Design and Analysis of Die for Brake Hose Bracket

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Abstract. One of the promising methods for the manufacture of complex shapes is the Sheet Metal Forming process. The Brake hose bracket is made using this process using several procedures for its manufacture. In this work, the processes carried out for the manufacturing of Brake hose bracket has been studied using Finite Element Analysis carried out using commercial analysis software, ANSYS. The making of the Die and Punch for the manufacture of the Sheet metal forming process of brake hose bracket. The bracket is made of mild steel material and the results were obtained and were in good agreement with that of the experimental values. The Stress distribution, Strain distribution and deformation experienced by the component and the die cavity during manufacturing process has been investigated and the conclusion were made. The FEM method proves to be efficient in understanding the stress and strain distribution in the component.

1. Introduction

The sheet metal forming is a process of producing different shapes for the components to be used for a purpose. The sheet metal forming process proves to be promising in the production of complex shapes for the components [1-3]. The Dies used for the forming process must possess certain high mechanical properties such as hardness, tensile strength, durability, etc. For this purpose, several analyses were carried out for the understanding of the material properties [4]. However, these analyses were done usually by the trial and error method at a slower rate. During the development of the Die, the cycle time for the development is directly influenced by the reduction of number of trials. For the analysis purpose, the ANSYS commercial software, from which number of trials may be reduced. The Numerical simulation of stamping process provides the necessary modifications needed for the development of a
simplified and productive die [5-7]. This paper investigates the various methodologies carried out for the development of a productive die.

2. Methodologies

Figure 1. Brake hose bracket component

![Figure 1](image.png)

Figure 2. Process flow chart

The production of the die is done by several processes such as blanking, forming, piercing, dimpling, etc. On performing these processes carefully, a simplified and productive die for the forming process may be obtained [8].

2.1. Blanking

The first process for the brake hose bracket is the blanking process. It is a process of cutting out the required shape of workpiece from the sheet metal using the die and the cavity. The required calculations are done for the required dimension and is further processed for the required shape of the brake hose bracket [9].

2.2. Forming

The first forming process is the process for making the collar shape of left and right components of brake hose bracket. In this process the left and right side of the brake hose bracket is made using a single punch. The forming process is one of the manufacturing processes which makes use of the stresses to produce plastic deformation to provide the required shapes during the forming processes. The major advantage in the process is that there is no material is removed during the process i.e., there is no material
wastage [10]. The forming process is generally referred as the process of beating with a hammer, squeezing, bending, pulling and pushing through a hole, etc. The second forming is used to make the bending shape of left and right side of components of brake hose bracket. The process is done by using a single punch to make the brake hose bracket. Bending is the process of producing V-shape, U-shape or channel shape along a straight axis in ductile materials mostly in sheet metals. The forming processes includes various operations, where the primary means of plastic deformation is a shearing load. The required calculations were made for the fabrication of the brake hose bracket.

2.3. Piercing
The first piercing process is done to cut and remove the unwanted part of the component. Piercing is a shearing process used to create a hole in sheet metal using a punch and die. The piercing process follows the same process flow and machinery as that of blanking except that the pierce being punched out is scrap in the piercing process. The various types of piercing processes include the lancing, perforating, notching, nibbling, shaving, cutoff and dinking. The thickness and strength of the workpiece material governs the amount of clearance between the punch and the die [11]. The load or pressure experienced at the cutting edge of the tool is determined by the punch-die clearance value. The second piercing process contain the pierced hole for one side, the whole piercing process will be completed. Piercing is a metal forging technique used along with some other forging processes during the manufacturing process of a part. The process is used to create a cavity pressed into the work. The piercing process affects the material properties and the grain structure of the material after the piercing process is completed.

2.4. Dimpling
The dimpling process involves the dimpling of a rolled flat strip prior to the roll forming process. The appropriate combination of dies to be used is indicated in the charts specified by the manufacture. In order to dimple a hole in the workpiece, the material is placed on the female die and then the male die is inserted in the hole to be dimpled. The mechanical force or pneumatic force is used to bring the dies together.

![Component after each process](image_url)
3. 3D modeling
The 3D modeling is done using the 3D modeling software ANSYS. The 3D model of the cavity and punch are designed as shown in figure 2 and figure 3.

Figure 4. Design of Cavity

Figure 5. Design of Punch

Figure 6. Assembly of punch and cavity
The analysis is done using ANSYS commercial software. The material properties are given as per the default material properties as defined in ANSYS material library. The analysis is done for Mild steel as shown in table 1.

| Properties          | Mild Steel |
|---------------------|------------|
| Density             | 7870       |
| Young’s modulus     | 1.4e+011   |
| Poisson’s Ratio     | 0.29       |
| Bulk modulus        | 1.1111e+011|
| Shear modulus       | 5.4264e+010|

Then the analysis model is modelled using static structural and the boundary conditions are provided for the simulation of Brake hose bracket manufacturing process. Then the Meshing process is done for the 3D model in ANSYS software as shown in figure 7.

![3D Mesh of punch and die assembly](image)

**Figure 7.** 3D Mesh of punch and die assembly

4. Results and Discussions
The analysis is carried out and the results were obtained and were interpreted and conclusions are drawn. The results were obtained for Equivalent Elastic Strain, Total Deformation, Directional Deformation, Equivalent (Von- Mises) stress, Maximum shear elastic strain. The results were shown in table 2.

| Material properties                      | Results          |
|------------------------------------------|------------------|
| Equivalent Elastic Strain (m/m)          | 9.5141e007       |
| Total Deformation (m)                    | 2.6729e008       |
| Directional Deformation (m)              | 6.1172e009       |
| Equivalent (Von- Mises) stress (Pa)      | 1.181e+005       |
| Maximum shear elastic strain (m/m)       | 1.0272 e006      |
Figure 8. Equivalent stress for mild steel

Figure 9. Equivalent stress experienced by die cavity

Figure 10. Total Equivalent Elastic Strain
Figure 11. Shear elastic strain

Figure 12. Directional Deformation

Figure 13. Total Deformation
The results obtained from the 3D analysis is interpreted and conclusions were drawn. The stress and strain distribution for the mild steel material during the process is simulated through the numerical analysis and the results were in good agreement with the efficiency of the process.

5. Conclusion

The sheet metal forming process is used to make the brake hose bracket for which Finite Element Analysis is carried out to understand the stress and strain distribution, deformation of the die cavity, etc. The results show that the sheet metal forming process can be used as a method for the manufacture of brake hose bracket.

The mild steel material is efficient in its performance as used for brake hose bracket. The material showed the results as of well within the deformation limit.

The processes followed for the manufacturing of the brake hose bracket is found to be in good agreement with the time consumption and the accuracy and ease of manufacturing of the product.

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