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REVIEW ON BAMBOO REINFORCED CONCRETE SLABS AND BAMBOO PROPERTIES

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Abstract - In the recent years there is significant research into the use of bamboo as a replacement of common High Yielding Strength Deformed HYSD bars which is costly and not environment friendly. This review brings research on the flexural behavior of concrete slabs that were reinforced with bamboo bars subjected to different loadings. The bamboo reinforced concrete slabs shows high elastic behavior and produced large deflections before failure. The review brings the idea about the engineering properties such as durability and mechanical properties of bamboo of using it as reinforcement in concrete slabs. The durability is checked by changing the tensile strength and young modulus of bamboo. It tells about the eco-friendly performance of bamboo over other comparable construction materials.

The review has tried to compile the effects of different methods such as processing and thermal treatment on the physical and mechanical properties of bamboo. The review looks at the flexural behavior of bamboo based slab panels with different materials such as fly ash, EPS infill. This review looks at bamboo because it is a eco-friendly, green and natural material that can help in supporting sustainable development.

Key Words: **Bamboo, Durability, Thermal Treatment, Processing, Bamboo based slab.**

1.INTRODUCTION

In most developing countries where about 70% of the population lives in villages and there is increasing demand for building materials such as cement and steel which are costly as well as it is renewable and not environment friendly. Thus there is a need to look for innovative material such as bamboo to use it as a reinforcing material[1].It has been investigated that bamboo has adequate material and strength to replace steel reinforcement. The durability tests on bamboo shows that bamboo not only have tensile strength but it could also withstand the contact of calcium hydroxide[7]. Another idea for sustainable construction is the replacement of cement by flyash and bamboo for steel bars. Test results have shown that the load carrying capacity and deformation capacity of bamboo strip as reinforcement is better than the PCC(Plain Cement Concrete) and RC slabs having mild steel as main reinforcement.[8]

2. BEHAVIOUR ON DIFFERENT LOADING SYSTEMS OF BAMBOO SLABS-

C.K. Kankam, B. Odum-Ewuakye 2001- In this paper a series of tests was performed on one-way Babadua reinforced concrete slab under third-point line loads. It provides the results of a study on the flexural strength and deflection characteristics of one-way slabs reinforced with babadua bars. Theoretically, all slabs are under-reinforced, and considering span to effective depth ratios, failure of the slabs was expected to occur over bending failure by fracture of the tension babadua bars. However, many slabs collapsed due to the crushing of concrete in compression after high deflection. On average, the experimental failure loads of slabs are 3.09 and 1.46 times the theoretical flexural and shear strength of the concrete section, respectively.
It concludes that the bamboo stems can be effectively used as reinforcing bars in concrete.

C.K. Kankam, B. Odum-Ewuakye 2005- This paper presents a summary of an investigation on the structural behavior of 14 two-way concrete slabs that were reinforced with babadua bars subjected to concentrated loads. Ten of the concrete slabs were subjected to constant loading while the remaining four slabs were subjected to repeated loading before failure. The mechanism responsible for the failure of slabs were of circular fan pattern. The failure loads from experiment were found to be 170% of the theoretical values. Also the experimental failure loads averaged 148% and 198% of the theoretical punching shear strength of the un-reinforced concrete section under constant and repeated loads, respectively.
The results of the investigation have shown that the stems of babadua plants are structurally suitable and durable as reinforcing bars in concrete slabs.

3. DURABILITY ANALYSIS OF BAMBOO-

Humberto C. Lima Jr. et.al 2007- Durability is a problem while using bamboo as a concrete reinforcement. This paper gives the results of an experiment done to calculate bamboo durability to be used as concrete reinforcement. By varying the hardness and Young Modulus of bamboo the durability can be calculated. Even after cleaning the surface, the presence of cement paste on the bamboo splint embedded in concrete prism and a layer of $Ca(OH)_2$ deposition in splint aged in solution of calcium hydroxide was observed. The

micrographs do not reveal a considerable deterioration of the bamboo fiber after ageing, only the fibers close to the splint surface showed some changes. There was no deposition of crystals of calcium hydroxide in the bamboo veins. The experimental tests on the bamboo showed that the bamboo tensile strength is comparable with the best woods used in constructions and even with steel. Bamboo average tensile strength is close to 280 MPa in the samples without node and 100 MPa in the samples with node. The tensile strength and Young Modulus did not decrease after 60 cycles of wetting and drying in solution of calcium hydroxide and tap water.

4. EFFECTS OF DIFFERENT METHODS ON BAMBOO -

Ya Mei Zhang et.al 2012- This paper focuses on the influence of thermal treatment on the properties such as mass loss, color changes, mechanical and chemical components of bamboo. The bamboo was thermally treated in a dry oven at seven temperature levels between 100–220° C for four duration times (1–4 h). The bamboo specimens at 8 % moisture content were thermally treated in a dry oven set at temperatures of 100–220° C for 1–4 h. For the determination of thermal treatment effect on mechanical properties, Modulus of elasticity (MOE) and Modulus of rupture (MOR) were determined with 80x10x3 mm^3 samples and a three point bending device. Fifteen bamboo samples were tested for each set of parameters. The vertical speed of the mobile head was 3 mm/min for MOE and a velocity of 10 mm/min for MOR.

$$MOE(N/mm^2) = \frac{l^3 \times \Delta P}{4b \times h^3 \times \Delta s}$$

$$MOR(N/mm^2) = \frac{3p \times l}{2b \times h^2}$$

where P is the load on rupture in N, $\Delta p/\Delta s$ is the slope of the elastic zone in N/mm, l is the span, it was 16 times of the thickness, h represents height and b represents the width, all expressed in millimeters. The results shows that with increasing temperature and duration, mass loss increases and reaches maximum value of 29%. When the samples were treated below 200° C the Modulus of elasticity (MOE) does not vary much but it decreased quickly when samples were treated above 200° C and the maximum reduction was 20.2 %. According to the obtained results, MOR increased first and then decreased when samples were heated at 100–220° C for 1–4 h. The maximum value was found when samples were heat-treated at 120° C. Thermal treatment has greatly changed the color of the bamboo. The chemical components contents also changed.

It concludes that the bamboo quality improves upon thermal treatment.

Bhavna Sharma, Ana Gatóo, Michael H. Ramage 2015 - This paper studies the mechanical properties of two commercial laminated bamboo products: bleached and semi-caramelized bamboo. This paper finds out the effects of processing on the mechanical properties of bamboo. The results indicate that the mechanical properties of bleached and semi-caramelized laminated bamboo are within range and not order of magnitudes different. With additional processing and thermal treatment the compressive and shear stress tends to increase. While, the tensile properties decrease with greater processing but the modulus of rupture in bending remains same. The major difference between the materials is the approximate 20% increase in bending modulus of elasticity (E_b) with increased processing and thermal treatment. The results indicate that the compressive and shear strength parallel to grain increase with thermal treatment. With caramelisation, the perpendicular strength in compression and tension parallel to grain decreases. The difference in mechanical properties is statistically large in the comparison of the bleached and caramelized material.

Further research is needed to find out the changes in the mechanical properties and the chemical composition of the processed materials to determine the relationship on a cellular level.

Finally it concludes that the effects of thermal treatment on bamboo needs to be further studied to find the various structural applications of bamboo.

5. STRUCTURAL BEHAVIOUR OF BAMBOO BASED SLAB PANELS WITH DIFFERENT MATERIALS -

S. Jeeva Chithambaram, Sanjay Kumar 2016 - There is a need to achieve the alternative building materials like fly ash as partial replacement of cement, and bamboo for steel bars, a costly building material. This gives considerable savings in consumption of cement and steel. Ferrocement is a composite produced from cement, sand, wire mesh, skeletal steel and certain mineral admixtures like fly ash. The main objective of this investigation was to study the effect of flyash on the flexural behavior of ferrocement slabs, test panels of 40 mm and 50 mm thick were considered. The bamboo strips in the skeletal grid with two layers of chicken wire mesh were placed as reinforcement in the test panels. With 15% cement replacement by fly ash for 40 mm thick slab tested under flexure, only 5–10% reduction in load carrying capacity is observed and for 50 mm thick slab the load carrying capacity is found to be nearly the same. Based on the experimental results, as the load increases the first cracks were seen on the tension face which is due to the failure of mortar on the tension face. But, the load carrying capacity of slab panels increased since the wire meshes present carried additional loads. The contribution of bamboo strips with respect to mortar and wire mesh of the theoretical ultimate load capacity of the slab is about three times higher corresponding to the experimental ultimate load capacity.

It concludes that the ferrocement slab panels using bamboo in place of steel and fly ash as partial replacement of cement can be used as roofing slab panels low cost housing.

Ari Wibowo et.al 2017 - In this paper the combination of bamboo as reinforcing bars and EPS (expanded polystyrene) as infill panels in reinforced concrete slabs were studied. The main purpose of this study was to investigate the load-carrying capacity and the flexural behavior of such slab system in order to be applied in design and construction practices. The slab specimens comprised three types of bamboo reinforced concrete slabs i.e.: RCS specimen (regular RC slab), BSC (with EPS infill panel and concrete stud), and BSB (with EPS infill panel and bamboo stud) were subjected to flexure loading test. The results shows that the slabs with EPS infill panel had 6% reduction in the flexural strength but 27% lighter as compared to the regular steel rebar reinforced concrete slab with same dimension. Shear connector of bamboo stud proved to be more ductile than the shear connector with concrete stud.

It concludes that the reinforced concrete slab with bamboo reinforcement and EPS infill panel showed good performance compared to slabs with steel rebar. However the deflection of the bamboo reinforced slabs with EPS infill panels is a major issue that needs further investigation.

Pankaj R. Mali, D. Datta 2018 - This paper present the flexural performance of bamboo reinforced concrete(BRC) slab panels under concentrated loading. Fifteen slabs were tested which were divided into three major categories i.e. PCC (Plain cement concrete), RCC (Reinforced cement concrete), and BRC (bamboo reinforced concrete) subdivided into UTBRC i.e. Untreated (plain) BRC slab panels, PTBRC i.e. Plain treated BRC slab panels and GTBRC i.e. Grooved treated BRC slab panels. The results show that the increase in ultimate load carrying capacity is in the sequence of 'PCC'(minimum), 'UTBRC', 'RCC' 'PTBRC','GTBRC'. The energy absorption capacity of GTBRC slabs under the same deflections was relatively higher by 48%, 21% and 9% than PCC, UTBRC and PTBRC slabs respectively. The overall research shows that the grooved bamboo strips used in concrete slabs panels improve flexural strength, ductility and mode of failure as compared to that of PTBRC and RCC slab panels.

It concludes that when grooved bamboo strip is used as reinforcement in concrete slabs it provides better load carrying capacity and deformation capacity as compared to that of PCC (Plain Cement Concrete) and RCC (Reinforced Cement Concrete) slabs.

REFERENCES

[1] "Flexural behavior of babadua reinforced one-way slabs subjected to third-point loading" by Charles K. Kankam, Brigitte Odum-Ewuakye
[2] "Babadua reinforced concrete two-way slabs subjected to concentrated loading" by C.K. Kankam, B. Odum-Ewuakye
[3] "Durability analysis of bamboo as concrete reinforcement" by Humberto C.lima Jr., Fabio L. willrich, Normando P. Barbosa, Maxer A. Rosa, Bruna S. Cunha
[4] "Effect of thermal treatment on the physical and mechanical properties of phyllostachys pubescen bamboo" by Ya Mei Zhang, Yang Lun Yu, Wen Ji Yu
[5] "Effect of processing methods on the mechanical properties of engineered bamboo" by Bhavna Sharma, Ana Gatóo, Michael H. Ramage
[6] "Flexural behaviour of bamboo based ferrocement slab panels with flyash" by S. Jeeva Chithambaram, Sanjay Kumar
[7] "Structural behavior of lightweight bamboo reinforced concrete slab with EPS infill panel" by Ari Wibowo, Indradi Wijatmiko, Christin Remayanti Nainggolan
[8] "Experimental evaluation of bamboo reinforced concrete slab panels" by Pankaj R. Mali, D. Datta