



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VI **Month of publication:** June 2026

DOI: <https://doi.org/10.22214/ijraset.2026.83591>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

An Analytical Study of Hybrid Fibre Reinforced Concrete

Mohammed Osama, Hemant Sood

PG Scholar, Construction Technology and Management, NITTTR, Chandigarh, India

Professor, Department of Civil Engineering, NITTTR, Chandigarh, India

Abstract: *The Concrete possesses high compressive strength but exhibits low tensile strength and brittle failure characteristics. Hybrid Fibre Reinforced Concrete (HFRC) offers an effective solution by combining two different fibres to enhance strength, ductility, and durability. This study investigates the mechanical and durability properties of M40 grade HFRC incorporating galvanized steel fibres and glass fibres in varying proportions. Six concrete mixes were prepared with a total fibre content of 3% by weight of cement. The combinations investigated were S0G0, S3G0, S2G1, S1.5G1.5, S1G2, and S0G3. Experimental investigations included compressive strength, flexural strength, ultrasonic pulse velocity (UPV), permeability, dynamic modulus of elasticity, and dynamic Poisson's ratio. Results indicate that hybridization of steel and glass fibres significantly improves the mechanical performance and durability of concrete. The optimum performance was observed in the S2G1 and S1.5G1.5 mixes, which exhibited enhanced compressive strength, flexural strength, reduced permeability, and superior crack resistance. The study demonstrates the effectiveness of hybrid fibre systems for high-performance concrete applications.*

Keywords: *Hybrid Fibre Reinforced Concrete, Steel Fibre, Glass Fibre, Compressive Strength, Flexural Strength*

I. INTRODUCTION

A composite fibre reinforced concrete enhances the compressive stress, strain and flexure and splittensile strength of concrete. Fibers are also acting as crack arrestor and reduce the propagation of cracks in concrete. Hybrid Fiber Reinforced Concrete (HFRC) is formed from a combination of different types of fibers, which differ in material properties, remain bonded together when added in concrete and retain their individuality and properties. The function of steel fiber to enhance the strength of concrete in fiber reinforced concrete under compression and flexural strength and glass fibre reduce the brittleness also act as a crack arrestor. So the combination of two different nature of fiber shows better prospect for hybridization. HFRC can sustain large degree of deformation. For comparative evaluation of performance, six different types of sample and 9 different types of specimens for each sample will be prepared and tested under UPV, compression and flexural strength. M40 grade concrete will be prepared, among six samples first sample S0C0 is prepared with without fibre and others samples are made with the fraction of steel is 3%, 2%, 1.5%, 1%, & 0% and respectively glass fibre in the same sample is 0%, 1%, 1.5%, 2%, & 3%. Combined fraction of fibre in concrete is kept 3% by the weight of cement. Here the numbers show the fraction of fibre in percentage by the weight of cement.

II. LITERATURE SURVEY

- 1) The reviewed literature indicates that the incorporation of fibers significantly improves the mechanical and durability properties of concrete. Various researchers have investigated the effects of steel fibers, polypropylene fibers, plastic fibers, natural fibers, and hybrid fiber systems on concrete performance.
- 2) Studies by G. Ruby Selina and Geethanjali (2014), Rajarajeshwari Vibhuti et al. (2013), and Patodi and Kulkarni (2012) demonstrated that hybrid fiber reinforced concrete provides superior compressive, tensile, and flexural strength compared to single-fiber concrete. The combination of different fibers effectively delays crack propagation and enhances structural integrity.
- 3) Research conducted by Vasudev and Vishnuram (2013), Shahidan (2009), Nataraja (2002), Dwarakanath and Nagaraj (1991), and Otter and Naaman (1988) revealed that steel fibers significantly improve compressive strength, tensile strength, toughness, and crack resistance. Most studies reported optimum performance at fiber contents ranging from 0.5% to 1.0%, beyond which strength gains tend to diminish.
- 4) Investigations by Nibudey and Nagarnaik (2013) and Andic (2014) showed that plastic and synthetic fibers improve strength characteristics and durability while contributing to sustainable construction practices. Natural fibers such as coconut fibers were found to enhance toughness, tensile strength, and energy absorption capacity, although excessive fiber content may reduce workability and compressive strength.

Several researchers also observed that increasing fiber volume fraction and aspect ratio generally improves strength properties up to an optimum level, after which performance may decline due to poor workability and fiber clustering. Hybridization of fibers was consistently reported to provide better crack control, ductility, and long-term durability.

Research Gap

In the previous research mostly experiment was done with single fibre reinforced concrete and some beneficial outcome was appeared. Each fibre has different property by which they can enhance the quality of concrete. Some fibres have less modulus of elasticity than cement matrix such as nylon, coir, sisal etc. On other hand some fibres have more modulus of elasticity than cement matrix like steel asbestos, glass etc. So the ideas are to blend two different natures of fibres and added to concrete mix then observe the results. It is expected to improve the following property of concrete by hybridization of fibre in concrete.

- Enhancing compressive & flexure strength.
- Reducing the brittleness of concrete.
- Utilizing the fibres as a crack arrestor.

III. OBJECTIVE OF THE WORK

- 1) To find out effect on compressive and flexural strength of M40 grade concrete by variation in percentage of isolated fibres.
- 2) To evaluate the compressive and flexural strength of HFRC (M40 GRADE CONCRETE) using predetermined combination of composite fibres.

IV. METHODOLOGY

The following materials are used for the preparation of hybrid fiber reinforced concrete.

- 1) Portland Pozzolan cement (PPC)
- 2) Fine aggregate (FA)
- 3) Coarse aggregate (CA)
- 4) Galvanized Steel fiber (GSF)
- 5) Glass Fibre (GF)

Various tests were conducted on cement, fine aggregate, coarse aggregate.

Preparation of mix design of M40 grade concrete. 6 Cubes and 3 beams were casted with control mix using natural aggregate.

First sample S0C0 is prepared without fibre and others samples are made with the fraction of steel is 3%, 2%, 1.5%, 1%, & 0% and respectively glass fibre in the same sample is 0%, 1%, 1.5%, 2%, & 3%. Workability tests, compressive strength, tensile strength of concrete were conducted.

V. MATERIAL TEST

Table-1: Material Testing Results

Test	Material	Equipment used	Values obtained
Specific gravity	PPC	Density Bottle	2.984
Initial setting time	PPC	Vicat apparatus	80 mins
Final setting time	PPC	Vicat apparatus	498 mins
Specific gravity	Fine aggregate	Pycnometer	2.62
Specific gravity	Coarse aggregate	Pycnometer	2.8
Water absorption	Coarse aggregate	Oven Dry Method	0.7 %
Workability	M340 Concrete	Slump cone apparatus	100mm

VI. MIX DESIGN

Table-2:M40MixProportioning

Cement(Kg/m3)	450
Fineaggregate(Kg/m3)	617.6
Coarseaggregate(Kg/m3)	1197.88
Water(li/m3)	183.06
Watercementratio	0.4

Mixratio1:1.37:2.60:0.37

VII. EXPERIMENTAL INVESTIGATION

A. Test Procedure

For concretetestspecimensconsistof150x150x150mmcubes and beams of 100x100x500mm . Compressive strength was obtain on the basis of concrete cube specimen tested at 7 and 28 and for flexure strength beams specimens were tested at 28 day.

B. Test on fresh concrete

On fresh concrete, workability testapply to check the affects of concrete strengthanddurabilityaswellasthe appearanceof thefinishedproduct. For easily placed and well compacted in homogeneously without bleeding and segregation concreteis to be well workable. In this work the workability of concrete is measured by slump test.

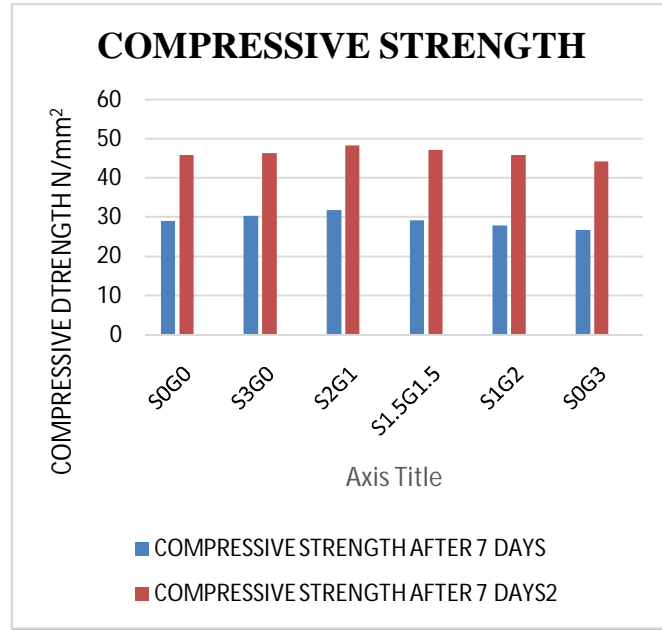
C. Testonhardened concrete

To ensure the design strength of hardened concrete various test is to be done and quality of concrete construction is achieved. It includes compressive strength test,flexuraltensilestrengthtest,strengthtest and modulus of elasticity

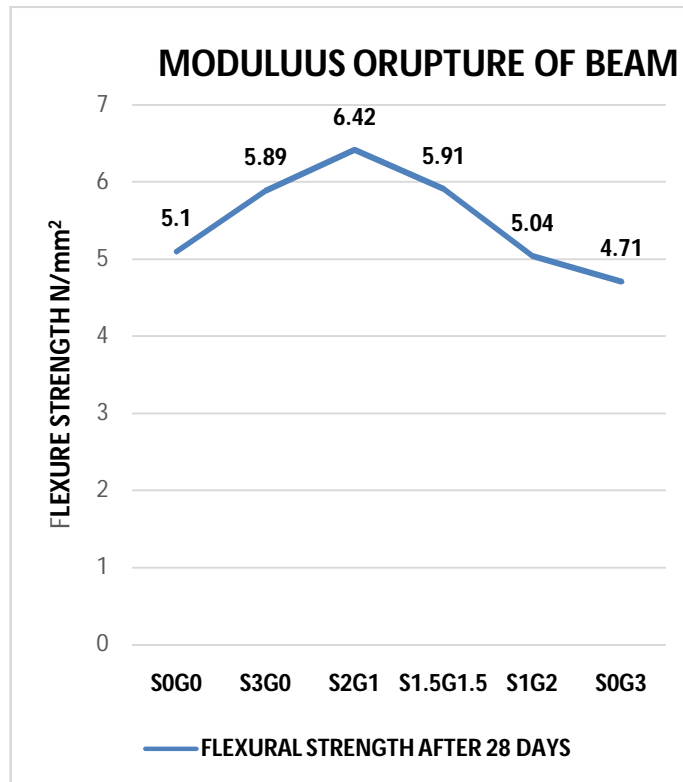
VIII. EXPERIMENTAL RESULTS AND DISCUSSION

Table-3: Mean Compressive Strength test and flexural strength result

Sample	Specification	Mean Compressivestrength (N/mm ²)		Mean Flexure Strength (after 28 days) (N/mm ²)
		7 days	28 days	
Sample I	S0G0	28.95	45.82	5.10
Sample II	S3G0	30.27	46.36	5.89
Sample III	S2G1	31.75	48.32	6.42
Sample IV	S1.5G1.5	29.26	47.08	5.91
SampleV	S1G2	27.93	45.85	5.04
SampleVI	S0G3	26.70	44.15	4.71

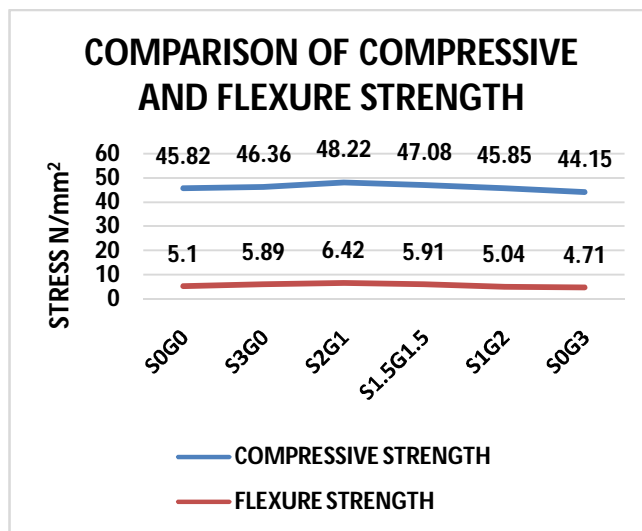


Flexural strength of concrete beam has calculated at the age of 28 days of curing shown in below table. It is represented in the form of modulus of rupture. Flexural strength of a beam is found maximum in sample III which contains 2.0% steel and 1.0% glass fibre. There is 18.91% increment as compare to non-fibrous concrete beam. It is analyze from the result the flexural strength decreases by increasing the glass fibre.



IX. COMPARISON BETWEEN FLEXURAL STRENGTH AND COMPRESSIVE STRENGTH

The relation between flexural strength and compressive strength is established. Representation of graph shows straight line relationship between the compression and flexural strength. The sample has lower compressive strength also shows lower flexural strength and increases with the increasing the corresponding value.



X. CONCLUSIONS

The outcomes of experimental results, the 28 days compressive strength of the sample III S2G1 with 2% steel fibre and 1% glass fibre content is found optimum. The compressive strength of S2G1 is found +5.23% greater than sample without fibre S0G0. Inclusion of 1% glass fibre also gives the good result but by increasing the glass fibre more than 1%, decreases the compressive strength and least compressive strength is found at the sample VI which contains maximum 3% glass fibre and 0% steel fibre. Only steel fibre also gives good result in compression. The sample contains 3% steel fibre has +1.18% greater compressive strength than sample S0G0.

In the case of flexural strength after 28 days, sample III S2G1 contains 2% steel fibre and 1% glass fiber has +25.88% greater flexural strength than sample S0G0. Two other samples, S3G0 & S1.5G1.5 also shows the growth in flexural strength as compared to S0G0 this increment is +15.5% & +15.88% respectively. But further increment in percentage of glass fibre reducing the flexural strength of concrete.

XI. SCOPE FOR THE FUTURE WORK

In this research it was studied how hybrid fibres improve the inbuilt property of concrete by means of compressive strength and flexural strength. Here five different fractions of fibres were implemented. This work can be proceeded by extension of experimental investigation so other properties of hardened concrete such as impact resistant, split tensile strength, propagation of cracks can be investigated.

After the testing of specimens it is observed in sample S0G0, S3G0, S2G1, the results are improving or stable in the higher fraction of steel fibre with the partial combination of glass up to a limit of 1.0% by the weight of cement. But further increment in glass fibre and decrement in steel fibre adversely affect the strength of specimen. Both the compression and flexural strength reduces for the sample S1G2, S0G3. So the new investigation can be done for the higher fraction of steel fibre beyond 3% and the fraction of glass is kept limited up to 1.0% by the weight of cement.

REFERENCES

- [1] A.Thakur and H. Sood, 'Study of Strength Properties of Hybrid Fiber Sisal/Polypropylene Reinforced Concrete using Ppc', International Journal for Research in Applied Science & Engineering Technology, vol. 5, pp. 1770-1777, 2017.
- [2] S. Maqbool and H. Sood, 'Effect of PET Fibers on the Mechanical Properties of Concrete', SSRG International Journal of Civil Engineering, vol. 3, no. 12, pp. 1-6, December 2016.
- [3] B.Rajrajeshwari Vibhuti, Radhakrishna, Aravind N (2013) "Mechanical properties of hybrid fibre reinforced Concrete for pavements"
- [4] S. C. Patodi, & C. V. Kulkarni (2012) "Performance Evaluation Of Hybrid Fiber Reinforced Concrete Matrix. International Journal of Engineering Research and Applications Vol. 2, Issue 5, September- October 2012, pp.1856-1863
- [5] G Selina Ruby, C. Geethanjali (2014) "Influence of hybrid fibre on reinforced concrete"
- [6] R. Vasudev, and B.G.. Vishnuram (2013) Studies on Steel Fibre Reinforced Concrete – A Sustainable Approach.
- [7] Mohammad Adnan Farooq, Dr Mohammad Shafi Mir (2013) "Laboratory characterization of steel fibre reinforced concrete for varying fibre proportion and aspect ratio" International Journal of Emerging Technology and Advanced Engineering, pp 2250-2459, Volume 3, Issue 2, February 2013



- [8] M.Natraj(2002) "Fiberreinforcedconcrete-behaviourpropertiesandApplication"
- [9] Shetty,M.S,"ConcreteTechnologyTheoryandPractices",S.Chand&Company,New Delhi.
- [10] IS516:1959,"MethodofTestsforStrengthofconcrete",BureauofIndianStandard, New Delhi.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)