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Maximum Mean Principal Stress Criterion for Three-Dimensional Brittle Fracture

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Abstract Cracks encountered in engineering structures are typically three dimensional, and the fracture mechanism remains unclear because of the superimposed stresses induced by mixed-mode I/II/III loading. This paper introduces a general 3D mixed-mode fracture criterion based on the maximum mean principal stress (MMPS) by introducing the concept of a characteristic fracture length that is related to the material tensile strength. This criterion has clear physical significance, a systematic mathematical expression and a wide scope of applications to estimate both the in- and out-of-plane fracture angles and fracture strength. The proposed criterion is validated for all mixed-mode conditions (I/II, I/III and II/III) and is compared with several widely used criteria based on experimental results reported in previous studies. Good agreement is achieved in terms of the fracture angles and, in particular, the fracture strength between the results predicted by the new criterion and the experimental results of various brittle materials.

Keywords: 3D Fracture criterion; Mixed-mode loading; Mean stress; Characteristic fracture length.

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