

Special issue

Geophysical Site Characterization for geotechnical studies: current practices and future developments

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Preface

This Special Issue aims to compile a collection of scientific and technical papers related to applications and research in the field of geophysical site characterization for geotechnical studies. Several geophysical techniques are indeed nowadays available and diffusely adopted to aid geotechnical parameters estimation and help in imaging their spatial distribution at the site. These techniques are currently adopted providing specific parameters directly involved in geotechnical evaluations (e.g. shear wave velocity for earthquake engineering studies). However, in most cases, combined interpretation of geophysical and geotechnical test requires specific analyses and integration strategies.

The idea for this Special Issue was launched during the 7th International Conference on Geotechnical and Geophysical Site Characterization – ISC'7 “Ground models, from big data to engineering judgement” held in Barcelona, Spain, in June 2024. On that occasion, a large number of papers regarding the current practices and future developments of geophysical site characterization for geotechnical studies were submitted to the conference by researchers from many countries, and Professor Marcos Arroyo, the Chair of the conference, together with Paola Montone, the Editor in Chief of Annals of Geophysics, supported the initiative to develop this Special Issue. The main idea was to collect in the Special Issue the best selected papers presented at the Conference in order to contribute to the definition of current practices and future developments of geophysical methods for site characterization and geotechnical studies.

Contributions of this special issue were then collected both by inviting researchers who participated at ISC'7 and whose works were considered of high relevance and by opening a call for paper submission related to: the development of ground models for large and small projects through specific integration and combined interpretation of geophysical and geotechnical tests; the direct application of in situ geophysical and geotechnical tests for earthquake engineering and seismic microzonation studies; the development of new testing apparatus and procedures involving a combination of geophysical and geotechnical testing methodologies; the integration of geophysical and geotechnical monitoring techniques for time-lapse evaluations; the role of big data and machine learning in site characterization; and to the use of numerical simulation techniques as an aid to geotechnical and geophysical testing.

This Special Issue is a compilation of 11 papers, as listed below:

- dos Reis Júnior et al. (2025) used GPR surveys for detecting water leakage in urban pavements. Particularly, computer modeling of GPR profiles enabled effective comparisons with real data and helps in calibrating key GPR attributes to allow for the precise delineation of leakage zones in both synthetic and real GPR datasets collected in the Amazon region of Brazil;
- Hojat et al. (2025) developed a customized electrical resistivity tomography (ERT) monitoring system and showed the results of its installation on a critical slope above a high-speed railway gallery for the time-lapse monitoring of the stability condition of the slope. Specifically, the optimization of the time-lapse inversion algorithm to

Preface

generate artifact-free ERT images that can reflect the real distribution of the water content and the complicated geological conditions are the site are discussed;

- Valvano et al. (2025) reported on the results of Medusa SDMT (Seismic Dilatometer) and SCPTu (Seismic Piezocone) performed at two different sites in the Emilia (Italy) plain focusing on the measurement of the shear wave velocity (V_s) and on the predictive capability of existing CPT and DMT empirical correlations, also proposing an updated DMT correlation to improve the accuracy of the predicted V_s in silty-sandy deposits, which are predominant in the Region;
- Cárdenas-Soto et al. (2025) used the seismic ambient noise and the seismic interferometry to study the seismic response of the Bridge of the Lions, Chapultepec Forest, México City (México). The acquired geophysical data explained the bridge deterioration, as a results of the local terrain subsidence, suggesting soil-structure interaction effects;
- Zapata-Franco et al. (2025) highlighted the importance of properly characterizing site effects for robust seismic risk assessment, recognizing the complexity of the variables involved. The application of a computational framework for assessing the probabilistic dynamic response of soils in the Port of Barcelona (Spain), essentially using information from seismic dilatometer Marchetti test (SDMT), provided valuable insights at addressing the complexity of soil dynamic characterization;
- Antunes et al. (2025) argued that the inversion of single-station Rayleigh wave ellipticity curve in routine site investigation can be an interesting tool. The presented research includes a numerical inversion exploration as well as three normally dispersive case studies in Lisbon County (Portugal), showing how the Rayleigh wave ellipticity curve yields cost-effective information on the shallow ground structure useful for limited spaces in urban areas;
- Bălă et al. (2025) provided a review study on the shear wave velocity (V_s) measurements in the area of Bucharest, as key input for seismic site amplification models and microzonation map. The data were used, together with the other geotechnical parameters and the geological model, to estimate the ground motion amplification of the area of Bucarest;
- Hirsh and Ritter (2025) studied the subsurface at the WINSENT research facility in SW Germany to derive geometric and dynamic parameters that are important to better understand the soil-structure interaction of wind turbines and the soil beneath. They derived 3-D compressional and shear wave velocity models with minor lateral variation that can be used as input for numerical modelling of wave propagation due to vibrating wind turbines. This knowledge can be used for the construction of modern wind turbines on land whose nacelles reach altitudes of more than 150 m above the ground;
- Posada et al. (2025) focused on studying sites dominated by complex topographic conditions. They analyzed ground motion records from an urban seismic network to implement techniques for characterizing site effects. They investigated how the topographic conditions of the terrain modify the seismic response at station sites. This study can contribute to the development of effective strategies for seismic response zonation, infrastructure design, and seismic risk assessment from a site characterization perspective;
- Deu et al. (2025) described a methodology for offshore in situ shear wave velocity measurements in the port of Barcelona. This type of testing is more challenging than onshore, due to the difficulties in the correct deployment of the instrumentation as well as of the wave source, in absence of direct visibility of the ground level below water. Medusa SDMT tests were performed in sea depths ranging between 15-17 m from a jackup and employing a drill rig to penetrate the probe down to 40 m below the seafloor. Results obtained in Lab from undisturbed samples were compared with the Medusa SDMT tests to validate the proposed approach;
- Rahimi et al. (2025) demonstrates the value of combining multiple non-invasive geophysical methods to characterize a landslide. Geophysical testing was conducted using Multichannel Analysis of Surface Waves (MASW), Horizontal to Vertical Spectral Ratio (HVSr), and Electrical Resistivity Tomography (ERT), supplemented by select soil borings. Overall, the integrated approach offers a more sustainable, rapid, and cost-effective solution for comprehensive landslide characterization and slope stability assessment and design, compared to relying solely on conventional methods.

We congratulate all of the authors who contributed to this Special Issue and thank the many reviewers who critically assessed the original manuscripts. We are indebted to the Editor in Chief, as well as to the Annals of Geophysics editorial team, for their efforts to complete this project.

We are very grateful to be the Guest Editors of this Special Issue, encouraging the geotechnical and geophysical community to pursue innovative multidisciplinary research studies in view of its potentiality.

List of papers of the Special Issue

- Antunes, A. C., P. Teves-Costa and R. C. Gomes (2025). The use of the inversion of single-station Rayleigh wave ellipticity curve in routine site investigation: numerical inversion and case-studies, *Ann. Geophys.*, 68, 3, this issue.
- Bălă, A., C. Gheablău and C. Arion(2025). Ground motion amplifications for Bucharest based on 3D geological model and assigned geophysical properties, *Ann. Geophys.*, 68, 3, this issue.
- Cárdenas-Soto, M., D. Escobedo-Zenil, J. Sánchez-González and M. C. Vidal-García (2025). Seismic Response Study Around the Bridge of the Lions, Chapultepec Forest, México City, *Ann. Geophys.*, 68, 3, this issue.
- Deu, A., D. Marchetti, A. Gens, A. Viana da Fonseca et al. (2025). Offshore Shear Wave Velocity Measurements for the Assessment of Soil Sampling Quality, *Ann. Geophys.*, 68, 3, this issue.
- dos Reis Júnior, J. A., H. O. da Rocha, M. M. Yano Taniyama, G. Mendes Duarte et al. (2025). Modeling and advanced Ground Penetrating Radar techniques for evaluating pipe leakage and pavement distress, *Ann. Geophys.*, 68, 3, this issue.
- Hojat, A., G. Tresoldi, R. Bianchi, F. Brambilla et al. (2025). Long-term analysis of ERT monitoring data measured on a critical slope above a high-speed railway gallery, *Ann. Geophys.*, 68, 3, this issue.
- Rahimi, M., C. Wood, M. Fathizadeh and S. Rahimi (2025). A Multi-method Geophysical Approach for Complex Shallow Landslide Characterization, *Ann. Geophys.*, 68, 3, this issue.
- Posada, G., F. Díaz-Parra and J. Montejo (2025). Characterizing Seismic Response from Ground Motion Records: A Local-Scale Study for Geotechnical Applications, *Ann. Geophys.*, 68, 3, this issue.
- Hirsh, J. R. and JR. R. Ritter (2025). Seismic structure at the test site for wind energy research, WINSSENT, Southwest Germany, *Ann. Geophys.*, 68, 3, this issue.
- Valvano, C., S. Amoroso, S. Hailemikael, L. Minarelli et al. (2025). Use of in situ tests to measure and predict shear wave velocity: the peculiarity of silty-sandy deposits in Emilia (Italy), *Ann. Geophys.*, 68, 3, this issue.
- Zapata-Franco, A. M., Y. F. Vargas-Alzate, D. Tarragó and A. Gens (2025). Probabilistic soil model for seismic risk assessment based on SDMT results, *Ann. Geophys.*, 68, 3, this issue.

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