

Use of Areca leaf Sheaths for Making Plyboard and Packaging Materials⁺

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Abstract

Arecanut leaf sheath was found suitable for making plyboards. Two plies of processed arecanut leaf sheaths in combination with an ordinary wood veneer as core glued with urea formaldehyde resin are used for making the plyboards. These boards may be used for making packing cases like tea chests, suitcases etc. The process of making the plyboards and the properties of the boards as a packaging material are reported.

Introduction

Arecanut palm (*Areca catechu* L.) is grown extensively in India. In the regular system of planting the population of 1300 palms/ha is common. Each palm sheds about five leaves in an year and thus about 1100 million leaf sheaths are shed annually from an area of about 1,80,000 ha. The stalks of the areca leaves are flat and somewhat cylindrical in shape, measure 60-100 cm long and 30-45 cm broad and possess a waxy water repelling surface. These are not put to any use presently. They are used to a limited extent for making caps for agricultural workers, containers for toddy, packing sheets for fish and also as an inferior fuel. When computed for their total availability, they provide a total flat surface of about 120 million m². Since it was felt that leaf sheaths could be used as atleast a partial

replacement for wood veneer, work was taken up in the institute to develop some economic uses for the same, particularly its suitability for making ply boards.

In India about 13 million m² of tea chest plywood is produced annually. About three-fourths of this is produced by small scale and cottage industries (Dokania, 1974). Plywood industry in India is faced with an increasing scarcity of soft wood required for plywood making as a result of dwindling resources of timber (Gupta and Singh, 1978). Hence if even a part of the requirements of plywood can be met for tea chests by arecanut leaf sheath (ALS ply boards), it could result in much saving of the timber resources. Further, this can fetch an additional income to the arecanut farmers. The process for making ALS ply boards and their various properties are discussed in this paper.

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+ CPCRI Kasaragod Publication No. 239.

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Materials and Methods

1. Processing of leaf sheaths

Leaf sheaths obtained from the farm are highly heterogenous having variations in structure, shape and thickness. The rear

end is thicker and the two edges are thinner. The thickness at the centre ranges from 3.0-8.5 mm (average 5.0 mm). A comparatively homogenous piece of fairly uniform thickness and size 50-65 x 20-25 cm can be obtained if a piece of about 10 cm length from either sides along the grain direction, 5 cm from the distal and 10-15 cm from the end across the grain direction are trimmed out from the sheath. Further, to get a flat sheath of uniform thickness and to remove the bucklings or folds, the sheath is flattened under pressure and heat. For this, the sheaths are soaked in water to about 75 per cent moisture and then pressed for 30 min in a hot Platten press at 4 kg/cm² pressure and 110°C temperature. This process gives flat sheaths of 1.0-1.5 mm thickness with about 12 per cent moisture.)

Table 1 shows the reduction in thickness at various points of the sheath profile after processing.

(To prevent fungal growth on the sheath surface, it can be soaked in 1 per cent copper sulphate solution for 24 hr before pressing. The pressed sheaths are then air dried for one hour or longer.)

2. Preparation of ply boards

Studies on glue adhesion properties have revealed that the ALS plyboards made with two veneers of areca sheaths as the faces and one veneer of even an ordinary wood species like Mango (*Mangifera indica* L.) as core ply and bonded with Urea formaldehyde (UF) resin make commercially acceptable boards with average dry and wet glue shear strengths of 50 kg and 12 kg respectively (Annamalai et al., 1982). They have been found to be superior to locally purchased non-ISI grade tea chest plywood, in wet glue shear strength, which was less than 6 kg.

Table 1. Reduction in thickness of areca leaf sheath profile upon processing

Distance across profile (cm)		Thickness in mm									
		Stem end			Distance from stem end in cm						Leaf end
		0	10	20	30	40	50	60	70	80	
0	Before Processing	—	1.40	1.20	1.20	1.20	1.15	1.49	—	—	
	After Processing	—	1.10	1.08	1.08	1.08	1.08	1.20	—	—	
5	Before	1.95	1.48	1.31	1.30	1.28	1.47	1.75	2.03	—	
	After	1.10	1.09	1.10	1.10	1.10	1.15	1.16	1.18	—	
10	Before	4.88	2.56	2.15	1.85	1.92	2.12	2.46	3.15	4.40	
	After	1.26	1.25	1.21	1.20	1.13	1.18	1.21	1.31	1.41	
15	Before	6.76	3.99	3.50	3.09	2.83	2.75	3.40	4.80	6.61	
	After	1.35	1.39	1.25	1.21	1.17	1.25	1.33	1.60	1.71	
20	Before	3.44	2.90	2.41	1.97	2.42	2.83	2.76	3.05	4.40	
	After	1.25	1.20	1.18	1.17	1.17	1.15	1.21	1.30	1.45	
25	Before	1.64	1.49	1.70	1.91	2.32	2.15	2.15	2.32	2.52	
	After	1.18	1.15	1.08	1.10	1.10	1.08	1.10	1.11	1.15	
30	Before	—	1.35	1.30	1.30	1.39	1.61	1.69	1.76	—	
	After	—	1.14	1.08	1.08	1.08	1.15	1.16	1.21	—	
35	Before	—	1.20	1.24	1.25	1.30	1.36	1.60	—	—	
	After	—	1.08	1.08	1.08	1.08	1.10	1.10	—	—	

Three ply boards using 1.5 mm thick Vellapine (*Vateria indica* L.) wood veneer as the core ply and UF resin by either cold setting at 4 kg/cm² pressure for 16 hr or by hot pressing at 95-100°C temperature and 14 kg / cm² specific pressure for 7 - 10 min were used in the present study.

3. Testing of the ply boards

The boards were tested for their various properties (Annamalai et al., 1982) as per the Indian Standard Specifications at the Western India Plywood Ltd., Baliapatam, Kerala and Indian Institute of packaging, Bombay. The details are listed in Table 2.

The wet tensile strength and wet bursting strength properties were determined after soaking the samples in water at 27°C for 4 hr.

For the transport container tests, tea chests of sizes 40×40×50 cm were prepared out of ALS ply boards as per the Indian Standard Specifications for plywood tea chests (I. S. 10, 1976). Each tea chest

was filled with 30 kg net weight of sand-saw dust mixture and the gross weight of each tea chest box was 33.5 kg. These tea chests were subjected to drop test, stack test and compression test (IS : 7028, 1973).

Results and Discussion

1. Weight and thickness

The weight/m² of the ALS plyboards are given in Table 3. The weight of ALS plyboards was about 80 per cent of that of conventional 3 - plywood boards. The thickness of the boards was about 3.8 - 4.3 mm.

2. Tensile strength

Details on the tensile strength of the boards are given in Table 3. Three ply (ALS) boards had about 30 per cent strength of 4.6 mm ISI grade 3 ply wood board and 50 per cent strength of locally purchased non-ISI grade 4 mm tea chest plywood board along the grain direction and it showed about 70 per cent strength

Table 2. Tests with areca leaf sheath (ALS) ply boards

Sl. No.	Name of the test	I. S. Test Code
1.	Tensile strength	IS : 1734 [1972] 10 and IS : 1060 [1966]
2.	Wet tensile strength	IS : 1060 [1966]
3.	Static bending strength	IS : 1734 [1972]
4.	Impact strength	IS : 303 [1975]
5.	Mandrel bending strength	IS : 4859 [1968]
6.	Bursting strength	IS : 1060 [1966]
7.	Wet bursting strength	IS : 1060 [1966]
8.	Puncture resistance	IS : 4006 [1966]
9.	Water Proofness - Cobb 30 min.	IS : 1060 [1966]
10.	Drop test	IS : 7028 [1973] Part I & IV
11.	Stack load test	IS : 7028 [1973] Part I & IV
12.	Compression Test	IS : 7028 [1973] Part IV

of ISI grade 3 plywood board and about three times more strength than the 3 - ply non - ISI grade tea chest plywood board across the grain direction. With regard to wet tensile strength, the boards showed about 45 per cent strength along the grain direction and about 1.8 times more strength across the grain direction with reference to 3 - ply non - ISI tea chest plywood.

3. Static bending strength

The static bending strength of the boards ranged from 144.0 - 171.9 kg / cm² (Table 3).

4. Impact strength and Mandrel bending strength

The impact strength and mandrel bending strength of areca leaf sheath plyboards are given in Table 4. The 3 - ply areca leaf

sheath boards showed slightly higher impact strength than 3 - ply ISI grade plywood boards. The areca leaf sheath (ALS) plyboards could be bent to a minimum diameter of 17.5 cm while the 3 - plywood boards could be bent up to a diameter of 35 cm only. This shows that ALS ply boards have double the flexibility of plywood boards.

5. Bursting strength

Details on the bursting strength of the boards is given in Table 5. The average bursting strength of ALS plyboards was approximately equal to the bursting strength of about 44 km/cm² of 5 mm cardboard and higher than that of a 9 ply 100 gsm corrugated fibre board which is about 25 kg/cm² (Anonymous, 1974).

Table 3. Weight, Tensile and Static bending strength of arecanut leaf sheath boards/ plywood boards

Sl. No.	Items	Along the grain direction			Across the grain direction			Remarks IS : test code
		Mean	Std. deviation	Range	Mean	Std. deviation	Range	
I Weight - gm/m²								
1.	3-ply arecanut leaf sheath board	2250	—	—	—	—	—	
2.	3-ply 4 mm plywood	2800						
II A. Tensile strength kg/cm²								
1.	3-ply arecanut leaf sheath board	157.36	—	—	276.50	31.00	235.3-316.7	IS: 1734 (1972) & IS: 1060 (1966)
2.	3-ply ISI grade plywood	530.80	52.7	475.5-615.3	376.10	42.41	313.9-412.9	IS: 1734 (1972)
3.	3-ply ISI grade tea chest plywood-4 mm	344.2	—	—	73.14	—	—	IS: 1060 (Part I) (1966)
B. Wet Tensile strength kg / cm²								
1.	3-ply arecanut leaf sheath boards	102.21	—	—	157.14	—	—	IS: 1060 (Part I) (1966)
2.	3-ply non ISI grade tea-chest plywood 4 mm	230.62	—	—	87.30	—	—	IS: 1060 (Part I) (1966)
III Static Bending Strength kg/cm²								
1.	3-ply arecanut leaf Sheath board	160.60	8.91	144.0-171.9	—	—	—	IS: 1734 (1972)
2.	3-ply ISI grade plywood	578.70	30.07	535.8-618.1	—	—	—	IS: 1734 (1972)

6. Puncture resistance

Table 5 gives details on the puncture resistance of ALS ply boards. The average values for the areca boards were about 45 per cent higher than that for 5 - ply 150 gsm corrugated fibre board.

7. Water proofness

The Cobb test for 30 min duration showed that ALS plywood absorbed 18.5 g of water/m² (Table 5) while the areca leaf sheath absorbed 121 g/m². Thus

water absorption capacity of the sheaths was considerably reduced when they were made into plyboards.

8. Transport container tests

In the drop test, the tea chests were given 10 sequential drops from a height of 75 cm, first on one corner, followed by drops on the three edges around (or touching) the corner and then dropped once each on all the faces. Neither damage or deformation to the tea chests nor seepage of sand - saw dust mixture was observed.

Table 4. Impact strength and Mandrel (Drum) bending strength of ALS boards and plywood boards

Sl. No.	Items	3 - ply ALS plyboard	3 - ply ISI grade plywood [4 mm]	Remarks IS: Test Code
I.	Impact strength - KgM / cm ²			
1.	Mean	0.4129	0.3983	IS : 303 [1975]
2.	Standard deviation	0.0266	0.0114	
3.	Range	0.3472-	0.3819-	
		0.4345	0.4172	
II.	Mandrel [Drum] bending strength Minimum bending: Diameter [cm]	17.5	35.0	IS : 4859 [1968]

Table 5. Properties of arecanut leaf sheath plyboards

Sl. No.	Items	ALS Boards Mean	Boards Range	Corrugated fibre boards	Remarks IS: Test Code
1.	Bursting strength Kg / cm ²	43.97	39.90- 53.20	25.00 [9 ply 100 gsm]	IS : 1060 Part - I [1966]
2.	Wet bursting strength [kg / cm ²]	34.55	27.30- 45.50	—	IS : 1060 Part - II [1966]
3.	Puncture resistance- Oz. inch / tear inch kg cm/tear cm]	494.00 [13.823	300.00- 625 00	340.00 [5 ply-150 gsm]	IS : 4006 Part - II [1972]
4.	Water proofness - Cobb [30 min.] g / m ² 3 - Ply ALS Board	18.47	17.26- 19.92	—	IS : 1060 Part - II [1966]
	Areca leaf sheath	121.0	—	—	S : 1060 Part - II [1966]

In the stack load test, the tea chests were superimposed with 450 kg weight for 24 hr. The tea chests made from ALS plyboards did not show neither deformation or damage nor seepage of sand-saw dust mixture.

Tea chests made of ALS plyboards when subjected to a compression load applied to the top side face exhibited average compression strength of 4295 kg while the tea chests made from locally purchased non ISI grade plywood showed a compression strength of 4338 kg.

The properties of the ALS plyboards developed as per the process described above indicate their possible applications in packaging. ALS plyboards showed 30-50 per cent strength of plywood boards with respect to tensile and static bending strengths. In certain cases of packaging like that of pharmaceuticals high strength properties as possessed by plywood are not required. But in the absence of a

material of lower strength properties, plywoods are employed. The transport container tests have shown that tea chests made of ALS plyboards performed almost equally well as the tea chests made of non ISI grade conventional plywood in their mechanical strength properties. These tea chests are suitable for movement of tea within the country. Two thirds of the total annual tea production of about 571 million kg (Anonymous, 1979) is consumed within the country itself and tea chest made from ALS plyboards can be used for this purpose. This will have several advantages. For instance, this will help the areca farmer for an additional income of about Rs. 1000/ha annually by sale of areca leaf sheaths. It will promote additional rural employment in the setting up of ALS plyboards manufacturing industry. Thirdly it will help to save soft wood which is becoming scarce in the country. The improved higher impact strength of the boards and their ability to bend short curvatures are very desirable properties for making briefcases, suitcases, tubular packages, etc.

Table 6. Results of Transport Container tests

Sl. No.	Items	Observation on ALS Plyboard boxes	Observation on non - ISI grade tea chest plywood boxes	IS Test code
1.	Drop test : 75 cm height. 10 sequential drops	Neither damage or deformation to the boxes nor seepage of contents was observed	Neither damage or deformation to the boxes nor seepage of contents was observed	IS : 7028 [1973] Part I & IV
2.	Stack Load test : 450 kg weight for 24 hr	Neither damage or deformation to the boxes nor seepage of contents was observed	Neither damage or deformation to the boxes nor seepage of contents was observed	IS : 7028 [1973] Part I & IV
3.	Compression test : Average compression strength	4295 kg	4338 kg	IS : 7028 Part IV [1973]

Acknowledgement

We gratefully acknowledge the facilities and assistance rendered by M/s. Western India Plywood Limited, Baliapatam, Kerala and particularly Dr. R. N. Kumar, Technical Manager for the advice given. We thank

Mr. V. Ragnathan, Deputy Director, Indian Institute of Packaging, Bombay and his colleagues for their help. The work on areca leaf sheath plyboards was initiated under the aegis of late S. R. K. Menon, N. Parur, Kerala.

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