On the relationship of peaks and troughs of the ellipticity (H/V) of Rayleigh waves and the transmission response of single layer over half-space models

Tuan T.T., Scherbaum F., Malischewsky P.G.

Hanoi University of Science, VNU, Viet Nam; University Potsdam, Germany; Friedrich-Schiller University Jena, Germany

Abstract: One of the key challenges in the context of local site effect studies is the determination of frequencies where the shakeability of the ground is enhanced. In this context, the H/V technique has become increasingly popular and peak frequencies of H/V spectral ratio are sometimes interpreted as resonance frequencies of the transmission response. In the present study, assuming that Rayleigh surface wave is dominant in H/V spectral ratio, we analyse theoretically under which conditions this may be justified and when not. We focus on 'layer over half-space' models which, although seemingly simple, capture many aspects of local site effects in real sedimentary structures. Our starting point is the ellipticity of Rayleigh waves. We use the exact formula of the H/V-ratio presented by Malischewsky & Scherbaum (2004) to investigate the main characteristics of peak and trough frequencies. We present a simple formula illustrating if and where H/V-ratio curves have sharp peaks in dependence of model parameters. In addition, we have constructed a map, which demonstrates the relation between the H/V-peak frequency and the peak frequency of the transmission response in the domain of the layer's Poisson ratio and the impedance contrast. Finally, we have derived maps showing the relationship between the H/V-peak and trough frequency and key parameters of the model such as impedance contrast. These maps are seen as diagnostic tools, which can help to guide the interpretation of H/V spectral ratio diagrams in the context of site effect studies. ?? 2010 The Authors Geophysical Journal International ?? 2010 RAS.

Author Keywords: Site effects; Theoretical seismology; Wave propagation

Year: 2011
Source title: Geophysical Journal International
Volume: 184
Issue: 2
Page : 793-800
Link: Scorpus Link
Correspondence Address: Tuan, T.T.; Hanoi University of Science, VNUViet Nam; email: tuantt@vnu.edu.vn
ISSN: 0956540X
DOI: 10.1111/j.1365-246X.2010.04863.x
Language of Original Document: English
Abbreviated Source Title: Geophysical Journal International
Document Type: Article

Source: Scopus

Authors with affiliations:

1. Tuan, T.T., Hanoi University of Science, VNU, Viet Nam
2. Scherbaum, F., University Potsdam, Germany
3. Malischewsky, P.G., Friedrich-Schiller University Jena, Germany

References:

1. Albarello, D., Lunedei, E., Alternative interpretations of horizontal to vertical spectral ratios of ambient vibrations: new insights from theoretical modelling (2009) Bull. Earthq. Eng., 8, pp. 519-534
2. Bonnefoy-Claudet, S., Cotton, F., Bard, P., The nature of noise wavefield and its applications for site effects studies. A literature review (2006) Earth-Sci. Rev., 79, pp. 205-227
3. Bonnefoy-Claudet, S., K??hler, A., Cornou, C., Wathelet, M., Bard, P., Effects of Love waves on microtremor H/V ratio (2008) Bull. seism. Soc. Am., 98 (1), pp. 288-300
4. F??h, D., Kind, F., Giardini, D., Inversion of local S-wave velocity structures from average H/V ratios, and their use for the estimation of site-effects (2003) J. Seismol., 7, pp. 449-467
5. (2005), Guidelines for the implementation of the H/V spectral ratio technique on ambient vibration-measurements, processing and interpretations, SESAME European research project, deliverable D23.12Haghshenas, E., Bard, P.Y., Theodulilis, N., Empirical evaluation of microtremor H/V spectral ratio (2008) Bull. Earthq. Eng., 6, pp. 75-108
6. Konno, K., Ohmachi, T., Ground-motion characteristics estimated from spectral ratio between horizontal and vertical components of microtremor (1998) Bull. seism. Soc. Am., 88, pp. 228-241
7. Malischewsky, P.G., Scherbaum, F., Love's formula and H/V-ratio (ellipticity) of Rayleigh waves (2004) Wave Motion, 40, pp. 57-67
8. Malischewsky, P.G., Scherbaum, F., Lomnitz, C., Tran Thanh, T., Wuttke, F., Shamir, G., The domain of existence of prograde Rayleigh-wave particle motion for simple models (2008) Wave Motion, 45, pp. 556-564
9. Mucciarelli, M., Herak, M., Cassidy, J., Increasing Seismic Safety by Combining Engineering Technologies and Seismological Data (2009), Ed.) ., Springer, DordrechtNakamura, Y., A method for dynamic characteristics estimation of subsurface using microtremor on the ground surface (1989) Q. Rep. RTRI, 30 (1), pp. 25-33
10. Nakamura, Y., (2000), pp. 177-402. , Clear identification of fundamental idea of Nakamura's technique and its applications, Proc. 12WCEE, No. 2656Nakamura, Y., Basic Structure of QTS (HVSR) and Examples of Applications, in Increasing Seismic Safety by Combining Engineering Technologies and Seismological Data (2009), pp. 33-51. , eds, Mucciarelli, M., Herak, M. & Cassidy, J., Springer, Berlin, doi:Nogoshi, M., Igarashi, T., On the amplitude characteristics of microtremor (part 2) (1971) J. seism. Soc. Japan, 24, pp. 26-40. , In Japanese with English abstract)
11. Stephenson, W.R., (2003), Factors bounding prograde Rayleigh-wave particle motion in a soft-soil layer, Pacific Conference on Earthquake Engineering, Christchurch, New ZealandPetrosino, S., (2006), Attenuation and velocity structure in the area of Pozzuoli-Solfatara (Campi Flegrei, Italy) for the estimate of local site response, PhD thesis, Universit? degli Studi di Napoli "Federico II"Suzuki, T., Amplitude of Rayleigh waves on the surface of a stratified medium (1933) Bull. Earthq. Res. Inst., 11, pp. 187-195
12. Wathelet, M., (2005), Array recordings of ambient vibrations: surface-wave inversion, PhD thesis, University of Lige, Belgium. Available at: (Last accessed 2008 June 10)