



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**EXPERIMENTAL STUDY ON VIBRATION ISOLATION
METHOD USING COCONUT FIBER AS AN ADDITIONAL
DAMPING**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) (Hons.)

by

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APPROVAL

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 Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

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AHMAD YUSUF BIN ISMAIL

ABSTRAK

Tangan manusia merupakan bahagian yang paling kerap menerima getaran daripada luar ketika melakukan kerja. Hal ini kerana, kebanyakan peralatan tangan yang digunakan menghasilkan getaran yang boleh menyebabkan 'hand-arm vibration syndrom' (HAV). Alatan yang selalunya menghasilkan getaran ialah mesin gergaji, mesin gerudi, mesin pengisaran dan banyak lagi. Dari lima belas eksperimen yang telah dijalankan, getaran yang dihantar ke tangan dikesan dengan menggunakan pecutan dan isyarat yang telah dinilai menggunakan penganalisa isyarat sebelum direkodkan dalam komputer riba. Keputusan yang diperolehi dalam bentuk graf akan dianalisis dan ditafsirkan. Untuk mendapatkan tahap getaran diserap, graf yang dikira dengan menggunakan indeks pengurangan getaran. Dari data yang dikumpulkan, ia boleh dilihat bahawa tahap getaran meningkat mengikut kelajuan mesin gergaji. Ini adalah disebabkan oleh daya geseran antara bilah dan kayu menghasilkan getaran. Keputusan mendapatkan dalam bentuk graf selepas dianalisis menggunakan penganalisa isyarat. Terdapat empat jenis sarung tangan yang telah direka dengan jayanya. Dari analisis dan pemerhatian, hasilnya menunjukkan keberkesanan gentian kelapa dalam mengurangkan tahap getaran. Ini adalah bukti dari pengiraan yang telah dibuat dengan menggunakan indeks pengurangan getaran (VRI).

ABSTRACT

Humans arms was the biggest part that always exposed to the vibrations. This was because, most equipment that humans conduct while working using hand and arms. Hand- arm vibration (HAV) is vibration that transmitted while working to the workers hand and arms. The vibrations usually come from operating hand-held power tools such as jigsaw, drilling machine or grinding machine. From fifteen experiments that has been conducted, vibration that transmitted to hand were detected by using accelerometer and the signal was evaluated using signal analyser before recorded in laptop. The result obtained in the form of graph was being analyzed and interpreted. To obtain the level of vibration absorbed, the graph is calculated by using vibration reduction index. From data collected, it can be seen that the level of vibration was increasing as the speed of the jig saw increases. This is caused by the friction force between the blade and the wood producing vibration. The results obtain in the form of graph after being analyzed using signal analyzer. There are four types of gloves that has been fabricated successfully. From the analysis and observation, the result shows the effectiveness of coconut fiber in reducing the level of vibration. This was proof from calculation that has been made by using vibration reduction index (VRI).

DEDICATION

I dedicate this thesis to my parents who always support and motivate me to set higher targets. I also dedicate this thesis to my sister cause they always give me inspiration from their experience. Besides that, I also want to dedicate this thesis to my supervisor that always teach, guide and encourage me not to give up.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

| | |
|--------|---|
| ASTM | American Standard Test Method |
| FFT | Fourier Transform |
| HAV | Hand- Arm Vibration |
| HAVS | Hand-Arm Vibration Syndrome |
| ISO | International Organization For Standardization |
| KN | Kilo Newton |
| N | Newton |
| NA | Not Available |
| PVC | Polyvinyl Chloride |
| PVA | Polyvinyl Alcohol |
| T | Transmissibility |
| VWF | Vibration-Induced White Finger |
| VS | Versus |
| VRI | Vibration Reduction Index |
| VL_d | Vibration Level Of Gloves With Additional Damping Materials. |
| VL_o | Vibration Level Of Gloves Without Any Additional Damping Materials. |
| WBV | Whole Body Vibration |
| cm | Centimeter |
| G | Gram |
| mm | Millimeter |
| rms | Root Mean Square |
| % | Percent |

CHAPTER 1

INTRODUCTION

1.1 Vibration

Vibration is a system that consists of mass of inertia for storing kinetic energy, springs for storing potential energy and damper where the energy is gradually lost. The altering transfer of energy between its potential and kinetic forms involves in the vibration of a system. Besides that, vibration is also being known as mechanical stimulus characterized by an oscillatory motion. The amplitude (peak to peak displacement, in mm) is determined by the extent of the oscillatory motion (Cardinale and Wakeling, 2005). In vibration, the frequency of the vibration (measured in Hz) determined by repetition rate of the cycle of oscillation (Cardinale and Wakeling, 2005). In our daily life routine, people were always exposed to the vibration which desirable or undesirable. For example, grass trimmer vibration, noise vibration from car on the streets and mostly vibration comes from industrials.

Moreover, it also happened in our body like in lungs and heart where consist of low-frequency oscillations. There also a high-frequency oscillations of the ear, and vibration form by body motion such as walking, jumping, and dancing. Many people that working in industrial experience vibration. For example, any unbalance in machines with rotating parts such as ventilators, fans, washing machines, centrifugal separators, lathes, centrifugal pumps, rotary presses, and turbines can cause vibrations.

Besides that, building and structure can experience vibration from natural phenomena such as earth quakes and wind, and also vibration from machinery, rail traffic, air and vehicle (Futatsuka et al., 1998). Fatigue failure can happened on structural system result from fluctuating stress due to vibration. For example, pedestrian bridges and floor in building experience fatigue failure due to vibration from human movement on them. When performing measurement, vibration are also undesirable such as while conducting an electron microscope and when fabricating micro-electromechanical systems.

Vibration can also be seen as a periodic motion that moving repeatedly after a certain interval time. This is known as the period of vibration. Other than that, harmonic motion is the simplest periodic motion that shows displacement as a harmonic function of angular velocity ω and time t . It also referred as circular frequency and measured in radians per second.

1.1.1 Whole Body Vibration

It has been known that vibration could affect the human health. Usually, people who are working in industrial vehicles such as bulldozers, power shovel or tractors may suffer from chronic lumbago after some period of time (Yoshimura et al., 2005). The transmissibility of vibration occurs through the feet when standing, the entire body length when reclining in contact with the vibration surface or buttocks when sitting. There are also vibrations that happened on body tissue which can be induced from impact related events. For example, the impact shocks that experienced through the leg when the heel strikes the ground during running or impact shock when hitting a ball. This impact causes initial vibration within the soft tissues, after that the tissues continue to oscillate as a free vibration. The vibrations vibrate at their natural frequency with decaying vibration caused by damping within the tissue (Cardinale and Wakeling, 2005).

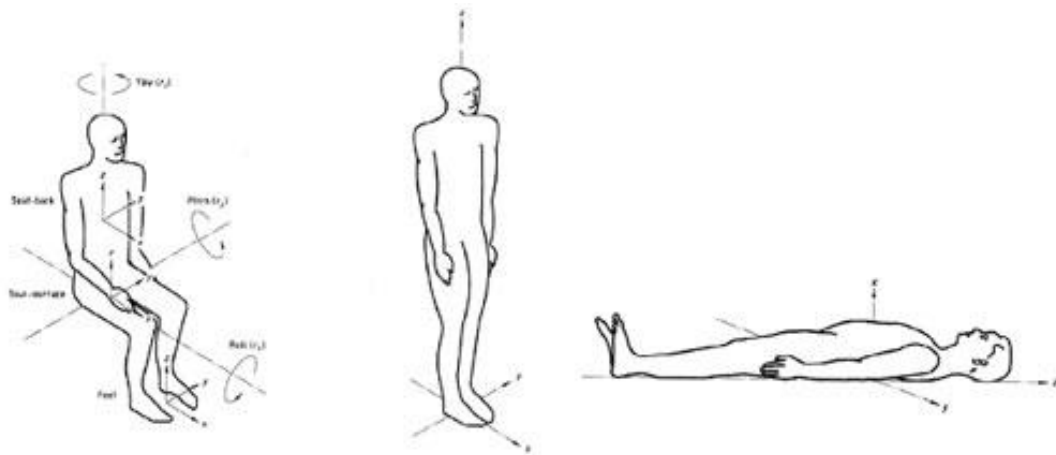


Figure3.1: Coordinate System for the Whole Body. (Berlanga et al., 2010)

The whole body vibration (WBV) consist the transfer of low-frequency environmental vibration to human body through a wide contact area as shown in Figure 1.1. In addition, each individual organ and the body as a whole have natural frequencies that can resonate with vibration energy received at their natural frequencies. Resonance that happened on the body or its parts due to WBV is suspected to cause adverse health effects, starting with chronic exposure. In reality, human are not normally exposed to the vibration of a simple, pure, single wave exposures include a multitude of simultaneous waves of differing magnitude, frequency and direction.

1.1.2 Hand-Arm vibration.

The biggest parts in humans body that always exposed to the vibration is human arms. This is because, most equipment that humans conduct while working using hand and arms which make it the most biggest parts that exposed to the vibration. This prolong exposure can cause a series of disorders in the sensorineural, vascular and musculoskeletal structures of the hand-arm system (Dong et al., 2002). Hand-arm vibration (HAV) is vibration that transmitted while working to the workers hand and arms. The vibrations usually come from operating hand-held power tools such as jigsaw, drilling machine or grinding machine.

There are few symptoms at an early stage of HAV:

- i. Numbness and tingling in the fingers.
- ii. Cannot feel things properly.
- iii. Weakening strength in the hands.
- iv. Blanching on fingers and become red and painful on recovery.

This symptom can cause:

- i. Distress, pain and sleep disturbance.
- ii. Inability to do work properly.
- iii. Reduce ability to work in damp or cold conditions which would trigger painful finger blanching attacks.
- iv. Loss grip strength, which might affect the ability to do work safely.

To reduce the risk of developing hand-arm vibration syndrome (HAVS), the International Organization for Standardization (ISO) has established a standard for measurement, assessment and evaluation of hand-transmitted vibration exposure. Vibration-induced white finger (VWF) has been most studied and considered as a hall-mark of HAVS. Its exposure-effect relationship proposed in a study and adopted in the standard and recommended as a basic for assessing the health effects. This vibration exposure level has been adopted as a main control target in the national standards, regulation or guidelines of many countries (Dong et al., 2012). Figure 1.2 below shows some coordinate system of the hand-arm system where the vibration transmitted to the hands.

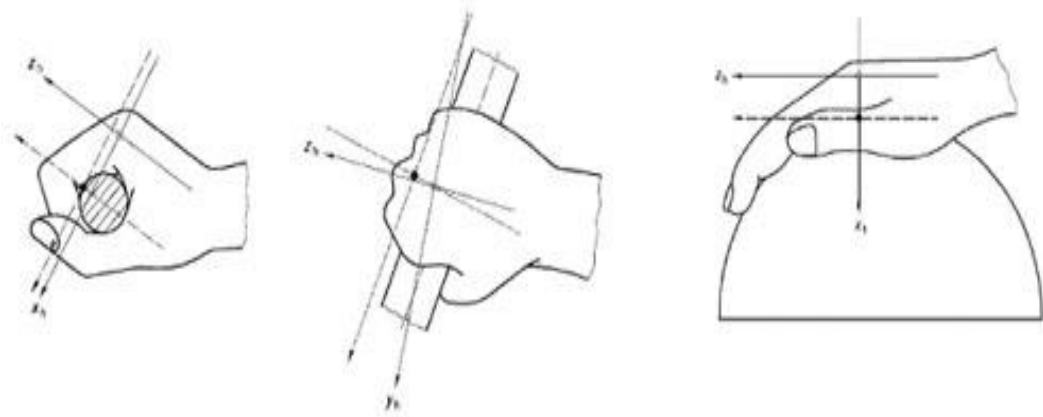


Figure 1.2: Coordinate System of the Hand-Arm System. (Berlanga et al., 2010)

1.2 Glove as vibration absorber

In an early century, gloves are used to warmed hands, holding hot pots, as decoration and to difference between worker and master. This is because only a reach man or family can own the gloves. In addition, in prehistoric times, a caveman worn a glove to protect their hands and took the form of bags resembling a primitive type of mitten. Today, gloves have been used widely in every sector including engineering, medical and many more. There are many kind of glove created with different function and materials.

Nowadays, there are many types of gloves has been created for a various function. There are gloves that used to protect hands from heat, cold, sharp object and excessive impact or fiction to the hands. For example, gloves that used to hold a hot pot is functioning as heat conductor to prevent hands from burns (Metastudio, 2005). In addition, gloves can be as a symbolism such as the white gloves is for wedding ceremony and black gloves for the funeral ceremony (Star, 1898). In the past, gloves is used to protect hands and as a fashion accessory, but because of gloves have a long history of being associated with numerous practice, rituals, customs and symbolisms makes it so special.

Some glove is used to conduct work that using hazardous chemicals and some of it used to reduce vibration that come from machinery tools transmitted to the hands

(Welcome et al., 2014). All glove that have been created with different type of materials and function only have one same objective which to protect hands. Table .11 shows some type of gloves materials with advantages and disadvantages of the materials on humans. But glove also can bring hazards to the user because of materials used to produce the glove. For example, natural rubber can kills sperms that directly exposed to it (Lonnroth, 2005).

Table 1.1: Glove Chart.(Argonne National Laboratory, 2013)

| Type | Advantages | Disadvantages | Use Against |
|--------------------------|--|--|--|
| Natural rubber | Low cost, dexterity, good physical properties | Poor vs. oils, organics, greases. Frequently imported, may be poor quality | Alcohol, bases, dilute water solution |
| Natural rubber blends | Low cost, better chemical resistance than natural rubber vs. some chemicals, dexterity | Physical properties frequently inferior to natural rubber | Same as natural rubber |
| Polyvinyl chloride (PVC) | Low cost, very good physical properties, medium chemical resistance, medium cost | Plasticizers can be stripped, frequently imported may be poor quality | Alcohols, salts, strong acid and bases, other water solutions |
| Neoprene | Medium cost, medium physical properties. Medium chemical resistance | NA | Anilines, phenol, oxidizing acids, glycol ethers |
| Nitrile | Low cost, dexterity, low cost excellent physical properties | Poor vs. benzene, trichloroethylene, methylene chloride, many ketones | Greases, oils, aliphatic chemicals, perchloroethylene, xylene, |
| Butyl | Polar organics, specialty glove | Expensive, chlorinated | Ketones, esters, glycol ethers |

| | | | |
|--------------------------|---|---|--|
| | | solvents, poor vs hydrocarbons | |
| Polyvinyl alcohol (PVA) | Resists a very broad range of organics, good physical properties, | Water sensitive, poor vs. light alcohols, very expensive | Aromatics, aliphatics, chlorinated solvents, ketones, esters, ethers |
| Fluoro-elastomer (Viton) | Organic solvents, specialty glove | Poor physical properties, extremely expensive, poor vs. some ketones, esters, | Chlorinated solvents, aromatics, aliphatics and alcohols |
| Norfoil (Silver Shield) | Good chemical resistance | Easily punctures, poor fit, poor grip, stiff | Use for hazmat work |

1.3 Natural fiber

Nowadays, the increased consciousness and environmental awareness throughout the world has developed an increasing interest in natural fibers and its applications in various fields. The use of natural fiber as reinforcing materials in both thermoset and thermoplastic matrix composites gives positive environmental advantage with respect to ultimate disposability (Singha & Thakur, 2008). This natural fiber can be found anywhere, even in a climatic zone people still can utilize the fiber to make product such as buildings, cloth and cordage.

Natural fiber is an element that can easily obtain anywhere throughout the world. This element can be considered as environment friendly materials because of its biodegradability and renewable characteristics. Natural fiber consist of animal and plant such as sheep, goat, rabbit, camel, coir, oil palm, coconut and many more.

Natural fiber from jute, coir and oil palm is an example of good reinforcement thermoset and thermoplastic materials (Bujang et al., 2007). Besides that, there are also man-made natural fiber such as rayon, acetate, nylon, polyester and many more. Figure 1.3 shows type of plant fibers that consist of bast, leaf, seed, fruit, grasses and reeds.

India and Sri Lanka is the most places that commercially produced coir that starting with food crop as its primary product. Coir fiber can be categorized into two categories which are immature coconut husks and fully ripened coconut husks. The immature coconut husk is very white in color, soft, thin and its coir still green. While for fully ripened coconut have a yield brown coir strong and highly resistance to abrasion (Hall, 2014).

Coconut fiber is a tropical tree which makes it easy to obtain and produced in a tropical country like Malaysia, Thailand, India and many more. In the past, coconut tree only can be found near the shore, but now since it has been commercially produced, there are many plantations of coconut fiber for commercial around the world.

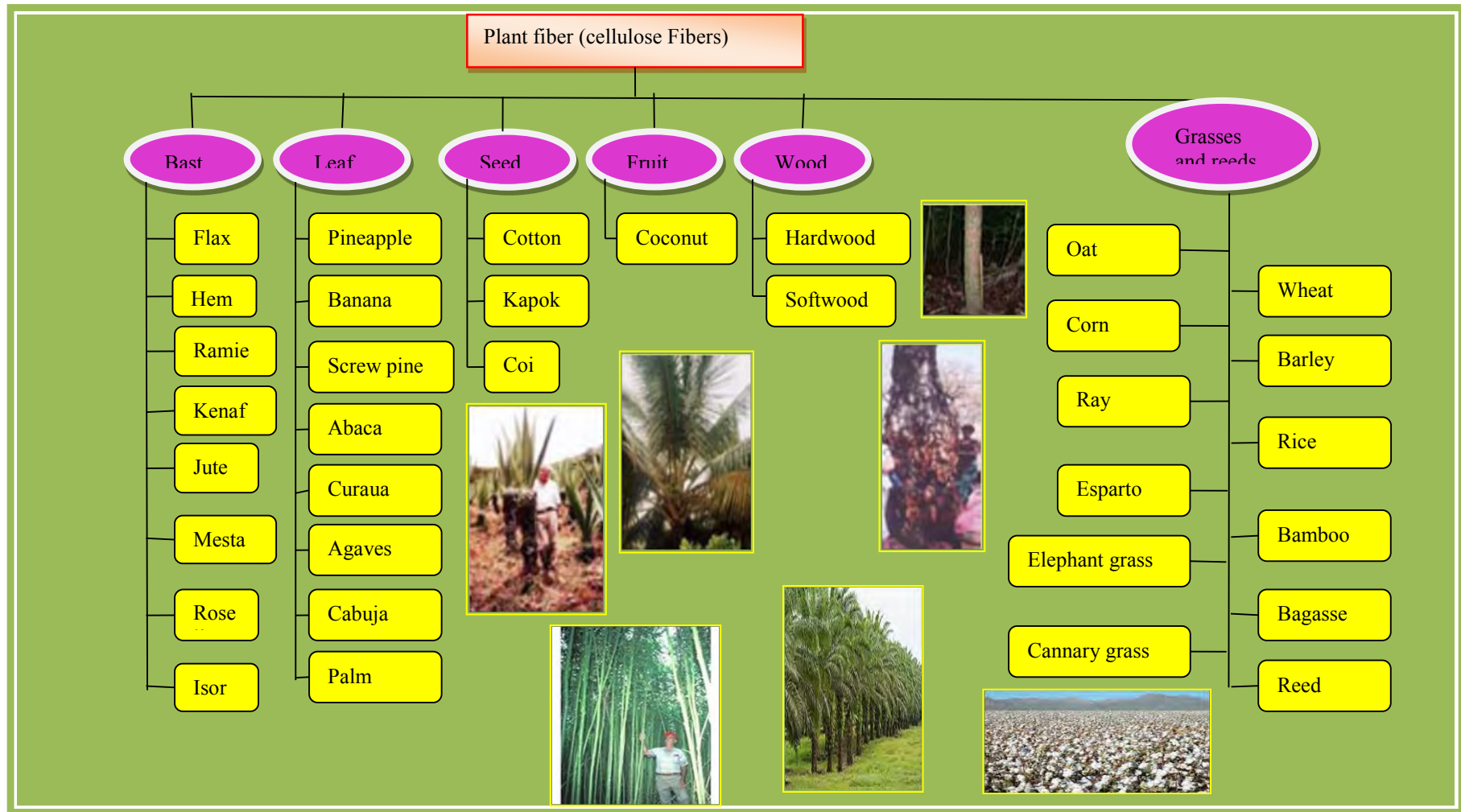


Figure 1.3: Type of Natural Fiber. (Wladyka, 2014)