

THE EFFECT OF SHEET THICKNESS TO
FORMABILITY USING HYPERFORM

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Thesis submitted in fulfillment of the requirements

for the award of the degree of

Bachelor of Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI MALAYSIA PAHANG

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LIST OF ABBREVIATIONS

AHSS	Advanced High Strength Steel
BHF	Blank holder force
DOE	Design of experiment
FB	Ferritic Bainitic
FE	Finite element
FEA	Finite element analysis
FLC	Forming limit curve
FLC0	Forming Limit Curve of minor strain 0
FLD	Forming limit diagram
FYP	Final year project
UTS	Ultimate tensile stress

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ABSTRACT

In this modern era the demand for reducing the vehicle weight for improved the fuel efficiency and structure stiffness for safety is high. Therefore, it will lead to the use of the advanced high strength steel (AHSS). It has been a trend in automotive and aircraft industry. Thus, sheet metal from various thicknesses are selected to be use in many auto parts. The purpose of this project is to determine the influence of sheet from various thicknesses to their formability by determining the forming limit diagram (FLD) of the sheet metal. The method that are used to perform the analysis is the finite element simulation in the Hyperform module of Altair's Hyperwork. The incremental radios analysis is used with single action draw and shell element is selected. Several parameters such as blank holder force and punch velocity have been controlled. The punch size and press force is constant for all the conducted simulation. After the simulations, the FLD and percentage of thinning are studied in Hyperview module. After result and data are produced several conclusion can be made in order to improve the quality and for better performance of the project.

ABSTRAK

Dalam era moden ini permintaan untuk mengurangkan berat kenderaan bagi meningkatkan kecekapan penggunaan bahan api dan kekukuhan struktur bagi keselamatan adalah tinggi. Oleh itu, ia akan membawa kepada penggunaan keluli kekuatan tinggi termaju (AHSS). Ia merupakan satu trend dalam industri automotif dan pesawat. Oleh itu, kepingan logam daripada pelbagai ketebalan dipilih untuk digunakan dalam banyak bahagian auto. Tujuan projek ini adalah untuk menentukan pengaruh kepingan keluli dari pelbagai ketebalan untuk kebolehbentukan mereka dengan menganalisis rajah had pembentukan (FLD). Kaedah yang digunakan untuk menjalankan analisis adalah simulasi unsur terhingga dalam modul Hyperform di Altair's Hyperwork. Analisis rados tambahan digunakan dengan seri tindakan tunggal dan elemen shell dipilih. Beberapa parameter seperti daya pemegang bahan dan halaju telah dikawal. Saiz punch dan tekan kuasa adalah tetap untuk semua simulasi yang dijalankan. Selepas simulasi, yang FLD dan peratus penipisan dikaji dalam modul Hyperview. Selepas keputusan dan data dihasilkan, beberapa kesimpulan boleh dibuat dalam usaha untuk meningkatkan kualiti dan prestasi yang lebih baik bagi projek ini.

CHAPTER 1

INTRODUCTION

1.1 Project Background

This analysis will be carried out on flat blanks with a range of thicknesses. Sheet metal is a thin, flat piece of metal which is formed through industrial process. The part that has been created from the sheet metal forming process has been broadly used in many field such as automotive and aircraft which can be viewed in Figure 1.1. The application of sheet metal is very crucial to produce uniquely light weight but strong structure of an object. For example, vehicles such as car has light weight is compulsory to meet safety regulations, emissions reduction, and solid performance in economical cost.

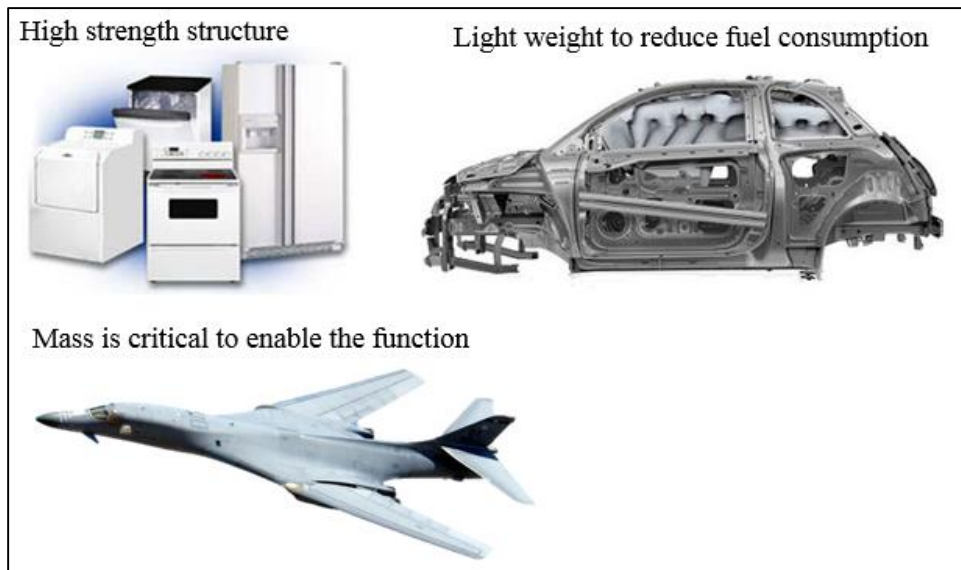


Figure 1.1. Purpose of sheet metal application

Source Automotive Manufacturing Solutions (2014)

One of the fundamental metal working is the metal forming. Metal forming is processes which force is applied to a piece of sheet metal beyond its yield strength to make it plastically deform but not to fail in order to alter the shape without any material addition or removal. The used of sheet metal forming is to develop product with complex shape as well as improving the strength of the material. Sheet metal forming is done by many techniques such as shearing and blanking, stretching, bending, and drawing.

To follow the increasing of the tolerance requirements of the finished part and the intricacy of it, the sheet metal processes is progressively advancing. A meticulous understanding about the material properties, the friction conditions and the forming process is important. As a consequence, the application of advanced theoretical and experimental engineering methods is used to gain this knowledge.

The prediction of sheet metal behaviors is determined by using forming limit diagram (FLD). FLD is a favorable concept for portraying the formability of sheet metal, which represent the maximum principal strains that can be experienced by sheet materials before the starting of necking. FLD concept and strain analysis method that introduced by Keeler and Goodwin are extensively used.

Recently, FEA Simulation software is invented to optimize all sort of forming process up to maximum extent. The benefits of using this software is the decrease of

product development cost and product development time. One of the FEA Simulation software is HyperForm, a module of Altair's Hyperworks. HyperForm is employed to analyze formability and determine a variety of defects such as wrinkles, spring-back and thinning exist in sheet metal forming process. By using the simulation, designing a new product or refining an existing product can be performed easily.

1.2 Problem Statement

Thickness of sheet plays important role in production as it will determine the suitable condition of forming process and the parameter that need to be controlled during the process. If the forming process is not conducted according to material requirement, after all the processes is done, defects may appear at certain location on the manufactured part. Then, additional finishing process will need to be applied to eliminate the defect and it will maximize the cost and time of production. Hence, the study regarding effect of sheet thickness is required in the material selection of a product. Conducting a real experiment test will increase the product development cost and time since it requires the preparation of material specimen, physical prototyping and testing. So, the FE simulation will definitely decrease the cost as well as the time consumption.

1.3 Research Aim & Objectives

The purpose is conducting forming simulation and also learning the effect of a range of sheet thickness by using FE simulation. The objectives for current research are:

- 1) To investigate the influence of sheet from various thicknesses to their formability by determining the FLD of the sheet metal.
- 2) To analyze the minor strain and major strain of various thickness of sheet metal in order to identify where the material surpass the level of formability.
- 3) To determine the necking and tearing of sheet metal.

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