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Study On Utilization of Jute & Bamboo Fibres as Supplementary Materials to Concrete

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Abstract
Concrete is one of the most widely used construction material in spite of some inherited issues (brittleness, weak in tension, etc.). A lot of effort has been made to alter concrete behavior with the help of additives like cementitious material, fibers, etc. Now a days, combination of additives are gaining popularity. Many research work has been carried to study the behavior of concrete with steel fibers, nylon fibers etc. But limited research has been carried out to study the mechanical properties of concrete with silica fume and natural fibers. Hence there exists a technical gap. This gap suggests a research program to study the mechanical properties of concrete with natural fibers (Jute and Bamboo) and silica fume as admixture. In this present study mechanical properties of concrete will be investigated with silica fume of 10% by weight of cement as admixture and in addition natural fibers like Jute and Bamboo will be added in different proportions. Further ANN Analysis will be performed to validate the experimental results. The classification of Neural networks (NN), such as Neural Network-Leven Berg-Marquardt (NN-LM) and Neural Network Gradient Descent (NN-GD) is used to perform the analysis. Feed-forward back propagation neural networks have been used in this project.
Keywords: *Silica fume, ANN Analysis, Neural Network-Leven Berg- Marquardt (NN-LM), Neural Network Gradient Descent (NN-GD), Feed-forward back propagation.*

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I. INTRODUCTION

Concrete is the most consumed construction material in the world. From its invention in the Roman era, its applications in different industries have ever been rising. Concrete is a composite material containing hydraulic cement, water, coarse aggregate and fine aggregate that hardens (cures) over time. The resulting material is a stone like structure which is formed by the chemical reaction of cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally the member breaks. The formation of cracks in the concrete may also occur due to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude as the time elapses and they finally make the concrete to fail. These drawbacks of concrete especially susceptibility to weak in tension, poor resistance to crack opening and low fracture strain capacity has severely censored its application.

The formation of cracks is the main reason for the failure of the concrete. To increase the tensile strength of concrete many attempts have been made. One of the successful and most commonly used methods is providing steel reinforcement. Steel bars, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until they encounter steel bars. Thus, need for multidirectional and closely spaced steel reinforcement arises. That cannot be practically possible. Fiber reinforcement gives the solution to this problem and which also compensate the brittleness behavior of plain concrete.

So, to increase the tensile strength of concrete and to compensate the brittleness behavior of plain concrete, fiber reinforced concrete is often considered as an alternative, which is the technique of introduction of fibers in concrete. These fibers act as crack arrestors and prevent the propagation of the cracks.

1.1.1 Fibre Reinforced Concrete

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber reinforced concrete is of different types and properties with many advantages. Fibers are usually used in concrete to control plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete.

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers may generally be classified into two: organic and inorganic. Inorganic fibers include steel fibers and glass fibers, whereas organic fibers include natural fibers like coconut, sisal, wood, bamboo, jute, sugarcane, etc. and synthetic fibers based on acrylic, carbon, polypropylene, polyethylene, nylon, Aramid, and polyester. Within these different fibers the character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities. Based on the type of fibers used in the concrete, there are four categories fiber reinforced concrete namely;

1. SFRC - Steel Fiber Reinforced Concrete
2. GFRC - Glass Fiber Reinforced Concrete
3. SNFRC - Synthetic Fiber Reinforced Concrete
4. NFRC - Natural Fiber Reinforced Concrete

1.1.2 Natural fiber reinforced concrete

Natural fiber reinforced concrete is cement based concrete matrix, in which small diameter discontinuous, discrete natural fibers dispersed randomly throughout the concrete matrix. Natural fibers are advantageous us concerning the environment, economy, energy and resources conservation. Natural fibers, due to their abundant production, easy handling, flexibility, and cheap availability are under consideration from past few decades. The use of natural fibers in concrete composites can result in the alternative eco-friendly, sustainable, and economical civil engineering construction materials. Natural fibers are comparable with artificial/steel fibers to be used as dispersed reinforcement in cement composites for having the improved toughness.

1.1.3 Jute Fibres

Jute fibres improve the resistance of concrete against cracking and also enhance the mechanical properties of concrete. The natural jute fiber can be the effective material to reinforce concrete strength which will not only explore a way to improve the properties of concrete, it will also explore the use of jute and restrict the utilization of polymer which is environmentally detrimental. Jute is an important fiber with a number of advantages. Jute has high specific properties, low density, less abrasive behavior to the processing equipment, good dimensional stability and harmlessness. Jute textile is a low-cost eco-friendly product and is abundantly available, easy to transport and has superior durability and moisture retention capacity. It is widely being used as a natural choice for plant mulching and rural road pavement construction. The biodegradable and low-priced jute products merge with the soil after using providing nourishment to the soil. The high amount of jute fibres in the concrete mix decreases the workability but it can be improved by using an admixture called tannin.

1.1.4 Bamboo Fibres

Bamboo fibres are focused as one of substitution for natural plant fiber having many advantages such as low cost, low density, ecologically friendly, sustainability and biodegradability. Bamboo fibres enhance the mechanical properties of concrete. Bamboo fibres have better modulus of elasticity than any other natural material. The longer is the fiber the higher it gives the tensile strength. Addition of Bamboo fibres to the concrete elevates the mechanical strength and tensile strength. It has low specific weight too. Bamboo fiber can reduce crack-width and deflection of concrete and increase beam post-cracking load-carrying capacity. The amount of fiber has effect on workability and quality of concrete. However, bamboo fiber can prevent the growth and propagation of cracks. The workability of bamboo fibred reinforced concrete can be improved by using an admixture called tannin.

1.2 Artificial neural networks (ANN) method

Many new prediction methods were developed in the last decades to investigate or to predict the mechanical properties of concrete containing supplementary cementitious materials (SCMs). Among them Artificial Neural Networks (ANN) model is more accurate and feasible. Artificial Neural Networks take their name from the networks of nerve cells in the brain. Although they represent a much simplified version of the human brain, yet these computational models inspired by biological neural network may provide new directions to solve problems arising in natural tasks. In contrast to digital computers, which offer sequential processing of information, ANNs parallel processing inspired by working of a human brain, gives computers an additional advantage to simultaneously process large volumes of data. ANNs are well suited for problems whose solutions require knowledge that is difficult to specify but for which there are enough data or observations. The neural network's ability to learn from experience without seeking prior knowledge about the governing relationships and to generalize when presented with unseen data forms the backbone of its modeling ability, with which it approximates any functional relationship with reasonable accuracy. It has been reported that the ANN has the ability to extract the patterns in phenomena and overcome the difficulties due to the selection of the model form, such as linear, power, or polynomial.

The appealing nature of ANN is its closeness to human perception that has led to diversifications of its applications. The modeling technique employed by ANN is far more superior to statistical regression as it can derive complex, non-linear and unknown relationships among independent and dependent variables through a learning process, thereby working as a universal function approximator. ANN thus finds its application in the field of engineering, which is always faced with unstructured problems. ANN methodology has been harnessed for modeling a variety of problems and phenomenon encountered in the field of Civil Engineering.

ANNs automatically constructs the relationships and adapts itself based on the data used for training. ANNs modeling ability to derive meaning from unknown and non-linear interrelationships among variables have been harnessed to aid the prediction of behavior of engineering and natural systems. Concrete's compressive strength is one such problem that is unstructured in nature involving highly non-linear relationships among its constituents and compressive strength. Likewise, the classification of NN, such as Neural Network-Leven Berg-Marquardt (NN-LM) and Neural Network Gradient Descent (NN-GD) is then used to carry out the experimentation in an intelligent method, it comes close to the actual values while calculating the mean absolute error (MAE) and mean square error (MSE) values. Feed-forward back propagation neural networks have been used in this paper. This technique also helps us to validate the experimental results. So an attempt will be made to predict mechanical properties of concrete with jute and bamboo fibres.

1.3 Objective

1. To study the mechanical properties of concrete using jute and bamboo fibers.
2. Validating the experimental results using ANN (Artificial neural networks) technique.

II. LITERATURE REVIEW

Mehran Khan et. al. (2019) There is increase in elastic modulus, compressive strength, compression total energy absorbed and compression toughness index by 40%, 35%, 68% and 22% respectively for concrete with 15% of Fly ash 2% coconut fibres and 15% silica fume content by cement.

Tasadd et. al (2019) stated that Compressive strength is only 6%less than plain concrete. However Split tension and flexure strength are enhanced by13% and 128% respectively and there is minimum increment of about 220% in total energy absorption and 130% in toughness as compared to plain concrete. Reinforcement in slab can be minimized up to 28% by using tension zone of JFRC (Jute fibre reinforced concrete).

Viviane et. al (2019) studied that Composites containing 6% and 8% pulp exhibited the best properties before cracking and specific deformation associated with maximum stress compared to reinforced with 10 and 12% of pulp. Increase in modulus of rupture, limit of proportionality, modulus of elasticity. Increase in the soaking and drying cycles also reduce the specific energy (toughness) because the energy consumed during fiber fracture is minimal compared to the developed during pull out process.

Ananda raj et. al (2019) his studies has explored structural distress in glass fibre reinforced concrete under loading and exposure to aggressive environments and conclusion are that the workability of concrete mixtures made with marble dust or graphite dust was so similar to that of control concrete as both the former and the latter possessed medium workability. A preliminary investigation showed that 20% marble dust as fine aggregate improved the strength characteristics of concrete. Then the further investigation has shown that 1% glass addition to concrete containing 20% marble dust as fine aggregate replacement produced higher strength properties than control concrete.

Sarada Prasad Kundu et. al (2018) The experimental results revealed that compressive strength, flexure strength and flexure toughness of tanning and polymer modified jute fibre reinforced concrete paver block are 30%, 49%, 166% higher respectively as compared to that of reference paver blocks. It is demonstrated that the use of surface modified jute fibre as fibre reinforced in concrete paver blocks not only enhances the mechanical properties but also the extends the service life of paver blocks that may lead to minimize life cycle, cost as well.

III. SCOPE OF STUDY

The concrete is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. The formation of cracks is the main reason for the failure of the concrete. To increase the tensile strength of concrete many attempts have been made. One of the successful and most commonly used methods is providing steel reinforcement. Steel bars, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until they encounter steel bars. Thus, need for multidirectional and closely spaced steel reinforcement arises. That cannot be practically possible. Thus, there is a technical gap. This problem has greatly necessitated this study in order to explore the option of using fiber reinforced concrete to limit the occurrence of cracks, increase the tensile strength of concrete and to compensate the brittleness behavior of plain concrete. But the vulnerability of steel fiber to corrosion and manufacture of synthetic fibres are quite costly and energy consuming restrains their applications. In these situations, the natural fibres are often considered as a potential alternative fiber to produce fiber reinforced concrete.

IV. METHODOLOGY

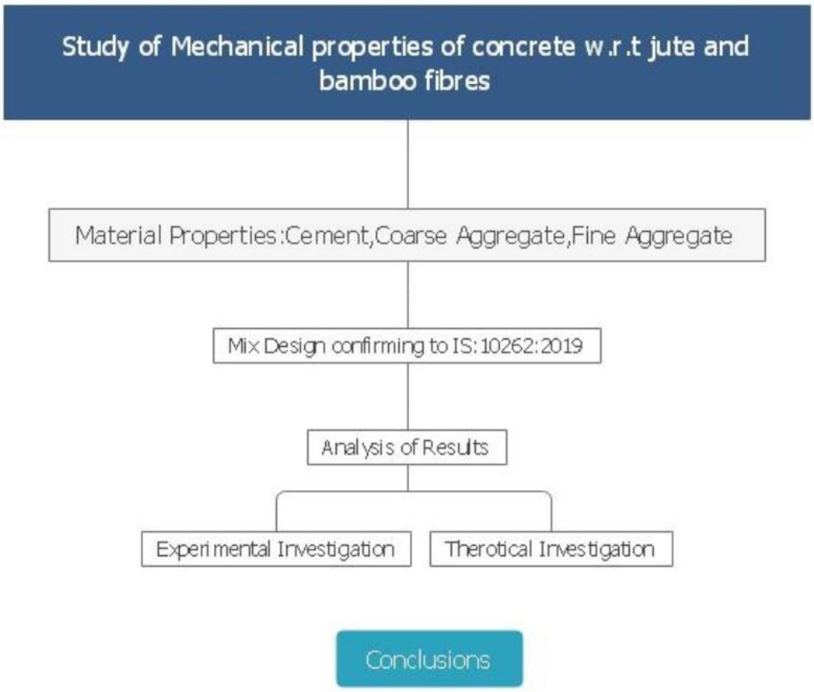

Figure 1: Flow Chart of Proposed Work

V. MATERIAL PROPERTIES

5.1 Cement

Table 1: Properties of Cement

Test	Experimental Results	IS Codes	Codal Provisions
Specific Gravity	3.1	IS 4301 Part XI:1988	3.0-3.20
% Fineness	2%	IS 4301 Part- I:1988	residue<10%
Normal Consistency	32%	IS 4301 Part- IV:1988	27-33% by wt.
Initial Setting Time	35 min	IS 4301 Part- IV:1988	should be>30min
Soundness	2 mm	IS 4301 Part- III:1988	should be<10mm

5.2 Fine Aggregate

Table 2: Properties of Fine Aggregate

Test	Experimental Results	IS Codes	Codal Provisions
Specific Gravity	2.69	IS 2386 Part-: III 1988	2.5-3.0
Sieve analysis	Zone - III	IS 2386 P-I:1963	N. A
Fineness modulus	2.4	IS 2386 P-I:1963	2.2-2.6
Water absorption	1%	IS 2386 P-III:1963	0.1-2%

5.3 Coarse Aggregate

Table 3: Properties of Coarse Aggregate

Test	Experimental Results	IS Codes	Codal Provisions
Specific Gravity	2.81	IS 2386 Part- III:1963	2.5-3.0
Impact value	27.9%	IS 2386 Part- IV:1963	Should be<35%
Water absorption	0.4%	IS 2386 Part- III:1963	0-2%

5.4 Jute fibers

Locally available untreated raw jute as shown in Figure 2 was used as a fiber to prepare the fiber reinforced concrete. Raw jute is purchased from a local factory in Rajam which is about 2.0–2.5 m long and grey to golden in color. Jute fibers have an average diameter of 0.1 mm, 162% absorption after 24 h immersion in water. The untreated jute fibres were cut into length of 50 mm.

Figure 2: Jute Fibers

5.5 Bamboo Fibers

Locally available untreated bamboo as shown in Figure 3 was used as a fiber to prepare the fiber reinforced concrete. The furniture manufacturing process produces waste in the form of bamboo fiber. This waste Bamboo fiber is collected from a local furniture manufacturing shop in Rajam which is golden in color. Bamboo fibres have an average diameter of 1.0 mm, 62%absorption after 24 h immersion in water. The untreated bamboo fibres were cut into length of 50 mm.

Figure 3: Bamboo Fibres

5.6 Silica Fume

Silica fume is a byproduct resulting from the reduction of high – purity quartz with coal or coke and wood chips in an electric arc furnace during the production of silicon metal or silicon alloys. Silica fume as shown in Figure 4 is used as an admixture in concrete.

Figure 4: Silica Fume

VI. EXPERIMENTAL INVESTIGATION

Based on concrete mix design as discussed in Annexure I Cement, sand, aggregate and water with a ratio of 1:1.61:3.04:0.48, respectively, are used for preparing plain concrete (PC).For preparing Fiber Reinforced concrete (FRC), same ingredient with addition of jute and bamboo fibres having 50 mm length are used with proportion varying from 0% to 1.5% by cement mass. Silica fume of 10% by weight of cement as admixture is also added to FRC. Concrete is prepared by hand mix. For preparing FRC, jute and bamboo fibres are soaked in water for 24 h. Then, fibres are left open in air for 30 min before mixing. To prevent balling effect fibres are added layer by layer to the concrete while mixing and it also helps uniform distribution of fibres. Due to prior immersion in water, fibres have absorbed comparatively less water. Molds are cast by spreading the concrete in three layers and tamping each layer 25 times with rod.

Molds of PC and FRC are prepared by same procedure. After 24 hours, specimens were demolded and placed into curing tank for 14 and 28 days. The details of the test specimen are shown in the Table 4.

Table 4: Quantities for Mix Proportion

Mix designation	Silica fumes (%)	Bamboo fiber (%)	Jute Fiber (%)	Fiber length (mm)	Coarse aggregate (Kg/m3)	Fine aggregate (Kg/m3)	Cement (Kg/m3)
MJB1	0	0	0	50	1214.268	642.576	399.125
MJB2	10	0	0	50	1214.268	642.576	399.125
MJB3	10	0	0.5	50	1214.268	642.576	399.125
MJB4	10	0	1	50	1214.268	642.576	399.125
MJB5	10	0	1.5	50	1214.268	642.576	399.125
MJB6	10	0.5	0	50	1214.268	642.576	399.125
MJB7	10	0.5	0.5	50	1214.268	642.576	399.125
MJB8	10	0.5	1	50	1214.268	642.576	399.125
MJB9	10	0.5	1.5	50	1214.268	642.576	399.125
MJB10	10	1	0	50	1214.268	642.576	399.125
MJB11	10	1	0.5	50	1214.268	642.576	399.125
MJB12	10	1	1	50	1214.268	642.576	399.125
MJB13	10	1	1.5	50	1214.268	642.576	399.125
MJB14	10	1.5	0	50	1214.268	642.576	399.125
MJB15	10	1.5	0.5	50	1214.268	642.576	399.125
MJB16	10	1.5	1	50	1214.268	642.576	399.125
MJB17	10	1.5	1.5	50	1214.268	642.576	399.125

6.1 Preparation of Concrete Specimen.

For each of the above cases mentioned in Table 4, a total of 1.765 ft^3 (0.05 m^3) of concrete was prepared to conduct slump test of fresh concrete as per IS-1199: 1959, and to cast 2 concrete cylinders (150mm diameter and 300mm height), 2 concrete cubes (150mm x150mm x 150mm) and 2 concrete prisms (100mmx 100mmx 500mm). After the 24 hours, the specimens were demolded, and submerged in water. Each of the cube, cylinder and prism were tested for compression, split-tension and flexure strength respectively at 14 and 28 days as per IS 516: 1959.

6.2 Network Architecture

Artificial neural network is a powerful data-modeling tool that is able to capture and represent complex input and output relationships. The design of the ANN model requires identifying the network architecture (i.e., number of input neurons, output neurons, hidden layers, and neurons in each hidden layers) and the network settings (activation function). Artificial neural networks consist of at least three layers, i.e., an input layer, one or more hidden layer/layers, and an output layer. The adopted network architecture consists of the following.

Seven neurons (Ni =7) in the input layer, which represent the variables of cement content (CC: kg), fine aggregate content (F.A; kg), coarse aggregate content (C.A; kg), water content (W; kg), silica fume content (SF; kg), bamboo fiber content (B; kg), and jute fiber content (J; kg). One neuron in the output layer, which represents the value of the corresponding compressive strength (MPa), split tensile strength (MPa), or flexural strength (MPa). One hidden layer with 10 neurons.

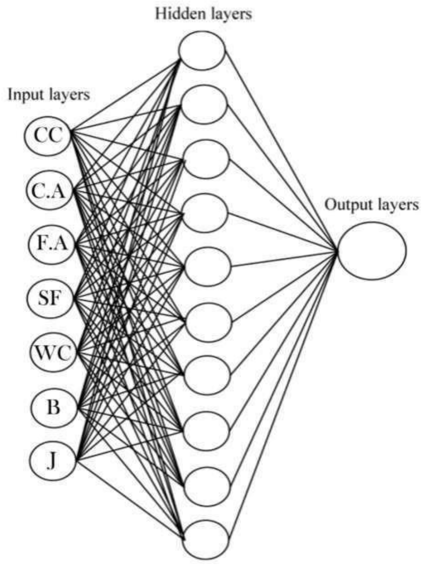

Figure 5: Architecture of ANN

The classification of training functions, such as Neural Network- Levenberg-Marquardt (NN-LM) and Neural Network Gradient Descent (NN-GD) is used to perform the analysis. MSE (mean square error) is used as a performance function and Feed-forward back propagation neural networks have been used in this paper.

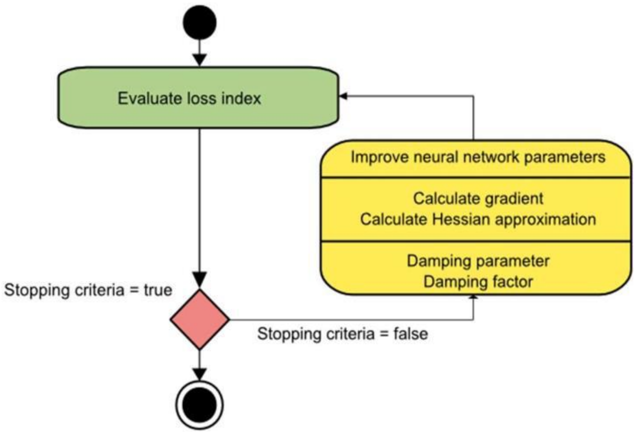

Figure 6: Training process of a neural network with the Levenberg- Marquardt algorithm

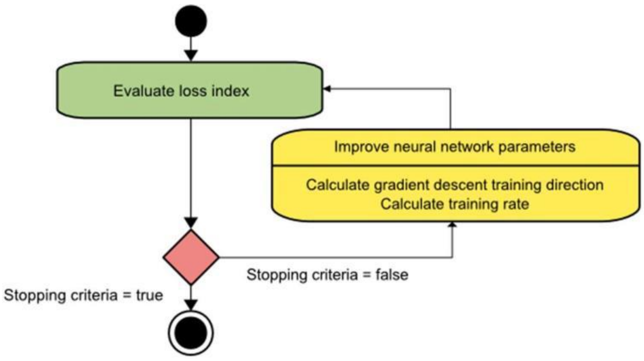

Figure 7: Activity diagram of the training process with gradient descent

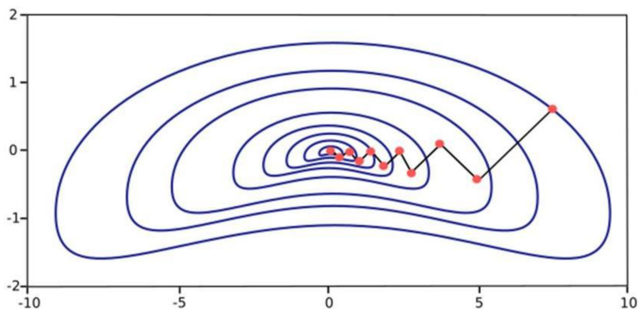

Figure 8: Graphical representation of direction (downhill gradient) of loss function in gradient descent training algorithm

VII.RESULTS & DISCUSSIONS

7.1 Compressive Strength

The simulation to detect the strength of compression was performed on Natural fiber reinforced concrete and control mixture with various proportions of Bamboo and Jute fibres with 10% silica fumes are given in Table 6.1 and Figure 6.1 From the test results it is seen that the compressive strength increases by 7% and 3% for MJB3 i.e., concrete with 0% Bamboo fibres and 0.5% Jute fibres by weight of cement for 14 days and 28 days respectively. The maximum Percentage of increase in compressive strength of 17% for 14 days and 12% for 28 days observed for MJB7 i.e., concrete with 0.5% Bamboo fibres and 0.5% Jute Fibres when compared to control specimen. Similarly, it is observed that MJB4 i.e., concrete with 0% Bamboo fiber and 1% Jute fibres by weight of cement showed decreased in compressive strength of 5% in 14 days and 28 days curing.

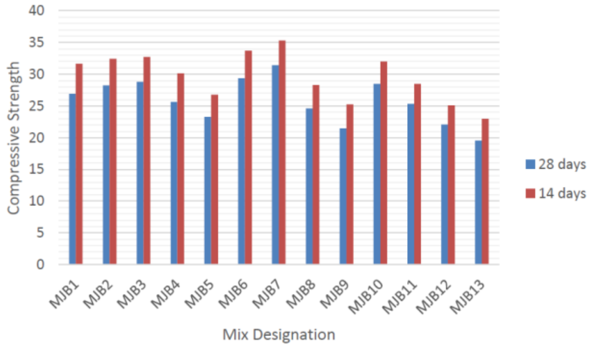

Figure 9: Compressive strength of concrete with bamboo and jute fibres

Whereas MJB10 i.e., concrete with 1% Bamboo fibres and 0% Jute fibres showed increase in compressive strength of 6% and 1% for 14 days and 28 days curing. Generally, a conclusion can be arrived such that compressive strength increases only for specimen which has 1% or less that 1% addition of Bamboo and Jute fibres and for all other specimens the compressive strength decreases. More over from the test results it known that Bamboo fiber has contributed in increase in compressive strength when compared to Jute fibres.

Table 5: Compressive Strength of Plain concrete and Fiber reinforced concrete

Mix designation	Silica fumes	Bamboo fiber (%)	Jute Fiber (%)	14 days compressive strength	% increase in 14 days	28 days compressive strength	% increase in 28 days
MJB1	0	0	0	26.90	0	31.64	0
MJB2	10	0	0	28.23	5	32.44	3
MJB3	10	0	0.5	28.79	7	32.71	3
MJB4	10	0	1	25.61	-5	30.12	-5
MJB5	10	0	1.5	23.28	-13	26.76	-15
MJB6	10	0.5	0	29.34	9	33.72	7
MJB7	10	0.5	0.5	31.42	17	35.31	12
MJB8	10	0.5	1	24.61	-9	28.29	-11
MJB9	10	0.5	1.5	21.45	-20	25.24	-20
MJB10	10	1	0	28.48	6	32.00	1
MJB11	10	1	0.5	25.33	-6	28.46	-10
MJB12	10	1	1	22.07	-18	25.08	-21
MJB13	10	1	1.5	19.55	-27	23.00	-27
MJB14	10	1.5	0	24.33	-10	27.33	-14
MJB15	10	1.5	0.5	22.16	-18	25.47	-20
MJB16	10	1.5	1	19.93	-26	23.45	-26
MJB17	10	1.5	1.5	19.69	-27	22.37	-29

7.2 Split Tensile Strength

The split tensile strength analysis was performed on Natural fiber reinforced concrete and control mixture with various contents of Bamboo and jute fibres with 10% silica fume under 14 days and 28 days curing are given in Table 6. The outcomes prove that the exponential increase in Split tensile strength of 21% and 17% for 14 days and 28 days curing for MJB7 i.e., concrete with 0.5% bamboo fibres and 0.5% of Jute fibres by weight of cement when distinguished with control specimen. It is evident from the results that concrete specimen with Bamboo fibres contribute the increase in the split tensile strength. Similarly, there is a decrease in the split tensile strength ranging from 3% to 17% for the concrete specimen having natural fibres more 1% by weight of cement. It is mainly owing to the occurrence of mat in the fiber which prevents the fiber from flow thus resulting in unequal distribution of fiber in the mixture.

Table 6: Split tensile strength of Plain concrete and Fiber Reinforced concrete

Mix designation	Silica fumes	Bamboo fiber (%)	Jute Fiber (%)	14 days Split tensile strength	% increase in 14 days	28 days Split tensile strength	% increase in 28 days
MJB1	0	0	0	2.28	0	2.65	0
MJB2	10	0	0	2.40	5	2.73	3
MJB3	10	0	0.5	2.61	14	2.97	12
MJB4	10	0	1	2.39	5	2.78	5
MJB5	10	0	1.5	2.22	-3	2.50	-6
MJB6	10	0.5	0	2.42	6	2.81	-6
MJB7	10	0.5	0.5	2.77	21	3.11	17
MJB8	10	0.5	1	2.20	-4	2.55	-4
MJB9	10	0.5	1.5	2.13	-7	2.40	-9
MJB10	10	1	0	2.30	1	2.68	1
MJB11	10	1	0.5	2.23	-2	2.59	-2
MJB12	10	1	1	2.08	-9	2.31	-13
MJB13	10	1	1.5	2.01	-12	2.26	-15
MJB14	10	1.5	0	2.27	0	2.58	-3
MJB15	10	1.5	0.5	2.06	-10	2.39	-10
MJB16	10	1.5	1	1.93	-15	2.24	-15
MJB17	10	1.5	1.5	1.90	-17	2.11	-20

7.3 Flexural Strength

Table.7 shows the flexural strength of Fiber reinforced concrete and plain concrete under 14 days and 28 days curing. From the test results it is evident that flexural strength increases by 61% and 58% for MJB3,44% and 43% for MJB4,9% and 10% for MJB5, 5% and 2% for MJB6 for 14 days and 28 days of curing. Whereas the maximum increase in flexural strength of 81% and 77% for 14 days and 24 days curing was observed for MJB7 i.e. concrete with 0.5% bamboo fibres and 0.5% jute fibres with 10% silica fumes. Similarly the flexural strength of MJB8 increases by 9% and 10%,MJB9 increases by 33% and 35%,MJB10 increase by 46% and 42%,MJB11 increases by 38% for 14 days and 24 days curing. The flexural strength of concrete for MJB12 increases by 19% and 15%,MJB13 increases by 1% and 2%,MJB14 increases 30% and 27%,MJB15 increases by 9% under 14 days and 24 days curing. Moreover the specimen MJB16 and MJB17 shows decrease in flexural strength when compared with control specimen. The increase in flexural strength is due to the presence of bamboo fibres and jute fibres which provide the bridging effect in concrete.

Table 7: Flexural strength of Plain concrete and Fiber Reinforced concrete

Mix designation	Silica fumes	Bamboo fiber (%)	Jute Fiber (%)	14 days Flexural tensile strength	% increase in 14 days	28 days Split Flexural strength	% increase in 28 days
MJB1	0	0	0	4.25	0	4.88	0
MJB2	10	0	0	6.05	42	7.04	44
MJB3	10	0	0.5	6.85	61	7.70	58
MJB4	10	0	1	6.14	44	6.98	43
MJB5	10	0	1.5	4.65	9	5.35	10
MJB6	10	0.5	0	4.46	5	4.96	2
MJB7	10	0.5	0.5	7.71	81	8.66	77
MJB8	10	0.5	1	4.65	9	5.35	10
MJB9	10	0.5	1.5	5.67	33	6.59	35

MJB10	10	1	0	6.22	46	6.91	42
MJB11	10	1	0.5	5.86	38	6.73	38
MJB12	10	1	1	5.05	19	5.61	15
MJB13	10	1	1.5	4.30	1	5.00	2
MJB14	10	1.5	0	5.54	30	6.22	27
MJB15	10	1.5	0.5	4.62	9	5.31	9
MJB16	10	1.5	1	3.96	-7	4.40	-10
MJB17	10	1.5	1.5	3.72	-12	4.32	-11

7.4 Prediction of NN

Table 8: Comparative analysis on actual and predicted values for 14 days curing

Mix Designation			**Compressive strength**			**Split Tensile strength**			**Flexural Strength**
Actual		**Predicted Values**		**Actual**		**Predicted Values**	**Actual**		**Predicted values**
NN-LM		**NN-GD**		**NN-LM**		**NN-GD**	**NN-LM**		**NN-GD**
MJB1	26.90	26.90	27.75	2.28	2.27	2.31	4.25	4.28	4.23
MJB2	28.23	28.23	29.96	2.40	2.44	2.42	6.05	5.72	6.07
MJB3	28.79	27.50	30.00	2.61	2.59	2.57	6.85	6.9	6.81
MJB4	25.61	25.61	27.22	2.39	2.37	2.40	6.14	6.6	6.16
MJB5	23.28	23.38	23.33	2.22	2.18	2.25	4.65	4.61	4.63
MJB6	29.34	30.15	29.03	2.42	2.40	2.45	4.46	4.8	4.48
MJB7	31.42	28.48	28.98	2.77	2.53	2.52	7.71	7.57	7.62
MJB8	24.61	24.61	24.84	2.20	2.29	2.25	4.65	4.72	4.68
MJB9	21.45	21.45	21.70	2.13	2.13	2.08	5.67	5.68	5.68
MJB10	28.48	28.48	26.90	2.30	2.30	2.35	6.22	5.71	6.14
MJB11	25.33	25.33	25.64	2.23	2.23	2.27	5.86	5.68	6.18
MJB12	22.07	22.07	21.56	2.08	2.08	2.05	5.05	4.97	5.03
MJB13	19.55	20.16	20.51	2.01	2.01	1.98	4.30	4.35	4.32
MJB14	24.33	24.33	24.50	2.27	2.25	2.17	5.54	5.59	6
MJB15	22.16	22.16	22.42	2.06	2.02	2.07	4.62	4.43	4.62
MJB16	19.93	19.93	20.22	1.93	1.92	1.97	3.96	3.82	3.72
MJB17	19.69	19.56	19.93	1.90	1.91	1.95	3.72	3.74	3.73

Table 9: Comparative analysis on actual and predicted values for 28 days curing

Mix Designation			**Compressive strength**			**Split Tensile strength**			**Flexural Strength**
Actual		**Predicted Values**		**Actual**		**Predicted Values**	**Actual**		**Predicted values**
NN-LM		**NN-GD**		**NN-LM**		**NN-GD**	**NN-LM**		**NN-GD**
MJB1	31.64	31.68	31.97	2.65	2.53	2.67	4.88	4.58	4.82
MJB2	32.44	34.16	34.50	2.73	2.73	2.75	7.04	7.32	6.62
MJB3	32.71	33.23	33.75	2.97	2.97	2.94	7.70	7.74	7.89
MJB4	30.12	29.93	31.43	2.78	2.85	2.82	6.98	7.2	6.93
MJB5	26.76	26.52	27.34	2.50	2.50	2.53	5.35	5.28	5.46

MJB6	33.72	34.07	33.71	2.81	2.81	2.83	4.96	5.3	5.3
MJB7	35.31	33.17	32.27	3.11	2.94	2.89	8.66	8.51	7.92
MJB8	28.29	28.66	28.72	2.55	2.62	2.58	5.35	5.4	5.8
MJB9	25.24	24.66	25.28	2.40	2.40	2.31	6.59	6.45	6.1
MJB10	32.00	31.43	31.58	2.68	2.68	2.72	6.91	6.5	6.3
MJB11	28.46	29.53	28.38	2.59	2.65	2.64	6.73	6.45	6.82
MJB12	25.08	25.15	25.14	2.31	2.31	2.30	5.61	5.67	5.1
MJB13	23.00	23.28	23.91	2.26	2.26	2.20	5.00	4.96	4.91
MJB14	27.33	27.61	27.90	2.58	2.58	2.49	6.22	6.15	6.55
MJB15	25.47	24.67	24.91	2.39	2.39	2.39	5.31	5.08	5.33
MJB16	23.45	22.87	23.56	2.24	2.24	2.22	4.40	4.42	4.53
MJB17	22.37	22.58	23.23	2.11	2.24	2.19	4.32	4.34	4.67

VIII. CONCLUSION

An experimental analysis was done to verify the joined influence of bamboo and jute fibres in the hardened concrete. Furthermore, the effect of fibres was also predicted using NN-LM and NN-GD methods, which have obtained the values nearer to the actual values. The major conclusions achieved from the simulation results are provided as follows:

- The compressive strength of concrete with 0.5% bamboo fibres ,0.5% jute fibres and 10% silica fume by weight of cement shows higher strength at 14 days and 28 days curing when compared to other mix.
- Specimen which has 1% or less that 1% addition of Bamboo and Jute fibres has increased in compressive strength and for all other specimens the compressive strength decreases. More over from the test results it known that Bamboo fiber has contributed in increase in compressive strength when compared to Jute fibres.

- The split tensile strength was maximum for concrete with 0.5% bamboo fibres, 0.5% jute fibres and 10% silica fumes which is 21% and 17% higher than the control specimen for 14 days and 28 days curing.

- The maximum percentage increase in flexural strength was obtained for 0.5% bamboo fibres, 0.5% jute fibres and 10% silica fumes which are 81% and 77% higher than the control specimen under 14 days and 28 days curing.

- The prediction of compression strength, Split tensile strength and flexural strength values using NN-LM and NN-GD has attained its maximum performance.

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