*Some Physical Properties of Apitong (Dipterocarpus Grandiflorus Blanco) in Relation to its Sapwood and Heartwood**

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INTRODUCTION

One of the factors which determine the utility of wood in the construction field is its physical properties. A knowledge of these properties and their effects on the behavior of wood in service would greatly help wood-users in selecting wooden materials for a particular purpose. Some of these properties are specific gravity, moisture content, and shrinkage.

Because of its affinity to water, wood after reaching fiber saturation point[1], has the property to shrink as a result of further moisture loss or to expand critically upon absorption of moisture below this point. This particular behavior of wood is best exemplified by the sticking of doors, windows, and all sorts of wooden construction during the rainy season or the loosening of joints during the summer months.

The degree by which wood shrinks or swells depends on several factors, one of which is its density or specific gravity. Specific gravity of wood controls to a certain extent any dimentional change that may take place with changes in moisture content below the fiber saturation point. In general, heavy woods shrink more than light woods over the same value of moisture change. Wood, therefore, should be selected with a certain content that will ensure the least subsequent shrinkage and swelling when in use (3)[2].

The above-mentioned physical properties are affected by the position of the wood in a tree from which it is cut. Results of studies indicate that specific gravity varies in the different parts of a tree. Brown, et al (3) and Balcita (2) noted that variations in the average specific gravity of wood are associated with their location in the tree from the butt to the top section as well as from the pith to the bark. Desch (4) observed that the heaviest wood is found at the base of the tree and that density decreases gradually from the pith to the bark in ring-porous wood.

Tiemann (7) and Wangaard (8) are of the opinion that specific gravity is a satisfactory criterion of clear-wood strength. Some strength properties such as maximum crushing strength, fiber stress at proportional limit, and stiffness have been found to vary directly with specific gravity, whereas other strength properties change at an exponential rate.

The indication of the variability of specific gravity, moisture content, and shrinkage properties of wood in the different parts

* The study was conducted in 1962 when Mr. B. C. Cariño was a thesis student at the U.P. College of Forestry.

[1] Fiber saturation point is the condition at which the cell lumens are assumed to be empty but the wood fibers are still fully saturated with moisture.

[2] Numbers in parenthesis refer to literature cited.

of the tree by past studies makes it imperative to assume that these properties vary from the heartwood to the sapwood for a given height of the tree. A study of the variability of these physical properties of apitong (*Dipterocarpus grandiflorus*, Blanco) with respect to its heartwood and sapwood would be contributory to the determination of the use for which this species is particularly best suited.

The object of this study, therefore, was to determine and to compare the specific gravity, moisture content, and shrinkage properties of the heartwood and sapwood of apitong for the benefit of wood-users.

MATERIALS AND METHODS

The materials used in this study were procured from the logging area of Interwood, Inc. Pañgil, Laguna. Twenty specimens 2¼ x 2¼ x 12 inches were cut from both the sapwood and heartwood of the same tree. They were dressed and cut squarely into 2 x 2 x 6 inches as prescribed by the American Society for Testing Materials (1).

Three evenly spaced lines were drawn across the tangential and radial sections and one at the middle of each end or cross-section to serve as a guide for corresponding measurements.

The tangential, radial and longitudinal measurements of each specimen at green condition were taken to the nearest 0.001 of a centimeter by the use of a vernier caliper. An Ohaus beam balance with an accuracy of 0.1 gram was used to obtain the weight of each specimen and also its corresponding green volume by the water displacement method.

In order to avoid excessive shrinkage as a result of severe drying conditions, the specimens were placed in a temperature-humidity controlled cabinet (30% equilibrium moisture content) for 60 days until the weights of representative specimens for both sapwood and heartwood remained constant. The specimens were then transferred to a paraffin oven and oven-dried at a constant temperature of $103° \pm 2°C$.

The ovendry radial, tangential and longitudinal measurements, ovendry volume, and weight of individual specimens were obtained by the same procedure as that of their green condition, after which the values of the moisture content, specific gravity, linear shrinkage, and volumetric shrinkage of individual specimens were calculated.

RESULTS AND DISCUSSION

The results were analyzed statistically by the comparison of the difference between two means, the summary of which may be found in Table 2.

Moisture Content:

Table 1 shows the average moisture contents for sapwood and heartwood which were found to be 79.7 and 90.7 percent, respectively, with range from 77.0 to 84.8 percent for sapwood and from 79.0 to 115.3 percent for heartwood.

Statistical analysis of the difference of the average moisture content between heartwood (90.7 percent) and sapwood (79.7 percent) of apitong shows a significant difference at the 0.01 level of probability based on a "t" distribution.

The results indicate that the heartwood for apitong from Pañgil, Laguna contained more moisture than the sapwood. This follows the conclusion of Peck (5) who stated that because of the time element involved before the cellulose molecules become heartwood they become dense so that there is a large amount of water held as absorbed water in the fibers and ray cells. Brown, et al (3) pointed out, however, that in hardwoods, the moisture is evenly distributed throughout the sapwood and heartwood at least in native species found in the United States.

Another reason that may be given is the fact that during drying the heartwood specimens exuded resin and other extraneous substances that may have been volatile, while there was no exudation from the sapwood. These substances cannot be accounted for other than they become a part of the lost weight and as such a part of the moisture loss. This then tends to increase the moisture content of the heartwood as it is expressed as a percentage of the oven-dry weight.

Specific Gravity:

The average specific gravity of apitong sapwood and heartwood are shown in Table 1 with values of 0.56 and 0.54 respectively. The values for sapwood ranged from 0.53 to 0.57 and for heartwood, the values ranged from 0.52 to 0.56.

Statistical analysis (Table 2) showed that the mean difference was found to be highly significant at 0.01 level, with the specific gravity of the sapwood higher than that of the heartwood.

This result, concurs with the conclusion of Somera (6) in his study with narra. He found that the specific gravity of the sapwood was greater than that of the heartwood.

This finding may again be explained by the fact that during the drying of the apitong specimens, the heartwood exuded extraneous substances while the sapwood did not. It follows then that since the specific gravity of wood is defined as the ratio of its oven-dry weight to its green volume (weight of an equal volume of distilled water) the heartwood would have a smaller specific gravity in spite of its heavier green weight

Brown, et al (3) pointed out, however, that the presence of extractives in the heartwood may bring about an increase in the specific gravity. This is true only if the extractives are not volatile. The findings of this study are otherwise and it would be worthwhile to study further the effect of these extractives on the physical properties of apitong.

Shrinkage:

The mean or average shrinkage values for both sapwood and heartwood are shown in Table 1. It may be noted that for sapwood specimens, the tangential section had the largest average shrinkage with 9.3 per cent followed by the radial section with 4.4 per cent and the longitudinal section with 0.23 per cent. The same trend has been observed in heartwood specimens although in all cases, the heartwood shrank more than the sapwood. The tangential section exhibited the highest average shrinkage being 11.4 per cent, the radial section, 5.4 per cent and the longitudinal section, 0.25 per cent. The volumetric shrinkage of the heartwood was 16.8 per cent.

As mentioned earlier, the sapwood was found to have a higher specific gravity than the heartwood. It should therefore, follow, that the sapwood under study would have a higher shrinkage value than the heartwood. However, the results are contradictory to those of Brown et al (3) who observed that wood of higher specific gravity shrank more than those of lower specific gravity.

This again may probably be due to the exudation of resins and other extraneous substances from the heartwood during drying which gave room for further contraction of the cell-wall resulting in higher volumetric shrinkage.

These findings may only be incidental, but they may be of value to future researches who may conduct studies along related fields.

CONCLUSION

Based on the results of the study the following conclusions may be deduced:

1. *Moisture Content:*

Apitong heartwood evidently contains more moisture than its sapwood the range of which varies from 79.0 to 115.3 per cent and from 77.0 to 84.8 per cent respectively.

2. *Specific gravity:*

The mean specific gravity of apitong heartwood was found to be lower than that of the sapwood the difference being 0.02. A comparison of the difference of the two means showed that it was highly significant at the 0.01 level.

3. *Shrinkage:*

As was expected, the average tangential shrinkage for both heartwood and sapwood was found to have the highest percentage, namely, 11.4 per cent for heartwood and 9.3 per cent for sapwood, followed by the radial section with 5.4 per cent for heartwood and 4.4 per cent for sapwood. The longitudinal shrinkage was the least with only 0.25 per cent and 0.23 per cent for heartwood and sapwood, respectively. The volumetric shrinkage of heartwood was found to have a higher percentage than that of the sapwood, namely 16.8 and 15.2 percent, respectively.

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TABLE 1. Average values of some physical properties of Apitong Heartwood and Sapwood.

Properties	Sapwood	Heartwood
Moisture Content	79.7%	90.7%
Specific gravity*	0.56	0.54
Volumetric shrinkage from green to oven dry condition	15.2%	16.8%
Radial shrinkage from green to oven dry condition	4.4%	5.4%
Tangential shrinkage from green to oven dry condition	9.3%	11.4%
Longitudinal shrinkage from green to oven dry condition	0.23%	0.25%

* Highly significant at the 0.01 level.

TABLE 2. Summary of Statistics for Comparing various properties between sapwood and heartwood of Apitong.

A. Moisture Content

Apitong	No. of specimens	Degrees of freedom	Average Moisture Content (%)	Sum of squares
Sapwood	20	19	79.7	63.02
Heartwood	20	19	90.7	2814.45
Total	40	38	—11.0*	2877.47

$t_c = 4.00 > t_{.01} = 2.712$

B. Specific Gravity

Apitong	No. of specimens	Degrees of freedom	Average Specific gravity	Sum of squares
Sapwood	20	19	0.56	0.0028
Heartwood	20	19	0.54	0.0033
Total	40	38	0.02*	0.0061

$t_c = 5.00 > t_{.01} = 2.712$

C. Volumetric Shrinkage

Apitong	No. of specimens	Degrees of freedom	Average Volumetric Shrinkage	Sum of squares
Sapwood	20	19	15.2	12.51
Heartwood	20	19	16.8	12.98
Total	40	38	—1.8	25.49

$t_c = 6.15 > t_{.01} = 2.712$