Investigation of the seismic rotational waves existing in the near-field seismic events

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The possibility of existence of rotational waves in the seismic field, so-called the seismic rotational waves - SRW, have had been discussed from the beginning of earthquakes investigation. Early notes on this theme were stimulated by strange, rotary and even screw-like deformations after earthquake, on parts of the tombs and monuments. Classic textbooks on seismology deny possibility that SRW could pass through a rock, and the rotational effects of earthquakes were explained by interaction of standard seismic waves with compound structure of inflicted object, which in fact might be the case. Nevertheless, it was proved theoretically that SRW may travel, first - through grained rocks, later this possibility was extended on rocks with microstructure or defects or even without internal structure due to asymmetric stresses in the medium. The SRW were for the first time effectively recorded in Poland by Roman Teisseyre, in 1976 and these waves are studied in a few centers dispersed around the world. Recently, the first monograph was published: Teisseyre R. et al, eds., 2006, covering among others the theoretical aspects of the rotation motion generation and propagation, the examples of field experiments, etc.

Consequently, recording of SRW requires new instrumentation techniques, because conventional seismographs are inertial sensors of linear velocities. From this reason a new kind of rotational seismometer consisting of two antiparallel pendulum seismometers – TAPS has been proposed. Unfortunately, the extremely high sensitivity to the translational motions of seismometers used in their construction can limit accuracy of such devices. From the above reason, the SRW recording by the fibre-optic rotational seismometer – FORS-II that bases on detection of the Sagnac effect has been proposed. The FORS-II uses classical fibre-optic gyroscope configuration with optimisation for extremely high rotation sensitivity, which is equal to 4.27 E-8 rad/s in the used 20 Hz detection band.

The investigation of the rotational components existing in the near-field seismic events by such system together with sets of two TAPS are the main part of this paper. Analysis based on a group of seismic events which took place between 2004-2006 in central Poland and have been recorded in the Ojcow Observatory. It should be noticed that data obtained from FORS-II were used directly whereas, data recorded by TAPS systems were numerical processed (by spline function approximation) for elimination

some measurement errors.

The obtained results indicate, in contrast to previously published results, that SRW travel more slowly than standard seismic waves which are much stronger. The recorded amplitude of rotational components have been identified in the range from 4.5·E-6 rad/s to 2·E-7 rad/s, which is less than 5-7 percent of the seismic event amplitude. Moreover, it was clear shown that TAPS system also detects such event with time and amplitude correlated with data recorded by FORS-II, and only some mistake in acquisition system limited their recording in the measurements previously made.