

SIMULATION OF DUCTILE RUPTURE: FROM MICROMECHANICS TO STRUCTURAL FAILURE

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Abstract

Since the pioneering work by Rice and Tracey (1969) and Gurson (1977), the micromechanical description of ductile damage from nucleation to final failure has been widely developed and adopted. Numerous extensions of the Gurson-Tvergaard-Needleman model (1984) have been and are still proposed. These are nowadays implemented in finite element codes. Using standard displacement-based formulations, these models lead to a strong mesh dependence (on element size, element type, element shape and orientation, ...). This implies that complex situations where the crack path changes cannot be analyzed in a robust and reliable way. These problems can be solved using so-called 'nonlocal' formulations, of which many types exist. The different versions of these models are now employed to simulate laboratory-size specimens. These usually include notched bars and pre-cracked specimens (e.g. Compact Tension or Single Edge Notch Tensile specimens). However, a major remaining challenge is the assessment of the integrity of critical mechanical components such as nuclear pressure vessels or pipelines containing potential defects. The use of damage models could be of particular interest in situations where standard assessment procedures based on global parameters (J-integral, Q-factor) are not applicable. This is the case of complex geometries, welds, or structures which do not initially contain cracks. The presentation will review the state-of-the-art of ductile damage modeling and illustrate the capabilities of these models to analyze the integrity of large-scale structures. The remaining challenges will be discussed.

Keywords: Ductile rupture; GTN model; Finite element simulation; Full-size test;



Example of a full-size test