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Design and Manufacturing of Die for RM-800 Oil Tank Cover

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Abstract: *Now a days sheet metal working processes are widely used in almost all industries like automotive, defense, mechanical industries. Also, sheet metal working processes are predominantly used as various reasons not only for industrial purpose but also utilized for commercial purpose as well. For that many people are working in developing the new trends using their innovative ideas. Especially in die design, many die sets are made for different functions such as progressive die, compound die etc. This project is also based on new design of die punch. The main aim of this project is to design a new die with interchangeable punches also reduce the weight of material by means of changing the material of die set. The project mainly focuses on different operations done on single die set in a single stroke of press, presently these operations are done separately in five steps which includes four drills and one plasma cutting. These operations are leading to reduce the production rate and increasing the cycle time with cost as well. As per our new die set, this should constantly eliminate the loss in the production time and reduce the man power for loading and unloading of workpiece. The parts of die sets, punch and die are designed and assembled in the Creo Parametric 1.0*

I. Introduction

A die is a special tool used in manufacturing industries to shape, form and cut a various variety of products and components. Like templates and mold, dies are generally customized and specially matched to the product they are used to produce. Products made with dies range from simple paper clips to complex pieces used in advance technology. Dies are typically made by die makers and tools and are used for production after mounting into a press.

For the forming of sheet metal such as automotive body components, two parts may be used, one called the punch, which performs the bending, stretching, piercing and/ or blanking functions. While another part, called the die block, securely clamps the work piece and provides similar stretching, bending, piercing and/or blanking operations. The work piece may pass through several stages using different tools or operations to obtain the final form.

Most of the construction machinery equipment parts assembled are made by mild steel. Most of these mild steel parts are manufactured on a machine called as “press tools”. A proper designing will give accurate mild steel parts in dimensions, shapes and size. In many industries press tool calculations, designing and drafting is done manually

Press tools are provided with an attachment on a press machine with punch and die as a major part use to perform different cutting and forming operations. Different press tools are used for different operations depending upon the shape and size of the product. Top plate of the die set is attached to the top press ram followed by pressure plate and punch plate in which punches are held, which moves up and down, by means of different power sources like mechanical, hydraulic and manual, while the die is fixed on the bed along with clamping plate and its accessories. A work piece on which operations are to be performed is held on a top of the die supported by stripper plates, where the punch will descend and perform the required operation and retracted.

1.1 Types of Dies

The theory of behaviorof sheet metal is kept as a backbone for the development of various kinds of dies which are differentiable through their function. In some of the dies, the sheet metal should be cut off from the strip and the remaining part is removed as a scrap. In some other dies, the complete part is finished within the single work station. According to their functions and construction the dies are divided into following groups.

1.1.1 Compound Dies

The die which performs to more than two cutting operations such asperforating andblanking etc. canbeperformed continuously in a single stroke. In compound die, the upper punch is connected to the ram comes in constant with metal and pierces the hold. This punch is moving downward, the springs keep on compressing and after certain limit the lower punch moves upward and blanks the outer portion. Here, the whole operation is performed at single work station, it produces accurate result but the die design is much complicated.

I.1.2Combination Dies

The die in which the forming and cutting operations are combined and carried out in a single operation. The blank is prepared first in the die and then it is held by pressure pads and drawn. This is entirely achieved within the die assembly by use of cam actuated punch and die members or by designing the die for use on a double action press which has slides on moving inside another or two independent rams.

I.1.3Progressive Dies

In progressive dies, the work pieces move from the first station to successive which carries various operations, to be performed in individual station. Each station works in series manner and the work piece is placed in stock till at the end of station which cuts off finished piece. End of each stroke, the stock is moving towards by one station and the complete work piece is constructed in a single stroke of ram. It can be designed forcomplicated operations such as bending, forming etc. In these dies, indexing at every station is very important and therefore accuracy is less. However, it is simple in design.

1.1.4Simple Dies

Simple dies or single action dies perform single operation for each stroke of the press slide. The operation may be one of the operation listed under cutting or forming dies.

1.2Die Construction

The die set is the primary piece of every die construction. It's made up of lower die and upper die both are machined in parallel in size. The piece of the die is provided with the shank which is used to clamp in the ram of the press. Both the lower die and upper die are aligned together with the guide pins. They are strongly attached to the stripper and the upper die is equipped with the bushings, which these pins slip-fit into. The die blocks are mounted in the lower die section in which they are attached through the die buttons. The punch plate is fitted on the upper shoe in same manner as the die block. It holds all the punches which perforated the sheet with the help of die at the bottom. While doing the punching operations, the punches can be prevented from the cracks by the help of spring loaded stripper plate. The stripper plate is held with in the top plate with an offset location of forces of springs by means of guide pins. This die set is the combination of two die sets. The upper die set is rectangular in form with four post die set. The lower die set is rectangular in shape with open die set which is used for simple parts in large quantities.

1.3 Problem Statement

In universal manufacturing company, they are using different operations like drilling, plasma cutting on oil tank cover plate of RM-800 mixer. These all operations are done individually so it takes more time to finish the component. So there is need to combine all operations in a single step of die punch. The monthly volume of component is near about 5000 to 6000 nos. Company needs cycle time reduction and cost reduction. The existing cycle time of operation is approximately 7 minutes. After implementation of this project we can expect this to 30 secs**.** The goal of this project is to design a die which combines operations like drilling, plasma cutting etc. in order to reduce cost, cycle time, man power and increase production rate

1.4 Objective of Project

- To reduce the cycle time of operations.
- To reduce the manpower requirement for the operations.
- To increase the accuracy of operations.
- To increase the rate of production.

II. Methodology And Materials

2.1 General Design Parameters/Considerations:

Force of press: The tonnage of a press is the force that the ram of a press is able to exert safely. Press slides exert forces greater than the rated tonnage because of the built-in safety factor, but this is not license to overload. The tonnage of the hydraulic presses is the piston area multiplied by the oil pressure in the cylinder. Changing the oil pressure varies the tonnage.

The tonnage of the mechanical presses is determined by the size of the bearings for the crankshaft or the eccentric and is approximately equal to shear strength of the crankshaft metal multiplied to the area of the crankshaft bearings. The tonnage of a mechanical press is always given when the slides is near the bottom of its stroke because it is greatest at this point.

2.2 Design clearance: Clearance is defined as the intentional space between the punch cutting edge and the die cutting edge. Clearance is always expressed as the amount of clearance per side. Theoretically, clearance is necessary to allow the fractures to meet when break occurs, as shown in the fig. The amount of the clearance

depends upon the kind, thickness and harness of material. Excessive clearance allows large edge radius (rollover) and excessive plastic deformation. The edges of the material tend to be drawn or pulled in the direction work force, and the break is not smooth. Large burrs are present at the break edge.

2.3 Centre of pressure: When the contour to be cut is of irregular shape, the simulation of irregular shearing force on one side of centre of ram may greatly exceed force on the other side. This results in bending moment in the press ram and undesirable deflection and misalignment. It is, therefore essential to find out the exact centre of pressure, which the point about which the summation of shearing force will be symmetrical. While dying out the punch position on the punch holder, it should be ensured that centre of line of the press ram passes exactly through the centre of pressure of blank. This centre of pressure is the C.G of the line i.e., the perimeter of the blank contour and not the area. Thus, the press tool should be designed in such a way that the centre of pressure will be on the axis of the press ram when the tool is mounted in the ram

2.4 Holding forces: In press tool it is very much essential to hold the component properly in order to ensure better press operations. The holding should be proper and adequate. The force required to hold the component during the bending operation is commonly known as holding pressure.

2.5 Selection of the Press: The press tool designer has to select proper type of press to be used and also the kind of press tools to be provided, considering the economic aspects. For example, it will be more economical to use a tool which will complete number of operations at one stroke of a press than to employ a number of cheaper and simple tools to perform same work in a series of operation. While selecting the press the quantity i.e. volume of work should also be taken into consideration.

III. Design and Calculations

3.1.1 Selection of Material

For selecting the suitable material for a die component, the die designer has to check the mechanical properties and possible causes, which may result the failure of component. The tool designer must know certain fundamentals of press operations for successfully designing press tooling.To obtain longer life high productivity of die, steels are being widely used as materials for die component. The most important advantage of using steels is they are originally soft and Machin able, by applying suitable heat treatment on it, they become extremely hard and wear resistant. Geometry of part to be manufacture on dies affects the hardness range of selected materials of die component. According to this, we are using high carbon steel for punch and mild steel for die.

3.1.2 Properties of High carbon steel: -

- It has granular structure
- It has less impact resistance.
- This can be magnetized permanently.
- High carbon steel cannot readily forge and welded.
- High carbon steel can be easilytempered andhardened.

3.1.3 Properties of Mild steel material: -

- Mild steel is soft, ductile and malleable.
- Good forming properties.
- It can be easily forged and welded.
- Mild steel can be magnetized permanently.
- It cannot easily have hardened and tempered.
- It has bright fibrous structure.
- It has tougher and more elastic than wrought iron.
- Tensile strength is better than cast iron and wrought iron, while compressive strength is better than wrought iron but less than cast iron.
- It`s melting point is 1400°C.
- Ultimate compressive strength varies from 8 ton/cmˆ2 to 12 ton/cmˆ2

3.1.4 Design Parameters

- Perimeter of the component
- Vertical shearing force
- Total width of the component
- Press tonnage
- Total length of the component
- Shear cut area

3.2 Calculation

3.2.1 Cutting Force Calculations

The Die set assembly was designed as per following specifications:
Diameter of 10.3mm and 7mm holes is to be pierced which is 3.15mm thickness.
Solution: -

F = Spt.

Where,

F = cutting force.
S = shear strength of stock material.
P = circumference of cutting edge.
T = thickness of material

S = 35.15 kg/mm^2 ……. (As per standard table)
S = 35.15 kg/mm^2 ……. (As per standard table)

Cutting force for ø25mm

P = π d
P = 78.5342 mm
t = 3.15 mm

F = Spt

F1= 8695.50 kg

For ø8.5mm (ø0.3149inch)

P = π d
P = 26.69 mm
t = 3.15 mm

F = Spt.

= 2955.18 kg ……. (For single hole)
= 11820.73 kg ……. (For double hole)

F2 = 11820.73 kg……. (2)

F = F1 + F2
F = 8695.50 + 11820.73

F = 20516.23 kg

∴Total vertical shearing force = 20516.23 kg

3.2.2 Clearance Calculations:

Clearance is defined as the intentional space between the punch cutting edge and the die cutting edge. Theoretically, clearance is necessary to allow the fractures to meet when break occurs.
Clearance = 5% of Thickness
= 0.05 * 3.15
= 0.1575 mm

$$\textbf{Factor of safety} = \frac{\textbf{Maximum stress}}{\textbf{Working or design stress}}$$

$$= \frac{\textbf{100000 kg}}{\textbf{20516.23 kg}}$$

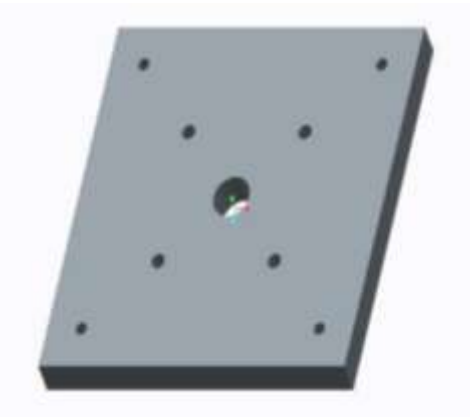
∴Factor of safety = 4.87

IV. Modeling

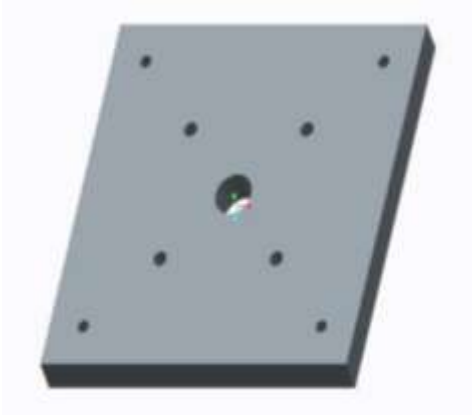
4.1 Modelling of Die

Commercially CAD/CAM soft wares like creo, catia, AutoCAD, ansys, solid works, pro-E etc. are providing a great deal of assistance in drafting and analysis in die design process. These soft wares are easily available, affordable and easy to handle. 3D modelling improves drawing efficiency and accuracy. Modelling

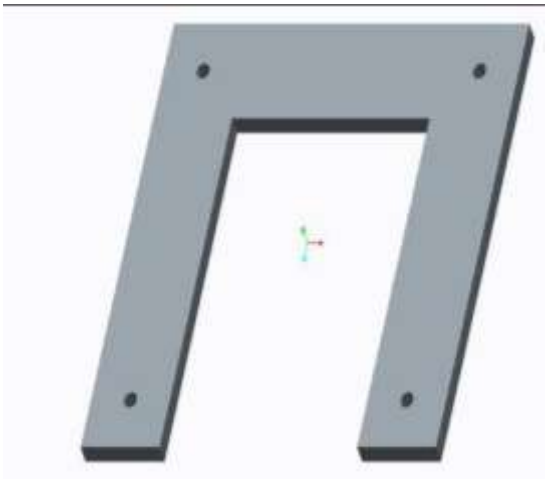
involves dimensions of all component such as punch holding plate, guide plate, base plate, Allen screw, punch, pressure plate etc. Collection of dimensions from various references, paper presentations,company manuals, and journals about the press and press tools, also information of CAD soft wares and its application in piercing operation.Design parameters, part modelling, assembly drawing using CAD software i.e. CREO. Design of all parts and accessories of press tools according to component drawing. Drawing commands in creo such as RECTANGLE, CIRCLE, EXTRUDE, LINE, REVOLVE, MIRROR, HOLE etc. have been used in modelling of die.After design calculations all the parts of die set and component where modelled using CREO Parametric



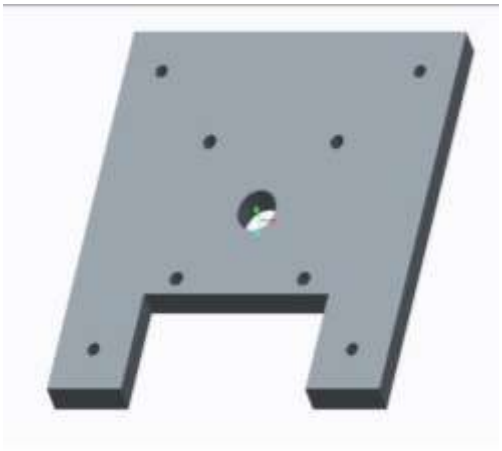
01.BASE PLATE



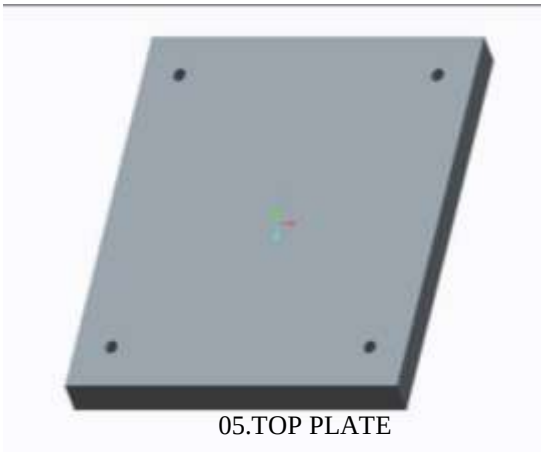
02. DIEBUSH PLATE



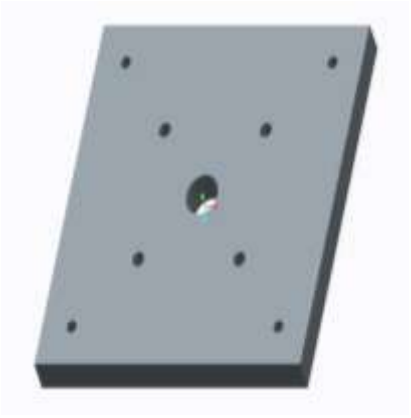
03.STRIPPER PLATE



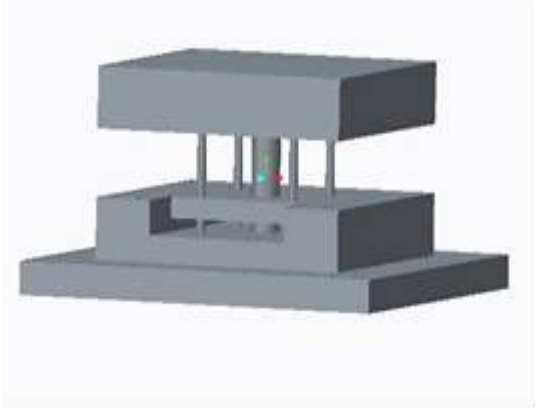
04. DIE GUIDE PLATE



05.TOP PLATE



06.PPRESSURE PLATE



07.ASSEMBLY

08. FINAL WORKPIECE

4.2 Components of Die Assembly

Die assembly consists of following parts.

Punch: -

A punch is the upper member of press tool. It is mounted on the lower end of the ram secured by punch holder and slides with it. During the operation it enters into the cavity formed in the die section. The punch is made of hard, wear resistant metal and is finally found to predetermined size providing just optimum clearance between the die and punch.

Punch retainer or punch pad: -

The punch retainer fits closely over the body of punch and holds it in its proper relative position. The retainer is in turn bolted to the punch and punch holder to provide some cushioning effect.

Punch holder: -

The punch retainer is bolted to punch holder. On its top it ends in shank, which is anchored to the press ram, and it exactly fits it to the ram opening for proper positioning and aligning of the punch.

Pressure plate: -

It is also called as backing plate. It is introduced between the punch and punch holder to distribute the pressure over the wide area and thus reduce the intensity of pressure on holder to avoid its crushing.

Die or die block: -

The die is lower member of press tool. It has opening or cavity to receive the punch. It is clamped on the bolster plate fitted on press body remains stationary. The punches and dies are general made of HSS, M.S. &HcHCR. Dies with working surface made of cemented carbide are mostly used in production process.

The profiles of working portion of the punch and of the hole on the die are made exactly the same as the profile to produce on the blank. However, some clearance is allowed between punch and die depending on quality and thickness of thematerial. The clearance is increased with hardness and thickness of work piece.

Die holder (lower shoe): -

The lower shoe of the die set is generally mounted on the bolster plate of press. Die block is mounted on the lower shoe. Also, guideposts are mounted on it.

Guide posts and bushing: -

The punch and die members are held in alignment by means of guide posts and bushings. They resist deflection of die members as operating pressures increase.

Stripper: -

The function of the stripper is to strip off or to make the punch and die free from the work at the end of cutting or forming operation.

IV .3 Operation Performed in Manufacturing of Die

Blanking:-

The material used is called stock and is generally ferrous or non-ferrous strips. During the working stroke the punch goes through the material and on the after stroke the material is lifted with the punch and is removed by the stripper plate mechanism. The restrict pin is a gage for the operator. In practice, he feeds the stock by the hand and locates the hole to be punched as shown. The part that is removed from the strip is always the work piece in a blanking operation.

Piercing:-
This operation consists of simple hole punching operation. It differs from blanking in that the punching is the scrap and the strip is the work piece which is useful. Piercing is nearly always accompanied by a blanking operation before, after or at the same time of operation.

Lancing: -
This is a combined two operations i.e. bending, cutting and lancing operation along a line in the work material. No metal is cut free during this operation. The punch is design to cut on two or three sides and bend along the north side.

Cutting off and parting off metal: -
A cutoff operation separates the work material along the straight line in a single line cut. Cutting off and parting off operations are used to separate the work piece from the scrap strip. Cutting off and parting off usually occur in final stages of a progressive die. Fig11 shows the basic principle of cutting off and parting off.

Notching: -
This operation removes metal from either or both edges of the strip of metal. Notching serves to shape the outer contours of the work piece in a progressive die or to remove excess metal before or drawing or forming operation in die. The removal of excess metal allows to flow or from without interference form excess interference from excess metal on the sides. Fig shows a typical example of notching.

Shaving:-
Shaving is secondary operation, usually following punch, in which the surface of the previously cut edge is then finished smoothly to accurate dimensions that are required. The excess metal is removed as chip with a metal-cutting tool. There is very little clearance (close to zero) between the punch and die, and only a thin section of metal can pass through it.

Trimming:-
This operation removes the distorted excess metal from drawn or formed parts. It also provides a smooth edge.

Plasma Cutting:-
Plasma cutting is a process that cuts through electrically conductive materials by means of an accelerated jet of hot plasma. Typical materials cut with a plasma torch include steel, Stainless steel, aluminum, brass and copper, although other conductive metals may be cut as well.

V. Conclusion And Scope

Conclusion and Future scope for the future work

This work can be modified to some extent by changing the design, type etc. Recently press machine with high force i.e. 100 tons is used in industrial companies. This type of press machines is used to produce high force so that operations with smaller forces are not suitable for this machine. In future if weuse press machines which can have small force are suitable for smaller operations.

In this work there are three holes with very small diameter which cannot be produced due to high force of press machine. There is a possibility to break the punches of smaller diameter holes. So that in future it will possible to produce that small holes by reducing the press force. For that it is essential to change the design of the project.

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