ENGINEERING AND TECHNOLOGY IN INDIA

Volume 5 | Issue 1&2 | Apr. & Oct., 2014 | 44-48
e ISSN-2230-9284 | Visit us : *www.researchjournal.co.in*
DOI : 10.15740/HAS/ETI/5.1and2/44-48

ARTICLE CHRONICLE :
Received : 17.08.2014;
Revised : 03.09.2014;
Accepted : 22.09.2014;

RESEARCH PAPER

Studies of mechanical properties of treated bamboo

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ABSTRACT

Steeping method was used for treating bamboo by using Boric acid Borax, Copper Chrome Boron and Cashew Nut Shell Liquid.Treatment was carried out for 14 day. After treatment, quality evaluation of bamboo was done by cutting bamboo in sample size of 61 cm (2') and exposing them to environmental condition. Mechanical properties of 61 cm (2') bamboo (30.5 cm (1') buried in soil and 30.5 cm (1') above soil were determined by using universal testing machine .After preservation time of 14 days it was observed, out of 20 lit of sample, 10 lit Boric Acid Borax liquid, 5 lit of Copper Chrome Boron liquid was absorbed by bamboo and cashew nut shell liquid was not absorbed by bamboo specimens. It was observed that for the tensile strength for bamboo treated with Boric Acid Borax, Copper Chrome Boron and Cashew Nut Shell Liquid was 38.20 N/mm², 30.69 N/mm² and 8.03 N/mm² for under soil and 48.09 N/mm², 39.09 N/mm² and 9.35 for over soil sample and compressive strength was 5.04 N/mm², 4.02 N/mm² and 0.39 N/mm² for under soil sample and 5.17 N/mm², 4.87 N/mm² and 0.58 N/mm² for over soil sample.

KEY WORDS : Bamboo, Treatment, Mechanical properties

How to cite this Article : Kurhekar, S.P. (2014). Studies of mechanical properties of treated bamboo. *Engg. & Tech. in India*, **5** (1&2) : 44-48.

INTRODUCTION

Bamboo is one of nature most valuable gifts to mankind. Its remarkable growth rate and versatile properties have made it one of the most sought after materials, especially in tropical countries. In Konkan region *Dendrocalamus strictus* (Manvel), *Bambusa bambus (*kalak), *Pseudoxytenanthera stocksii* (Mes) *Pseudoxytenanthera ritcheyi* (Manga) are locally available varieties (Ahad, 2003). Bamboo consists of 50-70s hemicellulose, 30% pentosans, and 20-25 per cent lignin. Bamboo is used for housing construction, mats, ladders, floating fenders, furniture, handicraft articles, baskets, etc. (Anonymous, 2009). Its versatile nature and innumerable uses have earned bamboo the name 'green gold of the forest'. Since bamboo is less expensive than construction materials like steel, cement and even wood, it is considered to be 'poor man's timber'. However, cost considerations makes bamboo an attractive material for reinforcement (Krishna Prasad Rajan *et al*., 2011). Though, there are many advantages of natural fibres, there is also certain limitation such as lower modules, low strength and poor moisture resistance when compared to synthetic fibres (Jarukumjorn and Suppakar, 2009). Composites reinforced with natural fibres received increasing interest from industries in a wide field of applications such as automobile, construction, aerospace and packing (Pickering *et al.,* 2007; Ku *et al.,* 2011). Natural fibres, when compared to glass fibres possess low density, low cost, consumes low energy, distributed worldwide, neutral to CO_2, no abrasion to machining, no health risk when inhaled and since it is biodegradable, it can be easily disposed (Paul Wambua *et al.,* 2003). The main drawback of using natural fibre is their high level of moisture absorption, insufficient adhesion between untreated fibres and the polymer matrix which can lead to deboning with age (Gassan, 2002). In order to increase the adhesion properties of natural fibre, the bamboo strips were subjected to different chemical treatments (Hongyan Chen *et al.,* 2011). By chemical modification (silane coupling), the mechanical properties of the composite such as tensile, flexural and impact strength increases due to improved adhesion between the polymer and bamboo fibre matrix (Sun-Young Lee *et al.,* 2009). Surface treatments of bamboo fibres improve interfacial bonding strength between fibres (Hongwa Ma and Chang Whan Joo, 2011). A major drawback with bamboo is that it is not durable against wood degrading organisms. Preserving bamboo extends their life, reduces costs in the long run and

improves safety of the structures they are used to form (Arenz *et al*., 2006; Gardener, 1945 and Kunal *et al*., 1994). Bamboo is a natural material of organic origin. Unlike varieties of timber like teak, a bamboo structure is voids of toxic deposits. The presence of starch makes it more attractive to microorganisms. Biological degradation can affect the usage, strength utility and value of the bamboo/bamboo product leading to decay and disintegration splits or cracks unsightly stains (Salim and Waheb, 2010). Low life of bamboo and its susceptibility to various attacking agents is the main cause for its fewer acceptances as construction material but preservation can extend the life of bamboo and can maintain its quality and hence make it suitable for the use as construction material.

EXPERIMENTAL PROCEDURE

The *Pseudoxytenanthera ritcheyi* (Manga) variety of bamboo was used for the present study. The bamboo of 4 year of age and more than 2 m in length was used.

Plastic container of 20 lit capacity was used for keeping and mixing the preservative chemicals and for carrying out the various treatments. The six containers were used for preservative treatment. Electrically operated cutting machine was used for cut bamboo in size of 61 cm (2') in length. To determine moisture content of bamboo, hot air oven was used. Universal testing machine was used for measurement of tensile and compressive strength during storage period of selected bamboo samples.

Boric acid borax treatment :

To prepare Boric Acid Borax preservative, in 2:2:0.5 ratio Boric acid (400 g), Borax powder (400 g) and Sodium Dichromate (100 g) was mixed in 20 lit of water. The bamboo specimens were kept in the Boric Acid Borax solution for 14 days.

Copper chrome boron treatment :

For preparing Copper Chrome Boron preservative in 1.5:3:4 ratio Copper Sulphate (600 g), Boric Acid (300 g) and Sodium Dichromate (800 g) was mixed in 20 lit of water. The bamboo specimens were kept in the Copper Chrome Boron solution for 14 days.

Cashew nut shell liquid treatment :

Cashew Nut Shell Liquid was processed from Metafile Industry. For the treatment 20 lit of Cashew nut Shell Liquid taken in a container. The bamboo specimens were kept in the Cashew Nut Shell Liquid for 14 days.

Steeping method :

This method was aimed at increasing storage life of well treated bamboo, reduce the vulnerability to mechanical attack and to retain the mechanical properties (Tensile and compressive). To carry out this test, bamboos of more than 915 cm (15') length along with their leaves were used. These bamboos were dipped in preservative and kept for 14 days. The three bamboo samples are kept in a single container.

Periodic quality evaluation :

To carry out periodic quality evaluation of bamboo, leaves of bamboo were removed. Bamboo was cut into size of 61 cm (2') size and was exposed to the environmental condition. Out of 61 cm (2') height, 30.5 cm (1') was kept under soil and 30.5 cm (1') above soil.

Mechanical properties :

Tensile stress during storage :

The dumbbell shaped bamboo sample having length 220 mm, width 30 mm and thickness 3 mm used to determine tensile stress during storage by using universal testing machine. The speed of machine was 10 mm/min.

Compression during storage period :

The square cross section shaped bamboo sample having length 50 mm and height 10 mm used to determine compression during storage by using universal testing machine. The speed of machine was 10 mm/min.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Chemical absorption :

To determine the absorption of preservative, the bamboo with leaves was dipped in the 20 lit containers. After preservation time of 14 days it was observed, out of 20 lit of sample, 10 lit Boric Acid Borax liquid, 5 lit of Copper Chrome Boron liquid was absorbed by bamboo.In Cashew Nut Shell Liquid test it was observed that during 15 days of treatment cashew nut shell liquid was not absorbed by bamboo specimens. It may be because of more viscosity of cashew nut shell liquid.

Visual observation during storage :

During the preservation study some changes in color was observed. The changes were noted visually. It was observed that the dark green colour of bamboo changes to brown colour. This may be because of chemical treatment and atmospheric condition.

Table 1 : Tensile strength (N/mm^2) for bamboo sample under soil

Day	Node of bamboo	Bab	Ccb	Cnsl	Untreated
15 Day	1	22.63	21.10	11.18	11.11
	2	26.06	24.06	12.67	12.49
	3	38.2	30.69	13.56	13.05
	4	14.68	13.7	10.87	10.17
	5	11.4	10.78	9.43	9.88
30 Day	1	19.86	16.16	9.38	9.4
	2	22.32	19.85	10.55	10.33
	3	35.18	27.56	12.47	11.59
	4	14.19	14.03	8.67	9.00
	5	10.74	10.41	8.00	8.60
45 Day	1	15.68	13.28	8.03	7.93
	2	17.9	15.04	9.32	9.12
	3	32.69	25.6	10.12	10
	4	13.43	9.36	7.48	7.32
	5	10.18	6.94	6.71	6.45

Table 2 : Tensile strength (N/mm^2) for bamboo sample above soil

Day	Node of bamboo	Bab	Ccb	Cnsl	Untreated
15 Day	1	27.12	24.71	13.05	13.01
	2	32.99	27.03	13.20	13.26
	3	48.09	39.09	14..54	14..52
	4	18.73	14.45	11.44	11.51
	5	14.78	11.43	10.67	10.75
30 Day	1	24.14	20.04	10.11	10.26
	2	31.22	26.11	11.23	11.18
	3	42.11	35.11	13.12	13.37
	4	17.83	14.12	9.20	9.31
	5	14.11	11.48	8.75	8.94
45 Day	1	18.58	17.52	9.56	9.35
	2	25.18	23.68	10.12	10.24
	3	33.04	28.0	11.09	11.07
	4	15.36	13.21	8.43	8.54
	5	13.06	10.26	7.69	7.56

Mechanical properties :

Treated and untreated bamboo strips after exposure to environmental conditions were used for tested for their mechanical properties on universal testing machine. They were tested for tensile and compressive strength.

Tensile strength during storage :

The dumbbells shaped bamboo strip was prepared for testing. The results obtained from universal testing machine are given in Table 1 and 2. The bamboo treated with boric acid borax treatment has the highest tensile strength. The results also that bamboo treated with copper chrome boron treatment have tensile strength less than that treated with boric acid borax treatment. The cashew nut shell liquid and untreated bamboo treatment bamboo has less tensile strength. As during storage period their quality detoriate.

Compressive strength during storage period :

Compressive strenght was determined by preparing square shape strip of bamboo sample. The results obtained from universal testing machine shows that bamboo treated with Boric Acid Borax treatment has the highest compressive strength.

Table 3 : Compressive strength (N/mm^2) for bamboo sample under soil

Day	Node of bamboo	Bab	Ccb	Cnsl	Untreated
15 Day	1	2.03	1.03	0.85	0.79
	2	2.18	1.16	0.87	0.83
	3	3.76	1.93	0.92	0.97
	4	2.60	0.95	0.49	0.55
	5	1.90	0.73	0.45	0.47
30 Day	1	3.07	1.87	0.60	0.63
	2	4.08	2.05	0.81	0.89
	3	4.85	2.80	0.96	0.95
	4	3.04	1.00	0.47	0.50
	5	2.0	0.92	0.29	0.33
45 Day	1	3.79	2.77	0.38	0.42
	2	4.63	3.04	0.52	0.56
	3	5.04	4.02	0.65	0.67
	4	2.63	1.13	0.28	0.31
	5	1.83	1.00	0.21	0.25

Table 4 : Compressive strength (N/mm^2) for bamboo sample above soil

Day	Node of bamboo	Bab	Ccb	Cnsl	Untreated
15 Day	1	4.15	3.76	0.62	0.58
	2	4.92	4.11	0.90	0.84
	3	5.17	4.87	0.84	0.86
	4	2.42	2.12	0.56	0.41
	5	1.94	1.53	0.41	0.35
30 Day	1	3.74	3.14	0.76	0.66
	2	4.02	3.59	0.99	0.97
	3	4.83	4.15	1.15	1.05
	4	2.61	1.69	0.59	0.54
	5	2.03	1.37	0.45	0.41
45 Day	1	3.10	2.90	0.87	0.96
	2	3.75	3.07	1.10	1.07
	3	4.03	3.28	1.35	1.27
	4	2.06	1.35	0.69	0.67
	5	1.7	1.24	0.51	0.42

It was found that that bamboo treated with copper chrome boron treatment have compressive strength less than that treated with boric acid borax treatment. The untreated bamboo and cashew nut shell liquid treatment bamboo has less compressive strength. The result obtained from universal testing machine for compressive strength is given in Table 3 and 4.

Conclusion :

- Preservation of *Dedrocalmus ritchy* (manga) variety of bamboo can be done by using Boric acid borax and Copper Chrome Boron.
- Cashew Nut Shell Liquid is not suitable for steeping method.
- Tensile strength and compressive strength treated with Boric Acid Borax was maximum.
- Tensile strength of bamboo goes on increasing from bottom to middle height and decrease from middle to top.

REFERENCES

Ahad, M. (2003). Mechanical properties of Calcutta bamboo. Wood science and forest product. pp. 84-105.

Anonymous (2009). BIS draft for structural design using bamboo, pp: 8-10.

Arenz, B.E., Held, B.W. Jurgens, J.A., Farrel, R.A. and Blanchette, R.A. (2006). Fungal diversity in soils and historic wood from the sea region of Antarctica. *Soil Biol. & Biochemistry,* **38**: 3057-3064.

Chen, Hongyan, Miao, Menghe and Ding, Xin (2011). Chemical treatments of bamboo to modify its moisture absorption and adhesion to vinyl ester resin in humid environment. *J. Compos. Mater.,* **45** (14) : 1533-1542.

Gassan, J. (2002). A study of fibre and interface parameters affecting the fatigue behaviour of natural fibre composites. *Composites: Part – A: Appl. Sci. Manufac.,* **33** (3) : 369-374.

Jarukumjorn, K. and Suppakar, N. (2009). Effect of Glass Fiber Hybridization on Properties Of Properties of Sisal Fiber-Polypropylene Composites. *Composites (Part B),* **40**: 623-627.

Ku, H., Wang, H., Pattarachaiya, Koop N. and Trada, M.A. (2011). A Review of Tensile Properties of Natural Fiber Reinforced Polymer Composites. *Compos. (Part B),* **42** : 856-873.

Lee, Sun-Young, Chun, Sang-Jin, Doh, Geum-Hyun and Kang, In-Aeh (2009). Influence of chemical modification and filler loading on fundamental properties of bamboo fibers reinforced polypropylene composites. *J. Compos. Mater.,* **43**: 1639.

Ma, Hongwa and Joo, Chang Whan (2011). *J. Compos. Mater.,* **45**: 2455.

Paul, Wambua, Jan, Ivens and Ignaas, Verpoest (2003). *Compos. Sci. Technol.,* **63**: 1259.

Pickering, K.L., Beckermann, G.W., Alam, S.N. and Foreman, N.J. (2007). Optimising industrial hemp fibre for composites. *Optimiz. Compos. Part – A: Appl. Sci. Manufac.,* **38** (2) : 461-468.

Rajan, Krishna Prasad, Veena, N.R., Maria, Hanna J., Rajan, Rathish, Skritvars, Mikad and Joseph, Kuruvilla (2011). Extraction of bamboo microfibrils and development of biocomposites based on polyhydroxybutyrate and bamboo microfibrils. *J. Compos. Mater*., **45** (12) : 1325.

Gardener, J.C.M. (1945). A note of the insect borers of bamboo and their control. *Ind. Efor. Bull. Ent. (N.S.) Ent.*, **125**.

Kumar, S., Shukla, K.S., Dev, I. and Dobriyal, P.B. (1994). Bamboo preservation techniques: a review. INBAR Technical Report No. 3. International Network for Bamboo and Rattan, New Delhi(INDIA). pp: 59

Salim, R. and Wahab, R. (2010). Effect of oil heat treatment on chemical constituents of semantan bamboo (*Gigantochlo scortechinii* gamble). *Modern Applied Sci.*, **4(**2): 107-113.

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