Void coalescence mechanism for combined tension and large amplitude cyclic shearing

Void coalescence at severe shear deformation has been studied intensively under monotonic loading conditions, and the sequence of micro-mechanisms that governs failure has been demonstrated to involve collapse, rotation, and elongation of existing voids. Under intense shearing, the voids are flattened, such that the void volume diminishes, whereafter the flattened crack-like voids rotate and elongate until interaction with neighboring micro-voids dominates the material response and coalescence sets in. Eventually, this leads to a complete loss of load carrying capacity. The severe shear loading, imposed at the far boundary, is in an early state of the deformation associated with significant stretching of parts of the void surface, while other parts remain practically un-deformed. A largely uneven distribution of the strain hardening, therefore, evolves along the void circumference and, thus, one cannot expect the void to return to its original shape in the case where the far-field loading is reversed. The present numerical work aims to investigate the evolution of micro-voids subject to constant tension and large amplitude cyclic shearing. The far-field loading, the void shape, and the void growth are monitored, and the calculations are pushed to coalescence and complete loss of load carrying capacity. The initially circular cylindrical voids are predicted to develop protrusions in the shearing plane with normal in the direction of the applied tensile load. These protrusions evolve during repeated cyclic shearing and spread towards neighboring voids - eventually being responsible for void coalescence.

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