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Influences of Joint Persistence and Groundwater on Wedge Failure Potential of Jointed Rock Slope

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Joint persistence and groundwater are critical factors that influence the stability of rock slope. Persistence dominates the extent of pre-existing potential failure surfaces. Under certain conditions, slope instability may vary with time, as the propagation of existing joints leads to the development of fully persistence failure surfaces. At the same time, groundwater may travel through the fracture network and provides an external force to unstable rock masses, resulting in the damage of rock slope failure hard to predict. In general, when a rock slope consists of two or more sets of joints, the wedge failure often becomes the initial structurally controlled failure of a progressive large landslide. A classic case, which was occurred at a steep cut rock slope on 32.5k, Provincial Highway 7, Taiwan, had been completely recorded with UAV-surveys, field investigations and witness. The landslide first occurred on 13th May 2019 as a wedge failure with the magnitude of the volume of 892 m^3 and resulted in a large landslide on 29th July 2019 with the magnitude of the volume of 37234 m^3, destroyed the protection measures and roads. According to the field investigation, groundwater was discovered flowing out from the line of intersection of persistence joints, which could be the main reason leads to the wedge failure and the progressive large rockslide. Hence, the couple mechanics-hydraulic behavior in a rock slope should be studied in more detail to mitigate such hazards.

In this study, sandbox model was applied to clarify the effects of the groundwater and joint friction on failures of single rock wedge. In addition, the software 3DEC, which is based on Distinct Element method, was carried out to extent the analysis conditions. The results of sandbox simulations were used to calibrate the performance of the numerical model, especially the coupled hydro-mechanical analysis. The stability of jointed rock slopes under different persistence and various water pressure conditions has been studied. It is believed that the study can enhance the way for stability analysis and monitoring of the potential failure of jointed rock slopes.

Keywords: Wedge failure; Joint persistence; Groundwater; Rock slope stability.

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