THE VOID SIZE EFFECT ON THE VOID GROWTH RATE IN DUCTILE MATERIALS

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It is well known that the failure of ductile materials results from the nucleation, growth and coalescence of microvoids. There have been numerous studies on the void growth in ductile materials. One of the most important work was done by Rice and Tracey (1969) who showed that the void growth rate scales exponentially with the mean stress level.

Recent experiments and numerical studies have repeatedly found that, under the same imposed loading, small voids tend to grow much slower than large voids. The Rice-Tracey model cannot capture this void size effect since the model is based on the classical plasticity theory of that possesses no intrinsic material length.

We have extended the Rice-Tracey model (1969) of void growth to account for the void size effect based on the Taylor dislocation model, and have found that small voids indeed grow slower than large voids (Liu et al., 2003). For a perfectly plastic solid, the void size effect comes into play through the ratio $\varepsilon l / R_0$, where l is the intrinsic material length on the order of microns, ε the remote effective strain, and R_0 the void size. For micron-sized voids and small remote effective strain such that $\varepsilon l / R_0 \le 0.02$, the void size influences the void growth rate only at high stress triaxialities. However, for submicron-sized voids and relatively large effective strain such that $\varepsilon l / R_0 > 0.2$, the void size has a significant effect on the void growth rate at all levels of stress triaxiality.

We have also obtained the asymptotic solutions of void growth rate at high stress triaxialities accounting for the void size effect. For $\varepsilon l / R_0 > 0.2$, the void growth rate scales with the square of mean stress, rather than the exponential function in the Rice-Tracey model (1969). The void size effect in a power-law hardening solid has also been studied.

References

J. R. Rice and D. M. Tracey, "On the Ductile Enlargement of Voids in Triaxial Stress Fields," *Journal of the Mechanics and Physics of Solids*, v. 17, p. 201-217, 1969.

B. Liu, X. Qiu, Y. Huang, K.-C. Hwang, M. Li, and C. Liu, "The Void Size Effect on the Void Growth Rate in Ductile Materials," *Journal of the Mechanics and Physics of Solids* (in press), 2003.