UNIVERSITI TEKNIKAL MALAYSIA MELAKA

(UTeM)

Design and Model Making of Forming Dies

A Thesis Submitted to the

Faculty of Manufacturing Engineering (Design Manufacturing)

In Partial Fulfillment of the Requirements for the Degree

by

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Faculty of Manufacturing Engineering

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DECLARATION

I hereby declare that this report entitled **"Design and Model Making of Forming Die"** is the result of my own research except as cited in the references.

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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 (*"Specify your specialization here (e.g. Process)"*). The members of the supervisory committee are as follow:

Mr. Wahyono Sapto Widodo
(PSM Supervisor)

"Insert the date and official stamp here"

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Abstract

Forming dies are typically manufactured by those who produce dies, in example the tools and dies maker and put into production after mounting into a press. The die is a metal block that is used for forming materials like sheet metal and plastic. In this study and scope of research, I have studied about the forming of sheet metal. Two parts may be used, one, called the punch (upper die), performs the stretching, bending, and blanking operation, while another part, called the die block (lower die), securely clamps the work piece and provides similar, stretching, bending, and/or blanking operation. The work piece may pass through several stages using different tools or operations to obtain the final form. In this case study/research, I'm designing a simple dies and try to produce the part of the dies using CNC machine in Advance Manufacturing Centre in UTeM. This thesis also included the problem statement before and after the process of making forming dies. But I'm not producing any part from the dies because I'm not making the die set for forming process. This is because usually the part is make in mass production and the cost is more cheaper when buying all those part than produce it ourselves. For this manufacturing of the dies, I'm using aluminum as the material for mock up for the dies.

CHAPTER 1

Introduction

1.1 Background

In this thesis, we will go through the procedure and the method of producing the forming dies; one of the most popular die processes in the industry. Basically, the forming die is not much different from drawing dies. The different between these two types of process is only the capability of the method. The drawing die is usually used to produce higher level product with deeper depth, while forming dies only cover the thin depth.

1.2 Problems Statements

For this research, the metal that being decide to form into product is aluminums. Aluminums is not a metal, this is because it not behave like steels, and it certainly doesn't stretch like steels. Like any other metals, it has advantages and disadvantages. Some of the characteristic and behaviors that being study before producing aluminums parts are:

1. Stretch Ability
2. Draw Ability
3. Compress Ability, and
4. Springback

1.2.1 Stretch ability

Aluminum does not have near the elongation ability of steel. For instance, typical deep-drawing steel has elongation somewhere around 45 percent, while a 3003–O temper, so aluminum will have elongation near 30 percent.

1.2.2 Draw ability

Draw ability is the metal's ability to flow plastically when subjected to tension, while stretch ability is the increase of surface area as the result of tension. Depending on the type, aluminum can draw very well. It has a good strength-to-weight ratio and is well-suited to the deep-drawing process, as well as multiple draw reductions. The reductions percentages are very comparable to those often used when drawing deep-drawing steel.

1.2.3 Compressibility

During ironing, the metal is squeezed down a vertical wall to increase the surface area while reducing the metal's thickness. It increases the metal sheet's surface area by squeezing the metal rather than exposing it to tension. Ironing is the basic process used to make beverage cans. When aluminum is ironed, it almost compressively flows like a hot liquid down the wall of the die cavity and punch, and it shines to a mirror like surface finish. In this case of process, the aluminums will not having any problems to form in the forming process.

1.2.4 Springback

Aluminum has more springback than soft draw-quality steel. However, the amount of springback that occurs can be controlled by designing the stamped product with respect to the springback value. Like steel, each type of aluminum has its own physical characteristics, and each one requires careful consideration.

1.3 Objective(s)

The objectives of this research are:

a) To design a forming die of a press part
b) To make CNC program for forming die
c) To machining a model using a CNC machine

1.4 Scope of Study

This study will cover the designing part of the dies, problems statements, re-design and decide the actual design. The design of the forming dies will also include the materials selections, the machine that to be used for machining process, time taken for machining, and finishing the poly model. In this research, we also will study about polystyrene which is being use to make the poly model for the dies. Polystyrene is the materials that very sensitive to all environmentalists and because of that; we have to make a correct decision so that the poly model will not cause any problems to environment when it not needed or when it needs to be disposed.

CHAPTER 2

Literature Review

2.1 The Basics of Dies

All forming operations deform sheet material by exposing it to tension, compression, or both. Most part defects, such as splits and wrinkles, occur in forming operations. Successful sheet metal forming relies heavily on the metal's mechanical properties. The metal being formed must have the ability to stretch and compress within given limits. It also must be strong enough to satisfy the part's fit and function. This balance between formability and strength often is hard to achieve. Most forming operations involve at least two basic components: a punch, representing the male portion of the die, and the cavity, representing the female portion.

2.2 Stamping Die

A stamping die is a special, one-of-a-kind precision tool that cuts and forms sheet metal into a desired shape or profile. The die's cutting and forming sections typically are made from special types of hardenable steel called tool steel. Dies also can contain cutting and forming sections made from carbide or various other hard, wear-resistant materials. Stamping is a cold-forming operation, which means that no heat is introduced into the die or the sheet material intentionally. However, because heat is generated from friction during the cutting and forming process, stamped parts often exit the dies very hot. Dies range in size from those used to make microelectronics, which can fit in the palm of hands, to those that are 20 ft. square and 10 ft. thick that are used to make entire automobile body sides. The part a stamping operation produces is called a piece part, as shown in figure 1. Certain dies can make more than

one piece part per cycle and can cycle as fast as 1,500 cycles (strokes) per minute. Force from a press enables the die to perform.

Figure 2.2

There are many kinds of stamping dies, all of which perform two basic operations like cutting, forming, or both. Manually or robotically loaded dies are referred to as line dies. Progressive and transfer dies are fully automated.

2.3 Cutting

Cutting is perhaps the most common operation performed in a stamping die. The metal is severed by placing it between two bypassing tool steel sections that have a small gap between them. This gap, or distance, is called the cutting clearance. Cutting clearances change with respect to the type of cutting operation being performed, the metal's properties, and the desired edge condition of the piece part. The cutting clearance often is expressed as a percentage of the metal's thickness. The most common cutting clearance used is about 10 percent of the metal's thickness. Very high force is needed to cut metal. The process often introduces substantial shock to the die and press. In most cutting operations, the metal is stressed to the point of failure, which produces a cut edge with a shiny portion referred to as the cut band, or shear, and a portion called the fracture zone, or break line as shown in below.

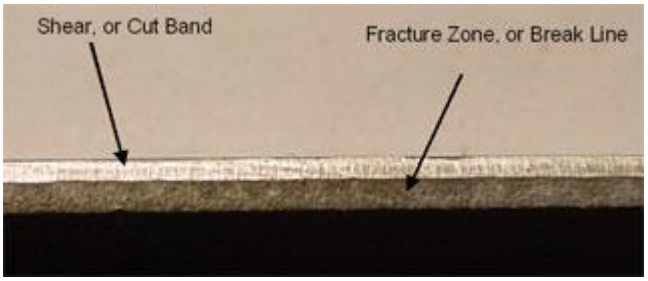

Figure 2.3(i)

There are many different cutting operations, each with a special purpose. Some common operations are:

a) Trimming

The outer perimeter of the formed part or flat sheet metal is cut away to give the piece part the desired profile. The excess material usually is discarded as scrap.

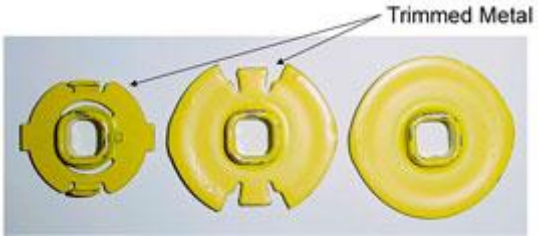

Figure 2.3(ii)

b) Notching

Usually associated with progressive dies, notching is a process in which a cutting operation is performed progressively on the outside of a sheet metal strip to create a given strip profile.

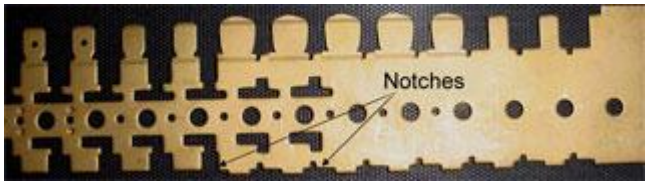

Figure 2.3(iii)

c) Blanking

A dual-purpose cutting operation usually performed on a larger scale, blanking is used in operations in which the slug is saved for further press working. It also is used to cut finished piece parts free from the sheet metal. The profiled sheet metal slug removed from the sheet by this process is called the blank or starting piece of sheet metal that will be cut or formed later.

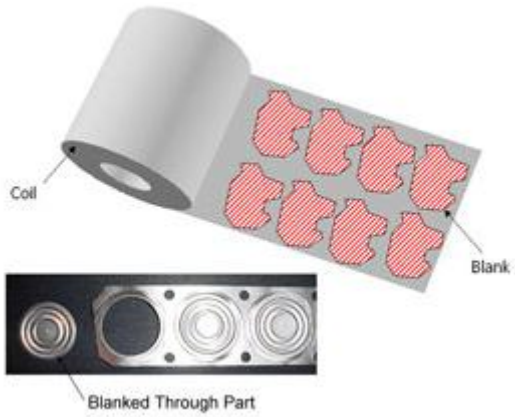

Figure 2.3(iv)

d) Piercing

Often called perforating, piercing is a metal cutting operation that produces a round, square, or special-shaped hole in flat sheet metal or a formed part. The main difference between piercing and blanking is that in blanking, the slug is used, and in piercing the slug is discarded as scrap. The cutting punch that produces the hole is called the pierce punch, and the hole the punch enters is called the matrix.

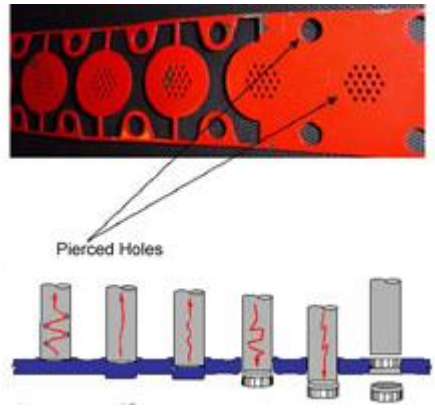

Figure 2.3(v)

e) Lancing

In lancing, the metal is sliced or slit in an effort to free up metal without separating it from the strip. Lancing often is done in progressive dies to create a part carrier called a flex or stretch web.

Figure 2.3(vi)

f) Shearing

Shearing slices or cuts the metal along a straight line. This method commonly is used to produce rectangular and square blanks.

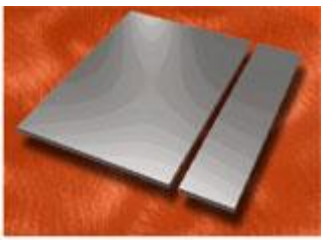

Figure 2.3(vii)

2.4 Embossing Dies

Embossing dies use tension to stretch metal into a shallow depression. The dies primarily are comprised of a punch and a cavity. The metal's thickness and mechanical properties, along with the forming punch geometry, determine the depth that can be achieved.

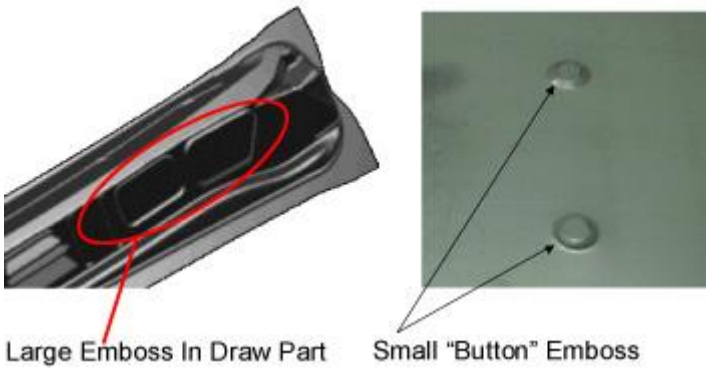

Figure 2.4

2.5 Solid Form/Dead Hit Dies

Solid form/dead hit dies; also called crash forming dies deform the metal using only a punch and cavity. These dies do not control metal flow and cannot prevent the metal from wrinkling or buckling. They are used to form simple parts, such as brackets and braces, made from thick, stiff metals that are more wrinkle resistant than thinner metals. Because this operation also uses tension to form the part, attempting to solid-form difficult part geometries using thin metal often results in severe failure.

Figure 2.5

Result of forming a difficult feature using thin sheet metal in a solid or crash form dies.

2.6 Drawing Dies

Drawing dies are the most impressive forming dies. Oil pans, automobile doors and fenders, cookware, and door knobs are just a few parts manufactured by drawing. Draw dies create the part shape by controlling metal flow into a cavity and over the forming punch. Draw dies utilize a special pressure-loaded plate or ring called a draw pad or blank holder to control the metal's flow into the cavity. This plate prevents the metal from wrinkling as it flows into the cavity. Increasing or decreasing the pressure exerted under the pad also controls how much metal feeds into the die. Although compression can occur when the metal is drawn, drawing uses mostly tension to obtain the part geometry.

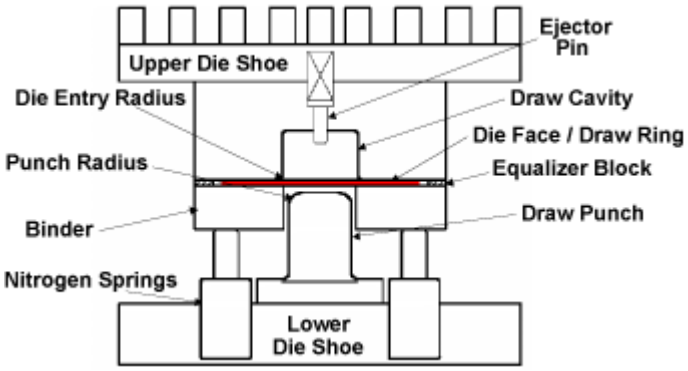

Figure 2.6

2.7 Flanging Dies

Flanging is bending metal along a curved axis. Two basic types of flanges are tension, or stretch, flanges, and compression, or shrink, flanges. Tension flanges are susceptible to splitting, and shrink flanges are susceptible to wrinkling. Flanges are created using a flanging die that wipes the metal between a punch and a lower die section. Both tension and compression occur during the flanging process.

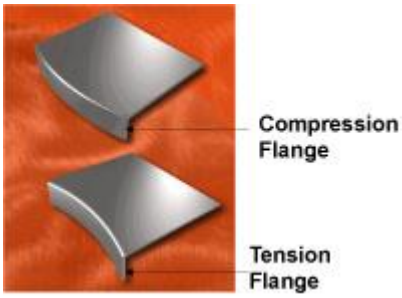

Figure 2.7

2.8 Ironing Dies

Ironing dies are similar to coining dies in that they deform the metal with compression. However, unlike conventional coining, ironing squeezes metal along a vertical wall. This highly compressive process unifies a wall's thickness and increases the drawn vessel's length. Items such as beverage and soup cans are made using an ironing process. Ironing allows an aluminum can's wall thickness to be reduced to as little as 0.002 in.

Figure 2.8

2.9 Extruding Dies

In extruding, the metal is flanged around the perimeter of a prepierced hole. Like during stretch flanging, the metal is susceptible to splitting during forming. Extrusions also are referred to as hole expansions or continuous stretch flanges. Often extrusions are tapped for holding fasteners used in the part assembly process.

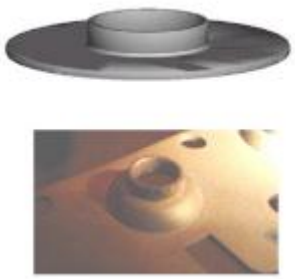

Figure 2.9

2.10 Coining Dies

Coining dies create the part's shape by squeezing the metal under extreme pressure. Coining also can reduce the metal thickness. Coins (metal currency) are created with the coining process. A simple round metal slug is placed into the die and forced to flow into a given shape by compressing it.

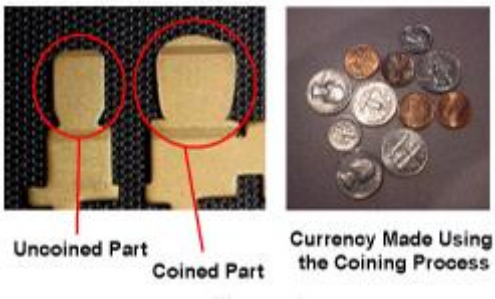

Figure 2.10

2.11 Dies Component and Accessories

Most stamping dies are constructed of several basic components, including die plates, shoes, die sets, guide pins, bushings, heel blocks, heel plates, screws, dowels, and keys. Dies also need stripper, pressure, and drawing pads, as well as the devices used to secure them: spools, shoulder bolts, keepers, and retainers, as well as gas, coil, or urethane springs.

2.11.1 Die Plates, Shoes, and Die Sets

Die plates, shoes, and die sets are steel or aluminum plates that correspond to the size of the die. They serve as the foundation for mounting the working die components. These parts must be machined or ground so that they are parallel and flat within a critical tolerance. Milled surface can be obtained that is as accurate as a ground surface. Most die shoes are made from steel. Aluminum also is a popular die shoe material. Aluminum is one-third the weight of steel, it can be machined very quickly, and special alloys can be added to it to give it greater compressive strength than low-carbon steel. Aluminum also is a great metal for shock absorption. The upper and lower die shoes assembled together with guide pins create the die set. The lower die