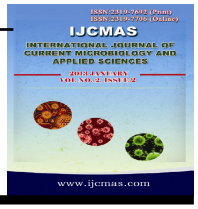
International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7692 **Volume 2 Number 2 (2013) pp.62–66**
http://www.ijcmas.com



Original Research Article

A study on physico-mechanical properties of *Thyrsostachy ssiamensis* (Kurz) Gamble and *Dendrocalmus membrances* (Munro) in Tumkur district, Karanataka, India

Narasimhamurthy*, C.Maya, Anand Nadanwar, and C.N.Pandey

Biology Division, Indian Plywood Industries Research and Training Institute [IPIRTI], Tumkur Road, Banglore-560 022.
***Corresponding author:** *murthy_simha59@rediffmail.com*

K e y w o r d s

Physical; Mechanical Properties; Specific density; Bamboo culms.

A B S T R A C T

The physical and mechanical properties of two bamboo species viz. *Thyrsostachys siamensis* and *Dendrocalmus membrances* were studied from three locations of bamboo viz. Top (T), Middle (M) and bottom (B). The average values of physical and mechanical properties of both bamboo species were reported. From the study it was observed that *Thyrsostachys siamensis* species is almost solid at bottom and middle portion, but hollow at top portion, where as *Dendrocalmus membrances* species is hollow in structure throughout its length. It was observed that the specific gravity of *Thyrsostachys siamensis* and *Dendrocalmus membrances* species of bamboo varies between 0.45 to 0.75 and 0.55 to 0.65 respectively depending mainly on the anatomical structure. Both species bears good mechanical properties however, the MoR and compressive strength of *Thyrsostachys siamensis* species was found to be about 15% more than that of *Dendrocalmus membrances* species and MoE of *Thyrsostachys siamensis* species was found to be about 5% more than that of *Dendrocalmus membrances* species.

Introduction

Bamboo is a fast growing fibrous grass available in abundance on the earth, particularly in tropical and subtropical regions. Their culms can grow to their full height of 3-30 m within a few months, due to the expansion of individual internodes already present in the buds. Bamboo has a very long history with human civilization. It has been widely used for household products and extended to industrial applications due to advances in processing technology and

The bamboo culm or stem are made into an extended diversity of products ranging from domestic household products to industrial applications. Examples of bamboo products are food containers, skewers, chopsticks, handicrafts, toys, furniture, flooring, pulp and paper, boats, charcoal, musical instruments, weapons etc. In Asia, bamboo is quite common for bridges, scaffolding and housing, but it is usually a temporary exterior structural material. Further more,

the general properties of the bamboo culms are based on the anatomical, chemical, physical and mechanical characteristics. Physical and mechanical properties of bamboo depend on the species, site/soil, climatic condition, silvicultural treatment, harvesting technique, age, density, moisture content, position in the culm, nodes or internodes and bio-degradation. Most studies had been carried out in order to highlight and observe these fundamental characteristics, as well as to maximize bamboo utilization. Age is an important factor for the developmentof strength properties. It is a general assumption that bamboo mature and reach its maximum strength in about three years.

Many studies have been carried on the anatomical features of bamboo and its anatomical features directly affect bamboo physical and mechanical properties.

Physical and mechanical properties of bamboo depend on the species, site/soil and climatic condition, silvicultural treatment, harvesting technique, age, density, moisture content, position in the culm, nodes or internodes and bio-degradation. Most of the studies had been carried out in order to highlight and observe these fundamental characteristics, as well as to maximize bamboo utilization Abd. Latif et al (1993), studied the effect of anatomical characteristics on the physical and mechanical properties of *B.bluemeana*.

Several authors reported the physical and mechanical properties of *D.strictus*. According to this study, age and height do not significantly affect moisture content.The radial and tangential shrinkage of *B.bluemeana,* did not differ significantly through age and height. The radial and tangential shrinkage ranges from 5.4% to 9.5% and 6.4% to 20.1% respectively.

The specific gravity of bamboo varies from about 0.5 to 0.79, and this would make the density about 648 kg/m^3 (40.5 lb/ ft^3). Similarly, reports established that the average specific gravity of bamboo ranged from 0.3 to 0.8. Chew et al. (1992), gives the density of *B.vulgaris*at 630 kg /m^3, which is relatively light, compared to other bamboos. Density is the major factor that influences the mechanical properties, and it is closely related to the proportion of vascular bundles. Abd. Latif (1990) suggested that longer fibre will decrease the shear strength, which was primarily due to cell wall thickness or density rather than the percentage of the parenchyma fibers. The cell wall thickness has a positive correlation with compression strength, bending stress at proportional limit and MOE, but negatively correlated to MOR. In the present study, the physical and mechanical properties of six year old *Thyrostaches siamensis* and *Dendroclamus memernceses* at three levels of culm height are evaluated.

Materials and Methods

A moderate-sized, strong bamboo forming loose clump, straight culm samples from two bamboo species namely *Dendrocalamus membranaceus* Munro and *Thyrsostachys siamensis* Gamble of 20-24 m high, 6-10 cm diameter and 12-15 m 4.5-5 cm diameter respectively of 4-6 year age were collected from bamboo Arboratum of BIAF, S. Lakkahalli near Tiptur taluk of Tumkur district, Karanataka, India for the study.

Five bamboo culms in each species were harvested and investigated for physical properties like length, diameter and number of internode etc., were recorded at felling site itself. Whereas mechanical properties like Modulus of elasticity (MOE), Modulus of rupture (MOR) and compressive strength

were evaluated at laboratory. Bamboo samples were converted into strips for determining mechanical properties. Each bamboo sample was divided into three portions of bottom (B), middle (M) and top (T). Strength of bamboo viz., compression parallel to grain & static bending were conducted using computer controlled Universal Testing Machine (UTM).

Moisture content (MC)

Sample blocks of *Dendrocalamus membranaceus* Munro and *Thyrsostachys siamensis* were derived from 3 height portions (bottom, middle and top) and 6 replicates, consisting of thirty-six bamboo samples. All sample blocks were cut from fresh culms of size 10 mm × 10 mm × culms wall thickness. They were weighed and dried in an oven at 103±2°C for 24 hr until a constant weight was attained.

Basic density

Sample for basic density studies were obtained from both node and internode at the bottom, middle and top culms portions from each bamboo species. Six replicates were used in the study. The sample blocks were oven dried for 48 h at 105±2°C until a constant weight were attained. The sample blocks were then weighed to give the oven dried weight. Basic mass per volume shall be calculated as follows:-

Mass per volume, I $g/cm^3=m_o /v_g x100$ $m_{o=oven}$ dry mass in grams $v_{g=}$ green volume in cm^3

MoR and MoE

Bamboo samples were converted into strips for determining MoR and MoE at three portions of bottom (B), middle (M) and top (T) under three point loading using UTM.

Compressive strength

Compressive strength of round bamboo samples were derived at three portions of bottom (B), middle (M) and top (T) using UTM.

Results

The samplesof two bamboo species were tested against physical and mechanical properties. The physical properties like culm height, internode length, number of internodes per culm and culm wall thickness etc. were measured at the felling site and results recorded as shown in the table 1. The moisture content of bamboo varies vertically from the bottom to the top. Green bamboo may have 100% moisture (oven-dry weight basis) and can be as high as 110 % as (table 2). Basic density of the two bamboo species varies from bottom to top and node to internode. In *Thyrsostachys siamensis* density varies from bottom to top in the range of 700 to 400kg/m3 along with node and internode. Whereas in *Dendrocalmus membrances* the density variation is 650 to 550 kg/m3 along with node to internode (table 3).

Mechanical properties of both the species were tested at laboratory using Universal Testing Machine (UTM) and results were recorded in the table 4. From the table the mean value of MOE of 7091MPa and 6827 MPa, MOR of 124.2 MPa and 109.1 MPa and compression strength of 77.5 and 67.0were observed for *Thyrsostachys siamensis* and *Dendrocalmus membrances* species respectively. From the above studies the results it is observed that the physical and mechanical properties of both the

species varies from bottom to top and node to internode of bamboo culms. Physical and mechanical properties of two bamboo species are presented in Table.1 and Table 4.

Table.1 Physical characteristics of *Thyrsostachys siamensis and Dendrocalmus membrances* bamboo tested in green condition.

S. No.	Characteristics	Bamboo species	
		Thyrsostachys siamensis	***Dendrocalmus membrances***
1	Culm height (cm)	1600	2000
2	No. of internodes/culm	13	25
3	Internode length (cm)		
	Bottom	33	27.94
	Middle	38	27.94
	Top	35.56	25.4
	Mean	35.52	27.09
4	Internode diameter (cm)		
	Bottom	11.43	12.7
	Middle	10.16	11.43
	Top	6.35	8.89
	Mean	9.31	11.00
5	Culm wall thickness		
	Bottom	solid	1.62
	Middle	solid	1.03
	Top	0.65	0.84

Table.2 Moisture content (%) at cross-section along the culm length at green condition

Bamboo species/portions	***Thyrsostachys siamensis***	***Dendrocalmus membrances***
Bottom portion	110.5	96.3
Middle portion	98.8	89.6
Top portion	95.3	87.5

Table.3 Basic density along the culm height

Bamboo species/ portions	***Thyrsostachys siamensis* (kg/m^3)**		***Dendrocalmus membrances* (kg/m$^{3)}$**	
	Node	**Internode**	**Node**	**Inter node**
Bottom portion	718	654	653	627
Middle portion	712	541	619	593
Top portion	450	415	601	563

Table.4 Mechanical properties of *Thyrsostachys siamensis* and *Dendrocalmus membrances*

Species	***Thyrsostachys siamensis***			***Dendrocalmus membrances***		
Properties	Comp St, MPa	MoR, Mpa	MoE, Mpa	Comp St, MPa	MoR, Mpa	MoE, Mpa
T	66.7	124.3	8464	64.7	102.3	6609
M	82.2	119.0	6402	69.7	97.3	7458
B	83.6	129.2	6407	66.7	127.7	6414
Mean	77.5	124.2	7091	67.0	109.1	6827

The physical and mechanical properties of the two bamboo species viz. *Thyrsostachys siamensis* and *Dendrocalmus membrances* were evaluated and results were recorded. From the results it is confirmed that *Thyrsostachys siamensis*is have marginally better mechanical properties as compared to *Dendrocalmus membrances.* The density variation is more in *Thyrsostachys siamensis* from node to internode and also at bottom to top locations of bamboo culm, because of solidness at bottom which gradually becomes hallow at top portion. But in *Dendrocalmusmembrances*not much variation was observed, due to its hollowness. Whereas mechanical properties of *Thyrsostachy ssiamensis* have exhibited 15 % more strength compare as to *Dendrocalmus membrances* in compression and bending. Whereas, MoE in bending of *Thyrsostachys siamensis* was observed 5 % higher than*Dendrocalmus membrances* species.

References

Abd.Latif, M., A.Ashaari, K. Jamaludin, and J. Mohd.Zin. 1993. Effects of anatomical characteristics on the physical and mechanical properties of *Bambusabluemeana*. Journal Tropical Forest Science 6(2): 159-170.

Abd.Latif, M., W.A. Wan Tarmeze, and A. Fauzidah. 1990. Anatomical features and mechanical properties of three Malaysian bamboos. Journal Tropical Forest Science 2(3): 227-234.

Anon. (1972).The use of bamboo and reeds in building construction.Department of Economic and Social Affairs. United Nations, New York.

Chew, L.T., S. Rahim, and K. Jamaludin. 1992. *Bambusa vulgaris* for urea and cement-bonded particleboard manufacture. Journal Tropical Forest Science 4(3): 249-256.

Dransfield, S. 1992. The bamboos of Sabah. Herbarium, Royal Botanic Garden, Kew,U.K. in association with Herbarium, Forest Research Centre, Forestry Department, Sabah, Malaysia. Sabah Forest Recoeds, No.14.

Janssen, J.J.A.1991. Mechanical properties of bamboo.Kluwer Academic Publishers.Forestry Sciences, Vol.37.

Lee, A.W.C., B. Xuesong, and N.P. Perry. 1994. Selected physical and mechanical properties of giant timber bamboo grown in South Carolina. Forest Prod.J. 44(9):40-46.

Limaye, V.D. 1952. Strength of bamboo (*Dendrocalamusstrictus*), Indian Forest Records. 1(1):1-17.

Tewari, D.N. 1992. A monograph on bamboo.International Book Distribution, Dehra Dun (India).

Shukla, N.K., R.S. Singh, and S.N. Sanyal. 1988. Strength properties of eleven bamboo species and study of some factors affecting strength. Journal of the Indian Academy of Wood Science. 19(2):63-80