Shear Behavior of Reinforced Concrete Beams Using Hybrid Fibres

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ABSTRACT

This research work presents the effect of fibers on high-vigor reinforced Concrete beams with and without fiber. The study parameters for the investigation included ultimate load, ultimate deflections, crack width, energy ductility and deflection ductility and the associated failure modes. In this study hooked end steel fiber of length 35mm with thickness of 0.6mm and polyolefin fiber of length 54mm with the size 1.22mm x0.732mm is utilized. The fibers were integrated in concrete at different volume fractions of 0.5%, and 1.0% with coalescence of steel-polyolefin at 80%-20%. The steel moulds of size 150mm x300mm cylinder, and 150mm x 200mm x2000mm beam, were habituated to cast the high vigor concrete specimens, and hybrid fiber reinforced concrete specimens. It consists of 3 cylinders for specimens for compression, 3 cylinder for splitting tensile vigor and 3 beams for shear vigor test for each volume fraction of hybrid fiber. The cast specimens were abstracted from the mould after 24 hours and sanctioned for remedying. Then the specimens were tested after 28 days remedying in the moist condition as per ASTM Codes. The test results of high-vigor hybrid fiber reinforced concrete beams were compared with high-vigor concrete beams [HSC] with no fibers. The test results show that the hybrid fiber content of 1.0% with80%-20% steel polyolefin coalesce exhibits better performance in terms of vigor, deformation, ductility and cracking characteristics.

Key words: - High Strength Concrete, Crimped Steel Fiber, polyolefin fibres.

1. INTRODUCTION

When subjected to a combination of moment and shear force, a reinforced concrete (RC) beam with either little or no transverse reinforcement can fail prematurely in shear before reaching its full flexural strength. This type of shear failure is sudden in nature and usually catastrophic because it does not give ample warning to inhabitants. One well-known example is the shear failure of beams in the U.S. Air Force Warehouse (Anderson, 1957), to prevent shear failures, beams are traditionally reinforced with stirrups. In general, the use of stirrups is expensive because of the labor cost associated with reinforcement installation. Also, casting concrete in beams with closely-spaced stirrups could be difficult and might lead to voids and associated poor bond between concrete and reinforcing bars. An alternative solution to stirrup reinforcement is the use of randomly oriented steel fibers, which have been shown to increase shear resistance (for example, Kwak et al., 2000). The use of deformed steel fibers in place of minimum stirrup reinforcement is currently allowed in ACI Code Section 11.4.6 (ACI Committee 318, 2008).

2. RELEGATED WORK

Fibre reinforced high strength concrete is now widely used throughout the world on major infrastructure works, tunnels, underground railways, large reinforcement structures. Fibre reinforced High strength concrete is gaining attention as an effective way to improve the performance of the concrete. The recent studies performed on a high performance fiber reinforced high strength concrete in a bridge deck found that adding fiber provided residual strength and controlled cracking. In developed countries, its use is most widespread in large area industrial floors. The most common applications are tunnel linings, bridge decks, airport pavements and slabs repairs. There has also been some recent experimental work on roller compact concrete (RCC) reinforced with steel fibers. Steel fiber increase the tensile strength of concrete and polyolefin fiber will increase the flexural strength. These kinds of fibres are widely used in mass constructions work where the reinforcement of strength is more. The main objective of using steel and synthetic fibres is to increase the strength and for controlling cracking. The usage fiber materials in concrete are not familiar in India because of its which cost but it is used in cities like Mumbai, Delhi and other major cities in India.

3. MATERIALS AND PROPERTIES

3.1 Cement:

Ordinary Portland cement of C53 grade conforming to both the requirements of IS: 12269 and ASTM C 642-82 type-I was used. We are conducting different types of tests on cement, those are Normal Consistency, Initial and Final setting times, Compressive strength of cement, Specific Gravity and Fineness of cement. From the test results obtained the conventional concrete can be designed according to IS10262-82(MIX DESIGN CODE).

3.2 Coarse Aggregate:

Normal aggregate that is crushed blue granite of maximum size 20 mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of coarse aggregate.

3.3 Fine Aggregate:

Well graded river sand passing through 4.75 mm was used as fine aggregate. The sand was air-dried and sieved to remove any foreign particles prior to mixing. We are conducting tests on fine aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of fine aggregate.

3.4 Steel and polyolefin fibers

Many efforts have been made in recent years to optimise the shape of steel fibres to achieve improved fibre-matrix bond characteristics, and to enhance fibre dispersibility in the concrete mix. ASTM A 820 provides a classification for four general types of steel fibres based on the product used in their manufacture (ACI Committee 544.1R, 1996):

- Cold-drawn wire
- Cut sheet
- Melt extracted
- Other fibres

A few of the more common types of steel fibres being shown in figure 1.1 (Knapton, 2003). Rounded, straight steel fibres are produced by cutting or chopping wire, typically having diameter between 0.25mm and 1.0mm. Flat, straight steel fibres having typical cross sections ranging from 0.15mm to 0.41mm thickness by 0.25mm to 1.14mm width are produced by shearing sheet or flattening wire. Crimped and deformed steel fibres are produced either with full length crimping or bent or enlarged at the ends only. Some fibres are deformed by bending or flattening to increase bonding and facilitate handling and mixing (Concrete Society, 1994). Some fibres have been collated into bundles to facilitate handling and mixing. During mixing, the bundles separate into individual fibres. Fibres are also produced from cold drawn wire that has been shaved down in order to make steel wool. Moreover, steel fibres are produced by the melt-extraction process (ACI Committee 544.1R, 1996). The ultimate tensile strength

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of steel fibre range from 345-1700 MPa, whereas the length range from 19 to 60mm, the aspect ratio (length/diameter) range from 30 to 100 and the young's modulus is 205 MPa .

Table 2 : properties of materials

PROPERTIES OF MATERIALS	RESULTS
Normal consistency of cement	31%
Setting Times of cement Initial Final	 33 minutes 10 hours 35 min
Compressive Strength of cement 3 days 7 days 28 days	 27.2 38.36 54.46
Specific Gravity of cement	3.15
Fineness of cement	10%
Specific Gravity of aggregates Coarse aggregates Fine aggregates	 2.65 2.6
Fineness modulus of aggregates Coarse aggregates	2.72
Fine aggregates	6.2

Table1: Properties of Fibers

Fiber Properties	Fiber details	
	polyolefin	Steel
Length (mm)	48	30
Shape	Straight	Hooked
Size / Diameter (mm)	1.22×0.732 mm	0.5mm
Aspect Ratio	39.34	60
Density (kg / m3)	920	7850
Young's Modulus (GPa)	6	210
Tensile strength (MPa)	550	530
Tensile strength (MPa)	530	532

4. EXPERIMENTAL RESULTS

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Fig 1 Slump Test

Fig 2 Testing Of Cylinders.

Fig 3 Flexural testing machine

Fig 4 CNBM beam crackings.

Fig 5 HYBM-1 cracking pattern

Fig 6 HYBM-2 Cracking pattern

Table: 1 Ultimate Load Yield Load Data of the Beams

Specimen name		**Control**	**0.5%beam**	**1%beam**
Volume fraction	Steel		0.35	0.7
	polyolefin		0.15	0.3
	Total		0.5%	1%
Yield load		70	75	80
Yield deflection		5.079	6.028	6.01
Ultimate load		90	100	105
Ultimate deflection		25.002	24.05	22.086
Yield crack width(mm)		5.98	4.25	4.42
Ultimate crack width(mm)		6.12	4.69	4.82

5. CONCLUSION

The hybrid fibre volume fraction of 1.0% with 80% - 20% steel polyolefin cumulate significantly amends the overall performance of high-vigor reinforced concrete beams. The incrementation in ultimate load was found to be 10.53% when compared to reference beam. The incrementation in ultimate deflection was found to be 22.03% when compared to reference beam. The maximum reduction in crack width at ultimate load was found to be 7.65% when compared to reference beam. The mode of failure was modified in to ductile mode in fibre reinforced concrete beams. The HYFRC beams exhibit enhanced ductility than that of the reference beam.

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