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"Experimental Study in RC Deep Beam by Using Hooked End Steel Fiber"

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Abstract – *This project report evaluates the shear strength of steel fiber reinforced concrete deep beam without and with hooked end steel fiber with the help of experimental work. For this experimental work 12 no. cubes of concrete and two simply supported deep beam were cast at the concrete technology laboratory. Test of two point load and compressive strength of cubes acting symmetrically with respect to center line of span after the beams were kept in curing room for 28 days. Fiber varied as 0%, 0.5%, 1%, 1.5% by the volume of concrete. Hooked end steel fiber are randomly mixed in concrete shear span to depth ratio kept as 0.5 Average ratio of actual and predicted shear strength for different equation is calculated and accuracy of the equation are check out as well as deflection and cracking pattern are also reported.*
Keywords – *Hooked end steel fiber, deep beam, shear strength, deflection, shear span to depth ratio.*

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I. INTRODUCTION

According to Indian Standard provisions, deep beam is a beam having clear span to overall depth ratio less than 2.0 for simply supported beam and 2.5 for continuous beam. The effective span is defined as the Centre-to-Centre distance between the supports or 1.15 times the clear span whichever is less. Reinforced concrete deep beams have many applications in building structures such as transfer girders, wall footings, foundation wall caps, floor diaphragms, and shear walls. Continuous deep beams occur as transfer girders in multi-story frames. The Deep beams are structural elements loaded as simple beams in which a significant amount of the load is carried to the supports by a compression force combining the load and the reaction. A deep beam is a beam having a depth comparable to the span length.

II. TYPES OF DEEP BEAMS

Deep beams may be classified to be of the following types:

2.1 Simply Supported

A deep beam is simply supported when it is supported at its ends such that translational displacement is not possible, but rotation is possible.

2.2 Continuous Beam

Continuous deep beam, which is supported at several support along the length of beam.

III. LOADING ON DEEP BEAMS

Loading on the deep beams may be in one of the following forms:

3.1 One Point Loading

A point load or concentrated load is one, which is considered to act at a point. In actual practice, the load has to be distributed over small area, because such small knife- edge contacts are generally neither possible nor desirable.

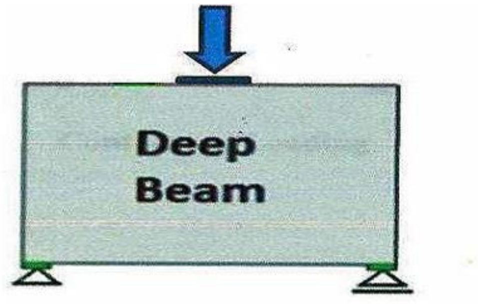


Fig.1 One Point Loading

3.2 Two Point Loading

Two point loads may act on the beam as shown in figure below:

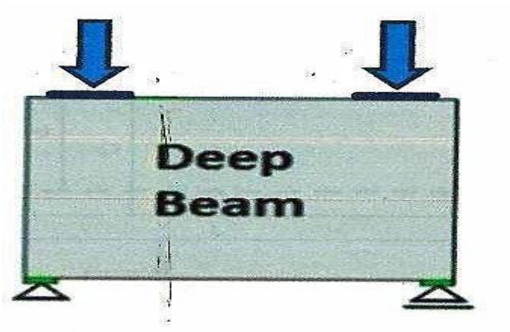


Fig. 2 Two point Loading

3.3 Continuous Loading

A distributed load is one, which is distributed or spread in some manner over the length of the beam. If the spread is uniform it is to be loaded uniformly distributed load.

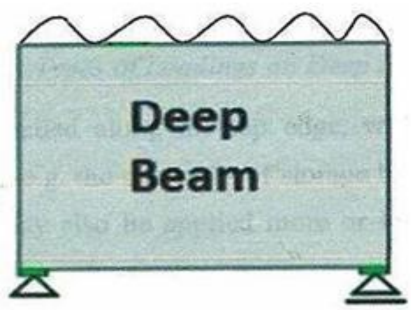


Fig.3 Continuous Loading

IV. OBJECTIVE

- The main objective of this investigation is to conduct an experimental study on strength & behaviour of deep beams. The detailed analysis has been carried out . The study also aimed at testing validity and usefulness of IS 456-2000.

- The objectives of the experimental investigation can be listed as follows:

1. To observe the deflection, cracking and failure modes of without steel fibre and with steel fiber reinforced simply supported deep beams subjected to a two points loading.
2. Steel fiber To check whether 0%, 0.5%, 1%, 1.5% steel fibre is sufficient for to achieve maximum strength.

V. METHODOLOGY

The important steps in the design of R.C. Deep Beams are following:

1. Determine whether the given beam is deep according to the definition.
2. Check its thickness with respect to buckling as well as its capacity to carry the major part of the shear

force by the concrete itself.

3. Design for flexure.
4. Design for minimum web steel and its distribution in the beam.
5. Design for shear. If the web steel already provided is inadequate, design additional steel for shear requirements.
6. Check safety of supports and loading points for local failure.
7. If the beams are not top loaded design the special features required for deep beam action under the special loading conditions.
8. Detail the reinforcement according to accepted practice.

VI. MATERIALS USED

M20 Grade Concrete Mix Design –IS10262 & IS456.

1) Cement-

Ordinary Portland cement of grade 53 was used. The Initial setting time of cement is 30 minutes and the specific gravity of cement is 3.15.

2) Fine Aggregate-

Fine aggregate used in this research work was conforming to IS and was clear sand passing through4.75mm sieve with a specific gravity of 2.68. The grading zone of aggregate was zone II.

3) Coarse Aggregate-

Coarse aggregate used in this research work was conforming to IS and was angular crushed aggregate with a specific gravity of 2.74.

4) Water-

Potable water available in the laboratory with the pH of
7.0 ± 1 and conforming to the requirement of IS: 456-2000 was used for mixing concrete and also for curing of specimens.

5) Fibre-

Diameter of fibre was measured and it was 0.6 mm. The specific gravity was determined based on the method specified in IS: 2386 (Part III). Five gram of fibre samples was accurately weighed in an electronic balance of accuracy 0.001 gm.

6) Reinforcements-

Fe 500 steel bars of diameters 8 mm and 10 mm were used as flexural reinforcements for deep beams and 8 mm diameter bars were used as stirrups and ties (shear reinforcement).

VII. PREPARATION OF REINFORCEMENT MESH

Fig. Preparation of Reinforcement Mesh

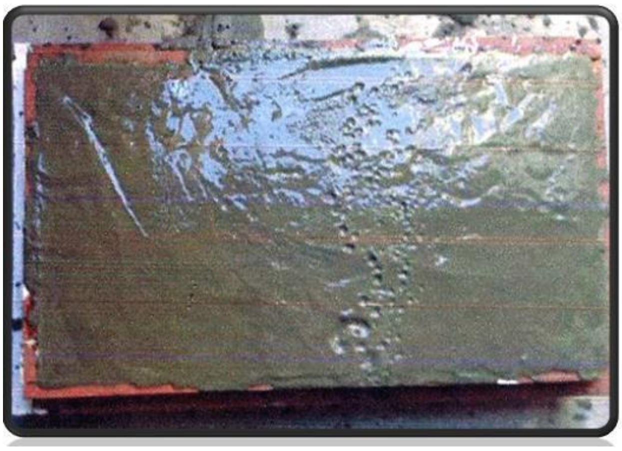


Fig.Casting Work

Table. Cubes with 0.5% hooked end steel Fibre.

VIII. TESTING OF SAMPLES

Fig. Testing of Beams

Table1: Cubes with 0.5% hooked end steel Fibre

Sr. No.	No. Of Days Cured	Dimension	Load (kN)	Strengt h (kN/m3)	Average Strengt h (kN/m3)
1	28	150x151x149	525	23.18	22.81
2	28	151x150x149	535	23.62	
3	28	151x147x148	480	21.62	

Table 2: Cubes with 1% hooked end steel Fibre

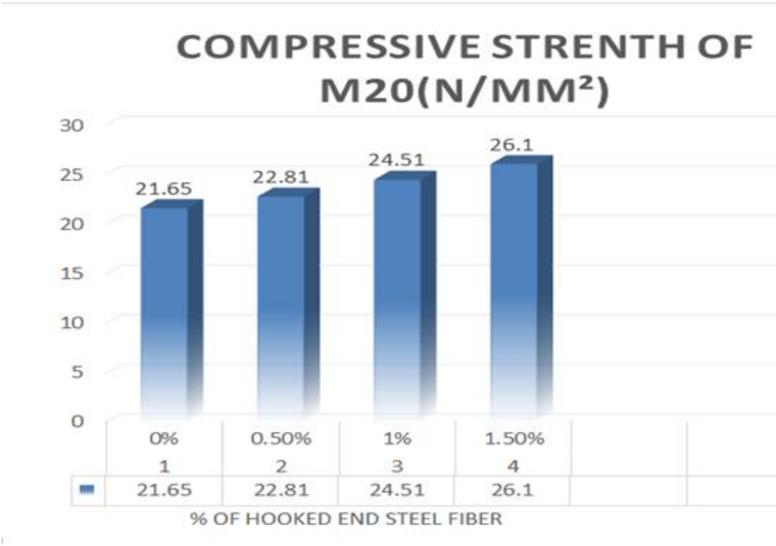
Sr. No.	No. Of Days Cured	Dimension	Loa d (kN)	Strength (kN/m3)	Average Strength (kN/m3)
1	28	151x148x150	545	24.39	24.51
2	28	150x148x147	535	24.10	
3	28	150x149x151	560	25.06	

Table 3: Cubes with 1.5% hooked end steel Fibre

Sr. No.	No. Of Days Cured	Dimension	Loa d (kN)	Strength (kN/m3)	Average Strength (kN/m3)
1	28	150x149x151	580	25.95	26.10
2	28	150x149x148	595	26.62	
3	28	151x148x149	575	25.73	

Table 4: Cubes with 0% hooked end steel Fibre

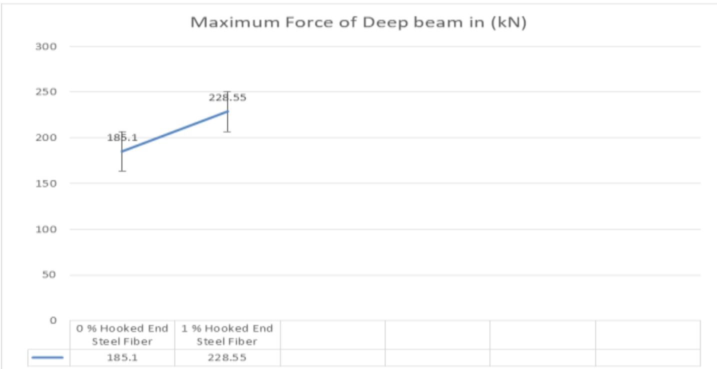
Sr. No.	No. Of Days Cured	Dimension	Loa d (kN)	Strength (kN/m3)	Average Strength (kN/m3)
1	28	150x147x148	470	21.32	21.65
2	28	150x151x148	495	21.85	
3	28	150x147x149	480	21.77	



IX. RESULTS

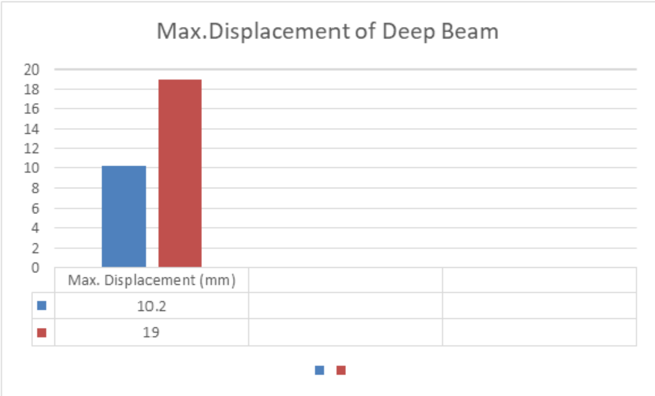
1. Type I: Beams without Fibre (B1)

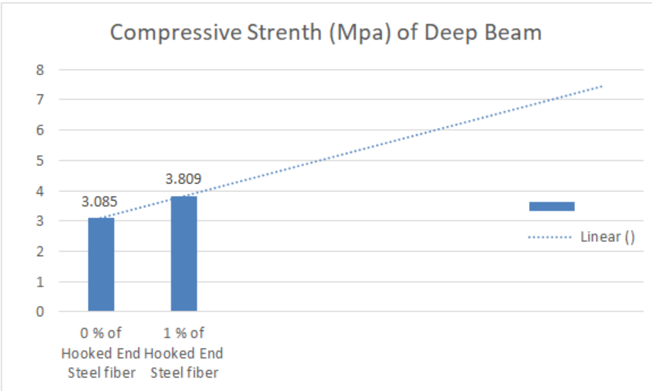
This beam is designed by using IS 456:2000 code and for 200 mm shear span. Shear span to depth ratio for this beam was 0.5. Loading was started as usual. Initial cracking load for this beam was found to be 130 kN. Minor cracks initiated in shear span region in the direction of the line joining the loading point and support. Also minor flexural cracks at mid span were seen. At increased load, increase in the crack width was observed. The ultimate load was found to be 185 kN. Total deflection at the centre of the beam was found to be 10.20 mm.



2. Type II: Beams with Fibres (B2)

This beam is designed by using IS 456:2000 code and for 200 mm shear span. Shear span to depth ratio for this beam was 0.5. Loading was started as usual. Initial cracking load for this beam was found to be 150 kN. Minor cracks initiated in shear span region in the direction of the joining the loading point and support. Also minor flexural cracks at mid span were seen. At increased load, increase in the crack width was observed. The average ultimate loads were found to be 228.550 kN. Total average deflections at the centre of the beam were found to be 19.00 mm.





X. CONCLUSIONS

1. All the tested deep beams has significantly low deflection at failure, failure was due to the shear-compression failure mode, the concrete part between the load point and the support experiences high compression after the inclined crack appears and eventually fails.
2. Failure was due to the shear cracking of deep beam, it implies that failure is due to shear rather than flexural deflection.
3. Due to high tensile strength of hook end steel fibre, initial cracks was developed after sufficient interval of time. Initial crack on conventionally designed deep beam was appeared at 150.33 kN load, whereas initial crack on deep beam with 1% steel fibre appeared at 195 kN .It implies that due to addition of 1% hook end steel fibre, better interlocking between fibre and concrete, so deep beam sustain more initial load. Hook end steel fibre increase ductility of deep beam.
4. In type II deep beam, By adding hook end steel fibre to the extent of 1%, complete shear reinforcement can be replaced without compromising its strength. Which in turn facilitate in good compaction of concrete.
5. In type II deep beam, If the fibre is 1% the flexural strength is found to increase nominally by average of 23.50%.
6. As load increases, position of neutral axis shifted downward, experimental position neutral axis is nearly the same to theoretical position of neutral axis.
7. As percentage of hooked end fiber increases the compressive strength of cubes also increases.

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