



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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# Experimental Study on Effect of Addition of Steel Fiber and Recron Fiber on the Percentage of Cement

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**ABSTRACT:** In this investigation, Steel fiber (SF) and recron 3-S fiber are used as an alternative binder and filler material for ordinary Portland cement. This paper deals with the results of an experimental investigation on the structural properties of fiber-reinforced concrete with the addition of steel fiber and recron fiber. M40 grade of concrete was considered for this study. Cement was replaced by Steel fiber with 1.5% and also cement was replaced by Recron 3-S fiber with 0.75%. effect of the addition of fibers on compressive strength, flexural strength, Split tensile strength, and direct shear test are studied. Cubes of 150 mm x 150 mm x 150 mm for compressive strength, beams of 100 x 100 x 400 mm for flexural strength, Cylinders of 150 mm (dia) x 300 mm (height) for split tensile strength, and push-off specimens of 450 x 150 x 150 mm for the direct shear test were cast. And cured for 28 days. All specimens were tested subsequently to study the strength performance of this concrete. The obtained results are analyzed further to replace the percentage of cement to conduct the new mix design with the replacement of cement with the fiber percentage. The newly designed mix design should achieve the strength of the M40 grade of conventional concrete. The grade of concrete is mentioned in this study for various changes in the percentage of cement that is replaced by the fiber-reinforced concrete results.

**KEYWORDS:** : Recron fiber, steel fiber, compressive strength, flexural strength, workability, strength of, split tensile strength, push-off Specimen, direct Shear test, cost analysis.

## I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate, and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material that can be molded into any shape and hardened into a rock-like mass known as concrete. The hardening is because of a chemical reaction between water and cement, which continues for a long period leading to stronger with age. The amount of cement production emits approximately equal amounts of carbon dioxide into the atmosphere. Cement production is consuming a significant amount of natural resources. To overcome the above ill effects, the advent of newer materials and construction techniques and in this drive, admixture has taken newer things with various admixtures has become a necessity. The availability of mineral admixtures marked the opening of a new era for designing concrete mixes of higher and higher strength. Steel fiber and recron 3-S fiber are new admixtures, whose potential is not fully utilized. Moreover, only limited studies have been carried out in India on the use of Recron Fiber for the development of high-strength concrete. Several experimental investigations have been carried out to study the workability, mechanical, and durability characteristics.

## II. RELATED WORK

In earlier studies (Job Thomas et. al 2007) the improvement in mechanical properties in concrete due to the addition of steel fibers were expressed as a function of fibers were expressed as a function of fiber reinforcing index and concrete length. In this work, the study reports on the test data for various percentages like 0.5, 1, 1.5%. The maximum strength parameters satisfy all the strengths. Amit rana carried the test on steel fibers giving the maximum strength in comparison to glass and polypropylene fibers. Fiber efficiency and fiber content are important variables controlling the performance of FRC (Balguru P.N. et. al. 1992) GGBS proves to be a good alternative binder to replace the cement at 50-60% replacement level. Concrete with GGBS gives less strength as compared to normal concrete at 28 days but GGBS concrete will gain strength up to 56 days. Beyond 56 days concrete with GGBS gives significantly more

strength than a normal concrete mix (K. Ganesh Babu et. al, 2000). Nikhil. A. Gadge et. al. 2013 this study focuses on the compressive strength performance of the blended concrete containing different percentages of 10, 20, 30, 40% by weight of slag and 0.5, 1, 1.5, 2% by weight of steel fiber. It concluded that the optimum dosage for the addition of steel fibered is 1.5%. Falah A. Almotri (2011) was studied by conducting tests on standard control specimens. The use of steel fibers in fly ash concrete improves its structural properties, especially the flexural tensile strength. Increasing the percentages of fly ash up to 30% and steel fibers up to 1.5% in concrete enhances the flexural tensile strength as well as the compressive strength. Korrapati Anil Kumar, et.al. investigates the workability, and strength properties of concrete with the Recron 3S in proportion 0, 0.2, 0.3, 0.4% is studied for M25 and M40 grade. M. Prabhu et. al. in this investigation recron fiber is added to concrete such as M20, M25, M30 for strength parameters. From this study, they concluded that in order to get maximum strength 0.75 of recron fiber should be used.

### III. METHODOLOGY

The experimental investigation to study the effects of adding steel fiber and Recron 3-S fiber on the properties of fiber-reinforced concrete is carried out for the M40 grade of concrete. Recron 3-s Fiber along and hooked-ended steel fibers are added in concrete. Ground recron 3-s fiber is added percentage as 0.75 % by weight of cement with the constant percentage of hook-ended steel fiber as 1.5% of cement weight. Hook-ended steel fibers with an aspect ratio of 50 were used throughout the experiment. Cubes of 150 mm x 150 mm x 150 mm sizes are cast to study the effects on compressive and a beam of size 100 mm x 100 mm x 500 mm is cast to study the effect on flexural strength and push-off specimens of 150 mm x 150 mm x 450 mm is cast to study the effect on shear strength and cylinder of 150 mm diameter and 300 m height is cast to study the effect on split tensile strength. Compaction of the entire specimen is done by using a table vibrator to avoid balling of fibers. All the normal concrete specimens are cured for 28 days and Fiber reinforced concrete (FRC) also specimens are cured for 28 days at room temperature and tested in surface dry condition, 1000-tonne universal testing machine (UTM) and 3000 KN Compressive Testing Machine (CTM). The strength obtained experimentally is compared with types of concrete designed.

#### Cement

For this investigation Ordinary Portland Cement (OPC) of 53 grade conforming to IS 12269-1987 has been used.

Table: 1 Physical properties of cement

Fineness	3.75%
Initial setting time (min)	35
Final setting time (min)	600
Specific gravity	2.88
Standard consistency	29%

#### Fine Aggregate

Locally available natural sand from Krishna River confirming (zone II) to I.S. 383-1970[33] was used. Various tests such as specific gravity, water absorption, sieve analysis, etc. have been conducted on fine aggregates to know quality and grading (dust). Silt content was removed by washing sand.

#### Coarse Aggregate

Locally available coarse aggregate having a maximum size of 20 mm down to 10 mm is used for the present work. Testing of coarse aggregate was conformed from IS 383-1970. Various tests such as specific gravity, water absorption, sieve analysis, etc have been conducted on coarse aggregate.

#### Water

Ordinary tap water is available in the laboratory and used for drinking purposes and has been used for preparing the concrete mix. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength-giving cement gel, the quantity and quality of water play a very important role.

#### Steel fiber

I.S.O. 9001:2008[34] certified hook-ended steel fiber confirming to ASTM A820 [35] type 1 Standards are used for experimental work. The properties of hook-ended steel fibers are given below.

Table: 2 Properties of steel fiber

Diameter of fiber (Df)	1
Length of fiber (Lf)	50
Aspect ratio (Lf/Df)	50
Modulus of elasticity	200 Gpa
Tensile strength	>1100 Mpa

**Recron fiber**

Reliance Industry Limited (RIL) has launched Recron 3s fiber with the objective of improving the quality of concrete. The Recron fiber spreads across the entire section when used in low dosages and also arrests cracking in concrete. Recron 3s is a state of art reinforcing material that is used to increase strength in a variety of applications like automotive batteries, paper, filtration fabrics, asbestos cement sheets, cement-based pre-cast products, and for improving the quality of construction. Recron 3s fibre has a triangular cross-section with cut lengths of 6, 12, or 18 mm which is being widely used in the Indian Construction industry market.

Table: 3 Properties of recron fiber

Length	6-12 mm
Tensile strength	About 6000 Mpa
Melting point	250°C
Dispersion	Excellent
Acid resistance	Good

**Compressive Strength test**

The cubes of size 150x150x150mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks.



a) Compressive testing machine



b) Flexural testing machine

**Flexural Strength Test**

The test is carried out to find the flexural strength of the prism of dimension 100 x 100 x 400 mm. The prism is then placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mould.

**Split Tensile Test**

The test is carried out by placing a cylinder specimen of dimension 150mm diameter and 300mm length, horizontally between the loading surface of the compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

**Direct shear strength**

The shear transfer strength was studied using a push-off specimen with dimensions of 150 mm x 150 mm x 450 mm with a shear plane length of 150mm. The 6 mm steel bar reinforcement was provided away from the shear plane to

prevent failure other than the shear mode, All the specimens were tested in direct compression on the universal testing machine of 1000 Tonne capacity.



c) Split tensile machine



d) Direct shear test

#### IV. EXPERIMENTAL RESULTS

##### 4.1 Testing on fresh concrete

###### Workability

The workability of fresh concrete mix and steel fiber and recron 3S steel fiber reinforced concrete mix was determined by using the slump cone test.

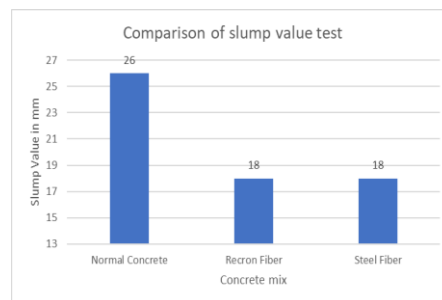


Fig: 1 Comparison of slump cone test

Fig. 1 The above fig shows the comparison of normal concrete, steel fiber reinforced concrete and recron fiber reinforced concrete. The average of each concrete mix design is taken to compare the slump value of specimens.

###### Dry density

Dry density is obtained by measuring the weight and volume of cubes, cylinders, beams, and push-off specimens. Results of dry density have been mentioned in the results are also shown in the figure.

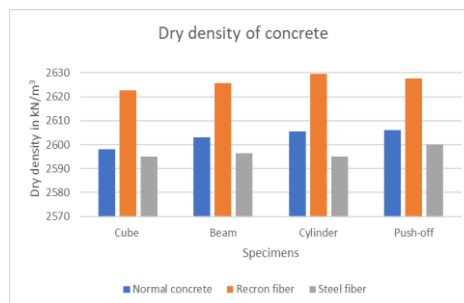


Fig: 2 Dry density of specimens

#### 4.2 Testing on hardened concrete

##### Cube compressive strength

The compressive tests were conducted as per I.S. (I.S.516-1959). Cube was subjected to a concentrated compressive force where failure under compression was expected to occur. A calibrated stiff CTM with capacity of 3000kN was used for testing of the cube specimen. The results obtained from this test are shown below.

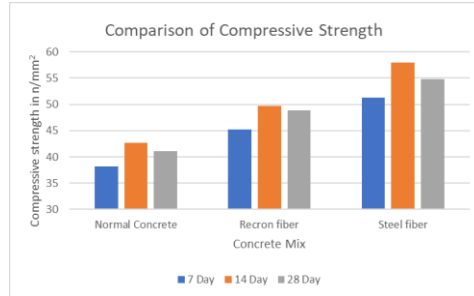


Fig.3. cube compressive strength

##### Flexural strength

The two-point bending beam tests were conducted on flexure specimens as per I.S. (I.S.516-1959). A calibrated flexural testing machine with a capacity of 600kN was used for testing of the flexure specimens and load was applied at the rate of 400kg/minute. The results calculated from the test are shown below.

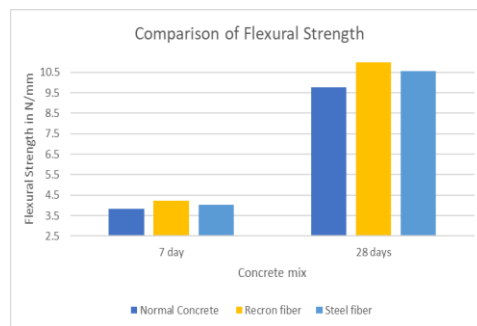


Fig.4. Flexural Strength

##### Split Tensile Strength

The split tensile test is well well-known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting direct tension tests, several indirect methods have been developed to determine the tensile strength of concrete. In this test generally, a compressive force is applied to concrete specimens in such a way that the specimens fail due to tensile stress induced in the specimen.

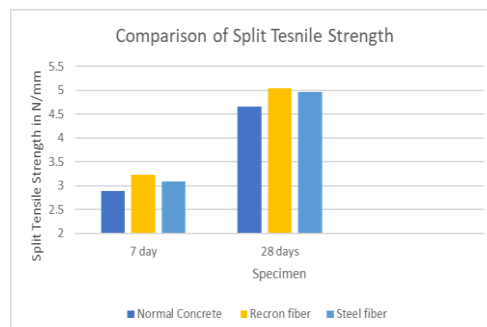


Fig.5. split tensile strength

### Direct shear strength

The shear transfer strength was studied using a push-off specimen with dimensions of 150 mm x 150 mm x 450 mm (Length x Width x Depth) with a shear plane length of 150mm. The 6 mm steel bar reinforcement was provided away from the shear plane to prevent failure other than the shear mode, All the specimens were tested in direct compression on the universal testing machine of 1000 Tonne capacity.

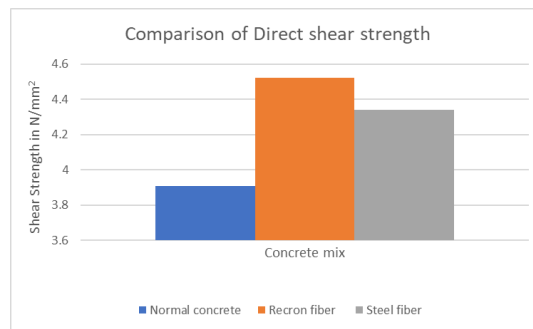


Fig:6. Direct shear strength

The above tests are performed on the fresh as well as hardened concrete. The results of all tests performed on the specimens with 0.75% of recron fiber and 1.5% of steel fiber. The results of all strengths are compared below.

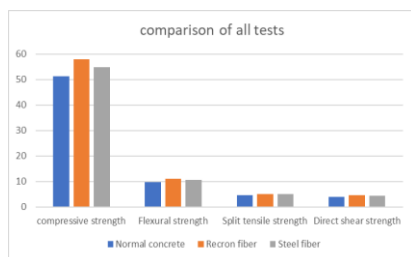


Fig:7. Comparison of all tests

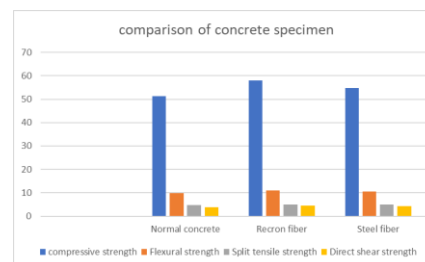


Fig:8 Comparison of concrete specimen

The strength parameters of normal concrete, recron reinforced concrete, and steel fiber reinforced concrete are compared above. This experimental study shows that the strengths are increasing in the case of recron fiber than normal concrete and steel fiber reinforced concrete. In compressive strength, the recron specimen increased by 13.19% for 28 days and steel fiber is increased by 7.01% compared to normal concrete. The flexural strength of recron fiber reinforced concrete strength is increased by 12.27% as compared to normal concrete, in steel fiber reinforced concrete it is increased by 7.87%. The split tensile is increased by 8.15% in recron fiber reinforced concrete and 6.43% increased in steel fiber reinforced concrete. The direct shear strength test results show an increasing percentage in recron at 16.15% and in steel fiber at 11.29%.

### 4.3 Cost analysis

As the main component of any structure is concrete, it creates a great impact on the cost of construction and determines whether the structure is economical or not. In this study, we are also performing the cost analysis of these concrete with various percentages of fibers. Our experimental study concluded that compressive strength with recron fiber reinforced concrete is 13.19% increased and steel fiber reinforced concrete 7.01% increased which can create a huge impact on the final cost per m<sup>3</sup>. And one of the objectives of this study is to use the optimum use of fibers and obtain maximum strength which are compressive strength, Flexural strength, and Split tensile strength.

The strength is increasing at 0.75% of recron fiber so it is decided to perform a cost analysis for this concrete, to check whether the recron fiber reinforced concrete is economical or not.

Table: 4 Cost analysis after the replacement of cement

Concrete mix	Grade of concrete	compressive strength (28 days)	Percentage increase	Cost	Cost increased
Normal Concrete	M40	38.18	-	4768	-
13.19 % replacement	M35.8	38.37	0.50%	4542	-4.73
10% replacement	M36	38.89	1.86%	4557	-4.43
5% replacement	M38.05	37.77	-1.08%	4962	4.06%

## V. CONCLUSION

The following conclusions are drawn from the results and discussion of this investigation are as follows

1. From results it is observed that the compressive strength of recron fiber reinforced concrete is greater than steel reinforced concrete. The study showed that compressive strength is increased by 13.19% after 28 days.
2. The workability of the fiber-reinforced concrete has been found to decrease with an concentration of recron fiber in the concrete mix.
3. Study of conventional concrete mix blended with recron fiber is showed 12.27% increment in flexural strength as compare to normal concrete.
4. Usage of recron 3s fibers will reduce the cost of maintenance by reducing the micro-cracks and hence the durability will increase. It is found that the use of recron 3s fiber reduces the segregation.
5. Study showed the split tensile strength is increasing by 8.15% for the recron fiber, as the recron have tensile strength more than 6000 Mpa where steel fiber has 1100 Mpa tensile strength.
6. Direct shear on the push-off specimen in recron reinforced concrete showing better results.the direct shear strength is increased by 16.15% as compared to other concrete mixes.
7. As the cement is replaced by the recron fiber with 0.75%, the grade of concrete will change because of a reduction in cement content. When we replace cement by 13.19% it will give us an M35.8 grade to achieve the M40 grade strength at 28 days. Similarly for 10% grade is M36, and for 5% it is M38.05.

## REFERENCES

- 1] Burcu Akcay and Mehnat ali Tasdemir (2012), "Mechanical behavior and fiber dispersion of hybrid steel fiber reinforced self-compacting concrete" Construction and Building Materials, vol. 28, Issue 1, pp. 287-293.
- 2] Naser S. Alimrani, Gyorgy L. Balazs, and Nabil Abdelmelek (2022), "One-Year Push-Off specimens using cocktail and polymeric fibers at elevated temperatures", volume 41 pp. 128-138.
- 3] Falah A. Almottiri (2011), "Physical Properties of Steel Fiber Reinforced Cement Composites Made with Fly Ash", Jordan Journal of Civil Engineering, vol no 5, issue no 2.
- 4] Mingke Deng, Jian Han, Haibo Liu, Meng Qin, and Xingwen Liang (2015), "Analysis of Compressive Toughness and Deformability of High Ductile Fiber Reinforced Concrete", Volume no 2015.
- 5] Suchita Hirde and Pravin Gorse, (2015) "Effect of Addition of Ground Granulated Blast Furnace Slag (GGBS) on Mechanical Properties of Fiber Reinforced Concrete", International Journal of Current Engineering and Technology, volume no 5, Issue no 3.
- 6] M.Prabu, I.Mohammedrafi, M.Sathees Kumar (2019), "Experimental Investigation on Concrete Using Recron Fiber as Reinforcement", International Journal of Innovative Research in Science, Engineering, and Technology, vol no 8, Issue no 3.
- 7] Nafisa tabassum, jonayed kaiser saourav, Md saiful Islam & Md. Moinul (2014), "A study on the strength characteristics of steel fiber reinforced concrete".
- 8] Nirmala D. B and Akshay Angadil (2023), "Experimental study on concrete by adding polyester fibers", "Slovak Journal of Civil Engineering" Volume no 31, Issue No 3.
- 9] Ashuvendra Singh (2017), "Experimental Study On Light Weight Fiber Concrete Using Pumice Stone As Partial Replacement Of Coarse Aggregate" Volume no 6, Issue no 6.
- 10] Neville, A. M. Properties of concrete, ELBS edition of 3<sup>rd</sup> edition, longman scientific and technical publication.Longman group limited, UK.
- 11] Ghadge Nikhil, Vidhale S. S. (2013) Mix design of fiber reinforced concrete using slag and steel finer."International Journal of Modern Engineering research. Vol 3, Issue-6.



- 12] Miloud B. (2005), "Permeability and porosity characteristic of steel fiber Reinforced concrete" Asian Journal of Civil Engineering ( Building and Housing) Vol-6, Issue-4 pp 317-333
- 13] Osman unal, Faut Demir, Tayfun Uygunoglu (2006) "fuzzy logic approach to predict stress strain curve of steel fiber reinforced concrete in compression" Building and Environment, Vol-42, pp. 3589-3595
- 14] Thomas Job, Ramaswami Anath (2007), "Mechanical properties of steel fiber reinforced concrete," Journal of Material in Structural Engineering, Vol-19, Issue-5. Pp 385-392.
- 15] IS 10262:2019, "Indian Standard Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi.
- 16] IS 12269 (1987), "Specification For 53 grade Ordinary Portland Cement", Bureau of Indian Standard, New Delhi.
- 17] IS 383 (1970), Specification Of coarse And Fine Aggregate From Natural Sources For Concrete", Bureau Of Indian Standards, New Delhi.
- 18] Korrapati Anil Kumar, Dr. Shaikh. Yajdani, Ganta Shanmukha Rao," Study on Properties of Concrete using Recron Fiber", International Journal of Science Technology & Engineering, Vol-4, Issue-3.
- 19] Rambalbha Gouda, Raghvendra Sahu," Study on the Behavior of various mineral admixtures And Recron fiber in Concrete", International Research Journal of Modernization in Engineering Technology and Science", Vol-4, Issue-7.
- 20] Ridhi Nehvi, Prashant Kumar and Umar Zahoor Nahvi, "Effect of different percentages of polypropylene fiber (Recron) on the compressive, Tensile and Flexural Strength of Concrete", International journal of Engineering Research & Technology, 2016, Vol.5, Issue 11.



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