An Experimental Investigation on Strength Properties of Steel Fiber Chip for M-25 and M-30 Grades of Concrete

Sakshi Acharya1, Pratiksha Malviya[2], Vikash Kumar Singh[3]
[1]M.Tech.Scholar, [2,3]Asst. Professor, Department of Civil Engineering
[1,2] Millennium Institute of Technology, Bhopal, India.
[3]Lakshmi Narain College of Technology, Bhopal, India

Abstract: This experimental investigation is carried out to experimental study the different strength characteristics of concrete with partial replacement of steel fiber with M-25 & M-30 grade concrete. The main objective of this investigation work is to improve the strength parameters i.e slump test compressive strength, split tensile strength and flexural strength of concrete grade M25 & M30 with different percentage of steel fiber chip (0%, 3%,6% and 9%). Compressive strength, split tensile strength, flexural strength increases up to 9 % steel fiber chip for M-25 and M-30 grade of concrete. The experimental work is carried out on a total no of 72 specimen of compressive strength, split tensile strength & flexural strength for each sample.

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

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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 3, 6, 9 & 12 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

Concrete is one of the most versatile building materials. It can be cast to fit any structural shape from ordinary rectangular beam or column to a cylindrical water storage tank in a high- rise building. It is readily available in urban areas at relatively low cost. Concrete is strong under compression but weak under tension. As such, a form of reinforcement is needed. The most common type of concrete reinforcement is by steel bars. The advantages in using concrete include high compressive strength, good fire resistance, high water resistance, low maintenance, and long service life. The disadvantages in using concrete include poor tensile strength, and formwork requirement. Other disadvantages include relatively low strength per unit weight. The longitudinal rebar in a beam resists flexure (tensile stress) whereas the stirrups, which are wrapped around the longitudinal bar not only holds the longitudinal bars in position but also resist shear stresses. In a column, vertical bars resist compression and buckling stresses while ties resist shear and provide confinement to vertical bars. Steel fibre reinforced concrete comprises cement, aggregates and steel fibres. Steel fibre reinforcement cannot be regarded as a direct replacement of longitudinal reinforcement in reinforced and prestressed structural members. In tension, SFRC fails only after the steel fibre breaks or is pulled out of the cement matrix. Properties of SFRC in both the freshly mixed and hardened state, including durability, are a consequence of its composite nature. The mechanics of fibre reinforcement which strengthens concrete or mortar is a continuing research topic.
Ahsana Fathima K M, et al (2014), describes the Behavioral study of steel fiber and polypropylene fiber. The fundamental point of this investigation is to think about the quality properties of steel fiber and polypropylene fiber strengthened cement of

M30 review with 0%, 0.25%, 0.5% and 0.75% by volume of cement. They demonstrated the outcomes that the polypropylene fiber fortified solid yield higher flexural quality with expansion of 0.5% polypropylene fiber by volume of cement. Saeid Hesami , Saeed Ahmadi , Mahdi Nematzadeh et al, Construction and Building Materials 53 (2014): 680-691. The utilization of pervious solid asphalt is essentially expanding because of diminishment of street overflow and retention of commotion. In any case, this kind of asphalt can't be utilized for substantial movement because of a high measure of voids and thus low quality of pervious cement. Rice husk cinder (RHA) was utilized as a part of request to reinforce pozzolanic bond glue and the impact of 0%, 2%, 4%, 6%, 8 %, 10% and 12% weight rates as a concrete substitution in solid blends on the mechanical properties was examined. Also, 0.2% Vf of glass (where Vf is the extent of fiber volume to add up to volume of cement), 0.5% Vf of steel and 0.3% Vf of polyphenylenesulfide (PPS) strands were utilized to enhance the mechanical properties of the pervious cement. Wenjie Ge Jiwen Zhang (2015) Flexural practices of half and half solid bars fortified with BFRP (Basalt Fiber Reinforced Plastic) bars and steel bars are examined in this paper. Ductile test, standard haul out trial of BFRP bars, and static flexural analysis of five diverse half breed fortified solid shafts were made. The tests demonstrate that BFRP bars have high rigidity and low versatile modulus contrasted and steel bars. The bond strength between ribbed BFRP bars and concrete is similar to that of screwed steel bars with the same diameter and there appears to be good bond performance. The bond strength of steel bars of 8 mm diameter is a little larger than that of steel bars of 10 mm diameter. The bond strength relative coefficient VF of BFRP bars can be considered to be 1.0, it is proposed that hybrid RC beams should be used in structures that have high requirements of flexural capacity but low requirements of Deflection. The ductility of hybrid RC beams can meet the requirement when AF/AS is suitably controlled.

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 interground 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%, 3%, 6% and 9% 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

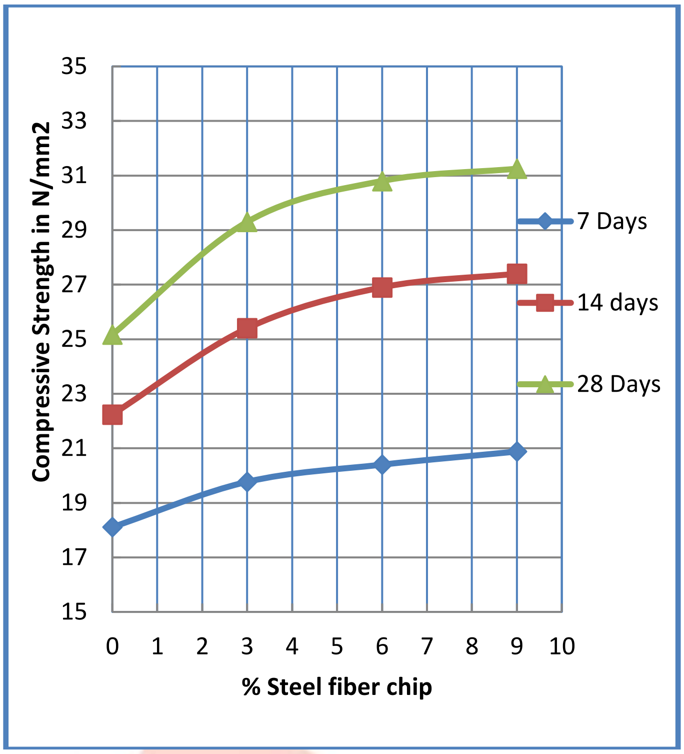
In this study the designed concrete is subjected to various tests to estimate the strength and other properties of the casted concrete. The main aim of the project is to monitor the developed strength attained by the concrete at various testing days from curing. Generally proper casting and curing of 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

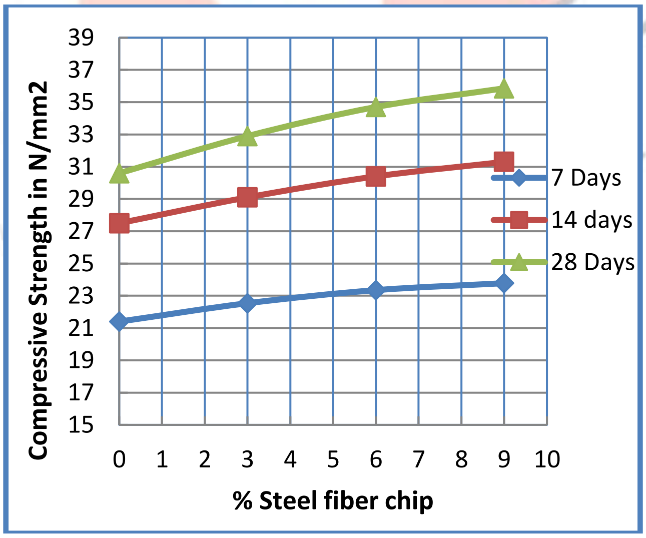
S. No.	% of Steel fibre chip	Grade of Concrete		
		7 Days	14 Days	28 Days
1	0 %	18.11	22.24	25.17
2	3 %	19.77	25.40	29.30
3	6 %	20.40	26.90	30.80
4	9 %	20.88	27.40	31.25



Graph 1 – Compressive Strength of M25 Grade concrete

Table 6 – Compressive Strength of M30 Grade concrete in N/mm²

S. No.	% of Steel fibre chip	Grade of Concrete		
		7 Days	14 Days	28 Days
1	0 %	21.40	27.50	30.60
2	3 %	22.54	29.10	32.90
3	6 %	23.35	30.40	34.70
4	9 %	23.78	31.30	35.86



Graph 2 – Compressive Strength of M30 Grade concrete

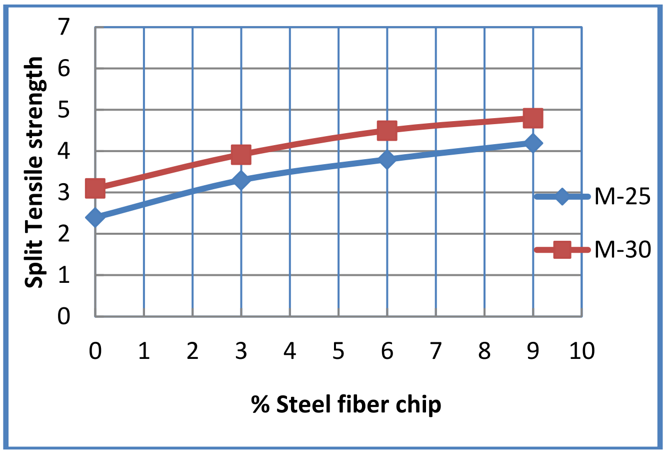
4.2. Split Tensile Strength Test

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	0 %	2.4	3.10
2	3 %	3.3	4.22

3	6 %	3.8	4.50
4	9 %	4.20	4.80



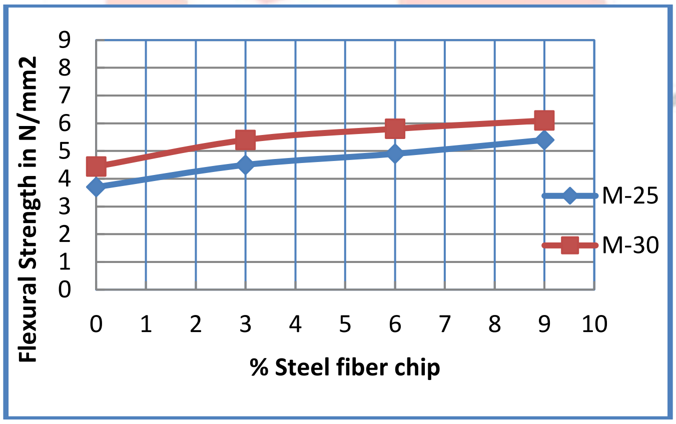
Graph.3 Split Tensile Strength at 28 Days

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	0 %	3.70	4.90
2	3 %	4.50	5.40
3	6 %	4.90	5.70
4	9 %	5.40	6.10



Graph 4 – Flexural Strength of concrete Beam

5. Conclusion

- Addition of steel fiber cheep resulted in significant improvement on the strength properties of concrete (M-25, and M-30) grade
- Compared to plane concrete the fiber addition resulted in better strengthening (compressive, tensile and flexural) properties of concrete.
- The maximum increase in compressive strength was observed of concrete grade M-25 and M-30 respectively at 9% of fiber cheep.
- compressive Tensile and flexural strength is continuously increased with increasing the percentage of steel and maximum tensile strength was achieved in the case of 9% steel fiber cheep for grade of concrete M-25,and &M-30.

Recommendations

Based on the investigation made the following recommendations are forwarded for studies in Purpose of future excellence.

- The interesting results confirm the promising application of concrete reinforced with steel Fibers cheep from industries. However, further, research work is still necessary in order to have a more in-depth understanding of the material properties and to evaluate possible practical applications. And also economic evaluation of the adoption of currently available steel fibers cheep technology should be investigated

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