HOW GOOD ARE SHEAR WAVE VELOCITY MODELS IN THE LOWER RHINE EMBayment OBTAINED FROM INVERSION OF AMBIENT VIBRATIONS?

INTRODUCTION

In a recent study, we have proposed a method to determine shallow shear wave velocity profiles in the Lower Rhine embayment (NW-Germany, see Fig. A-1) by combined inversion of single station and array measurements of ambient vibrations (Scherbaum, 2001, Scherbaum et al., 2002). In order to validate the resulting models we have performed three independent tests:

A) We have repeated array measurements for additional sites in the Lower Rhine embayment which have been analyzed previously by Budny (1984) using an active source. The inversion results have been compared to the findings of Budny (1984) and are presented in Fig. A-1 to Fig. A-6.

B) From fall 2000 to spring 2002, we have operated a 5 sec seismometer simultaneously to the borehole recording at station PLH of the Geological Survey of NRW. The largest recorded earthquake (ML=4.1) enabled us to calculate a full moment tensor solution to constrain the source parameters. This made it possible to test how well the ground motion at station PLH can be explained by the regional 1D crustal model combined with the site model obtained from ambient vibrations (Fig. B-1 to Fig. B-4).

C) We have used 12 surface and downhole recordings of local earthquakes (Table C-1) for stations used and parameters of a full moment tensor solution (see Fig. B-1 for stations used and parameters of the best moment tensor solution (Reamer and Hinzen, 2001)). This made it possible to test how well the ground motion at these stations is explained by the 1D crustal model, the site model obtained from ambient vibrations, and the obtained spectral ratios for different window lengths (e.g. 5 s and 7 s windows - Fig. C-2), we obtained different results. The results are shown in Fig. C-2 to Fig. C-4.

DISCUSSION OF RESULTS A-C

A) Shallow shear wave velocity models obtained from ambient vibrations match the available geotechnical information and are in good agreement to findings from previous studies of Budny (1984).

B) Synthetic modeling of waveforms are in good agreement with observed data. Additionally, the resonance peak frequency is modeled well. Discrepancies are observed for the site amplification factor and coda waveform. We assume that non-1D effects, e.g. local resonance or scattering, are responsible for this observation (Budny, 1984).

C) The observed spectral ratios for 12 local earthquakes show a fundamental resonance peak at 6 Hz which is explained by the shallow shear wave velocity model obtained from ambient vibrations. However, the observed site amplification factor is much larger than predicted by this simple 1D site structure. Possible explanations are:

- Uncertainties in seismometer/accelerometer calibration and/or coupling conditions of instruments.
- Non-1D effects, e.g., basin resonance or scattering.

RESULTS TEST A

In the top panels of Fig. A-5 and Fig. A-6 the 10 best fitting models for sites Ettendorf and Jülich, respectively, are shown (best model: dashed red, reference model from Budny, 1984: blue). Only the dispersion curve information is used for inversion in this case. In the lower left panel the Rayleigh wave fundamental mode dispersion curve of the 10 best models are shown together with the measured phase velocity values (compare Fig. A-4, green symbols = median values). Lower right panels depict the relative deviations of the calculated transfer functions for the 10 best models compared to the reference model after Budny (1984). For the fundamental resonance peak around 6 Hz the observed site amplification factors agree within a factor of two to the reference model.

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