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Modelling Fatigue Crack Growth with Time-Derivative Equations

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Predicting fatigue crack growth in metals remains a difficult task since available models are based on cycle-derivative equations, while service loads are often far from being cyclic. A set of time-derivative equations for fatigue crack growth is proposed here. For this purpose, three global variables and their thermodynamics counterparts are introduced in order to characterize the state of the crack: the crack length, the plastic blunting at crack tip and the elastic opening of the crack. The model is based on the thermodynamics of dissipative processes with a special attention paid to the elastic energy stored inside the crack tip plastic zone. Two laws were finally used: a crack propagation law, and an elasto-plastic constitutive behaviour for the cracked structure. The model was also implemented and tested. It reproduces successfully typical effect under monotonic and non-monotonic fatigue.

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