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APPLICATION OF UNCOUPLED DAMAGE MODELS TO PREDICT DUCTILE FRACTURE IN METALLIC SHEET BLANKING

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The increasing demand of high-quality products over the years has promoted the development of several models to predict damage accumulation and fracture during their manufacturing process. Due to their simplicity and overall accuracy, the uncoupled damage models (fracture criteria) have been the preferred choice to simulate ductile failure, especially in engineering applications. Nevertheless, the predictive capabilities of these type of models were classically limited by the complexity of the loading paths encountered in several forming processes, making them not suitable for all cases. This drawback is attributed to the use of stress triaxiality as the only variable introducing the influence of the stress state into their formulations, contrasting with several recent studies where it has been demonstrated that the Lode angle (related to the second and third deviatoric stress invariants) also plays a crucial role in damage accumulation [1]. Consequently, some advanced models have been recently formulated in the space of equivalent plastic strain, stress triaxiality and Lode angle, with successful results in a wide range of loading conditions.

In this work, a comparative study of different uncoupled damage models for the numerical prediction of ductile fracture in the blanking process is performed. The selected phenomenological models were recently implemented in a fully implicit homemade Finite Element code [2], which considers large strains, frictional contact and crack propagation (i.e. element deletion method). All the models considered here account for damage sensitivity to both the stress triaxiality and the Lode angle. The material characterization is performed thanks to different mechanical tests under different stress states and a full inverse analysis, taking into account the entire loading paths to fracture. Finally, the numerical predictions obtained for different process parameters are compared with experimental results, where especial attention is given to the final shape of the sheared edge.

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