Volume : 4 | Issue : 1 | January 2015 • ISSN No 2277 - 8179

Research Paper

Studies on Mechanical Properties of Bamboo Mat Board

AGRICULTURE

KEYWORDS : Bamboo mat board, mechanical properties, strength.

S.P.KURHEKAR	Assistant Professor, Department of Farm Structures, College of Agricultural Engineering and Technology, DBSKKV, Dapoli
A.D.RANE	Assistant Professor, College of Forestry, DBSKKV, Dapoli. Dist- Ratnagiri. Maharashtra
P.R.KOLHE	Assistant Professor, College of Agricultural Engineering and Technology, DBSKKV, Dapoli. Dist- Ratnagiri. Maharashtra

ABSTRACT

Bamboo mat board (BMB) is a plywood-like wooden board made from layers of woven bamboo mats that have been pressed together. It can be produced in a range of standard sizes. Three varieties of bamboo viz. Dedrocalamus ritchy (Manga), Dendrocalamus stocksii (Mes) and Dendrocalamus strictus (Manvel) were used to prepare bamboo mat boards. Mats were weaved manually and urea formaldehyde (resin) was used as glue to prepare bamboo mat boards. Boards were trimmed to a size of 0.60 m X 0.60 m Board of 9 mm, 12mm and 16mm thickness. Bamboo mat board prepared from Dendrocalamus stocksii (Mes) was superior in strength as compare to bamboo mat board prepare from other varieties of bamboo. With the increase in thickness, tensile strength, compressive strength, modulus of rupture, internal bond strength, screw and nail holding power of bamboo mat board increases. Plywood was having less strength as compare to bamboo mat board.C

Introduction:

Bamboo is a woody, valuable, strong and exceptionally fast growing grass. Bamboos vary in leaf size, texture and some are variegated. 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. Bamboo is a woody, valuable, strong and exceptionally fast growing grass. Bamboos vary in leaf size, texture and some are variegated. Bamboo is one of nature most valuable gifts to mankind. Bamboo is gaining importance as a replacement for wood in flooring and roofing panels and other housing components (such as windows, doors and partition panels), in furniture and in packing cases. Bamboo mat board (BMB) is plywood- like wooden board made from layers of woven mats that have been pressed together. The bamboo mat board technology is suitable for bamboo-growing regions with sufficient raw material that are inhabited by traditionally skilled crafts people, or other (potential) bamboo mat weavers. Apart from regions with natural bamboo forests, bamboo mat board could be produced in regions where bamboo is grown on plantations or in homesteads. Bamboo mat board can be used for paneling, ceilings, prefabricated shelters, packing cases, storage bins, roofs, doors and door panels, furniture and household utensils such trays and plates. Bamboo mat board is also used in concrete formwork.

Methodology

Material

The Denrocalamus ritchy (Manga), Dendrocalamus stocksii (Mes), Bambusa bambus (kalak) and *Dendrocalamus strictus* (Manvel) local varieties of bamboo were used for the present study. The study was conducted at College of Agricultural Engineering and Technology, DBSKKV, Dapoli, District Ratnagiri (Maharashtra). The bamboos of 4 year of age and more than 3 meter in length were used and chemical ingredient urea formaldehyde was used.

Sample preparation

Bamboo having length 3m were harvested and leaves of bamboo was removed by using knife. External knots of bamboo were removed by using electrically operated knot removing machine, available at Bamboo workshop of Department of Farm Structures. Bamboos were cut into length of 3m using cutting machine. The crosscut bamboo splits were spited by splitting machine. The green epidermal layer of the splints were be removed by using a sharp knife. Slivers of 1mm thickness were made manually by using a sharp knife. Slivers were sun dried to 15% moisture content. The dried slivers were manually woven into mats of 0.60 m × 0.60 m size .

Preparation of bamboo mat board

Manually woven mats were dripped in urea formaldehyde. Mats were dried in mechanical dryer. A dried resin mats were assembled. The number assembled depends upon the required thickness of bamboo mat board. Mats were pressed in hot press machine. Hot pressing melts the resin in the mats and bonds them together tightly. Mats were pressed together under high temperature of 110°C and pressure 150 to 200 kg/cm^2.Boards were trimmed to desired size and shape.

Physical properties

Density:-

The density of bamboo mat board was calculated by the formulae.

$\lambda = W/V$

Where, λ =density of sample, W= weight of sample at sampling, V= volume of sample at sampling.

Water absorption rate:-

The water absorption rate is calculated by the given formulae.

$$\Delta W = G_2 - G1 / G1 \times 100$$

ΔW = Water absorption rate of sample, G1 = weight of sample before absorbing, G2 = weight of sample after absorbing.

Mechanical properties

Universal testing Machine model number AG-X of 50 kg capacity available at College of Forestry, Dapoli was used to determine tensile strength, compressive strength, screw and nail holding power of bamboo mat board and plywood. Dumbbell shaped sample having length 220mm and width 30mm was used to determine tensile strength. For compression rectangular sample of length 100mm and width 30mm, was used. The speed of Universal testing machine was 10mm/min. Specimen used for the determination of modulus of rupture was having length of 25cm and width 3cm and with a span length of 20 cm. Standard procedures was followed to determine screw and nail holding power. The modulus of rupture (N/mm^2) was calculated by formula.

Where,

MOR = Modulus of rupture, N/mm2, P_{max} = Maximum bending load, N ., l = length of sample, mm., b = width of sample, mm., h = thickness of sample, mm

$$MOR = \frac{3 \times P_{max} \times l}{2 \times b \times h^2}$$

Internal bond strength was calculated by formula

$$I_s = \frac{P_{max}}{a \times b}$$

Where,

Is = Internal bond strength, N/mm^2, P_{max} = Maximum breaking load, N., a = length of sample, mm., b = width of sample, mm

Screw holding power was calculated by formula

Ps=411.1 × s^(1.50)×d

Nail holding power was calculated by formula

Pn=308 × s^(1.84)×d

Where, = Screw holding power, N., = Nail holding power, N.,S = Specific gravity., d = diameter

RESULTS:

Physical properties of bamboo mat board:

Density (kg /m^3) and water absorption capacity (%) were determined for different thickness of mats and boards. From Table 1 and 2 it is observed that as thickness increases density increases and water abortion decreases. Maximum density was recorded for bamboo mat board prepared form *Dendrocalamus stocksii* (Mes). Maximum values for water absorption were recorded for Plywood.

Table1: Density of bamboo mat board (kg/m3)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	520	390	437	386	430
2	12 mm	623	500	578	452	569
3	16 mm	788	625	687	585	683

Table 2: Water absorption capacity of bamboo mat board (%)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	50.0	49.0	52.6	54.3	51.9
2	12 mm	37.5	39.2	36.1	42.6	37.9
3	16 mm	30.0	30.6	32.2	38.5	31.7

Mechanical properties of bamboo mat board

As thickness increases tensile and compressive strength increases. Bamboo mat board prepared from *Dendrocalamus stocksii* (Mes) was superior in strength, internal bond strength and modulus of rupture. Plywood was found to have less strength as compare to bamboo mat board. For 16 mm thickness mat board prepared from *Dendrocalamus stocksii* (Mes) tensile strength, compressive strength, internal bond strength and modulus of rupture was 48.50 N/mm2, 26.3 N/mm20, 54.21 N/mm2and 0.161 N/mm2 respectively, plywood for these values were 39.5 N/mm2, 18.3 N/mm2, 42.4 N/mm2 and 0.116 N/mm2 respectively. Screw and nail holding power of *Dendrocalamus ritchy* (Manga) was less among bamboo mat boards and corresponding values for 16 mm thickness board were 595.3N and 407.4N respectively. Plywood was having lowest screw and nail holding power and respective values for 16 mm thickness were 567.2 N and 399.3N.

Tensile strength:

Table 3: Tensile strength of bamboo mat board (N/mm2)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	37.83	30.62	33.60	29.6	32.31
2	12 mm	43.21	34.28	39.51	33.4	37.56
3	16 mm	48.50	40.32	44.30	39.5	43.12

Compressive strength:

Table 4: Compressive strength of bamboo mat board (N/mm2)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	15.75	11.58	14.34	11.1	13.80
2	12 mm	19.21	15.83	18.14	14.4	17.75
3	16 mm	26.30	19.24	24.70	18.3	23.56

Modulus of rupture (MOR):

Table 5: Modulus of rupture (MOR) of bamboo mat board (N/mm2)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	42.32	32.84	37.43	29.1	36.78
2	12 mm	47.63	38.21	43.69	35.7	42.12
3	16 mm	54.21	44.10	50.40	42.4	49.43

Internal bond strength:

Table 6: Internal bond strength of bamboo mat board (N/mm2)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	0.126	0.102	0.112	0.098	0.110
2	12 mm	0.144	0.114	0.131	0.103	0.125
3	16 mm	0.161	0.134	0.147	0.116	0.143

Screw holding power:

Table 7: Screw holding power of bamboo mat board (N)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	386.6	210.4	322.1	205.4	320.4
2	12 mm	644.8	398.8	526.9	394.3	519.5
3	16 mm	1068.1	595.3	785.6	567.2	780.4

Nail holding power:

Table 8: Nail holding power of bamboo mat board (N)

Sr. No.	Thickness	Dendrocalamus stocksii (Mes)	Dendrocalamus ritchy (Manga)	Dendrocalamus strictus (Manvel)	Plywood	Control
1	9 mm	239.9	113.8	191.8	111.3	189.3
2	12 mm	449.4	250.2	350.8	258.5	348.5
3	16 mm	834.6	407.4	572.6	399.3	569.4

Conclusions:

Bamboo mat board of 9 mm, 12 mm and 16 mm thickness could be prepared using urea formaldehyde resin from Mes, Manga and Manvel varieties of bamboo.

Density of bamboo mat board increases as thickness increases. Maximum density was obtained for *Dendrocalamus stocksii* (Mes)

Water absorption capacity of bamboo mat board decreases as thickness increases and was minimum for *Dendrocalamus stocksii* (Mes)

With the increase in thickness, tensile strength, compressive strength, modulus of rupture, internal bond strength, screw and nail holding power of bamboo mat board also increases.

Tensile strength, compressive strength, modulus of rupture, internal bond strength, screw and nail holding power was found maximum for *Dendrocalamus stocksii* (Mes) and the respective values were 48.50, 26.30, 54.21, 0.161, 834.6 and 1068.1 for 16 mm thickness.

REFERENCE

Biswas B., 2011. Physical and mechanical properties of urea formaldehydebonded particleboard made from bamboo waste. International Journal of Adhesion and Adhesives, Vol-31, pp: 84-87. | | Correal J. and L. Lopez,2004. Mechanical properties of Colombian glued laminated bamboo Department of Civil & Environmental Engineering, Integrated Civil & Environmental Engineering Lab. Bogotá, Colombia, Vol-3. pp: 26-37. | | Khandkar S. R., Nazmul Alam D. M. and Md. Nazrul Islam, 2012. Physical and mechanical properties bamboo mat-wood veneer plywood, Forestry and wood technology discipline, Khulna University Vol-1(2), pp: 61-64. | | Nemli G. and J. Janssen,1991. Mechanical properties of bamboo, Forestry Science, Vol-37, pp: 55-60. | | Paudel S., 2008. Engineered Bamboo as a building material. International Network for Bamboo and Rattan, Beijing, China Taylor & Francis Group, London, ISBN 978-0-415-4759 pp: 30-36. | |