ANALYSIS OF NAIL WITHDRAWAL STRENGTH IN ROOF SYSTEM

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ABSTRACT

Current record show that failure due to wind storm in Malaysia has been increasing year by year. This natural disaster has a lot of negative impact especially to the public property. There are many factor to this failure occurs. From previous study, typical structure damage due to wind storm is roof and truss. Therefore, objective of this study is to determine the shear stress nail to the wood in roof connection system. There are three types of wood and two different size of nail will be tested. This study focus on examined the effect of types of wood and nail withdrawn force with specific depth. Result from this study determined that the higher the specific gravity of wood will increase the resistance shear force. The result also shown that increasing the depth of nail will increase the capacity force. It can be concluded that specific gravity and depth of nail is important to resist uplift force.

ABSTRAK

Rekod semasa menunjukkan bahawa kegagalan bumbung berfungsi disebabkan angin kuat dan ribut telah meningkat dari tahun ke tahun. Fenomena semula jadi ini telah membawa kesan buruk kepada terutama kepada harta benda awam. Banyak faktor menjurus kepada kegagalan ini. Faktor utama adalah disebabkan kegagalan sistem bumbung dan kekuda. Oleh itu, objektif kajian adalah untuk menentukan tegasan ricih kayu dalam sistem bumbung rumah. Tiga jenis kayu yang berlainan dan dua paku berbeza saiz akan diuji. Fokus kajian ini adalah untuk mengkaji kesan jenis kayu dan kuasa tarikan paku dengan kedalaman yang berbeza. Hasil kajian menunjukkan semakin besar gravity tentu kayu akan meningkatkan daya rintangan ricih. Hasil kajian juga menunjukkan bahawa peningkatan kedalaman kayu akan meningkatkan daya keupayaan. Kesimpulannya, graviti tentu kayu dan kedalaman paku adalah penting untuk menahan daya uplift.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Failure due to wind storm in Malaysia has been increase year by year. In fact, in last decades much more losses have been caused by several windstorm if compare to other disasters. According to International Disaster Database (2004), wind storm are listed top 10 natural disaster affected Malaysia. (Majid, 2005). Table 1 show the description of the reported wind damage in Malaysia from 1996 to 2005. (Majid, 2005)

Table 1.1: Reported wind damage in Malaysia. (Majid, 2005)

Date	Place	Description
26 December 1996	Sabah	Killed 270 people in
12 February 1999	Kuala Lumpur	Several houses and buildings structures has damaged and destroyed by wind. Loses are estimated more than RM 250,000
16 August 2004	Bukit Mertajam Seberang Perai	Twenty vehicles damage because roof apartment falling down
19 February 2005,	Sungai Siput, Perak	38 numbers of house damaged due to windstorm

Table 1 shows the recent damage due to windstorm in year 2010(Jan – Aug). It can be shown that most of the damage occurs in northern region on peninsular Malaysia. Furthermore it clearly state that most structure failure is roof and truss. The consequence of flying canopy and also flying debris had been noted as most dangerous hazardous. Figure 1a-1d show damage occurs due to windstorm.

Table 1.2: Damage due to Wind Storm in Malaysia (January – August 2010) (T.A. Majid et al, 2010)

	Place	Region	Numbers of Affected	Structure Damage
27-Jan-2010	Sungai Petani, Kedah	Sungai Petani, Kedah	350 Houses	Roof and Truss
5-Apr-2010	Bukit Mertajam, Penang	Northern Peninsular	21 Houses	Roof and Truss
5-Apr-2010	Mergong, Kedah	Northern Peninsular	13 Houses	Roof and Truss
12-Apr2010	Baling, kedah	Northern Peninsular	200 Houses	Roof and Truss
13-Apr-2010	Merbuk, Kedah	Northern Peninsular	150 Houses	Roof and Truss
22-Apr-2010	Sg besi - Kg Malaysia	Middle Peninsular	18 Houses	Roof and Truss
1-May-2010	Ulu Bernam, Selangor	Middle Peninsular	Secondary School	Roof and Truss
31-May-2010	Parit buntar-Perak	Northern Peninsular	*	Roof and Truss
11-Jun-2010	Batu Gajah-Perak	Northern Peninsular	30 houses	Roof and truss
13-Jun-2010	Temerloh, Pahang	Eastern Peninsular	9 houses and School	Roof and truss
7-July-2010	Beaufort, sabah	Eastern Borneo	50 houses	Porch, Roof
15-July-2010	Kuala Perlis, Perlis	Northern Peninsular	150 houses	Roof and truss
12-Aug-2010	Temerloh, Phang	Eastern Peninsular	20 houses Canopy	Roof Night Market

			Damage	
13-Aug-2010	Malacca	Southern Peninsular	Canopy Damage 3 Kills 30 injured	Night Market (Flying Debris
14-Aug-2010	Jerlun, Kedah	Northern Peninsular	1 Houses, Crop	Roof
14-Aug-2010	Petaling Jaya, Selangor	Middle Peninsular	*	Roof and truss
31-Aug-2010	Tanjung Malim	Middle Peninsular	Canopies Damage	Night Market

Figure 1.1: After Thunderstorm (T.A. Majid et al, 2010)

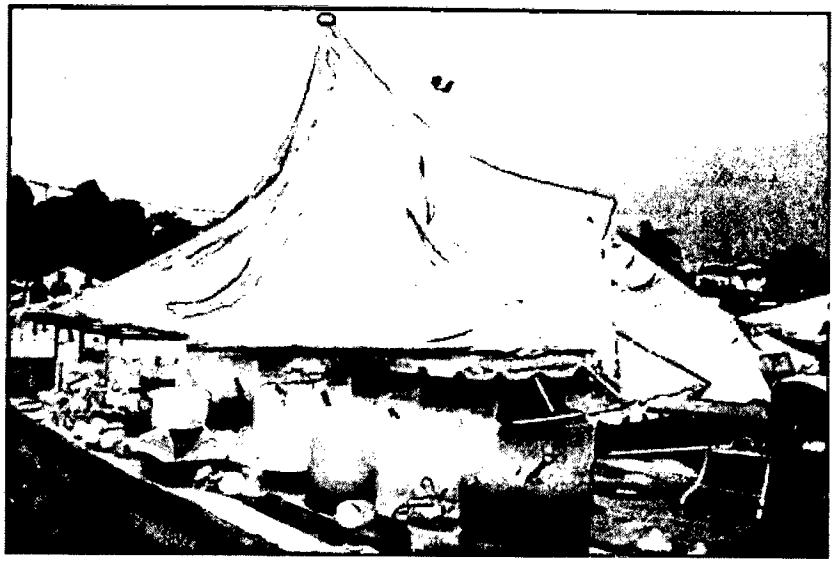

Figure 1.2 : Canopy Collapse (T.A. Majid et al, 2010)

Figure 1.3 : Roof Damage (T.A. Majid et al, 2010)

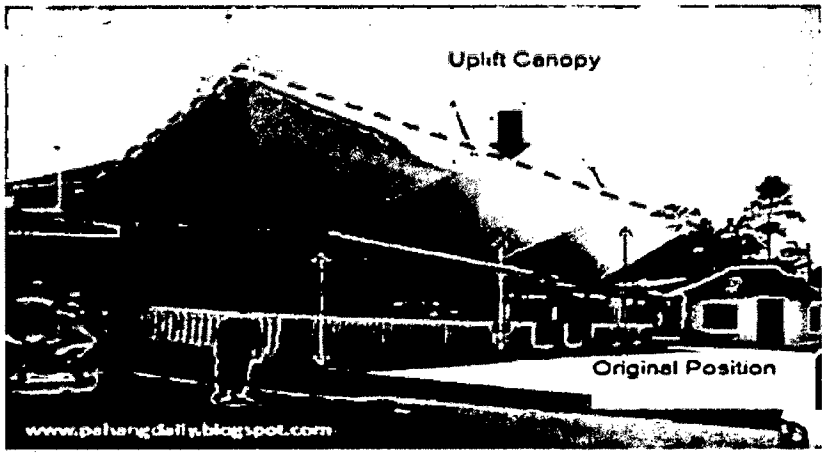

Figure 1.4: Uplift canopy (T.A. Majid et al, 2010)

1.2 Problem statement

Most of failure of roof system is occur at roof and truss. The important part of roof and truss is nail and wood. Nails are widely used as a joint component of furniture construction and since each wood species has its own properties, they also have different nail withdrawal resistance. Therefore, it is important for both producers and consumers to be aware of the best nail withdrawal resistance for the various wood species.

This study will be focus on to determine the maximum resistance of oven dried wood perpendicular to grain.

1.3 Objective of the study

The objective of this research is:

- To determine the shear stress nail to wood in roof connection system
- To obtain the relationship between nail and wood

1.4 Scope and limitation of study

The scope of work for this study will be involved three types of wood that is Cengal, Merbau and Pulai.. First, this specimen will be weight at dry and wet condition and will be put in the over for 24 hours. After that, the specimen will be weight. This formula will be used to determine the specific gravity of the specimen.

$$SG_{true} = \frac{\rho_{sample}}{\rho_{H_2O}} = \frac{(m_{sample}/V)}{(m_{H_2O}/V)} = \frac{m_{sample}}{m_{H_2O}}\frac{g}{g} = \frac{W_{V_{sample}}}{W_{V_{H_2O}}}$$

Two different diameter and depth of nail will be testing. This type of nail is commonly used in construction. (Aytekin, 2008)

CHAPTER 2

LITERITURE REVIEW

2.1 Wood / Timber

Wood is a hard, fibrous tissue found in many trees. It has been used for hundrends of thousands of year for both fuel and as a construction material. It is an organic material, a natural composite of cellulose fibers embedded in matrix of ligin which resist compression. Wood is sometimes defined as only the secondary xylem in the stems of trees.

In this study, three types of wood are selected. There are Cengal, Merbau and Pulai.

2.1.1 Cengal

Cengal or neobalancarpus heimii is a species of plant in the Dipterocarpaceae family. It is found in Malaysia, Singapore and Thailand. Cengal are straight-boled, large hardwood attaining 25 m in height on good sites. Chengal predominantly occurs in peninsular Malaysia under a wide range of conditions from low-lying swamp flats to hills at 10 000 m. The timber is a Heavy Hardwood with a density of 915-980 kg/m^3 air dry.

The sapwood is light yellow and sharply defined from the heartwood, which is light yellow-brown with a distinct green tinge, darkening on exposure to dark purple-brown or rust-red. The timber is classified as naturally durable and is normally very resistant to termite attack and fungal infestation. Texture is fine and even, with shallowly to deeply interlocked grain.

Chengal is suitable for all forms of heavy construction, railways sleepers, heavy duty furniture, laboratory benches, bridge, marine construction, boat building, and telegraphic and power transmission posts and cross arms, piling, mallets and other uses where strength and durability are required. (Exism Marketing Sdn Bhd, 2008)

Table 2.1: Strength Properties of Cengal (Exism Marketing Sdn Bhd, 2008)

Test Condition	Modulus of Elasticity (MPa)	Modulus of Rupture (MPa)	Compression parallel to grain (MPa)	Compression perpendicular to grain (MPa)	Shear strength (MPa)
Green	18,100	122	69	12	14
Air dry	19,600	149	75	12	14

2.1.2 Merbau

The Standard Malaysia name for this timber is Afzelia rhomboidea (Leguminosae). This species is found in Sabah and Sarawak only. Vernacular names applied include ipil (Sabah and Sarawak) with various epithets and merbau tanduk (Sabah). Only one species has been recorded in Malaysia. The timber is moderately hard to hard and is moderately heavy to heavy with density of 850 – 900 kg/m^3 air dry.

Although this timber is very dense, the timber work fairly well, dressed and turns to a smooth surface. However, the rather greasy characteristics of the wood tend to clog saws and planer blades easily.

The appearance of this timber is the heartwood is orange-brown or dark red-brown while the sapwood is usually pale yellow and very easy to distinguish. This timber is reputed to be very durable. The texture is moderately coarse but even with an interlocked grain and highly visible vessels containing a yellow substance as well as the presence of growth rings.

Merbau, Ipi or Kwila is a very attractive wood, with its growth ring figure and deep color. The timber is suitable for interior finishing, paneling, office fittings, flooring, superior joinery, cabinet- making, musical instrument, ornamental items and carvings.

The timber is widely used for the manufacture of reproduction antique furniture and strip flooring in the country. It is also suitable for heavy construction, power transmission poles, railway sleepers, decking, door and windows framed.

Table 2.2: Strength Properties of Merbau (Exism Marketing Sdn Bhd, 2008)

Test Condition	Modulus of Elasticity (MPa)	Modulus of Rupture (MPa)	Compression parallel to grain (MPa)	Compression perpendicular to grain (MPa)	Shear strength (MPa)
Green	13,900	89.0	46.7	6.4	10.8
Air dry	15,400	116.0	58.2	9.2	12.5

2.1.3 Pulai

Pulai is the standard Malaysia name for the timber of Alstonia spp. (Apocynaceae). Vernacular names applied include mergalang (Sarawak), pelai (Sarawak), pulai (Peninsular Malaysia, Sabah and Sarawak). Major species include A.angustifolia, A. angustiloba, A.macrophylia. The timber is a Light Hardwood with a density of 210-500 kg/m^3 air dry.

The appearance of this timber is the sapwood is not different from the heartwood, which is cream to light yellow in color. Pulai is classified as not durable. This timber is very susceptible to both fungal and insect attacks. Textures are moderately fine to rather coarse, with straight to shallow interlocked grain.

Pulai is suitable for plywood, pattern making, fret work, carving, picture frames, matchboxes and splints, pencil and tooth picks. It has also been successfully used for

making wooden clogs as well as disposable chopsticks. The root-wood from A. spatula and A. pneumatophora, which is known as basong, is very light, only 50-80 kg/m^3 air dry and has been used in the manufacture of pith-helmets.

Table 2.3: Strength Properties of Pulai (Exism Marketing Sdn Bhd, 2008)

Test Condition	Modulus of Elasticity (MPa)	Modulus of Rupture (MPa)	Compression parallel to grain (MPa)	Compression perpendicular to grain (MPa)	Shear strength (MPa)
Green	6,200	33.0	16.0	-	6.1
Air dry	7,100	43.0	25.0	-	6.3

2.2 Nail

Hand-forged nails were the first manufactured nails, and they date back to Biblical times. As people first used hewn beams, timbers, planks, and whole logs to build with, the early hand-made nails were spikes. With the development of the split wood shingle, nails of about 1" long came into use. When sawyers, and then sawmills, began cutting dimension lumber, the sizes and varieties of nails greatly expanded. Thus, over time, nails developed in different sizes, shapes, and used different heads to fasten lumber and wood. In conclusion, nail is important to construction stage.

Nails have always been in demand. Some blacksmiths made only nails and they were called "Nailers." Nails were so scarce (and expensive) in pre-1850 America that people would burn dilapidated buildings just to sift the ashes for nails. They did so because pulling the nails would have damaged most of them. After the nails were recovered, a blacksmith could easily straighten any nails that had been bent during construction. (Allen)

CHAPTER 3

METHODOLOGY

3.1 Introduction

The following chapter provides the reader information about the research methodology that will be conducted in this study in order to understand and to evaluate the investigation and the test result. In this chapter, it include research planning, explanation about material will be used, and also the method to determine shear force produce by the nail.

3.2 Material

3.2.1 Wood / Timber

In this testing, three type of wood is chosen. The type of wood is Cengal, Merbau and Pulai. This specimen is weight during dry and wet together the specific gravity data.

Figure 3.1:Merbau

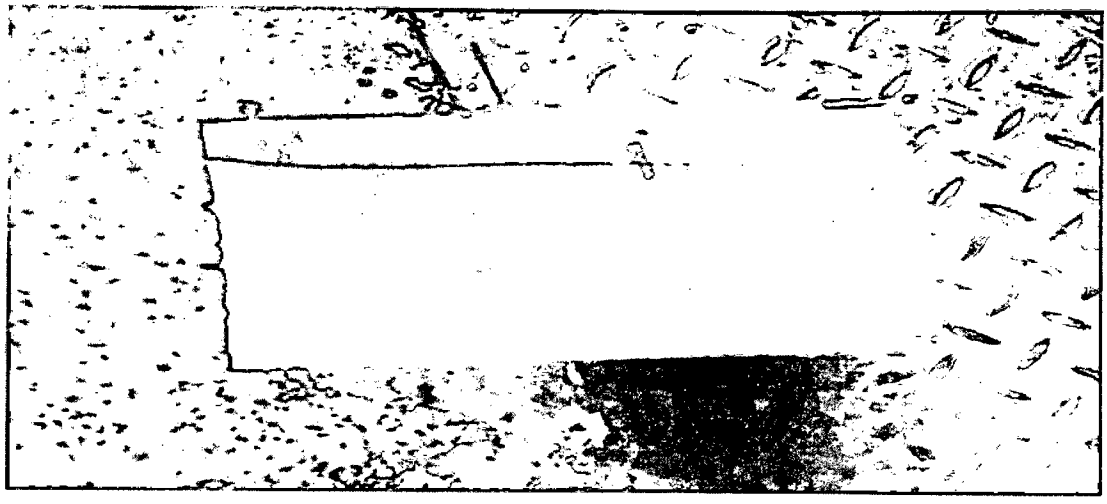

Figure 3.2: Cengal

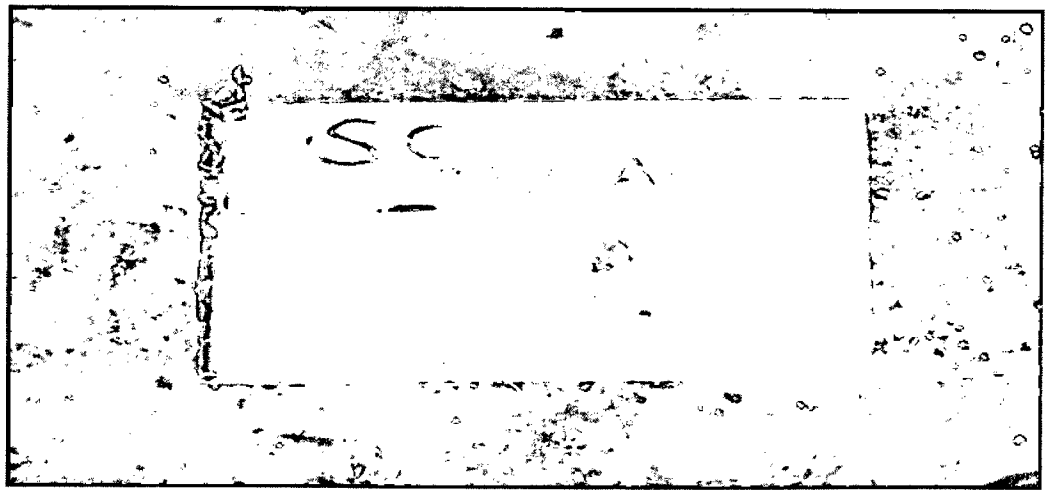

Figure 3.3: Pulai

3.2.2 Nail

In this study, two different depth and diameter of nail have been chosen. The nail specimen is as in figure below. The nail dimension is stated in the table 3.1. Three different depth of nail has been chosen. The depth of the nail to be study is 1 cm, 3 cm and also 5 cm.

Figure 3.4: Nail specimen