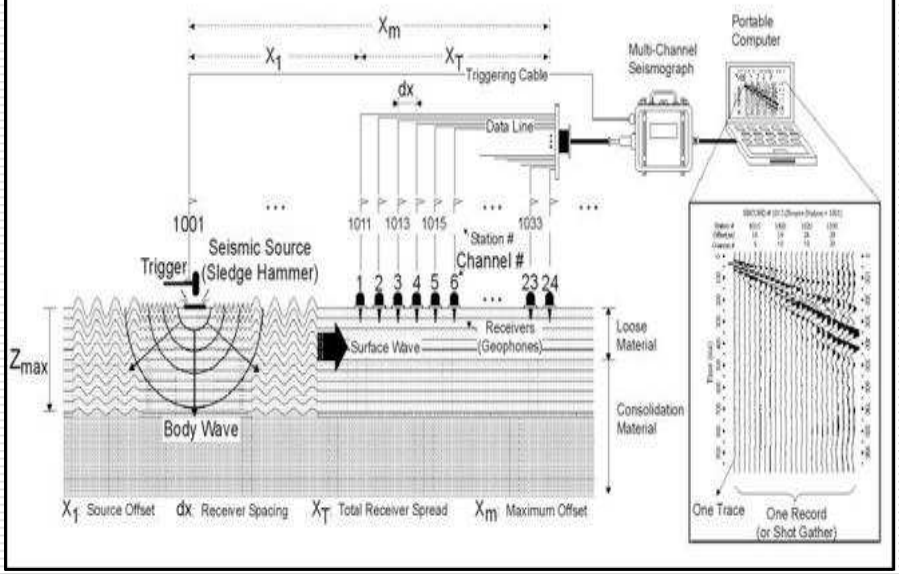
Applied Methods – MASW Method

Schematic illustrating a typical MASW Survey Setup



INTRODUCTION:

MASW a seismic method for near-surface (< 30 m) Characterization of shear-wave velocity (Vs) (**s**econdary or transversal wave).

It utilizes the Rayleigh-type surface waves (normally called "ground roll") recorded by multiple receivers (geophones) deployed on an even spacing and connected to a common recording device (seismograph). The surface wave method makes use of the dispersive property of Rayleigh waves.

Surface waves recorded as they propagate along the receiver line are analyzed through powerful and diverse multichannel processing techniques similar to a pattern-recognition approach to discriminate useful signal against all other types of noise.

The entire principal procedure for MASW usually consists of three steps:

1. Acquiring multichannel records (or shot gathers),
2. Extracting the fundamental-mode dispersion curves (one curve from each record), and
3. Inverting these curves to obtain 1-D (depth) Vs profiles (one profile from one curve).

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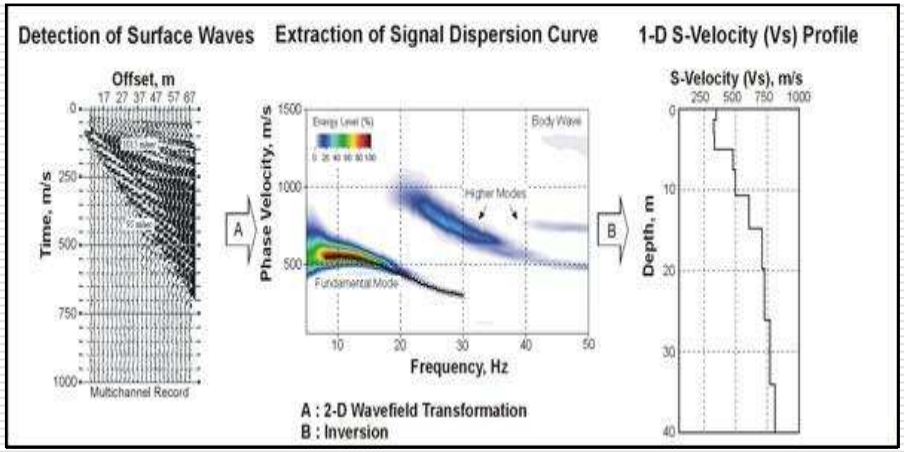

DATA PROCESSING:

Data processing (1-D) consists of three main steps:

1) preliminary detection of surface waves,
2) constructing the dispersion image panel and extracting the signal dispersion curve, and
3) back-calculating Vs variation with depth. The preliminary detection of surface waves examines recorded seismic waves in the most probable range of frequencies and phase velocities.

Construction of the image panel is accomplished through a 2-D (time and space) wavefield transformation method that employs several pattern-recognition approaches. The image panel shows the relationship between phase velocity and frequency for those waves propagated horizontally directly from the impact point to the receiver line. These waves include fundamental and higher modes of surface waves as well as direct body (compression) waves. The necessary dispersion curve, such as that of fundamental-mode Rayleigh waves, is then extracted from the energy accumulation pattern in this image panel. The extracted dispersion curve is finally used as a reference to back-calculate the Vs variation with depth below the surveyed area. This back-calculation is called inversion.

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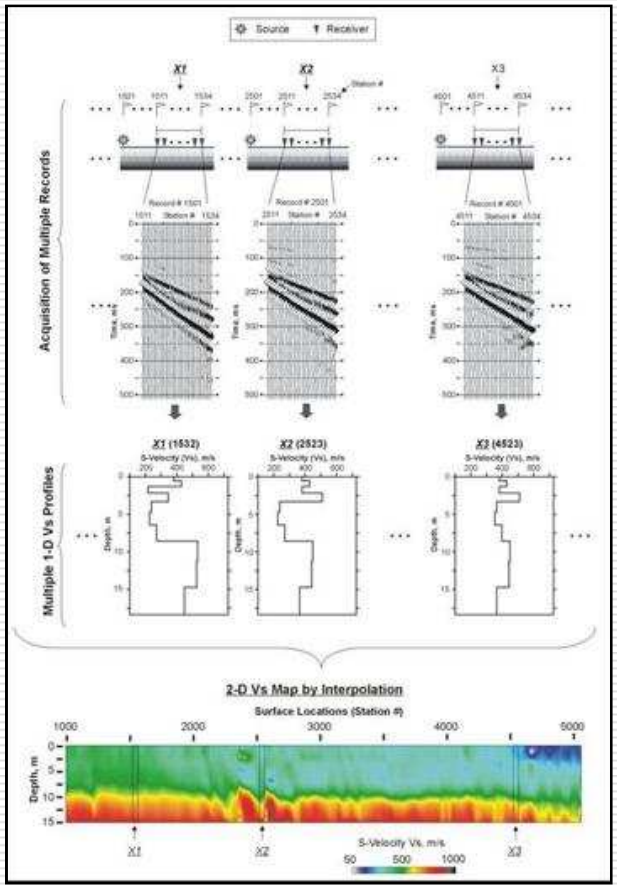

DATA INTERPRETATION:

A 2-D Vs map is constructed from the acquisition of multiple records with a fixed source-receiver configuration and a fixed increment of the configuration.

A source-receiver configuration indicates a setup of given source offset (*x1*), receiver spacing (*dx*), and total number of channels (*N*) used during a survey. The increment *dC* depends on the degree of horizontal variation in Vs along the entire survey line.

A small increment would be necessary if a high degree of horizontal variation is expected. In most cases where total receiver spread length *xT* is set in such a way that horizontal variation within *xT* can be ignored, an increment of half the spread would be sufficient. In theory, a shorter *xT* would ensure a higher accuracy in handling the horizontal variation. However, on the other hand, it would impede the accurate assessment of dispersion curves.

Once a multiple number (> 5) of records are acquired by regularly moving the source-receiver configuration, one 1-D Vs profile is obtained from each record through surface wave processing. Each Vs profile also has the appropriate horizontal coordinate (i.e., station number) to represent the vertical Vs variation. Naturally, the midpoint of the receiver spread is used for this purpose. Multiple Vs profiles obtained are then used for a 2-D (*x* and *z*) interpolation to create the final map. The kriging method is usually used for the interpolation.

ADVANTAGES: The MASW technique is the best seismic technique for measuring the modulus of base materials and subgrade material. Due to multichannel recording and processing schemes employed, results (Vs information) of the survey are highly reliable even under the presence of higher modes of surface waves and various types of cultural noise.

LIMITATIONS: Due to intrinsic properties of surface waves, resolution of the result is limited by the size of the anomaly. A rule of thumb is that the minimum size that can be resolved is about one tenth of depth.

Seismic Equipment – Recording Parameters

RECORDING PARAMETERS:

Instrument:

GEOMETRICS StrataVisor NZ II
(48 Channels)

Source Type: 10 kg Sledgehammer

Source Spacing: 3 m

Source Offset:

MASW Survey: Fixed 9 m

Spread Layout:

MASW-Survey: 24 active Channel
Roll Along

Trace Length: 1.000 ms

Sample Rate: 0.5 ms

Processing Sequence

- MASW SURVEY
  - SEG-2 to KGS Transcription
  - Geometry Setup
  - Shot & Trace Edit
  - Single Shot Filter Testing
  - Individual Shot Filtering
  - Top / Bottom Trace Mute
  - Shot Dispersion Curve Extraction
  - Shot Vs Inversion (1-D)
  - Line Vs Inversion (2-D)
- Used Software:
  - SurfSeis (Kansas Geological Survey)