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Spring back in Sheet Metal Bending-A Review

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Abstract: *One of the most sensitive features of the sheet metal forming is the elastic recovery during unloading called spring back. Sheet metals are prone to some amount of spring back depending on elastic deformation. Obtaining the desired size, shape depends on the prediction of spring back. Accurate prediction and controlling of spring back is essential in the design of tools for sheet metal forming. The spring back is affected by the factors such as sheet thickness, material properties, tooling geometry etc. This paper reviews the various parameters affecting spring back such as ratio of die radius to sheet thickness, sheet thickness, blank holder force, coefficient of friction etc.*

Keywords: *Spring back, Sheet metal, Sheet thickness, FEA*

I.Introduction

Bending processes are used to form the sheet metals. These are very familiar processes used in the manufacturing of panel’s electronic components, drums, components of automobile vehicle panels etc. The major problem in bending process is the spring back or spring-go. The spring back is a complex phenomenon and it depends on process parameters and material parameters. A lot of research has been done to investigate the parameters affecting spring back and to reduce spring back.

Over bending is the simplest way of combating spring back problem, especially in V-die air bends. The work piece is bent through a greater angle than required and the work piece springs back to the required angle. Spring back for low –carbon and soft non ferrous material is from 0 to 2^0. For 0.40 to 0.50 carbon steel and half hard materials spring back may vary from 3 to 5^0. Spring back may be as high as 10 to 15^0 in the harder materials. These figures are only used as approximations because of other variables that influence spring back. The practical way to determine the necessary amount of over bend is trial and error method. In recent years the Finite Element Analysis is considered as an effective tool for the prediction of the spring back.[1]

II.Principle of spring back

The elastic stresses remaining in the bend area after bending pressure is released will cause a slight decrease in the bend angle. Metal movement in this type is known as spring back, as shown in figure 1. The magnitude of the movement will vary according to the material type, thickness and hardness. A larger bend radius will also cause grater spring back. [3] Commercially available finite element analysis (FEA) software is used to analyze bending and spring back of different aluminum materials of different thickness.

For forming process the material is stressed beyond elastic limit so that the permanent deformation takes place. The material state becomes the plastic deformation zone; hence the sheet metal can be formed. Figure 1 shows the principle of spring back.

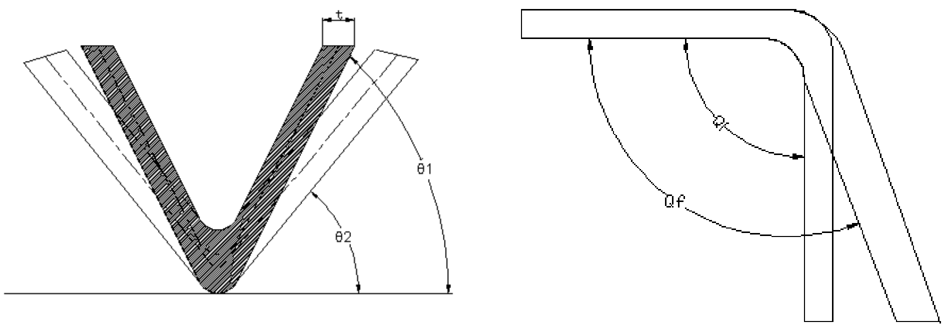

Figure 1. Principle of Spring back θ1> θ2 or (Qf>Qi)

III.Literature Review

3.1. Effect of ratio of die radius and the sheet thickness on spring back angle

Aysun Egrisogut Tiryaki et al. [4] studied the effect of ratio of die radius and thickness of the sheet. Ratio of the die radius and thickness of the sheet verses spring back angle, are plotted as shown in the figure 2. It is seen that after certain level the spring back effect increases as the R/t ratio increases. In order to investigate the effect of die radius and blank thickness on the spring back angle of flanging process, the following strategy was employed. Two groups of FE simulation models are generated with the identical R/t ratio that range between 1.0 and 5.0.

In this investigation, the first group the thickness is taken a constant and equal to 0.7 mm and the die radius is increased from 0.7 mm to 5.0 mm. In the second group the die radius is taken equal to 5 mm and the blank thickness is changed from 1.0 to 5.0. The material used in finite element simulation is High Strength Low Alloy (HSLA). The FE simulation response of spring back angle according to the determined sheet thickness and shoulder radius is reported. Also, using the result from the Case-G1 and Case-G2 of simulations, the graph of spring back angle against ratio of the die shoulder radius to sheet thickness is plotted, as shown in figure 2.

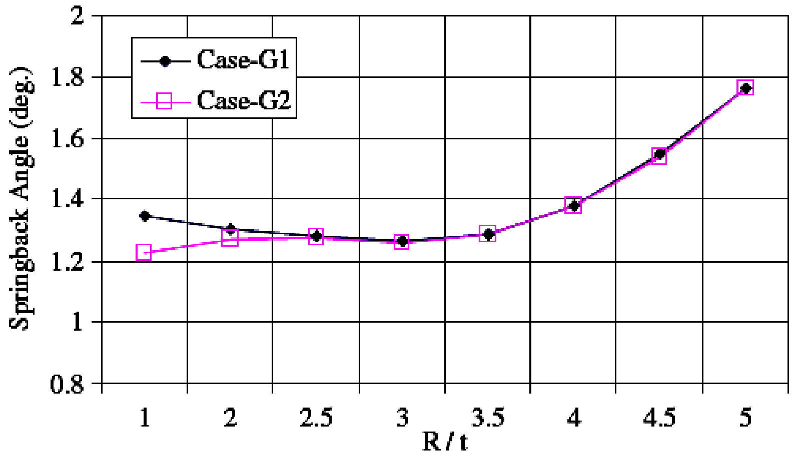

Figure 2. Effect of R/t on Spring back.

[Source-Prediction of spring back in wipe-bending process of sheet metal using neural network, Recep Kazan, Mehmet Fırat, Aysun Egrisogut Tiryaki]

3.2. Effect of sheet thickness on spring back

The effect the sheet thickness on spring back is shown in the figure 2. Here the comparison of the experimental and the Fem result is shown in the figure 2. It is seen that the spring back increases as the sheet thickness increases. The results of the FEM are obtained by using hyper form software with Ls-dyna as a solver and the experimental results are obtained on U shape bending machine [8].

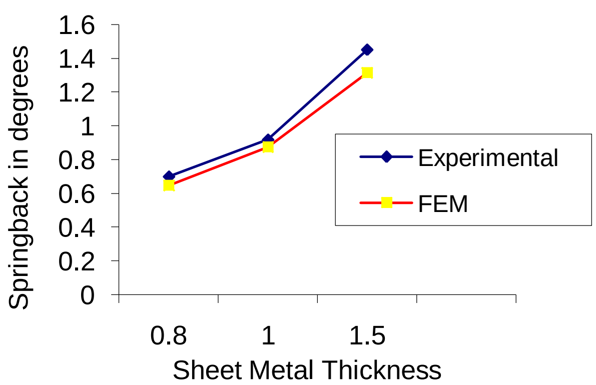

Figure 3. Effect of Sheet thickness on Spring back

[Source: Gawade Sharad, V. M. Nandedkar, "Prediction of Spring back Using FEA", IDDRG2012.]

IV. Sensitivity to the BHF

Jean-Phillippe Ponthot [7] studied the effect of blank holder force on the spring back. Blank holder is one of the important parameter in the control of spring back. It was experimentally observed that the spring back increases with small forces, but decreases as the force increases for large force values. The same phenomenon is found in the FE simulation using mild steel as shown in figure 4. The curves shows the extreme value of spring back angle theta for some values of the BHF and from peak value onwards the spring continues to decrease continuously with increase in the blank holder force. One can also find a BHF value where the considered spring back parameter almost vanishes.

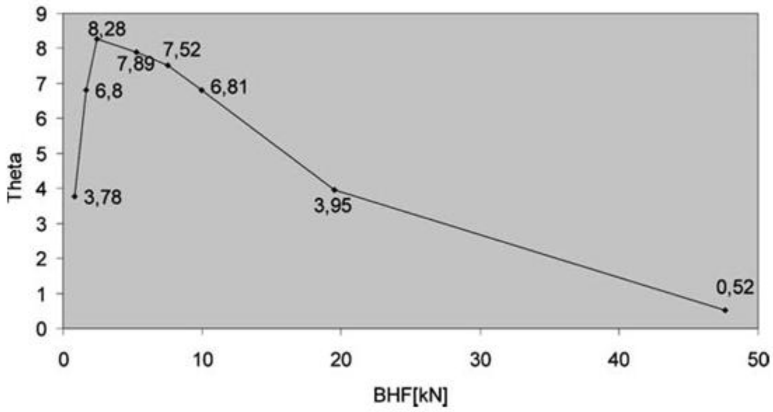

Figure 4. Effect of BHF on Spring back angle
[Source: Finite element simulation of spring back in sheet metal forming, Luc Papeleux, Jean-Phillippe Ponthot]

V. Sensitivity to the coefficient of friction

Friction is an important but not very well known factor influencing spring back. Its modeling is difficult because this coefficient is probably different on the curved and flat parts of both the die and punch. Moreover, it is very difficult to measure those coefficients experimentally. So, we have chosen to use the same coefficient on all parts of all the tools and study the results obtained for different values. Figure 5 show that the effect of coefficient of friction on spring back angle. Spring back curves also exhibit an extremum (Mild steel for this case). It is also important to note that the values of the parameters for low coefficient of friction are significantly different than the values for mean friction coefficients. That makes friction a very sensitive parameter. [7]

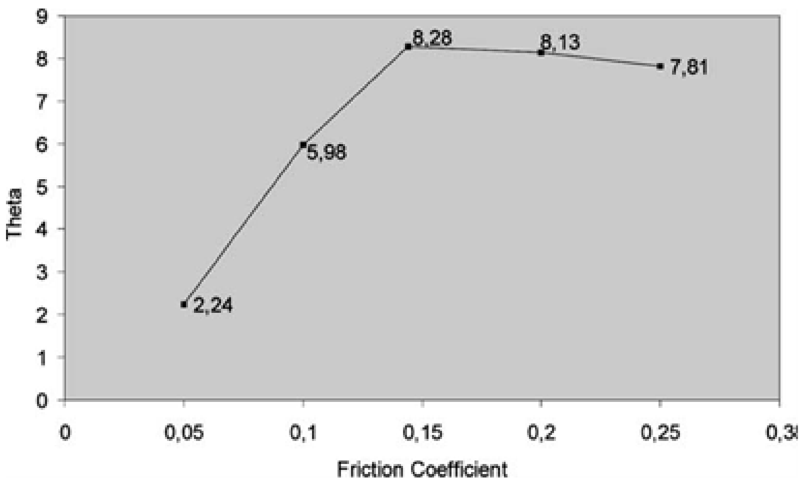

Figure 5. Effect of Friction Coefficient on Spring back angle
[Source: Finite element simulation of spring back in sheet metal forming, Luc Papeleux, Jean-Phillippe Ponthot]

VI.Conclusion

The following conclusions can be drawn from the above literature review.

1. It is seen from the above review that the spring is dependent on the parameters such as ratio of die radius to sheet thickness, sheet thickness, blank holder force, coefficient of friction.

2. For the ratio of die radius to sheet thickness ratio it is seen that the spring back is minimum up to certain value of R/t ratio and it increases with increase in R/t ratio.
3. For the sheet thickness the spring back increases with increase in sheet thickness.
4. For blank holder force the spring back increases first with increase in blank holder force and then continuously decreases with increase in blank holder force.
5. For the coefficient of friction, with increase in the coefficient of friction the spring back angle increases.

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