

EXPERIMENTAL STUDY ON STEEL FIBER REINFORCED CONCRETE

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ABSTRACT: Cement concrete is the most extensively used construction material all over the world. The main reason for its extensive use is because of its good workability and it can be molded to any shape. Internal micro cracks, leading to brittle failure of concrete. In this modern age, Structures of Civil Engineering have their own durability requirements, purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. From the research is it has found that using different type of fibers in concrete improves the mechanical properties, durability and serviceability of the structure. Here the concrete of M 20 grade have been studied by varying the percentage of fibers such as 0%, 0.5%, 0.1%, 1.5%, 2%, 2.5% and 3% by weight of cement with Aspect Ratio 60(30mm length and 0.5mm diameter). The Cubes and Cylinders were prepared for Compressive and Split Tensile Strength at 7th day, 14th day and 28th day of curing. With varied percentage of fiber reinforced concrete were studied and it has been found that there is significant strength improvement in steel fiber reinforced concrete. The Slump cone test results revealed that the workability reduces as the fiber content increases.

Steel fibers are add with concrete to increase the structural properties, particularly tensile and flexural strength. The extent of improvement in the mechanical properties achieved with SFRC over those of plain concrete depends on several factors, such as shape, size, volume, percentage and distribution of fibers.



(a) straight

(b) end-hooked

Fig 1: Various steel fibre profile

For a given shape of fibers, split tensile strength of SFRC was found to increase with aspect ratio (ratio of length to equivalent diameter).

Even with higher ratios of fibers gave good flexural strength, workability of SFRC was found to be affected with increasing aspect ratios.

Key Word: Concrete, Steel fiber, Compressive Strength, Split Tensile Strength and crack resistance.

I INTRODUCTION

Concrete is the mostly used as a construction material in the world. The reason for its mass use is that it provides good workability and can be moulded to any shape. Every structure is constructed to full fill the requirement and hence to meet this purpose, modification in traditional cement concrete has become important and mandatory. Since the use of SFRC has gathered great interest, with research demonstrating the potential benefits that may lie in the use of the material in both structural and non-structural applications

It has been observed that when we increase in fiber content up to the optimum value that increases the strength of concrete.

In SFRC, thousands of small fibres are dispersed on the concrete and randomly distributed in the concrete during mixing and it improves properties of concrete. In recent researches SFRC is being increasingly used fiber to improve the static and dynamic tensile strength, energy absorbing capacity and better fatigue strength.

II LITERATURE REVIEW

Rui D. Neves and Joao C. O. Fernandes de Almeida 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. Many other researchers had work on it, the recommended reinforcement of steel fibre in concrete is up to 3% by weight of cement only. Thus this thesis is on reinforcement of steel fibre upto 3% in 0.5% interval.

III MATERIAL AND METHODOLOGY

Concrete consists of three major components, viz. water, Portland cement, and aggregates. Properties of the final product i.e. cement changes according to the change in the ratio of its components and hence consequentially help the engineer in deciding the proper use of the same according to his need. To get a certain specific property in cement, Admixtures are added and hence enhance its required characteristic.

WATER:

The water in the concrete mix should be clean and free of impurities. The change in water content with respect of cement decides the properties of the cement like how easily the concrete flows, but also affects the final strength of the concrete. Excess water implies to easier flow of concrete, but decreases its strength.

PORTLAND CEMENT:

On mixing the water, cement hardens and hence all the ingredients are bounded together. Portland cement is the most common cement used and is composed of alumina, silica, lime, iron, and gypsum. Small amounts of other ingredients are also included.

AGGREGATES:

Most of the concrete mixtures consist of both coarse and fine aggregates, and help in increasing the strength of concrete with respect to what cement can provide alone. Nowadays, sand, gravel, crushed stone, recycled materials, including blast furnace slag, glass (mostly for decorative purposes), and ground-up concrete are used as aggregates.

STEEL FIBER

The amount of fibres added in the concrete mix is expressed as a percentage of total volume of the composite (concrete and fibres), termed volume fraction (Vf). Vf typically ranges from 0.1 to 3%. Aspect ratio is defines as fibre length (l) by its diameter (d). The aspect ratio of Fibres of a non circular shape can be determines by using an equivalent diameter for the calculation of aspect ratio. However, fibres which are too long tend to ballZ in the mix and create workability problems. Some recent research indicated that using fibres in concrete has limited effect on the impact resistance of the materials. The result of fiber reinforcement concrete indicates that the use of micro fibres offers better impact resistance compared with the longer fibres.

Properties OF SFRC:

In steel fibre reinforced concrete various mechanical properties are as

- compressive strength
- split tensile strength
- flexural strength

Advantages of SFRC:

Fast and perfect mixable fibres and High performance and crack resistance

- Optimize costs with lower fibre dosages
- Steel fibres reinforced concrete against impact forces, thereby improving the toughness characteristics of hardened concrete.

METHODOLOGY:

Concrete is strong in compression and weak in tension and also it has brittle character. The concept of using fibers reinforced concrete is to improve the characteristic strength of construction material. Use of fiber reinforcement in concrete increases the strength and ductility, but requires careful placement and labour skill. Internal micro cracks, leads to the brittle failure of concrete.

It is observed that one of the important properties of Steel Fiber Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation. Thus the concrete is reinforced with the steel fiber in various proportions such as 0%, 0.5%, 1.0%, 1.5%, 2%, 2.5% and 3% by weight of cement. All the volume proportions were tested with Aspect Ratio 60(30mm length and diameter of 0.5mm). The Compressive and Tensile Strength were analysed as per IS standards on 7th, 14th and 28th day of curing.

IV RESULT AND ANALYSIS**TEST RESULT OF CEMENT****FINENESS TEST:**

It is the ratio of the weight of cement which passes through the IS sieve no.9 by gentle sieving to the total weight of sample cement.

$$\text{Fineness of Cement (\%)} = (R2 / R1) \times 100$$

R1 = Weight of sample taken

R2 = Weight of residue after sieving

$$= (0.5/10) \times 100 = 5\%$$

CONSISTENCY TEST:

It is the water content required to produce a cement paste of standard consistency.

$$\text{Standard consistency (\%)} = (\text{Weight of water added} / \text{weight of cement}) \times 100$$

$$= (135 / 500) \times 100 = 27$$

IMPACT TEST FOR NATURAL AGGREGATE:

Impact test for Natural Aggregate:

S. no.	Total wt. of dry sample (A) in gm	Wt. of aggregate retained 2.36 mm sieve in gm	Wt. of aggregate passing 2.36 mm sieve in gm (C)	Aggregate impact value= (C/A)×100
1.	398	276	67	16.83
2.	356	287	76	21.34

Aggregate impact value (%) = 19.1

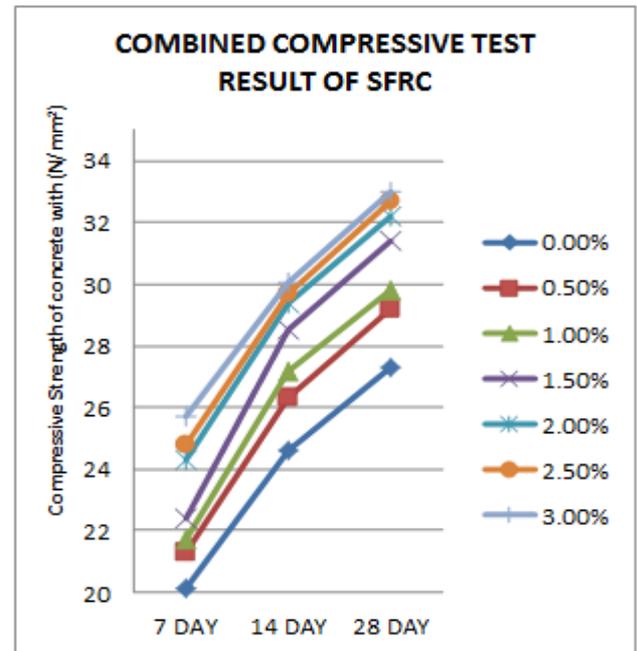
S. No.	Total wt. of dry sample in gm	Wt. of aggregate retained on 2.36 mm sieve in gm	Wt. of aggregate passing 2.36 mm sieve in gm	Aggregate crushing value
1.	3000	2590	410	13.67
2.	3456	2780	676	19.56

CA crushing value (%) = 19.61

COMPRESSIVE STRENGTH TEST

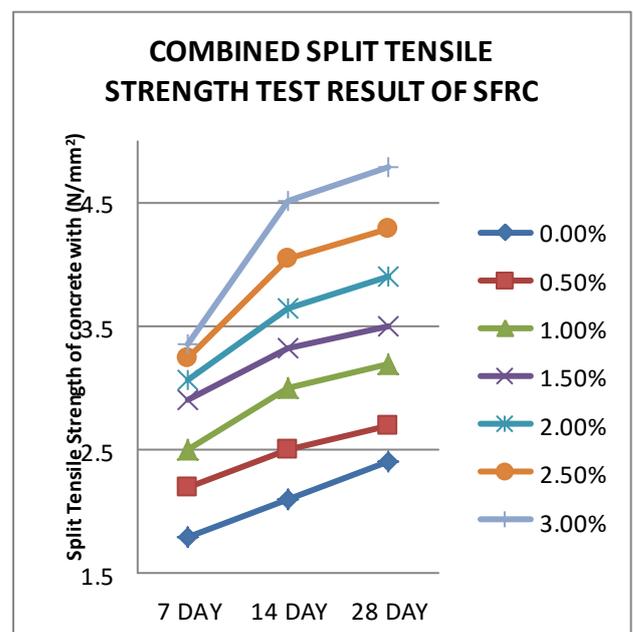
The reinforcement provided by fibres can work at both a micro and macro level. The ability of the fibre to control micro cracking growth depends mainly on the number of fibres, deformability and bond to the matrix. A higher number of fibres in the matrix leads to a higher probability of a micro-crack being intercepted by a fibre.

From Graph 1, it is observed that Compressive Strength increases as volume of Steel fiber increases. As per the previous research it is observed that the using Steel fiber upto 3% in concrete is good. The Compressive Strength of concrete with steel Fiber reinforced in proportions of 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% is 27.3MPa, 29.2MPa, 29.8MPa, 31.4MPa, 32.3MPa, 32.7MPa and 33MPa at 28th day of curing respectively. The Compressive strength is in increasing order and the maximum strength is gained at 3.0% of steel fiber use concrete that is 33 MPa.



TENSILE STRENGTH OF SFRC

From Graph 2, it is observed that Split Tensile Strength increases as volume of Steel fiber increases. As per the previous research it is observed that the using Steel fiber upto 3% in concrete is good. The Split Tensile Strength of concrete with steel Fiber reinforced in proportions of 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% is 2.4MPa, 2.7MPa, 3.2MPa, 3.5MPa, 3.9MPa, 4.3MPa and 4.8MPa at 28th day of curing respectively. The Split Tensile strength is in increasing order and the maximum strength is gained at 3.0% of steel fiber use concrete that is 4.8MPa.



V CONCLUSION

1. The Compressive Strength of SFRC (Aspect ratio 60) for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5% and 3% are 27.3 MPa, 29.2 MPa, 29.8 MPa, 31.4 MPa, 32.2 MPa, 32.7 MPa and 33MPa respectively at 28th day of curing.
2. The Split Tensile strength of SFRC for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5% and 3% are 2.4 MPa, 2.7 MPa, 3.2 MPa, 3.5 MPa, 3.9 MPa, 4.3 MPa and 4.8MPa respectively at 28th day of curing.
3. With the use of 3% of steel fibre gives the maximum result in compression as 25.7MPa, 30.05MPa and 33MPa at 7th day, 14th day and 28th day of curing respectively.
4. With the use of 3% of steel fibre gives the maximum result in Split Tensile Strength as 3.36MPa, 4.52MPa and 4.8 MPa at 7th day, 14th day and 28th day of curing respectively.
5. From the result it is observed that the workability of Steel Fibre reinforced concrete decreases as the percentage of steel fibres increases.
6. The addition of Steel Fibre in concrete increases the Tensile properties of concrete and also improves resistance to cracking.

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V BIOGRAPHIES

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