

## Domination of Grain Bearing on the Strength Properties of Engkabang Jantong as Fast Growing Timber in Sarawak

<sup>1</sup>Gaddafi Ismaili, <sup>2</sup>Badorul Hisham Abu Bakar, <sup>3</sup>Alik Duju, <sup>4</sup>Khairul Khuzaimah Abdul Rahim and <sup>5</sup>Iskanda Openg, Zurina Ismaili and Safarina Ismaili

<sup>1</sup>Department of Civil Engineering, Faculty of Engineering,  
Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

<sup>2</sup>School of Civil Engineering, Engineering Campus, Universiti Sains Malaysia,  
14300 Nibong Tebal, Pulau Pinang, Malaysia

<sup>3</sup>Applied Forest Science and Industry Development, Sarawak Forestry Corporation Sdn.  
Bhd., Lot 218, KCLD, Jalan Tapang, Kota Sentosa, 93250 Kuching, Sarawak, Malaysia

<sup>4</sup>Protected Areas and Biodiversity Conservation Division, Sarawak Forestry Corporation Sdn.  
Bhd., Lot 218, KCLD, Jalan Tapang, Kota Sentosa, 93250 Kuching, Sarawak, Malaysia

<sup>5</sup>Faculty of Civil Engineering, Universiti Teknologi MARA, 94300 Kota Samarahan, Sarawak, Malaysia

<sup>6</sup>Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

<sup>7</sup>Hospital Ampang, Jalan Mewah Utara, Pandan Mewah, 68000 Ampang, Selangor, Malaysia

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**Abstract:** Nowadays, the hardwood category which refers to heavy hardwood species no longer sustains to the market demand. The harvesting of this wood category takes longer period of time. Thus, several studies in timber engineering have been carried out to investigate the fast-growing indigenous species as the alternative to heavy hardwood categories. For this purpose, fast-growing indigenous species of Engkabang jantong were selected and also the test samples were prepared in small clear specimens. The British Standard, BS373.1957 method of testing small clear specimens of timber was adopted to evaluate the strength properties of the species. The strength properties determinations were referred to hardness, cleavage and shear parallel to grain. The results were represented into two different grain directions namely tangential and radial at two different conditions, i.e. green and air-dry condition. It was found that, hardness strength at tangential was higher than radial for both condition green and air-dry with 4.71 and 8.86%, respectively. At cleavage strength, it was reported that tangential possessed higher strength values than the radial for both conditions green and air-dry with 23.06 and 27.22%, respectively. Shear strength at tangential was higher than radial for both conditions green and air-dry with 11.70 and 8.58%, respectively.

**Key words:** Hardness • Cleavage • Shear parallel to grain • Radial • Tangential • Green • Air-dry

### INTRODUCTION

Sarawak is estimated more than 2500 tree species in the forest and majority of Sarawak's commercial timber species falls into the hardwood category [1]. This category of hardwood has no longer sustained to the market demand. State Government has strongly emphasized to encourage the establishment of plantation forests in Sarawak. An effort by planting the fast-growing species tree had been carried out since 1980s, includes

plantations of a number of other exotic species such as, *Acacia mangium*, *Araucaria* spp., *Eucalyptus* spp., *Gmelina arborea*, *Maesopsis eminii* and *Falcataria moluccana* (*Paraserianthes falcataria*) were established with the aim of producing general utility timber. *Acacia mangium* has been constituted the largest area of forest plantations in the country planted on a 15-year rotation for production of general-utility timber. However, as the effort had been carried out, the plantations grew turned out to be prone to a number of diseases. Due to this

reason, the effort has been taken by choosing fast growth indigenous timber species for plantation. Hence, the research on secondary timber with fast-growing time, durable and high engineering properties viz.; mechanical and physical properties have been carried out to perceive suitable and potential indigenous timber species for utilization of structural use. At recent, there is no comprehensive study that has been done yet and the lacking of the data for engineering properties is very much concern viz. physical and mechanical properties for fast-growing indigenous timber species. The purpose of this study is to investigate the domination of grain bearing on the strength properties of Engkabang jantong as fast growing indigenous timber in Sarawak.

Engkabang jantong is well recognized by the Iban as of the tree group which comprising of twenty species of a subfamily Shorea in Dipterocarpaceae in Sarawak [2, 3] and, also known as light red meranti [4]. The timber is a light hardwood with a density of 415 - 625kg/m<sup>3</sup> air dry and the timber falls into Strength Group C or SG6 [5]. The texture is rather coarse and the grain is straight to shallowly interlock and somewhat lustrous. It does not have any distinctive odour or taste [6]. The shrinkage is fairly low, with radial and tangential shrinkage averages 0.9 and 2.6%, respectively. Meanwhile for shear strength is 6.30N/mm<sup>2</sup>. This timber can be utilised for interior finishing, mouldings, panelling, pallet, furniture, staircase, plywood, joinery, cabinet making, tool handles, planking, shelving and the manufacture of doors [7]. For a comparable sample i.e., same age, same site, same tree, same species, etc. between-tree differences are assumed to reflect the high level of genetic variation within the population [8]. The green moisture content of the wood is variable within a tree and between trees and species [9]. Hardwoods have a more complex overall structure than softwoods, because they contain more cell types arranged in a greater variety of patterns. The proportion, structure and distribution of the cell types combine to give these woods a more varied appearance and grain [10]. Thus, this study conducted to determine the differences of strength properties due to an effect from different grain direction.

## MATERIALS AND METHODS

**Preparation of Specimen:** Engkabang jantong or *Shorea marcophylla* timber species was used in this study. The tree was collected from Sabal Reforestation Plot, Sarawak. Healthy and with straight bole trees were selected randomly. Sampling of test samples was made throughout the whole length of the tree. Samplings of logs were made from three section of tree bole viz.,

from bottom, middle and top parts. The logs were then ripped into half through the pith to obtain the flicthes. The flicthes were planed and machined into boards and subsequently planed to produce 20 x 20mm in cross-section sticks. The sticks were visually graded and only defect free green as well as air-dry samples are cut into specified length. British Standard, BS373.1957 was recommended as method of testing for small clear specimens [11].

**Hardness (Tangential/Radial):** For hardness test, 20 x 20mm in cross-section with 60mm in length specimen was required. By using Janka Method to determine the hardness, where hardened steel rounded ball of 11.25mm in diameter with projected area of 100mm<sup>2</sup> is forced into the wood to a depth of 5.64mm. The hardness tool is embodied with a special electrical contact which operates a signal bell when it reached 5.64mm deep into the wood. The rate of penetration of the hardness tools is 6.5mm/min. The load (kN) required to force the steel ball at this depth is then a measure of hardness.

**Cleavage (Tangential/Radial):** The specimen for cleavage test is 20 x 20mm in cross-section with 45mm in length, which also called 'Monnin' type. This test is carried out with some specimens cut to give a failure along radial and tangential surfaces. The movement rate of the cross-head is 2.5mm/min. The maximum load causing failure in either the radial or tangential direction is a measure of the resistance of timber to splitting. Load per mm of width to resist the splitting of cleavage is calculated by using the formula as follows:

$$\text{Load per mm of width to resist splitting} = \frac{P}{b} \quad (1)$$

where,

$P$  : Maximum load (kN),

$b$  : Breadth (mm)

**Shear Parallel to Grain (Tangential/Radial):** In shear parallel to grain test a specimen of 20mm<sup>2</sup> is used. A cube specimen is loaded through a ball seating on it with relatively small movement of the long pivoted arm giving approximately vertical shear. The movement of head descent is 0.6mm/min. The property determined is the measure of the resistance of the timber to shearing. The direction of shearing is in the parallel to the longitudinal direction of the grain and with the plane of shear failure parallel to the radial direction. Shear stress at maximum load can be calculated using the formula stated as follows:

$$\text{Shear stress at maximum load} = \frac{F}{A} \quad (2)$$

where,

$F$  : Maximum load (N)

$A$  : Cross-sectional area (mm<sup>2</sup>)

### RESULTS AND DISCUSSION

**Hardness (Tangential/Radial):** Hardness at tangential gave Engkabang jantong with 1669.48N at green condition, whilst at air-dry condition Engkabang jantong give readings of 1901.80N. It was found that, hardness at tangential readings increased 12.22% from green to air-dry condition. At the radial Engkabang jantong contributed with 1590.8N at green condition, but the strength increased 8.21% to 1733.23N at air-dry condition. From this study, results indicated that, the hardness at tangential was much higher for both conditions compared to hardness at radial. Tangential at green condition was 4.7% higher than at radial. For tangential at air-dry condition it was 8.8% higher than at radial. These could be due to several factors such as differences in the proportion of major wood constituents, i.e. cellulose, hemicelluloses and lignin present in the woods or differences in extractive contents [12]. Wood that been sawn roughly tangential to the annual growth was enabled high-grade timber to be obtained [13]. This was also normally due to the percentage of water in the timber had extracted out from the timber cell; thus, further process of air-dried had results the wood cell started to shrinkage or reduce in void and had enhanced the strength of wood itself or more harden as before. This was also reported by Lamond and Hartley [14] in their finding. The results for hardness strength were represented in Table 1.

**Cleavage (Tangential/Radial):** The results from the cleavage test for both tangential and radial shows that, at green condition gave higher mean reading than the air-dry condition with the mean readings of 8.37N/mm and it was decreased 2.99% to 8.12N/mm at air-dry condition. At radial Engkabang jantong at green condition revealed with mean readings of 6.44N/mm. Meanwhile, at air-dry condition, it was decreased 8.23% to 5.91N/mm. From the result, it showed that, cleavage at tangential for both conditions is 23.06 and 27.22% higher than the cleavage at radial for green and air-dry conditions, respectively. The results were confirmed by Moya and Muñoz [15] in their research, where cleavage at tangential direction was higher than radial direction. Wallis [16] had found that, the lowest value cleavage in radial direction was due to

Table 1: Hardness at tangential and radial

Grain direction	Seasning condition	Hardness (N)
Tangential	Green	1669.48
	Air-dry	1901.80
Radial	Green	1590.87
	Air-dry	1733.23

Table 2: Shear parallel to grain at tangential and radial

Grain direction	Seasning condition	Shear parallel to grain (N/m <sup>2</sup> )
Tangential	Green	6.41
	Air-dry	8.62
Radial	Green	5.66
	Air-dry	7.88

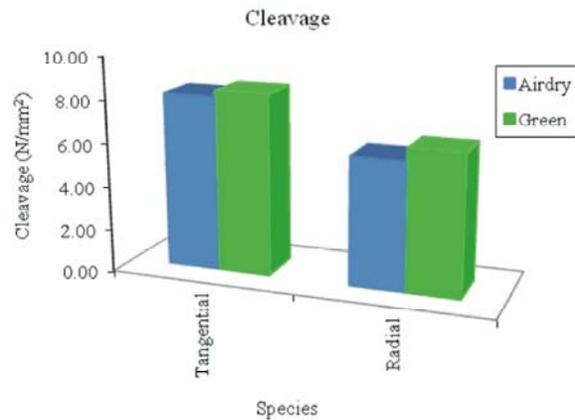


Fig. 1: Comparison of cleavage at tangential and radial at different condition

the relationship between air-dry density and the cleavage strength of timber along the fibres. The results for cleavage strength were illustrated in Figure 1.

**Shear Parallel to Grain (Tangential/Radial):** For shear parallel to grain at tangential, the mean reading at green condition shows that Engkabang jantong had 6.41N/mm<sup>2</sup>. At air-dry condition, the mean reading was 8.62N/mm<sup>2</sup>. It was obviously that the result acquired from shear parallel to grain in the tangential increase from green to air-dry with the increment of 25.64% or 2.21N/mm<sup>2</sup>. Results from shear parallel to grain at radial shows that in green condition Engkabang jantong had the mean value of 5.66N/mm<sup>2</sup>. Whilst, at the air-dry condition, Engkabang jantong had mean value of 7.88N/mm<sup>2</sup>. From these results, shear parallel to grain at radial value was 28.17% increased from green to air-dry for indigenous species. Madsen [17] in his research has found that, the shear stress does appear to be affected somewhat by moisture content between green and air-dry condition but it may and continued lose strength after further drying occurs.

This statement been supported by his finding in 1975, where moisture content (MC) greatly affected the shear strength [18]. This was closely related to the density of wood [19]. From observation, mean values for both green and air-dry conditions show that the mean value for shear parallel at tangential direction significantly greater than at radial direction. This was also observed by Riyanto and Gupta [20] in their studies; they have found that ring orientation was a strong but inconsistent factor affecting shear strength parallel to the grain. The results for hardness strength were represented in Table 2.

### CONCLUSION

Thus, from three different testing which referred to hardness, cleavage and shear show that Engkabang Jantong at tangential gave higher strength compared to radial. The results at hardness and shear strength were increased at air-dry condition. However, the cleavage strength result was decreased at air-dry condition. Moisture content greatly affects the shear strength of timber. It was found that, from the testing conducted show that at tangential at green and air-dry condition is higher than at radial. Hardness strength at tangential is higher than radial for both condition green and air-dry with 4.71 and 8.86%, respectively. Whereas, for cleavage strength at tangential is higher than radial for both condition green and air-dry with 23.06 and 27.22%, respectively. Meanwhile, for shear strength at tangential is higher than radial for both condition green and air-dry with 11.70 and 8.58%, respectively.

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