EFFECT OF INPUT-SOURCE FREQUENCY CONTENT ON RESULTS FROM SEISMIC TECHNIQUES FOR THE V_S PROFILE DEFINITION IN SPATIALLY VARIABLE SOILS

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Abstract

All around the world, foundation and construction codes consider the shear wave velocity (V_S) profile as a good indicator of soil stiffness. The definition of a V_S profile is a very common practice for site classification and soil characterization in geotechnical engineering. In order to obtain the V_S profile there are typically two approaches: direct exploration (e.g. Seismic Cone Penetration Test 'SCPT') and indirect exploration (e.g. seismic refraction 'SR' and multichannel analysis of surface waves 'MASW' techniques). Both, direct and indirect techniques require the use of an energy source to generate the waves necessary to characterize the V_S soil profile; for near surface (depth less than 30m) usually an impact force is used as input source.

The shear wave velocity (Vs) is equal to the product of wave length (λ) and wave frequency (f). On one side, wave length represents the limitation in terms of vertical resolution for indirect techniques; the shorter the wave length, the better the vertical resolution (thinner layers can be detected). On the other side, frequency content for the input source is not very well studied and its effect on vertical resolution for the Vs profile is not very well understood. As the Vs depends only on the soils variability, there is no way to modify it in the tests; so, what is modifiable in during the test is the frequency content in the input source and as a collateral effect, the wave length.

Numerical Simulation

By doing numerical simulations it is possible to analyze the effect of different approaches when interpreting the results obtained from seismic tests for soil characterization. In order to fully understand the results obtained in numerical models it is necessary to calibrate the model with theoretical results.

One of the main assumptions when defining the V_S profile for a specific site is the 'layered-soil' model. For each layer in the model it is assumed the soil properties are homogeneous. The layers' definition is the result of an expert interpretation process which follows the Soil Behavior Type 'SBT' classification presented by Robertson (2009). Under this assumption the V_S profile is obtained by using the ray-path theory for wave propagation and calculating a unique value for each layer corresponding with any specific SBT value.

On the other hand, a different and innovative approach is possible, which considers the effect of spatial variability of soil properties when defining the V_S profile. Under this approach the V_S profile is defined considering the randomness in the soil's shear-stiffness, so the ray-path theory for wave propagation must be carefully used in these models.

Conclusions

In this research the effect of frequency in the definition of V_S profile was studied by using numerical models to simulate the seismic refraction 'SR' test and the 'SCPT' test. The numerical models included homogeneous deterministic and spatially variable shear stiffness (the latter using random fields). In order to calibrate the numerical model three SCPT field test were carried out. Once the field results were replicated by the numerical models, the frequency for the input source is modified and new V_S profiles are obtained. The analysis of differences in Vs profile among different models allows to draw important conclusions about the effect of frequency in the Vs profile results.

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