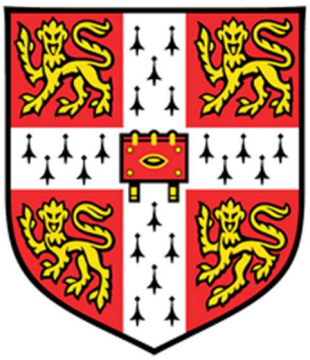
MEASUREMENT OF SOIL STRAINS UNDER EARTHQUAKE LOADING



Xiaoyu Guan

Department of Engineering

University of Cambridge

This dissertation is submitted for the degree of

Master of Philosophy

Christ's College August 2019

Abstract

Earthquake-induced soil deformation may cause significant damage to the structures and even pose a threat to human life. To describe and evaluate soil deformation, strains are used in related analyses. Thus, it is important to obtain strains. Currently, indirect measurement methods have been widely employed for soil strains. Specifically, soil strains can be obtained by double integration of measured accelerations where numerical errors might be induced. Some image-based techniques are also utilised to obtain strains in soils, but only the surface deformation analyses can be performed and are more likely to suffer boundary effects. On the other hand, various assumptions made in direct strain measurement would cause errors. This research aims to achieve direct measurement for strains within a soil body using a new device which consists a potentiometer and two accelerometers.

Since the soil strains in centrifuge models remain the same as those in the corresponding prototypes, two centrifuge tests were performed on a level soil bed and a slope model respectively to test the applicability of the new device in strain measurement. The soil movement under seismic loading has been analysed. Also, the strains from the measurement of the new devices have been compared with the indirect measurement of Piezo-electric accelerometers.

In both tests, the accelerations and displacements increase with the decreasing depth. The shear moduli increase with depth due to the increasing confining stress, while the damping ratios show an opposite variation with depth. Most normalised shear moduli obtained in the tests are within the bounds between two empirical curves, indicating the reliability of the centrifuge tests. Besides, the linear strains and the shear strains based on the measurement of the potentiometers and accelerometers on the new devices are close when large deformation of soil occurs. However, the shear strains measured by the new devices are smaller than those measured by the Piezo-electric accelerometers in both tests, while the differences between the obtained shear strains are smaller in the larger deformation problem. It is therefore concluded that the new device for direct strain measurements could be applicable for large soil deformation measurement.