Identification of Nonlinear Kinematic Hardening Parameters for Sheet Metal from Biaxial Loading Tests

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ABSTRACT

Minimizing production costs and overall weight of products is a major goal for manufacturers in the 21st century. One way to address this aim is the simulation of complex forming processes by means of finite element method (FEM) for process and design optimization. For this purpose, an adequate material model has to be chosen and the corresponding parameters have to be identified.

In this contribution a material law capable of describing elasto-plastic material behaviour utilizing a Hill-type yield function [1] in combination with a nonlinear kinematic hardening law based on the Frederick-Armstrong model [2] is used to identify parameters for sheet metal. By exploiting the optical measurements of biaxially loaded cruciform specimens with the help of digital image correlation (DIC) the displacements are used in a finite element model updating (FEMU) approach. For this purpose, a fine spray pattern that deforms with the specimen is applied to the surface of the sheet metal. At different stages of loading images of the pattern are captured and analysed to obtain the displacement field. For the adaptation to the experiments, the measured force data is taken as a boundary condition in the corresponding FEM simulation.
As can be observed in experiments, cold-rolled sheet metal exhibits orthotropic plastic behaviour and a translation of the yield surface upon load reversal (Bauschinger effect). To reproduce this accurately, an anisotropic elasto-plastic constitutive model with input parameters for the quadratic yield function and a nonlinear mixed hardening (isotropic + kinematic) law is implemented. Starting off with an initial guess for the parameters, the simulated nodal displacements are compared to those from the experiment. The measured displacement field is therefore interpolated to the nodes of the FEM-mesh. The hereby obtained objective function will then be minimized by means of optimization algorithms to identify the parameters for the given sheet metal.

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REFERENCES

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