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EXPERIMENTAL STUDY ON BANANA AND JUTE FIBRE REINFORCED COMPOSITE

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Abstract - *An experimental work has been conducted on banana and jute fibre reinforced composite. The main objective of this work was to improve the mechanical properties of composite such as compressive strength and flexural strength. The banana and jute fibres are subjected to alkali treatment with NaOH to avoid degradation of fibres and to improve the bond between fibres and the matrix. The fibres are treated for the periods of 4 hours, 8 hours, and 12 hours and are added in the proportion of 0, 0.1%, 0.3%, 0.5%, and 0.7% by the quantity of concrete. The outcome of this experiment was at 0.3% incorporation of 8 hours treated banana fibre shows maximum compressive and flexural strength compared to conventional concrete and at 0.3% incorporation of 4 hours treated jute fibre shows maximum compressive and flexural strength compared to conventional concrete. The outcome also indicates the maximum compressive strength and flexural strength for incorporation of raw banana and jute fibres when compared to treated fibres but treatment of fibres is necessary to remove lignin, pectin and cellulose from the surface of fibres.*

Key Words: **Jute fibre, banana fibre, alkali treatment, compressive strength, flexural strength.**

1. INTRODUCTION

Concrete is a blend of cement, coarse aggregates, fine aggregates, and water which solidifies with time. When water reacts chemically with cement, the hydration reaction begins. This reaction makes a different constituent to form an intense network; it binds the ingredients together into a strong rock-like solid. The freshly mixed concrete is frequently shaped into any size and shape. Concrete is strong in compression but there are numerous disadvantages like very minor tensile strength, nature of brittle failure, negligible crack resistance, etc. Usually, ordinary Portland cement is employed for various constructions.

Quality of concrete plays a vital role in good bonding. There are some factor that affects the quality of concrete such as concrete strength, sizes and texture of aggregates used in concrete and mix proportions. Compression, tension and flexural are some of the important engineering properties associated to concrete. The freshly mixed concrete should not segregate; the segregation can be avoided by proper mix proportion, placement and compaction of concrete.

1.1 Objectives

The project includes the below mentioned objective

1. To prepare a conventional concrete of M_{30} grade and study its properties.
2. To study the mechanical properties of banana and jute fibre-reinforced composite.
3. Comparison of results with conventional concrete.

2. LITERATURE REVIEW

S. Sakthivel et.al., (2019) [1], They studied about mechanical properties of concrete by conducting an experimental investigation on concrete by adding banana leaf ash and banana fibres in it. They observed that banana leaf ash has prospective to substitute cement. The banana fibres usually increase the properties of concrete. In this investigation, banana leaf ash is used About 0.2% of banana fibre is added as additional material to concrete to obtain good strength. Finally, they concluded that the addition of 2% and 6% of banana leaf ash enhance the compression strength of composite and addition of banana fibre of 0.20% intensifies the tensile strength of the composite.

Bal Gopal Guru et.al., (2018) [2], They conducted an investigation on M25 concrete to study the compressive strength of concrete by adding jute fibre. In this investigation they have selected the proportion of jute fibres of 0.5%, 1% and 1.5%. They tested specimens for different curing days such as 3, 7, 28 days. They concluded that 0.5% incorporation jute fibre gives better compressive strength when matched to conventional concrete. The incorporation of jute fibres should not exceed 1% by the quantity of concrete.

Suhas Pawar et.al., (2018) [3], They conducted an experiment on banana fibre reinforced composite to study it's mechanical properties. They observed great increase in flexural strength as compared to OPC. They incorporated banana fibre at the rate of 0%, 5%, 10%, and 15%. They concluded that the concrete with incorporating

banana fibre of 5% has shown good mechanical properties such as compression and tension. The concrete by using banana fibre up to 15% is safe, but the strength obtained is less.

Priyanka Goel et.al., (2017) [4], They studied the ductility of concrete and impact of jute reinforcement on the strength of the composite. They observed the drop in the compressive strength as the percentage of fibre rises and the properties of fresh composite influenced by inclusion of fibres in the composite. In spite of the drop in the compressive strength of jute fibre-reinforced composite, there is an enhancement in ductility afterward cracks in the composite through transmission of stresses through cracks and the fibre blocks the rapid transmission of cracks and prolongs the duration of deformation of straining to stay above the extreme.

Kesavraman et.al., (2017) [5], They presented an experiment on the impact of the use of extremely reactive metakaolin on the assets of the composite reinforced with banana fibres. They studied the compressive strength, split tensile strength, flexural strength, and impact strength test. HRM content used in this study was 5%, 10%, 15% and 20% and the banana fibres added in 0.5%, 1%, 1.5%, and 2%. They concluded the addition of 2% by volume of banana fiber-reinforced composite reveals a substantial intensification in compressive strength, flexural strength, impact resistance, and tensile strength.

3. MATERIALS AND METHODOLOGY

1. Cement

Cement is constituent which solidifies individually, and it binds additional materials together while solidifying. The cement contains various chemical components.

Table -1: Basic Properties of Cement

SL No.	Basic Test	Values
1	Fineness Modulus	5%
2	Specific Gravity	3.11
3	Standard Consistency	31%
4	Initial Setting Time	35 min
5	Final Setting Time	550min

2. Coarse Aggregate

The extreme size of the aggregates as per recommendation was 20mm. By conducting various tests according to IS2386 (part-3), the properties of coarse aggregates are determined.

Table -2: Basic Properties of Coarse Aggregate

SL No.	Basic Test	Values	Limits	Codal Provision
1	Fineness modulus	2.89	2.7 – 3.2	IS 383 - 2016
2	Specific gravity	2.63	2.5 – 2.9	IS2386-1963

3. Fine Aggregate

The fraction passing through 4.75mm to 150µ IS sieves are known as fine aggregates. Fine aggregate properties were determined by performing a test according to IS: 2386 (part 1). The result indicates that the arena confirms IS 1: 383-2016.

Table -3: Basic Properties of Fine Aggregate

SL No.	Basic Test	Values	Limits	Codal Provision
1	Fineness modulus	2.46	More than 2	IS 383 - 2016
2	Specific gravity	2.68	2.6 - 3	IS 2386-1963

5. Jute Fibre

Table -4: Physical Properties of Jute Fibre

SL No.	Physical properties	Values
1	Diameter	1.5 to 4mm
2	Ultimate length	150 to 300cm
3	Length	200mm
4	Density	1.5g/cc
5	Specific gravity	1.48

Fig.3.1: Jute fibre

6. Banana Fibres

Table -5: Physical Properties of Banana Fibre

SL No.	Physical properties	Values
1	Diameter	80 to 250µm
2	Ultimate length	500 to 1000cm
3	Length	200mm
4	Density	1.35g/cc
5	Moisture content	30%

Fig.3.2: Banana fibre

3.1 Alkali Treatment of Fibres

1. Prepare a solution by adding 5% normality of NaOH (sodium hydroxide) salt in water.
2. To get rid of unwanted soluble contents such as cellulose, hemi-cellulose, pectin, lignin etc. The fibres were needed to be immersed in the alkali solution of NaOH for 4, 8 and 12 hours respectively.
3. Then the fibres were washed through fresh-water for several times to eliminate the excess of NaOH sticking on the surface of fibres and then washed in running water.
4. The treated fibres were dried at 90 °c for 24 hours in an oven. Exactly the identical procedure is followed for one more set of weighed fibres i.e., for 8 hours, 12 hours.

Fig.3.3: Alkali Treatment of Fibres

3.2 Compressive Strength Test

The compressive strength test is performed according to Indian Standard Code IS516: 1959 on plain concrete, banana fiber reinforced concrete, and jute fiber reinforced concrete.

Fig.3.3: Compression Testing Machine

3.3 Flexural Strength Test

The flexural strength test is performed according to Indian Standard Code IS516: 1959 on plain concrete, banana fiber reinforced concrete, and jute fiber reinforced concrete.

4. RESULTS AND DISCUSSIONS

4.1 Compressive strength of Conventional Concrete

Table -6: Conventional Concrete

SL No.	No of days	Weight of specimen in grams	Density kg/m³	Failure load kN	Compressive strength Mpa
1	7	8575	2540.7	461.5	20.51
2	28	8850	2622.5	587.9	26.13

4.2 Compressive Strength of Banana Fibre

4.2.1 For 0 hour treated banana fiber

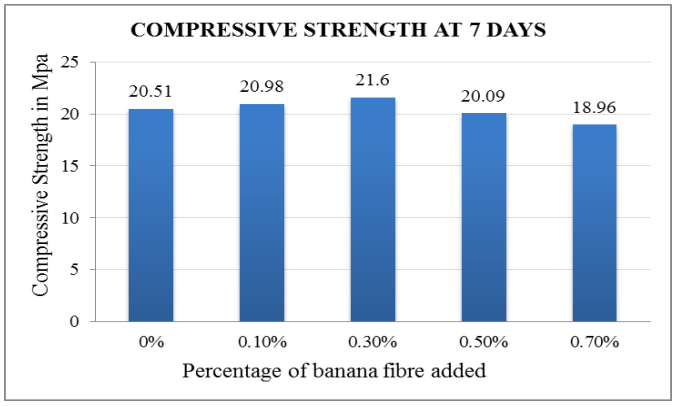

Chart -1: Compressive Strength at 7 days

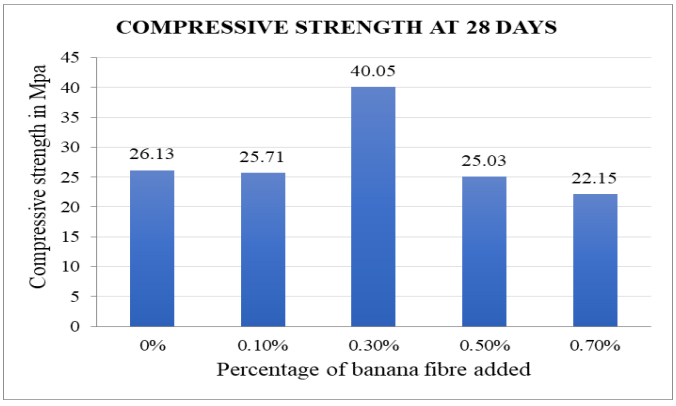

Chart -2: Compressive Strength at 28 days

4.2.2 For 4 hour treated banana fiber

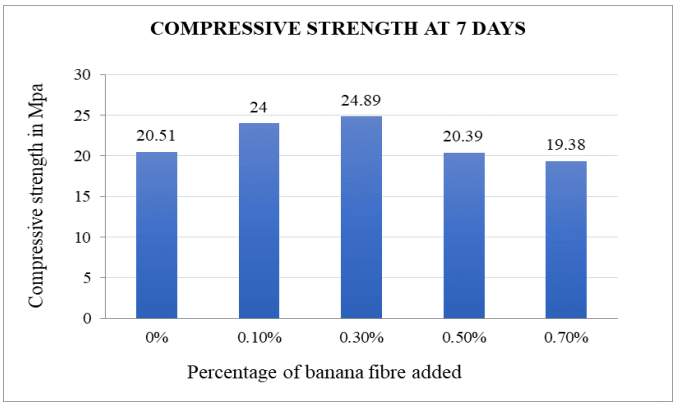

Chart -3: Compressive Strength at 7 day

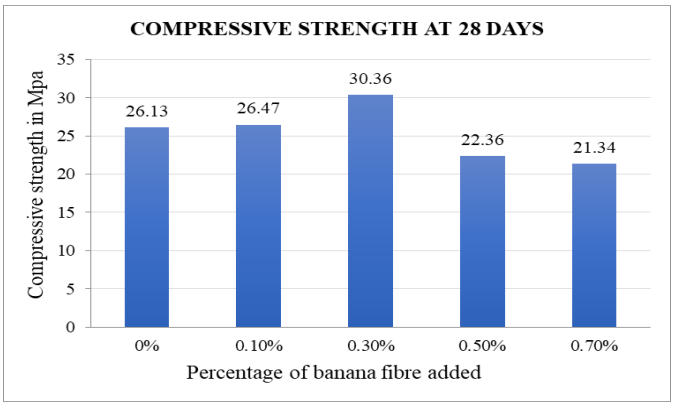

Chart -4: Compressive Strength at 28 days

4.2.3 For 8 hour treated banana fiber

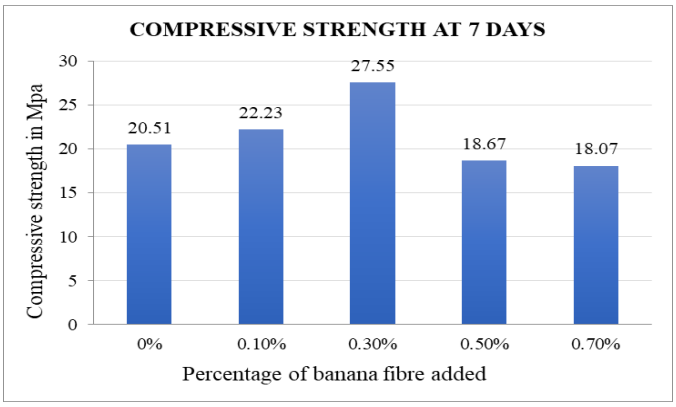

Chart -5: Compressive Strength at 7 days

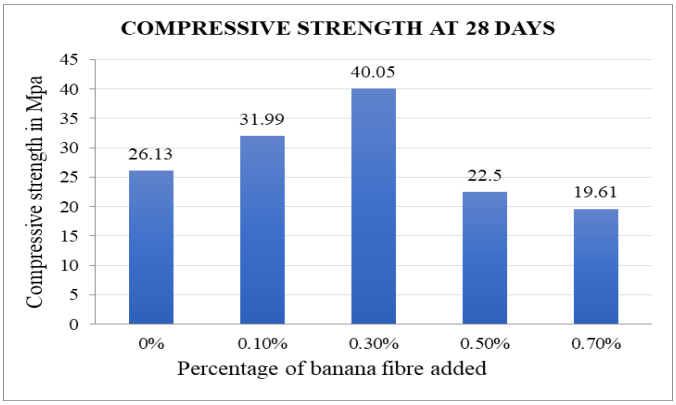

Chart -6: Compressive Strength at 28 days

4.2.4 For 12 hour treated banana fiber

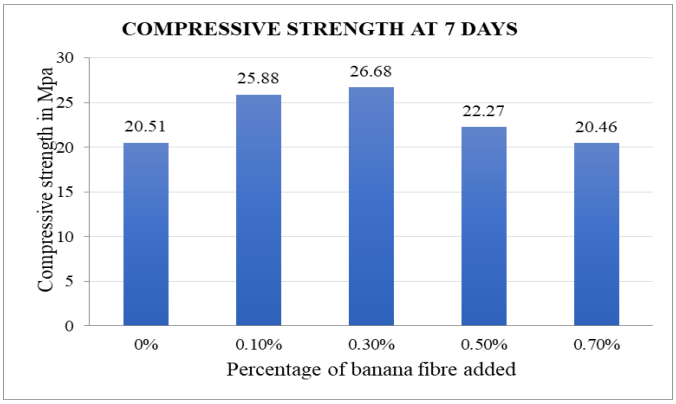

Chart -7: Compressive Strength at 7 days

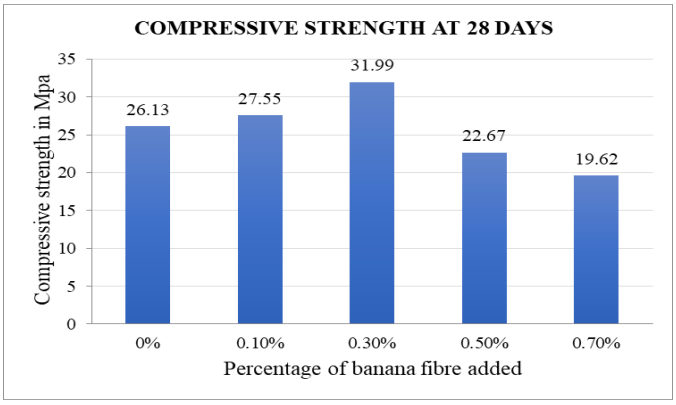

Chart -8: Compressive Strength at 28 days

4.3 Compressive Strength of Jute Fibre

4.3.1 For 0 hour treated Jute fiber

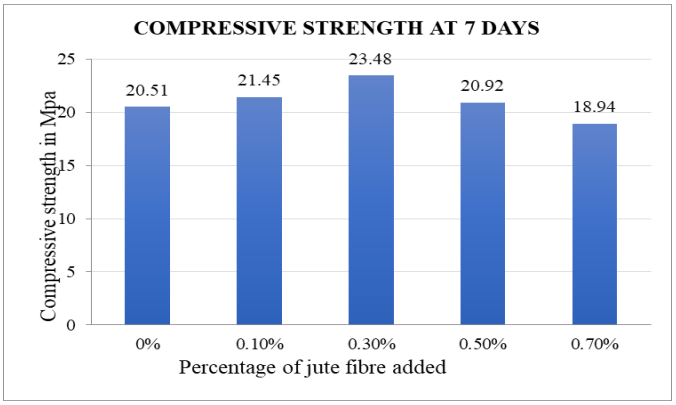

Chart -9: Compressive Strength at 7 days

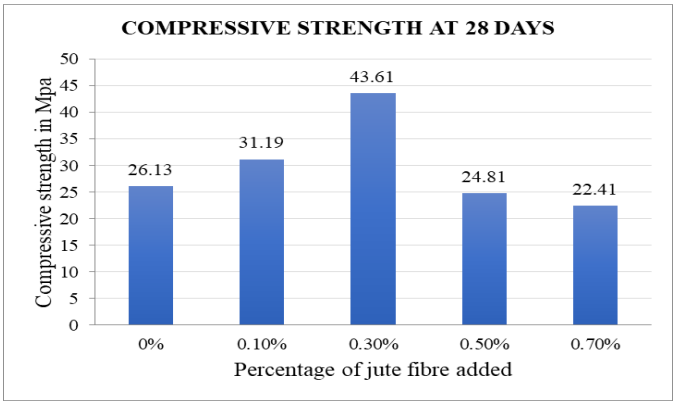

Chart -10: Compressive Strength at 28 days

4.3.2 For 4 hour treated Jute fiber

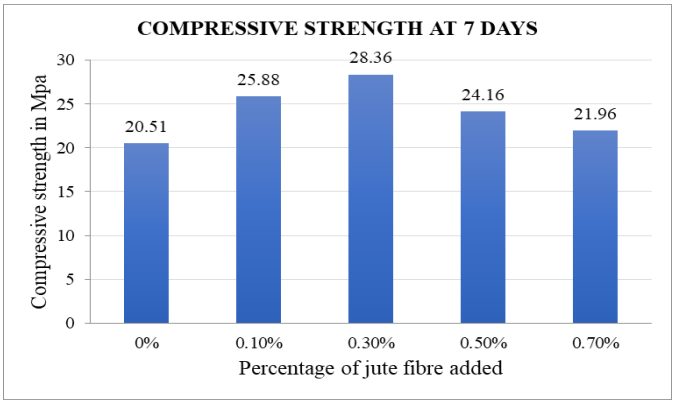

Chart -11: Compressive Strength at 7 days

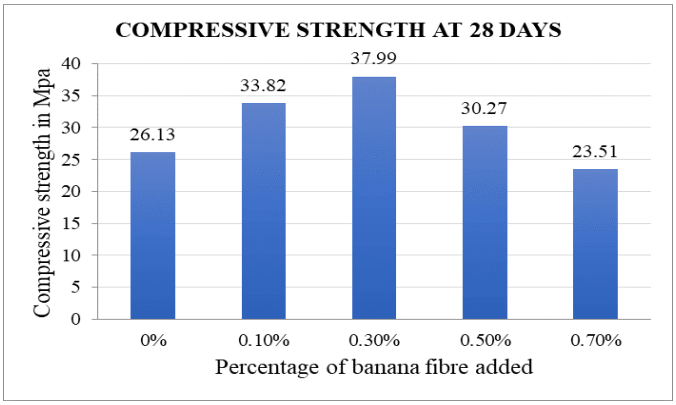

Chart -12: Compressive Strength at 28 days

4.3.3 For 8 hour treated Jute fiber

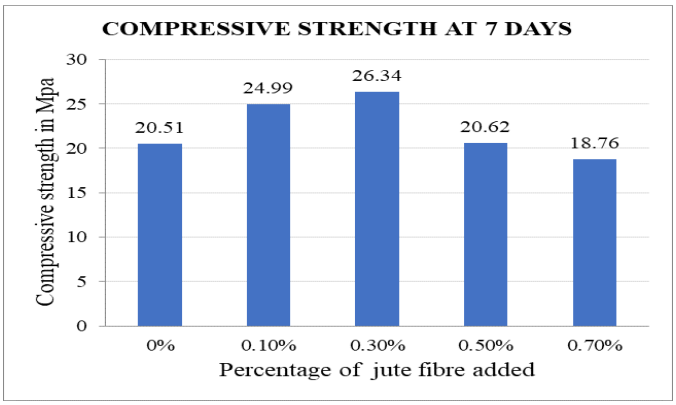

Chart -13: Compressive Strength at 7 days

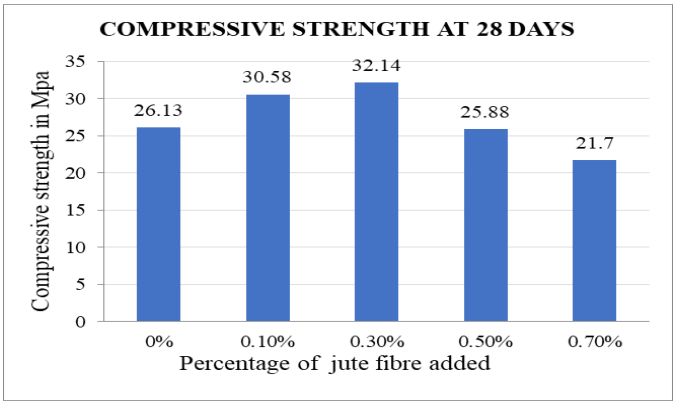

Chart -14: Compressive Strength at 28 day

4.3.4 For 12 hour treated Jute fiber

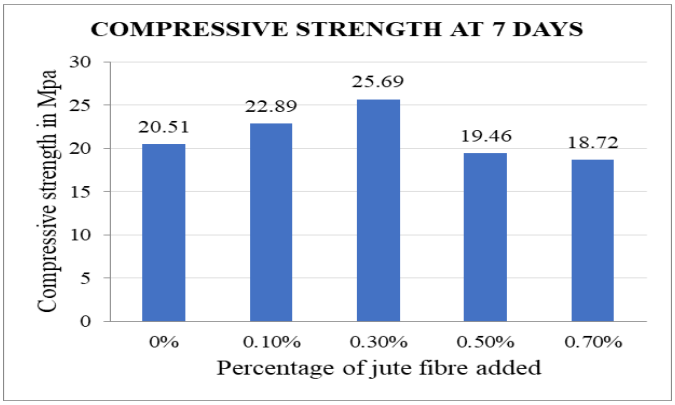

Chart -15: Compressive Strength at 7 days

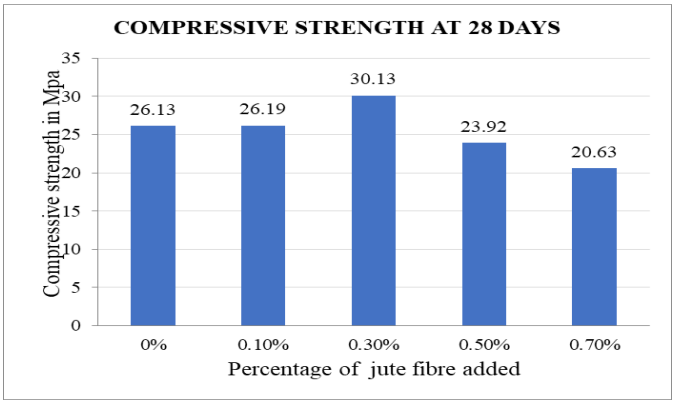

Chart -16: Compressive Strength at 28 days

4.4 Results on the flexural strength of concrete

Table -7: Conventional Concrete

SL No.	No of days	Weight of specimen in grams	Density kg/m^3	Failure load kg	Flexural strength Mpa	Deflection Mm
1	7	15415	2569	600	2.94	132
2	28	15590	2598	760	3.72	143
3	56	15855	2642	834	4.09	170

4.5 Flexural Strength of Banana Fibre

4.5.1 For 0 hour treated banana fiber

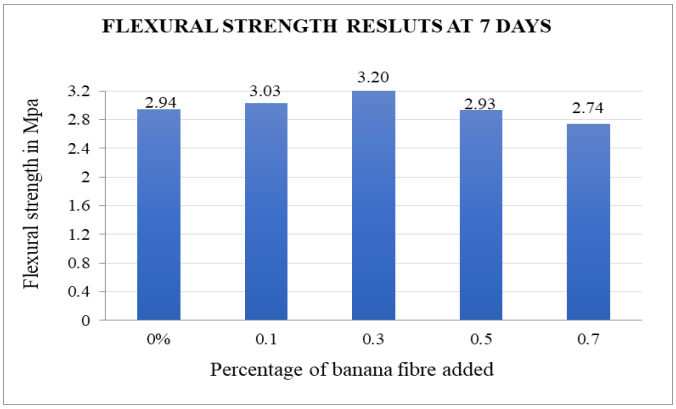

Chart -17: Flexural Strength at 7 days

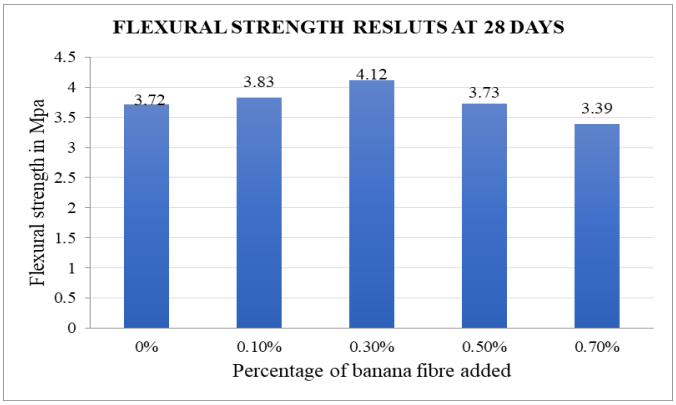

Chart -18: Flexural Strength at 28 days

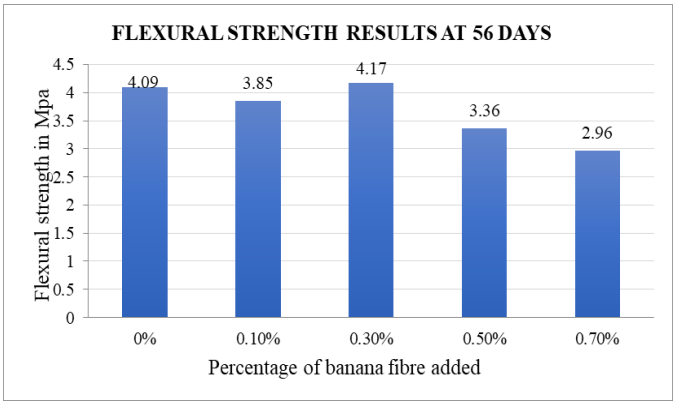

Chart -19: Flexural Strength at 56 days

4.5.2 For 4 hour treated banana fiber

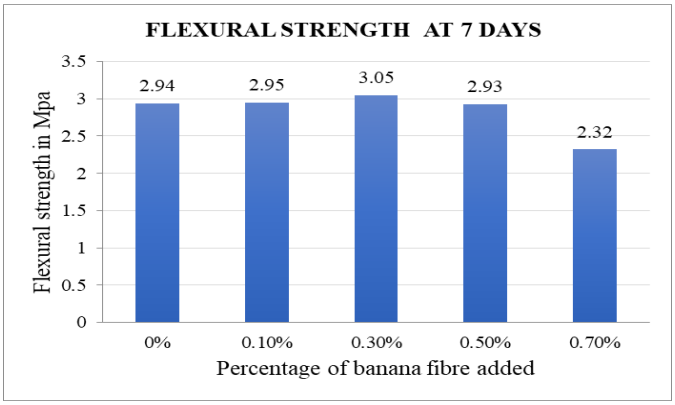

Chart -20: Flexural Strength at 7 days

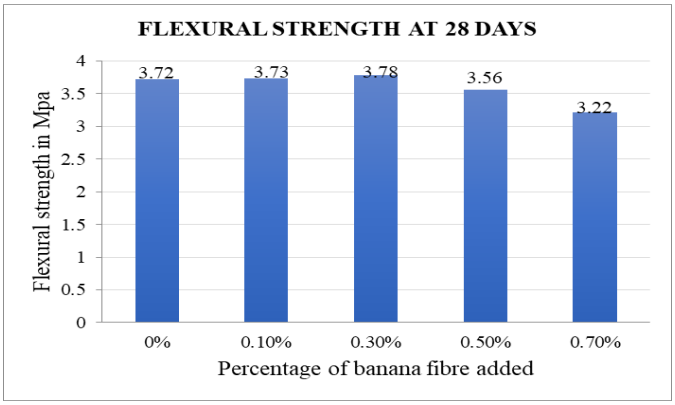

Chart -21: Flexural Strength at 28 days

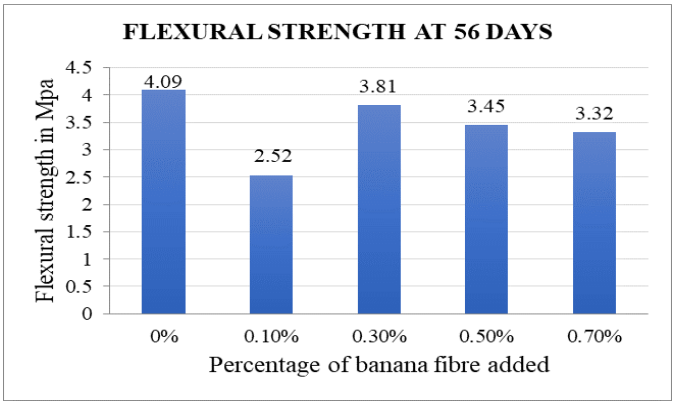

Chart -22: Flexural Strength at 56 days

4.5.3 For 8 hour treated banana fiber

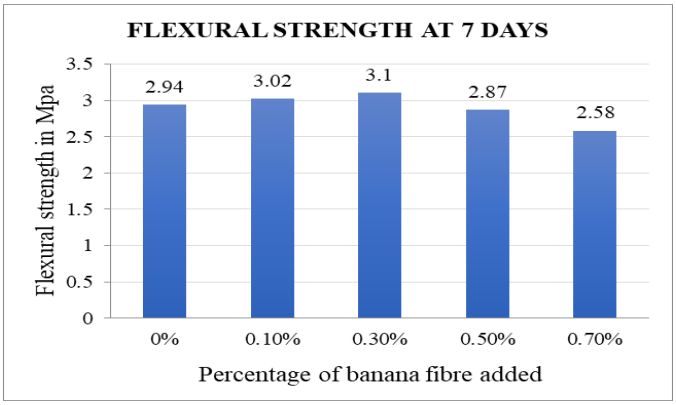

Chart -23: Flexural Strength at 7 days

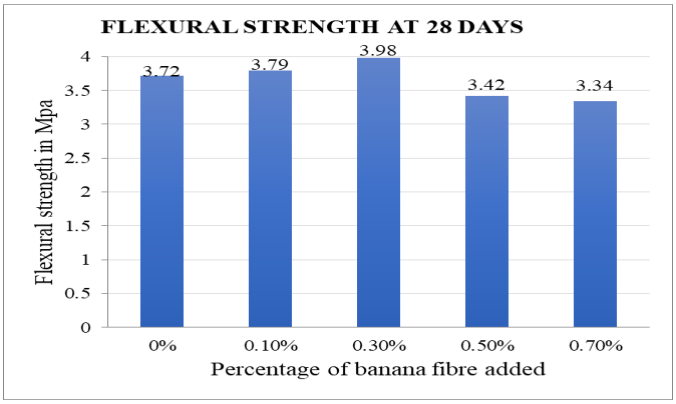

Chart -24: Flexural Strength at 28 days

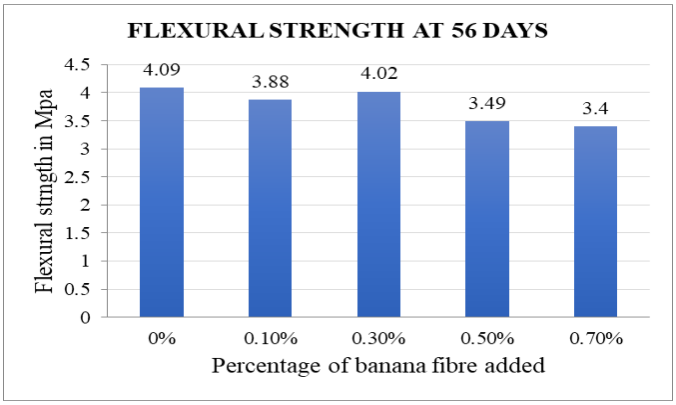

Chart -25: Flexural Strength at 56 days

4.5.4 For 12 hour treated banana fiber

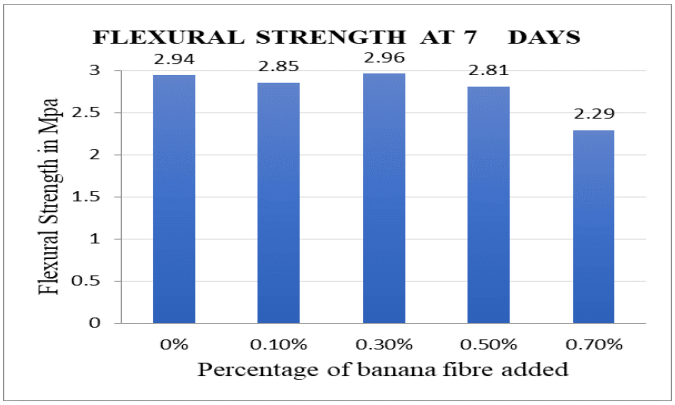

Chart -26: Flexural Strength at 7 days

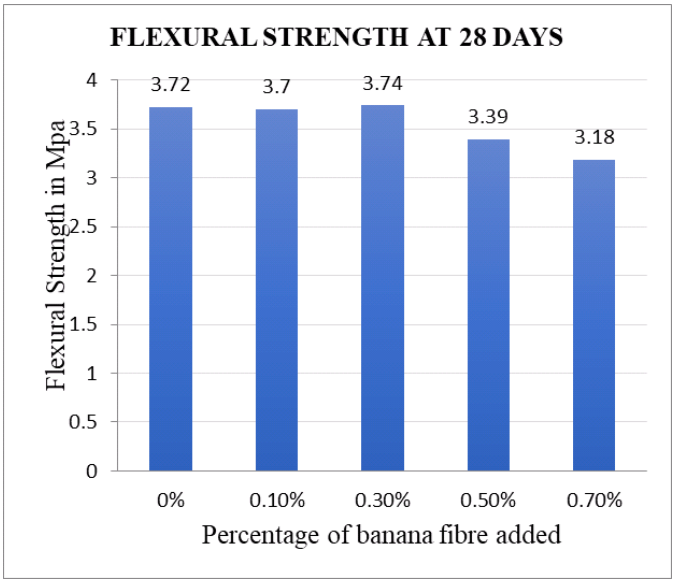

Chart -27: Flexural Strength at 28 days

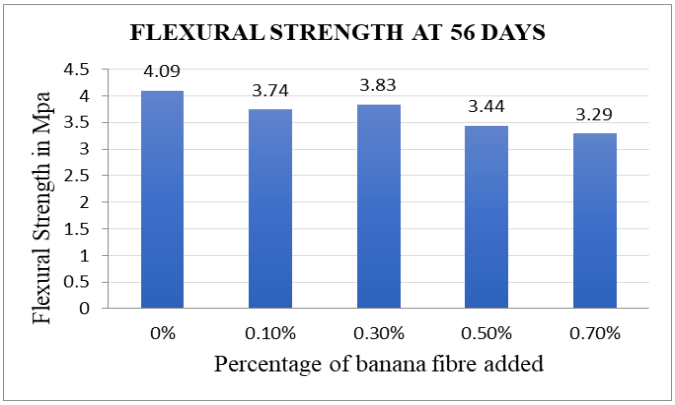

Chart -28: Flexural Strength at 56 days

4.6 Flexural Strength of Jute Fibre

4.6.1 For 0 hour treated Jute fiber

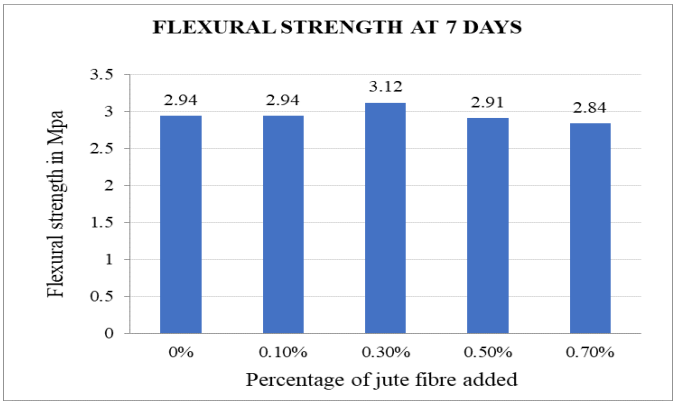

Chart -29: Flexural Strength at 7 days

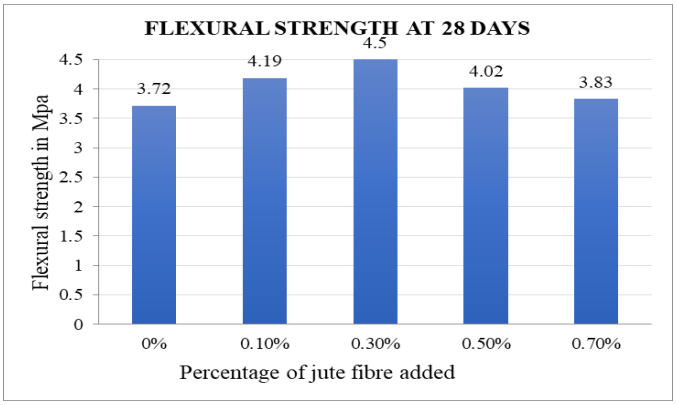

Chart -30: Flexural Strength at 28 days

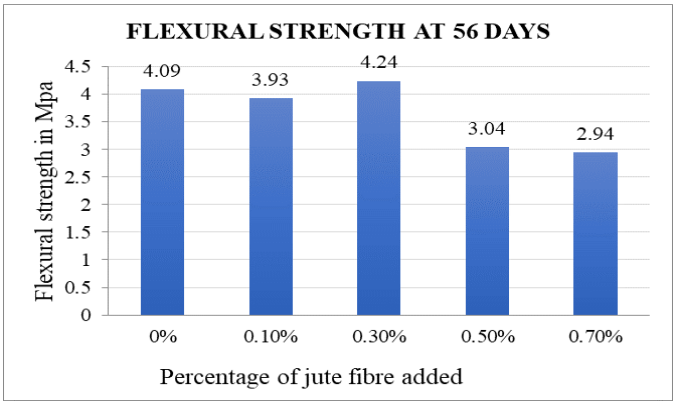

Chart -31: Flexural Strength at 56 days

4.6.2 For 4 hour treated Jute fiber

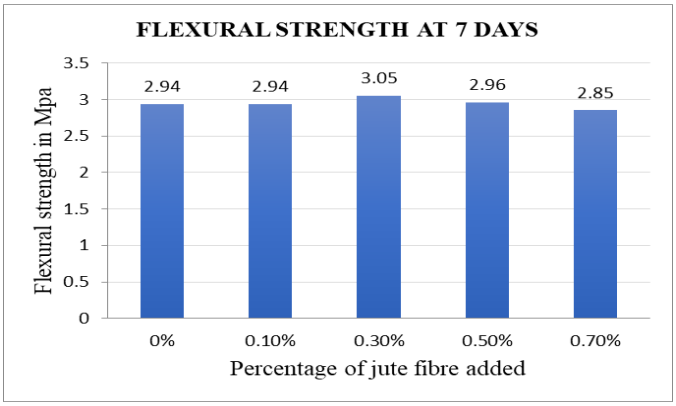

Chart -32: Flexural Strength at 7 days

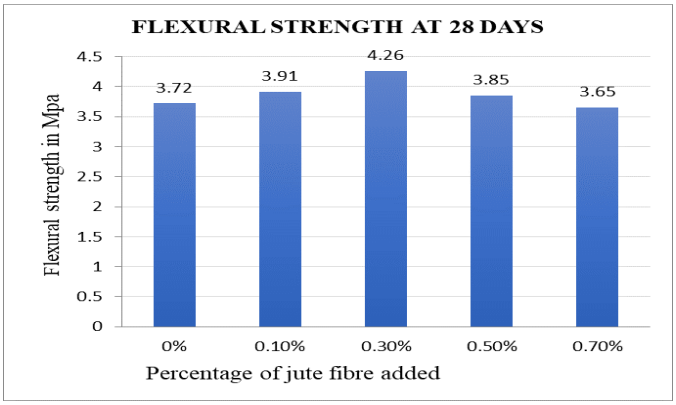

Chart -33: Flexural Strength at 28 days

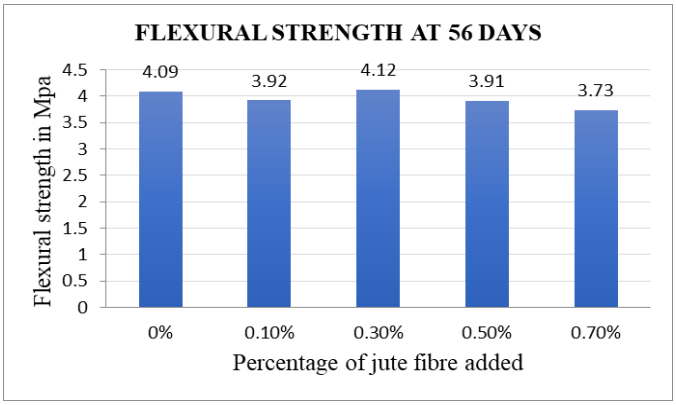

Chart -34: Flexural Strength at 56 days

4.6.3 For 8 hour treated Jute fiber

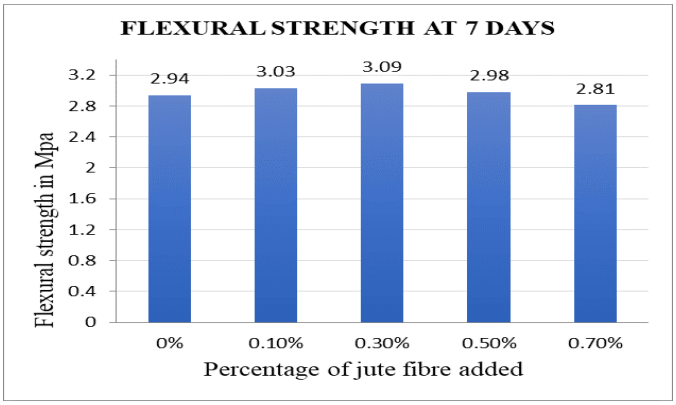

Chart -35: Flexural Strength at 7 days

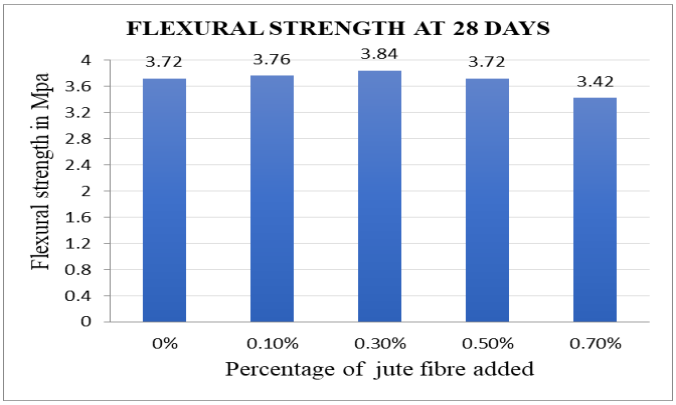

Chart -36: Flexural Strength at 28 days

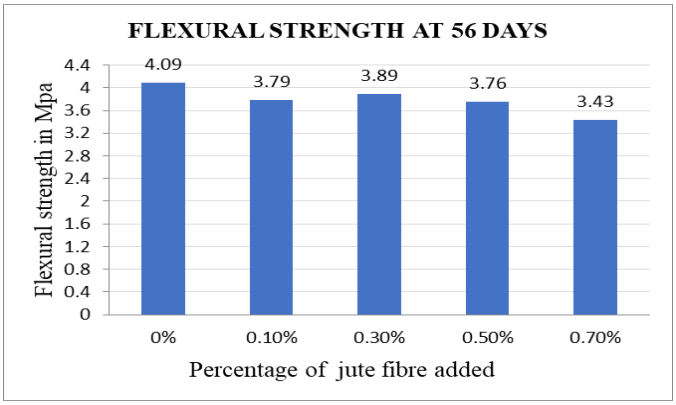

Chart -37: Flexural Strength at 56 days

4.6.4 For 12 hour treated Jute fiber

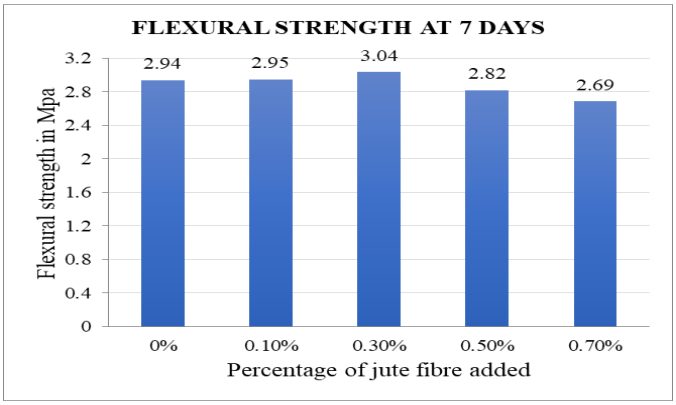

Chart -38: Flexural Strength at 7 days

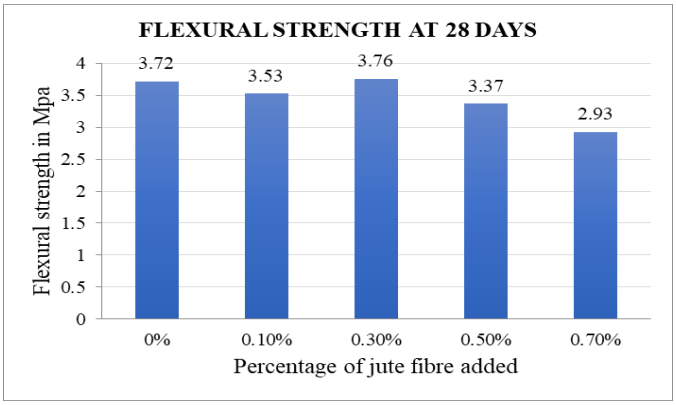

Chart -39: Flexural Strength at 28 days

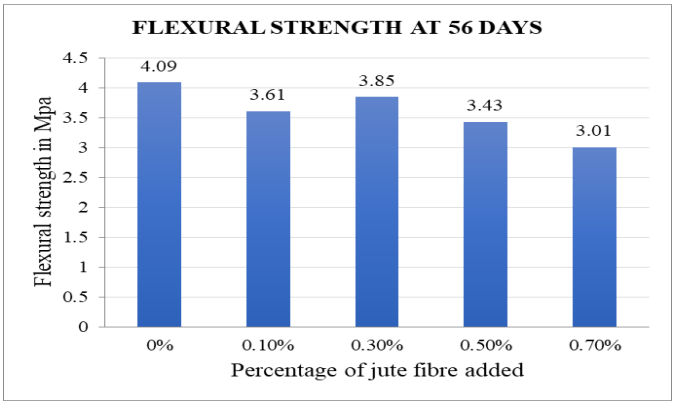

Chart -40: Flexural Strength at 56 days

5. CONCLUSIONS

- The incorporation of banana fibres and jute fibres in the composite was found to be an appreciable variation in the compressive strength and flexural strength of fibre reinforced composite.
- It has been observed that when raw banana fibre is incorporated in the composite by 0.3% by the weight of composite then the compressive strength increases by 40.05Mpa for 28 days and by adding 0.3% of 8 hours treated banana fibre compressive strength of 31.99Mpa is obtained for 28 days.
- There has been an increment in flexural strength of fibre-reinforced composite. It has been observed that when raw banana fibre is incorporated in composite by 0.3% weight of concrete, the flexural strength increased by 4.17 Mpa for 56 days and by inclusion of 0.3% of 8 hours treated banana fibre flexural strength increased by 4.02Mpa for 56 days of curing.
- It has been observed that when raw jute fibre is incorporated in the composite by 0.3% by the weight of composite then the compressive strength increases by 43.61Mpa for 28 days and by adding 0.3% of 4 hours treated banana fibre compressive strength of 37.99 Mpa is attained for 28 days.
- There has been an increment in the flexural strength of the jute fibre-reinforced composite. It has been noticed that when the raw jute fibre is incorporated into the composite by 0.3% by weight of composite, the flexural strength increases by 4.24Mpa for 56 days and the inclusion of 0.3% of 4 hours treated jute fibre the maximum flexural strength of 4.12Mpa is obtained for 56 days of curing.
- The incorporation of treated banana and jute fibres has been shown to improved workability and there is difficulty in mixing of composite as the proportion of fibre increases.
- The compression strength and flexural strength of alkali-treated fibre composite were reduced at all fibre contents when compared to the raw fibre-reinforced composite but the alkali treatment of fibre is necessary to avoid degradation of fibres.

6. FUTURE SCOPE OF THE WORK

- This research work can be expanded to study other properties of the composite and the experimental outcomes can be analyzed in a similar way.
- Natural jute fibre can be the effective material to strengthen concrete that will not only explore a way to improve concrete properties; It will also explore the use of jute and banana fibre and limit the use of the polymer that is harmful to the environment.

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