A non-local GTN based model for explicit crash simulations

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ABSTRACT

Automotive safety design requires carrying out actual crash tests but also numerous simulations of crash cases. These simulations are performed using explicit simulations codes and require material data to describe plasticity, crack initiation and possibly crack propagation. In this study, a DP450 steel sheet is used to build a material database incorporating various mechanical tests (tensile, notched tensile, shear, cracked panels...) carried out under quasi-static and dynamic conditions. The database is represented using the GTN model [1] extended to account for non von Mises plastic flow [2], shear damage [3] and heating due to plastic work [4]. To avoid strong damage and strain localization in the calculations, thus also avoiding spurious mesh dependence and increasing reliability, the non-local implicit gradient–enhanced formulation proposed in [5] is used. In this study, the cumulated plastic strain is chosen as the "non-local" variable as it allows regularizing simultaneously softening due to void nucleation and growth, shear damage and heating. This formulation is however not suited for explicit calculations. To solve this difficulty the modification proposed in [6] is used. It requires the introduction of a new parameter so that the acceleration of the "non-local" variable can be introduced in the equilibrium equations so as to be able to perform time integration using the explicit scheme. An element removal technique is then used to propagate cracks. The model is finally successfully used to reproduce the entire database as well as test parts representative of car crash.

References

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