AN EXPERIMENTEL STUDY OF LAMINATED RUBBER-METAL SPRING ON AXIAL VIBRATION

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This report is submitted in fulfillment in fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Design and Innovation)

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DECLARATION

"I admit that this report is all written by myself except for the summary and the article which I have stated the source for each of them"

Signature : ……

Name : ……

Date : ……

APPROVAL

"I/We approve that we have read this thesis thoroughly and in my/our opinion, this thesis has fulfilled the criteria covering all the aspects of scope and qualify and satisfied to be awarded for Bachelor of Mechanical Engineering (Design and Innovation)"

Signature : …….

Name of Supervisor: ……

Date : ……

DEDICATION

To beloved family, friends and lecture who supported throughout to finish this report

ABSTRACT

Laminated rubber-metal spring or rubber spring are used widely as isolator for heavy industries. In this study was to investigate natural frequencies of the metal that have be laminate in rubber to absorb any shock. This study also focus have to clamp correctly those plate due to the shape of this plate is circular. To get measurement data, I have use DEWESOFT software. And I need to compare those data with calculated data, which is using formula natural of fixe-free circular beam for various vibration mode. Due to more than one laminated of metal, I have to investigate five modes of vibration of those plate. If the percentage error of the result not more than 10% it consider the result was correct and clamped of the plated is correct. In this study I provide several concept design of the clamp and need to test it, which concept are get close result with calculated data.

ABSTRAK

Lapisan logam-getah digunakan secara meluas dalam industri berat. Dalam kajian ini untuk menkaji kekerapan semulajadi logam yang digunakn didalam getah yang digunakan sebagai penyarap hentakan. Kajian ini fokus kepada untuk mengapit dengan betulnya disebabkan bentuk logam itu bulat. Untuk mendapat data ukuran saya menggunakan perisian DEWESOFT dan saya perlu bandingkan data ukuran tersebut dengan data pengiraan yang menggunakan formula untuk mencari kekerapan semulajadi kepingan logam bulat tetap-bebas bagi pelbagai mod getaran. Oleh sebab lapisan logam lebih dari satu, saya perlu mencari lima mod getaran kepingan tersebut. Jika ralat peratusan tidak lebih daripada 10% ia mempertimbangkan keputusan itu adalah betul dan diapit dengan betul. Dalam kajian ini, saya menyediakan beberapa reka bentuk konsep pengapit dan perlu diuji, konsep pengapit yang mana mndapat hasil yang hampir dengan data pengiraan.

ACKNOWLEGMENT

All praise is due to Allah. May Allah's peace and blessings be upon the one after whom there is no other prophet.

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To my family and friends, my greatest treasures and gifts in my life, thank you. I am forever grateful to my big sister, Dr Zaleha Mustafa for instilling in me a desire to achieve my goals and a commitment to finish what I start, to the best of my ability, no matter what it takes.

With all my heart, I would like to thank my friends Muhammad Hafizuddin bin Zahar, Rosli bin Ronta, and Mohamad Hafifi bin Sarji who have supported me thorough this insightful journey

For myself, this dissertation has been a personal accomplishment, which I hope will benefit others as much as it has me.

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LIST OF ABBEREVATION

NR Natural Rubber

DAQ Data Acquisition

ICP Integrated Circuit Piezoelectric

BNC Bayonet Neill-Conselman

FTT Fast Fourier transform

LIST OF SYMBOL

E = Young Modulus

I = Second moment of inertia

ρ = Density

f = frequency

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Spring are very suitable mechanical components to absorb shock and vibration. Condition of high vibration and shock in automobile, railway vehicles, heavy machinery, pipe suspension system at power plants and steel plants are the common phenomenon in engineering. Spring thus used to cope up with those problems. Rubber being an elastic medium is the most universal material used for vibration damping(Al 1986). Rubber element also absorb considerable amount of overloads for short time without suffering any damage. During dynamic loading rubber converts the absorbed energy into heat by internal molecular friction (Mukhopadhyay et al 2014).

This phenomenon is known as damping and is continuous. This property is particularly helpful when shock have to be reduced quickly. In rubber-metal spring, both rubber and metal plates are to be joined systematically. Such, assembly of rubber and metal can be accomplish in various ways. It is also possible to use disc spring or Belleville springs in place of metal plates. Disc spring give wide variety of load deflection curves not readily obtainable with conventional form of spring.

Several information on rubber-metal springs are different literature. Present paper research on the comparative studies of rubber-metal spring with pure metal spring.(Jafari-Talookolaei 2017). This research focus on five mode of vibration because the more complex of the mode of vibration the more close to the real phenomenon of the vibration. (Le 2017)

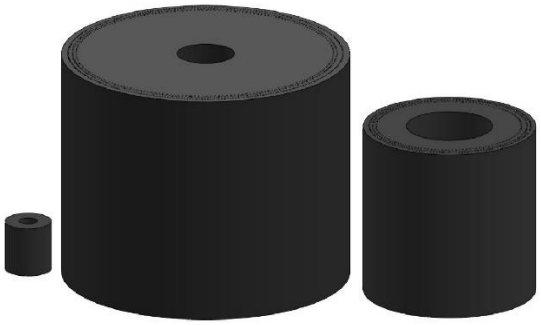


Figure 1-1: Rubber-Metal Springs
Sources :(http://www.antivibrationmethods.com/product/reinforced-rubber-springs)

1.1.1 Term terminology

Laminated is the technique of manufacturing a material in multiple layers, so that the material achieves improved strength, stability, sound insulation, appearance or other properties from the use of differing materials. This can apply to ensure that both material (metal and rubber) can combine their properties

Rubber is a latex from rubber tree. This latex is sticky, milky colloid drawn off by making incisions into the bark and collecting the fluid in vessels in a process called 'tapping'. This material have high of elasticity and usually use as insulator and vibration absorber.

Metal is type of material that is typically hard. Metal can be hammered or pressed permanently out of shape without breaking or cracking and Vibration is phenomena oscillation occur about an equilibrium point.

Vibration come from Latin "*vibrationen*" ("shaking brandishing"). The oscillation may be periodic, such as the motion of a pendulum. Axial direction – a displacement that occur more than one direction such as axis-X and axis-Y.

1.2 PROBLEM STATEMENT

This laminated rubber isolator is an important product which has role of reducing the transmission of seismic forces in building load and flexibly transforming its shape into horizontal direction during apply of force such as earthquake. This isolator is formed using dies by setting rubber and metal sheets alternatively. Various inspections have been conducted in critical manufacturing processes to assure the quality of the products.

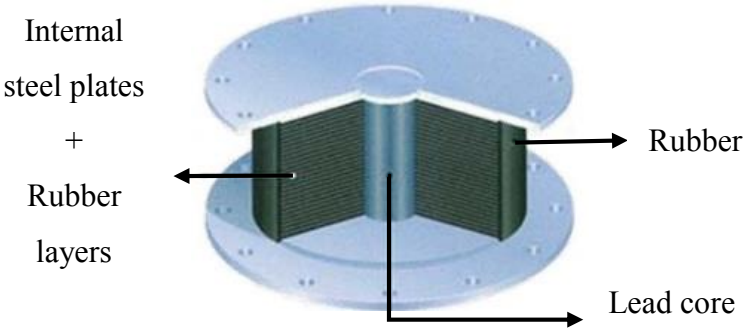


Figure 1-2: Structure of Laminated Rubber
Sources: (*https://structurae.net/products-services/lastolrb-lead-rubber-bearing)*

Figure 1-3: Application Rubber-Metal on Building
Sources: (*https://www.emaze.com/@ALTWWTRO/Flexible-Building)*

1.3 OBJECTIVE

I. To conduct an experimental study for laminated rubber-metal spring on axial loading

II. To investigated the natural frequencies of laminated rubber-metal spring for five modes of vibration

III. Study the five modes of vibration produce by the laminate rubber- spring metal spring

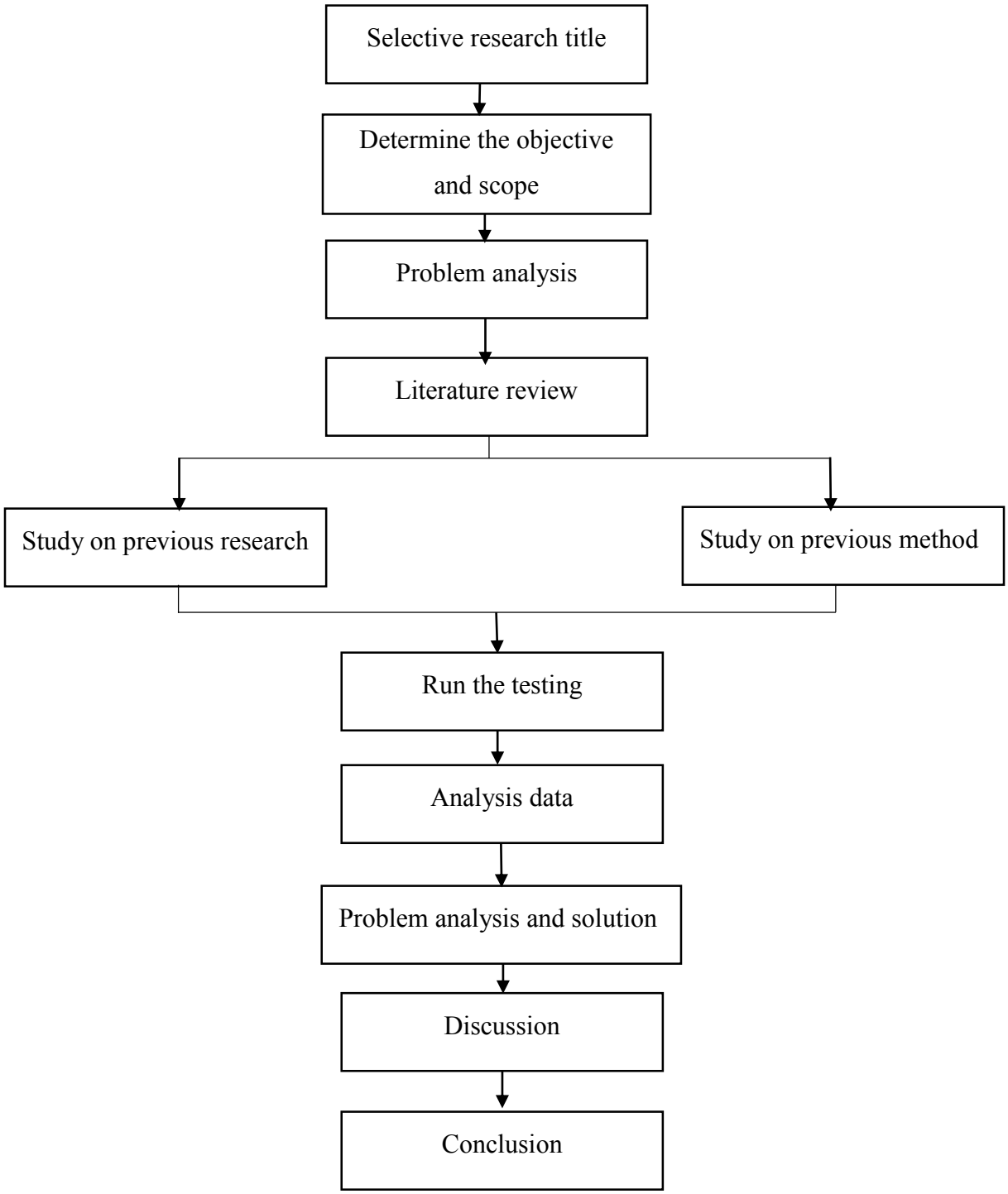
1.4 SCOPE OF PROJECT

I. Design the suitable clamp-base for laminated rubber-metal

II. Use Fourier series analysis to evaluate the free vibration sign at axial direction

III. Derive the five modes of vibration for natural frequencies of laminated rubber-metal spring

1.5 STUDY FLOW CHART



CHAPTER 2

LITERATURE REVIEW

This chapter is consisting of the previous research that has being carried out in the field of laminated rubber spring and axial vibration. All this information will provide more understanding but this study.

2.1 NATURAL RUBBER

Natural rubber (NR) is type of material which is have elasticity come from natural plant. To producing a natural rubber it come combination of chemical substance such as polyisoprene, unsaturated rubber, chemically active, intolerant aging(Zhao et al 2016). From all those combination it produce a substance widely used in medical and health industry, the transportation, industrial, agricultural, meteorological measurement. (Zhao 2014)

From other source, they definition the natural rubber is milky secretion or latex of various plants. Only one type of plant that commercial source of this rubber, this plant was call Hevea brasiliensis. To soften of the compound of rubber it was adding some ingredients and to overcome broken by mastication due to long polymer chain those rubber have through application mechanical shearing force by passing roller or rotating blades,(natural rubber, 2012)

Figure 2-1: latex of Hevea brasiliensis tree
Sources :(*http://treesandshrubs.about.com/od/treeshrubbasics/f/Where-Does-Latex-Come-From.htm*)

2.2 STAINLESS STEEL

To finish this research paper, I only focus on stainless steel to finding their natural frequencies, here have state some history of stainless steel. A stainless steel is resistant to stains, discoloration or loss of mass due to rusting. This is because it contains sufficient chromium to forma passive film of oxide on the surface, which isolates the substrate from the reactive environment. The film is able to reform in seconds in the event of damage. With an appropriate combination of alloying elements, stainless steels can be fully austenitic, a mixture of ferrite and austenite, fully ferritin or martensitic. (Al 2017)

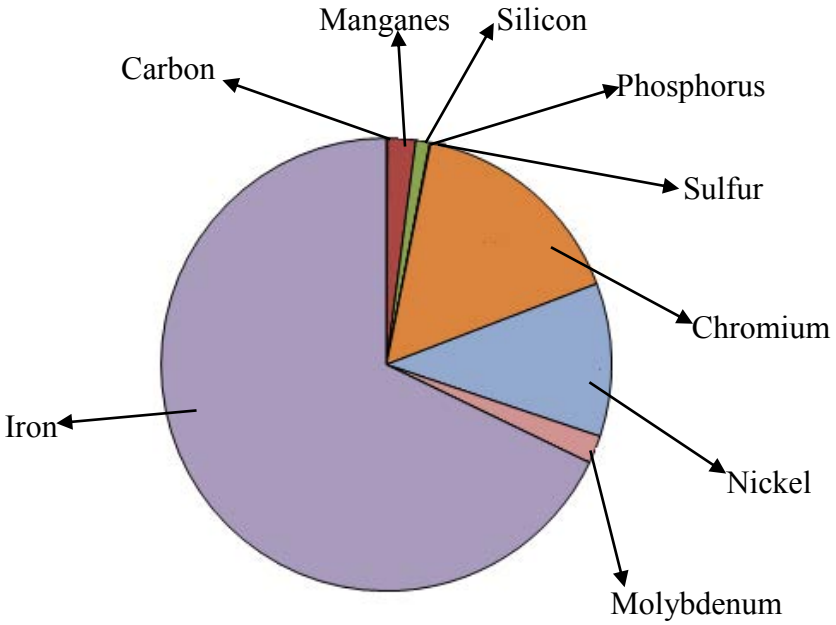


Figure 2-2: stainless steel composite

Sources: *(https://connecteddiscourse.wordpress.com/category/chemical-engineering/*

2.2.1 Background

The inverter of stainless steel was Harry Brearley. In 1904, French scientist Leo Guilet have document constitution of stainless steel. Brearly was investigated a ways to eliminated rusting in gun barrel, he found by accidently steel does not rusting and no dissolve in acid. Those

steel have combination of chrome, and two months later on August 20, 1912 for first time. (History of steel, 2015)

Figure 2-3: Harry Brearly
Sources*: (http://www.bssa.org.uk/about_stainless_steel.php?id=31)*

2.2.2 Group of stainless steel

Have state that there was five stainless steel group: ferritin, martensitic, austenitic, and duplex and precipitation hardening. Ferritin consist of 12-18% of chromium and content of carbon is low. This type of steel is magnetic, thus it cannot be hardened by heat treatment. Martensitic was a commercially produces as cutlery. This type of steel consist of 0.1-1.2% of carbon, highest compare to other type of steel. It have 12-18% chromium. It can be hardened but quenching and tempering, it also can through heat treatment to increases strength with good ductility. Austenitic stainless steel a type of steel non-magnetic. It was added nickel as a result, their crystal structure changing to austenite. The basic composited of this steel, 18% chromium and 8% nickel. Austenitic are most common stainless steel production, up to 70%, their common grades are alloy 304, alloy 304L and alloy 316L.

Duplex are type of stainless steel which have high level of chromium (18-28%) and 8% amounts of nickel. The strength and capability of this stainless steel can be explained by their chemical composition. Example of this type of stainless steel is Alloys 2403 and 2205. Last group of stainless steel precipitation hardening can be through heat treatment to increases their hardness. These type of steel combine high strength and hardness also corrosion resistance higher than martensitic chromium steel. (History of steel, 2015)