



ANALYSIS OF MECHANICAL PROPERTIES OF DIFFERENT BAMBOO SPECIES BY USING EXISTING ADHESIVES IN MARKET

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ABSTRACT

The paper details the evaluation of mechanical properties and comparison with the different bamboo species. The mechanical properties of the bamboo joints are performed using the present adhesive during the experimentation. The properties such as tensile strength, compressive strength, shear strength and bending strength were tested on 50 specimens of bamboo species with different adhesives using universal testing machine. Ten specimens of each joint is prepared using the single adhesive. All such bamboo samples prepared by different adhesive were laid for 7 days for drying. During experimentation it was observed that the mechanical properties of bamboo species with asian paints (Loctite touch) adhesive are found to be better as compared to the other bamboo species with different adhesive. Samples for the tests were prepared from the timber bamboo and African Bamboo. The bamboo is ease available in the rural areas in bulk.

Keywords: Mechanical properties Specimen, Adhesive , Tensile test, Compression test, Shearing test, Bending test, Reinforce, Interfacial bonding.

1.1 Introduction

Mineral resources available in the earth are now reaching its limits. Steel reinforcement used for constructions, furniture, machinery and other applications may be replaced by the development of bamboo. The bamboo setups are developed for sustainable development.

These set up are used to sustain the mechanical applications. As bamboo have the features of growing fast with high yield, as well as high intensity, rigidity, thermal stability, and other strengths in physical performance. Bamboo used for the mechanical applications is further enhanced by appropriate bamboo adhesives at bamboo joinery. As bamboo being a natural material. It is abundantly available in most of the part of world. It can be a replaced for steel in reinforced concrete structure for green building. Only option to the costly construction and furnishing materials is available with bamboo.

1.2 Literature Review

1.2.1. Utilization of bamboo as a low cost structural material.

Abdullah, A.A.A. (1983), Proceedings of the Symposium on Appropriate Building Materials for Low Cost Housing, Nairobi, 7-14 Nov. 1983 and E & F N Spon, London and New York: 177-182.

The work presented on the utilization of bamboo as a low cost material of construction is described. Mechanical properties as well as propagation techniques relating to some local species are presented.

1.2.2. An alternative to steel: Bamboo- A review.

Authors: Sandeep Bharadwaj, Rupali Sharma, Rajendra Kumar, detailed that the bamboo can be replacing steel in low and medium structures. As bamboo is having low cost, environmental friendly and sustainable. Here discussed

advances in bamboo material use in bridge components, as reinforcement in concrete known as bambcrete, as a replacement of structural steel in industrial structure.

1.2.3. Comparative analysis of tensile strength of bamboo and reinforcement steel bars as structural member in building construction.

Authors: Ogunbiyi Moses, S. Olawale, P. Simon, S. R. Akinole, discussed about Tensile strength tests were carried out on various steel and bamboo, the paper reviews that minimal breaking force of bamboo, it cannot be employed as a main structural member in building and other engineering works but can be used as portioning wall construction that is not heavy load bearing.

1.2.4. Development of layered laminate bamboo composite and their mechanical properties

Authors: C.S. Verma, V. M. Charia, present the mechanical properties of layered bamboo composites, laminates including tensile strength, compressive strength, flexural strength and screw holding capacity have been evaluated.

1.2.5. Strength of thermally treated glue laminates of bamboo bambusa vulgaris

Authors: Olajide O.B, Ogunsanwo O.Y, Aina K.S, detailed the strength of bamboo glue-lam is significantly affected by period of exposure to thermal treatment, also glueability of bambusa vulgaris laminates are affected by pressure.

1.2.6. Analysis of bamboo reinforced concrete column.

Authors: Ajinkya Kaware, U. R Awari, M. R. Wakchaure, discussed about African and timber bamboo are species of bamboo which has highest value of tensile and compression strength

1.2.7. Synthesis of low costs adhesives from pulp & paper industry waste.

Authors: R. K. Gothale, M. K. Mohan, P. Ghosh, presents lignin extraction from commercial black liquor and utilizes it as a partial substitute in phenol formaldehyde resin synthesis.

1.2.8. Study on bonding strength of bamboo/bamboo unidirectional laminate with adhesives effect of pressing time on adhesives bonding strength.

Authors: Mansur Ahamd, Syaiful Osman discussed about the bamboo available and superior material for the use of lighter and stronger sandwich structure.

1.3 Comparison of steel and Bamboo mechanical properties

The comparison of the mechanical properties of the steel bars and bamboo samples are presented in the table 1. Result presented shows the mechanical properties of the bamboo are same as the steel bars.

Table No 1. Comparison of Steel and Bamboo

Properties	Steel (KN/cm ²)	Bamboo (KN/cm ²)
Elastic Modulus	2100	2000
Tensile Strength	8-14	16
Compressive Strength	14	2-9
Bending Strength	14	6-27
Shear Strength	2-9	0-2

1.4 Objectives of the study

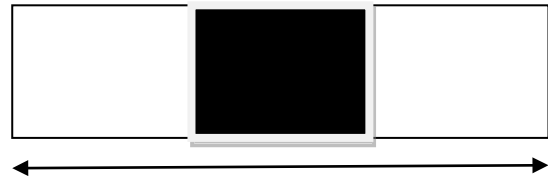
- To replace the steel by bamboo joints because the values of tensile, compressive, bending, shearing are very closer to mechanical properties of bamboo
- To do the comparative study mechanical properties of different bamboo
- To test the mechanical properties of bamboo using different adhesive
- To analysis of mechanical properties with the help of ANSYS software
- Formation of model to test the bonding strength of adhesives.

1.5 Experimental Investigation

1.5.1 Material

The properties such as tensile strength, compressive strength and shear strength were tested on 50 specimens of bamboo species using different adhesives for each test. The test was carried out on universal testing machine. Set of ten specimens were prepared of the lap joint using each adhesive for testing. The different adhesives were reinforced with the bamboo

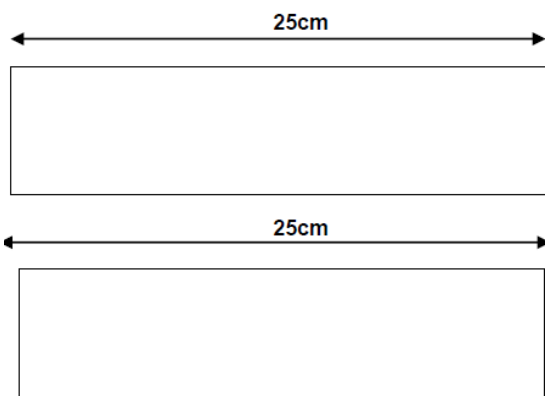
species for seven days. Mechanical Properties of the bamboo species with different adhesives determine on the sample size of length 25 cm and width 10cm



1.5.2 Preparation of the sample

Table No 2. Specimen preparation

Sr. No	Test	No.of Samples for five adhesive
1	Tensile Test	10x5=50
2	Compressive Test	10x5=50
3	Shear Test	10x5=50
4	Bending Test	10x5=50



1.5.3 Different types of adhesives were used for making lap joint.

The details of different Adhesives are used for the preparation of the samples. These adhesives are already exist in the market

- 1) Fevicol SR998
- 2) Asian Paints (Loctite touch)
- 3) Araldite
- 4) Dendrite Supreme
- 5) Fevicol Heat X (Heat Proof)

	Fevicol SR 998	Dendrite Supreme	Fevicol Heat X	Araldite	Asian Paints
Usage	For laminate to wood and Plywood	For fixing of laminates of wood ,boards etc	Best for inside laminates of Shutters	It is Suitable for variety of metals, ceramics, glasses etc	Transparent on appearance to make usable in visible application
Key Features	More resistance to heat and Sunlight	Highly Inflammable	High heat resistance capacity up to 170 0C	Lower Shrinkage ,Good resistance to dynamic loading	High strength lower water adsorption
Draying Time	3-5 minutes	8-10 minutes	10-15 minutes	100-150 minutes	5 hours
Viscosity	---	2200+_ 100CPS	---	30-45 pas	---
Temp	---	30 to 50 0C	---	---	---
Benzene Contain	Benzene Free	---	Benzene Free	---	Epoxy adhesive



Figure 1. Sampling

1.6 Testing on Machines

1.6.1 Tensile Testing

The tensile test of the bamboo sample was carried out on the universal testing machine to test the tensile strength and compressive strength of the materials.



Figure 2. Tensile Strength Testing

1.6.2 Compression Testing

The ability of a material to resist a force that tends to push it apart. Compressive test is carried out to measure the largest force that can be applied to the sample before material breaks.



Figure 3. Compressive Strength Testing

1.6.3 Bending Testing

Bending strength is a measure of the tensile strength of concrete beams or slabs. Flexural strength identifies the amount of stress and force on unreinforced concrete slab, beam can withstand such that it resists any bending failures.



Figure 4. Bending Strength Testing

1.6.4 Shearing Testing

A shear load is force that tends to produce a sliding failure on a material along a plane that is parallel to direction of the force.



Figure 5. Shearing Tensile Strength Testing

1.7 Experimental Calculations

Bamboo sample with the size length 25 mm, outer diameter 2.5 mm and inner diameter 0.5 mm used for the testing is represented in the figure 6.

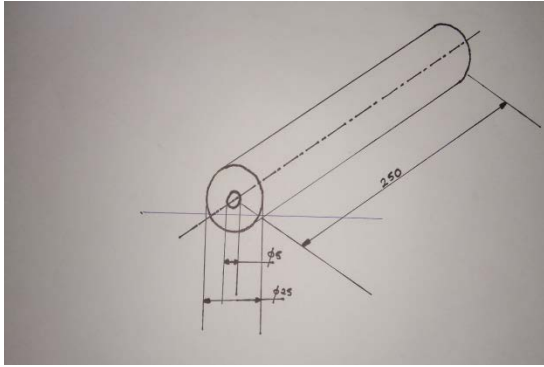


Figure 6. Diagrammatic representation of bamboo

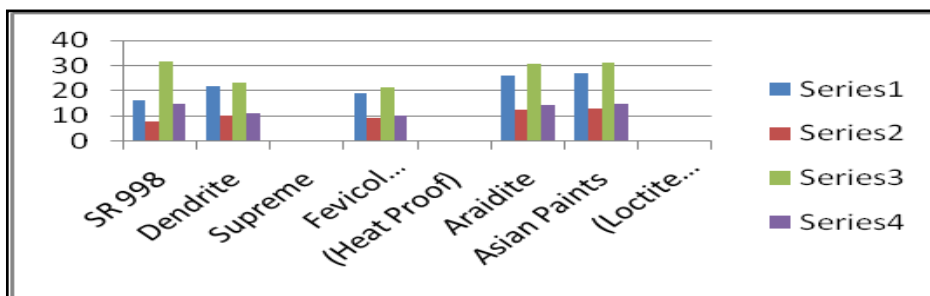
1.7.1 Load for Timber and African Bamboo for Tensile Strength

Bamboo sample were tested on the different machine to know the tensile strength using the different adhesive available in the market. The observation recorded during the test is tabulated in the table 3 and graphically represented in the figure 7.

Table No 3. Tensile Strength of Timber and African Bamboo

Sr. No	Adhesives	Stree on Timber Bamboo (KN/cm ²)	Load on Timber Bambo (KN)	Stree on African Bamboo (KN/cm ²)	Load on African Bamboo (KN)
1	<i>SR 998</i>	16.11	7.601	31.45	14.820
2	<i>Dendrite Supreme</i>	21.44	10.103	22.87	10.777
3	<i>Fevicol HeatX (Heat roof)</i>	18.66	8.793	21.147	9.965
4	<i>Araidite</i>	25.81	12.162	30.39	14.320
5	<i>Asian Paints (Loctite Touch)</i>	26.88	12.666	30.88	14.551

Figure 7: Graphical representation of the mechanical properties using different adhesive.



1.7.2 Load for Timber and African Bamboo for Compressive Strength

The compressive strength is recorded on the different samples using the different adhesive

available in the market. The observation recorded during the test is tabulated in the table 4.

Table No 4.Compressive Strength of Timber and African Bamboo

Sr. No	Adhesives	Stree on Timber Bamboo (KN/cm ²)	Load on Timber Bambo (KN)	Stree on African Bamboo (KN/cm ²)	Load on African Bamboo (KN)
1	<i>SR 998</i>	16.13	4.06	31.45	10.04
2	<i>DendriteSupreme</i>	21.44	6.64	22.87	9.88
3	<i>Fevicol HeatX(Heat roof)</i>	18.66	3.96	21.14	5.25
4	<i>Araidite</i>	25.81	9.02	30.39	10.22
5	<i>Asian Paints(Loctite Touch)</i>	26.88	9.22	30.88	10.58

1.7.3 Load for Timber and African Bamboo for shearing Strength

The shear strength is recorded on the different samples using the different adhesive available

in the market. The observation recorded during the test is tabulated in the table 5.

Table No 5.Shearing Strength of Timber and African Bamboo

Sr. No	Adhesives	Stree on Timber Bambo (KN/cm ²)	Load on Timber Bambo (KN)	Stree on African Bamboo (KN/cm ²)	Load on African Bamboo (KN)
1	<i>SR 998</i>	11.68	0.429	14.04	0.516
2	<i>DendriteSupreme</i>	13.75	0.505	16.28	0.598
3	<i>Fevicol HeatX(Heat roof)</i>	12.85	0.472	14.509	0.533
4	<i>Araidite</i>	16.33	0.600	16.66	0.612
5	<i>Asian Paints(Loctite Touch)</i>	17.11	0.628	17.70	0.650

1.7.4 Load for Timber and african Bamboo for Bending Strength

The bending shear strength is recorded on the different samples using the different adhesive

available in the market. The observation recorded during the test is tabulated in the table 6.

Table No 6. Bending Tensile Strength of Timber and African Bamboo

Sr. No	Adhesives	Stree on Timber Bamboo (KN/cm ²)	Load on Timber Bambo (KN)	Stree on African Bamboo (KN/cm ²)	Load on African Bamboo (KN)
1	<i>SR 998</i>	7.73	19.32	9.28	23.2
2	<i>Dendrite Supreme</i>	9.08	22.70	10.61	26.52
3	<i>Fevicol HeatX(Heat roof)</i>	8.72	21.80	9.62	24.025
4	<i>Araidite</i>	15.18	37.95	15.55	38.875
5	<i>Asian Paints(Loctite Touch)</i>	16.04	40.10	15.71	39.275

1.8 CAD Model

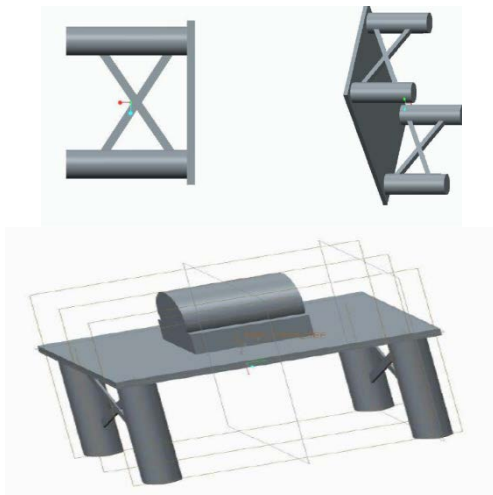


Figure 7. CAD Model



Figure 9. Top View of Actual Table with Adhesive Asian Paint

1.9 Table with Asian Paint Adhesive

Table of the bamboo samples using different adhesive is assembled for testing the bonding of the bamboo joinery. The figure 8 shows the picture of the assembled table.



Figure 8. Front View of Actual Table with Adhesive Asian Paint

1.10 Result

1.10.1 Analysis Based on ANSYS

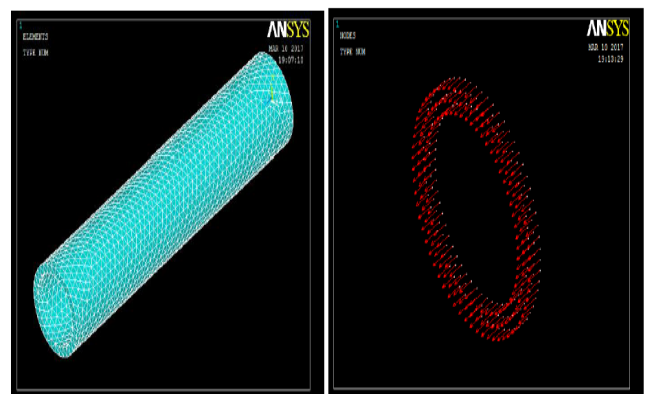


Figure 10. Tetrahedral meshing and loads on node condition

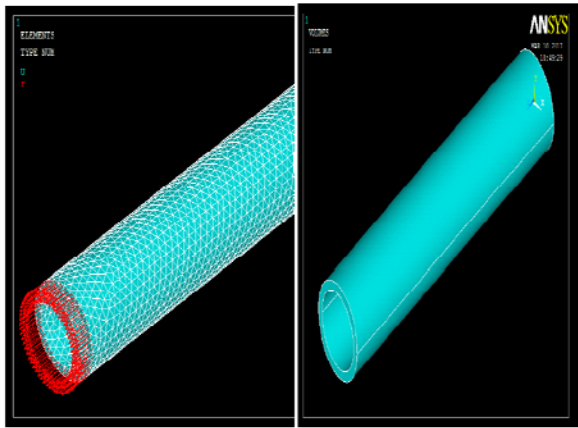


Figure 11. Analysis of standard shape of the Bamboo

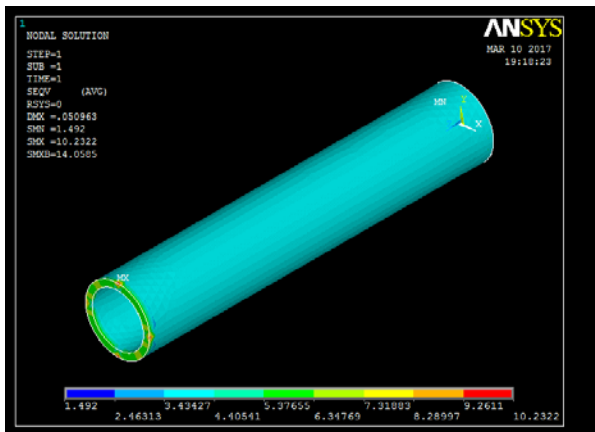


Figure 12. Strain

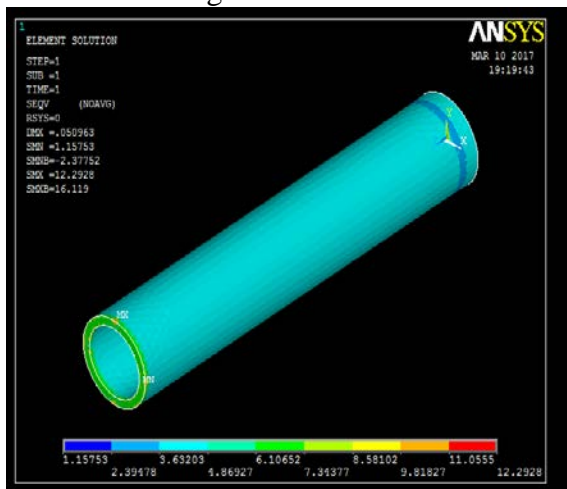


Figure 13. Elemental Solution

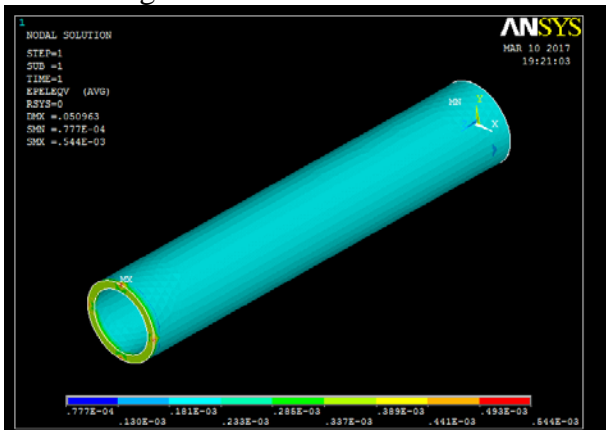


Figure 14. Nodal Solution

1.11 Conclusion

The experimental investigations on the effect of adhesive on mechanical behavior of bamboo species leads to the following conclusions:

The present study shows that the tensile strength of bamboo species are strong in Asian Paints (Loctite Touch) adhesives.

2. The current study reveals that the compressive strength of bamboo species are also strong in araldite and asian Paints.(Loctite Touch) adhesives.

3. It is also observed that compressive strength is greater than the tensile strength

4. It also shows that the shear and bending strength is more in Asian Paints (Loctite Touch) adhesives.

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