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Usage of a novel 3D point cloud-based roughness classification framework to correlate rockfall pre-failure deformation and slope roughness

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ABSTRACT

Rockfalls are a common hazard along transportation corridors in Western Canada, threatening both infrastructure and human safety. Knowledge of the location and approximate timing of potential rockfalls would enable mitigatory actions to be taken if necessary. As early as hundreds of days before failure, some rockfalls exhibit centimeter-scale movements which are measurable via change detection methods which utilize point cloud data from repeated terrestrial laser scanning (TLS). Characterization of pre-failure deformation magnitude and duration and associating these trends with various slope characteristics for past rockfalls can enable case-history based empirical temporal forecasting for future events (Rowe 2017). One such slope characteristic which may impact a rock block's pre-failure deformation behaviour is sliding plane roughness. Roughness of the slope directly underneath a potential rockfall block may impact both the deformation duration, deformation rates and acceleration trends, and whether pre-failure deformation is present at all. Existing methods of roughness classification such as Barton's JRC (Barton and Choubey 1977) are not optimized for assessment of a rock surface's relative ability to prevent sliding motion in one specific direction, nor do they leverage 3D point cloud data analysis techniques. The classification framework developed, described, and applied in this study utilizes a roughness orientation, shape, and magnitude analysis on an individual "roughness feature" basis. The surface being assessed receives a roughness score which is reflective of the bulk motion-resistive effect of all roughness features present. This framework is used to comparatively score back-scarp slope roughnesses for rockfalls whose pre-failure deformation length and magnitude have been obtained through a best-fit roto-translation method (Oppikofer et al. 2009). Correlations between slope roughness assessed using this new framework and pre-failure deformation will be investigated to assess whether slope roughness measurements obtained from TLS would be a useful input into a pre-failure deformation database and whether a more traditional JRC-derived analysis produces similar correlations.

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