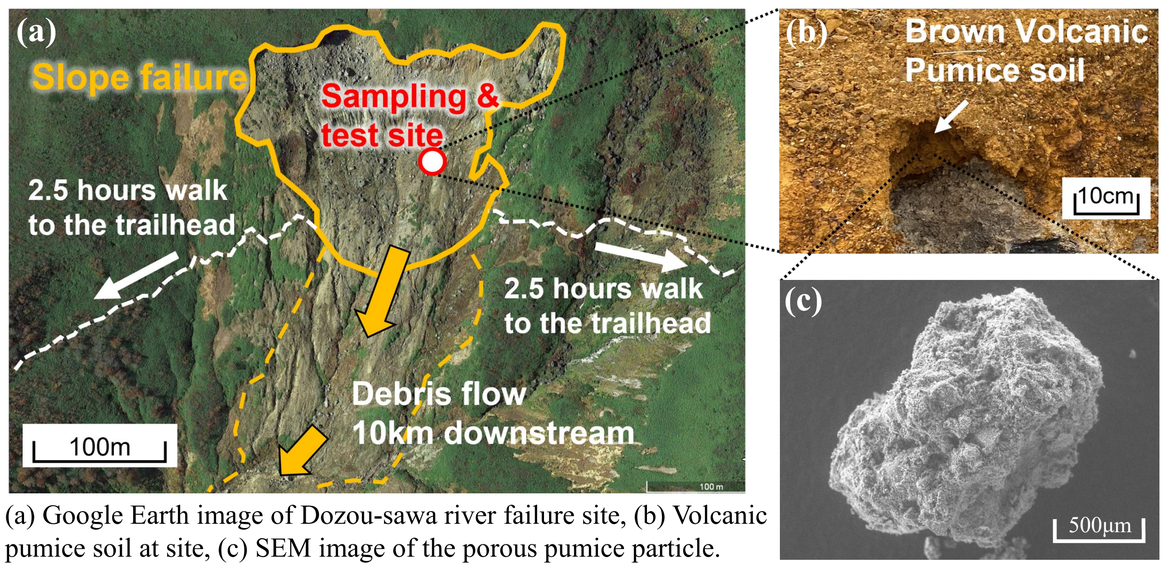
Development of in-situ direct shear test apparatus and its application to Dozou-sawa pumice soil

原位置一面せん断試験装置の開発とドゾウ沢軽石への適用

Volcanic pumice soils are widely distributed in Japan, causing slope disasters. They are susceptible to disturbance during soil sampling, transport, and trimming, so it is desirable to conduct in-situ tests while retaining the soil structure. In addition, when aiming at mountain slopes where vehicles cannot enter, the test apparatus must be transported by hand. In this study, a lightweight and small in-situ direct shear test apparatus was newly developed, and in-situ direct shear tests were conducted on a pumice soil in Dozou-sawa river. Laboratory direct shear tests were also conducted on the same soil to verify the validity of the apparatus.

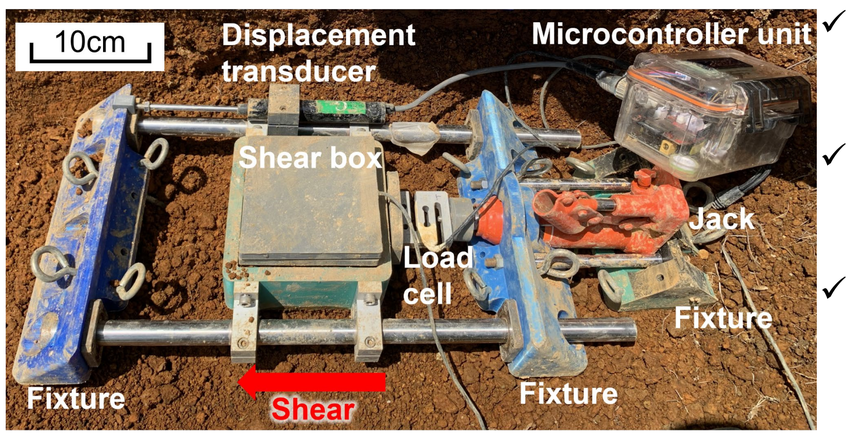
日本には火山性軽石地盤が広く分布し、斜面災害を引き起こしている。軽石地盤は多孔質粒子が緩い構造を保持しており、土の採取や運搬、トリミング時の乱れの影響を受けやすく、原位置で土粒子構造を保持したまま試験を行うことが望ましい。また、車両が入れない山間部の斜面をターゲットとする場合、人力で試験装置を運搬する必要がある。本研究では、軽量・小型の原位置一面せん断試験装置を開発し、岩手宮城内陸地震で大規模な崩壊と流動が発生したドゾウ沢の軽石地盤を対象に原位置一面せん断試験を行った。さらに、同じ試料で室内一面せん断試験を行って装置の有効性を検証した。

1. Dozou-sawa river & its pumice soil



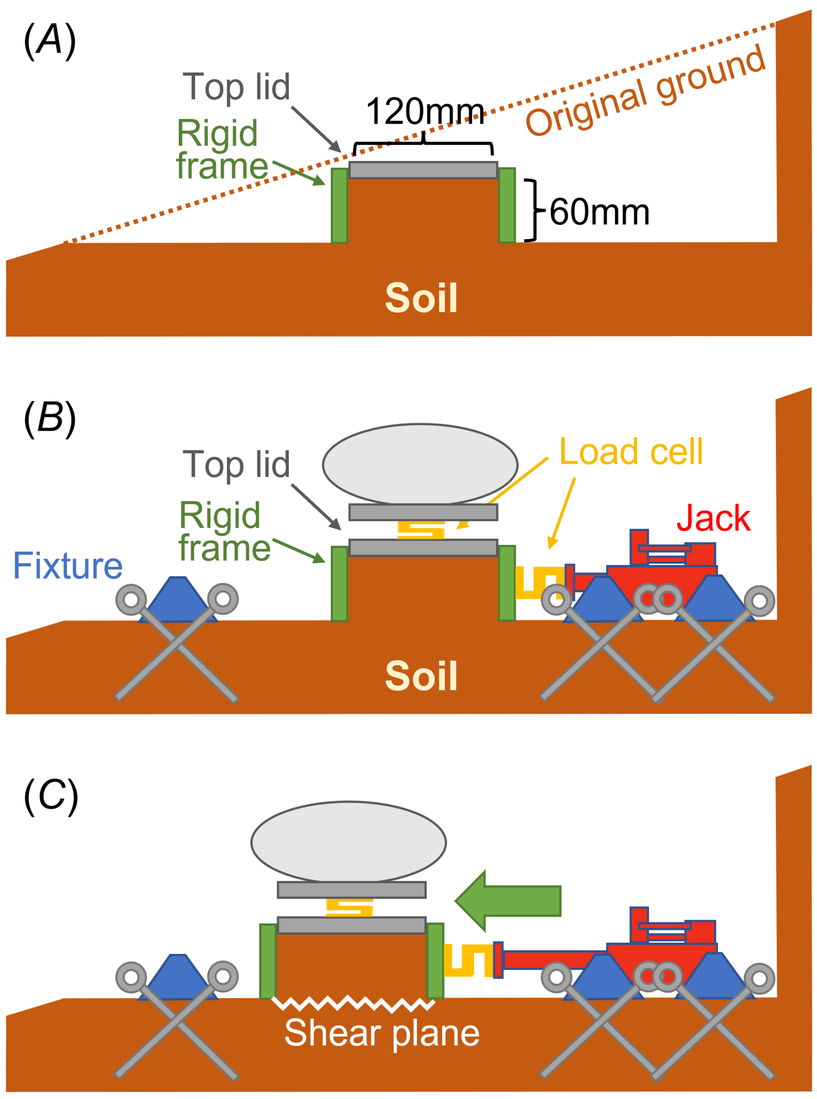
(a) Google Earth image of Dozou-sawa river failure site, (b) Volcanic pumice soil at site, (c) SEM image of the porous pumice particle.

2. In-situ direct shear test apparatus



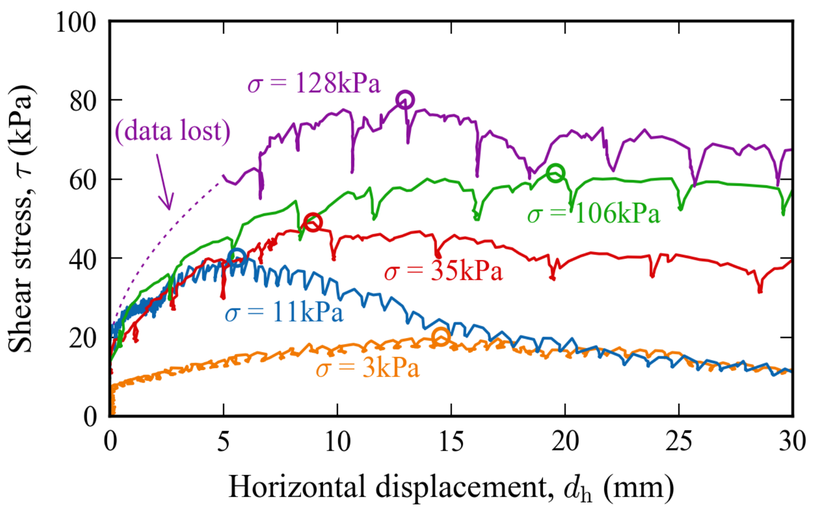
- ✓ About 5 kg in total. (the fixtures, frame & lid were 3D printed.)
- ✓ Maximum allowable vertical load (σ) was 140 kPa.
- ✓ The microcontroller enables data acquisition at a sampling rate of 10 Hz.

3. Procedure of in-situ direct shear tests



1. Excavate the slope horizontally, while preserving the specimen.
2. Place the frame and lid over the specimen.
3. Install fixtures, load cells & displacement transducers.
4. Apply a vertical load by stones or human weight.
5. Start recoding data.
6. Shear the specimen by jacking up.

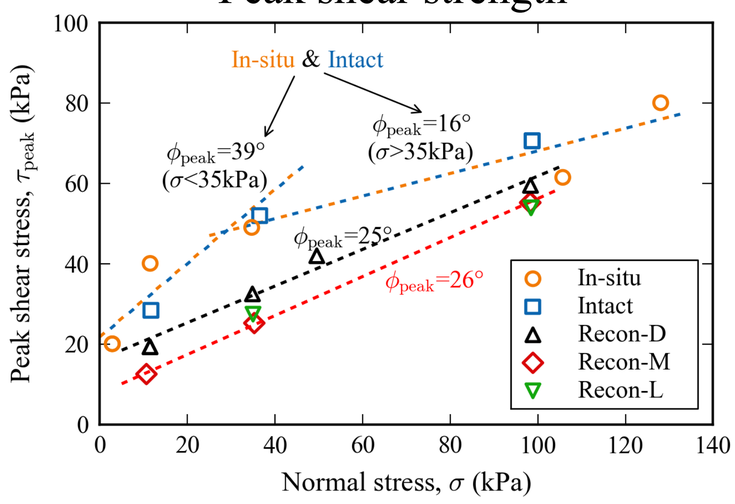
4. Results of in-situ direct shear tests



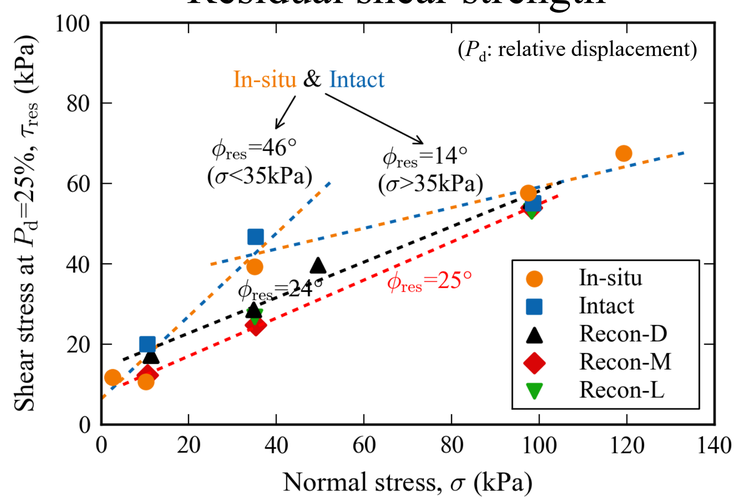
- ✓ Peak strength was observed at a horizontal displacement (d_h) of about 10 mm, followed by strain softening.
- ✓ The strain softening seemed to be due to the breakdown of the in-situ soil structure by shearing.

5. Comparison between laboratory direct shear tests

Peak shear strength



Residual shear strength



- ✓ In-situ direct shear tests and laboratory direct shear tests with intact specimens showed higher shear strength than the laboratory direct shear tests with reconstituted specimens, especially at lower confining pressures.
- ✓ In-situ tests and laboratory tests with intact specimens showed consistent shear strength, indicating that in-situ direct shear test apparatus could validly evaluate the shear strength of the pumice soil.

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