INVESTIGATE THE EFFECT OF SHEAR ANGLE OF HIGH SPEED STEEL PUNCHING TOOL IN PUNCHING PROCESS

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SUPERVISOR DECLARATION

I hereby declare that I have read this report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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Date : ……....

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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To my beloved parents

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ABSTRACT

Punching process is increasingly used in manufacture industry. Punching is among the most important sheet metal in manufacturing process in mass production of metal parts and components. This operation has a great impact in variety of industries such as automotive industry. In recent years, a further understanding of the technological aspects of the punching process has been gained especially in punching tools. Therefore, this paper will investigate the effect of shear angle of high speed steel punching tool in punching process. The punching tool will be redesign by changing the shear angle of the tool and the simulation will be done using finite element method with different force applied to the punching tool. The purpose of this paper is to investigate the effect of shear angle that occur in the punching process and choose the optimum shear angle in order to increase the tool life and minimize manufacturing cost. From analysis result shown when shear angle increase the force imposed by the tool also increased and the optimum shear angle is 4.5^{o}.

ABSTRAK

Proses penebukan semakin digunakan dalam industri pembuatan. Penebuk adalah di antara proses pembuatan kepingan logam yang paling penting dalam pengeluaran komponen dan bahagian logam secara pukal. Operasi ini memberi kesan yang besar di pelbagai industri besar seperti industri automotif. Dalam beberapa tahun ini, pemahaman lebih lanjut dari aspek teknologi penebukan telah diperolehi terutama di mata pemotong. Oleh yang demikian kertas projek ini membincangkan atau mengenalpasti kesan sudut potongan keatas mata penebuk jenis *high speed steel* dalam process penebukan. Mata pemotong akan direka bentuk semula dengan mengubah sudut potongan dan simulasi akan dilakukan dengan mengenakan daya yang berbeza kepada mata pemotong dengan menggunakan cara analisis unsur tak terhingga. Tujuan kertas projek ini adalah mengenalpasti kesan sudut potongan keatas mata pemotong dalam proses penebukan dan memilih sudut yang paling optimum dengan tujuan meningkatkan kadar hayat pada mata pemotong dan meminima kos pembuatan. Daripada analisa yang telah dibuat, keputusan menunjukkan apabila sudut potongan meningkat, daya yang diterima oleh mata pemotong juga akan meningkat dan sudut potongan yang optimum adalah pada 4.5^{o}.

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SYMBOL	
σ	Engineering Stress
P	Load
A_o	Cross sectional area
l	Instantaneous Length
l_o	Initial Length
E	Modulus of elasticity
e	Engineering Strain
V	cutting speed
D	depth of cut
F	feed rate
T	Thickness of sheet metal
Y	Yield Strength
c	clearance
D and d	die and punch diameter
UTS	Ultimate tensile Strength
CAD	computer-aided design
IGES	Initial Graphics Exchange Specification

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The research work in this project involves a theoretical investigation the effect of shear angle on high speed steel (HSS) punching tool in punching process. The project will be carried out to determine the effect of different shear angle on High Speed Steel (HSS) punching tool in punching process using Finite Element Method (FEM) based on punching process using Press Trumatic 2020 Rotation FMC Machine (Trumpf TruPunch 2020R). The result will show what the effect of different shear angle on the HSS punching tool while in punching process and the optimum shear angle.

Nowadays, CNC punching machine have been used to fabricate the product from sheet metal where the process is fully under computer controlled with preparing NC program. The technology in cutting process improve day by day rapidly which have plasma cutting, laser cutting, turret punch and etc.. Different type of machine, it will conduct different but same of basic.

Tool system is very important in machining process. Complete tool set contain punch, alignment ring, stripper and die. If one of these components not conducts wisely it will damage the product or will facing with machine damage. To sure the product is high quality and the process of manufacture can conduct safely, the quality of punch component especially tooling is very important. Punch is come in three designs which are flat punch,

punch with roof shear and angled punch. Better tool is defined as strength of wear resistance and toughness in one grade.

1.2 OBJECTIVE

1.2.1 Investigate the effect of shear angle on Turret Punch Insert using finite element analysis.

1.2.2 To choose the optimum shear angle of Turret Punch Insert using finite element analysis.

1.3 SCOPES

This project only considers on investigating of the effect different shear angle and the best shear angle of high speed steel punching tool. It will start with literature review and understands the statement of problem. After that, it will follow by the measuring the actual tool using Coordinate Measuring Machine. Next, from the actual measurement, the tool is developing with different shear angle by designing with CAD software, SolidWorks. The climax of the project is simulating the model using Finite element Software, ALGOR V22 Fempro. Lastly, the results from the simulation will use to analyze the effect of different shear angle by plotting the graph.

1.4 PROBLEM STATEMENT

Challenging for tooling manufacturer is how to use their tool on hard machine for fabricating on soft metal. So they will think which material is the best in term of costing, quality of the product and time consideration. Thus they will think how the defect will occur. The factor that will define is work piece and tool material, punch geometry, sheet metal thickness and clearance. In this project just will consider on punch geometry (shear angle). The concept used in this project is connected with pressure and theory of energy. Even by giving same force but the pressure will change due to contact with surface area. In addition, by changing the shear angle of the tool, it hopes tool life will be improved. This is because selection of right shear angle or generally, punch geometry is very important for tool life and the final product. So, improvement of tool life is very important because tool will often facing adhesive and abrasive wear in contact zone. In addition, tool will affect dimensional and form error. As in phase process of shearing, after given the force, work piece will in plastic phase and then will reach fracture limit and micro cracks will appear which turn onto macro cracks. As a result the edge will not appear smoothly by appearing the burr as shown in Figure 1.1. The productivity and quality in sheet metal can be assessed by the burr height after blanking process. Accordingly to geometry of punch, this project will investigate the effect of shear angle. (*Serope Kapaljian, Steven Schmid; 2006, R.Hambli; 2001*)

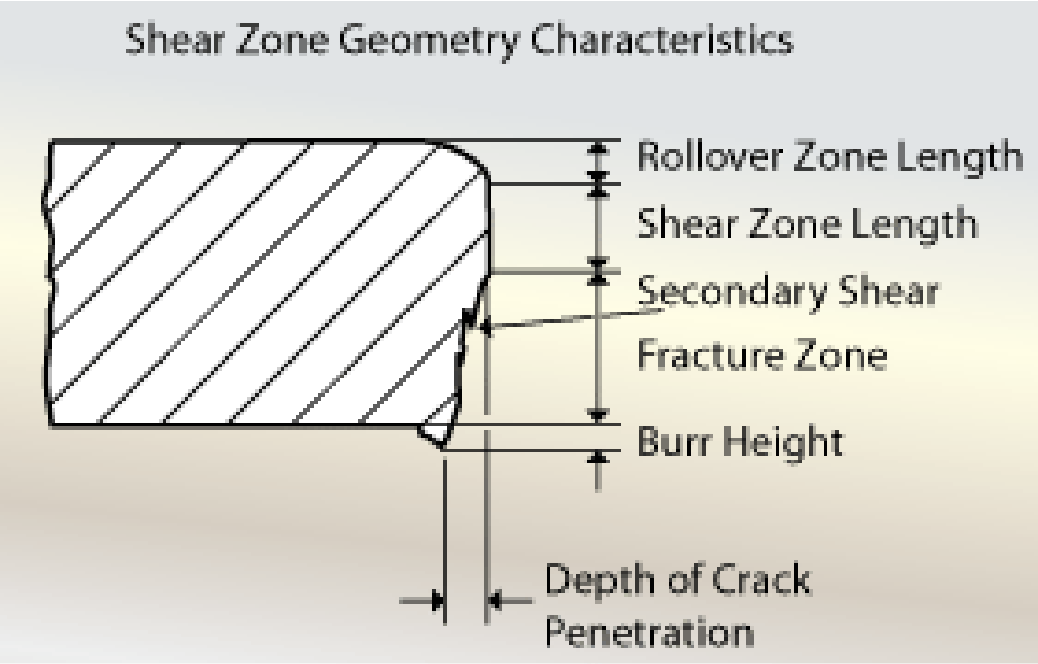

Figure 1.1: Geometry of sheared workpiece

Source: Serope Kapaljian, Steven Schmid; 2006

1.5 CHAPTER OUTLINE

Chapter 1 consists of the detail about the project. In this chapter is explaining of the project background, objective, scopes and the statement problem.

Chapter 2 is extracted from the reference books; handbook or journals found that related to this project. The description of manufacturing process method, types of forming and shaping process, classification of sheet metal, blanking and punching process, press machine, tool systems and tool wear occurred is describe in this chapter.

In chapter 3, the flow process for the whole project is detailed. Flow chart for the project is drafted for a quick overview of the methodology.

Chapter 4 provides all the data collected. It started with measurement on the actual insert and develops the design using SolidWorks by changing the shear angle of the insert. The next step is develop finite element model using ALGOR V22 Fempro, and lastly simulate the model using ALGOR V22 Fempro. It's also includes discussion of the finding data.

Lastly in Chapter 5, the whole project is concluded and some recommendation. The conclusion based on the project objective and the recommendation is for improvement for further study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The science, engineering and technology of manufacturing process and systems continue to move on speedily on a worldwide scale and with major impact on the financial systems of all peoples. This is because with this condition people can invent many products with various shapes. As a result, that science, engineering and technology of manufacturing processes and system people can do many things.

With knowledge of manufacturing, till today many kinds of manufacturing have been generated. To produce parts, need variety of manufacturing processes. The broad groups of the handing routine for materials base are follows; *(*(*Serope Kapaljian, Steven Schmid; 2006*)

Casting-expendable mold and permanent mold

i. Forming and shaping- rolling, forging, extrusion, drawing, sheet forming, powder metallurgy and molding.
ii. Machining- turning, boring, drilling, milling, shaping, broaching and grinding, ultrasonic machining; chemical, electrical, and electrochemical machining; and high- energy- beam machining.

iii. Joining- welding, brazing, soldering, diffusion bonding, adhesive bonding and mechanical joining.

iv. Finishing- honing, lapping, burnishing, deburring, surface treating, coating, and plating.

v. Nanofabrication is the most advanced technology and is capable of producing parts with dimensions at the nano level (one- billionth); it typically involves processes such as etching techniques, electron- beams, and laser beams. Present applications are in the fabrication of microelectromechanical systems (NEMS), which operate on the same scale as biological molecules.

2.2 FORMING AND SHAPING PROCESSES

Forming and shaping process is one of manufacturing process which some of the product can replace function of casting process. It can reduce the cost. As in Manufacturing Engineering and Technology told that about the characteristics every types process that in categories forming and shaping as shown in Table 2.1.

Table 2.1: General Characteristics of Forming and Shaping Processes

General Characteristic of Forming and Shaping Process	
Process	Characteristics
Rolling	
Flat	Production of flat plate, sheet and foil at high speeds; good surface finish, especially in cold rolling; very high capital investment; lot-to- moderate labor cost.
Shape	Production of various structural shapes (such as I- beam and rails) at high speeds; includes thread rolling; requires shaped roll and expensive equipment; low- to- moderate labor cost; moderate operator skill.

Forging	Production of discrete parts with the set of dies; some finishing operations usually required; usually performed at elevated temperatures, but also cold for smaller parts; die and equipment costs are high; moderate- to- high labor cost; moderate- to- high operator skill.
Extrusion	Production of long lengths of solid or hollow shapes with constant cross-section; product is then cut into desired lengths; usually perform at evaluated temperatures; cold extrusion has similarities to forging and is used to make discrete products; moderate- to- high die and equipment cost; low- to- moderate labor cost; low- to- moderate operator skill.
Drawing	Production of long rod and wire with various cross sections; good surface finish; low- to- moderate die, equipment and labor costs; low- to- moderate operator skill.
Sheet- metal forming	Production of wide variety of shapes with thin walls and with simple or complex geometries; generally low- to- moderate labor cost; low- to- moderate operator skill.
Powder metallurgy	Production of simple shape or complex shapes by compacting and sintering metal powders; moderate die and equipment cost; low labor cost and skill.
Process of plastics and composite materials	Production of a wide variety of continuous or discrete products by extrusion, molding, casting, and fabricating process; moderate die and equipment costs; high operator skill in processing of composite materials.
Forming and shaping of ceramics	Production of discrete products by various shaping, drying, and firing process; low- to- moderate die and equipment cost; moderate- to- high operator skill.

Source: Serope Kapaljian, Steven Schmid; 2006

2.3 CLASSIFICATION OF SHEET METAL PROCESSING

Based on the Table 2.1 sheet metal processing is one of the forming and shaping group of manufacturing process. It conducts in a cold working or carried out in the room temperature. The manufacturing processes involve in sheet metal processing are with cutting, forming and finishing. Kapalkjian classified basic types of sheet metal processing into three groups; shearing, bending, and forming, while Vukota Buljavonic into two groups; cutting and plastic deformation, while K Venkataraman classified into four groups; shearing, bending, forming and drawing. But they agreed the processes related for cutting or shearing processes. Referred to Kapalkjian, he classified shearing processes are blanking, punching, die cutting, fine blanking, and slitting, while in plastic deformation of forming groups are bending, stretch forming, deep drawing and various other forming processes. Actually shearing involves the cutting of flat material forms from sheet, plate or strip.

Refer to the definition given by Kapalkjian base on shearing operation;

i. Blanking (Figure 2.1) where the slug is the part to be used and the rest is scrap.
ii. Punching (Figure 2.1) where the sheared slug is scrap or may be used for some other propose.
iii. Die cutting is a shearing operation that consists of the following basic processes (Figure 2.2):
    a. Perforating- punching a number of holes in a sheet
    b. Parting-shearing the sheet into two or more pieces
    c. Notching- removing pieces (various shapes) from edge.
    d. Lancing-leaving a tab without removing any material.
iv. Fine blanking will make very smooth surface and square edges can be produced.
v. Slitting is shearing operation can be carried out by means of a pair of circular blades similar to those in can opener.