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Comparative study on steel fiber reinforced cum control concrete under tension

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Abstract

Critical investigation for M-20, M-30and M-40 grade of concrete to study the tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0%, 1%, 2% and 3% volume fraction of hook strain. Steel fibers of 50, 60 and 67 aspect ratio are used. A result data obtained has been analyzed and compared with a control specimen (0% fiber). A relationship between aspect ratio vs. tensile strength represented graphically. Result data clearly shows percentage increase in 28 days tensile strength for M-20, M-30and M-40 Grade of Concrete.

Keywords: Steel fibers give tensile strength to concrete

1. Introduction

Concrete is most widely used construction material in the world. Because of its ability to get cast in any form and shape, it has almost replaced old construction materials such as brick and stone masonry. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cemetitious material, aggregate and water and by adding some special ingredients. Hence concrete is very well suited for a wide range of applications. However concrete has some deficiencies as listed below, Low tensile strength, Low post cracking capacity, Brittleness and low ductility, Limited fatigue life, not capable of accommodating large deformations, Low impact strength

The presence of micro cracks at the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibers in the mix. Different types of fibers such as those used in traditional composite materials have been introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. Thus the fiber-reinforced concrete is a composite material essentially consisting of conventional concrete or mortar reinforced by fine fibers.

The fibers can be imagined as an aggregate with an extreme deviation in shape from the rounded smooth aggregate. The fibers interlock and entangle around aggregate particles and considerably reduce the workability, while the mix becomes more cohesive and less prone to segregation. The fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. Fibers help to improve the compressive strength, tensile strength, flexural strength , post peak ductility performance, pre-crack tensile strength, fatigue strength, impact strength and eliminate temperature and shrinkage cracks. Essentially, fibers act as crack arrester restricting the development of cracks and thus transforming an inherently brittle matrix, i.e. cement concrete with its low tensile and impact resistances, into a strong composite with superior crack resistance, improved ductility and distinctive post-cracking behavior prior to failure. Hence this study explores the feasibility of steel fiber reinforcement; aim is to do parametric study on compressive strength, flexural strength, tensile strength study etc. with variables of grade of concrete, aspect ratio and percentage of steel.

2. Experimental Programme

2.1 Material used

The material used for this experimental work are cement, sand, water, steel fibers, and superplasticizer.

Cement: Ordinary Portland cement of 53 grade was used in this experimentation conforming to I.S. – 12269- 1987.

Sand: Locally available sand zone II with specific gravity 2.65, water absorption 2% and fineness modulus 2.92, conforming to I.S. – 383-1970.

Water: Potable water was used for the experimentation.

Superplasticizer: To impart additional workability a superplasticizer (Rheobuild 1100) 0.6 % to 0.8% by weight of cement was used. It is based on sulphonated naphthalene polymers with following properties as per I.S. – 9103-1999.

Fibers:
Steel Fibers: In this experimentation Hook tain Steel fibers were used. The different aspect ratios adopted were 50, 60, and 67.

Aspect Ratio	Length (mm)	Diameter (mm)
50	35	0.70
60	30	0.50
67	30	0.40

2.2 Experimental methodology

Tensile strength test: For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported. Tensile strength was calculated as follows as split tensile strength:

Tensile strength (MPa) = $2P / \pi DL$, Where, P = failure load, D = diameter of cylinder, L = length of cylinder

Fig. 1. Testing of tensile strength test specimen

2.3 Experimental results

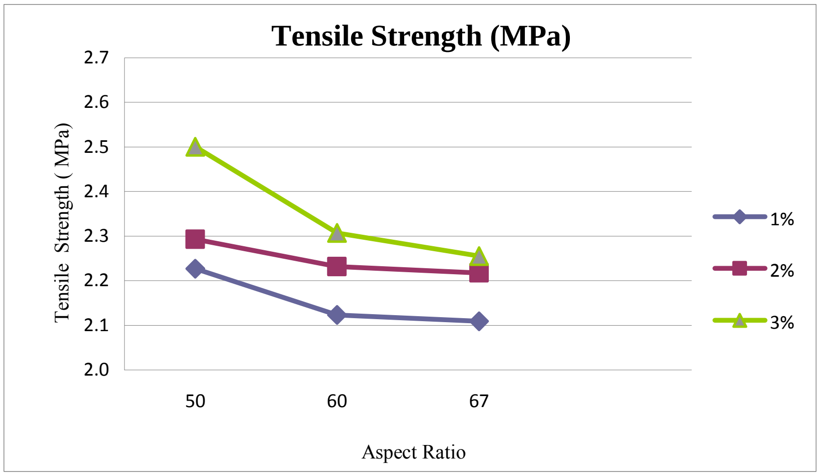
Following graphs give tensile strength result for M20 grade of concrete with 0%, 1%, 2% and 3% steel fibers for aspect ratio 50, 60 and 67.

3. Results and Discussion

Tensile strength: **-** For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast**.** Graph 1 show that for M20 grade of fiber reinforced concrete is always higher than the control concrete. It is observed that the tensile strength increasing as the volume of fiber increases. As per the result it is observed that for M20 grade of concrete with addition of 3% fiber with aspect ratio 50 give the max tensile strength. Graphs 2 indicate the result for M30 grade of concrete it is observed that for addition of 3% fiber with aspect ratio 50 give the max tensile strength. Graph 3 indicated the higher tensile strength for M40 grade of concrete with addition of 3% fiber with aspect ratio 50. About 3% to 47 % increase in tensile strength was achieved over control concrete.

Table 1
Tensile strength of SFRC with 0% fibers M20 grade

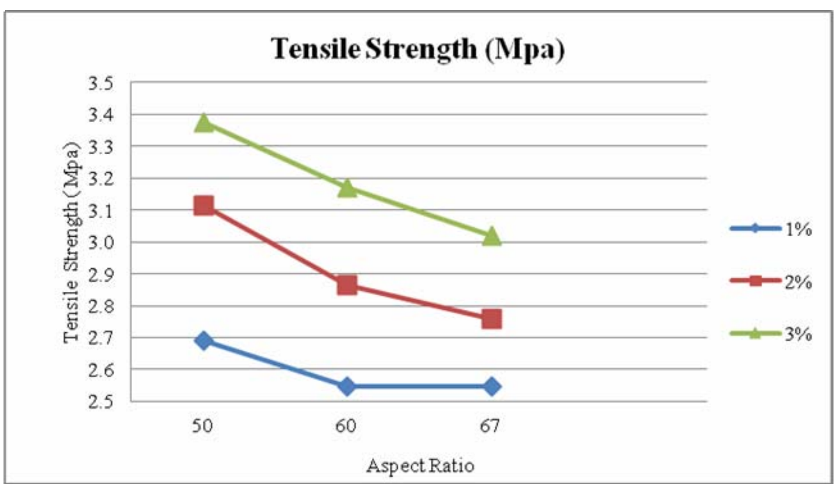
Tensile strength (MPa)	Average Tensile strength (MPa)
1.56	
1.84	1.93
2.41	



Graph 1. Aspect ratio vs. tensile strength for M-20 grade

Table 2
Tensile strength of SFRC with 0% fibers M30 grade

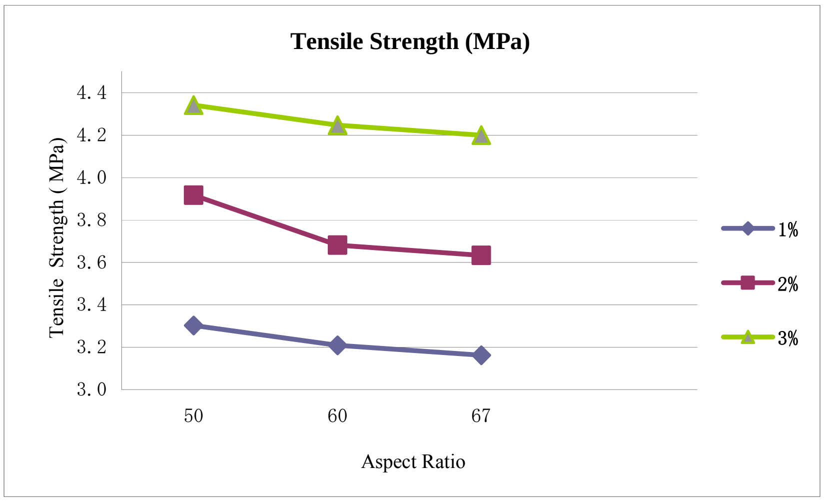
Tensile strength (MPa)	Average Tensile strength (MPa)
2.43 2.29 2.15	2.29



Graph 2. Aspect ratio vs. tensile strength for M-30 grade

Table 3
Tensile strength of SFRC with 0% fibers M40 grade

Tensile strength (MPa)	Average Tensile strength (MPa)
2.83 3.11 3.26	3.07



Graph 3. Aspect ratio vs. tensile strength for M-40 grade

4. Conclusions

The following conclusions are derived from the present investigation:

1. It is observed that tensile strength increases from 3% to 47% steel fibers are on higher side from 3% fibers as compared to that produced from 0%, 1% and 2% fibers.
2. It is observed that strength increases from 3 to 17% through utilization of 1% steel fibers.
3. It is observed that strength increases from 14 to 35% through utilization of 2% steel fibers.
4. It is observed that strength increases from 16 to 47% through utilization of 3% steel fibers.
5. It is observed that for higher percentage of Steel fiber deflection is less.

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