Effect of Repeated Liquefaction History on Structural Performance under Large Seismic Action

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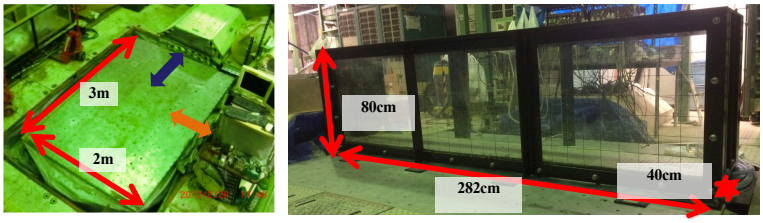
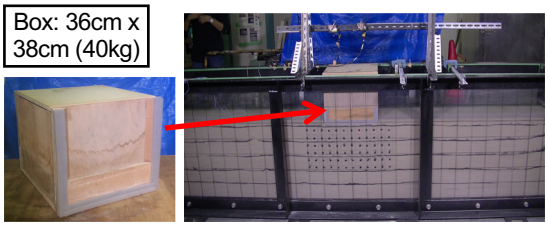
Introduction: Shaking Table Tests

It has been observed that recurrent liquefaction is a common issue in sites at risk and pose a serious threat to structures integrity. It is a general belief that densification of the soil induced by liquefaction increases its resistance and make the site safer. However, this might not always be the case. The test results compare the building movement in the case of no previous liquefaction and two other cases of previous liquefaction history.



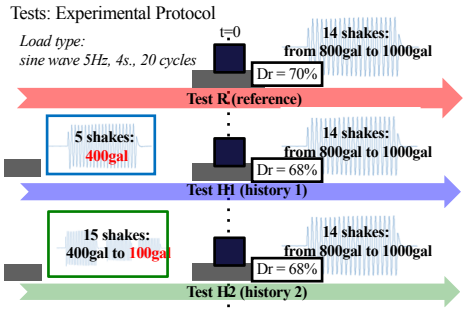
Shaking table apparatus and soil container



Superstructure in the shaking table model

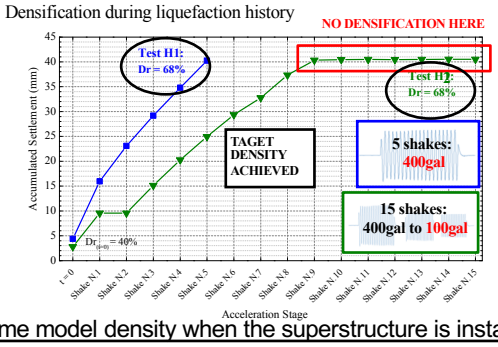
Methodology of Study

A reference test (R) with no liquefaction history has been compared to tests that were subjected to previous shakes before the main load application. The test R was prepared at the target density by air pluviation. The structure was installed before any load was applied to the model. For the tests with liquefaction history, test H1 and H2, the soil was initially prepared at a loose density. The loading history was then applied, at the end of which the target relative density was achieved: here 70%. Once this part finished, the structure was installed in the model. Therefore, at the time of the structure installation, the different cases have the same density and geometry: the difference is thus due to the loading history.



Test experimental protocol for the comparative study

Three tests are compared: **R**, the reference test, and **H1** and **H2** two test with different loading history as shown on the left figure

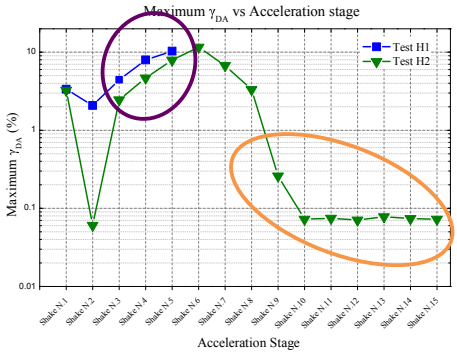


Same model density when the superstructure is installed

Test Results

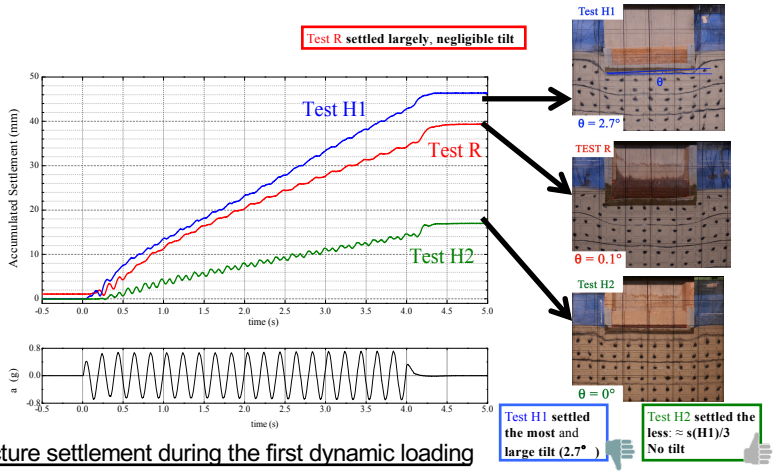
As shown on the bottom right figure, **the deformation resulting from the first dynamic load applied to the model was significantly different in all three cases**. In the case H1, the loading history resulted in a settlement more important of the structure. Howerver, in the case H2, the settlement was greatly reduced. A major difference between the tests H1 and H2 lies in the shear strain history of the model: when the last double amplitude of the shear strain was large (10% for test H1) the deformation became worse. On the opposite for a small double amplitude of the shear strain (<1% for test H2), the deformation was greatly reduced.

Large strain: 10% in double amplitude of the shear strain



Small strain: less that 1% in double amplitude of the shear strain

Shear strain history of the cases H1 and H2



Structure settlement during the first dynamic loading