International Journal of Research Studies in Science, Engineering and Technology
Volume 2, Issue 7, July 2015, PP 120-124
ISSN 2349-4751 (Print) & ISSN 2349-476X (Online)

Evaluation of Effectiveness of SFRC Deep Beams in Shear

Abhijeet Pabale, A.J.Mehetre

Department of Civil Engineering, AVCOE Sangamner, India

Abstract: *The rapid ascent of fibre reinforced concrete to the main stream construction material has been spectacular and paralleled by no other construction material. In spite of coming a long way, there still exist a number of areas where fibre reinforcement has shown promise but an extensive use has not been transpired. One of such areas is 'Structural Concrete'. Deep beam is such a structural element whose span to depth ratio is comparatively very small. They are often used as transfer girders in tall buildings, long span construction etc. which may catastrophically fail in shear. Behavior of normal reinforced concrete deep beams and steel fiber reinforced concrete deep beams subjected to predominant shear with or without stirrups and web reinforcement is presented to evaluate the effectiveness of steel fibers in deep beams. The review of research work shows that the inclusion of steel fibres in reinforced concrete deep beams result in enhancing their deformation characteristics at all stages of loading up to failure as well as improving their shear resistance. Therefore, the use of steel fibres is an attractive alternative to test for deep beams for different parameters.*

Keywords: *Deep Beam, Steel Fiber, Shear- span ratio, Fiber volume ratio, fiber aspect ratio, longitudinal steel ratio, Shear Reinforcement, Web Reinforcement.*

1. Introduction

Deep beams are recognized by relatively small values of span-to-depth ratio. As per code provisions given by Bureau of Indian Standards [1] a beam shall be considered as deep beam when the ratio of effective span to overall depth ratio is less than 2.0 for simply beams. Reinforced concrete deep beams have very useful structural applications such as pilecaps, water tanks and tall buildings.

It has been found that the use of steel fibers of short length and small diameter as reinforcement improves the strength & deformational characteristics of cement. An experimental program was therefore, conducted to study the effectiveness of steel fibers as web reinforcement in reinforced concrete deep beams.

The simply supported deep beam is subjected to Point loading with different shear span to effective depth ratios. The failure of the deep beam is in shear and the shear is resisted by shear reinforcement. If the spacing between the reinforcement is less then it is quite difficult to achieve full compaction of concrete. The shear may be resisted by using steel fibers instead of shear reinforcement. Generally three types of cracks, namely flexure, flexure shear and shear develop in deep beams under applied load, depending upon L/D ratio, tensile and web reinforcement, shear span to depth ratio, use of steel fibers etc. These cracks ultimately cause the deep beams to fail. Apart from these cracks, deep beams also fail due to crushing at their supports or loading points due to insufficient anchorage of the tension reinforcement within the beams themselves.

2. Experimental Programme

2.1. Test Material

Ordinary Portland cement of 53 grades was used having fineness modulus of 7.3 and crushed aggregate of maximum size 10mm were used. The grade of concrete is M20 with mix proportion of 1:1.5:3 by weight with water cement ratio of 0.50 was kept constant for all beams [7]. The crimped steel fibers of 0.5 mm diameter with aspect ratios of 100 were used.

2.2. Specimen Details

All the beams were of rectangular cross section with effective span of 700 mm and width 100 mm. The effective spans to overall depth ratio was 2 so as to achieve the desired shear span to effective depth ratio (a/d)

In order to study the shear strength of deep beam, total number of 05 specimens was cast. [02 Plain beams (100mm x 350mm x 700mm)], [02 beams with steel fibres 0.5% (100mm x 350mm x 700mm)] and [02 beams with steel fibres 01% (100mm x 350mm x 700mm)] were cast by using crimped steel fibers with volume fraction (0.5 and 1.0 %). Three bars of 08mm diameter as longitudinal reinforcement were used in all deep beams.

2.3. Test Procedure

Both the surfaces of beams were white washed to aid to the observations of crack development during testing. The beams were tested to failure under point top loading in compressive testing machine of capacity 200 tones. The first crack load and the ultimate load was determined.

Fig1. *Test Setup of CTM with Fixed Roller Base for Shear*

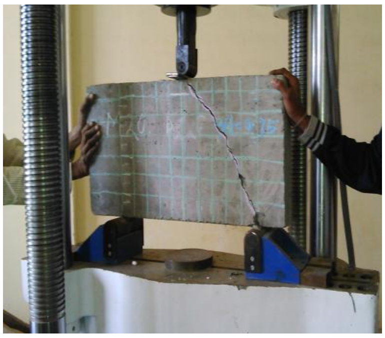
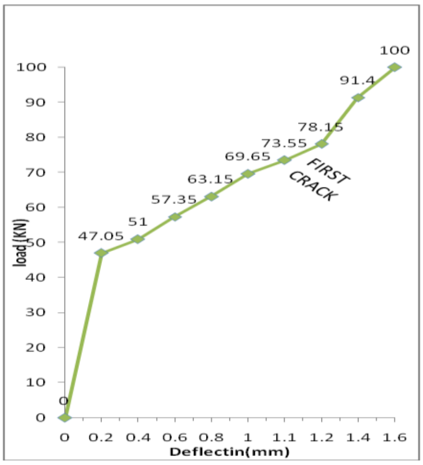


Fig2. *Failure Pattern of R.C.C. Beam*

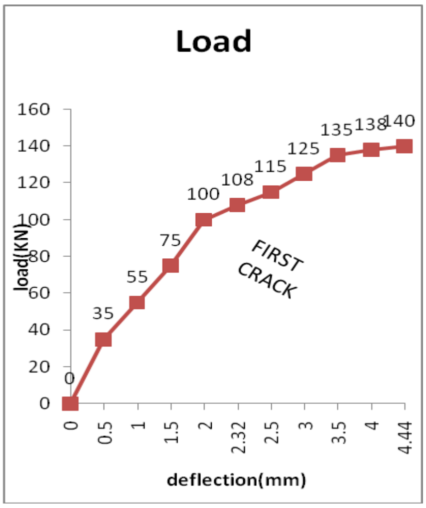
2.4. Test Result and Discussion



Graph1. *M-20 Plain Deep Beam-(Load Vs Deflection)*

Discussion:

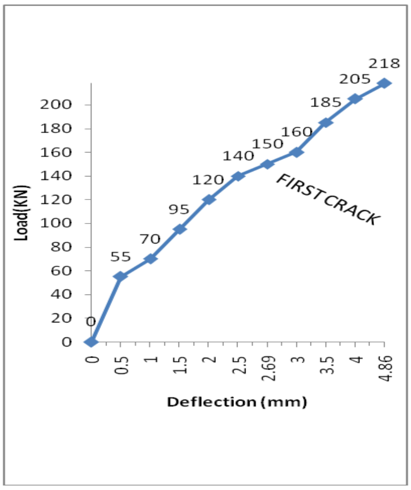
The above graph indicates load vs deflection for M-20 plain beam with 100mm wide. Here the first crack occurs at load- 73.55KN, deflection of 1.1 mm and the ultimate load is 100 KN with deflection of 1.6mm.



Graph2. *Deep Beam, M-20 (0.5% addition of steel fibres) load vs deflection*

Discussion:

The above graph indicates load vs deflection for M-20 with steel fibre beam. Here the first crack occurs at load- 108KN, deflection of 2.32 mm and the ultimate load is 140 KN with deflection of 4.44 mm.



Graph3. *M20 Deep beam- 2(1.0% addition of steel fibre) (load Vs deflection)*

Discussion:

The above graph indicates load vs deflection for M-20 beam with 1.0% steel fibre. Here the first crack occurs at load- 150KN, deflection of 2.69 mm and the ultimate load is 218 KN with deflection of 4.86mm.

It is evident from Graph 1 that ultimate strength is less when there are no Steel Fibres in the deep beam i.e. for Plain beam of M20 grade.

It is clear from graph 2 and 3 that the addition of steel fibers in concrete mix significantly influenced the cracking behavior, first crack strength and ultimate strength of deep beams. For example beams which contained no fibers and without web reinforcement, exhibited a sudden formation of a long inclined crack. On the other hand, inclined cracks went through a slow process of widening and extension in beams with 0.5 %, 1.0% of fiber content and without web reinforcement.

In beams with steel fibers first diagonal crack formed at about 60 – 66 % of ultimate load almost in the middle of the shear span. As the load was increased inclined crack propagated towards the support and loading points. Further increase in the load resulted in the propagation and widening of the existing cracks leading to shear failure.

Addition of steel fibers in concrete mix significantly influenced the cracking behavior and ultimate strength of deep beam. This lower rate of crack propagation in fiber reinforced beams may attributed to the restraint provided by the steel fibers that bridge the cracks, this contributing to port cracking strength.

3. Conclusion

Following conclusions are draw based on the results discussed in the previous topic

- The inclusion of short steel fibers in concrete mix provides effective shear reinforcement in deep beams and provides better crack control in beams.
- Both the first crack strength and ultimate strength in shear increase for fiber reinforced beams because of their increased resistance to propagation of cracks.
- Shear strength increases with fiber content and decreasing a/d ratio.
- Maximum increase of 40 % in first cracking load for beam containing 0.5 % of fiber was observed when compared with beam containing no web reinforcement.
- When all the beams were tested in this program, maximum shear strength was observed in beams reinforced with 0.5 % and 1.0 % steel fibers followed by beams containing web reinforcement
- These results supports use of 1.0% steel fibers as an alternative to conventional web reinforcement in deep beams.

Acknowledgement

This achievement would be worthless if it was not for the timely help and guidance of well wishers. I know an acknowledgement is not enough to scale their help and wishes. Yet I take this opportunity to express our gratitude towards professors without whom the project work would not have shaped.

I wish my gratitude towards my guide Professor A. J. Mehetre for his constant interest, encouragement and valuable guidance during completion of project work. He constantly shored me up, enabling me to develop an understanding of the project. I would like to thank Dr. G.J.Vikhe Patil, Principal of the Institute who has provided me this opportunity to present this thesis.

I would like to thank Prof. Dr.J.B.Gurav, Head, Civil engineering department for his kind co-operation and constant inspiration during this course.

References

[1] IS: 456-2000, Code of Practice for Plain and Reinforced Concrete (Fourth Revision), Bureau of Indian Standards, New Delhi, 2000.

[2] ACI Committee 544, State-of-the-Art-Report on Fiber Reinforced Concrete (ACI 544, 1R-96, Re-approved 2002).

[3] Prof. R.H. Shaha S.V. Mishara, “Crack and Deformation of SFRC Deep Beams”, I.E. (I) Journal – CV (Aug 2003), pp. 44-48.

[4] S.K. Madan, G. et. al. “Steel fibers as replacement of web reinforcement for RCC deep beams in shear”, Asian Journal of Civil Engineering (Building and Housing) Vol.8.No. 5, (2007), pp. 479-489

[5] Remigijus Salna, Gediminas Marciukaitis, “The Influence of Shear Span Ratio on Load Capacity of Fiber Reinforced Concrete Elements with Various Steel Fiber Volumes”, Journal of Civil Engineering and Management, Vol. XIII, No3, pp. 209-213.

[6] CIRIA Guide -2 : The Design of Deep Beams in Reinforced Concrete, Ove Arup and Partners, Construction Industry Research and Information Association, London, 1977 (Reprinted with Amendments, 1984).

[7] IS: 10262 – 1982, Recommended Guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi, 2000.

AUTHORS’ BIOGRAPHY

Abhijeet Rajendra Pabale, ME Structures (2013-15), Dept.of Civil Engineering, AVCOE, Sangamner, Maharashtra, India.

BE Civil, Dept. of Civil Engineering (2009-13), Shreeyash College of Engineering and Technology, Aurangabad, Maharashtra, India

Second University Topper in BE CIVIL 2012-13 from DR. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

Working as an Lecturer in Matoshri College of engineering, Nashik, Maharashtra, India

Prof.A.J. Mehetre, Assistant Professor, Dept. of Civil Engineering, AVCOE, Sangamner, Maharashtra, India.

Working as an Assistant Professor in Dept.of Civil Engineering, AVCOE, Sangamner, Maharashtra, India, Since 2008