



**UNIVERSITI PUTRA MALAYSIA**

**MACHINING CHARACTERISTICS OF OIL PALM WOOD TREATED  
WITH PHENOL FORMALDEHYDE RESIN USING COMPRESS METHOD**

**CHONG YI WAY**

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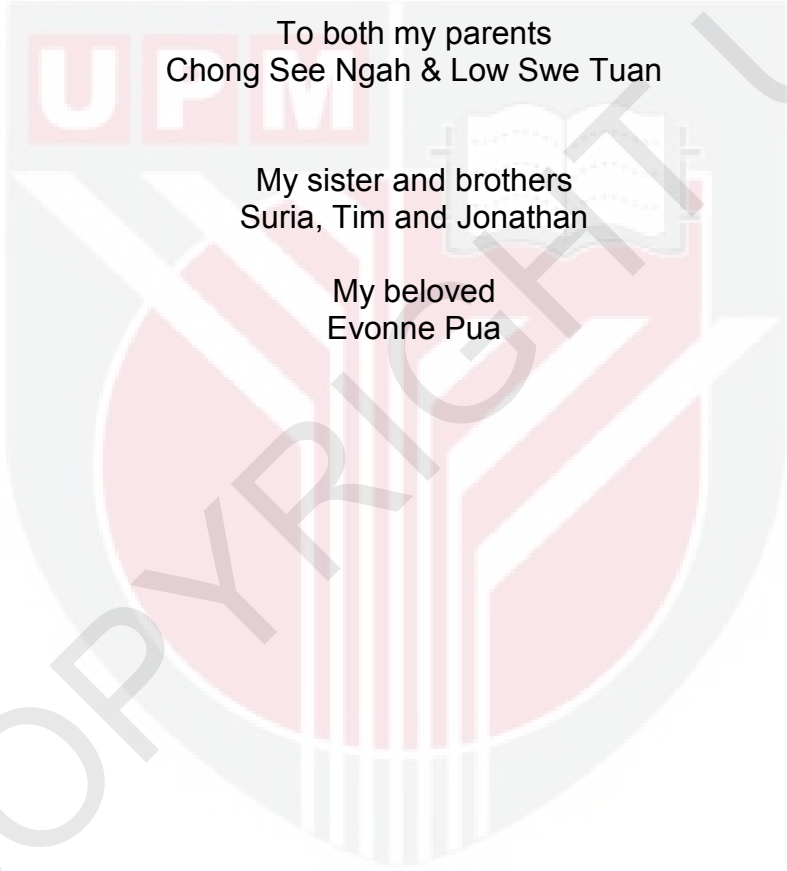
**MACHINING CHARACTERISTICS OF OIL PALM WOOD TREATED  
WITH PHENOL FORMALDEHYDE RESIN USING COMPRESS METHOD**



By  
**CHONG YI WAY**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
Malaysia, in Fulfilment of the Requirements for the Degree of Master  
of Science**

**June 2011**



To both my parents  
Chong See Ngah & Low Swe Tuan

My sister and brothers  
Suria, Tim and Jonathan

My beloved  
Evonne Pua

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

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**Chairman : Associate Professor Edi Suhaimi Bakar, PhD**

**Faculty : Forestry**

The objective of this study is to evaluate the machining characteristics of oil palm wood treated with phenol formaldehyde resin using compress method. This study is divided into three parts. The first and second parts of the machining study are based on ASTM 1666-87 standard and their surface roughnesses are assessed based on ISO 4288 standard. The first part of the study is on the planing characteristic of treated OPW, the second part of the research looked into the drilling and cross-cutting characteristic of treated OPW and finally the third part of research, examined the tool wear of tungsten carbide circular saw used to cut the treated OPW.

The planing test showed that the treated OPW improved vastly from those of untreated OPW and on par with Rubberwood. In general, the planing of the treated OPW and the Rubberwood fell into the Grade I (very good), compared to Grade III (average) for untreated OPW. Surface roughness assessment from the test placed treated OPW close to those of Rubberwood range which are within 4  $\mu\text{m}$ -12  $\mu\text{m}$ , while the untreated OPW are averaged

at 20  $\mu\text{m}$  with some readings top the upper and lower limit of the profilometer.

In the second part of the study, there were two tests - drilling and cross-cutting. Drilling was done using four different Forstner bits to test the effects of diameter and rake angle of the bit toward the drilled holes. Smaller diameter (25 mm) and higher rake angle ( $30^\circ$ ) shows better result than those of bigger diameter (32 mm) and lower rake angle ( $20^\circ$ ). While for the cross-cutting study, the quality of cut of treated OPW exceed Rubberwood and untreated OPW.

In the final study, it was found that the treated OPW will cause more severe wear on the rake side of the saw tip followed by Rubberwood and untreated OPW. The clearance side of the saw tip had a more severe wear when cutting untreated OPW followed by treated OPW and Rubberwood. On average the tool wear rate of saw tip used to cut treated OPW is the highest followed by those used to cut untreated OPW and Rubberwood .

In conclusion, the compress treatment, significantly improved the planing, drilling and cross-cutting characteristic of OPW. The treated OPW produced are comparable to Rubberwood if not better. Forstner bit with smaller diameters and higher rake angle gave a better result in sense of its bored quality. The treated OPW causes the cutting tool to wear but at a more gradual rate while the untreated OPW may cause chipping on the saw blade due to the splintering of the vascular bundles during cutting.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk Ijazah Master Sains

**SIFAT PEMESINAN KAYU KELAPA SAWIT YANG DIRAWAT DENGAN  
PHENOL FORMALDEHYDE MELALUI CARA RAWATAN COMPRESS**

Oleh

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Objektif kajian ini adalah bagi menilai sifat pemesanan kayu kelapa sawit yang dirawat dengan phenol formaldehyde yang melalui cara rawatan compress. Kajian ini dipecahkan kepada tiga bahagian. Bahagian pertama dan kedua kajian pemesanan ini dijalankan dengan merujuk kepada standard ASTM D1666-87 dan sifat kehalusan muka kayu dimesin dijalankan dengan merujuk standard ISO 4288. Bahagian pertama, adalah penilaian ciri-ciri pengertaman kayu kelapa sawit yang sudah dirawat manakala bahagian kedua melihat ciri-ciri penggerudian dan pemotongan keratan lintang kayu kelapa sawit yang dirawat. Bahagian ketiga menyiasat ciri-ciri kehausan mata pisau “tungsten carbide circular saw” yang digunakan dalam pemotongan kayu kelapa sawit yang dirawat.

Kajian pengertaman menunjukkan bahawa kayu kelapa sawit yang dirawat adalah setara dengan kualiti kayu getah dan jauh bertambah baik berbanding dengan kayu kelapa sawit yang tidak dirawat. Secara umum, pengertaman kayu kelapa sawit yang dirawat jatuh di kelas I (sangat baik), berbanding dengan kelas III (sederhana) pada kayu kelapa sawit yang tidak

dirawat. Ujian penilaian kekakasaran kayu kelapa sawit yang dirawat menempatkannya dalam lingkungan yang sama dengan kayu getah pada 4  $\mu\text{m}$  sehingga 12  $\mu\text{m}$ , sedangkan kayu kelapa sawit yang tidak dirawat berada dalam lingkungan 20  $\mu\text{m}$  dan ke atas, sebahagian bacaan untuk kayu kelapa sawit yang tidak dirawat menjangkau keupayaan bacaan tertinggi dan terendah profilometer yang digunakan.

Terdapat dua bahagian dalam kajian kedua, iaitu penggerudian dan pemotongan keratan lintang. Ujian penggerudian dijalankan dengan menggunakan empat bit Fortsner yang berbeza untuk menguji pengaruh diameter dan sudut "rake" terhadap kualiti lubang yang digerudi. Daripada kajian ini, didapati diameter kecil (25 mm) dan sudut "rake" tinggi (30°) menunjukkan hasil yang lebih baik berbanding diameter yang besar (32 mm) dan sudut "rake" yang kecil (20°). Manakala pada ujian pemotongan keratan lintang, kualiti pemotongan kayu kelapa sawit dirawat adalah lebih baik daripada kayu getah dan kayu kelapa sawit yang tidak dirawat.

Dalam kajian terakhir penyelidikan ini, didapati kayu kelapa sawit dirawat akan mengakibatkan kehausan yang lebih serius di bahagian "rake" mata pisau diikuti kayu getah and kayu kelapa sawit tidak dirawat. Bahagian "clearance" mata pisau pula didapati akan mengalami kehausan yang lebih serius jika kayu kelapa sawit tidak dirawat dipotong berbanding kayu kelapa sawit dirawat and kayu getah. Secara purata, boleh disimpulkan bahawa kayu kelapa sawit dirawat akan mengakibatkan kehausan yang lebih serius and tinggi berbanding kayu kelapa sawit tidak dirawat dan kayu getah.

Secara kesimpulan, melalui rawatan “Compress”, ciri-ciri pengertaman, penggerudian dan pemotongan keratan lintang telah mempertingkatkan secara signifikan. Kayu kelapa sawit yang dirawat adalah setara dengan kayu getah jikalau bukan lebih baik. Diameter yang kecil dan sudut “rake” yang tinggi pada mata gerudi “Forstner” akan memberi keputusan penggerudian yang lebih baik dari segi quality. Turut dapat disimpulkan bahawa kayu kelapa sawit yang telah dirawat akan mengakibatkan kehausan mata pisau yang tinggi tetapi pada kadar yang lebih sekata berbanding kayu kelapa sawit yang tidak dirawat yang ada keberangkalian besar terjadi “chipping” pada mata pisau akibat daripada vakular bundel yang terangkat semasa pemotongannya.



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I certify that a Examination Committee has met on 30 June 2011 to conduct the final examination of Chong Yi Way on his thesis entitled “Machining Characteristic of Oil Palm Wood Treated with Phenol Formaldehyde Resin Using Compress Method” in accordance with Universalities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the candidate be awarded the Master of Science.

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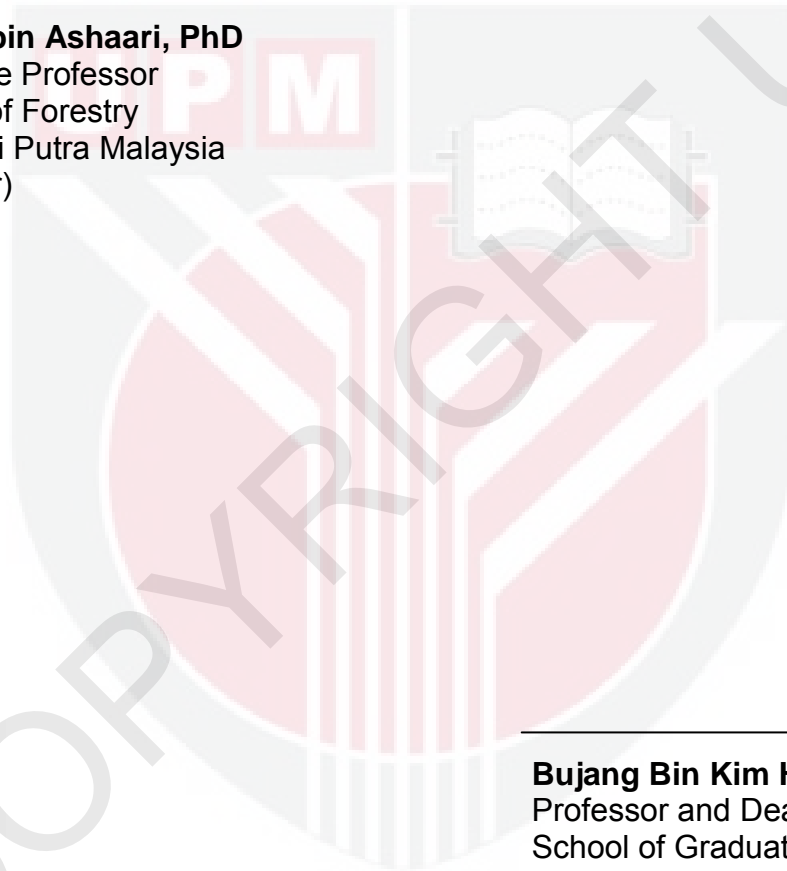
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Date: 22 November 2011

This thesis was submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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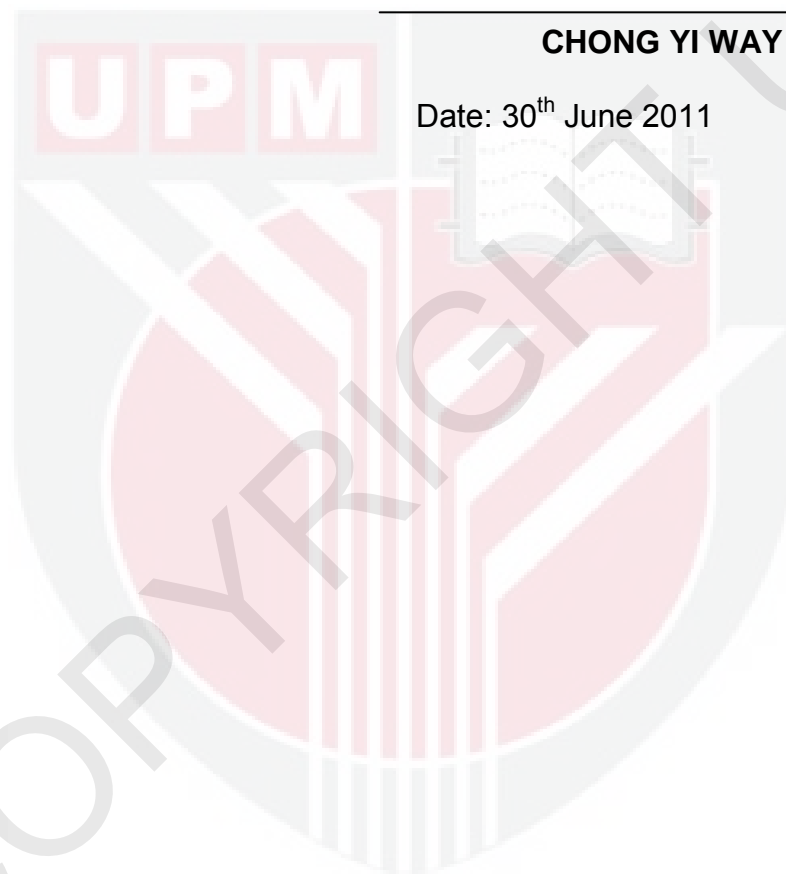
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## DECLARATION

I declare that the thesis is my original work except for the quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.



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