SIMULATION OF THE DRILLING ANALYSIS ON MACHINING CHARACTERISTICS TOWARDS CARBON STEEL USING THE RESPOND SURFACE METHODOLOGY (RSM)

ABDULLAH IZUDDIN BIN ADLI
B051810108

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2022

SIMULATION OF THE DRILLING ANALYSIS ON MACHINING CHARACTERISTICS TOWARDS CARBON STEEL USING THE RESPOND SURFACE METHODOLOGY (RSM)

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

by

ABDULLAH IZUDDIN BIN ADLI

B051810108

970929-11-5307

FACULTY OF MANUFACTURING ENGINEERING

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **SIMULATION OF THE DRILLING ANALYSIS ON MACHINING CHARACTERISTICS TOWARDS CARBON STEEL USING THE RESPOND SURFACE METHODOLOGY (RSM)**

Sesi Pengajian: **2021/2022 Semester 2**

Saya **ABDULLAH IZUDDIN BIN ADLI (970929-11-5307)**

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

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

☑ TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:
C57A, Jalan Sulaiman, Kampung Baru
Ayer Manis, 81020, Kulai, Johor

Cop Rasmi:

Tarikh: 30/06/2022

Tarikh: 30/06/2022

*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 that this report entitled “Simulation of the drilling analysis on machining characteristics towards carbon steel using the response surface methodology (RSM)” is the result of my own research except as cited in references.

Signature : 

Author’s Name : ABDULLAH IZUDDIN BIN ADLI

Date : 30/06/2022

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:

……

(PROFESOR MADYA IR. DR. MOHD AMRAN BIN MD ALI)

ABSTRAK

Projek ini memberi tumpuan kepada parameter pemotongan yang sesuai bagi proses pusingan, seperti kelajuan pemotongan, kadar suapan, kedalaman pemotongan, yang mempunyai kaitan secara langsung dengan tindak balas keluaran, termasuk halaju, tegasan, suhu, dan kadar penyingkiran bahan (MRR). Dalam projek ini, penggunaan perisian DEFORM 3D digunakan secara meluas untuk simulasi analisis proses pemesinan bagi keluli karbon, akan digunakan. Dalam projek ini Kaedah Permukaan Tindak Balas (RSM) digunakan untuk menganalisis data pemesinan penggerudian. Keseluruhan larian eksperimen adalah 15 larian yang dikumpul daripada kaedah Box Behnken menggunakan tiga faktor dengan satu titik tengah. Simulasi pemesinan ditetapkan kepada 750 langkah untuk setiap larian. Set parameter pemotongan dilakukan melalui simulasi. Pengesahan parameter pemotongan dilakukan selepas pengoptimuman proses simulasi pemesinan penggerudian. Berdasarkan keputusan dan perbincangan yang telah diperoleh, parameter yang paling ketara terhadap tindak balas adalah kelajuan pemotongan. Kelajuan pemotongan menyumbang kepada faktor besar ke arah interaksi semua tindak balas. Pengoptimuman respons tunggal dan berbilang diperolehi.

ABSTRACT

This project focuses on the suitable cutting parameters of the turning process, such as cutting speed, feed rate, depth of cut, which have directly related to the output response, including velocity, stress, temperature, and material removal rate (MRR). In this project, the use of DEFORM 3D software is widely used for the simulation of machining process analysis for carbon steel, will be applied. In this project the Response Surface Method (RSM) was used to analyse the drilling machining data. The entire experimental run was 15 runs gathered from the Box Behnken method using three factors with one centre point. The machining simulation is set to 750 steps for each run. The set of cutting parameters is performed through simulation. The validation of the cutting parameters was performed after the optimization of the drilling machining simulation process. Based on the result and discussion that have been obtained, the most significant parameter towards the responses is cutting speed. Cutting speed contributes to massive factor towards the interaction of all the responses. The optimization of the single and multiple responses is obtained.

DEDICATION

Only

my beloved father, Adli bin Abu Bakar

my appreciated mother, Noraniah binti Ibrahim

my adored sister and brother, Amirah Fatimah and Amin Solehuddin

for giving me moral support, money, cooperation, encouragement, and also understanding

Thank You So Much & Love You All Forever

ACKNOWLEDGEMENT

In the name of ALLAH, the most gracious, the most merciful, with the highest praise to Allah, I manage to complete this final year project successfully without difficulty.

I want to thank Professor Madya Ir. Dr. Mohd Amran bin Md Ali for the countless guidance and support for me until I managed to complete my Final Year Project.

My gratitude to my parents and family, who always supported and accompanied me with prayers during my journey to complete this research. Their advice and encouragement have brought my spirit to this success. I want to prolong my gratitude and thankfulness to all of my friends who have helped me a lot from the beginning till the end.

Finally, thank you to Universiti Teknikal Malaysia Melaka (UTeM) for giving me this opportunity to enhance my knowledge and experiences that can be used for my future benefit. Knowledge and all the experiences gained will be beneficial and shared with others for a good purpose.

TABLE OF CONTENTS

CHAPTER 3: METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

MRR	-	Material Removal Rate
RSM	-	Response Surface Roughness
BBD	-	Box Behnken Design
ROP	-	Rate of Penetration
MSE	-	Mechanical Specific Energy
TOB	-	Torque on Bit
ANOVA	-	Analysis of Variance
SFPM	-	Surface feet per minute
HSS	-	High Speed Steel
3D	-	Three Dimensional
FEA	-	Finite Element Analysis
CCD	-	Central Composite Design

LIST OF SYMBOLS

cm	-	Centimetre
m	-	Metre
%	-	Percent
mm	-	Millimetre
MPa	-	Mega Pascal
GPa	-	Giga Pascal
°C	-	Degree Celsius
mm/min.	-	Millimetre per minute
rpm	-	Revolution per minute
Vc	-	Cutting Speed
DC	-	Drill bit Diameter
n	-	Spindle Speed
f_r	-	Feed Rate (Distance per minute)
N	-	Rotational Speed
f	-	Feed
v	-	velocity
d	-	Displacement
t	-	Time

CHAPTER 1
INTRODUCTION

This chapter describes the overview of the study for the research. This chapter contains the research background, problem statement, objectives, scopes of research, rationale of research, research methodology, and project report organization.

1.1 Research Background

According to Luo *et al*. (2021), A drilling finite element model was used to simulate the drilling process, which then was validated and amended using experiments. The drilling process is carried out utilizing simulation as a result of this study. Since this drilling process test is time-consuming and expensive, building a thorough and accurate finite element simulation will save time and money during the experimentation and can therefore be used to anticipate drilling parameters for other materials long in advance. Therefore, as a matter of fact, applying finite element analysis gives significant benefits.

One of the branches of multipoint tools is the drilling procedure. This drilling process produces a circular hole in a workpiece. According to Luo *et al*. (2021), The drilling process is performed in a semi-closed setting. Friction, drilling temperature, coolant usage, and chip removal difficulty are all issues that arise between the tool and the workpiece. In this application, the drilling process parameter is indeed essential. The cutting speed, feed rate, and depth of cut (velocity, stress, temperature, and material removal rate (MRR)) are the drilling process parameters. In this application, the drilling process parameter is indeed essential. The cutting speed, feed rate, and depth of cut (velocity, stress, temperature, and material removal rate (MRR)) are the drilling process parameters. This process parameter is the current main focus of this research.

Carbon steel is utilised in a wide range of applications. Because of its versatility, carbon steel is often employed in a wide range of applications. Carbon steel can be stressed and broken under pressure, but it is less likely than other steel. Because of this, carbon steel is very effective in applications that demand a lot of strength. Carbon steel is presently applied in various applications, including building materials, tools, and automotive parts. According to Singh (2020), plain carbon steel is ideal for applications where strength and other properties are not critical and in which high temperatures and corrosive conditions are not a key consideration.

The deformation of the workpiece as a result of the drilling process is researched using the finite element method in this study. DEFORM-3D software is used in this research study. This is because DEFORM-3D has proven accurate in the finite element method application. According to Luo *et al*. (2021), employing finite element simulation, changes in residual stress and strain, drilling temperatures, and axial forces, among other physical processes not suited for observation in the drilling process, may be clearly and inherently calculated. This research is an infrequent topic that should be thoroughly investigated to acquire a thorough understanding of the drilling analysis on machining features in carbon steel.

1.2 Problem Statement

One of the important objectives is to increase the drilling process reaction by combining single and multiple responses and optimization to guarantee that the drilling process works smoothly and lasts as long as possible. Several methods for optimising drilling have been developed, including the rate of penetration (ROP), mechanical specific energy (MSE), torque on bit (TOB), and cost per foot of drilling mentioned by (Hegde and Gray, 2018). According to (Arabjamaloei and Shadizadeh, 2011), The ROP optimization approaches are the most often employed, even though all these strategies attempt to improve and obtain the best drilling performance. The ROP optimization approaches are the most often employed, although these strategies attempt to improve and obtain the best drilling performance. However, based on Mustafa et al. (2021) research, increased drilling efficiency does not always equal a higher ROP. It is critical to realize that a high ROP might result in poor hole cleaning, reduced bit life, and wellbore instability.

Past studies by Chatterjee *et al*. (2016) suggest various attempts have been made to construct finite element models that can determine particular outputs such as temperature distribution at the tool tip and workpiece contact, drilled hole quality, and thrust force, and cutting force. However, the research does not sufficiently address a simple, viable model for forecasting several performance aspects in drilling operations using a finite element method. However, the research does not sufficiently address a simple, viable model for forecasting several performance aspects in drilling operations using a finite element method. Therefore, the present study proposes a finite element model for determining the most significant cutting parameter such as cutting speed, feed rate, and depth of cut towards responses (velocity, stress, temperature, and material removal rate (MRR)).

Consequently, this project focuses on drilling AISI 1045 using the simulation method. The selected input parameters are cutting speed, feed rate, and depth of cut. The material characteristics are material removal rate (MRR), velocity, cutting temperature, stress, and cutting force. The cutting tool used is carbide

1.3 Objectives

The objectives are as follows:

(a) To determine the most significant cutting parameter such as cutting speed, feed rate, and depth of cut towards responses (cutting velocity, effective stress, cutting temperature, and material removal rate (MRR)).

(b) To find the interaction of the cutting parameter such as cutting speed, feed rate, and depth of cut toward responses.

(c) To optimize the response through single and multiple responses.