SURFACE INTEGRITY AND WEAR MECHANISM H13 TOOL STEEL MACHINABILITY ASSESMENT

MOHAMAD HAZZIM BIN MOHD ANUAR
B091810293

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2022

Faculty Of Mechanical And Manufacturing Engineering Technology

SURFACE INTEGRITY AND WEAR MECHANISM H13 TOOL STEEL MACHINABILITY ASSESMENT

Mohamad Hazzim Bin Mohd Anuar

Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

2022

SURFACE INTEGRITY AND WEAR MECHANISM H13 TOOL STEEL MACHINABILITY ASSESMENT

MOHAMAD HAZZIM BIN MOHD ANUAR

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

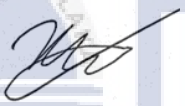
Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project entitled " Surface Integrity And Wear Mechanism H13 Tool Steel Machinability Assesment " is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : MOHAMAD HAZZIM BIN MOHD ANUAR

Date : 28 JANUARY 2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Of Manufacturing Engineering Technology (Process And Technology) With Honours.

Signature : .....

PROFESOR MADYA Ts. DR. UMAR AL-AMANI BIN HJ AZLAN
Dekan
Fakulti Teknologi Kejuruteraan Mekanikal Dan Pembuatan
Universiti Teknikal Malaysia Melaka

Supervisor Name : ASSOCIATE PROFESSOR TS.DR.UMAR AL-AMANI BIN HAJI AZLAN

Date : 28 JANUARY 2022

DEDICATION

This research is dedicated to my dear and respected parents, Mohd Anuar bin Bidin and Juliana binti Ibrahim, who have provided me with a strong moral foundation and a decent education as an inspirations. They have given me a great motivation and discipline to approach a task with passion and dedication. I would not be able to accomplish without their dedication and affection. I would love to dedicate this to my respected supervisor, Associate Professor Ts.Dr.Umar Al-Amani bin Haji Azlan who has taught me and guided me through out my Final Year Project and foremost my career as a student. Finally, I would like to dedicate this to all my coursemates and friends who have always been stood by my side no matter how hard the challenge is in order to complete my studies and research.

ABSTRACT

In the field of engineering, the factors of surface roughness and tool wear are highly correlated with each other. Each material has a different property. This study, the analysis will be tested on the material of H13 tool steel. H13 is a hard steel material because it contains 5 percent chromium in its chemical composition. The purpose of this study was to find out the surface roughness of H13 and to analyze the tool wear on the cutting tool. Problem statement of this study shows that there are no data about the machining process towards H13 because the material itself is a rare item. Generally, this study will be carried out by cutting the H13 material on a CNC turning machine under wet conditions where there is a usage of fluid coolant. There are four cutting speed values which will be begun from 100,140,170 and 200 m/min. There are two feed rate values which are 0.05 and 0.10 mm/rev. In this study, depth of cut will be constant at the value of 0.5mm. Upon completion of the CNC machining process, analysis of surface roughness will be performed by using a surface roughness tester, while tool wear will be tested on a microscope and scanning electron microscope. The result shows that H13 material can be performed in CNC turning machine under wet condition. The parameters provided are very suitable when the cutting process is done. Finally, this study will provide an understanding for the students especially in analyzing the factors of surface roughness and wear mechanism.

ABSTRAK

Dalam bidang kejuruteraan, faktor kekasaran permukaan dan kehausan mata alat adalah merupakan perkara yang sangat berhubung kait antara satu sama lain. Setiap bahan mempunyai sifat-sifat yang berbeza. Pengajian ini, akan dilakukan Analisa mengenai bahan alat keluli H13. H13 merupakan bahan keluli yang keras disebabkan ia mengandungi 5 peratus chromium dalam komposisi kimia. Tujuan pengajian ini adalah untuk mengetahui faktor kekerasan permukaan H13 dan menganalisa kehausan mata alat. Pengenalpastian masalah dapat dilakukan apabila data mengenai H13 dari sudut pemesinan tidak banyak dilakukan disebabkan bahan H13 ini merupakan bahan yang sukar didapati. Umumnya, pengajian ini akan dilakukan dengan pemotongan bahan H13 pada mesin pusing CNC dalam kondisi basah di mana terdapat penggunaan cecair penyejuk. Terdapat empat nilai kelajuan pemotongan bermula daripada 100,140,170 dan 200 m/min. Terdapat dua nilai kadar suapan iaitu 0.05 dan 0.10 mm/rev dan nilai tetap kedalaman pemotongan iaitu 0.5mm. Apabila selesai proses pemesinan CNC, analisa kekasaran permukaan akan dilakukan dengan menggunakan alat penguji kekasaran permukaan, manakala kehausan mata alat akan diuji pada mikroskop dan pengimbasan mikroskop elektron. Hasil eksperimen menunjukkan, bahan keluli H13 boleh dilakukan dalam pemesinan CNC dalam kondisi basah. Parameter yang disediakan juga amat sesuai ketika proses pemotongan dilakukan. Akhir kata, kajian ini memberikan kefahaman yang mendalam kepada para pelajar terutamanya dalam menganalisa faktor kekasaran permukaan dan kehausan mata alat.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

I would like to express my gratitude to my respected and beloved supervisor, Associate Professor Ts. Dr Umar Al-Amani bin Haji Azlan who has been providing me with a good guidance, great deal of support and assistance in the journey of completing my final thesis. This project would not have been possible without my co-supervisor, Ts. Dr. Norfauzi bin Tamin whose expertise in the research of machining parameters and guided me on how to develop understanding about surface integrity and wear mechanism. I would like to pay my special regards to Tc. Mohd Azimin bin Ibrahim who has been assists me on how to handle CNC machine with safety. I should also appreciate to all staff engineer in the Faculty of Engineering Technology for assists me on the machining work.

I would like to extend my deepest gratitude to my beloved parents En Mohd Anuar bin Bidin and Pn.Juliana binti Ibrahim for providing me with passion, love, support and good education. I would not be at this succeed not without their guidance.

Finally, I would like to thank to all my beloved course mates who has been assists me as well as taught me on how to be a good friend, good students and to be a good person.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

fr	-	Feed Rate
μ	-	Micron
$\boldsymbol{Vc}$	-	Cutting Speed
$\boldsymbol{d}$	-	Diameter of workpiece, Depth of Cut
$\boldsymbol{n}$	-	Spindle Speed
$\boldsymbol{\pi}$	-	Pi
$\boldsymbol{Do}$	-	Original Diameter
$\boldsymbol{Df}$	-	Final Diameter

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research Background

According to Outeiro (2014) has stated that the aerospace, power, and biomedical industries are greatly concerned with incorporating absolute dependability and maximum safety into the functional performance of machined components. Surface integrity is critical to functional performance and is affected by a variety of machining parameters. As a result, the industry's primary concern is determining which combination of machining parameters provides the best surface integrity for machined components (Outeiro., 2014).

With the advancement of technology, chip-based machining methods (turning, milling, drilling, and so forth.) retain their importance. Steel materials used throughout the manufacturing industry are constantly being improved (Ince., 2016). In today's chip-based manufacturing industry, turning is the most common type of machining. As a result, there are multiple researches in the industrial and academic worlds coping with the enhancement of factors affecting turning operations such as minimum roughness, tool wear, tool temperature measurements, and vibration, among many others (Ince., 2016). There is now a substantial amount of research published in the literature on the effects of cutting parameters on cutting forces and surface roughness in turning (Ding et al., 2010).

In this project, the wear mechanism and surface integrity of H13 Tool Steel will be studied using a Computer Numerical Control (CNC) Machine during the turning process with Tungsten Carbide. In the lab experiment, cutting parameters such as cutting speed and

feed rate will be provided. Every cutting process causes a difference in the wear mechanism and material surface integrity.

The material used in the lab will be AISI H13 Tool Steel. It has good thermal softening resistance, high hardenability, high strength, and high toughness. As a result, this steel has been widely used to manufacture a wide range of hot working dies, including forging dies, extrusion dies, die-casting dies, and so on (Outeiro., 2014).

In order to complete the outcome such as wear mechanism, surface integrity and its microstructures will be studied based on the provided cutting parameters with a constant depth. The expected result will be delivered in the next chapter.

1.2 Problem Statement

The main problem statement in this project is the lack study of machining parameter particularly on wear mechanism and surface integrity of material H13 Tool Steel. Surface integrity research in the machining of AISI H13 Tool Steel was primarily concerned with the experimental evaluation of the effects of cutting process parameters, tool geometry, and tool wear on workpiece surface roughness, residual stress, and subsurface alteration, such as white layer formation (Outeiro., 2014). In general, quality of a material really depends on its surface roughness. Thus, it will decide the lifetime cycle (fatigue) can withstand in a longer period or short-term period.

1.3 Research Objective

There are several objectives will be set in this work. They are as follow :

a) To study several machining parameters which will be set at the CNC Machine.

b) To study wear mechanism and surface integrity by using tungsten carbide cutting tool.

1.4 Scope of Current Work

In this experiment, the material that will be tested is H13 Tool Steel and the cutting tool is using the Tungsten Carbide. The cutting process involves wet condition which is using the Fush type coolant. The CNC Lathe Machine is a 3 axis machining and the model that will be used is DMG MORI SEIKI, CTX 310 Ecoline. Cutting speed, feed rate, and depth of cut are the three types of parameters. In general, there will be two outcomes that need to be observed which are the wear mechanism and surface integrity, whereby surface integrity will be divided into two factors which are surface roughness and microstructures. The process flow is shown in Figure 1.1.

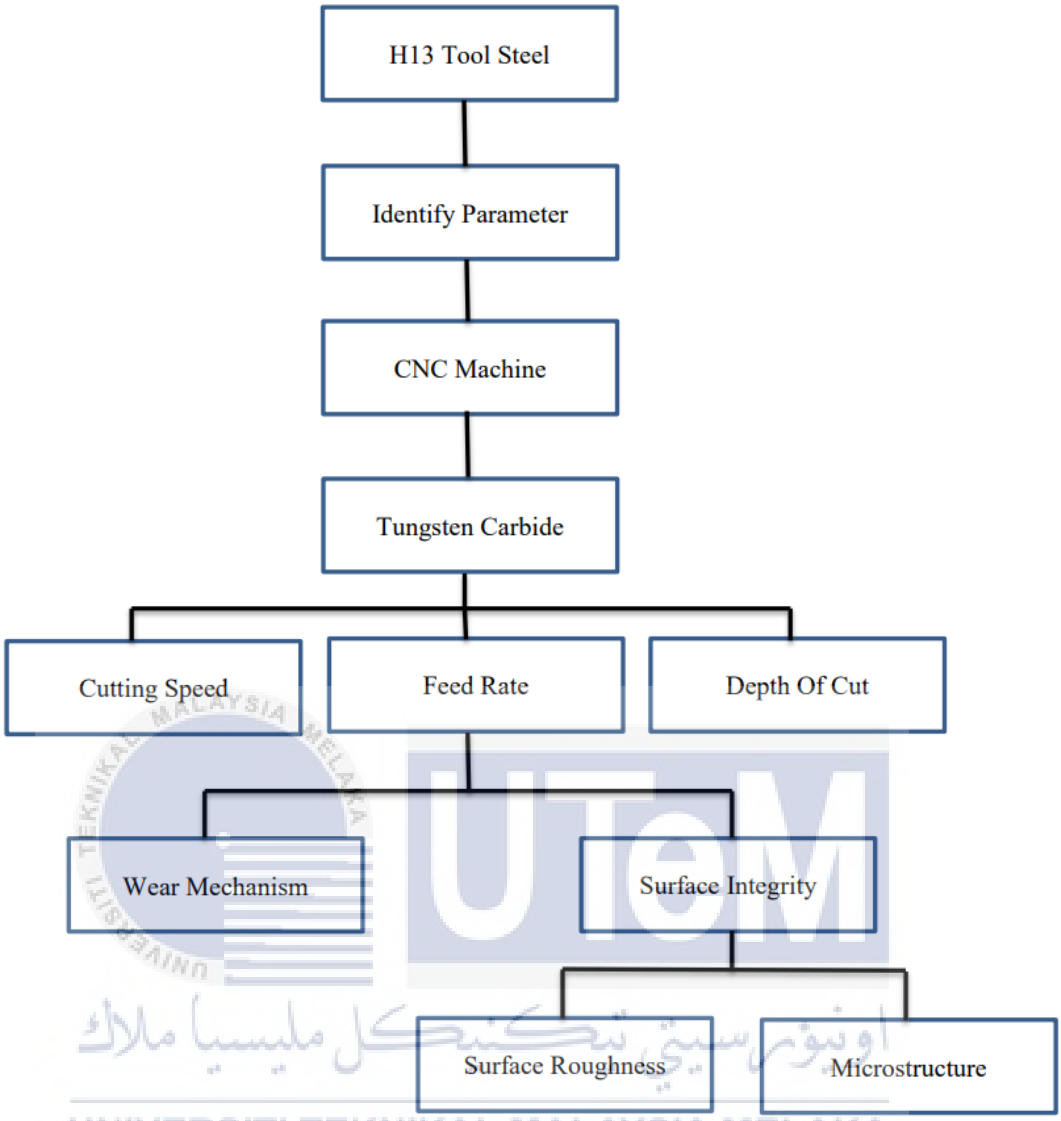


Figure 1.1 Flow Process of Experiment

1.5 Significant of Study

This study's finding will provide a good impact in Industry of CNC Machine. In general, the application of CNC Machine will increase the quality of producing more products and made more complex design along with the development of the time. Furthermore, this research will give a great opportunity of knowing more specifically about material H13 Tool Steel in the engineering industry. Thus, a new research on the CNC Machine towards the material of H13 Tool Steel will be delivered.

CHAPTER 2

LITERATURE REVIEW

2.1 Turning Process

Kumar & Kiran Kumar (2017) has stated that any of several procedures in which a piece of raw material is cut into a desired final form and size by a controlled material-removal process is referred to as machining. The numerous methods that have this common characteristic, controlled material removal, are now referred to as subtractive manufacturing, as opposed to processes of controlled material addition, which are referred to as additive manufacturing (Kumar & Kiran Kumar., 2017).

Turning is a cutting technique in which material is removed from a rotating work piece with a point cutting tool that is typically aided by cutting fluids. Turning operations, according to Kumar and Kiran Kumar (2017), are operations that rotate the work piece as the principal way of moving metal against the cutting tool. The most common machine tool used in turning is the lathe. Turning, drilling, and milling are the three primary machining techniques. Other procedures classified as miscellaneous include shaping, planing, drilling, broaching, and sawing (Kumar & Kiran Kumar., 2017).

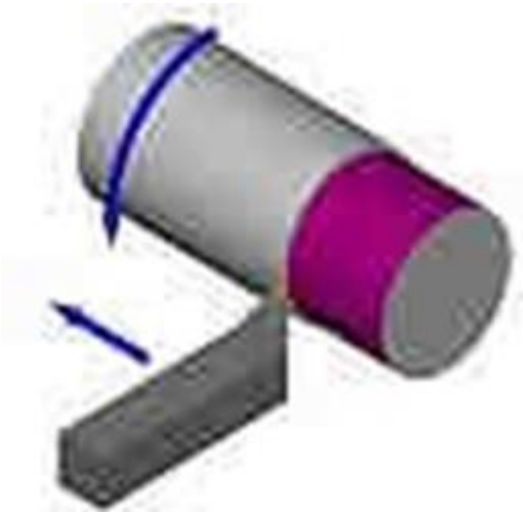


Figure 2.1 Turning Operation (Kumar & Kiran Kumar., 2017)

Krishna Madhavi et al (2017) stated that a turning machine or lathe, a work piece, a fixture, and a cutting tool are all required for the turning process. The work item is mounted to the machine's rotating fixture and allowed to spin at high speeds. The cutting tool feeds into the rotating work piece and removes material in the form of small chips to achieve the desired shape. A relatively good surface finish is sought to increase the tool life and fatigue strength of the product. Feed rate had the greatest effect on surface roughness, spindle speed had a modest effect, and depth of cut had little effect (Krishna Madhavi et al., 2017).

According to Rizal et al (2018) has stated that the product material is gripped by a chuck in front of the spindle of the lathe machine and turned at n revolutions per minute. When the tool insert comes into touch with the work piece material, it offers resistance to the cutting tool's penetration during chip removal. This must be overcome using a force, F, known as the machining or resultant force. This force is examined by dividing it into three components, or three axes. The cutting force, Fc, in the direction of the cutting motion, combined with the feed force, Ff, forms the active force, Fa. Because there is no motion in