THE RELATIONSHIP BETWEEN VOID RATIO AND SHEAR WAVE VELOCITY OF GOLD TAILINGS

HSIN-PEI NICOL CHANG

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DISSERTATION SUMMARY

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HSIN-PEI NICOL CHANG

Supervisor: Professor G. Heymann

Department: Civil and Biosystems Engineering

University: University of Pretoria

Degree: Master of Engineering (Geotechnical Engineering)

South Africa, as one of the world's largest gold producing countries, also generates large amounts of tailings. These tailings are disposed in tailings dams, which pose great threat to the environment in the case of failure, in particular, liquefaction. In order to evaluate the potential of liquefaction, the void ratio of the tailings is required and is often impossible to obtain. Seismic methods allow an indirect method to estimate void ratio of in situ deposits of which tailings are examples of.

Currently, the use of seismic methods to estimate void ratio of tailings rely on shear wave velocity – void ratio relationships derived for sands. It is thus uncertain whether this relationship holds for gold tailings, which is classified as a sandy silt or silt.

The measurement of shear wave velocity of tailings is done in the laboratory using a triaxial apparatus modified to accommodate bender element. Shear wave velocities are measured using wide square pulses and continuous sinusoidal waves.

The results show that there is a near linear relationship between void ratio and shear wave velocity normalized against effective stress. The position of this relationship lies below the previously published results for sands. Shear wave velocity of gold tailings is more sensitive to changes in effective stress than changes in void ratio or over-consolidation ratio. Furthermore, using phase sensitive detection of continuous waves, we can conclude that shear wave velocity of gold tailings is also frequency dependent.

Key words: Shear wave velocity; void ratio; bender elements; gold tailings; seismic methods; liquefaction; silts.

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a	Real number.
b	Complex number.
B	Relative response of the Biot medium.
e	Void ratio.
f	Wave frequency.
F	Relative response of the forced harmonic oscillator.
FC_{th}	Threshold fines content.
G_{max}	Small strain shear stiffness.
G_S	Specific gravity of soil particles.
L	Distance between sender and receiver bender element.
L_E	Effective travel distance of shear wave.
M	Mass of sample.
M_{Solid}	Mass of solids in a sample.
n	Index number of the complex number set
N	Total number of data points taken.
q'	Effective deviatoric stress.
p'	Mean normal effective stress.
Pa	Atmospheric pressure.
S_B	Subsystem response of Biot medium.
S_F	Subsystem response of forced harmonic oscillator.
t	Travel time of shear wave from sender to receiver bender.
T	Period of the wave.

V	Volume of sample.
V_{Solid}	Volume of solids in the sample.
V_V	Volume of voids in the sample.
V_S	Shear wave velocity.
Vs(n)	Normalized shear wave velocity (against effective stress).
w	Moisture content.
ε	Axial strain.
ε_x ε_y ε_z	Axial strain in the x, y, and z direction.
θ	Phase angle.
γ	Unit weight of soil.
λ	Wave length.
ρ_w	Density of water.
σ'_v	Effective vertical stress.
τ	Time shift of two signals used in cross correlation.