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Influence of Steel Fibers Chips on the Mechanical Properties of Concrete - An Experimental Investigation

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Abstract: This experimental investigation is carried out to experimental learn about the different strength traits of concrete with partial alternative of steel fiber with M-25 & M-30 grade concrete. The predominant goal of this investigation work is to enhance the strength parameters i.e slump test compressive strength, split tensile strength and flexural strength of concrete grade M25 & M30 with extraordinary percentage of steel fiber chip 0%, 0.5 %, 1 %, 1.5%, 2% and 2.5% respectively. Compressive strength, break up tensile strength, flexural strength will increase up to 2 % steel fiber chip for M-25 and M-30 grade of concrete. The experimental work is carried out on a total no of 108 specimen of compressive strength, split tensile strength & flexural energy for every sample.

Key words- course aggregate, steel fiber chip, compressive strength. Split tensile strength. Slump value

1. INTRODUCTION

Plain concrete processes a very low tensile strength, limited ductility, and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle failure of the concrete. The most widely accepted remedy to this flexural weakness of concrete is the conventional reinforcement with high strength steel. Restraining techniques are also used to. In spite of the fact that these strategies give rigidity to individuals, they however don't build the innate elasticity of solid itself. Likewise the fortification putting and proficient compaction of RCC is extremely troublesome if the solid is of low workable particularly on account of overwhelming solid (M-25 and M - 30 Grade of cement). Plain concrete and comparative weak materials, basic breaks (miniaturized scale splits) grow even before stacking, especially because of drying shrinkage or different reasons for volume change. The width of these splits surpasses a couple of microns, however their two measurements might be of higher extent.

2. OBJECTIVE

The point of our venture is to utilize the Steel Fibers chips support to concrete. Our objective is to add the Steel fibers chips (chip metal) fiber to the concrete and to study the strength properties of concrete with the variation in fiber content. i.e., to study the strength properties of concrete (M-25 & M-30 Grade) for fiber content of 0%, 0.5 %, 1 %, 1.5%, 2% and 2.5% respectively at 7, 14 & 28 days. The strength properties being studied in our thesis are as follows:

1. Compressive strength
2. Split tensile Strength
3. Flexural strength

These properties are then compared to the conventional M25 &M-30 grade cement concrete.

3. LITERATURE REVIEW

Fang et al. (2022) We suggested a novel three-dimensional (3D) packing model, taking into account the random distributions of coarse aggregates (CA) and steel fibres, to better understand the damage characteristics of ultra-high performance concrete (UHPC) including coarse aggregates (CA) under load effects. A 3D meso scale model was created based on the packing model to simulate the quasi-static compression characteristics of UHPC. The model considers UHPC to be a four-phase composite made up of steel fibers, CA, interfacial transition zones, and homogeneous mortar matrix. Additionally, using numerical analysis, we looked at the failure characteristics of UHPC specimens with various mix ratios. The simulation and experiment yielded results that concurred with one another, demonstrating the viability of using the mesoscopic model and 3D packing modelling approach to study the mechanical behaviours of UHPC.

Darssni et al. (2022) One of the most recent innovations in the building sector is ultra-high performance concrete (UHPC). The fibres' presence is the main factor in UHPC's strain hardening behaviour, ductility, and toughness. The main criteria used to choose a fibre are compatibility of material properties, sufficient interaction between the fibre and matrix to transmit stresses, and an ideal aspect ratio to ensure effective post-cracking behavior. The nature, fibre combination, fibre orientation, mechanical properties, and fibre geometry of a fibre have a significant impact on its efficiency. For judicious fibre selection, a number of criteria must be met, as explained above. In light of this, a critical review is provided in this study to give stakeholders quick access to information about the impact of the fibre on the raw and hardened properties of UHPC. In the first section, the mechanism by which fibres and binders interact as well as the strength characteristics of metallic, inorganic, polymeric, carbon, and hybrid fibres used in UHPC are described in detail. The effects of fibre dosage and geometry on workability, rheology, microstructure, and compressive strength, tensile strength, and durability properties are investigated in the second section. Future potential applications, current difficulties, and an overall summary are presented based on the findings.

Fan et al. (2022) the upgraded concrete known as ultra-high-performance concrete (UHPC) has superior mechanical strength, ductility, and durability qualities. The impact of steel fibre on its constitutive laws and the impact of the specimen's geometric dimension on its strength, however, hadn't received enough attention. A variety of specimens with various fibre volume contents and fibre types were tested in order to look into how steel fibres affect the characteristics of UHPC. In the meantime, tests on the mechanical characteristics of UHPC at various ages, from 3 days to 28 days, were done. Additionally, specimens in the shapes of a dog-bone, a prism, and a cylinder were created to explore the impact of specimen geometric dimensions on the characteristics of UHPC. The findings showed that as fibre volume content and curing age increased, so did elastic modulus, tensile peak stress, and the associated strain. The tensile performance of specimens with hooked-end fibres was superior to that of specimens with straight fibres. Additionally, the tensile properties of UHPC were significantly impacted by the various geometric dimensions of the specimens. Conversion factors were suggested for the transformation of strength obtained from specimens with different geometric dimensions to reference specimens based on the experimental results. Additionally, the stress-strain relationship of UHPC was proposed using both compressive and tensile constitutive laws

3. METHODOLOGY

Materials -The materials used in experimental work for making concrete mixture are cement, Fine aggregate, coarse aggregate and Steel fiber chips, are detailed describe below:

Cement: Cement is by far the primary constituent of concrete, in that it performs the binding substance for the discrete ingredients. Arranged out of normally creating crude materials and infrequently mixed or underground with modern squanders. The bond utilized as a part of this investigation was Portland concrete of 43 grades adjusting to IS 8112-1989.

Fine Aggregate: Aggregates which engage nearly 70 to 75 percent quantity of concrete are sometimes observed as inert ingredients in more than one sense. However, it is now well recognized that physical, chemical and thermal properties of aggregates substantially influence the properties and performance of concrete. The fine aggregate (sand) used was clean dry sand was sieved in 4.75 mm sieve to take out all pebbles.

Coarse Aggregate: Coarse aggregate are used for building concrete. They could be in the form of unequal broken stone or naturally occurring gravel. Materials that are large to be maintained on 4.75mm sieve size are named coarse aggregates. Its most elevated size might be up to 40 mm.

Water: Water is a primary part of concrete as it effectively contributes in the compound response with bond. Since it plays out the quality giving concrete gel, the sum and nature of water is basic to be investigated deliberately. Compact water is by and large thought to be acceptable.

Steel Fiber Chip: Stainless steel chip were taken as steel fibers for this study. These are industrial waste of high-grade stainless steel with four sided strands, giving for cleaning edges to handle toughest jobs. Since each chip is made of a single strand of stainless steel, they will not tear or splinter. Also, they will not corrode. It has a good tensile strength and the fiber strips length vary by 1, 1.5 and 2 inches. These fibers will improve toughness, durability and tensile strength of concrete

Table. 1 Physical Properties of 43 Grade Portland cement

S.No.	Physical Properties	Values of Portland Cement used	Requirements as per IS 8112-1989

1	Standard Consistency	29.2 %	-
2	Initial Setting Time	45 Minutes	Minimum of 30 minutes
3	Final Setting Time	265 Minutes	Maximum of 600 minutes
4	Specific gravity	3.15	-
5	Compressive strength in N/mm2 at 3 days	29	Not less than
6	Compressive strength in N/mm2 at 7 days	38.5	Not less than
7	Compressive strength in N/mm2 at 28 days	48	Not less than

Table 2. Physical Properties of Fine Aggregate

(Tests as per IS: 2386 – 1968: Part III)

S. no	Physical properties	Values
1	Specific gravity	2.6
2	Fineness Modulus	2.83
3	Water Absorption	0.75%
4	Bulk density (kg/m3)	1654
5	Free moisture content	0.1%

Table 3. Physical Properties of Coarse Aggregate (Tests as per IS: 2386 – 1968 Part III)

S. No	Physical properties	Values
1	Specific gravity	2.6
2	Fineness Modulus	2.73
3	Water Absorption	0.5%
4	Bulk density (kg/m3)	1590
5	Free moisture content (%)	0.2%
6	Aggregate Impact value (%)	11.2
7	Aggregate Crushing value (%)	25.12

Table 4. Properties of Steel Fiber Chips

S. No	Properties of Fibres	Steel Fiber Chip
1	Length used (mm)	40 to 60
2	Diameter (mm)	0.50
3	Available form	winded
4	Color	silver thin wires
5	Specific gravity	0.87
6	Water Absorption (%)	210

4. Experimental Procedure

The estimation of concrete with Steel Fiber Chip and Fine aggregates used as substitute of aggregate materials is completed during concrete specimen testing. Concrete include cement, water, fine aggregate, coarse aggregate. Concrete is replaced with alternative materials by varying percentage of replacement. The Steel Fiber Chip is used as partial replacement for fine aggregate and Cement in the range of 0%, 0.5 %, 1.0 %, 1.5%, 2%, 2.5 % by weight of course aggregate and cement and its optimum level is to be found. For testing the strength of normal and other variation mix totally 72- cubes of size 150x150x150mm were casted for compression strength test. Then 72-beam of size 700x100x100mm is casted for flexural strength testing. For testing the Split tensile strength 72-cylinders of 150mmx300mm are casted as per mix design proportions. Once 24hours completed from casting the concrete specimens are de-moulded and allowed for continuous curing in a tank with portable water. The specimen are taken and tested at required 7th day, 14th day & 28th day and tensile & durability test at 28th day from curing. Then compare the Strengths of M25 and M-30 design mixes.

Figure 1. Curing of concrete

Figure 2. Compression test machine

Figure 3. Flexural test setup

Figure 4. Splitting tensile setup

V. Results and Discussion

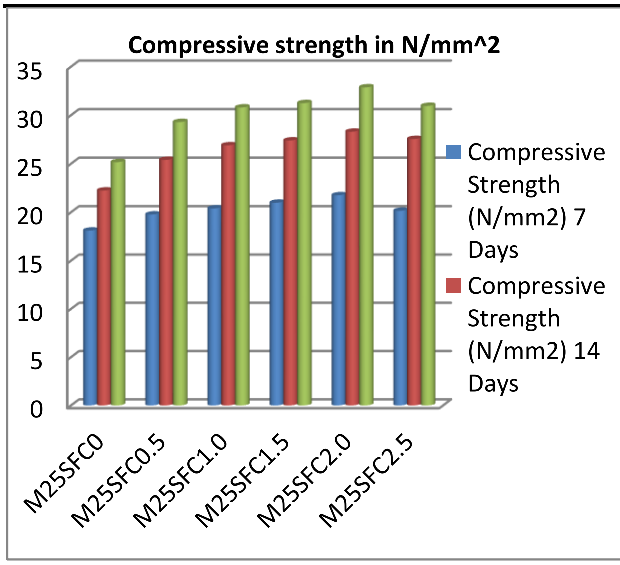
In this study the designed concrete is subjected to various tests to estimate the strength and other properties of the casted concrete. The main aim of the project is to monitor the developed strength attained by the concrete at various testing days from curing. Generally proper casting and curing of concrete will increase the strength of the concrete. For this project each test is carried out with 3 samples for every mix ratio and tested at required curing time. Then the average values are used for the investigations. The series of testing procedures are detailed below:

4.1. Compressive Strength Test

Concrete is weak in tension and strong in compression so the concrete should be strong to attain high compression. In this study for each mix 3-samples were tested and the average strength is compared with nominal mix of M25 and M-30 grade. Compressive strength ofcompressive lading a significant can bear below making edge. The arise of these compressive strength at the Time of 7, 14 and 28 days are shown in table 5 & 6..

Table.5 Compressive Strength on Concrete M25 Cubes

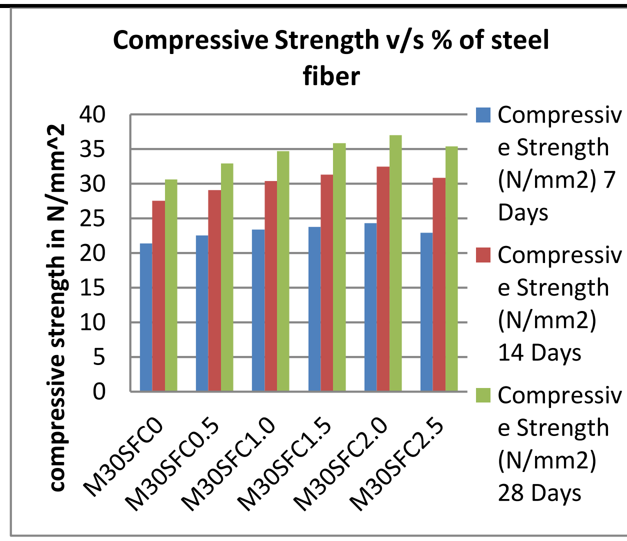
S. No.	% of Steel fibre chip	Grade of Concrete		
		7 Days	14 Days	28 Days
1	M25SFC0	18.11	22.24	25.17
2	M25SFC0.5	19.77	25.40	29.30
3	M25SFC1.0	20.40	26.90	30.80
4	M25SFC1.5	20.98	27.40	31.25
5	M25SFC2.0	21.75	28.30	32.87
6	M25SFC2.5	20.15	27.55	30.96



Graph 1 – Compressive Strength v/s % of steel fiber

Table 6 – Compressive Strength of M30 Grade concrete in N/mm^2

S. No.	% of Steel fibre chip	Grade of Concrete		
		7 Days	14 Days	28 Days
1	M30SFC0	21.40	27.50	30.60
2	M30SFC0.5	22.54	29.10	32.90
3	M30SFC1.0	23.35	30.40	34.70
4	M30SFC1.5	23.78	31.30	35.86
5	M30SFC2.0	24.30	32.43	36.98
6	M30SFC2.5	22.93	30.87	35.43



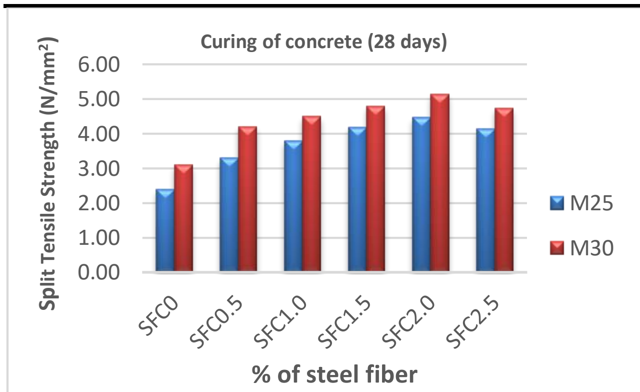
Graph 2 – Compressive Strength of M30 Grade concrete

4.2. Split Tensile Strength Test

Totally 72 cylinder specimens of size 100 mm diameter and 300 mm height with 3 different % mixes were casted and tested. Three weight fractions were considered for steel fiber chip of constant length. Results for split tensile strength based on the values of test data. A sample comparison graph for steel fibres chip concrete is plotted to study conventional concrete strength which is shown in Graph no 3. The predicted value of the split tensile strength of different mixes has been compared with the experimental results in Table-7

Table.7 Split Tensile Strength of Concrete at 28 Days

S. No.	% of Steel fibre chip	Grade of Concrete	
		M25	M30
1	SFC0	2.4	3.10
2	SFC0.5	3.3	4.22
3	SFC1.0	3.8	4.50
4	SFC1.5	4.20	4.80
5	SFC2.0	4.47	5.15
6	SFC2.5	4.15	4.74



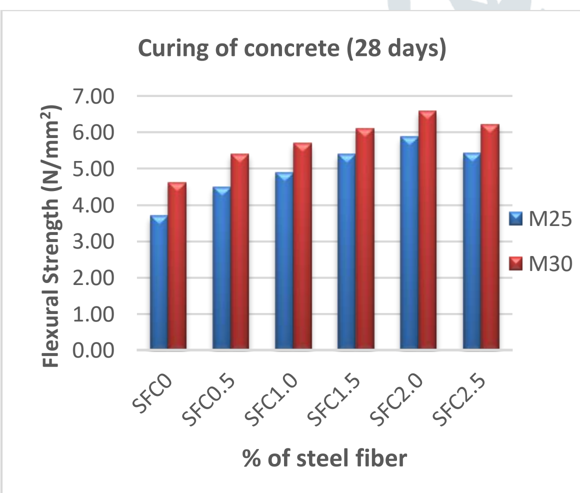
Graph.3 Split Tensile Strength at 28 Days

4.3 Flexural strength Test

The determination of compressive and flexural strength of the prepared samples is carried out as per IS code. The following table the compressive and flexural strength of various samples using steel fibres cheep.

Table 8 – Flexural Strength of concrete Beam

S. No.	% of Steel fibre chip	Grade of Concrete	
		M25	M30
1	SFC0	3.70	4.62
2	SFC0.5	4.50	5.40
3	SFC1.0	4.90	5.70
4	SFC1.5	5.40	6.10
5	SFC2.0	5.88	6.59
6	SFC2.5	5.42	6.22



Graph 4 – Flexural Strength of concrete Beam

5. Conclusion

The optimum percentage of steel fiber chip added was 2% since increased fiber addition resulted in loss of workability.

The Slump of the concrete mix reduces from 66 mm to 54 mm on increasing the percentage of steel fiber (from 0% to 2.5%) for M-25 Concrete mix.

The Slump of the concrete mix reduces from 63mm to 49mm on increasing the percentage of steel fiber (from 0% to 2.5%) for M-30 Concrete mix.

The Compressive strength of M25 concrete mix increases from 25.17N/mm2 to 32.87N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 32.87 N/mm2 to 30.96 N/mm2 with addition of 2% to 2.5% of steel fiber chips.

The Compressive strength of M30 concrete mix increases from 30.60N/mm2 to 36.98N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 36.98 N/mm2 to 35.43 N/mm2 with addition of 2% to 2.5% of steel fiber chips.

The Tensile strength of M25 concrete mix increases from 2.4N/mm2 to 4.47N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 4.47 N/mm2 to 4.15 N/mm2 with addition of 2% to 2.5% of steel fiber chips

The Tensile strength of M30 concrete mix increases from 3.1N/mm2 to 5.15N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 5.15 N/mm2 to 4.74 N/mm2 with addition of 2% to 2.5% of steel fiber chips

The Flexural strength of M25 concrete mix increases from 3.7 N/mm2 to 5.88N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 5.88 N/mm2 to 5.42 N/mm2 with addition of 2% to 2.5% of steel fiber chips

The Flexural strength of M30 concrete mix increases from 4.62N/mm2 to 6.59N/mm2 on increasing the percentage of steel fiber (from 0% to 2%) and decreases from 6.59 N/mm2 to 6.22 N/mm2 with addition of 2% to 2.5% of steel fiber chips

6. References

1) Ali Majid, Anthony Liu, HouSou, Nawawi Chouw, "Mechanical and Dynamic Properties of Coconut Fibre Reinforced Concrete." Construction and Building Materials. Reed Business Information, Inc. (US). 2012. High Beam Research. 5 Sep. 2013.

2) Noor Md. Sadiqul Hasan, Habibu rRahmanSobuz, Md. ShibleeSayed and Md. Saiful Islam, "The Use of Coconut fibre in the Production of Structural Lightweight Concrete". Journal of Applied Sciences, 12: Pages 831-839. 2012.

3) Mahyuddin Ramli, Wai Hoe Kwan, Noor Faisal Abas. "Strength and durability of coconut-fibre-reinforced concrete in aggressive environments". Construction and Building Materials, Volume 38, Pages 554–566. January 2013.

4) Yalley, P. P. and Kwan, Alan ShuKhen. "Use of coconut fibre as an enhancement of concrete". Journal of Engineering and Technology 3, Pages 54-73. 2009.

5) Domke P. V., "Improvement in the strength of concrete by using industrial and agricultural waste". IOSR Journal of Engineering, Vol. 2(4), Pages 755-759. April 2012.

6) Paramasivam P, Nathan G. K., Das Gupta N. C., "Coconut fiber reinforced corrugated slabs", International Journal of Cement Composites and Lightweight Concrete, Volume 6, Issue 1, Pages 19-27. 1984.

7) LiboYan andNawawiChouw. Department of Civil and Environmental Engineering, The University of Auckland, Auckland Mail centre, New Zealand.

8) J.M.Crow, The Concrete Conundrum,2006, available at www.chemistryworld.com

9) A. short and W.Kinniburgh, Lightweight Concrete, Applied Science Publishers, London

10) M.Ali,B,Nolot and N. Chouw, April 2009, " Behaviour of coconut fibre and rope reinforced concrete members with debounding length .Annual Australian Earthquake Engineering Society Conference, "New Castle Earthquake Dec.11-13.Paper 04

11) Majid Ali. ,11 July 2011, " Coconut Fibre – A Versatile Material and its application in Engineering - .Journal of Civil Eng.& Const. Tech. Vol.2(9),pp.189-197,2 Sept.2011