A Paris Law-Based Cohesive Zone Model for Fatigue Crack Growth Simulations

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Abstract: This paper presents a Paris law-based cohesive zone model (CZM) for fatigue crack growth simulations to enable the consideration of the plasticity induced crack closure effect, which is known to be a source of substantial crack growth retardation. In order to avoid the addition of any redundant model parameters, the basic equation of the CZM is derived from the Paris law so that the CZM has only the parameters of Paris law. Thus, the parameters can be determined by referring the existing experimental data of the Paris law without any troublesome fitting processes. Only the parameter to be fitted is the penalty coefficient of the CZM. It can be optimized by fitting the stress intensity factors calculated by the proposed CZM and the conventional finite element method (FEM). Using the penalty coefficient, fatigue crack growth simulations are performed, and the crack growth behavior is compared to that calculated by the FEM-based method. The results are in quantitatively good agreement with those of the FEM-based analysis. Finally, elastic-plastic simulations using the proposed CZM are performed, and the retardation of crack growth by plasticity induced crack closure effect can be observed.

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