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Reflection of Plane Waves from the Free Surface of a Hard Sphere-Filled Elastic Metacomposite

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ABSTRACT

This study examines the reflection of plane waves from the free surface of a half-space composed of a hard sphere-filled elastic metacomposite using an effective medium model. Despite its practical and theoretical importance, this problem has received limited attention in the literature. The research presents, for the first time, explicit formulas and numerical examples for the reflection angles and amplitudes of reflected waves in a particulate metacomposite half-space with wave attenuation. These formulas extend classical results for homogeneous elastic materials, where wave numbers are real and amplitudes are constant, to metacomposites, where wave numbers are generally complex and amplitudes decay with propagation distance. The study provides a detailed analysis of reflected plane shear waves and surface compressional waves when an incident shear wave propagates at an angle smaller than the critical angle. The efficiency and accuracy of the effective medium model are validated by comparing predicted phase velocities and attenuation coefficients for an infinite metacomposite space with established results from the literature. These comparisons highlight the reliability of the model and its capability to accurately capture the dynamic behavior of particulate elastic composites. The findings contribute to a deeper understanding of wave reflection phenomena in metacomposites, offering valuable insights for applications in material design and wave manipulation in advanced composite systems.

Keywords: reflection of plane waves; particulate composite; free surface