

**DETERMINING THE POSSIBILITY OF USING NON  
DESTRUCTIVE TESTING (NDT) TO DETECT THE  
DETERIORATION OF WOOD PRODUCTS**



**RESEARCH MANAGEMENT INSTITUTE  
UNIVERSITY TEKNOLOGI MARA  
40450 SHAH ALAM  
SELANGOR  
MALAYSIA**

**BY:**

**LIEW YIT LIAN  
LIEW FUI KIEW  
DR. DAYANG MARYANI AWANG HASHIM**

**SEPTEMBER 2010**

Date : 1 September 2010  
Project File No. : 600-RMU/SSP/DANA 5/3 (6/2009)

Prof. Dr. Abu Bakar bin Abdul Majeed  
Assistant Vice Chancellor (Research)  
Research Management Institute (RMI)  
Universiti Teknologi MARA  
40450 Shah Alam

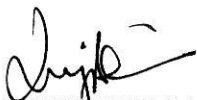
Dear Professor,

**FINAL RESEARCH REPORT “DETERMINING THE POSSIBILITY OF USING NON DESTRUCTIVE TESTING (NDT) TO DETECT THE DETERIORATION OF WOOD PRODUCTS”.**

With reference to the above, I am pleased to submit six hard copies (four to RMU UiTM Sarawak and two to RMI Shah Alam) and a soft copy of the Final Research Report entitled, “Determining the Possibility of Using Non Destructive Testing (NDT) to Detect the Deterioration of Wood Products”.

Thank you.

Yours sincerely,



**LIEW YIT LIAN**  
The Leader  
Research Project

# TABLE OF CONTENTS

<b>Contents</b>	<b>Page</b>
Title Page	ii
Research Offer Letter	iii
Letter of Submission	v
Research Group	vi
Acknowledgements	vii
Table of Contents	viii
List of Tables	ix
List of Figures	x
Abstract	xi
<b>1.0 INTRODUCTION</b>	<b>1</b>
1.1 Wood	1
1.2 Objectives	4
<b>2.0 LITERATURE REVIEW</b>	<b>6</b>
2.1 Non Destructive Testing	6
2.2 Modulus of Elasticity (MOE)	8
2.3 Vibration Method	10
<b>3.0 METHODS AND MATERIALS</b>	<b>13</b>
3.1 The Statistical Analysis	13
3.2 Sample Preparation	13
3.3 Experimental Methods	14
<b>4.0 RESULTS AND DISCUSSIONS</b>	<b>17</b>
4.1 Determination of MOE Using NDT	17
4.2 Effect of Weather on MOE	20
<b>5.0 CONCLUSION AND RECOMMENDATION</b>	<b>24</b>
<b>BIBLIOGRAPHY</b>	<b>25</b>
<b>APPENDIX A</b>	<b>30</b>
<b>APPENDIX B</b>	<b>39</b>

## ABSTRACT

Dynamic modulus of Elasticity (MOE) is one of the widely used characteristics for the evaluation of wood strength. MOE of five selected tropical species, which were *Acacia mangium*, *Lithocarpus* sp., *Cotylelobium melanoxyton*, *Paraserianthes falcataria* and *Elmerrillia mollis* were studied using the free-free flexural vibration method, which is one of the NDTs. The decrease or increase of MOE indicated that NDT is possible to be used to detect the deterioration of wood caused by the natural surroundings. The result had also shown that NDT was to be used successfully to trace the changes of MOE. The relationship between MOE and the temperature, rainfall and humidity were studied and MOE was found not significantly correlated with the temperature, humidity and rainfall.

# CHAPTER 1

## INTRODUCTION

### 1.1 Wood

Concise Encyclopedia of Wood defined wood as the hard, fibrous tissue that comprises the major part of stems, branches and roots of tree, belonging to the plant groups known as the gymnosperms and dicotyledonous angiosperms. Wood is the most fascinating material and renewable resource because of its complex structure and its wide application on earth (Bucur, 1995).

According to Wood Handbook (1987), the compositions of dry wood are cellulose (approximately 50%), lignin (23 – 33% for softwoods, and 16 – 25% for hardwoods), hemicelluloses (5 – 30%) and minor amounts of extraneous materials (5 – 10%). The major constituent which is cellulose is a high molecular weight linear polymer consisting of chains of bonded glucose monomers. The cellulose molecules are arranged into ordered strands called fibrils during the growth of the tree. The larger structural elements are formed by the organized fibrils comprising the cell wall of the wood fibers. Wood fibers can be used to form paper, synthetic textiles, films, lacquers and explosives. It has a great commercial value.

Lignin occurs in the wood throughout the cell wall and it is concentrated throughout, towards the outside of the cells and between the cells. It is a three dimensional phenyl-propane polymer. The structure and distribution of the lignin in wood are still not fully understood. To remove the lignin from the wood on a