

ABSTRACT

A theoretical investigation of scattering of waves at unilateral contact interfaces between elastic surfaces is the central theme in this thesis. Mathematical models have been developed and solved analytically for different kinds of contacts and interface conditions. This study is relevant to wave assisted sliding, evaluation of interface conditions and properties etc.

An incident harmonic wave is considered that propagates in a grounded medium and interacts with an unrestrained medium. The incident wave field can excite the sliding of the unrestrained medium which is held frictionally or imperfectly against the grounded medium. The sliding velocity is calculated analytically by the solution correction method. The analysis is based on the stress distributions at the interface on an analogous bilateral problem, which, together with a set of corrective wave fields gives a closed-form solution of the problem. Also, the interface is considered to be preloaded with normal and shear stresses. Localized slip and separation may take place at such interfaces. If normal stress developed by the incident wave is weak compared to the normal preload, the interface will not separate. A separation appears, therefore, between the surfaces if the stress developed become stronger compared to the preload. Also, the localized slip can take place at the interface which depends on the shear preload and friction at the contact region. Coulomb friction model is used in the contact region of the interface. Further, the formulation is extended to see the effect of viscous friction or imperfect bonding at the interface for which a linear spring model is used. The boundary conditions in both the problems involve equality and inequality constraints. These constraints are verified for the different contact bands at the interface, which are in agreement with theoretical predictions. The sliding of an unrestrained medium and the distribution of interfacial stresses are numerically calculated for a pair of materials and analyzed for different excitation parameters and contact conditions. The frictional and imperfect interfaces result in dissipation of a part of the incident energy. The energetics of waves and the energy dissipation in the presence of frictional and imperfect contact interfaces are investigated. Next, the anelastic behavior of the sliding medium is considered in the analysis. The dissipative property of the anelastic medium is governed by the quality factor which is frequency dependent in general. A

constant quality factor model is used in this analysis which leads to a modification in the phase velocity dispersion of the viscoelastic waves. The effect of sliding velocity on the wave amplitudes, propagation directions and on the critical incidence is also studied. It is found that, induced sliding depends on the material properties, preloads, excitation and contact conditions.

Keywords: Elastic wave, Layered medium, Frictional interface, Stick-slip motion, Separation, Sliding motion, Imperfect interface, Energy partition, Anelasticity.