Physical and Mechanical Properties of Oil Palm Trunks

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Abstract

Wood-based industry in Malaysia is dependent on the natural forest resources and forest plantations. The highly demand of this resource makes it more scarce and expensive. Currently the industries are searching for other resources to overcome the over dependence on local timber. The waste biomass from the oil palm industries can be turned into value-added products providing an alternative raw material for the wood industry, but OPT (Oil Palm Trunk) are reported to be difficult to dry, not only because of its extremely high green moisture content (MC), but also its drying defects. The objectives of this study are to characterize of physical and mechanical properties in the OPT at different layers of the trunk (bark to pith). To have different layer of trunk, the OPTs are sawn with sawing around pattern and were soaked with 85% concentration of ethanol liquids for 24 hours and dried using oven until archived 12 % moisture content. 30 samples for bending 20mm x 20mm x 300mm, and 20mm x 20mm x 60mm for compression were tested according to ASTM D2395-14. The result showed a gradual increase in mechanical and physical properties on trunk depth for both treatment, but the treatment sample show the highest value in MOR and MOE for both testing. It is concluded that the OPT soaked with Ethanol and dry with normal oven dry can improved the strength properties of OPL lumber.

Keywords: Oil Palm trunk (OPT), Ethanol, Physical Properties, Mechanical Properties, Modulus of Rupture, Modulus of Elasticity

1. INTRODUCTION

Demands for wood by many wood-based industries all over the world are expected to exceed the existing supply in the future. Researchers over the globe are today studying about materials to replace timber in anticipating the decrease of timbers. Many types of alternative materials which are organic in nature such as wood and non-wood forest products are being researchers. One of the materials is the oil palm stems. Oil palm stem is one of the focus agriculture in Malaysia. Today, 4.17 million ha of land is being planted with these agriculture trees, (Sulaiman et al., 2012) and over the years the area seemed to be increasing. The life age of an oil palm tree is between 25 to 32 years. After this period the oil palm trees are no more considered to have an economic value added. They need to be proceeding with new trees. Several of these oil palm stems are left to rot in the field.

1.1 PROBLEM STATEMENTS

The abrupt demand for wood by many wood-based industries in Asia and elsewhere are expected to exceed the existing supply. Product industry in Malaysia is facing of challenges, it very critical in the needed and not sufficient supply of raw material to sustain the growth in the industry. Today, using of material such as wood in making furniture are declining, the research for other materials to be used to sustain the wood is more needed to replace wood as the main material in the furniture manufacturing industry. The demand for good wood is increasing but it is predicted that future wood supply will face shortage and there will be the crisis to obtain longer solid wood. it can be effect to the furniture manufacturing industry. It has to find the new resources that can be utilized commercially.

1.2 OBJECTIVES

1) To determine the strength properties of the Oil Palm Trunks with two different treatment.

2) To determine the properties of Oil Palm Trunks of outer layer and inner layer.

2. MATERIALS AND METHODS

2.1 Material Preparation

2.1.1 Oil Palm Trunks

The trunk with diameter ranges over 43 - 55 cm were divided into 3m long portions i.e. top, middle (50% height of a tree) and bottom(1.4 m from ground level). A 6" band-head rig was used to saw the trunk to cants (unfinished OPT sawn to be further processed) size using sawing around method and then a 4" band-life saw was used to sawn to oil palm lumber(OPL). The samples treatment (a) were soaked with 75% ethanol,and on the other hand, the other samples were leave with green condition without any treatment (b) . Both treatments were placed in the oven and the drying process took at least 72 hours at 103+- 2oC until the weight was consistence. The sample was tested according to ASTM D2395-14 all the testing was carried out at Bengkel industri perkayuan laboratory test by intron machine testing.

2.1.2 Ethanol for drying

Drying can be cause to be displaced into contact of the pit boarders. It can be solvent change with alcohol, acetone, or alcohol-benzene. 85 per cent ethanol and the specimen dried at high temperature (Comstock &Côté, 1968).According to (Lamb, 1967), The content of water in fines coals can be replace with ethanol, and Comstock &Côté, 1968 was mention no aspiration take place during wood drying. The effect has be attributed to much lower surface tension of ethanol making the surface tension of ethanol make the surface tension force insufficient pull membrane across the pit chamber (Petty &Puritch, 1970).It can be change many occur in size and number to gaps medium the standard which from the Margo the bordered pit membrane. It using 85 per cent of ethanol and drying using 5 days to change in each liquid were used to ensure that compete exchange the liquid took place(Petty & Puritch, 1970).

2.1.3 Sample Preparation

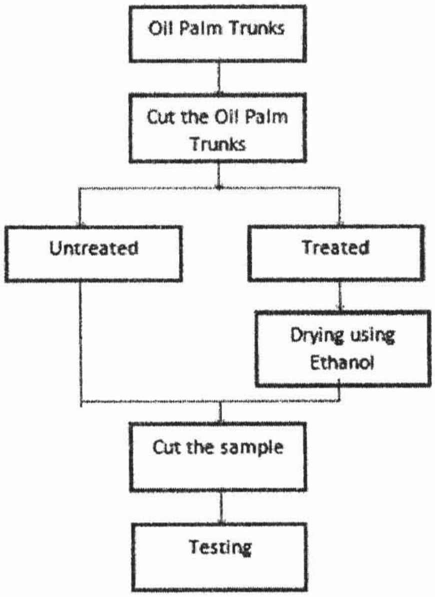

Figure 1: Sample preparation for test the strength

3. TESTINGS

3.1 Mechanical Properties

3.1.1 Compression testing

Compression test was carried out based on ASTM D4761-13 with the sample dimensions of 20mm x 20mm x 60mm. This test was conducted using Instron Machine with moveable head speed of 5 mm/min with Max load as a guard line to find sample mean.

3.1.2 Bending testing

Bending test using a same standard but the different of sample size dimensions with compression test which is 20mm x 20mm x300mm were made. Test will conducted using instron machine with moveable head speed of 5 mm/min. Using MOR and MOE as a instructions to find sample mean.

3.2 Physical Properties

3.2.1 Density

Density was focus on the mass and volume of the panel. The test tools a measure as a parameter to use length and width, sliding calliper and digital micrometer. This test was conducted by formula.

$$\text{Volume} = \text{Length} \times \text{Thickness} \times \text{width}$$

$$\text{Density (P)} = \frac{\text{Mass}}{\text{Volume}}$$

3.2.2 Water Absorption

Water absorption is known how the samples were absorbed to the water and look particle durable to the water and fire resistance (KHAZAEI, 2007). With the sample size dimensions 50mm x 50mm x 20mm and soaked for 24 hours to see the rate of water absorption in the OPT. Formula as a parameter to measure the test.

$$\%\ \text{Water Absorption} = \frac{\text{WAS - WBS}}{\text{WBS}} \times 100$$

WAS = Weight After Soaked
WBS = Weight Before Soaked

3.2.3 Thickness Swelling

Thickness swelling testing are basically determine view this words how the development of OPT when immersed in water, it can measure using the soak method. The sample was same with water absorption which is 50mm x 50mm x 20mm. All sample were soaked into water 24 hours because duration the sample consistent.

$$\%\ \text{Thickness Swelling} = \frac{\text{TAS - TBS}}{\text{TBS}} \times 100$$

TAS = Thickness After Soaked
TBS = Thickness Before Soaked

4. RESULTS AND DISCUSSIONS

Every Oil Palm Trunks was been undergoes the physical and mechanical testing will be analyzed base on the layer at the bottom, divided by layer. The testing includes density, water absorption, modulus of rupture, modulus of elasticity and max load. The research is devoted to standard strength test sample. The result testing was been recorded in the table form and was been select base on mode. It was been analyze in the SPSS in order to determine the significant level.

4.1.1 Comparing between treated and untreated

Table 1: Comparing between treated and untreated

	Treated	Untreated
Density (Kg/m^3)	175.09	395.66
Water Absorption (%)	2.79	6.31
Thickness Swelling (%)	2.9	0.028
Modulus Of Elasticity (MPa)	4.41	2.58
Modulus Of Rupture (MPa)	880.29	326.4
Max Load (kN)	0.573	0.134

Graph shown that untreated are lower than from treated. The strength of Thickness Swelling is 0.028, modulus of elasticity is 2.58, modulus of rupture is 326.4, and max load is 0.134. It because Oil Palm Trunks comprise of essential tissues and it is not stand in comparison to dicotyledons and the Oil Palm Trunks does not prepare cambium. In Oil Palm Trunks comprises of parenchyma and vascular pack. This fibre additionally can be impact the dampness content. In manage the fibre has less quality and average analyzed dicotyledonous wood (H.P.S Abdul Khalil, et al., 2012).For Density and water absorption shown that the untreated are more highest depend on treated. Density of treated was 127.09, with water absorption was 2.79, and density of untreated was 395.66 with water absorption 6.31. It was observed that the OPT cannot be identify, because during process cutting the sample from Oil Palm Trunks, the sample have machining error. That why the density and water absorption was treated less than untreated.

4.1.2 Comparing between outer layer and inner layer

4.1.2.1 Density

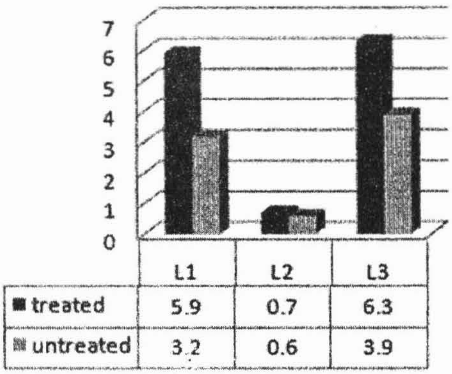

Figure 2: Comparing between layers for Density

From figure 2, the layer 1 shown lowest mean for untreated which is 156.28 and highest mean to treated, that is 176.23. Layer 2 shown that untreated are higher, which is 182.8 and treatment is 170.85. Lastly for layer 3 still untreated are higher which is 847.85 and treated which is 178.5. Layer 3 is good density because where the peripheral zone (outer layer) was produced using little of parenchyma cells and high measure of vascular packs which give steadier in the mechanical properties of the palm trunks (Lim, S.C. & K.C. Khoo, 1986). The outer layer impacted expansive by the quantity of vascular group every square unit which is decline around the inside (Erwinsyah, 2008).

4.1.2.2 Water Absorption

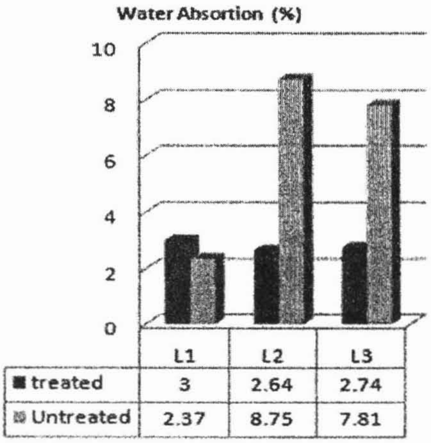

Figure 3: Comparing between layers for Water absorption

Figure 3 summarizes that the layer 1 highest at treated which is 3.00 and untreated are lowest 2.37 while the layer 2 show that vice versa between treated and untreated which is 2.64 and 8.75. Lastly for layer 3 shown same with layer 2 which is treated 2.7a and untreated which are 7.81. Based on graph we can conclude that there the higher in the quantity of vascular pack was created a lessening in rate of parenchyma cells which high limit. The most noteworthy water retention was arrived at the focal of trunks and abatement to external bark of trunks. Layer 2 and layer 3 are expressed that fibre is to be found in the bigger vascular packages closer the base of the palm trunks and tight clamp verse (Erwinsyah, 2008).

4.1.2.3 Thickness Swelling

Figure 4 show the trend of, it means the graph growing up from layer 1 to layer 3. Layer 1 show that the highest of treatment is 1.8, layer 2 is 5.6 and layer 3 is 6.8. Untreated session show that the trend in graph which is Layer 1 is 0.021, layer 2 is 0.031 and layer 3 is 0.033. Based on graph we can conclude that, for untreated the inner bark a commonly high moisture contain by middle and less in outer part. Outer part of the contained higher vascular bundles compared to that of middle, so like the central region which is slightly rich of parenchyma and very soft. After treatment the ethanol replaces at Oil palm trunks and it change the measure of lumber and membrane pore (Fauzi et al., 2012). It can absorb more water and expend the size from real size sample.

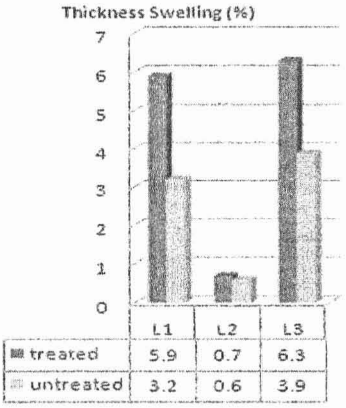

Figure 4: Comparing between layers for Thickness Swelling

4.1.2.4 Modulus of Rupture (MOR)

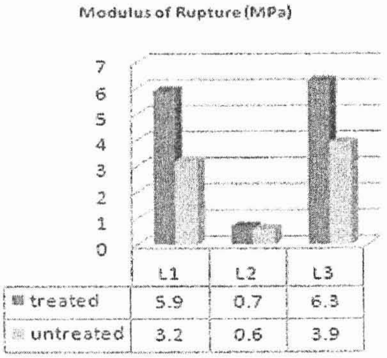

Figure 5: comparing between layers for Modulus of Rupture

It can summarize the graph in figure 5 not follow the trend. Layer 1 shown treatment highest treated which is 5.9 and untreated which are 3.2. The middle layer, Layer 2 shown the gaps between treated and untreated are not much to distinguish only 1 percent, which is treated 0.7 and untreated which is 0.6. The inner layer shows that the highest between layer 1 and layer 2. Which is treated is 6.3 and untreated is 3.9. Based on graph we can conclude the outer layer are more strength than inner layer. In inner layer OPT has a long fibre is like a wide span , it will increase the burden imposed on the sample when compared with the inside of the OPT It because in inner layer Oil Palm Trunks fibre length increase periphery, longer fibre at the likely more developed more matured fibrous tissues in this layer (Erwinsyah, 2008).

4.1.2.5 Modulus of Elasticity

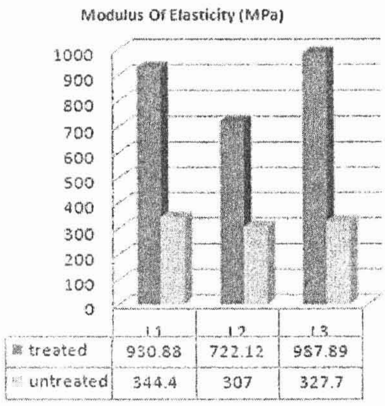

Figure 6: Comparing of layer for Modulus of Elasticity

Modulus of elasticity is defined as the change in stress with applies strain. (Marvin Pitts et al,. 2010). Layer 1, layer 2 and layer 3 shown the graph for treated are highest which is 930.88, 722.12 and 987.89. Meanwhile, for untreated show that the elasticity of sample not stable which is layer 1 are 344.4, layer 2 which is 307 and layer 3 is 327.7. At the result we can summarize that the treated highest because of effect for process drying. The outer layer show that fibre OPT more strength than the inner layer, it is because the structure of inner layer while the heap safe capacity is higher when stacked in the direction parallel to the grain ((Erwinsyah, 2008). In addition to the strength of the outer layer is caused by vascular bundle on the inside, it will cause the strength.

4.1.2.6 Max Load

Based on figure 7 shown, the graph for treated follow the trend. Layer 1 are highest which is 1.68 compared to Layer 2 which is 0.28 and lowers at Layer 3 which is 0.008. Meanwhile for untreated the graph not follow the trend, based on graph shown layer 2 are highest which is 0.3 follow by layer 1 which is 0.244 and lastly layer 3 which is 0.128. Based on the graph we can conclude layer 1 must take a highest load to crack the sample, it is because at inner layer amount of vascular bundle low compare with layer 2 and layer 3. Layer 2 and layer 3 lower than layer 1 we can conclude main part of the trunks was generally darker color in peripheral than inner layer (Erwinsyah, 2008). The highest value achieved in the area of the bottom of the shaft and peripherals such area is less intense, for compression properties of the OPT is very low.

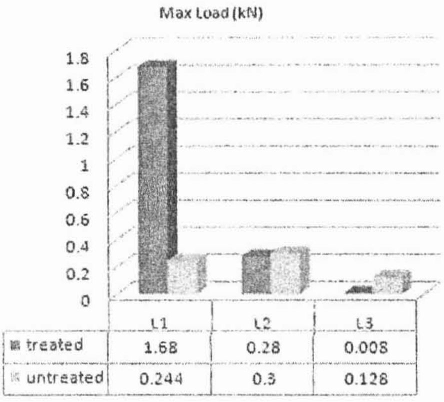

Figure 7: Comparing of layer for Max Load

5. CONCLUSIONS

Oil Palm Trunks bars that have been dealt with better contrasted and untreated stem Oil Palm Trunks. This is proving by the consequences of my tests as far as mechanical testing of bending and compression while for physical testing is the thickness and water absorption. This is apparent from the consequences of tests I discovered the numbers recorded in the OPT are dealt with is higher than that of untreated stem Oil Palm Trunks. In the interim, the force variable is likewise impacted by the layer found in the storage compartment Oil Palm Trunks. In light of my examination I found that the treated stem Oil Palm Trunks is suitable for utilization in the assembling of furniture. , I recommended that the treated oil palm trunks are ideal to be an option to timber developing interest increment

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