



## **DESIGN ANALYSIS OF METAL FORMING PROCESS FOR THE CORRUGATED METAL GASKET**

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

By

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2017

## DECLARATION

I hereby, declared this report entitled “Design Analysis of Metal Forming Process for The Corrugated Metal Gasket” is the results of my own research except as cited in reference.

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Sesi Pengajian: **2016/2017 Semester 2**

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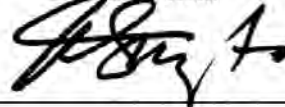
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## APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.).

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## ABSTRACT

The report presents the work done on the Design Analysis of Metal Forming for the Corrugated Metal Gasket. The objectives of this project are to design corrugated metal gasket and die forming, to study relationship between the appropriate clearance and friction coefficient; and to simulate and analyze corrugated metal gasket and die forming. CAD software that is used in this project is CATIA V5 while Finite Element Analysis software that used is ANSYS Workbench. Nowadays, creating a die is worth, hence, to ensure a complete die is created without mistaken, simulation that is one of the methods used to help a designer to analysis parameter or factor that will influence the shape or quality of product especially for corrugated metal gasket, is done. This project has two parameters that are important. The first parameter is friction coefficient that is quite complex and cannot be readily solved. For example, the absence of friction may result in parts that are perhaps impossible to form at all. It will depend on a certain amount of friction that may be beneficial to the forming process or not. The second parameter is the amount of die clearance or forming clearance that will result in intolerable product characteristics, while if lowest die clearance that can cause the tool in stress because it exerts greater punching force. At the end of this project, the suitable value of die clearance and friction coefficient are selected and the designs for die forming are completely done by using CAD software.

## ABSTRAK

Laporan ini membentangkan tentang kerja yang telah dilakukan dalam Analisis Reka Bentuk Pembentukan Besi untuk Gasket Besi Beralun. Objektif projek ini adalah untuk mereka bentuk gasket besi beralun dan pembentukan die, untuk mengetahui hubung kait antara pelepasan dan pekali geseran yang berpatutan, dan untuk mensimulasi dan menganalisa gasket besi beralun dan pembentukan die. Perisian yang digunakan dalam projek ini ialah CATIA V5 manakala perisian Finite Element Analysis yang digunakan adalah ANSYS Workbench. Pada masa kini, membuat die adalah memberi keuntungan, oleh itu, untuk memastikan sebuah die disiapkan tanpa ada kesilapan, simulasi yang digunakan untuk membantu pereka bentuk untuk menganalisa parameter ataupun faktor yang akan mempengaruhi bentuk dan kualiti produk terutama gasket besi beralun, telah disiapkan. Projek ini mempunyai dua parameter yang penting. Parameter pertama ialah pekali geseran yang merupakan agak rumit dan tidak mudah untuk diselesaikan. Sebagai contoh, ketidakhadiran geseran yang memungkinan bahagian yang mungkin mustahil untuk dibentukkan. Ianya bergantung kepada jumlah geseran tertentu yang mungkin memberi faedah kepada proses pembentukan ataupun tidak. Parameter kedua ialah jumlah pelepasan die atau pelepasan pembentukan yang akan membawa kepada ciri-ciri produk yang tertahan manakala jika pelepasan die yang terbawah yang membuatkan mata alat tegang kerana ia mengenakan daya ketukan yang lebih kuat. Di akhir projek ini, nilai pelepasan die dan pekali geseran yang sesuai dipilih dan reka bentuk untuk pembentukan die telah disiapkan sepenuhnya dengan menggunakan perisian CAD.

## **DEDICATION**

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## LIST OF ABBREVIATIONS

3D	–	3 Dimension
CATIA	–	Computer Aided Three Dimensional Interactive Application
V5	–	Version 5
PTFE	–	Polytetrafluoroethylene
UTS	–	Ultimate Tensile Strength
CAD	–	Computer Aided Design
CAM	–	Computer Aided Manufacturing
CAE	–	Computer Aided Engineering
PLM	–	Product Lifecycle Management
ENOVIA	–	Enterprise Innovation Interactive Application
ANSYS	–	Analysis of System
PSM	–	Projek Sarjana Muda / Bachelor Degree Project
FEA	–	Finite Element Analysis

## LIST OF SYMBOLS

$R_B$	–	Radius Bend
$R_C$	–	Radius Cut
$\alpha$	-	Alpha
$R$	–	Ratio
$t$	–	Thickness
mm	–	millimeter
$\sigma$	-	Stress
$e$	-	Strain
$E$	–	Modulus of Elasticity or Young Modulus
$\mu$	-	Coefficient of Friction

# **CHAPTER 1**

## **INTRODUCTION**

This chapter has a few sub-topics for introduction that need to discuss. Includes background of the study and objectives that need to achieve in this project. The scope of the study is clearly informed the limitation of the research and method that are used. Also problem that face or it will influence for our project. In a nutshell, it is the summary of this project and how project it will do.

### **1.1 Background of Study**

Metal stamping or sheet metal forming probably the most versatile products of modern technology, that are used to replace parts previously welded together from several components. An advantage of sheet-metal parts is the uniform thickness of the material which can be controlled up to a close range with tolerances. Generally, sheet metal forming processes have a many type of process but in this project only involved forming process.

Forming process is a process which makes use of force to cause plastic deformation of the material to produce required shape. In forming, the bend line may be curved, circular or otherwise shaped. The variability of the bend line causes the material to expand on one's side and be compressed on the opposite site. Forming operations basically divided by two types (Ivany Suchy, 2006): 1. Shrink Flanges, 2. Stretch Flanges. Shrink Flanges, the material of a flange is squeezed or compressed during forming, while stretch flanges are stretched and subsequently thinned.

## **1.2 Problem Statement**

Frictions in metal stamping have many beneficial as well as detrimental effects on the tooling and quality of produced parts. If increases the pressure between the tool and sheet-metal, which is result in a both deformation with subsequent degradation of surface quality and wear of tooling.

The problem of friction is quite complex and cannot be readily solved. On the other hand, some processes, such as forming process depend on a certain amount of friction, the removal of which may not be beneficial to the forming process at all. In the absence of friction, this may result in parts that are perhaps impossible to form at all.

The amount of cutting clearance between the punch and die is great importance in sheet-metal work. This because it will affect to the life of the die and the quality of the product. Higher cutting clearance that will results in intolerable product characteristics, while if lowest cutting clearance that can cause the tool in stress because it exact the greater punching force.

A new die of forming die need to design using 3D design software example: CATIA V5 and SolidWorks then forming die will be testing using Finite Element Analysis software example ; ANSYS Workbench. Using this software, the model will be simulated by changing its die clearance and friction coefficient. Results from this simulation also to check whether model produce a good quality of part without any defects also to improve a new design to get a better product.

### **1.3 Objectives**

The objectives for this project are:

- i. To design corrugated metal gasket and die forming using CATIA V5.
- ii. To study relationship between the appropriate clearance and friction coefficient during forming process.
- iii. To simulate and analyze corrugated metal gasket and die forming using Finite Element Software.

### **1.4 Scope of project**

In this project, the important aspect that should consider is a dimension for the corrugated shape (wave) that has at a surface metal gasket. It will focusing for a three wave only for a corrugated metal gasket and size that selected is 300-A. So, a new die need to design to ensure it form a corrugated metal gasket from metal gasket. The important aspect need to know or identify is tools geometrical quantities, the elasticity of the tools, the shape of workpiece, type of workpiece material, condition of the contact between tool and workpiece and process condition during forming process.

## **CHAPTER 2**

### **LITERATURE REVIEW**

In this chapter, contain of information about a corrugated metal gasket, forming operations, basic die forming, design principles during forming operations, and simulation software. This information is based on the document examples: journals, thesis, project papers, and book. Also, this chapter includes summarizing of this project.

#### **2.1 Gasket**

##### **2.1.1 Definition of Gasket**

Gasket is a piece of part that's usually fills the space between two surfaces. Generally, gasket is used to prevent leakage happen at the joined part and to maintain that seal under operating conditions. Gasket are made of elastomers (rubber, polyurethane, silicone), fibrous material (carbon fiber, cellulose, glass), metals (stainless steel, aluminum, copper), and "soft" materials (cork, PTFE, flexible graphite (Admin, 2016)). Materials that used for gasket depends on the condition or function that one applies e.g: Copper gasket is used for ultrahigh vacuum systems (John Bickford, 2016)