LIQUEFACTION STUDY USING THREE DIMENTIOANAL DISTINCT ELEMENT METHOD

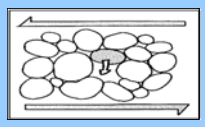
3次元個別要素法による液状化現象の数値解析

EARTHQUAKE AND LIQUEFACTION INDUCED DAMAGES

Liquefaction is one of the the most important, complex and controversial topic in geo-technical earthquake engineering. Built environment is suffered severe damage due to liquefaction of soil. Adverse effects of liquefaction include flow failures, lateral spreads, ground oscillation, loss of bearing strength and settlement.

Mechanism of liquefaction

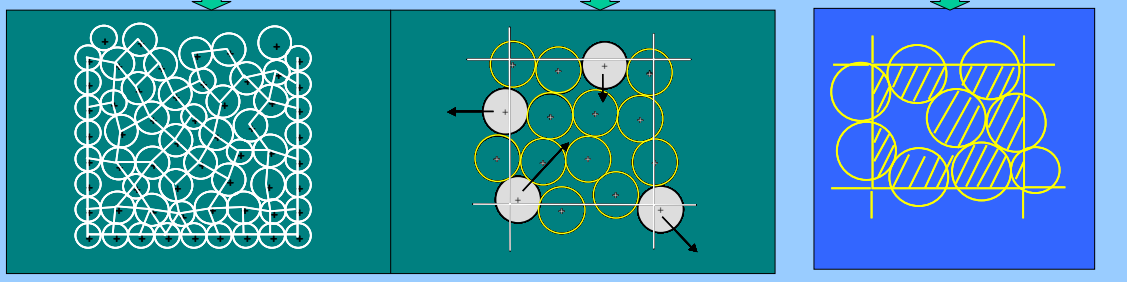
Liquefaction is a process by which sediment below water table temporarily loses its strength and behaves as a viscous liquid rather than a solid.



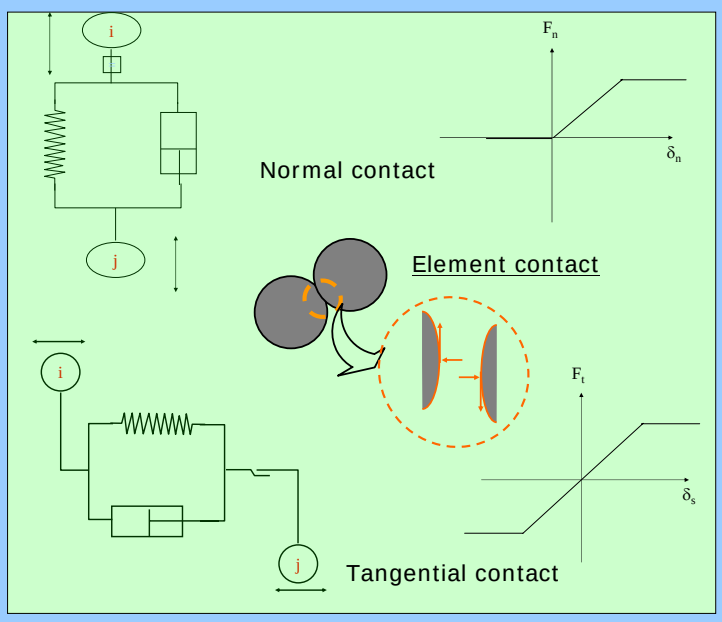
Seismic wave passing through saturated granular layers, distort the granular structure, and cause loosely packed groups of particles to collapse. These collapses increase the pore water pressure between the grains if drainage cannot occurs. If this pore water pressure rises to the level of weight of overlaying soil, liquefaction will occur.

Background

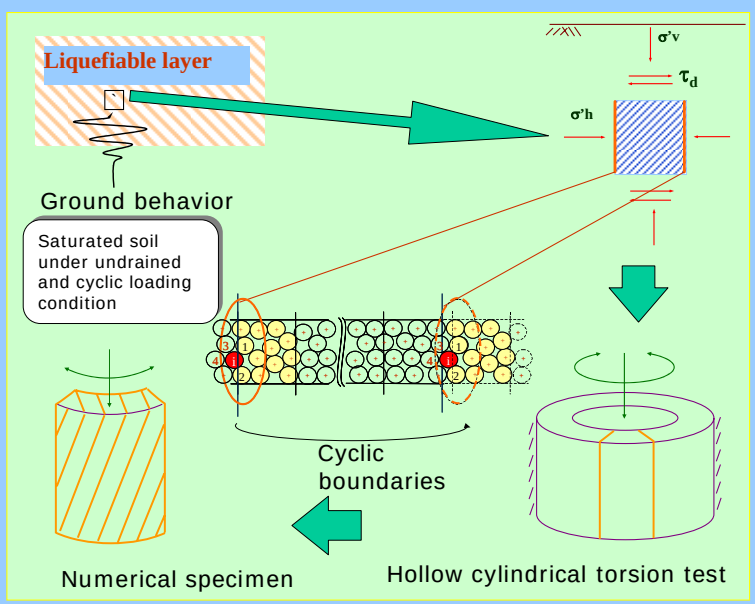
	2D		3D
Without consideration of pore water pressure	Constant volume analysis (sawada et al.)		
consideration of pore water pressure	Closed pore analysis -Complicated algorithm (*Tarumi & Hakune*)	Approximated element volume analysis -Sudden change in the effect of pore water (*Nakase et al.*)	Present study considering direct effect of pore water



Numerical modeling



Modeling of element contact



Modeling of specimen with boundary condition

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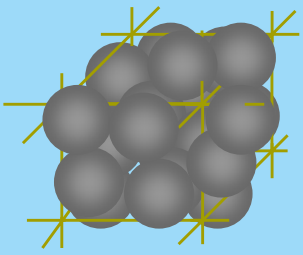


Given domain is divided into a number of cells and element volume, pore volume change and pore water pressure are calculated within the cell as a unit volume.

Element volume (V_E)

⇩

pore volume (VP = VT-VE)

⇩

Excessive PWP Difference (PWPD)
= (VPO-VP) / VPO * EW

⇩

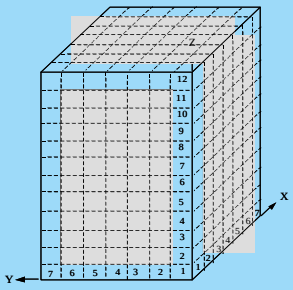
Excessive pore water pressure(PWPt)
=PWPt-1 + PWPD

⇩

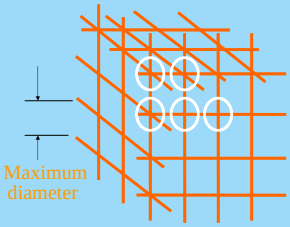
Amount of Water Flow

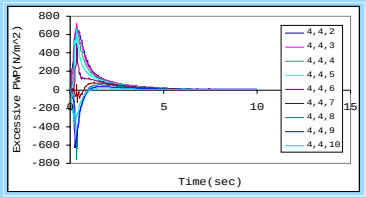
⇩

Balance Pore volume (VPO)

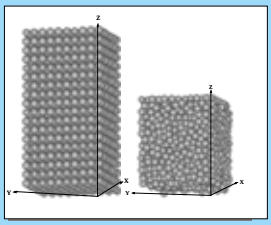


Treatment of water pressure

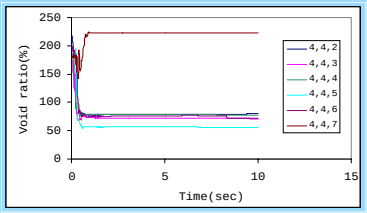




Change of excessive pore pressure during packing

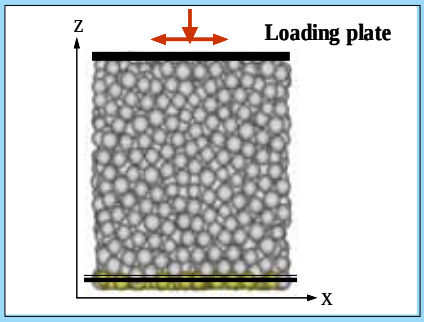


Element location before and after packing

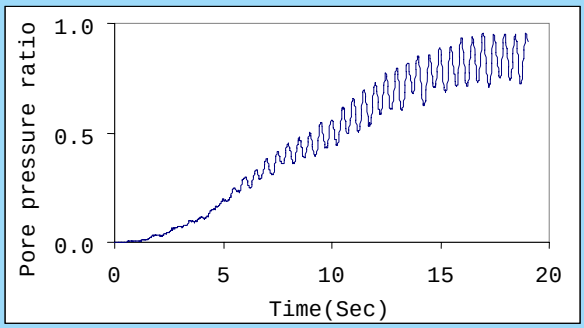


Change of void ratio during packing

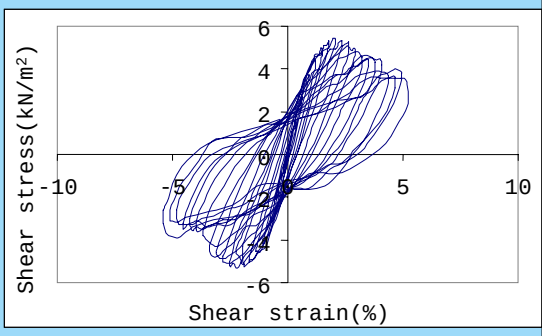
Preparation of numerical specimen



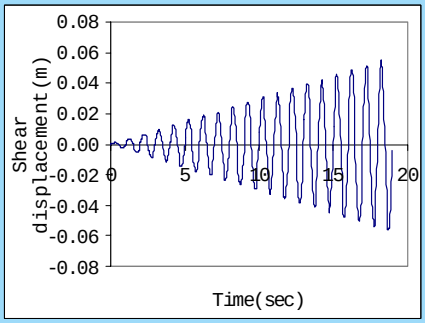
Specimen set-up



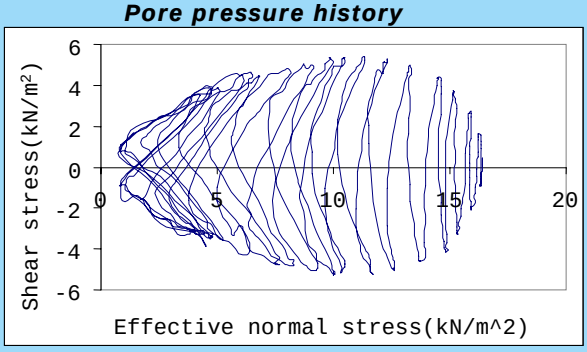
Pore pressure history



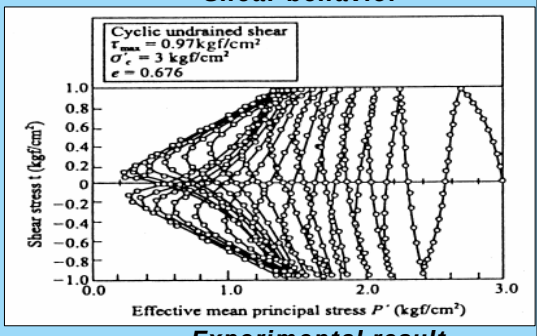
Shear behavior



Displacement input

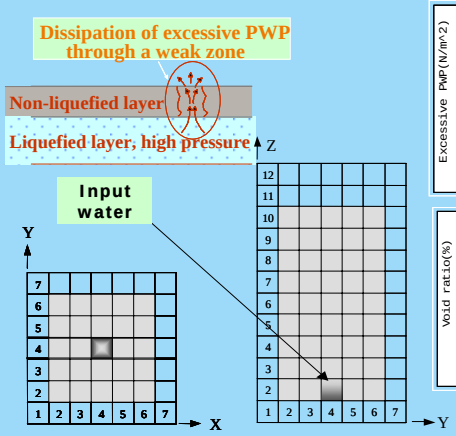


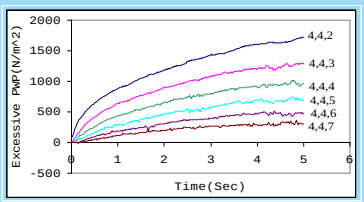
Shear –effective normal stress curve

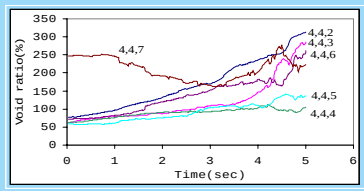


Experimental result

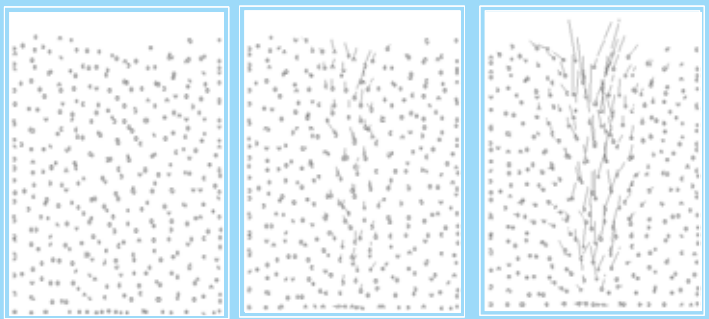
Experimental and simulation results







Excessive PWP and void ratio in column 4,4



t = 1 sec ***t = 3 sec*** ***t = 5 sec***

Location of particles at different time

Sand Boiling Simulation

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