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AN INTEGRATED METHODOLOGY FOR PARAMETER IDENTIFICATION AND SHAPE OPTIMIZATION IN METAL FORMING AND STRUCTURAL APPLICATIONS

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ABSTRACT

The simulation of metal forming processes using FEM is today a well established procedure, which opens doors to solving new and more complex problems using alternative approaches, such as inverse methodologies/problems.

In this paper two types of inverse problems will be presented and discussed: the parameter identification and the shape optimization problems. The aim of the first type of problems is to evaluate the input parameters for material constitutive models that would lead to the most accurate results with respect to physical experiments. The second category involves determining the initial geometry of a given specimen in order to provide the desired final geometry after the forming process.

The purpose of this work is to formulate these inverse problems as an optimization problem and introduce a straightforward methodology of process optimization in metal forming. To reach this goal, an integrated optimization approach, using a finite element code together with a numerical optimization program, was developed. A gradient-based optimization method was employed as a combination of the steepest-descent method and the Levenberg–Marquardt techniques.

Numerical applications are presented in the parameter optimization category, namely, the characterization of a non-linear elastic–plastic hardening model and the determination of the parameters for a non-linear hyperelastic model. It is also discussed the simultaneously identification of both constitutive material model parameters and the friction coefficient parameters. From the point of view of shape optimization category of problems, some examples are also shown and discussed such as the determination of the initial geometry of a specimen in the upsetting bill problem (figure 1) and a methodology for the “square plate with central cut-out” problem (figure 2).

The final results for both categories are satisfactory, being proved that this kind of algorithms have great potential for future developments in more demanding and realistic benchmarks.

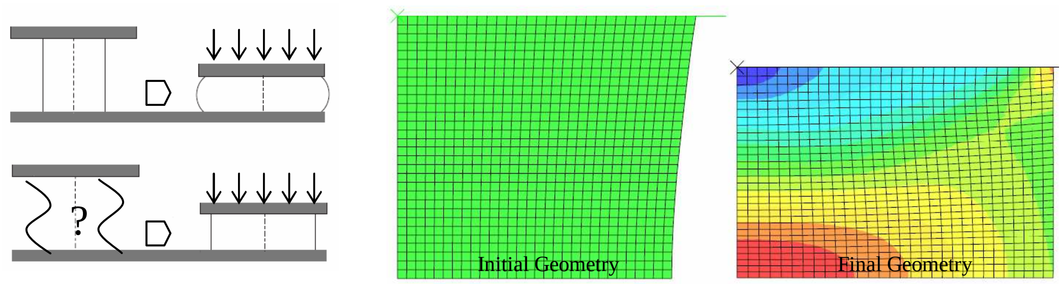

Fig. 1: Upsetting bill problem. Determination of the initial geometry of the specimen in order to obtain a box shaped final specimen.

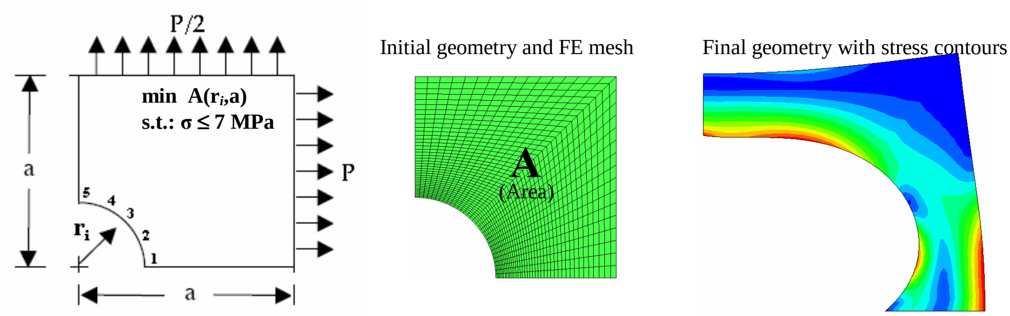

Fig. 2: Square plate with central cut-out problem solved by a gradient-based method.

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