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Flexural Characteristics of Rattan Cane Reinforced Concrete Beams

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----------**ABSTRACT**----------

The potentials of Rattan Cane as a reinforcement material in concrete beams were investigated. The principal objective was to determine the flexural behaviour of Rattan Cane Reinforced Concrete Beams. Tensile strength tests were conducted on rattan cane samples to assess their qualities as reinforcement material. Singly Steel Reinforced and Singly Rattan Cane Reinforced Concrete Beams of 750mm length having 150mm width and depth were compared with Plain Concrete Beam in this research work. The flexural strength, load carrying capacity and deflection characteristics of each beam were observed and compared. It was discovered that using Rattan Cane as reinforcement can increase the load carrying capacity of beams. It was also discovered that for Singly Rattan Cane Reinforced Concrete Beam, the load carrying capacity increased by about 20% over that of the plain concrete beam having the same dimensions while for Singly Steel Reinforced Concrete Beam, the load carrying capacity increased by about 2.3 times over that of the plain concrete beam having the same dimensions. Further studies are also recommended on the use of Rattan Cane as reinforcement in concrete.

KEYWORDS: *Concrete, Beams, Steel, Rattan Cane*

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I. INTRODUCTION

Rattan cane is a very important forest product and it has been used extensively by the rural people for various activities such as furniture, utensils, agricultural implements and housing.

Rattan is a member of the bamboo family and its use in Portland Cement Concrete has been studied extensively by Clemson Agricultural College (Glen, 1950).

According to Lucas and Dahunsi (2004), the rattan cane concrete bond strength ranges between 0.816 and 0.598 N/mm^2 depending on the species and natural conditions, as compared to 2.07 N/mm^2 obtained for steel concrete bond. These values represent between 3.94 and 28.86 per cent of the bond strength of steel with concrete. They fall within the range obtained by Nindyawati et al (2013), that is 0.33 – 0.48 N/mm^2, although Harish et al (2013) obtained between 0.90 – 1.95 N/mm^2 for some bamboo species bonded with concrete.

The average tensile strength for this bamboo family was determined to be between 204 N/mm^2 and 250 N/mm^2 (Alade el al, 2004), this result is comparable to mild steel. Tensile strength is also influenced by the diameter of the reinforcement.The average compressive strength of the different bamboo family has been discovered to depend on the bamboo species. Harish et al (2013) obtained 108.9 N/mm^2, Chung and Yu (2002) obtained 103 N/mm^2 while Baldaniya et al (2013) got 109 N/mm^2 as the average compressive strength of bamboo.Akinyele and Olutoge (2011), were able to investigate the properties of rattan cane reinforced façade. It was observed that rattan cane reinforced façade and the conventional reinforced façade both experienced flexural type of failure, but due to the low modulus of elasticity of rattan cane, its façade exhibited larger strain than those of steel reinforced façade. However, the research showed that the rattan façade had lower crack widths when compared with that of steel which gave it an advantage when exposed to moisture.Akinyele and Aresa (2013), carried out a research work on the use of bamboo and rattan cane as alternative materials to steel in reinforced struts. All the struts were subjected to axial load and the results after crushing showed that all the struts failed in the same manner with average compressive strength of bamboo and reinforced struts being about 78.18% and 63.48% that of steel struts respectively. Average crack width generated in bamboo and rattan reinforced struts were about 83.64% and 169.69% that of steel reinforced struts respectively.Mahzuz et al (2013), carried out a research on Zali bet (Calamusguruba) which is a specie of rattan cane. Tensile test was conducted on the rattan while pull out test was conducted on rattan embedded in concrete. It was discovered that rattan offers much less tensile strength than steel. In addition, the bond strength of rattan was also discovered to be much less than that of steel.This paper presents the flexural behaviour of rattan cane reinforced concrete beam compared with that of conventional steel reinforced concrete beam.

II. MATERIALS AND METHODS

Materials

Rattan Cane

The Rattan Cane used for this study was obtained from Ikirun, Osun State, Nigeria. The rattan cane was 12mm in diameter and it was cut into 700mm long as required for the research work.

Coarse Aggregate

The granite used for this research work was 12mm size. It was sourced from a quarry along Ibadan-Ile Ife expressway in Nigeria

Fine Aggregate

The sand used for this research work was sourced from Iree, Osun state, Nigeria. The impurities were removed and it conformed to the requirements of BS 882 (1992).

Steel Reinforcement

The reinforcement of size 12mm was obtained in Ikirun, Osun State, Nigeria. The reinforcement was cut into 700mm long.

Cement

The cement used was Ordinary Portland Cement. It was sourced from Iree, Osun State, Nigeria and it conformed to the requirements of BS EN 197-1: 2000.

Concrete Mix Design

The concrete used in this research work was made using Ordinary Portland Cement, Sand and Gravel. The concrete mix proportion was 1:2:4 by weight and a water cement ratio of 0.50 was used. The mix proportion was designed for 20 N/mm^2 at 28 days.

Casting of Samples

Beam Specimen

Concrete was poured into moulds 150 x 150 x 750mm in size. The different types of beam samples were:

. Plain Concrete Beam without any reinforcement.

. Singly Steel Reinforced Concrete Beam: Two 700mm long Steel Reinforcement Bars were placed on top of the first layer of 25mm which served as cover to reinforcement.

. Singly Rattan Cane Reinforced Concrete Beam: Two 700mm long Rattan Canes were placed on top of the first layer of 25mm which served as cover to reinforcement.

After 24 hours, samples were demoulded and submerged in open water tank for curing for 28 days as required for the test.

Testing of samples

The tests were carried out at the Ministry of Works and Transport, Ibadan, Nigeria and Federal Polytechnic, Ado Ekiti , Nigeria.

The tensile strength test was performed on 12mm Steel Reinforcement samples as well as 12mm size Rattan Cane samples. The specimens were placed in Technotest-Eurotronic machine and tensile load was applied until fracture.

The Flexural Test on the Concrete Beams was carried out on Universal Testing Machine. The sample was weighed before being put in the Flexural Machine. Each specimen was simply supported over an effective span of 450mm. The beams were tested in flexure under third point loading. The loads were applied at third points between the supports on top of the beam at a distance of 150mm from each support. The loads were applied on the beam until the first crack was noticed and the corresponding deflections were recorded until the final collapse of the beam was reached.

III. RESULTS AND DISCUSSIONS

Tensile Strength of Rattan Sticks and Steel Reinforcements

The results of the tensile strength test done on the Rattan Sticks and Steel Reinforcement used are shown in Tables 1 and 2. The results revealed there was no significant difference in the stress values among the three rattan sticks and among the three steel bars.

Table 1: Tensile Strength Test Results of Rattan Sticks

Stick No	Stick size (mm)	Ultimate load (kN)	Stress (N/mm^2)	Average stress (N/mm^2)
1	12	8.70	83.75	
2	12	8.76	84.32	83.20
3	12	8.47	81.54	

Table 2: Tensile Strength Test Results of Steel Reinforcement

Bar No	Bar size (mm)	Ultimate load (kN)	Stress (N/mm^2)	Average stress (N/mm^2)
1	12	72.23	638.62	
2	12	72.01	636.64	639.16
3	12	72.64	642.21	

Flexural Strength of Concrete Beams

· Plain Concrete Beam

In the plain concrete beam, the first crack occurred vertically from the point of load application. It was observed that the beam failed at the ultimate load of 40.9 kN. The beam failed suddenly which showed brittle failure.

· Singly Steel Reinforced Concrete Beam

The results of load versus deflection for the Singly Steel Reinforced Concrete Beam after 28 days curing in water is shown in Table 3. The corresponding graph is also shown in Figure 1. The results revealed that the ultimate load carrying capacity as 95 kN and maximum deflection of 32mm. The maximum crack width was 4mm.

Table 3: The result of loading Singly Steel Reinforced Concrete Beam

Deflection (mm)	Load (kN)
2	22
4	47
6	68
8	74
10	79
12	83
14	86
16	90
18	91
20	92
22	93
24	94
26	94
28	94
30	95
32	95

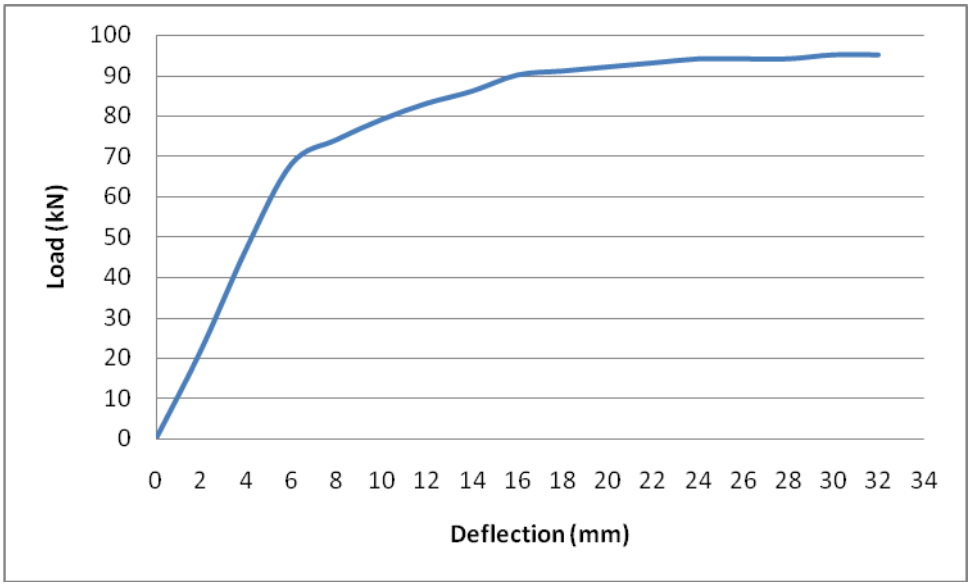

Figure 1: Load-Deflection Curve for Singly Steel Reinforced Concrete Beam

· Singly Rattan Cane Reinforced Concrete Beam

The results of load versus deflection for the Singly Rattan Cane Reinforced Concrete Beam after 28 days curing in water is shown in Table 4. The corresponding graph is also shown in Figure 2. The results revealed that the ultimate load carrying capacity as 48 kN and maximum deflection of 18mm. The maximum crack width was 5mm.

Table 4: The result of loading Singly Rattan Cane Reinforced Concrete Beam

Deflection (mm)	Load (kN)
2	7
4	14
6	22
8	28
10	31
12	35
14	40
16	45
18	48

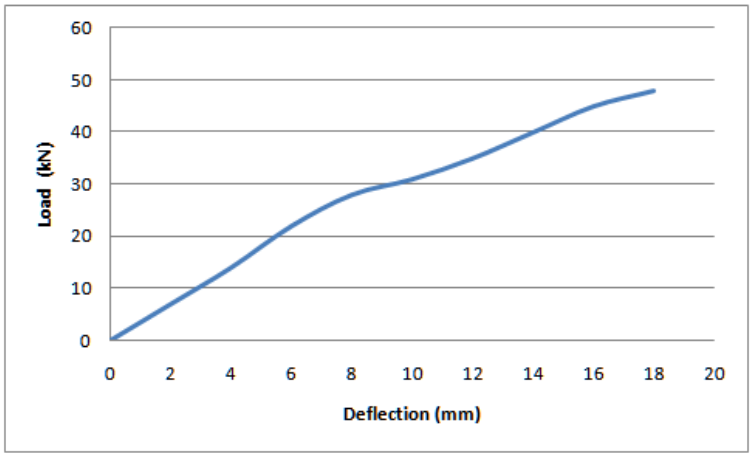

Figure 2: Load-Deflection Curve for Singly Rattan Cane Reinforced Concrete Beam

IV. CONCLUSIONS AND RECOMMENDATIONS

From the investigations carried out, the following conclusions can be made:

Using Rattan cane as reinforcement can increase the load carrying capacity of beams having the same dimensions.

At Ultimate load, the Singly Rattan Cane Reinforced Concrete Beam crushed under load followed by the rupture of the Rattan Cane whereas the Steel did not rupture but lost its elasticity.

For Singly Rattan Cane Reinforced Concrete Beam, the load carrying capacity increased by about 20% over that of the plain concrete beam having the same dimensions.

For Singly Steel Reinforced Concrete Beam, the load carrying capacity increased by about 2.3 times over that of the plain concrete beam having the same dimensions.

The maximum deflection of Singly Steel Reinforced Concrete Beam is about 1.8 times than that of the maximum deflection of Singly Rattan Cane Reinforced Concrete Beam

Both Singly Rattan Cane and Steel Reinforced Concrete Beams showed elastic behaviour while performing flexural tests on them.

Singly Steel Reinforced Concrete Beam has better elastic behaviour than Singly Rattan Cane Reinforced Concrete Beam.

The following are recommended from this study:

Durability studies should be carried out on the use of Rattan Cane as reinforcement.

The creep and shrinkage properties of Rattan Cane should be investigated.

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