DETERMINATION OF CLEARANCE FOR THE DESIGN OF BENDING DIE FOR LOOPING A CABLE STAYED SUPPORT PLATE

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

by

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DECLARATION

I hereby, declared this report entitled "Determination of Clearance for The Design of Bending Die for Looping a Cable Stayed Support Plate" is the results of my own research except as cited in reference.

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Date : 21 JUN 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineereing of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.).
The members of the supervisory committee are as follow:

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(WAHYONO SAPTO WIDODO)

ABSTRAK

Projek tahun akhir bertajuk "Penentuan Pelepasan untuk Reka Bentuk Lenturan Die Untuk Membentuk Gelungan Pada Plat Sokongan Kabel Kekal". Projek ini memberi tumpuan kepada reka bentuk lenturan die untuk menentukan jarak optimum antara '*punch'* dan *'die'* untuk lenturan plat sokongan kabel kekal. Selain itu, ia juga memberi tumpuan untuk menentukan daya yang sesuai untuk reka bentuk optimum lentur pelepasan '*die'* semasa lenturan. Kedua-dua parameter antara '*punch'* dan *'die'*; dan daya semasa lenturan digunakan untuk menentukan sama ada ia akan dapat menghasilkan bentuk akhir yang baik pada plat dengan sedikit atau tiada kecacatan seperti retak atau patah. Reka bentuk pemodelan 3D lenturan die direka menggunakan perisian CATIA. Bahan yang digunakan untuk plat sokongan kabel kekal adalah keluli tahan karat dengan ketebalan 2 mm dan 140 mm panjang. Dengan menggunakan Analisis Dinamik Eksplisit dari perisian ANSYS, hasil daripada Finite Element Analysis bagi setiap reka bentuk lenturan die dengan jarak yang berbeza dan daya diperolehi. Kelegaan yang berbeza antara '*punch'* dan *'die'* digunakan untuk analisis adalah 0.1 mm, 0.2 mm, 0.3 mm, 0.4 mm dan 0.5 mm; manakala daya yang berbeza digunakan untuk analisis ialah 427 N, 214 N, dan 107 N. Keputusan analisis yang telah diperolehi adalah daripada jumlah keseluruhan perubahan bentuk dan bersamaan (von-Mises) tekanan pada plat. Dari keputusan akhir analisis, ia diperolehi bahawa jarak optimum antara '*punch'* dan *'die'* adalah reka bentuk lenturan die dengan jarak 0.2 mm. Daya paling sesuai untuk jarak optimum die yang diperolehi adalah 214 N. Reka bentuk dengan jarak 0.2 mm mempunyai keputusan jumlah keseluruhan perubahan bentuk 89.195 mm dan tekanan bersamaan 28121 MPa. Tidak ada kecacatan seperti retak atau patah berlaku berdasarkan keputusan analisis.

ABSTRACT

This final year project entitled “Determination of Clearance for The Design of Bending Die for Looping a Cable Stayed Support Plate”. This project focused on the design of bending die to determine the optimum clearance between the punch and die for bending of cable stayed support plate. Besides, it also focused to determine the suitable force for the design of optimum bending die clearance during bending. These two parameters which were the clearance between punch and die; and the force during bending were used for determining whether it will be able to produce a good final shape of the plate with small or no defect. The 3D modelling designs of bending die are designed using the CATIA software. The material used for the cable stayed support plate was stainless steel with thickness of 2 mm and 140 mm long. By using the Explicit Dynamic Analysis from ANSYS software, the result of Finite Element Analysis for each design of bending die with different clearance and the force are obtained. The different clearance between punch and die used for the analysis were 0.1 mm, 0.2 mm, 0.3 mm, 0.4 mm, and 0.5 mm; whereas the different forces used for the analysis were 427 N, 214 N, and 107 N. The results of the analysis were focused for the total deformation and the equivalent (von-Mises) stress of the plate. From the final results of the analysis, it is obtained that the optimum clearance between punch and die are the design of bending die with 0.2 mm clearance. The most suitable force for the optimum clearance of the die obtained was 214 N. The 0.2 mm clearance design had results of total deformation of 89.195 mm and the equivalent stress of 28121 MPa. There is no tear defect occur based on the analysis results.

DEDICATION

During the hard time preparing this report, I want to give my thanks to those who fully support and understanding me;

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CATIA	-	Computer Aided Three Dimensional Interactive Application
FEA	-	Finite Element Analysis
SWG	-	Standard Wire Gauge
HSS	-	High Strength Steel

LIST OF SYMBOLS

mm	-	Millimeters
in	-	Inches
%	-	Percentage
α	-	Bend angle
Ri	-	Initial bend radius
Rf	-	Final bend radius
t	-	Thickness plate
Y	-	Yield strength
E	-	Young's modulus
F	-	Force
C1	-	Coefficient
P	-	Bend force
B	-	Bending line length
Ts	-	Tensile strength

LIST OF EQUATIONS

CHAPTER 1

INTRODUCTION

This chapter describes the brief explanation of the background of sheet metal working for bending die for looping a cable stayed support plate. In this chapter, background of study, problem statement, objectives, scopes and limitation of this study are discussed.

1.1 Background

Historically, metal was shaped by hand using a hammer. Later, larger hammers were constructed to press more metal at once, or to press thicker materials. Along with the evolution of presses came the evolution of the dies used within them. A machine press, commonly shortened to press, is a machine tool that changes the shape of a work piece. Press tools are commonly used in hydraulic and mechanical presses to produce components at a high productivity rate. Generally press tools are categorized by the types of operation performed using the tool, such as blanking, piercing, bending, forming, forging, and trimming. The press tool will also be specified as blanking tool, piercing tool, and bending tool.

Sheet metal bending is a process of straining sheet metal around a straight axis to take a permanent bend where the metal on the inside of neutral plane is compressed, while the metal on outside of neutral plane is stretched. This bending process sometimes caused defects to the part being bent due to the compression and tension during the bending process.

1.2 Problem Statement

In bending a U-shaped part into a loop-shaped, defect such as crack tend to occur. The crack may occur at the outer part of the U-shaped part due to the extension during bending process, or the crack may occur on the inside part of the U-shaped part due to the compression during the bending process. The factor of this defect may be due to the due to the clearance between the punch and die, and the force put into the bending die to perform the bending process. The cable stayed support plate is formed from U-shaped part to the loop-shaped part. Thus, the design of bending die for looping a cable stayed support plate is to be made. Furthermore, the analysis of its clearance and force of the bending die will be made, in order to reduce the defect.

1.3 Objectives

The objectives of this research are:

1. To design a bending die for looping a U-shaped cable stayed support.
2. To analyze the optimum clearance required for the design of the bending die.
3. To analyze the force used to bend the plate for the optimum clearance of the bending die.

1.4 Scopes

The scopes of the research are as follows:

a) The project focus on the design of bending die for looping a cable stayed support plate using the Catia software.

b) Literature study from different sources is carried out to investigate the design parameter of a bending die that is the clearance and force used in the bending process.

c) The simulation will be made using Explicit Dynamic in Finite Element Analysis (FEA) using ANSYS software. The simulation focused on determining the clearance and force used during bending process. The results of the analysis are focused on the total deformation and equivalent stress.

1.5 Limitations

This research is limit by some of these factors as follows:

1. The shape and size of the U-bend and loop of cable stayed support plate is based on the standard size of cable stayed support plate.
2. The material for cable stayed support plate is the stainless steel.
3. Design of the bending die will be made using the CATIA software.
4. The parameter focused in this project are the clearance between punch and die and the force during bending.
5. The Finite Element Analysis (FEA) of the design of bending die will only be simulated by using explicit dynamic analysis in ANSYS software. The simulation only focused on the total deformation and equivalent stress only.

CHAPTER 2
LITERATURE REVIEW

This chapter describes the literature review which covers for the study of understanding the project. The chapter explains on the brief history of sheet metal working and also the study of the bending process. The understanding of designing bending die, bending parameter, bending defect and bending force are also obtained from the literature review. The study of this literature overview regarding bending process and designing of bending die are important in order to accomplish the objectives of this project.

2.1 Metal Forming

In fabricate metal products, metal forming is the most known process from three major technologies used; the other processes are casting and metallurgy process. Metal forming is a process where the metal billet or blank is shaped using tools or dies and this process depend on different factors such as the characteristic of work piece materials, the mechanics of plastic deformation and the finished product requirement. The selection of tool geometry and material are also influenced by these factors. Metal forming is normally performed after the primary processes of extraction, casting, and powder compaction and before the finishing processes of metal cutting, grinding, polishing, painting and assembly.

2.1.1 Classification of metal forming process

Initially, a simple work piece is made up of a billet or a sheet of metal, where it will then plastically deformed between tools and dies to obtain the final configuration. All metal forming processes can be classified into two broad categories;

1) Bulk or Massive Deformation Processes

   In bulk or massive deformation process, the materials used are usually in a shape of billet, rod, or slab form. The surface-to-volume ratio in the formed part increases considerably under the action of largely compressive loading where the surface of the deforming metal and the tools are in contact and the friction between them may have a major influence in the material flow (Boljanovic Vukota, 2010).

2) Sheet Metal Forming Processes

   Sheet Metal Forming Processes involves partial or complete plastic deformation of the material (Boljanovic Vukota, 2010).

2.2 History of Sheet Metal Forming

Sheet Metal Forming has been used since the last century. The history and development of the sheet metal industry are progressing throughout the years and the techniques used are getting more lenient by the involvement of machineries and technologies. This rapid growth of development promotes a more stable and faster development of the sheet metal.

The development and growth of sheet metal forming can be seen in the eighteenth century, where the practices of metal technologies are found as evidence of the product of the iron industry. According to (James M. A., 1981), before the output of the furnace and commercial forges could be turned to everyday use, however, additional processing often was necessary. He said that the conversion of primary metal forms such as castings, rough