ROTAPHONE - a new mechanical sensor system and measurement method for detection of seismic ground motions

Development status

Phase 4

The transition from the prototype to the final and fully functional form. At this stage, the prototype is already fully tested, or the technology is certified and ready for mass deployment.

IP protection status

Patent granted

Partnering strategy

Collaboration, licensing

Institution

Charles University

Vlastník

CPPT UK

Challenge

Measurements of rotational ground motions are becoming relevant in a wide range of fields, especially seismiology, where a good measurement and detection instrument can prevent and avoid some of the unpleasant consequences of earthquakes and geological phenomenon. Considering this, Rotaphone is intended for use in seismic prospecting in which it can reach excellent resolution of geological structure (order of magnitude of meters). It has been developed with the aim of simplifying to a large degree the interpretation of data obtained, being a precise, complete, easy and compact measurement system. Rotaphone is able to measure both rotational and translational components by the same device at the same time. This represents the biggest novelty of the device comparing with the other competitive ones in the market that need two independent devices for the rotational and the translational components to be measured. This disadvantage is solved by Rotaphone.

Description

The developed mechanical seismic combined sensor allows measurements of 6 components of seismic motion, i.e. 3 orthogonal translations components, 3 rotational components around the orthogonal axes at a given measurement point in a short-period range. The frame of the instrument is a solid rigid metal disc adapted so that it can be easily anchored to the ground motion that is measuring. The geophones are mounted near the edge of this massive disc. A supporting plate allows the disc to turn around the vertical axis by exactly 45°, so that after eight rotation increments the individual geophones turn full circle, which is useful when the seismic source is capable of producing identical source pulses repeatedly (e.g. in prospecting measurements). The disc and the supporting metal plate

are attached to each other by means of a central fixing screw. Seismic sensors are of two types, vertical and horizontal, according to the seismic motion component they measure. The horizontal sensors have varying orientations so that it is possible to derive from them the waveform of two mutually perpendicular horizontal. The lowest number of sensors that need to be deployed on the frame for measuring three translational and three rotational components using a calibration based on the frame rigidity is 4 vertical sensors and 4 horizontal sensors. Nevertheless, it is advantageous to use a higher number of sensors (16) that are arranged in parallel pairs. The device could have also the shape of a cylinder other than disc. Typically, its dimensions are within decimetres to meters, usually within 1 m. Its weight enables easy transfer and manipulation and for that reason it is typically made of light metals (e.g. duralumin). The primary outputs of the seismic sensors are signals from vertical and horizontal sensors, e.g. geophones. The sensor outputs do not represent the real ground motion, however, because they are influenced by the frequency characteristics of the sensors. The goal is to measure the real ground motion in a certain frequency band. The instrument is designed for the frequency range 4 - 100 Hz. For that reason, the signals from the sensors are filtered with a band filter and are corrected with regard to the frequency characteristics. (The analog outputs from the individual gephones are converted to digital outputs by a 16-channel A/D transducer attached to the disc). The device contains also a GPS antenna used to synchronize time. The sensor is a part of a measuring set including also the generator of seismic rotations, capable to produce identical source signals repeatedly. The repeatability of the source signal enables us to suppress noise and reach thus sufficient depth detectability range.

Commercial opportunity

The instrument is suitable for measuring wave fields generated both by man-made sources (quarry blasts, a generator of rotational motions) and by natural sources (e.g. local earthquakes, rockbursts etc.). It can be used mainly in seismiology centers, but the applications of the device are much wider, including oil and gas exploration, mining industry, geological survey, geothermal energetic, evaluation of soil conditions under man-made structures of strategic importance (nuclear power plants, radioactive waste deposits, etc.), water table detection and water-saturation of sediment.