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Modeling Combined Tension-Shear Failure of Ductile Materials

YEHUDA PARTOM, Retired — Failure of ductile materials is usually expressed in terms of effective plastic strain. Ductile materials can fail by two different failure modes, shear failure and tensile failure. Under dynamic loading shear failure has to do with shear localization and formation of adiabatic shear bands. In these bands plastic strain rate is very high, dissipative heating is extensive, and shear strength is lost. Shear localization starts at a certain value of effective plastic strain, when thermal softening overcomes strain hardening. Shear failure is therefore represented in terms of effective plastic strain. On the other hand, tensile failure comes about by void growth under tension. For voids in a tension field there is a threshold state of the remote field for which voids grow spontaneously (cavitation), and the material there fails. Cavitation depends on the remote field stress components and on the flow stress. In this way failure in tension is related to shear strength and to failure in shear. Here we first evaluate the cavitation threshold for different remote field situations, using 2D numerical simulations with a hydrocode. We then use the results to compute examples of rate dependent tension-shear failure of a ductile material.

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