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A general phase-field model for fatigue failure in brittle and ductile solids. (English)

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Comput. Mech. 67, No. 5, 1431-1452 (2021).

Summary: In this work, the phase-field approach to fracture is extended to model fatigue failure in high- and low-cycle regime. The fracture energy degradation due to the repeated externally applied loads is introduced as a function of a local energy accumulation variable, which takes the structural loading history into account. To this end, a novel definition of the energy accumulation variable is proposed, allowing the fracture analysis at monotonic loading without the interference of the fatigue extension, thus making the framework generalised. Moreover, this definition includes the mean load influence of implicitly. The elastoplastic material model with the combined nonlinear isotropic and nonlinear kinematic hardening is introduced to account for cyclic plasticity. The ability of the proposed phenomenological approach to naturally recover main features of fatigue, including Paris law and Wöhler curve under different load ratios is presented through numerical examples and compared with experimental data from the third author et al.'s previous work ["Microstructure influence on fatigue behaviour of nodular cast iron", Mater. Sci. Eng. A 556, 88–99 (2012; doi:10.1016/j.msea.2012.06.062)]. Physical interpretation of additional fatigue material parameter is explored through the parametric study.

MSC:

74R20 Anelastic fracture and damage
74R10 Brittle fracture
74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)

Keywords:

fracture energy degradation; local energy accumulation; experimental validation; Paris law; Wöhler curve; elastoplastic material

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