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Springback Prediction Compensation and Optimization for Front Side Member in Sheet Metal Forming using FEM Simulation

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Abstract. Numerical simulation by finite element method has become a powerful tool in predicting and preventing the unwanted effects of sheet metals technological processing. One of the most important problems in sheet metal forming is the compensation of springback. To improve the accuracy of the formed parts, the die surfaces are required to be optimized so that after springback the geometry falls at the expected shape. This paper presents and discusses numerical simulation procedure of die compensation by using the methods of Simplified Displacement Adjustment (SDA). This analysis use Benchmark 3 models of Numisheet 2011. Sensitively analysis was done by using finite element method (FEM) show that the springback values are influenced by element size, integration points and material properties.

Introduction

Every process of metal that involves the plastic deformation is produce springback phenomenon. Springback can be considered as a dimensional change which happens during unloading, due to the occurrence of primarily elastic recovery of the material [1]. Therefore, springback occurrence theoretically exists in whatever kind of sheet metal forming or stamping process. It cannot be eliminated because the elastic deformation is always coming during the sheet forming process. As a result, the final shape of the drawn part will deviate from the shape imposed by the forming tool.

Li et al. [2] reported that the most important problem in sheet metal forming is the compensation of springback. Many efforts have been done to eliminate the springback problem [3,4,5]. Most of them focus on mechanical based methods for increasing sheet tension during sheet bending [6,7,8] which considerably reduces the degree of springback. The other method is geometry based compensation. This method can give the dimensional accuracy of the final product, especially in complex model [9].

Two common methods for springback compensation are explained in the literature, the Displacement Adjustment (DA) method [10] and the Spring Forward (SF) proposed by Karafillis and Boyce (K&B) [11]. The SF method has a more physical approach, based on the internal stresses that cause springback and computing the constraint forces to maintain equilibrium following forming. The algorithm of SF is based on the assumption that the inverse of stress correspondingly results in the response of forward deformation instead of spring backward [12]. This concept was different with the real process of sheet forming. The other hand, the DA method algorithm is based on the real springback investigation. The DA method is a strictly geometrical method, to move the surface nodes defining the die surface in the direction opposite to the springback error. The displacement vectors at each node are used to adjust the trial die design until the target part shape is achieved.