



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**THE EFFECT OF MICRO DRILLING PARAMETERS
ON THRUST FORCE IN MICRO DRILLING OF CFRP
PANEL**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical and Manufacturing Engineering Technology (Process and Technology) with Honours.

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ABSTRAK

Penumpukan mata alat dan ketepatan lubang adalah factor utama yang digunakan oleh pembuatan untuk mengurangkan kos dalam industry penerbagangan. Kajian ini bertujuan untuk memilih parameter yang optimum untuk memberi impak yang baik kepada daya dan mata alat. Penyelidikan ini mempunyai beberapa parameter pemotongan seperti kelajuan spindle dan kadar suapan. Reka bentuk jig diperlukan untuk memandu mata alat ke proses pemotongan dan melindungi dynamometer. Ini bertujuan untuk mendapatkan keputusan daya dan menjaga keselamatan dynamometer kerana kosnya yang tinggi. Daya teras paling rendah yang dihasilkan terhadap proses Mikro-penggerudian akan mengurangkan kecacatan terhadap lubang masuk dan keluar. Ujian tribologi telah digunakan untuk mengenal pasti sifat komposit CFRP seperti kadar pakai dan daya geseran. Daya tujahan yang rendah yang dihasilkan semasa proses penggerudian mikro akan mengurangkan pengecualian ke atas masuk dan keluar dari lubang. Parameter penting telah ditentukan oleh Analisis varians (ANNOVA). Kaedah Taguchi telah digunakan untuk menyaring dan menghilangkan parameter yang tidak penting untuk mengenal pasti kuasa terendah. Parameter terbaik untuk eksperimen ini ialah kelajuan spindle ialah 12000 rpm dan kadar susapan 0.01 mm/rev Akhir sekali, Kaedah Faktor 2-Tahap telah digunakan untuk mengoptimumkan parameter eksperimen. Parameter terbaik untuk eksperimen ini ialah 8000 rpm dan kadar suapan 0,01mm/rev.

ABSTRACT

Tool wear and hole accuracy are the main factors observed by the manufacturer to reduce the cost in the aerospace industry. This study was carried out to find the optimum parameter that will give a good impact on the force and tool wear. This research executed the variant in the cutting parameter used such as spindle speed and feed rate while maintaining the number of drilled holes. This research had been conducted with data collection on the range of the cutting parameter. The design of jig is required to guide the cutting tool and covered dynamometer during machining. It will help to achieve a reliable result of force and protect the safety dynamometer due to it is highly cost. Tribology test had been run to identify the properties of CFRP composite such as wear rate and frictional force. The lowest thrust force that produces during the micro-drilling process will reduce delamination on entry and exit of holes. The significant parameter had been defined by Analysis of variance (ANOVA). Taguchi Method was used to screening and eliminate the parameter that not significant to identify the lowest force. The optimize parameter for this design are spindle speed 12 000 rpm and feed rate 0.01 mm/rev. Finally, 2-Level Factorial Method has been applied to optimize the parameter of the experiment. This design was optimizing the parameter which is spindle speed 12000 rpm and feed rate 0.01mm/rev.

DEDICATION

To my beloved parents who always support me

Abdul Latiff Mohamed and Hasnah Lasri

To my sister

Hasliza Abdul Latiff

Samsiah Abdul Latiff

Hafiza Abdul Latiff

To my lecturer and supervisor, for their guidance and encouragement

Ts. Dr. Norfariza binti Ab Wahab

To my friends, for their support

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LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
N	-	Newton
kg	-	Kilogram
mm	-	Millimetre
mm / sec	-	Millimetre per second
S / N	-	Signal-to-noise
rpm	-	Rotational per minute
mm/rev	-	Milimetre per revolution
µm	-	Micro metre

LIST OF ABBREVIATIONS

CNC	Computer Numerical Control
CAM	Computer-Aided Machining
FRP	Fibre Reinforced Polymer
CFRP	Carbon Fibre Reinforced Polymer
SEM	Scanning Electron Microscope
POD	Pin on disc

CHAPTER 1

INTRODUCTION

1.1 Introduction

The aerospace industry had applied an important process which is drilling in manufacturing its component. The study of drilling is highly demanded by industry due to overcome its defect and improve the quality of the hole. Besides, the development of drilling to enhance the lifetime of a drill bit that will affect the manufacturing cost.

There are few types of drilling machine that previously apply by industry which is Pillar Drilling Machine, Column Drilling Machine and Radial Drilling Machine. Nowadays, it had been improved by using Computer Numerical Control (CNC) machine. Every machine had their abilities and cost for the type of drilling process. Pillar Drilling Machine used for high capacity and Column Drilling Machine is purposely for much stronger drilling. Radial Drilling Machine able to move the cutting tool along the vertical axis.

Commonly there are four types of the hole making the process which centre drilling, boring, step drilling and core drilling. The purpose of the hole making process to gain an accurate size and geometrically of a hole in a corrected location drilling process. The development of numerical control in drilling had overcome the time to undergo the whole making process. There are also a few types of drill bit that commonly use in the aerospace industry such as brad drill and dagger. It is because both of drill geometry will produce a high quality of hole and reduce delamination. Even though both it is the best, there is a lack of research on twist drill. Therefore, this research use twist drills as a drill bit to identify its effect on micro-drilling. Fibre Reinforced Polymer (FRP) composite is the combination of

two or more materials that will form a new material that will enhance its properties. The research of FRP has been conducted extensively but it must be continuing to gain more data about the composite.

1.2 Project Background

This research had a focus on micro drilling in cutting operation. The conventional machine also able to use micro-drilling operation but there is a limitation on size drill bit due to its maximum spindle speed. The micro drill bit with diameter less than 1.0 mm commonly required a minimum spindle speed nearest to 10 000 rpm. The most conventional machine is not able to achieve that value of speed. This research used micro drill bit HSS Carbide with diameter 0.9 mm and its shank is diameter 3 mm. It will produce a hole with diameter 0.9 mm and required a collect that able to hold the diameter 3 mm of the shank of the drill bit.

The machine that had been selected CNC Router MDX-540 machine. It is because this machine had a maximum speed with 12,000 rpm. It meets the requirement of the micro drill bit with diameter 0.9 mm.

This project used a micro drill bit as a tool to measure the output parameter in the drilling process where the method that applied is Taguchi Method and 2-Level Factorial Method. The cutting parameter needs to set up to gain the result of effect drilling process on Carbon Fibre Reinforced Composite (CFRP). There are a few cutting parameters that had been constructed which is spindle speed and feed rate depend on cutting speed of material.

1.3 Problem Statement

Every year the application in the aerospace industry, increasing the demand due to revolution on improving the technology. Mostly the development of this technology due to reducing costs and improve the performance of machining process.

Next, research and development to improving the parameter are very important. The requirement in accuracy and precision for product aircraft is very critical. The development in parameter will increase the safety for human and produce a reliable aircraft. There is a lot of research that had made to optimize the parameter by using a drill bit with an average diameter of 6 mm. The workpiece that been used by other research CFRP composite with a different average thickness of the panel. The drill bit used by industry is brad, dagger and twist drill.

Lastly, manufacturing required to rapidly change the tools due to the wrong optimization of the parameter. Hole quality is also affected by the selection of the parameter during the drilling process.

1.4 Objective

1. To fabricate jig which can hold the workpiece on dynamometer during the micro-drilling process.
2. To characterize micro-drilling on CFRP panel and observe tool.
3. To characterize the effect of drilling parameter on Carbon Fibre Reinforced Polymer (CFRP) composite using Taguchi Method and 2-Level Factorial

1.5 Scope of Work

This project will focus on the measure and analysis of the effect of micro-drilling on FRP composite. To develop the experiment, the designation and fabrication of jig are important to ensure the Dynamometer is safe during the drilling process. The set-up cost of Dynamometer is very high due to its accuracy on measuring force.

The analysis of the cutting parameter needs to prepare before the experiment. It is because the cutting parameter will affect the output parameter. Therefore, the hypothesis will be valuable with the optimum of machine parameter on the CFRP composite during the micro-drilling process.

Dynamometer Type 9257BA with tool holder Type 9403 had used to measure the force that presents on the cutting process. It is placed below the FRP composite during the process. This machine can measure and analyse the force by referring to cycle time that had been set for the experiment. The data will transfer to the Dyno ware software and it will show the figure of force along the time that had been set.

Next, to reduce the cost of manufacturing this research will observe the effect of drill on the tool that called tool wear. Tool wear is a factor that the industry will always develop and improve due to reduce the cost. The machine that will be used to observe the tool wear is a Scanning Electron Microscope (SEM) machine. This machine can zoom in to micro drill bit and show the image of the tool wear after the cutting process.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter had been discussed the overview of the development drilling operation and drilling mechanism. This study had focused on micro drilling characteristic for Fibre Reinforced Plastic (FRP). The analysis of this study needs to observe on hole accuracy, surface roughness and thrust force.

2.1 Drilling Process

The drilling process is a cutting process that removes the selection area of material by the rotation of the drill bit. In manufacturing, drilling had become a high demand in the market from the simple work to the critical work such as micro drilling and vibration drilling. The requirement of joining structure for CFRP are usually use drilling process (Panchagnula and Palaniyandi, 2018). The aerospace industry is one of the most industry that high demand in this developing technology. It is because the industry required highly precise and accurate in the dimension of their product. Both criteria are not only for their client requirement but it also important to ensure human safety.

The main purpose of this process is to cutting removal and create a hole. The hole is depending on the size of the drill bit. The drill bit is held by a few types of clamp based on the machine that had been used. For example, hand drill usually clamps by its holder while

milling machine required collet to hold the end drill bit in a tool holder. Figure 2.1 shows the mechanism of milling machine.

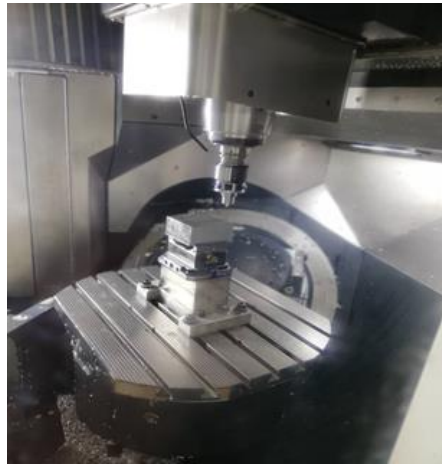


Figure 2.1 The image of CNC milling machine

There is two basic type of drilling machine which is centre drill machine and portable machine. Centre drill machine use for a job that required the workpiece need to be clamp on the worktable while portable drill machine is used for a job that clamp by itself such as drilling on the wall. Every machine has their own purpose to ensure the process and design can be achieved.

However, it had been improved into the Computer Numerical Control. The development of this machine had improved the input parameter accuracy and able to identify the output parameter that needs to observe. It had increased the performance of the machine in order to carry on the process that required high accuracy and precise on the job such as the manufacturing of aerospace. The most important on Aerospace structures manufacturing is the drilling process (Ramirez et al., 2014). One of the main materials on the aerospace component is FRP. The common material of drill bit that used to drill FRP is carbide. Some of the processes required the presence of abrasive to increase the friction in the drilling process. An abrasive reaction will fasten the life cycle for the tool. The initiation cracks that occur on the tool will increase the cost of maintenance. The improvement in advance