Undrained resistance of pumice volcanic soil from the earthquake-induced Takanodai landslide, Minamiaso, Kumamoto

Muhammad Umar, Gabriele Chiaro, Takashi Kiyota

Geo-disaster Mitigation Engineering

Introduction

The 2016 Kumamoto Earthquakes caused a number of geo-disasters in the Mount Aso Caldera, including a large-scale flow-type slope failure known as the Takanodai landslide (Fig. 1) that destroyed 7 houses and killed 5 people. Between April and October 2016, the authors conducted a series of geotechnical damage surveys and field investigations in the Mount Aso Caldera, and retrieved samples of pumice volcanic soil to be tested in the laboratory.

Fig. 1. View of the Takanodai landslide (looking downhill), with damaged houses and the large debris avalanche at Aso Ohashi Bridge visible in the distance

Torsional Shear Apparatus

Laboratory testing was carried out using the fully automated torsional apparatus shown in Fig. 2. Such a device is capable of achieving double amplitude shear strain levels exceeding 100%.

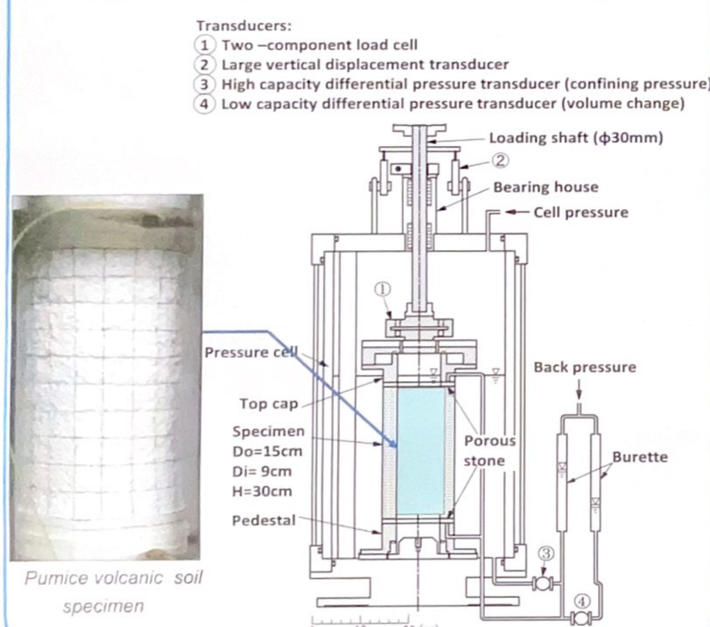

Fig. 2. Large-strain torsional shear apparatus used in this study

Symbols: Cyclic stress ratio (CSR = τ_{cyclic}/p_0'), Static stress ratio (SSR = τ_{static}/p_0'), Double amplitude shear strain or residual shear strain (γ_{DA}), Relative density, Dr

Site Characteristics

Field observations indicated that the Takanodai landslide was a mobile earth slide that developed into a flow-type slide on a low slope angle (around 10-15°)

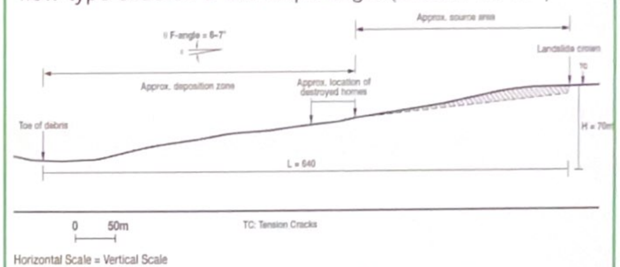

Fig. 3 Cross-section through the Takanodai landslide

A borehole describing a typical soil profile up to the depth of 14m and soil exposed in the trial pit are shown in Figs. 4 and 5, respectively.

Fig. 4. Soil profile

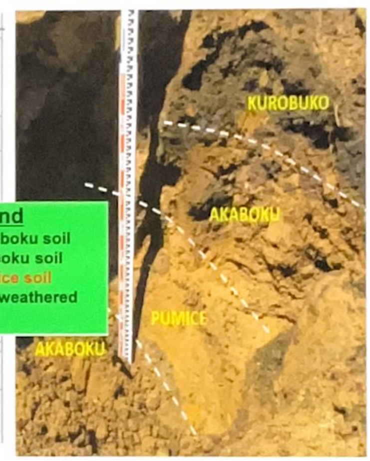

Fig. 5. Soil exposed in the trial pit

Undrained Monotonic Test

Stress-strain responses of Toyoura sand and Pumice soil is show in Fig. 6. Strain-softening behavior (i.e. decrease in shear strength owing to shear strain increase) can be observed after the transient peak stress for Pumice soil. Moreover, pumice soil showed a tendency to deform under a nearly constant stress (residual shear strength).

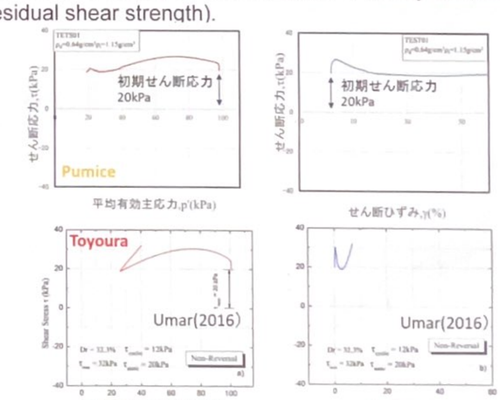

Fig. 6. Undrained monotonic test with initial static shear