UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF SPRINGBACK PROBLEM ON ALUMINUM SHEET

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

by

LIONG SHUN HSIANG

FACULTY OF MANUFACTURING ENGINEERING

2010

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **ANALYSIS OF SPRINGBACK PROBLEM IN ALUMINUM SHEET**

SESI PENGAJIAN: 2009/2010

Saya LIONG SHUN HSIANG(B050610113)

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM 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 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	

(TANDATANGAN PENULIS)

Alamat Tetap:
LOT 3161, JALAN ALLAMANDA 1
98000 MIRI, SARAWAK

Tarikh: 09th APRIL 2010.

Disahkan oleh:

(TANDATANGAN PENYELIA)

Cop Rasmi: MOHAMAD HAIDIR BIN MASLAN
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Tarikh: 26/5/2010

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

DECLARATION

I hereby, declared this report entitled "ANALYSIS OF SPRINGBACK PROBLEM ON ALUMINUM SHEET" is the results of my own research except as cited in references.

Signature	:	…….
Author's Name	:	LIONG SHUN HSIANG
Date	:	9th April 2010

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 (Engineering Materials) with Honours. The member of the supervisory committee is 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 (Engineering Materials) with Honours. The member of the supervisory committee is as follow:

(Signature of Principal Supervisor)

……

(Official Stamp of Principal Supervisor)

(Signature of Co-Supervisor)

……

(Official Stamp of Co-Supervisor)

ABSTRACT

Springback is an important issue in aluminum sheet forming. Springback defined as elastic recovery during unloading. It cause by elastic recovery due to bending. Bending operation is one of the process involves springback. In automobile industry, it is an issue to predict final shapes of the part after springback and die or bending tools design to compensate for springback. For this research, an experimental study carried out to determine the springback of aluminum. Experiment laboratory for microstructure, bend test and tensile test are carrying out for aluminum sheet 1106. Varies factor affecting springback problem of aluminum sheet are analyze. The result determine on how the springback relates to the properties of aluminum sheet.

ABSTRAK

“Springback” ialah satu isu penting dalam pembentukan logam. “Springback” dikenali sebagai pengembalian elastik selepas beban dilepaskan. Ia disebabkan daripada kekenyalan bahan tersebut selepas pembentukan.. Operasi melenturkan bahan adalah satu proses melibatkan “Springback”. Dalam industri pembuatan kereta, ia adalah satu isu untuk meramalkan bentuk terakhir selepas “springback” dan pereka peralatan untuk mengurangkan springback. Untuk pengajian ini, satu pengajian dibuat untuk menentukan “springback” aluminum. Eksperimen untuk mikrostructur, ujian lentur dan ujian tegangan dilakukan. Faktor yang menyebab masalah “springback” telah dianalisa. Keputusan menentukan bagaimana faktor tersebut mempengaruhi kadar “springback”.

DEDICATION

For my beloved family.

ACKNOWLEDGEMENT

Initially, I would like to express thousand thanks to Encik Mohamad Haidir bin Maslan. He is my Project Sarjana Muda supervisor had provided his time to help me correct my draft report and provide his knowledge and teaching throughout the problem while going through writing the draft.

Secondly, I would like to express thanks for my course mate and moral support for junior student for supporting me doing the PSM.

I would also like to thank my family for all of their support throughout my education. Without their love, I would not have been able to accomplish any of things I have in my life.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

°	-	Degree
%	-	Percentage
2 D	-	Two Dimensional
3 D	-	Three Dimensional
ASTM	-	American Society for Testing and Materials
E	-	Modulus of elasticity
FEM	-	Finite element method
FEA	-	Finite element analysis
GPa	-	Gigapascals
In.	-	Inch
Ksi	-	Kilo pound force per square inch
Mm/mm	-	Millimeters
MPa	-	Mega Pascal
N/m^2	-	Newton per square meter
N/mm^2	-	Newton per mili-square meter
kN/mm^2	-	Kilo Newton per mili square meter
Pa	-	Pascal
Y	-	Modulus of elasticity

CHAPTER 1

INTRODUCTION

1.1 Research Title

Analysis of Spring Back Problem on Aluminum Sheet

1.2 Background of research

Aluminum has been a popular and widely used material in automobile manufacturing industries. Aluminum alloy are preferred because of their lightweight and strength properties. Aluminum alloy has relatively low tensile properties compared to steel. This project is to identify the springback effect of aluminum and to explain the causes of springback effect. This project also determines the springback rate of aluminum. Springback is a phenomenon that happens in every metal sheet forming industry. Spring back explained by dimensional changes during unloading cause by elastic forming of the part. Sheet metal forming tools includes L-Shape forming, Press Brake Forming, etc. Sheet metal formed between tools to obtain desired shape required. For this reason, springback in sheet metal process involve a major in automobile industries. The accuracy of dimension remains significant concern in sheet metal forming process.

Springback problem has become one major and unsolved problem especially for car manufacturer that the sheets need to bend to complex shape. This study will focus on springback phenomenon and correlate the material properties to understand the

phenomenon. Because most of the materials used for car manufacturer required for forming operation, there is sometime hard to make a proper forming procedure required for this operation. This operation consumes time to prepare a proper forming method to compensate springback problems. Some of the materials has good formability while others having problems with springback. Effect of process parameters on springback and strength of the springback has been research by manufacturing department but the knowledge about the material springback problems are limited due to many factors affect the springback of the material. There is numerous factors influence the accuracy of prediction of springback. Certain calculation involving numerical integration complicates springback prediction. Some material goes through heat treatment process, tempering process and cold rolling process that changes the structure of the material influence the springback prediction. If not correctly predict and compensate for, springback will cause the final part shape to deviate from design specifications and to create assembly problems. The springback is the key problems in forming process. A number of numerical technical methods devised to predict-springback, which enable the forming tool configuration to modify to meet desired part surface. The purpose of this project is to analysis on springback problems on aluminum material used for automobile, on the analysis of experiment tensile test, finite element analysis (FEA) and then the equations to simulating springback. All the causes of springback problems analyzed. The forming process analysis using finite element method (FEM) or called finite element analysis (FEA). Nowadays, these methods considered as an effective way of simulating bending operations and predicting springback. FEA provides numerical trial and error procedures, which consumes less time and more economical way of designing and producing dies. There are some FEA programs providing effective and powerful tools and environments to model and simulate operations of sheet metal forming. Aluminum is an expensive material; therefore, design engineers use FEA in design stages to reduce material and manufacturing costs.

The deep drawing process commonly used to manufacture sheet metal products. During the process, initially curved or flat blank material clamped between the die and the blank holder. When the punch pushed into the die cavity, the blank is plastically deformed and the specific shape of the punch and the die transferred to it.

After the tools removed, the elastically driven change of the product shape, or so-called springback, occurs. This phenomenon results into the deviation of the obtained product shape from the design specification and can be the major cause of assembly problems. In sheet metal, forming the quality of the final product depends on the proper tool design, choice of the blank material, blank holder force, lubrication and some other process parameters. To manufacture a product with the desired shape and performance an extensive knowledge about the influence of various parameters needed. In order to establish this knowledge base, experimental try-outs or numerical simulations are used. Finite element simulation of sheet metal forming is a powerful tool, which allows test any modifications of the deep drawing process parameters, prior to the actual tools manufacturing. Calculations made to predict and compensate for springback and the numerical simulations repeated as often as necessary until the product with the desired shape produced. Currently the numerical analysis is not able accurately predict the springback of a formed product. There is always a difference between the level of springback obtained in simulations and reality, especially for the products with complicated geometry.

1.3 Research Problem

Springback are major problem to all forming process. To manufacture a product with the desired shape and performance an extensive knowledge about the influence of various parameters needed. In order to establish this knowledge base, experimental try-outs or numerical simulations are used. Finite element simulation of sheet metal forming is a powerful tool, which allows test any modifications of the deep drawing process parameters, prior to the actual tools manufacturing. Calculations made to predict and compensate for springback and the numerical simulations repeated as often as necessary until the product with the desired shape produced. Currently the numerical analysis is not able accurately predict the springback of a formed product. There is always a discrepancy between the level of springback obtained in simulations and reality, especially for the products with complicated geometry. Because springback depends on the material properties of the sheet metal, tooling geometry, friction and many other factors, it is difficult to predict springback of

material. Therefore, this compensation is heavily dependent on the designer's experience and trial and error.

1.4 Research Hypothesis

The springback of aluminum may cause by tensile strength, Young modulus and elastic modulus of the materials. It may also cause by bending angle, process of bending and strength of materials. The aluminum sheet may springback more when the bending radius angle increases. When the thickness of the aluminum sheet is less, the aluminum may springback more. When the die radius is much bigger, the aluminum may springback more.

1.5 Objective

The objective of the research is:

(a) To analyze the springback problem of aluminum sheet

(b) To analyze springback properties of various factors (bending angle, thickness, and material properties (tensile) of aluminum

(c) To analyze springback of aluminum sheet using tensile testing and bend test.

(d) To analyze relationship between tensile test and bend test.

(e) To find how the orientation of aluminum sheet influence the springback angle.

1.6 Research Scope

The scope of research including

(a) Study the springback behavior of the aluminum sheet 1100.

(b) Conduct experiment of aluminum sheet to investigate springback using tensile testing, bending test, and microstructure.

(c) Test method covers tension testing of aluminum at room temperature, to determine yield strength, yield point elongation, tensile strength, elongation, and reduction of area.

(d) Study about other research of springback.

1.7 Thesis Organization

Chapter 1 is the introduction to this thesis, and provides a background of this thesis. The objective and thesis organization are provided in this chapter.

Chapter 2 describes about literature review describe about springback. From here, causes of springback literature described and other researches about springback are included. This chapter also provide brief introduction about properties that influence springback.

Chapter 3 is the methodology of the thesis. It covers the details on how to predict springback of aluminum and ways to analysis the result. The tests included in this thesis are tensile testing and bend testing.

Chapter 4 is the result and discussion from the methodology of the thesis. It covers the details on the springback result cause by bending process and other result obtained from the tensile test. It also covers result about microstructure of springback of aluminum as well. In this part, much of the springback problems were discuss as well. These discussions were discussed based on the result obtained from tensile testing and bend testing.

Chapter 5 is the conclusion of the project. Conclusion includes recommendation to improve the result of the experiment and further research needed to do to obtain more research of the topic.

1.8 Important of Research

The important of this research is springback allows reduce the rate of predicting springback of aluminum sheets. The inaccurate definition of the dependence of springback on the above parameters can cause products loss due to scrapping or reworking. Many researches and studies conducted to compensating springback problems using the actual mechanical and geometrical properties of materials under deformation. The important of springback prediction and compensation can save resources and reduce product losses due to scrapping or reworking. Knowledge about springback enable user to predict springback accurately before the material undergoes forming operation. Springback is major factors influencing the quality of the formed sheet metal parts. High springback of sheet metal often results in the formed component being out of tolerance, introducing problems during assembly or installation. Therefore, a precise prediction of springback is desirable in sheet metal forming process because it leads to proper design of the forming tools and material forming operation. On other hand, it can allow designers to design product using proper material to compensate springback effect. Predicting springback not only requires significant try-out time but also increases the cost. In this research, experiment were carried out the best way springback characteristic of aluminum sheet metal.

CHAPTER 2

LITERATURE REVIEW

The objective of this literature study is to understand the springback phenomenon and to ascertain the reasons of its inaccurate numerical prediction. One of the reasons for poor springback prediction is that this phenomenon not accurately represented in finite element formulations. Various assumptions of material behavior - constant elastic properties during forming, simplified elastic-plastic anisotropy and work hardening - introduce the large modeling error. In addition, the accuracy of the springback prediction affected significantly by the quality of simulation of the forming operation. Chosen contact algorithms, the method of unloading, the time integration scheme, the element types and the tooling can be other reasons for significant deviation of the numerically predicted springback from that observed in real practice. Furthermore, an analyst plays an important role and inexperienced users may cause substantial inconsistency of the springback results. Naturally, this tends to complicate the fabrication process. When a material formed, the stamping tool bends the metal into certain angle with given bend radius.

2.1 Definition of springback

The springback is a term used to describe as the elastic recovery of metal (metal return to its original shape) after stressing (to deform a body by a force) (Mandigo & Crane 1993, p. 1794). Springback is another name of elastic deformation. Dies are attempt to impart permanent, or plastic deformation into the sheet metal product. Steel and aluminum, two common stamped materials can exhibit both elastic and