

DESIGN OF PROGRESSIVE PRESS TOOL FOR AN ALPHA METER COMPONENT

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Abstract

The sheet metal manufacturing Design and development of different components is one of the important phases. like shearing, piercing and blanking etc. There is a highly complex process and leads to various uncertainties.

Progressive tool components are modeled in solid works with selected dimensions from the given 2D diagram and design calculations.. Results obtained from theoretical calculations are in good agreement with empirical dimensions of CAD model.

Keywords: Die, punch, piercing, CAD.

1. INTRODUCTION

The design and manufacture of press tools, or punches and dies, is a branch of production 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.

More and more it has become the practice to produce from sheet metal by some form of pressing process, work pieces that would have been made from bar, forging or casting two or three decades ago. Also, the handling of both strip material and semi-finished components has assumed an importance simply because fast and efficient movement means cheap products from operators who do not suffer fatigue from the handling of awkward or heavy components. However, it should not be forgotten that press design has made many advances in recent years in common with, for example, the machine tool industry, and machines are now available that are capable of withstanding the heavy stresses set up in many modern production process.

2. TYPES OF PRESS TOOLS

- Progressive Tools
- Combination Tools
- Compound Tools
- Bending tools

A Progressive Tools-Progressive tool performs many operations at different stages in each stroke. The stock strip is advanced through a series of stations that form one or more distinct press working operations on the strip to get the component.

B Combination Tools- A die in which cutting operation and non-cutting operations on a part is accomplished in single stroke of the press. The cutting operations may be blanking, piercing, trimming and are combined with non cutting operations which may include bending, forming, drawing and embossing etc.

C Compound Tools- Similar to a progressive tools, a compound tool also produce blanks having pierced holes but the difference being that the former performance the operations at more than one station where as the later performs both the operations simultaneously at the same station. The conventional positions of the blanking punch and die are inverted. The blanking punch being clamped to the die shoe forms part of the bottom tool, whereas, the blanking die being clamped to the die head forms part of the top tool. The piercing punches assume the conventional position and inside the blanking die opening piercing punches are mounted with a punch holder. Their mating piercing dies are formed in the blanking punch.

3. ELEMENTS OF PROGRESSIVE TOOLS

A-Die Set- It is one of the basic elements of the stamping industry which can be defined as a sub press unit consisting of a bottom plate and top plate together with guide pillars and bushes by means of which the top and bottom plates are aligned. The purpose of die set is to utilize the entire die assembly.

B-Top Plate- 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.

6. TOOL DESIGN

Tool design is one of the most skill full job, because almost all the components which are produced using press tool will be demanded high dimensional accuracy therefore at most care should be taken will designing the press tool.

6.1 Press Tool Design Considerations

Several points have to be taken into considerations during press tool design process.

- All the parts are designed should have the capability to bear the forces.
- Sufficient space should be provided to load the stock.
- Die set should be made of proper material.

6.2 Selection of Material

Along with the important design consideration one should also know about the proper material selection for components of a die set various types of tool steels with their suitability for components of die set. Material or selected tool steel should be Very hard to resist wear and strong to bear load and at the same time die set components may have very complicated shape, design and need very accurate sizing. So here we use D2 material for both Die and Punch because D2 steel is an air hardening, high-carbon, high chromium tool steel. It has high wear and abrasion resistant properties.

Table 1 Mechanical Properties of D2 Material

Properties	values	units
Elastic modulus	210000	N/mm ²
Poissons ratio	0.3	
Shear modulus	7900	N/mm ²
Mass density	7700	Kg/m ³
Tensile strength	1736	N/mm ²
Compressive strength	2150	N/mm ²
Yield strength	1532	N/mm ²
Thermal conductivity	20	W/(m-K)
Specific heat	460	J/(kg-K)

6.3 Calculation

6.3.1 Strip Layout

Clearance per side of sheet – 3mm

%area of utilization = $\frac{\text{area of blank} \times \text{no of rows}}{\text{Pitch} \times \text{width}}$

Area Of Blank- 122663.26mm
No Of Rows- 1
Pitch-158.52mm
Width-119mm

$$= \frac{12663.26 \times 1}{158.52 \times 119}$$

$$= 67.12\%$$

6.3.2 Shear Force (Blanking)

$$\text{Shear force} = L \times S \times T_{\max}$$

L - length of cut L=557.37mm

S – Thickness of sheet S=0.5mm

T_{max} - shear strength T_{max}=82.7 N/mm²

$$= 557.37 \times 0.5 \times 82.7$$

$$= 23047.15 \text{ N/mm}^2$$

6.3.3 Shear Force (Piercing)

F_{s1} = 20.05 x 0.5 x 82.7 = 829.068 N/mm²

F_{s2} = 12.99 x 0.5 x 82.7 = 537.22 N/mm²

F_{s3} = 13.29 x 0.5 x 82.7 = 549.54 N/mm²

F_{s4} = 143.05 x 0.5 x 82.7 = 5915.33 N/mm²

F_{s5} = 39.25 x 0.5 x 82.7 = 1622.95 N/mm²

F_{s6} = 28.06 x 0.5 x 82.7 = 1160.37 N/mm²

F_{s7} = 25.92 x 0.5 x 82.7 = 1071.88 N/mm²

Total Fs(piercing) = 11686.36 N/mm²

Total Shear Force = 23047.15 + 11686.36
= 34733.51 N/mm²

6.3.4 Stripping Force

Stripping force = 20% of total shear force
= 6946.7 N/mm²

6.3.5 Press Tonnage

Total Press Capacity =
Total Shear Force + Stripping Force

$$= 41680.212 \text{ N/mm}^2$$

Press Tonnage = $\frac{\text{press capacity}}{70\%} = \frac{41680.212}{0.7}$

$$= 59543.16 \text{ N/mm}^2$$

$$= 59.54 \text{ tons}$$

$$\frac{59.54}{9.8} = 6.075 \text{ tons}$$

Hence 50 tonnage machine is used for this tool

6.3.6 Clearance

Clearance = $c \times t \times \sqrt[3]{T_{\max}}$

$$= 0.01 \times 0.5 \times \sqrt[3]{82.7}$$

$$= 0.05 \text{ mm}$$

6.3.7 Design Of Die Block

$$\begin{aligned} \text{Thickness of die } (T_d) &= \sqrt[3]{fs} \\ &= \sqrt[3]{41680.212} \\ &= 34.67 = 35 \text{ mm} \end{aligned}$$

$$\text{Thickness of bottom plate} = 1.5T_d = 52.5\text{mm}$$

$$\text{Thickness of top plate} = 1.25T_d = 43.75\text{mm}$$

$$\text{Thickness of stripper Plate} = 0.75T_d = 26.25\text{mm}$$

$$\text{Thickness of punch holder} = 0.5 T_d = 17.5\text{mm}$$

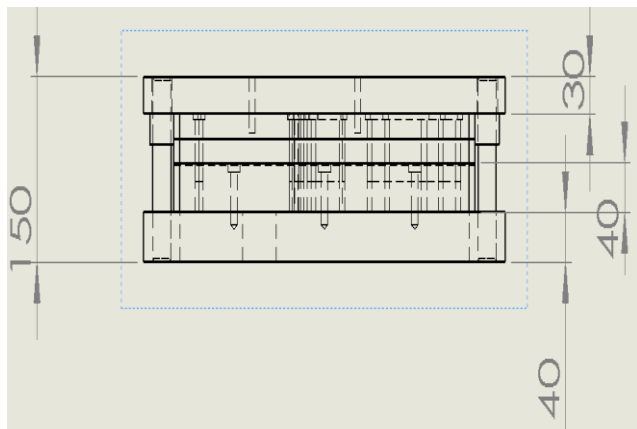


Fig 5 Front view of the assembly

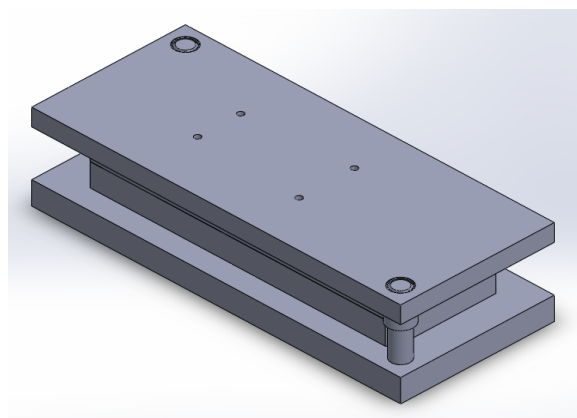


Fig 6 3D model of the tool assembly

7. PUNCH AND DIE ANALYSIS

After designing and modeling, the press tool is analyzed. Punch and Die analysis is carried under computer aided engineering software to ensure that the design is safe. Punch and Die are the parts which undergo repeated loads in press tools, which is expensive too. Computer aided engineering software it provides an opportunity to improve the design of the part prior to manufacturing. Hence based on the analysis Result necessary material or geometrical changes are incorporated.

7.1 Die Analysis of Blanking Tool

Initially modeling is done then boundary conditions and suitable material is applied to the die. The below figure

shows the stress distribution of die under the applied loading condition. The orange and blue color in the plot indicates the maximum and minimum stress distribution respectively.

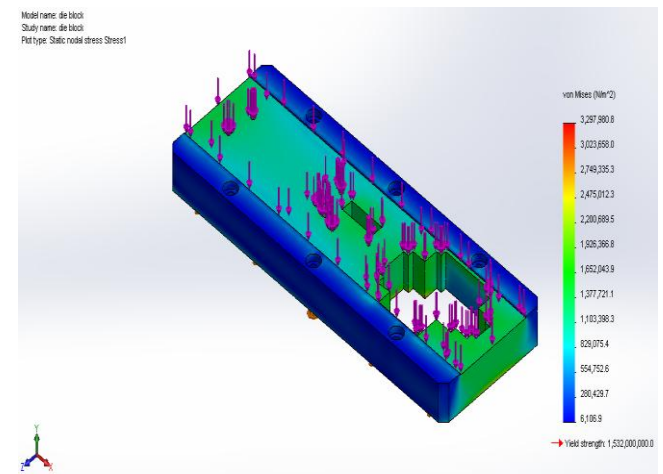


Fig 7 Static Stress Analysis of Blanking Die

7.2 Punch Analysis

Initially modeling is done then boundary conditions and suitable material is applied to the die. The below figure shows the stress distribution of die under the applied loading condition. The orange and blue color in the plot indicates the maximum and minimum stress distribution respectively.

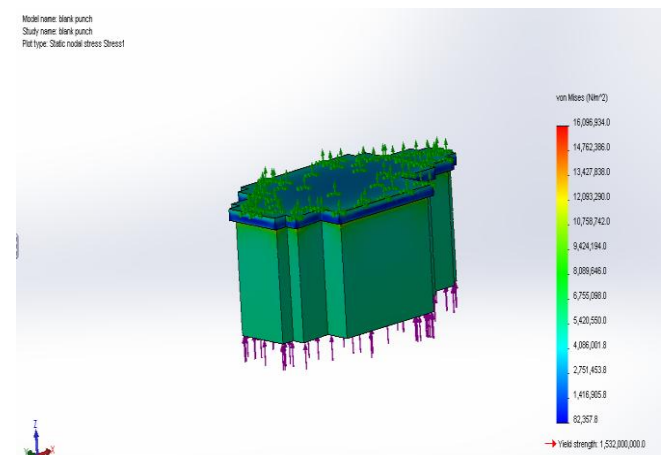


Fig 8 .Static Stress Analysis of blanking punch

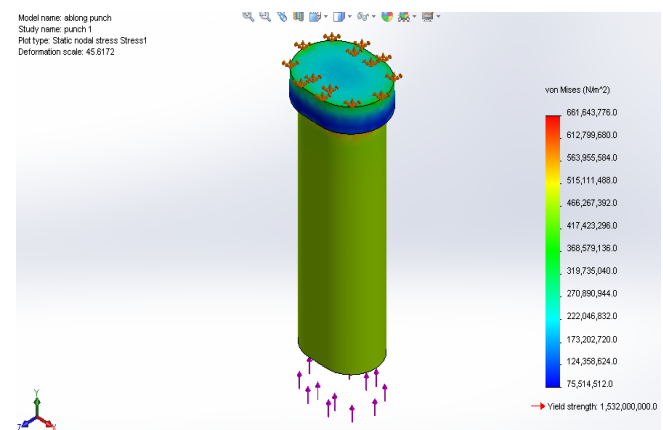


Fig 9 Static Stress Analysis of piercing punch

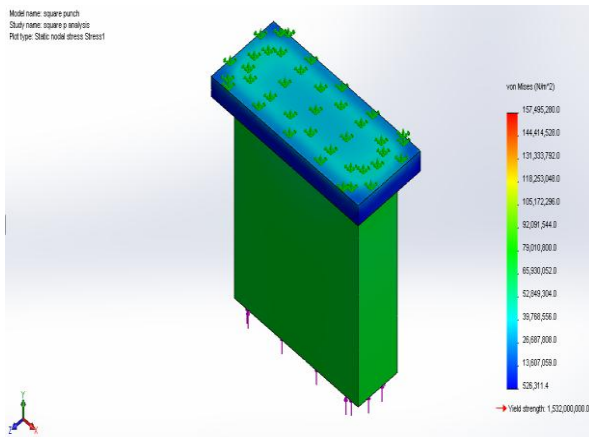


Fig 10 Static Stress Analysis of rectangle hole punch

7.3 Analysis Result Table

Table 2 Maximum Stress distribution in punch and die of blanking tool

Sl no	Type	Value	Unit
1	die	16.1	N/mm ²
2	Rectangle punch	157.5	N/mm ²
4	Oblong punch	661.6	N/mm ²

8. CONCLUSION

In this work some significant aspects of press tool design for alpha meter component is discussed and also detail study and analysis were carried out. Punch and Die analysis of the tool were carried out and the design was found to be safe. Both in punch and die maximum stress developed was very less when compared to the yield stress value. Through analysis it confirms that the material selected for both punch and die is safe. Punch and die designed is made detachable so that only the damaged part is replaced. By incorporating finite element method overall production rate is optimized.

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I am Vinay Kumar A V, Doing M.Tech (Tool Engineering) in Government Tool Room and Training Centre, Mysore. Currently carrying out my final semester project work on Press Tool.

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