International Journal of Research in Advent Technology, Vol.4, No.6, June 2016
E-ISSN: 2321-9637
Available Online at www.ijrat.org

Fexural Behaviour of Fibre Reinforced Concrete Layered Beams

Prabha G [1], Tamilselvan S[2]
([1]Assistant Professor, [2] PG Student, Easwari Engineering College, Ramapuram, Chennai-600089)
***Email id**: s.tamilselvan222@gmail.com*

Abstract: Fibre Reinforced Concrete (FRC) is a special type of concrete which have large amount of fibres. FRC contains fibre only 2 % to 5 % by volume of concrete because of balling and clustering problem but Slurry infiltrated fibre reinforced concrete (SIFCON) can be used fibre up to 3 % of volume of concrete. Since FRC is a ductile layer of high performance fibre reinforced concrete with significantly large amount of fibres, hence it can be used to reduce the wear and tear. To evaluate the structural response of reinforced concrete beams and also to improve the structural response of the beam by addition fibres, a study has been proposed to introduce FRC layer in tensile zone. Layers of 10mm, 20mm and 30mm FRC with 1 % of fibre content is to be proposed to provide in 100×150×850mm reinforced concrete beams. Two 8mm diameter and two 8mm diameter rods are to be provided in the tension and compression zones, respectively. A literature review related to FRC and flexural behaviour of reinforced concrete beams is done and presented in this report. The proposed future work on this study is to evaluate the flexural response of different layers of FRC reinforced concrete beams. The proposed data is to be taken are the load-deflection, initial cracking load and deflection, load-compression and tension strains, number of cracks, cracks spacing, crack propagation and moment curvature relationships. This report contains the material characteristics of ingredients in concrete and the mix design for M30 grade concrete as per relevant Indian standards.

***Keywords*−−** crimbed-steel fiber, hooked-steel fiber,

1 INTRODUCTION

The main idea of using steel fibres with cementitious based materials aims to increase the tensile strength of plain concrete thus derive a material that will illustrate an increased ductility and enhanced strength (tensile, compressive and shear). Fibres can be used in combination with different types of cementious materials such as standard concrete, high strength concrete or high performance cementious composites. Numerous experimental investigations took place the last two decades so as to study the flexural behaviour of fibre reinforced concrete (FRC) beams in an attempt to propose constitutive material models that will be able to predict their overall mechanical response and their maximum carrying capacity due to normal shear stress-strain ultimate conditions. Ultra High Performance Fibre Reinforced CementitiousComposites, Which is the material used to perform the experimental investigation presented in this research work, is a class of cement composites which have superior characteristics in terms of material properties. The materials mechanical and fracture properties are substantially enhanced compared to other types of concrete. With the advent of special processing methods and the use of high volume fraction of steel fibres, concretes of high compressive and tensile strength as well as high energy absorbtion capacity havebeenreported.The produced materials are characterized by strain hardening and followed by tension softening due to localization of cracks. Products like Reactive Powder Concrete, and Ductal represent characteristic examples of this promising class of cementitiouscomposites.It is generally acceptable that the mechanical behaviour of FRC materials is relatively complicated given their sensitivity related to different factors such as fibre reinforcement ratio, fibre orientation and distribution. Geometry and material of the fibres and concrete properties.

1.1 *Fibre Reinforced Concrete*

Fibre Reinforced Concrete (FRC) is a composite material made primarily from hydraulic cements, aggregates and dicrete reinforcing fibres. Fibre incorporation in concrete, mortar and cement paste enhances many of the engineering properties of these materials such as toughness, flexural strength, resistance to fatigue, impact, thermal shock and spalling. The use of fibre reinforcement is not a particularly recent idea. During ancient times, fibres extracted from organic material were used. Fibre Reinforced Concrete started to come to its modern industrial floors, pavements and precast elements, bridge decks.

2 OBJECTIVE OF THE PROJECT

The objectives of this project are as follows,

The main objective of the project is,

(1) Mechanical properties of FRC

- Compression
- Tension
- Flexure

(2) To study the Flexural behaviour of FRC plates

(3) To study the flexural behaviour of control and FRC layer flexural beams

(4) Comparison of structural behaviour of control and FRC layered flexural beam.

3 LITERATURE REVIEW

D. Nicolaides and G.Markou[1] (2015) worked on the main idea of using steel fibres with cementitious based materials aims to increase the tensile strength of plain concrete thus derive a material that will illustrate an increased ductility and enhanced strength. Ultra high performance Fibre Reinforced Cementitious composites, which is the material used to perform the experimental investigation presented in this research work, a class of cement composites which have supiror characteristics in terms of material properties.It is generally that the mechanical behaviour of FRC materials is relatively complicated given their sensitivity related to different factors such as fibre reinforcement ratio, fibre orientation and distribution, geometry and material of the fibres and concrete properties. The FRC material behaviour is highly nonlinear that makes modelling of its mechanical response at the material level a rather difficult task. Even though in the international literature many numerical material models have been proposed so as simulate the mechanical behaviour of FRC structure members, there isn`t yet a numerical model that has gained a general acceptance from the international scientific community. Thus further research is still required towards achieving this task. One of the most recent attempts in the development of an objective material model that will be capable in predicting the FRC materials mechanical behaviour and its maximum capacity when used as the main material in beam-shaped specimens. Presented by barros et al.In this research work the proposed material model is integrated within a finite element beam which uses the layer approach so as to discretise the beam`s section. As it was mentioned in their work, each section of the beam finite element was discretized with three layers and the conventional steel reinforcement was also converted into layers so as to behaviour of the FRC material was modelled by using a bilinear stress-strain curve that does not foresee any remaining compressive strength after the crashing of concrete, while the tensile behaviour of the material was described by a tri-linear stress-strain relationship.The addition of fibres in concrete affects both compressive and tensile behaviour of the material thus derives a composite material that incorporates elastic and softening branches. As it was stated by numerous researchers, the stress-strain relation for the case of compression foresees an initial elastic behaviour followed by a peak plateau that eventually ends when the concrete crashes. For the case of the material behaviour in tension, the elastic region is significantly smaller given that the micro-cracks develop faster when the material is under tension and given the low ultimate tensile strength of concrete.

H. Wang and A. Belarbi[2] (2014) have done their elaborate research on Experimental Investigations of High-Performance the concrete mix used in this study was based on an existing MODOT mix design. For practical application, the volume fraction of polypropylene fibre was used to make the FRC and take the benefits of the fibers, while ensuring good workability of concrete. It should be noted that the purpose of this study was to qualitatively investigate the benefits gained from the fibers to the FRC reinforcing system the different volume fraction`s effect was not a variable to be investigated in this study. The compression strength of concrete on the day of testing was 30 MPA and 48 MPA for FRC and plain concrete, respectively.This section will provide a summary of overall flexural behaviours of the FRC/FRC hybrid system in terms of crack distribution, load-deflection response, relative slip between the rebar and concrete, cyclic loading effect on flexural behaviour, and strain distribution in concrete and reinforcement. Comparison between FRP/Plain concrete system and FRP/FRC system is also discussed. The crack widths were smaller in the case of FRC beams as compared to plain concrete beams at the service load. As discussed earlier, the crack spacing was decreased at the service load due to the contribution from the fibers. Since the crack width is proportionally related to the crack spacing, the crack width is expected to be smaller in the FRC beams at service at service loads.the typical experimental moment-deflection curves for plain concrete beams and FRC beams reinforced with different type of FRP rebars. With the increasing of moment, crack occurred in the testing region when the moment exceeded the cracking moment Mcr. Consequently, the flexural stiffness of the beams was significantly reduced and the curves were greatly softened. As expected, due to the linear-elastic behaviour of the FRP rebars, the FRP reinforced beams showed no yielding. The curves went up almost linearly until the crushing of concrete.

Won K. Lee, and Daniel C.Jansen[3] (2010), The beams were simply supported and subjected to a four-point bending load, the beams contained no compression reinforcement and no internal shear reinforcement. The beams were tested in a screw-driven testing machine with a 1.33 MN load capacity. A reinforced beam specimen in the testing machine.

TABLE-1 MIX PROPORTION

Grade	Cement :FA:CA	W/C	SP
M30	1:1.7:2.7	0.43	0.4

Mix Design for M30 Concrete=1:1.7:2.7

A TEST SETUP

Fig-1 Test Setup of Beam

B Failure Pattern in Beam

Fig-2 Failure Pattern in Beam

4 TEST RESULTS

TABLE-2 Strength of reference and FRC Beams Subjected To Static and Cyclic Loadong

Loading Type	Control Mix	FRC 10mm	FRC 20mm	FRC 30mm
Static loading system	33.43	38.50	38.79	38.66
Cyclic loading system	31.17	35.50	36.70	40.60

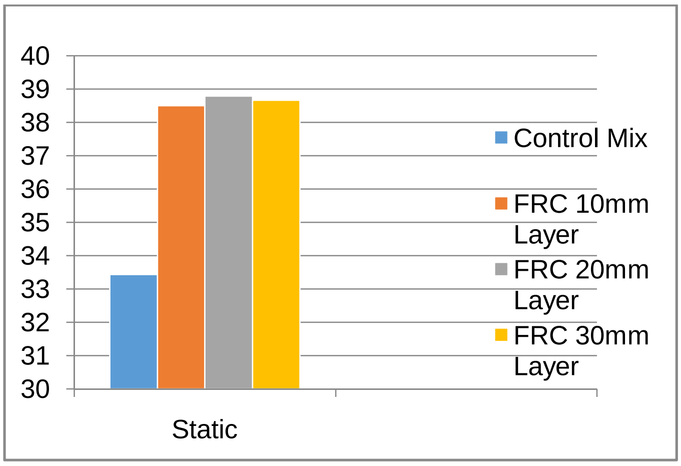

Fig-3 Strength of FRC beams subjected to static loading.

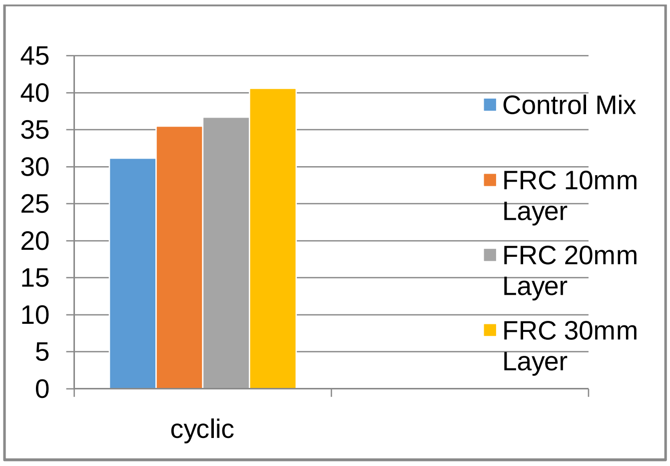

Fig-4 Strength of FRC beams subjected to cyclic loading.

5 CONCLUSION

This paper attempts to study the behavior ofFRC reinforced beams under different loading conditions. This casting of Fibre reinforced concrete layered beams is feasible with the designed mould. The failure of fibrereinforced concrete layered beams occurred nearly at the centre of the span whereas the failure in case of fibre reinforced concrete beams under the loads showing that the failure governed by the beam flexure. When fiber is added to 10% to 30% to its volume, it increases upto 30% in high flexural strength and high modulus of elasticity.

REFERENCES

[1] Nicolaides D. "Flexural Behaviour of Fibre Reinforced Concrete" Fracture and fatigue of CADRIFRC PhD thesis UK: Cardiff University 2004
[2] Markou G. Detailed three dimentional nonlinear fibre simulation for the analysis of large scale reinforced concrete structures. PhD thesis. National technical University of athens 2011.
[3] Markou G, "3D Finite elements modelling of FRC structures". 2013.
[4] Belarbi, A., and Watinks, S.E., "Performance Evaluation of FRC Rebar featuring ductility and health monitoring capability, Proceedings of the Fourth international symposium on fibre reinforced concrete" ,1999.
[5] Belarbi. A and Wang, H., "Bond Splitting Behaviour of FRC Reinforcing bars Embeded in fibre reinforced concrete" , proceeding for the,2005.
[6] Balaguru, P. and Najm, H.,(2004) "High Performance Fibre Reinforced Concrete Mixture Proportions with high fibre volume fractions", ACI Materials Journal 2004.
[7] Amir A. Mirsayah and NemkumarBanthia 2002,. "Shear strength of Steel Fibre Reinforced Concrete", ACI Materials Journal, Vol.99, No.5, 2002.
[8] Jansen, D. C. Choi, S and shah,. S studying shear crack inltiation and growth of Reinforced Concrete Beams using steel fibre , 1996.
[9] Wang, .H and Belarbi, A., Flextural Behaviour of Fibre Reinforced with FRC rebars, 2005.
[10] Masmudi, R Bentnoknme, B and Gao, D., "Insvestigation on the bond of fibre reinforced concrete beams with FRP rebars". 1998.
[11] Henrik Thomsen, Enrico spacone ,suchart K., "water penetration of concrete reinforced with long and short steel fibres", Transections of the japan concrete institute 2000.
[12] Kim D.J. Naaman A.,E. Tawil S. "correlation between tensile and bending behaviour of FRC composite with scale effect".
[13] Nagabhushanam,.M., Ramakrishnan, V., and Vondern, G. "Fatigue strength of fibrillated fibre reinforced concrete"., 1989.
[14] Nataraja, M C, Dhang N and Gupta A.P (1999) " Stress strain curve for steel fiber reinforced concrete in compression", cement and concrete composite UK Vol 21, No 5/6 1999, PP. 383-390
[15] Nataraja, M C, Dhang N and Gupta A.P (2000) " Toughness Characterisation steel Fiber Reinforced Concrete", cement and concrete composite UK Vol 30, No 4., 2000, PP. 593-597
[16] Nataraja, M C, Dhang N and Gupta A.P (2000) " A study on Behaviour Of for steel fiber reinforced concrete in compression", cement and concrete composite UK Vol 1, No 1, Jan 2000, PP. 1 - 11
[17] Nataraja, M C, Dhang N and Gupta A.P (2001) " Splliting Tensile Strength Of steel fiber reinforced concrete in compression", Indian Concrete Journal Vol 75, No 4 2001, PP. 287-290
[18] Nataraja, M C, Dhang N and Gupta A.P (1999) " A study on the steel fiber reinforced concrete Composite Using Pulse Velocity Technique",Indian concrete bulletin UK Vol 65, 1998, PP. 25-27