International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Physical and Mechanical Properties of Particle Board from Lops and Tops of *Melia dubia*

Prakash .V[1], Uday .D .N[2], Sujatha .D[3], Kiran .M .C[4]

Abstract: ***The purpose of this study was to evaluate the technical feasibility of making three layered particle board panels from wood alternatives such as lops and tops (branches) of plantation timber species. Today lops and tops of the plantation timbers are considered to be of low value and are mostly used as fuel wood. Scenario remains same in Indian Plywood Industries which are mostly using plantation timbers as raw materials for peeling. In this study Lops and tops of Melia dubia was converted in to battens of irregular size which were later on converted in to wood chips and then to wood particles using particle board manufacturing facility, Urea formaldehyde resin was used as bindingmaterial and the particle boards were produced using a hydraulic hot press (FPT). These particle boards were tested for their physical and mechanical properties according to the procedures defined in IS: 3087-2005. The test results indicate that the particle board made using the lops and tops of Melia dubia confirms to the requirements of IS-3087: 2005 Grade II particle board of wood and other lignocellulosic materials for general purpose.***

Keywords: *Melia dubia*, Particle board, Urea Formaldehyde resin

1. Introduction

Demand for wood based particle boards has increased greatly due to population growth while the timber resources are alarmingly depleted. Therefore, a huge imbalance in the supply and demand for wood based particle board has initiated search for wood alternatives as raw materials for the particle board industry. The demand for wood composites from wood waste has been increasing as demand supply gap for timber is been continuously widening. The use of renewable biomass as a raw material in composite production is one approach and use of renewable biomass may result in several advantages such as environmental and socioeconomic benefits. World wide a growing number of industrial plants processing forest products are facing raw material shortages, some of them have started operating below 50% of their designed production capacities (Setunge et. al, 2009). Inadequate raw materials and stringent forest policies have forced the wood based industries to become self-reliant in terms of acquiring their own raw materials (K. T. Parthiban et. al, 2009).

Rapidly changing economic and environmental needs of the society are putting ever – increasing pressures on the forest industry to "do more with less" (R. C. Kuhad et. al, 2013). Providing a continuous raw material supply at low material cost is an increasing challenge for the forest product industry (Rathke et. al, 2012).*Melia dubia* (Malabar Neem) is a deciduous tree, attaining a girth of 1.2 to 1.5 meter and a height of about 20 meter with a spreading crown and a cylindrical straight bole of about 9 meter. An exceptionally large tree measured in South Chanda Division, Maharashtra had a height of 32 meter and a girth of 2.7 meter at breast height (12 meter). *Melia dubia* can be named as an opportune raw material for plywood manufacturing because of its geometry and facts like it is free from knots, resistance to insect and termite attack etc. Lops and tops of these timbers have no importance as it is considered to be only good as fuel wood. Particle board is a wood based panel product manufactured under elevated pressure and temperature from wood or other lignocellulosic materials and an adhesive which acts like a binding material. Particleboards have been widely used throughout the world for house construction, furniture manufacture, etc. (Vanchai Laemlaksakul et al 2010).According to the end uses of wood-waste and their possible reuse products, particle board has found typical application as floorings, wall and ceiling panels, furniture, separation walls etc…The manufacture of particle board from recycled wood-based waste is the most common way to reuse these waste materials. The purpose of this research was to study the use of lops and tops of *Melia dubia* tree to make three layered particle board and to appraise its mechanical and physical properties. This erudition is essential before the commercialization of these particle boards which is value added product from lops and tops.

Water resistant particle board can be manufactured using recycled wood waste material of different wood species for use in kitchens and bathrooms and as flooring-based material and in outdoor environments (T. H. Yang et al 2007).Low density particleboard is manufactured from wheat straw and corn pith and has found to be having good tensile and compressive strength (D. Wang, and X. S. Sun 2002).

2. Materials and Methods

Melia dubia lops and tops were extracted from a plywood industry, this lops and tops are generated when *Melia dubia* timber is prepared for peeling veneers. Lops and tops were reduced to battens of irregular size and shape manually using machetes which were converted in to wood chips using a disc type chipper. These chips were later on converted in to wood particles through hammer mill. These particles contains moisture more than 40% and this needs to be brought down to 3 – 4 % by drying which was done in a single pass dryer 1.65 meter in diameter and 6.17 meter in length has shovels mounted on a shaft which rotate at a speed of 7 rpm and the temperature maintained in the dryer was around 120^0 C. A motor operated sieve was used to segregate core and face particles.

Conventional urea formaldehyde resin was used for the preparation of particle board with Melia dubia. For the preparation of resin molar ratio of urea/formaldehyde used at

Licensed Under Creative Commons Attribution CC BY

initial stage [mole ratio 1:1.72 or weight ratio of urea: formalin = 1:2.3 with 10% melamine on the weight of the total urea. The reactants are allowed to react at pH 8.0 for one and half an hour at $90^0 \pm 2^0$ C under reflex to ensure complete formation of methylol urea. Further reaction is completed by adding traces of dilute acetic or formic acid [pH 4.5 – 5.0] leading to UF polymer formation. Once desired viscosity is obtained [flow time in B-4 flow cup 16 – 17 seconds in hot condition] the pH is raised to 7.5 – 8.0 and resin is cooled. When temperature reaches 60^0 C, 10% second urea on the weight of total urea taken is added to reduce the formaldehyde emission level. The properties of the resin are given in table 1.

The necessity of adding second urea is to keep certain amount of free urea in resin system for

1) To mop up free formaldehyde that may be present at the end of preparation and
2) To mop up free formaldehyde generated during hot pressing of particle board. All attempts to add second urea was to remove much of free formaldehyde from resultant particle board.

For the present work, melamine has been used as scavenger to mop free formaldehyde from UF resin.

Table 1: Properties of Resin

Sl.No	Particulars	Results
1.	Flow time of resin in B4 flow cup	20 -22 seconds
2.	Water tolerance	1:2 – 1:3
3.	Solid content	50%
4.	Gelation time	62 seconds
5.	Shelf life	One and half months

Conventional urea formaldehyde resin (50% solid content) was used for the preparing the particle board. Water tolerance of the resin was 1:2 – 1:3.

3. Manufacturing Particleboard

Particle boards were produced using standardized methods which are in par with industrial production practices. The ratio of face: core particles was 40:60, these particles were oven dried to a moisture content of 3-4%.

Figure 1: Disc type Chipper in closed postion

Figure 2: Disc type Chipper in open postion

Figure 3: Hammer mill in closed postion

Figure 4: Hammer mill in open postion

Licensed Under Creative Commons Attribution CC BY

Figure 5: Face Particles

Figure 6: Core particles

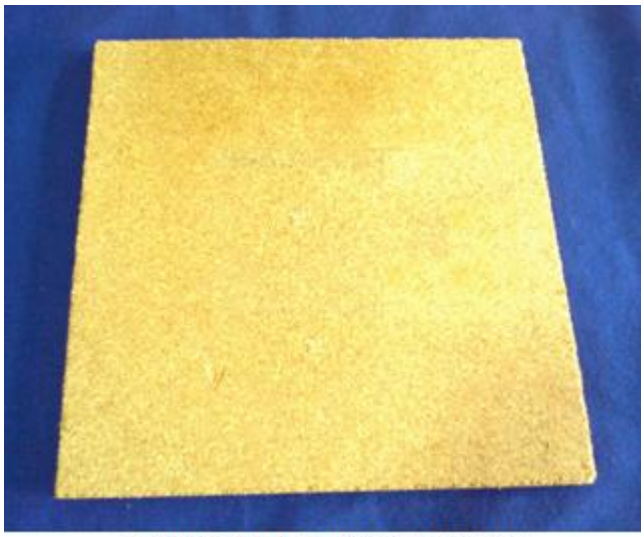

Figure 7: Melia Dubia particleboard

Blending and Hot pressing

Resin used for face and core particles
100 parts oven dry face particles- 12 parts resin on solid basis
100 parts oven dry core particles- 8 parts resin on solid basis

Pressing parameters

1) Temperature = 160 ± 5^{0}C
2) Pressure
   a) Compression Cycle = 25 Kg/cm^{2}for 8 mins.
   b) Curing Cycle = 12 Kg / cm^2 for 7 mins.

Pressed boards were allowed to stabilize for a period of 24 – 48 Hours to attain equilibrium moisture and then trimmed on all the four sides to get a board of 305mm X 305mm.

Testing

The finished boards were kept in an open space approximately for 3 days to remove formaldehyde trapped inside. The test samples were cut and physical &mechanical properties were determined as per IS 3087:2005 (Indian Standard for particle board of wood and other lignocellulosic materials for general purpose).

Table 2: Prescribed values as per IS 3087:2005 for particle board from wood and other lignocellulose materials for general purpose and test results

Sl. No	Tests	Prescribed value for Flat Press Three Layered Particleboard Grade II	Test Result
1	Density Kg/ m^3	500-900	888
	Variation (%)	±10	± 4.2
2	Moisture Content (%)	5-15	6.79
	a. Average		
	b. Variation (%)	± 3	± 0.1
3	Water absorption (swelling in Water) (%)	40 (Max)	38.8
	a. 2 hrs soaking		
	b. 24 hrs soaking	80 (Max)	75.2
4	Swelling due to general absorption (%)	0.5 (Max)	0.27
	a. Length		
	b. Width	0.5 (Max)	0.27
	c. Thickness	12 (Max)	11.87
5	Swelling due to surface absorption (%)	9 (Max)	7.24
6	MOR (N/mm^2)	11	14.8
	a. Average		
	b. Individual	10	10.6
7	MOE (N/mm^2)	2000	2800
	a. Average		
	b. Individual	1800	2505
8	Tensile strength perpendicular to surface (Internal bond Strength in dry state) N/mm^2	0.3	0.36
9	Screw holding strength (N)	1250	1898
	a. Face		
	b. Edge	850	1317

4. Result and Discussion

Particle boards from *Melia dubia* can be made using urea formaldehyde resin. The process parameters for manufacturing particle board from *Melia dubia* is almost same as that of the other timber species except that during drying additional care is to be taken that the particles dried must be processed further without any delay or else particles will pick up the moisture which will enhance the problems of blister formation during pressing.

From the Table 2 it is observed that the physical and mechanical properties of the boards made confirms to the requirements of the FPT Grade – 2 particle boards as per IS 3087 : 2005. Specifications for particle boards of wood and

Licensed Under Creative Commons Attribution CC BY

other lignocellulosics materials (medium density) for general purpose.

5. Conclusion

Investigations were carried out in which lops and tops of *Melia Dubia* from plywood manufacturing facility were converted in to wood particles which was later used to manufacture particle board. Boards produced was tested as per IS 3087:2005 and the result shows that the board confirms to Flat Press Three layered particle board Grade II medium density particle boards. Further studies can be extended to examine the suitability of lops and tops of *Melia Dubia* for production of FPT Grade I particle board and MDF.

6. Acknowledgement

This research was a part of research project entitled “Study on suitability of plantation grown species viz. *Melia Dubia* for particle board manufacture”, at IPIRTI Bangalore.

References

[1] Bates D M & Watts D G, Nonlinear Regression Analysis and Its Applications (Weley, New York) 1988.
[2] D. Wang, and X. S. Sun, “Low density particleboard from wheat straw and corn pith,” *Industrial Crops and Product*, vol. 15, pp. 47–50, 2002.
[3] http://www.hunsply.com/Melia_Dubia_%20Kadbevu.pdf accessed June 1 2012.
[4] Indian Standard IS 3087: 2005 Particle boards of wood and other lignocellulosic materials (medium density) for general purposes – specification.
[5] K. T. Parthiban, Akilesh Kumar Bharathi, R. Seenivasan, K. Kamala and M. Govinda Rao. "Integrating Melia dubia in agroforesty farms as an alternate pulpwood species".
[6] Rathke et al. (2012). "Design of particleboards," BioResources 7(3), 2970 - 2985.
[7] Setunge, S., Wong, K.K., and Jollands, M. (2009). "Economic and environmental benefits of using hardwood sawmill waste as a raw material for particleboard production," Water Air and Soil Pollution 9, 485-495.
[8] T. H. Yang, C. J. Lin, S. Y. Wang, and M. J. Tsai, “Characteristics of particleboard made from recycled wood-waste chips impregnated with phenol formaldehyde resin,” *Building and Environment*, vol. 42, no. 1, pp. 189–195, 2007.
[9] Vanchai Laemlaksakul “*Physical and Mechanical Properties of Particleboard from Bamboo Waste”,* World Academy of Science, Engineering and Technology 40 2010.

Licensed Under Creative Commons Attribution CC BY