

Experimental Study on the Effect of Steel Fibres in Concrete Short Column

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Abstract - Short Columns are generally subjected to Compressive loads only, but in practice the minimum reinforcement has been provided for ductile failure. To replace the minimum reinforcement, the steel fibres are added. The aim of the project is to study the Effect of Steel fibres when used in Plain Cement Concrete (PCC) Short Column. Two types of steel fibres - Hooked end fibre and Crimped fibre of length 30mm and diameter 0.5 mm were used in 0.5%, 1% and 1.5% of volume fractions for short column. To compare the Strength of fibre columns, the PCC and Reinforced Cement Concrete (RCC) with minimum reinforcement of M20 grade concrete were also casted. All specimens were cured for 28 days and tested under compression in UTM. The resulting structural behaviour and failure pattern of the specimens are studied.

Key Words: Hooked end fibre, Crimped fibre, aspect ratio, short column, Compression Test.

1. INTRODUCTION

Fibre Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. The aim of the project work is to study the structural behavior of short column made of steel fibre reinforced concrete, in comparison to Plain Cement Concrete and Reinforced Cement Concrete. The fiber is often described by a convenient parameter called "aspect ratio". The aspect ratio of the fiber is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150. Fibre reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. The shape of the fibre plays a vital role in increasing the integrity. Hence the FRC should contain short discrete fibers that are uniformly distributed and randomly oriented. Shape, dimension and length of fibre is also important. Interfacial bond between the matrix and the fibre also determine the effectiveness of stress transfer, from the matrix to the fibre. A good bond is essential for improving tensile strength of the composite.

2. TYPES OF FIBRES

Based on the Literature Study Two Types of Steel Fibres are used in this Project, namely Hooked End Fibre and Crimped Fibre. Both Steel Fibres of 30mm Length and 0.5mm Diameter were used. The aspect ratio of the fibre is 60. The fibres were used in proportions of 0.5%, 1% and 1.5% of the volume of the concrete mass. Figure 1 shows the appearance of Hooked End Fibre. Figure 2 shows the appearance of Crimped Fibre.



Fig-1: Hooked End Fibre



Fig-2: Crimped Fibre

3. MATERIAL PROPERTIES

3.1 Cement

The cement used was Ordinary Portland Cement of grade 53 conforming IS: 8112-1989. Table 1 shows the Physical Properties of Cement.

Table 1 Physical Properties of OPC Cement

S.No	Description	Experimental Value
1	Specific gravity	3.15
2	Initial setting time	30 mins
3	Final setting time	600 mins

3.2 Fine Aggregate

Manufactured sand conforming to the code IS 383-1970. Table 2 shows the Physical Properties of Fine Aggregate.

Table 2 Physical Properties of Fine Aggregate

S.No	Description	Experimental Value
1	Specific gravity	2.47
2	Water absorption	1.57%
3	Fineness modulus	3.087(zone II)
4	Bulk density	1950kg/m ³

3.3 Coarse Aggregate

Crushed coarse aggregates of 20mm size were used for casting. Table 3 shows the Physical Properties of Coarse Aggregate.

Table 3 Physical Properties of Coarse Aggregate

S.No	Description	Experimental Value
1	Specific gravity	2.80
2	Water absorption	1.8%
3	Fineness modulus	7.2
4	Bulk density	2886kg/m ³

4. EXPERIMENTAL INVESTIGATION

The fibre was mixed well with the concrete matrix and the resulting concrete was casted into the cylindrical moulds of short column. Figure 3 shows the concrete mix with Steel Fibre.



Fig- 3: Concrete Mix with Steel Fibre

The plain cement concrete and reinforced cement concrete columns were made of M20 grade mix. The mix was prepared by using Indian Standard code book IS 10262 – 2009. For preparing RCC column, 6 numbers of 8mm diameter rods were used. While preparing fibre reinforced concrete mix, the fibre was added at the end and mixed thoroughly, to endure even distribution. The concrete was casted into cylindrical moulds of 150mm diameter and 600mm length. The size of the column is chosen in such a way so as to ensure, that the specimen behaves as short column. The casting was done after mixing the concrete thoroughly and casted into the greased moulds with regular compaction as shown in figure 4.



Fig- 4: Cylindrical Specimens

5. COMPRESSION TEST

The dried concrete columns were subjected to compressive loading in a Universal Testing Machine (UTM) of 100-ton capacity with the loading plane perpendicular to the axis of the short column as show in figure 5. The load deflection

curves of all the columns were also generated and were compared to during the result analysis.



Fig- 5: Compression Test

The ultimate load and deflection of each short column was obtained and the results are represented in the table 4.

6. RESULT AND DISCUSSION

It can be seen that the ultimate load increases with increase in steel fibre. The load deflection curves of all the specimens were plotted in figures 6,7,8,9,10,11,12 and 13.

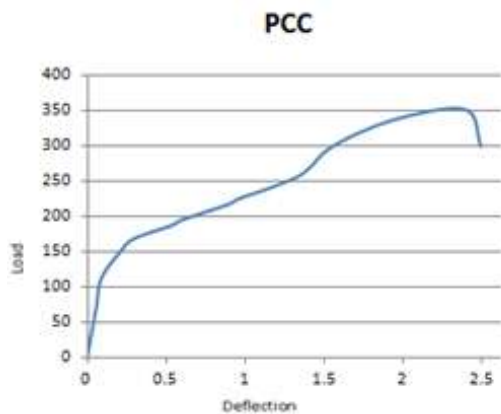


Fig- 6: Load - Deflection for PCC Specimen

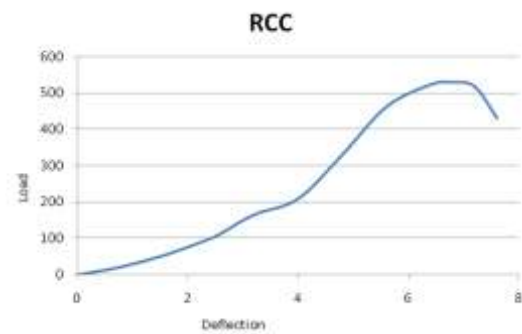


Fig- 7: Load - Deflection for RCC Specimen

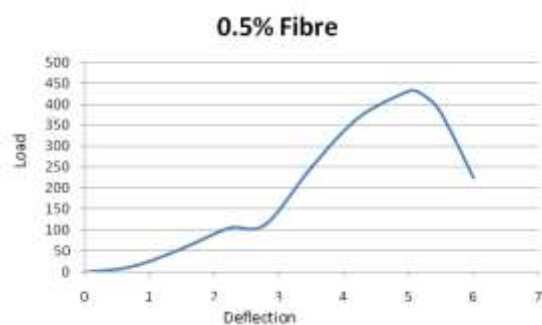


Fig- 8 : Load - Deflection for 0.5% Crimped Fibre

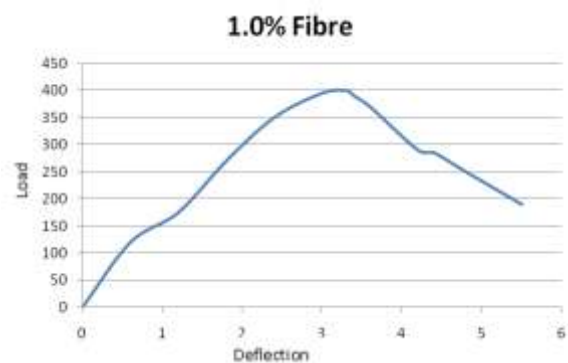


Fig-9 : Load - Deflection for 1.0% Crimped Fibre

Table 4 Load Deflection Values of Specimen

	PCC	RCC	Crimped Fibre			Hooked Fibre		
			0.5%	1.0%	1.5%	0.5%	1.0%	1.5%
Ultimate load (kN)	352.5	530	421	401	528.4	544.9	621.95	620.8
Deflection at ultimate load(mm)	2.4	6.8	5.1	3.4	6.9	4.9	6.5	5.1

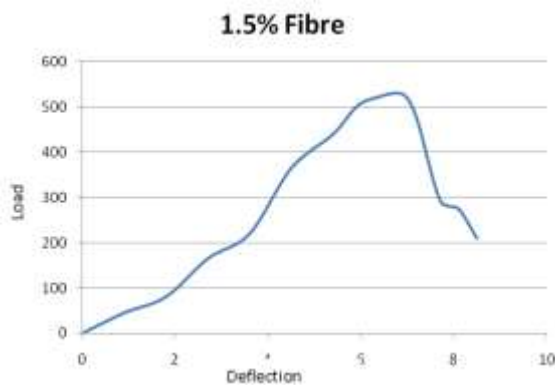


Fig- 10 : Load - Deflection for 1.5% Crimped Fibre

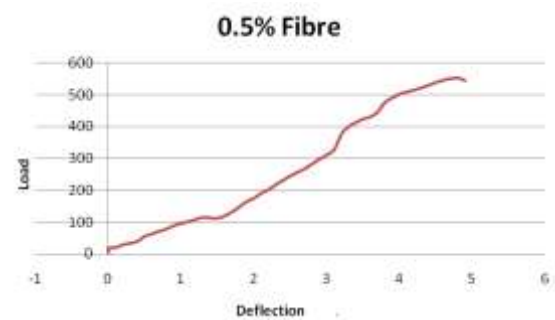


Fig- 11 : Load - Deflection for 0.5% Hooked End Fibre

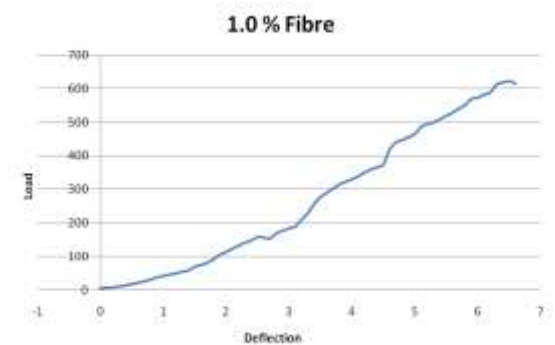


Fig- 12 : Load - Deflection for 1.0% Hooked End Fibre

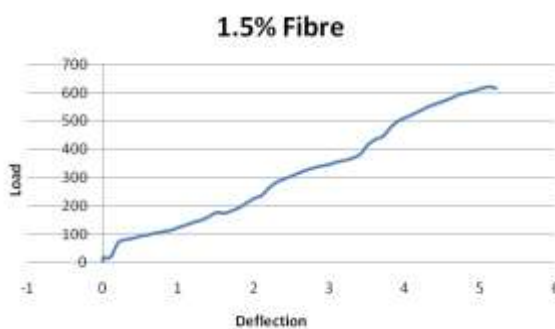


Fig- 13 : Load - Deflection for 1.5% Hooked End Fibre

7. CONCLUSIONS

- It can be observed from figures 10 and 13 that the behavior of RCC is achieved when 1.5% of steel fibre used.
- It can also be seen very clearly that addition of steel fibre increases the deflection of concrete before failure indicating increase in ductility.
- Hooked End Fibre is capable of withstanding the ultimate load with minimum deflection when compared to Crimped Fibre.

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