



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

Experimental Study on Impact Resistance of Steel Fibre Reinforced Concrete

Vallabhy¹, Shekina Davidson²

Assistant Professor, Department of Structural Engineering, Prathyusha Engineering College (PEC), Tiruvallur,
Tamil Nadu, India¹

P.G. Student, Department of Structural Engineering, Prathyusha Engineering College (PEC), Tiruvallur, Tamil Nadu,
India²

ABSTRACT: This study describes the impact resistance of fibre reinforced concrete with inclusion of steel fibres. The steel fibres are added in the range of 0.5%-2.5% of volume of mix. A simple economical and practical drop weight impact testing machine is used to determine the impact resistance for steel fibre reinforced concrete [SFRC]. Impact test are carried out on SFRC with aspect ratio (l/d) as 60. The specimens were tested at 7 days, 14 days and 28 day strength for concrete grade M25 and workability test. The test result shows the variation of impact energy strength with different volume fraction of fibres. Steel fibres can be defined as discrete, short length of steel having ratio of its length to diameter (i.e. aspect ratio) in the range of 20 to 100 with any of the several cross-sections, and that are sufficiently small to be easily and randomly dispersed in fresh concrete mix using conventional mixing procedure. The random distribution results in a loss of efficiency as compared to conventional rebar's, but the closely spaced fibres improve toughness and tensile properties of concrete and help to control cracking. In many situations it is prudent to combine fibre reinforcement with conventional steel reinforcement to improve performance. This paper examines the impact responses of fibre reinforced concrete and to evaluate the resistance levels of FRC beams when subjected to impact loadings.

KEYWORDS: Impact resistance, steel fibre, toughness, tensile properties, aspect ratio.

I. INTRODUCTION

Steel fibre (SF) is the most popular type of fibre used as concrete reinforcement. Initially, SFs are used to prevent/control plastic and drying shrinkage in concrete. Further research and development revealed that addition of SFs in concrete significantly increases its flexural toughness; the energy absorption capacity, ductile behaviour prior to the ultimate failure, reduced cracking, and improved durability. This paper reviews the effects of addition of SFs in concrete, and investigates the mechanical properties, and applications of SF reinforced concrete (SFRC). The beneficial influence of SFs in concrete depends on many factors such as type, shape, length, cross section, strength, fibre content; SFs bond strength, matrix strength, mix design, and mixing of concrete. The addition of SFs in the conventional reinforced concrete (RC) members has several advantages such as 1- SFs increase the tensile strength of the matrix, thereby improving the flexural strength of the concrete. 2- The crack bridging mechanism of SFs and their tendency to redistribute stresses evenly throughout the matrix contribute to the post-cracking strength and restraining of the cracks in the concrete. 3- Increase ductility of the concrete. 4- SFRC is more durable and serviceable than conventional RC. The main objective of this project is to study the Impact resistance parameter of fibre reinforced concrete with mix proportion of fibres for M25 grade concrete and comparing with the conventional concrete and to know the optimum percentage of addition of fibres to concrete and finding maximum ratios.

II. EXPERIMENTAL STUDY

The experimental investigation was focused on the effect of various fibre dosages on impact resistance of FRC. Mix proportion was designed using IS 10262-2009 and IS 456-2000 with mean target strength of 39.36 MPa (M25) for control mix. Portland Pozzolana cement of grade 53 was used in this study. A coarse aggregate with a maximum nominal size of 20 mm and a fine aggregate with a fineness modulus of 3.38 were used in the experiment. Hooked-end

steel fibres were used; their geometry and apparent shape are shown in Fig.1 and their properties are listed in Table 1. Super plasticizer of SP-430 was used to adjust the workability of mixtures.

Table 1: Properties of steel fibre



Figure 1: Steel Fibres

PROPERTIES	DESCRIPTION
DIAMETER	0.3mm-0.7 mm
LENGTH	25-35 mm
DENSITY	7900 Kg/m ³
YOUNG'S MODULUS	2.1×10^5
RESISTANCE TO ALKALIS	GOOD
RESISTANCE TO ACIDS	POOR
HEAT RESISTIVITY	GOOD
ELONGATION	5-35%

III. MIX DESIGN

In this study, water cement ratio of 0.47 was adopted for M25 grade concrete and steel of 0.5%, 1%, 1.5% volume fractions were used.

Table 2: Contents of mix proportion

Constituents	Content kg/m ³ of concrete
Cement	336
Fine aggregate	834
Coarse aggregate	1206
Water content	158
Fibres	
0.5%	12.67
1%	25.34
1.5%	38.01
Super plasticizer	1.34 kg/m ³ (0.4% by the weight of cement)

IV. TEST METHOD

The impact test was performed in accordance with the impact testing procedures recommended by ACI Committee 544. The test was carried out by dropping a hammer weighing 44.7N (10 lb) from a height of 457mm (18 inch) repeatedly on a 64mm (2.5 inch) hardened steel ball, which is placed on the top of the centre of the cylindrical specimen (disc). The test continued until it fails. For each specimen, two values were identified corresponding to initial and ultimate failure. The former value measures the number of blows required to initiate a visible crack, whereas the latter measures the number of blows required to initiate and propagate cracks until ultimate failure. According to the ACI committee, the ultimate failure occurs when sufficient impact energy has been supplied to spread the cracks enough so that the test specimen touches the steel lugs. However, in this study, if the specimen separated completely into halves before touching the lugs, then this was declared the point of ultimate failure. From this test, impact energy absorption capacity of each specimen was calculated by the equation $\text{Impact Energy (E imp)} = (0.5mv^2)$ Where m = mass of the hammer, n = no of blows, V = Impact velocity.

V. RESULTS AND COMPARISON

The results are based upon the number of blows that are required to initiate initial crack and number of blows that are required for final crack. Impact resistance of mono fibre reinforced concrete was calculated at different curing periods and compared to conventional concrete. The impact energy was calculated as follows

$$H = (gt^2)/2$$

$$V = g \cdot t$$

$$m = W/g$$

where V is the velocity of hammer by impact g is acceleration due to gravity, t is the time required for hammer to fall from a height of 457mm, H is the height of the hammer, weight of the hammer substituting the known values we get

$$457 = (9810 t^2) / 2$$

$$t = 0.3052 \text{ sec}$$

$$V = 9810 \times 0.3052 = 2994.01 \text{ mm/s}$$

The above value substitute in Impact energy equation

$$E_{\text{Imp}} = (0.5 \times 44.3 \times 2994.012) / 9810 = 20.345 \text{ KN-mm}$$

Table 3: Impact resistance for initial crack

Fibre dose	Number of blows for initial crack	Impact energy (KN-mm)	% increase in impact energy
PCC	18	441.59	-
0.5%	111	2455.75	450.00
1%	158	3405.96	663.64
1.5%	231	4903.15	995.45

Table 4: Impact resistance for final crack

Fibre dose	Number of blows for initial crack	Impact energy (KN-mm)	% increase in impact energy
PCC	25	601.33	-
0.5%	148	3151.41	411.67
1%	188	4007.97	536.67
1.5%	301	6286.61	930.00

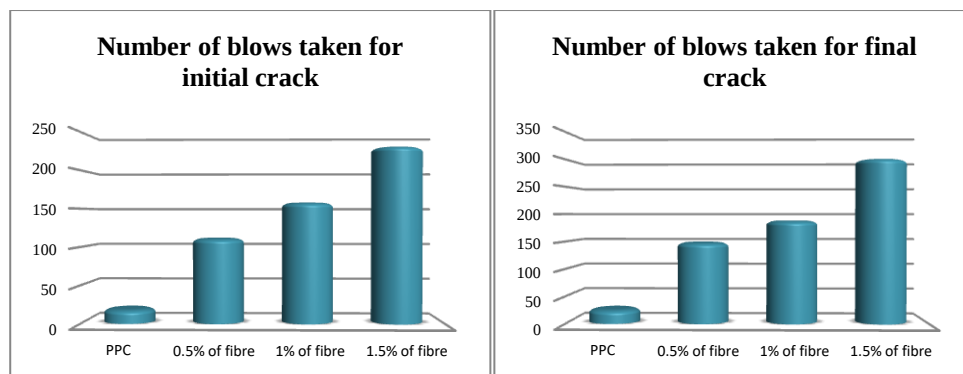


Figure 2: Number of blows taken for initial crack

Figure 3: Number of blows taken for final crack

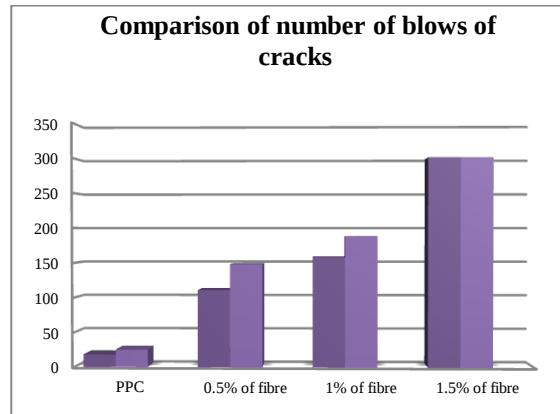


Figure 4: comparison of number of blows of crack

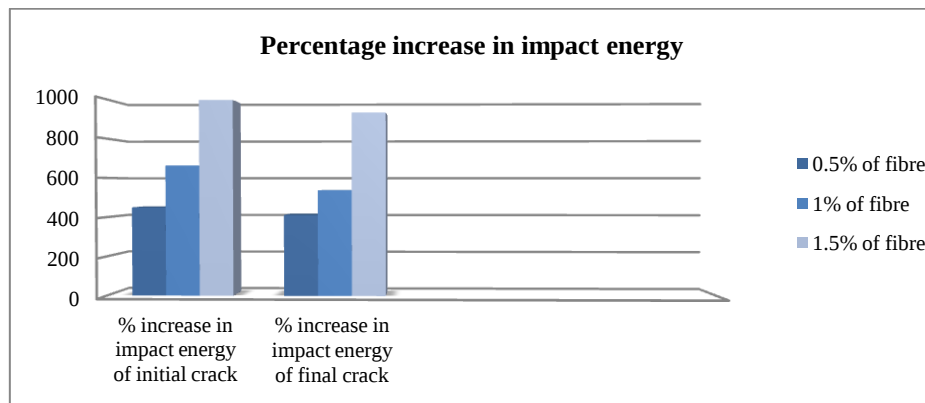


Figure 5: Percentage increase in impact energy

Table 5: Comparison between compressive strength and number of blows

	Compressive strength	Initial crack	Final crack
PPC	34.56	18	25
0.5% of fibre	35.68	111	148
1% of fibre	38.26	158	188
1.5% of fibre	39.36	231	301

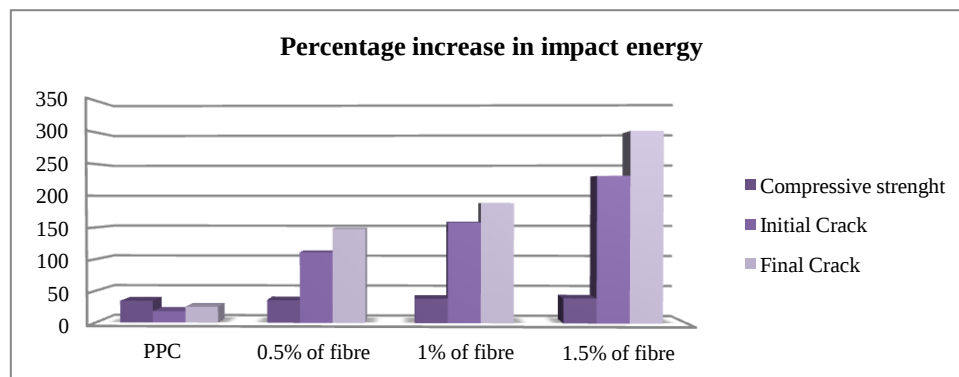


Figure 5: Percentage increase in impact energy

Increase in fibre dosage resulted in increase of number blows required for initial and final crack. Maximum number of blows was found to be 231 and 301 for initial and final cracks respectively for a fibre dosage of 1.50%. The difference between number blows for final crack and initial crack increased with increase in fibre dosage. Maximum difference was seen for the fibre dosage of 1.50%. Impact energy was directly associated with the number of blows. Impact

energy increased with increase in fibre dosage for both initial crack and final crack. More increase in impact energy was observed for initial crack as compared to final crack for all the fibre dosages. Compressive strength also followed the same trend as that of impact resistance. Although the change in compressive strength was not as substantial as that of impact resistance, slight increase in compressive strength was observed with increase in fibre dosage.

VI. CONCLUSION

In this context, the composite was fabricated with steel fibre. Their mechanical properties like impact strength from impact test and compressive strength are investigated and the following conclusions were drawn.

- Steel fibres were found to be effective in improving impact resistance of the concrete.
- Impact resistance increased with increase in fibre dosage and the maximum resistance in terms of number of blows was found for a fibre dosage of 1.50%
- From the above experimental data, it can be concluded that because of its mechanical properties Steel fibre reinforced composites can be extensively used in highway and airport pavements, hydraulic structures, etc.

REFERENCES

1. Vitor M.C.F Cunha, Joaquina.A.O.Barros, Jose .M.Sena cruz "Pullout behaviour of Steel fibers in self-compacting concrete" American society of civil engineers.
2. Victor Marcos- meson, Alexander Michel, Anders solgaard, Gregor Fischer, Carola Edvardsen, Torben Lundskovhus " corrosion resistance of steel fibre reinforced concrete"
3. Patil Shweta, Rupali Kavilkar "Study of Flexural Strength in Steel Fibre Reinforced Concrete "International Journal of Recent Development in Engineering and (ISSN 2347 - 6435 (Online) Volume 2, Issue 5, May 2014).
4. B. Murnal, R. N. Chatorikar "Impact resistance of steel fibre reinforced concrete" International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
5. Seong-Cheol Lee , Joung-Hwan Oh and Jae-Yeol Cho "Compressive Behavior of Fiber-Reinforced Concrete with End-Hooked Steel Fibers" Materials 2015, ISSN 1996-1944.
6. K. Sai Abhinav, N. Srinivasa Rao "Investigation on impact resistance of steel fibre reinforced concrete" Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 07 | July-2016 p-ISSN: 2395-0072.
7. A.E. Naaman and V.S.Gopalarathnam "Impact properties of steel fibre reinforced concrete in bending" The international journal of cement composites and light weight concrete, Volume 5, Number 4, November 1983.
8. Jacek katzer " steel fibers and steel fibre reinforced concrete in civil engineering" the pacific journal of science and technology.
9. Yu-chen ou, Kuang-yen lin, Kuo-chun chang "Compressive behavior of steel fibre reinforced concrete with a high reinforcing index" American society of civil engineers.
10. P .Ramdoss and K. Nagamani " Impact characteristics of high performance steel fibre reinforced concrete under repeated dynamic loading" the international journal of civil engineering"
11. Nemkumar Banthia and Christiane joy "Marine Curing of steel fibre composites" the international journal of civil engineering.
12. Amman and Jordan "Tensile strength of steel fibre reinforced concrete" American society of civil engineers.
13. Nemkumar Banthia and christiane joy , Francesco Beneandino, Lidia Rizzuti, Giuseppe spadea, Ramanth swamy "Stress strain behavior of steel fibre reinforced concrete in compression" Journals of materials in civil engineering (march 2008/255).
14. Jousha A McMahan and Anna C.Birely "performance of steel fibre reinforced in concrete in bridge deck" the international journey of materials in civil engineering.
15. Shashwatsharda, Manvendra singh, Sarbjeet singh "A review on properties of fibre reinforced cement based materials" IOSR Journal of mechanical and civil engineering (IOSR – JMCE).
16. Srinivasa rao, Mohan rao P.rama, Jagadeesh.P "Experimental evaluation of strength properties of steel fibre reinforced concrete" Asian journal of civil engineering 2016, volume17.
17. P.S Song, B.C Sheu, Hwang S "Assessment of statistical variation in impact resistance of high strength concrete and high strength steel fibre reinforced concrete" Cement and concrete research volume 35, issue 2, February 2005.
18. Tsai, C. T., Li, L. S., Chang, C. C. & Hwang, C. L. 2009. Durability Design and Application of Steel Fiber Reinforced Concrete in Taiwan. Arabian Journal for Science and Engineering, 34.



19. Turatsinze, A., Granju, J. L., Sabathier, V. & Farhat, H. 2005. Durability of bonded cement-based overlays: effect of metal fibre reinforcement. Materials and structures, 38, 321-327. Williamson, G.R (1978). Steel Fibers as Reinforcement in Reinforced Concrete. Proceeding, US Army Science Conference, West Point, Vol.3, pp 363-377.
20. Williamson, G.R. (1974). The Effect of Steel Fibers on Compressive Strength of Concrete, Fiber Reinforced Concrete. SP-44. ACI, pp 195-207, Detroit. Michigan, USA



**Impact Factor:
7.512**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 6381 907 438 ijirset@gmail.com



www.ijirset.com

Scan to save the contact details