UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ERGONOMIC ASSESSMENT AT INDUSTRY
(WHOLE BODY VIBRATION)

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours

By

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **ERGONOMIC ASSESSMENT AT INDUSTRY (WHOLE BODY VIBRATION)**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honours. The member of the supervisory committee is as follow:

………………………………

Supervisor

ABSTRAK

Laporan ini membincangkan tentang Penilaian Ergonomik, Getaran Seluruh Badan untuk Mesin Penekan di Jati Beringin SDN BHD. Magnitud yang tinggi terbentuk pada seluruh badan disebabkan oleh mesin penekan. Kemungkinan ianya akan menyebabkan penyakit dan masalah kesihatan pada manusia terutamanya sakit tulang belakang. Kajian ini akan memberikan bacaan pendedahan getaran harian selama 8 jam berkerja dan nilai dos getaran yang terdedah kepada pekerja semasa bekerja serta kesan yang terhasil terhadap tubuh badan manusia. Standard untuk laporan ini adalah 'nilai pendedahan terhad' dan 'nilai pendedahan semasa'. Keputusan analisis diantara mesin yang berlainan akan dibandingkan dengan ISO 2631. Untuk mengatsi masalah getaran ini, perlindungan dengan kadar yang rendah diperlukan kepada pekerja apabila mereka terdedah dengan getaran dan getaran ini akan membahayakan diri mereka. Ia juga mengkhususkan kewajipan majikan untuk mengenalpasti dan mentafsir risiko getaran, langkah-langkah yang akan diambil untuk mengurangkan atau mengelakkan pendedahan getaran dan butiran bagaimana untuk menyediakan maklumat serta latihan bagi pekerja. Mana-mana majikan yang bercadang untuk menjalankan kerja yang melibatkan risiko daripada pendedahan getaran mestilah melaksanakan satu siri langkah perlindungan sebelum dan semasa kerja tersebut.

ABSTRACT

This report discuss about the Ergonomic Assessment, Whole Body Vibration (WBV) for Stamping Machine at Jati Beringin Sdn Bhd. High magnitude of whole-body vibration formed by the stamping machine may cause diseases and health problems to the human especially a low back pain. This study will give an account of daily exposure to vibration A(8) and Vibration Dose Value (VDV) exposed to the workers during work and the effects produced by the exposure towards human body. The standard gives 'exposure limit values' and 'exposure action values'. The result of different specification machine will compare with reference from International Standard Organization 2631 (ISO 2631). For prevention, minimum protection requirements for workers when they are exposed, in the course of their work, to risks arising from vibration . It also specifies employers' obligations with regard to determining and assessing risks, sets out the measures to be taken to reduce or avoid exposure and details how to provide information and training for workers. Any employer who intends to carry out work involving risks arising from exposure to vibration must implement a series of protection measures before and during the work.

DEDICATION

To my beloved mother and father

MUSTAPAR BIN ALI

PATIMAH BT AHMAD

and to all my friends

ACKNOWLEDGEMENT

First of all, thanks to ALLAH SWT for giving me the strength and the chances in completing this Final Year Project. In preparing this report, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts.

In particular, I wish to express my sincere appreciation to my supervisor, En. Nor Akramin Bin Mohamad for encouragement, guidance, critics and friendship. I am also very thankful to all lecturers in faculty of manufacturing engineering for their guidance, advices and motivation. Without their continued support and interest, this report would not have been the same as present here.

Finally, I would like to thanks my family especially my parent for their constant support, encouragement and understanding during my studies.

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LIST OF ABBREVIATIONS

a	-	Acceleration
AR	-	Army regulation
A1	-	Exposure in 1 hour
A2	-	Exposure in 2 hour
A4	-	Exposure in 4 hour
A8	-	Exposure in 8 hour
EAV	-	Exposure action value
ELV	-	Exposure limit value
Hr	-	Hour
ISO	-	International Standard Organization
LBP	-	Low back pain
Min	-	Minutes
MSD	-	Musculoskeletal Disorders
P-P	-	Peak to peak
r.m.s	-	root mean square
TLV	-	Threshold limit value
VDV	-	Vibration dose value
WBV	-	Whole body vibration

CHAPTER 1
INTRODUCTION

1.1 Project title

The ergonomic assessment in manufacturing industries

1.2 Background of project

Vibration appears as an integral part of our everyday live such as cars, trucks, and motorcycles we feel vibration, washer machine and dryers vibration, lawn mowers vibration, powered hedge clippers and brush cutters vibration, power boats vibration, powered shop tools vibration. An example at working area are machinery vibration, lift trucks vibration, pneumatic and electrically powered tools all vibration, and the list goes on and on. For most part, little is thought about vibration since it is so common until something happens to make us take notice.

Vibration refers to six directional motion of an object. There are actually up to six directions at any one point (Bridger,2009) front to back, side to side, up or down and three corresponding rotation, pitch, yaw and row. What we see with our eyes as an object moves is called displacement. What we do not see is the object"s speed, or velocity, the time rate to change of a moving object. Nor do we see acceleration, which is the time rate of change of speed of the moving object. Rotation is not measured in human vibration work.

For our information, be aware that there are some 8 million workers in the U.S alone that are occupationally exposed to vibration (Bridger,2009) of which 7 million exposed to whole body vibration (WBV) and 1 million are exposed to harm arm vibration (HAV). The medical effect of WBV and HAV is not same.

Whole body vibration (WBV) or head to toe vibration is usually experienced by operator of truck, buses, locomotive, lift truck, heavy equipment operation, farm vehicle operation, overhead cranes and found near vibrating machinery such as punch presses or mould shakeout areas in foundries. In this project, the heavy equipment operation (stamping machine) had been choose to do analysis because of this part more relate with our studies.

Studies of disease in large worker population and laboratory studies have indicated that WBV exposure is associate with various musculoskeletal disease including but not limited to low back pain, degenerative inter vertebral disc disease, and herniated and slipped discs. In addition, some studies show that female exposed to WBV have additional gynaecological risks especially during pregnancy (Waldemar, 1998).

Some medical consequences of WBV exposure appear as cumulative trauma disorders (CTDs), where WBV exposure is experienced by the worker with no apparent difficulties for an extended period of time. Then, problems such as a slipped disc might occur for no apparent reason or from an innocuous event like leaning over to pick up a light object. Research work, in the United States and elsewhere is seeking to elucidate these actual injury mechanisms (Sharawan, 2008). WBV exposure can cause both safety and health problem.

The „Vibration Directive" (Directive 2002/44/EC) sets minimum standards for controlling the risks from whole-body vibration. The Vibration Directive requires that member states of the European Union implement national legislation to implement the requirements of the Directive by 6th July 2005. National legislation may apply more favourable provisions than those required by the Directive, and should not reduce the protection afforded to workers by any pre-existing national legislation. (refer **Appendix B**)

1.3 Problem statement

In fact, the WBV have been detected as important risk factors which may cause Musculoskeletal Disorders (MSD) and they must be strictly controlled. Occupations that require operating heavy equipment expose workers daily to low frequency vibration generally less than 100Hz. Expose to these vibration can cause serious physical problem ranging from chronic back pain with vibration. The combination increase stress and load on the neck, shoulder and lower back. To compensate for the discomfort from vibration, worker should change their position. However, if the position is incorrect, the stress may be increased.

Short term exposure vibration causes only small physiological effects such as a slight degree of hyperventilation and increased heart rate. Vibration also causes increased muscle tension from voluntary muscle contraction. Muscles become tense in order to dampen the vibration. Low frequency vibration of moderate intensity can induce sleep. Higher frequency has the opposite effect. Vibration can also become blurred because of the movement of the image on the retina.

Vibration is also traumatic to the spine. Intervertebral disc serve as shock absorbers and become susceptible to injury over prolonged periods. It also constant exposure to vibrations represents the ultimate cumulative trauma. Besides that, the prolonged exposure to whole body vibration can lead to bulging or herniated disc. Anyone with chronic pain in the back or tingling down their legs should be concerned.

1.4 Objective

There are some objectives related to this project about Whole Body Vibration (WBV) at stamping machine:

1.4.1 Analyse the effect of whole body vibration.

1.4.2 Analyse the relationship between vibration and low back pain.

1.4.3 Discuss about factor of whole body vibration and calculate the effect of lower back pain.

1.4.4 To reduce the effect of vibration and develop prevention program for the company.

1.5 Scope of project

1.5.1 6 workers are selected to analyse the vibration of stamping machine while operate.

1.5.2 Using stamping machine (80 ton & 250 ton).

1.6 Chapter outline

1.6.1 Chapter 1

In this chapter, the project is focus about background, objective, problem statement, scope of project and chapter outline. Refer **Appendix A** for Gantt Chart

1.6.2 Chapter 2

Literature review mostly will discuss about reference journal and describe the journal. Besides that, it related with another chapter to discuss the problem at industry and more about idea to run this analysis.

1.6.3 Chapter 3

This chapter discuss about methodology. It mostly related with chapter at above. This chapter is very important before start the analysis because it is the reference during doing the analysis. It also discuss about method will used to get the optimize result.

1.6.4 Chapter 4

The result will describe after do the analysis. From the data of analysis, the result will show in graphic, figure and tables. This method is more easy to understand and easy to do comparison. After get the result, this chapter will do the discussion about result. The discussion also very important and can relate with literature review. The factor in the result will find after finish the discussion.

1.6.5 Chapter 5

In this chapter discuss about the program prevention to reduce the exposure limit value to minimum and follow the ISO2631 standard machine operation.

1.6.6 Chapter 6

As the last chapter, the analysis will conclude with related with objective of analysis. Besides that, in this chapter also describing about suggestion to improve the analysis for future study.

CHAPTER 2

LITERATURE REVIEW

2.1 Vibration

Vibrations arise when a body moves back and forth due to external and internal forces. In the case of whole-body vibration, it may be the seat of a vehicle or the platform on which a worker is standing that vibrates, and this motion is transmitted into the body of the driver. There are a number of parameters that define human exposure to WBV. These include displacement, velocity, acceleration, direction, magnitude, frequency and duration. The response of the human body to external vibration depends on the characteristics of the input signal and the composition of the body, including the distribution of body mass, and viscoelastic properties of connective tissues.

2.1.1 Measurement

Vibration is defined by its magnitude and frequency. The magnitude of vibration could be expressed as the vibration displacement (in metres), the vibration velocity (in metres per second) or the vibration acceleration (in metres per second per second or m/s^2). However, most vibration transducers produce an output that is related to acceleration (their output is dependent on the force acting on a fixed mass within the transducer and, for a fixed mass, force and acceleration are directly related), so acceleration has traditionally been used to describe vibration.(Bovenzi, 1999)

2.1.2 Direction

Vibrations acting on the whole body or subsystems of the body are normally specified in three orthogonal axes (x, y and z). Vibrations can be measured in the anatomical axes of each motion segment (pelvis, head, vertebra or hand). However, for practical purposes, vibrations transmitted from the machine to the worker are usually measured in basicentric axes centred at the point of transmission to the body. Actually WBV measurements are simultaneously obtained using three accelerometers attached to a small metal cube and placed in the center of a hard rubber pie plate type disk. The measurement disk can be placed on the floor near a vibrating machine where the worker stands (Bridger, 2009.)

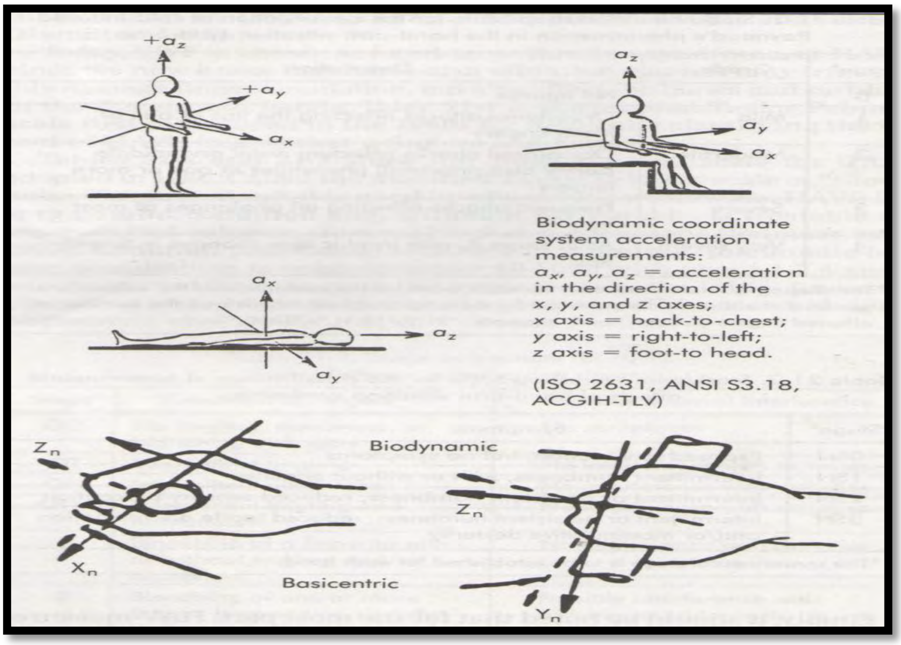

Figure 2.1: Figure below shows the triple vector (triaxial), mutually perpendicular coordinate direction respectively used for WBV measurement.

(Source: Ergonomic in Manufacturing Book)

2.1.3 Displacement, velocity, and acceleration

To define a vibrating system in three dimensions, vibrations are measured as three linear acceleration a_x, a_y and a_z in ms^{-2} and corresponding angular accelerations about the x, y, and z axes, a_{rx} (roll), a_{ry} (pitch) and a_{rz} (yaw) in rad s^{-2}. For more detailed analysis of the effect of vibration on individual segments, when attemping a biomechanical analysis of the segmental forces involved or when operators are exposed to large magnitudes stocks, sudden stops or collisions then rotational components of vibration become important and should be measured to obtain a complete understanding of whole body response. Although generally measured in units of accelerations, vibration may also be expressed in terms of the velocity (ms^{-1}) or displacement (m) of the system, depending on the information required. At low frequencies, displacement can be large and may be important to design parameters of the system. At high frequencies, displacement become progressively smaller and may be difficult to measure even at relatively high level of accelerations.

2.1.4 Magnitude and duration

The magnitude of vibration generally measured in units of acceleration. As an acceleration waveform varies in time, the magnitude is normally measured as the root mean square (r.m.s) average value of the acceleration signal (a), but can also be expressed as the peak value of the acceleration (A). The ratio of peak to r.m.s acceleration (A/a) measured over the same time period is termed the crest factor. Simple harmonic (sinusoidal) motion has a crest factor of ~ 1.414 whereas random vibration has a crest factor of ~ 4, but that will vary slightly with the duration of measurement. For steady state vibration the r.m.s value provides a reliable measure of magnitude provided that it is measured over a time period sufficient to obtain a representative sample of the acceleration time series, generally >227s for WBV measure. For nonsteady state vibration having a crest factor >9, the r.m.s value may underestimate the health effect of the vibration exposure and additional measures should be considered in evaluating the magnitude of the acceleration. (Bovenzi 1999)

2.1.5 Frequency

Frequency represents the number of times per second the vibrating body moves back and forth. It is expressed as a value in cycles per second, more usually known as hertz (abbreviated to Hz). For whole-body vibration, the frequencies thought to be important range from 0.5Hz to 80Hz. However, because the risk of damage is not equal at all frequencies a frequency-weighting is used to represent the likelihood of damage from the different frequencies. As a result, the weighted acceleration decreases when the frequency increases. For whole-body vibration, two different frequency weightings are used. One weighting (the Wd weighting) applies to the two lateral axes: x and y, and another (the Wk weighting) applies to the vertical, z-axis vibration. When considering the risks to health from whole-body vibration an additional multiplying factor must be applied to the frequency weighted vibration values. For the two lateral axes (x and y) the acceleration values are multiplied by 1.4. For the vertical, z-axis vibration the factor is 1.0.

A number of frequencies have been identified as the resonance frequencies of subsystem within the body using a variety of measurement technique. Subjective measure of discomfort and pain also be used to detect resonance of internal organ. Refer **Table 2.1** Resonance of internal organ will not show on whole body transmission curves due to the small mass involved, but are critical in defining vibration tolerance limits, and critical frequencies. Values are for z axis acceleration unless otherwise stated.