

Role of Hooked End Steel Fiber in Shear Strength Improvement in R.C. Deep Beam

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ABSTRACT: The beam which have depth greater in relation to span are considered as deep beam. As the depth is more, span is less, there beam have good moment of resistances, however the shear strength of deep beam is less. The shear strength of deep beam is depends on various factors. If the strength of concrete is increased the shear strength of deep beam also increases. The strength of concrete can be increased by adding fiber in it. There are various type of fibers which can be used to enhance the properties of concrete. In the present work, hooked end steel fibers are used and its effect has been studied. Percentage variation of steel fibers is considered as 0%, 0.5%, 1%, 1.5%, 2% and 3%.

KEYWORDS: Steel fiber, shear strength, Replacement, Ultimate load, two point load,

I. INTRODUCTION

A beam is considered as deep beam, if the depth of the beam is large in relations to the span of the beam. According to IS 456: 2000, a beam is considered as deep beam when a ratio of effective span to overall (L/D) is a less than 2 for simply supported members and 2.5 for continuous member.[7]

Deep beam are used as the wall of water tank bunkers. It is also used as a load distribution structure element such as transfer girder, pile caps, foundation wall and in offshore structure.

Deep beams behave effectively in flexure, but they behave critically in shear. (Resistances to bending moment are greater and resistances are less.) Various scientists have given solution to enhance the shear strength of the deep beam. One of the options is introduction of fibers in concrete.

In the present work to the effect of addition of hooked end steel fibers in concrete for deep beam is studied with respect to shear strength, of deep beams. The variations in deflections of deep beams are also observed during the testing for various percentage of hooked end steel fibers. At the same time effect on compressive strength for M20 grade concrete and tensile strength of the same has been studied.

II. METHODOLOGY

In order to achieve the stated objectives, the study was carried in following stages. Compressive strength, split tensile strength of concrete and shear strength of deep beam on the initial stages, all the materials and equipment needed must be gathered and checked for availability.[1]

Then, the concrete mixes according to the predefined proportions. Concrete samples were tested through concrete test such as cube test. Finally, the results obtained were analysed.

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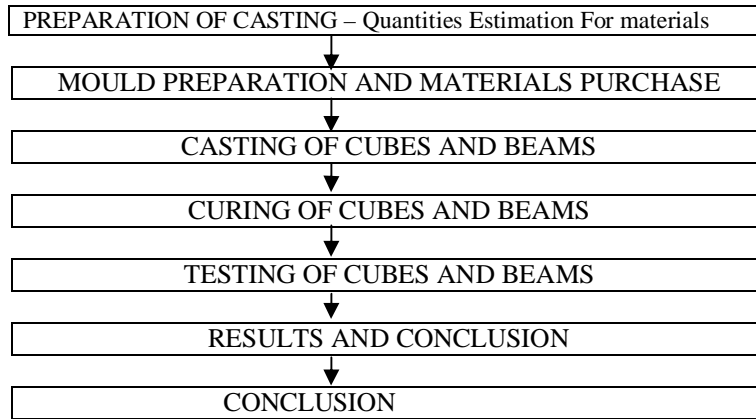


Figure 1 Flow Chart Of Experimental program

2.1 Concrete Mix Design

Conventional concrete was designed by using Indian standard method. Trial contains for grades M20 with replacement of cement by hooked end steel fiber in concrete with different dosage like 0, 0.5%, 1.0%, 1.5%, 2%, and 3% respectively. The properties like compressive strength, split tensile strength and flexural strength of concrete using hooked end steel fiber are studied. [2]

IS10262:1982[4] code method of mix design was used for mix design of M20 grade of concrete. Concrete specimens with various percentage of steel fiber were prepared. The details of various mix proportions for different replacement levels of cement by steel fiber are shown in Table no 1.

Table 1 Constituent material used for concrete

Sr. NO	Steel Fiber(%)	W/C Ratio	MIX PROPORTION(Kg/m ³)				
			Cement (Kg)	Steel Fiber(Gm)	Sand (Kg)	Aggregate(Kg)	Water
1	0	0.5	32	00	70	93	16
2	0.5	0.5	31.84	160	70	93	16
3	1.0	0.5	31.68	320	70	93	16
4	1.5	0.5	31.52	480	70	93	16
5	2.0	0.5	31.36	640	70	93	16
6	3.0	0.5	31.04	960	70	93	16

2.2 Details of Specimen

2.2.1 Beams

Total 18 simply supported deep beams were tested up to failure. All beam of specimen series as a percentage of fibre 0%, 0.5%, 1%, 1.5%, 2% and 3% were of rectangular cross-section, 150 mm wide and 350 mm deep having total span 700 mm. Two bars of 10 mm diameter at top and two bars of 10 mm diameter at bottom were provided as reinforcement. Grade of reinforcement is Fe-500. Shear span-to-depth ratio is kept as 1.42 for all beams of specimen. The fibre volume fraction varies as 0 %, 0.5 %, 1 %, 1.5 %, 2 % and 3 % for each % of steel fiber having 3 no. of samples has been casted using M20 grade of concrete. The details of test beach are given in fig 2. The shear strength has been found out from flexural test on deep beams. The two point loading system is used. While testing adopted further deflection are also observed.

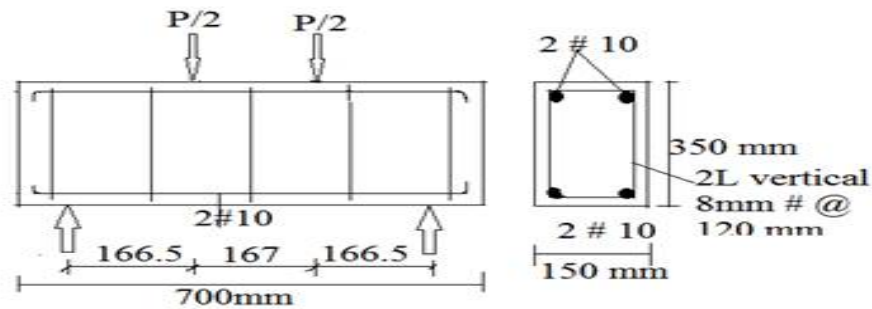
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Vol. 5, Issue 5, May 2016



Figure 2 Beam Specimen and Experimental Set Up



Typical Reinforcement in RC Deep Beam

2.2.2 Cubes

The cube of size 150mm × 150mm × 150mm has been casted for various % of steel fibers. Percentage variation of steel fiber is considered as 0%, 0.5%, 1.0%, 1.5%, 2%. For each % of steel 3 no. Of samples have been casted using M20 grade of concrete. Compressive test on cube was conducted on compressive testing machine. The compressive strength is done after 28 days curing.

2.2.3 Cylinders

The cylinder of size 150mm was diameter and 300 mm for height have been casted for various % of steel fibers. Percentage variation of steel fiber is considered as 0%, 0.5%, 1.0%, 1.5%, 2%. For each % of steel 3 no. Of samples have been casted using M20 grade of concrete. Split tensile test on cube was conducted on Universal Testing Machine. The split tensile strength is done after 28 days curing.

2.2.4 Steel Fiber

Hooked End Steel Fiber

Length	60mm
Diameter	0.75mm
Formation	Glued
Anchorage	Hooked

III. RESULT AND DISSCUSION

Compressive strength

The results of compressive strength for specimen after 28 days curing are obtained and are presented in Table 3. 1

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(An ISO 3297: 2007 Certified Organization)

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Table 3.1 Compressive Strength Of Concrete (N/mm²)

Sr. NO.	Cube Designation	% Fiber Content	Cube Compressive strength (N/mm ²)	Average Cube Compressive strength (N/mm ²)	% INCREASE IN COMPRESSIVE STRENGTH
1	A	0	20.88	21.37	11 %
2	B		22.04		
3	C		21.02		
4	A	0.5	25.55	23.80	3 %
5	B		28.53		
6	C		17.33		
7	A	1.0	25.02	24.50	1.5 %
8	B		24.88		
9	C		23.60		
10	A	1.5	18.93	24.85	1.3 %
11	B		27.86		
12	C		26.97		
13	A	2.0	25.82	25.18	
14	B		24.40		
15	C		25.33		

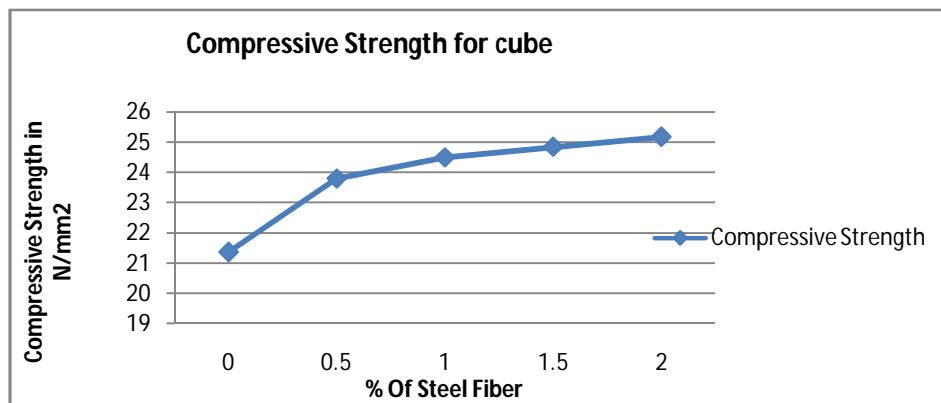


Chart 3.1 Variation Of Compressive Strength With respect to % of steel Fiber

Chart No 3.1 shows the variation of compressive strength for various % of steel fibers. From above graph it can be seen that the compressive strength increases with increases in % steel. It is also observed that rate of increase in compressive strength is more upto 0.5% of steel fibers. From 0% to 0.5 % the rate increases in compressive strength is 11%. From 0.5% to 1 % of steel fiber the rate of increases in compressive strength is 3%. From 1% to 1.5 % of steel fiber the rate of increases in compressive strength is 1.5 %. From 1.5 % to 2 % of steel fiber the rate of increase in compressive strength is 1.3%.

3.2 SPLIT TENSILE TEST

The results of Split Tensile Strength for specimen after 28 days curing are obtained and are presented in Table 3. 2

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

Table 3.2 Split Tensile Strength Of Concrete (N/mm²)

SR. No	Cylinder Designation	% Fiber Content	Split Tensile Strength (N/mm ²)	Average Split Tensile Strength (N/mm ²)	% INCREASE IN TENSILE STRENGTH
1	A	0	1.51	1.56	25 %
2	B		1.07		
3	C		2.10		
4	A	0.5	2.07	1.95	17 %
5	B		2.45		
6	C		1.34		
7	A	1.0	2.63	2.28	3.5 %
8	B		2.53		
9	C		1.68		
10	A	1.5	1.97	2.36	1.8 %
11	B		2.69		
12	C		2.42		
13	A	2.0	2.29	2.40	
14	B		2.35		
15	C		2.56		

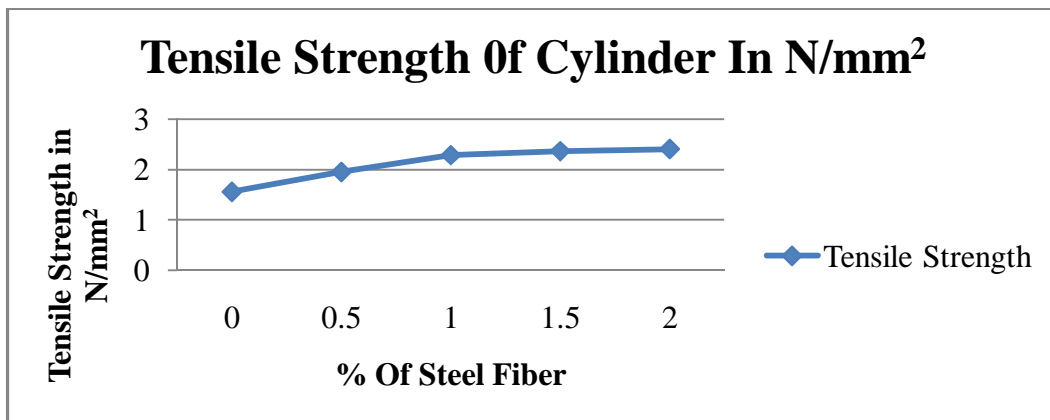


Chart 3.2 Variation Of Split Tensile Strength With respective to % of steel Fiber

Chart No 3.2 shows the variation of tensile strength for various % of steel fibers. From above graph it can be seen that the tensile strength increases with increases in % steel fibers. The rate of increases in tensile strength is more from 0 to 1%. Further, The rate of increases is very less. From 0% to 0.5 % of fiber the rate of increase in tensile strength is 25 %. From 0.5% to 1 % of steel fiber the rate of increases in tensile strength is 17 %. From 1% to 1.5 % of steel fiber the rates increase in tensile strength is 3.5 %. From 1.5 % to 2 % of steel fiber the rate increase in tensile strength is 1.8%.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 5, May 2016

3.3 SHEAR STRENGTH

A) The result of Shear Strength for Beam specimen after 28 days curing are obtained and are presented in Table 3.3

Table 3. 3 Shear Strength For Beam (N/mm²)

Sr. NO.	Beam Designation	% Fiber Content	Shear Force (KN)	Average Shear Force(KN)	Average Shear Strength (N/mm ²)	% INCREASE IN TENSILE STRENGTH
1	A	0	155.23	148.77	2.83	28 %
2	B		150.08			
3	C		141.00			
4	A	0.50	185.23	190.64	3.63	10.5 %
5	B		192.24			
6	C		194.45			
7	A	1.0	208.26	210.62	4.01	9 %
8	B		211.38			
9	C		212.22			
10	A	1.50	225.00	229.62	4.37	5 %
11	B		233.88			
12	C		229.98			
13	A	2.00	239.24	240.62	4.58	15 %
14	B		240.00			
15	C		242.62			
16	A	3.00	270.00	275.64	5.25	
17	B		275.00			
18	C		281.92			

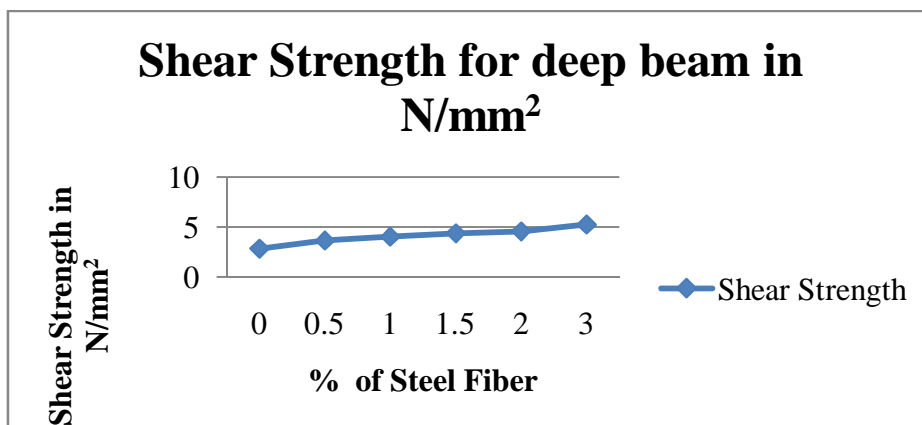


Chart 3.3 Variation Of Shear Strength With respective to % of steel Fiber

Chart No 3.3 shows the variation of Shear strength for various % of steel fibers. From above graph it can be seen that the shear strength increases with increases in % steel. The rate of increases in Shear strength 0% to 0.5 % of fiber the rate of increase in shear strength is 28 %. From 0.5% to 1 % of steel fiber the rate of increases in shear strength is 10.5 %. From 1% to 1.5 % of steel fiber the rate of increase in shear strength is 9 %. From 1.5 % to 2 % of steel fiber the rate of increase in shear strength is 5 %. From 2.0 % to 3 % of steel fiber the rate of increase in shear strength is 15 %.

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

IV. CONCLUSION

In the present the study the effect of general % varying in steel fiber are 0% , 0.5%, 1%, 1.5%, 2% and 3% in deep beam work. The following conclusions has been drawn from above study

1. The compressive strength of concrete can be improved by addition of hooked end steel fibers. As the % of steel fibers increase the compressive strength also increase.
2. The Tensile strength of concrete can be improved by addition of hooked end steel fibers. As the % of steel fibers increase the Tensile strength also increase
3. The Shear strength of concrete beam can be improved by addition of hooked end steel fibers. As the % of steel fibers increase the shear strength also increase.

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