1. Keywords (completed by CPPT)

Technology keywords
Seismic, translation, rotation, earthquake, geophone

Market keywords
Instrument, sensor, seismic, earthquake, geophone

NACE keywords
M72.1 - Research and experimental development on natural sciences and engineering

2. Summary

The developed mechanical seismic sensor allows simultaneous collocated detection of three rotation rate and three ground velocity components in a short-period range. The instrument is designed for the frequency range 4 - 100 Hz. The basic principle is described in the patent CZ 3012017 (J. Brokešová, J. Málek, J. Štrunc: Rotational Seismic Sensor System, Seismic Measuring Set Containing that System, and Seismic Survey Method) owned by MFF UK. The instrument is significantly innovated according to experience with the previous prototype, gained both in the USGS Albuquerque Seismological Laboratory as well as during the several-years-lasting in-field testing in various seismoactive regions. The new features are mainly the arrangement of the elemental sensors (geophones), the shape and material of the rigid frame suppressing mechanical resonances, the calibration performed in situ (simultaneously with each measurement), and frequency range extended towards higher frequencies. The sensor is a part of a measuring set including also the generator of seismic rotations, capable to produce identical source signals repeatedly. This generator is at the proposing team disposal. The repeatability of the source signal enables us to suppress noise and reach thus
sufficient depth detectability range. The instrument is intended for use in seismic prospecting in which it can reach excellent resolution of geological structure (order of magnitude of meters). However, the applications of the device are much wider, including oil and gas exploration, mining industry, geological survey, geothermal energetics, 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 sedimentary layers, and engineering seismology.

3. Description
A measuring instrument, a combined seismic sensor system able to measure 6 components of seismic motion, i.e. 3 orthogonal translations components, 3 rotational components around the orthogonal axes at a given measurement point. 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.). The frame of the instrument is a solid rigid body adapted so that it can be easily attached to the ground motion of which is measured. Advantageously, it can have the shape of a disc or cylinder, for example. 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). Seismic sensors are mounted at various points on the frame and 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 seismic components. 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, even number of sensors that are arranged in parallel pairs.

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. For that reason, the signals from the sensors are filtered with a band filter and are corrected with regard to the frequency characteristics.

4. Advantages
A measuring instrument, a combined seismic sensor system able to measure 6 components of seismic motion, i.e. 3 orthogonal translations components, 3 rotational components around the orthogonal axes at a given measurement point. 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.). The frame of the instrument is a solid rigid body adapted so that it can be easily attached to the ground motion of which is measured. Advantageously, it can have the shape of a disc or cylinder, for example. 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). Seismic sensors are mounted at various points on the frame and 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 seismic components. The lowest number of sensors that need to be deployed on the frame for
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5. Developmental stage

☐ Already on the market  ☑ Project already started
☑ Available for demonstration  ☐ Project in negotiations- urgent
☐ Concept stage  ☐ Proposal under development
☐ Field tested/ evaluated  ☐ Prototype available for demonstration
☐ Under development/ lab tested (available at...)

6. IPR status

☐ Copyright  ☐ Patent(s) applied for but not yet granted
☐ Design Rights  ☐ Patents granted
☐ Exclusive Rights  ☑ Secret Know-How
☑ Granted patent or patent application essential  ☐ Trade Marks
☐ Other (registered design, plant variety, etc.)

7. Partner sought
We are interested in out-licensing.

8. Type of partnership considered

☑ Commercial agreement with technical assistance  ☑ Manufacturing agreement
☐ Financial agreement  ☑ Research cooperation agreement
☐ Join venture agreement  ☑ Services agreement
☑ Licence agreement
☐ Technical cooperation agreement

9. Research team

Name: Doc. RNDr. Johana Prokop Brokešová, CSc.

Link: http://is.cuni.cz/webapps/whois2/osoba/1352752087623523/?lang=cs
10. Team capacity in relation to the project
   Team specialists are available for consultation.

11. Galery
12. External links (e.g. publications, leaflets, etc.)

<table>
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<tr>
<th>Publication</th>
<th>Modern trends of nuclear power plants seismic safety, magazine “Energetika” (n.3/2017 volume 67)</th>
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<tbody>
<tr>
<td>Web</td>
<td><a href="http://rotaphone.eu/">http://rotaphone.eu/</a></td>
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