



IMPACTS OF ADDING JUTE FIBRES TO CONCRETE

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Abstract —The modernisation in construction technology has damaged our environment to a greater extent. This research aims at providing environment friendly fibers to fiber reinforced concrete. Concrete is one such basic component in which constant up gradation has always been implemented in order to improve its properties by adding different admixtures or additives. Jute Fiber is one such material which could be added in concrete to improve its properties and strength without having any environmental damage.

Keywords—Concrete, jute fiber, admixtures, additives, fiber reinforced concrete

“I. INTRODUCTION”

Concrete is a composite construction material composed primarily of aggregate, cement and water. The aggregate is generally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. It has been recognized that the addition of small closely spaced and uniform dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as Fiber Reinforced Concrete.

A. Fiber Reinforced Concrete

Fiber-reinforced concrete (FRC) is concrete containing fibrous material, which increases its structural integrity. The only disadvantage of cement concrete is its brittleness, with relatively low tensile strength and poor resistance to crack opening and propagation and negligible elongation at break. To overcome these discrepancies reinforcement with dispersed fibers might play an important role. Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete. Some types of fibers produce greater impact and abrasion in concrete. Generally fibers do not increase the flexural strength of concrete, and so cannot replace moment resisting or structural steel reinforcement.

Types of fiber reinforced concrete

The following are the types of fiber reinforced concrete which are discussed in the following section:

1. Natural Fiber reinforced concrete
2. Steel FRC
3. Mineral FRC
4. Glass FRC

B. Classification of natural fibres

Natural fibres are divided into animal fibres and plant cellulose fibres. Plants that produce natural fibres are termed as primary and secondary depending on the utilization. Primary plants are grown for their fibres while secondary plants are plants where the fibres are extracted from the waste product. There are thousands of natural fibres available and therefore there are many research interests in utilization of natural fibres to improve the properties of composites.

1. Coir fibre

Coir is a versatile natural fibre obtained from the coconut shell. Coir is very durable to the natural weathering. Blending of coir fibre improves the ductility, flexural and tensile strengths, fracture toughness and crack inhibiting properties of the matrix. Use of coconut fibres has shown an enhancement of concrete with respect to toughness, tensile strength and torsion

2. Bamboo fibre

Bamboo is one of the building materials that have high tensile strength and light weight. Bamboo fibres can be used as replacement with concrete which will decrease the cost of concrete that is 10000cm³ per 1m³ of concrete. From the test results it is observed that bamboo can potentially be used as substitute for steel reinforcement. Also bamboo is an eco-friendly material, limiting the use of steel can reduce carbon dioxide emissions.

3. Jute fibre

Jute with the highest production volume is the cheapest natural fibres. These fibres are extracted from the ribbon of the stem. Jute fibers are composed mainly of the plant materials cellulose and lignin. Recent studies have shown that jute fibre delays the hardening of concrete and improves the resistance of concrete against cracking. Workability of jute fiber reinforced concrete mix is improved by using an admixture called tannin.

4. Bagasse fibre

Bagasse is a fibrous remains obtained from sugar cane after the extraction of sugar juice. Sugar cane is a commercially grown agricultural crop in South East Asia. Bagasse remains are used in the sugarcane factories or in the paper pulp industries. Sugar content tests on bagasse had shown a residue of about 0.02 percent sugar by mass in the fibres which would not cause any retardation in the setting of concrete.

5. Sisal fibre

Sisal fibre is obtained from the leaves of the plants. Leaves are crushed between the rollers and the mechanically scraped. Sisal fibre is coarse and inflexible because of its strength, durability, ability to stretch and resistance to deterioration in saltwater. The addition of sisal fibre to the concrete matrix reduces its ability to creep. Sisal is very well resistant against moist, good tension resistance or tensile strength. well resistant against heat. From the results discussed in this review it is clear that incorporation of the But due to high moisture absorption by the natural fibres, compressive strength does not gave desirable results. However, in future, the advanced chemical treatments to these fibres may help in modifying the natural fiber reinforced concrete performance.

“II. METHODOLOGY”

A. Alkali Treatment on jute fibres

Procedure

1. The jute fibres were soaked in a 5% NaOH solution.
2. The initial weight of fabric pieces (W_1) was noted.
3. The fabrics were kept immersed in the alkali solution for 1, 2, 4, 6 and 8 h.
4. The fabrics were then washed several times with fresh water to remove any NaOH sticking to the fibre surface.
5. Then the fibres were dried at room temperature for 48 h followed by oven drying at 100°C for 2 h.

B. Compressive Strength Test on Jute Fiber Reinforced Concrete

Concrete is primarily strong in compression and in actual construction, the concrete is used in compression. Concrete, which is strong in compression, is also good in other quality. Higher the Compression strength better is the durability. Preparation and conduct of compressive strength is comparatively easy and give consistent result than tensile strength or flexural strength. This test for determining compressive strength of concrete has therefore assumed maximum important.

Procedure

The whole procedure is divided into two parts viz. procedure of casting and procedure of testing.

Procedure of casting

1. Fill concrete into the mould in layer approximately 50 mm deep by moving the scoop around the top edge of the mould as the concrete slides form it, in order to ensure the symmetrical distribution of the concrete within the mould.
2. If compaction is done by hand tamps, the concrete with the standard rod, strokes being uniformly distributed over the cross section of the mould. For 15 mm cube, number of strokes should not be less than 35 per layer and 25 strokes for 10 cm cubes. Tamp the sides of the mould to close the voids left by tamping bars. If compaction is done by vibration then each layer is compacted by means of a suitable vibrating hammer or vibrator or vibrating table. Mode and quantum of vibration of laboratory specimen shall be near the same as those adopted in actual operation.
3. Storing the specimen in a place for 24 + 0.5 hours from time addition of water to dry ingredients. Remove the specimen from the mould and keep it immediately submerged in clean, fresh water and keep them until taken out just prior to test. Water in which the specimen is submerged shall be renewed every 7 days.

Procedure of testing

1. Age of test: usually testing is done after 7 days and 28 days. The days being measured from the time water is added to the dry ingredients.
2. Test at least 3 specimens at a time.
3. Test the specimen immediately or removal from water and while they are still in the wet condition. Wipe off the surface water. If the specimens are received dry, keep them in water for 24 hours before testing.
4. Place the specimen in such a manner that the load shall be applied to opposite sides of the cube cast i.e. not to the top and the bottom.
5. Align carefully the center of the thrust of the spherical scaled plate.
6. Apply load slowly and at the rate of 14 N/mm². Till the cube breaks.
7. Note the maximum load and appearance of the concrete failure i.e. whether aggregates have broken or cement paste separates from the aggregates etc.



“Fig2.1 Compression Test on cube specimen”



“Fig 2.2 Cube specimen after compression test”



“Fig 2.3 Split Tensile Test on cylindrical specimen”



“ Fig 2.4 Cylindrical specimen after split tensile test”

C. Split Tensile Test on Jute Fiber Reinforced Concrete

When a concrete cylinder is subjected to compressive loads applied along diametrically opposite lines i.e. when load is applied along the axis of the cylinder, then an element on the vertical diameter of the cylinder is subjected to vertical compressive stress and a tensile stress in the lateral direction.

$$\sigma_t = 2P/\pi ld$$

Where,

P = compressive load on cylinder

L = length of cylinder

D = diameter of cylinder

Procedure

1. Place the cylinder with the longitudinal axis in horizontal direction between the plates of compression testing machine.
2. Place narrow strips of packing material such as plywood between the plates and cylinder surface.
3. Load is applied at such a rate that tensile stress acting on the vertical diameter increases at a rate of 0.7 N/mm²/minute.

C. Durability Tests on Jute Fiber Reinforced Concrete

Sulphate Attack Test

For acid attack test concrete cube of size 150 x 150 x 150 mm are prepared. The specimen are cast and cured in mould for 24 hours, after 24 hours, all the specimen are demoulded and kept in curing tank for 7-days. After 7-days all specimens are kept in atmosphere for 2-days for constant weight, subsequently, the specimens are weighed and immersed in 5% sulphuric acid(H_2SO_4) solution for 60-days. After 60-days of immersing in acid solution, the specimens are taken out and were washed in running water and kept in atmosphere for 2-day for constant weight. Subsequently the specimens are weighed and loss in weight and hence the percentage loss of weight was calculated.



“Fig 2.5 Cube specimen immersed in H_2SO_4 solution”



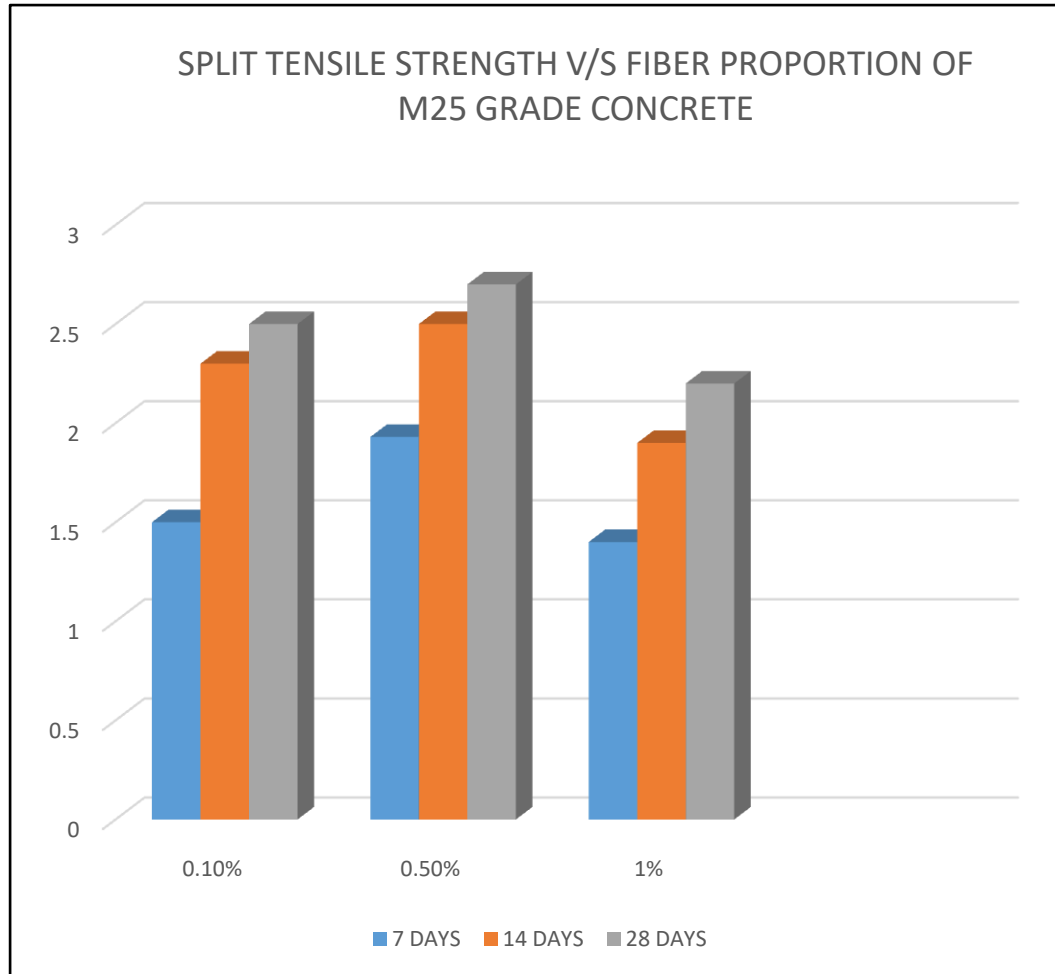
“Fig 2.6 Cube specimen after sulphate attack”

“III. RESULTS AND DISCUSSION”

A. Compressive Strength Analysis

“Table 3.1 Results of cube test of M25 grade concrete”

Sr No.	Type Of Specimen	Proportion Of Fibres	Fiber Aspect Ratio	Results In Mpa		
				7 Days	14 Days	28 Days
	Cube	0	0	19	24	26
1	Cube	0.1 %	200	22	24.3	26.3
2	Cube	0.1 %	400	22.8	23	25
3	Cube	0.1 %	666.7	21.2	22	24.5
4	Cube	0.5 %	200	23.1	26.3	33.3
5	Cube	0.5 %	400	24	25.8	30
6	Cube	0.5 %	666.7	22.4	26	28
7	Cube	1 %	200	21.7	23.2	26
8	Cube	1 %	400	21	22.7	24.4
9	Cube	1 %	666.7	20.2	23	25.6



“Fig 3.1 : Graph of Compressive strength v/s fiber proportion for M25 grade concrete”

2) For M20 grade concrete :

“Table 3.2 Results of cube test of M20 grade concrete”

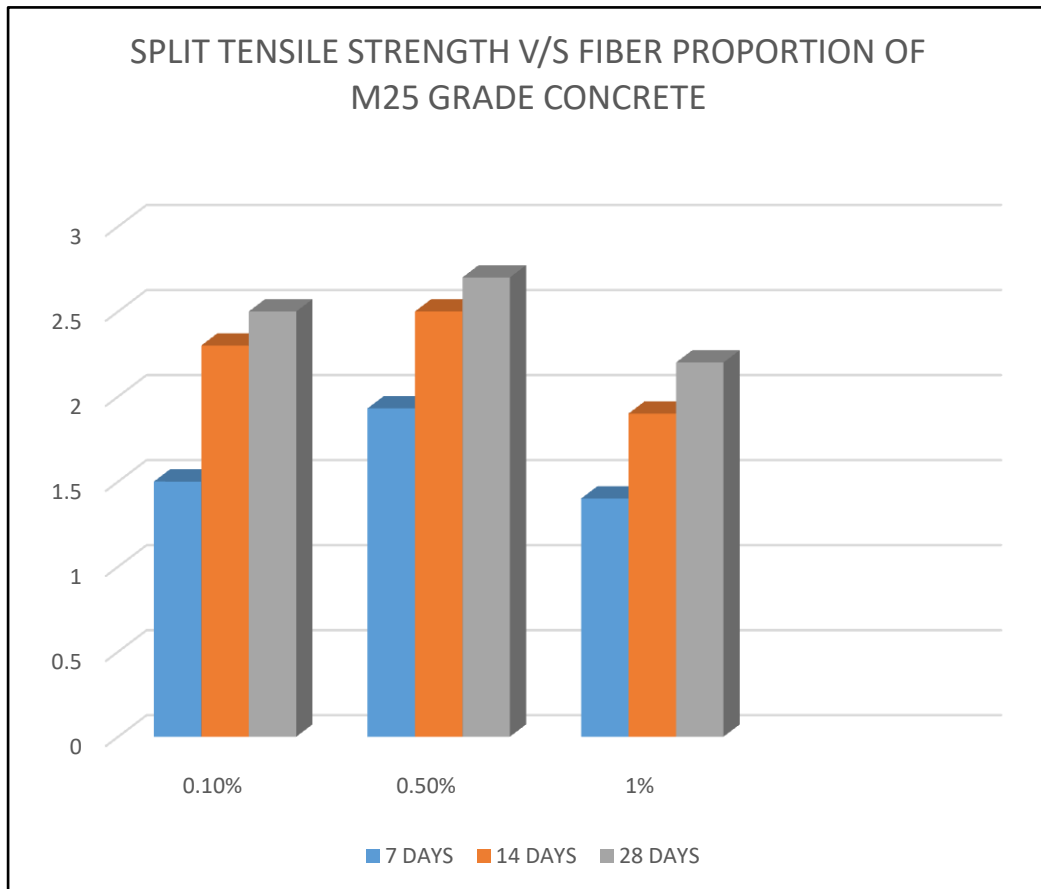
Sr No.	Type Of Specimen	Proportion Of Fibres	Fiber Aspect Ratio	Results In Mpa		
				7 Days	14 Days	28 Days
	Cube	0	0	15	19	21
1	Cube	0.1 %	200	16.5	19.2	21
2	Cube	0.1 %	400	14.5	18.5	20.1
3	Cube	0.1 %	666.7	14.5	17	20
4	Cube	0.5 %	200	18	21	24.3
5	Cube	0.5 %	400	16.2	19	23
6	Cube	0.5 %	666.7	16	20.4	23.5
7	Cube	1 %	200	15	17.5	19
8	Cube	1 %	400	14.2	16	18
9	Cube	1 %	666.7	13	15	17.9

B. Split Tensile Strength Analysis

1) For M25 Grade Concrete :

“Table 3.3 Results Of Split Tensile Test Of M 25 Grade Concrete”

Sr No.	Type Of Specimen	Proportion Of Fibres	Fiber Aspect Ratio	Results In Mpa		
				7 Days	14 Days	28 Days
	Cylinder	0	0	1.4	1.9	2.4
1	Cylinder	0.1 %	200	1.5	2.3	2.5
2	Cylinder	0.1 %	400	1.4	2.0	2.2
3	Cylinder	0.1 %	666.7	1.38	1.9	2.1
4	Cylinder	0.5 %	200	1.93	2.5	2.7
5	Cylinder	0.5 %	400	1.89	2.2	2.6
6	Cylinder	0.5 %	666.7	1.5	2.2	2.4
7	Cylinder	1 %	200	1.4	1.9	2.2
8	Cylinder	1 %	400	1.3	1.8	2.0
9	Cylinder	1 %	666.7	1.2	1.5	1.8



“Fig 3.2 : Graph of Split Tensile Strength v/s fiber proportion of M25 grade concrete”

2) For M15 Grade Concrete :

“Table 3.4 Results Of Split Tensile Test Of M 15 Grade Concrete”

Sr No.	Type Of Specimen	Proportion Of Fibres	Fiber Aspect Ratio	Results In Mpa		
				7 DAYS	14 DAYS	28 DAYS
	Cylinder	0	0	0.9	1.2	1.6
1	Cylinder	0.1 %	200	1.3	1.43	2.0
2	Cylinder	0.1 %	400	1.14	1.39	1.95
3	Cylinder	0.1 %	666.7	1.0	1.35	1.78
4	Cylinder	0.5 %	200	1.4	1.8	2.3
5	Cylinder	0.5 %	400	1.3	1.64	2.1
6	Cylinder	0.5 %	666.7	1.1	1.56	1.9
7	Cylinder	1 %	200	1.0	1.31	1.68
8	Cylinder	1 %	400	0.98	1.21	1.56
9	Cylinder	1 %	666.7	0.89	1.1	1.45

C. Durability Test Analysis

1) For M 25 grade concrete

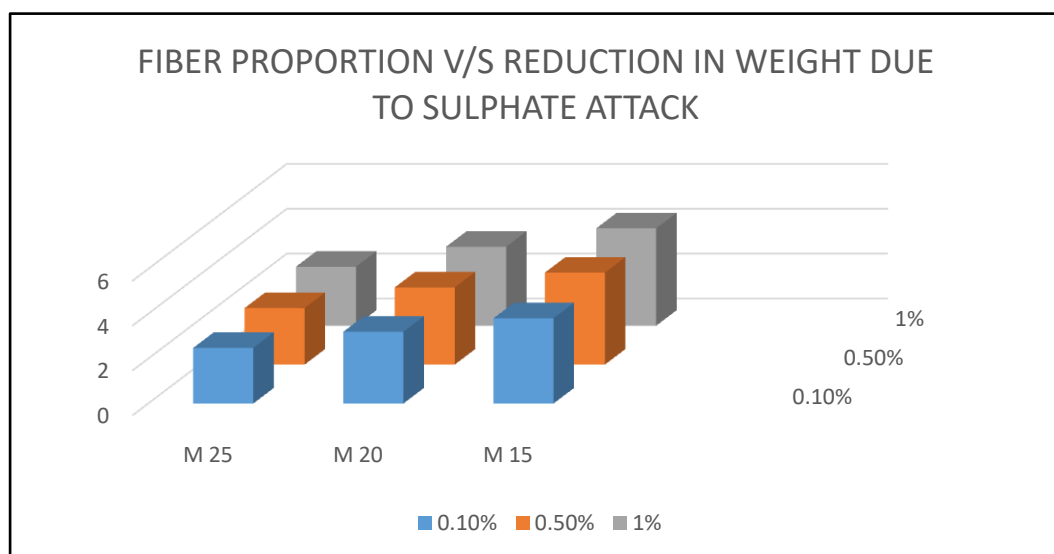
“Table 3.5 Results of durability test on cube specimen”

Sr No.	Type of specimen	Fiber content	% Reduction in weight
1	Cube	0.1%	2.48
2	Cube	0.5%	2.52
3	Cube	1%	2.63

2) For M 20 grade concrete

“Table 3.6 Results of durability test on cube specimen”

Sr No.	Type of specimen	Fiber content	% Reduction in weight
1	Cube	0.1%	3.2
2	Cube	0.5%	3.44
3	Cube	1%	3.52



“Fig 3.3 Graph of fiber proportion v/s reduction in weight due to sulphate attack”

“IV. CONCLUSIONS”

- It is hereby concluded that by adding jute fibres the compressive strength and split tensile strength increases to 33% and 10% respectively.
- Also the reduction in weight due to sulphate attack is within permissible limits.
- But increase in fibre proportion beyond a certain limit leads to decrease in compressive strength and tensile strength of concrete as due to increase in fiber proportion the water absorption increases which leads to increase in porosity thereby decreasing the strength characteristics.
- Increase in fiber aspect ratio also leads to decrease in the strength characteristics.

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