Equipment for MASW Surveying

- Seismograph (24-channel)
- Seismic Source (20-lb sledgehammer)
- Seismic Receivers (4.5-Hz Geophones)
- Cables (4-15 ft takeout spacing)

Seismograph

A seismograph is a multi-channel device that records vibration-induced electric currents coming from each seismic receiver in a digital format. Each channel is dedicated to recording currents from one receiver, and the total number of channels determines the number of receivers that can be recorded synchronously and independently. A twenty-four (24) channel seismograph is most common. Although a high dynamic range (for example, 24-bit) is always an advantage, it is not as critical as in a body-wave (reflection) surveying because of the strong nature of surface waves.

Seismic Source

A seismic source can be anything that can apply an impact on the ground and generate seismic waves (ground vibrations). A sledgehammer is most commonly used. The weight of the hammer head determines the total impact power, which in turn determines the depth of influence (depth of investigation). A sledgehammer in the 10-20 lb range is usually used for an investigation depth smaller than 100 ft. Depending on the condition of the impact point on the ground (for example, loose or well-compacted dense soil), the same impact power can achieve different investigation depths. A simple solid plate (commonly called a hammer plate) is usually used as a coupling device against which the hammer impact is applied rather than to the bare ground. Although a solid aluminum plate (about 1-ft by 1-ft size) is most commonly used, results from recent studies indicate a plate made of softer material (for example, urethane) can be more effective in generating longer-wavelength surface waves that are essential for deeper investigation.

A more powerful and controllable source (for example, a weight-drop source) is often used to improve the investigation depth and maximize survey speed for a large-scale survey that requires an unusually high number of impacts during the survey. Whenever neither the sledgehammer nor a weight-drip source can achieve the desired investigation depth or if they cannot be used due to the potential damage to the ground surface, a passive MASW survey can be considered. The effectiveness of a passive survey, however, can be significantly limited by such uncontrollable factors as location, time, energy level, and spectral contents of surface waves generated by passive sources such as traffic.

Seismic Receivers

A seismic receiver is a device highly sensitive to vibration and generates electric currents proportional to the vibration strength. Its natural frequency usually sets the lowest frequency it can record without significant distortion and damping. In most MASW surveys aiming at an investigation depth smaller than 100 ft, signal surface waves are in a frequency range of approximately 5-50 Hz. Because of this reason, 4.5-Hz geophones (the lowest frequency geophone commercially available at reasonable cost) are most commonly used. However, higher frequency phones (for example, 10-Hz, 14-Hz, 40-Hz, etc.) can also be used for progressively shallower depths of investigation (for example, investigation depths smaller than 70-ft, 50-ft, 30-ft, etc.). A single geophone (instead of multiple geophones) is connected to each channel. For surveying over pavement, geophones are laid vertically without spikes. This usually provides sufficient coupling to record surface waves effectively. Nowadays, use of a long belt on which all geophones are attached without spikes is quickly becoming popular to use in MASW surveys. Called a land streamer, this improves the survey speed by one or two orders of magnitude. Click for an article on land streamer posted in a Geometrics webpage.

Cables

A seismic cable has evenly-spaced hookup points (called takeouts) where an individual geophone is connected. The spacing (for example, 4-ft, 10-ft, etc.) and total number of takeouts determine total length of a cable and total number of channels it can accommodate. The takeout spacing determines the longest receiver spacing (dx) that can be used for a given survey. The maximum receiver spacing (dx) used for most of MASW surveys is smaller than 15 ft.