UNIVERSITI PUTRA MALAYSIA

STRUCTURAL RUBBERWOOD LVL : AN ENGINEERED WOOD PRODUCT FOR PREFABRICATED TIMBER ROOF TRUSS

CHEE YUH SHENG

FH 2003 20

STRUCTURAL RUBBERWOOD LVL : AN ENGINEERED WOOD PRODUCT FOR PREFABRICATED TIMBER ROOF TRUSS

CHEE YUH SHENG

GRADUATE SCHOOL
UNIVERSITI PUTRA MALAYSIA

2003

STRUCTURAL RUBBERWOOD LVL :
AN ENGINEERED WOOD PRODUCT FOR
PREFABRICATED TIMBER ROOF TRUSS

BY
CHEE YUH SHENG

A paper submitted in partial fulfillment of the requirements
for the Degree of Master Science
in Wood Industry and Technology
Graduate School,
Universiti Putra Malaysia

May 2003

Abstract of professional paper submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

STRUCTURAL RUBBERWOOD LVL – AN ENGINEERED WOOD PRODUCT FOR
PREFABRICATED TIMBER ROOF TRUSS

By
Chee Yuh Sheng

Supervisor : Prof. Madya Dr. Paridah Md. Tahir

Timber roof truss system is one of the major structural application of timber in the housing industry in the country. Since its introduction into the local roof market in 1975, prefabricated timber roof truss system have earned a good reputation as they are designed using advanced structural engineering principles. The timber species such as Balau, Kekatong, Keranji, Resak, Merbatu and Kempas, are commonly preferred or specified to be used for roof truss fabrication. These species are belonged to the strength groups of SG1 to SG4, in accordance to timber strength grouping in MS 544 : Part 2 : 2001. However in recent years, the supply of these excellent strength wood species has been declining due to gradual depletion of natural forest and the reduction of logs production. On the other hand, the demand for timber in the prefabricated timber roof truss industry is continue to grow. As a result, lesser-known timber species and lower strength groups timber, commonly grouped under 'chap char' in the local timber trade, were 'conveniently' mixed and supplied into the market. If this situation continue to be unchecked and not properly addressed, it will bring serious adverse implication to the local timber trade and industry. Therefore a long term solution, an alternative structural material for the timber roof truss industry, should draw attention and concern to conduct research in this area. The purpose of this paper is to determine the structural properties of LVL made from Rubberwood and Radiata Pine. These structural LVL were manufactured by CHG Plywood Sdn. Bhd.'s LVL plant and the specimens were send to UiTM Shah Alam for strength properties test. The test were conducted in accordance to AS/NZS 4063 : 1992. The results show that Rubberwood LVL falls in the SG4 category which is compatible to Resak, Kapur, Kasai and some of Meranti species, and its bending strength properties is superior than LVL made from Radiata Pine. The paper conclude that Rubberwood LVL poses sound structural properties which can provide an alternative material for the prefabricated timber roof truss industry in the country.

ACKNOWLEDGEMENTS

Praised the Lord for His love and kindness.

I wish to express my most sincere thanks and gratitude to my supervisor, Prof. Madya Dr. Paridah Md. Tahir for her guidance, suggestion, advice and encouragement throughout the course of writing this paper.

My sincere appreciation is due to Prof. Madya Zakiah Ahmad and Prof. Madya Dr. Azmi Bin Ibrahim of Faculty of Civil Engineering, Universiti Technology Mara, for their kind assistance and support in carrying out the testing which have contributed to the success of this paper.

For my wife Mui and daughter Qian Ning, thanks for your loves and cheers during the course of my study.

DECLARATION

I hereby declare that the paper is based on my original work except for quotations and citations that have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institution.

Name : CHEE YUH SHENG

Date : May 2003

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

CHAPTER 1

INTRODUCTION

1.1 Background

Traditionally, indigenous architecture in the country, in particular the houses, has been predominantly timber based. Unfortunately, due to economic and other reasons and perhaps the changing environment, timber construction in the country has been replaced mainly by concrete construction. Currently, the sole major of timber application in the country's housing industry, particularly for structural application, is for making roof trusses.

Prefabricated timber roof truss system has been introduced into the local roof market in 1975, since then it has earned a good track record and dominated the building and housing industry, because the system is designed based on sound structural engineering principles. The timber species such as Balau (*Shorea* spp.), Kekatong (*Cynometra* spp.), Keranji (*Dialium* spp.), Resak (*Vatica* spp.) and Kempas (*Koompassia malaccensis*) are commonly preferred or specified to be used for roof truss fabrication because of their excellent strength properties. These species are belonged to the strength groups of SG1 to SG4, in accordance to timber strength grouping in MS 544 : Part 2 : 2001.

The use of these lesser-known wood species with their unknown strength properties and durability in roof truss, definitely do not provide the assurance of safety in the roof structure of the building. The lack of quality assurance practiced by some of timber roof truss fabricators were linked to few incidents of roof collapses recently reported in the country, which has leading to the suspension of prefabricated timber roof truss by JKR in their construction projects (Master Builders Journal 1st Quarter 2002).

1.2 Statement of Problem

In recent years, the supply of these preferred timber species has been declining due to gradual depleting of natural forest and the reduction of logs production. On the other hand, the demand for timber in the prefabricated timber roof truss industry is continue to grow, as a result, lesser-known timber species and lower strength groups timber, commonly grouped under 'chap char' in the local timber trade, were 'conveniently' mixed and supplied into the market. Regular supply of consistence quality timber for the prefabricated timber roof truss industry in the country has become an issue. An alternative of timber supply need to be sought after to address the supply and quality issues. At this juncture Structural Laminated Veneer Lumber (SLVL) would offer an ideal solution.

1.3 Justification

Several studies have been done on structural properties of LVL made from some Malaysian Hardwood species by Wong E.D. (1995), Jenny Chin S. C. (1997) and Chuo T. W (1999). However, dwindling of our forest resources is foreseeable that the future supply of wood species from the natural forest is getting lesser. Therefore dependant of natural forest wood species in abundant and regular supply for processing into LVL is not a viable business strategy.

Under such a scenario of raw material supply, Rubberwood is seen to be an important source. As a plantation species which is vastly available, can be supported in long run by replanting program, the wood supply is warrant with sustainability. Hence, more R&D efforts should have focus on Rubberwood as a material for SLVL manufacturing in the country.

1.4 Objectives

The objective of the paper are :

a) To investigate the structural properties of LVL made from Rubberwood

b) To classify Structural Rubberwood LVL into timber strength grouping in accordance to MS 544 : Part 2 : 2001

c) To compare the structural properties of solid Rubberwood LVL and Radiata Pine LVL.

CHAPTER 2

LITERATURE REVIEW

2.1 Laminated Veneer Lumber

Laminated Veneer Lumber (LVL) is a wood composite product consist of wood veneers and adhesive. Veneers are mainly rotary peeled, dried and laminated together under high temperature and pressure, in case for exterior structural application, phenolic resin is commonly used. Laminated Veneer Lumber (LVL) also known as parallel laminated veneer (PLV) because of the orientation or lay-up of the veneer layers, where the wood grain of all plies running in parallel direction to the length, during the manufacturing process (Rauma-Repola, 1985).

With the high quality resource being a constraint, in this case good quality of raw material in large diameter log form, lower quality and small diameter logs can be converted into veneers and then reconstitute it together with adhesive, randomizing the defects in any piece of the reconstituted wood. As a result, the reconstituting process produces homogenous and uniform structure. This would allow greater working strengths on the reconstituted lumbers and a freedom to make them into any size or length. So, essentially, LVL is an engineered or man-made lumber.

LVL has been commercially produced since the early 1970's in North America. Improvements in properties of LVL have been achieved through continuous research in various aspect of manufacturing i.e. end jointing of veneers, hot pressing, quality control and resin technology (Chui et al., 1994). Being an engineered wood, structural grade LVL has the similar characteristics like a sawn lumber, but with a much uniform properties through out the whole piece of lumber, therefore it has superior structural properties compared to a piece of natural sawn lumber of the same wood species.

2.2 Advantages of LVL

There are many advantages of LVL over sawn lumber (Asian Furniture. September 1999, pg. 64), they are :

2.2.1 General

1. It can be made from small diameter logs.
2. It can be made from low strength wood species.
3. It can be made of relatively thick veneer (fewer plies, less glue).
4. It can be produced in large volumes.
5. It requires minimal veneer grading.
6. It can be sold 20-30% more than sawn lumber
7. It does not require extensive engineering support.

2.2.2 Technical

1. Higher design strength values.
2. Absence of wane.
3. More uniform moisture content.
4. Better dimensional stability and uniformity.

2.2.3 Marketing

1. Great variety of sizes.
2. Engineered qualities.
3. Better looking

2.2.4 Economic

1. Higher recovery than sawn lumber.
2. Higher value end product
3. Entire product is 100% usable.

2.3 Applications of LVL

The application of LVL as construction material in homes and buildings is not new in the developed nations, especially in North America and Scandinavia the usage is on the increase. LVL is commonly used as construction material in homes, construction and in low-rise commercial constructions. It is often preferred by designers because it provides freedom while designing which is otherwise difficult to obtain with conventional sawn lumber. It is used for beams, joists, heades, girders, trusses and purlins. LVL is also used as flange material in I-beams, a product that uses the strength of LVL and rigidity of OSB producing a strong, lightweight building material that is making strong inroads into the floor joist market. LVL has appeared in the market place as a replacement for increasingly scarce high quality solid sawn lumber in structural applications (Vlosky et. al., 1994).

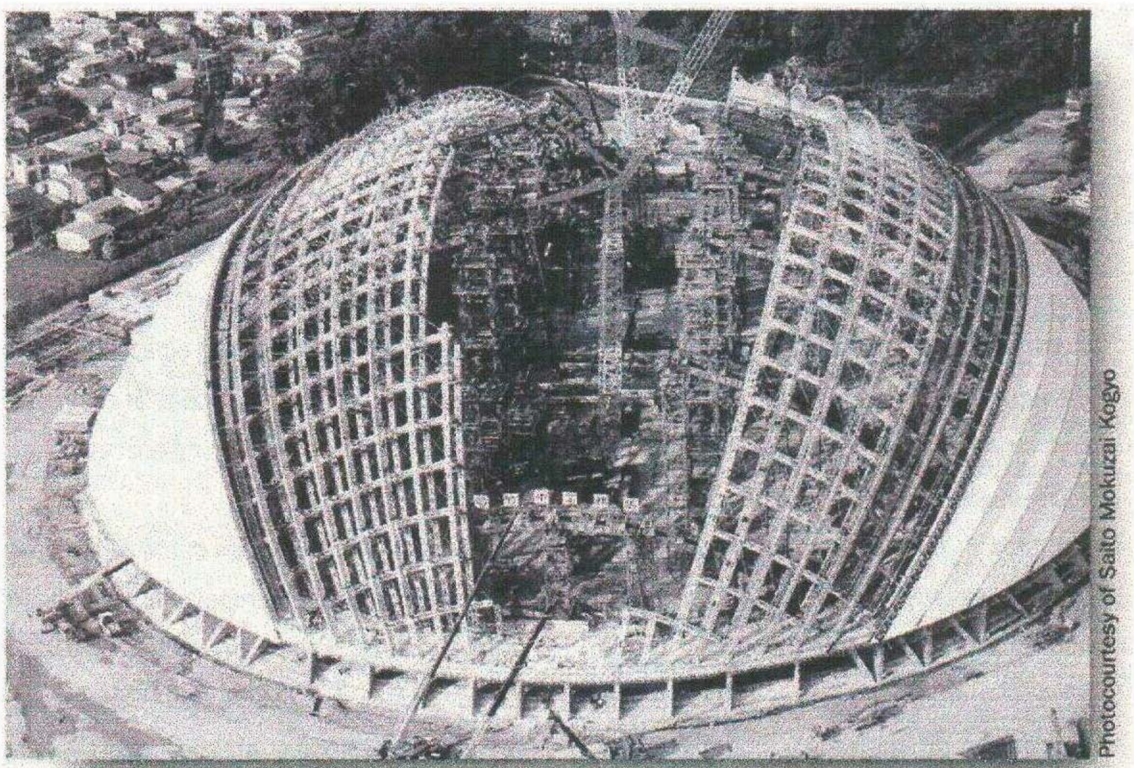
Table 1 illustrates comparison between LVL and structural lumbers, its properties, applications and dimension available.

Table 1 : Comparison between LVL and stress-graded lumber.
(Numbers according to Finnish standards and based on use of Finnish softwood)

	LVL	Stress-Graded Lumber (T30)
Allowable stresses (MPa)		
a. MOR	1.6	1.1
b. MOE	10,000	7,000
c. Shear	1.7	1.0
Main applications	joists, roof trusses, purlins, I-beams	Studs, roof trusses, load-bearing structures
Max. dimension offered		
a. Length	Unlimited	6,000mm
b. Width	75mm	150mm
c. Thickness	1,200mm	225mm

Source : LVL Technology. Asia Pacific Forest Industries. December 1992. Pg. 34.

The typical advanced application of LVL are for structural construction of Olympic Stadiums, modern bridges, high-rise and commercial buildings and so forth in the North America and Scandinavia countries.



Under construction is the Odate dome, the world's largest wooden dome.

Plate 1 : Construction of super structure, wooden dome, using LVL.
(Photo taken from Asiantimber Vol.19 No.7, July 2000 Pg.28)

2.4 Prefabricated Timber Roof Truss

Since its introduction into the local roof market in 1975, prefabricated timber roof truss system has earned a good track record and has dominated in the building and housing industry. Unlike the conventional roofing system that involves nailing together of numerous individual roof components at the construction site, prefabricated timber roof truss is an integrated building components which forms part of the Industrialised Building System (IBS) developed and widely used now in the developed countries, whereby individual roof components have been assembled, designed based on sound engineering principles, in the factory. The assembled roof components are delivered to the construction site and bolted together to form large dimension, well spaced frameworks roof system for the buildings.

Prefabricated timber roof truss system employed small sections of timber, and held together by proprietary punched metal plate fasteners, which are fabricated in a factory, to form lightweight frameworks for the roof structure. The roof structure is made by positioning the truss rafters at a close interval to each other. The trusses are regarded as engineered component parts of a roof system that are designed using established engineering principles. The roof system designs are provided by the proprietor of the metal plate fasteners. The design process dictates the strength group of the timber (e.g. SG1, SG2 etc. in accordance to Malaysian Standard MS 544:Part 2:2001) and size to be used by each member of the truss, as well as the size and location of the punched metal plates. This is to ensure the system would perform its function securely as expected.

Plate 2 : Roof structure constructed using prefabricated timber roof truss for a typical double storey house

Plate 3 : Closer look at single unit of prefabricated timber roof truss framework

2.5 LVL Used as Prefabricated Timber Roof Truss

One of the most commercially produced LVL intended for the prefabricated timber roof truss is Hyspan, a well recognized brand name of structural laminated veneer lumber manufactured by Carter Holt Harvey Wood Products, Australia. Hyspan is manufactured by laminating radiata pine veneers, using phenolic adhesive, in a continuous press line. The manufacturing process is conforming to the requirements of AS/NZS 4357:1995 Structural Laminated Veneer Lumber.

The structural properties for Hyspan have been determined by testing in accordance to method specified in AS/NZS 4063:1992 Timber-Stress-graded-In-grade Strength and Stiffness Evaluation. The published structural design properties of Hyspan is given in Table 2.

Table 2 : Design properties for Hyspan.

Design Properties For Hyspan		
Modulus of Elasticity	E	13,200 MPa
Basic Working Stresses		
Bending, MOR	F'b	16.0 MPa
Tension parallel to grain	F't	10.0 MPa
Compression parallel to grain	F'c	13.0 MPa
Shear	F's	1.7 MPa
Compression perpendicular to grain	F'p	4.7 MPa
Joint Strength Group		JD4

Source : Hyspan ® Span Tables for Residential Building. Carter Holt Harvey Wood Products, Australia. November 1997.

.Plate 4 : Hyspan used in construction of roof structure for residential house.
(Photo taken from Hyspan ® Span Tables for Residential Building. Carter Holt Harvey Wood Products, Australia. November 1997)

2.6 Rubberwood

2.6.1 General Characteristic

Botanical name *Hevea brasiliensis*. Rubberwood is moderately hard and heavy with a density of about 640 to 700 kg/m3 (at 15% MC), and is classified as a light hardwood. There is no distinct difference between sapwood and heartwood which is creamy white when freshly cut and becoming pale pink and a light straw colour after exposure. The wood has straight grains and a moderately coarse texture.

Rubberwood contains abundant starch hence it is susceptible to stain and damage by Lyctus (powder post) borers in dry wood, therefore it is classified as non-durable wood species under the Malaysian Forest Service Trade Leaflet No.4 issued by The Ministry of Primary Industries, published by The Malaysian Timber Industry Board (First Published 1975. Revised 1981). However, it is a fairly easy timber to treat with insecticide and fungicide for properties enhancement, because its wood vessels are moderately large to large and have simple perforations. In term of working properties ; the timber is easy to plan, bore and having good nailing property.

It is the most popular timber for Malaysian furniture manufacturing; also suitable for panelling, parquet flooring, staircases, utility articles and block board cores. (100 Malaysian Timbers, MTC Light Hardwood)