

SOME PHYSICAL AND STRENGTH PROPERTIES OF PLYWOOD MANUFACTURED FROM NIGERIAN GROWN TIMBERS*

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Abstract :

Tests were conducted on five sheets of plywood made from Nigerian-grown species, to determine some physical and mechanical properties. The plywood contains 3 plies: 1 mm thick *Antiaris africana* facings and 4 mm thick *Terminalia superba* as core. Static binding strength, impact strength, density, moisture content, and glue bond quality were determined as specified in B. S. 4512 (1969) and B. S. 1445 (1972). Modulus of rupture (MOR), modulus of elasticity (MOE), impact strength, density, moisture content and glue bond quality of samples from each of 5 boards were determined.

The mean value for MOR was 47.38 N/mm² and 31.76 N/mm² (perpendicular and parallel to grain of face veneer respectively). MOE parallel to grain was 19209.44 N/mm² and MOE perpendicular to grain was 3498.29 N/mm². Mean density and moisture content as received was 597.65 kg/m³ and 9.84% respectively. At the testing conditions of 65% relative humidity and 20°C, mean density was 589.85 kg/m³ while moisture content was 8.37%. Impact strength had the mean value of 198.80 mm while the glue bond quality was 5.0 (50%). These properties suggest high strength acquisition by structures made of the plywood. Except for the between board glue bond quality, there was no significant variation between the plywoods tested ($p > 0.05$).

Introduction :

Plywood is widely used in Nigeria. There has been an increasing demand, production, and consumption of plywood as indicated by Little (1964), Enabor (1971) and Adeyoju (1975). However, a more scientific use of the material is limited by the lack of precise data specifying its strength and other properties to the general public. Such information is necessary for the efficient and economic application of this high-value product.

The present preliminary study was, therefore, conducted with the objective of testing some of the physical and mechanical properties of a plywood made from Nigerian grown timbers. It was also to obtain results which would form a basis for the derivation of grade stresses as well as to generate further interest in such tests.

Materials and Methods :

The investigations were conducted on 6 mm thick standard size (2400 x 1200 mm), 3-ply *Antiaris africana* L. faced bonded by phenolic resin glue. A commercial grade plywood was used to estimate the strength of the panel.

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Five utility grade commercial boards, randomly selected from a stack of 152 boards in a dealer's shop at Ibadan market, formed the material from which samples or specimens were taken. Each board was divided into four equal parts from which sample specimens were randomly selected for test of physical and strength properties. Properties tested comprised static bending strength, impact strength, glue bond quality (the knife test), density and moisture content.

Twenty specimens were tested for each property (4 from each board) after conditioning them to constant weights in an environment maintained at 65% relative humidity and 20°C. The methods of tests were as specified in BS 4512 : 1969 and BS 1455 : 1973.

Results :

The mean value of the results of tests made on each board as well as the grand mean, standard deviation and coefficient board glue bond quality, there was no significant variation ($P > 0.05$) within and between the plywood boards tested. The glue bond quality was significantly different between boards ($P > 0.05$).

Discussions and Conclusions :

Investigation of various plywood species by Curry (1953) revealed that MOR parallel to the grain was always greater than MOR perpendicular to the grain. In the present investigation, however, a contrary result was obtained with the MOR perpendicular to grain being greater than that parallel to grain in each instance.

It is considered that the difference between the two sets of results may be due to the composition of the plywood panels tested. Curry's specimens were of a 1 : 1 : 1 construction; the two outer veneers and the core were of equal thickness and single species was used throughout. The plywood tested by the present author was of a 1 : 4 : 1 construction, with the outer faces 1 mm thick and the core 4 mm thick. In addition, the core was made of Afara and the faces were of Antiaris. With such a thick core and thin faces, the contribution of the core to the strength of the plywood was no longer negligible in relation to the face contribution.

The analysis of variance results, except for the knife test, showed no significant variation within and between the boards. However, coefficients of variation from the mean were fairly high, particularly for MOR and MOE perpendicular to grain and the glue bond quality.

It is very likely that these variations have arisen as a result of commercial nature of the test material. It may have contained strength reducing characteristics or manufacturing variation.

The high coefficients of variation in MOR and MOE perpendicular to grain were probably due to greater influence of the thick, poorer quality, and more variable core wood. Lower grade wood is usually used for the core veneer in plywood manufacture, which therefore likely contained more strength reducing characteristics as well as wider variations in properties. Differences arising from heartwood and sapwood veneers as well as the human element might

have largely contributed to the high variation in glue bond quality.

The slight drop in density from 597.65 kg/m^3 as received to 589.85 kg/m^3 at test was probably as a result of a drop in moisture content of the boards due to conditioning. In both instances the variation was small and uniform. Moisture contents of the boards were more varied when estimated before conditioning than after conditioning. This is to be expected since the boards were selected from large stacks in the dealer's store conditions. Consequently there were slight variations in the moisture content values. After conditioning however, the moisture content of the boards tended to be uniform in all the boards.

It has to be emphasized that the data obtained and discussed, are most relevant to 6 mm plywood made up of 3 plies and of the type tested, and may not be used for any other thickness or construction. Much information is still required for grade stresses for plywood made from Nigerian grown timbers for design purposes. This is particularly important since plywood made in Nigeria comes from a wide range of species as compared with other countries. Finland, for example, has all its plywood made from birch alone. Canada and the United States of America have between 80 and 90% of their plywood made from Douglas fir (FAO, 1966).

Acknowledgement

I wish to acknowledge the kind supervision and valuable suggestions offered at every stage of this work by Mr. A. J. Comben, formerly Senior Lecturer in Forest Utilization and Engineering, Department of Forest Resources Management, University of Ibadan, Nigeria.

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TABLE I.
PHYSICAL AND STRENGTH PROPERTIES OF a 6mm, 3-PLY COMMERCIAL GRADE
PLYWOOD BOARDS MANUFACTURED FROM NIGERIAN GROWN TIMBERS

Board	MODULES OF RUPTURE (N/mm ²)		MODULUS OF ELASTICITY (N/mm ²)		IMPACT STRENGTH	GLUE BOND QUALITY (SCORE OUT OF 10)	DENSITY Kg/m ³		MOISTURE CONTENT (%)	
	Per. to face grain	Per. to face grain	Per. to face grain	Par. to face grain			As Received	At Test	As Received	At Test
A	50.72	33.82	3663.11	17057.11	204.80	3.0	617.32	611.32	9.78	8.69
B	47.55	33.31	3312.21	20444.67	149.50	6.0	518.65	572.99	9.72	8.08
C	51.20	30.91	3995.73	19891.74	172.30	5.0	606.99	602.99	8.80	8.80
D	47.27	31.05	3323.21	18232.21	211.30	3.5	564.32	556.99	9.79	8.36
E	40.18	29.74	3197.21	20421.47	156.00	7.0	617.99	504.98	11.10	8.63
Mean ⁺	47.38	31.76	3498.29	19209.44	178.80	5.0	597.65	589.85	9.84	8.37
S.D. ⁺	12.00	5.62	718.54	3002.22	3.15	1.93	67.23	67.12	0.93	0.54
C.V. ⁺	25.00	17.00	20.00	15.00	17.00	38.00	11.00	11.00	9.00	6.00

+ Mean, S. D. and C. V. of the 20 samples tested for each property.