PERFORMANCE OF AISI 1045 STEEL OF SIMULATION TURNING PROCESS BASE ON PREVIOUS EXPERIMENTAL RESULT

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

by

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ABSTRAK

Tujuan projek ini adalah untuk mengesahkan hasil keluli AISI 1045 yang telah dikumpul daripada data eksperimen terdahulu dengan kerja simulasi yang telah dilakukan dalam projek ini. Parameter pemotongan yang dipilih dalam simulasi pusingan keluli karbon AISI 1045 ini ialah kelajuan pemotongan, kadar suapan dan kedalaman pemotongan. Data eksperimen bertindak balas yang telah dikumpul termasuk suhu pemotongan, tegasan berkesan, jumlah halaju dan kadar penyingkiran bahan. Selanjutnya, hubungan antara parameter pemotongan kepada tindak balas telah disiasat. Kemudian, respons melalui respons tunggal dan berbilang telah dioptimumkan. Analisis varians (ANOVA) digunakan untuk menentukan parameter pemotongan yang paling berpengaruh kepada tindak balas keluaran. Kotak-Behnken Kaedah Permukaan Tindak Balas (RSM) digunakan untuk menyiasat interaksi antara parameter pemotongan kepada tindak balas output. Keseluruhan larian simulasi ialah 15 larian yang ditetapkan kepada 500 langkah untuk setiap larian. Pengesahan hasil simulasi ini kepada keputusan eksperimen sebelumnya sebagai penunjuk ketepatan Perisian Simulasi Deform 3D. Parameter yang paling mempengaruhi tindak balas adalah kelajuan pemotongan dalam proses simulasi pusingan untuk keluli AISI 1045. Selepas proses pengoptimuman respons tunggal, kesemua empat respons telah ditambah baik dengan kombinasi interaksi 2 hala yang berbeza masing-masing. Sementara itu selepas proses pengoptimuman berbilang respons, respons telah dipertingkatkan dengan kombinasi parameter yang paling dikehendaki. Dalam projek ini, dapat disimpulkan bahawa semua objektif telah dicapai dengan berjaya.

ABSTRACT

The purpose of this project is to validate the result of AISI 1045 steel that has collected from previous experimental data with the simulation work that has been done in this project. The selected cutting parameters in this turning simulation of the carbon steel AISI 1045 were cutting speed, feed rate and depth of cut. The respond experimental data that has been collected including cutting temperature, effective stress, total velocity and material removal rate. Further, the relationship between cutting parameters to the responses were investigated. Then, the response through single and multiple responses were optimized. The variance analysis (ANOVA) was used to determine the most influential cutting parameters to the output responses. The Box-Behnken of the Response Surface Method (RSM) was used to investigate the interaction between the cutting parameters to the output response. The entire simulation run was 15 runs which were set to 500 steps for each run. This validation of the simulation result to the previous experimental result as an indicator the precision of Deform 3D Simulation Software. The most affecting parameter on responses was cutting speed in turning simulation process for AISI 1045 steel. After single responses optimization process, all of the four responses were improved with different combinations of 2-way interaction respectively. Meanwhile after multiple responses optimization process, the responses were improved with the most desired combinations of parameters. In this project, it can concluded that all the objectives had been achieved successfully.

DEDICATION

Only

my beloved father, Chan Chee Hun

my appreciated mother, Ng Chew Khim

my adored brother, Chan Wai Chong

my adored sisters, Chan Ean Eing and Jolin Chan Zhi Ying

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

Thank You So Much & Love You All Forever

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LIST OF ABBREVIATIONS

AISI	-	American Iron and Steel Institute
ANOVA	-	Analysis of Variance
ASTM	-	American Society for Testing and Materials
BBD	-	Box-Behnken Design
CAM	-	Computer-aided Manufacturing
CCD	-	Central Composite Design
CCW	-	Counterclockwise
CNC	-	Computerised Numerical Control
CW	-	Clockwise
DOE	-	Design of experiments
FKP	-	Fakulti Kejuruteraan Pembuatan
HSM	-	High Speed Machining
HSS	-	High Speed Steel
ISO	-	International Organization for Standardization
MRR	-	Material Removal Rate
NC	-	Numerical Control
OFAT	-	One Factor at a time
RSM	-	Response Surface Method
2D	-	2-dimensional
3D	-	3-dimensional

LIST OF SYMBOLS

Vc	-	Cutting Speed
d	-	Depth of Cut
b	-	Chip Width
h	-	Chip Thickness
D	-	Diameter
N	-	Rotating Speed
Fr	-	Feed Rate
f	-	Feed Per Rev
m/s	-	Meter per second
m/min	-	Meter per Minute
mm/rev	-	Millimeter per Revolution
mm	-	Millimeter
mm/sec	-	Millimeter per second
mm^3/sec	-	Cubic millimeters per second
Mpa	-	Megapascals
%	-	Percentage
psi	-	Pounds per square inch
ksi	-	Kilopound per square inch
Gpa	-	Gigapascal
µm	-	Micrometres or microns
°c	-	Degree Celsius

CHAPTER 1

INTRODUCTION

This chapter explains the significant of the study in exploring performance of AISI 1045 steel of simulation turning process base on previous experimental result. In this chapter, the research background, problem statement, objectives, scope of the research, rational of research and project report arrangement were presented precisely.

1.1 Research Background

According to Qasim *et al*. (2015), the goal of contemporary industrial producing is to provide high-quality things in less time and at a lower cost. For this, automatic and versatile production techniques comparable to computerized numerical control (CNC) machines are used, which might cut back time interval whereas maintaining high precision. Nowsaday, the most well-known operation to remove unwanted material we used in industry is turning.

According to Nalbant *et al*. (2006), to achieve good cutting performance, it should be critical to set input (turning) parameters with higher accuracy during this operation. In most situation, the best or suitable turning parameters are create or develop based on previous experience or by following research. In this experiment, AISI 1045 mild steel will be used in turning process base on the previous simulation result.

Muñoz-Escalona *et al.* (2005) have claimed that AISI 1045 Steel is one of the most extensively used steel grades, with a wide range of applications in industrial processes due to its low cost and great machinability. In this study, the most relevant cutting parameters to the output responses will be determined using a variance analysis (ANOVA). The relationship between the cutting parameters and the output response will be investigated using the Box-Behnken of the Response Surface Method (RSM). Cutting speed, feed rate, and depth of cut were took as consideration as cutting parameters in this carbon steel AISI 1045 turning simulation. The accuracy of the Deform 3D software simulation will be determined by comparing the testing results to the earlier experimental results.

1.2 Problem Statement

According to Kazban *et al.* (2008), the higher the cutting forces, the higher the temperature on the cutting surface. Therefore, one of the improvement required to enhance the performance of AISI 1045 steel is decrease its and tool piece surface cutting temperature during the turning process. The lower the temperature the smoother the surface of AISI 1045 steel. According to Senthilkumar *et al.* (2013), from most of the geometries to turning AISI 1045 steel, the effect of temperature at the cutting zone on wear at the flank area is examined.

Attanasio *et al.* (2009) has claimed that the tool nose radius and feed rate have the greatest influence on both maximum and lowest stresses, whereas lubrication has the least influence. The second improvement required to enhance the performance of AISI 1045 steel is reduce the effective stress formed on the carbon steel AISI 1045 during the turning process. Rech and Moisan (2003) had discovered that cutting speed was the most important element influencing residual stress level. In their investigation, cutting speed, regardless of feed rate (50 to 150 m/s), tends to increase external residual stress. The uneven surface of cutting tool which increase the surface roughness of work piece also have to take as the consideration. Dahlman *et al.* (2004) discovered that rake angle had the greatest impact on residual tensions. The compressive pressures rose as the feed rate increased. Varied cutting depths did not result in different stress levels.

Lastly, material removal rates has to take into the account during this project report is carry on. The higher the material removal rates, the shorter the time require to cut the material, hence its reduce the processing time. According to Chevrier *et al.* (2003), to achieve high material removal rates, high speed machining (HSM) is recommended which also good in reduce not processing times, use low cutting forces, higher dimensional accuracy and good surface finishing quality. Salomon *et al.* the teams who introduced the HSM concept have studied that making cutting speed higher can result in low cutting temperature after it achieve the critical value.

1.3 Objectives

The objectives are as follows:

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

(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.

1.4 Scopes of the Research

The scopes of research are as follows:

(a) Design experimental matrix of tuning process parameters using response surface methodology using Minitab software.

(b) Perform turning machining simulation using Deform 3D software for collecting data.

(c) Perform statistical analysis “Response Surface Methodology” (RSM) and Analysis of Variance (ANOVA) using Minitab software.

1.5 Rational of Research

The rational of research as follows:

(a) The type of material of the work piece must be available in the market. In this case, we have chose carbon steel AISI 1045.

(b) The cutting tool should be carbide, which can easily cut the work piece. The hardness of cutting tool must be higher than the work piece.

(c) The carbon steel AISI 1045 is chosen in this research because it is the most demand material, which is the most used material in the manufacturing sector.

(d) The cutting parameter must be determine and optimise such as cutting speed, feed rate and depth of cut toward responses. After that, the statistical analysis "Response Surface Methodology" (RSM) must be performed by using Minitab software.

1.6 Project Report Arrangement

The arrangement of this project is as following. Chapter 1 is start with research background, problem statement, objectives, and scope of the research, rational of research are delineated in order to better define particular aspects of AISI 1045 steel when cut by carbide cutting tool during the turning process in this project report. Chapters 2 literature review comprises previous study or research about the turning process, material carbon steel AISI 1045, cutting tool, geometry of cutting tool, defect of cutting tool, design of experiment, analysis of variance (ANOVA) and research gap and summary. Chapter 3 methodology describes all the procedures, methods, steps and precautions when carry out the simulation of turning process of carbon steel AISI 1045 with the carbide cutting tool. Different cutting speed, feed rate, depth of cut and design of experiment will apply and stated in this stage. Chapter 4 is analyze the information, data, result, statistical analysis "Response Surface Methodology" (RSM) and Analysis of Variance (ANOVA) by using Minitab software after running the cutting process through the simulation software. In Chapter 5, conclusion and recommendation about this research are examined.

CHAPTER 2

LITERATURE REVIEW

This chapter focuses on the research, studies and theories that have been studied and found out by a lot of researchers since some times ago. Related information of previous studies are extracted as references and discussion based on their research about turning process, material carbon steel AISI 1045, cutting tool, geometry of cutting tool, defect of cutting tool, design of experiment, analysis of variance (ANOVA) and research gap and summary.

2.1 Turning process

According to Chen (2000), turning as known as a type of machining, a material removal process, which is used to make rotating parts by remove material that do not want. The turning method requires a lathe or lathe, a workpiece, a device and a reducing tool. The workpiece is a preformed piece of fabric that is attached to the system, which in turn is attached to the turning device and allowed to spin at excessive speed. The milling cutter is generally a unmarried-factor cutting tool that is additionally fixed in the system, despite the fact that some operations use a couple of-factor tools. The reducing device suits into the rotating component and cuts the material into small chips to create the preferred form. Figure 2.1 shows the process of turning using lathe machine.