Effect of Contact Conditions on Void Coalescence at Low Stress Triaxiality Shearing

Recent numerical cell-model studies have revealed the ductile failure mechanism in shear to be governed by the interaction between neighboring voids, which collapse to micro-cracks and continuously rotate and elongate until coalescence occurs. Modeling this failure mechanism is by no means trivial as contact comes into play during the void collapse. In the early studies of this shear failure mechanism, Tvergaard (2009, "Behaviour of Voids in a Shear Field," Int. J. Fract., 158, pp. 41-49) suggested a pseudo-contact algorithm, using an internal pressure inside the void to resemble frictionless contact and to avoid unphysical material overlap of the void surface. This simplification is clearly an approximation, which is improved in the present study. The objective of this paper is threefold: (i) to analyze the effect of fully accounting for contact as voids collapse to micro-cracks during intense shear deformation, (ii) to quantify the accuracy of the pseudo-contact approach used in previous studies, and (iii) to analyze the effect of including friction at the void surface with the main focus on its effect on the critical strain at coalescence. When accounting for full contact at the void surface, the deformed voids develop into shapes that closely resemble micro-cracks. It is found that the predictions using the frictionless pseudo-contact approach are in rather good agreement with corresponding simulations that fully account for frictionless contact. In particular, good agreement is found at close to zero stress triaxiality. Furthermore, it is shown that accounting for friction at the void surface strongly postpones the onset of coalescence, hence, increasing the overall material ductility. The changes in overall material behavior are here presented for a wide range of initial material and loading conditions, such as various stress triaxialities, void sizes, and friction coefficients.