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RESEARCH ARTICLE

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AN EXPERIMENTAL INVESTIGATION ON THE STRENGTH AND WORKABILITY CHARACTERISTICS OF STEEL FIBER REINFORCED CONCRETE

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ABSTRACT

Here in this paper we are going to deal with the concrete by looking at its basic properties such as tension and compression. We all know that concrete is weak in tension and strong in compression. To overcome the weakness of the concrete in tension we are going to increase the tensile property of concrete by adding steel fibres of crimped shape which is known as 'Crimped Steel Fiber' along with some super plasticizer and thus the derived concrete is mentioned as 'Steel Fiber Reinforced Concrete'. The aspect ratio chosen for this particular property determination is 50.

The steel fibres are added in volume fraction addition with varying percentages of steel such as 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%. Here at these varying percentages, the result of this particular concrete increases up to 1.5% and after this point the value decreases. To calculate such values the concrete is subjected to following tests such as compression test, flexural test, split tensile test and shear test.

INTRODUCTION

At the present era concrete is widely used for constructional activities,since it is a basic material used for construction.Concrete at its full ability is weak in tension and strong in compression i.e. the tensile property of the concrete is low. To overcome this disability, special fibers are used which are in the form of steel fibers. There are also different steel fibers such as (plastic fibers,steel fibers,polythene fibers etc.). These fiber materials enhances the strength properties of the concrete such as low growth resistance, high shrinkage cracking, low durability, etc. Such type of 'Steel FiberReinforced Concrete' is widely used in various constructional activities such as irrigational structures, hydrological structures, residential buildings, commercial buildings etc. Mostly steel fibers are seen to be performing well as compared to the other random fibers.

What is 'Steel Fiber Reinforced Concrete'?

Fiber reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibers.

In Fiber Reinforced Concrete (FRC),several fibers in measured quantity are dispersed and distributed in the concrete at the time of the mix and this

enhances the concrete's strength properties.SFRC is widely used in construction for itsexcellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost-resistance. These fibers increase the toughness, enhances the shock resistance property and also resists the plastic shrinkage cracking of the cement mortar. Fibers comes in various shapes across its cross section such as circular, triangular or flat .The fibers are measured in a specific term known as 'Aspect Ratio'.

What is 'Aspect Ratio'?

The aspect ratio of the fiber is the ratio of its length to its diameter.

The main reason to incorporate this fiber into concrete mix is that it increases the toughness, resistance to shock loads and resistance cracks due to plastic shrinkage of the mortar. For FRC to be a viable construction material, it must be able to compete economically with existing reinforcing system.

OBJECTIVES

The main objective of this proposed project work is to study the characteristic properties of Steel Fiber Reinforced Concrete produced by using crimped steel fiber of aspect ratio 50 with different percentages like 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% by volume fraction addition along with the addition of super plasticizer.

To achieve the above objective the following experimental works are planned i.e.

- To find out the workability characteristics of Steel Fiber Reinforced Concrete.
- To find out the strength characteristics like compressive strength, tensile strength, flexural strength and shear strength of Steel Fiber Reinforced Concrete.
- To find out the near surface characteristics of Steel Fiber Reinforced Concrete.

MATERIALS AND METHODOLOGY

The materials used are cement, coarse aggregates,fine aggregates, steel fibers and super plasticizer.

A. MATERIALS

1. **CEMENT:** The cement used in this project is 'Ordinary Portland Cement' (OPC) of 43 grade. The tests for the cement according to the code book IS 8112-1989 are as follows,

Table1: Test results of cement

MATERIAL PROPERTIES	RESULTS
a) Initial setting time.	30 minutes
b) Final setting time.	6 hours
c) Std. consistency test.	30 minutes
d) Specific gravity	3.15

2. **COARSE AGGREGATES:**The coarse aggregates used in the project are of good quality crushed stone gravels and are purchased from locally available dealer. The tests for the coarse aggregates according to the code book IS 383-1970 are as follows,

Table 2: Test results of coarse aggregates

MATERIAL PROPERTIES	RESULTS
a) Bulk density	1780 kg/m^3
b) Water absorption test	1%
c) Specific gravity	2.67

3. **FINE AGGREGATES:**The fine aggregates used in this project is naturally available river sand when calculated related to zone 1. The tests for the fine aggregates according to the code book IS 383-1970 are as follows,

Table 3: Test results of coarse aggregates

MATERIAL PROPERTIES	RESULTS
a) Bulk density	1680kg/m^3
b) Water absorption test.	1%
c) Zone	I
d) Specific gravity	2.64

4. **STEEL FIBERS:** The steel fibers used are of crimped shape and are known as 'Crimped Steel Fibers' with 50mm length and 1mm dia. The aspect ratio is 50. These fibers have a density of 7850kg/m^3 and ultimate tensile strength of 395MPa.

The following steel fibers are manufactured and purchased from Stewols India (P) Ltd. situated in Nagpur, India.

B. METHODOLOGY

1) MIX DESIGN:

Table 4: Mix design proportions for M30 grade

CEMENT	FINE AGGREGATES	COARSE AGGREGATES	W/C RATIO
1	1.70	2.70	0.45

2) **MIXING:**The mixing of the materials has two stages where the initial mix being dry mix and the final mix being wet mix.

- The dry mix means mixing of dry materials such as cement, steel fibers, fine aggregates and coarse aggregates.
- Wet mix means mixing of dry materials using water and super plasticizer according to the calculated w/c ratio i.e. Water –cement ratio.

Fig.1: Dry mixing

Fig.2: Wet mixing

3) **WORKABILITY TESTS:**The workability tests are done to determine the workability factor the mixed 'Steel Fiber Reinforced Concrete'. The tests conducted are,

i. Slump cone test.
ii. Compaction factor test.

Fig 3: Slump cone test

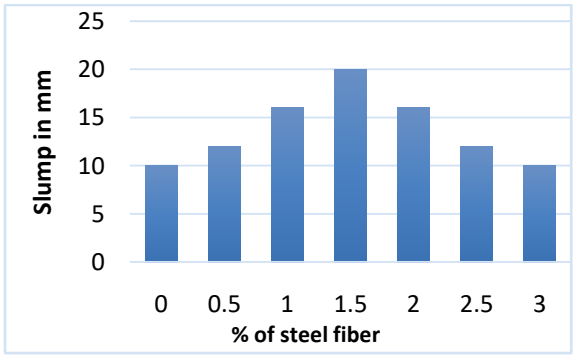

Fig 3.1: Graph for slump cone test

Fig 3.2: Compaction factor test

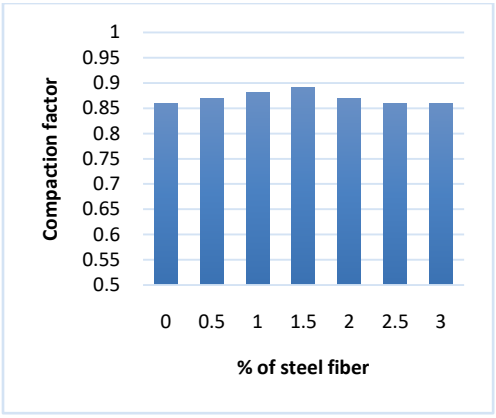

Fig 3.3: Graph for compaction factor Test

4) STRENGTH DETERMINING TESTS:

Strength determining test are the ones conducted on the casted concrete specimens to determine it failure or deflection under loaded conditions with varying loading strategies. The different strength determining tests are as follows,

i. Compression test.
ii. Split tensile test.
iii. Shear test.
iv. Flexural test.

COMPRESSION TEST:

Fig 4: Compression test

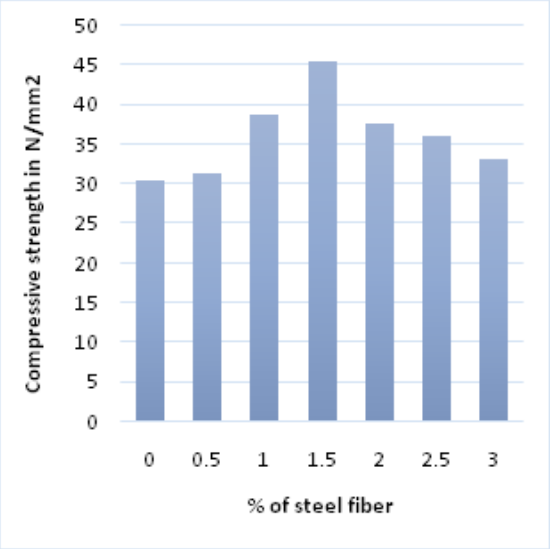

Fig 4.1: Graph for compression test

SPLIT TENSILE TEST:

Fig 4.2: Split tensile test

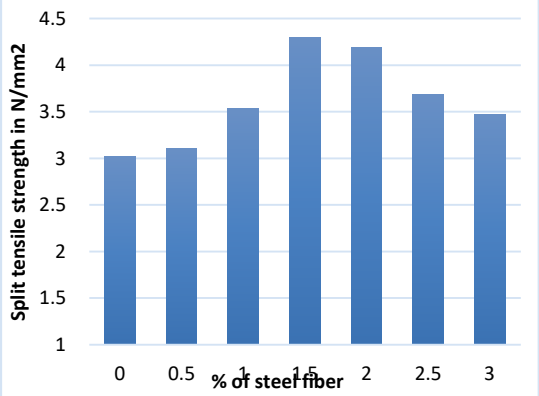

Fig 4.3: Graph for split tensile test

SHEAR TEST

Fig 4.4: Shear test

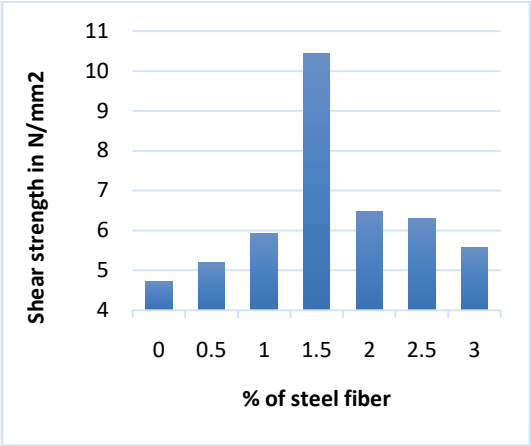

Fig 4.5: Graph for shear test

FLEXURAL TEST:

Fig 4.6: Flexural test

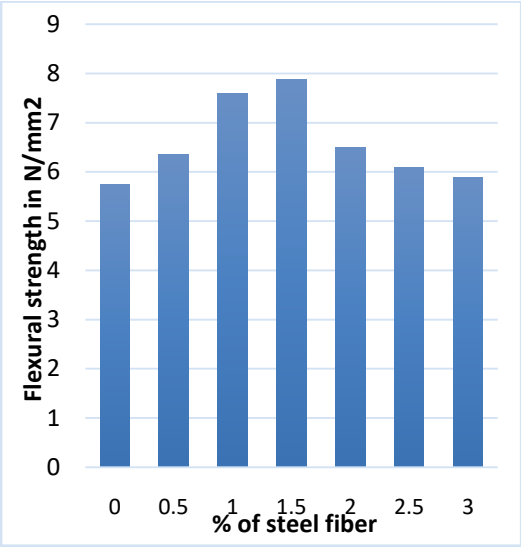

Fig 4.7: Graph for flexural test

5) **NEAR SURFACE CHARACTERISTICS TEST:**Near surface characteristics test are the tests conducted on casted concrete specimens i.e. concrete cubes to determine its behaviour when exposed to water. There are two tests to determine this property and are as follows,

   i. Water absorption test.

   ii. Sorptivity test.

WATER ABSORPTION TEST: In this water absorption test the concrete cube is taken and its dry weight is noted. Later the cube is immersed in water for 24 hours and later the wet weight is taken, by this we can know the water absorption capacity of the cube at that particular percentage of steel fiber added.

Fig 5: Dry weight of the specimen

Fig 5.1: Wet weight of the specimen

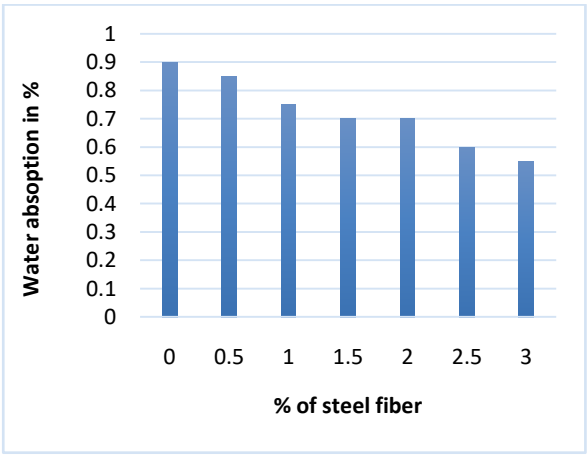

Fig 5.2: Graph for water absorption test

SORPTIVITY TEST: Sorptivity test is another test conducted to the concrete specimen in order to know the movement of water in the concrete cube when its surface is in contact to the water.

Fig 5.3: Sorptivity test

Fig 5.4: Measuring height of water after 24 hrs.

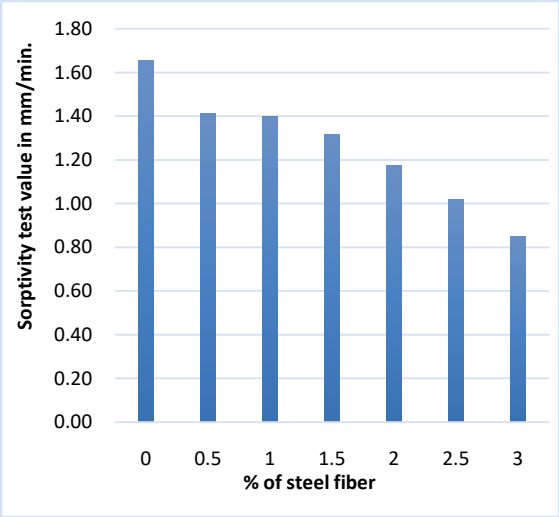

Fig 5.5: Graph for sorptivity test

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