UNIVERSITI PUTRA MALAYSIA

STRUCTURAL APPLICATIONS OF MALAYSIAN BAMBOOS

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MASTER OF SCIENCE

(STRUCTURAL ENGINEERING)

UNIVERSITI PERTANIAN MALAYSIA

STRUCTURAL APPLICATIONS OF MALAYSIAN BAMBOOS

by

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B.E. (Agricultural) (UPM)

thesis submitted in partial fulfilment of the requirements for the degree of
Master of Science in Structural Engineering in the
Department of Civil and Environmental Engineering
Faculty of Engineering
Universiti Pertanian Malaysia.

1987

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Date: 14 MAY 1987

Dean of Graduate Studies

ACKNOWLEDGEMENT

The author wishes to express his gratitude and thanks to Ir. Abang Abdullah Abang Ali, Associate Professor and Dean, and Dr. S.A. Salam, Associate Professor of Civil Engineering, for their valuable supervision, encouragement and help to make this study possible.

Thanks are also to Mr. Wong Khoon Meng, Botanist, Forest Research Institute, Mr. Ismail Hashim, Lecturer of the Faculty of Forestry, Universiti Pertanian Malaysia and Mr. J.J.A. Janssen, Senior Lecturer, Eindhoven University of Technology, Netherlands, for their helpful advice.

The author also wishes to extend his thanks to Mr. Ghazali Said and Mr. Mohd. Rashid, technicians, Strength of Materials Laboratory for their help in collecting test materials and laboratory testing.

The author also wishes to acknowledge his debt to the many books and review papers from which he has consulted.

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A	Average cross-sectional area of test specimen in mm^2.
A_s	Total shearing areas in mm^2.
d_i	Inner diameter of test specimen in mm.
d_o	Outer diameter of test specimen in mm.
E	Modulus of elasticity.
L	Distance between supports in mm.
m	Mass of test specimen in gm.
m_o	Oven-dry mass of test specimen in gm.
M	Percentage moisture content (dry weight basis).
P	Maximum load in Newton.
P'	Load in Newton at limit of proportionality.
S_g'	Specific gravity at test condition.
S_g	Adjusted specific gravity.
t	Average wall thickness of test sample in mm.
v	Volume of test specimen in cm^3.
δ	Change in gauge length as measured with an extensometer.
Δ	Mid-span deflection in mm at limit of proportionality.
σ_b	Ultimate bending stress.
σ_c	Ultimate compressive stress (parallel to the grain).
σ_c'	Compressive stress at limit of proportionality.
σ_m	Crushing strength per unit wall thickness.
σ_s	Ultimate shearing stress.
σ_t	Ultimate tensile stress.
σ_t'	Tensile stress at limit of proportionality.

ABSTRACT

An abstract of the thesis submitted to the Senate of Universiti Pertanian Malaysia as partial fulfilment of the requirements for the degree of Master of Science.

STRUCTURAL APPLICATIONS OF MALAYSIAN BAMBOOS

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1987

Supervisor: Abang Abdullah Abang Ali

Faculty: Faculty of Engineering

This experimental study to determine the structural applications of Malaysian bamboo is divided into three main parts namely a study on the physical and mechanical properties of three selected species of Malaysian bamboo, testing of four types of bamboo connectors, and testing of two mono-pitch trusses.

It was found that the physical and mechanical properties of Malaysian bamboo tested are similar to those of light hardwood. Based on the strength properties obtained, it can be concluded that the bamboo species selected are suitable for use in construction. For the species tested, the Gigantochloa levis species was found to be the strongest, followed by the Dendrocalamus asper and Bambusa blumeana species.

Of the four bamboo connectors tested, it was found that the bolted-plywood bamboo connector showed better strength results. The other types of bamboo connectors tested suffered considerable slip at the joints.

It was also found that the mono-pitch bamboo truss is of sufficient strength to be utilised for home construction. A spacing of up to two metres could be used if the trusses are to carry a corrugated asbestos roof over a span of 4.5 metres.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian daripada syarat keperluan Ijazah Master Sains.

KEGUNAAN STRUKTUR BAGI BULUH-BULUH DI MALAYSIA

oleh

Yap Chee Lin

1987

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Kajian ujikaji ini yang bertujuan untuk menentukan kegunaan struktur bagi buluh-buluh di Malaysia dibahagikan kepada tiga bahagian utama iaitu kajian ke atas sifat-sifat fizikal dan mekanikal tiga jenis buluh terpileh yang terdapat di Malaysia, ujian kekuatan empat jenis penyambung buluh, dan ujian kekuatan dua kekuda curam sehala.

Hasil kajian menunjukkan buluh-buluh yang diuji mempunyai sifat-sifat fizikal dan mekanikal yang sama dengan yang terdapat pada kayu keras jenis ringan. Berdasarkan kepada sifat-sifat kekuatan yang diperolehi, dapat disimpulkan bahawa jenis-jenis buluh yang diuji adalah sesuai digunakan dalam pembinaan. Daripada jenis yang diuji, Gigantochloa levis mempunyai kekuatan yang tertinggi sekali dikutii oleh Dendrocalamus asper dan Bambusa blumeana.

Daripada empat jenis penyambung buluh yang diuji, penyambung buluh yang menggunakan papan lapis dan bolt memberikan kekuatan yang lebih baik. Penyambung-penyambung jenis lain mengalami kegelinciran yang tinggi pada sambungan.

Adalah didapati juga bahawa kekuda buluh curam sehala mempunyai kekuatan yang memadai untuk digunakan dalam pembinaan rumah. Satu jarak sehingga dua meter boleh digunakan jika kekuda-kekuda ini menyokong bumbong asbestos berombak pada rentang 4.5 meter.

CHAPTER 1

INTRODUCTION

1.1 General Introduction

Low-cost housing is important to many countries in the developing world. A fast increase in population and an active migration to urban areas resulting in the growth of slums and squatter colonies, contribute to the urgency of the problem. Today, it has become a serious national problem in many developing countries.

Efforts are being made to find ways by which indigenous raw materials can be fully utilised to produce building materials. The development of cheap building materials from locally available raw materials such as agricultural, forest and industrial wastes, can contribute to the success of low-cost housing programmes. Although research into non-conventional building materials which can be used in low cost housing has started way back in the seventies, research and development activities on bamboo technology for housing in Malaysia has remained fragmentary. The use of this material which is found in abundance in many parts of the country should be encouraged.

1.2 Bamboo resources in Malaysia

In Malaysia, bamboos are commonly found in the rural areas and they can be divided into village or cultivated bamboos, and native or forest bamboos. The native bamboos are normally seen on the fringes of the forest, on steep hill sides and in clearings. Holtum[1] reported that they can be found in regions from sea level up to the top of the Main Range, wherever the conditions are conducive to their growth. Cultivated bamboos are easily found along streams as well as planted in clusters around country homes. They play an important role in sustaining the traditional life styles within the village communities.

Forest management in Malaysia has for a long time neglected bamboo as a resource to be exploited systematically. It is at present being considered as weeds, interfering with timber growth and regeneration. Various physical and chemical methods have been experimented by Watson & Wyatt-Smith[2], and Chin[3] to eliminate bamboos. In the few instances where bamboo has been considered as a resource, licenses or permits are issued for their extraction where a nominal amount of royalty is collected.

Ueda and Ono[4] maintained that there are more than seventy species of the genera Bambusa, Gigantochloa and Schizostachyum in Peninsular Malaysia. However, Salleh & Wong[5] commented that there has never been an attempt to properly inventorise bamboo resources in this country. Nevertheless, during forest inventories, the occurrence of bamboo has

been routinely noted but not quantified. Thus these inventories do not provide the amount of bamboo available in the country. Nevertheless, McGarth[6] reported that there were 50,000 acres of land in Peninsular Malaysia holding varying densities of bamboo growth.

Anon[7] maintained that an attempt had been made in 1981 at quantifying the stocking of bamboo and rattan in the state of Kedah. The inventory confirmed that bamboo occurred significantly, more within logged-over areas than within undisturbed forests. Table 1.1 compares the resource abundance as estimated through this inventory.

TABLE 1.1

THE ABUNDANCE OF BAMBOOS IN UNDISTURBED AND LOGGED-OVER FOREST AREAS IN THE STATE OF KEDAH

		Bentong-type bamboo (*Gigantochloa* spp.)		Bamboo of other species	
Forest type	Area (ha)	No. of 6-m lengths harvestable	Dry weight (tonne)	No. of 3-m lengths harvestable	Dry weight (tonne)
Undisturbed	126,829	1,585,000	10,500	3,171,000	3,900
Logged-over	173,776	25,371,000	169,100	148,752,000	181,400
Total	300,605	26,956,000	179,600	151,923,000	185,300

(Source: Anon.[7]).

However, no similar attempt has been made in the other states of Malaysia; which would allow an estimate of the extent of occurrence and amount of bamboo present in the whole country.

Salleh & Wong[5] also reported that studies are underway to revise the identification and classification procedures of bamboos and to provide a comprehensive field key to their identification. It is now known that there are 45 species of bamboos found in Peninsular Malaysia, including 25 that are indigenous. The species found are of various dimensional sizes and growth habits.

1.3 Utilization of bamboos

Bamboos are used for many different purposes by the village people of Malaysia and may be described as a necessity of their life. Even in this modern age, the usefulness of bamboos continues, and is likely to continue. Many traditional uses of bamboo have been documented but there is no quantitative assessment of the extent of utilisation of bamboos in the rural communities. Wong[8] commented that the type of bamboos and how they are used depend on circumstances. Attributes of stem size and wall thickness, which influence the range of utilization, are important characteristics of the species.

Wong[8] reported that on the organised scale, bamboo has been used to make vegetable baskets (in the state of Perak), poultry cages (Kedah state), and incense sticks (Selangor state). These cottage industries are based where the Gigantochloa scortechinii species grows in large quantities. In the state of Perlis, the Schizostachyum zollingeri species