

Performance of Steel Fiber Reinforced Concrete

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Abstract:

Cement concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. Ordinary cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks, leading to brittle failure of concrete. In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibers added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of Steel Fiber Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation. In this paper effect of fibers on the strength of concrete for M 30 grade have been studied by varying the percentage of fibers in concrete. Fiber content were varied by 0.25%, 0.50%, 0.75%, 1%, 1.5% and 2% by volume of cement. Cubes of size 150mmX150mmX150mm to check the compressive strength and beams of size 500mmX100mmX100mm for checking flexural strength were casted. All the specimens were cured for the period of 3, 7 and 28 days before crushing. The results of fiber reinforced concrete for 3days, 7days and 28days curing with varied percentage of fiber were studied and it has been found that there is significant strength improvement in steel fiber reinforced concrete. The optimum fiber content while studying the compressive strength of cube is found to be 1% and 0.75% for flexural strength of the beam. Also, it has been observed that with the increase in fiber content up to the optimum value increases the strength of concrete. Slump cone test was adopted to measure the workability of concrete. The Slump cone test results revealed that workability gets reduced with the increase in fiber content.

Keywords: Compressive strength, Flexural strength, Hooked end steel fiber, Optimum Value, Steel fiber reinforced concrete, Workability.

I. Introduction

Steel Fibre reinforced concrete (SFRC) is defined as concrete made with hydraulic cement containing Fine and coarse aggregate and discontinuous discrete fibre. In SFRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties. SFRC is being increasingly used to improve static and dynamic tensile strength, energy absorbing capacity and better fatigue strength. . Janesan, P. V. Indira and S. Rajendra Prasad [1] reported the effect of steel fibre on the strength and behaviour of reinforced concrete is two-way action. They concluded that the addition of steel fibre increases the ultimate strength and ductility. The plain structure cracks into two pieces when the structure is subjected to the peak tensile load and cannot withstand further load or deformation. Steel fibres are generally used to enhance the tensile strength and ductility of concrete. As stated in ACI 544, 3R-08 [2], fibre volume fraction used in producing steel fibre reinforced concrete should be within 0.5% to 1.5% as the addition of fibre may reduce the workability of the mix and will cause balling or mat which will be extremely difficult to separate by vibration. However higher percentage of fibre can be used with special fibre adding techniques and also placement procedures. According to ACI 544, 3R-08 [2], aspect ratio is referred to the ratio of fibre length over the diameter. The normal range of aspect ratio for steel fibre is from 20 to 100. Aspect ratio of steel fibre greater than 100 is not recommended, as it will cause inadequate workability, formation of mat in the mix and also non uniform distribution of fibre in the mix. To avoid any honeycombing, bleeding, segregation and heterogeneous features by improving the workability, use less water and paste. Rui D. Neves and Joao C. O. Fernandes de Almeida [3] varied the percentage of volume of fibre in the concrete up to 1.5%. There results indicates that the addition fibres to concrete enhances its toughness and strength and peak stress, but can slightly reduced young's modulus. Generally, for structural applications, steel fibres should be used in a role supplementary to reinforcing bars. Steel fibres can reliably inhibit cracking and improve resistance to material deterioration as a result of fatigue, impact, and shrinkage, or thermal stresses. A conservative but justifiable approach in structural members where flexural or tensile loads occur, such as in beams, columns, or elevated slabs (i.e., roofs, floors,

or slabs not on grade), is that reinforcing bars must be used to support the total tensile load. This is because the variability of fibre distribution may be such that low fibre content in critical areas could lead to unacceptable reduction in strength. In applications where the presence of continuous reinforcement is not essential to the safety and integrity of the structure, e.g., floors on grade, pavements, overlays, and shotcrete linings, the improvements in flexural strength, impact resistance, and fatigue performance associated with the fibres can be used to reduce section thickness, improve performance, or both.

II. Methodology:

Ordinary Portland cement of 53 grade was used. The coarse aggregates used were crushed aggregate passing through 20 mm sieve size and retaining on 4.75 mm sieve size. The fine aggregate used was uncrushed sand. The mix design was conforming to IS 10262:2009. Water cement ratio of 0.45 was adopted. Throughout the test the concrete used was M30 grade and end hooked steel fibre have been used.

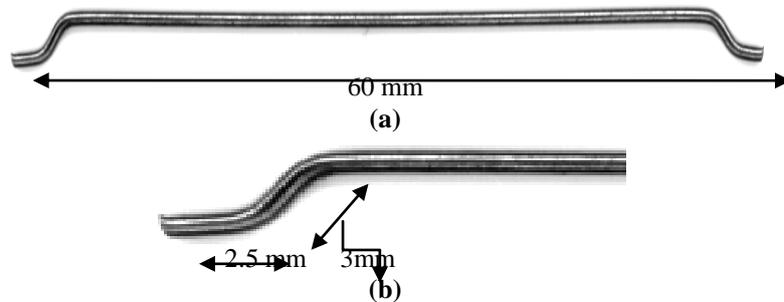


Fig. No. 1 Dimensions of the DRAMIX ZC 60/.80 fiber and its end part

III. Results And Discussion:

Effect of steel fibre reinforcement for studying the parameters of SFRC, like cube compressive strength and flexural strength, cubes and beams were casted and tested. The effect of increase in steel fiber percentage by volume of cement were studied. Workability of steel fiber reinforced concrete mix was observed by the slump cone test. The observation for 3, 7 and 28 days curing period were recorded and presented in the form of tables and graphs.

1) The compressive strength was calculated as follows:

$$\text{Compressive strength (MPa)} = \text{Failure load} / \text{cross sectional area.}$$

2) The flexural strength was calculated as follows:

$$\text{Flexural strength (MPa)} = (P \times L \times 6) / (4 \times b \times (d^2)) \quad (1)$$

Where, P= Failure Load, L= Center to center distance between the supports= L=400mm,

b= Width of specimen= 100mm, d= depth of specimen=100 mm.

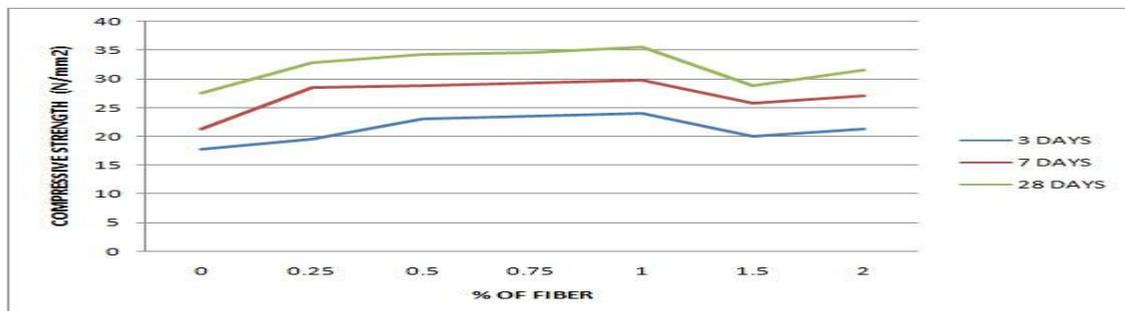


Fig. No. 2 Variation of Compressive strength with respect to % of fiber content

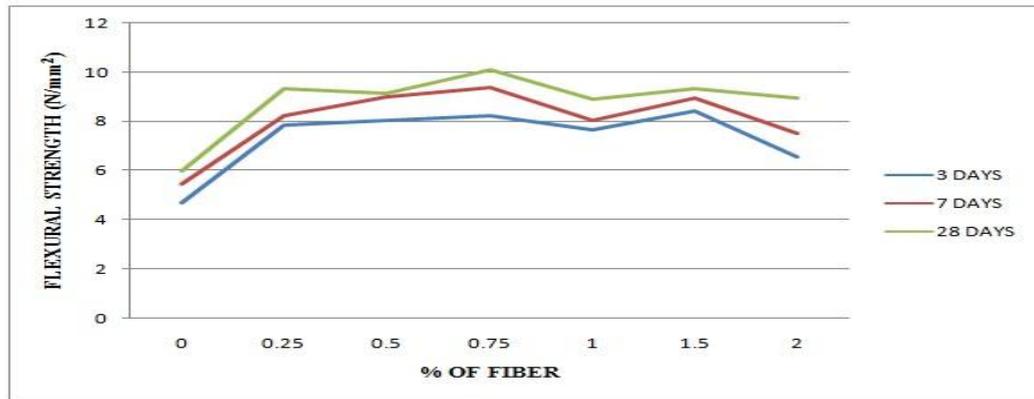


Fig. No. 3 Variation of Flexural strength with respect to % of fiber content

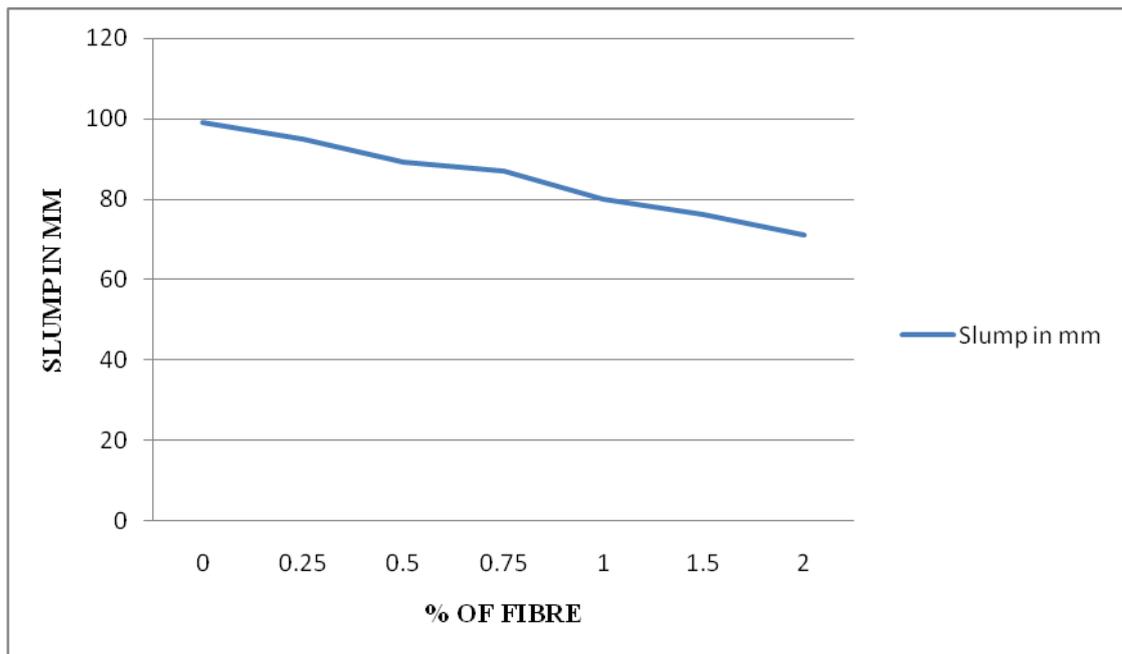


Fig. No. 4 Variation in Slump of concrete with respect to % of fiber content

1. Conclusions:

Following conclusions were drawn from the work carried out;

- 1) It is observed that the workability of steel fibre reinforced concrete gets reduced as the percentage of steel fibres increases.
- 2) Compressive strength goes on increasing by increase in steel fibre percentage up to the optimum value. The optimum value of fibre content of steel fibre reinforced concrete was found to be 1%.
- 3) The flexural strength of concrete goes on increasing with the increase in fibre content up to the optimum value. The optimum value for flexural strength of steel fibre reinforced cement concrete was found to be 0.75%.
- 4) While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which led into splitting of beam in two piece geometry. But due to addition of steel fibres in concrete cracks gets ceased which results into the ductile behaviour of SFRC.

References:

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IMAGE CALLERY:



1) STEEL FIBRE REINFORCED CONCRETE



2) CRACK OBSERVED IN SPECIMEN