INVESTIGATION OF BAMBOO AS REINFORCEMENT IN CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH

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ABSTRACT

This study investigated the feasibility of using bamboo as a reinforcement alternative to steel in concrete structural members. The specifications studied the bamboo's flexural strength in concrete. The paper represents the current utilization of cement in the construction industry. The paper mostly focuses on the amount of fly ash can be used instead of cement. The percentage of fly ash which gives the maximum strength according to our conclusion has been also recorded here. Paper gives the remarkable results about the properties according to compressive strength and flexural strength. According to Indian standards, compressive and flexural strength tests were conducted on these samples.12 cubes and 2 beams were casted and tested after a curing of 7, 28 days. The specimens were casted with percentage replacements of cement with fly ash of 10%, 20%, 30%. The review paper summarizes the conclusion on the basis of tests conducted for various properties of concrete like strength, durability etc. The test results indicated that the bond strength for bamboo was lower than those for steel and FRP (Fiber Reinforcement Plastic) as reported in the literature. The data collection was mainly based on the tests conducted on the prepared specimen in the laboratory. From the past researches and the conclusion made by us shows the positive change in the utilization of bamboo in construction field. As these results gives the great potential towards environment friendly.

Keyword: - *Structural behavior, Failure mode, Crack pattern monitoring and Compressive strength.*

1. Introduction

In today's society, most buildings are built using such materials as steel reinforced concrete and structural steel. Specifically, concrete is a high quality and economical material with its ability to support fire and earthquake defence in buildings constructed in developed and developing countries. One of the significant faults of concrete is its low tensile strength. Steel reinforcing bars are typically used for reinforcement. Steel is one of the best materials for complementing the low tensile strength of concrete because of its high tensile strength, over 792 N/mm^2. Unfortunately, structural steel is not easy to find in many countries due to limited natural resources and lack of skilled labour. For the same reasons, use of steel reinforcement in concrete is not widespread. Some buildings in the world have been built of just plain concrete or bricks without steel reinforcement. These buildings typically cannot withstand the effects of natural disasters such as earthquakes, hurricanes, and storms. In a few countries, buildings which did not use enough steel have been crumbled by natural disasters such as earthquakes. Even though steel reinforcement is a very suitable material for complementing concrete's low tensile strength, there are many difficulties such as economics, technique, and efficiency that need to be addressed. To overcome these problems, many scientists and engineers have been trying to seek out new materials for increasing the tensile capacity of concrete. Specifically, bamboo is one of the most suitable materials to substitute for reinforcing bar in concrete. Bamboo is a composite material with long and parallel cellulose fibers in its structure. Also, it exhibits good flexibility and toughness characteristics. The most surprising thing is its growing speed as most growth occurs during the first year and almost all growth ceases by the fifth year. The strength of bamboo does increase with its age, but the maximum strength occurs at 3-4 years and then begins to decrease in strength In fact, bamboo can bend as much as touching the ground without breaking. On the environment side, the bamboo is a harmless plant at pollution because it assimilates a lot of nitrogen and other function is to decrease the carbon dioxide in the air. Also, some bamboo even sequester up to 12 tons of carbon dioxide from the air per hectare.

In construction, bamboo is a high-yield renewable material such as "ply boos" which is a kind of bamboo in the world used for wall paneling and floor tiles. A tower at the "Phanomena" in Zurich is an enormous bamboo structure. On the building, the bamboo canes used were 6 to 11cm (0.2 to 0.36 ft) in diameter. In Hong Kong, double layered bamboo scaffoldings are a typical application on construction. The scaffoldings are used as a working platform for erecting brickwork and curtain walls. Normally, East Asian, China, India, and other countries use bamboo as construction scaffolding because of its price, weight, flexibility, and toughness. Even though the scaffolding gets a heavy load, it bends but does not break. Bamboo is grown in many areas of world and is divided into one thousand-two hundred-fifty kinds of bamboo. Most bamboo can be found in East Asia because of its tropical and subtropical regions. Bamboo use in construction is common in Asian due to factors including economical aspects, lightweight, flexibility, and toughness. When compared to steel's tensile strength, bamboo's value of 370 MPa. Bamboo is a good replacement material for timber in construction due to its lightweight, good flexibility, low cost, and tough character. Specifically, the tensile strength of bamboo is stronger than conventional grasses. In addition, bamboo reaches its mature growth within five years (Amada et al. 2001). On the negative side bamboo shows weakened bond with concrete, lower modulus of elasticity, strong water absorption, and low durability and low resistance to fire compared to steel reinforcement.

2 Experimental Setup

In this stage collection of materials essential and the data required for mix design are obtained by sieve analysis and specific gravity test. Sieve analysis is carried out from various fine aggregates (FA) and coarse aggregates (CA) samples and the samples which suit the requirement are selected. Specific gravity tests are carried out for fine and coarse aggregate. The various materials used were tested as per Indian standard specifications.

2.1 Materials

Raw materials required for the concreting operations of the present work are cement, fine aggregate, coarse aggregate (CS) and water. Cement: Ultra tech cement of 53 Grade ordinary Portland cement was used whose specific gravity is 3.15. The properties of materials are shown below the table.

Table 1 Property of Materials

Sl. No	Property	Test results
1	Normal consistency	31%
2	Specific gravity for Cement	3.15
3	Specific gravity for Fly Ash	2.27
4	Specific gravity for Fine Aggregate	2.66
5	Specific gravity for Coarse Aggregate	2.75
6	Initial setting time	31 min
7	Final setting time	572 min
8	Fineness of cement	98.5 %
9	Compressive strength of cement At 28 days	53.33 N/mm^2
10	Fineness modulus of Sand	2.65
11	Fineness modulus of Coarse Aggregate	2.75

2.2 Compressive strength

Compression test: It is the most common test conducted on hardened concrete as it is an easy test to perform and also most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on specimens cubical in shape as shown in figure 1 of the size 150 × 150 × 150 mm. The test is carried out in the following steps: First of all the mould preferably of cast iron, is used to prepare the specimen of size 150 × 150 × 150 mm. During the placing of concrete in the moulds it is compacted with the

tamping bar with not less than 35 strokes per layer. Then these moulds are placed on the vibrating table and are compacted until the specified condition is attained. After 24 hours the specimens are removed from the moulds and immediately submerged in clean fresh water. After 28 days the specimens are tested under the load in a compression testing machine.

Fig -1 Specimen for Compressive Strength

TABLE 2 7 days Compressive Strength Results

Sl. No	Total replacement by FA in percentage	Mix Design	Compressive StrengthN/mm^2
1	**0**	M_{25}	18.26
2	10	M_{25}	18.34
3	20	M_{25}	19.74
4	30	M_{25}	20.25

TABLE 3 28 days Compressive Strength Results

Sl. No	Total replacement by FA in percentage	Mix Design	Compressive StrengthN/mm^2
1	**0**	M_{25}	26.55
2	10	M_{25}	26.90
3	20	M_{25}	27.90
4	30	M_{25}	29.50

2.3 Flexural strength for beam

Flexural strength tests were performed on universal testing machine (UTM) of 600 KN capacities. Two beams of 1000*150*150 mm from each batch were subjected to this test. The comparative study was made on properties of concrete after percentage replacement of cement by fly ash in the range of 0%, 10%, 20%, and 30%. Among all values 30% cubes got the highest value. So we are making beam of 30% replacement of fly ash. Beams are made up of both bamboo and steel reinforcement.

Flexural strength of the concrete at various percentage levels was calculated with the help of universal testing machine (UTM). The tests were carried out confirming to IS: 516-1959(8). The specimen was tested under midpoint loading. There is considerable increase in the flexural strength of concrete with the increase in the percentage of fly ash up to 30% in both bamboo and steel reinforced beams. However there was decrease in the strength compared to normal steel reinforced concrete beams.

$$\text{Flexural strength} = 3Wl/2bd2 \quad N/mm^2$$

Where

W = weight of the load applied (N)
L = Length of the flexural beam (mm)
B = Breadth of the flexural beam (mm)
D = Height of the flexural beam (mm)

TABLE 4 28 days flexural Strength of beam Results

Sl. No	Total replacement by CS in percentage	Mix Design	Load (N)	Flexural StrengthN/mm^2
1	**0**	M_{25}	6300	2.80
2	10	M_{25}	6375	2.83
3	20	M_{25}	6700	2.97
4	30	M_{25}	6850	3.04

Fig -2 Beams testing in universal testing machine

Fig -3 Cracks obtained while applying load at mid span

3. Comparative Graph for cubes

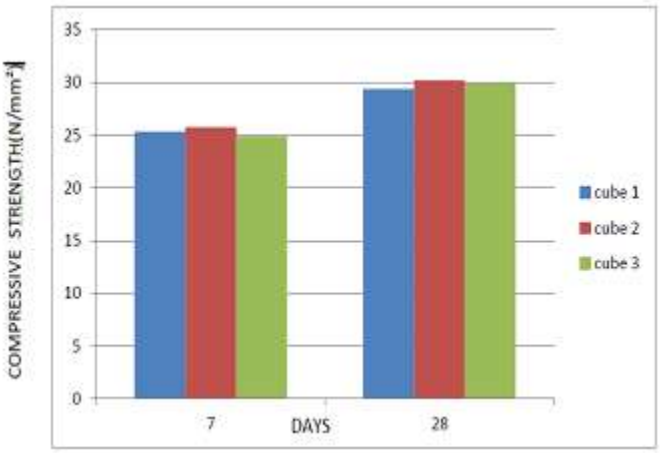

Fig -4 0% FA concrete cubes

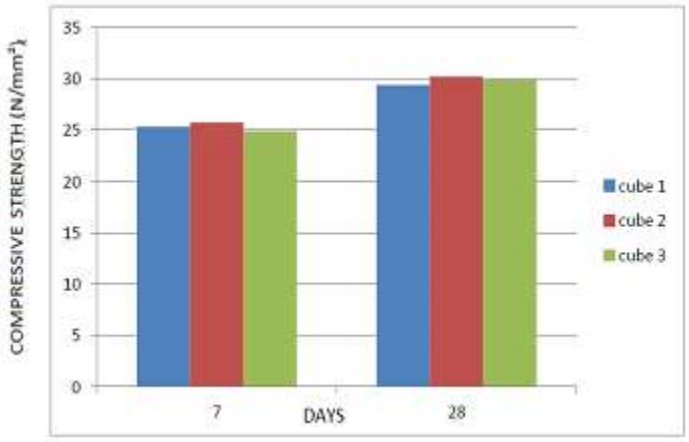

Fig -5 10% replacement FA concrete cubes

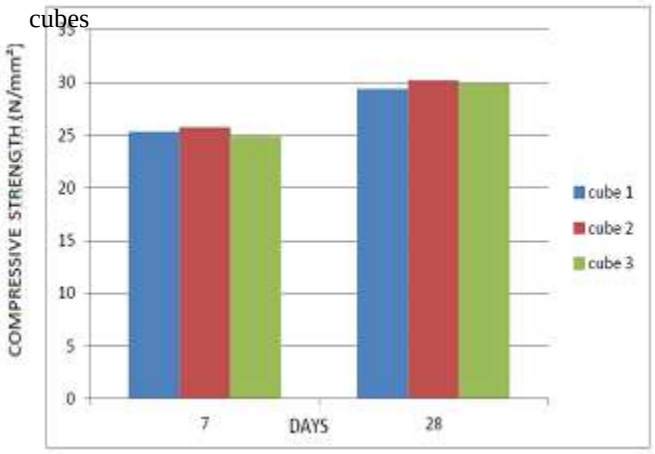

Fig -6 20% replacement FA concrete cubes

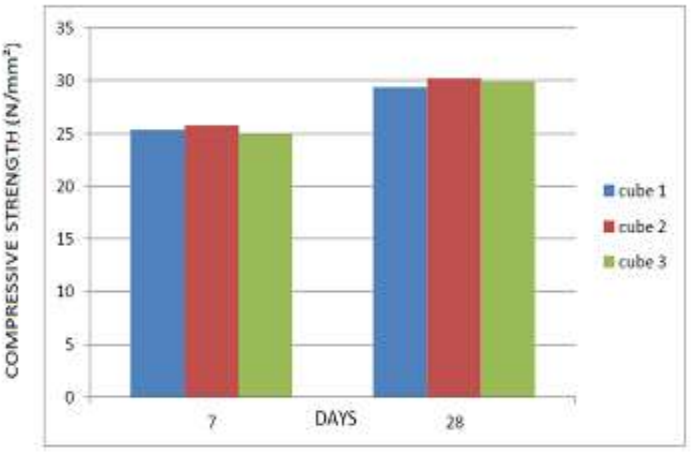

Fig -7 30% replacement FA concrete cubes

4. Conclusions

- In this research program, the feasibility of the use of bamboo as a reinforcement agent in concrete is evaluated through flexural strength test.
- Also the compressive strength test on concrete cube with size 150 x150 mm was done. The main purpose of that experiment is to evaluate the possibility of using bamboo as reinforcement instead of steel and other materials as FRP.
- Slump loss of concrete increases with increase in w/c ratio of concrete.
- Slump loss of concrete goes on increasing with increase of quantity of fly ash.
- The addition of fly ash resulted in increase in weight of concrete. The increase in weight is in direct proportion to the amount of fly ash added.
- The average weights of control mix of 10%, 20%, 30% are obtained as 8.17kg, 8.24kg, 8.36kg respectively. Which meets the criteria of heavy weight concrete that full fill the strength requirements.
- The addition of fly ash resulted in as acceptable value in compressive strength of concrete at 30% replacement of cement.
- Replacement of cement with fly ash gives optimum strength at 30% replacement then there was a marginal decrease in the strength.
- At 30% replacement of cement gives maximum strength at the age of 28 days. It has obtained a maximum strength of 29.50 N/mm².

- The flexural strength also gives the maximum result at 30% and at the age of 28 days. After which it shows decrease in the strength.
- Using of bamboo as reinforcement gives the environment friendly concrete. It is economical when compared to steel reinforcement; it is having more strength when compared to steel reinforcement.
- The load is applied at mid span; the strength obtained for bamboo reinforced beam is 6850N. Whereas steel reinforced beam obtained strength of 63000N.

5. REFERENCES

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