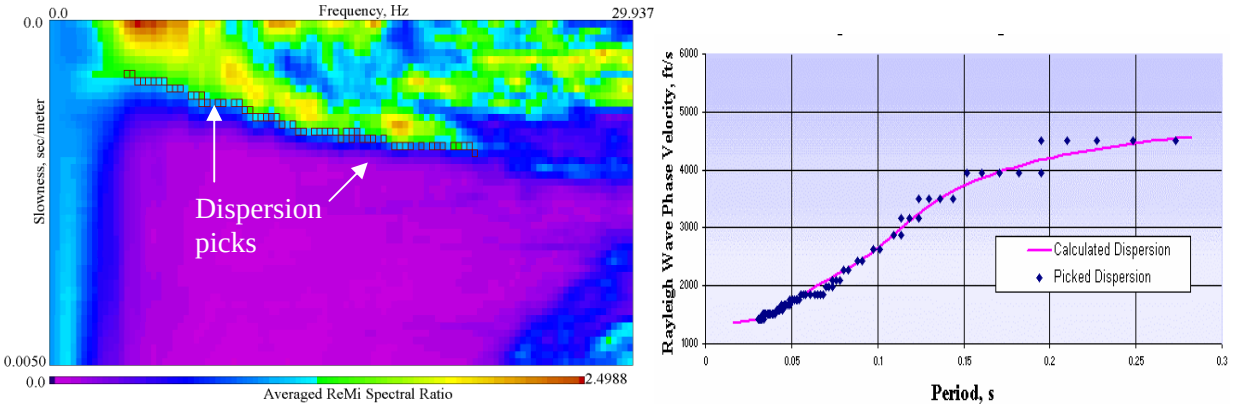
SeisOpt® ReMi™ V_s30 Method

Shear-wave Profile Using Refraction Microtremor (ReMi)

Overview

ReMi is a new, proven seismic method for measuring in-situ shear-wave (S-wave) velocity profiles. It is economic both in terms of cost and time. Testing is performed at the surface using the same conventional seismograph and vertical P-wave geophones used for refraction studies. The seismic source consists of ambient seismic "noise", or microtremors, which are constantly being generated by cultural and natural noise. Because conventional seismic equipment is used to record data, and ambient noise is used as a seismic source, the ReMi method is less costly, faster and more convenient than borehole methods and other surface seismic methods, such as SASW and MASW used to determine shear-wave profiles. Depending on the material properties of the subsurface, ReMi can determine shear wave velocities down to a minimum of 40 meters (130 feet) and a maximum of 100 meters (300 feet) depth.



Shear-wave dispersion curve derived from ambient seismic noise, shown on the left, is picked and modeled (right panel)

Procedure. The data acquisition procedure consists of obtaining five to ten 20-second seismic noise records using conventional seismograph and P-wave geophones. The wavefield transformation of the noise record reveals the shear-wave dispersion curve (Figure, above left). The shear-wave dispersion curve from the wavefield transformation is then manually picked and the picks modeled to determine the subsurface shear-wave velocity profile (Figures, above right and on reverse side of this page). During data analysis, the wavefield from the three separate noise records are manually picked and modeled for the purpose of quality control. The resolution of the final model is quantified based on the uncertainty in the picks.

ReMi can be used to obtain V_s profiles for:

- *Earthquake site response*
- *Liquefaction analysis*
- *Soil compaction control*
- *Mapping the subsurface and estimating the strength of subsurface materials*
- *Finding buried cultural features, such as dumps and piers*
- *Offshore surveys to determine depth to bedrock for harbor and pier extensions*

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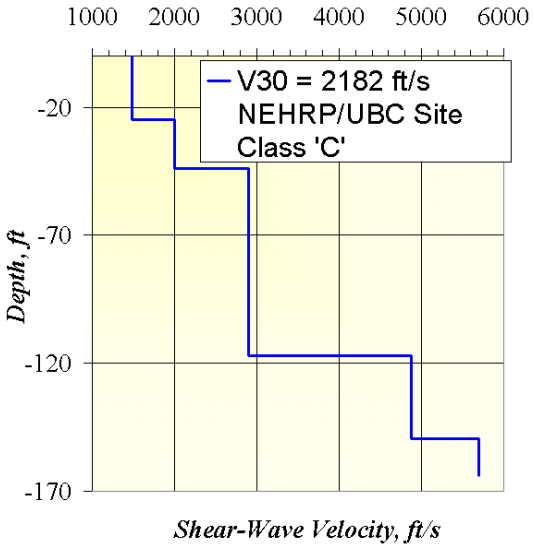
Key Benefits. The ReMi method offers significant advantages. In contrast to borehole measurements ReMi tests a much larger volume of the subsurface. The results represent the average shear wave velocity over distances as far as 200 meters (600 feet). Because ReMi is non-invasive and non-destructive, and uses only ambient noise as a seismic source, no permits are required for its use. ReMi seismic lines can be deployed within road medians, at active construction sites, or along highways, without having to disturb work or traffic flow. Unlike other seismic methods for determining shear wave velocity, ReMi will use these ongoing activities as seismic sources. There is no need to close a street or shut down work for the purpose of data acquisition (Per picture below). And a ReMi survey usually takes less than two hours, from setup through breakdown. These advantages sum to substantial savings in time and cost.



SeisOpt ReMi output: Shear-wave profile determined by modeling the dispersion picks.

Left: Recording SeisOpt ReMi data inside a house in Arizona, USA done by AMEC Earth & Environmental (courtesy of Mike Rucker). The objective was to analyse soil condition beneath the house. AMEC used 1-ft geophone spacing and the phones were mounted using large binder clips. The noise was induced by shuffling across the floor.

Right: Recording ReMi at the airport in Phoenix, Arizona, USA (Mike Rucker, AMEC Earth & Environmental. The survey was as part of the geotechnical investigations for airport runway extension. Because ReMi uses standard seismic recording equipment and ambient seismic noise as a source, no permits, traffic stops or even advance notice to authorities were required. Since all that was needed was to make 10, 20-second noise recordings, V_s30 was determined in less than two hours, including setup and breakdown of the seismic array.