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RESEARCH ARTICLE

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Effect of needle punch technique on the properties of MDF board from bamboo (*Dendrocalamus strictus*)

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ABSTRACT : Bamboo is as a raw material found in whole over India. A number of production techniques can be used to improve the properties of MDF; particularly the tensile strength perpendicular to grain (internal bond). One of the new techniques is needle punch. Where-in the wooden frame with needles is used to punch the fibre mattress before making a board. Effect of needle punch technique on physical and mechanical properties of MDF board was evaluated. Boards were prepared from bamboo with 6%, 8% and 10% phenol formaldehyde resin using needle punch technique (two time punch) after the mat formation at three different pressure *i.e.*, 14 kg/cm^2, 17.5 kg/cm^2 and 21 kg/cm^2, respectively, for 15 minute hot pressing. The physical and mechanical properties of MDF board were evaluated as per IS specification 12406:2003.An increase trend in the internal bond strength of MDF board with the increase in needle punching during mat formation as well as resin content and pressure was observed. The results indicate that suitable MDF boards can be prepared using needle punch technique (two time punch) with 10% resin content at 21kg/cm^2 specific pressure which meets most of the other physical and mechanical properties as per IS: 12406:2003. Some of the physical properties of board like water absorption and general swelling were higher than the Indian Standard requirements which can be controlled by suitable treatment.

KEY WORDS : MDF Board, *Dendrocalamus strictus*, Bamboo fibre, Phenol formaldehyde

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INTRODUCTION

Forest assets in India have been dependably one of the wealthiest resources. But now-a-days there is a lack of strong wood in our country. This gap between demand and supply of different raw materials is probably going to additionally augment because of ascend in populace and expectation for everyday comforts of human. In perspective of this some substitute in raw materials for strong has been produced. Composite wood like MDF, plywood, particle board, block board, and so forth, assuming significant part in giving a standout amongst the most critical substitute for timber in different

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applications in furniture products, building construction, railroads, cars, and so on. A few such board items made by reconstitution of wood and other lingo-cellulosic residues buildups utilizing appropriate folios are accessible in the market. These (MDF, Plywood, Particle board and so on) items are empower properties to be controlled and coordinated to strong wood for different purposes. In the coming years the utilization of composite items will expand complex for different purposes and one of the plant categories bamboo is accessible in India plentifully. Bamboo is an inexpensive and fast-grown resource with favorable physical and mechanical properties comparable to some common wood species like Giant bamboo *Dendrocalamus giganteus* fibre has potential for MDF production (Marinho *et al.,* 2013). Bamboo has great potential as an alternative to wood for many applications (Lakkad and Patel, 1981; Jain *et al.*, 1993; Shupe *et al.,* 2002). Bamboo is a hardy grass that grows in the tropical and sub-tropical regions of the world. Bamboo is also one of the oldest building materials used by human kind (Abd.Latif *et al.*, 1990). It produces very high end quality and long fibres which makes it a very suitable natural resource for the making of medium density fibre boards. Medium Density Fibre board is a panel with a density range of 0.600-0.900 g/cm^3. MDF (Medium Density Fibre board) is a dry formed panel product manufactured from lignocelluloses fibres combined with a synthetic resin or other suitable binder (Winistorfer and Young, 1996).It is dense, flat, and stiff, has no knots and is easily machined it makes an excellent substitute for solid wood in many applications, except when the stiffness of solid wood is required, such as in a long bookshelf. Its smooth surfaces also make MDF an excellent base for veneers and laminates. It is also cut into a wide range of sizes and shapes, applications are many, including industrial packaging, displays, exhibits, toys and games, furniture and cabinets, wall paneling, molding, and door parts. Several production techniques can be used to improve the properties of MDF, especially the tensile strength perpendicular to grain (internal bond) as it is the weakest properties among all the mechanical properties of MDF board. Chaowana (2013) described bamboo as an alternative raw Material for wood and wood-based composites. It was stated that with modern techniques and adapted technologies, bamboo can be processed into a wide range of products which successfully compete with wood and other raw materials in the future. One of the techniques is needle punch technique in which the wooden frame with needles is used to punch the fibre mattress before making a board. In which technique change the orientation of fibre before the pressing than can improve the internal bond strength of the board.

Therefore, the aim of this study was to validate the effect of needle punch technique used in the preparation of MDF boards from bamboo on the internal bond strength along with other physical and mechanical properties of board at different resin content and pressure.

EXPERIMENTAL METHODS

Dendrocalmus strictus culms were collected from the bajewala near Forest Research Institute, Dehradun (latitude: 30^{0}19'N and longitude: 78^{0}04'E). PF resin was used as binding agent with 35% solid content. Bamboo clumps were converted into chips and after that chips dipped in water for 24 hrs with 5% of NAOH. After 24 hrs chips were passed from condense machine. Then fibres were dried in oven at 50^{0}C to achieve moisture content of 7-9%. 2kg dried fibres were taken for making MDF. PF resin were applied at different resin content *i.e.* 6%, 8%, 10% resin solids based on oven-dry weight of bamboo fibres. After blending the fibres were spread evenly into 21 x 21 cm wooden box frame using metal caul plate as a base. Paraffin wax was applied on to the caul plate to prevent the fibres from sticking to the plate during hot pressing. The mat formed was initially pre-pressed manually to consolidate the thickness. After pre-pressing use the needle frame for two time punches and then wooden frame was taken out. The mat was then hot pressed at an elevated temperature of 140-150^{0}C at three different pressure *i.e.* 14 kg/cm^2, 17.5kg/cm^2 and 21kg/cm^2. The mat was hot pressed for 15min. After hot-pressing, these MDF boards were conditioned for 24 hrs at ambient room temperature and humidity prior to properties evaluation. The physical and mechanical properties of the MDF board were evaluated based on the Indian Standard specification IS: 12406-2003.

EXPERIMENTAL RESULTS AND ANALYSIS

The values of various physical and mechanical tests of MDF board prepared from *Dendrocalamus strictus* with 6%, 8%, and 10% PF resin content at 14kg/cm^2,17.5kg/cm^2,and 21kg/cm^2 different pressure are

given in Table 1, 2 and 3. The values are calculated as per IS specification (12406:2003).

The density of fibre board varies from 0.612 to 0.845 gm/cm^3 and moisture content percentage varies from 9.91 to 6.43.

The water absorption of boards after 2hrs and 24hrs at different resin content and pressure is depicted in Table 1, 2 and 3. The data indicate that water absorption is higher in all the MDF boards and do not meet the requirement of Indian Standard. The minimum water absorption was observed in boards prepared using 10% resin content at 21 kg/cm^3 and maximum water absorption was observed in board's prepared using 6% resin content at 14 kg/cm^3.

The general swelling was observed higher than the Indian Standard. Water absorption due to surface (in thickness) varies from 9.14 to 5.68 after 2 hrs soaking.

The modulus of rupture of MDF board varies from

Table 1 : Physical and mechanical properties of MDF boards of *Dendrocalamus strictus* (14, 17.5 and 21 kg/cm^2, 6% PF resin and 140-150^0 C temperature)

Sr. No.	Pressure (kg/cm^2)	Density (g/cm^3)	Moisture content (%)	Water absorption (%)		General swelling (%)		
				2 hrs	24 hrs	T	W	L
1.	14	0.612	9.91	93.08	106.45	46.11	0.68	0.68
2.	17.5	0.641	8.26	82.96	93.76	40.40	0.54	0.53
3.	21	0.685	7.77	75.30	86.28	34.39	0.45	0.40

Contd… Table 1

Sr. No.	Pressure (kg/cm^2)	Surface absorption (2hrs)	IB (N/mm^2)	MOR (N/mm^2)	MOE (N/mm^2)	Screw withdrawal (N)	
						Face	Edge
1.	14	9.14	0.309	14.36	1420.28	1036.33	765.3
2.	17.5	7.60	0.356	19.60	1835.10	1178.9	882.38
3.	21	6.47	0.407	23.32	2321.11	1321.78	937.36

Table 2 : Physical and mechanical properties of MDF boards of *Dendrocalamus strictus* (14, 17.5 and 21 kg/cm^2, 8% PF resin and 140-150^0 C temperature)

Sr. No.	Pressure (kg/cm^2)	Density (g/cm^3)	Moisture content (%)	Water absorption (%)		General swelling (%)		
				2 hrs	24 hrs	T	W	L
1.	14	0.669	7.37	62.12	69.72	34.81	0.64	0.67
2.	17.5	0.769	7.01	57.2	66.57	26.37	0.54	0.54
3.	21	0.813	6.52	47.26	57.44	20.04	0.34	0.42

Table 2 contd…

Sr. No.	Pressure (kg/cm^2)	Surface absorption (2hrs)	IB (N/mm^2)	MOR (N/mm^2)	MOE (N/mm^2)	Screw withdrawal (N)	
						Face	Edge
1.	14	8.67	0.381	17.64	1734.10	1402.11	1111.47
2.	17.5	7.87	0.590	23.36	2439.05	1565.66	1285
3.	21	6.14	0.680	25.94	2731.91	1669.37	1402.15

Table 3 : Physical and mechanical properties of MDF boards of *Dendrocalamus strictus* (14, 17.5 and 21 kg/cm^2, 10% PF resin and 140-150^0 C temperature)

Sr. No.	Pressure (kg/cm^2)	Density (g/cm^3)	Moisture content (%)	Water absorption (%)		General swelling (%)		
				2 hrs	24 hrs	T	W	L
1.	14	0.673	6.97	60.94	67.65	33.02	0.61	0.61
2.	17.5	0.767	6.69	52.9	61.83	25.10	0.50	0.49
3.	21	0.845	6.43	44.91	53.94	17.92	0.33	0.40

Table 3 contd…

Sr. No.	Pressure (kg/cm^2)	Surface absorption (2hrs)	IB (N/mm^2)	MOR (N/mm^2)	MOE (N/mm^2)	Screw withdrawal (N)	
						Face	Edge
1.	14	7.40	0.418	20.87	2132.26	1501.83	1313.11
2.	17.5	6.90	0.663	25.23	2548.72	1639.55	1401.32
3.	21	5.68	0.806	28.41	2943.36	1836.06	1482.48

14.36 N/mm^2 to 28.41 N/mm^2 and maximum MOR *i.e.*, 28.41 N/mm^2 was observed in the board prepared using 10% resin content at 21 kg/cm^2 specific pressure for 15 minutes. Boards having 8% resin content at 21 kg/cm^2 specific pressure and boards having 10% resin content at 17.5 kg/cm^2 also meet the requirement of Indian Standard.

The modulus of elasticity of MDF board varies from 1420.28 N/mm^2 to 2943.36 N/mm^2 and maximum value 2943.36 N/mm^2 was observed in the board prepared with 10% resin content at 21 kg/cm^2 specific pressure for 15 minutes. Boards having 8% and 10% resin content at 21 kg/cm^2 and 17.5 kg/cm^2 meet the requirement as per IS specification, respectively.

Tensile strength perpendicular to the grain (Internal bond strength) values at different resin content and pressure after using needle punch technique (Two time punch) are shown in Table 1, 2 and 3. The data indicated that only boards having two time punch before hot pressing with 10% resin content at 21 kg/cm^2 specific pressure for 15 minutes meet the IS specification requirement. The use of needle punch technique helps in changing the orientation of the fibres which helps in increasing the internal bond strength of the board.

Screw withdrawal strength of MDF boards having 8% and 10% resin content at two different pressure *i.e.* 17.5kg/cm^2 and 21kg/cm^2 meet the requirement of Indian Standard (12406-2003).

Conclusion :

The suitable MDF board can be prepared from fibres of *Dendrocalamus strictus* using Needle Punch Technique (Two time punch) with 10% resin content at 21kg/cm^2 specific pressure for 15 minutes which meets most of the requirement of MDF board as per the Indian Standard IS: 12406-2003.

REFERENCES

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

Anonymous (1981). Methods of test for wood particleboards and boards from other lignocellulosic materials, IS: 2380 (Part- I- 21), Bureau of Indian Standard, New Delhi.

Anonymous (2003). Specification for medium density fibreboard for general purposes. IS: 12406, Bureau of Indian Standard, New Delhi.

Chaowana, Pannipa (2013). Bamboo: An Alternative raw material for wood and wood-based composites. *J. Materials Sci. Res.*, **2**(2): 90-102.

Jain, S., Kumar, R. and Jindal, U.C. (1993). Development and fracture mechanism of the bamboo/polyester resin composite. *J. Mater. Sci. Lett.*, **12** (8) : 558-560.

Lakkad, S.C. and Patel, J.M. (1981). Mechanical properties of bamboo, a natural composite. *Fibre Board Sci.* & *Tech.*, **14** (3) : 319-322.

Marinho, N.P., Nascimento, E.M., Nisgoski, Silvana and Valarelli, I. D. (2013). Some Physical and Mechanical Properties of Medium-Density Fiberboard Made from Giant Bamboo. *Materials Res*., **16**(6): 1387-1392.

Shupe, T.F., Piao, C. and Hse, C.Y. (2002) Value added Manufacturing Potential in Honduran /Alianza. USAID Project Pp21

Winistorfer, P.M. and Young, T.M. (1996): Modeling and comparing vertical density profýles. *Wood & Fiber Sci*., **28** (1): 133-141.