IDENTIFICATION OF 3D LATERAL VARIATIONS IN PSEUDO-3D ENVIRONMENT

Hossien RAHNEMA
Associate Professor of Civil & Environmental Engineering Dept., Shiraz University of Technology, Shiraz, Iran
rahnema@sutech.ac.ir

Farhad NIKNAM
M.Sc. Student of Civil & Environmental Engineering Dept., Shiraz University of Technology, Shiraz, Iran
f.niknam@sutech.ac.ir

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Site investigation is of specific importance in different branches of the geosciences. This method has been welcomed by geotechnical and geophysical engineers due to two of its important properties including non-destructivity and short test duration. The ability to investigate a wide range of sites at a very short period of time, as well as the lack of an alternative with economic justification, makes these methods unique (Park et al., 1999).

In the early 1980s spectral analysis of surface waves method was introduced. Since this method enjoys the use of two receivers as well as fast Fourier transform, it became very popular among civil engineers (Heisey et al., 1981). In 1999, a method using numerous receivers was developed (Park et al., 1999). This method was called multi-channel analysis of surface waves, which was much stronger than the previous one with clearer and more reliable results. Among these, traditional surface waves methods using Rayleigh waves dispersion curve under spectral analysis of surface waves and multi-channel analysis of surface tests, mainly applied to estimate shear wave velocity in order to identify site. Besides, it should be regarded that f-k approach may not consider some local variations in the site; for example, lateral variation is ignored. They will lead to unreliable results. Meanwhile, a method called multi-offset phase analysis (MOPA) was introduced to study phase variation versus offset in a model with lateral heterogeneity (Strobbia & Foti, 2006; Vignoli & Cassiani, 2010).

One of the methods that has received attention recently is the investigation of 3D environment using acquisition with 2D receiver array on the surface of the ground. Boiero et al. (2011) changed rectangular arrays of receivers; i.e. they replaced 3D and/or linear arrays orthogonal to the wave source by linear arrays (Boiero et al., 2011). Pan et al. (2018) investigated a pseudo-3D environment by repeating the test and moving the receivers in one line. They obtained lateral variations using dispersion curve modifications (Pan et al., 2018).

As represented in previous works, most of surface wave studies have focused on 2D array and lateral heterogeneity in pseudo-3D environment has not attracted so much attention. Thus, this paper is aimed to investigate lateral variations in pseudo-3D environment. According to MOPA's ability to investigate phase variation versus offset in areas with lateral heterogeneity. Therefore, in current article synthetic models with lateral heterogeneity are studied. The main purpose of this paper is to provide a method to detect automatic and location of lateral variations in pseudo-3D environment using numerous analyses in two orthogonal directions. In fact, the 3D environment is developed using a combination of numerous 2D analyzes. Eventually, a more detailed analysis of site properties is obtained by the transform process.

A linear relationship between the offset and the phase is assumed in the current phase-offset study. The relationship is displayed in Equation 1 (Aid & Richards, 1980).

$$\varphi(\omega,x)=-k_m(\omega)\cdot x+\varphi_0(\omega) \qquad (1)$$

In this paper, synthetic models are analyzed using ABAQUS software that is shown in Figure 1. Then the obtained results are processed by MATLAB codes. The phase versus offset diagram of the model with lateral variations, derived from the MATLAB results, is plotted in Figure 2. As shown in the figure, the slope change is at a distance of 11 meters, which indicates lateral variations.

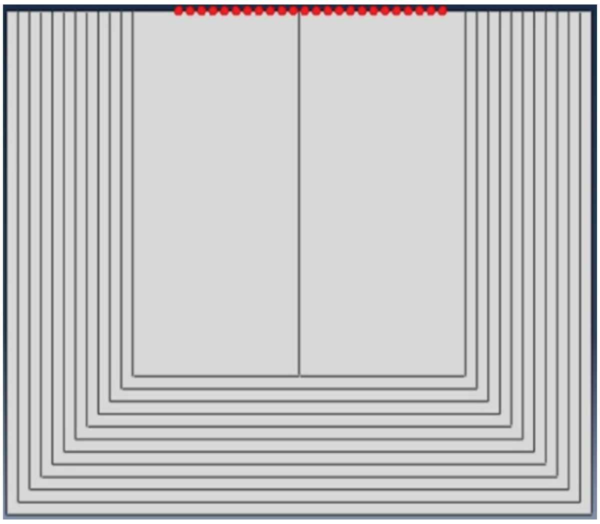

Figure 1. Synthetic models in ABAQUS environment.

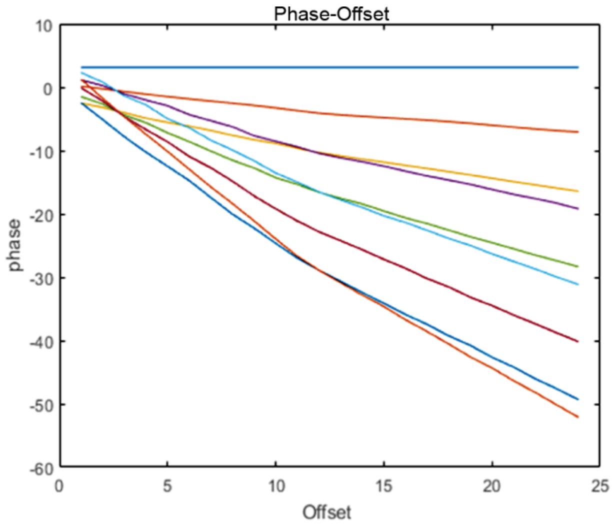

Figure 2. Phase offset diagram resulted from MATLAB.

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