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Modeling Fatigue Crack Growth by Damage Accumulation Ahead of the Crack Tip Based on Strip-Yield Mechanics

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Abstract

Elber assumed deltaKeff is the actual driving force for fatigue crack growth (FCG), and his hypothesis is the basis for strip-yield models widely used to predict fatigue lives under variable amplitude loads. However, as briefly reviewed in the text, deltaKeff cannot explain all load sequence effects, hence it is at least worth to verify if FCG models based on it are indeed intrinsically better than concurrent models based on other principles. To do so, the traditional strip-yield mechanics is used here to predict FCG rates based both on Elber's principles and on the alternative view that FCG is instead due to damage accumulation caused by the cyclic strain history ahead of the crack tip, an idea that does not need or use the deltaKeff hypothesis. To fairly compare both models, FCG rates are estimated using cyclic strains induced by the plastic displacements calculated by the same strip-yield procedures, assuming there are strain limits associated both with the FCG threshold and the material toughness. Despite based on conflicting principles, both models can reproduce quite well FCG data, a somewhat surprising result that deserves to be carefully analyzed.