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Study of Spring Back Process in Sheet Metal: A Review

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Abstract: Springback is one of the most common problems in the sheet metal forming operation now a day. The springback is a geometric phenomenon that affects accuracy by changing the geometric shape. The most prominent feature of sheet metal forming process is an elastic recovery phenomenon during unloading which leads to spring. In this paper springback process of sheet metal is studied. A brief review of some researcher is presented with experimental and FEM approach.
Keywords: Springback, Sheet forming, Elastic recovery, Experimental approach, FEM approach

I. INTRODUCTION

In sheet metal forming, the shape of the blank obtained at the end of the forming step closely conforms to the tools' geometry. However, as soon as the loads are removed, elastically-driven change in the blank shape takes place. This process is termed springback. In the automotive industry, engineering guidelines and finite element software are used in the design process for new sheet metal parts. springback refers to the elastically driven change of shape that occurs after deforming a body and then releasing it. The concept is understood by anyone who has manually bent a metal wire or strip. For a sufficiently small bend radius, some part of the bending remains after unloading and some part is recovered during unloading (or has sprung back). For bend radii larger than some critical value, the initial shape of the body is recovered. The recovered portion of the deformation is referred to as springback. As such, the definition inherently refers to a difference in geometry between the loaded state and the unloaded state.

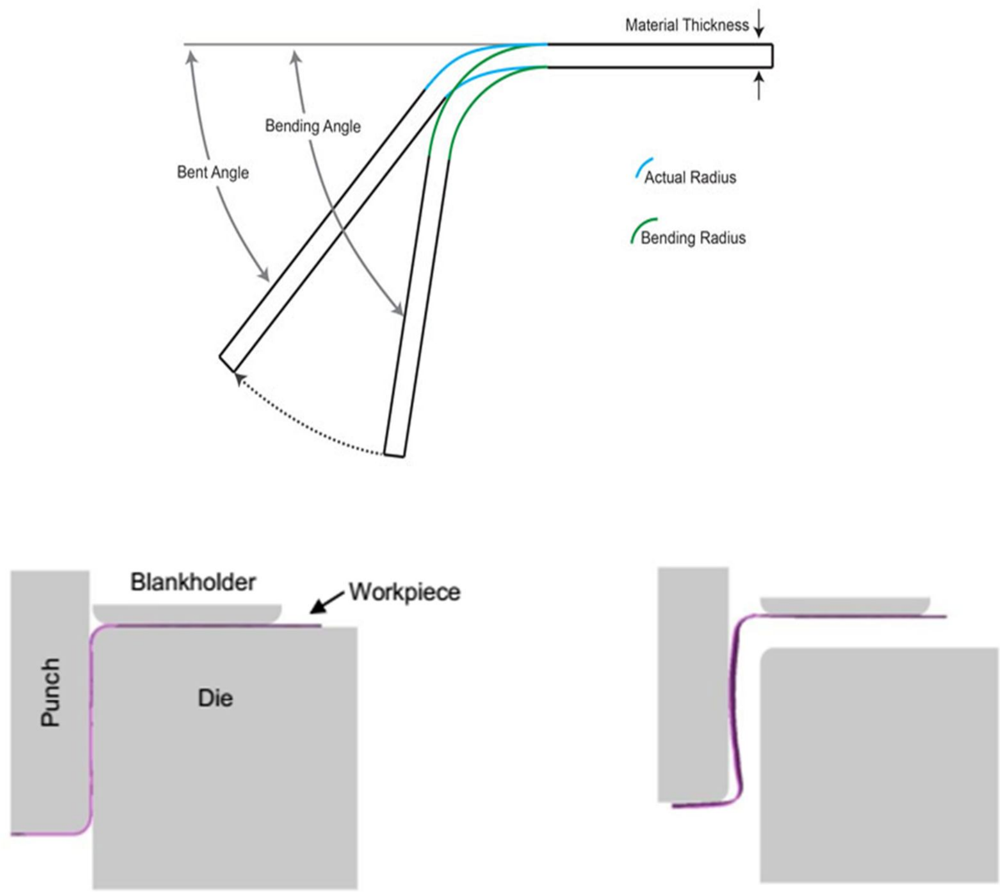

Fig.1 Springback in bending process

II. LITERATURE SURVEY

S. Toros et.al. (2012) [1] investigated TRIP800 steel formability and springback characterization by finite element analysis method using different material models. Additionally, the capability of the Hill-48 and Barlat-89 on predicting the variation of the yield stress and anisotropy values with respect to the angle from rolling direction is investigated for different methods like Lankford parameters and ErrMin approaches. S.K. Panthi et.al (2010) [2] investigated a TEIP algorithm, for large deformation and large rotational problems in indigenous Finite Element software. This software was used to predict the springback in a typical sheet metal bending process and to investigate the influence of these parameters on springback. Hyunok. Jyhwen Wanga et.al. (2008) [3] they observed that the final bend angle, which is the angle achieved upon removal of the punch, is smaller than the initial bend angle. This springback is due to the elastic recovery of the sheet metal. Various theoretical models have been proposed to predict the springback using the tooling geometry and the known properties of the sheet metal. However, in a production environment, the actual properties of any given workpiece may vary from the nominal properties of the lot. This variation causes the actual springback to deviate from the theoretical predictions. In this paper they presented a practical incremental bending methodology to control punch displacement to achieve more accurate final bend angles. In the proposed approach, workpiece properties are estimated from measured loaded and unloaded bend angles. They found that the proposed method can better predict springback and effectively control the bend angle variation in a production environment. Peng Chenb, Muammer et al. (2007) used the DOE and FEA approach for variation simulation and Springback analysis for high strength advanced steel (AHSS) parts. They applied this approach to study an open-channel, double-phase steel piece to determine the effects of material variations, roughing media force, and friction on springback variation. This approach provides a fast and accurate understanding of the influence of random process variations on the Springback variation of the formed part using FEA techniques, eliminating the need for expensive and time-consuming physical experiments. S.K. Panthi and. Al. (2007) [5] developed a large strain deformation algorithm based on total plastic-elastic-incremental deformation (TEIP) for a typical sheet-bending process. The bending process involves significant stress, rotation and springback due to the elastic recovery of the material. Finite Element Method (FEM) software based on the TEIP constraint and capable of handling large rotation and elastic recovery was used. In particular, this study examines the effect of the load on the springback by varying the thickness as well as the radius of the matrix. M. Firat (2007) [6] has described a kinematic hardening plasticity model based on an additive back stress form to improve the predicted deformation response of the sheet. Huang Lina et al. (2007), [7] they developed age-training technology, which is characterized by high elastic returns, making it possible to manufacture large integral parts of wing cladding panels, which necessitates designing a prediction method. They analyzed the age formation process and the elastic recovery of 7B04 aluminum alloy plates using ABAQUS commercial finite element software. They studied the effects of plate thickness and formation time on elastic returns. They found that elastic returns decreased with increasing plate thickness and forming time. Fuh-Kuo Chen et al. (2006), [8] they studied, using finite element analysis, the mechanics of the deformation of the phenomenon of elastic return in the L-bending of sheets. They classified the distribution of axial stresses in the folded sheet into three zones: the flat area under the blank holder (zone I), the fold zone around the corner of the die (zone II), the unfolded zone next to it of the folding zone (zone III). The distribution of stresses in zone I is fairly uniform and therefore has little influence on springback. While the stress distribution in zone II causes a positive springback, the distribution of stresses in zone III produces a negative springback. The total springback thus depends on the combined effect of those produced by zones II and III. Finite element analysis also indicates that smaller matrix radii and matrix gap will reduce the springback in the L-fold process. Shi-Hoon Choi and. Al. (2006), [9] they predicted the Springbackof polycrystalline materials in a numerical way using plasticity models of elastic and visco-plastic crystals. The anisotropic deformation moduli for textural components typical of high-strength steel plate and high-strength, low-carbon steel plate were calculated with the upper-lower bound and the self-consistent model elastic. The yield strength constraints of polycrystalline materials were calculated with the visco-plastic self-consistent polycrystalline model. The influence of the texture components on the springback has been analyzed in detail. W.M. Chan et. al. (2004), [10] they presented in this paper a study on the elastic return in the process of forming a V-folded metal with a pinched end and a free end. J.R. Cho et.al. (2003) [11], they investigated the numerical investigation on spring-back characteristics to the major process parameters.For this they used updated Lagrangian thermo-elastoplastic finite element method to a plane-strain sheet metal U-bending process. Peng Chen et.al. (2003) [12], developed a methodology for the variation simulation of springback was developed, which provides a rapid understanding of the influence of the random process variations on the springback variation of the formed part using FEA techniques eliminating the need for lengthy and costly physical experiments.

III. SPRINGBACKPROCESS: FEM APPROACH

The several researchers investigated the springback process by the use of experimental and finite element approach. Fuh-Kuo et.al. (2006) analyzed the Deformation analysis of springback in L-bending of sheet metal. In their study, the deformation mechanics of the springback phenomenon in the L-bending of sheet-metal was examined and a new method that could efficiently reduce springback in the L-bending of sheetmetal was proposed. The deformation mechanics of springback phenomenon in the L-bending of sheet-metals was investigated by the finite elementanalysis. The axial stress distribution in the bent sheet was classified into three zones: the flat zone under the blank-holder (zone I), bending zone around the die corner (zone II), unbending zone nextto the bending zone (zone III). The stress distribution in zone I is quite uniform and hence has little influence on the springback. While the stress distribution in zone II results in a positive springback, whereas the stress distribution in zone III produces a negative springback. The total springback therefore depends on the combined effect of those produced by zone II and zone III. The finite element analysis also indicates that the smaller die radius and die gap will reduce the springback in the L-bending process. A reverse bend approach was also proposed in the present study to reduce the springback in the L-bending process. The finiteelement analysis reveals that the stress distribution pattern varies with the use of the reverse bend approach, resulting in a significantreduction of springback. However, the reverse bend approach may cause uneven surface around the die corner. Hence, the use of the reverse bend approach must be cautious if the surface quality is required. [8]

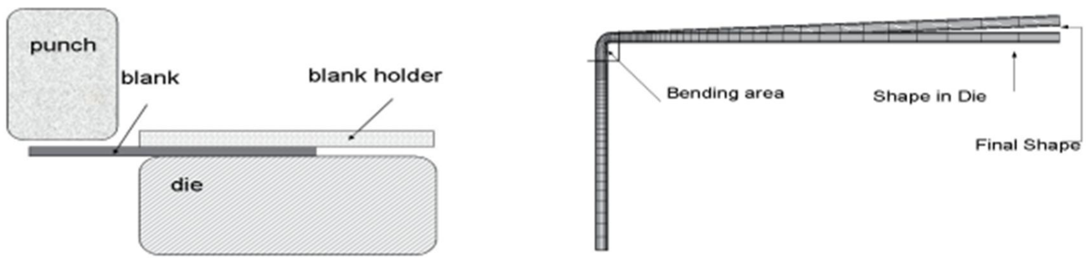

Fig.2 Springback in bending process [8]

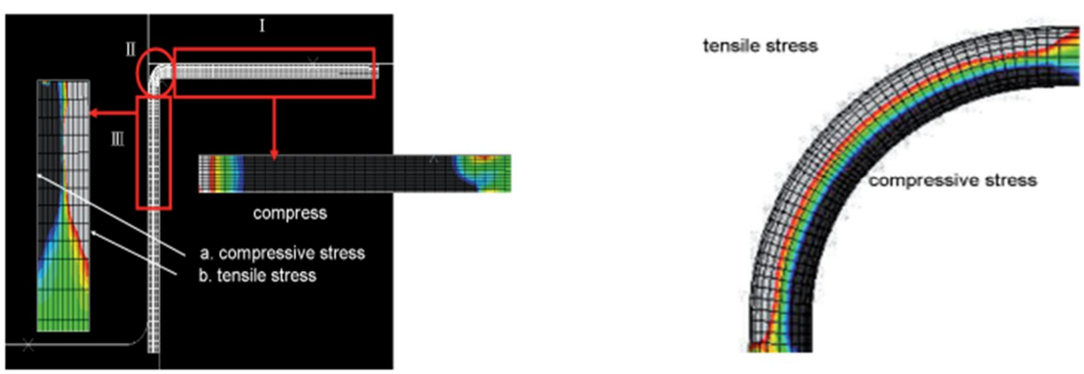

Fig.3 Meshing in springback process [8]

In another investigation of springback process Peng Chen et.al (2007), observed that variations in the mechanical and dimensional properties of the material, lubrication and other forming process parameters are the main causes of springback variation. it may lead to problems during assembly of the stamped components and resulting in quality issues. To identify thevariati on of springback and to improve the quality of the forming process, simulation analysis could be adopted in the early designstage. In this study there are two approaches may applyfor the variation simulation and analysis of the springbackfor advanced high strength steel (AHSS) parts, that is Design of experiment (DOE) and finite element analysis (FEA) approach. In DOE the deterministic FEA simulation, random number generation was used to introduce uncertainties to avoid the issues caused by it. This approach was, then, applied to open-channel shaped part made of dual phase (DP) steel to investigate the effects of variations in material, blank holder force an dfriction on the springback variation. This approach provides a fast and accurate understanding of the influence of random process variations on the springback variation of the formed part using FEA techniques, eliminating the need for expensive and time-consuming physical experiments. [12]

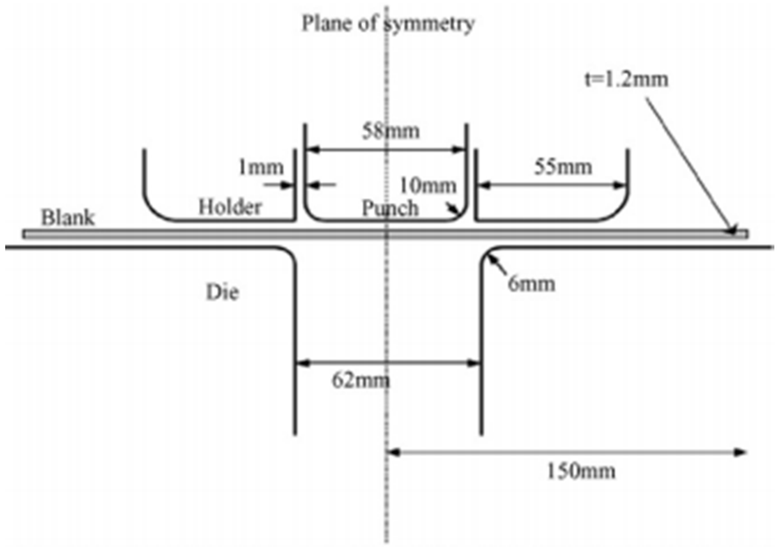

Fig.4U bending process in sheet metal [12]

The effects of BHF, material and friction on springback and springback variation of DP steel channel have been analyzed parametrically using the FEA and DOE with random number generation (computer experiment). On the basis of the quantitative and qualitative analysis made herein, the following conclusions could be drawn. The sidewall curl is very sensitive to the contact condition in the simulation; hard contact is preferred for high strength steel. Springback variation in this case is not distinguishable from the system-level noise. Therefore, it is uncontrollable in this case. In order to reduce springback variation, the standard deviations used for variable randomization has to be decreased; virtually, it means that a system-level adjustment of the press has to be performed to reduce the part-to-part variation of the equipment. On the other hand, if the springback variation is large and uncontrollable, then the springback compensation technique has to be chosen with it in mind.A methodology for the variation simulation of springback was developed, which provides a rapid understanding of the influence of the random process variations on the springback variation of the formed part using FEA techniques eliminating the need for lengthy and costly physical experiments. [12]

In another investigation of springback process Jyhwen Wang et.al (2008), studied the springback control in air bending process. They proposed a practical incremental bending methodology to control punch displacement to achieve more accurate final bend angles. In the proposed approach, workpiece properties are estimated from measured loaded and unloaded bend angles. The estimated properties are used to determine the final punch position required to obtain the desired bend angle after springback. A series of bending experiments was performed. It was found that the proposed method can better predict springback and effectively control the bend angle variation in a production environment. [4]

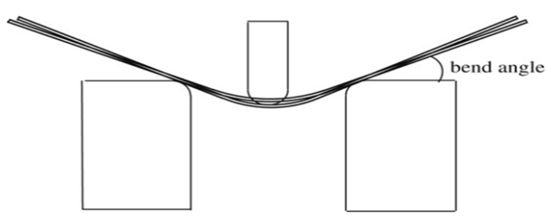

Fig.5Springbackin air bending process [4]

This paper presents a new method for springback control in the air bending process. The method attempts to minimize springback error by utilizing the information collected from loading–unloading cycles. As the loaded and unloaded angles are the final stroke. For example, given the desired angle of 40 degrees ,the punch was moved to 17 degrees loaded angle first. The punchretracted and the unloaded angle was measured. The process was repeated for loaded angles of 26 and 36 degrees. Thus, three loading–unloading cycles (therefore, three pairs of loaded and unloaded bend angles) were used to find the thickness and material properties that best describe the springback characteristics of the workpiece material. It should be noted that the number of incremental bend angles can be increased to improve the prediction of sheet metal properties and thickness. [4]

IV. CONCLUSION

In this paper the springback process was studied. A brief review of some researcher is included with experimental and FEM approach. It includes both the numerical and experimental approach. There are some conclusions made by the analysis in this paper.

A. A reverse bending approach was proposed in the study to reduce the springback in the L-bending process.
B. The sidewall curl is very sensitive to the contact condition in the simulation; hard contact is preferred for high strength steel.
C. The elastic recovery depends largely on the properties of the material (creep stress, Young's modulus, strain hardening) and geometric parameters (sheet thickness, die radius, sector angle) under minimum load conditions and decreases with increasing compression depth. It is observed that any combination of material and geometry becomes irrelevant after a certain formation load / compression depth.
D. The springback decreases with increase in Young’s modulus, but increases with increase in yield stress and strain hardening.

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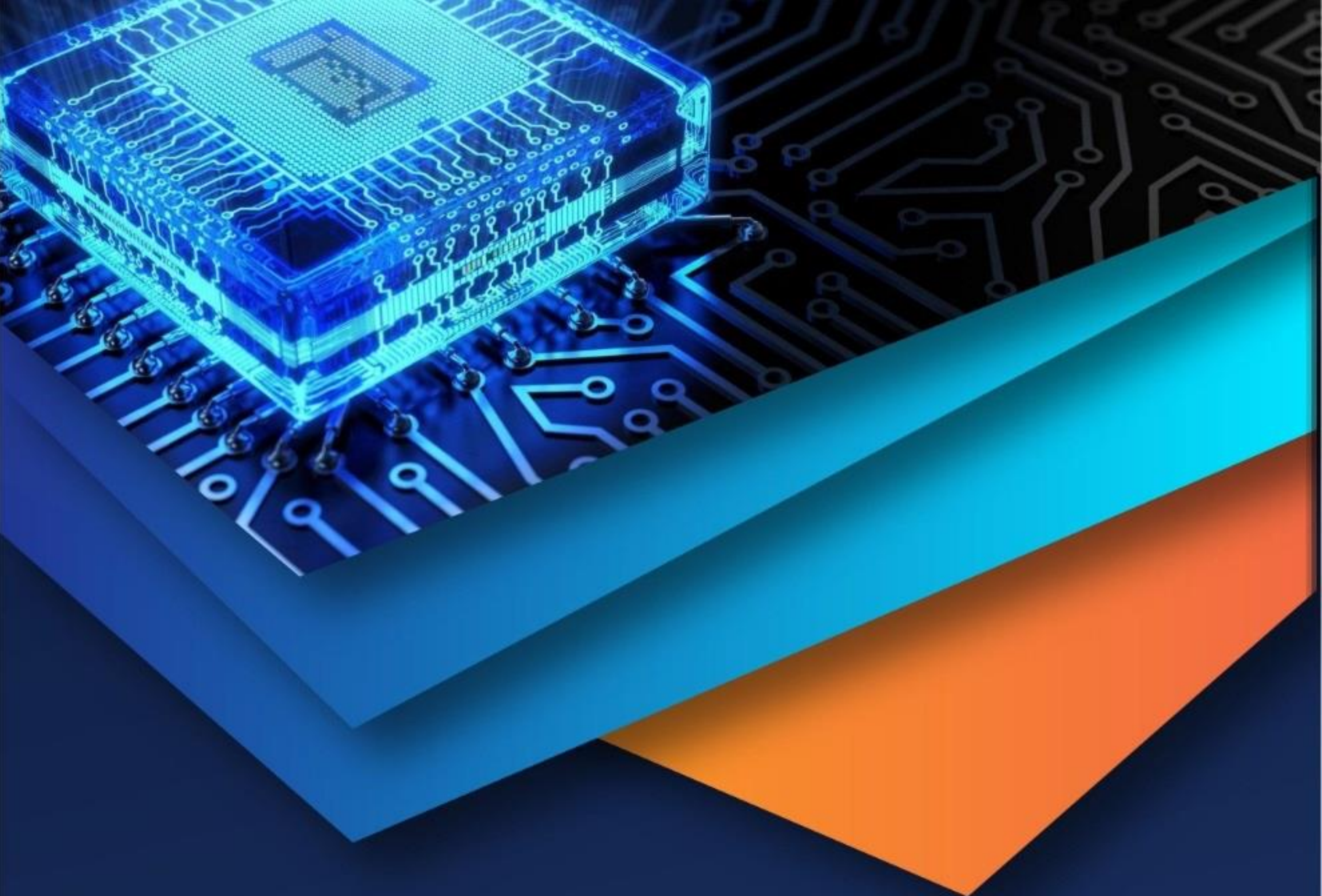

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