Mechanism of earthquake-induced landsliding, a case of October 2004 Mid-Niigata Prefecture Earthquake

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1. Introduction

The 2004 Mid Niigata Prefecture Earthquake (Chetesu Earthquake) occurred on 17:56, 23 October (JST) being 13 km deep, magnitude 6.8(JMA), in Chuetsu region, Niigata Prefecture, marked the largest seismic intensity 7 (JMA) in the seismological observation history of Japan. A series of aftershocks jolted the same area, and thousands of slope failures were triggered by the sequence of earthquakes, caused significant damage to slopes, roads and dwellings. To clarify the occurring mechanism of earthquake-induced landslides, we studied the Shiotani-kamisawagawa landslide, the biggest one among those induced by Chuetsu Earthquake.

2.Shiotani-kamisawagawa landslide

The Shiotani-kamisawagawa landslide is located 4 km northeast of the mainshock epicenter, and 10 km east from the center of Ojiya city. The landslide occurred on a 400-200 m elevated slope, in the Imo River basin, one of the most slope failure concentrated area in the earthquake. The study area is mainly occupied by Pliocene mudstone interbedded with sandstone, and geological structure is characterized by the Higashiyama anticline, its axis is running through the western part of the area with NNE direction. The size of the landslide is about 650 m long and about 450 m wide.

3. Landsliding mechanism

Topographical map and aerial photograph prior to the earthquake indicated that the landslide occurred in pre-existing landslide topography. In the field, very clear landslide deformations were observed through the slope, such as clear main scarp, large depression and back rotational feature in the upper block, tilting and surface failures in the middle block, and transverse ridges in the lower block. Based on comparison of aerial photographs before and after the earthquake, the displacement of ponds, paddy fields and road indicated that the direction of the landsliding is about S40E and the maximum horizontal displacement is about 100 m.

On the main scarp, it is observable that the slip surface cutting the bedding plane of the sediment, and clear slickenlines on the surface. These slickenlines directed S35-40E, coinciding with the moving direction calculated from aerial photographs. However, the moving direction of the pre-existing landslide is estimated about S60E from topographical map. According to geomorphological deformation and geological structure, it is estimated that the landslide occurred firstly deep-seated almost along the bedding plane of the sediment, and then triggered the rotation of the head. In the boring core, which conducted along the main traverse line, slickensides and slickenlines were observed near the boundary (max 80 m deep) of the fresh mudstone and its upper part of fractured mudstone.

4. Conclusion

Although the studied landslide occurred in pre-existing landslide topography, it slipped in different direction and different depth from the pre-existing landslide. The result of the study may have some implications for landslides triggered by large earthquake. Under the thick concern of Tonankai/Tokai earthquake and inland large earthquake triggered by active fault, clarify the coseismic behavior of landslide is being very important. Therefore, to reveal the occurring characteristics of earthquake-induced landslides, we are now investigating dozens of important landslides in the Chuetsu Earthquake region.

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