Geophysical Research Abstracts
Vol. 13, EGU2011-7656, 2011
EGU General Assembly 2011

Sliding-surface-liquefaction of sand-dry ice mixture and long runout submarine landslides

Atsuya Tsukui (1), Hiroshi Fukuoka (1), Akito Tsutsumi (1), and Shintaro Yamasaki (2)

(1) Kyoto Univ., Japan (tsukui@landslide.dpri.kyoto-u.ac.jp, fukuoka@scl.kyoto-u.ac.jp, tsutsumi@kueps.kyoto-u.ac.jp), (2) Kitami Institute of Technology (yamasaki@mail.kitami-it.ac.jp)

There are a lot of historical witnesses records about large-scale burning of flammable gas possibly ejected dissolved methane hydrates (MH) from sea floor. Since the vast distributions of the BSR in the continental margins, a lot of papers have been published which pointed out the possibilities of that gasification of those hydrates could have triggered gigantic submarine landslides. Recent triaxial compression tests on artificially prepared sand-MH-mixture samples revealed that they have slightly higher strength than the ones of only sands and MH's endothermal characteristics may resist against accelerating shear and large-displacement landslides as well. While, the stress-controlled undrained ring shear apparatuses have been developed at Disaster Prevention Research Institute, Kyoto University to reproduce subaerial landslides induced by earthquakes and rainfalls. Using this apparatuses, Sassa and Fukuoka found localized liquefaction phenomenon along the deep saturated potential sliding surface due to excess pore pressure generation during the grain crushing induced bulk volume change. This phenomenon was named as "sliding surface liquefaction." Similar sudden large pore pressure generation was observed in pore pressure control test simulating rain-induced landslides. In this paper, authors examined the shear behavior of the dry sand-dry ice mixture under constant normal stress and shear speed control tests using the latest ring shear apparatus. Sample was mixture of silica sands and dry-ice pellets (frozen carbon-dioxide). Those mixtures are often used for studying the mechanism of the methane hydrates in laboratories because no explosion protection facility is required. Applied total normal stress was 200 kPa and initial effective normal stress was maintained at about 70 kPa by slightly opening the drainage valve to vent CO2 gas. When the sample was sheared at 30 cm/s, the stress path reached failure line of friction angle of about 37 degrees immediately. However, excess pore air pressure increased soon after and the stress path moved toward the origin along the failure line. This means rapid shearing generates frictional heat and it accelerates the gasification of dry ice quickly. The obtained shear speed – excess-pore-pressure ratio relationship clearly shows speed dependency. When the speed is high, excess pore pressure ratio is high, which can contribute to high mobility of the landslide mass. Crushing of pellets may contribute to increase the total surface area of dry ice and to acceleration of gasification. Authors conducted high-velocity friction experiment of clayey silts samples from the core of the Integrated Ocean Drilling Program (IODP) Expedition 316 Sites C0006 obtained by the drilling vessel "CHIKYU". It showed certain rate velocity strengthening and weakening, however, the content was much smaller than that observed in this test series. This sliding-surface-liquefaction in the sand - dry ice mixture supports the possibility of similar accelerating displacement in the sand-MH mixture or boundaries between MH and sand layer induced by certain strong ground motion under sea floor. To simulate the earthquake-induced submarine landslides due to gasification of MH, authors applied the Kobe-quake wave form to the sample. The sliding surface liquefaction appeared when the initial stress condition is close to the failure line. Because MH has similar expansive gasification characteristics, MH still has high possibility to cause gigantic submarine landslides under certain strong earthquake condition.