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Design and Analysis of Blanking and Bending Press Tool to Produce Anchor Bracket Component

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Abstract- **In this paper Design and analysis procedure to develop Blanking and bending press tool for Anchor Bracket component is discussed. Press tool manufacturing is one of the widely emerging trends in production area. Basically sheet metal components are produced using press tools. As the name itself suggests press tool means manufacturing the sheet metal components by applying the predetermined force. The components manufactured using this process possess high dimensional accuracy therefore automobile and aircraft firm depend largely on press tools. Anchor bracket is a part which is used in brake assembly unit of automobiles. Sequence of operation is planned initially and then press tool is designed and analyzed. The purpose of carrying out analysis is to prevent the costly tryouts and thus optimize the quality and rate of production.**

Keywords-Blanking, Bending, Anchor Bracket.

I. Introduction

Press Tool is the process which is used to produce the sheet metal components. Operations like Blanking, piercing, bending, forming etc. can be performed using press tool process. The basic operation that is performed using press tool is blanking and piercing. Both blanking and piercing process includes shearing of the sheet metal, therefore initially the shearing strength of the sheet metal material has to be determined. In this paper we restrict our study only regarding blanking and bending operation. Blanking is the shearing operation in which the sheet metal is squeezed between a punch and die as shown in fig.1. Due to the high cutting force of punch the desired profile of the sheet metal gets separated from the strip. The separated portion of sheet metal is called Blank. The next operation to be discussed is bending.

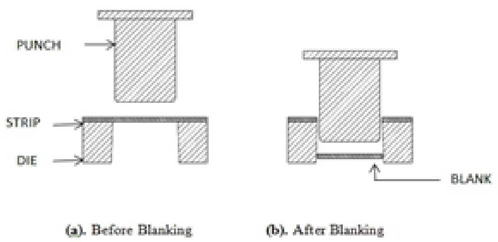


Fig 1. Blanking Process

In this operation the sheet metal is squeezed between a male and a female part which is called as punch and die. Hence the sheet metal takes the desired shape as that of punch and die.

II. Component Study

Name of the component: Anchor Bracket
Material: AISI 304 Stainless steel
Thickness: 2mm
Shear Strength: 560 MPa

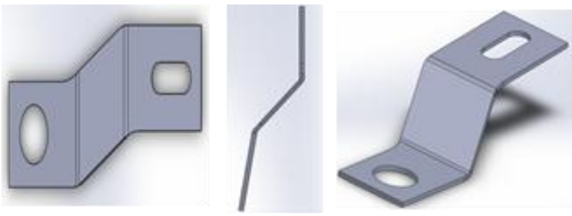


Fig 2. 3D Model of Anchor Bracket

Initially the 2D drawing received by the customers is redrawn using Auto Cad to identify the missing dimensions, and then necessary inputs will be incorporated. The conceptual drawing of the tool is done in Auto Cad and bill of material is prepared and material is ordered. Machining is started based on the data of detailing.

III. 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.

A. Important considerations in Press Tool Design

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

- All the parts that are designed should have the capability to bear the heavy forces.
- There should be safety and ease of both operator and setter.

- Sufficient space should be provided to load the stock.
- Die set should be made of proper material.

B. 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. Most of them are manufactured by machining and then finishing operations. Their manufacturing involves processing of tool steel to make these components, and then these are hardened by different hardening methods like water hardening, oil hardening, air hardening. 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. It is heat treatable and will offer hardness in the range 55-62 HRC, and is machinable in the annealed condition. D2 steel shows little distortion on correct hardening. D2 steel's high chromium content gives it mild corrosion resisting properties in the hardened condition.

TABLE I. Chemical Composition D2 Material

C	Si	Cr	Mo	V
1.50%	0.30%	12%	0.80%	0.90%

TABLE II. Mechanical Properties of D2 Material

Properties	**Value**	**Units**
Elastic Modulus	210000	N/mm^2
Poisons 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 Expansion Coefficient	$1.04X10^{-5}$	/K
Thermal Conductivity	20	W/(m-K)
Specific Heat	460	J/(Kg-K)

IV. Blanking Tool

According to sequence of operations planned the initial process to be carried out is blanking. Shear force required to blank the sheet is calculated according to the formula and based on that press tonnage is determined. Press tonnage means total capacity of the machine to be selected for blanking considering all the criteria. Clearance is calculated and incorporated in designing of punch and die.

A. Shear Force Calculation

Shear Force=L x T x τ (1)
= 309.5 x 2x 56
= 34664 Kg
L= Length of Cut in mm (From CAD Data)
T= Thickness in mm
τ= Shear Strength in Kg/mm^2

B. Stripping Force

Stripping Force=20% of Total Shear Force (2)

$$= \frac{20}{100} \times 34664$$
= 6932.8 Kg

C. Press Force

Press Force= Total Shear Force + Stripping Force
= 34664 + 6932.8
= 415968 Kg
≈ 41.5968 Tons

D. Press Tonnage

Press Capacity

$$= \frac{\text{Total Sum of shear force+Stripping Force}}{70\%} \quad (3)$$

$$= \frac{41.5968}{0.7}$$
= 60 Tons

E. Clearance Calculation

Clearance=0.005xtx√fs (4)
=0.005 x 2 x √56
=0.07mm/side
t=Thickness in mm
fs=Shear Force in Kg/mm^2

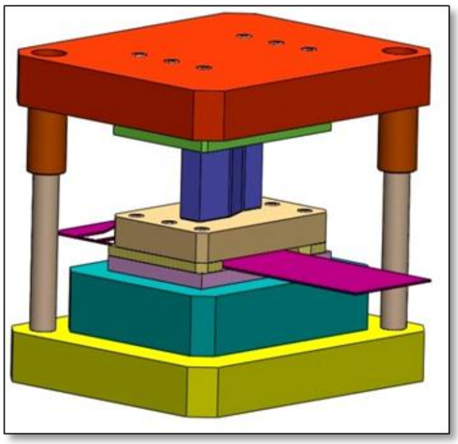


Fig 3: 3D Model of Blanking Tool

V. Bending Tool

Bending is the second operation that is carried out. Total force required to bend the sheet metal is calculated using the formula. The type of bending is Z bending which is similar to V bending. Spring back is considered and necessary excess bend angle is provided which is called as over bending technique.

$$\text{Bending Force} = \frac{C \times Su \times W \times t2}{L} \quad (5)$$

$$= \frac{0.1 \times 65 \times 30 \times 22}{75}$$

=22 Tons

L =Width of Die Opening in mm
Su=Tensile Strength in Kg/mm^2
W= Width of Sheet at bend in mm
t = Thickness of Sheet in mm
$C = \frac{4t}{L}$

$$\text{Press Selection} = \frac{\text{Bending Force}}{\text{Press Efficiency}} \quad (6)$$

$$= \frac{22}{0.7}$$

=32 Tons

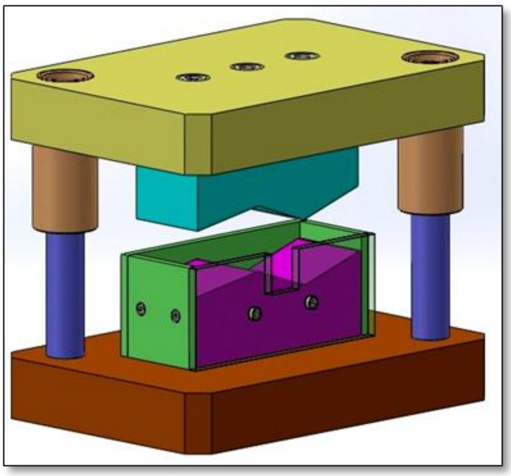


Fig 4: 3D Model of Bending Tool

VI. 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. Usually D2 or OHNS (oil hardened non shrinking steel) material is used for punch and die. It is very essential to carry out the analysis in order to prevent practical tryouts. Tryouts are always costly and also time consuming, instead if the parts are analyzed using 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.

A. Die Analysis of Blanking Tool

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

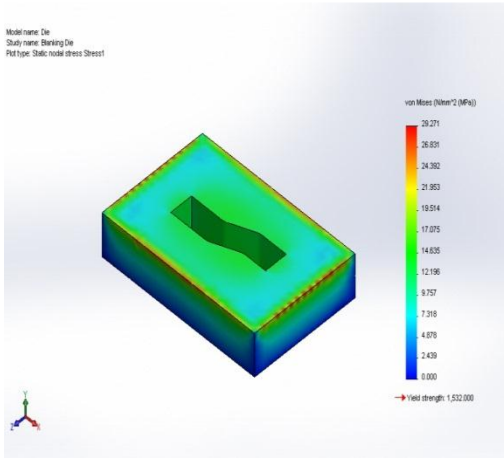


Fig 5**.** Static Stress Analysis of Blanking Die

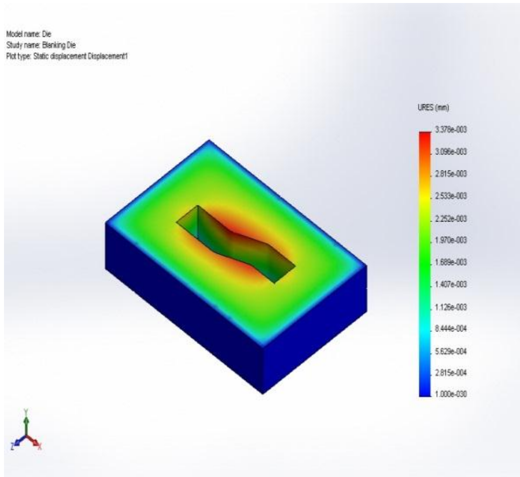


Fig 6**.** Static Displacement Analysis of Blanking Die

B. Punch Analysis of Blanking Tool

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

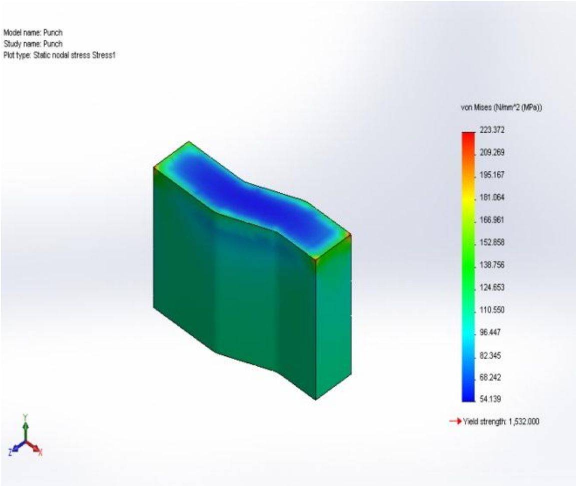


Fig 7. Static Stress Analysis of Blanking Punch

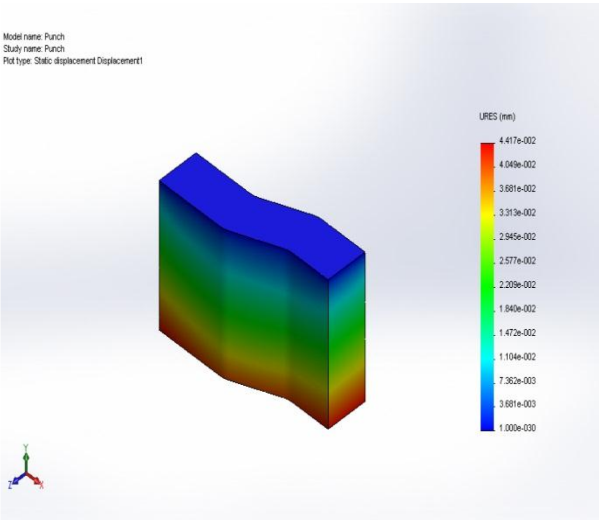


Fig 8. Static Displacement Analysis of Blanking Punch

C. Analysis Result Table of Blanking Tool

The analyzed results of punch and die are listed in the below table.

Table III. Maximum Stress distribution in punch and die of blanking tool

Sl. No	Type	Value	Unit
1	Die	29.271	N/mm^2
2	Punch	223.372	N/mm^2

Table IV. Maximum displacement of punch and die of blanking tool

Sl. No	Type	Value	Unit
1	Die	0.003	mm
2	Punch	0.04	mm

D. Die Analysis of Bending Tool

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

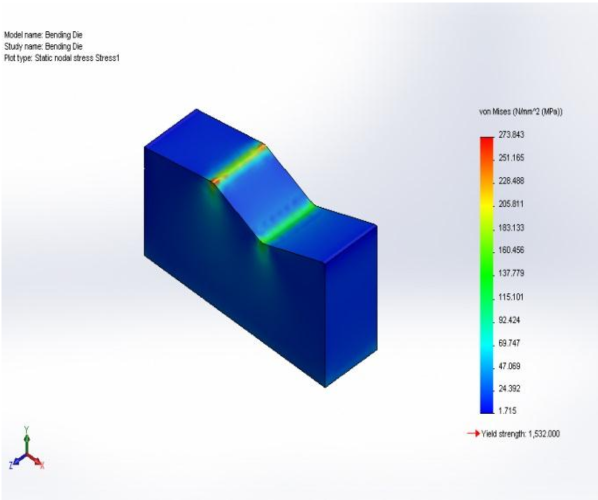


Fig 9. Static Stress Analysis of Bending Die

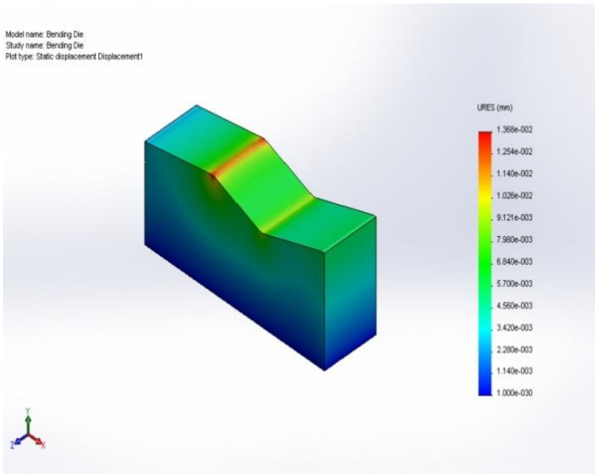


Fig 10. Static Displacement Analysis of Bending Die

E. Punch Analysis of Bending Tool

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

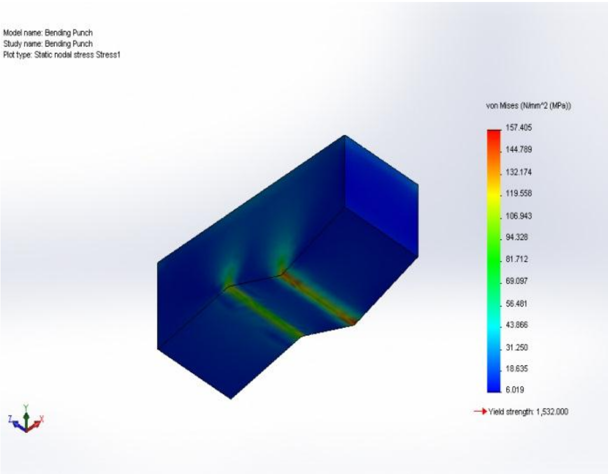
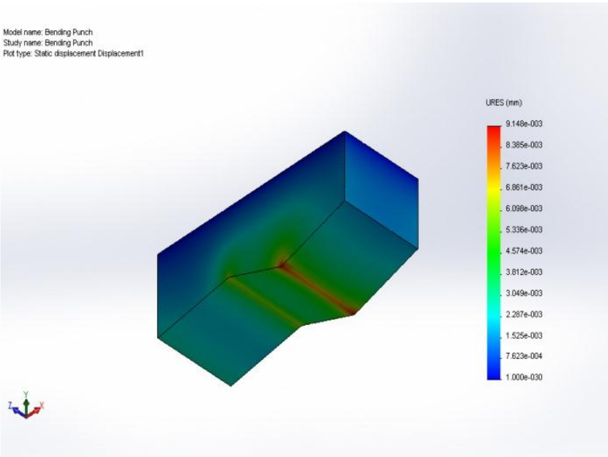


Fig 11. Static Stress Analysis of Bending Punch



F.Analysis Result Table of Bending Tool

Fig12. Static Displacement Analysis of Bending Punch

Table V. Maximum Stress distribution in punch and die of bending tool

Sl. No	Type	Value	Unit
1	Die	273.843	N/mm^2
2	Punch	157.405	N/mm^2

Table VI. Maximum displacement of punch and die of bending tool

Sl. No	Type	Value	Unit
1	Die	0.001	mm
2	Punch	0.009	mm

VII. CONCLUSION

In this work some significant aspects of press tool design for anchor bracket 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. The results reveal that by integrating CAD/CAE will be highly beneficial. By the implementation of computer in design, accuracy of design is improved and design process time is reduced drastically than by traditional method. Many design problems which are complicated to eliminate by traditional methods are eliminated by using CAD system.

VIII. ACKNOWLEDGEMENT

I am Anudeep S, 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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