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[1.]T.V. Viswa TEJA, [2.]Ch. VINEEL

A COMPARITIVE STUDY ON PERFORMANCE OF SYNTHETIC AND NATURAL FIBERS ON COMPRESSIVE AND FLEXURAL STRENGTH OF CONCRETE

[1.] Civil Engineering, Anil Neerukonda Institute of Technology & Sciences (ANITS), Visakhapatnam, INDIA

Abstract: Ordinary concrete - a stone like structure which is formed by the chemical reaction of the cement, aggregate and water and is a brittle material which is strong in compression but very weak in tension, which causes cracks under small loads. These cracks gradually propagate to the compression end of the member and finally, the member breaks. These increase in size and magnitude with time and finally fails. One of the successful reinforcing methods is providing steel reinforcement but even then, cracks in reinforced concrete members extend freely. Thus, need for multidirectional and closely spaced steel reinforcement arises. Fiber reinforcement gives the solution for this problem. So, to increase the tensile strength of ordinary concrete a technique of introduction of fibers in concrete is being used. These fibers act as crack arrestors and prevent the propagation of the cracks, improves the post cracking response of the concrete, i.e., to improve its energy absorption capacity and apparent ductility, and crack control. The Present study focuses upon, Synthetic (Polypropylene) Fiber Reinforcement (SFRC) of 1% and 3% and Natural (Jute) Fiber Reinforcement (NFRC) of 1% and 3% by weight and are compared with respect to their compressive strength and flexural strength. The present study concludes considering the practical issue of workability of fibers, that in between synthetic and natural fibers selected, 1% Polypropylene fibers can be added as a reinforcement to ordinary concrete to enhance both compressive strength by nearly 2 times at 28 days curing duration and flexural strength by 35%% at 28 days curing duration.
Keywords: synthetic fibers, natural fibers, compressive, flexural, fiber reinforced concrete

1. HISTORY AND DEVELOPMENT

The use of fibers to increase the structural properties of construction material is not a new process. From ancient times fibers were being used in construction. In olden days, horse hair was used to reinforce mortar. Egyptians used straw in mud bricks to provide additional strength. Asbestos was used in the concrete in the early 19th century, to protect it from formation of cracks. But in the late 19th century, due to increased structural importance, introduction of steel reinforcement in concrete was made, by which the concept of fiber reinforced concrete was over looked for 5-6 decades. Later in 1939 the introduction of steel replacing asbestos was made for the first time. But at that period, it was not successful.

From 1960, there was a tremendous development in the FRC, mainly by the introduction of steel fibers. Since then use of different types of fibers in concrete was made. In 1970's principles were developed on the working of the fiber reinforced concrete. Later in 1980's certified process was developed for the use of FRC. In the last decades, codes regarding the FRC are being developed. According to terminology adopted by American Concrete Institute (ACI) Committee 544, there are four categories of Fiber Reinforced Concrete namely 1) SFRC (Steel Fiber Reinforced Concrete), 2) GFRC (Glass Fiber Reinforced concrete), 3) SNFRC (Synthetic Fiber Reinforced Concrete) and 4) NFRC (Natural Fiber Reinforced Concrete). It also provides the information about various mechanical properties.

— Advantages of Fiber Reinforced Concrete

- Temperature resistance
- Toughness
- Plastic shrinkage cracking

≡ Ductility
≡ Tensile and flexural strength

— **Disadvantages of Fiber Reinforced Concrete**

≡ In general, the fiber reinforcement is not a substitution to conventional steel reinforcement. The fibers and steel reinforcement have their own role in concrete technology.
≡ Fibers are not efficient in withstanding the tensile stresses compared to conventional steel reinforcements. But fibers are more closely spaced than steel reinforcements, which are better in controlling crack and shrinkage.
≡ The synthetic fibers are uneconomical.

— **Properties of Fiber Reinforced Concrete**

Apart from the factors that affect the properties of conventional concrete, fiber reinforced concrete is affected by following factors:

≡ Transfer of stress between matrix and fiber
≡ Aspect ratio
≡ Quantity of fiber
≡ Orientation and distribution of fibers

Transfer of stress between matrix and fiber:

≡ Modulus of elasticity of matrix must be lower than that of fiber for efficient stress transfer.
≡ Interfacial bonds also determine the degree of stress transfer.
≡ Bonds can be improved by larger area of contact, improving frictional properties and degree of gripping.

Aspect ratio:

Aspect ratio is defined as the ratio of length to width of the fiber. The value of aspect ratio varies from 30 to 150. Generally, the increase in aspect ratio increases the strength and toughness till the aspect ratio of 75.

Quantity of Fiber:

Generally, quantity of fibers is measured as percentage of cement content. As the volume of fibers increase, there should be increase in strength and toughness of concrete. In the present study, it is finalized to test for percentages of 1.0% and 3.0%.

Orientation and distribution of fibers:

Randomly dispersed discrete fibers orientation is chosen (d) and it depends on the method of adding fibers, the casting equipment used and the fresh concrete properties among others.

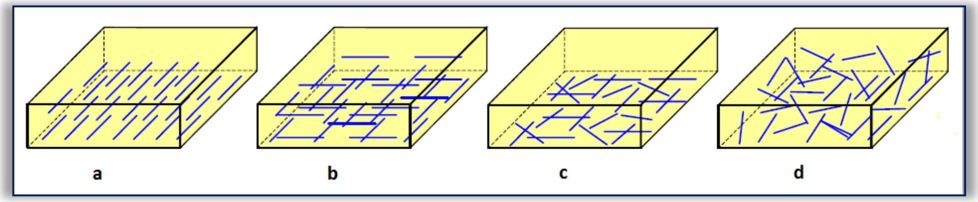


Figure 1. Distribution of different discontinuous fibers. (a) Biased 1-D fiber orientation, (b) Biased 2-D fiber orientation, (c) Plane random fiber orientation, (d) Random fiber orientation

A good fiber is the one which possess the following qualities:

≡ Good adhesion within the matrix.
≡ Compatibility with the binder, which should not be attacked or destroyed the concrete.
≡ An accessible price, taking into account the proportion within the mix.
≡ Being sufficiently short, fine and flexible to permit mixing, transporting and placing.
≡ Being sufficiently strong, yet adequately robust to withstand the mixing process.

— **Objective**

The present study focuses upon the compressive and flexural strength variations of concrete by addition of (1% and 3%) synthetic (Polypropylene) and natural fibers (Jute) and compare their strengths to ordinary concrete at different ages and conclude upon the suitability of fibers in perspective of their performance.

2. REVIEW OF LITERATURE

≡ Durability: A.L. Ardeshana et al (2012) expresses that addition of polypropylene fibers improved durability of concrete. The polypropylene fibers bridge the cracks and minimize interconnecting voids, this resulted in dense concrete. Therefore, this can be used for water retaining structures like water tanks, swimming pools, which ought to be designed as impermeable.

≡ Strength: Viswa Teja. T.V., and Vineel, Ch (2019) conducted investigations on Steel Fiber Reinforcement and Polypropylene Fiber Reinforcement of 1% and 3% by weight and compared with respect to compressive strength and flexural strength. The study concluded that 3% Steel fibers can be added as a reinforcement to ordinary concrete to enhance both compressive strength by 55% at 28 days curing duration and flexural strength by 60% at 28 days curing duration. L.N. Vairagade et al (2015) states that the inclusion of steel fiber in the concrete mix leads to an improvement in mechanical properties and a better resistance to heating effects. It also increases crack resistance to a high extent. The properties (flexural strength, tensile strength & compressive strength) of steel fiber reinforced concrete are superior to that of ordinary concrete. From his experimental work it was observed that the flexural strength increases for 0.75% and 1.5% of steel fibers in ordinary concrete whereas it decreases in case of 2%.

≡ Compressive behaviour of SFRC: Yu-Chen Ou et al (2012) conducted compression tests on SFRC cylindrical specimens and states that adding steel fibers had little effect on the modulus of elasticity or the compressive strength of SFRC.

≡ Economical consideration: M.A. Mansur et al (2015) expresses that the use of jute fiber reinforced concrete help to a great extent in providing low cost housing where jute fiber is abundant. Jute fiber reinforcement has more energy absorption capacity used in shatter and earth quake resistant construction.

≡ Load carrying capacity: Amit Rai et al (2010) states that plain concrete fails suddenly once the deflection corresponding to the ultimate flexural strength is exceeded, on the other hand, fiber-reinforced concrete continue to sustain considerable loads even at deflections considerably in excess of the fracture deflection of the plain concrete. Steel fibers reinforce concrete against impact forces, thereby improving the toughness characteristics of hardened concrete.

≡ Effect of Polypropylene Fiber on Properties of Concrete: Vinay Kumar Singh (2014) studied the effect of addition of polypropylene fiber in ordinary concrete. Addition of fibers in different percentages (0% to 0.7%) has been studied for their effect on strength properties of concrete. Results showed that the addition of polypropylene fiber (upto certain limit) to concrete exhibit better performance and has shown improvement in compressive strength and flexural strength to that of plain concrete. It is observed that the compressive strength of concrete and flexural strength of concrete increases with addition of fibers upto certain limit. Addition of 0.35% fibers into the concrete showed better results in compressive strength and addition of 0.25% fibers into the concrete showed better result in flexural strength. Also, it can be observed that 28 days compressive strength is increased by 2.44% with addition of 0.35% of fiber compared to Plain M-25 concrete. It can be observed that 28 days flexural strength is increased by 51.05% with addition of 0.25% of fiber compared to normal concrete.

3. TYPES OF FIBERS USED IN PRESENT STUDY

≡ Synthetic (Polypropylene) Fibers: The synthetic fibers have the advantage compared to steel fibers that they have a very high resistance to acidic and alkaline environment and thus do not require concrete cover to protect against corrosion. This also gives FRC with synthetic fibers a better aesthetical surface than FRC with steel fibers as the steel fibers at the surface will corrode and discolour the concrete when exposed to outdoor weather. An important negative aspect to the synthetic fibers is that they will soften at elevated temperatures and melt at about 150-160^{o}C, thus losing all their mechanical properties. This limits their use in structures where there is a risk of fire.

≡ Natural (Jute) Fibers: In developing countries, there has been an acute shortage of cheap but durable building materials for the construction of low-cost housing. The use of jute fiber reinforced cement composites may offer a possible solution in this respect.

— Mechanical Properties

The tensile strength of concrete improves by adding reinforcement fibers. This might enhance the concrete's toughness, ductility and energy absorption under impact and increase the post crack capacity when added in sufficient quantity.

The fibers can act in different ways, but mainly in two mechanisms:

≡ They can stop micro cracks from developing into larger cracks either from external loads or from drying shrinkage.

≡ Secondly, after cracking the fibers that span the cracks that have formed will give the concrete a residual load bearing capacity.

— **Compressive strength**

In the stress-strain relation for concrete in compression the concrete has got an almost linear response up to about 30% of the compressive strength. After this a gradual softening happens up to the concrete compressive strength, where the stress-strains relation exhibits a strain softening until failure by crushing. The main explanation of the concrete's macroscopic behaviour during compressive failure is proposed by Neville (1997). This explanation states that there are interfaces between the aggregate and the hardened cement paste, and that in these interfaces micro cracks develop even at smaller load levels. These cracks develop through the weakest part of the concrete (the cement is less strong and stiff than the aggregate for normal-strength concrete, but in high-strength concrete these are more equal), and eventually result in crushing.

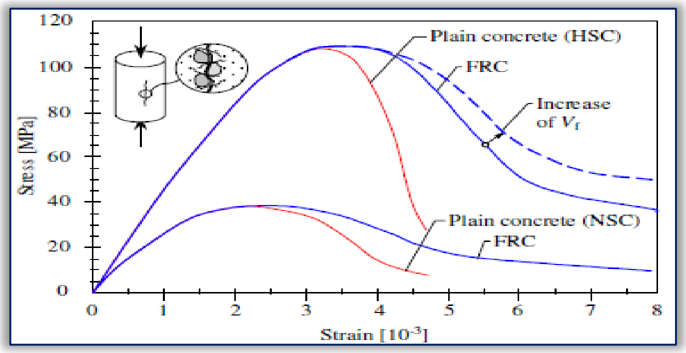


Figure 2. Behaviour of Standard concrete and FRC in compression

When fibers are added to the ordinary concrete it becomes more ductile and increase the resistance against longitudinal crack growth. The effect of fibers on concrete compressive strength is highly dependent of the fiber type, their size and properties, the amount of fibers added and the properties of the matrix.

— **Tensile strength**

The important effect of fibers on concrete tensile strength is on the tensile fracture behaviour. In normal concrete the tensile load carrying abilities of the concrete will decrease a lot after crack widths of about 0.3 mm. The FRC will be able to carry considerable loading after cracking. After the initial cracking has started, the fibers across the cracks will often be able to carry more load than other weak zones in the matrix. Therefore, new cracks will continue to form in the brittle matrix. When many cracks have formed the fibers will have plastic deformations by being drawn out of the concrete matrix. The ultimate failure will happen when the fibers get completely drawn out of the concrete. This way the FRC will have a much more ductile behaviour than regular concrete and will have some residual capacity after the stress-strain diagram has reached its peak.

— **Materials Used**

In the present study, grade of concrete considered is M 20 (1:1.5:3) with a water cement ratio of 0.5.

Figure 3. Polypropylene fibers

Figure 4. Jute fibers

≡ Cement: Ordinary Portland cement (OPC) is by far the most important type of cement. The OPC was classified into three grades namely 33 grade, 43 grade and 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. Ordinary Portland cement of 53grade is used in this project work.

≡ Fine aggregates: It should be passed through IS Sieve 4.75 mm.

≡ Coarse aggregates: It should be hard, strong, dense, durable and clean. It must be free from adherent coatings and injurious substances. It should be roughly cubical in shape. Flaky pieces should be avoided.

Table 1. Properties of polypropylene fibers

S. No.	Property	Value
1	Cut Length	12mm
2	Effective Diameter	25 – 40 microns
3	Specific Gravity	0.90 – 0.91
4	Melting Point	160-165°C
5	Young's Modulus	>4000MPa
6	Alkaline Stability	Very good

≡ Water: Water should be free from acids, oils, alkalis, vegetables or other organic impurities.

— **Testing Setup under Present Study**

≡ **Cubes**

To study the compressive strength of concrete, 12 cubes of 150 mm size for each type of concrete were cast. 150 mm cube moulds were filled with concrete and placed on table vibrator and vibrated for 1 minute, after the compaction was completed, the surfaces of the cubes are levelled with a trowel and were marked for identification. These specimens were demoulded after 24 hours of casting and cured in water for required age.

≡ **Prisms**

To study the flexural strength of concrete, 12 prisms of 500 mm X 100 mm X 100 mm size for each type of concrete were cast and compacted. These specimens were demoulded after 24 hours of casting and cured in water for required age.

≡ **Curing of specimens**

After the specimens were demoulded, these were stored under water at room temperature until tested at curing periods of 7, 14, 21 & 28 days.

Figure 5. Cube mould

Figure 6. Prism mould

Figure 7. Specimens in curing tank

Table 2. Specimen details for Testing Procedure

S. no.	Type of Concrete	Cubes	Prisms
1	SFRC with 1% & 3% (Polypropylene fibers) (M20 Grade)	36 (1%) + 36 (3%) (9 each for 7days, 14 days, 21days and 28 days curing period)	36 (1%) + 36 (3%) (9 each for 7 days, 14 days, 21 days and 28 days curing period)
2	NFRC with 1% & 3% (Jute fibers) (M20 Grade)	36 (1%) + 36 (3%)	36 (1%) + 36 (3%)
3	Ordinary/Conventional Concrete (M20 Grade)	36	36
Total		180	180

— **Testing of Specimens**

After curing period, specimens were taken out of curing tank and tested for compressive and flexural strength of concrete.

— **Compression test**

Compressive strength of the concrete = (maximum load) / (Cross-sectional area)

The average value of the specimens tested is considered as compressive strength of the concrete.

Figure 8. Compression Strength Testing Setup

— **Flexure test**

Flexural strength is calculated as follows:

≡ Case 1, where fracture occurs within the middle third of the span. Then flexural strength of concrete = $(Pl) / (bd^2)$

≡ Case 2, where fracture occurs outside the middle third of the span. Then flexural strength of concrete = (3Pa) / (bd²)

where, a is the distance between the line of fracture and the nearest support, b and d are width and depth of specimen, l is the length of the span on which the specimen is supported, P is the maximum load applied to the specimen

The average value of the specimens tested is considered as flexural strength of the concrete.

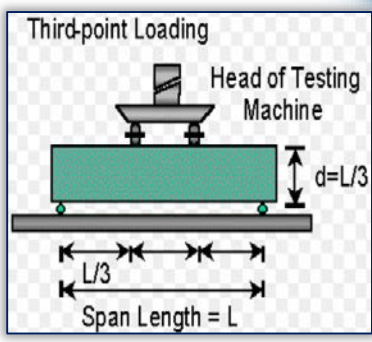


Figure 9. Flexural Strength Testing Setup

4. RESULTS AND DISCUSSIONS

a) Comparison between Compressive strength of 1% SFRC and 3% SFRC

Table 3. Compressive strength of cubes with 1% SFRC

Curing duration (days)	Compressive strength (N/mm²)									Average Compressive strength (N/mm²)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
7	31.56	31.68	31.78	31.89	32.18	32.65	32.75	32.89	32.95	32.26
14	35.56	35.89	36.15	36.25	36.34	36.44	36.84	37.33	37.46	36.47
21	40.88	40.88	40.88	40.98	41.12	41.25	41.33	41.33	41.35	41.11
28	42.56	42.62	42.67	42.89	43.11	43.15	43.39	43.42	43.51	43.04

Table 4. Compressive strength of cubes with 3% SFRC

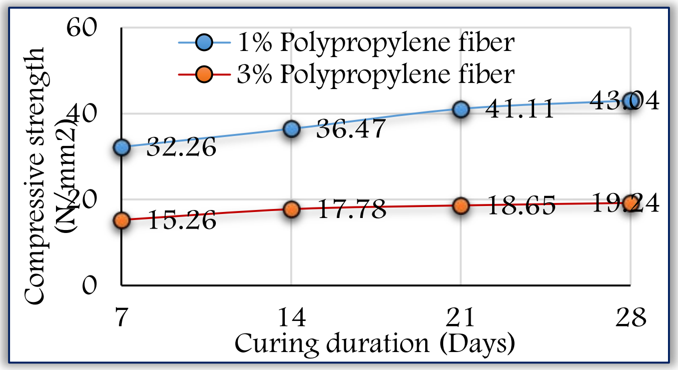
Curing duration (days)	Compressive strength (N/mm²)									Average Compressive strength (N/mm²)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
7	14.67	14.77	14.78	14.89	15.46	15.46	15.56	15.56	16.1	15.26
14	17.72	17.72	17.75	17.78	17.78	17.78	17.82	17.83	17.85	17.78
21	18.22	18.42	18.44	18.54	18.58	18.64	18.67	19.11	19.23	18.65
28	18.67	18.78	18.89	18.96	19.54	19.56	19.56	19.56	19.65	19.24

From the graph:

— At 7 days, compressive strength of SFRC with 1% polypropylene fibers is higher by 110% than that of SFRC with 3% polypropylene fibers.

— At 14 days, compressive strength of SFRC with 1% polypropylene fibers is 105% more than SFRC with 3% polypropylene fibers.

— At 21 days, compressive strength of SFRC with 1% polypropylene fibers is 120% more than SFRC with 3% polypropylene fibers.



Graph 1. Variation of compressive strength for 1% & 3% SFRC with curing duration

— At 28 days, compressive strength of SFRC with 1% polypropylene fibers is 123% more than SFRC with 3% polypropylene fibers.

— Polypropylene fibers addition have increased the compression strength significantly for both 1% and 3% fiber content.

b) Comparison between Flexural strength of 1% SFRC and 3% SFRC

Table 5. Flexural strength of prisms with 1% SFRC

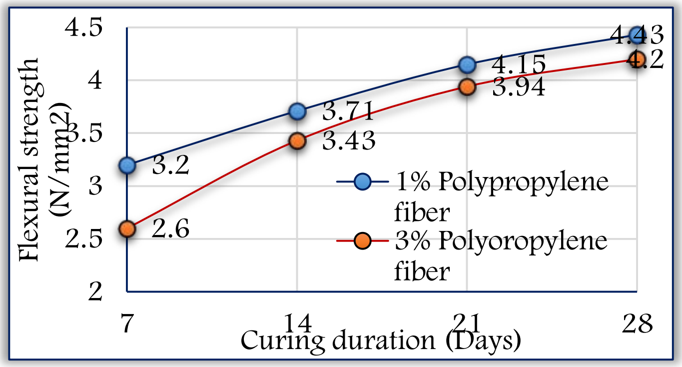
Curing duration (days)	Flexural strength (N/mm²)									Average Flexural strength (N/mm²)
	P1	P2	P3	P4	P5	P6	P7	P8	P9	
7	3.00	3.00	3.00	3.10	3.20	3.20	3.30	3.40	3.40	3.20
14	3.80	3.60	3.80	3.60	3.80	3.50	3.70	3.70	3.80	3.71
21	4.00	4.00	4.00	4.10	4.20	4.20	4.20	4.20	4.30	4.15
28	4.20	4.20	4.20	4.20	4.40	4.40	4.60	4.60	4.70	4.43

Table 6. Flexural strength of prisms with 3% SFRC

Curing duration (days)	Flexural strength (N/mm²)									Average Flexural strength (N/mm²)
	P1	P2	P3	P4	P5	P6	P7	P8	P9	
7	2.20	2.40	2.60	2.60	2.60	2.60	2.80	2.80	2.80	2.60
14	3.30	3.40	3.40	3.40	3.40	3.40	3.50	3.50	3.60	3.43
21	3.80	3.80	3.80	4.00	4.00	4.00	4.00	4.00	4.10	3.94
28	4.00	4.10	4.10	4.20	4.20	4.20	4.30	4.30	4.40	4.20

From the graph:

- At 7 days, flexural strength of SFRC with 1% polypropylene fibers is higher by 23% than that of SFRC with 3% polypropylene fibers.
- At 14 days, flexural strength of SFRC with 1% polypropylene fibers is 8.20% more than SFRC with 3% polypropylene fibers.
- At 21 days, flexural strength of SFRC with 1% polypropylene fibers is 5.30% more than SFRC with 3% polypropylene fibers.



Graph 2. Variation of flexural strength for 1% & 3% SFRC with curing duration

- At 28 days, flexural strength of SFRC with 1% polypropylene fibers is 5.50% more than SFRC with 3% polypropylene fibers.
- Polypropylene fiber addition increased the flexural strength significantly for both 1% and 3% fiber content.

c) Comparison between Compressive strength of 1% NFRC and 3% NFRC

Table 7. Compressive strength of cubes with 1% NFRC

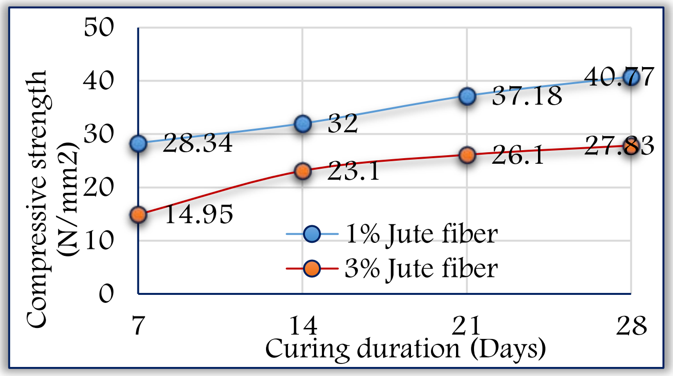
Curing duration (days)	Compressive strength (N/mm²)									Average Compressive strength (N/mm²)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
7	27.55	27.65	27.65	28.44	28.44	28.44	28.65	29.11	29.15	28.34
14	31.10	31.10	31.80	32.00	32.10	32.10	32.15	32.85	32.90	32.00
21	36.44	36.44	36.44	37.33	37.34	37.34	37.74	37.74	37.77	37.18
28	40.0	40.0	40.0	40.10	40.20	40.20	42.0	42.22	42.22	40.77

Table 8. Compressive strength of cubes with 3% NFRC

Curing duration (days)	Compressive strength (N/mm²)									Average Compressive strength (N/mm²)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
7	14.11	14.30	14.67	14.67	15.11	15.11	15.21	15.67	15.67	14.95
14	22.11	22.55	22.67	22.87	23.11	23.55	23.67	23.67	23.67	23.10
21	25.22	25.22	25.77	25.87	26.22	26.22	26.77	26.77	26.87	26.10
28	27.44	27.44	27.44	27.44	27.56	27.56	28.44	28.56	28.56	27.83

From the graph:

- At 7 days, compressive strength of NFRC with 1% jute fibers is higher by 89.50% than that of NFRC with 3% jute fibers.
- At 14 days, compressive strength of NFRC with 1% jute fibers is 38.50% more than NFRC with 3% jute fibers.
- At 21 days, compressive strength of NFRC with 1% jute fibers is 42.50% more than NFRC with 3% jute fibers.
- At 28 days, compressive strength of NFRC with 1% jute fibers is 46.50% more than NFRC with 3% jute fibers.



Graph 3. Variation of compressive strength for 1% & 3% NFRC with curing duration

- An important shortcoming for the Jute fiber is that their workability is poor compared to synthetic fibers.

d) Comparison between Flexural strength of 1% NFRC and 3% NFRC

Table 9. Flexural strength of prisms with 1% NFRC

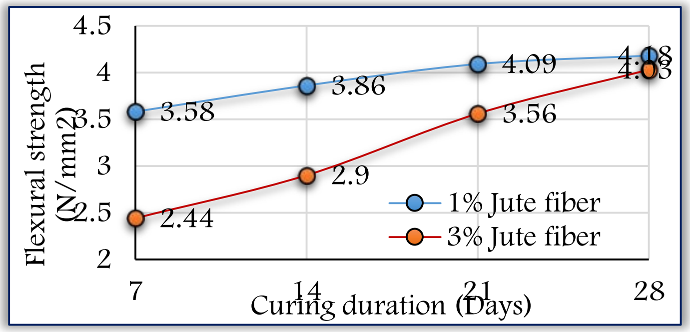
Curing duration (days)	Flexural strength (N/mm²)									Average Flexural strength (N/mm²)
	P1	P2	P3	P4	P5	P6	P7	P8	P9	
7	3.30	3.30	3.40	3.40	3.40	3.40	4.00	4.00	4.00	3.58
14	3.70	3.70	3.80	3.80	3.80	3.90	3.90	4.00	4.10	3.86
21	3.90	3.90	4.00	4.10	4.10	4.20	4.20	4.20	4.20	4.09
28	4.00	4.00	4.20	4.20	4.20	4.20	4.20	4.30	4.30	4.18

Table 10. Flexural strength of prisms with 3% NFRC

Curing duration (days)	Flexural strength (N/mm²)									Average Flexural strength (N/mm²)
	P1	P2	P3	P4	P5	P6	P7	P8	P9	
7	2.20	2.40	2.40	2.40	2.40	2.40	2.60	2.60	2.60	2.44
14	2.70	2.80	2.80	2.90	2.90	3.00	3.00	3.00	3.00	2.90
21	3.30	3.40	3.40	3.40	3.40	3.60	3.80	3.80	3.90	3.56
28	3.90	3.90	3.90	4.00	4.00	4.10	4.10	4.20	4.20	4.03

From the graph:

- At 7 days, flexural strength of NFRC with 1% jute fibers is higher by 46.70% than that of NFRC with 3% jute fibers.
- At 14 days, flexural strength of NFRC with 1% jute fibers is 33.10% more than NFRC with 3% jute fibers.
- At 21 days, flexural strength of NFRC with 1% jute fibers is 14.90% more than NFRC with 3% jute fibers.
- At 28 days, flexural strength of NFRC with 1% jute fibers is 3.75% more than NFRC with 3% jute fibers.



Graph 4. Variation of flexural strength for 1% & 3% NFRC with curing duration

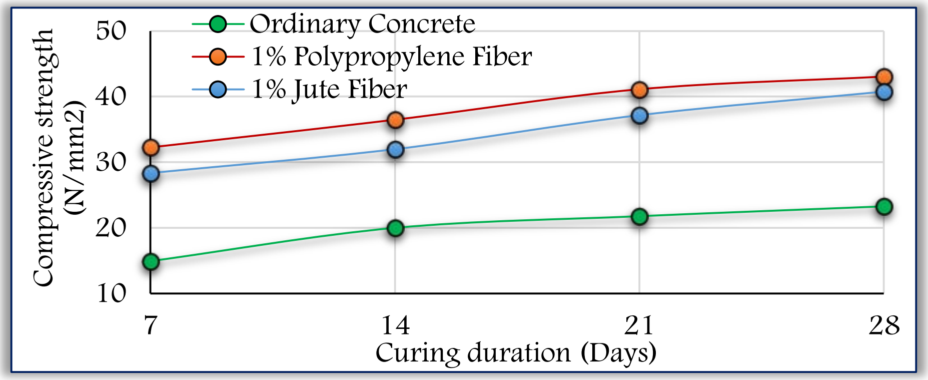
e) Comparison between Ordinary/Conventional Concrete, SFRC & NFRC (At 1% & 3% Fiber Content)

Table 11. Compressive Strength variation for Conventional Concrete, SFRC & NFRC (1% & 3% Fiber Content)

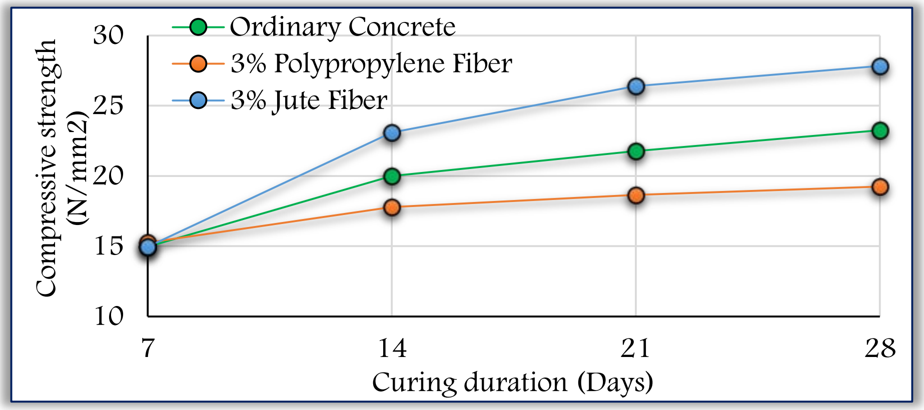
Curing duration (Days)	Compressive strength (N/mm²)				
	Conventional Concrete	SFRC (1%)	SFRC (3%)	NFRC (1%)	NFRC (3%)
7	14.96	32.26	15.26	28.34	14.95
14	20.00	36.47	17.78	32.00	23.10
21	23.26	41.11	18.65	37.18	26.10
28	26.63	43.04	19.24	40.77	27.83

Table 12. Flexural Strength variation for Conventional Concrete, SFRC & NFRC (1% & 3% Fiber Content)

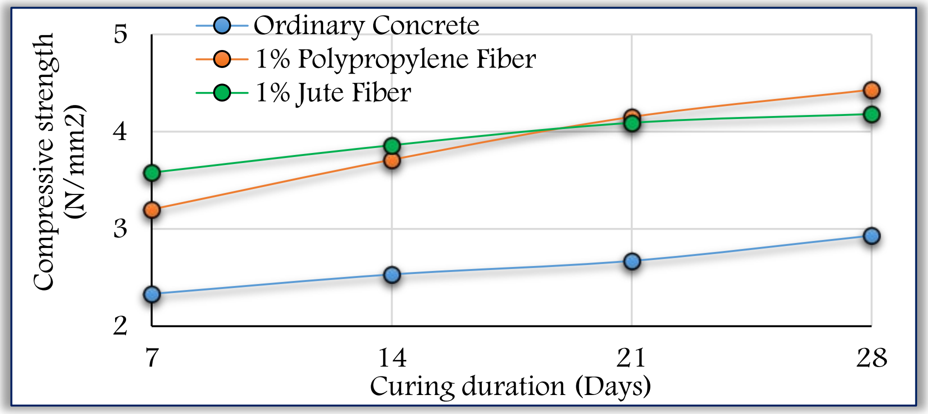
Curing duration (Days)	Flexural strength (N/mm²)				
	Conventional Concrete	SFRC (1%)	SFRC (3%)	NFRC (1%)	NFRC (3%)
7	2.33	3.20	2.60	3.58	2.44
14	2.53	3.71	3.43	3.86	2.90
21	2.67	4.15	3.94	4.09	3.56
28	2.93	4.43	4.20	4.18	4.03



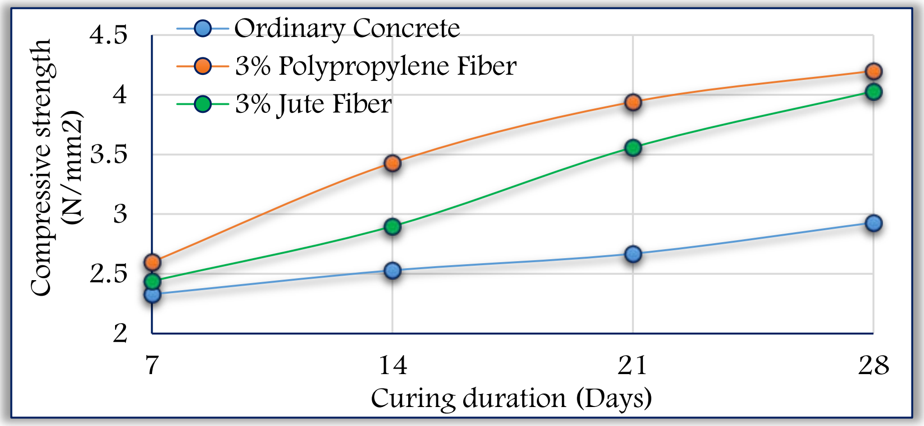
Graph 5. Variation of compressive strength for 1% SFRC, 1% NFRC & ordinary concrete with curing duration



Graph 6. Variation of compressive strength for 3% SFRC, 3% NFRC & ordinary concrete with curing duration



Graph 7. Variation of flexural strength for 1% SFRC, 1% NFRC & ordinary concrete with curing duration



Graph 8. Variation of flexural strength for 3% SFRC, 3% NFRC & ordinary concrete with curing duration

5. CONCLUSIONS

Based on the experimental work and analytical work carried out in the present study, the following conclusions are made:

- Addition of fibers (by weight percentage 1% and 3% in the present study) in ordinary concrete significantly contributes for the increase in the compressive strength and flexural strength.
- Both 1% and 3% Jute fibers reinforced concrete yielded for higher compressive strength as well as flexural strength values especially at lower percentages. Further increase in the percentage is resulting for a decrease in the compressive strength. Also, due to the nature of material, its workability and material mixing becomes difficult while casting.
- 1% Polypropylene fiber reinforced concrete yielded for higher compressive strength compared to ordinary concrete but, it was observed that further increase is resulting in decrease of the compressive strength whereas, Flexural strength for both 1% and 3% polypropylene fiber reinforced concrete has increased significantly. In due consideration of compressive strength decrease further study can be carried out to identify the optimal percentage.

— As a comparison between the types of fibers i.e. Jute and Polypropylene, Jute Fibers were found to be difficult to handle in mixing and casting.
— Polypropylene fibers are comparatively better in mixing and casting but the load carrying capacity of the percentage of fibers being added is much low.
— The present study concludes considering the practical issue of workability of fibers, that in between synthetic and natural fibers selected, 1% Polypropylene fibers can be added as a reinforcement to ordinary concrete to enhance both compressive strength by nearly 2 times at 28 days curing duration and flexural strength by 35%% at 28 days curing duration.

References

[1] A. L. Ardeshana, Dr Atul K Desai (2012) "Durability of fiber reinforced concrete of marine structures", International Journal of Engineering Research & Applications (IJERA), volume -02, issue-4, pp 215-219
[2] Amit Rai, Dr Y. P. Jashi (2010) "Applications and properties of fiber reinforced concrete". International Journal of Engineering Research And Applications (IJERA), volume-4, pp 24-32
[3] IS:456-2000 Plain and Reinforced concrete-code of practice
[4] IS:516-1959 Methods of Tests for Strength of Concrete
[5] L.N. Vairagade, V.M. Bhedi (2015) "Comparison of strength between steel fiber reinforced concrete and conventional concrete". International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC), vol-3, issue-02, pp 5-10
[6] M.A. Mansur, (2015), - "Jute fiber reinforced concrete materials for building construction", International Journal of Cement Composites and Lightweight Concrete, volume-04, issue-02, pp 116-123
[7] Vinay Kumar Singh (2014), "Effect of Polypropylene Fiber on Properties of Concrete", International Journal Of Engineering Sciences & Research Technology (IJESRT), Volume -3, pp 312-317
[8] Viswa Teja. T.V., and Vineel. Ch., (April, 2019), "A Comparative Study on Compressive and Flexural Strength of Fiber Reinforced Concrete and Ordinary Concrete", in Journal of Emerging Technologies and Innovative Research (ISSN: 2349-5162), Issue IV, Volume VI, pp 485-506
[9] Yu-Chen Ou, Mu-Sen Tsai, Kuang-Yen Liu and Kuo-Chun Chang (2012) "Compressive behavior of steel fiber reinforced concrete with a high reinforcing index" American Society of Civil Engineers (ASCE), Journal of materials in civil engineering 2012, volume-24, issue-02, pp 207-215

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