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A STUDY ON STEEL FIBER REINFORCED CONCRETE COMPARING WITH NORMAL CONCRETE

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ABSTRACT

In India, the highly laden vehicles on limited road space require roads to resist high stresses and minimized maintenance because of rapid infrastructure growth engines and enormous increases. Beton floors provide long lasting service life and have excellent application in heavy loading traffic. In this paper, the pressure and bending strength with and without steel fibers are assessed. There are also stresses. The test results show that reinforced concrete with steel fiber is an excellent new form of composites compared to normal concrete because road thickness is reduced without affecting the capacity of the carriage and is an economic-efficient technology. Significant changes are also noted in temperature stress values.

1. INTRODUCTION:

The cement has a very low tensile strength, limited ductility and little cracking resistance. The inner micro-cracks in concrete are present and due to the spread of such cracks, their poor tensile strength eventually leads to a fragile concrete fracture.

In the past, tensile properties of concrete components have been improved through the utilization of conventional reinforced stainless steel bars and the use of restricting techniques. Although both of the tensile strengths are inherent in concrete members, the tensile strength of the concrete itself is not increased however.

Adding small fibers to concrete which have been closely spaced and evenly dispersed would act as a crack arrestor and significantly increase its basic properties such as tensile strength, durability etc.

1.1 CONCRETE:

INTRODUCTION:

Béton is a composite building material, mainly made of aggregate, cement and water. There are many concrete formulations with various characteristics and concrete is the world's most used product made by man.

Fig (1.1): manual concrete mixing

HISTORY:

The Latin "concretes" (meaning compact or condensed) means "concrescere," "concrete" (together) and "crescere" (together) (to grow). Maybe it was 12 million years ago that cement was the earliest occurrence known when the natural deposit was created by a natural combustion of a shale of oil next to a calcareous bed. In the 60's and 70's, these old deposits have been explored. In 800 BC, in

Greece, Crete and Cyprus lime morter was used on a human-term scale, and from 300BC to 476AD the Romans extensively used concrete for more than seven centuries.

1.2 CONSTITUENTS OF SFRCS CONCRETE:

PORTLAND CEMENT:

Because of hydration the cement gains strength. It consists of calcium and mainly fine powder, mainly composed of calcium silicates and aluminum silicates. The paste forming of cement and water coats every sand and stone particle. Cement pastes harden and gains strength by means of a chemical reaction called hydration. The quality of the concrete and the strength of the paste depend on the ratio of water to cement. The water-cement ratio is a mixing water weight which is divided by a cement weight. Quality concrete made as much as possible by reducing the water cement ratio without sacrificing fresh concrete workability. Using less water, the concrete generates better quality if the concrete is placed, consolidated and cured properly. Aside from mixtures, cement is the most expensive ingredient in concrete, which is used in very small quantities.

2. REVIEW OF LITERATURE

Fiber reinforced ceiling (FRC) is a cement composite, fine and gross aggregates and fibers of varying sizes. Because concrete is of low tension, the tensile strength is increased by the addition of fibers. FRC's mechanical and physical characteristics vary with the volume of fiber, mixing proportions, dimensions, forms, volume of coarse aggregates. Zeena and Stuntmen (1973) suggested that the maximum volume of fiber was based on considerations of workability. The aspect ratio (l/d) is 90 to 125 as far as this requirement is concerned. For (l/d) 90 to 125, the maximum fibre volume is 6 to 10 per cent by fiber weight. But Swami (1975) suggested that the 80-100 aspect ratio is optimal for strength and mixing, lacing and compaction. Niyogi (1981) concluded that, given good operability and moderate increase in compressive strength, the aspect ratio of around 50 appears to be good.

The above statements show that the aggregate size for fiber reinforced concrete should not exceed ten mm from Swami (1975), Zeena (1975) and Edington et.al(1974).

While the compressive strength increased by 20mm was observed by Williamson(1974).

The above concludes that the FRCmix design is not properly proceeded and the water-ciment ratio legislation with regard to SFRC also needs to be re-established taking into consideration the presence of fibres. The fiber type, the volume percentage and the aspect ratio are also likely to affect the strength of concrete, as well as the different factors which affect the strength of hardened concrete. Therefore, extensive studies need to be undertaken to establish a model that will help to develop SFRC mixes.

2.1 COMPRESSIVE STRENGTH

The fiber reinforcement can work on micro level as well as on macro level. At the micro level, the fibres, leading to higher compression forces, stop micro cracks. Fibers improve the static compressive strength of concrete with an increased strength and have little effect on compressive strength, ranging from essentially nil to steel fibers. The fibers, however, significantly increase the ductility of the material after cracking or energy absorption.

2.2 FLEXURAL STRENGTH:

In general, the steel fibers have a much more effective effect than either the compressive or tensile strength on the flexure strength of the SFRC, with an increase of more than 100 percent. The growth of bending strength, not only with regard to the amount of fibres, but also to the appearance ratio of fibres, is particularly sensitive.

2.3 TENSILE STRENGTH:

Steel fibers have generally a far greater effect on the SFRC tensile strength and the fiber content and aspect ratio increase tensile strength.

2.4 APPLICATIONS OF SFRC:

SFRC is used in various civil engineering applications and to name few

- Refractory's, manhole covers, thin precast roofing and flooring elements, pipes, poles, industrial flooring, caissons, wall panels.
- Rapid dome construction, Blast resistant structures, Earthquake resistant structures, pavements and overlays, patching and repair works, mine and tunnel supports and linings.
- Machine foundations and structures resisting high impart load, road slope stabilization, bridge decking, car parking's, repair of dam bridges, lining of the steep incline of canals and beam-column joints.

3. EXPERIMENTAL INVESTIGATION

3.1 MIX PROPORTIONING OF SFRC BY ABSOLUTE VOLUME METHOD

Since no accepted mixing design methods for reinforced fiber concrete are available, mixing design usually depends on the intended application of materials. Trail mixes using available materials form the most practical method for designing the FRC mix. In the present investigation, 4 types of SFRC mixes are prepared with the specifications shown in table 3.1 on absolute volume method.

TABLE 3.1

Scheme of experimental investigation

S.NO	ASPECT RATIO	AGGREGATE/CEMENT RATIO	%OF FIBRE	ID MARK
1	60	4	0%	Pcc
2	60	4	1%	F1
3	60	4	2%	F2
4	60	4	3%	F3

For each mix, 9 cubes, 9 cylinders were casted and tested.

Mixes were prepared using the materials mentioned above satisfying the I S specifications.

Cossy aggregates of crushed granite were used with a 12.5 mm sieve which passed 50 percent and kept on a 10 mm sieve and 50 percent on a 20 mm sieve and were held on a 12.5 mm sieve.

The gross total was 60% by weight. The weight was 60%.

3.2 QUANTITY REQUIRED FOR 9 CYLINDERS:-

Volume of concrete required for 9 cylinders $=\frac{\pi}{4}\times 0.15^2 \times 0.30\times 9$

$=0.04768875$ cu.m

Quantity of cement required for 0.04768875cu.m of concrete $=0.04768875\times 383$

=18.26479kgs

Quantity of water required for 0.04768875cu.m of concrete =0.04768875X191.6

=9.137161lit

Quantity of coarse aggregate require for 0.04768875cu.m of concrete=0.04768875X1094

=52.17149kgs

Quantity of fine aggregate require for 0.04768875cu.m of concrete =0.04768875X551

=26.27650kgs

3.2.1 MIX M20 FOR 0% OF STEEL FIBRE FOR 9 CYLINDERS:-

CEMENT	WATER	F A	C A	0% OF FIBRE
18.26479kgs	9.13716lit	26.27650kgs	52.17149kgs	0.00kgs

3.2.2 MIX M20 FOR 1% OF STEEL FIBRE FOR 9 CYLINDERS:-

CEMENT	WATER	F A	C A	1% OF FIBRE
18.26479kgs	9.13716lit	26.27650kgs	52.17149kgs	0.01×0.04768875×7850=3.7435kgs

3.2.3 MIX M20 FOR 2% OF STEEL FIBRE FOR 9 CYLINDERS:-

CEMENT	WATER	F A	C A	2% OF FIBRE
18.26479kgs	9.13716lit	26.27650kgs	52.17149kgs	0.02×0.04768875×7850=7.4871kgs

3.3 SPLIT TENSILE TEST:

Because of difficulties in the direct stress test, several indirect processes for determining the tensile strength have been developed. Splitting tests are known as indirect tests for the determination of concrete's tensile strength, sometimes referred to as concrete's dividing force.

SAMPLE CALCULATION OF CYLINDER SPLIT TENSILE STRENGTH OF MIXES 20 GRADE FOR 3 DAYS(WITH 1% FIBRE):

Tensile stress== $\frac{2P}{PLD}$

TABLE 3.3.1(A)

SL NO	SPECIMEN	LOAD(KN)	SPLITE TENSILE STRENGTH($\frac{N}{mm^2}$)	MEAN ($\frac{N}{mm^2}$)
1	SPECIMEN 1	95	1.34	1.36
2	SPECIMEN 2	100	1.41	
3	SPECIMEN 3	90	1.27	
4	SPECIMEN 4	100	1.41	
5	SPECIMEN 5	105	1.48	
6	SPECIMEN 6	90	1.27	

4. RESULTS AND DICUSSION

The strength properties of SFRC mix depends on various factors such as water cement ratio, proportions of mix, % of fiber content ,aspect ratio of fiber etc.

COMPRESSIVE STRENGTH FOR CUBES:

COMPRESSIVE STRENGTH Vs % OF FIBERS:

FOR 3 DAYS:

The fig shows variation of compressive strength with % of fibers

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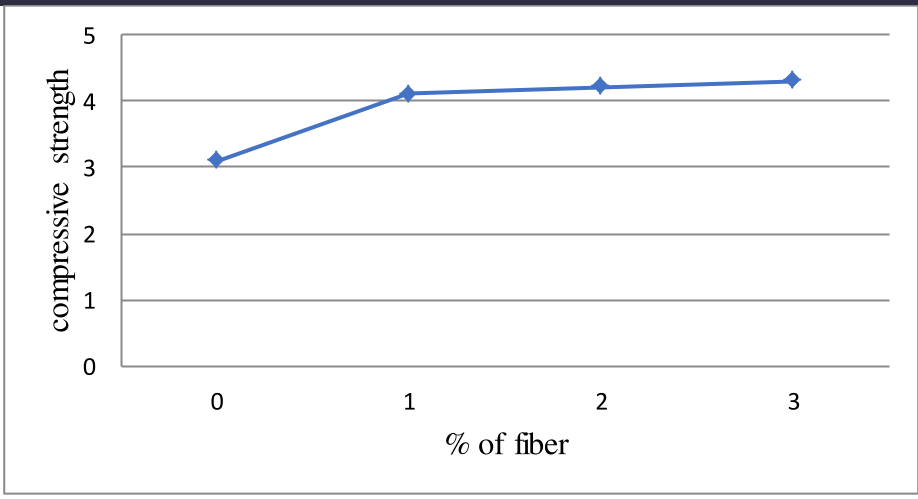

Fig.4.1 Compressive strength Vs % of fibers

From this graph it can be observed that as % of fibers increases from 0 to 3%, the compressive strength also increases.

Maximum compressive strength obtained with 3% of fiber is 18.2N/MM^2 which is more than12.43N/MM^2 more than the plane mix without fibers is.

COMPRESSIVE STRENGTH Vs % OF FIBERS:

FOR 7 DAYS:

The fig shows variation of compressive strength with % of fibers

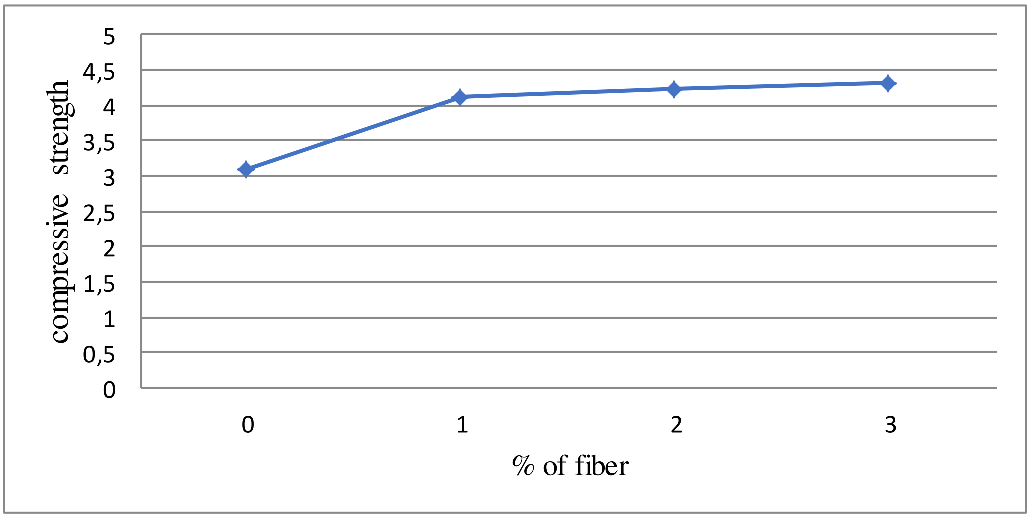

Fig.4.2 Compressive strength Vs % of fibers

From this graph it can be observed that as % of fibers increases from 0 to 3%, the compressive strength also increases.

Maximum compressive strength obtained with 3% of fibers is 35.9N/MM^2 which is 25.7N/MM^2 more than the plane mix without fibers.

COMPRESSIVE STRENGTH Vs % OF FIBERS:

FOR 28 DAYS:

The fig shows variation of compressive strength with % of fibers

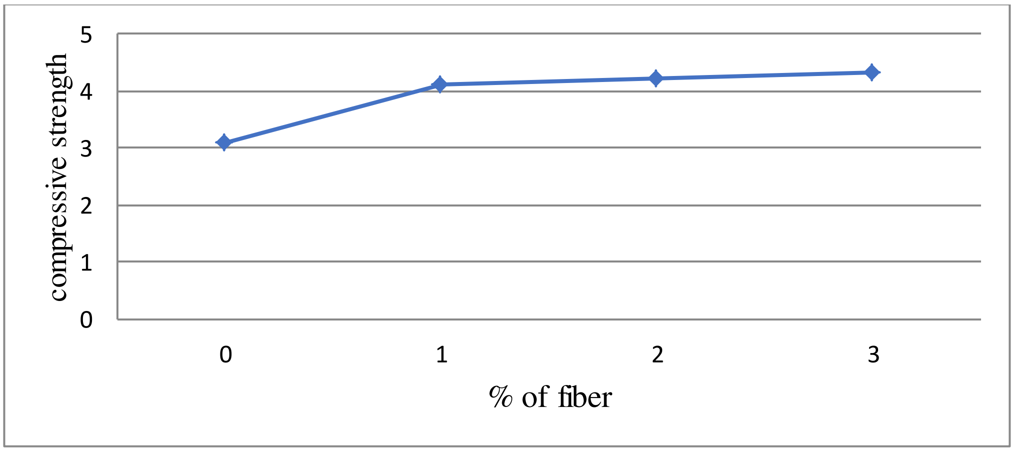

Fig.4.3 Compressive strength Vs % of fibers

From this graph it can be observed that as % of fibers increases from 0 to 3%, the compressive strength also increases.

Maximum compressive strength obtained with 3% of fiber 53.9N/MM^2 which is 38.6N/MM^2 more than the plane mix without fibers

SPLITE TENSILE STRENGTH FOR CYLINDERS

SPLIT TENSILE STRENGTH VS % OF FIBERS

FOR 3 DAYS:

The fig shows variation of split tensile strength with % of fibers

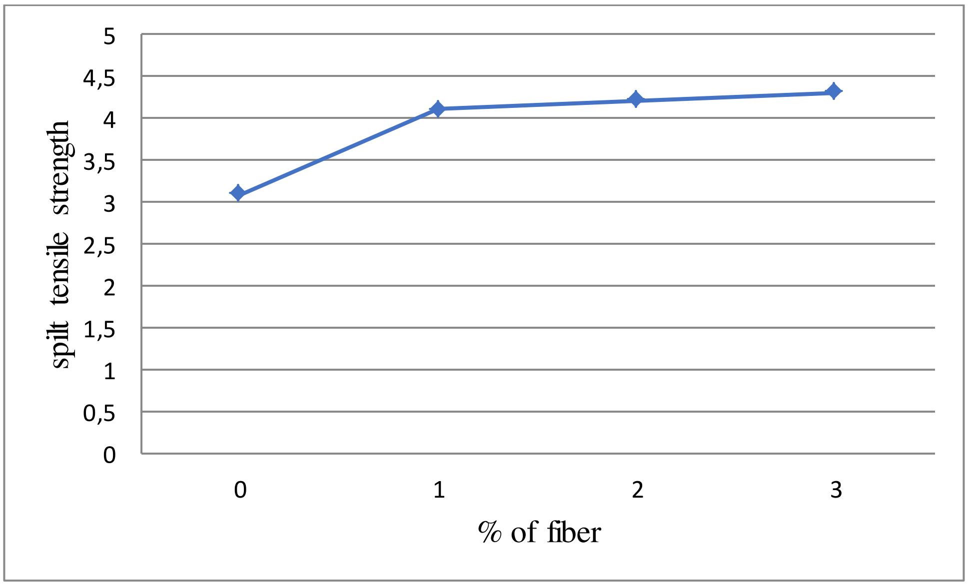

Fig.4.4 split tensile strength vs % of fibers

From this graph it can be observed that as % of fibers increases from 0 to 3%, the tensile strength also increases.

Maximum split tensile strength obtained with 3% of fiber is 1.448N/MM^2 which is 1.004N/MM^2 more than the plane mix without fibers.

SPLIT TENSILE STRENGTH VS % OF FIBERS

FOR 7 DAYS:

The fig shows variation of split tensile strength with % of fibers.

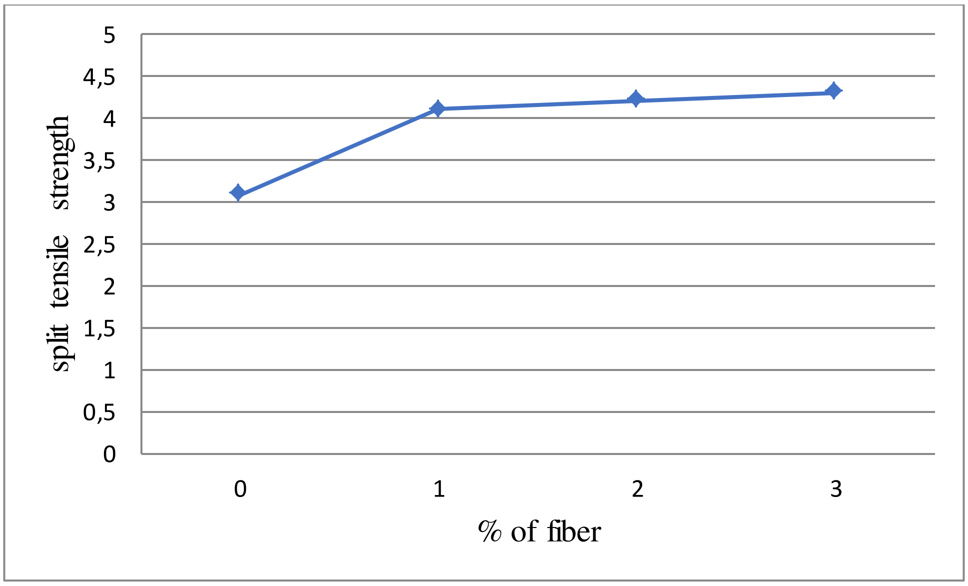

Fig.4.5 split tensile strength vs % of fibers

From this graph it can be observed that as % of fibers increases from 0 to 3%, the tensile strength also increases.

Maximum split tensile strength obtained with 3% of fiber is 2.9N/MM^2 which is 2.051N/MM^2 more than the plane mix without fibers.

CONCLUSIONS

Under the limitations of the experimental work, the following conclusions can be

Made.

- According to the above experimental experience we can conclude that adding of steel fibers gives desirable results up to 3% of adding
- The compressive & split tensile strength of steel fiber reinforced concrete is more than the plain concrete mix .
- Therefore we can conclude that by adding of steel fiber reinforced concrete we can

reduce the cracks and also increase the ductility properties of plain cement concrete.

- Maximum compressive strength obtained cubes for 3 days with M20 mix, W/C=0.4, A/C=4, l/D=60, is 18.2 N/MM^2 for 3% of fiber content. It is 12.43 N/MM^2 more than that of the plane mix without fibers.

- Maximum compressive strength obtained cubes for 7 days with M20 mix, W/C=0.4, A/C=4, l/D=60, is 35.9 N/MM^2 for 3% of fiber content. It is 25.7 N/MM^2 more than that of the plane mix without fibers.

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