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Design and Manufacturing of Blanking Operation Pair Die for Press Tool Machine

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Abstract. In order to create large numbers of a particular component from sheet metal, press tools are utilized. The construction and configuration of the press tool determines the specific component produced. As a result of the numerous forms of press tool construction, a variety of diverse operations may be carried out, such as blanking and bending and piercing and shaping and drawing and cutting and splitting off and embossing and coining and notching. Metals with a thickness of less than six millimeters are often referred to as strip. A sheet metal technique called blanking is used to create flat components of a certain form. Blanking is the process of cutting off the necessary shape's perimeter and reassembling the pieces. Depending on the activity, the press tool used for blanking activities is referred to as a blanking tool. Many other industries use press operations, including food processing and packaging, defense, textile, automotive, and aviation manufacturing. In order to better understand press tool design, materials, manufacturing, and calculations related with press tool calculations an effort is made to study. With the use of a prototype blanking press tool and real-time design, this project attempts to create a circular component with a 20mm diameter.

Keywords: Design, manufacture, and analysis of blanks and dies;

INTRODUCTION

An important field of production technology die and mould manufacture has a direct impact on how economically and technically feasible it is to produce a large number of discrete components. Today's die manufacturing encompasses almost every facet of the industry's production process, from product conception and development to the final product itself, including everything from component and process design to prototyping and quality control. There will be an emphasis on current research and its implementation in the field [1]. Press machines are often used in high-volume manufacturing businesses. Thickness may vary greatly, however thin sheets are called sheets, and whereas thick plates are regarded plates with a thickness more than 4 mm. Gauge refers to the thickness of the sheet metal that is passed in between. Sheet metal is simply fed between the dies of a press tool to perform a press operation. The reciprocating motion of the punch is caused by the ram action of the press machine Mechanical, pneumatic, manual and hydraulic press machines are all types of press machines available. Sheet metal components have already taken the place of many more costly cast, forged, and machined goods in today's world of practicality and economy. Many popular sheets metal forming items include desks, filing cabinets, appliances, automobile bodywork, plane fuselages, mechanical toys, and beverage cans. As a result of its reasonable cost and high carbon content, carbon steel is the most often used sheet metal because of its great strength and formability features. For aircraft and spacecraft sheet production, aluminum and titanium metals are also often employed. This paper's goal is future potential of different die designs by reviewing existing research. The following are some of the statements made by the numerous writers in the construction of the work [2-4].

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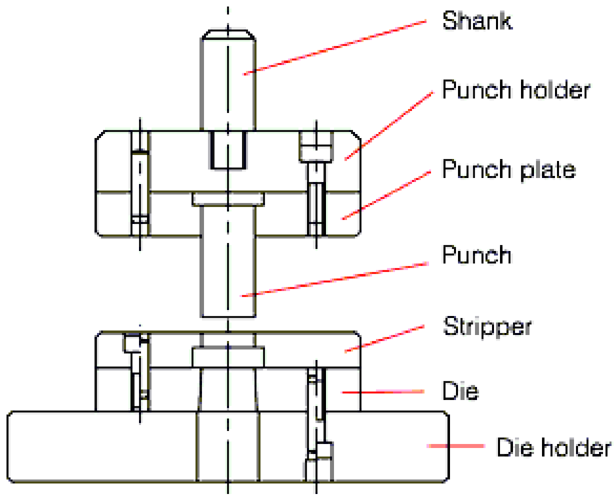

Figure 1. Principle of Press Tool Operation

For example [5] sheet metal dies play a vital role in the production of automobiles and other consumer goods. When it comes to building a car's chassis and body in white, there is a lot of equipment involved. As stated by accurate product design and production data are necessary. It is necessary to create new products when a product's design is not ideal, since this leads to flaws in the final product. It is recommended by that mould design and technology solutions include the mould’s technical performance, economics, and environmental ramifications throughout the course of its life cycle. Preliminary selection of mould design possibilities may be aided by using a technique described here. Other than Sheet metal forming is plagued by geometric, boundary, and material non-linearity [6]. Radii and clearance parameters include components such as clearance, lubrication, blank holding force, and trajectory. The creation of component drawing tools necessitates this process of trial and error. Vishwanath MC and other researchers have looked at this issue before [7]. A progressive die for producing an oil filter cup will be built using Pro/E software, according to him. Making Progressive Dies necessitates the usage of many stations. This die, designed by the authors, has two phases of operation that work together. Pinning precedes blanking.

There are several components that might influence the blanking process, thus it's important to predict their prospective effects and interactions. [8] Blank soft Software and Neural Networks were utilized to mimic the blanking process, together with FEM and ABAQUS-Explicit software. Blanking is a common separation method in large-scale manufacturing [9]. But blanking analysis is heavily dependent on phenomenological understanding. SDBHOOSE et al. researchers have been identified. His study focuses on the use of quality techniques to improve mechanical seal production quality [10]. Defects on the manufacturing line are constantly monitored using statistical techniques such as Check Sheets, Histograms, Pareto analysis, and the like [11] For example, he works with the Die Designer to help create online-maintainable dies and to watch for tool failures caused by the dynamism and dynamic action of press tools while they're in use. Based on the thickness of the sheet, the press tool machines may be 1 tons, 2 tons, 3 tons, etc.

The press tool machine is available in a number of variants. The current production design and press tool machine experimental is based on a capacity of 20 tons with a bed size of 482 x 318 mm and a gap availability of 243 mm from bed to ram bottom. The sliding range is 25mm. The number of strokes per minute (SPM) is 55, the shank hole diameter is 32, and the number of strokes per minute (SPM) is 735mm. The motor has a rated output of 1.5 horse power and a rotational speed of 1440 revolutions per minute [12].

EXPERIMENTAL METHODOLOGY

The punch and die holder on the press tool are used to secure the die to the machine. Besides holding the punch, the die holder also helps to keep the die rigid. Three distinct back plates are utilized in a die. The power of the push action prevents the components from penetrating too deeply into the holder thanks to this feature. Parts are held in place by backing plates, which may also be utilized for height adjustment. Punch plates are used to keep the punch in place while the press is running. There are a number of additional uses for a stripper besides scrap removal, such as directing the punch point during press operation. To ensure effective operation, a space between the punch and die plate must be left. This space is dependent on the thickness and kind of material of the sheet metal. Punches are made of high-speed tool steel operated by a motor, and the size of the punch controls the press's output. The technique for making a blanking press tool is outlined in this document, and it is detailed below based on selection of raw materials for the manufacturing of pair dies [13-14]

Figure 2. Mechanical Press Tool Machine

HCHCr, steel alloys with a high carbon content, are often used to make press tools. When all of these considerations have been taken into consideration it is necessary to make a decision on which material is best for a certain application. D2 and EN31 are the most often utilized materials. The supporting plate is made of mild steel. Cutting tools are also made from D3, high carbide, chromium steels, and high-speed steels. An itemized list of the items used in this experiment is provided below. Required shapes are made from D3, high carbide, chromium steels, and high-speed steels. An itemized list of the items used in this experiment is provided below [15].

As a high carbon alloy steel, EN31 is suitable for various automotive applications such as heavy-duty gears and shafts as well as pinions and camshafts because of its high hardness. Low carbon and low hardness mean it is neither brittle nor malleable on the outside. Table Nos. 2, 3 and 4 illustrate the properties of En31. This alloy is a high carbon, high chromium tool steel for cold work applications. D2 is a very hard-wearing alloy that undergoes extensive deep hardening. When cooled by air, it hardens to minimize deformation during heat treatment. Die blanking and shaping dies, as well as thread rolling dies, are common examples of long-run tooling applications that need high wear resistance. Tables 5 and 6 illustrate the mechanical characteristics of D2 steel [16].

Table 1. Chemical Composition of EN31

Carbon (C)	0.18
Silicon (Si)	0.35
Manganese (Mn)	1.0
Sulphur (S)	0.05
Phosphorus(P)	0.05

Surface hardness is required for components having friction surfaces in order to endure wear. With the use of an electrically heated arc chamber, EN31 steel, which is often found in bearings and splines, is hardened on the surface (GTA). Cryogenic treatment was used to increase the hardness even more. To impart heat to the friction surface, the GTA torch employs a thoriated tungsten (2 percent) electrode. At various points during surface hardening, welding current and angle of the electrode tip were changed to achieve differing temperatures. Temperatures ranged from 50°C [Shallow Cryogenic Treatment (SCT)] to 196°C [Deep Cryogenic Treatment (DCT)] for five separate soaking durations (DCT) [17].

There was dry ice and liquid nitrogen for superficial and deep cryogenic therapy, respectively. The microhardness and microstructures of the specimen were examined in detail. According to the results of microstructure investigation, the remnant austenite has been transformed to plate martensite with carbide particle precipitates. Current and soak duration improve surface hardness. At 200 A, the hardest electrode tips are discovered for all electrode tip angles. After 15 hours of soaking, the maximal hardness is achieved. Those treated at 190 °C had higher hardness than samples treated at 50 °C. SCT and DCT both need 200 A welding current with a 45° electrode tip angle and an additional 15 hours of soak time in order to get the best hardness [18].

Table 2. Physical properties

Melting Point(T_m)	1421^0C
Density (ρ)	7.7 x 1000 kg/m^3

Table 3. Mechanical & Thermal properties

Izod Impact Strength	77.0 J
Rockwell Hardness	62
Modulus of Elasticity	190- 210 GPa.
Thermal Expansion	10.4 x10^{-6} / ºC

Table 4. Chemical Composition

Carbon (C)	1.6
Silicon (Si)	0.6
Vanadium (V)	1.1
Manganese (Mn)	0.6
Sulphur (S)	0.03
Molybdenum (Mo)	1.2
Phosphorus(P)	0.033
Chromium (Cr)	13

Table 5. Physical & Mechanical Properties

Density	7810 kg/m^3
Yield Stress	450N/ mm^2
Modulus of Elasticity	215000N/ mm^2
Tensile strength	750N/ mm^2
Rockwell Hardness	65
Melting point	1540^0C

For the construction of the blocks, mild steel and HCHCr were employed in their construction. HCHCr (EN31 and P20) is used for the punch and die block, whereas H13 and EN8 is used for the base plate and guide block. It is important that the punch and die block have a higher level of strength than the base plate and guide block. Since punch and base are made of strong materials, this is the case. EN31 and EN8 outperform all others in terms of strength, machinability, thermal characteristics, load factor, and cost. The punch and base are made of EN31, while the die and guide block are made of EN31 [19].

When the power press machine's hub is linked to a piece of metal, a punch is used to hit the metal. The machine's capacity determines the machine's hitting power. To secure the punch in place, a nut is used to taper the top of the punch and secure it in place. The punch's dimensions design is shown in the following images. The design of the Die block determines the final product's form and size. The product has a 20mm diameter and is shaped like a coin. Clearance between the punch and the Die block is required, otherwise the process cannot proceed. The thickness of the sheet is used to calculate the clearance, which is about 10% of the sheet thickness. Positive tolerance for the the block should be 0.2mm to 2mm sheet thickness [20].

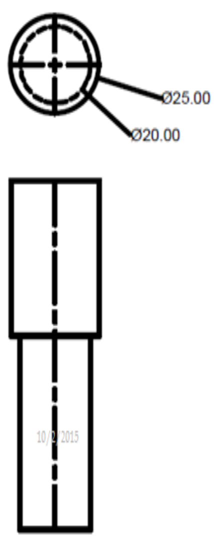

Figure 3. Punch and Die Block

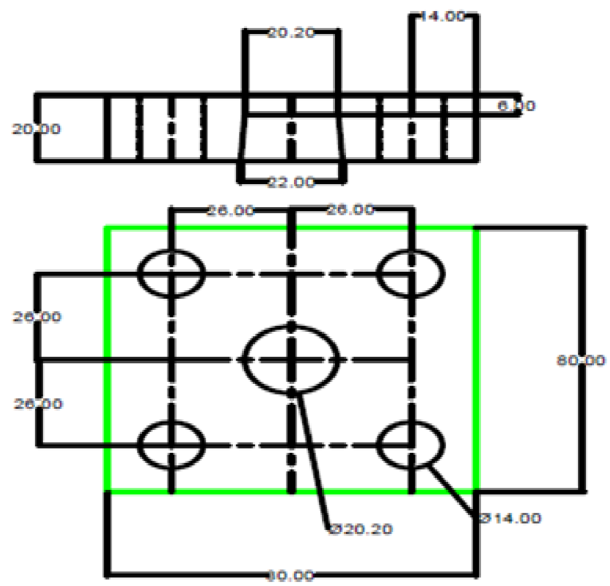

Figure 4. Guide Block and Base Plate

The Guide block has no use in the manufacturing process since it sits in between the punch and the Die block. Countering Shear force and performing sheet metal operations are the key goals. The dimensions and design of the guide block are shown in Figure 3 and 4. The work item or scrap is placed on the base plate or bottom plate at the end of the arrangement. The bottom plate of the punch is made of a strong material to prevent the die from breaking when it is struck with high force. Punch and base plate are made of the same material.

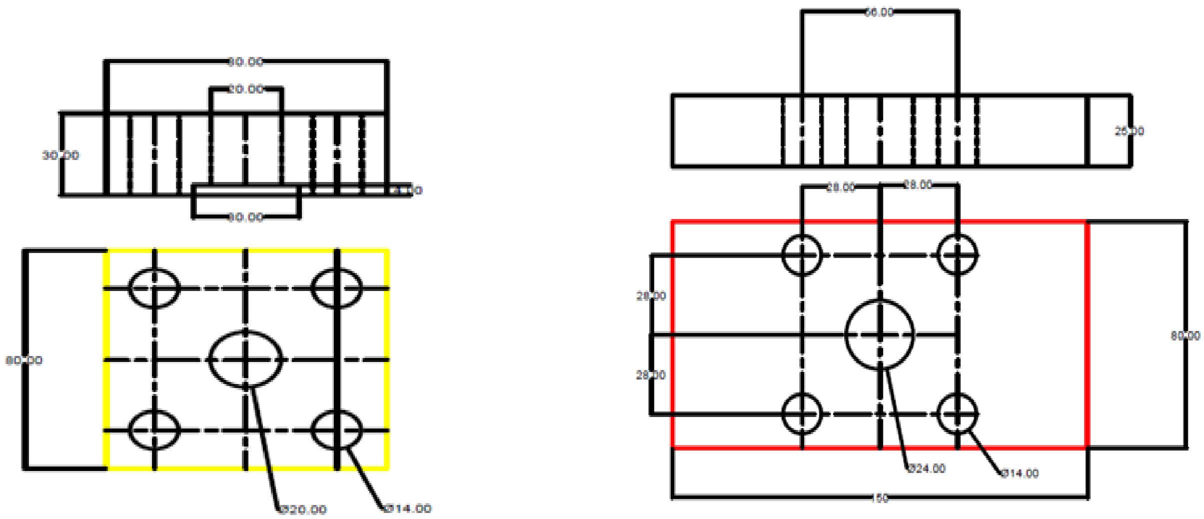

Figure 5. Base Plate of the pair die

A front and top view of all four pieces, as well as the screws, are shown below

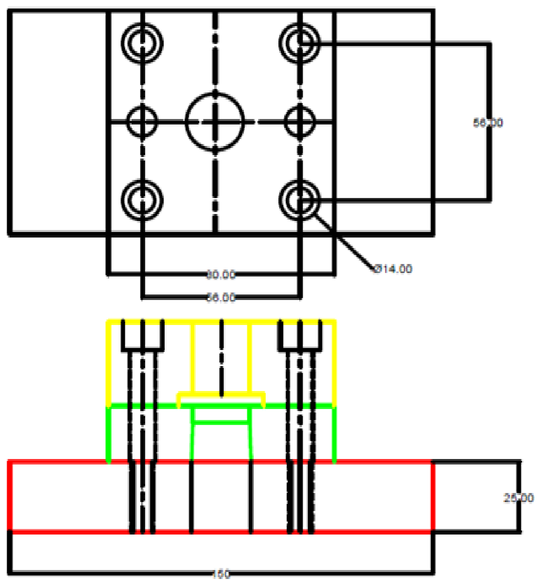

Figure 6. Assembly diagram of pair die

DESIGN CALCULATIONS

Figure 7 depicts the strip's arrangement. To decide the next stages, a strip calculation is done.

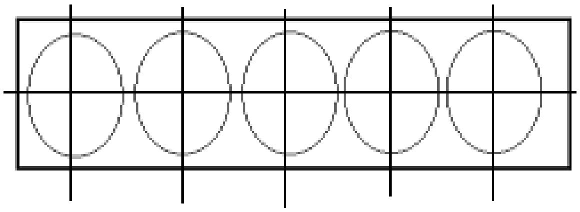

Figure 7. Strips

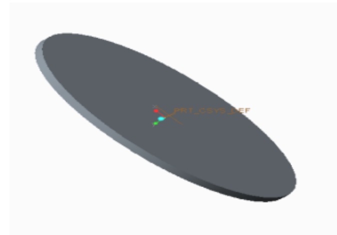

Figure 8. Blank

Strip percentage = (Component Area x 4)/Strip Length x Strip Width

Shear force = (KxLxTxS)/1000tons)
= (1.5x2x3.141x10x0.5x420)/1000 tonnes
= 1.97 tonnes of shear force.

- K=1.1 to 1.5 (constant dependent on clearance), L=length of cut in mm,
- T=thickness of cut in mm
- S=Shear strength of material in kg/mm2
- Net force is equal to the sum of the shear force and the squeezing force, or 1.97 + 0.2 = 2.2 tonnes.

Shear, stripping, and net forces as well as their corresponding respectable values are listed below. A total of 1, 97%, 0, 22%, and 2, 24%.

Figure 8 depicts the blank, and the computations for it are as follows:

- 1.2 x 2.2 = 2.64 tonnes of total force for the press
- 3Fsh = 4.2mm is the thickness of the die plate.
- Td = Plate Thickness; 0.5xtd = 2.5mm for the thickness of the punch holder.
- Substituting td values yields the same result.
- Bottom plate thickness = (1.5 x td) = 7.5mm
- Td = 6.25mm for the thickness of the top plate.
- Stripper plate thickness = 0.5 x td= 2.5mm
- Cutting clearance is equal to C x S x (T_{Max})/10 = 0.05mm 0.01 to 0.05

(for accurate) based on material property (maximum stress that can be tolerated = 1000 N/mm^2
a cutting clearance of 4% of the sheet thickness The wall's thickness is equivalent to 6% of the black punch's diameter. To cut through the material, you'll need 69 Newton-meters of force. Calculations were performed based on the end product needed, and the manufacturing process began. In order to obtain a soft material, we heat treat the material prior to performing machining operations [21]. Annealing should be performed to soften D2 material. Heating (1550-16000F) is followed by an extremely slow cooling (around 10000F) in the annealing process. Finishing should be the last step in the machining process. In order to achieve a hardened material after machining Quenching (1500F cooled), Tempering(9500F), and hardening to (1800-18500F). After then, the tool may only be obtained via completing processes [22]. CNC lathe and milling processes are included under machining (Computer Numerical Control). Facing and turning are two of the lathe's primary functions. In addition to that, we employed a drilling machine to do the drilling and tapping tasks. The following is the CNC software for milling [23].

CNC Machine Coding:

```
N10 G00 G90 X70 Y25;
Z1 S800 M3
N20 Z-5;
N30 G01 X20 F150;
N40 G00  Z100;
N50 X25 Y50;
N60 M30;
```

ANALYSIS FOR PUNCH.

Press Tool Efficiency is mainly depended upon, defect accumulation in press components reduces the efficiency of press tools. When a press tool's die is defective, it has a negative influence on the press's overall output efficiency. Damage to the press tool rises as a result of ineffective interactions between the punch and the die caused by flaws such punch cracking and die corrosion. A better press tool design, in accordance with the findings of this study, should be employed to avoid or at least minimise escalating energy costs [24].

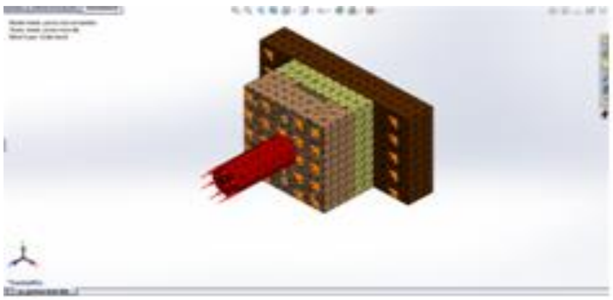

Figure 9. Meshing

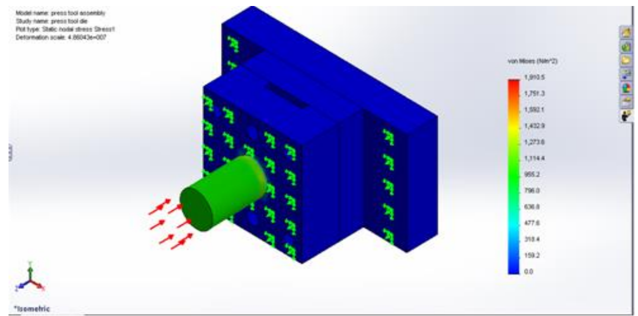

Figure 10. Vonmises Stress

Using stress analysis, a product's quality, safety, and performance may be quickly validated. Figures 11 and 12 shows.

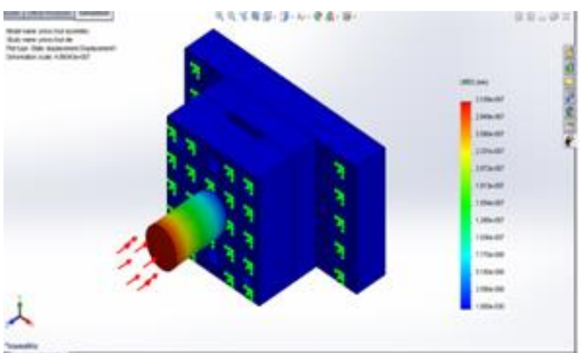

Figure 11. Displacement of Static

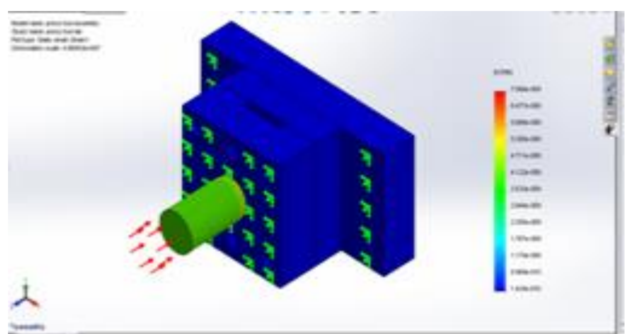

Figure 12. Displacement of Strain

The analysis is carried out using the SOLID WORKS programme. By using this software, we find out the forces in material, it's extracts and generates various deformation zones with various parameters. The component deforms, the product remains static and unchanged throughout time, and the material's stress-strain relationship remains constant [25-26].

CONCLUSION

The creation of a press tool for the fabrication of sheet metal component blanks was based on die design principles. The required tonnage of the press is insufficient for the operation. Thus, the prior press-ton machine may utilize it without any problems. Furthermore, the designed press tool combination and mechanical press have excellent geometric compatibility.

- Steel alloys are often used to make the tools. P, D, and H types are distinguished by their carbon content. all D type has a higher amount of carbon, which means it has greater strength. They're mostly used in the manufacture of tools.

- A 20mm-diameter output product with a 2.2-tonne capacity was developed. Above 2.5 Tonnes, this is the best choice.
- An area of stress and strain displacement has been identified in a punch.
- It is thus advised that a newly produced combination press tool be constructed in order to increase production capacity, efficiency, and manufacturing flexibility, while lowering the product's overall cost of production as well.

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