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Effects of Process Parameters And Investigation Of Springback Using Finite Element Analysis

Arati M. Lokhande[1], Dr. Vilas M. Nandedkar[2]
[1]Department Of Mechanical Engineering, KGCE, Karjat
[2]Department Of Mechanical Engineering, SGGSIE&T, Nanded

***Abstract*— One of the most sensitive features of sheet metal forming is the elastic recovery during unloading called springback. Sheet metals are prone to some amount of springback depending on elastic deformation. Variations in the mechanical and dimensional properties of the incoming material, lubrication and other forming process parameters are the main causes of springback variation. Accurate prediction and controlling of springback is essential in the design of tools for sheet metal forming. This paper gives the prediction of springback for U bending using FEA. In this research the material properties for IS513D are used. Sheet metal with four different thicknesses such as 0.7, 0.8, 0.9, 1.0mm are used. Also four different blankholder forces are used. The effects of these parameters on sheet metal are studied and springback is investigated.**

***Keywords*— FEA, blankholder force, sheet thickness, springback, U- bending**

I. INTRODUCTION

Sheet metal forming is one of the most common manufacturing processes for used parts in various industries like inner and outer panels and stiffeners in automotive and aeronautic industries, food cans and civil engineering applications. Wide range of these products should satisfy tight tolerances compared to desired geometry. Considering high cost of tools and product in sheet forming processes, detection and controlling disturbing factors for producing precise product is so important. In most processes, geometry and configuration of die components could be obtained from the geometry of product at the end of loading. Therefore elastic recovery of formed part in unloading, known as springback is the most important factor in deviation of final product from desired geometry. Fig. 1 shows springback.

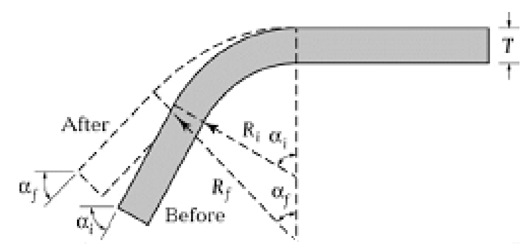

Figure 1: Springback[8]

α_i: bend angle before springback
α_f: bend angle after springback
R_i: bend radius before springback
R_f: bend radius after springback

Bhadpiroon Sresomroeng, Pakorn Chumrum, Jiraporn Sripraserd and Varunee Premanond [1] developed an AutoForm model is for prediction of springaback and side wall curl of new material such as AHSS in U-bending process related to springback phenomenon. Gang Liu, Zhongqin Lin, Youxia Bao, and J. Cao [2] studied the effect of variable blankholder force in the forming process to reduce springback. M. Kadkhodayan, I. Zafarparandeh [3] studied the relation of the blank-holder force and final springback, taking a benchmark of NUMISHEET'93 2-D draw bending and using a commercial FEM code. A. Behrouzi, M. Shakeri, B. Mollaei Dariani [4] presented an algorithm for inverse springback modelling using bending theory and FE modelling. M. Safaei, W. De Waele, M. Abdel Wahab, P. De Baets [5] proposed a series of finite element analyses using the Hill's 48 transverse anisotropic yield model and a standard U-shape forming test based on NUMISHEET'93 has been performed.

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Yanshan Lou, Jin Sung Kim, Hoon Huh and Sung-Ho Park [6] investigated the springback characteristics during a sheet metal forming process using the unconstrained cylindrical bending test based on NUMISHEET2002 proceedings. Peng Chen, Muammer Koc[7], used the Design of experiment (DOE) and finite element analysis (FEA) approach for the variation simulation and analysis of the springback for advanced high strength steel (AHSS) parts. Gawade Sharad [8] studied the effect of sheet thickness on springback. This research gives the prediction of springback for U bending.

II. Modelling Of Springback

Springback is affected by various factors as Die radius,Sheet thickness, Blankholder 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 IS 513D using various parameters and validate the results. The study accounts for various controlling parameters for springback .

The material used is IS 513D for the header of side wall (U bending) used in automobile vehicle panel. The material is used with three different thicknesses as 0.7mm, 0.8mm, 0.9mm, 1.0mm. The material composition and properties are shown in table1 and 2.

TABLE 1
Chemical Composition for IS513D

C	M	P	S
0.12%	0.50%	0.04%	0.04%

TABLE 2
Material Properties for IS513D

Yield stress (MPa)	Ultimate Tensile Stress (MPa)	K (MPa)	n	Coefficient Of Friction
196	293	600	0.20	0.125

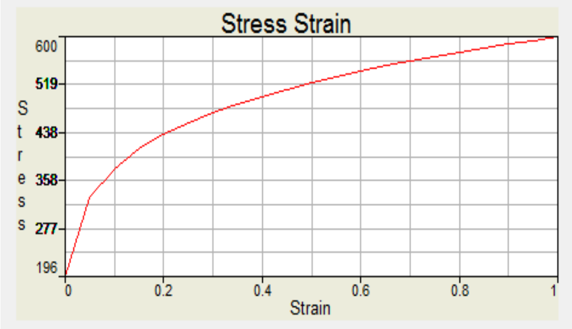


Figure 2 Stress Strain Curve for IS 513D

III. Simulation Conditions

The FEM simulation was performed using Hyperform. The FE model with geometries of tool and initial sheet blank are given in Fig. 3. An IS 513D sheet of variable thickness, was used as the blank sheet material. The initial rectangular blank size of 210 mm in length is employed.

Here bending process is simulated using FE software hyperform and Radioss. The simulation modelling is shown in fig. 4. In the simulation, die radius is maintained constant as 5 mm and the sheet thickness and BHF varies. The results are obtained for various thicknesses as 0.7mm, 0.8mm, 0.9mm, 1.0mm and various BHF ranging from 1KN to 7.5 KN.

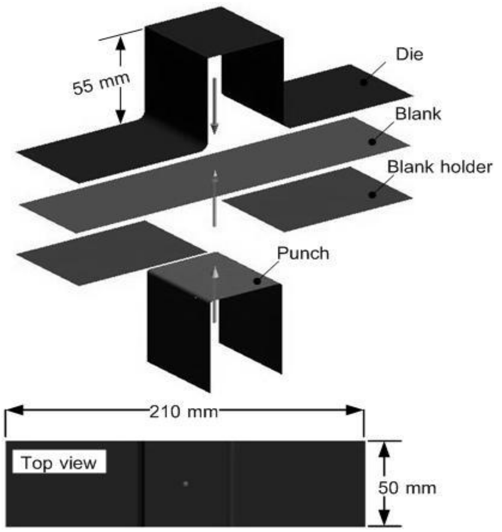


Figure 3 Initial Blank Sheet [1]

TABLE 3
PROCESS PARAMETERS FOR SIMULATION

Process Parameters	Values
Die Radius (mm)	5
Blank Force (KN)	1, 2.5* ,5, 7.5
Blank Thickness (mm)	0.7, 0.8*, 0.9, 1.0

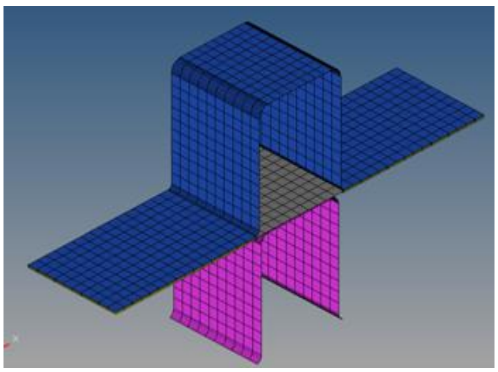


Figure 4 Modelled Die And Punch

IV. RESULT AND DISCUSSION

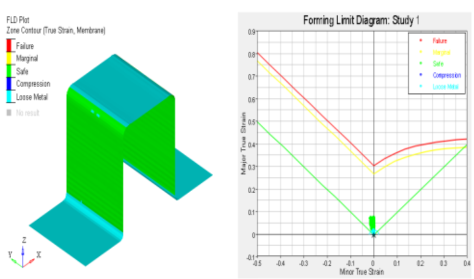


Figure 5 Forming Limit Diagram

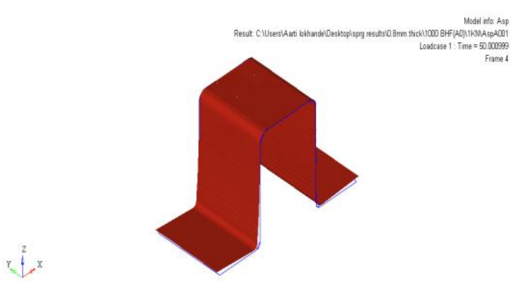
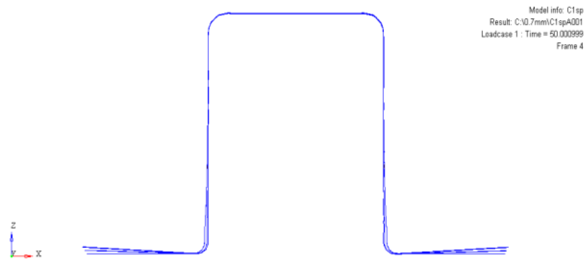
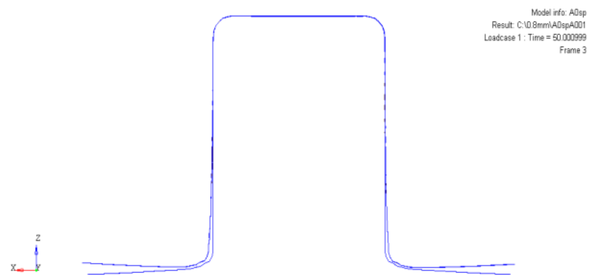


Figure 6 Springback

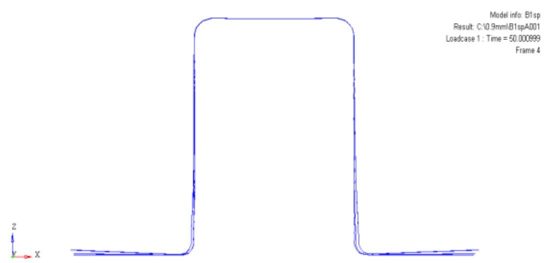
Results for variable sheet thickness



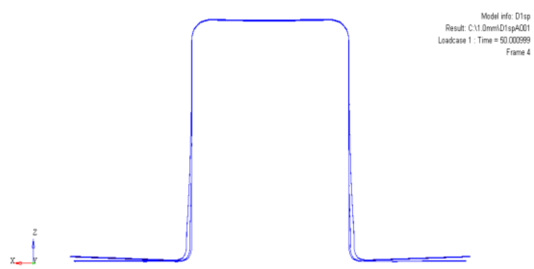
0.7mm sheet thickness



0.8mm sheet thickness



0.9mm sheet thickness



1.0mm sheet thickness

The process is simulated for various sheet thicknesses. The simulation results show changes in the component with changes in sheet thickness. The sheet thickness is varied from 0.7mm to 1.0mm.

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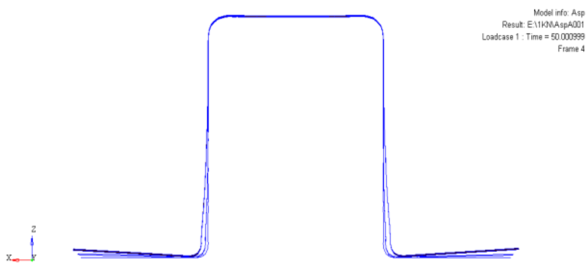
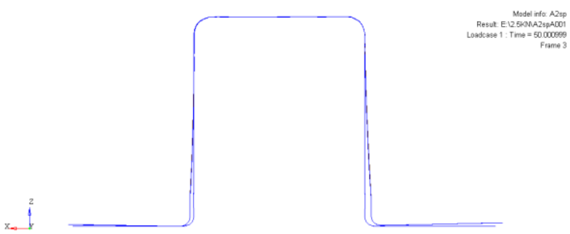
It is seen that this factor has a deep effect on springback and springback varies along with it. As the sheet thickness is increased it is found that there is an increase in the springback.

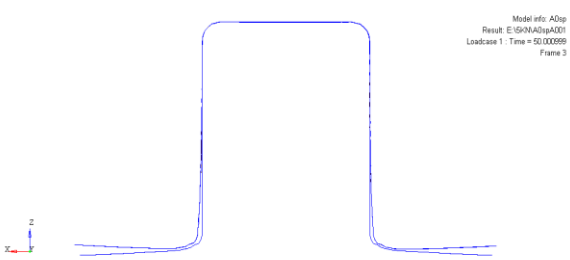
Results for variable Blank holder Force



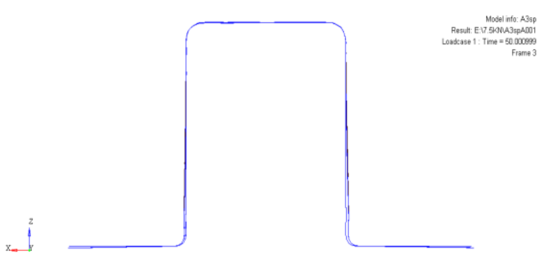
1KN BHF



2.5 KN BHF



5 KN BHF



7.5 KN BHF

The process is simulated for various blank holder forces. The simulation results show changes in the component with changes in blank holder forces. Blank holder forces are varied from 1 to 7.5 KN. It is seen that this factor has a deep effect on springback and springback varies along with it. As the blank holder force is increased it is found that there is a decrease in the springback.

After performing springback analysis on different sheet thickness and different BHF, following graphs are observed.The results concluded from reference [8] are springback increases with sheet thickness and that from [1] are springback decreases with increasing BHF.

The graphs based on these parameters derive the conclusions.

V. Conclusion

In this study, the springback in material IS 513D in U-bending process was explored by investigating the effects of different design and process parameters, which include blank holder force and sheet thickness. A HyperForm model is developed for prediction of springaback in the material IS 513D in U-bending process related to springback phenomenon. The RADIOSS is used as the solver which shows the results. It is found that sheet thickness and blankholder force has an effect on springback.

Several conclusions can be drawn from the results of the study:

The finite element simulation provides a satisfactory prediction of springback results.

Increasing the applied blank holder force is one of the methods to reduce springback in industry. The same trend was also observed in FE simulations with Hyperform along with RADIOSS solver for springback. Thus, to demonstrate the reduction in springback with increasing blank holder force, the simulation was performed with different BHF (1 KN to 7.5 KN).

The springback increases with the sheet thickness. This is proved by varying the sheet thickness from 0.7mm to 1.0mm. as the thickness of sheet increases the springback also increases.

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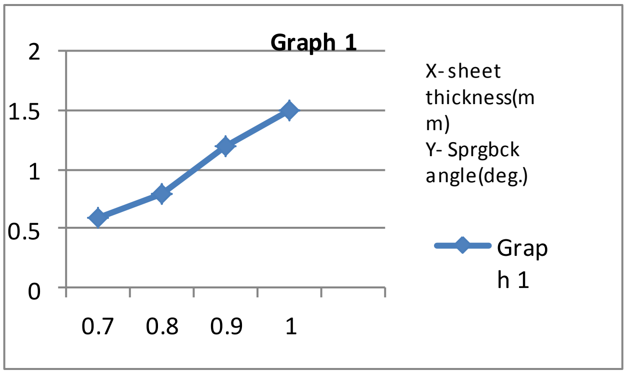
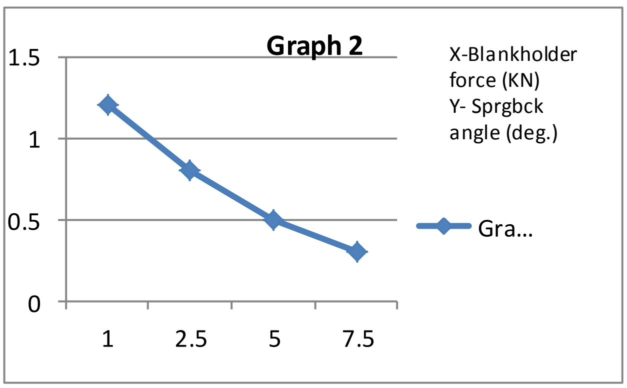


Graph 1: Sheet thickness Vs. Springback angle



Graph 2: Blank holder Force Vs. Springback angle

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