ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 1, Issue 2, June 2016

An Experimental Study on Flexural Behaviour of Steel Fibre Reinforced Concrete

[1]Sandeep Gowda M, [2]Ashwin K N, [3]J K Dattatreya
[1] Post graduate student, [2] Asst. Professor, [3] Research professor
[1]sanjugowda22@gmail.com,[2] meetashwinkn@yahoo.com, [3]jk.dattatreya@gmail.com

***Abstract*— The objective of this study is to analyze the effects of steel fibre reinforcement in concrete for different dosages. Concrete mixes were prepared using M30 grade concrete with hooked end steel fibres of aspect ratio 80 (L/D where L=60mm and D=0.75mm) were added at a dosage of 0.25%, 0.5%, 0.75%, and 1.0% to volume fraction of concrete. The flexural strength was determined using a two point loading system. Load v/s deflections graphs were plotted for various percentages of fibre concrete specimens. Test results were compared with plain concrete specimen. From the experimental work it is found that with the increase in the steel fibre content in concrete there is an increase in flexural strength. The flexural strength at 1% steel fibre content is 9.1N/mm^2 and the 0% fibre content is 5.78N/mm^2 hence increase of 57.43% flexural strength is obtained.**

Index Terms*—Fibre reinforced concrete, *hooked end steel fibre, toughness, flexural strength.

I. INTRODUCTION

Concrete is a brittle material which is strong in compression and weak in tension. Concrete undergoes complete loss of loading capacity, once the failure is initiated. This property of concrete which limits the application of material can be overcome by inclusion of distribution of random fibres. In earlier days many fibres like asbestos, steel, nylon, coir, etc have been used. Out of these, steel fibres can improve flexural strength of concrete. According to many researchers, the steel fibre addition into the concrete creates low workability. Therefore to overcome this problem super-plasticizer is added but Corrosion is the main drawback of using steel fibres.

Steel Fibre reinforced concrete (SFRC) is defined as concrete made with cement containing fine aggregate, coarse aggregate and discontinuous discrete fibres [1]. In SFRC, small steel fibres (SF) are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all direction [2]. The influence of incorporating steel fibres into the concrete was to delay and control the tensile cracking [3]. SFRC increases tensile strength, both at first crack and at ultimate crack, particular under flexural loading [4]. Steel fibres are capable of holding the matrix together even after extensive cracking. The transformation of concrete from a brittle to a ductile type of material with the help of steel fibres would increase the energy absorption characteristics of concrete and its ability to withstand impact loading [5]. The random distribution of steel fibres assists in controlling the propagation of micro-cracks present in the matrix and prevents the widening of smaller cracks into major cracks [6].

In the last few years due to increase in experimental investigations in the field of structural engineering, the necessity for accuracy in deformation measurement is felt more than ever. In structural engineering field, the most common test is bending test, in which the deformation of the beams should be evaluated in order to calculate any other structural parameter. Use of Linear Variable Differential Transformer (LVDT) is a primitive technique for obtaining deformation of bending tests. LVDT's are simple to install and gives high accuracy of results. The disadvantages of LVDT are high cost and inability to obtain the whole displacement field [7]. In this paper, flexural strength is determined by varying different percentages of steel fibres i.e. 0%, 0.25%, 0.5%, 0.75% and 1%

II. EXPERIMENTAL PROGRAM ME

Materials used

The materials used in this experimental work are cement, water, sand, hooked end steel fibres and super plasticizer.

Steel fibres: The steel fibres are added in different percentage variation to volume fraction of concrete i.e. 0%, 0.25%, 0.5%, 0.75% and 1%.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 1, Issue 2, June 2016

Curing period: The beam specimens are cured for 28 days.

Super plasticizer: In order to improve the workability of fresh concrete Super plasticizer (ConplastSP430) was used.

Grade of concrete	:	M30
Cement	:	OPC 53 grade
Coarse aggregate	:	20mm down
Water cement ratio	:	0.4
Fly ash	:	20% of cement

Table 1: Properties of steel fibre

Type of steel fibre	Length (mm)	Diameter (mm)	Aspect ratio (L/D)
Hooked end steel	60	0.75	80

Preparation and casting of specimens

The concrete beam of dimension 150mmX150mmX700mm was casted and the specimens were removed from mould after 24 hours and cured in water till 28days. All the specimens were prepared with reference to Indian Standard Specifications.

Experimental Procedures

Experiment investigation has been carried out with reference to M30 grade concrete. The mix design for M30 grade concrete is done as per ACI method. Six concrete specimens were prepared for every dosage of steel fibres, where steel fiber added homogenously with a percentage of 0.25%, 0.5%, 0.75% and 1% to volume fractions of concrete. Testing of the specimens was done with recommendation of the ICI technical committee on Fibre Reinforced Concrete (ICI-TC/01). The mix proportions of all mixes are shown in table 2.

Table 2: Mix proportions

Materials	Unit	Mix
Cement	Kg/m^3	320
Fly ash	Kg/m^3	80
Fine aggregate	Kg/m^3	820
Coarse aggregate	Kg/m^3	990
Steel fibres	**%**	0, 0.25, 0.5, 0.75, 1
Super-plasticizer	**%**	1
	Kg/m^3	4
Water	Kg/m^3	160
W/C	**%**	0.4

III. RESULTS AND DISCUSSIONS

Flexural strength

For flexural strength test, specimens of beam having dimensions 150mmx150mmx700mm were cast with M30grade concrete. The mould were filled with 0%, 0.25%, 0.5%, 0.75% and 1% of hooked end glued steel fibers for flexure test. Two point loading system was adopted over an effective span of 450mm on flexural testing machine. Graphical representation of flexural strength values for varying percentages is shown in Fig 1. Values of flexural strength for mixes (Plain concrete, 0.25%SF. 0.5%SF, 0.75%SF and 1%SF) were shown in table 3.

Table 3: Strength Properties of M30 Grade Concrete

MIX ID	Flexural strength 28 days (N/mm^2)
Plain Concrete	5.78
0.25% steel fibres	6.49
0.5% steel fibres	6.51
0.75% steel fibres	7.95
1% steel fibres	9.1

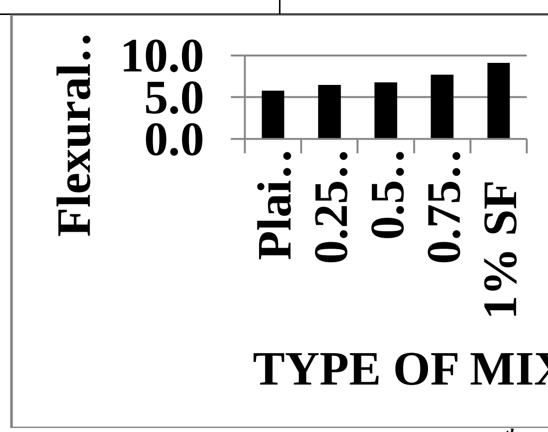

Fig 1: Type of mix vs. Flexural strength at 28th day

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 1, Issue 2, June 2016

Set Up For Load-Deflection Measurement

Fig: 2 was the set up used to determine the load – deflection plot for the specimen. The arrangement was made in such a way that the ends are restrained. Since the ends are restrained the mid- span is subjected to pure bending, at mid span L angle rigid steel plate is fixed to record mid span deflection using LVDT and hence the accurate load-deflection plot is available.

Fig 2: Set up for the evaluation of flexural strength and load- deflection plot

The load- deflection curves were plotted for Plain concrete (PC), 0.25%SF, 0.5%SF, 0.75%SF and 1%SF.

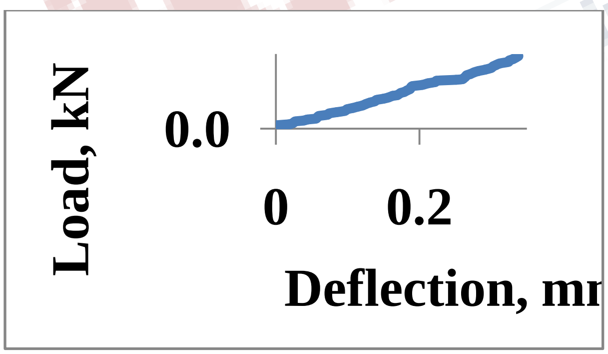

Fig 3: Load-deflection graph for plain concrete at 28days

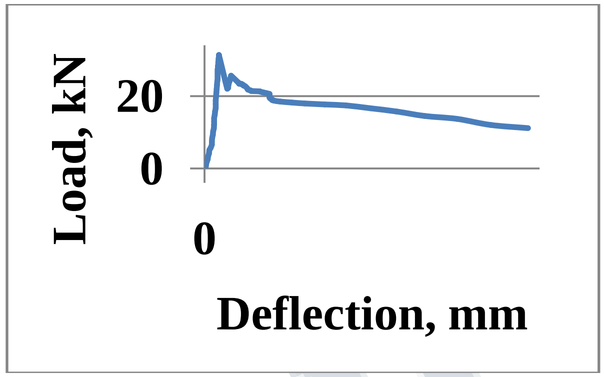

Fig4: Load-deflection graph for 0.25% SF at 28days

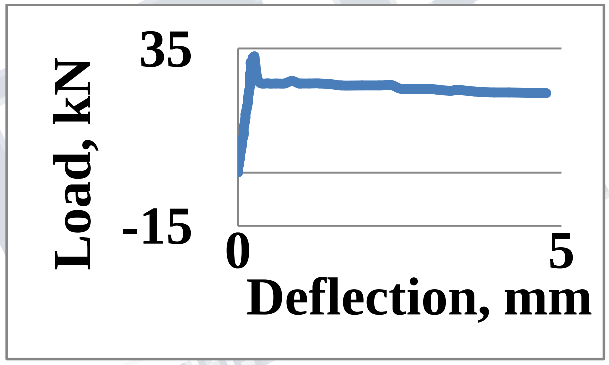

Fig5: Load-deflection graph for 0.5% SF at 28days

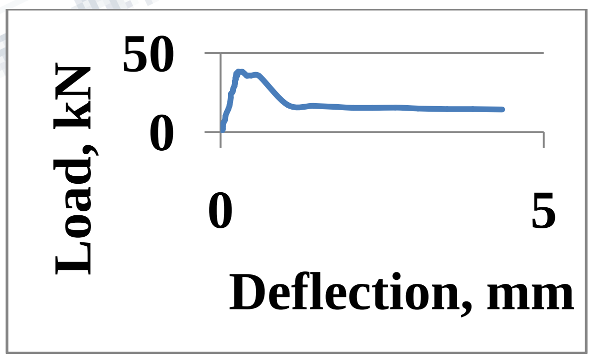

Fig 6: Load-deflection graph for 0.75% SF at 28days

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 1, Issue 2, June 2016

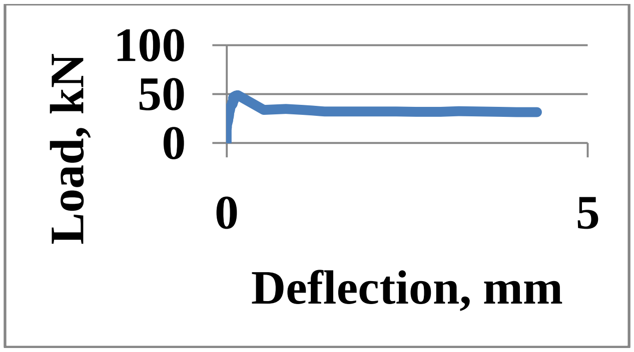

Fig7: Load-deflection graph for 1% SF at 28days

Table 4: Average peak loads and corresponding deflections

Fibre mix proportion by volume (%)	Deflection (mm)	Load (kN)
0	0.338	27.3
0.25	0.25	31.2
0.5	0.22	31.3
0.75	0.21	38.3
1	0.153	48.7

Typical load deflection curve obtained in this investigation for concrete containing different combinations of fibres are presented in Figure 3, 4, 5, 6 and 7. As the percentage of steel fibre increases there is a decrease in deflection. The optimum % of SF is found to be 1% where the deflection is less compared to all other dosage of fibres.

V.CONCLUSION

The study on the effect of steel fibres can still be a promising work as there is always a need to overcome the problem of brittleness of concrete. The following conclusions could be drawn from the present investigation.

1. Density of concrete is more as the percentage of steel fibre increases.
2. It is observed that there is no much increase in flexural strength from 0.25% to 0.5%.
3. The specimen 0.75%SF and 1%SF gives better Flexural strength.
4. The flexural strength 5.78N/mm2 of Plain concrete is increased by 57.43% (9.1N/mm2) at 1% of SF.
5. The optimum value for flexural strength of steel fibre reinforced concrete was found to be 1%.
6. While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two piece geometry. But due to addition of steel fibres in concrete, cracks gets ceased which results into the ductile behaviour of Steel fibre reinforced concrete.

REFERENCES

[1]. N. Shireesha, S. Bala Murugan, G. Nagesh Kumar, Experimental Studies on Steel Fiber Reinforced Concrete, International Journal of Science and Research (IJSR) (2013).

[2]. Amit Rana, Some Studies on Steel Fibre Reinforced Concrete, International Journal of Emerging Technology and Advanced Engineering (IJETAE) Volume 3, January 2013.

[3]. K.R.Venkatesan, P.N.Raghunath, K.Suguna, Flexural Behaviour of High Strength Steel Fibre Reinforced Concrete Beams, International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 4, January 2015.

[4]. A. Sivakumar* and V. M. Sounthararajan, Toughness characterization of steel fibre reinforced concrete – A review on various international standards, Journal of Civil Engineering and Construction Technology Volo.4(3), March 2013.pp 66-69.

[5]. Dr. Th. Kiranbala Devi, T. Bishworjit Singh, Effects Of Steel Fibres in Reinforced Concrete, International Journal of Engineering Research & Technology (IJERT) Volume 2 OCT-2013.

[6]. Kim Hung Mo, Kathy Khai Qian Yap, U. JohnsonAlengaram, Mohd Zamin Jumaat, The effect of steel fibres on the enhancement of flexural and compressive toughness and fracture characteristics of oil palm shell concrete,ELSEVIER Construction and Building Materials 55 (2014) 20–28.

[7]. Ardalan Hosseini, Davood Mostofinejad, and Masoud Hajialilue-Bonab, Displacement Measurement of Bending Tests Using Digital Image Analysis Method, IACSIT International Journal of Engineering and Technology, October 2012.Volume 4 no.5.

[8]. ICI technical committee on Fibre Reinforced Concrete (ICI-TC/01).