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Possibility of submarine landslide triggering due to dissociation of hydrates – an approach through ring shear tests

Hiroshi FUKUOKA (1) and Atitkagna DOK (2)

(1) Niigata University, Research Institute for Natural Hazards and Disaster Recovery, Niigata, Japan (fukuoka@cc.niigata-u.ac.jp), (2) Institute of Technology of Cambodia, Phnom Penh, Cambodia

Abstract: In Japan, the MH21 Research Consortium is developing the advanced technology of mining submarine methane hydrates by reducing pressure of hydrates to induce dissociation and gasification of hydrates. However, assessment and prediction technology of dissociation is still under development through intensive study. On the other hands, authors have pointed out the possibility of large-scale submarine landslides by the sliding surface liquefaction of the hydrate bearing- layers. Author has tested dry-ice and silica-sands mixture specimen as a methane hydrate substitutes in a series of partially-drained high speed / stress-controlled ring shear tests. Their results strongly suggest the possibility of sliding surface liquefaction under strong seismic condition, while the possibility of extensive dissociation especially under mining by reducing pressure is not clear. Author modified the ring shear apparatus DPRI-7 of Kyoto University so that it can cool down the specimen and measure the specimen temperature during shearing. Silica sands #7 submerged in TBAB (Tetra-butyl-ammonium bromide) solution was used for the specimen. This TBAB solution was frozen at around room temperature of 8 – 12 degrees Celsius under 1 atmospheric pressure. A series of constant speed shearing test was conducted to examine the rate-effect. Frictional characteristics was achieved under 0.1 – 10 cm/s of shear speed which was changed in stepping-up and down. The results show rather the temperature effect was obvious than the speed. At the first shearing of the specimen immediately after frozen, extreme high peak stress was obtained. Then the residual shear strength showed medium peak at temperature of about 4 degrees, then gradually decreased up to about 10 degrees. The medium peak of shear strength may come from the generation of angular grains due to crushing the specimen during initial shearing. The decreasing thereafter may have resulted from further crushing, rounding of the hydrates and possible dissociation of the hydrates due to heating in the shear zone. Temperature was continuously rising although the tests and finally all the hydrates were melted. Unfortunately, no excess pore pressure generation was observed possibly because of low saturation degree of the sample and apparatus. As for rate effect, cyclic shear rate test clearly showed that the negative rate effect in other word, velocity-weakening was obvious for shear speed exceeding 0.5 cm/s. Cyclic loading test applying step-up shear stress amplitude showed that "Sliding surface liquefaction" can take place under certain lower frequency seismic condition for the tested TBAB - silica sand mixture sample.
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