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Initial Pore Pressure Ratio in the Earthquake Triggered Large-scale Landslide near Aratozawa Dam in Miyagi Prefecture, Japan

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Abstract

The Iwate-Miyagi inland earthquake with magnitude of 7.2 on 14 June 2008 in Tohoku region of Japan resulted in more than 4,000 landslides. The deep large-scale landslide near Aratozawa Dam in Ohu Mountains of Miyagi Prefecture occurred shortly after the earthquake. In this paper, landslide geotechnical simulation with high normal stress and pore-water pressure measurement in undrained conditions is explained through laboratory experiment by means of ring shear tests. We used the newest version of undrained dynamic loading ring shear apparatus to test volcanic tuff samples from the collapsed zone and flank side of the Aratozawa landslide. The simulation results of combined triggering factors using ring shear apparatus implied that the initiation mechanism of Aratozawa landslide was influenced by initial pore pressure before being triggered by the earthquake.

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Keywords: Iwate-Miyagi earthquake; deep landslide; ring shear tests; initial pore pressure ratio

1. Introduction

The Iwate-Miyagi Nairiku (inland) earthquake with magnitude of 7.2 occurred on 14 June 2008 at 8:43 JST in Tohoku region of Japan with the epicenter located at 39°01.7' of north latitude and 140.9°52.8' of east longitude[1,10,22](Fig.1). The depth of the earthquake was reported of about 8 km with the source area beneath the Ohu Mountains[5]. The Ohu Mountains stretches from north to south of Tohoku region across Iwate and Miyagi Prefecture.

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The type of this earthquake was a reverse faultwith the surface of fault found from east of the epicenter to the southwest besides Mount Kurikoma[1,5].The 2008 Iwate-Miyagi earthquake resulted inmore than 4,000 landslides, mainly in the form of shallow debris slide and deep-seated slide[21]. Those thousands of landslides destroyed road network or blocked the rivers and reservoirs, with landslides distribution up to 15 kilometers from the epicenter[3, 10]. Along the fault line, most of the large-scale landslides were found on the hanging wall side where Mount Kurikomais located[21,7,5,10]. There are three dam reservoirswith their upstream coming from Mount Kurikoma: Hanayama dam which store the water of Ichihasama River, Aratozawa dam for Nihasama River and Kurikoma dam for Sanhasama River. These three main rivers (Hasama Rivers) from Mount Kurikoma are part of Kitakami river basin which is the biggest river basin in Tohoku region. During the 2008 Iwate-Miyagi Nairiku earthquake, numerous slope failures, landslides and debris flows took places on the Hasama Rivers. For example, theDozousawa shallow landslide generated long-traveling debris flow near the top-east of Mount Kurikomaand hit the Komanoyu hot spa hotel and Gyoja waterfall with the flow distance more than 10 km on the upstream of Sanhasama River[5,6,21]. Other large-scale landslide was occurred near the Aratozawa Dam reservoir on the upstream of Nihasama River, which is the main concern in this study.

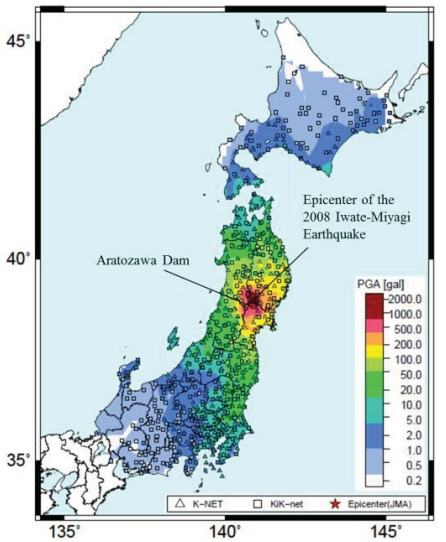

Fig.1. Distribution of peak ground accelerationof the 2008 Iwate-Miyagi Nairiku earthquake (K-Net and KiK-Net data from NIED, Japan)

The deep large-scale landslide near Aratozawa Dam reservoir on the southeastern part of Mount Kurikoma of Miyagi Prefecture occurred shortly after the earthquake (Fig.2). Aratozawa landslide is located 14 km south-southwest of the epicenter, experienced peak ground acceleration of more than 1,000 gal[7]. In addition, this landslide hada gentle gradient varied for about 2-4 degree with height of the head scarp of 50-150 m which moved about 300 m and resulted inmassive blocks of 1,300 m in length, 900 m in width and more than 100 m deep[3,5,7]. Such aunique deep large-scale landslide is importantto be studied in detail particularly for the mechanism of landslide initiation. The Aratozawa landslide is located just upstream of the reservoir. Although the 2008 Iwate-Miyagi earthquake as a triggering factor has been reported based on a geological site investigation and analysis[7,8,10,22], the mechanism of landslide initiation and its causal factors have not yet been clarified in detail.