ACOUSTICS2008/2424
Analysis of acoustical transmission and reflection from a sandy stratified rough sediment using the grain shearing model

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A number of applications, such as geoacoustic inversion or object detection, require an appropriate theoretical consideration of the sound reflection and transmission problem. The analysis we present here includes three essential aspects: account for a constitutive behavior of a saturated unconsolidated granular material, presence of vertical gradients in material properties, and roughness of the sediment surface. Accepting the Buckingham grain shearing model (see e.g. JASA, vol. 117, pp. 137-152) for the stress-strain relationship in the sediment, the gravity-induced variations of the longitudinal and shear rigidity can be described. The corresponding numerical solution for the plane interface is presented and the influence of infinite rigidity gradients at the surface is discussed. Another important contribution is provided by the interface roughness that considerably improves the penetration conditions. This problem is solved using a statistical treatment of a number of roughness realizations with a given spatial spectrum. The developed numerical tool enables to study the influence of all these factors and estimate the penetrated energy for different acoustical frequencies, roughness parameters, and grain sizes (This work was founded by DGA and Thales Underwater Systems).