# DETERMINATION OF 1-D SHEAR WAVE VELOCITIES USING THE REFRACTION MICROTREMOR METHOD

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**GEOP 480: Special Topics**

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## PURPOSE OF THE ARTICLE

- To briefly discuss the method, data acquisition and interpretation of the data to yield one-dimensional shear-wave velocities.

## OUTLINE

- INTRODUCTION
- BACKGROUND
- SURVEY DESIGN & DATA ACQUISITION
- DATA PROCESSING & INTERPRETATION
- CONCLUSION

## INTRODUCTION

- The ReMi method is useful in determining:
  - Site-specific earthquake response
  - Liquefaction potential
  - Soil compaction
  - Subsurface geology
- Current commonly used techniques of estimating shallow shear velocities for assessment of earthquake site response are too costly for use in most urban areas.
- They require large sources to be effective in noisy urban settings.
- So that, the Refraction Microtremor (ReMi) method overcomes these problems by using standard P-wave recording equipment and surrounding noise to produce average one-dimensional shear-wave profiles down to 100m depths.

## BACKGROUND

### What is ReMi Method?

- The refraction microtremor technique is based on two fundamental ideas.
  - ✓ common seismic-refraction recording equipment can effectively record surface waves at frequencies as low as 2 Hz.
  - ✓ a simple, two-dimensional slowness-frequency (p-f) transform of a microtremor record can separate Rayleigh waves from other seismic arrivals, and allow recognition of true phase velocity against apparent velocities.
- Two essential factors that allow exploration equipment to record surface-wave velocity dispersion, with a minimum of field effort, are
  - ✓ the use of a single geophone sensor at each channel, rather than a geophone “group array”, and
  - ✓ the use of a linear spread of 12 or more geophone sensor channels.

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## BACKGROUND

- Single geophones are the most commonly available type, and are typically used for refraction rather than reflection surveying.
- The advantages of ReMi from a seismic surveying point of view are :
  - It requires only standard refraction equipment already owned by most consultants and universities;
  - it requires no triggered source of wave energy; and
  - it will work best in a seismically noisy urban setting.
  - Traffic and other vehicles, and possibly the wind responses of trees, buildings, and utility standards provide the surface waves this method analyzes.

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## BACKGROUND

- Briefly, ReMi processing involves 3 steps:
  - **Velocity Spectral Analysis**
  - **Rayleigh Phase-Velocity Dispersion Picking**
  - **Shear-Velocity Modeling**

## SURVEY DESIGN & DATA ACQUISITION

### Equipments Used

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- The equipment needed includes :
  - a 12- or 24-channel digital refraction gear with 4.5-14 Hz single vertical geophones phones and recording cable.
  - The total array length can vary from 300 ft to 600 ft.
  - Arrays as short as 60 ft and as long as several kilometers have been used for recording ReMi data.
  - As a rule of thumb the maximum depth of resolution is about one-third to one-half the length of the array.
  - Amplitude or frequency-response calibration of geophones is not needed - as with refraction, ReMi uses only the phase information in the recorded wavefield.

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## SURVEY DESIGN & DATA ACQUISITION

### Recording Data

- Acquire 5 to 10 records of background noise, 15 to 30 seconds long each.
- If the site is quiet, activate some sort of source during each record by driving up and down the geophone line in a truck, running or walking up and down the line, striking a hammer or dropping heavy (greater than 50lbs) objects.
- No timing or locating of the source is needed.

## DATA PROCESSING & INTERPRETATION

### Briefly;

- They used the data collected at the Los Angeles County Fire Station in Newhall, California to demonstrate the data processing and interpretation of refraction microtremor data.

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## DATA PROCESSING & INTERPRETATION

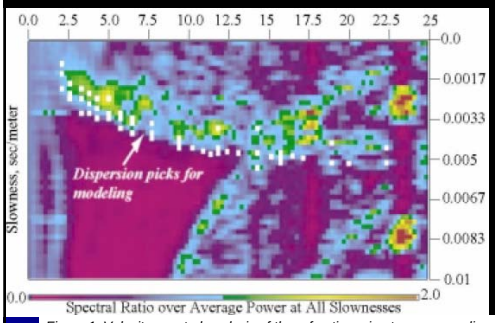


*Figure 1: Velocity spectral analysis of the refraction microtremor recordings at Newhall site, California. The low energy envelope of the p-f image is picked for modeling.*

## CONCLUSION

- Several tests have shown that common seismic refraction equipment can yield accurate surface-wave dispersion information from microtremor noise.
- Rapid and very inexpensive shear-velocity evaluations are now possible at the most heavily urbanized sites, and at sites within busy transportation corridors.
- The Advantages of Using ReMi Method:
  - ReMi tests a much larger volume of the subsurface.
  - Because ReMi is non-invasive and non-destructive, and uses only ambient noise as a seismic source, no permits are required for its use.
  - a ReMi survey usually takes less than two hours, from setup through breakdown.