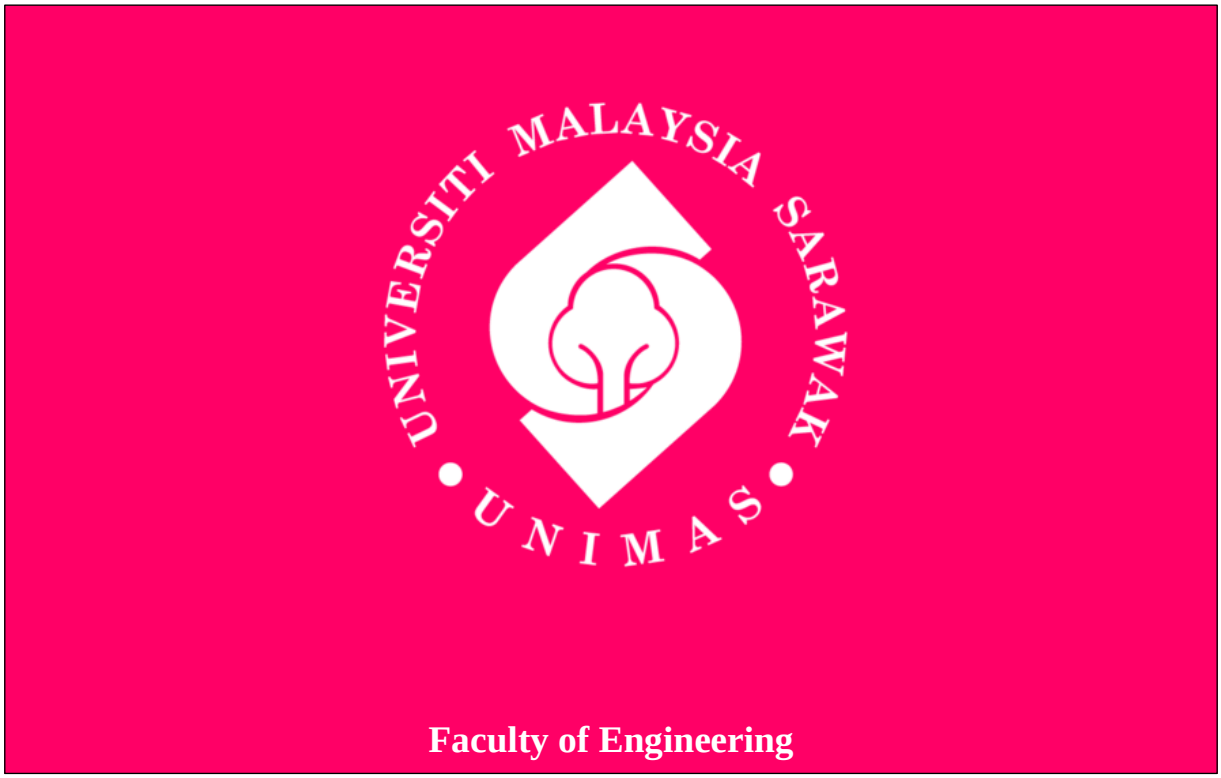

BEHAVIOURS OF ENGINEERING PROPERTIES OF ACACIA HYBRID UNDER COPPER CHROME ARSENIC (CCA) TREATMENT AT DIFFERENT AGE GROUPS

Ellyne Anak Enduat

Bachelor of Engineering with Honors

(Civil Engineering)

2018

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

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This declaration is made on the 12th day of June 2018.

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I Ellyne Anak Enduat, ~~H~~46701, Faculty of Engineering

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DR. GADDAFI ISMAILI
SENIOR LECTURER
CIVIL ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING
UNIVERSITI MALAYSIA SARAWAK

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BEHAVIOURS OF ENGINEERING PROPERTIES OF ACACIA HYBRID UNDER COPPER CHROME ARSENIC (CCA) TREATMENT AT DIFFERENT AGE GROUPS

ELLYNE ANAK ENDUAT

This project is submitted in partial fulfilment

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From left: Dominic, Nash, Dr. Gaddafi, Dayang, Suzanna and Ellyne

To my beloved family, friends and everyone

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Abstract

This paper aim is to determine the behaviour of engineering properties of Acacia hybrid under copper chrome arsenic (CCA) at air-dry condition of different age groups. The engineering properties are determined by conducting three (3) mechanical strength tests namely; a) shear parallel to grain test, b) tensile parallel to grain test and c) cleavage test. The specimens for these three tests are divided into two (2), one is for controlled specimens, and the other one is for treated specimens. The specimens are treated to evaluate the performance of Acacia hybrid under CCA treatment. Also, the tests are conducted in both direction of tangential and radial for shear parallel to grain test and cleavage test. The specimens are tested in small clear size as stated in British Standard (BS 373: 1957).

For 7-year-old, the average values strength for shear parallel to grain, tensile parallel to grain and cleavage are 16.00 MPa (radial) and 17.06 MPa (tangential), 141.80 MPa, and 13.67 N/mm (radial) and 15.82 N/mm (tangential) for controlled specimens and 16.78 MPa (radial) and 17.52 MPa (tangential), 158.40 MPa, and 14.61 N/mm (radial) and 16.69 N/mm (tangential) for treated specimens respectively. For 10-year-old, of controlled specimens, the average values of strength for shear parallel to grain, tensile parallel to grain and cleavage are 17.46 and 18.18 MPa (radial and tangential), 148.99 MPa, and 15.00 and 17.66 N/mm (radial and tangential) and 17.92 and 18.59 MPa (radial and tangential), 176.44 N/mm and 16.41 and 18.21 N/mm (radial and tangential) for treated specimens respectively. Meanwhile for 13-year-old, the results are 16.62MPa and 17.61 MPa for radial and tangential planes, 144.19 MPa, and 14.19 N/mm and 16.19 N/mm (radial and tangential) for controlled specimens and 16.88 and 17.67 MPa (radial and tangential), 160.26 MPa, and 15.41 N/mm and 16.86 N/mm (radial and tangential) for treated specimens respectively. The conclusion drawn that 10-year-old Acacia hybrid exhibits the highest strength on shear parallel to grain, tensile parallel to grain and cleavage followed by 13- and 7-year-old. The treated specimens seemed to perform slightly better than that of the controlled specimens.

Abstrak

Tujuan projek ini adalah untuk mengkaji ciri-ciri kejuruteraan Akasia hibrid yang dirawat menggunakan tembaga arsenic krom pada keadaan udara normal dari kumpulan umur yang berbeza. Ciri-ciri kejuruteraan ini ditentukan dengan menjalankan tiga (3) ujian kekuatan mekanikal iaitu; a) ujian ricih selari dengan ira, b) ujian tegangan selari dengan ira, dan c) ujian belahan. Spesimen untuk ketiga-tiga ujian ini dibahagikan kepada dua(2) bahagian, satu untuk specimen yang dikawal, dan yang seterusnya untuk specimen yang dirawat. Spesimen ini dirawat untuk menilai prestasi Akasia hibrid tersebut selepas dirawat menggunakan tembaga arsenik krom. Selain itu, ujian kekuatan mekanikal ini dilakukan di kedua-dua arah radial dan tangen bagi ujian ricih selari dengan ira dan ujian belahan. Spesimen ini diuji dalam saiz yang kecil selaras dengan Piawaian British (BS 373: 1957).

Nilai purata kekuatan mekanikal untuk spesimen berumur 7 tahun bagi ujian ricih selari dengan ira (radial dan tangen), tegangan selari dengan ira, dan kekuatan belahan (radial dan tangen) adalah 16.00 MPa (radial) dan 17.06 MPa (tangen), 141.80 MPa, dan 13.67 N / mm (radial) dan 15.82 N / mm (tangen) untuk spesimen terkawal dan untul specimen terkawal adalah 16.78 MPa (radial) dan 17.52 MPa (tangen), 158.40 MPa, dan 14.61 N / mm (radial) dan 16.69 N / mm (tangen). Bagi spesimen terkawal yang berumur 10 tahun, nilai purata kekuatan mekanikal bagi ricih selari dengan ira, tegangan selari dengan ira, dan belahan adalah 17.46 dan 18.18 MPa (radial dan tangen), 148.99 MPa, dan 15.00 dan 17.66 N / mm (radial dan tangen), manakala untuk spesimen terkawal ialah 17.92 dan 18.59 MPa (radial dan tangen), 176.44MPa serta 16.41 dan 18.21 N / mm (radial dan tangen). Sementara itu bagi umur 13 tahun, hasilnya ialah 16.62MPa dan 17.61 MPa untuk permukaan radial dan tangen, 144.19 MPa, dan 14.19 N / mm dan 16.19 N / mm (radial dan tangen) untuk spesimen dikawal dan 16.88 dan 17.67 MPa (radial dan tangen), 160.26 MPa, serta 15.41 N / mm dan 16.86 N / mm (radial dan tangen) bagi spesimen yang dirawat. Kesimpulannya, Akasia hibrid yang berumur 10 tahun menunjukkan kekuatan mekanikal yang tertinggi dalam ujian ricih selari dengan ira (radial dan tangen), tegangan selari dengan ira, dan ujian belahan bagi radial dan tangen serta diikuti umur 13 dan 7 tahun. Spesimen yang

dirawat juga menunjukkan sedikit peningkatan daripada spesimen yang terkawal dalam kekuatan mekanikal.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF EQUATIONS

LIST OF FIGURES

ABBREVIATIONS

Abbreviations	Full Name
BC	Before Century
BS	British Standard
CCA	Copper Chromated Arsenic
CE	Common Era
CR	Controlled Specimens at Radial Plane
CT	Controlled Specimens at Tangential Plane
DBH	Diameter of Breast Height
FRC	Forest Research Centre
FRIM	Forest Research Institute Malaysia
FYP	Final Year Project
ha	Hectare(s)
ISO	International Organization for Standardization
MC	Moisture Content
SFC	Sarawak Forestry Corporation
TR	Treated Specimens at Radial Plane
TRTTC	Timber Research & Technical Training Centre
TT	Controlled Specimens at Tangential Plane
UniMAS	University Malaysia Sarawak

CHAPTER 1

INTRODUCTION

1.1 General

Timber has been used throughout the history of mankind and has provided human with a broad range of building products and construction materials (Jumaat et al, 2006). It is known at the most sustainable construction material as it is renewable and also absorbs carbon dioxide as it grows (Davies, 2012).

Malaysia is one of the main producers of the world's good quality timbers that are very highly demanded all over the globe (Jumaat et al., 2006). However, the country does not fully utilize these rich resources in the field of engineering in general and as structural materials in particular. Lacking of knowledge on timber properties and design among the engineers is one of the factors that the usage of timber as a structural member in country is almost non-existence.

Then, Forest Research Institute Malaysia (FRIM) together with Timber Research & Technical Training Centre (TRTTC), Sarawak, and the Forest Research Centre (FRC), Sabah, was undertaken a collaborative research project entitled "Improving Utilization and Value Adding of Plantation Timbers from Sustainable Sources in Malaysia" to conduct a research and evaluate the basic timber properties of plantation-grown timbers. This research information's will be used to utilize the timber species more efficiently and effectively.

In Sarawak, the government is committed to establishing one million hectares of commercial plantations by the year 2020 (PERKASA, 2009). A total of 332, 000 ha of forest are planted with various fast-growing species and about 245, 000 ha or 72% of the total planted forest areas are planted with A. *mangium* and its hybrids (Anon,

2014). This is an effort to meet current and future raw materials demand from the timber industry as well as to conserve the natural forest (Jusoh & Adam, 2009).

After few testing are done on *Acacia mangium*, it is proven that the timber species is categorized under strength group 5 (SG5) (Ismaili et al, 2011). However, for new breed species of *Acacia mangium*, namely Acacia hybrid, it mechanical strength properties is still lacking. Therefore, in this research work, secondary timber of Acacia hybrid with fast-growing rate, durable and high strength properties has chosen as a subject to this study. It is as an alternative to evaluate mechanical strength properties of Acacia hybrid and introduce this species as materials for construction of the building.

1.2 Problem of Statement

In the early days in Malaysia, due to lack of information on the properties of *Acacia mangium*, the timber was used for low-value products such as pallets, sawdust for fuel and core veneer (Lim, Gan, & Tan, 2011). However, after few researches were done, the value of *Acacia* timber has increased. Today, *Acacia mangium* is one of major plantation in Malaysia.

Since Acacia hybrid is a new species, the information on its properties is still lacking. Although Acacia hybrid appears to acquire many desirable properties such as faster growth and greater resistance to heart rot (Ismail & Farawahida, 2007) but its basic characteristics is yet undefined. Studies of their basic characteristics are important for future utilization.

Furthermore, the usage of timber in our country is lacking in structural applications used especially for heavy weight constructions such as portal frames and large size beam and column constructions. Timber has widely used as a non-structural application such as formworks, panelling, partitions and etc. Therefore, this species is selected to study its strength properties and these findings will be useful to utilize this species to accommodate the huge demand for industrial purpose and enhance the effective utilization of this species for furniture, outdoor and even for structural application in the future.

1.3 Research Background

In this study, the behaviours of engineering properties of Acacia hybrid are determined. There are three (3) mechanical tests involved in this research, they are a) shear parallel to grain, b) tensile parallel to grain and c) cleavage test. For shear and cleavage test, it involved both of tangential and radial planes. The condition of specimens is constant at an air-dry condition where the moisture content must be lower than 19%. The specimens are divided into two (2) conditions, treated and controlled. The total of specimens is approximately 1,200, where at least 40 specimens for each test.

1.4 Aim and Objectives of Studies

This research aim is to study the behaviours of engineering properties of Acacia hybrid under Copper Chrome Arsenic (CCA) treatment at the different age group using a small clear size in accordance with British Standard BS 373: 1957 for Acacia hybrid. The objectives of this study have been identified as follows:

1. To determine the physical and mechanical properties of Acacia hybrid at different age groups in air-dry condition, and
2. To compare and evaluate the behaviours of strength performance between controlled and treated Acacia hybrid

1.5 Scope of Study

This scope of study concentrates on laboratory work to determine the engineering properties of Acacia hybrid under copper chrome arsenic (CCA) treatment at air-dry condition from different age group. Various testing method was carried out to analyse the strength performance of Acacia hybrid in a small clear size. The tests are such as tensile, cleavage and shear parallel to grains. All of these tests were in accordance with British Standard BS 373: 1957.

1.6 Chapter Outlines

This research is divided into five (5) chapters. Chapter one (1) will explain the general of timber including the utilizing timber in the world and throughout Malaysia, the problem statements and the objectives of study.

Chapter two (2) will explain the literature review related to this study such as strength, physical and mechanical properties of timber species and finding from previous research.

Chapter three (3) describe the methodology used to carry out the testing. The procedure of laboratory works will be detailed explain in this chapter.

Chapter four (4) discuss the findings from the laboratory tests that have been conducted which include Tensile Test, Cleavage Test and Shear Parallel to Grain Test and compare it with previous studies.

Chapter five (5) will describe the important conclusions derived from this study as well as suggestions and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 General

This chapter outlines the opinions and knowledge from others author and serves as a guideline to achieve the aim and objectives of this research work.

2.2 Background of Timber

Timber is known as oldest building materials in the world. It has been used for a construction purposes since ancient times (Therlandersson & Larsen, 2003). In Japan, most of temples are built by using timber structure. The most famous temples are known as Horyuji Temple. Horyuji Temples has been constructed about 607 CE (Greene, 2005). It consists of Golden Hall (*kondo)* and five – storey Pagoda. The pagoda is supported by single wooden that is extended from the base to the finial of the building. The timber beam is connected by using bracket system where there are no single nails are used to construct the Horyuji Temple (Moffett, Fazio, & Wodehouse, 2003).

Figure 1: Bracket system that is used to hold the timber beam of Horyuji Temple