Similarity Methods in Elasto-Plastic Beam Bending

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ABSTRACT

In industrial metal forming processes high versatility is claimed with respect to material types, geometric dimensions and process parameters. In order to control and optimize the production process efficient simulation models are required. Usually, metal forming simulation models are very complex and highly non-linear. Thus, parameter studies take a large computational effort. A very efficient and practicable way to reduce the number of the essential parameters is the application of Similarity Methods [1].

In the following, plastic bending of cantilever beams is investigated. Especially, the plastic deformations are caused by a drop test as shown in [1]: A cantilever beam is fixed on a drop mass which is falling down from a predefined height and stopped by an elastic spring, such that the impact causes plastic deformations. In [1] experimental results have presented with various materials and geometric dimensions. Applying the concept of similarity, i.e. the Buckingham Pi Theorem, the number of parameters to describe the process has been reduced by introducing appropriate normalized quantities.

In this paper, two simulation models for the drop test experiment are implemented in order to investigate several material types and geometric dimensions of the beam. First, the bending process is modelled in the framework of linear beam theory assuming a uni-axial state of stress and elastic – ideal plastic material behaviour, cf [2-3]. The formulation is derived in terms of the normalized quantities of [1].

Furthermore, a Finite Element model for the drop test process is implemented using the software package ABAQUS. The beam is modelled by continuum elements, and a dynamic analysis is performed for the impact process. With this model, parameter studies are performed. The results are compared with the experimental results of [1], and the normalized representation of the results is extended to further material types and geometrical parameters.

The presented investigations are the basis for further applications of similarity theory in more complex metal forming processes.

REFERENCES

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