SOP S-6

STANDARD OPERATING PROCEDURE FOR SEISMIC REFRACTION METHOD SAMPLING AT THE WEST KINGSTON TOWN DUMP/URI DISPOSAL AREA SITE

Northeast Geophysical Services

Seismic Refraction Procedure

The seismic refraction method relies on travel times of sound waves, measured in milliseconds, traveling through and refracting from subsurface layers with contrasting densities. The seismic refraction lines will be surveyed using a Geometrics Geode, 24-channel seismograph.

Geophones will be nominally spaced 40 feet apart with some shorter spacings to help define overburden velocities. Each segment will be tested with 5 to 7 shots. The general shot configuration will consist of one shot at either end of the segment, one shot about 100 feet off each end, and one to three shots within the segment. The energy source will consist of a small explosive charge buried about 3 feet deep. Approximate relative shot point and geophone elevations will be surveyed by NGS using a pop level.

Equipment needed:

- Bound field logbook
- Tape measures, hip chain and compass for locating survey lines.
- Paint, pin flags and flagging for marking survey lines.
- Brush axes, and chain saws for clearing survey lines.
- Geometrics Geode 24 channel seismograph instrument
- Ancillary equipment including 24 geophones, seismic cables, electric blaster, 12-volt battery, power inverter, shot wire, and power auger.
- Pentium IV laptop PC Computer for running seismograph, downloading and processing data.

Survey Steps

1. Follow the sampling pattern outlined in the Work Plan
2. Locate, mark and clear survey lines.
3. Layout seismic cables and set geophones.
4. Setup seismograph and computer and test geophone responses.
5. Drill shot holes and bury explosive shots.
6. Monitor ambient noise and conduct seismic shots along survey segment.
7. Inspect integrity of shot data - repeat if necessary.
8. Move equipment to next survey segment and repeat steps 3-7 above.
9. Process and interpret seismic data.
10. Prepare profiles and report.

Data Reduction

The seismic data will be processed and interpreted using the RIMRock Geophysics SIPT-2 (formerly U.S.G.S. SIPT-2) seismic interpretation program. This program calculates seismic velocities by regression and by the Hobson-Overton method, and solves for layer thickness using the delay-time method and iterative ray tracing modeling.

QA/QC

QA/QC procedures are detailed in the operating manual referenced below.

Reporting

Profiles of each seismic refraction line will be produced that show the interpreted results of the survey. Typically, the profiles will show three interpreted layers: unsaturated overburden, saturated overburden, and bedrock. Abrupt lateral changes in the bedrock seismic velocity can be identified that may indicate fractures or rock type changes. Any such features will also be shown on the seismic interpretation profiles.

In order for the seismic refraction method to accurately estimate velocity layer depths, certain natural conditions should exist:

a.) Layers should increase in velocity and in thickness with depth. A typical example would be ten feet of unsaturated soil at 1,500 fps overlying 50 feet of saturated soil at 5,000 fps that overlies bedrock at 16,000 fps.

b.) There should be a sufficient velocity contrast between different layers. Ideally, each velocity layer would be 2 to 3 times faster than the overlying layer.

c.) The velocity within a layer should be relatively constant throughout that layer (lateral homogeneity).

In addition to these conditions, it is also important that there be a low level of background noise at the site. Nearby road traffic noise or heavy equipment operations may delay the field survey. Ground truth data, if available, will be used to compare and calibrate the seismic information. Under favorable conditions seismic refraction results can be fairly precise, within +/- 10 percent.

References

Geode and Stratavisor NZ Operations Manual, Geometrics, Inc., 2001, 150 pages.

Application of Seismic Refraction Techniques to Hydrologic Studies, F.P. Haeni, U.S. Geological Survey, 1988, 86 pages.

Seismic Refraction Exploration for Engineering Site Investigations, Bruce B. Redpath, U.S. Army Engineer Waterways Experiment Station Explosive Excavation Research Laboratory, 1973, 51 pages.