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# Mitigation of soil liquefaction using microbially induced desaturation

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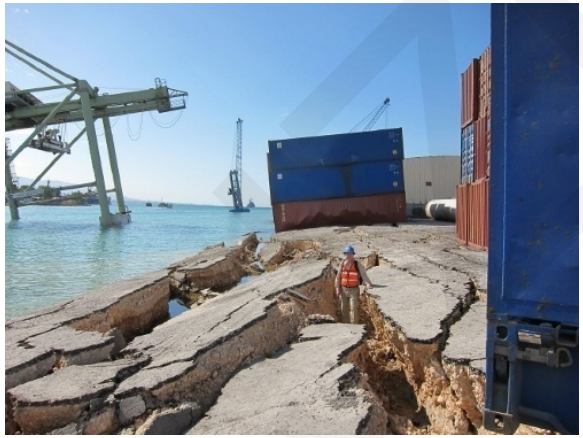
# Background – soil liquefaction



Loss of bearing capacity
(1964 Niigata Earthquake)



Lateral spreading
(2011 Christchurch Earthquake)



Dislocation of retaining wall
(2010 Haiti Earthquake)



Uplift of buried structures
(2004 Chuetsu Earthquake)

# Background – existing liquefaction countermeasures

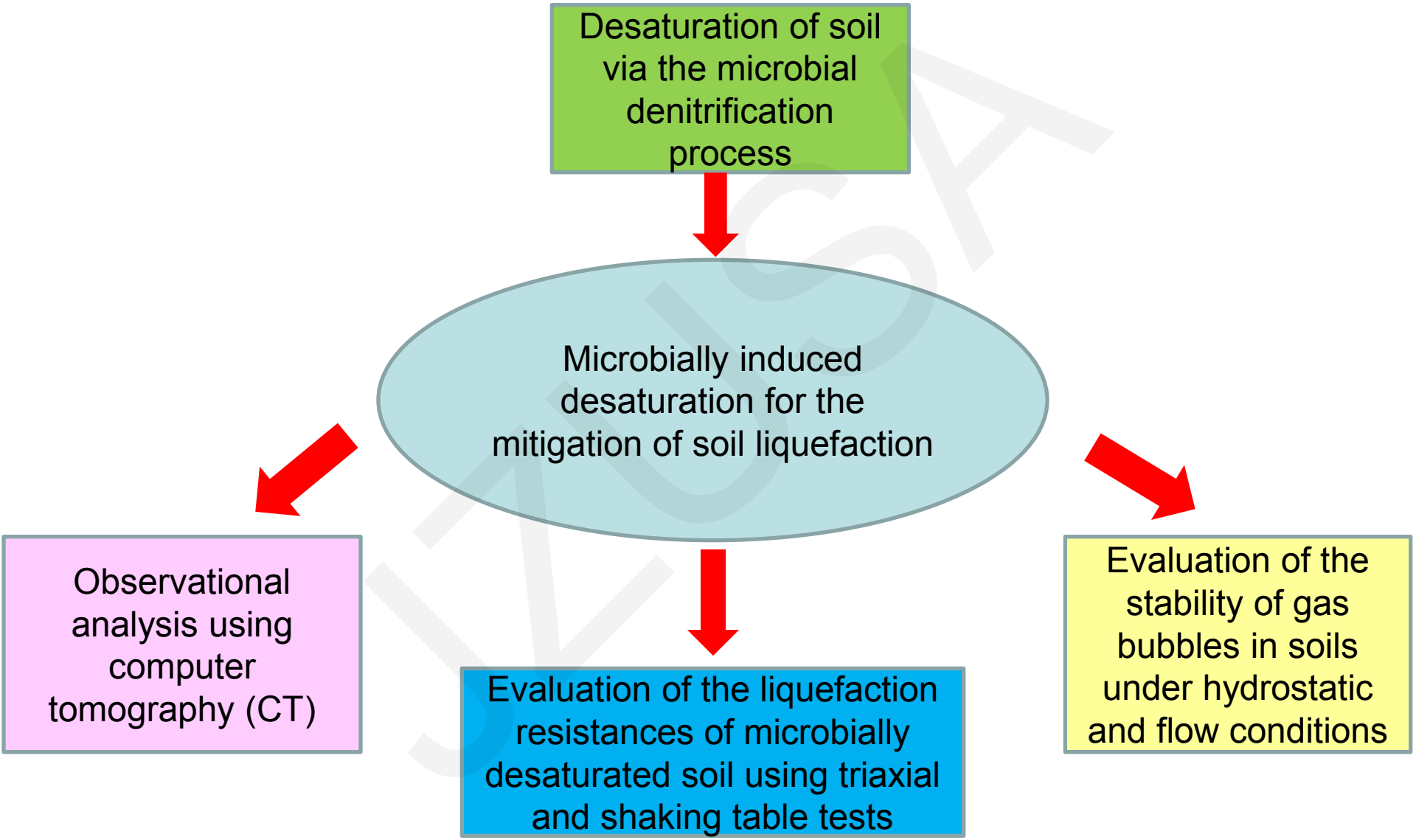
- Densification
- Solidification
- Pore pressure dissipation
- Lowering of ground water table
- Shear strain restraint

**These conventional liquefaction countermeasures are too expensive for normal buildings and structures.**

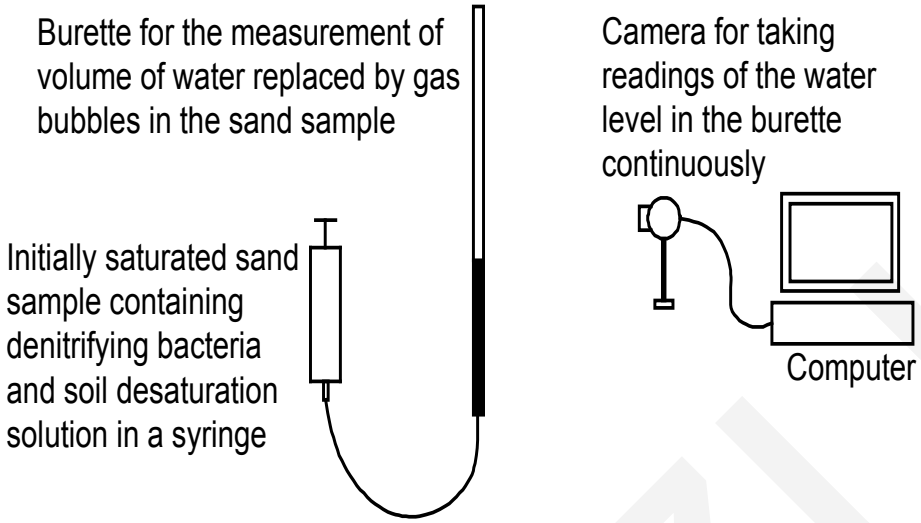
**A cost-effective technique for the prevention/mitigation of soil liquefaction is needed.**

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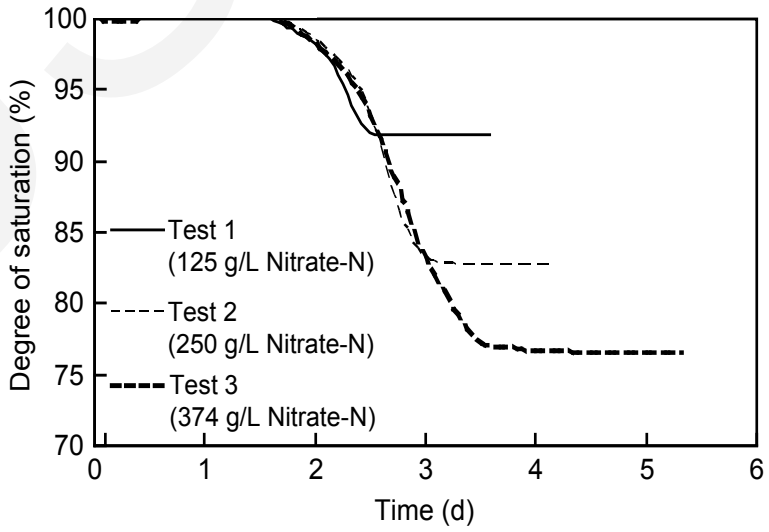
# Methodologies



# Desaturation of soil via the microbial denitrification process



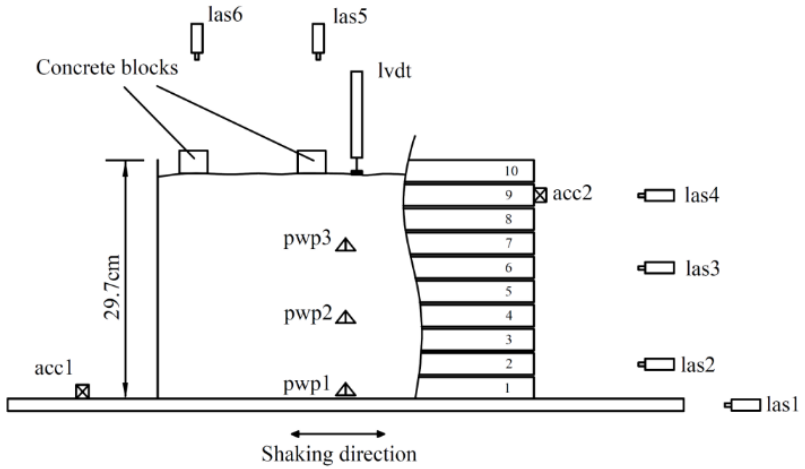

**Set-up of soil desaturation test**



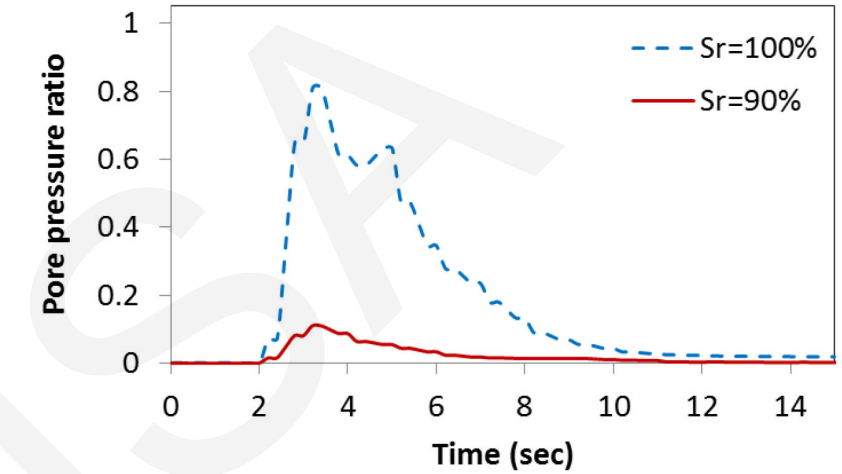

**Variation of saturation degree with time in the soil desaturation test**

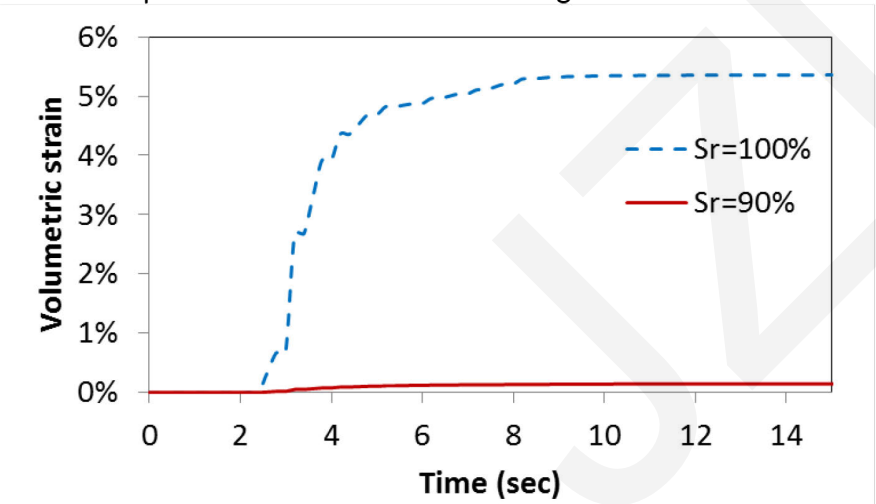
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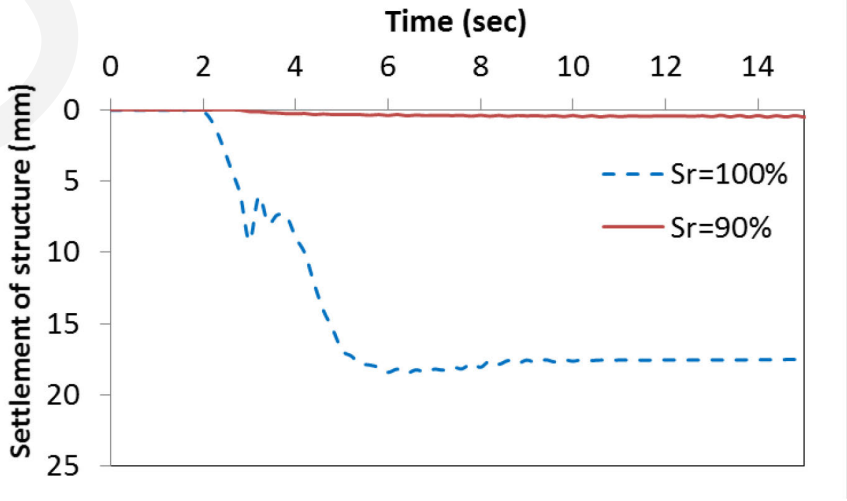
# Liquefaction resistances




Set-up and instrumentation of shaking table test

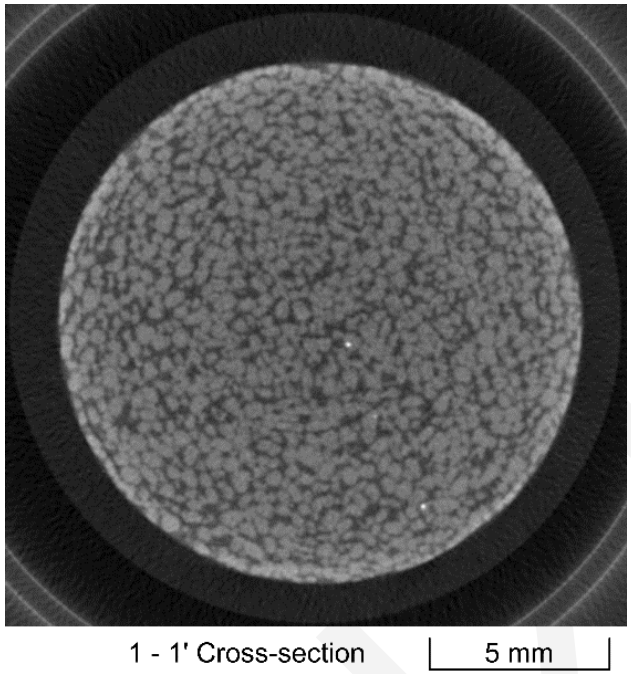


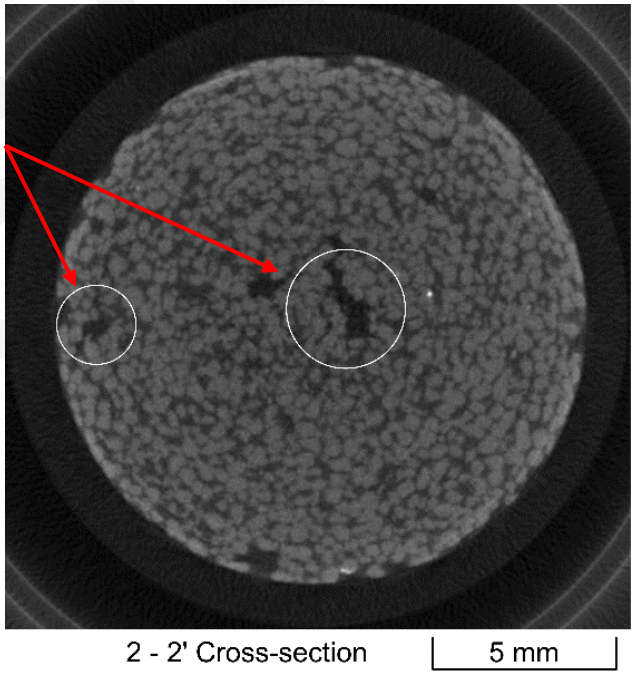

Seismic responses for relatively loose soils under $a_{max}$ = 0.5 m/s$^2$
(Blue lines: saturated soil; Red lines: microbially desaturated soil)

# CT images of saturated and microbially desaturated soil



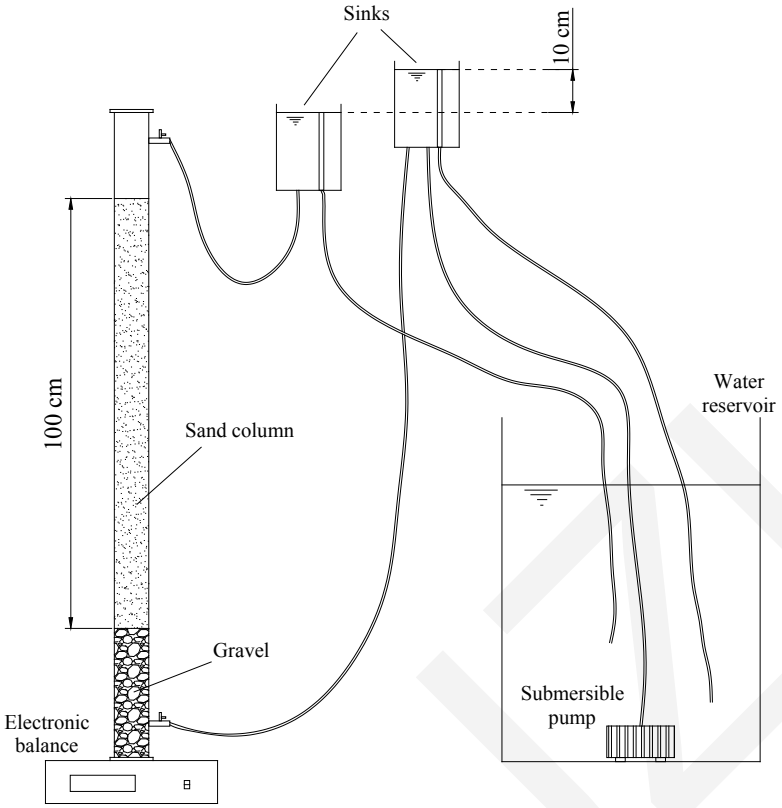

Saturated soil

Gas pockets

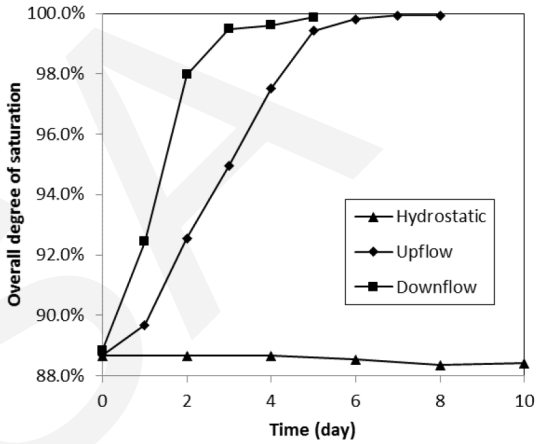



Microbially desaturated soil with 94% saturation degree

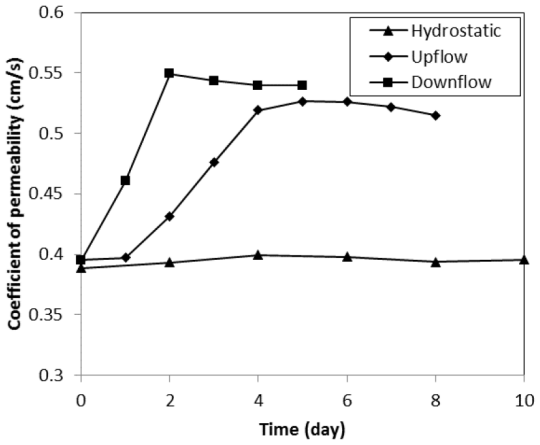
# Stability of gas bubbles in soils under hydrostatic and flow conditions




Set-up of gas stability test




Variation of saturation degree with time




Variation of permeability with time

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# Conclusions

1) The saturation degree of sands can be effectively reduced by the microbial method.

2) Microbially induced desaturation can improve the liquefaction resistance of soil by showing much lower pore pressure generation, much smaller volumetric strain, and much smaller settlement of the structure in desaturated soil.

3) CT images reveal that gas phase of the desaturated soil is in the form of small pockets of gas bubbles. The small pockets have a size a little larger than a sand grain.

4) Gas phase in microbially desaturated soil is stable in the hydrostatic condition, but becomes unstable in the steady flow conditions. So measures should be taken to prevent steady water flow if the desaturation method is used.

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