A Study on Characteristic Strength of Bamboo Fiber Reinforced Concrete

[1]Bindu M, [2]Dr. Narendra B.K, [3]Manjunatha J.K
[1]PG Student, [2]Professor, [3]Assistant Professor
[1]Department of Civil Engineering,
[1]BGS Institute of Technology, B.G. Nagar, India

Abstract **- The mixing of small closely spaced and evenly distributed fibers to concrete avoids crack and significantly develop the Cracking arrestors, Impact strength, Tensile strength, Fatigue resistance, and Wear and Tear. This has been proved. The concrete Ductility is augmented by mixing of fibers. Such a complex material is Fiber Reinforced Concrete (FRC). Bamboo is a multipurpose reserve categorized by large ratio of strength to weight and its ease of work with simple tools. It is one of the rapidly growing natural reserves. Present day construction works uses concrete as a basic material. To achieve Tensile strength Steel is used as reinforcement because concrete is fragile in tensile strength. Most commonly encountered problems in Steel are corrosion, expensive etc.; therefore studies are going on to use Bamboo as reinforcement in concrete and as structural material because of its beneficial characteristics. Some of the fibers that can use in production of FRC are Aluminum, Coir, Jute, Carbon, Steel etc. The Bamboo fibers are also used in concrete as a natural fiber to produce Bamboo Fibers Reinforced Concrete (BFRC) to impart some desirable properties to concrete. In this project we are going to study the characteristics strength properties of BFRC. After knowing, complete behavior of BFRC, it can be suggested for precast units and small slab units and as a structural material. Thus the research has commercial application.**

Index Terms **– Fiber Reinforced Concrete, Bamboo fiber, Workability and Strength Properties.**

I. INTRODUCTION

The threat to environment, the future sustainability of natural reservoirs and the towering prices of raw materials for engineering and standard plastics have forced to use natural reparable materials for development and fabrication of polymer composites. In past the reinforcement industry was dominated by the use of synthetic fibers; however the natural fiber had gained much stimulant to substitute synthetic fiber in numerous applications. Natural fibers are of vital economic importance for some developing countries: e.g. sisal in Tanzania, cotton in West African countries, jute in Bangladesh. Agricultural crops have been utilized by some of the countries where there is scarcity of forest resources, for development and research on polymer composites. For the construction and advancement of polymer composites, Bamboo can be used. It is found in abundance in Asia and South America. In many Asian countries although Bamboo is considered as natural engineering material it has not been explored fully to its extent. Has it takes only several months to grow up it has evolved as backbone for socio-economical status of society. Because of its high strength to weight ratio, traditionally it has been used in varied living facility and tools. This property is due to the longitudinal alignment of fibers. In practice, in addition to the extraction of bamboo fibers in controlled way from bamboo trees it is mandatory to fabricate the bamboo based composites.

II. MATERIALS

Cement

Cement used for our research is OPC (43 grade) of Ultra Tech cement confirming IS: 8112-1989 is used. The specific gravity of the cement was 3.15. The normal consistency, initial setting time, final setting time were 36%, 65 minutes and 660 minutes respectively. The cement mortar strength obtained for 7days test M-sand: 31.3n/mm^2.

Fine Aggregate

Locally available-sand passing through 4.75mm sieve and retained at 1.18 sieve was used for all of the mixes of FRC. The aggregates used were in compliance to zone II of IS: 383-1970. The specific gravity of the fine aggregate was 2.44. The water absorption and bulking of sand were 0.104% and 13% respectively.

Coarse Aggregate

Locally obtainable crushed angular aggregate sieved through 12mm was used for all of the mixes of FRC. The aggregate used were confirming to Table 2 of IS: 383-1970. The specific gravity of the coarse aggregate was 2.64. The water absorption, aggregate impact value and aggregate crushing value were 0.356%, 29.8% and 3.47%.

Bamboo Fibers

The bamboo fibers used in this project work is locally known as ***Pannangi Biduru***. The scientific name of the species is ***Dendrocalamus Strictus Nees***. The bamboo strips obtained were cut into fibers of dimensions (A x 2 x 1) mm where A being 20, 30, 40, 50, 60, 70, 80, and 90 all in mm. As the bamboo fibers are susceptible to the biological attacks; that is from fungus, termites etc… It was given treatment of Wood Guard's anti-termite solution. The amount of bamboo added in the concrete mix will be 1% of the weight of the cement.

Chemical Admixture

In this research work, chemical admixture, super plasticizer confirming to IS: 9103 was used. The super plasticizer used was Fasroc Complast SP430 DIS (Sulphonated Naphthalene Formaldehyde). The specific gravity is 1.145.

III. EXPERIMENTAL WORK

Mix Proportions

Using IS method of mix design M 25 was designed. The following Table gives Mix proportion for M 25 grade concrete to cast prisms, cylinders, cubes and L-shaped specimens.

Table 1 M 25 Grade Concrete Mix proportion

Concrete grade	Cement (kg/m^3)	Water (l/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	W/C
M 25	342.2	154	893.11	974.08	0.45

Preparation and Casting of test specimens

In case of mixing for fiber reinforced concrete, all the ingredients cement, fine and coarse aggregate were initially mixed in dry condition in the concrete mixer for one minute. After that Bamboo fibers were added and mixed thoroughly for getting uniform mix. Formerly 70% of estimated quantity of water was poured to the dry mix and mixed systematically for one minute. The remaining 30% of water was mixed with the super-plasticizer and was added into the mixer and mixed for five minutes.

Cube moulds of 150x150x150mm were used to cast cube specimens. In order to remove the specimen from the mould easier the moulds were greased before casting. After taking the cubes out of the moulds they were cured in curing tank for 28days for the respective compressive strength tests.

Cylinder moulds of 100mm diameter and 200mm height were used to cast cylinder specimens. In order to remove the specimen from the mould easier the moulds were greased before casting. After taking the cylinders out of the moulds they were cured in curing tank for 28days for the respective split tensile strength tests.

Prism moulds of 500x100x100mm were used to cast prism specimens. In order to remove the specimen from the mould easier the moulds were greased before casting. After taking the prisms out of the moulds they were cured in curing tank for 28days for the respective flexural strength tests.

L-shaped moulds of 150x90x60 were used to cast L-shaped specimens. In order to remove the specimen from the mould easier the moulds were greased before casting. After taking the L-shaped specimens out of the moulds they were cured in curing tank for 28days for the respective shear strength tests.

IV. RESULTS AND DISCUSSIONS

Fresh Concrete Test Results

From the fresh concrete test results shown in the table 2, we can observe that the slump flow diameters of all the aspect ratio is 0mm, the W/C ratio of all the aspect ratio is 0.45 , the compaction factor are in the range of 0.9320-0.9910 and the Vee Bee time are in the range of 65.03-153.92sec. Hence all the aspect ratios except aspect ratio 20 and 90 are considered as Fiber Reinforced Concrete because aspect ratio 20 and 90 did not satisfy the acceptance criteria of Fiber Reinforced Concrete. The aspect ratio 20 gives the compaction factor of 0.9320 which is very much less than conventional concrete compaction factor. The aspect ratio 90 gives Vee Bee time of 153.92 which is thrice the Vee Bee time of conventional concrete and hence the workability decreases with the increase in the length of the fiber with reference to the Vee Bee Consistometer test. Therefore the maximum length that can be adopted for the mix is 80mm; longer fiber length will break while mixing the composites of the concrete. The following table gives the workability test results of fresh concrete,

Table 2 Fresh Concrete Test Results

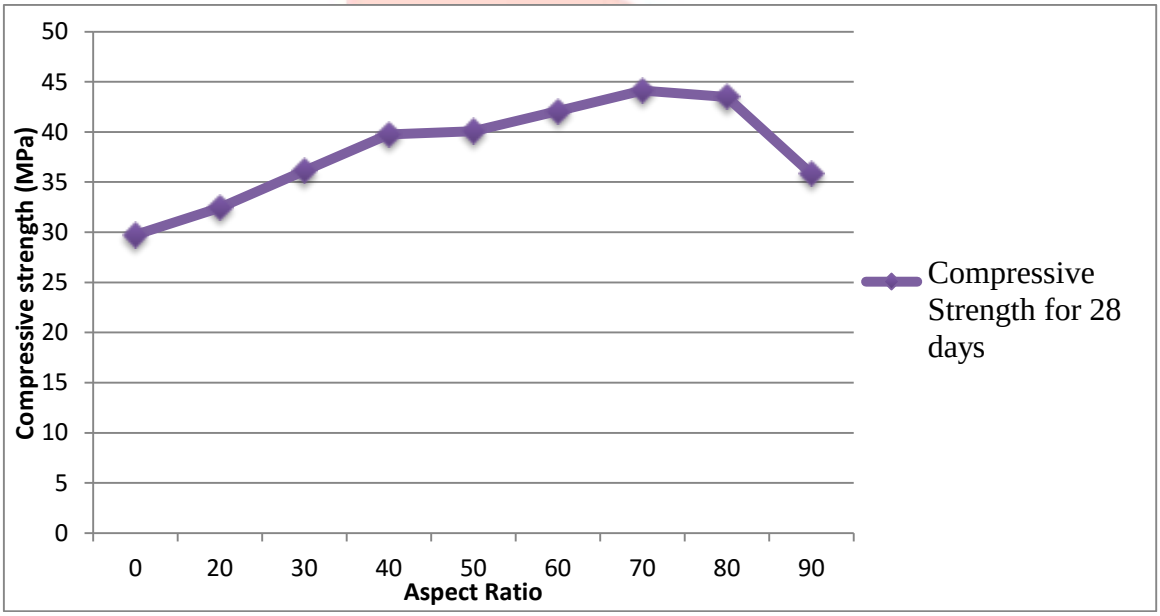
Concrete mix with Aspect Ratio	W/C Ratio	Slump (mm)	Compaction factor	Vee Bee time (sec)
Conventional concrete	0.50	0	0.9963	51.93
0	0.50	0	0.9953	60.52
20	0.45	0	0.9320	65.03
30	0.45	0	0.9480	72.03
40	0.45	0	0.9652	83.73
50	0.45	0	0.9563	95.43
60	0.45	0	0.9764	107.13
70	0.45	0	0.9910	102.47
80	0.45	0	0.9832	130.53
90	0.45	0	0.9521	153.92

Hardened Concrete Test Results

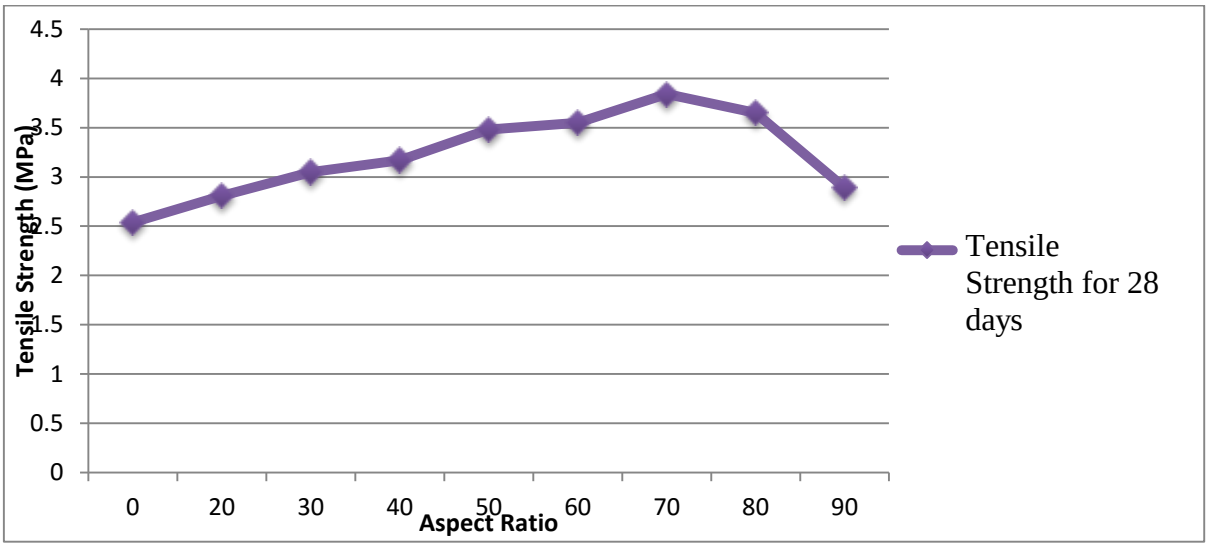
From the hardened concrete test results shown in table 3, we can observe that the Compressive strength of the mix composition is in the range of 29.72-44.13 Mpa for 28 days, the Split Tensile strength are in the range of 2.54-3.84 Mpa for 28 days, the Flexural strength are in the range of 9.25-16.97 Mpa for 28 days and the Shear strength are in the range of 4.05-9.16 Mpa for 28days. Also it is found that the mix composition attains maximum strength compared to conventional concrete, this indicates that the incorporation of bamboo fibers improves the strength. Compare to all the aspect ratios, aspect ratio 70 attains greater Compressive strength, Spit Tensile strength and Shear strength. Also compare to all aspect ratios, aspect ratio 80 attains grater Flexural strength.

Table 3 Hardened Concrete Test Results for 28days

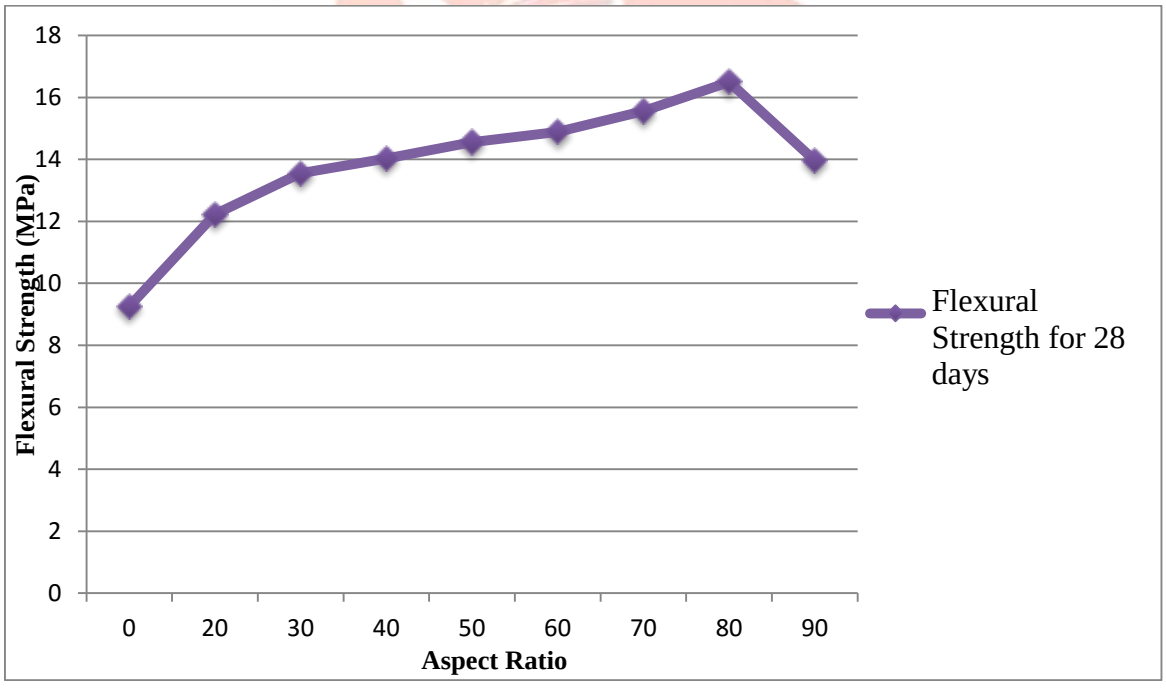
Aspect Ratio	Compressive Strength (Mpa)	Tensile Strength (Mpa)	Flexural Strength (Mpa)	Shear Strength (Mpa)
0	29.72	2.54	9.25	4.05
20	32.46	2.81	12.23	5.71
30	36.13	3.05	13.55	6.07
40	39.76	3.17	14.03	6.85
50	40.09	3.48	14.56	7.01
60	42.07	3.55	14.89	7.89
70	44.13	3.84	15.56	9.16
80	43.50	3.65	16.97	8.76
90	35.84	2.89	13.97	7.87



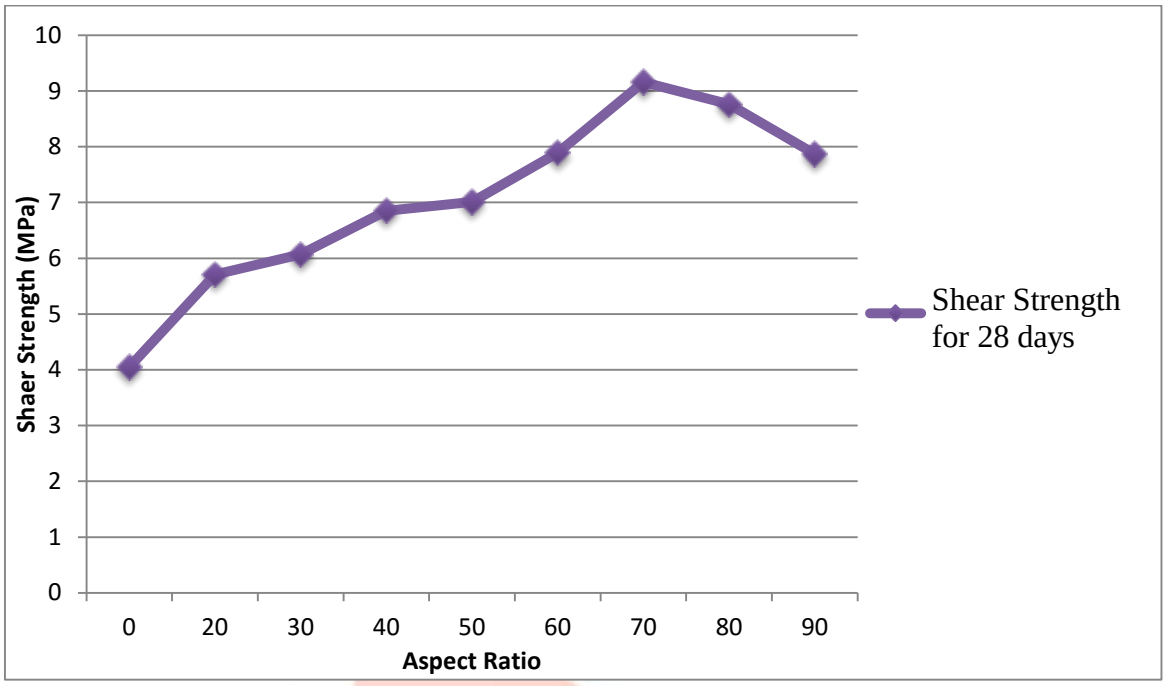
Graph 1 Compressive Strength-28 days



Graph 2 Spit Tensile Strength-28 days



Graph 3 Flexural Strength-28 days



Graph 4 Shear Strength-28 days

V. CONCLUSIONS

The desirable range of aspect ratios were efficiently giving out good strength is observed from 30 to 80. It is also observed that, the specimens made from conventional concrete breaks immediately at failure whereas the Bamboo fiber reinforced concrete at failure the specimen remains to be intact even at failure. The fibers acts as a crack resistors, hence take up a lot more load as compared to the conventional concrete. Bamboo Fiber shows good potential and increased strength when used in the Fiber reinforced concrete. It was observed that the conventional concrete beams would break with application of the loads, whereas the Bamboo Fiber reinforced concrete gave enough warning by cracking and then fail. It has crack resistant properties characteristics compared to the conventional concrete as the fiber is crack resistor. The concrete cover spalling and reinforcement debonding failure due to micro-crack propagation are delayed. Inclusion of fibers improves the mechanical properties of the concrete which is an innovative low cost material which can be promoted in construction field. The characteristic strength was more for the aspect ratio 70, compared to any other aspect ratios. It was found that the Bamboo fiber being slender in nature, the maximum length that can be adopted for the mix is 80 mm; longer Fiber will break while mixing the composites of the concrete. It was also found that the workability decreases with the increase in the length of the fiber (with reference to the Consistometer Vee Bee test); hence to increase expediency percentage inclusion of plasticizer / super plasticizer may be increased.

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