EVALUATION OF EFFECT OF CHEMICAL TREATMENT ON TENSILE STRENGTH OF RATTAN CANE

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ABSTRACT

In order to design any structural component efficiently, it is necessary to know in advance the strength capability of the material to be used. Rattan cane presents a problem in this respect since the quality cannot be controlled as they are naturally occurring materials. All the other materials that are used structurally are manmade and therefore some form of quality control can be exercised during their productions, this has led to some research work on the structural properties of rattan cane. This project work will focus on one of the characteristics of rattan cane through assessing effect of moisture content in the rattan cane in its untreated or unmodified phase of and after modifications or treatments using liquid chemicals to be painted on the surface of rattan cane in its performance structurally in mechanical parameters like tensile strength.

Keywords: Calamus-vittayila , modifications, moisture content, primer, *Rattan cane, tensile, treatments, varnish*

INTRODUCTION

Reinforcement of cementitious materials generated considerable interest in recent years. The high technology of manufacturing conventional reinforced concrete of cement and iron or steel bars coupled with its increasing costs has stimulated the interest on how other materials could be used easily in reinforcing concrete and at a cheaper cost. The use of Fibre Reinforced Polymer (FRP) as an emerging technology for concrete structures has been tested and proved successful, this is because of its inherent characteristics such as corrosion resistance, high strength, light weight and anticipated long-term durability. Attention is gradually been focused on the use of bamboo (Bambusa vulgaris) and rattan cane (Calamus deerratus) as alternative reinforcement in concrete. However, in current project specimen from Calumus Vittiyila as alternative rattan cane species has been checked in terms of its physical characteristics namely moisture content and tensile strength test.

Rattan is comparatively cheaper than wood and bamboo; and has tremendous a growth potential in rural areas. Whereas the mechanical properties and behaviour of steel have been thoroughly studied and well documented. determined ultimate tensile strength, yield strength, Young's modulus and bond strength (when embedded in concrete) of rattan samples cut from three years and older trees comprehensive studies on the behaviour of bamboo, but only very few comprehensive data are available on tensile and flexural properties of rattan ***(De Zoysa and Vivekanandan, K., (2015))*** determined the yield strength, ultimate strength and modulus of elasticity of a rattan (Calamus guruba) through experimental investigation.

REVIEW OF LITERATURE

2.1 General overview about Rattan

Calamus Vittayila Rattan Species

A solitary-stemmed, climbing cane. The leaf sheaths are armed with densely-arranged spines, and a long spiny, flagellum (special-ised climbing organ) which helps the cane to grow high into the forest canopy. (Ding, W. D., Koubaa, A., and Chaala, A. (2013).)

Distribution: Bhutan (Mongar, Sarbhang and Zhemgang) and India (Arunachal Pradesh, Assam, Meghalaya, Sikkim and West Ben-gal). (Ding, W. D., Koubaa, A., and Chaala, A. (2013).)

Harvesting of rattan and its transportation

Up to10% of the mature growing stock of rat-tans can be harvested at a rotation of three years from clumps of age 6 to 15 years. The older the better in respect of number of stems and also length in each clump. A single clump may yield about a quintal of canes of about 15 years of age. Care should be taken to harvest

only the mature stems which exhibit loosening of leaf sheath and exposure of lowest part of the stem. It is suggested to limit the harvesting only in the dry season. Unwinding the canes manually from the branches of supporting trees instead of pulling them to avoid breaking and wastage of the top portions. (Supardi, N., Dransfield, J. & Pickersgill, B., 2013)

Fig.1 Rattan Cane sticks

Rattan oil curing, bleaching and preservation

Why cure, bleach and preserve rattan?

Rattan is a natural material and degrades over time. It is also susceptible to fungal and insect attack and this can seriously affect the quality, usability and the price of the canes. Curing, bleaching and preserving the rattan adds value to the raw material, preserves it's unique qualities and improves its durability. *(Uhl, N.W. & Dransfield, J., 2014.)*

2.2 Some Technological Constraints

Structural properties

A major constraint consists in the limited utilization of the many rattan species. Out of a total of about 600 species only about 50 are said to be utilized commercially. In the Philippines, 12 out of 68 belong to this category (***Tesoro, 1988). IPGRI and INBAR (1998)*** list 21 Calamus species in order of their priority using as criteria cane size, commercial potential and use for rural industries. This selection relates partly to the quantities available, partly to unsuitable dimensions, and partly to inferior properties for processing and utilization. (***Supard, Dransfield, J. & Pickersgill, B., 2013)***

2.3 Some Mechanical Properties of Rattan Cane

Flexural Characteristics of Rattan Cane Reinforced Concrete Beams

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)***.

2.4 List of Modification Techniques of Rattan cane Properties

Many methods or techniques of modification are being using in the world. From these the following are the main:-

- Heat Modification
- Chemical Modification

- Impregnated Modification
- Densification ***(Militz and Zbig 2009)***

Resin impregnation modification involves impregnation of monomeric or pre-polymeric resins of low molecular weights in to porous structures. Such treatment has been reported to improve dimensional stability and mechanical strength. MMA (Methyl Methacrylate are resin which are inexpensive and accessible which are being used in India too.***(Devi and Maji 2013).***

The current project work focuses on chemical modification of Rattan by using Varnish and Primer Chemicals.

Description on Chemical Treatments

a) Varnish is a clear transparent hard protective finish or film. Varnish has little or no color and has no added pigment as opposed to paint or wood stain which contains pigment. However, some varnish products are marketed as a combined stain and varnish. Varnish is primarily used in wood finishing applications where the natural tones and grains in the wood are intended to be visible. It is applied over wood stains as a final step to achieve a film for gloss and protection. Varnish finishes are usually glossy but may be designed to produce semi-gloss sheens by the addition of "flatting" agents. (https://**en.wikipedia.org**/wiki/**Varnish)**

Fig. 2 Clear Synthetic Varnish

b) Primer(Wood Primer)

A primer is a chemical consists of 20%-30% synthetic resin, 60%-80% solvent and 2%-5% additive agent. Some primer contains polyethylene (plastic), for better durability.

Fig. 3 A water-based primer

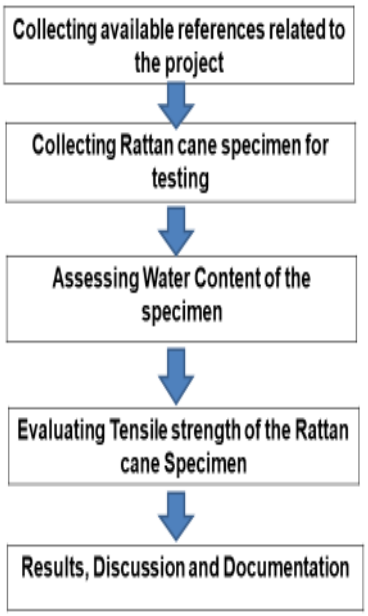
In practice primer is often used when painting many kinds of porous materials, such as concrete and especially wood . Priming is mandatory if the material is not water resistant and will be exposed to the elements.

Priming gypsum board (drywall) is also standard practice with new construction.

METHODOLOGY

The project work was begun from collecting available documents which are relating to title mainly focusing in the engineering aspect to be discussed under the major title of the project. Gathering Rattan Cane specimen which is familiar in India so as to evaluate its physical property and tensile property. Analysing of moisture content in laboratory oven dry testing on rattan cane specimen on its overall performance was done and the results were recorded. By using Universal Testing Machine, tensile strength test was done for 500 millimetre long and 9 to 10 millimetre thick Vittayila Calumus species Rattan cane to check its Mechanical performance capacity in accordance to be needed in laboratory machines sizes by putting mortar mix at the two ends for being gripped into the machine. And the final step was writing discussions, recommendations and conclusions based on the results and observations investigated in accordance to each specific laboratory test in terms of oven dry moisture content test and Tensile strength test.

Flow- chart for Methodology



RESULTS AND DISCUSIONS

4.1 RESULTS

As it was observed the availability of water in the composition of rattan cane sample specimen while conducting oven dry laboratory test there was significant change in performance of the used rattan cane specimen in different categories having different weight.

Water content Results of both Untreated and Treated Rattan Cane Samples

The following three tables are being included to put the results of moisture content in three separate trials and for the three specimen containing five rattan cane stick length of 25mm so as to have accurate results for more

analysis as it was observed in laboratory conduction session.

Table 1: Determination of water content for Untreated Rattan cane samples

No.	Parameters	Trial (1)	Trial (2)	Trial (3)
1	Initial Weight(W1) in grams	5.8	5.6	6.0
2	After Keeping in Oven(W2) in grams	5.0	4.9	5.25
3	Moisture Content (W1-W2)/W2 * 100%	16	14.26	14.24
Average Moisture Content		**14.83**		

Hence, average moisture content of the rattan cane is **14.83%** (untreated rattan).

Whereas:- Moisture Content = (W1-W2)/W2 * 100%

- 'W1' is initial Weight

- 'W2' is moist weight

Hence, the result of the moisture content for the three groups of Vittayila Calamus species Rattan cane of length 25 millimetres was 14.83% which was before any chemical was being painted on the surface of rattan cane specimen.

Determination of water content for treated rattan cane

Table 2-Varnish painted Rattan

No.	**Parameters**	**Trial (1)**	**Trial (2)**	**Trial (3)**
1	Initial Weight(W1) in grams	6.1	6.0	6.2
2	After Keeping in Oven(W2) in grams	5.50	5.30	5.00
3	Moisture Content in percentage	10.31	13.30	12.73
Average Moisture Content		**12.14**		

The result 12.14% from table number 3, declares that there will be decrement in moisture content of rattan about 2.69% from 14.83% initially at its untreated or unpainted stage.

Table 3- Wood Primer chemical painted rattan cane

No.	Parameters	Trial (1)	Trial (2)	Trial (3)
1	Initial Weight(W1) in grams	6.60	7.25	6.60
2	After Keeping in Oven(W2) in grams	6.00	7.50	6.00
3	Moisture Content (W2-W1)/W1 * 100%	10.00	11.54	10.00
Average Moisture Content		**10.52**		

The result 10.52% from table number 4, declares that there will be decrement in moisture content of rattan about 4.31 % from 14.83% initially at its untreated or unpainted stage which is comparably very good result and shows wood primer solution chemical is good enough in reduction of the water content.

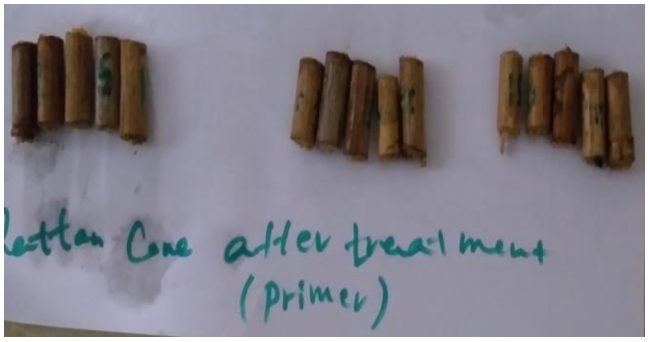


Fig.4 Treated rattan cane samples with primer chemical

Fig.5 Varnish Painted Oven dried Rattan Cane on Weighing Balance

Therefore, from the two chemicals, primer chemical as a treatment or modification is more likely preferable because of its lesser effect due to lesser result observed than that of varnish paint treatment. Thus, it is better to utilise or adopt the wood primer so as to use rattan as an alternative to steel as a reinforcement in much better probability in not to be easily lead to failures in terms of corresponding mechanical strength parameters which can be affected negatively from change in moisture or water content in the composition of the rattan cane in use.

Tensile strength comparison between Untreated and Treated rattan cane Samples

Sample Calculations of Tensile Strength

Stress = Force/ Area

Untreated Rattan Cane Specimen

Specimen 1:- Tensile Stress (Strength)

= Load applied / Area

Area= 3.14 * (10mm * 10)/ 4 = 78.5 sq. mm

Load= 10.2kN

Tensile Strength = 10.2 * 1000 N/ 78.5 sq. mm = 130 MPa

Varnish Painted (Treated) Rattan Cane Specimen:-

Specimen 1:- Tensile Stress (Strength)

= Load applied / Area

Area= 3.14 * (10mm * 10)/ 4

= 78.5 sq. mm

Load= 13.0kN

Tensile Strength

= 13.0 * 1000 N/ 78.5 sq. mm = 165 MPa

Table 4- Summary of Tensile Strength for untreated and Varnish painted Rattan Cane Sample

	Tensile Strength in MPa	
No.	**Untreated**	**Treated**
1	130	165
2	135	172
3	142	175
	Average=135.7	Average=170.6
Percentage increase in tensile strength = 25.7%		

Hence, using the rattan cane which has been painted with Varnish chemical solution can increase about quarter or 25.7% percentage increment in tensile strength performance. This result is raised due to decrement of moisture content within 48 hours duration of drying after being painted and prevention capacity of the chemical from exposures and insects and fungicide due to good composition of the chemical.

Primer Painted Rattan Cane Sample

Specimen 1:- Tensile Stress (Strength)

= Load applied / Area

Area= 3.14 * (10mm * 10)/ 4 = 78.5 sq. mm

Load= 14.85 kN

Tensile Strength = 14.85 * 1000 N/ 78.5 sq. mm = 189 MPa

Specimen 2:- Tensile Stress (Strength) = Load applied / Area

Area= 3.14 * (9mm * 9mm)/ 4 = 63.6 sq. Mm

Load= 12.2 kN

Tensile Strength = 12.2* 1000 N/ 63.6 sq. mm = 192MPa

Table 5- Summary of Tensile strength of untreated and Primer Painted Rattan Cane Sample:-

	Tensile Strength in MPa	
No.	**Untreated**	**Treated**
1	130	189
2	135	192
3	142	195
Average=135.7		Average=192
Percentage increase = 41.86%		

This amount of decrement in water content result in 41.86% percentage increase in tensile strength is very exciting so as to use for the species of rattan till in many in number and in better quantity too. This amazing result be raised due to decrement of moisture content within 48 hours duration of drying after being painted and prevention capacity of the chemical from exposures and insects and fungicide due to good composition of the chemical.

Therefore, from the two chemicals, the wood primer chemical is preferable because of its better effect due to better result observed than that of varnish paint. Thus, it is better to utilise or adopt primer so as to use rattan as an alternative to steel as a reinforcement in better confidence no to be exposed to the phenomenon of failures in terms of tensile strength parameter.

4.2 Discussions

- Rattan is a natural material and degrades over time. It is also susceptible to fungal and insect attack and this can seriously affect the quality, usability and the price of the canes. Curing, bleaching and preserving or treatments like chemical painting the rattan adds value to the raw material, preserves its unique qualities and improves its durability.

- Untreated rattan should not be used for reinforcement in place steel reinforcement bars because of its lesser strength performance and its biological behaviour leading to decaying within the concrete.

- As it was observed in testing the rattan cane's behaviour, it is good to put rattan cane member or sticks dry enough before utilising at least for two years for construction activities. The results seen in the two tables

above are tensile strength in MPa after putting the rattan cane sample of having 500mm in dry place till 48 hours so as to have had dried rattan cane with lesser water content so as to gate better strength at last. Moisture in organic materials in specifically can affect their overall mechanical performance, as it has been seen in the case of rattan cane too. And as it has been observed in laboratory oven dry test, the oven dried rattan cane has better mechanical strength due to lesser water content in their composition.

CONCLUSION

The use of Fibre Reinforced Polymer as an emerging technology for concrete structures has been tested and proved successful; this is because of its inherent characteristics such as corrosion resistance, high strength, light weight and anticipated long-term durability. Attention is gradually been focused on the use of rattan cane as an alternative reinforcement in concrete after the success recorded in the use of Fibre Reinforced Polymer.

While selecting Rattan Canes sticks for construction activities we have to check for it's for maturity and check whether it is seasoned or not. Besides this, Canes shall not break on bending or any other processing stage and Canes shall be either oil-cured or chemically treated with anti-staining fungicide, bleached or fumigated so as to have better in mechanical strength including tensile strength performance.

Rattan has the tenacity and strength that is high enough so that it can be used as a material for the reinforced concrete construction especially in light weight structures. The tensile properties of the Rattan cane reinforcing material are normally distributed and its stress ratios satisfied the minimum requirement value. Moreover, primer painted and varnish painted rattan cane has much better tensile strength after painting and being dried for more than two days through lower moisture content within its composition and being protected from insects.

Depending on the increment in tensile strength performance due to the modification or treatments like varnish and wood primer used, it is possible to conclude as specifically primer treated modified rattan cane of similar diameter or thickness can substitute the same diameter steel, but in lesser spacing between the rattan cane mesh of reinforcement and varnish painted rattan can be used in closer spacing than wood primer bars, in the situation where it is not possible to gate wood primer chemical for advanced benefit over it.

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