

CHAPTER V

CONCLUSIONS AND RECOMMENDATION

The purpose of this final chapter is to attempt to bring together all that has been presented in the previous chapters, into some sort of cohesive whole. The differing relationships observed in some instances (for example, between group of upper and lower (butt) sections, and between dry untreated OPL (oil palm lumber) and densified gum-rosin-treated samples is a key finding of this work. From the results of various parameter studies and the treatment types used certain inferences can be made about variations in MC (moisture content) and BD (basic density) within OPT (oil palm trunk) material that affect the strength of OPL scantlings in general.

5.1 Summary of Conclusions of the Results from Experimental Work

5.1.1 Physical characteristics of oil palm trunk

Basic properties-related parameters that include variations of MC and BD, in pith to periphery zone of high yielding tenera (a hybrid between those of dura and pisifera) palm with tree heights were identified. Based on results, the MC in pith and its intermediate zones (ranging from 359.31% to 366.73%) were higher than the MC of periphery zone (ranging from 192.03% to 195.11%). The BD increased from the vicinity of the pith (ranging from 191.12 to 299.75 kg m⁻³) towards the periphery zone (between 311.78 and 314.43 kg m⁻³).

The main adverse effect of this variability is the gradient in radial position with tree heights, which will greatly influence processing, production output and the product quality. For oil palm, the dependency of MC and BD differed with heights,

but did not significantly differ between test samples of similar position along its diameter.

Based on basic properties estimates, it is therefore possible to predict the exact position of usable raw materials for specified end uses. For example, OPT of high density (250 kg m^{-3} and above) with the lowest MC (300% and below) is located outside a distance of 139 mm radius from the pith.

5.1.2 Gum rosin treatment for improved quality of oil palm lumber

The OPL scantling was impregnated with a gum rosin using a prototype VI (vacuum infusion) system. With regards the resin infusion, it was noted that the gum rosin flow is directly proportional to the permeability of OPL macrostructure and the pressure difference between the inlet and outlet, but inversely proportional to the gum rosin viscosity.

After compensating some changes to the OPL scantling (with the introduction of grooves and channels), the gum rosin was homogeneously dispersed within the lumber structure. The positive ASE (antiswelling efficiency) values proved that the gum rosin had penetrated into the cell wall.

5.1.3 Strength of oil palm lumber

As for flexural strength properties, the magnitude of MOR (modulus of rupture) and MOE (modulus of elasticity) were directly related to the BD value, but inversely correlated to the MC gradient. In general, the strength of densified gum rosin-treated lumber increased to approximately 66% compared to dry OPL samples.

5.2 Limitations of the Research

It is evident that a number of relationships between dependent and independent variables have been encountered which are sample specific, although in many cases similar effects have been observed between groups. Precautions are sought before the application of these findings to industrial practice.

Even though the specific findings for individual oil palm stands are of interest, the use of this information will depend on the choice of sorting strategy adopted at log yard. As such, some sawmills are able to segregate the lower sections from upper OPT logs for sawn lumber productions, whilst others may not. At the primary processing stage, a segregation strategy using a laser scanner to separate usable material may involve the use of OPT log size variables, together with other measurements. A variable such as whorl spacing of vascular bundles may be used to determine the height of OPT log, if proven effective.

Variables relating to basic properties used in this work are limited to OPT materials obtained from a single plantation site only. The usefulness and validity of the variables such as axial and radial direction are probably to have been undermined for curved OPT logs from peat area of oil palm plantation. More complex orientation structure of vascular bundles and log form variables (due to leaning oil palm tree growth) could also be determined. For example, the compression wood variables. Data to describe both the severity of compression wood and its distribution through the OPT log is inadequate. However, these variables do signify segregation criteria of OPT material that could credibly be put into practice. In some circumstances, the use of less-than-perfect variables derived from this research work could lead to other useful observations.

5.3 Future Work

The study conducted showed a promising future for OPT log. Although there are limitations, the conversion of OPT log to sawn lumber is technically viable. Thus more researches are needed in order to commercialize the use of OPT as sawn lumber substitutes to wood.

The differences in strength properties among the OPT log section may well be explained in terms of the differences in the microstructure of vascular bundles and the presence of parenchyma cells. It is therefore recommended that such study should be carried out in order to obtain more information pertaining to the amorphous and crystalline structures within the OPT structure. Apart from its basic properties, dimensional shrinkage of OPL was highly dependent on the sawing pattern types. A follow-up of research on relationship between fibre morphology and shrinkage of OPL would be essential information.

For the VI process, the issue of flow sensing, mainly flow progression on both the OPL edges is a critical area that requires further development. With advancements in microelectronics, it would be interesting to note if any of new generation of sensors have key features of speed, accuracy, reliability, reduced cost, minimum intrusiveness, and an ability to interface with control hardware. Furthermore, it would be useful to develop a model for gum rosin impregnation that include the compaction rate, time duration and the mass of gum rosin flowing through the OPL microstructure so that the best strategy to end an infusion could be predicted. Other variables of potential interest include those between log ovality and stiffness, and between slope of vascular bundles and stiffness, that would be better explored at a fundamental level by small-scale testing. The effect of plantation site,

for example, could be better determined by testing matched samples from undulating hilly and peat areas.

