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Response of the Randa rock slope instability to small regional earthquakes

Jeffrey Moore (1), Jan Burjanek (2), Valentin Gischig (1), Simon Loew (1), and Donat Faeh (2)

(1) Department of Earth Sciences, ETH Zurich, Switzerland (jeffrey.moore@erdw.ethz.ch), (2) Swiss Seismological Service, ETH Zurich, Switzerland

A number of observations in the Matter valley of southern Switzerland attest to the significance of earthquake induced rock slope movements, however owing to the long return period of large earthquakes, co-seismic landslide hazards are not often fully appreciated. In this study, we investigate the seismic response of a large unstable rock mass above the village of Randa in Canton Valais. The site is the subject of numerous interdisciplinary investigations aimed to understand the internal structure and dynamic response of the roughly 5 million m3 of unstable material. We employ ambient vibration measurements and fiber optic (FO) strain monitoring to measure the rock mass response to small nearby earthquakes. Notable amplification was observed within the unstable rock mass, with strong polarization in the direction of instability deformation. Results further highlight resonant frequencies of internal rockslide blocks, or effective compartments with similar behavior, which help us understand the rockslide internal and deformation structure. In May 2010, a ML 3.4 earthquake occurred in the area. Five km from the epicenter at Randa, we measured clear transient deformations up to 50 micrometers across surface tension cracks. Spectral peaks from the FO strain record match closely with ambient vibration measurements and new analysis of seismic data recorded during previous experiments. Comparing strain records from either side of the instrumented block, two spectral peaks at 3 and 5 Hz were apparent. 5 Hz energy was found to be out of phase, indicating Eigen-mode block vibration, while 3 Hz energy was in phase, suggesting a resonant frequency of the larger unstable rock mass. 3 Hz resonance could be observed from other ambient vibration measurements distributed around the unstable rock mass, while 5 Hz peaks were visible only in the area of the instrumented crack. The combined methodology offers a new view into the rockslide structure, highlighting effective block assemblages and offering clues as to their size, which matches well with local geodetic displacement monitoring and structural characterization.