Design of Slot Piercing Tool for Diaphragm Spring in a Single Plate Clutch Assembly

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Abstract – Press tools are used to produce a particular component in large quantity, out of sheet metals where particular component achieved depends upon press tool construction and its configuration. The different types of press tool constructions leads to different operations namely blanking, bending, piercing, forming, drawing, cutting off, parting off, embossing, coining, notching, shaving, lancing, dinking, perforating, trimming, curling etc. Generally metals having thickness less than 6mm is considered as strip. Blanking is one of the sheet metal operations where we produce flat components of prerequisite shape. In Blanking the required shape periphery is cut and cut-out piece is called blank. The press tool used is for blanking operation is called as blanking tool, if piercing operation it is piercing tool and so on based on operation that we perform. The application of press operations are widely used in many industries like food processing, packing, defense, textile, automobile, aircraft and many apart from manufacturing industry. In this connection an attempt is made on to learn the press tool design, materials, manufacturing used for press tool and calculations involved in it. In this work, a real time design of a simple blanking press tool and manufacturing of a prototype is made along with analysis where the output is a circular piece having diameter of 20mm. The press machine is of mechanical type.

Index Terms – Blanking, Manufacturing, Piercing, Study of Components and Design.

1. INTRODUCTION

The design and manufacture of press tools, or punches and dies, is a branch of product iron technology that has extended into many lines of engineering manufacture over the past seventy years. There is no doubt that the accuracy achieved by new ideas in design and construction applied by the press tool designer, coupled with increased speed and rigidity of the presses etc. Used have all contributed toward maintaining this form of metal tooling well to the force as a means of obtaining pleasing, yet strong, durable articles that can withstand severe day-today usage. High rate production industries generally use press machines. Thickness can vary significantly, although extremely small thicknesses are considered as sheet and above 6mm are considered as plate. Thickness of the sheet metal fed in between is called its gauge. Sheet metal is simply fed in between the dies of press tool for any press operation toper form. The reciprocating movement of punch is caused due to the ram movement of press machine. The press machine may be of electrical type, mechanical type, pneumatic type, manual type and hydraulic type. In today's practical and cost conscious world, sheet metal parts have already replaced many expensive cast, forged and machined products. The common sheet metal forming products are metal desks, file cabinets, appliances, car bodies, aircraft fuselages, mechanical toys and beverage cans and many more. Due to its low cost and generally good strength and formability characteristics, low carbon steel is the most commonly used sheet metal because high carbon composition gives high strength to the material. The other sheet metals used are aluminum and titanium in aircraft and aerospace applications.

In this fast growing economical world requirements for doing thing faster have risen like anything. Fully Customers focused approach towards the market will definitely fetch a better result, to rule out the monopoly that the wheel manufacturers in India are having now. Metal working comprises of deformation methods in which a metal billet or blank is formed by tools or dies. The design and mechanism of such methods depend on an understanding of the features of the raw material, the parameters at the tool/work piece interact, the mechanics of plastic deformation, the machine used, and the requirement of finished-product. These are the influencing parameters for selection of tool geometry and material as well as processing conditions like work piece and die temperatures and lubrication.

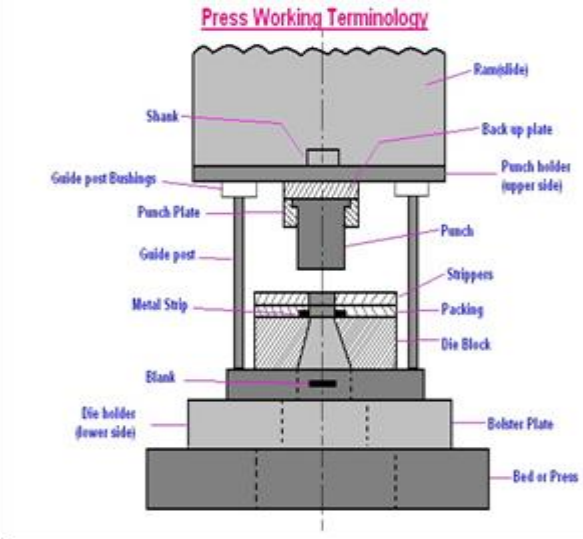

Figure 1.0: Press tool

1.1 Piercing:

Piercing is the cutting of holes in sheet metal, generally by removing a slug of metal, with a punch and die. Piercing is similar to blanking, except that in piercing the work metal that surrounds the piercing punch is the work piece and the punched-out slug is scrap. While in blanking the work piece is punched out. Piercing is ordinarily the fastest method of making holes in steel sheet or strip and is generally the most economical method for medium-to-high production. Pierced holes can be almost any size and shape; elongated holes are usually called slots. The accuracy of conventional tool steel or carbide dies provides pierced holes with a degree of quality and accuracy that is satisfactory for a wide variety of applications. Piercing tool involves cutting of clean holes with a resulting scrap slug. The operation is called die cutting and can also produce flat components where the die and the shaped tool is pressed into a sheet material employing a shearing action to cut holes. This method can be used to cut parts of different sizes and shapes in sheet metal, leather and many other materials.

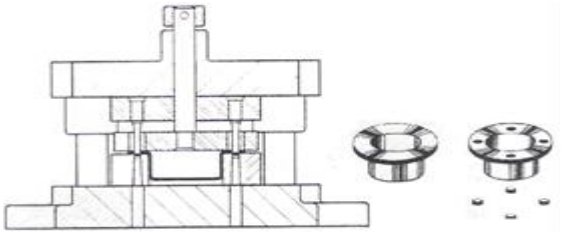

Figure 1.1: piercing operation

2. OBJECTIVE OF STUDY

i) Introduction of press tool.

ii) Study of the piercing tool.

iii) Study the major components of piercing tool working system.

iv) Material specification.

2.1 Scope of study:

i) Avoid tearing of sheets.

ii) Avoid complexity of the design.

iii) Avoid errors related to the clearances.

2.2 Benefits from study:

i) It provides good surface finish and accuracy.

ii) It provides a high strength in thin parts.

3. PART OF PIERCING TOOL

3.1 Top Plate:

It is the top portion of the complete tool, which holds the top assembly or complete tool through the punch holder.A plate that is designed to hold in place the upper assembly. The top plate is attached to the ram of the press by the shank. The upper working member of the tool is called the top plate. The punch assembly including the punch holder and thrust plate is mounted on the top plate. The tool shank, which locates the whole tool centrally with the press ram, is also screwed into the top plate.

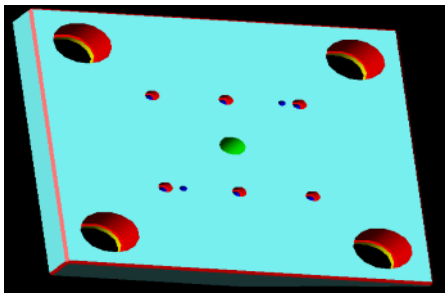

Figure 3.1: Top Plate

3.2 Bottom Plate:

It is also called as die shoe or bolster plate, its main function is to provide a rigid foundation and base to the assembly. It assembles the fixed half of the tool.A plate that is designed to hold in place the lower die shoe. The bottom plate is attached to the top surface of the press bed. The all machine tool, bottom plate is the one of the parts of a press. It is main supporting member for work piece holding dies and different controlling mechanisms of press. Size of the table limits the size of work piece that can be processed on a press. In case of some special presses the base carries mechanism for tilting the frame in any desirable inclined position too. This plate is a thick plate secured to the press bed, which is used for locating and supporting the die assembly. Its thickness is usually 5 to 12.5 cm. Bottom plate gives cushioning effect to the die as well as provides enough space for the tool to be clamped to the press bed. There may be opening in the base plate, which allows the blank, or slug to fall and clear off from the tool. The die assembly including stripper, all bottom elements are mounted on the bottom plate.

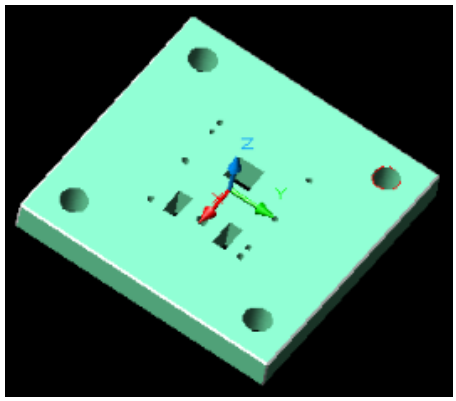

Figure 3.2: Bottom Plate

3.3 Stripper Plate:

This plate is also called as guide plate. This plate helps in stripping operation. It not only strips the strip from the punch but the main function of this plate is to guide the punch accurately which maintains the alignment between punch and die. A plate designed to remove sheet metal stock from the punch as it pulls away from the die during the operation. Hence the plate is made with same care as die plate. It is made out of mild steel. In some cases this guide plate is also made of tool steel. A channel is milled in the plate which will guide the stock strip. Stripper plate is used to discard the work piece outside the press after the completion of cutting or forming operation. After the cutting when punch follows upward stroke the blank is stripped off from the punch cutting edge and prevents it from being lifted along with the punch. This action of prevention is performed by the stripper.

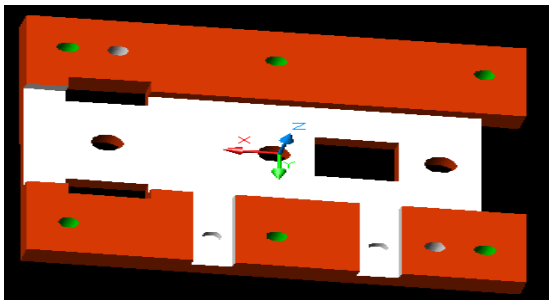

Figure 3.3: Stripper Plate

3.4 Thrust Plate:

It is the hardened plate which prevents the hard punches from digging into the soft top plate. It is also called pressure plate. It is placed so that the intensity of pressure does not become excessive on punch holder. The plate distributes the pressure over a wide area and intensity of pressure on the punch holder is reduced to avoid crushing.

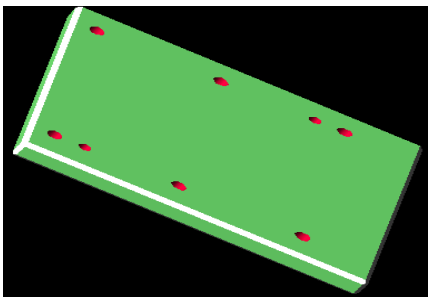

Figure 3.4: Trust Plate

3.5 Die Plate:

A hardened steel block containing machined impressions or cavities that shape the as the punch descends from above. The die retainer also holds the die button. In this plate all die inserts held accurately. The complete die set consists of a punch, die and some other accessories which are described in this section later. Perfect alignment of punch and die is most important for satisfactory working of punch. Accessories of die set provides the require alignment and rigidity to the system and improves accuracy of the system performance. These accessories are the finished parts, removal of waste. This plate thickness as same as die insert thickness.

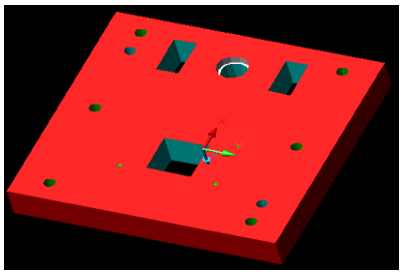

Figure 3.5: Die Plate

3.6 Punch:

This is most important element of the tool. It is the cutting element of the tool. It is the main tool of die assembly which directly comes in contact of work piece during its processing, its detail have already been described. Punch gives the whole size and the shape on the component. A punch is a male member of a complete die which mates or acts in conjunction with the female die to produce a desired effect on the material being worked. Lower end of the ram holds punch holder which is equipped with the punch plate. Punch plate is generally made of stainless steel or HSS. The punch plate holds the punch rigidly and accurately.

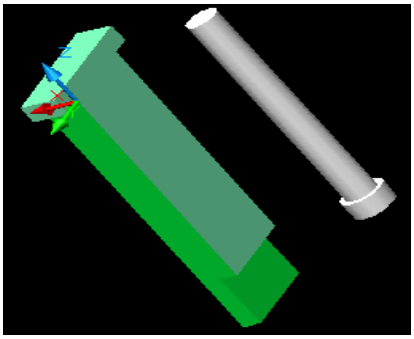

Figure 3.6: Punch

3.7 Punch Holder:

This plate is also called as punch plate all the punches are accurately held in this plate. The device used to mount the punch on the top plate. This plate should be thick enough to accommodate punch shoulder and keep the punches perpendicular. It is also known by its other name upper shoe of die set. Punch holder is clamped to the ram of press. It holds the punch below it.

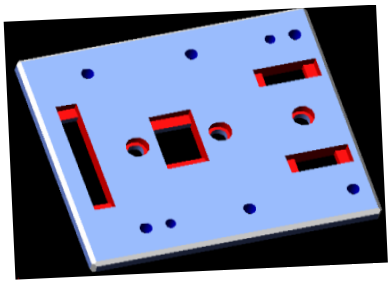

Figure 3.7: Punch Holder

3.8 Stoppers:

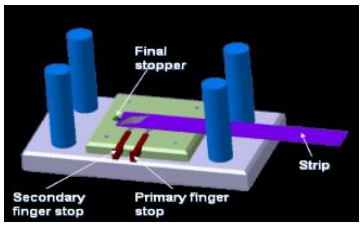

Figure 3.8: Stoppers

Stoppers are installed on the dies to arrest the feedings movement of the strip, to the requirement. It is used for manual feeding finger stops locate the strip for each station except for the final station. This stop is actuated manually, and is mounted in the stripper plate.

3.9 Pilots:

In progressive press tools the function of pilots is to position the stock strip accurately and to bring it into proper position (Registering) for successive blanking, piercing, bending or other press operations. Mechanically fed strip normally under fed and pull forward in the same direction with the feeding motion by the pilots, because any mechanical feeding mechanism utilizes a unidirectional locking device which prevents any back feeding of the strip. A long, slender punch with a rounded tip used to position the metal sheet by entering a previously formed hole. Pilots are longer so that they enter the sheet before other tools form the metal. Pilot is used for correct location of blank when it is fed by mechanical means. The pilot enters into the previously pierced hole and moves the blank to the correct position to be finally spaced by the stops. Normally pilots are fitted to the punch holders.

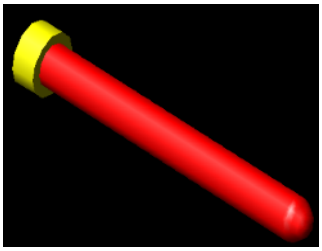

Figure 3.9: Pilots

3.10 Screw:

The main function of the screws is to hold all the parts in the press together. In assembly process the parts of tool are held together rigidly by socket head cap screws. Also screws fastened the assembly. Screws are available in standard size.

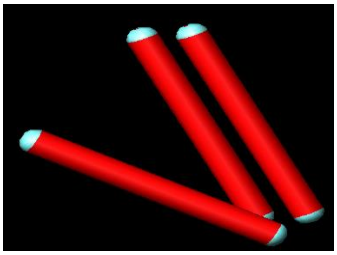

Figure 3.10: Screw

3.11 Dowels:

The function of the dowels is to align them properly in one axis. Dowels hold the parts in perfect related alignment by absorbing side pressure and lateral thrust. Dowels always should have case hardening.

Figure 3.11: Dowels

3.12 material specifications

1) TOP PLATE : - Mild Steel (M.S.)
2) BOTTOM PLATE : - Mild Steel (M.S.)
3) STRIPPER PLATE : - Oil hardening non Shrinking Steel (OHNS).
4) THURST PLATE : - Oil hardening non Shrinking Steel (OHNS).
5) DIE PLATE : - High Carbon High Chromium (HCHCr).
6) BASE PLATE : - Mild Steel (M.S.)
7) PUNCHES : - High Carbon High Chromium (HCHCr).
8) PUNCH HOLDER : - Steel EN-31.
9) STOPPER : - Steel EN-31.
10) PILOTS : - Steel EN-31.

11) SCREW : - Oil hardening non Shrinking Steel (OHNS).

12) DOWELS : - Oil hardening non Shrinking Steel (OHNS).

4. ADVANTAGES

ii It provides high strength in thin parts that can have complex shape.
iii With the help of this we can make any sheet metal part in very reasonable price.
iiii In which easy to make parts in different colors.
iiv It provides good dimensional accuracy and surface finish.

5. DISADVANTAGES

ii It needed heavy machinery and no intricate forming such as: bosses, ribs, Etc.
iii Its initial cost is high.

6. APPLICATIONS

ii Press tool are commonly use in hydraulic, pneumatic, and mechanical presses to produce components at high volume.
iii Press tool are use in sheet metal industry for forming a different components.
iiii This can be recommended for coining, extruding and embossing.
iiv Press tool are use in vehicle body building like 3 wheeler, 4 wheeler, ships, aircraft etc.

7. CONCLUSION

We have studied the various components of the press tool which is made up of different types of the material and each component has its different working. Also we have gained a great deal of confidence and knowledge in the way of tool manufacturing. The tool can also be designed and manufactured without any these analyses, but the success and the economics of the tool is not assured. And the strong positive guidance given by our guides during solving of problems is really commendable; hence the success of the design of the tool is assured. To overcome the huge time production difficulties and to automate the process, we are introducing the way of manufacturing approach for producing the press tool with significant period. We have used Engineering aspects theoretically from various resources.

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