A CASE STUDY

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Development and testing of bamboo mat boards

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■ **ABSTRACT :** Three varieties of bamboo *viz.*, *Dedrocalamus ritchy* (Manga), *Dendrocalamus stocksii* (Mes) and *Dendrocalamus strictus* (Manvel) were used to prepare bamboo mats were weaved manually and treated with glue. Urea formaldehyde (resin) was used as glue to prepare bamboo mat boards. The resin application was done by dipping. Bamboo mats were dipped for 10 min in urea formaldehyde. 30 kg of resin was required for complete dipping of bamboo mats. Mats were pressed together at 110^0 C temperatures and pressure of 150 kg/cm^2 was applied for 5 min. This is for spreading glue properly. Mats were again pressed at 110^0 C at a pressure of 200 kg/cm^2 for 10 min to from bamboo mat boards. Boards were trimmed to a size of 2.1 m × 1.2 m board of 9 mm, 12 mm and 16 mm thickness were prepared. Bamboo mat board can be prepared from *Dendrocalamus stocksii* (Mes), *Dedrocalamus ritchy* (Manga) and *Dendrocalamus strictus* (Manvel) using urea formaldehyde resin. *Dedrocalamus ritchy* (Manga) was easy to prepare slivers of bamboo. Density of bamboo mat board increased as thickness increases. Maximum density was for *Dendrocalamus stocksii* (Mes). Water absorption bamboo mat board decreased as thickness increases and was minimum for *Dendrocalamus stocksii* (Mes). Tensile strength and compressive strength for bamboo mat board increased as thickness increases. For *Dendrocalamus stocksii* (Mes) maximum tensile strength and maximum compressive strength was 37.83, 43.21 and 48.50 N/mm^2 and 15.75, 19.21 and 26.30N/mm^2 for 9,12 and 16 mm thickness, respectively.

■ **KEY WORDS :** Bamboo mat board, Bamboos

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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. Bamboos play a dominant role as woody raw material for a variety of products in the tropical regions. It has been reported that about 50 genera and 700 species of bamboo are found all over World. Asia alone accounts for 400 species. Over 136 species in 30 genera occur in India (Suri and Chauhan, 1984) production is 2,47,239 tonnes. The Konkan region contributes 70,000 tonnes of bamboo production (Choudhary, 2008). Bamboo is used for housing construction, mats, ladders, floating fenders, furniture, handicraft articles, baskets, etc. (Bansal and Zoolagud, 2002). 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'. Among the many uses, bamboo is an important construction material, such as scaffolding, bridges, shelters, towers and for simple and modern engineered structures (Biswas, 2011; Hiziroglu, 2008 and Janssen, 2005).

Bamboo consists of 50-70s hemicelluloses, 30 per cent pentosans, and 20-25 per cent lignin (Tamolang *et al.,* 1980; Chenef *et al.,* 1985). Ninety per cent of the hemicelluloses is xylem with a structure intermediate between hardwood and soft wood xylems. The lignin present in bamboos is unique, and undergoes changes during the elongation of the culms. Bamboo is known to be rich in silica (0.5 to 4%), but the entire silica is located in the epidermis layers, with hardly any silica in the rest of the wall. Bamboos also have minor amount of resins, waxes and tannins. None of these, however, have enough toxicity to import any natural durability (Beeson, 1941; Gardener, 1945; Mathew and Nair, 1988; Gnanaharan, 1993). 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 Khandkar *et al.* (2012). It is usually made of three layers of mats and is about 3 mm thick. It can be produced in a range of standard sizes. Bamboo mat board has similar properties to plywood, and is sufficiently rigid and flexible tough substitute for it in a wide range of applications. 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. The technology is particularly suitable in regions where bamboo plantations are desirable for the restoration of degraded forests or wastelands such as abandoned shifting cultivation areas. The production of mats requires the use of large culmed species and the unit is, therefore, particularly suitable for tropical, sub-tropical and warm temperature regions where larger bamboos grow. 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

The *Denrocalamus ritchy* (Manga), *Dendrocalamus stocksii* (Mes), *Bambusa bambus* (Kalak) and *Dendrocalamus strictus* (Manvel) variety of bamboo were used for the present study. Bamboo having length 3m were harvested and leaves of bamboo were removed by using knife. External knots of bamboo were removed by using electrically operated knot removing machine. Bamboos were cut into length of 3m using cutting machine. The crosscut bamboo splits were splitted. 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 per cent moisture content. The dried slivers were manually woven into mats of 0.60 m × 0.60 m size in rectangular pattern (90°).

Preparation of bamboo mat boards :

Mature green bamboo
↓
Cross cutting
↓
Splitting and sliver making
↓
Mat weaving
↓
Resin application
↓
Assembling and hot pressing
↓
Dimensioning and finishing

Bamboo mat boards were prepared at Divine Bamboo Mat Board Manufacturing Pvt. Ltd., Kolahpur. Urea formaldehyde was used as glue to prepare bamboo mat boards. Manually woven mats were dipped in urea formaldehyde. Bamboo mats were dipped for 10 min in urea formaldehyde. 30 kg of resin was required for complete dipping of bamboo mats. Mats were dried in mechanical dryer to a moisture content of 15 per cent. Dried resin-coated mats were assembled. Mats were pressed in hot press machine. Mats were pressed together at 110^0 C temperatures and pressure of 150 kg/cm^2 was applied for 5 min. This is for spreading glue properly. Mats were again pressed at 110^0 C at a pressure of 200 kg/cm^2 for 10 min to from bamboo mat boards. Boards were trimmed to a size of 2.1 m × 1.2 m.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant

Table 1: Density of bamboo mat board and plywood (kg/m^3)

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

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

Sr. No.	Thickness	*Dendrocalamus stocksii* (Mes)	*Dendrocalamus ritchy* (Manga)	*Dendrocalamus strictus* (Manvel)	Plywood
1.	9 mm	50	49	52.6	54.3
2.	12 mm	37.5	39.2	36.1	42.6
3.	16 mm	30	30.6	32.2	38.5

Table 3: Tensile strength of bamboo mat board and plywood (N/mm^2)

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

Table 4 : Compressive strength of bamboo mat board and plywood (N/mm^2)

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

discussion have been presented under following heads :

Physical properties of bamboo mat board :

Density (kg /m^3) and water absorption capacity (%) was determined for different thickness (Table 1 and 2).

Mechanical properties of bamboo mat board :

Universal testing machine was used for determination of mechanical properties of bamboo mat board.

Tensile strength :

The dumbbells shaped strip of 220mm × 30mm of bamboo mat board was used to determine tensile strength of bamboo mat boards (Table 3).

Compressive strength :

For compression rectangular sample of 100mm × 10mm was used. The speed of universal testing machine was 10mm/min (Table 4).

Conclusion :

– Bamboo mat board of 9 mm, 12 mm and 16 mm thickness could be prepared using urea formaldehyde resin from all three varieties of bamboo.
– Density of bamboo mat board increases as thickness increases. Maximum density was for *Dendrocalamus stocksii* (Mes)
– Water absorption bamboo mat board decreases as thickness increases and was minimum for *Dendrocalamus stocksii* (Mes)
– Tensile strength for bamboo mat board increases as thickness increases. Maximum tensile strength for *Dendrocalamus stocksii* (Mes) was 37.83, 43.21 and 48.50 N/mm^2 for 9,12 and 16 mm thickness, respectively.
– Compressive strength bamboo mat board increases as thickness increases *Dendrocalamus stocksii* (Mes) has maximum compressive strength of 15.75, 19.21 and 26.30N/mm^2 for 9,12 and 16 mm thickness, respectively.

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