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Co-Chairs: Miroslav Urbanek, COMTES FHT; Yunzhi Wang, The Ohio State University

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Evaluation of ductile damage in forging

Miroslav Urbanek, Czech Republic

ABSTRACT

The purpose of this study is to evaluate the parameters of material plasticity and fracture models at room temperature and at rates up to 1 mm/min for steels which are ordinarily used for forging, for instance, the 38MnVS6 steel. The behaviour of materials during forming was evaluated and described using Marc Mentat and DEFORM software tools.

Several fracture models were examined from the perspective of the planned research tasks which involve testing at forging temperatures up to 1100°C. The fracture models considered were those which are implemented as standard tools, for example: Cockcroft and Latham, Oyane, and Rice and Tracey. These can be employed for numerical simulations of forging, punching, and shearing, the most frequent operations in the manufacture of forged parts.

Standard tensile tests, torsion tests, and compressive tests on special conical specimens were carried out. Based on the tensile test data, an FEM analysis of the stress–strain curve was conducted. The ductile fracture models were then calibrated using multiple stress–strain conditions, including triaxial stress states, and various Lode angles.

Tensile and compressive tests were carried out on a Zwick 250 kN testing machine which was provided with the ARAMIS digital image correlation system from the GOM company. For the torsion tests, an MTS Bionix (25 kN and 250 Nm) servohydraulic testing machine was employed.

The actual size of cracks in conical specimens after compressive testing was determined by metallographic observation using a Nikon Epiphot 200 optical microscope, and a computer with the NIS Elements image analysis software.

KEYWORDS: FEM, tensile test, torsion test, plasticity, ductile damage