Public Abstract

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Development of an integrated approach combining artificial neural network material based modeling with finite element analysis of forming processes

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Abstract:

The use of a finite element model (FEM) for design and analysis of a metal forming processes is limited by the incorporated material model's ability to predict deformation behavior over a wide range of operating conditions. Conventionally generated rheological models prove deficient in several respects due to the difficulty in establishing complicated relations between many parameters. More recently, artificial neural networks (ANN) have been suggested as an effective means to overcome these difficulties. To this end, a robust ANN with the ability to determine flow stresses based on strain, strain rate, and temperature is developed and linked with finite element – based simulation model. Comparisons of this novel method with conventional means are carried out to demonstrate the advantages of this approach as applied to industrial applications.

The FEM model is integrated with the developed ANN material based model in order to account for the effects of strain, strain rate, and temperature variations within the material during hot-forming. An industrial case study involves hot forging of an aftermarket automotive wheel made out of 6061 aluminum is used to evaluate the effectiveness of the integrated approach. The load-displacement curves predicted by the developed virtual model are in good agreement with the experimental observations of an industrial forging process.

The developed approach and knowledge gained from the present work, has a wide range of application in general, and is not limited to hot forming of the investigated materials.