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Strong 6-dof seismic ground motion records and their engineering interpretation

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For many years only three translational components of surface seismic ground motions:

- horizontal: $u(t)$, $v(t)$ along x & y axes and
- vertical $w(t)$ along axis z

were applied in seismic engineering codes used in structural design. However, one can also define two rockings $\psi(t)$ and $\theta(t)$ about axes x and y respectively, as well as torsion $\varphi(t)$ about z axis. The reason for not including rotational ground motion in seismic engineering was lack of credible 6-dof strong motion data. Even nowadays seismologists are concentrated on acquiring tele-seismic small and very small signals rather than on finding strong ground rotations (e.g. Igel et al. 2012). It should be pointed out that from the engineering point view particular importance is played by the **horizontal and rocking ground motion** interaction.

The earliest strong 6-dof record can be attributed to Nigbor (1994) who acquired induced ground rotations reaching 38mrad/s from a very strong explosion of 1 kT explosives. Another strong ground rocking, reaching level of 26mrad/s was acquired from a swarm of earthquakes by Takeo (1998). Grazier reported indirectly acquired ground rotations of 0.26 rad/s from the 1994 records Northridge earthquake records (3.1 degree of residual tilt).

In the presentation planned for the 2019 EGU a detailed analysis of ground rotations from induced seismic events from a coal mining basin (Zembaty et al. 2017) as well as from recent earthquake recording campaign provided by Perron et al. (2018) will be carried out. Fourier and response spectra of Modified Mercalli VII 6-dof ground motion (horizontal PGV=18.4cm/s & PGVrot=6mrad/s) will be presented and analyzed in detail. Special response spectrum proposed for analysis of slender towers will be presented too. The role of specific interaction between horizontal and rocking ground motion will be highlighted, including very recent analyses of these data (Bonkowski et.al., 2019) and a comparison with actual Eurocode 8.6 proposal (Zembaty, 2009) will be carried out.

References

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