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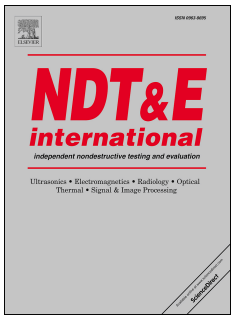

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Accuracy of parameter identification using the dispersion of surface waves and the role of data quality for inhomogeneous concrete

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Abstract
We study the influence of the data quality on the accuracy of parameter identification for inhomogeneous concrete. The surface of the concrete may differ as a result of either intentional action (decoration or repair) or the interaction of initially homogeneous concrete with the environment. Non-destructive evaluation of the concrete surface layer is vital to monitoring the integrity of concrete structures and preventing their irreversible damage. We use the methodology (also used for ground structure recovery) of multichannel analysis of surface waves as the non-destructive testing (NDT) tool in the civil engineering domain to characterize the concrete surface layer. The procedure consists of the generation and reception of surface waves within the required frequency band. Then, the phase velocity dispersion characteristic is extracted and used as input data for solving the inverse problem to obtain the variation of the shear wave velocity as a function of the sample depth.
Two aspects of data quality are considered: completeness in the frequency or wavelength domain and accuracy. In the former case, the efficiency of identification is studied for variable ranges (in the frequency or wavelength domains) of the dispersion curve of the fundamental mode of the surface wave. The role of data accuracy is evaluated through comparison of the identified parameters using experimental and appropriate synthetic data.
To perform these studies, cuboidal models of inhomogeneous concrete composed of two layers of different classes of concrete are prepared. During experiments, surface wave signals are acquired within a frequency range of 35 kHz to 160 kHz using a non-contact ultrasonic automated scanner, which enables quick and precise signal recording, avoiding concrete surface modification through the use of the coupling agent. Experimental dispersion curves are obtained using the Slant-Stack transformation. The synthetic data are obtained from the solution of the Thomson-Haskell model. The inversions are performed using the in-house software CLOUD and tested and validated on the multilayer model samples. The criteria for the optimum wavelength intervals of the dispersion curves are proposed: the lower wavelength limit $\lambda_L \leq d$, and the upper wavelength limit $\lambda_U \geq 3.5d$, where d is the thickness of the top layer. The consequences of narrowing the intervals are thoroughly studied, and upper and lower limits are determined both for experimental and synthetic data. It is shown that the efficiency of inversion depends on both wavelength limits and accuracy of the data.

Keywords: Surface waves, concrete, surface layer, dispersion, inversion, non-contact measurements, identification.

1. Introduction

In inhomogeneous concrete structures, the outer layer is different from the rest of the material as a result of either intentional action or the interaction of an initially homogeneous material with the environment. The former case applies to concrete structures covered by a layer of concrete or another material for decoration or to repair or renew the surface. In the latter case, the influence of humidity, temperature (particularly in cases of relatively low temperatures), chemical and biological factors induce changes of the surface layer properties, causing the

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