Strain localization during drained torsional shear tests in crushable artificial pumice soil

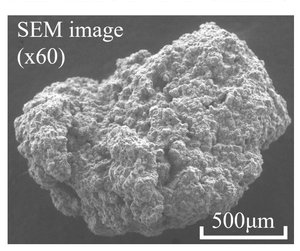
破砕性人工軽石の排水ねじりせん断時のひずみの局所化

Volcanic pumice soils are widely distributed in Japan, causing serious slope disasters. Pumice soils are characterized by its porous and highly crushable particles and its high contractancy during consolidation and shear. In this study, hollow cylindrical torsional shear tests were conducted using a crushable artificial pumice soil. Effect of particle breakage on shear behavior were discussed by comparing the results with those of silica sand. In addition, image analysis was performed on the specimens during shearing to examine the effects of particle breakage on strain localization and shear band formation.

日本には火山由来の高間隙構造を有する軽石が各地に分布し、斜面災害を引き起こしている。軽石の特徴として、多孔質で破砕性を有し、圧密やせん断に伴って高い収縮性を示すことが挙げられる。本研究では、破砕性を有する人工軽石を用いて平均有効主応力一定条件のもとで中空ねじりせん断試験を実施し、珪砂（非破砕性土）の試験と比較することで、粒子の破砕性がせん断挙動に及ぼす影響について考察した。さらに、せん断中の供試体に対して画像解析を行い、破砕がせん断時のひずみの局所化やせん断層の形成に及ぼす影響についても検討した。

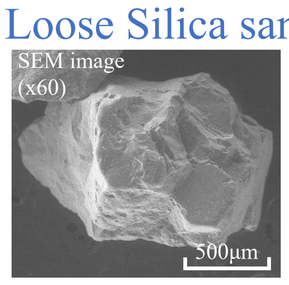
1. Material & Test procedures

Artificial Pumice soil (AP)



- Mixture of DL clay, cement and water, cured for 7 days
- Porous & Crushable
- High void ratio (e_{ini}=2.27-2.31)

Loose Silica sand (LS)



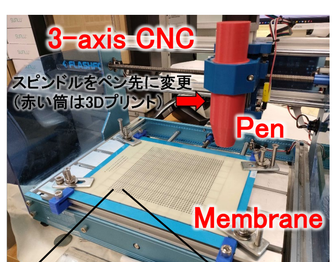
- Normal sand (for comparison)
- Same PSD as artificial pumice
- e_{ini}=0.85
- Dr=36% (loose)

Test Procedure:

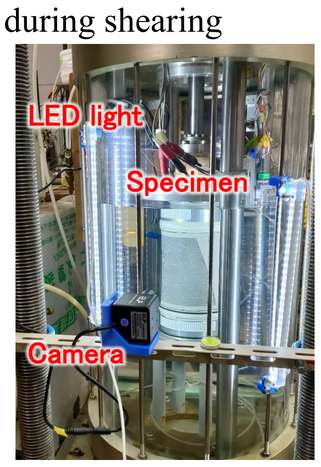
Prepare Specimen (reconstituted) → Saturation → Consolidation 20→100kPa → Drained Monotonic Torsional Shear until shear strain γ=30% → Sieving

2. Image Analysis

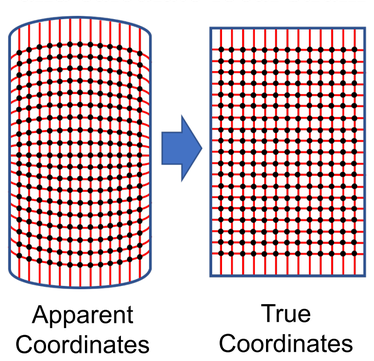
1. Plot grid points on an outer membrane



2. Shoot and track dots during shearing

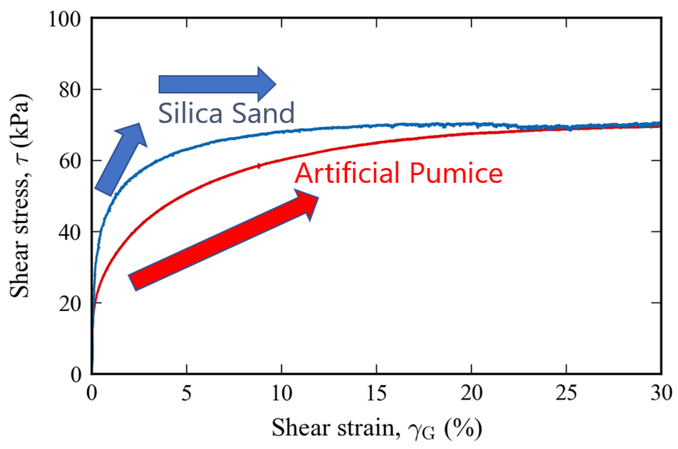


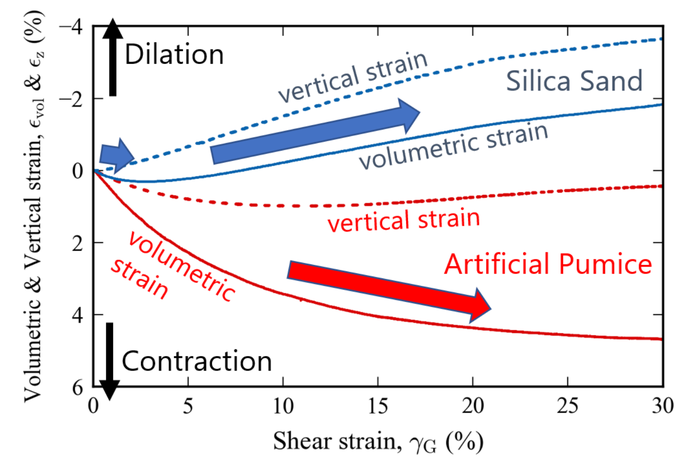
3. Convert coordinates and calculate local strain

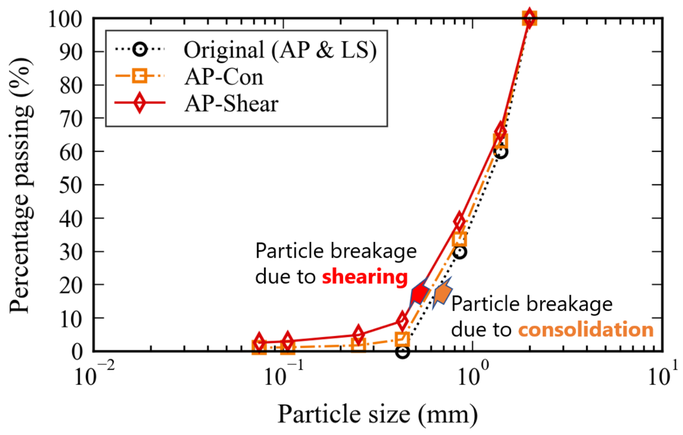


↑Following the method proposed by Zhao & Koseki (2020)

3. Results of tests

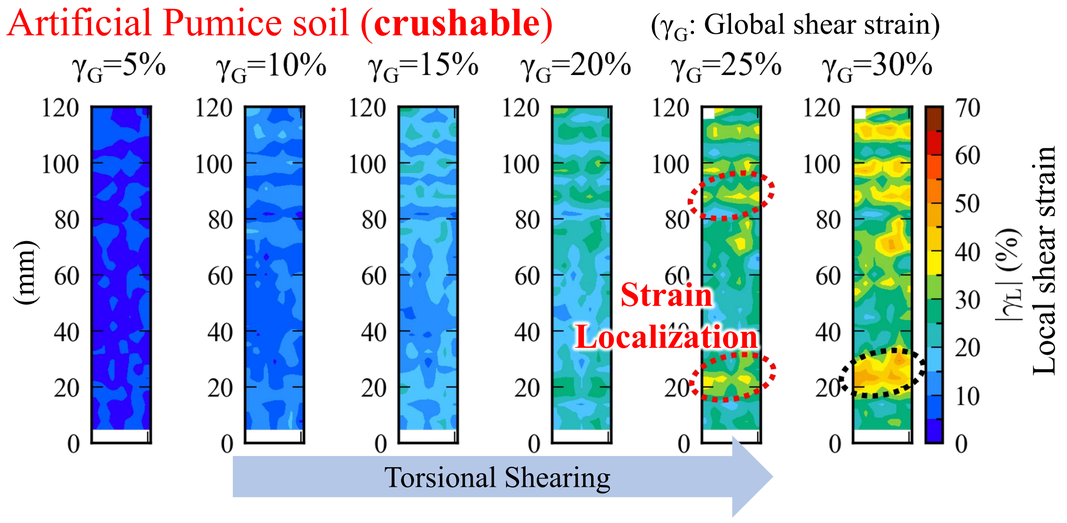


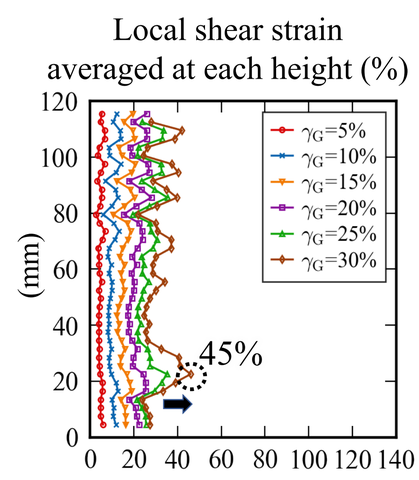




4. Results of image analysis

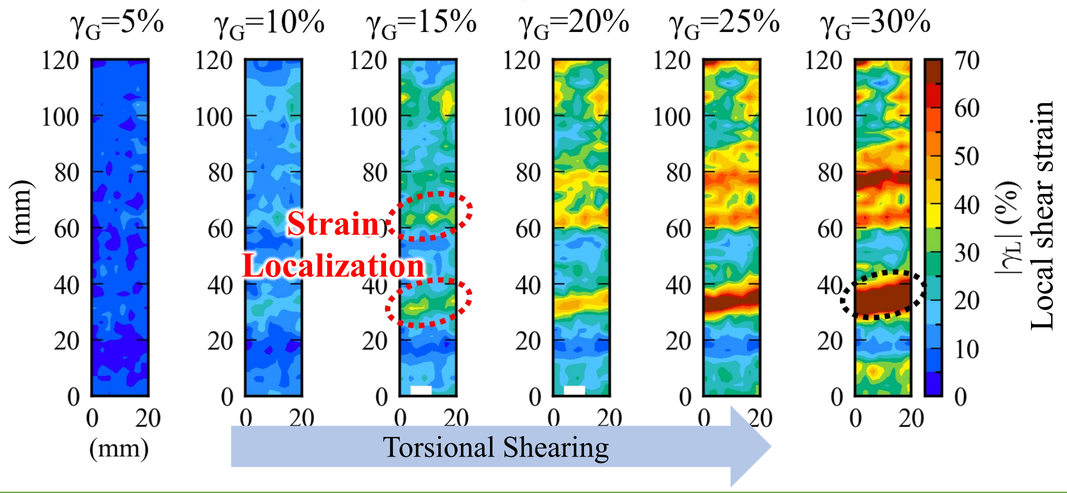
Artificial Pumice soil (**crushable**) (γG: Global shear strain)

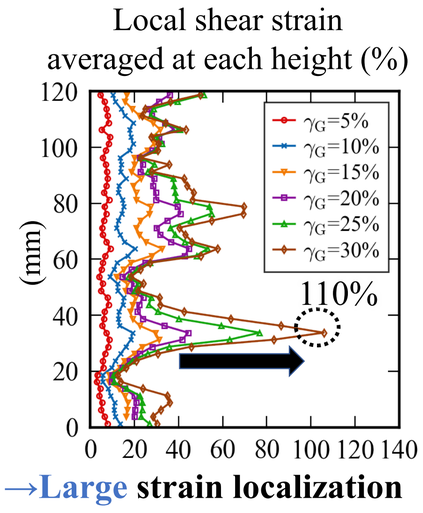




→**Small strain localization**

Loose Silica sand (**uncrushable**)





→**Large strain localization**

5. Conclusion

- ✓ The artificial pumice soil showed slower increase in shear stress and strong contractancy, compared to the loosely packed silica sand. Significant particle breakage was observed during consolidation and shearing.
- ✓ Image analysis revealed that strain localization occurred more slowly in the artificial pumice soil than in the loosely packed silica sand because of particle breakage.

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