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Suitability of *Melia dubia* for Manufacture of Flush Door

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Abstract: ***The purpose of this study was to optimize the process parameters for producing flush door from fast growing plantation timber species Melia dubia. Flush door from Melia dubia was produced with phenol formaldehyde resin employing hot pressing technique. Flush door thus produced was subjected to evaluation of physical and mechanical properties as per relevant specifications (IS 2202, 1999). From the outcome of the tests carried out, it was found that the flush door from Melia dubia conforms to the requirements as laid in the Indian standards. It can be concluded from this study, that Melia dubia timber can be used for manufacturing flush door whichmeets the requirements of Indian standards as prescribed in IS: 2202 – 1999 (specifications for Flush doors).***

Keywords: Flush door, Phenol formaldehyde resin, fast growing, Plantation timber species, *Melia dubia*.

1. Introduction

The present demand and supply scenario of raw materials for wood based industries and stringent forest policies have forced these industries to become self - reliant in terms of acquiring their own raw materials. Fast growing plantation timber species which can be grown through farm forestry/Agro forestry in a wide range of climatic and soil condition are one of the best alternative that can be looked upon to satisfy the growing demand for timber to some extent, intensive silviculture management may further contribute to grow more timber in a given area of land under given time period.

Melia dubia also locally known as Kadbevu or Hebbevuis one of the plantation timber species gaining popularity for its fast growing characteristic requiring less maintenance and emerging as a promising raw material for wood based panel industry in India in the current scenario. The geometry of this tree is an added advantage when it is subjected to peeling/veneering resulting in less wastage compared to any other plantation species and this tree poses anti - termite characteristic by nature. This species is being well accepted among farmers as it can be grown in a variety of climatic conditions and is suitable for agro forestry as well as farm forestry, another advantage is that it can be planted as an intercrop or it can also be planted on the bunds along the boundaries of a farm land. *Melia dubia* is currently being promoted as a source of raw material for wood based panel industries and the results are encouraging as growing number of farmers are keen in taking up *Melia dubia* plantation at a large scale and also the number of industries adopting this species as raw material is gradually showing a rising trend. Considering its sustainable availability, a series of studies to utilize this species for various end use applications were taken up in the past and this species is found to be suitable for producing plywood, particleboard, laminated veneer lumber (LVL), medium density fibre board (MDF) and block board etc. In this study suitability of *Melia dubia* was examined to produce flush door.

Flush doors are composite doors which are alternate to the conventional doors which are made of only solid wood. Flush doors are most widely used in the current scenario of construction industry. They are made from a combination of both solid wood and composite wood. solid wood is used for the rails and stiles which forms the frame for door, whereas the core of the flush door is made from a variety of materials such as particle board (solid or tubular board (hollow core particle board)), Medium density fibreboard (MDF), block board or small sections of solid wood known as battens that are assembled edge wise. This core is then covered with cross bands and face veneers on both sides as shown in fig 1 and fig 2. After all these steps, the edge of the wood veneer will be lipped with edge banding.

The core and the veneers are glued under high pressure and temperature. The left out portion of logs during veneer peeling which is also known as peeler core or lumber cores can be sawn and used as battens for flush doors and thus reducing cost of the door.

2. Literature Review

A report by World Wide Fund for Nature (WWF) and Planning Commission of India, making use of International Tropical Timber Organization (ITTO) 's analysis has projected a severe shortage in the supply of timber by 2020 from both domestic as well as international sources (Shrivastava, and Saxena, 2017). According to an estimate, there is a demand for 123 million cubic meter (cu. m) of timber in the India. Against this demand, the production is estimated to be 1.873 million cu. m (ICFRE, 2003), and 0.6 to 1 million cu. m (Behera, 2005). According to Sood (2014), only 3.2 million cu. m of wood was produced from Indian forests during 2011. According to Forestry Sector Report (2010), there was a production of 2.3491, 2.4054, 2.61502, 2.32402 and 2.18509 million cu. m timber during 2006, 2007, 2008, 2009 and 2010, respectively, averaging to around 2.375 million cu. m per year (Dev. et. al, 2019).

For sustained domestic supply of timber there is a need to strengthen research and development in clonal plantations, silviculture and other technologies for developing short rotation and high yielding plantations, as these varieties will not only meet the market timber needs, but will also be preferred by the farmers/growers for better economic returns (Parthiban. et. al, 2014). The concept of agroforestry is shaping perspectives in forest management by reducing the pressure on available natural forests and It has been

estimated that due to agroforestry plantations 46% of global agricultural land is under more than 10% tree cover. (Saravanan. et. al.2013). There is currently considerable interest worldwide in the potential for trees on farms to increase incomein a manner that maintains or enhances the diversity of species. In economic terms it can be important that the trees have the potential to produce a variety of products with a large local and international market (Newman.1997).

Melia dubia which belongs to the family *meliaceae* and has its trade name as Malabar neem and locally called as *Hebbevu* (Kannada), MalaiVembu (Tamil) it is an indigenous fast growing tree species with multipurpose usage such as for packaging and asraw materials for plywood, particleboard, laminated veneer lumber (LVL) etc. *Melia dubia* could be used as an alternate source of raw material for pulp and paper in India (Parthiban. et. al, 2009). *Melia dubia* attains a height of 20 – 25m with a wide spreading crown and a cylindrical bole of 9m length and 1.2 to 1.5m girth at 10 – 12 years age (Nuthan. et. al.2009). This species is suitable for plantation viz. farm forestry and agro forestry under various agro climatic conditions. The yield per hectare (ha) of plantation depends on the spacing provided between the saplings (Patil. et. al, 2017). Apart from being a fast growing speciesanother advantage of *Melia dubia*is that it possesses anti - termite properties by its nature (Swaminathan et. al, 2012). Thus, in the current scenario this species is favourable for farmers, foresters and plantation growers for its fast growing nature which helps in increasing the net income of the farmer compared to any other tree species which can be taken up as agro forestry or farm forestry plantations.

3. Scope

For any wood based industry to survive in the market, uninterrupted supply of timber raw materials is the key. Shortage of raw materials have forced many wood based industries to run below their installed production capacities. In such situations, the forest research laboratories are working on to identify various fast growing plantation timber species which can substitute the timber from natural forests as raw material source for wood based panel industries on the other hand research institutes are working on to make most use of the plantation timbers by reducing the wasteage. *Melia dubia* is one such fast growing plantation timber species which is suitable for producing panel products like plywood, particle board, laminated veneer lumber (LVL), medium density fibreboard (MDF) etc. This research work is an extension of the previous woks to find out the suitability of *Melia dubia* for manufacturing block board.

3.1 Objectives

1) Optimization of parameters for manufacturing flush door from *Melia dubia.*
2) Formulation of resin.
3) Evaluation of physical and mechanical properties as per the relevant standard (IS 2202, 1999).

Figure 1: Cross sectional view of a Flush door

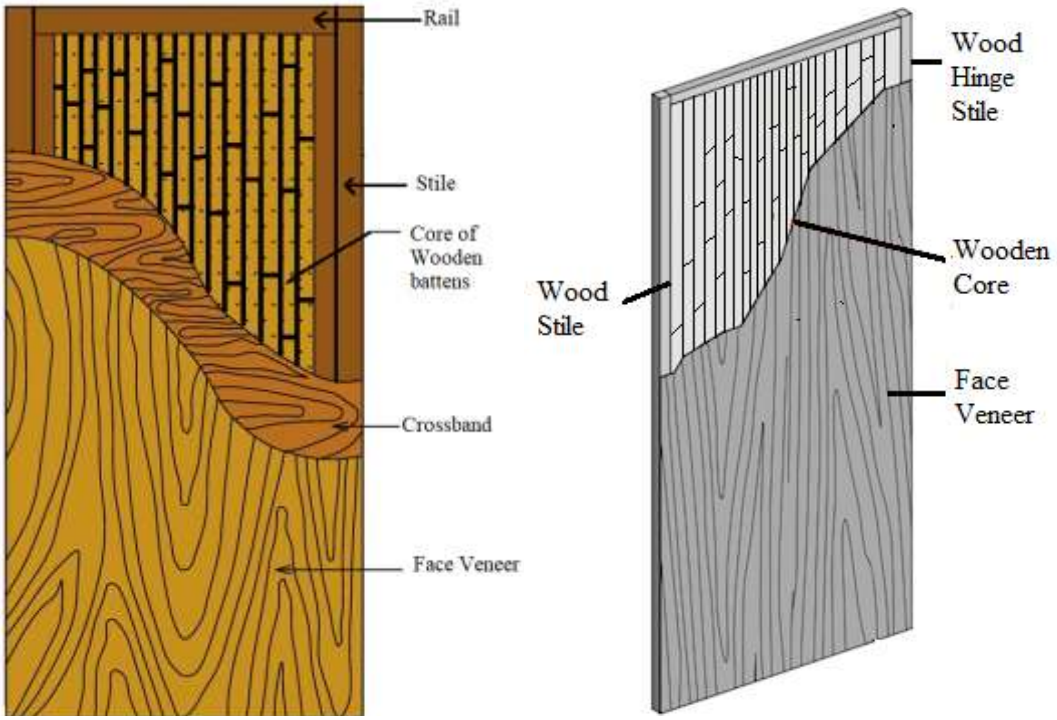

Figure 2: Pictorial view of a Flush door

4. Materials and methods

Melia dubia logs were sawn using through and through technique and the sawn pieces were subjected to air seasoning to bring down its moisture content slowly to 10% in order to avoid warping, bending and cracking of the sawn pieces. The planks thus obtained were subjected to ripping in a multiple rip saw and reduced in to battens of thickness and width of approximately 27 mm. These battens were assembled between the edge strips of width 45 mm and thickness 27 mm in such a manner to avoid significant gaps and where the battens were smaller, the joints were staggered. Rotary peeled *Melia dubia* veneers of thickness 1.4 mm were used as cross bands on both the sides of the core and rotary peeled *Melia dubia* veneer of 0.5 mm was used as face veneers on both the surfaces.

Phenol formaldehyde resin

100 parts of phenol and 180 parts of formalin of 37 percent formaldehyde were charged into a resin reactor. Reaction was carried out in presence of a catalyst i. e., sodium hydroxide, at a temperature of 80^{o}C - 82^{o}C for about 90 minutes. The resin thus prepared had a flow time of 24 seconds when measured in IS 3944, (1982) - B4 flow cup at ambient temperatureand a solid content of about 48%. The conventional resin formulation was adopted in this study.

Manufacture of flush door

A core of size 1925mm X 850mm X 27mm was prepared using the battens of *Melia dubia*, rotary peeled veneers *Melia dubia* of thickness 1.4 mm coated with Phenol formaldehyde (PF) resin was used as cross bands on either side and rotary peeled veneer of *Melia dubia* were used as face veneer on both the surface. The assembly was loaded into hot press and compressed at 145^{0}C with a specific pressure of 14kg/cm^{2}for a time duration of 20 mins. After stipulated curing time the door was unloaded from the hot press and stacked. The door was allowed to stabilize for 24 hrs to attain equilibrium moisture. The door was then subjected to trimming and sanding to obtain a flush door of dimensions1845 mm X 785 mm X 30 mm (Length X Width X Height).

Testing

The flush door produced was subjected to tests as per IS - 2202 (1999) and the results of the tests are tabulated in the Table - 1.

5. Test results

Table 1: Test results as per IS: 2202 - 1999 for Flush door from *Melia dubia*

S. No.	*Tests*	*Requirement as per IS: 2202 (Pt - I): 1999*	*Results*
1.	a) Dimensions, mm	Tolerance: Height ± 5 mm (nominal dimensions) Width ± 5 mm (nominal dimensions) Thickness ± 1 mm (nominal dimension) Variation in the thickness between any two points – not more than 0.8 mm	 0 0 + 0.9
	b) Squareness, mm	Deviation not more than 1 mm per 500 mm length	0.89 0.0
2.	General flatness, mm	Twist, cupping & warping not greater than 6 mm	2.0

3.	Local planeness, mm	Depth of deviation not greater than 0.5mm	0.39
4.	End immersion test	No Delamination	No Delamination
5.	Glue adhesion test	No Delamination	No Delamination
6.	Knife Test	Minimum pass standard	Pass standard
7.	Impact indentation, mm	No cracking, tearing or delamination Depth of indentation not greater than 0.2mm	Conforms 0.06
8.	Slamming	No visible damage after 50 drops	No damage
9.	Flexure (deflection in mm) 15 mins after loading 50 Kg 3 mins after load removal	Deflection at maximum load not greater than 1/30 of length & 1/15 of width, whichever is less Residual deflection not greater than 1/10 of maximum deflection	31.46 1.6
10.	Shock resistance. Soft and light body impact Soft and heavy body impact	 No visible damage No visible damage	 No visible damage No visible damage
11.	Buckling (deflection in mm) After 5 mins of 40 Kg loading 15 mins after load removal	No deterioration Initial deflection not greater than 50mm Residual deformation after 15 minutes of unloading not greater than 5 mm	No deterioration 23.1 1.2
12.	Edge loading (deflection in mm) After 15 mins of 100 kgs loading 3 mins after load removal Lateral buckling	Deflection at max. load not greater than 5 mm Residual deflection after removal of load not greater than 0.5 mm Not more than 2 mm during loading No residual lateral buckling after load removal	2.6 0.42 No lateral buckling No residual buckling
13.	Screw withdrawal strength, N	Not less than 1000 Surface condition: No visible damage to the surface either by delamination of extra chipping off at the points of withdrawal	4770 No visible damage
14.	Varying humidity test	No visible warping, twisting or delamination Maximum departure from the general planeness not more than 1 mm Recovery – At least 90% of the change in dimension	Conforms 0.66 98.2
15.	Misuse	No permanent deformation of the fixing or any other part of the door set in hindering its normal working after test	No permanent deformation

6. Results and Discussions

Flush door produced from *Melia dubia* was subjected to tests as per IS: 2202 – (1999) and the results obtained are tabulated in Table – 1. From Table – 1, it is clear that the variation in dimensions of the flush door are very well within the prescribed limits. Surface defects conforms to the standard. The value for twist, cupping and warping obtained was 2mmwhich is not to be more than 6mm to conform to the standard. Value of depth of deviation for local planeness achieved is 0.39 against the required value of 0.5 and no delamination was observed during end immersion and glue adhesion test. No cracking, tearing or delamination was observed during the impact indentation test and the depth of indentation was 0.06mm which is well within the prescribed value of 0.2mm. No visible damage was witnessed after 50 drops during the slamming test. During screw withdrawal strength test a value of 4770 N was obtained against the required value of 1000N and no visible damage was witnessed to the surface. During the varying humidity test any kind of warping, twisting or delamination was not observed. No permanent deformation of the fixing or any other part of the door set in hindering its normal working was observed after the test to check the misuse of the door. The sample also conforms to the knife test carried out to check the adhesion of plies.

As discussed earlier since *Melia dubia*is anti - termite by itself (Swaminathan et. al, 2012), thisspecies does not require any additional preservative treatment and no spot test was conducted on the samples since chemical preservation was not employed.

7. Conclusion

From the above discussions it is evident that flush door manufactured from *Melia dubia*is conforming to IS: 2202 – (1999), the Indian Standards for flush doors and can be concluded that *Melia dubia* is suitable for manufacturing of flush door. The outcome of this study adds a new entry to the list of end uses of *Melia dubia* timber and this supports in promoting *Melia dubia* as a promising short rotation plantation timber species and this species can be regarded as the need of the hour for ensuring uninterrupted supply of raw materials for wood based panel industries as *Melia dubia* is suitable for manufacturing a wide range of wood based panel products.

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