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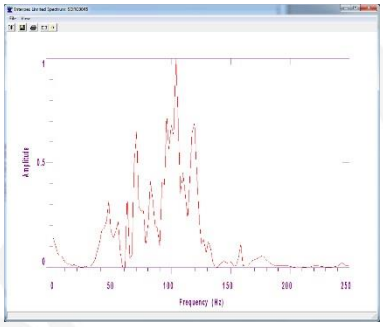
CONTROLLABLE SEISMIC SOURCE

The Controllable Seismic Source (CSS) generates impulsive shear waves whose frequency content can be controlled.

Background

Seismic technology is one of the most reliable ways to characterize underground formations, including voids and man-made structures such as tunnels. Seismic surveys require the use of a seismic source and an array of detectors (geophones) connected to a seismograph. The seismic source induces a shock wave in the ground and the reflection is received by the geophones for later interpretation. The way seismic waves propagate and reflect depends on the subsurface characteristics that include type of soil, layers and solid objects and voids. The use of S-waves is of particular interest since these waves do not propagate on air or water, which are the two basic components of voids and tunnels. The penetration depth and resolution during an S-wave survey are dependent on the frequency of the S-waves, hence the importance of a seismic source capable of generating a wide frequency response, especially in the high frequency range. Unfortunately, impact S-wave sources are not controllable, difficult to handle and are not frequency rich.



Description

The unit is self-contained and designed to be used from a vehicle with minimum effort for the operator. The CSS can be used with any commercially available seismograph system with a standard trigger input.

The CSS makes use of a linear magnetic servo motor to impulse a variable load inside a shock cavity. By adjusting the speed, acceleration and mass of the load, a variety of frequencies can be obtained. A computer controlled interface provides the means for adjusting these parameters plus repetition rate. The unit is attached to a standard 2” trailer hitch receiver in the back of a vehicle and powered by the vehicle 12V electrical system. A pneumatic system is used to quickly deploy or retrieve the unit and to produce a solid coupling to ground. A remote control handheld unit is used to manually trigger the unit, either from inside or outside of the vehicle, minimizing operator’s exposure and physical fatigue. These unique features make the CSS a powerful tool compared to sledge hammers or conventional ground shakers.

Honeywell

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The system is operated by attaching the shock unit to a standard 2” receiver on a vehicle. Using the computer interface, the operator adjusts the speed and acceleration of the load to change the frequency of the shock wave, depending on the depth and size of the intended target. A low frequency is used to obtain wide data of the area whereas a higher frequency is used to obtain greater resolution. A wider range of frequencies can be obtained by changing the weight of the internal striker. Data is then collected by geophones or other sensors and then transmitted to the seismograph for processing and storage.

Advantages

This tool provides three levels of improvement over the limitations of conventional seismic sources. First, the energy, repetition rate and frequency of the shock waves are controllable by using a magnetic linear motor. The impact mass is coupled to the motor by a set of rails and springs that allow the mass to freely impact the shock cavity, improving the frequency characteristics of the wave. Second, the unit is adaptable for mobile deployment using a vehicle with a conventional trailer hitch. Since the unit is electrically operated, all controls and data acquisition systems can be inside the vehicle, making it safer than manually carried units. Third, the configuration of the shock cavity and the coupling with the magnetic linear motor provides higher frequency content with better repeatability than those obtained using sledge hammers, elastic or explosive sources.

Other advantages of this tool include the capability of generating inward or outward shear waves as well as vibrational waves. Wave profiles can be saved in the computer and recalled for later use. Ergonomic advantages include low external acoustic noise eliminating the need of ear protection and reduced operator’s fatigue because hammering is not required.

Applications

- Geophysical Surveys
- Subsurface Structures and Void Detection
- Oil and Gas Exploration
- Road Defect Analysis

Intellectual Property Status

This technology is patented under US Patent number 8,807,266 B1, issued 08/19/2014.

Keyword List

Seismic source, shear wave source, void detection

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