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Determination of the shear wave velocity in the construction site by multi-channel analysis of surface waves (MASW) and preparation of shear wave velocity zoning maps to the depth of 30 meters using geographic information system (GIS) - A case study in Shahrood

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Extended Abstract

Summary

This study investigates the shear wave velocity (Vs) profile to the depth of 30 meters in Shahrood area using the multi-channel analysis of surface waves (MASW) method. Geotechnical and geophysical data collected from 12 MASW tests were integrated using the geographic information system (GIS) technology to create a zonation map of shear wave velocity across Shahrood area. The findings reveal that more than 90% of Shahrood area soils exhibit shear wave velocities between 350 and 750 m/s, indicating type II soil according to seismic design standards. This information is crucial for understanding site response characteristics and implementing resilient infrastructure planning.

Introduction

The study of dynamic soil properties, particularly shear wave velocity (Vs), plays a crucial role in geotechnical seismic studies, offering insights into site behavior under seismic loads. Shahrood, a seismically active area, requires precise characterization of its soil profiles for adequate earthquake hazard mitigation. MASW is a non-invasive method to determine Vs profiles without drilling boreholes, which traditionally is costly and time-consuming. Given geological heterogeneity in Shahrood area, this research aims to generate a comprehensive Vs profile for the area using MASW, complemented by GIS for spatial analysis, providing a critical foundation for further geotechnical assessments and urban planning in seismically active areas.

Methodology and Approaches

The MASW methodology involves three main stages: data acquisition, data processing, and inversion to generate Vs profiles. Data were collected using a 12-channel seismograph and vertical geophones positioned at regular intervals, while the seismic waves were generated using an impact source. Fourier transformations were employed to analyze the recorded wave data, converting them from time to frequency domains and isolating the phase velocity of Rayleigh waves. Inversion of dispersion curves enabled the development of depth-dependent Vs profiles. To improve data accuracy, noise reduction and frequency filtering techniques were applied. The processed Vs profiles were then integrated with GIS to create a zonation map, offering a layered spatial analysis of Vs across the study area.

Results and Conclusions

The results indicate a significant variation in Vs across Shahrood area, with a general trend of increasing Vs with depth. In the central and southern parts of the Shahrood area, Vs values mostly range between 375 and 750 m/s, while the eastern and western parts of the area display denser soils with Vs values exceeding 750 m/s. This spatial distribution categorizes the majority of soils in the area as type II. The generated zonation map provides essential information for assessing local seismic site effects and offers a practical tool for urban planning and structural design in the area.