DEM analysis on the stress wave responses of spherical particle assemblies in Triaxial Tests

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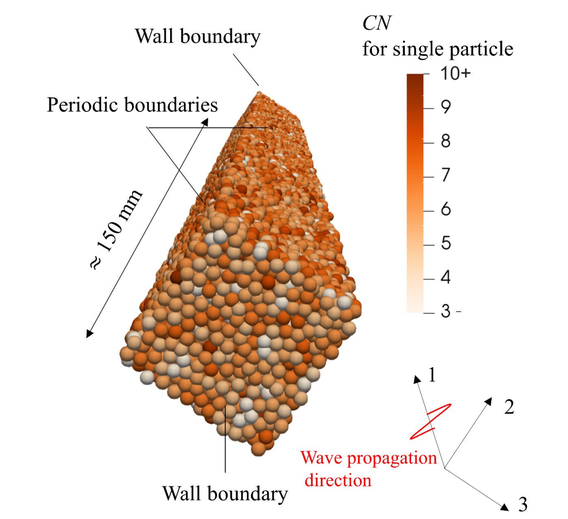
三軸試験における粒状体の弾性波応答のDEM解析

It is challenging to understand the stress wave responses of cohesionless particle assemblies including compression (P-) and shear (S-) wave velocities (V_p and V_s). Discrete element method (DEM) enables to simulate the wave propagation during triaxial compression using spherical particles. Four samples are isotropically confined at various initial packing densities and then sheared monotonically up to the critical state. Small-amplitude wave propagation simulation is performed during shearing along the axis of loading. V_p and V_s are found to be well correlated with the stress state, as well as the soil fabric.

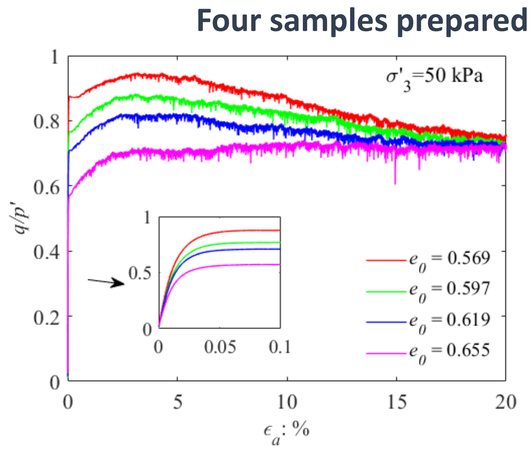
非粘性粒状体の弾性波応答、すなわちP波およびS波の速度（V_p および V_s）を理解することを目的とし、個別要素法（DEM）を用いて、球状粒子供試体の三軸圧縮時の波動伝播のシミュレーションを行った。4種の様々な初期充填密度の供試体を等方的に拘束し，極限状態まで単調せん断した。さらに、せん断時に微小振幅の波動を載荷軸方向に伝播させた。その結果，V_p と V_sは，応力状態や土の堆積構造と高い相関があることがわかった。

Representative random packing sample

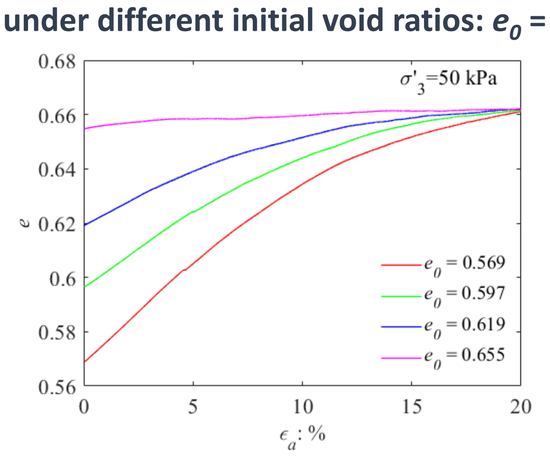


Typical mechanical responses

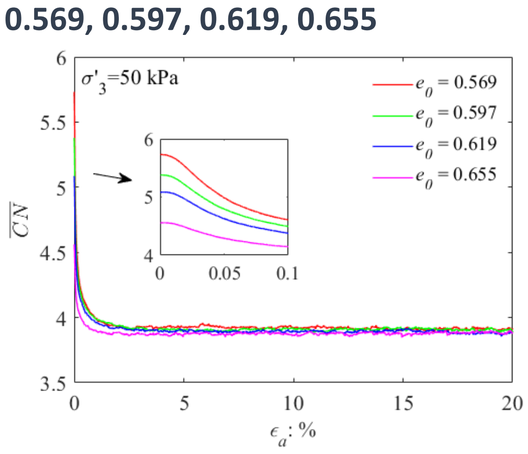
Four samples prepared under different initial void ratios: e_0 = 0.569, 0.597, 0.619, 0.655



Stress-strain response (q/p'-ε_a)



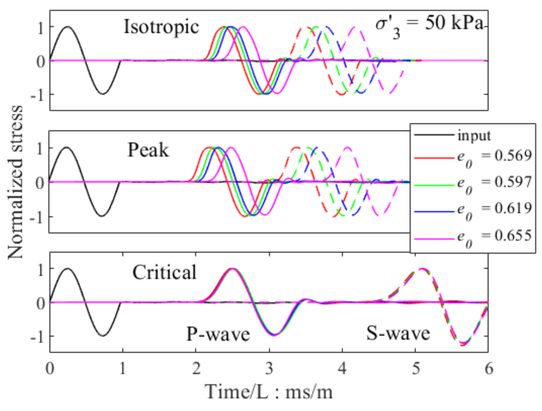
Void ratio (e)



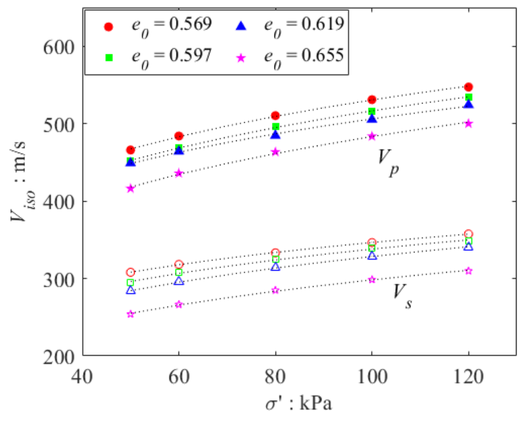
Mean coordination number ($\overline{CN}$)

Stress wave responses — Small amplitude of a sinusoidal pulse is activated to the wall boundaries to generate dynamic waves propagating through 1-axis

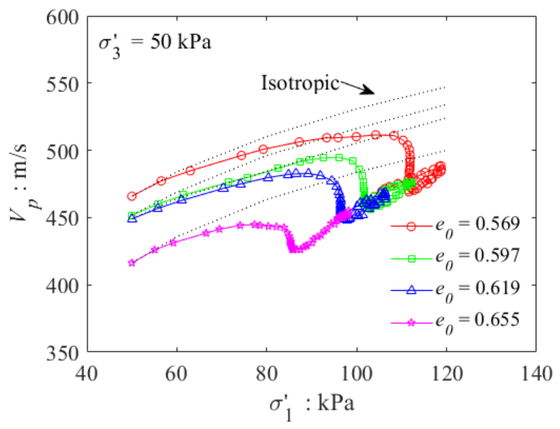
P- and S- wave signals

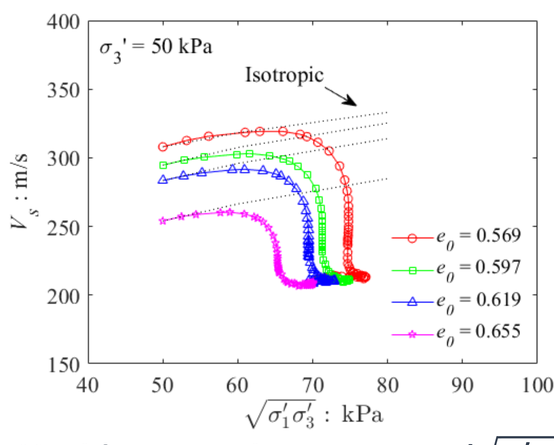


V_p and V_s in the isotropic state



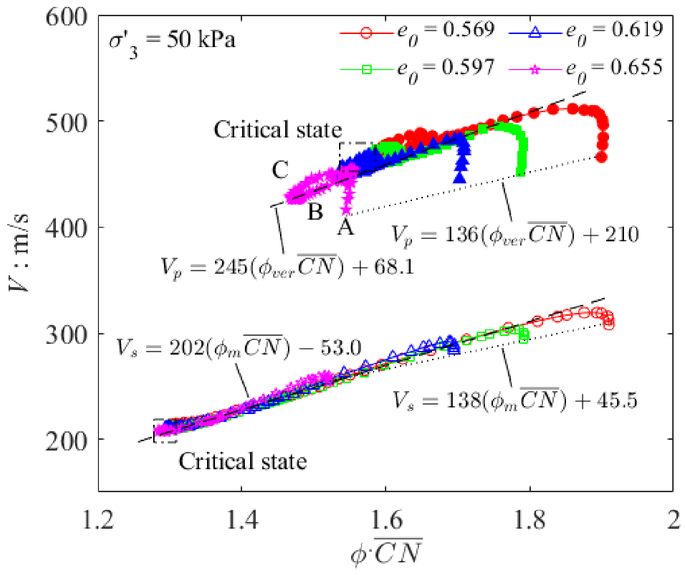
V_p and V_s during triaxial loading



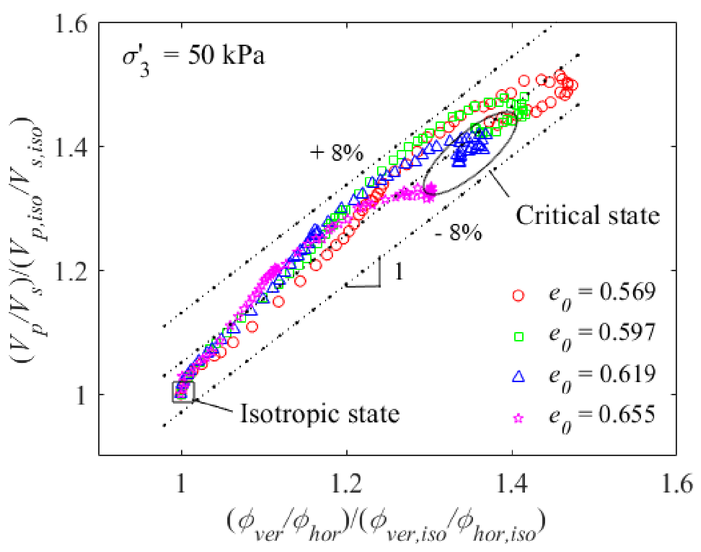


V_p and V_s with isotropic effective stress (σ') V_p with major principal stress (σ'_1) V_s with geometric mean stress ($\sqrt{\sigma'_1\sigma'_3}$)

Relationships between V_p , V_s and the soil fabric ($\Phi_{ij} = \frac{1}{N}\sum_{k=1}^{N} n_i^k n_j^k$)

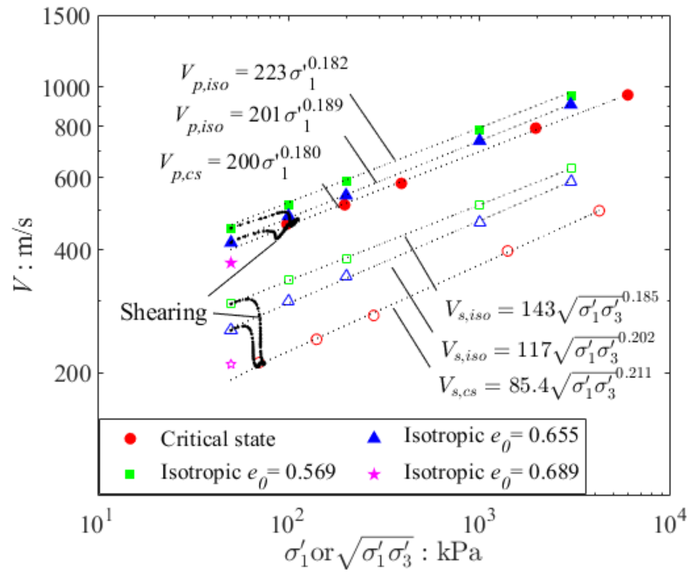


V_p and V_s with soil fabric (Φ) and $\overline{CN}$



Velocity ratio (V_p/V_s) with fabric ratio (Φ_{ver}/Φ_{hor})

V_p and V_s in the critical state



V_p with σ'_1 or V_s with $\sqrt{\sigma'_1\sigma'_3}$

For further information, contact below.
Prof. Reiko Kuwano, Dr. Masahide Otsubo
Bw-304, Institute of Industrial Science, the University of Tokyo
TEL：+81-3-5452-6843
E-mail: kuwano@iis.u-tokyo.ac.jp

Yang Li (2021)
桑野研究室
東京大学 生産技術研究所 Bw-304
電話: 03-5452-6843
E-mail: kuwano@iis.u-tokyo.ac.jp