"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree in Bachelor of Mechanical Engineering (Structure & Material)"

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DESIGN A STRAIN DEMONSTRATION UNIT

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"With this, I acknowledge and confess that the content of this report is genuinely my effort except those of mentioned source and resources"

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ABSTRACT

This project is related about to design a strain demonstration unit. This demonstration unit is a device that can perform a strain test. To design this demonstration unit, there have many step need. It starts with sketching the shape of the demonstration unit that need to produce. After the sketching approve, and then using the drawing software to draw the modeling of the demonstration unit with dimension. In this project, the drawing software used is Solid Works 2001plus. After that, fabricate the demonstration unit follow the drawing that has been draw. Material used is mild steel with thickness 1.5 mm. Then, the demonstration unit had been use to perform strain test with three types of material, mild steel, aluminium and copper. The strain gauges had been store on the specimen to detect the displacement occur when specimen is under loading. The value from the experimental will be compared with theoretical value to check the agreement. The result from experimental and theoretical had been discussing details in Chapter 4 at it shows that the result is close agreement. The tensile test also had been performed. The result from this test also had been discussed in Chapter 4 and the discussion of the result discuss in Chapter 5.

ABSTRAK

Projek ini adalah berkenaan dengan merekabentuk unit demonstrasi terikan. Unit demonstrasi ini adalah alat yang boleh digunakan untuk menjalankan ujian terikan. Bagi menghasilkan unit demonstrasi ini, terdapat beberapa langkah diperlukan. Bermula dengan membuat lakaran bagi bentuk unit demonstrasi yang akan dihasilkan. Kemudian, sesudah dipersetujui oleh penyelia, lakaran tadi akan dilukis menggunakan perisian komputer. Dalam projek ini, perisian yang digunakan adalah Solid Works 2001plus. Berdasarkan pada lukisan yang dibuat, kerja-kerja fabrikasi dijalankan bagi menghasilkan unit demonstrasi ini. Unit demonstrasi terikan ini digunakan untuk menjalankan ujian terikan dengan menggunakan tiga jenis bahan iaitu besi keluli lembut, aluminium dan tembaga. "*Strain Gauges*" dipasang pada setiap spesimen bagi mengukur nilai terikan yang terhasil apabila spesimen dikenakan daya. Keputusan ujian akan dbandingkan dengan keputusan teori untuk memeriksa persamaan. Keputusan ujian ini dibincang dalam Bab 4 dimana ianya menunjukkan keputusan yang hampir sama. Ujian tegangan juga dilakukan. Tujuan ujian ini adalah untuk mendapatkan nilai modulus keanjalan bagi bahan tersebut. Keputusan ujian ini juga dibincangkan dalam Bab 4 dan perbincangan terhadap keputusan dibincangkan dalam Bab 5.

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LIST OF SYMBOLS

SYMBOL	DEFINITION
D	Diameter
E	Modulus of Elasticity
F, P	Force
GF	Gauge Factor of Strain Gauge
I	Moment of inertia
m	Mass
M	Bending moment
t	Thickness
T	Torque
u	Strain-energy density
U	Strain energy; work
V	Shearing force
V	Volume; shear
Vo	Bridge Output Voltage
Vex	Bridge Excitation Voltage
w	Width; distance; load per unit length
W,	Weight
Z	Plastic section modulus

BACIS GREEK	**DEFINITION**
γ	Shearing strain
α	Coefficient of thermal expansion
ε	Normal strain
σ	Normal stress
ρ	Distance; density
τ	Shearing stress
ν	Poisson's ratio
ω	Angular velocity

SUBSCRIPT	**DEFINITION**
Maks	Maximum
Min	Minimum
x	x direction
y	y direction
xy	xy direction

CHAPTER 1

INTRODUCTION

1.1 Introduction

This project is related to design and develop a demonstration unit of strain. The demonstration unit is used to analyze the value of strain for material such as mild steel, aluminium, copper and brass. This demonstration unit is same function with experiment device in lab, but this demonstration unit is used in the classroom for the lecture. It small in size and light weight make it easy to carry anywhere.

Through this project, the materials used as specimen are mild steel, aluminium and copper. The usage of strain gauge is also be used to measure the value of stress and strain. The value can read from strain meter or data logger when load is incurred. The concept of strain unit demonstration is where specimen will fix to the test box and the end of the specimen will hang with the load to make sure that the value can be read easily.

The unit demonstration will be used the classroom. Normally, strain test is done while practical class in a laboratory. But, with this device strain test can brought into the classroom. It will help students to concentrate or have more understand about the strain. The students also can have an idea and more knowledge of the strain concept. In addition, the students can do research and compare between theoretical and experimental value.

The value of experiment will be compared with the theory so that the percentage difference between theory and experiment no exceed than 10% and the demonstration unit can be performed in the lecture.

1.2 Project Background

Based on the project given, the design of strain demonstration unit is using Solid Works 2001plus software. Before the designs have been perform with this software, the sketching of the demo unit have been perform to chosen the suitable shape of demo unit. The suitable shapes have been chosen and re-draw by using the drawing software. With reference to the drawing, the fabrications of the demo unit have been done. The process that involves in this fabrication is welded. After finish the fabrication process, the demo unit has been paint with suitable color

In this project also, three types of material have been chosen to make a test specimen. It made of mild steel, aluminium and copper. On each of test specimen, the couple of strain gauge is put on up and down specimen surface. This strain gauge will detect the deflection occur to the test specimen and measure the strain value when performing the experiment. The strain gauge will connect to the input terminal on data logger and screen output will show the value of strain.

The tensile tests also have been performed for this project. This test is to obtain the material properties by using a universal testing machine. In this testing, three test specimens, all from mild steel material had been done.

1.3 Objectives

- To design and develop a demonstration unit of strain. The purpose of this project is to analyze the value of strain for materials like mild steel, aluminum and cuprum.

- To compare the value of strain from theoretical and experimental and get the percentage of error for each specimen.

- To provide more comprehensive strain in the material such as the level of material strength when the load is incurred.

- To produce and provide the help-learning device. The purpose of demonstration unit is to make sure the students have more comprehension about the strain.

1.4 Scope of Project

The scope of this project is to develop a strain demonstration unit to use in the lecture to understanding student about principle of strain. It is also used to measure the value of strain for the test specimen and compare that value with theoretical value.

1.5 Summarize of the Chapter

Chapter 1 is about of the introduction of the project, background of project and also the objective of the project.

Chapter 2 contains the theoretical background include the definition of stress and strain, the strain gauges, theory of simple bending and also about a tensile test.

Chapter 3 discusses about strain demonstration unit. It includes the design of strain demonstration unit and it fabrication.

Chapter 4 is about experimental work. It presents about the result from experimental and theoretical. Also discuss the percentage of error from both results. Result for tensile test also present in this chapter.

Chapter 5 is explaining about the discussion. It explains the discussion from tensile test result and experimental work result.

Chapter 6 contains the suggestions for future work and the conclusion for the project.

CHAPTER 2

THEORETICAL BACKGROUND

2.1 Stress and Strain Definition

When external forces are applied to a stationary object, stress and strain are the result. Stress is defined as the object's internal resisting forces, and strain is defined as the displacement and deformation that occur. For a uniform distribution of internal resisting forces, stress can be calculated by dividing the force (F) applied by the unit area (A):

$$\text{Stress } (\sigma) = F/A \tag{2.1}$$

Strain is defined as the amount of deformation per unit length of an object when a load is applied. More specifically, strain (ε) is defined as the fractional change in length, as shown in Figure 2.1. Strain is calculated by dividing the total deformation of the original length by the original length (L):

$$\text{Strain } (\varepsilon) = \Delta L/L \tag{2.2}$$

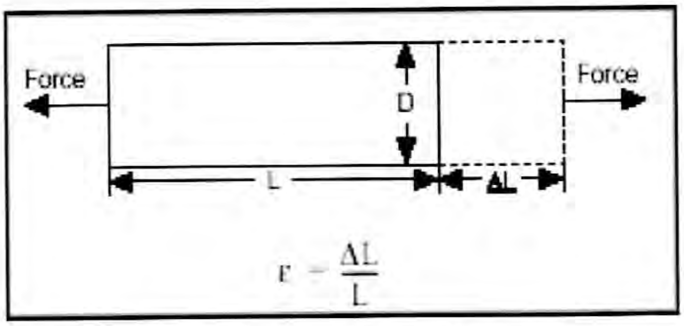

Figure 2.1: Definition of Strain

Strain may be compressive (negative) or tensile (positive) and is typically measured by strain gauges. Although dimensionless, strain is sometimes expressed in units such as in./in. or mm/mm. In practice, the magnitude of measured strain is very small. Therefore, strain is often expressed as micro-strain ($\mu\varepsilon$), which is $\varepsilon \times 10^{-6}$.

When a bar is strained with a uniaxial force, as in Figure 2.1, a phenomenon known as Poisson Strain causes the girth of the bar, D, to contract in the transverse, or perpendicular, direction. The magnitude of this transverse contraction is a material property indicated by its Poisson's Ratio. The Poisson's Ratio, ν of a material is defined as the negative ratio of the strain in the transverse direction (perpendicular to the force), ε to the strain in the axial direction (parallel to the force), ε_T or $\nu = \varepsilon_T/\varepsilon$. As the length increases and the cross sectional area decreases, the electrical resistance of the wire also rises. Poisson's Ratio for steel, for example, ranges from 0.25 to 0.3. Figure 2.2 show the Poisson ratio.

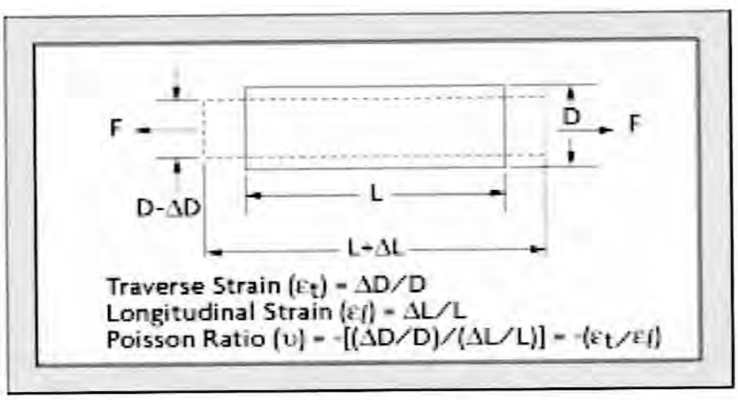

Figure 2.2: Poisson Ratio

Shearing strain considers the angular distortion of an object under stress. Imagine that a horizontal force is acting on the top right corner of a thick book on a table, forcing the book to become somewhat trapezoidal, which is as shown in Figure 2.3. The shearing strain in this case can be expressed as the angular change in radians between the vertical y-axis and the new position. The shearing strain is the tangent of this angle.

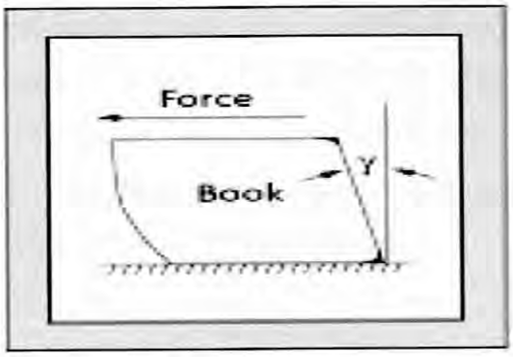

Figure 2.3: Shearing Strain

Bending strain, or moment strain, is calculated by determining the relationship between the force and the amount of bending which results from it. Although not as commonly detected as the other types of strain, torsion strain is measured when the strain produced by twisting is of interest. Torsion strain is calculated by dividing the torsion stress by the torsion modulus of elasticity.

2.2 The Strain Gauges

While there are several methods of measuring strain, the most common is with a strain gauge. The term strain gauge usually refers to a thin wire or foil, folded back and forth on itself and bonded to the specimen surface as seen in Figure 2.4 that is able to generate an electrical measure of strain in the specimen. The deformation of an object can be measured by mechanical, optical, acoustical, pneumatic, and electrical means. The earliest strain gauges were mechanical devices that measured strain by measuring the change in length and comparing it to the original length of the object. For example, the extension meter (extensimeter) uses a series of levers to amplify strain to a readable value. In general, however, mechanical devices tend to provide low resolutions, and are bulky and difficult to use.

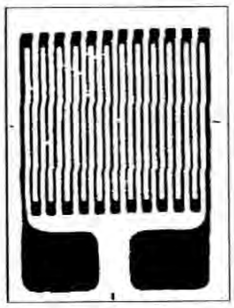

Figure 2.4: Wire resistance strain gage.

The most widely used gauge is the bonded metallic strain gauge. The metallic strain gauge consists of a very fine wire or, more commonly, metallic foil arranged in a grid pattern. The grid pattern maximizes the amount of metallic wire or foil subject to strain in the parallel direction. Figure 2.5 show the typical bonded metallic strain gauge. The cross sectional area of the grid is minimized to reduce the effect of shear strain and Poisson Strain. The grid is bonded to a thin backing, called the carrier, which is attached directly to the test specimen. Therefore, the strain experienced by the test specimen is transferred directly to the strain gauge, which responds with a linear change in electrical resistance. Strain gauges are available commercially with nominal resistance values from 30 to 3000 Ω, with 120, 350, and 1000 Ω being the most common values.