DUAL SCALING OF MOVING CRACK WITH MACRO- AND MICRO-DAMAGE

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ABSTRACT

Presented is a dual scale moving crack model containing microscopic damage ahead of a macroscopic crack. The scale change is assumed to occur gradually over a transition region which will be referred to as the mesoscopic zone where materials damage changes from the macro to the micro scale or vice versa. It consists of two adjoining surfaces on which restraining stresses are present in contrast to the free surface of the macrocrack and the cohesive stress of the atomic bond that is assumed to be an intrinsic and constant material property. Moreover, this damaged or restraining zone is not assumed arbitrarily. It is determined for each step of crack advancement.

The energy density function dW/dV is used to exhibit the dual scale character of the model. Numerical results are made in terms of the macro-distance ahead of the original crack while the micro-defect bluntness can vary depending on the tip geometry. Damage ahead of the macrocrack is assumed to take place in the form of a micronotch. Such a generality has not been considered previously. The macro-dW/dV behavior with distance remains as the inverse r relation yielding a perfect hyperbola for the homogeneous material. The micro-dW/dV relations are expressed in terms of a single undetermined parameter. Its evaluation, however, is beyond the scope of this investigation although the qualitative behavior is expected to be similar to that for the stationary crack. The major contribution of this work lies in developing a running crack model where macro and micro effects are treated simultaneously in a single formulation.