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Behaviour of Steel Fibre Reinforced Concrete Beam under Cyclic Loading

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Abstract: *This paper describes the influence of steel fibre distribution on the ultimate strength of concrete beams. An experimental & analytical investigation of the behaviour of concrete beams reinforced with conventional steel bars and steel fibres under cyclic loading is presented. It is now well established that one of the important properties of steel fibre reinforced concrete (SFRC) is its superior resistance to cracking and crack propagation. As a result of this ability to arrest cracks, fibre composites possess increased extensibility and tensile strength, both at first crack and at ultimate load and the fibres are able to hold the matrix together even after extensive cracking. The net result of all these is to impart to the fibre composite pronounced post – cracking ductility which is unheard of in ordinary concrete. The transformation from a brittle to a ductile type of material would increase substantially the energy absorption characteristics of the fibre composite and its ability to withstand repeatedly applied, shock or impact loading. Tests on conventionally reinforced concrete beam specimens, containing steel fibres in different proportions, have been conducted to establish load-deflection curves. It was observed that SFRC beams showed enhanced properties compared to that of RC beams with steel fibres. The experimental investigations are validated with the analytical studies carried out by finite element models using ANSYS.*
Keywords: *Steel fiber, concrete, properties, crack, ductility, technology.*

I. Introduction

SFRC is a composite material made of cements, water, fine and coarse aggregate, and a dispersion of discontinuous, small fibres. These short discrete fibres are uniformly distributed and randomly oriented. They are mixed with concrete before pouring. The reinforced concrete structures are subjected to cyclic loads during dynamic loads such as earthquake shocks, traffic loads on the bridges, etc. It is well known that plain concrete is brittle and weak under flexural loads. To eliminate the disadvantages of plain concrete is added fibers into concrete mix. All admixtures meeting ASTM specifications for use in concrete are suitable for use in SFRC. Steel fiber-reinforced concrete (SFRC) has gained increased popularity in construction industries in recent years.

Properties of Concrete Improved by Steel Fibres:

- Flexural Strength**:** Flexural bending strength can be increased of up to 3 times more compared to conventional concrete.
- Fatigue Resistance**:** Almost 1 1/2 times increase in fatigue strength.
- Impact Resistance**:** Greater resistance to damage in case of a heavy impact.
- Permeability**:** The material is less porous.
- Abrasion Resistance**:** More effective composition against abrasion and spalling.
- Shrinkage**:** Shrinkage cracks can be eliminated.
- Corrosion**:** Corrosion may affect the material but it will be limited in certain areas.

The different types of steel fibres which are available is shown in Fig 1.2

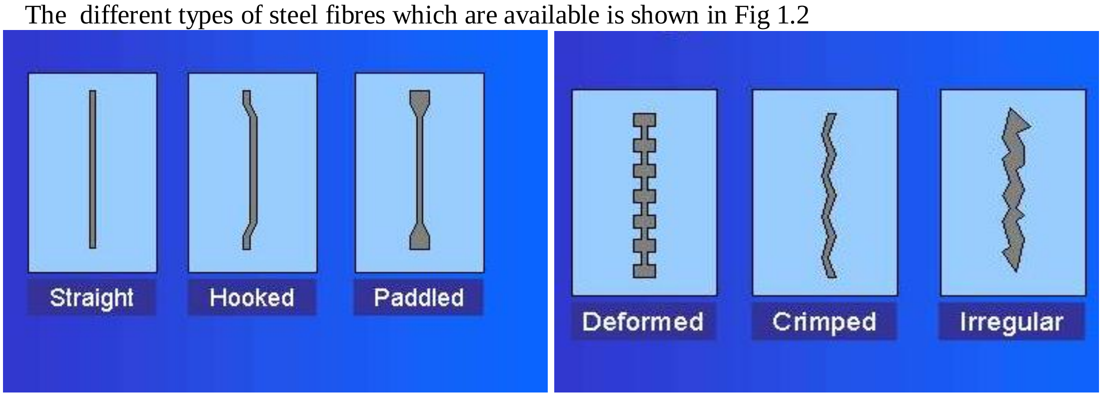

Fig 1.2 Types of steel fibres

1.1 Objectives

The objective of this study is to:

- Investigate the mechanical properties like flexural strength, modulus of elasticity flexure beams and cylinders.
- Investigate ductility requirement , moment rotation capacity, energy absorption capacity for SFRC beams under cyclic loading using hybrid steel fibers of different volume fractions
- Improve the resistance of conventionally reinforced structural members to cracking, deflection and other serviceability conditions, by utilizing the inherent material properties of fiber concrete.

1.2 Need for the Research

To improve:

- Ductility.
- Energy absorption.
- Moment rotation capacity.
- Structural strength.
- Confinement characteristics.

1.3 Scope

The scope of work is to study the behaviour of steel fibre reinforced beams under cyclic loading and comparing the results both analytically (using ANSYS- a general purpose finite element-modelling package) and experimentally. The parameters investigated are:

- Midspan Deflection
- Strain measurement
- Location & type of crack occurrence

1.4 Research significance

It is clearly seen from the literature that the behaviour of beam is affected by the properties of core concrete. Ductility is desirable in reinforced concrete frames under seismic loading. Ductility is generally achieved by providing closely spaced horizontal ties, but this causes difficulties in placing concrete in densely reinforced portions resulting in bad concreting. To avoid such closely spaced stirrups, confinement characteristics of core concrete has to be improved, which increases the ductility of the core concrete. In this respect, steel fibre reinforced concrete (SFRC) which posses ductility, toughness and tensile strength more than the plain conventional concrete can be considered to replace the plain concrete .It is expected that use of SFRC can eliminate partially or fully the ties ,thus avoiding the congestion of reinforcement.

1.5 Summary of review of literature

- It is clearly seen from the literature that the behaviour of RC beam is affected by the properties of Steel fibre reinforced core concrete.
- Many investigators have established that inclusion of high strength, high elastic modulus steel fibres of short length and small diameter improves the tensile strength and ductility of concrete significantly.
- The combination of steel fibres and stirrups demonstrates a positive composite effect on the ultimate load, ductility and failure pattern of concrete beam.

II. Materials and Methods

2.1 Materials:

The materials used in the experimental work are tested for their properties and the details are furnished. Raw materials listed below were used for preparation of the specimens:

- Ordinary Portland Cement (OPC)
- Coarse aggregate with 10 mm maximum size
- Fine aggregate
- Steel Reinforcement:

  High Yield for main bar (12 mm,10 mm) and;
  Mild steel for shear reinforcement (8 mm)
- Crimped and Hooked end steel fibres
- Plywood with thickness 12 mm to prepared formwork.

2.1.1 Details of Fibres

Fibre used – Hooked end, Crimped with following aspect ratios and diameters. The properties of fibres are given in Table 2.4

s.no	Fibre	Aspect ratio (l/d)	Length (mm)	Diameter (mm)
1	Hook End -1	80	60	0.75
2	Hook End -2	65	35	0.55
3	Hook End -3	45	50	1.11
4	Crimped	50	50	1

Table 2.4 Properties of Fibres

III. Mix Design

Considering the capacity of beam testing machine, the grade of the concrete is M30. The mix design of the M20 grade concrete as per IS: 10262-1982.

Water	cement	Fine aggregate	Coarse aggregate
214.24	465.7	506.52	1123.6
0.46	1	1.08	2.41

3.1 Design Of RC Beam

The RC Beam is designed based on the load carrying capacity of the testing Equipment. The limiting load applied on the beam from the equipment is considered as 250kN.. The dimensions and reinforcement details for the beam are given below.The detailing of the beam is done as normal detailing and ductile detailing.
L - 1800 mm B - 150 mm D - 225 mm

3.1.1 Fibre proportions in RC Beam

s.no	Proportions
1	Control beam without fiber & normal detailing as per IS456
2	Control beam without fiber & ductile detailing as per IS13920
3	Crimped fibre with AR-50+ Hooked End fibre with AR-80
4	Hooked end fibre with AR-80+ Hooked End fibre with AR-45

IV. Experimental set up

All beams after casting are cured for 28 days prior to testing.Cyclic Loading is the application of incremental Push and Pull Load. The analysis is also known as Push-Pull analysis. The loads are applied incrementally as positive and negative loads.Hydraulic jack and load cells(10tonnes or 25 tonnes) are placed above and below the beam in order to attain the effect of cyclic loading. Each beam is tested for corresponding load increment and finally the4 behaviour of beam is studied.

4.1 Analytical investigation

The study on the structural frame is basically a deflection controlled analysis; hence the analysis is carried out by the application of lateral force. The 3D model is analysed and the displacement results are observed from cyclic loading by applying each load increment both in positive direction and in negative direction. Figure showing the reinforcement details in ansys is shown below.

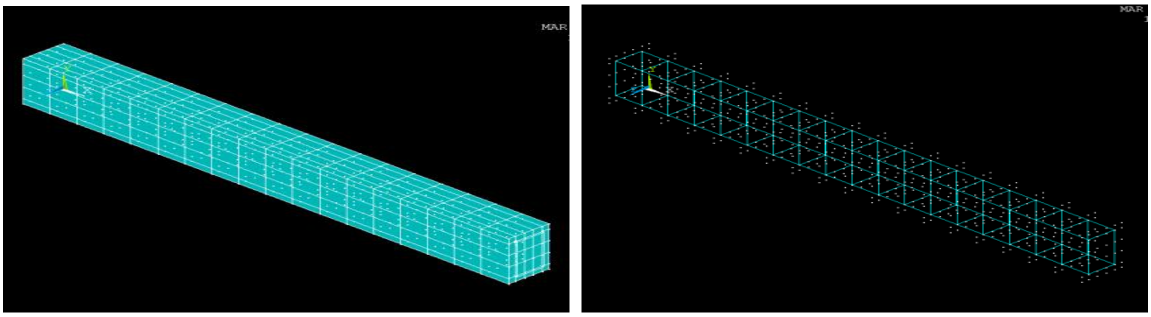

Fig.4.1.1 Reinforcement details in ANSYS

V. Schedule of work

Cylinders are casted by using the various fibre configurations in order to get the corresponding modulus of elasticity. The same results are compared analytically using ANSYS software.

VI. Conclusion

The experimental values of the strain and deflection of steel fiber reinforced concrete beams are compared with that of the corresponding estimated values of the strain and deflection of reinforced concrete beams without fiber. The comparison reveals that the strength depends on the presence of fibre and it increases with decrease in the spacing of stirrups (increase in the percentage of web reinforcement). The ultimate strength of SFRC beams is analytically obtained. The analytical results were compared with the experimental results.

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References

[1]. S. Pant Avinash1, R. Suresh Parekar (2010) “Steel fiber reinforced concrete beams under combined torsion-bending-shear” Journal of Civil Engineering (IEB) 38(1) 31-38

[2]. R.P. Dhakal and H.R. Song (2009) “Effect of bond on the behaviour of steel fibre reinforced concrete beams” ICI Journal, Vol. 1,No.4

[3]. Mukesh Shukla (2011)“Behaviour of Reinforced Concrete Beams with Steel Fibres under Flexural Loading” International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October, pp 843-846

[4]. Florian Finck(2010) “Acoustic Emission analysis of SFRC Beams under cyclic bending loads” Journal of Civil Engineering (IEB) 38(1) 21-28

[5]. Vengatachalapathy.V 1 , Ilangovan.R (2010)“A Study on Steel Fibre Reinforced Concrete Deep Beams With and without Openings” International journal of civil and structural engineering, Volume 1, No. 3

[6]. Pant Avinash S, Parekar Suresh R(2009) “Steel Fiber Reinforced Concrete Beams Under Bending, Shear And Torsion Without Web Reinforcement” International Journal of Recent Trends in Engineering, Vol. 1, No. 6

[7]. I.J Sluys And R.De Borst (2010)“Computational modelling of impact test on steel fiber reinforced concrete beams” Journal of civil Engineering, Vol. 2, No.4

[8]. Hai H. Dinh and James K. Wight(2009) “Shear behavior of steel fiber-reinforced concrete beams without stirrup reinforcement” ISET Journal of Earthquake Technology, Technical Note, Vol. 44, No. 3-4

[9]. Hamid Pesaran Behbahani1, Behzad Nematollahi(2011) “Flexural behaviour of steel-fibre-added-rc (sfrc) Beams with C30 and C50 classes of concrete” Engineering structures ,Science Direct 37

[10]. Gustavo J. Parra-Montesano’s(2010) “Shear strength of beams with deformed steel fibres” International journal of applied engineering research, Volume 1, no1