RU4-S4: MULTIMODAL INVERSION OF SURFACE WAVES FOR THE NEAR SURFACE CHARACTERIZATION OF NATIONAL ACCELEROMETER NETWORK STATIONS

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Introduction and Method

This poster reports on the results of a surface wave test characterization campaign conducted at 19 stations of the Italian Accelerometer Network in Liguria, Piemonte, and Sicilia. The objective of this survey is the identification of the shear wave velocity profile and the depth of the seismic bedrock. Three case histories located in Sicilia are presented to underline the importance of higher modes in surface wave inversion in different stratigraphic conditions. Combined seismic refraction tests performed on the same seismic dataset can provide an useful comparison to assess the reliability of the results.

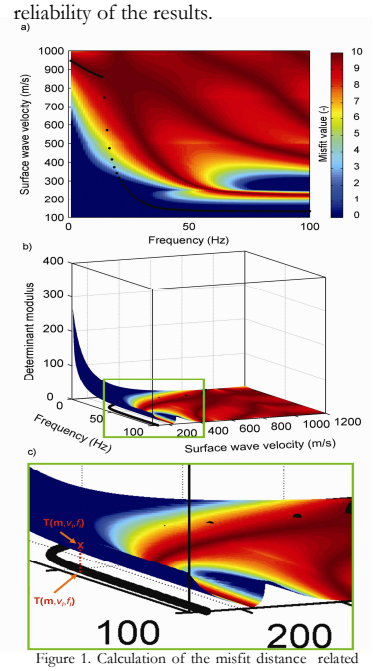

Figure 1. Calculation of the misfit distance related to the Haskell-Thomson determinant

Surface wave inversions were performed using a multimodal inversion code which does not require the mode numbering, obtaining an enhancement of resolution, an increase of penetration depth, and a reduction of interpretation errors due to mode misidentification.

In the case histories presented here, the fundamental mode approach for the inversion would produce significant errors.

A stochastic algorithm was applied in dispersion curve inversion, using a multimodal error function based on the minimization of a misfit distance related to the Haskell-Thomson determinant (Figure 1) (Ernst 2007, Maraschini et al. 2008).

Santa Croce Site

The experimental dispersion curve for this site (composed by one branch with discontinuities around 45 Hz), was inverted using the multimodal inversion algorithm.

From the obtained results (Figure 2) we can observe that the experimental curve jumps on the 1st higher mode in the frequency range lower than 45 Hz, probably because of the marked impedance contrast between the topsoil and the bedrock.

The fundamental mode inversion (without any additional information) would provide an erroneous estimation of the half-space velocity due to the mode misidentification.

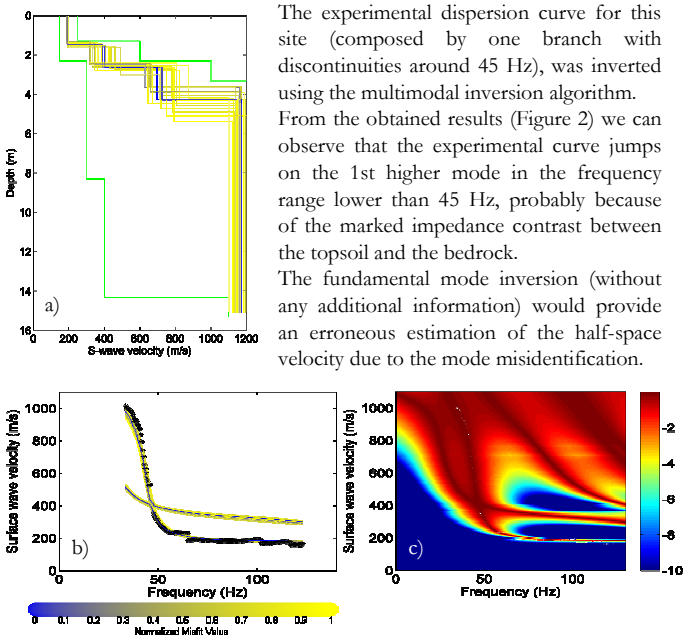

Figure 2. Santa Croce. a) 20 best fitting profiles with Monte Carlo boundaries (green); b) theoretical dispersion curves of the 20 best fitting profiles compared with the experimental one; c) Haskell Thomson determinant of the best profile compared with the experimental dispersion curve

Ispica Site

A calcareous shallow bedrock below the topsoil was expected for this site.

The experimental dispersion curve is composed by several branches; all of them were considered in the inversion process: the higher and the slower velocity branches provided information on the bedrock and the topsoil, respectively. The fitting in term of dispersion curve is very good, and the interface position is in good agreement with the seismic refraction results (Figure 3).

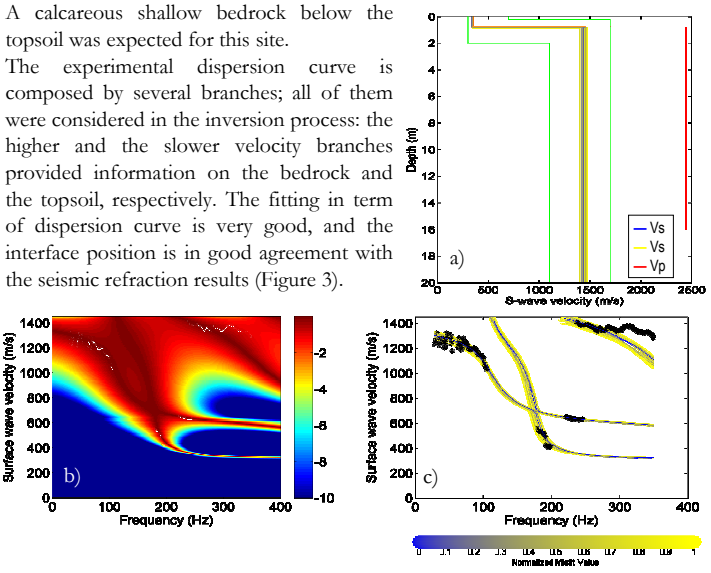

Figure 4. Ispica. a) 20 best fitting profiles with Monte Carlo boundaries (green); b) Haskell Thomson determinant of the best profile compared with the experimental one; c) dispersion curves of the 20 best fitting profiles compared with the experimental dispersion curve.

Noto Site

The experimental dispersion curve was composed of a main branch and two small branches with higher velocities.

The inversion was performed using all the branches, and the obtained results shows an interface between the soft shallower layer at about 2m depth, and a gradual velocity increase below this depth. The bedrock is about 7 m depth. The position of the first interface is in good agreement with refraction results (Figure 4).

Also in this case the inclusion of higher modes in the inversion process enhances the model resolution and avoid errors due to mode misidentification.

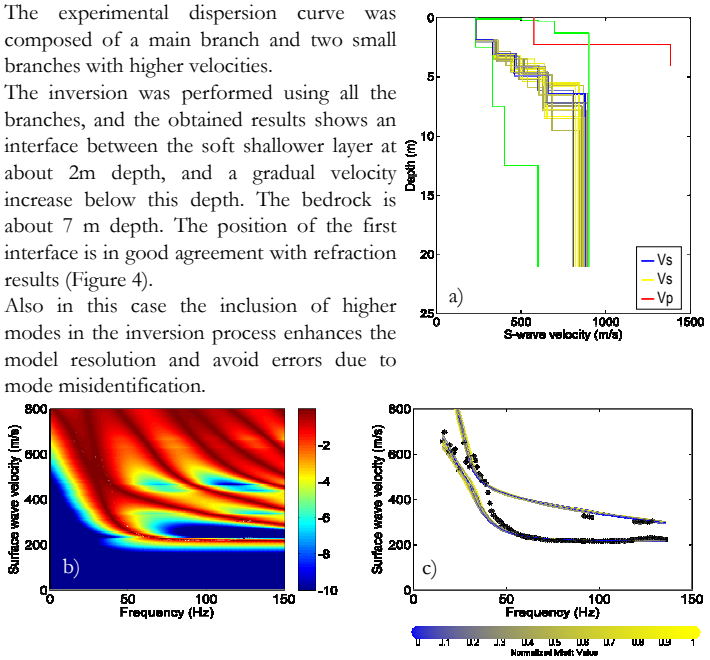

Figure 4. Noto. a) 20 best fitting profiles with Monte Carlo boundaries (green); b) Haskell Thomson determinant of the best profile compared with the experimental one; c) dispersion curves of the 20 best fitting profiles compared with the experimental dispersion curve.

References

• Ernst, F., 2007, Long-wavelength statics estimation from guided waves: 69th EAGE Conference and Exhibition, Extended Abstracts, E033, London, United Kingdom.
• Maraschini, M., F. Ernst, D. Boiero, S. Foti, and L.V. Socco, 2008, A new approach for multimodal inversion of Rayleigh and Scholte waves: Proceedings of EAGE Rome, expanded abstract.