EXPERIMENTAL INVESTIGATION ON VIBRATION AND SHOCK TEST ON PACKAGING PRODUCTS

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A report submitted in fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Plant & Maintenance)

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DECLARATION

I declare that this project report entitled “Experimental Investigation on Vibration and Shock Test on Packaging Product” is the result of my own work except as cited in the references.

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APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Plant & Maintenance)

Signature : …….

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Date : ……..

DEDICATION

This final year project is dedicated to my loving family. There is no doubt in my mind that without my parents continued support, counsel I that could not have completed this process and never stop giving of themselves in countless ways. My siblings also have never left my side and who stands by me when things look bleak.

I also dedicate to my great lecturer for giving guidance to complete this report and to all my friends who encourage and support me throughout the process. Lastly, special thanks to all the people in my life who touch my heart that always being with me throughout entire undergraduate project session.

ABSTRACT

Technological development in making of packaging product will provide product more protection especially from vibratory environment. The packaging product which will be tested is an electronic component and known as printed circuit board of laptop. The test that has been conducted is divided into two types, which are vibration test and shock test. Vibration test contains two elements that can be analyzed and also can relate the reliability and durability of product packaging. This is because the packaging product contains very sensitive structure where it is easily broken. The element known as natural frequency and transmissibility. It is important to know the natural frequency where it can show the exact resonance frequency occurs and makes the packaging product vibrate. Other than that, by referring to transmissibility, the isolator can be determined either it can suppress the input vibration or not. There are two types of isolator that were tested which where sponge and polystyrene. Based on the result of transmissibility, the limit maximum acceleration that can be tested for sponge isolator is 5 G. While, the limit maximum acceleration that can be tested for polystyrene is 7 G. So, polystyrene is more suitable as isolator in comparison with sponge. Therefore, by referring to the shock tested, the fragility of packaging product can be described.

ABSTRAK

Pembangunan teknologi dalam pembuatan produk pembungkusan akan memberi produk lebih banyak perlindungan terutama dari segi persekitaran getaran. Produk pembungkusan yang akan dilakukan ujian terhadapnya ialah sebuah alat elektronik dari ‘laptop’. Sehubungan dengan itu, ujian yang akan dijalankan terbahagi kepada dua iaitu ujian getaran dan ujian kejutan. Dengan adanya ujian getaran, dua elemen boleh dianalisis dengan mengkaitkan kebolehpercayaan dan ketahanan produk pembungkusan. Ini kerana, produk pembungkusan mempunyai struktur yang sangat sensitif dimana ia mudah patah. Dua elemen tersebut dikenali sebagai frekuensi semula jadi and kebolehpindahan. Frekunsi semula jadi penting untuk dicari kerana ia boleh menunjukkan berlakunya frekuensi resonan dimana ia akan mengakibatkan berlakunya getaran pada produk pembungkusan tersebut. Selain itu, dengan merujuk kepada kebolehpindahan, dapat menentukan sama ada ‘isolator’ tersebut dapat menindas getaran yang berlaku ataupun disebaliknya. ‘isolator’ yang diuji terdiri dari dua jenis iaitu ‘sponge’ dan ‘polystyrene’ Berdasarkan hasil dari ujian kebolehpindahan, had pecutan maksimum yang boleh diuji bagi ‘isolator sponge’ ialah 5 G. Manakala, had pecutan maksimum yang boleh diuji bagi ‘ isolator polystyrene’ ialah 7 G. Jadi, ‘polystyrene’ lebih sesuai untuk dijadikan ‘isolator’ berbanding dengan ‘sponge’. Oleh itu, dengan merujuk kejutan yang diuji, kerapuhan produk pembungkusan dapat diterangkan.

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LIST OF ABBREVIATIONS

PCB	Printed Circuit Board
FRF	Frequency Response Function
SRS	Shock Response Spectrum
PC	Personal Computer
FR4	Flame Retardant 4
SMC	Surface Mount Component
BGA	Ball Grid Arrays
PTH	Pin through Hole
BW	Bandwidth
CEI	Commission Electrotechnique International
DAQ	Data Acquisition
FT	Fourier Transform

IEC	International Electrotechnical Commission
VR	Vibration Research

CHAPTER 1

INTRODUCTION

1.1 Background

In the course of lifetime, every manufactured product must be done packaging before it goes to final consumer. Without packaging the goods manufactured could be damaged or spoiled. This is because along the way of transportation, there are some environmental conditions such as uneven road that causing vibrations. In order to make the packaging withstand the effects of the environmental condition, the design of packaging and product must be verified using significant laboratory testing where more particularly to mechanical shock and vibrations. Vibrations are defined as oscillations in mechanical dynamic systems. This vibration can be analyzed using vibration testing. There are two types of method in vibration testing which are sinusoidal vibration testing and random vibration testing.

Random vibration testing can relate with the real vibratory environment. The principle characteristic of random vibration is to simultaneously excite all the frequencies of a structure (Tustin W, 1967). Any vibration is described by the history of motion and the amplitude of motion is expressed in terms of displacement, velocity or acceleration. The differences between sinusoidal and random vibration were prediction which based on amplitude time history. This is because the sinusoidal vibration is cyclic and repetitive. Sinusoidal vibration

also is the simplest motion and can fully describe by straightforward mathematical equations. That is why in sinusoidal vibration, the amplitude can be predicted at any point in time. Meanwhile in random vibration, the amplitude at any point in time is not related to that at any other point in time. This is because the instantaneous amplitude of random vibration cannot be expressed in mathematically as exact function of time and also possible to determine the probability of occurrence of particular amplitude on a statistical basis.

An analysis of random vibrations enables to determine the response of structure to vibrate the loads that are random in nature. For example, the response of a sensitive electronic component mounted in a car that is subjected to the vibration from the engine, pavement roughness and acoustic pressure. These vibrations have a continuous frequency spectrum that must be determined in order to understand its effects on a structure. This frequency analysis is performed using the power spectral density (PSD) which is the ideal tool for describing random vibrations. The characterization of random vibration typically results in a frequency spectrum of power spectral density which designates the mean square value of some magnitude passed by a filter, divided by the bandwidth of filter. Thus, power spectral density defines the distribution of power over the frequency range of excitation.

However, the analysis of sinusoidal vibrations is the most relate to response a product quality and studying the behavior of products under extreme conditions. For example, the response of a sensitivity electronic component structure can be determine by looking at it natural frequency and resonance frequency.

1.2 Problem Statement

Nowadays, packaging is one of important thing in industrial because the structure of products need to be protected from any obstacle especially vibration environment. Normally, vibration environment will produce effects on structure of product especially the electronic component whether it fail or safe. The problem of electronic packaging will appear when product packaging arrives to the customer. This is because the product might be not functional or damage. Thus, the material of electronic component is very perishable due to their sensitivity. So, in order to know the failure, the electronic component must be tested in the experiment. Therefore, the failure will not occur during the shipping, if the durability of electronic component can cope with vibration environment. But during conduct the experiment, there will be problems that need to solve it which:

1. How to find the failure of packaging product in real life.
2. How to prevent the sensitivity of packaging product while in transportation.

1.3 Objective

The objectives of this project are as follows:

1. To design vibration and shock testing rig for reliability and durability of packaging product.
2. To investigate the performance of packaging product in term of fragility on various environmental vibration.

1.4.1 Scope Of Project

This study will focus on the results of vibration and shock measurement that presented in this report. The results of packaging product will be obtained from the electrodynamic shaker in order to identify failure of product packaging in term of reliability, durability and fragility using frequency response function (FRF) and shock pulse waveform

The product that will be tested in vibrations and shock is electronic component which the printed circuit board (PCB) of laptop as test specimen. The test specimen will depend on the design fixture that connects to shaker tables. This is because the limited access to whole structure of electronic component is depend on how the design fixture been attached together.

1.5 General Methodology

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review

   Journals, articles or any materials regarding the project will be reviewed.

2. Design

   The fixture must be design based on electronic component and must be fabricated.

3. Experimental

The test rig of experiment must be design and based on random vibration.

4. Inspection

   The structure of packaging product will be inspected and review the vibration at certain frequency level.

5. Measurement

   The data measurement will be taken directly on the digital vibration control software.

6. Analysis and proposed solution

   Analysis of random vibration will be presented on how the resonance will occur and what frequency of electronic packaging will be failure. Solution will be proposed based on the analysis.

7. Report Writing

   A report on this study will be written at the end of the project.

The methodology of this study is summarized in the flow chart as shown in Figure 3.1 at chapter 3.

CHAPTER 2

LITERATURE REVIEW

2.1 Packaging

Modern electronic contains of the large range of package types and each package will fail due to different reasons. Electronic packaging contains of housing and interconnection of integrated circuits to form electronic systems. Therefore, electronic packaging must provide a circuit support and protection, heat dissipation, signal distribution, power distribution and manufacturability. In case study is to emphasis the electronic circuit support and protection because it has co relationship between the severe vibration environments. These structures of electronic packaging can further improve for vibration protection, by considering the dynamic properties and response of the critical internal component. In terms of years, every electronic component has its own durability but at the same time, the reliability of component must be considered. According (D.S.Steinberg, 1988) said that the main durability of such equipment is based on the ability of their sensitive component, as example of Printed Circuit Board (PCB) where the ability to faced severe vibration environment without developing the critical fatigue to the mounted component, soldered joint, connectors and others.

Observations of the most failure of electronic device used in military equipment are due to extreme temperature condition, severe vibration, humidity and dust. (V.Rogov, 1998)

state that, electronic industry has moving back towards designs based on the military guidelines due to when reliability becomes a critical factor. Meanwhile, according to US Air Force statistic mention all failures has been observed in electronic equipment that used in defense application are about 55 percent due to thermal problem, 20 percent due to vibration problem, 19 per cent because of humidity and 6 percent due to dust and others reason.

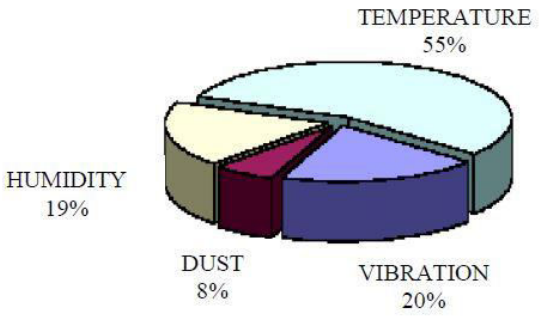

Figure 2.1: Failures in electronic equipment.

Based on Figure 2.1 shows vibration was the second higher percentage failure in electronic equipment. If severe vibrations happen, it can cause high displacement and stress where will lead to failure of lead wires, solder joint, cracking of printed circuit board (PCB) and loosening of fastening screws. Even the mode uses of electronic equipment is differences but in term of electronic packaging is deserve to including in all situation. Usually, different environmental condition such as during service life, in transportation and humidity can impress different types of vibration that were cause electronic equipments to failure (Steinberg, 2000).

2.2 Printed Circuit Board (PCB) Design

The main compartment in laptop is known as motherboard, main board or system board. This motherboard is linked to the mother of the PC (Personal Computer) which all connection point of everything needed to run a laptop. The motherboard is the main PCB in PC that enables the integration and control of all other components and devices in a complete computer system. All laptop component in PCB has own sensitivity and durability to bear from different environment especially in severe vibration. The PCB material that been used in several laptop is FR4 A1 Level copper and usually contains of 1.6 mm thickness with 4 layer. The component used to attach on the surface PCB has different types of package mounting technologies which are Surface Mount Component (SMC), Ball Grid Arrays (BGA), Pin-through-hole (PTH). Based on PTH, the component lead is soldered into a hole that extends through the PCB and SMC used solder directly to the surface of the PCB. While the BGA used a small array of small solder balls that cover the underside of the package body to attach to the PCB. These types of package mounting technologies can be seen through Figure 2.2