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MODAL ANALYSIS OF 2-D SEDIMENTARY BASIN FROM FREQUENCY DOMAIN DECOMPOSITION OF AMBIENT VIBRATION ARRAY RECORDINGS

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The frequency domain decomposition is a well-established spectral technique used in civil engineering to analyze and monitor the modal response of buildings and structures (Brincker et al., 2001; Michel et al., 2010). The method is based on singular value decomposition of the cross-power spectral density matrix from simultaneous array recordings of ambient vibration. This method is advantageous to retrieve not only the resonance frequencies of the investigated structure, but also the corresponding modal shapes without using an absolute reference. This is an important piece of information, which can be used to identify areas of minimum and maximum ground motion on the structure.

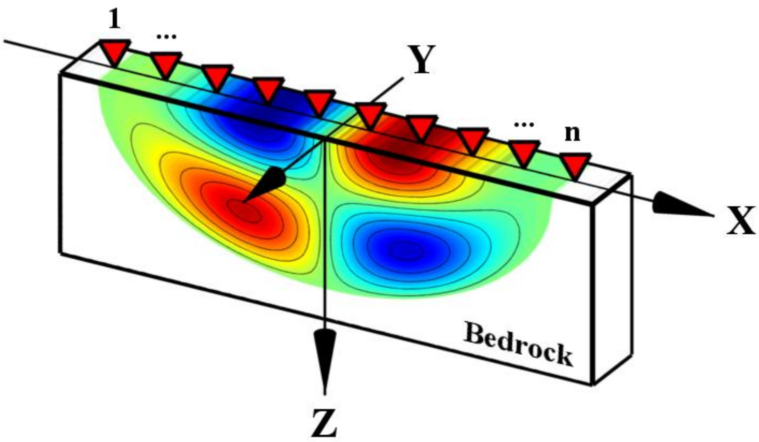

Figure 1. Schematic representation of 2D resonance in a simplified sedimentary valley section. In this example the displacement of the $SH_{1,1}$ resonant mode is showed. Rigid bedrock is assumed. On the free surface, the wave-field is sampled by a seismic array of *n* stations (red triangles)

We apply this approach to evaluate the SH and P-SV resonance characteristics of 2D Alpine sedimentary valleys through decomposition of ambient vibration recordings from linear seismic arrays deployed perpendicularly to the valley axis (e.g. Figure 1). Results are presented for a set of synthetic models, initially used to validate the method, and for a real acquisition survey performed in the Rhone valley (Switzerland).

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For the real case, up to nine separate resonant frequencies (Figure 2), together with their corresponding modal shapes (Figure 3), were retrieved for the SH case using the frequency domain decomposition method. We then compare these mode shapes with results from classical site-to-reference spectral ratios and the solution from analytical and numerical modal analysis.

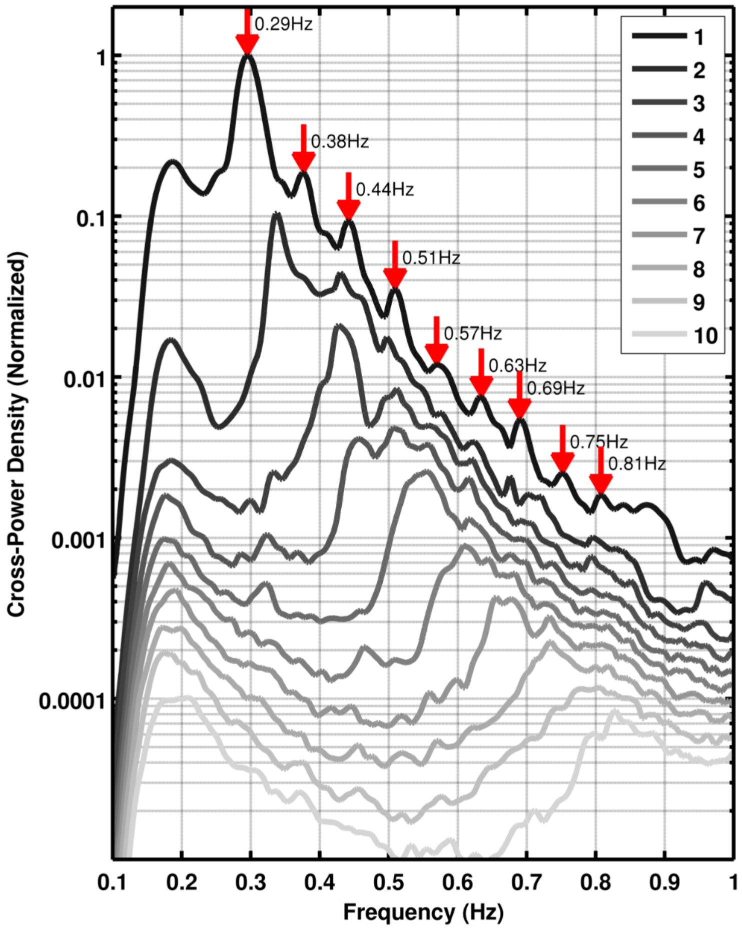

Figure 2. Cross-power density spectrum from FDD analysis of the Martigny linear array in the range 0.1-10Hz. All the 10 eigenvalue curves are presented for comparison, while the red arrows indicate the nine identified resonant modes.

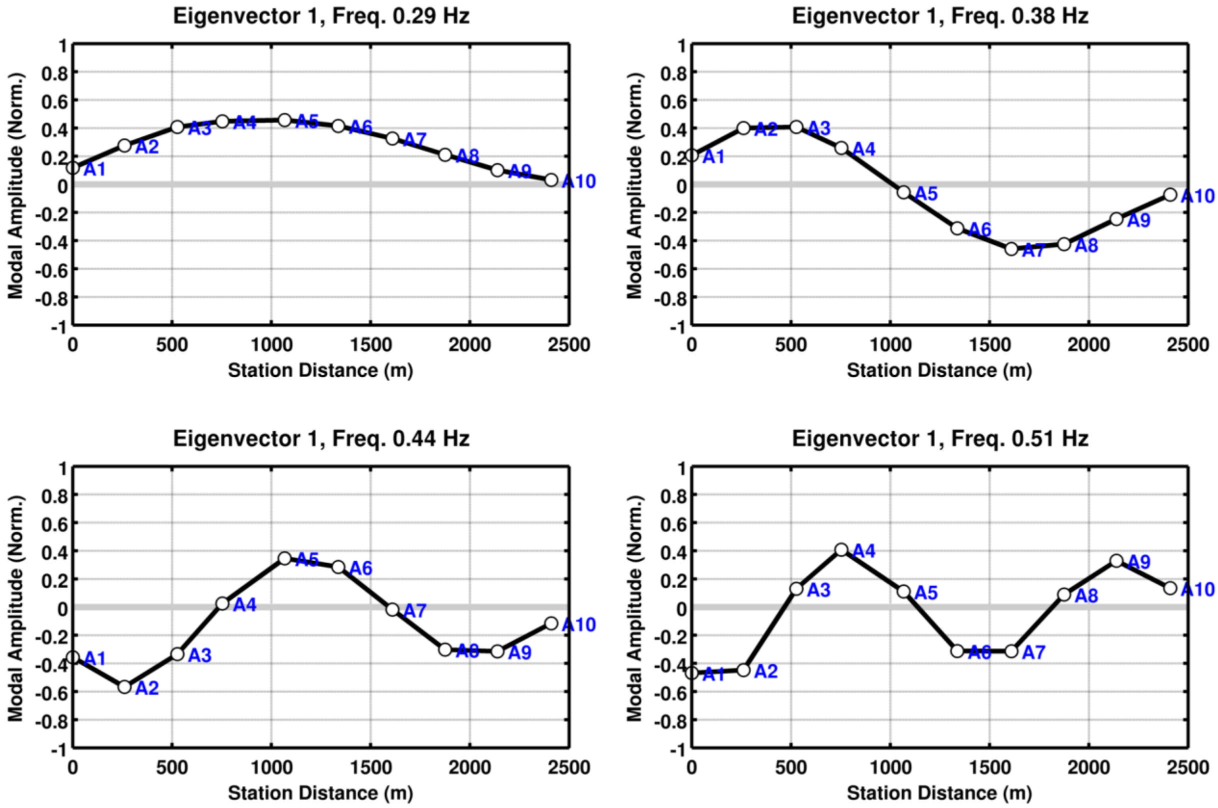

Figure 3. Modal shapes of the first six modes identified on the power-spectrum of Figure 2. The modes have clearly progressively increasing number of peaks and nodes along the array profile.

REFERENCES

Brincker, R, Zhang, L, Andersen, P, (2001) Modal identification of output-only systems using frequency domain decomposition. *Smart materials and structures*, 10(3), 441.

Ermert, L, Poggi, V, Burjnek, J, Fäh, D, (2014) Fundamental and higher 2-D resonance modes of an Alpine valley. *Accepted for publication in Geophys. J. Int.*, DOI:10.1093/gji/ggu072

Michel, C, Guéguen, P, El Arem, S, Mazars, J, Kotronis, P, (2010) Full scale dynamic response of an RC building under weak seismic motions using earthquake recordings, ambient vibrations and modelling. *Earthquake Engineering & Structural Dynamics*, 39(4), 419-441.