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Rapid design of corner restraining force in deep drawn rectangular parts

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Abstract

With the development of finite element method and computer technology, the complete modeling of the forming of a 3D sheet metal part is becoming realistic. However, an accurate 3D simulation is usually too time-consuming to be used in the early stage of design. One solution is to model the straight side of a 3D part as a plane strain problem and the corner section as an axisymmetric problem. Unfortunately, the axisymmetric solution often over-predicts the severity of the deformation at the corner and leads to a very conservative design. In this study, a modified axisymmetric model with a center offset is proposed to predict tearing failure in the corner sections of 3D parts. The proposed offset is found to be a function of the center strains, failure height, and tooling/process parameters, including tooling geometry, material properties, friction coefficient, and restraining force provided by the binder. Finite element analyses of both 3D and 2D axisymmetric models for square and rectangular cup forming are utilized to verify the proposed concept and to define the function. Excellent predictions of the failure heights are obtained. The proposed model enables engineers to rapidly specify the right amount of the restraining force in the corner section based on the desired center strains and forming depth. A detailed design algorithm is provided.

Keywords: Sheet metal forming; Failure prediction; Axisymmetric model; Tooling design; Process design