MICROMECHANICS BASED IMPERFECT INTERFACE MODEL WITH APPLICATION TO WAVE PROPAGATION

Anil Misra and Orestes Marangos

Department of Civil and Mechanical Engineering
University of Missouri-Kansas City,
350H Flarsheim Hall, 5100 Rockhill Road,
Kansas City, MO 64110, U.S.A.
misraa@umkc.edu

The authors have developed a kinematically driven micromechanical methodology for interfaces that utilizes, (1) a directional distribution function of asperity contact orientations as an additional measure of surface roughness, and (2) an iterative procedure to obtain the asperity contact forces at each load increment recognizing that the asperity contact force distribution is not always known *a priori* [1]. The derived model is utilized here to understand the effect of surface roughness and asperity shear resistance on the initial normal and shear stiffness behavior of interfaces. We find that the initial normal stiffness is nonlinear, and is related to the normal stress and the initial interface closure. Interestingly, the closure behavior varies from an exponential to a power law behavior depending upon the initial closure. Power laws, hyperbolic and exponential functions with asymptotic maximum closure have been utilized in the past to model closure behavior. However, the functional form of the closure behavior critically depends upon the initial closure which may be a result of the interface mismatch. We also find that the initial shear stiffness critically depends upon the asperity contact orientation and the asperity friction. Also, the interface initial shear stiffness varies nonlinearly with roughness. We also observe that for very smooth interfaces, the ratio of initial shear and normal stiffnesses becomes proportional to the asperity contact stiffness and independent of asperity friction. The calculated initial normal and shear stiffness are used to investigate plane wave propagation behavior through interfaces utilizing the well established imperfectly bonded interface model [2]. We find that the amplitudes of the reflected and transmitted waves as well as the group time delay of the wave-packets are significantly influenced by the interface normal stress and initial closure conditions. Since the derived model explicitly incorporates the asperity heights and radii of curvature, scale-dependent overall interface stiffnesses are obtained. The model may thus be used to elucidate the frequency dependency of wave transmission in interfaces.

References:

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[2] Rokhlin, S.I. and Wang, Y.J. Analysis of boundary conditions for elastic wave interaction with an interface between two solids. *J. Acoust. Soc Am*., 89, 503-515, 1991.

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