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A Cascaded Magnetostrictive Vibration Source System for Underground Construction Applications

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For underground construction seismic measurements can contribute knowledge to geology and relevant geotechnical parameters. Within the cooperative project OnSITE - Online Seismic Imaging System for Tunnel Excavation - a new seismic source is in development. The design of the seismic source takes into account the special requirements for such an application: high signal frequency (up to several kHz) to obtain resolution in the order of few meters (1-2 m), generation of repeatable signals at short time intervals to implement a large measuring point density, and a high signal/noise ratio.
In the first step, two magnetostrictive actuators in similar fashion - custom-made by ETREMA Products, Inc. (USA) - were used for a cascaded seismic vibration source system. The bandwidth of the pilot signal for this vibration source system covers the range from 300 Hz up to 6 kHz. After principally testing the source system in the research and teaching mine Reiche Zeche in Freiberg (Germany), further field measurements at this test site showed a high-grade signal repeatability for frequencies above 600 Hz for the head signal and good signal repeatability in the near field (Hock et al. 2008). To avoid 1) feedback effects between vibrator and medium – causing resonance at certain frequencies, e.g. around 3000 Hz and around 5500 Hz – and 2) unwanted phase shifts between the two vibrator signals at frequencies above 3000 Hz, an signal excitation with an open loop control for amplitude and phase is necessary in combination with only one real-time processor for controlling both actuators.
In a second step, a source system was constructed consisting of 2 nearly identical (90%) actuators - again custom-made by ETREMA Products, Inc. (USA) - which are approximately one third lighter than the actuators in the first prototype. This new prototype was applied for the first time during a seismic survey in the Piora adit (above the Gotthard base tunnel near Faido, CH) in November 2008 with success.
The survey comprised 103 shot points in general with 1 m spacing and at least 10 excitations per shot point. For S-wave generation the Shover principle (Edelmann, 1981) was applied. Therefore 5 excitations were made with the vibrators in phase and 5 excitations with a phase shift of 180 deg between the two vibrators. 16 three-component geophones, developed by the GFZ, were deployed in small boreholes along a gallery part with geophone intervals of 10 m. For comparison purposes and further optimizing of the source system two different recording systems were partly operated during the survey. First results of the seismic test survey will be presented.

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References

Edelmann, H.A.K., 1981: Shover Shear-Wave Generation by Vibration Orthogonal to the Polarization. Geophysical Prospecting, 29, 541-549.

Hock, S., Polom, U., Mikulla, S., Krüger, K., Giese, R., Lüth, S., 2008: Evaluation of a High-frequency Seismic Source System in Mining Application. Near Surface 2008, 14th European Meeting of Environmental and Engineering Geophysics of the Near Surface Geoscience Division of EAGE, 15.-17.9.2008, Krakow, Poland.