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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Effects of relative density and accumulated shear strain on post-liquefaction residual deformation" *by* J. Kim et al.

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Most of all, we thank referee for the thorough review on the manuscript.

- If the residual shear deformation is main concern, the test should not be conducted under K0-test condition, because K0 condition is only for level ground to investigate 1-dimension settlement without any initial shear stress. Monotonic shear loading to evaluate residual shear deformation should not be done under K0 condition but under anisotropic stress condition with different vertical and stresses without keeping K0 stress.

As the reviewer stated, the K0 condition was not completely achieved during the whole test series. Instead, the K0 condition was kept during the consolidation and drainage

only, and the lateral strain constraint condition was kept during the undrained cyclic and monotonic loading process. The term "K0 condition" was changed to "lateral constrained condition" because the current text may lead to misunderstanding on the part of the reader.

- Links between the lab test conditions and actual field conditions to be considered in design are not clear to conduct the test; namely, how undrained cyclic loading, monotonic loading and drainage are combined. It is difficult to imagine that a soil element is first under K0 condition for uniform level ground, and then suddenly monotonic shear stress appears. The meaning of drainage and its timing is also unclear in terms of design practice.

Settlement will be predominant in reclaimed ground that has spread horizontally. In level ground near the coast, on the other hand, residual shear strain will be predominant. In intermediate cases for which the circumstances are somewhere in between, both residual strains will occur. Residual shear strain is generated immediately after an earthquake and residual volumetric strain takes place as time passes after the end of the earthquake. So, drainage is conducted following monotonic loading.

- In Fig.16, which seems to be the conclusive results of the paper, the number of test dada seems insufficient with too crude stepwise parameters to demonstrate the reliability of the correlations between residual volumetric strain and residual shear strain along other variables incorporated in the test program, Dr, accumulated shear strain. More systematic test program with more steps of changing parameters may be needed for this paper to demonstrate reliability as a reference in considering actual engineering design.

This study has developed a test program to evaluate residual strain characteristics. The effects of relative density and accumulated shear strain were examined. We focused on loading pattern B, and used patterns A and C for comparison. Since lateral displacement of loose to medium density induces the damage, the test cases have

compositions of relative density between 40% and 60%. All test cases have been conducted at least twice to confirm data reproducibility, and representative data have been shown. Conducting more cases to verify this tendency would be worthwhile, but a great deal of labor would be required for each case. Over 20 experiments have been conducted with a precise control technique to evaluate the behavior of soil, and then 6 cases have been shown considering the test results comprehensively. This study has suggested the relationship we aim for between residual shear strain and residual volumetric strain, and provides meaningful findings in its conclusion as well. Given this, it is hard to agree with the idea that more cases are needed to achieve our objective. The authors feel that the data are sufficient to attain the conclusion given for the scope of research delineated during the introduction.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 1579, 2013.