



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**STUDY THE MATERIAL PERFORMANCE OF ALUMINUM -
ZINC AND GALVANIZED IRON FOR ROOFING**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor's Degree in Manufacturing
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By

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Bumbung merupakan satu komponen yang bertindak sebagai tempat perlindungan bagi sebuah rumah. Terdapat banyak jenis bumbung seperti bumbung jubin, bumbung jerami, bumbung gentian kaca dan bumbung logam. Bagi projek kali ini, kajian tentang sifat-sifat mekanikal Aluminium-Zink, kepingan bumbung logam Alu-Zn dan Galvanized Iron, kepingan bumbung logam GI bagi sistem bumbung. Spesimen untuk ujian tegangan disediakan mengikut ASTM E8 dengan dimensi 165mm × 19mm × 0.3mm dalam bentuk tulang anjing. Untuk ujian keletihan pula ukuran mengikut ASTM E467 dengan dimensi 117mm × 26mm × 0.3mm dalam bentuk tulang anjing. Untuk ujian tegangan, nilai purata menunjukkan Alu-Zn adalah lebih tinggi berbanding dengan spesimen GI dengan nilai 347.46 MPa atau 53.81%. Keadaan ini berlaku kerana fasa Martensite berlaku pada spesimen Alu-Zn, pada suhu 600°C. Sementara itu spesimen GI muncul dalam fasa Bainite apabila disejukkan pada suhu bilik daripada suhu sebelumnya 450°C. Bagi ujian keletihan pula, pada kitaran 5 adalah had kitaran untuk spesimen Alu-Zn dengan daya yang dikenakan sebanyak 14.187 MPa. Pada peringkat ini, perubahan fasa berlaku daripada elastik kepada perubahan bentuk plastik. Sebaliknya, spesimen GI juga menunjukkan pada kitaran 5 adalah had kitaran untuk perubahan fasa dengan daya yang dikenakan sebanyak 6.959 MPa. Mengenai perubahan fasa, faktor yang mempengaruhi setelah daya yang berbeza dikenakan adalah 50.98% kepada spesimen Alu-Zn berbanding spesimen GI dalam ujian keletihan adalah ikatan yang terbentuk antara atom bagi kedua-dua spesimen berikut. Spesimen Alu-Zn terdiri daripada ikatan kovalen dan ikatan logam, manakala spesimen GI terdiri daripada ikatan kovalen sahaja. Oleh itu, kajian ini telah mengenalpasti dengan jelas bahawa sifat mekanikal bagi spesimen Alu-Zn dan spesimen GI. Kajian ini juga telah mengenal pasti bahawa Alu-Zn mempunyai kekuatan tegangan yang lebih tinggi dengan nilai 347.46

MPa. Ujian keletihan pula telah menunjukkan bahawa pada kitaran 5 adalah had kitaran dengan daya yang dikenakan adalah 14.187 mpa.

ABSTRACT

Roofing is a part which is act as shelter for a house. There are many type of roofing such as tile roof, thatched roof, fiberglass roof and metal roof. For this project, to study about mechanical properties of Aluminum-Zinc, Alu-Zn sheet metal roof and Galvanized Iron, GI sheet metal for roofing system. Specimen for tensile testing prepared according to ASTM E8 with dimension of 165 mm × 19 mm × 0.3 mm in dog bone shape. For fatigue testing were prepared according to ASTM E467 with dimension of 117 mm × 26 mm × 0.3 mm in dog bone shape. For the tensile testing, mean value show that Alu-Zn specimen is higher compare to GI specimen by 347.46 MPa or 53.81%. This condition appear due to Martensite phase occur in Alu-zn specimen, from 600 °C. Meanwhile appear in GI specimen is Bainite phase when quench at room temperature from 450 °C. Fatigue testing showed cycle count of 5 cycles is the limit for Alu-Zn specimen with force applied is 14.187 MPa. At this stage, phase changes occur from elastic to plastic deformation. On the other hand, GI specimen also showed cycle count of 5 cycles is the limit with force applied is 6.959 MPa. On the top phase changes, factor that influence different force applied by 50.98% to Alu-Zn specimen and GI specimen in fatigue testing is bonding. Alu-Zn specimen consists of covalent and metallic bond, whereas GI specimen consists of covalent bond only. Hence, this project provides a clear mechanical property of Alu-Zn and GI specimen. This study has identified that Alu-Zn show higher tensile strength by 347.46 MPa. Fatigue testing show cycle limit at 5 cycles with force applied is 14.187 MPa.

DEDICATION

I want to thanks to my family, lecturer and friends that give me extra spirit to continue develop this project.

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This project has guide a profitable training experience including support and guideline until I finish the 14 week period. I learned more from this Final Year Project about the way to work. It gives me a real working skill in finishing project. Besides improving and learning deeper about testing that I used. Whatever I learnt from my supervisor, I accepted as a valuable experience for my life.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

FEA	-	Finite Element Analysis
Alu-Zn	-	Aluminum Zinc
GI	-	Galvanized Iron
ASTM	-	America Society for Testing and Material
MPa	-	Mega Pascal
σ	-	Stress
P	-	Force
A	-	Area
ε	-	Strain
L_f	-	Final Length
L_o	-	Origin Length
ΔL	-	Change of Length
OYS	-	Offset Yield Strength
EUL	-	Extension under Load
E	-	Slope
Fe	-	Ferum/Iron
Al	-	Aluminum
ZN	-	Zinc
$^{\circ}\text{C}$	-	Degree of Celcius
FCC	-	Face Centred Cubic
HCP	-	Hexogonal Close Packed
S-N	-	Strain-Number of Cycle to Failure

CHAPTER 1

INTRODUCTION

1.0 Brief History of Roofing

The top of each house is known as the roof. Roof indeed has a wide variety. There are bumpy, and some form of a flat surface. However, these classifications play a different role with the same purpose of protecting households from heat, cold, rain, wind, and other weather effects. The roof reinforcement structure created with the aim of slowing the lifespan of the roofing sheets. In addition to the reinforcement structure, the type of material also affects the strength of the roof. There are many types of materials for the production the roof. Generally, the material of choice for the manufacture of a roof is like clay, metal, leaf thatch and fibre. The material properties have its own advantages. Therefore, a study was carried out on the roof of the structure and the material used for the production of a roof influencing physical strength when a certain load is imposed on the structure.

Roof coverings even function only as a building, failure causes the entire building suffered the same consequences. Thus, the design should be more detailed in order to obtain a structure the roof can bear any burden in a variety of conditions. The storm is not identified correctly, but expectations to apply can be obtained through the events of last were recorded. This information is important for designers to be able provide a secure roof system design used in what circumstances (Zalipah, 2005).

1.1 Problem Statement

Peninsular Malaysia's climate is influenced by the winds of Sumatra. The wind is also known as squall brings heavy rain, accompanied by lightning, thunder, and storms that reach speeds up to 80 km / hour. It was named because of the wind blowing from Sumatra the island of Sumatra to the west coast of Peninsular Malaysia. This phenomenon occurred in April and May, mainly between Port Kelang and Johor (Ku Kassim Ku Yaacob et al, 2007). The failure of the roof structure caused by wind loads reported from time to time. To overcome this problem, a shield of material performance of Alu-Zn and galvanized for roofing in term of mechanical properties will be conducted to give potential solution to the roof problems.

1.2 Objectives

The purpose of this project are:

- a) To proof concept of Finite Element Analysis, FEA for Aluminum - Zinc and Galvanized Iron.
- b) To investigate the mechanical properties of Aluminum – Zinc metal roof and Galvanized Iron.

1.3 Scope of Project

- (a) To conduct mechanical testing such as Tensile Testing and Fatigue Testing on colour pre-painted (Alu-Zn) and Galvanized Iron (GI).
- (b) To analysis mechanical properties between pre-painted (Alu-Zn) and Galvanized Iron (GI).

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Scientific sources such as journals, newspapers, articles, magazines and the Internet are referred as a reference and generates an understanding in this report. Among the important aspects of the sport in the literature review are types of roof, aluminium roof, roofing galvanize, and the testing.

2.1 Roof Structure

Most of the roofs of houses in Malaysia are a horizontal structure. Roof structures play a role to support the roof load. The structure of roof component should be support the cover roofing system and all load of material that meet during system installation. Wood and steel are the materials used in the installation of roof trusses. Roof frame assembly can be done by installing one by one on top of the house with nails, screws, bolts and nuts. But now, the installation of the roof can be installed directly from the factory. Around the same time Mohd Shukari Midon et al, (1996), for the wall panel, the firstly truss must be installed at industry and shall lifted to site when it needed. Installation of truss can be doing with using nailed plywood gusset plates as shown in the plan or using the punched metal plates. If using the metal plate, the truss will produce in industry that supplied the plate. So, the size of plate that required for every joint is counted by the licenced industry while the size of wood that act as a truss is constant like in sketching.

The process starting with installs the first trusses at one end. When it put at right place, the truss has should be tightened using the nail or screw at wall plate. With use the 50 mm x 100 mm of timber, the end truss then temporarily braced to the ground as shown in figure 2.1.1. This bracing must be strong, although it just temporary because the other trusses must be fastened to it. So, the second truss can be install with put it upside down firstly as shown in figure 2.1.1 and after that, it will lift correctly and the temporary brace with use to hold the position as shown in figure 2.1.2. So, other trusses can be install using same method.

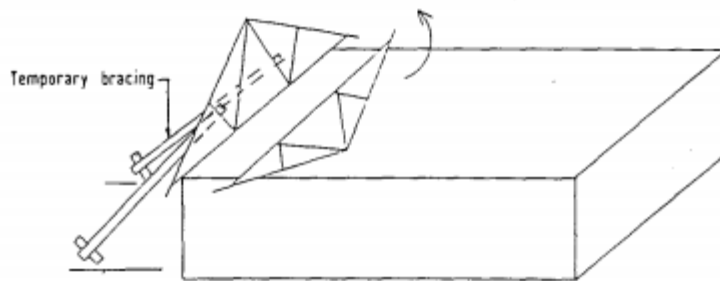


Figure 2.1.1: Erection of first truss
(Mohd Shukari Midon et al, 1996)

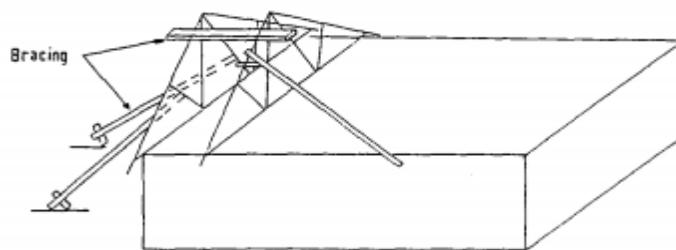


Figure 2.1.2: Erection of second truss
(Mohd Shukari Midon et al, 1996)

2.2 Roofing

The roof of a building is a cover that protects the building from heat and rain. There are various types of the roof where each has its own advantages. However, as strong as any of a roof, if the water does not flow down to the well, the roof is less well physically. Roof covering materials in the production of various types such as, tile roof, thatched roof, fiberglass roof and metal roof.

2.2.1 Tile Roof

In Malaysia, in the past, only rich people can afford to own a tiled roof, because it had to be brought in from abroad. Therefore, a tiled roof is often associated with the wealthy. Roof tiles made of clay tile is still the most popular variant in society. Because it has a very good structure, not easily weathered, safe from fire, and not rusty. However, the tiles also have disadvantages such as the roof colour will fade, mossy and weight. According to Poncogunawan (2015), roof tiles will fade. This is because clay tile created in the combustion process, and without the addition of other materials. So that when exposed to heat and rain can change colour. In addition, clay tiles are arranged will be heavier and require a strong structure.



Figure 2.2.1: Tile roof

2.2.2 Thatched Roof

Thatched roof is a roof of a building made of sago leaves. It is a type of palm tree found in the woods and a lot of Indonesia, Malaysia, and Papua New Guinea. Tree House has many pinnate shaped front 6-8 meters long first straight then slowly bend down. To make the roof of a thatched leaf material is not difficult; just provide some kind of material such as thick bamboo split over 1.5 meters, sago palm leaves and a stem Bamban is cut thin and long like a rope. Once the material is complete, bamboo thatched roof is folded in and then knitted wear ropes made of sticks Bamban (Syahril, 2013).

In Malaysia there is some resorts use thatched roof as a roof in order to maintain the concept of authenticity of Malay. Thatched roof also impact both in terms of beauty and peace atmosphere in the residents living there. This was discussed by Zuhairuse Md Darus et al (2014), developments and design of resort such as Tanjung Jara and Aryani in Terengganu, The Datai, Bon Ton and Langkawi Lagoon on Langkawi, Pangkor Laut in Perak and Club Med Cherating in Pahang is a symbolic an excellent for traditional Malay vernacular designs concept. for attaining the desired aspiration which transcends the language barrier and traditional architectural synthesis from the design angle and the overall concept, these resorts have successfully embraced the glory of native architecture and elevate the splendour and authenticity especially in the adaptations of local building materials.



Figure 2.2.2: Thatched roof

2.2.3 Fibreglass Roof

Fiberglass roof is used in the installation of the roof in an industrial and warehouse area. The aim is to allow energy refract around the surrounding. This statement can prove by CV.Sekar Sion Company that said fiberglass roof is a roof that serves as a light, translucent, but not easily penetrates to the extreme sunlight. The roof has a strong structure so awe and unbreakable when to use and very useful to minimize the use of electricity. The use of the roof is usually used in residential warehousing, indoor field, and industry. Among the advantages of fiberglass roof is durable in terms of its use, not easily fragile, less expensive when compared with the use of durable quality and can reduce UV rays. <<http://www.supplierbahanbangunan.com>>

According to Sanjay M et al (2008), a reduction of the heating and cooling loads of more than 50% can be seen when polystyrene or polyurethane insulation layers are used compared to a similar but un-insulated building roof.



Figure 2.2.3: Fiberglass Roof

(Source: <<http://www.supplierbahanbangunan.com/atap/atap-fiberglass>>23/05/16)