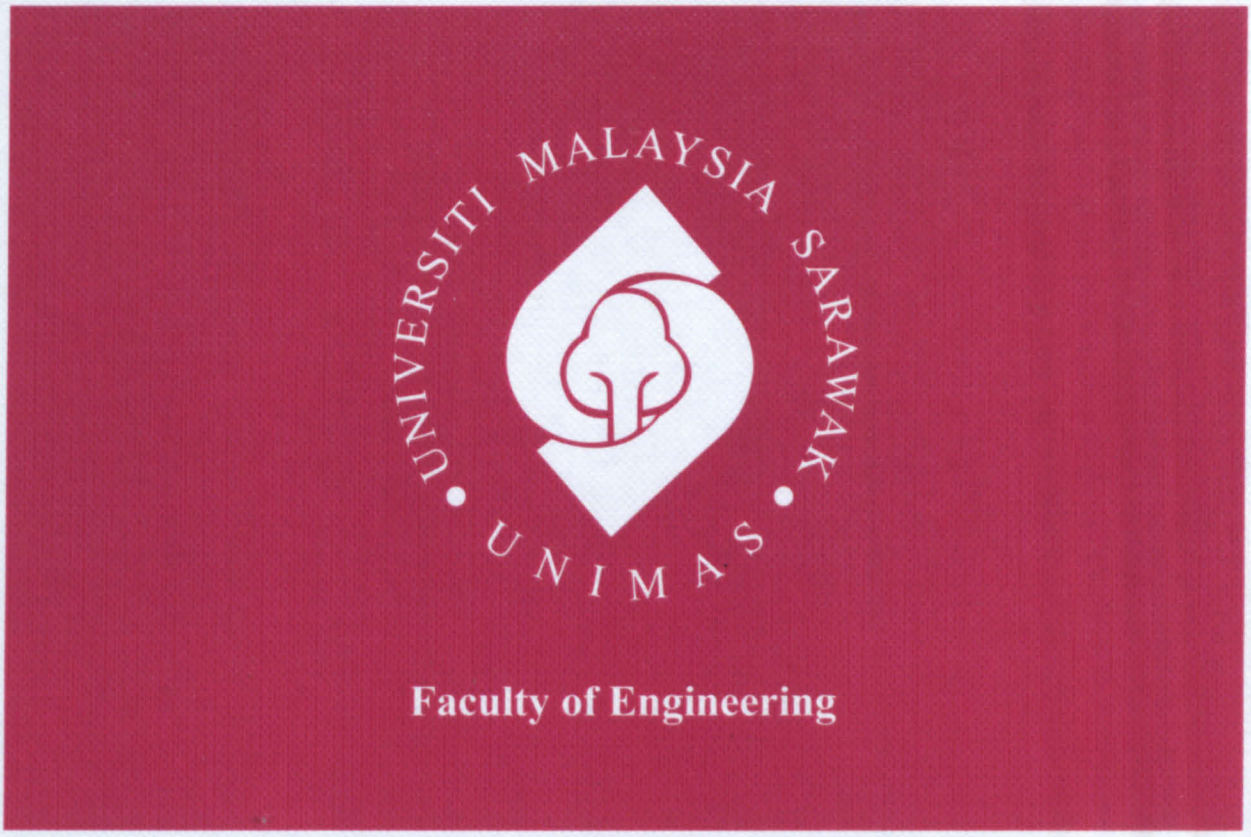

BEHAVIOUR OF CLEAVAGE PROPERTIES OF SMALL CLEAR LAMINATED ACACIA HYBRID SPECIES OF SARAWAK

DAVIDSON SATING ANAK RIANG

Bachelor of Engineering with Honours
(Civil Engineering)
2020

UNIVERSITI MALAYSIA SARAWAK

BORANG PENGESAHAN STATUS TESIS

Judul: **BEHAVIOUR OF CLEAVAGE PROPERTIES OF SMALL CLEAR LAMINATED ACACIA HYBRID SPECIES OF SARAWAK**

SESI PENGAJIAN: 2016 – 2020

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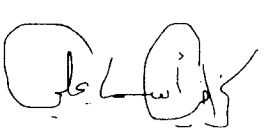

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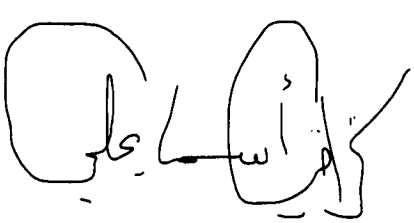

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Project Supervisor

4-8-2020

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Date

BEHAVIOUR OF CLEAVAGE PROPERTIES OF SMALL CLEAR LAMINATED ACACIA HYBRID SPECIES OF SARAWAK

DAVIDSON SATING ANAK RIANG

This project is submitted in partial fulfillment of

the requirements for the Degree of Bachelor of Engineering with

Honours (Civil Engineering) 2020

Dedicated to my beloved family, friends, and everyone

For their love, endless support, encouragement, and sacrifices

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Last but not least, a sincere thanks goes to all others who contributed, directly and indirectly, to help enable this project to be completed successfully. I am proud of being a part of student who joins this research. I hope this research can go for further study because Malaysia is a tropical country which is rich with timber sources.

ABSTRACT

The aim of this research to determine the behaviour properties of small clear laminated Acacia hybrid species of Sarawak. The realisation has grown that many earth's resources are non-renewable. Hence, it is important to develop a more economical construction that is eco-friendly and long-lasting product. Therefore, timber such as Acacia *mangium* and Acacia *auriculiformis* are selected for study purpose as they are fast-growing time, durable and high strength properties. These properties are the main reason Acacia *mangium* and Acacia *auriculiformis* are one of the resources suitable used for construction. In this study, the Acacia *mangium* and Acacia *auriculiformis* are combined, forming Acacia hybrid. Then, the Acacia hybrid was laminated with different years which are, 7 years with 10 years, 7 years with 13 years, and 10 years with 13 years. Basic information on physical and mechanical properties for introducing good use of *Acacia* hybrid species of Sarawak was tabulated to determine the best cleavage properties result of the combination. The relationship between density, moisture content and cleavage properties of small clear specimens were investigated for each group of age combination. The relationship of Acacia between physical properties and mechanical are directly proportional. As proved by Dr. Alik Duju, the relationship between moisture content and density are linear regression. The basic density is lower as the moisture content is higher. The cleavage strength properties of timber also affected by the change of density and moisture content. Strength properties of timber is lower as the basic density become lower. The strength of Acacia hybrid can be increased throughout detail study and effective further laboratory works. All data are analysed by using statistical analysis, where the graph and line graph used to compare the value on each combination with significant level of 95%. The average value or mean, standard deviation, and variance also calculated for each group of combination to analyse more detail of the strength of combination.

ABSTRAK

Tujuan penyelidikan ini untuk mengetahui sifat-sifat spesies Akasia hybrid di Sarawak yang dilaminasi kecil. Realisasi telah berkembang bahawa banyak sumber bumi tidak boleh diperbaharui. Oleh itu, adalah mustahak untuk mengembangkan pembinaan yang lebih ekonomik, iaitu produk mesra alam dan tahan lama. Oleh itu, kayu seperti Acacia *mangium* dan Acacia *auriculiformis* dipilih untuk tujuan kajian kerana kayu tersebut mempunyai sifat pertubuhan pada masa yang cepat, tahan lama dan mempuyai sifat kekuatan yang tinggi. Sifat-sifat ini adalah sebab utama Acacia *mangium* dan Akasia *auriculiformis* adalah salah satu sumber yang sesuai digunakan untuk pembinaan. Dalam kajian ini, Acacia *mangium* dan Acacia *auriculiformis* digabungkan, membentuk Akasia hybrid. Kemudian, Akasia hibrid dilaminasi dengan umur Acacia hybrid lain yang berbeza umur, iaitu, 7 tahun dengan 10 tahun, 7 tahun dengan 13 tahun, dan 10 years dengan 13 tahun. Maklumat asas mengenai sifat fizikal dan mekanikal untuk memperkenalkan penggunaan kayu jenis spesies Acacia hibrid di Sarawak dijadualkan untuk menentukan hasil sifat pembelahan terbaik dari kombinasi tersebut. Hubungan antara ketumpatan, kandungan kelembapan dan sifat pembelahan spesimen kecil disiasat untuk setiap kumpulan umur. Hubungan Acacia antara sifat fizikal dan mekanikal adalah berkadar terus. Seperti yang dibuktikan oleh Dr. Alik Duju, hubungan antara kandungan kelembapan dan ketumpatan adalah regresi linier. Ketumpatan asas kayu Acacia lebih rendah kerana kandungan lembapannya lebih tinggi. Sifat kekuatan pembelahan kayu juga dipengaruhi oleh perubahan kepadatan dan kandungan lembapan. Sifat kekuatan kayu lebih rendah kerana ketumpatan asas menjadi lebih rendah. Kekuatan Acacia hybrid dapat dipertingkatkan melalui kajian terperinci dan kerja makmal yang lebih berkesan. Semua data dianalisis dengan menggunakan analisis statistik, di mana graf bar dan graf jenis garisan digunakan untuk membandingkan nilai pada setiap kombinasi dengan tahap signifikan 95%. Min purata, sisihan piawai, dan varians juga dikira untuk setiap kumpulan gabungan untuk menganalisis lebih terperinci mengenai kekuatan gabungan.

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LIST OF ABBREVIATION AND NOTATIONS

AFOCEL – Association Foret-Cellulose

ASTM – American Society for Testing and Materials

BS – British Standard

CIDB – Construction Industry Development Board

FAO – Food and Agriculture Organization

FPDSB – Forest Plantation Development Sdn Bhd

FRIM – Forest Research Institute Malaysia

GTA – Global Trade Atlas

ITTO – International Tropical Timber Organization

JHS – *Jabatan Hutan Sarawak*

JPS – *Jabatan Pengairan dan Saliran*

JPSM – *Jabatan Perhutanan Semenanjung Malaysia*

MDF Plant – Medium-density Fireboard Plant

MOE – Modulus of Elasticity

MOR – Modulus of Rupture

MTC – Malaysian Timber Council

MTIB – Malaysian Timber Industry Board

NRE – Ministry of Natural Resources and Environment

PFR – Plant and Food Research

PRF – Phenol Rersorcinol-Formadehyde

SFC – Sarawak Forestry Corporation

TRADA – Timber Research and Development Association

UM – University of Malaya

UNESCO – The United Nations Educational, Scientific and Cultural Organization

UPM – University of Putra Malaysia

UTM – University of Technology Malaysia

WWF – Worldwide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1 General

Timber is an essential material in buildings and bridges construction since ancient time. Figure 1.1 shows one such evidence the oldest temple near Nara, Japan completed by 607 AD. The temple originally named Wakakusadera when it was commissioned by Prince Shotoku before the name changed to Horyu-ji after devoted to the Buddha of healing and in honour of the prince's father, named Yakushi Nyorai. Once upon a time, Horyu-ji one of the powerful Seven Great Temples in Japan located near Ikaruga, Nara Prefecture. In the modern era today, UNESCO was gazzeted Horyu-ji as a world heritage site. This evidence shows that the Japanese ancient was practice use of timber as their main component to build their building. According to Mechtild (2016), Japan's abundance of wood species is reflected in Japanese culture. The Japanese themselves frequently define their culture as being *a ki no bunka,* or "culture of wood".

Photo 1.1: Horyu-ji temple (Marian et al., 2003)

Nowadays, timber has been used in a whole country around the world to produces economics, durability and stability of product therefore, the product can stand for a long time. Malaysia, a rainforest tropical country was among the main suppliers of the excellent quality timbers that are very highly demanded over the globe. However, in fact, the country is not fully utilising the resources for engineering field for structural materials when compared with well-developed countries. The application on timber as a structural member in the country still unsatisfactory. The problems can be observed when timber trusses and formworks in the construction project ongoing in this country is very limited. The practice of using timber is still hard to compete with other materials. Some factors that contribute to this problem is the knowledge of design and properties of timber is still lack between the architects and engineers (Jumaat et al., 2006). This phenomenon more serious as courses on timber design offered by universities is very limited.

1.2 Problem Statement

In Malaysia, there are very limited research works and study are done on timber engineering when compared with other materials used for construction such as concrete and steel. Research on timber only began by Forest Research Institute of Malaysia (FRIM) after late 60s. Following that actions, several universities and organisations such as Universiti Malaya (UM), Universiti Teknologi Malaysia (UTM), Universiti Putra Malaysia (UPM) and Kolej Universiti Tun Hussien Onn was volunteer in developing the usage of the timber for structural use. Meanwhile, several organisations are involved such as the Malaysian Timber Council (MTC), Malaysian Timber Industry Board (MTIB) and Construction Industry Development Board (CIDB). From the research, the Code of Practise MS 544 starts to develop. Besides, the timber joint strength, engineered wood product and trusses of roof also included.

For this research, the information about laminated Acacia hybrid species of Sarawak has limited sources. Only the general information about timber has many founded. The problem might happen due to the research for the past years only focus on common species which mostly founded around the world. In addition, research on *Acacia mangium* and *Acacia Auriculiformis* can easily found on book, journal, internet or magazine but, the species of Acacia hybrids for that species is very little.

1.3 Aim & Objectives

Analyse and examine the behaviour properties in terms of mechanical and physical of small clear laminated Acacia hybrid species of Sarawak was the aim of this research. The research will concern more on cleavage mechanical properties, while for physical properties, density and moisture content was considered. Specifically, these were contingent on fulfilling the three objectives:

1. Determining the engineering properties of small clear laminated Acacia hybrid,
2. To compare and evaluate the behaviour of cleavage properties of small clear laminated Acacia hybrid, and
3. To identify the best result cleavage properties of small clear laminated Acacia hybrid from different age combination

As mentioned in the above objectives, this study will be focused on Acacia hybrid combination at age 7 years with 10 years, 7 years with 13 years, and 10 years with 13 years.

1.4 Works Scope

The behaviour of Acacia hybrid in term of cleavage properties is the main research to study with two combinations of different age, which are 7 years, 10 years and 10 years. Totally, the testing requires 180 samples of small clear laminated Acacia hybrid (which is of the 'Monnin' type) with dimension 4.5 cm × 2.0 cm ×2.0 cm (length × width × height). The test pieces have applying by the load at a constant crosshead speed of 0.254 cm/min or 0.0042 cm/s (0.10 in./min). The test will be made radially and tangentially means that, for each combination, 30 pieces samples used to give a failure under test along a radial surface and other 30 pieces used to give a failure under test along a tangential surface. After that, all result recorded and compared with cleavage properties of solid Acacia.

Besides that, the study will be focused on the timber physical properties, which include moisture content, specific gravity and density. Determining moisture content in

timber is important because it can affect some characteristics of timber, such as strength, weight, durability and workability. The relationship between stiffness or strength and density of timber are directly proportional. High density of timber will contribute to high strength and stiffness.

Another study will conduct in this research is microscopy and macroscopy. Microscopy is a technical field where very small objects and materials will be observed by using microscopes while, macroscopy is referred to as the substance that can be seen with naked eyes. In this project, microscopy conducted to observes the behaviour of cell inside Acacia hybrid before and after conducting the testing. The behaviour of cells of Acacia hybrid might be different after load applied to it during the testing process. The cellular, lignin, fibres and lumen of Acacia have undergone some deformations.

1.5 Significant of Study

The research will be giving a great overview for architects and engineers regarding the properties of laminated Acacia hybrid species of Sarawak that can be used for construction. They will have an advantage by identifying the best combination of laminated Acacia with different years. The best combination will have a good testing result. By using this case study, the architects and engineers able to determine the best quality of timber based on its physical properties, which are moisture content and density. Moisture content gives big impact on the strength of timber as the more water inside the timber, become softer the timber will be. Hence the strength of timber will be decrease-decreased too. Microscopy and microscopy study also important to determine the quality of good timber. Timber no defect can be selected for construction purpose.

1.6 Chapter Outline

Introduction for Chapter 1 in this chapter is an overview of the timber. It included the general and problem statement. Problem statement needs to clarify to write the aim and objectives of this study. Scope of work is the explanation about the work that will

conduct in this research. The significant study is to give an overview of the reader about the importance of this research.

Next, Chapter 2 is literature review, where it outlines the ideas from other researchers around the world regarding the timber. This idea may be founded in book, e-book, journal, thesis, internet, magazine, newspaper and other sources. Start from the background of the timber until the material selected for this research was outlined in this chapter.

Chapter 3 is methodology, where in this chapter, the procedures to carry out the testing and the value during testing was recorded and expressed in the graph for interpreting. This chapter includes how the material is processed into small clear specimen for testing and the machine used.

Chapter 4 are the results, discussion, and analysis. In this chapter, it will discuss what will happens after conducting the result. The data during testing will be discussed and analysed here. Data then expressed in a graph for comparing.

Chapter 5 is the conclusion, where in this chapter, it concludes what was happens during research conduct. Some recommend was describes for better improvement for a future of the study.