Some new theoretical considerations about the ellipticity of Rayleigh waves in the light of site-effect studies in Israel and Mexico

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Abstract: It is well-known that ground motion amplification due to soft soils, common in urban areas, is a major contributor to increasing damage and number of causalities. Indirectly, the study of Rayleigh-wave ellipticities has recently gained considerable popularity in the context of studying ambient seismic vibrations for seismic hazard analysis. The output can be integrated into the inversion process for the velocity structure. Due to the strong impedance contrast in the shallow subsurface structure, local site effects are often fairly well predicted by simple models. Therefore, a thorough theoretical understanding of even a single layer over half-space (LOH) is not only of theoretical but also of considerable practical interest. Adding to this argument is the fact that an accepted theoretical model for the interpretation of H/V-measurements from ambient vibrations, still has to be developed. A useful starting point for the theoretical investigation of the ellipticity of Rayleigh waves is the exact formula derived by Malischewsky and Scherbaum (2004). It can be shown, that already the simple LOH model is able to produce a great variety of H/V-versus-frequency curves with different character. We cite observations from Israel and Mexico as an example of H/V-curves with more than one maximum. This phenomenon is usually contributed to additional layers, where the first maximum is connected with the shear-resonance frequency of the first layer and the secondary maximum with a resonance frequency of a deeper layer. We demonstrate that already the simple LOH model yields two peaks in a certain range of Poisson ratios. However this simple model cannot explain the experimental curves under consideration, where more complex models and higher modes are necessary. These considerations can yield constraints for Poisson ratios which are otherwise less controlled. In conclusion, such theoretical investigations of analytical or half-analytical character are necessary for a better understanding of the behaviour of the ellipticity of Rayleigh waves and its use for site effect studies.

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