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Study of the mechanical properties of raffia bamboo *Vinifera L. Arecaceae*

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Abstract

Raffia Vinifera L. Arecacea is a type of fast-growing palm, which is found in marshy environments and along rivers. In this study, the "Raffia Bamboo" is the stalk of a Raffia palm widely used in the West Region of Cameroon as a building material. From the litterature review, few informations about its elastic properties are available. Our investigations focused on the elastic moduli and strengths of raffia bamboo and the consequent analysis. The raffia bamboo is a composite material, consisting of a fragile marrow (matrix) inside a thin shell (reinforcement), smooth and hard which protects the marrow. The experimental determination of its elastic properties at 13% moisture content allowed us to evaluate: the shear modulus of the marrow (about 5.8 MPa); the respective longitudinal elastic moduli of the shell, the marrow and the raffia bamboo (17 043 MPa; 959 MPa; 13 008 MPa); the transverse elasticity modulus of the raffia bamboo (about 3 149) ; and finally, the tensile strength of the shell (247 MPa), the respective bending strengths of the marrow and raffia bamboo (738 MPa; 5943 MPa) . From the analysis of the results, the elastic properties of the raffia bamboo Vinifera L. Arecacea allow us to classify this material among the light woods, useful for construction and decoration.

Keywords : *Raffia bamboo, marrow, shell, Composite material, modulus of elasticity, shear, strength*

Résumé

Le raphia est un genre de palmier à croissance rapide, de la famille des Arecaceae que l'on rencontre dans les milieux marécageux et le long des fleuves. Dans cette étude, le « bambou de Raphia » est le pétiole d'une palme de Raphia Vinifera L. Arecacea largement utilisé dans la Région de l'Ouest Cameroun comme matériau de construction. La revue de la littérature montre que très peu d'informations sont disponibles sur ses propriétés élastiques. Dans ce travail, nous présentons des résultats sur les propriétés élastiques du bambou de raphia et l'analyse conséquente. Le bambou de raphia est constitué d'une moelle fragile à l'intérieur d'une coque mince, lisse et dure qui protège cette dernière. Il peut donc être assimilé à un matériau composite dont le renfort est constitué de fibres. La détermination expérimentale des propriétés élastiques à 13% d'humidité a permis de trouver: un module de cisaillement de la moelle d'environ 5,8 MPa, un module d'élasticité longitudinal de l'ordre de 17 043 MPa pour la coque, 959 MPa pour la moelle, 13 008 MPa pour le bambou de raphia ; un module d'élasticité transversale de l'ordre de 3 149 MPa pour le bambou de raphia; et enfin, une résistance en traction de l'ordre de 247 MPa pour la coque, une résistance en flexion 738 MPa pour la moelle et 5 943 MPa pour le bambou de raphia . Il ressort de l'analyse des résultats que les propriétés élastiques du bambou de raphia Vinifera L. Arecacea nous permettent de le classer parmi les bois légers utiles pour la construction et la décoration.

Mots clés : *bambou de Raphia ; coque, moelle, matériau composite, module d'élasticité, cisaillement, résistance*

1. Introduction

The «raffia bamboo» is one of the oldest building materials used by humans in the West Region of Cameroon. The raffia palm, often under-exploited, is present in the intertropical zone. It is a palm whose petiole designated «raffia bamboo» used as building materials, insulation, decoration and the manufacture of art objects (Chambost J. et al., 2001).

Investigation lead to the conclusion that there is unfortunately no study on the determination of the elastic properties of raffia bamboo *Vinifera L. Arecacea*. In addition, the production and uses of raffia bamboo are based solely on ancestral ability. In the West Region of Cameroon, raffia bamboo offers a real opportunity the poor local population, to build the houses with that cheap, abundant and fast growing material that can meet the need of economic housing (Ingram et al., 2010).

Some information on the basic properties of raffia bamboo has been examined (Foadieng et al., 2014), but the study of its elastic properties and applications as raw material is very limited. Further studies are needed to assist and promote its application in the modern world. The optimization of the properties of raffia bamboo *Vinifera L. Arecacea* with a view to its valorization requires knowledge of its mechanical properties through tests such as near infrared spectroscopy (Carneiro and al., 2010, Kelley and al., 2004, Kothiyal and Raturi, 2011, Kohanand al., 2012) , static-bending method, longitudinal and complex vibration tests (Chih-Lung Cho, 2007) used on some tropical woods. In this study, we propose to evaluate the elastic moduli and the strengths of raffia bamboo *Vinifera L. Arecacea*.

2. Materials and Methods

2.1. Material

The Raffia bamboo *Vinifera L. Arecacea* is locally called «dink». Our survey concerns samples deducted at Mbieng quarter of Bandjoun village, subdivision of Poumougne, Koung-Khi Division, West Region of Cameroon. Mbieng is situated at 5°25 of North latitude, 10°25 of east longitude, and at 1509 m of altitude (Institut Géographique National, 1973). The Raffia *Vinifera L. Arcaceae* presents itself under shape of a tuft constituted of several feet, themselves composed of palms. A raffia palm includes 4 parts; the leaflet, the rachis, the leafstalk and the basalt girdle. The leafstalk designated by «raffia bamboo» has a lucid green colour when it is fresh and greyish when it is dry. It is 5 to 10 meters height and its diameter varies from 2 to 10 cm. It is a low fund species; the leafstalk is smooth and the leaves are in opposite needles, and have a parallel nervation.

The selected samples don't present any macroscopically observable defect and have been harvested at the state of the dead wood. They have a length of 2 m at least and a medium-diameter of 38 mm. During about 3 months, these samples cut in pieces of about 1m long, have been exposed at the ambient temperature of the Laboratory of Mechanics and Modelling of Physical System (L2MSP) of the University of Dschang Cameroon. Such as wood, raffia palm petiole is known to be a heterogeneous and anisotropic material. The fragile marrow inside a hard and smooth shell. It can be modeled as an anisotropic material having three main directions (figure 1.b): radial (R), tangential (T) and longitudinal (L) direction.

2.1.1. Preparation of the specimens

After three months of drying and conditioning in the laboratory, specimens were sawn according to NF EN 408 (AFNOR, 2004). This standard recommends that for bending tests, the minimum span length of the specimen should be equal to 18 times its diameter (distance between the two furthest points of its cross-section), and if not, the span length of the beam shall be recorded in the test report. On each specimen, two

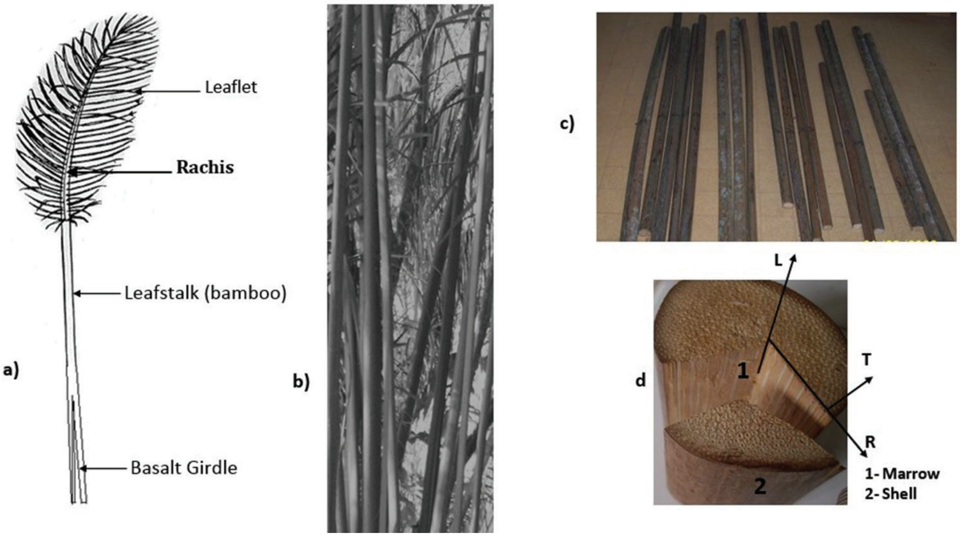

Figure 1: a) Raffia palm; b) Raffia Bamboos; c) pieces of raffia bamboo; d) Principal directions in a piece of raffia

electric strain gauges were fixed parallel to its axis and symmetrically on surfaces previously cleaned with sandpaper. For each sample to be tested, five specimens, cut in its immediate vicinity in the initial structure, are retained (figure 3), one for controlling the variation of the moisture content during the test, two for cutting the marrow beams (removed from the shell), and another for the strength test, the last to determine the yield load.

Twelve samples were selected for testing; so 48 specimens for bending tests and 12 specimens of humidity test.

2.1.2 Test specimen for bending of raffia bamboo (marrow + shell)

The specimen has a length of 380 mm and a cross-section of 36 mm mean diameter. To minimize undesirable bending effects, two strain gauges of (120±0.3%) Ω strength were sticked symmetrically on the specimen and parallel to its axis (Talla and al., 2007). They are connected so as to form a half Wheatstone bridge as shown in figure 4. Subsequently, ten samples were selected for each series of tests.

After sticking, we checked the value of the resistances of the gauges. The wiring resistance, close to 120 Ω, must be measured with a fairly good accuracy, compared to typical values (0.02%). The sticking of these gauges was done with the Alteco 110 glue of Japanese manufacture. The strains are measured directly by means of a modern measuring strain gauge EI 616 by DELTALAB. Its use saves us to calculations since it displays strains with an accuracy of the order of 1mm/m.

2.1.3 Specimen of the marrow

The specimen of the marrow of raffia bamboo has a length of 380 mm and a section of 20 × 20 mm^2. The deflections are measured by an analog comparator of SEB mark (Anti-shock) and precision of 1% since its porosity state does not allow the use of strain gauges. During the tests, the temperature and the relative humidity of the laboratory are given by an electronic thermo-hygrometer, model ETHG913R of Oregon Scientific.

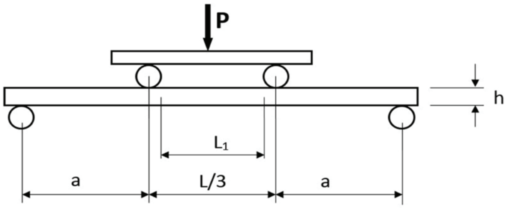

Figure 2: Testing device for measuring the elastic modulus and the bending strength

2.1.4 Bending device

The device used for the static bending test is illustrated by the diagram in figure 5. Each specimen is placed horizontally on two cylindrical supports provided on the device, one fixed and the other free in rotation. At the support points and loading points, a 30 mm diameter cylinder made of steel minimizes the perpendicular shear force. We chose 4-point bending because the polymers are relatively ductile and break in 3-point bending without reaching the maximum load. The loads are constituted by solid steel prisms each provided with a groove enabling it to be threaded onto the support rod (4). These loads sit on the plate (3) fixed by a screw on the end of the support rod. These loads are masses, with respective values of 10 kg, 5 kg, 2 kg, 1 kg and 0.5 kg.

2.2 Tensile testing of the shell

2.2.1 Description of the specimen

After conditioning samples for a period of 14 weeks in the laboratory, specimens were extrated with the following dimensions:

- Overall length 140 mm
- Working length of 80 mm
- Working section of 2 × 4 mm^2

With the epoxy adhesive, we have fixed sandpaper on the ends of the specimens to prevent sliding during the test. Figures 6 and 7 show the structure of a specimen ready to test. The specimens shall be of full cross-section and of sufficient length to provide a test length of at least 10 times the largest dimension of the section NF EN 408.

The jaw system used here was designed to allow effective clamping of the specimen. It consists of a U-shaped container in which are housed four square plates of 30 mm. We have glued sandpaper on these plates to prevent sliding and thus increase the bonding between the heels and the tablets. When the specimen is correctly assembled, the failure occurs in the working area. Figure 8 illustrates the mounting under testing conditions with failure by bursting in the testing area of the specimen.

The force must be applied at constant speed. The loading system used shall be capable of measuring

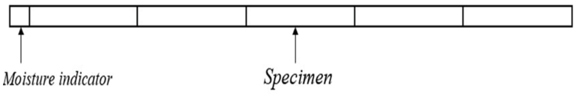

Figure 3: position of a specimen to be tested on a sample

force with an accuracy of 1% of the force applied to the specimen.

2.2.2 Tensile testing machine

It is a hydraulic press with: a dynamometer to estimate the forces applied and graduated in KN, two jaws, one of which is integral with the fixed cross-member and the other is integral with the mobile crossbeam (figure 9).

2.2.3 Operating principle

Since the specimen is fixed between the jaws, the operator acts on the lever of the pump. The oil pressure in the piston chamber induces the piston to move progressively. This puts the movable traverse in motion and consequently the displacement of the movable jaw tends to pull the specimen. In our various tests, we have assimilated raffia bamboo to wood in order to use the laws and techniques applied to wood.

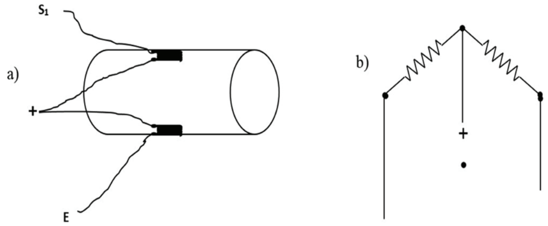

Figure 4: a) position of the gauges and their wiring in the half-bridge of Wheatstone; b) Standard wiring diagram

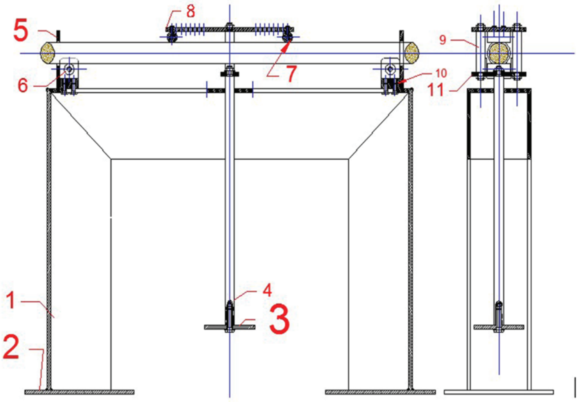

Figure 5: A device for bending test

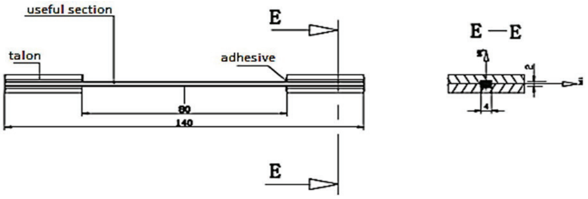

Figure 6: Diagram of the tensile test specimen

2.3 Methods

2.3.1. Tests

The tests are essentially the bending and tensile tests:

- 4-point bending for the determination of the modulus of elasticity. In this case, when the bamboo specimen is loaded, two strain gauges sticked intimately and in parallel to the axis of the specimen, undergo the same strain as the surfaces of the specimen on which they are sticked. This strain results in a variation ΔR of the resistance of the gauges which is proportional to the strain ε (Avril et al., 1984), and which is a function of the deflection.
- The measurement of ΔR makes it possible to calculate the strain. For greater accuracy, we used a DELTALAB brand strain gauge bridge which converts ΔR into strain and directly displays the deformations with accuracy about 1 μm/m.
- 3-point bending for the determination of the shear modulus. When the specimen is loaded, an analog comparator with 1% accuracy indicating that the deflection is increasing with the load.
- Simple tensile tests are carried to determine the modulus of elasticity and the strength of the shell.

2.3.2 Experimental set up

In 4-point bending, the test consists of a beam simply placed on two cylindrical supports (Barkas et al., 1953) and loaded at two points placed respectively at one third and two-thirds of the span of the beam by a Perpendicular load P to its mean fiber. The span of the beam is denoted L and the deflection f is determined from the strains coming from the gauges. These electrical gauges are connected to a strain gauge bridge which directly gives the small strains in μm/m (Hearmon et al., 1948). For the marrow of bamboo raffia, the deflections are given by an analog comparator. The force P is less than or equal to one third of the yield load so that the deflections remain within the elastic range. In each test, we have a beam of almost invariable diameter d according to ISO / TC165 N 315. We shall first study the effect of the intensity of the load P on the deflection by varying its Value for a fixed span. And then that of the length L of the span of the beam by varying its value for a fixed load.

In 3-point bending, the test consists of a beam placed on two supports, and loaded in the middle by a load P perpendicular to its mean fiber. The span of the beam is denoted L and the deflection f is given by an analog comparator of 1% precision. The force P is less or equal to one third of the yield load so that the deflections remain within the elastic range. In each test, we have a beam of characteristics described previously in this paragraph 2.2.2. This series of tests gives us data allowing to evaluate the shear modulus.

The axial tensile test involves placing a specimen between the jaws of a tensile testing machine and apply on the two ends a load P parallel to the fibers. A progressive loading is applied to the specimen until it breaks in some cases. The deflections and the forces applied to the test piece are recorded progressively and then converted respectively into strain and stress. The forces P are less or equal to one third of the yield load.

Figure 7: Photo of a shell specimen

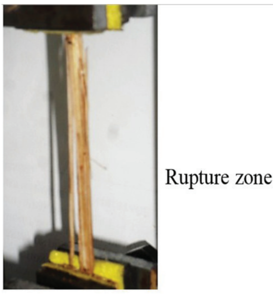

Figure 8: illustration of the rupture of a specimen

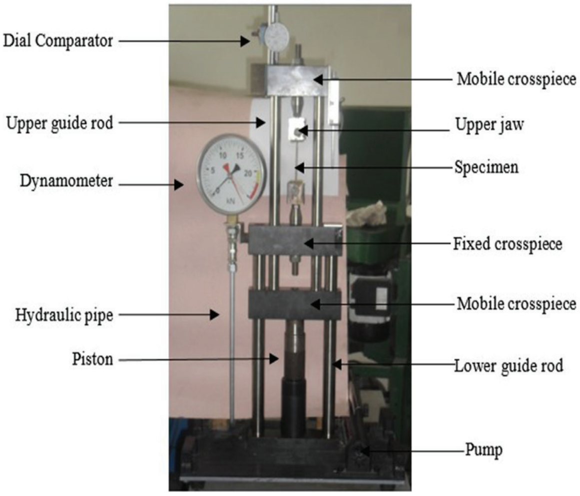

Figure 9: Tensile testing device

2.3.3 Mechanical properties test: Modulus of elasticity and flexural strength

The specimen is loaded symmetrically in 4-point bending, on a span L = 360 mm as shown in figure 2. It receives the mechanical actions on simple supports consisting of steel cylinders of 30 mm of diameter which allow us to minimize the local shear. The supports of the ends can rotate and the others are fixed. If P_{max} is the yield force, the maximum force applied for the modulus of elasticity is less than 0.4 F_{max}.

If h is the height or the diameter of the specimen, L/3 = 6h, and L_1 = 5h = 5L/18. The deflection f is measured at the center of the reference length L_1. The elastic moduli are calculated according to the recommendations of the European Standard NF EN 408 (AFNOR 2004).

3. Results

3.1. Hygroscopy and density

Table 1 lists the densities and water content of the specimens during the tests.

3.2. Results of static tests

In this part, we worked under the internal laboratory temperature of 24°C and a relative humidity of 70%. Ten specimens were selected for this series of tests.

3.3. Mechanical properties of the marrow in bending test

3.3.1 Modulus of elasticity of the marrow and strength

The specimen is subjected to loads which induce small deflections. From the experimental data we have obtained the curves of figure 10.

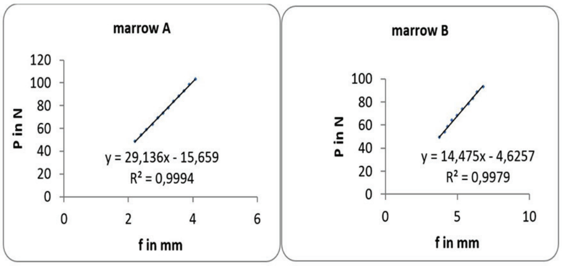

Figure 10 : load-deflection curve of the marrow

Tableau 1 : moisture content (H%), anhydrous density (ad), infra-density (Id)

Specimen	shell			marrow			raffia bamboo		
	H (%)	ad	Id	H (%)	ad	Id	H (%)	ad	Id
A	13.31	0.794	0.653	13.92	0.174	0.124	11.62	0.3	0.27
B	14.34	0.71	0.579	13.37	0.127	0.069	10.93	0.29	0.32
C	12.44	0.782	0.633	14.33	0.222	0.175	13.36	0.26	0.21
D	13.22	0.827	0.704	14.04	0.231	0.187	11.63	0.29	0.24
E	11.57	0.906	0.786	13.76	0.159	0.113	14.33	0.23	0.21
F	13.36	0.983	0.813	13.07	0.179	0.129	11.47	0.27	0.23
G	14.33	0.777	0.678	13.36	0.207	0.135	12.14	0.29	0.26
H	12.14	0.861	0.714	13.82	0.125	0.095	12.47	0.29	0.26
I	12.47	0.798	0.655	12.92	0.173	0.137	12.28	0.28	0.22
J	12.28	0.834	0.679	14.71	0.189	0.145	11.94	0.25	0.25
Average	12.946	0.8272	0.7104	13.73	0.1786	0.1309	12.22	0.28	0.25
Standard deviation	0.925	0.076	0.106	0.56	0.036	0.035	0.99	0.02	0.03

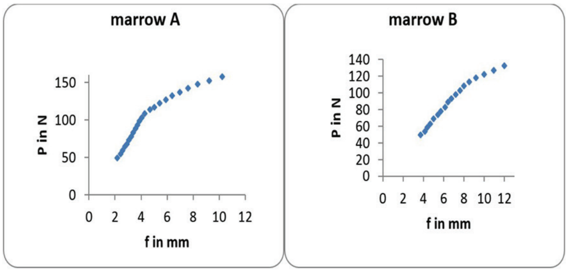

Figure 11: load-deflection curve for the strength of the marrow

Table 2: Load (F_m), longitudinal modulus of elasticity (E_m), marrow strength (F_m) and pore volume ($_\gamma$)

Specimen	Ea (MPa)	G (MPa)
A	57,31	5,52
B	50,41	6,3
C	52,80	5,32
D	53,51	5,65
E	56,56	5,17
F	56,18	6,61
G	49,8	5,56
H	55,15	6,85
I	55,33	5,73
J	33,91	5,36
Average	52,096	5,807
Standard deviation	6,87	0,57

This figure (10) shows 2 examples of curves that give the load as a function of the deflection.

The elastic properties of the marrow of raffia bamboo are estimated according to NF EN 408 standard and grouped in table 2. In the same table, we present the experimental value of the pore volume which significantly affects its mechanical behaviour.

From static tests, we evaluated the value of the 4-points bending strength of the marrow. The experimental data allowed us to represent the curves of the load as a function of the deflection to the yield load. We show in figure 11 the shape of these curves.

3.3.2. Shear modulus of the marrow

The specimen is subjected to 3-point bending loads according to the European standard NF EN 408. From the experimental data, we obtained deflection-load curves whose shape is given in figure 12. A linear regression analysis of the curves in figure 12 yields correlation coefficients $R^2 \geq 0.99$ as required by NF EN 408 for accuracy. According to this standard, we evaluated the apparent modulus of elasticity and then Shear modulus of the raffia bamboo marrow. Table 3 lists the different results obtained.

3.3.4 Elasticity modulus of the shell and its axial tensile strength

Ten samples were chosen for this series of tests. Twelve specimens are subjected to loads which induce small deflections. The experimental data allowed us to represent experimental strain-stress curves whose

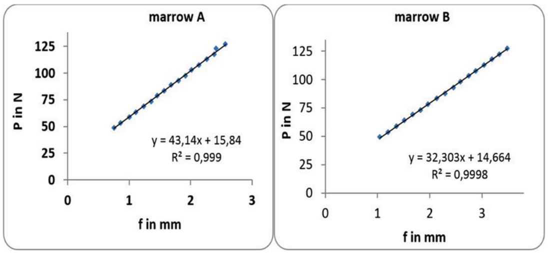

Figure 12: load-deflection curve for the shear of the marrow

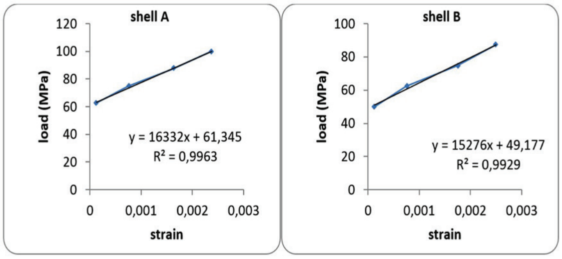

Figure 13: stress-strain curve for the shell in axial tension

shape are deduced from load-deflection curves given in figure 13.

A linear regression analysis applied to these curves yields a correlation coefficient greater than 0.99 as required by NF EN 408 standard for accuracy. The elasticity modulus of the raffia bamboo shell was estimated and the void content evaluated. The results are summarized in table 4. Twelve shell specimens of the selected samples were each subjected to a static tensile test to the yield load.

The experimental data allowed us to represent the train-stress curves whose common shape is given in figure 14.

From the ultimate load to failure P_{max}, we deduced the tensile strength parallel to the fibers according to the European standard NF EN 408 of March 2004.

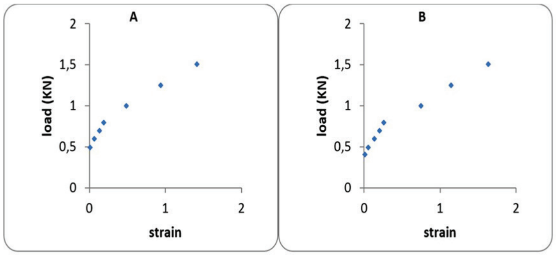

Figure 14: stress-strain curve for the strength of the shell in axial tension

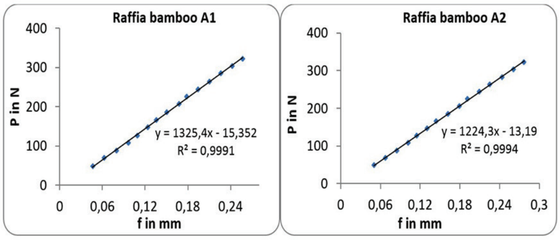

Figure 15: load-deflection curve for the strength of the shell in axial tension

Table 4: Elasticity Modulus (E_C), maximal load (P_{max}), tensile strength (F^m) and void content ($_\gamma$)

Specimen	E_C (MPa)	P_{max} (KN)	F_m (Mpa)	γ %
A	16332	1.80	225.00	57.34
B	15276	1.70	212.50	60.17
C	16310	2.05	256.25	57.98
D	16819	2.00	250.00	48.21
E	18140	2,25	281.25	46.07
F	16630	2.00	250.00	46.88
G	17442	2.00	250.00	55.66
H	18417	2.00	250.00	53.40
I	17769	2.20	275.00	57.24
J	17299	2.1	262.50	55.38
Average	17043.4	2.01	246.88	53.83
Standard Deviation	852.47	0.10	12.50	4.82

3.3.5 Overall elasticity modulus of raffia bamboo and its bending strength

Ten test specimens were chosen for this series of tests. The specimen is subjected to loads which induce small deformations. The experimental data allowed us to represent curves that give the load as a function of the deflection (Mohssine, 2006). A linear regression analysis applied to these curves gives a correlation coefficient greater than 0.99 as required by NF EN 408 standard for accuracy. Two examples of these curves are shown in figure 15. This test made it possible to estimate the overall elastic properties of raffia bamboo grouped in table 5.

We consider that this material is a composite of parallel fibers represented by the shell (reinforcement), and a resin represented by the marrow (matrix) (Sylvie, 2009-2010). Knowing the modulus of elasticity of the marrow and the shell we used the theory of homogenization to calculate that of raffia bamboo *vinifera L. arecaceae*. Thus, from

Table 5: E_{gL} is the experimental longitudinal elasticity modulus of the raffia bamboo, E_{gTcal} the calculated transversal elasticity modulus, E_{gLcal} the calculated longitudinal elasticity modulus, P_{max} the yield load and F_m the raffia bamboo strength.

Specimen	E (MPa)			P_{max} (N)	F_m (MPa)
	E_{gL}	$Eg_{Lcal.}$	$Eg_{Tcal.}$		
A	13488.82	12800.86	3247.25	1259.3	5666.85
B	12385.96	12593.96	2415.72	1254.4	5644.80
C	12956.36	12594.75	3199.17	1489.6	6703.20
D	14807.27	13192.00	3257.45	1548.4	6967.80
E	10820.7	11611.62	3293.45	1122.1	5049.45
F	11722.42	11242.79	3225.87	1215.2	5468.40
G	12256.52	12222.17	3205.48	1229.9	5534.55
H	12789.42	12816.39	3266.09	1445.5	6504.75
I	14957.11	13719.17	3254.56	1372.0	6174.00
J	13897.16	12605.01	3124.18	1455.3	6548.85
Average	13008.17	12383.92	3148.92	1339.17	5942.48
Standard deviation	1244.89	1006.08	261.84	134.26	687.35

the law of mixtures (equation 1), we have deduced the elastic modulus E_{gL} of the material (Guitard, 1987):

$$\varepsilon = \varepsilon A = \varepsilon B \qquad \text{(Eq. 1)}$$

et

$$E_g = f_c\, E_c + f_m\, E_m \qquad \text{(Eq. 2)}$$

Where E_c is the longitudinal modulus of elasticity of the shell and E_m that of the marrow, ε_m the strain of marrow and ε_c that of the shell.

f_c (eq. 2) is the volume fraction of the shell and f_m that of the marrow with $f_c + f_m = 1$

$$f_c = \frac{V_c(1-(\gamma_c/100))}{V_T(1-(\gamma_T/100))} \qquad \text{(Eq. 3)}$$

Where V_c is the volume of the shell and V_T is the volume of the whole raffia bamboo (shell + marrow),

γ_c is the degree of porosity (void content) of the shell and γ_T is that of the whole raffia bamboo.

The transverse elastic modulus E_{gTcal} is always obtained from the law of mixtures (equation 4):

$$E_T = \frac{E_c \cdot E_m}{E_c \cdot f_m + E_m \cdot (1-f_c)} \qquad \text{(Eq. 4)}$$

In table 5 we presented the theoretical values of the moduli of elasticity of raffia bamboo (longitudinal and transverse) considered as a composite material with parallel fibers. Thess calculated longitudinal and transverse moduli are denoted respectively by E_{gLcal} and $E_{gTcal.}$

4. Discussion

The variability observed in the elastic properties is a characteristic of materials from vegetable origin. We obtained the average longitudinal modulus of elasticity of the marrow which has a value of 959 MPa, yet that of the most brittle coniferous and poplar with a density of 290 kg/m^3 is 7 000 MPa (Natterer, 2004). Its mean bending strength is estimated at 738 MPa. We can conclude that the marrow of raffia bamboo is the weak link of this material, responsible of its great flexibility. The mean shear modulus is evaluated at 6 MPa much lower than that of conifers and poplar which is 440 MPa (Lemaitre, 1988). We can conclude that the marrow of raffia bamboo is comparable to the matrix of a composite material with parallel fibers.

The meanelasticity modulus of the shell has a value of about 17 043 MPa, close to that of Doussié which is 17 020 MPa (Bartosz, 2004). Its mean longitudinal fiber tensile strength is 247 MPa much higher than that of Azobe, with an average of 180 MPa with a density of 1 070 kg/m^3 at 12% moisture (Bartosz, 2004). We can conclude that the shell of the raffia bamboo *Vinifera L. Arecacea* constitutes the strong link of this material and plays the role of reinforcement for this composite. It can be ranked among the heaviest timber. The global elasticity modulus of raffia bamboo has an mean value of 13 008 MPa close to that of oak which is about 13 000 MPa (Natterer, 2004). The strength of raffia bamboo in bending test is estimated at 17 MPa, higher than that of Balsa which is 15 MPa (Bartosz, 2004). The raffia bamboo can therefore be classified as timber.

The modulus of elasticity obtained from the law of mixtures is close to the modulus of elasticity obtained experimentally. This confirms the fact that this material can be considered as a composite material with parallel fibers. Three of the main mechanical properties of raffia bamboo *Vinifera L.Arecacea* are thus determined. From the experimental study of the mechanical properties, it is deduced that the raffia bamboo *Vinifera L. Arecacea* is a building material that can be classified among the light woods.

5. Conclusion

The general objective of this study was to study the elastic properties of raffia bamboo under low bending load at internal laboratory temperature and relative humidity. In order to achieve this objective, the study was divided into two parts. The first part concerns the determination of modulus of elasticity, shear strength and flexural strength. Static bending tests were carried out on raffia bamboo beams with a diameter of about 36 mm and a span length of 360 mm and then on beams of the marrow (20 mm × 20 mm × 360 mm).These tests allowed us to evaluate the moduli of elasticity and shear, and the strengths of both raffia bamboo and its marrow. It emerges that the marrow is the weak link of the raffia bamboo responsible for its great flexibility since the shell can be classified among hardwoods. For whole bamboo, the elasticity modulus is similar to that of lumber, it can be classified as lightweight construction wood. Its properties allow its use in decoration and internal coating.

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