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Idealized curved surface for mimicking slope failure: toward the sequential failure

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In Tai et al. (2020), the concept of idealized curved surface (ICS) is proposed to mimic the failure surface, and the application to a large-scale landslide yields good agreement with the satellite image for the post-failure flow paths. The ICS consists of two constant curvatures in the down-slope and cross-slope directions, respectively. Hence, it is convenient to evaluate the stability based on the moment of momentum with respect to the plausible ICS. In this study we are going introduce a new formula for the stability analysis, in which the balance of angular momentum is employed, so that the local failure thickness (above the ICS) and the local ground water level can be taken into account. That is, the depth distribution of the landslide body may also have significant impacts on the slope stability.

Motivated by the similarity between landslide and granular avalanches, the periodic sand avalanches on a heap are investigated by means of the snap shots of high-speed camera, where the sand is accumulated up to a specific volume before sliding down. It is found that the first failure takes place near the toe of the avalanching body and the rupture surface develops and moves upwards. The ICS and the associated stability analysis can well explain the initial failure near the toe. This concept can also be applied to the mystery of the Hsiaolin landslide, taking place in southern Taiwan in 2009, where the released volume is up to more than 22 Mm^3 but the mean slope is around 21 degrees. In spite of a 2D analysis, it can be found that, with a reasonable groundwater level, the first failure could be suspected to develop around the toe part. Therefore, we speculate that the plausible state of the landslide is the rainfall induced rise of groundwater level, inducing the sequential landslides and resulting the resultant large-scale landslide event.