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# Summary

This dissertation primarily deals with the development of a new geostatistical model for the independent management of Epistemic Uncertainties (EUs) and Aleatory Variabilities (AVs) in shear wave velocity profiles ( $V_s$ ) obtained with surface wave methods. This topic has gained much interest in light of the recent probabilistic advancements in of ground motion predictions, particularly in case of only deterministic available solutions.

An overview of the methods that address for the influence of epistemic uncertainties and aleatory variabilities in probabilistic hazard studies is initially presented. The essential role of the process for the Identification, Quantification, and Management (IQM) of uncertainties and variabilities is widely discussed along with the included practical criticisms.

The dissertation focuses on the role played by site effects in hazard studies. The research is primarily devoted to the study of these effects by means of 1D Ground Response Analyses (GRAs). In this regard, the dissertation presents an extensive analysis of the most critical sources of EUs and AVs included in this type of numerical simulations. Also, the effects of these sources on the results are explicitly investigated and summarized.

In particular, the dissertation highlights the primary importance of shear wave velocity profiles in GRAs. In this regard, substantial consideration is given to different seismic (i.e., geophysical) tests that experimentally estimate this parameter. An extensive and precise analysis of the sources of EUs and AVs in each geophysical tests is presented and summarized along with the issues for their identification and quantification. Also, the usually adopted methods for the management of uncertainties and variabilities are described and discussed in details.

The development of the new geostatistical model is strictly connected to the compilation of the Polito Shear Wave velocity Database (PSWD). This collection of high-quality surface waves experimental data represents the main ingredient for the analysis of the random variables involved in the problem and for the rigorous calibration of the model. Moreover, the availability of a large amount of data and the study of the geostatistical model allowed examining in depth three main side products of the dissertation. The first regards the accurate study of the uncertainties and variabilities included in the processing of surface wave tests and the experimental dispersion curve. The second concerns the development of a robust transformation law between the wavelength of the Rayleigh waves and the depth of the harmonic average  $V_s$  profile. The third main side product of the research is the implementation of a method for inversions with a variable number of layers.

The primary characteristics of the proposed geostatistical model are the experimentally-based calibration, the separation of the random variables space and time, the site- and test-specific features, the user-friendliness, and the flexibility. The flexibility of the model is demonstrated by a prototype application to Down-Hole tests, which represents its natural future development.

The proposed geostatistical model is validated by means of a real case study for the site of Mirandola (Italy). Both the linear viscoelastic and the nonlinear responses of the deposit are modeled. The results show a significant improvement in the management of EUs and AVs in GRAs, compared to the methods usually adopted for scientific and technical applications. The geostatistical model

allows a rigorous control of the level of uncertainties and variabilities introduced in the hazard study. However, further research should be devoted to additional validations of the randomization model in light of the possible separation of EUs and AVs in the final result. Indeed, the model is capable to manage indistinctly the uncertainties that are the results of the identification and quantification steps. Also, the extension of the model architecture to other geophysical tests (e.g., Down-Hole tests) can be easily implemented and represents a further research's goal. In this regard, a preliminary validation of the extended model is finally proposed and applied to a real Down-Hole test performed in Mirandola.