.48	0.00021	42400
SPC6	9.90	0.00021	32615
AC2	9.9	0.0002	38076
BSPC1	9.90	0.00026	36666.6
BSPC2	11.31	0.00026	35357.14
BSB2	11.31	0.00027	37700
BSPC3	9.90	0.00028	37700
BSPC4	11.31	0.00028	38076
BS3	8.48	11.31	37700
BSPC5	8.4	8.48	40380
BSPC6	8.46	8.46	35071

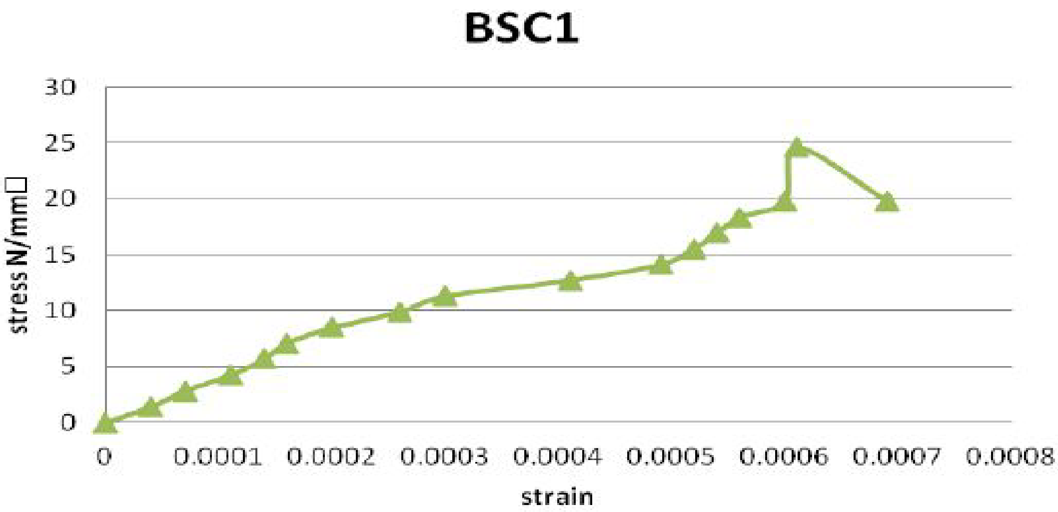

Fig. 4 Stress-strain curve at 0% steel, 0% polyolefne.

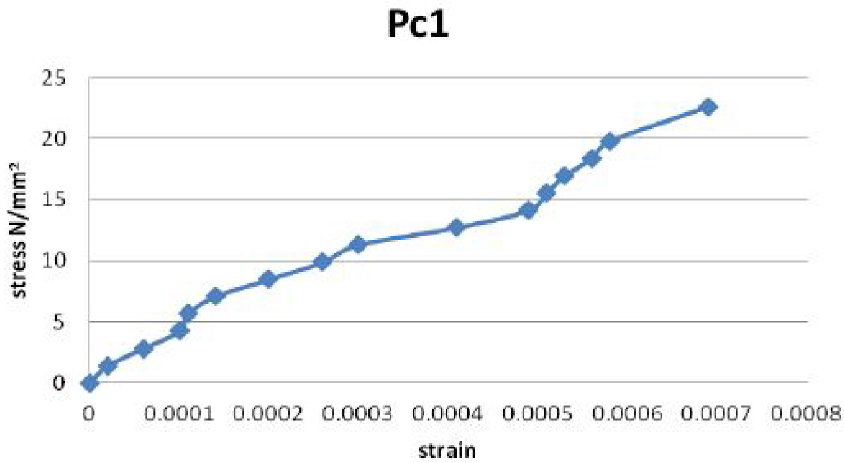

Fig. 5 Stress-strain curve at 0.5 steel, 0% polyplefin with 10% adding bottom ash.

condition of steel fibers increase the ultimate stress and the corresponding ultimate strain with respect to the plain concrete. It shows that when the specimen suffers the load and reaches the ultimate stress, the concrete will express that the crack or fracture, however it does not come to pieces, this is showing that good bonding on steel and polyolefin fiber.

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