E07

Aratozawa landslide simulation model using LS-RAPID

〇Hendy SETIAWAN, Kyoji SASSA, Kaoru TAKARA, Maja OSTRIC

1. Introduction

Landslides which occurred on the water body like rivers and reservoirs are generally affected by hydrological influences and geological factors, though major trigger might came from the earthquake or heavy rainfall. The Iwate-Miyagi inland earthquake with magnitude 7.2 on 14 June 2008 in Tohoku region of Japan resulted about more than 4,000 landslides mainly in the form of shallow debris slide and deep-seated slide. Those thousands of landslides destroyed road network or blocked the rivers and reservoirs, with the landslide distribution up to 15 kilometers from the epicenter.

Fig 1. Aratozawa landslide

The deep large-scale landslide near Aratozawa Dam in Ohu Mountains of Miyagi Prefecture occurred shortly after the earthquake (Fig.1). This landslide has gentle gradient varied of about 2-4 degree with height of a head scarp of 50-150 m which resulted massive blocks of 1,300 m in length, 900 m wide and more than 100 m deep, moved about 300 m with the volume total of 67 million m3. Study on large-scale landslide near Aratozawa reservoir is carried out due to its unique characteristic both in location, antecedent causes, triggering factors and failure behavior. Thus, the objective of this research is to understand the initiation mechanism and motion behavior of the deep large-scale landslide on the upstream of Aratozawa reservoir through laboratory experiment and landslide modeling.

2. Methodology

We conducted laboratory experiment using undrained dynamic ring shear apparatus (Fig.2) to observe pore water pressure generation and failure motion in large shear displacement of Aratozawa samples during the 2008 Iwate-Miyagi inland earthquake.

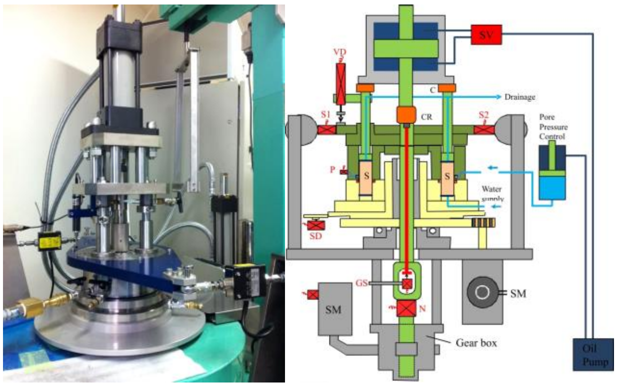

Fig 2. The ring shear apparatus ICL-2 version

Following from experiment results, the LS-RAPID geotechnical simulation was carried out. The concept of this model is to integrate the initiation process (*stability analysis*) by pore pressure increase and seismic loading, and the moving process (*dynamic analysis*) including the process of volume enlargement by entraining unstable deposits within the travelling course (Sassa et al. 2010). Such principle is drawn in a vertical imaginary column within a landslide mass as shown in Fig 2.

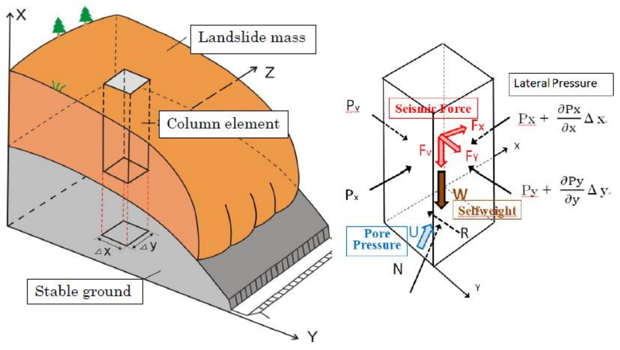

Fig 2. Vertical imaginary column within a landslide mass

3. Results

Through pore pressure controlled tests using ring shear apparatus, we found that the critical pore pressure ratio of the samples reached 0.61-0.63 (Fig 3). That means the earthquake loading cannot cause landslide motion if any pore pressure was not working on the sliding surface at the time of earthquake.

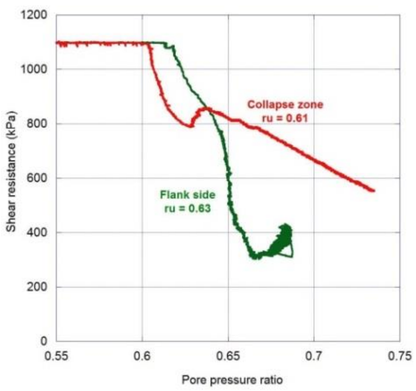

Fig 3. Critical pore pressure ratio of Aratozawa samples

In forward, we used this result as input parameter to conduct landslide modeling by means of LS-RAPID as shown in Fig 4.

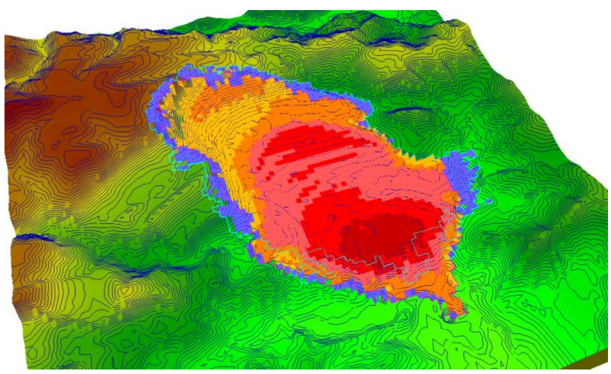

Fig 4Simulation of Aratozawa landslide using LS-RAPID

The recent results in this research implied that the Aratozawa landslide was triggered by combined factors of the earthquake with initial pore water pressure as antecedent hydrological cause. In addition, the Aratozawa landslide mechanism is well explained using the integration method of experiment and model of LS-RAPID.

Reference

Miyagi, T., Yamashina, S., Esaka, F., and Abe, S. (2011). Massive landslide triggered by 2008 Iwate-Miyagi inland earthquake in the Aratozawa Dam area, Tohoku, Japan. Landslides 8:99-108.

National Research Institute for Earth Science and Disaster Prevention in website: http://www.bosai.go.jp/e/activities/database/earthquake.html.

Sassa K, Nagai O, Solidum R, Yamazaki Y, Ohta H. (2010). An integrated model simulating the initiation and motion of earthquake and rain induced rapid landslides and its application to the 2006 Leyte landslide. Landslides 7:219-236.

Setiawan, H., Sassa, K., Takara, K., Miyagi, T., Fukuoka, H., and He, B. (2014). The simulation of a deep large-scale landslide near Aratozawa Dam using a 3.0 MPa undrained dynamic loading ring shear apparatus. in Landslide Science for a Saver Geoenvironment Volume 1 The International Programme on Landslides (IPL) pp 459-465. Springer.