

**Wang, B.**, Siegmund, T., A Numerical Analysis of Constraint Effects in Fatigue Crack Growth by Use of an Irreversible Cohesive Zone Model, International Journal of Fracture, 132, 2005, pp. 175–196

### **Abstract**

The analysis of constraint effects in fatigue crack growth in multi-layer structures is discussed. The process of material separation under cyclic loading is described by a cohesive zone model (CZM) with an irreversible constitutive relationship. The traction–separation behavior does not follow a predefined path, but is dependent on the evolution of the damage dependent cohesive zone properties. A modified boundary layer model is used in simulations of fatigue crack growth along the centerline crack of the metal layer sandwiched between two elastic substrates. Fatigue crack growth is computed for a series of values of metal layer thickness under constant and variable amplitude loading conditions. The results of the computations demonstrate that certain combinations of load magnitude, layer thickness and material properties results in significant constrain effects in fatigue crack growth. The influence of these constraint effects on fatigue crack growth rates and on crack closure processes is determined. The evolutions of the traction–separation law, the accumulated and current plastic zones, as well as the stress fields during the crack propagation are discussed.

### **Keywords**

Cohesive zone model, Constraint, Cyclic loading, Fatigue crack growth, Multilayer structures