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Former ammunition depot Mitholz: seismic response of a rock mass damaged by accidental explosions

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In 1947, an uncontrolled explosion of the subsurface ammunition storage Mitholz in the Swiss Kander Valley caused several fatalities, the partly destruction of the ammunition storage and the adjacent village of Mitholz – and a leftover of 3'500 t of unrecovered ammunition remnants. In 2018, a risk analysis of the site, which until then was used for military purposes and was planned to host a computer server centre, revealed unacceptable risks for the surroundings of the depot.

Especially rock falls and earthquake-induced ignition of the ammunition were considered high (10⁻³ to 10⁻² per year, estimated by Risk&Safety AG (2018)). In the course of a more detailed investigation on seismic stability (a.o. with CSD Ingenieure AG) ambient vibration measurements at Mitholz were performed to support the further assessment of the rock characteristics. A combination of the field measurements with numerical simulations aimed to understand the seismic stability of the damaged cavern.

For an array measurement 21 seismic sensors (LE-3D 5-s and LE-3Dlite 1-s) were located both inside the tunnel system and outside at the surface above the cavern (Figure 1). The seismic response was analyzed with all state-of-the-art methods (amplification, polarization and normal mode behaviour) as described e.g.in Burjanek et al. (2014), Kleinbrod et al. (2019) and Häusler et al. (2019). Amplification factors are highest in the area just above the destroyed cavern and fracturing of the rock mass decreases the further away stations were located from the centre of the detonation (Figure 1c). Polarization direction is east-west – in line with the predominant geological fracturing and faulting of the underlying early cretaceous limestone (Oehrlikalk).

Results of these measurements were used to calibrate the elastic properties of a 2D model to analyze the earthquake stability of the underground structure. Earthquake-induced displacement patterns of the rockmass involve rockfall of instable blocks at the outside (Dreispitz), rockfall and breakdowns within the caverns, and even a complete collaps of the tunnel system along the pre-existing fault-system of the Mitholz-fault seems possible. This study shows, that ambient vibration measurements and their analysis can be succesfully applied to characterize the subsurface not only for mass movements, but also to special cases of superficial mass displacements like underground explosions.

REFERENCES


Figure 1. Location of the 1947 detonated underground ammunition storage chamber at Mitholz and results of the ambient vibration measurements. a) Measuring configuration of the passive seismic array at the Drüspitz peaks and the plateau Uf der Flue; b) Location of the site in Switzerland between Kandersteg and Kandergrund and the topography and naming of the area; c) Amplification map of the mode shape at 3 Hz with the arrows indicating the normal mode vector (polarization).