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The inverse medium problem for geotechnical site characterization: theory, computations, and field experiments

Arash Fathi and Loukas F. Kallivokas

The University of Texas at Austin

We discuss recent progress in site characterization based on full-waveform inversion, which results in an estimation of the soil's distributed Lamé properties. We consider the soil medium to be elastic and terminated by Perfectly-Matched-Layers (PML) that limit the computational domain to the size of interest.

We then use the apparatus of PDE-constrained optimization to tackle the associated inverse medium problem. We discuss a *discretize-then-optimize* approach, which yields consistent material gradients, and, therefore, solves the associated inverse problem more robustly than alternative formulations. Next, we report on numerical experiments with idealized topographies and synthetic records involving arbitrarily heterogeneous media, and demonstrate successful reconstruction of the assumed Lamé properties.

We also report solutions of the inverse medium problem using actual field data. We compare our full-waveform-based results against profiles obtained using the Spectral Analysis of Surface Waves (SASW) method, also a non-invasive method. And, finally, we attempt to validate the full-waveform inversion profiles by consulting results obtained through an invasive in-situ approach (CPT). We report fairly good agreement.