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Numerical modeling of the dynamic response of prone-to-fall columns to ambient vibrations: comparison with measurements and potential application

Alexandre Capron (1), Johann Valentin (1), Denis Jongmans (1), Laurent Baillet (1), Eric Larose (1), Pierre Bottelin (2), Frédéric Donze (3), and Anne Mangeney (4)

(1) ISTerre CNRS : UMR5275 – Université de Grenoble Alpes, BP 53, F-38041 Grenoble CEDEX 9, France, (2) 3SR, Université de Grenoble Alpes, G-INP, CNRS, BP 53, F-38041 Grenoble Cedex 9, France, (3) GET, OMP, UPS-Toulouse III, CNRS : UMR5563, IRD, 14 av Ed. Belin, 31400 Toulouse, France, (4) Institut de Physique du Globe de Paris, Université Paris Diderot, UMR 7154 CNRS, Paris, France

During the last two decades, seismic noise measurements have been increasingly used in gravitational hazard assessment for both investigation and monitoring purposes. The wide frequency range allows ambient vibrations to be applied for investigating geological and civil engineering structures in a great variety of sizes, from the lithospheric or crust scale to a few m-thick landslide and rock column or buildings. On unstable slopes, ambient vibrations have been applied in very different ways for reconnaissance, depending on the investigation purpose and the landslide type. The simplest way to extract information from ambient vibrations on a given site is to perform single-station measurements with a 3-C sensor and to process the records computing Fourier spectra of the three components or the spectral ratio between the horizontal and vertical components (the so-called H/V method). On landslide sites, several studies revealed significant spectral amplification at given frequency and polarization of the wave-field in the direction of maximum slope displacement.
They show that different characteristics of the seismic noise (resonant frequencies, polarization, and spectral amplification) could be used from the spectral analysis of the motion or of spectral ratios for characterizing the landslides. For cliff-like sites, this study aims to identify the pertinent and applicable parameters that could be extracted from ambient vibrations and used to gain information on the prone-to-fall column geometry. We first use 2D numerical modeling for better understanding the influence of the rear fracture characteristics (wideness w and depth L) on the horizontal motion H(f), as well as on the spectral ratios H(f)/V(f) and H(f)/Hr(f), where Hr(f) is the horizontal motion measured at a reference site. We then identify the seismic parameters able to characterize the column decoupling and we compare numerical results to data acquired at two rocky sites exhibiting cliff-like geometry. During this study, the influence of other internal factors like presence of additional fractures and of an interbedded soft layer (Figure 1) is also tested.