International Journal Of Engineering Research And Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 13, Issue 9 (September 2017), PP.60-64

Effect on Compressive Strength of Fiber-Reinforced concrete By addition of Jute Fibers

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ABSTRACT:- The modernisation in the 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,Fiber reinforced concrete,Admixtures,Jute Fiber,Construction

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. The cement, commonly Portland cement, and other cementitious materials such as fly ash and slag cement, serve as a binder for the aggregate. Plain cement concrete has relatively high compressive strength but possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to the brittle fracture of the concrete. 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. Cement concrete composite is the most important building material and its consumption is increasing in all countries. 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. Steel is the conventional reinforcing material in concrete. Although steel enhances the strength and modulus of concrete but it lacks the ability to absorb mechanical impact. The steel makes the reinforced cement concrete (RCC) structure heavy and in due course of time as a result of water/moisture diffusion through micro crack developed in the RCC structure steel starts corroding leading to failure of the concrete. On the contrary, if the micro crack formation and propagation can be minimized by dispersion of short fibers, the mechanical properties as well as the durability of the concrete can be improved. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete

B. Types of Fibre 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

- Natural Fiber Reinforced Concrete

Natural fibre reinforced concrete is a concrete which is made from natural fibres like jute, sisal, coir, bamboo etc. According to study of natural fibers, compared to natural inorganic fibers, vegetable fibers (natural organic) are very much renewable, eco-friendly, economical and production cost is also very low.

- Steel fiber reinforced concrete

Steel fiber is one of the most commonly used fibers. Generally, round fibers are used. Steel fibers permit the tensile strength of the SFRC to be used in design, because the matrix will no longer lose its load-carrying capacity at first crack. They also improve the bond between the matrix and the reinforcing bars by inhibiting the

growth of cracks emanating from the deformations (lugs) on the bars. Steel Fiber Reinforced Concrete (SFRC) mixes contain higher cement contents and higher ratios of fine to coarse aggregate than do ordinary concretes, and so the mix design procedures the apply to conventional concrete may not be entirely applicable to SFRC. Commonly, to reduce the
quantity of cement, up to 35% of the cement may be replaced with fly ash.

- **Mineral fiber reinforced concrete**

Polypropylene and nylon fibers are found to be suitable to increase the impact strength. They possess very high tensile strength, but their low modulus of elasticity and higher elongation do not contribute to the flexural strength Asbestos is a mineral fiber and has been proved to be the most successful of all the fibers as it can be mixed with Portland cement. Tensile strength of asbestos varies between 560 and 980 N/mm^2. Carbon fibers are often based on oxidized and via pyrolysis carbonized polymers like PAN, but the end product is almost pure carbon. The strongest engineering materials are generally made as fibers, for example carbon fiber. Carbon-fiber-reinforced polymers are a type of Composite material. Composites consist of two parts; a matrix and reinforcement. In CFRP the reinforcement is carbon fiber, which provides the strength.

- **Glass fiber reinforced concrete**

Glass fiber is a recent introduction in making fiber concrete. Glass fiber reinforced concrete (GFRC) consists of high strength glass fiber embedded in a cementitious matrix. In this form, both fibers and matrix retain their physical and chemical identities, a combination of properties that cannot be achieved with either of the components acting alone.

C. Classification of natural fibers

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.

- **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.

- **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.

- **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

- **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.

- **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. Compressive Strength Test on Jute Fibre 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. Bond strength is important in R. C. C. Compressive strength also indicated extent of Control exercised during construction. Resistance to abrasion and volume stability improves with the compressive strength. Test for compressive strength in therefore very important in quality control of concrete. 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. Cylinder used is 150 mm diameter and 300 mm height. Wherever cylinders are used for compressive strength results, the cube strength can be used to calculate with the following formula:
Minimum cylinder strength required = 0.8* compressive strength, specified for 150 mm cube.

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. For the cylindrical specimens, number of strokes shall not be 30 per layer. 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. Cylindrical specimens are capped with a thick layer of neat cement generally 2 or 3 hours after molding operations. Caps shall be formed by glass plate or metal plate. Work the plate on the mould till its lower surface rests on the top of the mould. The cement for the capping shall be mixed o a stiff plate for about 2 hours before it is to be used in order to avoid tendency of the cap to shrink. Adhesive of the paste to the capping to the capping plate can be avoided by coating the plate with a thin of oil or grease.

4. 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 rest. Water in which the specimen is submerged shall be renewed every 7 days.

Procedure of testing

5. 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.

6. Test at least 3 specimens at a time.

7. 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.

8. Note down the dimension nearest to 0.2 mm and also the mass.

9. 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.

10. Align carefully the center of the thrust of the spherical scaled plate.

11. Apply load slowly and at the rate of 14 N/mm2. Till the cube breaks.

12. Note the maximum load and appearance of the concrete failure i.e. whether aggregates have broken or cement paste separates from the aggregates etc.

III. RESULTS AND DISCUSSION

A. Compressive Strength Analysis

The following results are obtained by conducting the compressive strength test on M25 grade cube specimen.

Table 3.1 : Results of Compressive strength test on M 25 grade concrete cube specimen

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	23.1	26.3	33.3
2	Cube	0.1 %	400	24	25.8	30

3	Cube	0.1 %	666.7	22.4	26	28
4	Cube	0.5 %	200	22	24.3	26.3
5	Cube	0.5 %	400	22.8	23	25
6	Cube	0.5 %	666.7	21.2	22	24.5
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

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	18	21	24.3
2	Cube	0.1 %	400	16.2	19	23
3	Cube	0.1 %	666.7	16	20.4	23.5
4	Cube	0.5 %	200	16.5	19.2	21
5	Cube	0.5 %	400	14.5	18.5	20.1
6	Cube	0.5 %	666.7	14.5	17	20
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

Figure 3.1 : Compressive strength on cube specimen

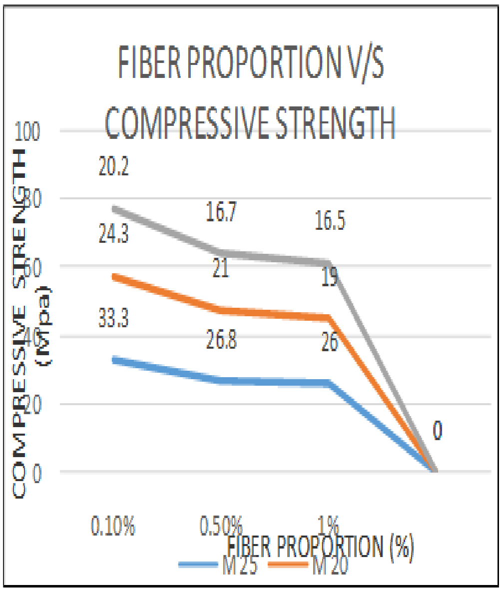

Figure 3.2 : Graph of fiber proportion v/s split tensile strength

IV. CONCLUSIONS

- It is hereby concluded that by adding jute fibres the compressive strength
- But increase in fibre proportion beyond a certain limit leads to decrease in compressive strength 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.

ACKNOWLEDGEMENT

I would like to articulate my profound gratitude and indebtedness to **Prof. Dixit Patel and Mr. Maulik Kansagra** who had contributed a lot for this research to be a success.

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