

Numerical Simulation and Centrifuge Modeling of Sand Liquefaction

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Introduction

The development of excess pore pressures during an earthquake may lead to soil softening, loss of stability and bearing failures. The ability of the constitutive model to predict permanent volume changes during cyclic loading is a major factor in seismic analysis. This poster presents the application of a kinematic cyclic plasticity model in the simulation of sand liquefaction and the validation of the numerical study by centrifuge-based experimental results.

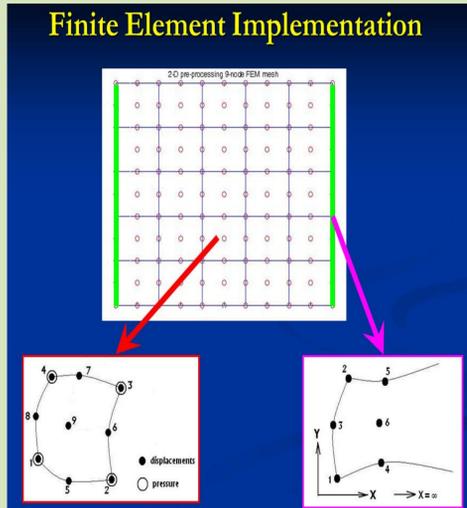
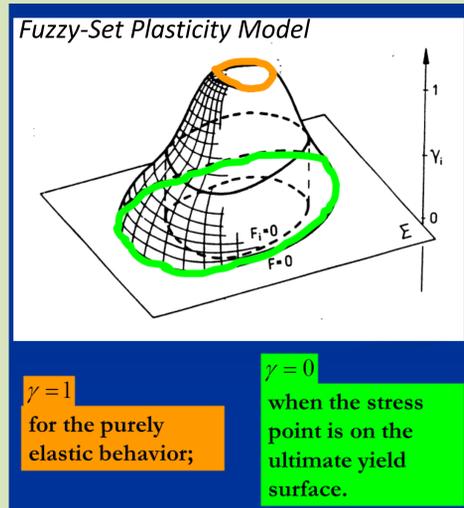


Building Collapse

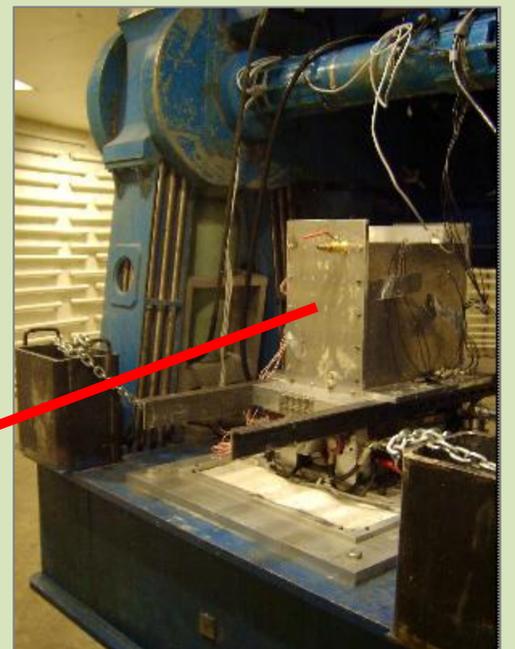


Land Spreading

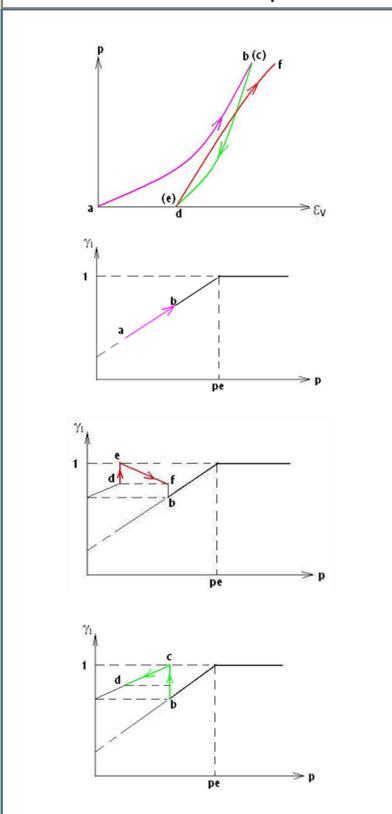
Numerical Modeling



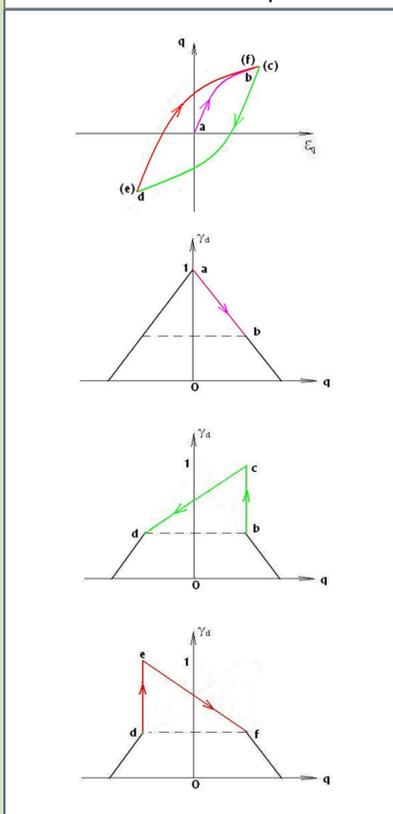
Experimental Modeling



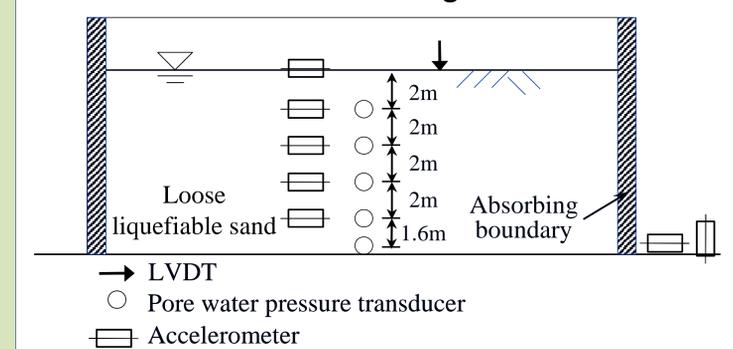
Volumetric Membership Function



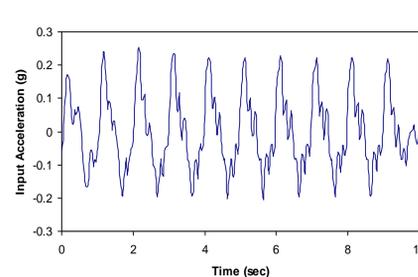
Deviatoric Membership Function



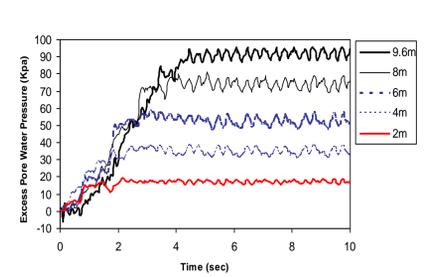
40-th Scale Centrifuge Model



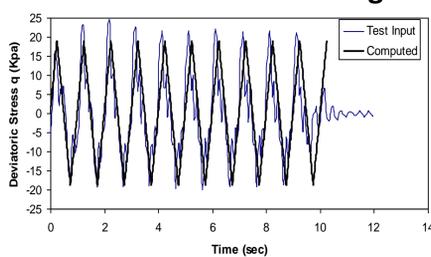
Shake Table Input Motion



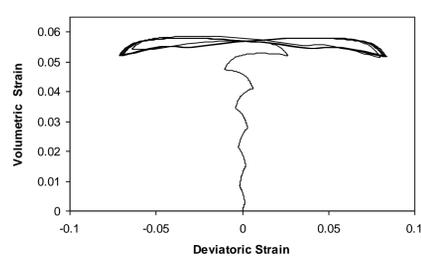
Pore Water Pressure



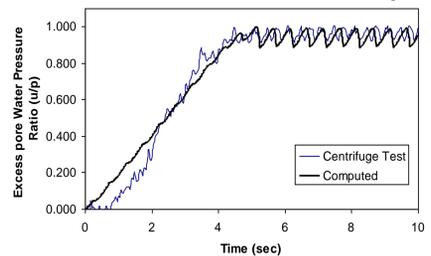
Deviatoric Stress Loading



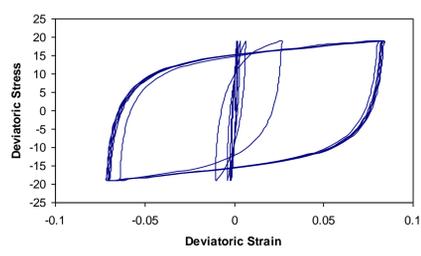
Computed Deviatoric Strain



Pore Water Pressure Buildup



Computed Deviatoric Stress



Conclusions

1. Centrifuge modeling experiments and numerical simulation of a liquefiable sand layer are conducted and compared. Both the numerical and experimental results show that the development of pore water pressure and liquefaction are a consequence of the base excitation.
2. The computed results showed good agreement with the experimental data.
3. The developed fuzzy-set plasticity formulation and computational procedure are an effective means to assess liquefaction potential and liquefaction-related deformations.

References:

1. Bao, Y. and Sture, S., "Numerical modeling of cyclic mobility based on fuzzy-set concepts in plasticity theory", Computers and Geotechnics, Vol. 38, Issue 3, p.p. 375-382, 2011.
2. Bao, Y. and Sture, S., "Application of a kinematic-cyclic plasticity model in simulating sand liquefaction", International Journal of Advances in Engineering Sciences and Applied Mathematics, Vol. 2, Issue 3, p.p. 119-124, 2010.
3. Ge, L., Bao, Y., Ni, C. K. and Ko, H. Y., "Seismic centrifuge modelling of earth dams", Geomechanics and Geoengineering, Vol.5, Issue 4, p.p. 247-257, 2010.