EFFECTS OF CUTTING PARAMETER ON MACHINING PERFORMANCE FOR WOOD-PLASTIC COMPOSITE MATERIAL

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

by

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FACULTY OF MANUFACTURING ENGINEERING

2013

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Investigate Surface Integrity When Machining FC300 Cast Iron Using Uncoated Carbide Ball End Mill: Study Of Surface Profile**

SESI PENGAJIAN: 2012/13 Semester 1

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I hereby, declared this report entitled “Investigating Cutting Parameter For Wood Plastic Composite” is the results of my own research except as cited in references.

Signature	:	
Author’s Name	:	Muhammad Faizh Bin Sazali
Date	:	3 June 2013

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The member of the supervisory committee is as follow:

………………………………

ABSTRACT

Wood-plastic composite (WPC) is a very promising and sustainable green material to achieve durability without using toxic chemical. The term WPCs refers to any composites that contain plant fiber and thermosets or thermoplastics. In comparison to other fibrous materials, plant fibers are in general suitable to reinforce plastics due to relative high strength and stiffness, low cost, low density, low CO_2 emission, biodegradability and annually renewable. Plant fibers as fillers and reinforcements for polymers are currently the fastest-growing type of polymer additives. One of the most important advantages of wood is its easy machinability in contrast to metal and plastic products. However its non-uniform characteristic resulting from the combination with polymer plays a significant role on its efficient and effective machining. Any surface defects due to improper machining process will reduce the quality of the final products resulting in increase in the cost of the manufactured unit. Therefore it is important to evaluate the machining parameters and relate them with the fiber characteristics and compositions. Thus, this study aims to study the effect of cutting parameters namely spindle speed, feed rate and depth of cut on machining performance of WPC with different composition. Statistical Respone Surface Methodology techniques were used to evaluate the effect of cutting parameters on machining performance. Lastly, the optimal cutting parameter for machining WPC is proposed.

ABSTRAK

Komposit kayu-plastik (WPC) adalah bahan hijau yang sangat menjanjikan dalam mencapai ketahanan tanpa menggunakan bahan kimia toksik. WPC adalah merujuk kepada mana-mana komposit yang mengandungi serat tumbuhan dan termoset atau termoset. Berbanding dengan bahan-bahan serat lain, serat tumbuh-tumbuhan adalah secara umum di antara yang sesuai untuk mengukuhkan plastik kerana kekuatan relatif tinggi dan ketegangan, kos yang rendah, kepadatan yang rendah, kadar pelepasan CO_2 yang rendah serta biodegrabiliti yang sentiasa diperbaharui. Pada masa kini, fiber tumbuhan dijadikan sebagai bahan pegisi di dalam polimer semakin berkembang untuk dijadikan penambah polimer. Salah satu kelebihan yang paling penting di dalam memesin kayu adalah mudah berbanding dengan logam dan produk plastik. Walau bagaimanapun ciri-ciri yang tidak seragam yang terhasil daripada gabungan polimer memainkan peranan penting di dalam kecekapan dan keberkesanan memesin. Kecacatan permukaan hasil dari proses pemesinan yang tidak betul mengurangkan kualiti produk akhir yang mengakibatkan peningkatan kos pembuatan. Oleh itu adalah penting untuk menilai parameter pemesinan dan mengaitkan ia dengan ciri-ciri serat dan komposisi. Oleh itu, kajian ini bertujuan untuk mengkaji kesan parameter pemotongan iaitu kelajuan gelendong, kadar suapan, dan kedalaman pemotongan terhadap prestasi pemesinan WPC dengan komposisi yang berbeza. Teknik Respone Surface Methodology digunakan untuk menilai kesan prestasi parameter pemotongan di dalam pemesinan. Akhir sekali, parameter pemotongan yang optimum untuk memesin WPC dicadangkan.

DEDICATION

For my beloved parents and friends, who always encourage and give all the support that I really need during accomplish this thesis.

ACKNOWLEDGEMENT

Bissmillahirrahmanirrahim,

First and foremost, I thank to Allah the Almighty for blessing me to complete my Final Year Project. I want to take this opportunity to record my utmost and sincere gratitude to my supervisor, Dr Raja Izamshah bin Raja Abdullah. Without him, I can never start work on my project and to proceed until this point of development. He has shown me guidance, important advice, and inspiration throughout my project. He has also give me knowledge essential in doing this project.

Besides, I would like to show my appreciation to my lectures, who have taught me over the years in UTeM. They have taught me the basic of Manufacturing Engineering, and this invaluable knowledge had provided me a firm foundation for doing this project. Most importantly, the knowledge I required from them has prepared me for my career in the future.

Big thanks and appreciation to my parents, family, friends, and others for their cooperation, encouragement, constructive suggestion and full of support for the report completion, from the beginning till the end. Also thanks to everyone, that has been contributed by supporting my work and helps myself during this Final Year Project. Your kindness and cooperation of my paperwork is much appreciated.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The study is mainly about investigating the parameter of machining wood plastic composites. This study is mainly focusing on investigating the effect of spindle speed, feed rate and depth of cut to surface finish of the machined workpiece and also to measure the accuracy of wood plastic composite after machined.

1.2 Background of Study

Basically, the study is performed to investigate the parameter of machining wood plastic composites. Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted. Three parameters were used in this experiment which is spindle speed, feed rate and depth of cut.

The endmill material used is high-speed-steel tool with two flutes end mill. High speed steels which are harder and more heavily alloyed tend to be more brittle than the standard general purpose types [1].

Wood plastic composite is new materials extend the current concept of 'wood composites' from the traditional compressed materials such as particle-board and medium density fiberboard (MDF) into new areas and, more importantly, a new generation of high performance products. The first generation of ‘wood composites’ was a combination of recycled wood flour or chips and binders [2].

1.3 Problem Statement

Wood plastic composites represent a new era of materials development that combines the old with the new to deliver an exciting new option for the end user. In making the wood plastic composites, the composition of wood plastic composite gives the different properties of itself. Due to the different loading of the wood plastic composite, the parameters need to be compatible for machining process such as spindle speed, feed rate and depth of cut. The parameter of machining are proclaim need to be suit with the composition of fiber and matrix material to cut the wood plastic composite which the surface roughness are affected by the parameter used.

Milling composite materials is a rather complex task owing to its heterogeneity and the number of problems, such as surface delamination, that appear during the machining process, associated with the characteristics of the material and the cutting parameters. Understanding and reducing these problems, the machining process need to be study to evaluates the cutting parameters (cutting speed, feed rate and depth of cut) under the surface roughness, and damage in milling laminate plates of carbon fiber-reinforced plastics (CFRPs). [10]

1.4 Objectives:

The purpose of the project is:

1. To investigate the effects of cutting parameters on machining performance of WPC (surface roughness, accuracy and surface quality)
2. To optimise the cutting parameter for machining WPC with respect to the machiningperformance.

1.4 Organization of the Report

This report is divided into two phases which is Projek Sarjana Muda (PSM) 1 and 2. Overall, this project contains 6 chapters. There are introduction, literature review, methodology, result and discussion, and conclusion and recommendation.

In Chapter 1 : Introduction, is briefly explained the background of the study, the study of machine efficiency in industry and the relation of development of jig and machine efficiency, followed with the problem statement, objective of the study, scope, importance of this study and the organization of the report.

In Chapter 2 : Literature review, the theory of machine efficiency and development of jig, problem issue and tools of the method used with supporting ideas that taken from journal, books, and articles are explained in detail.

In Chapter 3 : Methodology, all methods that will be used to achieve the objectives and obtain the results are explained. The systematic planning and the process flow diagram (PFD) also provided to show the overall study flow.

In Chapter 4 : Result and Discussion focuses on the result and data being collected from the study. Besides, the discussion of the result been gained is explained further in this chapter.

In Chapter 5 : Finding and conclusion, the final chapter of this report concludes all the finding of the study and present the suggestion and recommendation in order to improve this study for future.

CHAPTER 2

LITERATURE REVIEW

2.1 Milling

The milling is the most using in cutting process in modern production. A milling operation involves a co-ordinated linear, or multiple-axis feeding motion of the multi-edged cutter as it rotates across and into the workpiece [3].

2.1.2 Milling Machining Operation

There are two basic types of milling operations, which is

a) Face (or end) milling

b) Peripheral milling (or plain)

2.1.2.1 Face Milling

Peripheral milling generates a surface parallel to the axis of rotation, while in face milling operation, is used for profiling and slotting operations [4].

2.1.2.2 Peripheral milling

Face milling is used for relatively wide flat surfaces (usually wider than 75 mm). Endmilling, a type of peripheral milling operation, is used for profiling and slotting operations [4].

2.2 Endmill

Endmill have straight or helical teeth on the periphery, and usually have end teeth. They may have straight or tapered shanks. Straight shank endmill may be single or double end. They may be solid, inserted blade, indexable insert, or tipped construction and may have square, chamfer, radius or ball ends [1].

2.2.1 Endmill Types

Endmill types are categorized by :

a) Two flute Endmill
b) Three flute Endmill
c) Multiple flute Endmill
d) Roughing Endmill

2.2.1.1 Two-Flute Endmill

Two flute have a greater chip handling capacity than multiple-flute endmill. Two flute endmills. End teeth are designed to cut to center [1].

2.2.1.2 Three-Flute Endmill

Three Flute Endmills. End teeth may or may not be designed to cut to center [1].

2.2.1.3 Multiple-Flute Endmill

Multiple-flute Endmills are available in both center cutting and non-center cutting. Multiple-flute Endmills may produce finer finishes and longer tool life than two-flute endmills, owning to a lighter chip load per tooth [1].

2.2.1.4 Roughing Endmill

Roughing endmill can be used in a wide variety of materials and will generally remove more material in less time than conventional heavy duty endmill [1].

2.2.1.5 Endmill Element

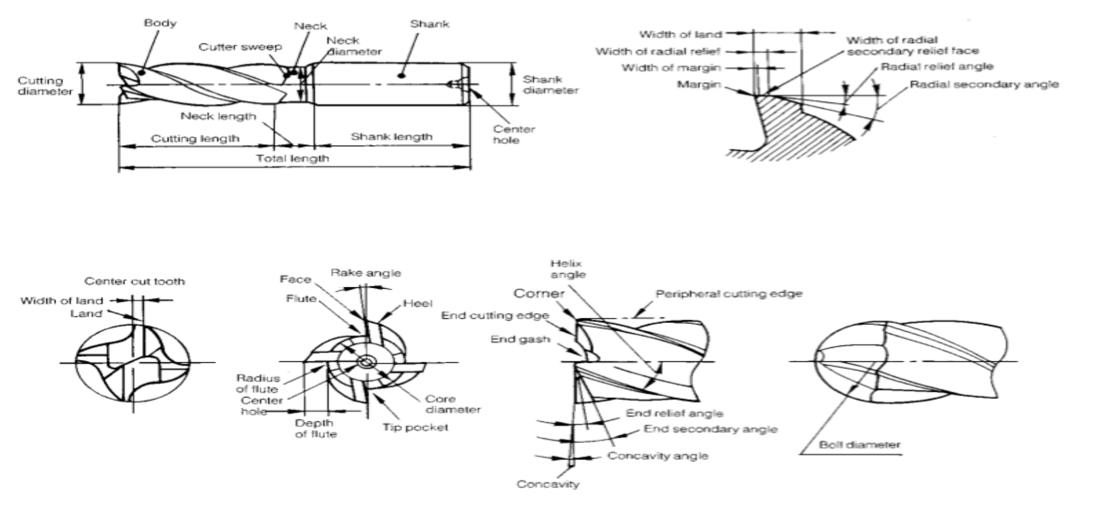

Figure 2.1 Endmill element [1]

Cutting edge	The leading edge of the cutter tooth. The intersection of two finely finished surfaces, generally of an included angle of less than 90 degrees.
Flute	The chip space between the back of one tooth and the face of the following tooth.
Cutting edge angle	The angle which a cutting edge make with an axial plane at any given point.
Heel	The back edge of the relieved land.
Helix Angle	The cutting edge angle which a helical cutting edge makes with a plane containing the axis of a cylindrical cutter.
Neck	The section of reduced diameter between the flutes and shank of a shank type cutter.
Peripheral cutting edge	The angle between an angular cutting edge of a cutter tooth and the axis of the cutter, measured by rotation into an axial plane.

Rake	The angular relationship between the tooth face, or a tangent to the tooth face at a given point and a given reference plane or line.
Axial rake	Applies to angular (not helical) flutes.
Helical rake	Applies to helical teeth only (not angular).
Shank	The projecting portion of a cutter which locates and drives the cutter from the machine spindle or adapter.

2.3 Speed and Feed for Milling

Speeds and feeds are the most important factors to consider for best result in milling. Improper feeds and speeds often cause low production, poor work quality and unnecessary damage to the cutter. The speeds and feeds used depend on the material to milling. For example, use lower speed ranges of hard materials, tough material, abrasive material, heavy cuts, minimum tool wear and maximum cutting life. For higher speed ranges is use of softer material, better finishes, smaller diameter cutter, light cuts, maximum production rates and non-metallics material.

2.3.1 Milling composites

Nowadays many composite materials used in manufacturing because it have gained popularity (despite their generally high cost) in high-performance products that need to be lightweight, yet strong enough to take harsh loading conditions such as aerospace components, boat and scull hulls, bicycle frames, swimming pool panels and racing car bodies. Bases on [9], he concluded that higher cutting speeds give better surface finish on milling composite. He also stated measurement of surface roughness in FRP composite is less dependable than in metals, because protruding fiber tips may lead to incorrect results. Conventional machining of fiber-reinforced composites is difficult due to diverse fiber and matrix properties, fiber orientation, inhomogeneous nature of the material, and the presence of high-volume fraction (volume of fiber over total volume) of hard abrasive fiber in the matrix. Most of the results on GFRP composite machining show that minimizing the surface roughness is very difficult and it has to be controlled [9]. In order to get good surface quality and dimensional properties, it is necessary to employ optimization techniques to find optimal cutting parameters and theoretical models to do predictions [9]. Taguchi and response surface methodologies can be conveniently used for these purposes.

2.4 Surface roughness

Surface roughness are used to determine and evaluate the quality of a product. Surface roughness of a machined product could affect several of the product's functional attributes, such as contact causing surface friction, wearing, light reflection, heat transmission, ability of distributing and holding a lubricant, coating, and resisting fatigue [6]. Furthermore, the surface quality acts a very important role in the performance of milling as a good –quality milled surface significantly improves fatigue strength, corrosion resistance, or creep life of a product. The final surface roughness might be considered as the sum of two independent effects [7]:

1) The ideal surface roughness are a result of the geometry of the tool and feed rate and
2) The natural surface roughness are a result of the irregularities in the cutting operation

2.5 Cutting Tool Material

The selection of cutting tool materials for a particular application is important factors in machining operations. Consequently, the cutting tool material must possess the following characteristics:

- Have sufficient hardness to cut other material.
- Capable of retaining hardness at high temperature.
- Must rank high in wear resistance

Currently, the two general classes of tool materials cover the requirements of milling operations. These are the high speed steels and carbide tool materials. Other tool materials such as ceramics and compacted diamond are used in milling. Coatings and surface finishes have also in use enhanced tool life [1].

2.5.1 High speed Steel

The high speed steels are tool steels capable of maintaining a useful cutting hardness at important temperatures. They do not lose hardness permanently unless exposed to temperatures higher than the tempering temperatures which are in excess of 100°F. This property, often called red hardness, is due principally to two alloying elements, molybdenum and tungsten, separately or in combination. High speed steels are classified as “M” or “T” types depending upon which is the major alloying element. All high speed steels also contain carbon, vanadium and chromium while some grades also include cobalt as an alloying element.

High-speed steel has following advantages:

- HSS costs less than carbide or ceramic tooling
- HSS is less brittle and not as likely to break during interrupted cuts
- HSS tool can be re-shaped easily