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FACTORS INFLUENCING THE VALUE OF SPRING BACK OF SHEET MATERIAL IN BENDING

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ЧИННИКИ ВПЛИВУ НА ВЕЛИЧИНУ ВІДПРУЖИНЕННЯ ЛИСТОВОГО МАТЕРІАЛУ ПРИ ГНУТТІ

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.

Bending processes are used to form the sheet metals. 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 20. For 0.40 to 0.50 carbon steel and half hard materials spring back may vary from 3 to 50. Spring back may be as high as 10 to 150 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.

The elastic stresses remaining in the bend area after bending pressure were released will cause a slight decrease in the bend angle. Metal movement in this type is known as spring back. 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. 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.

Spring back refers to the elastic recovery of deformed parts. Spring back occurs because of the elastic relief from the bending moment imparted to the sheet metal during forming. Spring back is common and inevitable in each stage of the production process where the material undergoes geometrical changes. Accordingly, factors related to the generation of stress in the material during loading and unloading processes influence the spring back behavior of press-formed parts. In every industry, quality and productivity are major issues for being competitive. For example, a car frame needs to be designed to achieve strength requirements and aesthetic aspects; on the other hand, cost of production and repeatability is crucial to the business. A stamping process has been one solution used in practice to achieve these goals in the sheet metal fabrication business. However, spring back, a shape discrepancy between the fully loaded and unloaded configurations, undermines the stamping benefits, since a major effort on the tooling design is needed to compensate spring back.

According to the shape of the product, the bending is divided into the following: Air

bending .U- bending, V-bending, Roll bending, Edge bending. The accuracy and success of the bending process depends upon the operating parameters as well as, material properties, clearance, radius of the die and punch, friction condition etc. In past, sheet metal bending processes are dependent on the designer's experience and involve trials and errors to obtain the desired result. Many analytical models are proposed to study spring back in bending by using simple beam or plate bending and these models use a simplified assumption.

The nature of the bending process. V-Bending: A V-bending operation is commonly performed by compressing the metal strip between a matching V- shaped punch and die. In most of the air bending, or free bending, a sheet is commonly supported by two shoulders of a stationary die. The advantages of the V-bending die are the economical set-up time and fabrication of a wide of part size and complex shape It has the advantage over other bending processes, for ample, there is no need to change the dies to obtain different bending angles. The basic advantages of the V-die bending process are as follows: a simple tool design, an economical setup time, and an enormous range of sizes and complex shapes that can be fabricated for the part but in contrast result in less accuracy.

Methods and methodology.

1. Finite Element Method. In this method of analysis, a complex region defining a continuum is discretized into simple geometric shapes called finite elements. The material properties and the governing relations are considered over these elements and expressed in terms of unknown values at element corner. An assembly process, duly considering the loading and constraints, results in a set of equations, solution of these equations gives us the approximate behavior of the continuum. The analysis which uses FEM is known as FEA. A general purpose FEA program consists of three modules; a pre-processor, a solver, and a post processor. Commercial FEA programs can handle very large number of nodes and nodal degrees of freedom provided a powerful hardware is made available. User's manual, theoretical manual, and verification problems manual, document a commercial FEA program

2. Non Linear Analysis. In it an initial condition at the start of each increment is the state of the model at the end of the previous one. This dependency vides a convenient method for following complex loading histories, such as a manufacturing process. At each increment, the solver iterates for equilibrium using a numerical technique such as the Newton Raphson method. Due to the iterative nature of the calculations, non linear FEA is computationally expensive, but reflects the real life conditions more accurately than linear analyses.

3. Newton Raphson method. Newton Raphson method is the widely used technique to arrive at the solution for the non linear problems. Concept of time: the loads in a non linear analysis are applied in an incremental manner. Hence while simulating such behavior needs specify the load as a function of time. The time is just used to define the pattern in which the load should be increased for the model. The time specified here is completely a pseudo time and cannot be mistaken with the real time is used to apply time varying loads in a transient analysis.

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, better to use the same coefficient on all parts of all the tools and study the results obtained for different values. Spring back curves also exhibit an extremum. 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.