# Study of Factors Affecting the Springback Angle and its Analysis using HYPERFORM

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*Abstract*— Springback is the geometric change made to a part at the end of the forming process. This happens when the part has been released from the forces of the forming tool and due to uneven force distribution along the cross section. During the development of tools, Springback is compensated by software in order to remove the component from the tool to get the required dimensions. As a result, intense tryout loops that occur at a very late stage in the development of the tool can be reduced to a minimum. Simulation software can not only detect Springback early on, it can also compensate for it. This paper gives the prediction of Springback for an automotive component named Bracket Shock Absorber mounting used in automotives. In this research the material properties for E 34 are used. Sheet metal with different thicknesses such as 5, 4 and 3 mm are used. Also different die radius such as 5, 4 and 3 mm are used. The effects of these parameters on sheet metal are studied and Springback is investigated.

***Key words:*** Die Radius, HYPERFORM, Springback Angle, Thickness

## I. INTRODUCTION

Springback refers to elastic recovery of non uniform stress distribution in a deformed part after the removal of bending forces. Finite element simulation of sheet metal forming is an efficient tool which issued in industrial practice especially in Stamping die Production, to eject the geometrical defects caused due to elastic Springback. This phenomenon results in a change of the actual designed part geometry from that desired in the design phase and hence can cause significant problems during assembly. In order to keep the product development time and manufacturing Costs low, Finite Element Analysis (FEA) aims to provide reliable information required for the desired modification of tool and product geometry, before the tool manufacturing. Therefore, the accurate information obtained from the numerical simulation of Springback is essential for the development Engineers.

In this paper, the Springback analysis (elasticity of sheet metal after forming) of sheet metal components made up of High Strength Steels (HSS) is studied. A sheet metal component from automobile is chosen for analysis. The analysis of Bracket Shock Absorber mounting is carried out. Using HYPERFORM simulation, Springback analysis of sheet metal formed component by applying different materials for analysis is performed. The actual tool profile in the analysis is represented by Computer-Aided Design (CAD) model of the tool geometry. Springs back are checked in the finite element analysis.

The material used for HYPERFORM analysis is E 34 which is a HSS. Effect of parameters such as the effect of change in thickness of the geometry and the effect of change in the die radius has been studied and Springback is predicted.

## II. LITARATURE SURVEY

S. Gawade and V.M.Nandedkar [1] presented a study of the factors affecting the Springback such as sheet thickness, material properties along with the tooling geometry etc. The paper also reviews the various parameters affecting Springback like ratio of die radius to the sheet thickness, blank holder force, coefficient of friction etc. predict the effect of these parameters on formability of a trapezoidal cup using Altair HYPERFORM radios predictive tool

A. Lokhande, V.M Nandedkar.[2], studied the variations in the mechanical and dimensional properties of the incoming material, lubrication and other forming process parameters that cause Springback variation. They examined the behavior of sheet metals of different thickness' subjected to different blank holding forces and also studied their Springback behavior.

S B Chikalthankar, G D Belurkar et al[3] This paper reviews the various parameters affecting Springback such as punch angle, grain direction of sheet metal material, die opening, ratio of die radius to sheet thickness, sheet thickness, punch radius, punch height, coining force, pre bend condition of strip etc.

Vorkov,R. Aerens,D.Vandepitte et al [4], studied the Springback analysis of different types of HSS using the FEM element modeling using two standard types of elements; shell elements and solid elements. The calculations were used in commercial FEM software, Abaqus. They implemented a model to predict precise Springback and found out the accuracy in the function of the number of elements through the thickness. They also measured the deflections in the sheet during and after bending to study the effect of Springback on the sheet metal.

## III. MODELLING OF SPRINGBACK

Springback is affected by various factors as Die radius, Sheet thickness, Blank holder force, etc. Springback effect is a major cause of concern for sheet metal forming industries which leads to inaccuracies in the final product produced and eventually leads to problems in assembly. The problem being taken for the project is to study the effect of Springback phenomenon on material E 34 using various parameters and validate the results. The study accounts for various controlling parameters for the parameters that affect the Springback angle . The material is used with three different thicknesses as 5, 4 and 3 mm. The material composition and properties are shown in table1 and 2.

| C | Mn | P | S | AL | SI | Nb | Ti | V |
|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.7 | 0.03 | 0.03 | 0.03 | 0.2 | 0.055 | 0.045 | 0.095 |

Table 1: Chemical composition for E 34

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| K (GPa) | N | E (GPa) | μ | ρ (Kg/mm³) | UTS(GPa) | YS (GPa) |
|---|---|---|---|---|---|---|
| 0.854 | 0.18 | 210 | 0.3 | 7.8 x 10-6 | 0.4-0.5 | 0.3 |

Table 2: Material Properties for E 34

## IV. SIMULATION CONDITIONS

The CAD model or tool model of bracket shock absorber mounting has been prepared in CATIA V5 R22. In further process this tool model will be migrated into IGES format and meshing of punch,die and blank will be done by choosing appropriate mesh size,followed by defining the suitable parameters and simulated in HYPERFORM 14.0 for various sheet metal materials and thickness. Number of iterations would be done till the desired result achieved.Using the results achieved a suitable material will be selected. A prototype tool will be manufactured with the new material and tryout will be carried out on hydraulic press and validating and comparing the result with pressed component. The FEM simulation was performed using HYPERFORM. The FEA model with geometries of tool and initial sheet blank are given in fig.1. A sheet of material E 34 having variable thickness was used as the blank sheet material. CAD model of existing chassis has been prepared in CATIA V5. CAD model data is migrated into HYPERFORM, for meshing. This tool model will be migrated into IGES format and meshing of punch,die and blank will be done by choosing appropriate mesh size,followed by defining the suitable parameters and simulated in HYPERFORM 12.0 for various Sheet metal materials and thickness. The finite element analysis is carried out on HSS and materials E 34. From the analysis max Springback value and angles are evaluated. The tool description along with its weight and size is shown in Table 3. The load conditions applied are mentioned in Table 4

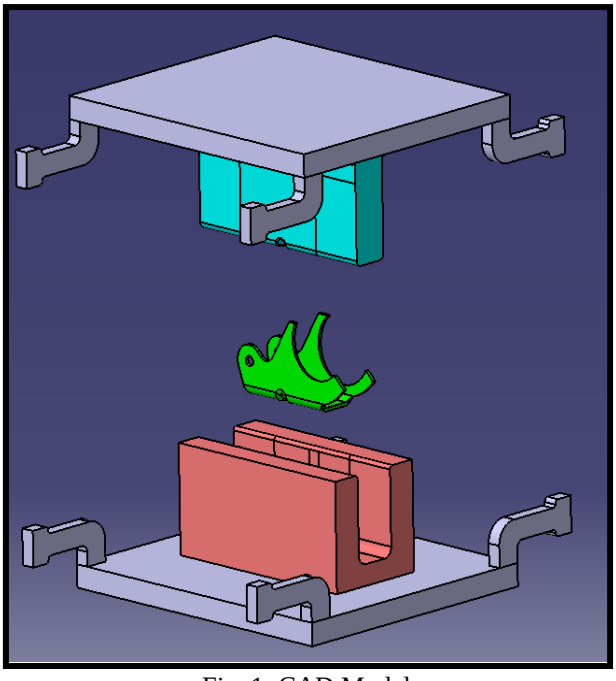


Fig. 1: CAD Model

| Sr No | Description | Weight(T) | Size (Mm) |
|---|---|---|---|
| 1 | Punch | 0.024 | 300*170*63 |
| 2 | Die | 0.039 | 300*180*60 |
| 3 | Top Plate | 0.049 | 450*400*32 |
| 4 | Base Plate | 0.049 | 450*400*32 |
| | Total Weight | 0.161 | |

Table 3: Total Weight of the tool

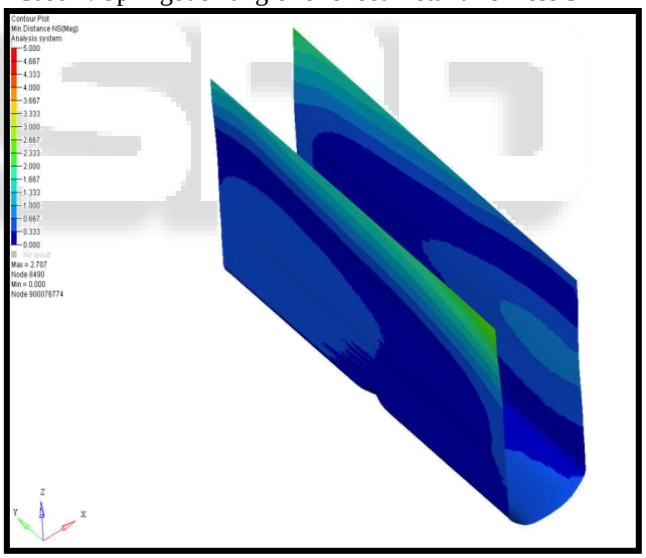
| | |
|---|---|
| Draw Force | 68 T |
| Tryout press | 300T |
| Blank Size | 300*275*5 Thk |

Table 4: Load Conditions Applied

## V. RESULTS AND DISCUSSIONS

The analysis of the component is carried out using HYPERFORM. Altair HYPERFORM is a comprehensive finite-element-based sheet metal forming simulation framework. Its unique process-oriented environment captures the forming process with a suite of highly tailored and configurable analysis and simulation tools. HYPERFORM delivers a cost-effective solution that allows users to develop an optimal manufacturing process. The analysis of the automotive component by using HSS material E 34 showed for varying thickness 5, 4 and 3 mm. In fig.2 the Springback analysis result and Springback angle for the material E 34 having thickness 5 mm is shown.

Case 1: Springback angle for sheet metal thickness 5 mm



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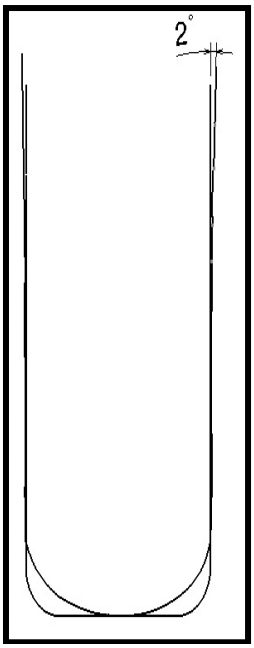


[1]

Fig. 2: Springback angle for sheet metal thickness 5 mm

In fig.3 the Springback analysis result and Springback angle for the material E 34 having thickness 4 mm is shown

Case 2: Springback angle for sheet metal thickness 4 mm

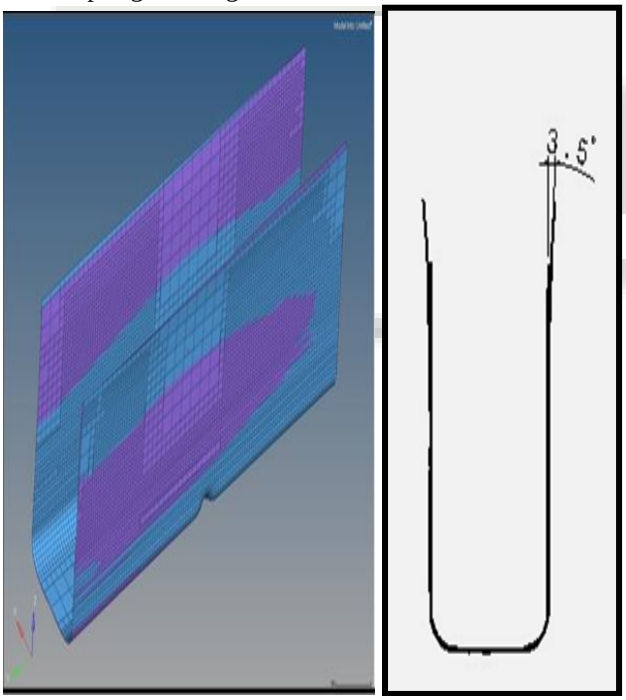


Fig. 3: Springback angle for sheet metal thickness 4 mm

In fig.4 the Springback analysis result and Springback angle for the material E 34 having thickness 3 mm is shown.

Case 3: Springback angle for sheet metal thickness 3 mm

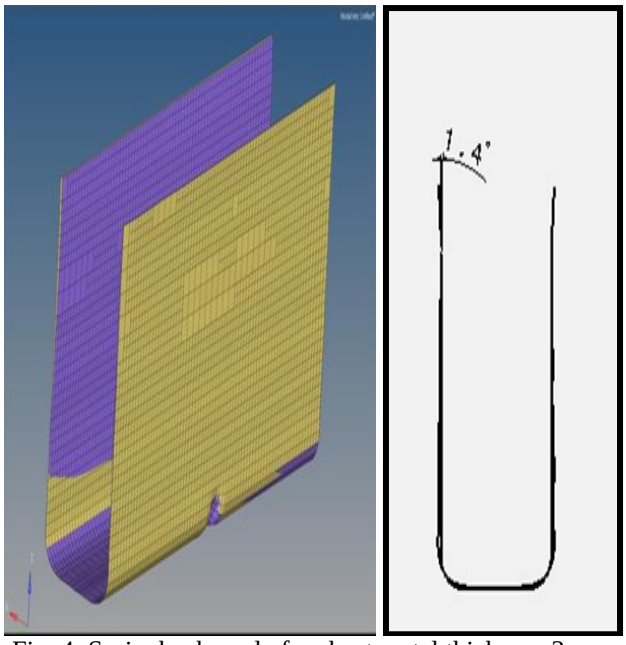


Fig. 4: Springback angle for sheet metal thickness 3 mm

The change in Die Radius is also one of the factors that affect the Springback angle. The HYPERFORM analysis for varying Die Radius i.e 5, 4 and 3 mm are shown in the results below

In fig.5 the Springback analysis and the Springback angle for die radius 5 mm is shown

Case 1: Springback angle for die radius 5 mm

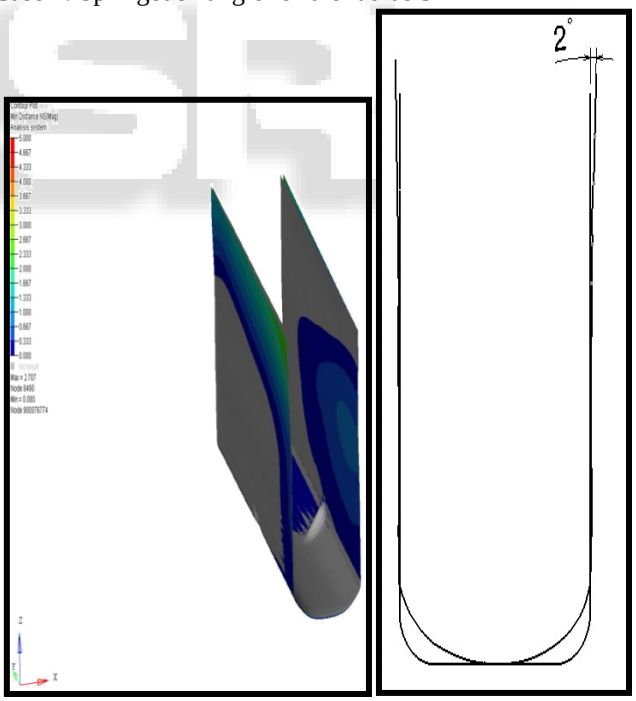


Fig. 5: Springback angle for die radius 5 mm.

In fig.6 the Springback analysis and the Springback angle for die radius 4 mm is shown

Case 2: Springback angle for die radius 4 mm

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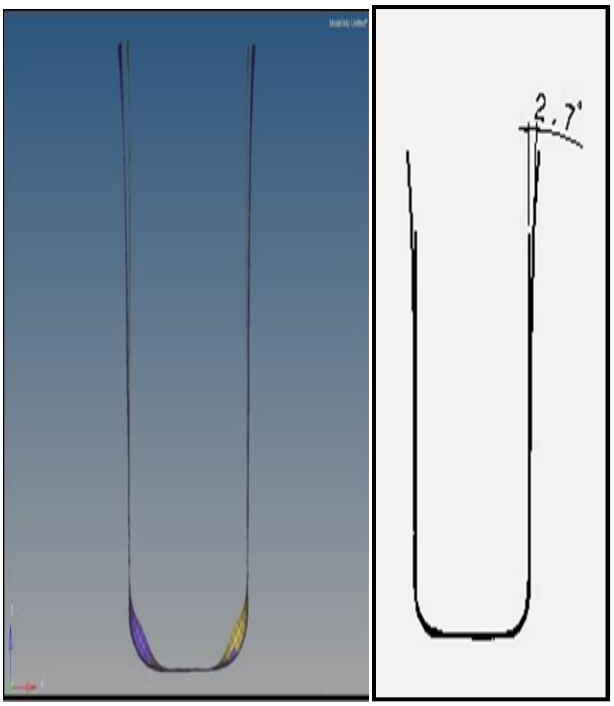



Fig. 6: Springback angle for Die radius 4 mm

In fig.7 the Springback analysis result and the Springback angle for die radius 3 mm is shown.

Case 3: Springback angle for die radius 3 mm

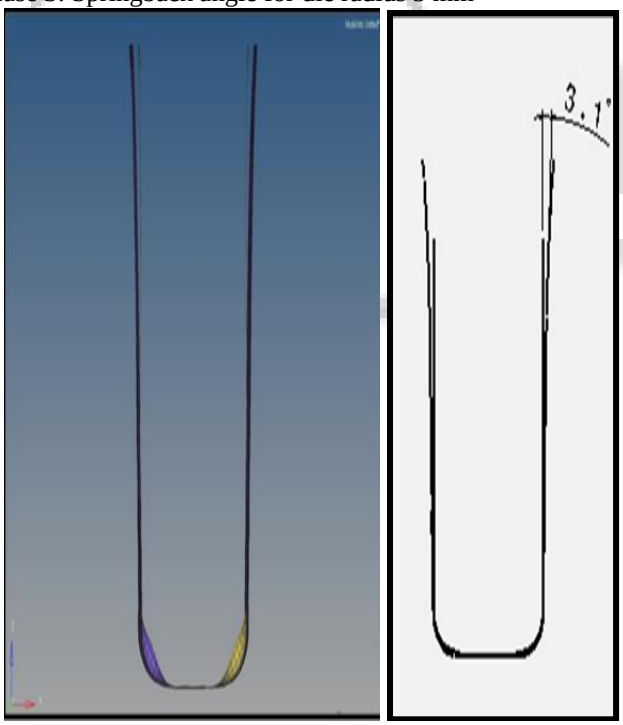



Fig. 7: Springback angle for die radius 3 mm

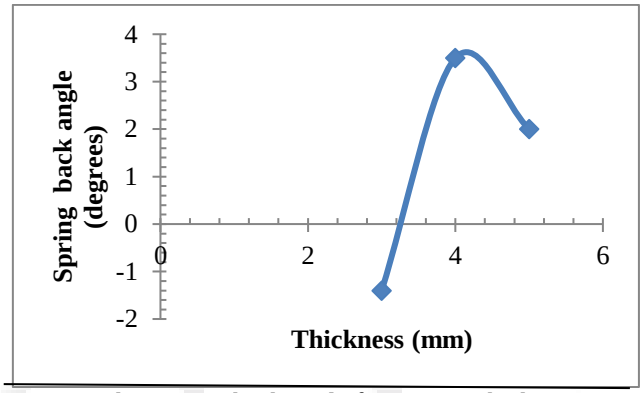
In table 5, the analysis results of the Springback angle for different thicknesses and die radius has been shown.

| SR No | Thickness (mm) | Die radius (mm) | Springback angle |
|---|---|---|---|
| 1. | 5 | 5 | 2˚ |
| 2. | 4 | 5 | 3.5˚ |
| | | | |
| 3. | 3 | 5 | -1.4˚ |
| 4. | 5 | 5 | 2˚ |
| 5. | 5 | 4 | 2.7˚ |
| 6. | 5 | 3 | 3.1˚ |

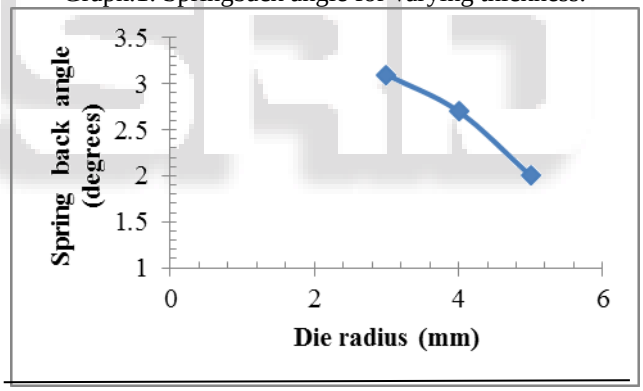
TABLE 5: Analysis Result Table

*A. Graphical Representation of Analytical Results:*

Graph 1 and 2 represents the Springback analysis for varying thicknesses and die radius respectively. In graph 1, it can be seen that the Springback angle increases with the increase in thickness. In graph 2, it can be seen that the Springback angle increases with the increase in the die radius




Graph.1. Springback angle for varying thickness.




Graph. 2: Springback angle for varying die radius.

## VI. CONCLUSION

In forming process, due to the plastic-elastic characteristic of metals it is typical that any deformation of sheet metal will have both elastic and plastic deformation. After the metal work piece is removed from the tool or deformation implement that the elastic deformation will be released and only the plastic deformation remain. When a metal forming tool is planned and designed to deform a work piece, the shape imparted by the tool will be a combination of elastic and plastic deformation, the release of the elastic deformation is the Springback often observed at the end of a metal forming process. The Springback has to be compensated to achieve an accurate result. In this paper, the Springback behavior of the automotive component by applying HSS material E 34 is studied. FEA Study has been done with help of HYPERFORM 12.0. Using HYPERFORM the behavior of the sheet metals for varying thickness and varying die radius is studied. After HYPERFORM simulation we can see that

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the Springback angle increases with the decrease in the thickness. Also due to varying die radius i.e. the decrease in the die radius increases the Springback angle.

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