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Investigation on Mechanical Properties of Concrete made of Bamboo fibre

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ABSTRACT: Concrete is a construction material with a very limited tensile strength capacity, needs to be reinforced to overcome tensile loads and strain. One of significant aspects of randomly distributed discrete fibres in cement composite is their ability to slow down the propagation of tensile cracks by improving the post cracking behaviour and flexural toughness of the composite. Bamboo Fibre is one of the natural fibres having a favourable performance in tension and shear. In this research compressive strength and split Tensile strength of Bamboo fibre concrete is determined and compared with the Conventional concrete. The Bamboo Fibres are cut with an aspect ratio ranging from 60 to 100 are added in the concrete in steps of 0%, 1%, 2%, 3%, & 4% to that of the weight of the cement. M20 grade concrete prepared as per Nominal mix ratio of 1:1.5:3.

KEYWORDS: Bamboo, fibre reinforced concrete, tensile strength, compressive strength

I. INTRODUCTION

Cement is a very commonly used construction material, which can be mixed with desired quantity of fine aggregate, coarse aggregate and water to make a hardened product called concrete. Cement based materials have low tensile strength and easily cause brittle failure [1]. Because of the load and environment changes, micro cracks appeared in cement products. Therefore, it is the main reason for cement aging and destruction. In order to improve the mechanical properties of concrete, it is good to mix cement with fibres which have good tensile strength [2]. The parameters of compressive strength, tensile and flexural strength of the self-made short bamboo fibre reinforced cement composite material has high tensile strength. The length of the original fibre is between 3cm to 7cm and fibres were cut into 1cm, 1.5cm and 2cm separately. The results indicate that making bamboo reinforced cement composite is viable, and the rupture strength of cement composite would be improved by adding bamboo fibres and the pre-treatment of bamboo fibre would enhance mechanical properties of the cement composite [3]. At all the curing ages, both the natural fibres such as coir and sugarcane fibres enhance all the three mechanical strength properties such as compressive strength, split tensile strength, modulus of rupture and flexural performance [4]. Use only bamboo showing a pronounced brown colour. This will insure that the plant is at least three years old. Select the longest large diameter culms available. Do not use whole culms of green, unseasoned bamboo. Avoid bamboo cut in spring or early summer. These culms are generally weaker due to increased fibre moisture content [5]. The bamboo flakes contained a high amount about 4.92% of sugars which has a significant retarding effect on the Portland cement matrix [6]. It was found that the addition of chemical admixtures was necessary to counteract this adverse effect. With a Bamboo cement ratio of 12.75 and 2% aluminium sulphate alone or in combination with sodium silicate, it was possible to produce a board which satisfied the strength and dimensional stability requirements of international standard [7].

The mechanical properties and dynamic characteristics of a proposed combined polymer composite which consists of a polyester matrix and coconut fibres are determined. Results were found that the strength of composites tend to decrease with the amount of fibre, which indicates ineffective stress transfer between fibre and matrix [8]. The dynamic

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characteristics of the composite was also having a same effect where the natural frequency decreased with increase of coconut fibre volume however the damping ratio was found to be increased by the incorporation of the fibre. When higher fibre content of 15% was used, the damping ratio shows the maximum values for almost all the frequency mode. It was observed that the effects of reinforcing polyester matrix with coconut fibres lead the composite more flexible and easy to deform due to high strain value and low stiffness. In fact, it may also be used to reduce high resonant effect[9].The technique of inclusion of steel fibres in Column joints appears to be a useful solution in the case of joints subjected to repeated or cyclic loading[10]. During testing it has been noted that addition of fibres could improve the dimensional stability and integrity of the joints. Also, it is possible to reduce the congestion of steel reinforcement in the beam-column joints by replacing part of ties in the columns by steel fibres [11]. Load carrying capacity of the joints also increased with the increasing fibre content [12].

II. PROPERTIES OF MATERIALS

Fibre Reinforced Concrete is a type of concrete prepared from fibres of any type along with concrete. In this investigation for the preparation of the Bamboo Fibre Reinforced Concrete (BFRC), material such as cement, Bamboo fibre, fine aggregate, coarse aggregate and potable water are added. The properties of these materials are arrived by conducting various related tests

CEMENT

The cement used in this study was OPC 53 grade. An OPC 53 Grade sample was tested to obtain the following characteristics which is shown in Table 1

Table 1 Physical properties of cement

Sl.No	Properties	Value
1	Specific gravity	3.17
2	Standard consistency	28%
3	Initial setting time	45 minutes
4	Final setting time	612 minutes

FINE AGGREGATE

It is desirable to use the coarser variety of fine aggregate having a high fineness modulus for making workable and strong concrete. Table 2 shows properties of fine aggregate.

Table 2 Test on Fine Aggregate

Sl.No	Properties	Value
1	Specific gravity	2.52
2	Fineness Modulus	3.786
3	Water absorption	1.20%

COARSE AGGREGATE

Coarse Aggregate consists of natural occurring stones. Angular and roughly cubicle particles are ideal.The following tests were carried out on coarse aggregate.The properties of coarse aggregates are given in Table 3.

Table 3 Test on Coarse Aggregate

Sl.No	Properties	Value
1	Specific gravity	2.74
2	Fineness Modulus	3.752
3	Water absorption	0.80%

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BAMBOO FIBRE

The length of the original fibre is between 30mm to 70mm. In the experiments, fibres were cut into 20mm length. The diameter of the fibre is 0.3mm. The following table 4 and table 5 shows the physical and chemical properties of bamboo fibre got from the manufacturer.

Table 4 Physical Properties of Bamboo Fibre

Sl.No	Properties	Value
1	Length	20 mm
2	Diameter	0.3 mm
3	Aspect ratio	66.67
4	Specific gravity	1.152
5	Tensile strength	73-505 Mpa
6	Modulus of elasticity	$10 \times 10^3 - 40 \times 10^3$ Mpa
7	Bulk density	1158 kg/m ³
8	Water absorption	1.45%

Table 5 Chemical Composition of Bamboo Fibre

Component	Result (%)
Cellulose	44.15
Lignin	29.28
Sugar	24.79
Pectin	0.73
Ashes	1.05

III. EXPERIMENTAL INVESTIGATION

In this study the mechanical properties of Bamboo Fibre reinforced concrete were carried out for different percentage of Bamboo Fibre. Bamboo Fibre having diameter 0.3 mm and aspect ratio (l/d) 67.67 were used. M20 grade (1:15:3) of concrete was used for making of bamboo Fibre Reinforced Concrete with the water cement ratio of 0.5. A total of 30 specimens were cast such as 15 numbers of cubical specimen and 15 number of cylindrical specimen. Cubical and cylindrical specimens were divided into 5 variation of Bamboo Fibre. The variables of specimens considered as Conventional Concrete (CC), Bamboo Fibre Reinforced Concrete are named as BFRC₁, BFRC₂, BFRC₃ and BFRC₄. The percentage of fibre used is 0%, 1%, 2%, 3% and 4% respectively.

IV. RESULTS AND DISCUSSIONS

The workability of concrete made with bamboo fibre in five variations was studied at fresh state of concrete by conducting slump test and compaction factor test. The results are showed in Figure 1 and Figure 2, which indicated that both the slump and compaction factor is decreasing with the addition of fibre.

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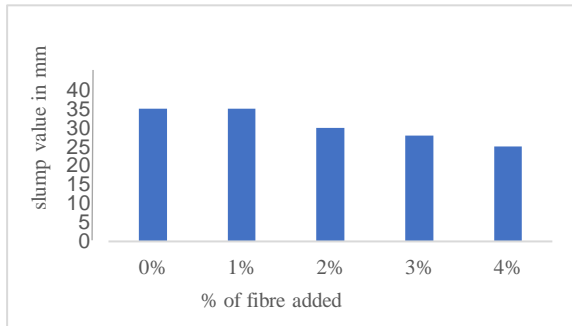


Fig. 1 Slump value

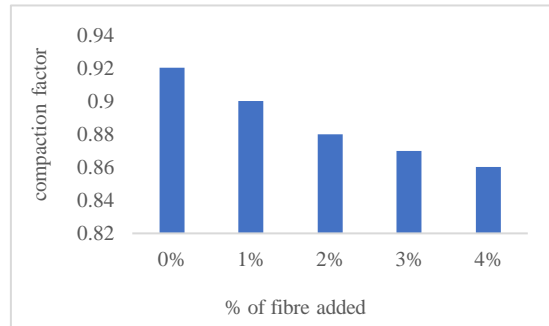


Fig. 2 Compaction Factor

The hardened properties of bamboo fibre added concrete for various proportions were studied by conducting compression test on cubes and split tensile test on cylinders at 28 days. The results are showed in Figure 3 and Figure 4, which reported that the compressive strength and tensile strength is getting increased with the addition of fibre.

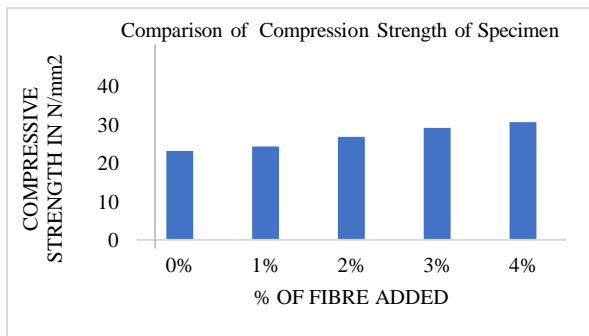


Fig. 3 Compressive strength

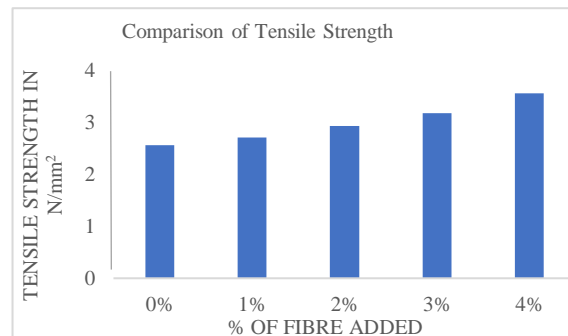


Fig. 4 Tensile Strength

V. CONCLUSION

Bamboo fibre used in concrete shows increment in both tensile and compressive strength. The percentage increase in compressive and tensile strength for 4% fibre is 32.2% and 38.7% respectively. Workability of BFRC is low when compared with the conventional concrete since water reducing agent was not used. Hence workability can be increased by using water reducing agent. Thus fibre reinforced concrete can be seen as an appealing alternative to conventional confining reinforcement in all aspects. The optimum fibre content can be obtained by studying the all properties by varying amount of fibre content.

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