OPTIMIZATION OF MACHINING PARAMETERS FOR MILLING OPERATION ON CARBON FIBRE REINFORCED PLASTIC (CFRP) MATERIAL

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

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I hereby, declared this report entitled "OPTIMIZATION OF MACHINING PARAMETERS FOR MILLING OPERATION ON CARBON FIBRE REINFORCED PLASTIC (CFRP) MATERIAL" is the result of my own research except as cited in references.

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Date : 1 September 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:

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ABSTRAK

Karya ini adalah kajian eksperimental mengenai parameter pemesinan dalam operasi penggilingan untuk polimer bertetulang serat karbon (CFRP) untuk membandingkankekasaran permukaan. Objektif utama kajian ini adalah untuk mengkaji pengaruh parameter pemesinan seperti kelajuan pemotongan, kadar umpan dan kedalaman pemotongan pada kekasaran permukaan cfrp. Objektifnya adalah untuk menentukan mana dari parameter pemesinan berikut yang menghasilkan kemasan permukaan terbaik dan juga membandingkan hasil yang diperoleh untuk mengatur pengaruh terbaik parameter pemesinan pada permukaan permukaan menggunakan metode taguchi. Untuk menentukan kelajuan pemotongan terbaik untuk bahan, ada parameter pemotongan lain yang perlu tetap, seperti kadar suapan dan kedalaman pemotongan. Dalam operasi pemesinan, kualiti kemasan permukaan adalah syarat penting bagi banyak benda kerja. Oleh itu, pemilihan parameter pemesinan sangat penting untuk mengawal kualiti permukaan yang diperlukan. Tumpuan untuk menentukan mana parameter pemesinan berikut menghasilkan kemasan permukaan yang terbaik dan juga untuk membandingkan hasil yang diperoleh untuk mengatur kesan terbaik dari parameter pemesinan pada permukaan permukaan menggunakan kaedah Taguchi. Di antara parameter yang dipertimbangkan, kelajuan mempunyai kesan terbesar pada kekasaran permukaan bahan kerja. Kelajuan optimum yang diperoleh menggunakan pendekatan Taguchi dalam eksperimen ini ialah 5000 rpm. Begitu juga, umpan dan kedalaman angka potongan masing-masing 800 mm / min dan 0.3 mm.

ABSTRACT

The present work concerned an experimental study on machining parameters in a milling operation for carbon fiber reinforced polymer (CFRP) to compare the surface roughness. The main objective of the study was to study the effect of machining parameters such as cutting speed, feed rate and depth of cut on the surface roughness of CFRP. The objective was to determine which of the following machining parameters produces the best surface finish and to compare the results obtained to regulate the best effect of machining parameters on the surface finish using Taguchi method. In order to determine the best cutting speed for the material, there were other cutting parameters needed to be constant, such as feed rate and depth of cut. In machining operation, the quality of surface finish is an important requirement for many workpieces. Thus, the choice of machining parameters was very important for controlling the required surface quality. The focus on determines which of the following machining parameters produces the best surface finish and also to compare the results obtained to regulate the best effect of machining parameters on the surface finish using Taguchi's method. Among the considered parameters, speed has the greatest impact on the workpiece's surface roughness. The optimum speed obtained using the Taguchi approach in this experiment is 5000 rpm. Similarly, the feed and depth of cut figures were 800 mm/min and 0.3 mm, respectively.

DEDICATION

Only

My beloved mother, Teoh Meng Chin

my adored sister and brother, Heman and Yunitha

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

Thank You So Much & Love You All Forever

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CFRP	-	CARBON FIBER REINFORCED POLYMER
S/N	-	SIGNAL TO NOISE
ANOVA	-	ANALYSIS OF VARIANCE
O.A	-	ORTHOGONAL ARRAY
DoE	-	DESIGN OF EXPERIMENT
Ra	-	SURFACE ROUGHNESS

LIST OF SYMBOLS

μm	-	micrometer
mm	-	millimeter
mm/min	-	millimeter per minute
rpm	-	revolutions per minute
f	-	feed rate
d	-	depth of cut
D	-	cutting speed
E	-	elastic modulus
ε	-	strain
σ	-	stress
ρ	-	density

CHAPTER 1

INTRODUCTION

1.1 Project Background

Process of composite material and machining parameters are essential to creating the fundamental part for achieved required shapes and dimensional resistances. For the delivery of complex features of the composite component, conventional machining measures, for example, milling, boring, turning, and grinding, are often used. The chips formation, it is usually finished by removing unwanted material from the workpieces. The material removal rate, shape and size of the chip removal and good surface finish is all depends on the kinematic relationship between the workpieces and the cutting tools.

Composite materials are regularly made with the closest shapes and include a secondary process. Normally, the manufactures would prefer using milling machine in order to attain the desired shape, dimensional tolerance and good finishing surface. Besides that, the milling process is used in composite production as an effective machining measure to achieve comprehensive and high-quality surfaces. As for selecting cutting tools and machining parameters, the fiber used in composites has a significant impact. Ensure that the selected tools for the method of machining are sufficient for the material. In order to improve machinability in milling, data on the cutting mechanism is necessary. Surface roughness affects dimensional precision, mechanical part efficiency, and manufacturing cost. Thus, the manufacturer has directed to enhance the cutting condition to accomplish the great surface finish. The requirement for high quality on the workpiece surface condition, particularly the machined surface's roughness because it effect on material surface, function, and significance to be consistent intolerance and surface finishing.

Previous research from different researchers indicated that surface roughness is firmly dependent on cutting parameters, measurement of the tools and the resulting machining strength. Cutting speed has strongly affected the nature of surface finish in each machining phase. Most researchers locate that speeding up a cutting level increases the surface finish where the surface's roughness decreases.

This experiment studies the optimization of machining parameters for milling operation on carbon fiber reinforced plastic (CFRP) material using the Taguchi method. Taguchi method can systematically formulate the experimental layout and, using statistical analysis of variance (ANOVA), evaluate the important impact of each experimental parameter, and, after all, assess the optimal combination of parameters to produce the best machining condition. Taguchi used the signal-to-noise (S/N) ratio as the efficiency trait of choice. The average (mean) and variance (standard deviation) of the experimental result ratio expressed by the S/N of the machining parameters involved in this experiment are cutting speed, feed rate, and depth of cut. The main objective is to find the machining parameters' combination to achieve low surface roughness during the end mill.

1.2 Problem Statement

Carbon Fibre Reinforced Plastic is frequently utilized in today's society, particularly in industry, because to its desirable features of high strength, light weight, and corrosion resistance. However, because CFRP composites are difficult to process, they require a lot of specifications and requirements. Furthermore, machining CFRP with the wrong technique and settings might result in poor surface quality, such as significant surface roughness. Composites, despite their great mechanical qualities, are difficult to machine due to their toughness. Not only that, in this study, there was not much experimental data for the milling process using carbon fiber reinforced polymer (CFRP). Data for thrust force of CFRP using milling process was also scarcely and to obtain the accurate thrust force was also onerous due to the different thickness of carbon fiber reinforced polymer.

1.3 Objectives

- To investigate the machining parameters in order to achieve low surface roughnessduring end mill operation.
- To find out a set of optimum values for the selected factors in order to reduce surfaceroughness using Taguchi's method.

1.4 Scope

- To determine the set of optimum values for the selected control factors to reducesurface roughness.
- To discover the combination of machining parameters to accomplish low surfaceroughness during the end mill process.

1.5 Important of Study

This undertaking is done to examine machining parameters in a milling operation for the chosen polymer material (CFRP) to compare the surface roughness. Previous researchers carried out to investigate the milling machine parameters, which is cutting speed, feed rate, and depth of cut to build up these machining parameters to acquire a good surface finish. These machining parameters show that cutting speed impacts the most, as per the past investigation. Hence, the feed rate and depth of cut is influenced by the cutting speed.

1.6 Organization Report

This report contained total of three chapters in total. Chapter 1 refers to the project background, objective, problem statement and the scope of this study. Chapter 2 exemplifies the literature review of the report. This chapter examines the machining parameters, essentials of processing machining, cutting tool, cutting process, and tool wear. Chapter 3 shows up as the methodology of the experimental design of the report. The process and methods of the experiment will be discussed about as a flowchart and an experimental procedure.

1.7 Summary

Background of the study identified with the machine is completed. The problem statement and objective are built, which will be specific, measurable, and achievable. Next, thescope of the project is defined, and the organization of the report is made to depict the progression of the report in each chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the fundamentals of milling machining will be examined, and the parameters of the milling machine are discussed. A literature review is a content that means surveying the fundamental motive of research information. In this study, the literature review will concentrate on the computer's details, experiment procedures, surface roughness, and all project-relevant details. This chapter covers information on the milling process to gain a deeper understanding of the machining process requirements.

2.2 Milling Operation

Milling is the most common method of machining, a process of material removal, which by cutting away the unwanted material may produce a variety of factors on a component. A milling machine, workpiece, tool, and the cutter is required for the milling process. A cutter is a cutting tool that is likewise made sure about and turns at high speed in the milling machine. The material in small chips is cut off from this workpiece to create the desired form by feeding the workpiece into the cutting tool. The milling machine is quite possibly the most adaptable customary machine with different metal cutting abilities. A few complex activities, for example, ordering, group processing, and stradle processing can be performed on a milling machine.

According to Prachi Londhe/Chilwant et al. 2016, with a rotating multipoint cutting tool called milling cutter, milling is the process of removing extra material from the workpiece. The machine tool used for milling is known as the milling machine. Milling machines are classified as both vertical and horizontal. Knee-type, ram-type, output or bed type, and planer- type are also known as these machines. Not only that, speed, feeding, and cutting depth are thethree primary factors in any simple milling process. Of course, other variables such as materialtype and type of tool materials have a significant effect. Still, these three are the ones that can be adjusted by the user, right on the computer, by changing the controls. Milling operation can be performed on the workpiece to yield the desired part shape by various process. There are many types of milling machines. Quite possibly the most adaptable conventional machine tools with a broad scope of metal cutting abilities is the milling machine. A few complex tasks, for example, ordering, group processing, ride processing, and so on, can be performedon a milling machine.

2.2.1 End Milling

To machine a predefined highlight, for example, a profile, space, pocket, or even an unpredictable surface form, an end mill makes either fringe or opening cuts, controlled by the progression over distance, across the workpiece. The function's width can be machined in a single pass or accomplished by machining and making several passes at a smaller axial cuttingdepth. Figure 1 shows end mill process.

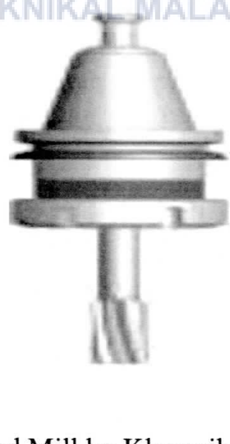

Figure 1: End Mill by Klancnik, 17 2000

2.2.2 Chamfer Milling

Chamfer milling allows a fringe cut along the edge of the workpiece or an element to produce an angle surface. For the most part, with a 45-degree point, this chamfer can be machined on either the outside or inside a component and can follow either a straight or bended way.

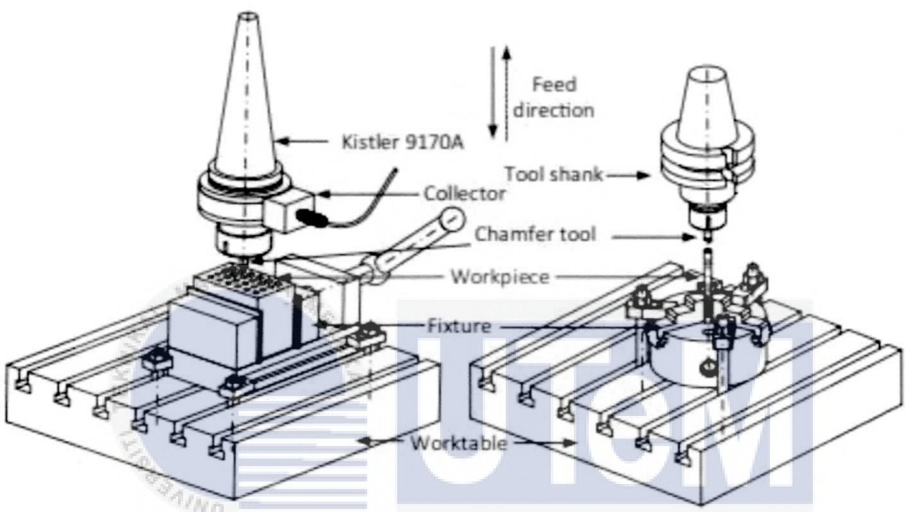

Figure 2: Chamfer Milling

2.2.3 Face Mill

To have a smooth finish, a face mill machines a flat surface of the workpiece. The face's depth can be machined in a solitary pass or should be possible by machining at a more modest pivotal cutting profundity and making a few passes.

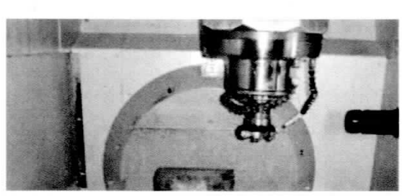

Figure 3: Face Milling by Andres Bustillo, 13 August 2020