FABRICATION AND ANALYSIS OF GRINDING JIG FOR BEVEL END PIPE JOINT TO REDUCE VIBRATION

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

by

MUHAMMAD FITRI BIN ZAHARI

B051710168

960209-14-5701

FACULTY OF MANUFACTURING ENGINEERING

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **FABRICATION AND ANALYSIS OF GRINDING JIG FOR BEVEL END PIPE JOINT TO REDUCE VIBRATION**

Sesi Pengajian: **2020/2021 Semester 2**

Saya **MUHAMMAD FITRI BIN ZAHARI (960209-14-5701)**

mengaku membenarkan Laporan Projek Sarjana Muda (PSM) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☑ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan)

☐ TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:
7-4-5 Jalan 15/2A
Taman Wilayah Selayang
68100, KL. WP Kuala Lumpur

Tarikh: 2 September 2021

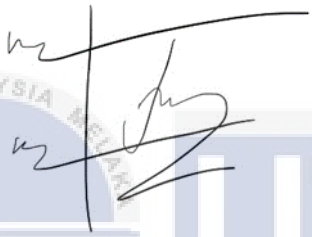
Cop Rasmi:
DR. NUR IZAN SYAHRIAH BINTI HUSSEIN
PROFESOR MADYA
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Tarikh: 1 September 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Fabrication and Analysis of Grinding Jig for Bevel End Pipe Joint to Reduce Vibration” is the result of my own research except as cited in references.



Signature : ……

Author’s Name : MUHAMMAD FITRI BIN ZAHARI

Date : 2 August 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

.....

(ASSOC. PROF. DR. NUR IZAN SYAHRIAH BINTI HUSSEIN)

ABSTRAK

Penghasilan serong pada hujung paip untuk sambungan kimpalan biasanya menggunakan mesin canai dan sering dilakukan secara manual. Dalam keadaan ini, getaran yang dihasilkan daripada mesin canai akan memberi kesan kepada kesihatan manusia seperti penyakit yang disebut “Hand Arm Vibration Syndrome” (HAVS). Ia adalah penyakit yang disebabkan oleh pendedahan kepada alat getar untuk jangka masa yang lama. Seterusnya, untuk mengelakkan getaran ini dihasilkan dari mesin canai yang dihantar ke tubuh manusia semasa menggunakan mesin canai. Pembuatan jig dan lekapan menjadi objektif untuk projek ini. Jig buatan dapat mengurangkan getaran yang dihasilkan oleh mesin canai, yang mengurangkan penggunaan dua tangan ketika melakukan pengahsilan serong dari harus memegang paip dan mesin canai secara serentak kepada hanya memegang paip. Jig dan lekapan masih menghasilkan getaran tetapi ia mengurangkan penyerapan getaran ke tubuh manusia yang membuatkan keselamatan pekerja terjamin. Jig dan lekapan difabrikasi dibengkel kerana mesin yang mudah diakses. Jig dan lekapan difabrikasi dengan menggunakan beberapa proses pembuatan seperti pemesinan, penggabungan, pengimpalan dan proses gerudi. Setelah semua bahagian dibuat, proses pemasangan telah dilakukan untuk memastikan jig berfungsi seperti yang dirancang sebelum analisis dapat dilakukan. Analisis dibuat dengan mengurangkan getaran yang dihasilkan dari mesin canai yang terdedah pada tubuh manusia, kemudian membandingkan jumlah getaran dengan mesin canai manual. Jig berjaya memanjangkan jangka masa penggunaan alat yang bergetar dari mencapai had getaran yang boleh membahayakan pengguna. Seterusnya, ketepatan menghasilkan sudut serong semasa menggunakan jig yang dibuat telah diukur. Sebuah meter getaran tangan digunakan untuk menganalisis getaran yang dihasilkan oleh jig pada tubuh manusia untuk membuktikan bahawa getaran dikurangkan dari 2.5m/s² kepada 1.8m/s² untuk penggunaan manual. Untuk analisis sudut serong, protraktor serong digunakan untuk memeriksa ketepatan hasil sudut serong pada paip seperti yang dinyatakan pada jig sebelum beroperasi. Jig ini berguna untuk pekerja yang menggunakan mesin canai secara harian seperti industri minyak dan gas di mana proses paip serong dilakukan setiap kali proses paip kimpalan diperlukan.

ABSTRACT

Bevelling a pipe end for a welding joint usually uses the hand grinder, and operators tend to operate it manually. In this situation, the grinder's vibration will affect human health, such as a disease called Hand Arm Vibration Syndrome (HAVS). It is a disease caused by exposure to vibrating tools for a longer time. Thus, it is crucial to avoid this vibration from the grinder transmitted to the human body while operating the grinding machine. Fabrication of a jig and fixture is the aim of this project. The fabricated jig and fixture can reduce the grinder's vibration, which neglects the use of two hands when bevelling from holding a pipe and grinder simultaneously into just holding a pipe. The jig and fixture still produce a vibration, but it is less value of the vibration absorption toward the human body, ensuring workers' safety is secure. The jig and fixtures were fabricated in the workshop because there have accessible machines. Jig and fixture were fabricated using manufacturing processes, such as machining, joining, welding, and drilling. After all the parts were done with fabrication, the assembly process was done to ensure the jig was working as planned before analyzing the project. An analysis was obtained by reducing the vibration produced from the grinder machine exposed to the human body, then comparing vibration with a manual grinder. Then, the accuracy of the bevel angle produced when using the fabricated jig and fixture was measured. A hand-arm vibration meter was used to analyze the jig's vibration on the human body, proving that vibration was reduced from 2.5184 m/s^2 to 1.8408 m/s^2 for manual bevelling. The jig and fixture were successfully extending the period of use for vibrating tools from reaching the vibration limit that can endanger the user. For the bevel angle analysis, a bevel protractor was used to check the bevel angle at the bevelled pipe as stated at the jig before operating. This jig is useful for the operator in daily use of grinders such as the oil and gas industry, where the bevel pipe process is done every time the welding pipe process is needed

DEDICATION

I wholeheartedly dedicate this study
to my beloved father, Zahari Bin Zainal; to my mother, Dara Binti Mokhtar;
to my family;
to my helpful classmates and friends;
to my honorable and resourceful supervisor, PM Dr. Nur Izan Syahriah Binti Hussein
for assisting me by means of giving me moral supports, knowledge, time, cooperation, encouragement and understandings.
Thank You So Much

ACKNOWLEDGEMENT

First of all, praises to The Almighty for His mercy and graces that I can finish this “Projek Sarjana Muda 2” just in time. Furthermore, without the help and support of the kind people around me, I would not have done it, and I would like to thank those people who contributed ideas and knowledge to produce this research.

I would like to express my sincere appreciation and gratitude to Professor Madya Dr Nur Izan Syahriah Binti Hussein, my “Projek Sarjana Muda 2” supervisor, for her patience, commitment, support and motivation in supporting me with her knowledge of welding professions. First, I want to thank all my friends for their support and guidance on how to write a good report and share useful knowledge.

Apart from that, I have learned and got a very good experience based on the journey to complete this project and it is very helpful with my research as I get a complete understanding of the fabrication process.

I am also grateful to my family, who provided full support and encouragement whenever I felt discouraged and disappointment to complete this project. Last but not least, I would like to thank to my friend and colleagues for their support and guide me through the report's format.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

FKP	-	Fakulti Kejuruteraan Pembuatan
HAVS	-	Hand Arm Vibration Syndrome
UK	-	United Kingdom
SOCSO	-	Social Security Organization
JSOH	-	The Japan Society for Occupational Health
VEA	-	Vibration Energy Absorption
BP	-	Blood Pressure
BOM	-	Bill of Material
USA	-	United State of America
ASTM	-	American Society Testing Material
GOST	-	Gosudarstvennye Standarty State Standard
EAV	-	Exposure Action Value
ELV	-	Exposure Limit Value
OELs	-	Occupational Exposure Limits
TLV	-	Threshold Limit Value

LIST OF SYMBOLS

mm	-	Millimetre
g	-	Gram
m/s²	-	Frequency weighted acceleration
%	-	Percentage
Inch	-	Inches
°	-	Angle of degree
Hz	-	Hertz
$\bar{X}$	-	Arithmetic mean
σ	-	Standard deviation
u_p	-	Standard uncertainty

CHAPTER 1

INTRODUCTION

1.1 Background of Study.

Making bevel end pipe joint is mostly done using a grinder, which is a worker handling it manually or using automatic pipe bevelling machines. Pipe bevelling is the process where an angle is formed between the edge of the pipe or tube end and a plane perpendicular to the surface. A pipe with more than 3mm thickness needs a bevel for the welding joining regarding welding standards. The welding standard of an end pipe joint of bevel angle for welding is 37.5°. However, grinder results also form a non-uniform bevel angle because of many factors, such as unskilled workers.

Vibration while handling tools is common when a worker uses machines or tools frequently without a stop for some time. Exposure to vibration during handling vibration tools or machines can cause harm to the users. Prolonged and intensive exposure to vibration often affects workers. Such vibration exposure may cause vibration-induced white finger or hand-arm vibration syndrome, but effective exposure control remains an important issue (Dong et al., 2020).

Hand Arm Vibration Syndrome (HAVS) affects many workers who use vibrating tools over the years and can lead to a lifelong disability. Vascular symptoms include cold-induced spasms of the fingers and hands, blanching of the fingers, and atrophic skin changes in the fingertips. According to the Health and Safety Executive, UK stated that in 2019 has 205 cases related to HAVS. Sensorineural symptoms include numbness and tingling in the fingers and hands, reduced sensory perception, and manipulative dexterity. While handling a machine or tools, many factors can lead to this disease if overexposed. The study confirmed that a handheld workpiece's vibration generally resulted from two types of vibration sources: (i) the vibration generated on the machine and transmitted to the workpiece; and (ii) the grinding vibration generated at the grinding interface. In principle, the data of absorption vibration can be obtained from constructing a combination of grinding machine, a jig, and vibration reader tools, similar to those used to simulate the vibration response of a handling a grinding machine (Chen et al., 2017).

1.2 Problem Statement.

Grinding is one of the typical manufacturing processes operated by a machine or manually using a human hand. Because of manual use, the result of the bevel angle is often not uniform. Therefore, performing a standard quality of bevel angle is an important parameter to archive a good welding joint (Deepali et al., 2016). By that, while grinding parts like a pipe using a hand grinder, it will cause some problems such as vibrations absorption while handling it and will affect the workers using it (Vihlborg et al., 2017). Other than that, some significant effects on humans can reduce grip strength, and sometimes the person will be unable to feel the heat of the cup.

Furthermore, fabricating a grinding jig that focuses on reducing vibrations for the bevel end pipe joint must be appropriately planned for workers to do a job safely without harming their health. The shape of the groove is one of the factors that may affect the residual stress of the welding joint (Akbari et al., 2012). This study developed a methodology for performing analyses and evaluations based on a grinding jig for the bevel end pipe joint. First, an analysis will be made by comparing the amount of vibration exposed to the human hand using a traditional method and using this jig and measuring the bevel angle form by a jig. For the second investigation step, the vibration reading response was simulated and measured in a laboratory (Krajnak, 2018). The functional jig and fixture can reduce the

grinding machine's vibration while making the bevel end pipe joint. Because of the reduction of vibration, it can also ensure that workers' working process is safe.

1.3 Aim and Objective.

This project aims to make a grinder process for bevel end pipe joint safe for workers who handle it because they will be exposed to continuous vibration. The objectives of this project are:

i. To fabricate jig and fixture for workers to bevel a pipe in preparation for welding to reduce vibration exposure.

ii. To analyze the vibration absorption on workers when using the jig when bevelling an end pipe for the welding joint and to measure the bevel angle while using the jig.

1.4 Scope.

The study was conducted at Fakulti Kejuruteraan Pembuatan (FKP) UTeM workshop. This study was aimed to fabricate a grinding machine's jig for bevel end pipe joint without a worker's need to handle a grinder and analyze a vibration absorption and bevel angle produced by jig through an experiment and analysis. The detailed design of the fabricate jig and fixture already undergoes the previous study's design process and has been drawn using SolidWorks Software. For the fabrication part, the previous research acted as a guide to the fabrication process. The jig parts were assembled as complete jig through several manufacturing processes and then underwent testing and analysis. Due to this process, bolt and nut acted as connectors to connect the hand grinder with the jig. The analysis was conducted using a hand-arm vibration meter to measure the vibration absorption on the fabricate jig and bevel protractor to measure the accuracy of bevel angle produce when using jig and fixture.

1.5 Significant of Study.

This research aims to provide the best way to reduce the vibration absorption produced by jig due to workers' handling for more extended periods, where certain grinding

methods should be examined. Collect the data from the vibration produced when the worker operates a grinder machine by hand for a specific time. To analyze the vibrations produced by the grinder machine when conducting a process of bevelling end pipe joint between traditional method or jig features designed to reduce vibration and mainly performed with an automatic machine. This study will help the industry facing this kind of manufacturing process through their daily project. For example, a piping worker needs to welding hundreds of pipes a day before welding it. These can ensure their life is safe while using this jig compare to handling a grinder manually using hand to do bevelling on end pipe.

1.6 Thesis Outline.

Chapter 1 begins with a research background, problem statement, objectives, the scope of the research and fabrication, and analysis of grinding jig for bevel end pipe joint to reduce vibration. This chapter composes the introduction, problem statement, objectives, scopes, the significance of the study, and project framework. Chapter 2, the literature review, is used by looking at previous research about the vibration absorption on humans while operating a grinding machine while bevelling an end pipe. A literature review provides a comprehensive background and supportive material research. Chapter 3 describes the process flow and the methodology of the study. Chapter 4 presents the experimental results by referring to the previously supported study. Chapter 5 discusses the significance of the results. Finally, summarizes and conclude this thesis and come out and recommendation for future work.

1.7 Activity Planning.

A Gantt chart provides a graphical illustration of a schedule that helps plan, coordinate, and track specific tasks in a project. Gantt charts may be simple versions created on graph paper or more complex automated versions using project management applications such as Microsoft Project or Excel. However, to complete this PSM 2 according to the time given, a Gantt chart is compulsory for this project. The Gannt chart is shown in the Appendices of this report.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

This chapter will review previous research on the journal, book, and internet resources related to vibration affecting workers handling grinding machines. This review's purpose is to review previous studies on the analysis, which included the effective method for reducing vibration and jig design to minimize worker handling of a machine or tools. As a result, various sources were identified and subsequently reviewed. A literature review identifies, evaluates, and synthesizes the relevant literature within a particular field of research. A study on the previous research will illuminate how knowledge has evolved within the field, highlighting what has already been done, what is generally accepted, what is emerging, and the current state of thinking on the topic. Besides, within research-based texts such as a Doctoral Thesis, a literature review identifies a research gap and articulates how a particular research project addresses this gap. In this topic, some research can be evaluated to reduce the vibration absorption during handling a grinding machine with hand while making a bevel for end pipe joint due to starting a welding process of joining a pipe. However, most research is about reducing vibration to avoid getting Hand Arm Vibration Syndrome (HAVS) because of exposure to vibration. The analysis taken from the new method of using modified jig compared to the traditional method is handling a grinding machine manually with hand.

2.2 Hand Arm Vibration Syndrome (HAVS).

(Su et al., 2011) stated that in 2005, 2.3 million Malaysian workers were working, which exposes to the vibration that applied to the Social Security Organization (SOCSO) but only 15 workers sick cause by vibration. Handheld power tools such as grinding machines produce a lot of vibration that can absorb into the human hand when performing a bevelling process at the end of the pipe joint. This vibration will affect human health, such as exposure to a disease such as White Finger Syndrome or Hand Arm Vibration Syndrome (HAVS) (Vihlborg et al., 2017).

The prevalence of HAVS ranged from 5% to more than 80% globally, depending on the types of tools, the extent of vibration exposure, and climatic factors (Su et al., 2011). HAVS is caused by the repeated use of manual vibrating machines - grinder, chainsaws, and power drill, for example. It may also be triggered by the operation or use of vibrating machinery. The vibration causes the condition to be not noticeable. It's possibly because the tiny nerves and arteries in the finger suffer from mild yet frequent injuries. Over time, some of their functions may be lost, and their symptoms may be present. Up to 1 out of 10 people with vibrating tools may probably grow HAVS. Other than that, according to The Japan Society for Occupational Health (JSOH), which uses Occupational Exposure Limits (OELs) as a recommended guide to not exceed 2.8 m/s² for 8-hour of working time (World Health Organization, 2009). The Control of Vibration at Work Regulations in 2005 stated that the Exposure Action Value (EAV) and Exposure Limit Value (ELV) is in m/s² A (8); the average (A) exposure during an eight-hour (8) day, taking into account the vibration's intensity and duration. A tool or machine's vibration rate is measured in meters (m) per second (s) square. The regulations set the daily EAV as 2.5 m/s² A (8), and ELV is 5 m/s² A (8). Exposure to hand-arm vibrations is associated with a risk of hand injury in the form of vascular disorders, nerve malfunction, and effects on the musculoskeletal system (Heaver et al., 2011). Therefore, the workers involved are provided with periodic health monitoring. The Guidelines on occupational vibration (DOSH, 2003) were utilized in Malaysia as a reference for workers engaged in the vibration operation of the hand-arm. In this specific recommendation, the threshold limit value (TLV) determined and the time of exposure for vibrations transmitted in A (8):

- 4 hours and less than 8 hours = 4 m/s²
- 2 hours and less than 4 hours = 6 m/s²
- 1 hours and less than 2 hours = 8 m/s²
- Less than 1 hour = 12 m/s²

This disease is not showing the result instantly but will affect the worker who is exposed regularly. Workers will have some problems such as loss of grip strength, tingling, loss of sensation in the fingers, and many more.

Figure 2.1: Hand nerve affected by vibration tools (Sabitoni, 2018).

Characteristics of HAVS shows such as follow:

i. The constellation of symptoms is caused by ongoing exposure to vibrations.

ii. It can take from 6 months to many years for HAVS to develop, depending on the strength of the vibrations.

iii. Often using vibrating tools, the vibration can damage the internal human systems, such as Figure 2.1.

iv. The damage is irreversible and may leave the worker with a permanent disability.

v. The circulatory system, the muscle, and the nerves in the hands and the arms can be affected.

2.3 Bevel.

A bevel is a surface edge that is not perpendicular to the face of the object. For safety, wear resistance, or to ease the joining with another part, a bevel is usually used to soften the edge of an object. Bevelling is carried out prior to welding on thicker pieces of metal, and 37.5° is the standard for bevel angle in welding. On top of that, parameters such as the gas flow rate affected by the current supply and bevel angle can determine the weld's strength (Sathish et al., 2012). The bevel provides the plate or pipe with a smooth, clean edge and allows the correct form to be welded. In addition, to prevent center-line cracking from joining the separate pieces of metal.

The particularly thick pipe will have a "V" shaped groove when the bevel is made. It is to reduce the amount of welding filler metal used. Bevelling is an important part of the engineering method for pipe welding. Due to being welded together, two pipe ends have their shapes changed by removing some of the metal from either end (Deepali et al., 2016). Bevelling can be carried out manually by hand-grinding or by automated bevelling. The bevelling end of the pipe is an important part of achieving high-quality welding. It improves the surface area of the welding area and results in better welds that can withstand more tension. In addition, as the pipe ends are bevelled, there is a greater probability that welding will be allowed, thereby minimizing the cost of repair or cutting and allowing the project to stay on schedule.

Figure 2.2: Bevelling end pipe manually with hand grinder machine (Stuart, 2015).