UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SURFACE AND SUB SURFACE ANALYSIS WHEN HARD TURNING OF AISI D2 TOOL STEEL

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

by

ABDUL AZIM BIN MAT SALLEH

FACULTY OF MANUFACTURING ENGINEERING

2008

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

TAJUK:

"SURFACE AND SUB SURFACE ANALYSIS WHEN HARD TURNING OF AISI D2 TOOL STEEL"

SESI PENGAJIAN:
2008/2009 Semester 2

Saya **ABDUL AZIM BIN MAT SALLEH**
mengaku membenarkan laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM / tesis 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 / tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
/	TIDAK TERHAD	

LOT 10510, KPG. SALAK,
BELIMBING, JALAN PASIR MAS,
17500 TANAH MERAH,
KELANTAN

Cop Rasmi:

Tarikh: ______________________

Tarikh: ______________________

* Jika laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
Karung Berkunci 1200, Ayer Keroh, 75450 Melaka
Tel : 06-233 2421, Faks : 06 233 2414
Email : fkp@utem.edu.my

FAKULTI KEJURUTERAAN PEMBUATAN

Rujukan Kami (Our Ref) :
Rujukan Tuan (Your Ref):

11 Januari 2012

Pustakawan
Perpustakaan UTeM
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya,
75450 Ayer Keroh, Melaka

Saudara,

PENGKELASAN LAPORAN PSM SEBAGAI SULIT / TERHAD LAPORAN PROJEK SARJANA MUDA MUDA KEJURUTERAAN PEMBUATAN (MANUFACTURING PROCESS): ABDUL AZIM BIN MAT SALLEH

Sukacita dimaklumkan bahawa laporan PSM yang tersebut di atas bertajuk **"SURFACE AND SUB SURFACE ANALYSIS WHEN HARD TURNING OF AISI D2 TOOL STEEL"** mohon dikelaskan sebagai SULIT/TERHAD untuk tempoh Lima (5) tahun dari tarikh surat ini.

2. Hal ini adalah kerana HASIL KAJIANNYA ADALAH SULIT.

Sekian dimaklumkan. Terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Yang benar,

……………………………………………………..

DR AHMAD KAMELY BIN MOHAMED
Pensyarah,
Fakulti Kejuruteraan Pembuatan

DECLARATION

I hereby declared this report entitled **“Surface and Sub Surface Analysis When Hard Turning of AISI D2 Tool Steel”** is the result of my own research except as cited in the references.

Signature	:	………………………………………………..
Author’s Name	:	………………………………………………..
Date	:	……………..…………………………………

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 Design) with Honours. The members of the supervisory committee are as follow:

(Signature of Supervisor)

……………………………………….

(Official Stamp of Supervisor)

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 Design) with Honours. The members of the supervisory committee are as follow:

(Signature of Principle Supervisor)

…………………………………

(Official Stamp of Principle Supervisor)

ABSTRACT

In finish turning, surface quality is often of great concern because of their impact on the product performance in terms of functional behavior and dimensional stability. Thus, the understanding of how the surfaces quality is related to cutting parameter is of practical significance. Work material has been studies are AISI D2 of 40 HRC. Cutting test was conducted on CNC Lathe model SL-20. A tungsten carbide cutting tool coated with Titanium Nitride (TiN) is used in this study. All work material were machined at the different cutting speed which is, Vc= 200 m/min, Vc=150 m/min, Vc = 100 m/min, and feed rate, f = 0.03 rev/min and depth of cut = 0.3 mm. Results shows that good surface finish of 0.26 µm was obtained at cutting speed, Vc = 200 m/min. It was observed that the surface roughness is influenced by the cutting speed.

ABSTRAK

Dalam kerja-kerja penyudahan melarik, kualiti permukaan merupakan perkara yang perlu diambil kira kerana ia boleh memberikan impak kepada prestasi produk yang dihasilkan dari segi fungsi dan kestabilan dimensi. Oleh itu, pemahaman mengenai bagaimana perkaitan diantara kualiti permukaan dengan parameter pemotongan secara praktikalnya adalah penting. Bahan kerja yang digunakan dalam kajian ini adalah AISI D2 dengan kekerasan 40 HRC. Ujikaji pemotongan telah dilakukan dengan menggunakan mesin larik "CNC" model SL-20. Mata pemotongan yang digunakan adalah dari jenis karbida tungsten saduran "Titanium Nitride (TiN)". Semua bahan kerja telah dimesin dengan kelajuan pemotongan yang berbeza di mana, Vc= 200 m/min, Vc=150 m/min, Vc = 100 m/min, dan kadar uluran, f = 0.03 rev/min dan kedalaman pemotongan ialah 0.3 mm. Keputusan menunjukkan penyudahan permukaan yang terbaik iaitu 0.26 μm diperolehi pada kelajuan pemotongan, Vc = 200m/min. Hasil kajian mendapati bahawa kekasaran permukaan adalah dipengaruhi oleh kelajuan pemotongan.

DEDICATION

This is my special dedication to my parent En. Mat Salleh bin Hassan and Pn.Normah Binti Yahya for their support for my study in UTeM. Also thanks to my PSM Supervisor, Dr. Ahmad Kamely bin Mohamad for guide me for this project and I'll not forget my entire classmate and lecture for help me so much. Thank you

ACKNOWLEDGEMENTS

Alhamdulillah, thank to Allah the Almighty God for giving me strength and patience to work on this Final Year Project Report. I would like to take this opportunity to express my sincere and deepest gratitude to my Project Supervisor; Dr. Ahmad Kamely bin Mohamad for his guidance and opinion in the cause of completing this report.

My greatest thanks to my beloved family for their prayers, support, and encouragement to me for throughout this entire period of the Final Year Project 1 and 2. I would like to thanks, Dean of Faculty of Manufacturing Engineering, University Technical Malaysia, Melaka, my academic supervisor, and to all the lectures in the faculty. I also would like to convey my biggest thanks to all FKP technicians for supporting me throughout my project. The knowledge and experience I gained from you all will not be forgotten.

I'm also obliged to everyone who had directly and indirectly involve through contributions of ideas, as well as materials and professional opinions. Last but not least,. all my friends out there for their moral support and valuable help that they have provided me throughout my project.

TABLE OF CONTENT

4. CHAPTER 4 RESULT AND DISCUSSION

5. CHAPTER 5 CONCLUSION AND RECOMMANDATION

LIST OF TABLE

LIST OF FIGURE

LIST OF ABBREVIATION

CAM	=	Computer Aided Manufacturing
CNC	=	Computer Numerical Control
LCD	=	Liquid Crystal Display
USB	=	Universal Serial Bus
HIP	=	Hot Isostatic Pressing
AISI	=	American iron and Steel Institute
RPM	=	Rotation per Minute
HSS	=	High Speed Steel
CCTV	=	Closed Circuit Television

CHAPTER 1

INTRODUCTION

1.1 Project Background

Microstructure is defined as structure of prepared surface or thin foil of material as revealed by microscope above 25x (magnificent). The microstructure of material can strongly influence physical properties such as strength, toughness, ductility, hardness, corrosion resistance, high / low temperature behavior, wear resistance, and so on, which in turn govern the application of these materials in industry practice. ("Metallographic and Microstructures," American Society for Metals, Metals Park, OH, 1985, p. 12.)

The title of this project is “Surface and sub-surface analysis when hard turning of AISI D2”. While surface is the macrostructure on which it is superimposed. The material from which objects are constructed also possesses other prominent properties, such as softness or hardness, slipperiness and friction, and thermal qualities such as thermal flow and thermal conductivity. The general issues rise in this project with respect to surface and sub-surface as well to these other properties of object materials.

The perception of surface texture is a multidimensional, when we describe the texture of a surface, we may focus on dimensions such as roughness/smoothness, bumpiness, or jaggedness, or perhaps on the degree of element cluster that produces the surface microstructure.

To achieve the result of surface and sub surface, the project will used the material of AISI D2 tool steel. Generally describe the tool steel is refer to a variety of carbon and alloy steels that are particularly well-suit to be made into tools. The suitability comes from their distinctive hardness, resistance to abrasion, their ability to hold a cutting edge, and their resistance to deformation at elevated temperatures. Tool steel are generally use in heat-treated stated.

Tools steels are made to a number of grades for different applications. Choice of grade depends on, among other things, whether a keen cutting edge is necessary, as in stamping dies or whether the tool has to withstand impact loading and services conditions encountered with such hand tools. For this project, the types of tools steels grades is AISI D2. The D-grade tool steels contain between 10% and 18% chromium. These steels retain their hardness up to a temperature of 425 °C. D-2 steel is a semi-stainless alloy containing 1.5% carbon and 11-13% chromium.

Thus, the project will undergo to analyze the AISI D2 surface and sub-surface when hard turning by CNC machine. The expectation result will be the different surface and sub-surface condition due to the parameter setting.

1.2 Problem Statement

In the previous study, Ramesh, A. and Melkote, S.N. discuss about the FE model of white layer formation in orthogonal machining of AISI 52100 hardened steel that incorporates the effects of stress and strain on transformation temperature, volume expansion and transformation plasticity. In this study the project have undergo to the machining of AISI D2 and to find the effect of cutting condition on the formation of white layer. However there is relatively work form the previous study in term of the phase transformation during machining.

This is important to know the differential between two types of material. The result and the analysis should assault a tool include:

a) Find the differences between the surface and parameter used.
b) Find the surfaces roughness value on each sample from different parameter.
c) The hardness value as to compare from the actual material hardness value.

1.3 Objective

There are three objectives that need to achieve in this project. The objective is list below:

1. To analyze the surface and sub-surface defect when hard turning of AISI D2.
2. To study the influence of cutting parameters on surface roughness.
3. To compare the hardness value of the material (AISI D2 Tools Steel) before and after machining.

1.4 Significant Of Study

The optimum cutting tool material for hard turning is CBN, but other material such as carbide are also can performs well even though it is not as tough as CBN and tool tends to be easily affected by thermal shock. Hard turning in some materials can produce a “white layer” or amorphous zone on the surface of the workplace. This surface defect is invisible to the eye and must be measured using instruments.

1.5 Scope

The study have conducted with the several parameters, the first is the material. Material used in this study is the AISI D2 tool steel. The machining process involved of CNC machine model SL-20 with spindle speed of 100 rpm, 150rpm and 200 rpm. The cutting tool used is Tungsten Carbide. This study will only cover the defect of material to the surface and the surface roughness defect on the different cutting parameters.

CHAPTER 2

LITERATURE REVIEW

2.1 CNC Lathe Machine

CNC Lathes are rapidly replacing the older production lathes (multispindle, etc) due to their ease of setting and operation. They are designed to use modern carbide tooling and fully utilize modern processes. The part may be designed by the Computer-aided manufacturing (CAM) process, the resulting file uploaded to the machine, and once set and trialled the machine will continue to turn out parts under the occasional supervision of an operator.

The machine is controlled electronically via a computer menu style interface, the program may be modified and displayed at the machine, along with a simulated view of the process. The setter/operator needs a high level of skill to perform the process, however the knowledge base is broader compared to the older production machines where intimate knowledge of each machine was considered essential. These machines are often set and operated by the same person, where the operator will supervise a small number of machines.

2.1.1 CNC Lathe – SL 20

The CNC Lathe machine that use in this project is from Haas Automation Model SL 20. Haas Automation's complete line of CNC lathes is designed to meet the needs of modern machine shops, now and long into the future.

The SL Series offers a wide range of capacities, and space-saving Big Bore option increases capacity further while retaining the original footprint. The SL-20, with a max turning capacity of 10.3" x 20" and an 8.3" chuck, has a bar capacity of up to 2.0".

Haas high-performance turning centers also feature massive headstock castings with symmetric ribs for rigidity and thermal stability on-the-fly wye-delta switching for peak performance throughout the rpm range and embedded chip trays and high-volume coolant systems for efficient chip removal. The Haas control features advanced tool management, single-button features, 15-inch color LCD monitor and a USB port. Haas has raised CNC turning to new levels of reliability, ease and productivity. Below is the figure of CNC Lathe Machine (Sl-20).

Figure 2.1: CNC Lathe Model SL-20

2.1.2 SL-20 Machine Specification

Below is the specification of the CNC Lathe machine that use in this project.

Table 2.1: CNC Lathe SL-20 machines specification, *HAAS product machine guides*

Capacities	S.A.E.	Metric
Max Cutting Diameter	10.3 "	262 mm
Max Cutting Length	20.0 "	508 mm
Spindle Max Rating	20 hp	14.9 kW
Spindle Max Speed	4000 rpm	4000 rpm
Spindle Max Torque	154 ft-lb @ 650 rpm	209 Nm @ 650 rpm
Tool Size (OD turning)	1.00 "	25.4 mm
Number of Tools	10	
Coolant Capacity	40 gal	151 L
Power Required (cont)	14 kVA; 200-250 VAC @ 50A, 3-phase 60 Hz	14 kVA; 200-250 VAC @ 50A, 3-phase 60 Hz
Machine Weight	9000 lb	4082 kg