Complex plasticity model coupled with double damage curve in prediction of ductile fracture

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ABSTRACT

The paper summarizes the continuum damage mechanics approach consisting of the plasticity coupled with damage. It was shown that it is important to incorporate the material weakening in order to capture the post-initiation stage of cracking or rupture to describe the crack propagation more closely to reality than it is in the case of uncoupled models [1]. These phenomenological models have an advantage of simple calibration process but disadvantage in limited prediction abilities, especially regarding the slant fracture [2]. This could be overcome by coupled models which naturally also brings some drawbacks. The most pronounced one is the mesh dependency which can be solved by employing the regularization of output variables by nonlocal characterization functions [3]. Nevertheless, this was not used because of the intricacies in implementing into the commercial finite element code [4]. Instead, the Lode dependent plasticity [5] was implemented with the help of VUMAT user subroutine into the Abaqus software based on the finite element method, and it was coupled with the double damage curve approach, revisited from fatigue [6], via the weakening or softening effect in scope of local approach. The experimental campaign was executed on the aluminium alloy 2024-T351. It consisted in tensile tests, torsion test and upsetting. Then, the numerical approach was applied to three different cases to observe the performance. The first was the tension of notched cylindrical specimen with very good results. In the last two cases, the approach was applied under the plane strain conditions where the predictions were not so satisfying when compared to the experimental observation. This was the tension of flat plate and notched tube. In the end, the conclusions were drawn and the future studies outlined.

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