

Development of Veneer – Bamboo Mat Flexi Ply

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ABSTRACT

Flexi Ply or Flexible plywood is one of the latest panel product based on wood and is hailed as architect's dream product and the interest in this product is growing day by day. Assembly of veneers in flexi ply is quite opposite to that in plywood. While the face veneers grain run across the length of the board, the thin inner layer (veneer grain) runs along the length of the board. However, flexi ply tends to break when bent too much, due to rupture of the thin inner layer. In order to overcome this problem, IPIRTI has developed a technology for flexi ply with the inner layer of veneer being replaced by bamboo mat. This reduces the possibility of breakage when rolled. Plywood of 3 mm and higher thickness have the tendency to break when rolled i.e., due to the non flexibility of the product. The flexi ply developed in combination with bamboo mat has flexibility up to 8mm thickness panels. The flexi ply so developed has great potential for applications in cabins of curved shapes, arch panels, furniture and joinery manufacturers.

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Introduction:

Bending plywood, also known as Flexi ply, Wacky Wood and Wiggle wood, is generally made out of veneers from imported hardwood with the layers all running in one direction, this allows bendability to the panel and can be applied on a curved shape.

The plasticizing effect of phenol formaldehyde resin forming mixes on wood has been taken advantage of in making flexible plywood.

In the past plywood's were manufactured and certain treatment techniques were adopted to make the plywood flexible so as to bend it to any desired shape. These techniques were labour and time intensive which led to search for other developments.

Super-flexible plywood allows cold forming to the smallest radius requirements without any heat forming or water treatment. Self-supporting structure eliminates the need for structural skeletons or special supports. Unique design models, rounded structures and complex multi-radii shapes that were virtually impossible to create with traditional materials, can be easily prepared. Stag Flex can meet almost any thickness requirement by increasing the number of composite layers (e.g. increasing thickness to 10mm, 15mm, 16mm, 18mm,

20mm, etc.). Combinations of sheets of different thicknesses are simply glued.

Flexible Plywood has a specialized construction allowing it to be easily bent to shape. The arc formed by the bend is perpendicular to the grain direction of the face and the exact bending radii have to be determined in accordance with the type of surface finishing required and the extent of the surface to be treated. The bending radii will vary for each thickness.

Literature survey:

Wood impregnated with a concentrated aqueous solution of urea is swollen about 10 per cent more than it is swollen in water, on an external volume basis and considerably more on a cell wall volume basis [Stamm, 1964, Chapter 15,]. Impregnated specimens of hardwood one centimeter square are very plastic at oven temperatures following drying and can be twisted or bent quite easily to severe curvatures. This technique was applied for a short period in bending 2-inch thick oak ribs for wooden mine sweeper boats. Although the bending could be done at lower pressures than steam bending at the same temperature, more failures occurred than with steam bending. This is believed to be due to uneven distribution of the urea in the wood resulting in non-uniform plasticization.

More recently it has been found that impregnation of wood with liquid ammonia causes a high degree of swelling [Stamm, 1955] and a high degree of plasticity of wood [Schuerch, 1964, Bariska, Skaar and Davidson 1960]. Liquid ammonia, unlike water enters the crystallites of cellulose modifying their crystal lattice, as well as being sorbed in the amorphous regions. Liquid ammonia plasticizes isolated lignin at about -300C in contrast to heat plasticization that starts at about 1250C [Goring, 1962, 1963]. Because of this plasticizing action of liquid ammonia, small specimens of wood have been given very severe bends while still saturated at temperatures as low as -300C. Upon evaporation of the liquid ammonia, the wood shrinks, loses its plasticity and becomes set in the bent form.

Scope:

The furniture, shop fitting, bar fitting and joinery trades are increasingly being asked to create curved and shaped structures. To accommodate these uses, a range of flexible plywood is being developed. Flexible plywood provides a cost-effective, convenient solution for producing rounded structures, especially when small radii are required. It can take on any desired shape. Once it is glued, laminated or veneered, it will hold the required shape.

Materials & Methodology:

The quality of veneer required for production of flexi ply is different from that of veneers needed for the manufacture of plywood. The veneer used for making flexi ply should contain deep lathe checks which enable the panel to be bent easily in lengthwise directions. The lathe checks are the cracks formed on the veneer at the point of cutting at the knife side which are normally controlled or minimized by the application of pressure bar compression for obtaining smooth, tight and uniformly thick veneer. The two parameters considered for measurement of lathe checks are the depth of check and frequency of checks [number of checks per unit length]. The relationship of lathe check depth to frequency is that depth of check is inversely proportional to frequency. A veneer considered as tight if the depth of check is less than 50% of the thickness. However, the quality of veneer needed for flexi ply is that it should contain deep lathe checks and therefore pressure bar compression is not exerted at the point of cutting. That is to say that, the gap and lead [horizontal opening and vertical opening between knife and pressure bar] should be kept as too large or it must be maintained as equal to the thickness of veneer and in this case it is set at 3.5 mm as gap and lead for peeling veneers containing deep lathe checks.

Bamboo Mats:

Bamboo mat is the basic raw material. It is bamboo/reed culm viz., species with long internodes like *Ochlandra tranvancorica* and *Melocanna bambosoides*, Thickness of slivers used for mat weaving is in the range of 0.6mm ± 15%. Bamboo mat

woven in sinusoidal pattern has been used to make flexi ply. Veneers thickness of 2.4mm and 3.5 mm from plantation species viz., silver oak were used in this study.

PF Resin Manufacture and Quality Assessment:

Conventional Phenol Formaldehyde resin having the properties given below was used for bonding the veneers.

Properties of resin

Viscosity: 60 ± 10m Pa.s at 27⁰C

Flow time of 24 ± 2 sec, at 28⁰C when measured in B-4 flow cup of IS: 3944 Water tolerance: 1:10 ± 2.5 at 270C

Mats of size 8' x 4' are dipped into the resin solution for adequate soaking the mats are given 5 minutes of dipping time. After the stipulated time the resin soaked mats are removed from the resin solution and kept in an inclined position for about 30 minutes to facilitate draining out of excess resin.

Stabilization and drying of resin coated mats:

Resin coated mats are kept one above the other for at least 1 hour for stabilization. The stabilized mats are dried in either a drying chamber or industrial dryers such as band dryer at a temperature of 90 ± 5⁰C till the moisture content comes down to 8 ± 2 percent. Alternatively, resin coated mats can be dried in air, but air drying is time consuming process and dependent upon prevalent weather condition. The veneers were also dried to a moisture content of 6-8% before assembling.

The veneers were assembled on top and bottom while the Resin coated mats formed the central core layer. The grain direction of veneer was at right angle to the length of the panel. The entire assembly was done on an Aluminium metal cauls coated with releasing agent. The assembly was then loaded into the hot press. The pressing details are given in Table I.

Hot pressing:

The assembled materials are loaded on to the hot press. The following press schedule was adopted.

Table: 1. Pressing Details

Pressure	100 kg/cm ²
Temperature	140 ⁰ ± 5 ⁰ C
Pressing Time	Thickness + 3 minutes for curing

Trimming and Checking:

The hot pressed boards are trimmed to required size, in a DD saw. The trimmed boards are graded based on visual defects such as poor bonding, blisters, delamination, resin penetration, starved joints. This product does not require any sanding. Few products of flexi ply are shown in Fig. 1 and Fig. 2 respectively.

Evaluation of properties

Two set of samples received from industries (veneer flexiply) and two samples of Bamboo mat flexi

ply processed in house were taken for testing as per relevant standards and the values of the same are given in Table: 2.

Sl. No.	Properties	Grain Direction	Tested as per IS:	Industrial sample Flexiply with veneers	IPIRTI Flexiply with Bamboo mat as core
1	Thickness		1734	8mm	8mm
2	Density, kg/m ³		1734		580
3	Moisture content %		1734		6.39
4	Cyclic test		1734	Pass	Pass
5	MoR N/mm ²	Alg	1734	39.46	41.82
		Acc	1734	4.123	4.518
6	MoE N/mm ²	Alg	1734	3760	4380
		Acc	1734	41.13	81.92
7	Bending Test (Mandrel test)		4859		
		Acc		Pass	Pass
8	Min Bend. Radius mm	Alg	4859	1277.6	1033.0
9	Min Bend. Radius mm	Acc	4859	232.1	205.9
10	Tensile st. N/mm ²	Alg	1734		32.23574
		Acc	1734		15.01581



Fig. 1: Flexiply of 8mm thick



Fig. 2: Table developed using flexiply

Results & Discussions:

From the study it is observed that utilization of bamboo mat as a core material in the centre, the flexibility of the product is higher than when veneer is used in the centre (**Table: 2**). From **Table: 2** it is observed that the strength properties of the flexi ply made using bamboo mat combination has better

strength properties than the veneer flexi ply except the tensile strength in across direction. Since the thickness of veneer used in veneer flexi ply is very less (0.6mm), the shear force acts neutral in the across directions while bamboo mat used is of 1.2mm thick wherein in the grain direction do not remain as same as veneer leading to lesser tensile strength. The tensile strength in across directions gets eliminated considering the enduse application of flexi ply. The flexi ply is mostly used for curved beams, joinery etc where small radii is bent along the grain directions. Hence the tensile strength (**Table: 2**) should remain higher in along direction which has been achieved.

Since no standards were available for evaluating the results of flexi ply, the product developed at IPIRTI was tested for properties being evaluated for imported veneer flexi ply. The test results of IPIRTI flexi ply was compared with the flexi ply available in the market. The test results indicates that the flexi ply made using bamboo mat combination pocessed excellent properties for both 5mm and 8 mm when compared with the flexi ply available in the market

Conclusions:

From this study, it is found that by changing the peeling lathe settings veneers suitable for making flexible ply can be made from silver oak species. Maximum of 3.5mm thick veneers can be peeled with higher lathe checks without deteriorating the quality of veneer. Bamboo mat reinforcement as a central core layer enhances strength and flexural properties when compared with the flexible ply procured from the market.

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