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Effect of Different Positions of Steel Fibers on Strength of Concrete

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Abstract: In this project we have used steel fibers, which are straight and circular in shape and placed in different forms (i.e Horizontal, Staggered, and Vertical). The aim of our project is to use the Steel Fibers with different positions as Fiber reinforcement to concrete. objective is to add the Steel fibers of 1mm guage diameter to the concrete and to study the strength properties of concrete with the variation in fiber position. i.e., to study the strength properties of concrete (M20 Grade) for fiber content of 1.0% by weight at 7days and 28 days. The compressive strength being studied in our project. And then this compressive strength compared with plain concrete.

Keyword: AutoCAD 2013, Steel Fibre, UTM Characteristics

Introduction

Concrete is a composite material containing hydraulic cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. The formation of cracks in the concrete may also occur due to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude as the time elapses and the finally makes the concrete to fail. The formation of cracks is the main reason for the failure of the concrete. To increase the strength of concrete many attempts have been made. One of the successful and most commonly used method is providing steel reinforcement. Steel fibers, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until encountering are fiber. Fiber reinforcement gives the solution for this problem. So to increase the strength of concrete a technique of introduction of fibers in concrete is being used. These fibers act as crack arrestors and prevent the propagation of the cracks. These fibers are uniformly distributed and randomly arranged. This concrete is named as fiber reinforced concrete. The main reasons for adding fibers to concrete matrix is to improve the post cracking response of the concrete, i.e., to improve its energy absorption capacity and apparent ductility, and to provide crack resistance and crack control. Also, it helps to

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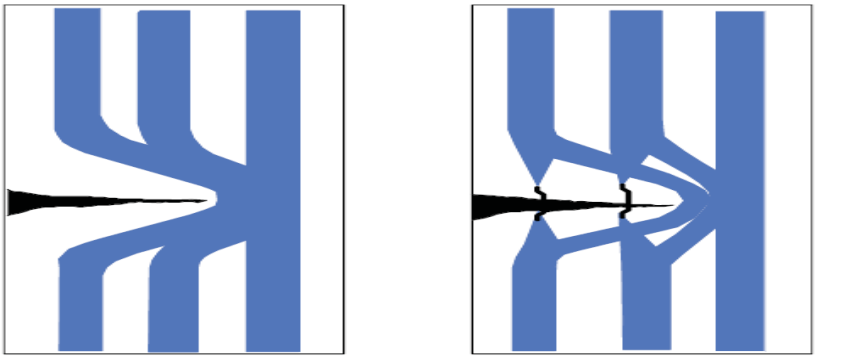
maintain structural integrity and cohesiveness in the material. The initial researches combined with the large volume of follow up research have led to the development of a wide variety of material formulations that fit the definition of Fiber Reinforced Concrete. The main reason for incorporating steel fibers in concrete is to impart ductility to an otherwise brittle material. They enable concrete to continue to carry load after cracking has occurred, the so-called post crack behaviour, or toughness as shown in fig.1.1

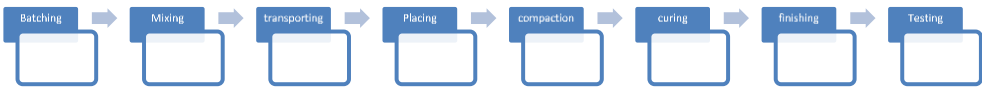


plain concrete - no tension is transmitted across the crack

SFRC - some tension is transmitted across the crack by the fibres

Methodology

Generalised concrete manufacturing process is adopted for study work which is elaborated below:



EXPERIMENTAL SETUP

In order to study the interaction of Steel fibers (straight fiber) with concrete under compression 24 cubes were casted respectively. The experimental program was divided into four groups. Each group consists of 6 cubes of 15x15x15cm respectively, 3 cubes for 7 days testing and 3 cubes for 28 days testing.

a) The first group is the consists of Plain concrete with 0% fiber (PCC).

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b) The second group consisted of 1% of Steel fibers (straight fiber), placed horizontally with aspect ratio 130, by weight.

c) The third group consisted of 1% of Steel fibers (straight fiber) placed staggered with aspect ratio 130, by weight.

d) The fourth group consisted of 1% of Steel fibers (straight fiber), placed vertically with aspect ratio 130, by weight.

MIX DESIGN

FOR M20 GRADE OF CONCRETE (1:1.5:3)

Weight Calculations :

Weight of one cube = $0.15 \times 0.15 \times 0.15 \times 24$

$= 0.081$ KN

$= 81.00$ N

$= 8.1$ Kg.

Quantity Calculations :

For one block-

Cement required = 1.5 Kg

Fine Aggregate = 2.25 Kg

Coarse Aggregate = 4.5 Kg

Water required = 0.5 x cement content

$= 0.5 \times 1.5$

$= 0.75$ litres.

For three block-

Cement required = 4.5 Kg

Fine Aggregate = 6.75 Kg

Coarse Aggregate = 13.5Kg

Water required = 0.5 x cement content

$= 0.5 \times 4.5$

$= 2.25$ litres.

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Fiber Quantity Calculations :

In this experimental investigation straight steel fiber placed horizontally, staggered and vertically.

For one cube-

Steel fiber used- 1% by weight

Weight of one steel fiber- 1.25 gm (1mm gauge 130 mm long)

For one block, weight of steel- 81gm fiber

No. of fibers for 1 block- 64 No.

Results

Table: Compression Test Values of M20 Grade

S.N	Type of Concrete	7 Days		28 Days	
		Average Load (KN)	Average Compressive Strength (N/mm²)	Average Load (KN)	Average Compressive Strength (N/mm²)
1.	Conventional Concrete	506.66	22.51	580	25.77
2.	SFRC Placed Horizontally	563.33	25.03	646.66	28.73
3.	SFRC Placed Staggered	556.67	24.74	673.33	29.92
4	SFRC Placed Vertically	553.33	24.590	683.33	30.36

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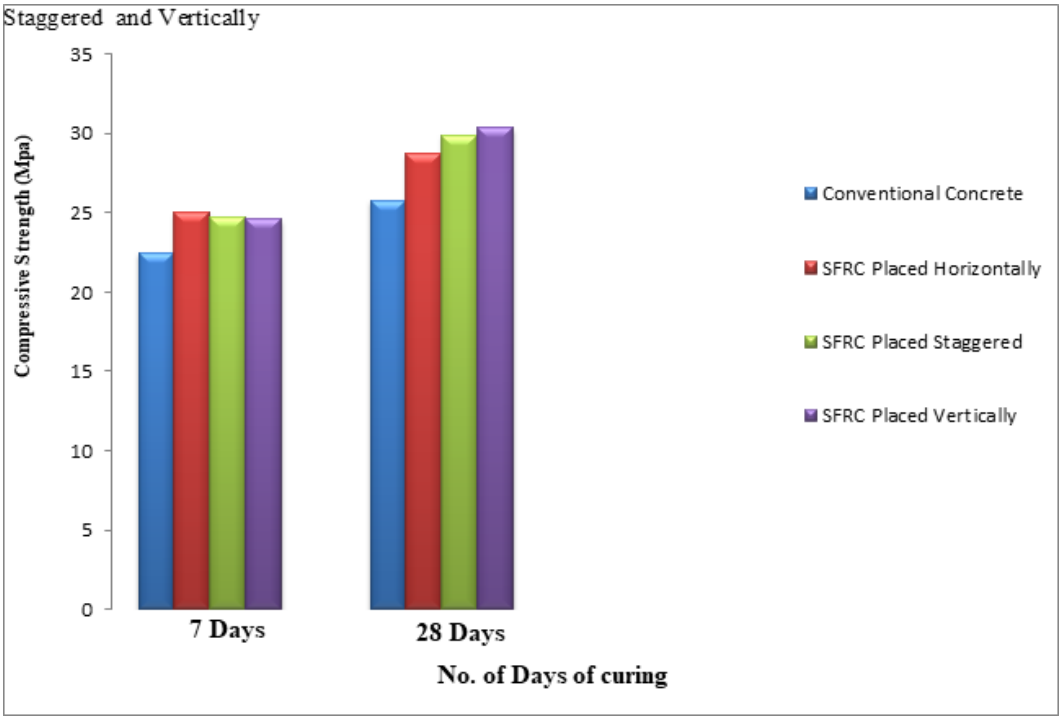

Fig. : Comparison of Conventional Concrete with SFRC Placed Horizontally, Staggered and Vertically

DISCUSSIONS :

The strength of conventional concrete is found to be 22.51 N/mm2 at 7days and 25.77 N/mm2. It is because of due to –

1. Aggregates used are tough, the toughness/Impact value of aggregate is found to be 28.04%
2. Crushing strength/value of aggregate used is found to be 32.55%
3. The alite content in the cement increases the strength of cement.

Table: Comparing the compressive strength of plain concrete and fiber reinforced concrete in which steel fiber placed at different position after 7 days of curing.

Plain Concrete (N/mm^2)	Steel Fiber Reinforced Concrete (N/mm^2)	Percentage Increase in Strength
22.51	Placed Horizontally (25.03)	11.19 %
	Placed Staggered (24.74)	9.90 %
	Placed Vertically (24.59)	9.24 %

Table: Comparing the compressive strength of plain concrete and fiber reinforced concrete in which steel fiber placed at different position after 28 days of curing.

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Plain Concrete (N/mm^2)	Steel Fiber Reinforced Concrete (N/mm^2)	Percentage Increase in Strength
25.77	Placed Horizontally (28.73)	11.48 %
	Placed Staggered (29.92)	17.19 %
	Placed Vertically (30.36)	18.91 %

The variation in the compressive strength with respect to change the way of placement of fiber can be observed. From the results obtained, it is clear that the steel fibers placed in vertical form gives more strength than other forms (i.e. staggered and horizontal form)

Conclusions

It is observed that after 7 days:-

1. By placing steel fibers horizontally, the Compressive Strength of concrete increases by 11.19%.
2. By placing steel fibers in staggered form, the Compressive Strength of concrete increases by 9.90%.
3. By placing steel fibers vertically, the Compressive Strength of concrete increases by 9.24%.

It is observed that after 28 days:-

1. By placing steel fibers horizontally, the Compressive Strength of concrete increases by 11.48%.
2. By placing steel fibers in staggered form, the Compressive Strength of concrete increases by 17.19%.
3. By placing steel fibers vertically, the Compressive Strength of concrete increases by 18.91%.

From above it has been concluded that, among the three forms (Horizontal, Staggered, Vertical) after 7 days steel fibers placed horizontally gives maximum compressive strength and after 28 days steel fibers placed vertically gives maximum compressive strength for concrete. So it is considered as optimistic.

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