JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL STUDY ON PERFORMANCE OF MECHANICAL PROPERTIES OF CONCRETE USING HYBRID FIBER (JUTE & STEEL)

P. Easwaran[1], M. Dharani[2], G. Kavishre[2], D. Keerthiga[2], M. Subarahavi[2]

1. Assistant Professor of Civil Engineering, Vivekanandha College of Technology for Women

2. Students of Vivekanandha College of Technology for Women

ABSTRACT – The performance required for concrete structures are more complicated. It is shown that the concrete is the most commonly used material in the world for the engineering works. Especially high strength concrete is nowadays very well utilized in many aspects. In this study the steel fiber and jute fiber is used as hybrid fiber in concrete. With the different percentage of steel fiber and jute fiber has been used in concrete mix. Steel fiber and jute fiber having length of 5cm and different percent by weight of concrete are 0.00% (conventional) 0.5%, 1%, 1.5% were added to prepare concrete cubes, prism and cylinder. The compressive strength, flexural strength and split tensile strength has carried out for the different mix proportions of steel fiber and jute fiber. The result shows that the increase and decrease in the compressive strength and the flexural strength of concrete with the different mix proportion.

Keywords - Jute fiber, steel fiber, Slump cone test, compressive strength, Flexural strength and Split tensile strength.

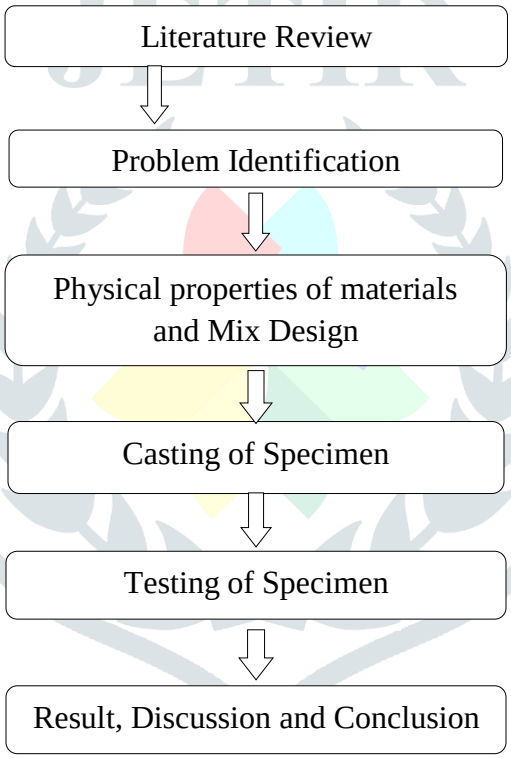
1. INTRODUCTION

In recent years, the quest for enhancing the mechanical properties and durability of concrete has led to the exploration of various additives and reinforcement. Among these, both jute fibers and steel fibers have gained significant attention due to their district characteristics and potential benefits in concrete composites.

Jute fibers is natural and biodegradable fiber, derived from the natural bast of the jute plant which grow in 2.5m long with diameter of base of the stem around 25mm, offer an eco-friendly alternative to synthetic fibers. The jute is locally available in Bangladesh and less expensive. It improves the compressive, tensile, flexural strength, crack control moreover enhances the durability. It is lightweight have good flexibility and can be easily mixed with concrete. The primary benefits of using jute fiber in concrete is its ability to mitigate cracking. It helps to distribute stresses more evenly throughout the concrete matrix, reducing the formation and

propagation of cracks. This is particularly beneficial in applications where concrete is exposed to drying shrinkage, temperature fluctuations, or external loading enhance the flexural strength of concrete, making it more resistant to bending and tensile stresses. Incorporating Jute fibers into concrete improves its durability by reducing the risk of Cracking and deterioration over time. Jute fibers help minimize water penetration and chloride increase. Workability of concrete Mixes by jute fiber acting as a dispersing agent and reducing segregation and bleeding. In addition to Hooked end steel fibers are commonly used as reinforcement in concrete to improve its mechanical properties to change the result in significant load carrying capacity after the concrete has cracked. It helps to prevent the shrinkage and expansions that might occur due to the effect of high temperature and formation of cracks in the cement paste, increase the toughness and durability. They are often used in applications such as industrial floors, pavements, and precast elements, where improved durability and strength are required. The hooked ends of the fibers provide a mechanical bond with the concrete matrix, improving their effectiveness in reinforcing the concrete Finally, the use of hooked end steel fibers can lead to more durable and resilient concrete structures, especially in high-performance applications.

2. METHODOLOGY



3. MATERIAL PROPERTIES

The different materials are used to making a good concrete. The proper determination of material gives the good performance of concrete such as control cracks, improve the impact resistance and durability. In this research, the mix of M20 grade of concrete is calculated.

3.1 Cement

Ordinary Portland Cement (OPC) of 53 grade was used as binding material with the reference of IS 12269:1987. It was classified into 33 grade, 43 grade, 53 grade. The 53 grade of **JSW** cement is used in this

experiment. It attain compressive strength of 53 Mpa after 28 days of curing and each cement bag contains 50 kg. It helps to achieving higher early and ultimate strength compare to lower grade cement.

Table 1 - Cement Properties

S.NO	PHYSICAL PROPERTIES	VALUE
1.	Initial setting time	1 hours
2.	Final setting time	6 hours
3.	Consistency test	28 %

3.2 Fine Aggregate

M- Sand is used as fine aggregate. It is produced by crushing rocks to required grain size like granite, basalt or limestone. The particles generally in the range of 75 microns to 4.75mm sieve as per IS 383:1970. It helps to filling the voids in concrete due to coarse aggregate by using fine aggregate.

Table 2 - Fine Aggregate Properties

S.NO	PHYSICAL PROPERTIES	VALUE
1.	Specific gravity	2.8
2.	Fineness modulus	2.78
3.	Bulk density	1.803 kg/m^3

3.3COARSE AGGREGATE

The coarse aggregate obtained from crushed stone, gravel in the quarries. The particles sizes are passed in 20mm and retained in 16mm sieve as per IS 383:1970. It reduce the shrinkage and cracking by providing internal support and resisting external loads. Furthermore it makes a concrete strong and durable.

Table 3 - Coarse Aggregate Properties

S.NO	PHYSICAL PROPERTIES	VALUE
1.	Specific gravity	2.75
2.	Fineness modulus	7.65
3.	Water Absorption	0.6 %

3.4 WATER

Water plays a crucial role in concrete both during mixing and curing phases. Water is needed to hydrate the cement particles, initiating the chemical reaction that binds the ingredients together and forms the hardened concrete matrix. The water-to-cement ratio is carefully controlled to ensure proper hydration and strength development. Additionally, water facilitates workability, aiding in the placement and consolidation of concrete, excessive water can lead to decreased strength and durability, so precise control of water content is essential for optimal concrete performance.

3.5 JUTE FIBER

The natural fibers are used in the concrete mix to provide the more compressive strength and also provide some tensile strength. The use of natural fiber is taken on consideration as an economic aspects. Improve compressive strength, tensile strength, flexural strength, toughness, ductility and fracture mechanism of hardened concrete.

Table 4 - Jute Fiber Properties

S.NO	PHYSICAL PROPERTIES	VALUE
1.	Length	50 mm
2.	Diameter	0.5 mm
3.	Specific gravity	1.35

3.6 STEEL FIBER

Among the different type of fiber available in the market, hooked end steel fibers are the most used for structural applications because of their anchorage mechanisms, together with their length and tensile strength, offers additional pull-out resistance and may further improve the performance of the structural element, compared to smooth fiber.

Table 5 - Steel Fiber Properties

S.NO	PHYSICAL PROPERTIES	VALUE
1.	Length	30 mm
2.	Diameter	0.5 mm

3.7 ADMIXTURE

Chryso admixture is a type of chemical additive used in concrete to improve its performance and properties. It can enhance workability, durability, strength and reduce water content among other benefits. Chryso admixture are often used in various construction projects to achieve specific performance requirements for the concrete mix.

4. MIX DESIGN

Mix design is a process of finding right proportion of cement, fine aggregate, coarse aggregate for concrete to achieve target strength. It involves various steps, calculations and laboratory testing to find mix proportions. The mix design has been done for the concrete grade of M20.

EXPERIMENTAL WORK

The experiment was carried out for the M20 grade of concrete. The test on fresh concrete was slump cone test and the tests on hardened concrete were like Compressive Strength, Split Tensile Strength and Flexural Strength performed for the different fiber content percentage. The mix proportions for different fiber content as shown in given below.

Table 6 – Mix Proportions

Mix proportion	% of steel fiber	% of jute fiber
Trial 1	0	0
Trial 2	0.5	0.5
Trial 3	1	1
Trial 4	1.5	1.5

5. RESULTS

5.1 COMPRESSIVE STRENGTH

The compressive strength test is carried out for cubes at 7, 14 and 28 days. The size of concrete cubes are 150mm x 150mm x 150mm. The cubes with the different fiber percentage content were tested. Two specimens from each batch should be prepared for testing. Specimens were placed in compressive testing machine and load gradually applied on the specimen axially. The load continuously increased until the specimen reach its resistance. The maximum load can be noted and the compressive strength of the specimen should be determined. The compressive strength of concrete can be calculated by using the following formula:

Compressive strength (N/mm^2) = P/A

Table 7 – Compressive Strength of M_{20} Grade of concrete

Mixes	% of steel fiber	% of jute fiber	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
Trial 1	0	0	14.25	19.52	23.52
Trial 2	0.5	0.5	16.31	20.54	25.69
Trial 3	1	1	19.86	23.61	29.52
Trial 4	1.5	1.5	15.24	18.23	24.72

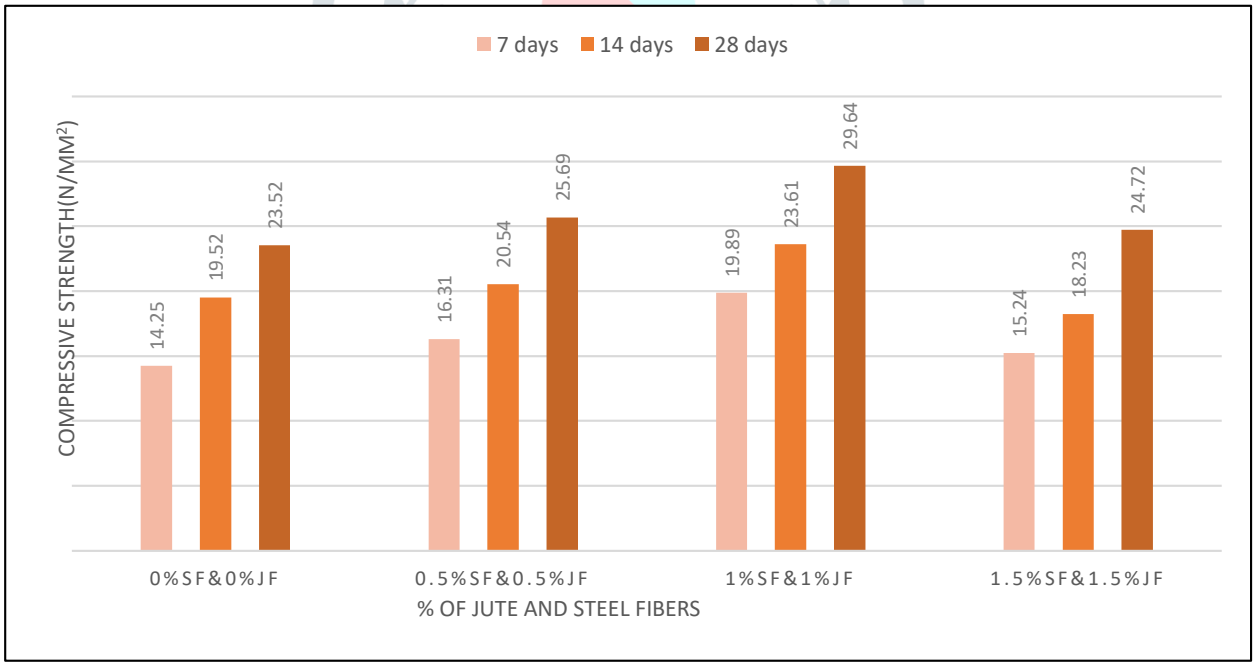


Fig 1. Compressive Strength for M_{20} Grade of Concrete

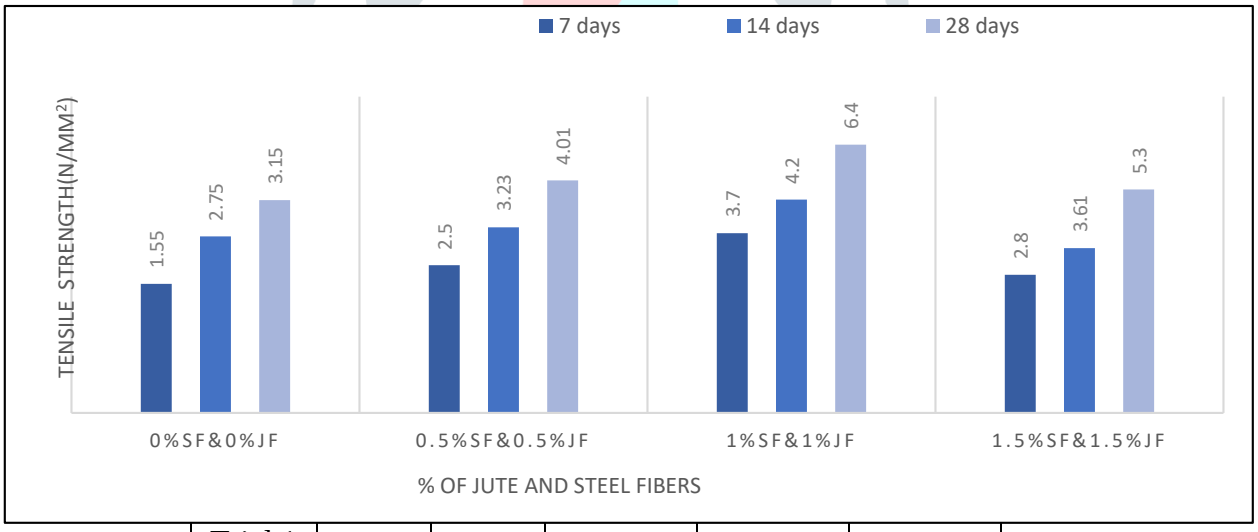
5.2 SPLIT TENSILE STRENGTH

The Split tensile strength test is carried out for cylindrical specimen at 7, 14 and 28 days. The size of concrete specimens are 150mm x 300mm. The specimens with the different fiber percentage content were tested.

Tensile Strength of concrete

Table 8 – Split M_{20} Grade of

Mixes	% of steel fiber	% of jute fiber	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
Trial 1	0	0	1.55	2.73	3.15
Trial 2	0.5	0.5	2.5	3.23	4.01
Trial 3	1	1	3.7	4.2	6.4
Trial 4	1.5	1.5	2.8	3.61	5.3



Mixes	% of steel fiber	% of jute fiber	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
Trial 1	0	0	1.55	2.73	3.15
Trial 2	0.5	0.5	2.5	3.23	4.01
Trial 3	1	1	3.7	4.2	6.4
Trial 4	1.5	1.5	2.8	3.61	5.3

Fig 2. Split Tensile Strength for M_{20} Grade of Concrete

5.3 FLEXURAL STRENGTH TEST

The Flexural strength test is carried out for prism specimen at 7, 14 and 28 days. The size of concrete specimens are 100mm x 100mm x 500mm. The specimens with the different fiber percentage content were tested

.Table 9 – Flexural Strength of M_{20} grade of concrete

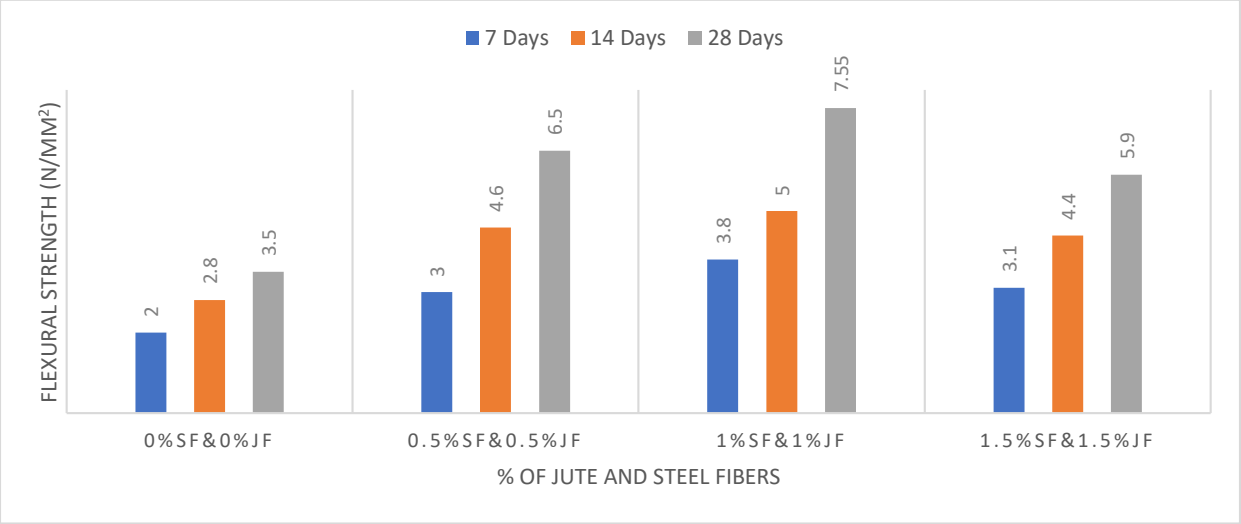


Fig 3. Flexural strength for M_{20} Grade of Concrete

6.

Mixes	% of steel fiber	% of jute fiber	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
Trial 1	0	0	2	2.8	3.5
Trial 2	0.5	0.5	3	4.6	6.5
Trial 3	1	1	3.8	5	7.55
Trial 4	1.5	1.5	3.1	4.4	5.9

CONCLUSION

- The slump test concluded that while increasing percentage of the fiber content, the slump value decrease which means that increasing fiber content reduces the workability.
- Compressive strength increases till the increasing of fibers at 1%SF-1%JF. At 1.5%SF-1.5%JF compressive strength of fiber concrete decreases.
- For flexural strength, strength increases as increasing the fiber content but till 1%SF-1%JF. More than this content gives no improvements.

- For Split tensile strength, strength increases as increasing the fiber content till 1%SF-1%JF and after that the strength decreases while increase in fiber content.

7. REFERENCES

1. J. Blunt, G. Jen, C.P. Ostertag "Enhancing corrosion resistance of reinforced concrete structure with hybrid fiber reinforced concrete" corrosion science 92 (2015) 182-191
2. Le Huang, Yin Chi, Lihua Xu, Ping Chen, Aoli Zhang " local bond performance of rebar embedded in steel – polypropylene hybrid fiber reinforced concrete under monotonic and cyclic loading. Construction and Building materials 103 (2016) 77- 92
3. S. Taner Yildrim, Cevdet E. and Fehim Findik "Properties of Hybrid Fiber Reinforced Concrete under repeated Impact Loads ". Published on (2010)
4. Mohamed Hechmi El Ouni, Ali Raza, Khaled Mohamed Elhadi, Marc Azab, Muhammad Arshad, Matiullah "Parametric Investigation of GFRP – RCC jute – fiber recycled aggregate concrete elements" structures 45 (2022) 1043- 1061
5. Vikrant S. Vairagade, Kavith S. Kene "Experimental Investigation on Hybrid Fiber Reinforced Concrete" International Journal of Engineering Research and Applications (JERA)ISSN:2248-9622(2012).