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Long runout mechanism of recent earthquake-triggered landslides in Japan and China

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1. Rapid, long runout mechanism on horizontal sliding surface
The 2008 Iwate-Miyagi Nairiku Earthquake, Japan of Ms 7.2 caused uncountable landslides in the epicenter area. Largest was the Aratozawa Dam Landslide and its volume is estimated as 70 million cubic meters. It ran rapidly for about 300 m in less than 5 minutes on almost horizontal (1 - 2 degrees) sliding surface. Authors sampled weathered pumice and sand/siltstone from surface of the landslide toe part for ring shear tests and obtained following results; (1) The cyclic loading ring shear test on weathered pumice using observed earthquake main shock acceleration waveform showed limited residual shear displacement. (2) Repeated undrained cyclic loading ring shear tests on saturated siltstone sample finally showed unlimited shear displacement behavior even though the shear stress was as small as about 5 degrees (3) Undrained monotonic loading ring shear test on same pumice proved that the steady state strength is only 30 kPa for shear displacement larger than about 100 mm. Because the steady-state strength is independent of initial normal stress, smallest apparent friction angle of 1 - 2 degrees can be expected.

2. Long runout mechanism of limestone detachment type landslide
Many limestone detachment-type landslides have been triggered by the gigantic 2008 Wenchuan Earthquake, China. The Chaping landslides is the largest one and blocked the downslope river to create temporal reservoir, which was, then removed by the army. Authors sampled the landslide debris of crashed limestone near the toe part and conducted ring shear test. The specimen was fully saturated and sheared under undrained condition and constant-shear-speed condition to obtain the long-distance shear behavior. Stress path reached failure at peak friction angle of 41.8 degrees and then went down along the failure line until shear displacement reached about 100 mm. The stress condition stayed the ultimate steady state thereafter. This stress path shows typical behavior of the Sliding surface liquefaction. Apparent friction angle can be calculated as only about 9.5 degrees. This small value can clearly show the high mobility of the landslide.

3. Long runout mechanism of scraping foreground soils and building foundation
The main shock of the Wehchuan Earthquake caused two major landslides in Beichuan city, Wangjiayan landslide and Jingjiashan landslide. The former one slid into the city center and claimed lives of about 1,600, which is the largest casualty by a single landslide in the quake. It traveled very long distance and destroyed numerous buildings in the city center. Many buildings were flattened and wrecked into pieces in front of the toe of landslide mass of more than 100 meters wide. Other partly-destroyed buildings were inclined and apparently affected by partial upheaval or subsidence. Yin, et al. (2008) suggested that extremely strong air blasting caused by the rapid landslide mass movement could be the mechanism of flattening. However, similar experience was recorded in the 1985 Jizukiyama Landslide by torrential rainfall, and the 1995 Takarazuka Golf Course landslide triggered by the Kobe quake in Japan. In both cases, landslide mass ran scraping soils in front of the debris toe. This mechanism can be partly explained by quick and undrained loading by the rapid moving landslide mass onto the alluvial ground and the generated excess pore pressure.