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GEOTECHNICAL CHARACTERISATION OF AN ANALOGUE LUNAR SILT

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1. ABSTRACT

Lunar silt samples available for research are limited in quantity and difficult to access. A more complete understanding of lunar soil behaviour is required for developing engineering solutions for potential lunar base stations. To supplement the lack of material available for experimental research, two terrestrial soils were characterised to determine their suitability as analogue lunar silts.

2. MATERIALS

LUNAR REGOLITH

- Loose and cohesive material
- Well graded, fine grained soil
- Uniform physical properties
- Variable chemical composition

VOLCANIC ASH

- 2010 Eyjafjallajökull eruptions
- Loose black natural material
- Variable physical properties
- Variable chemical composition

HPF5 SILT

- Artifically manufactured silt
- Pale pink cohesive material
- Uniform physical properties
- Uniform chemical composition

3. METHODOLOGY AND RESULTS

WATER

To simulate the lack of water on the moon, which is only found in solid form at the lunar poles, all experiments were performed dry.

GRAVITY

The *g*/6 gravitational acceleration on the moon of 1.62 m/s^2 was accounted for post-experimentally during analysis of results.

MOISTURE CONTENT ω

Obtained from oven-drying tests.

LUNAR 0% ASH 0.3% HPF5 0.04%

G_s SPECIFIC GRAVITY

Obtained from pyknometer tests.

LUNAR 3.10 ASH 2.78 HPF5 2.67

DENSITY ρ_{min} ρ_{max}

Measured in kg/m^3.

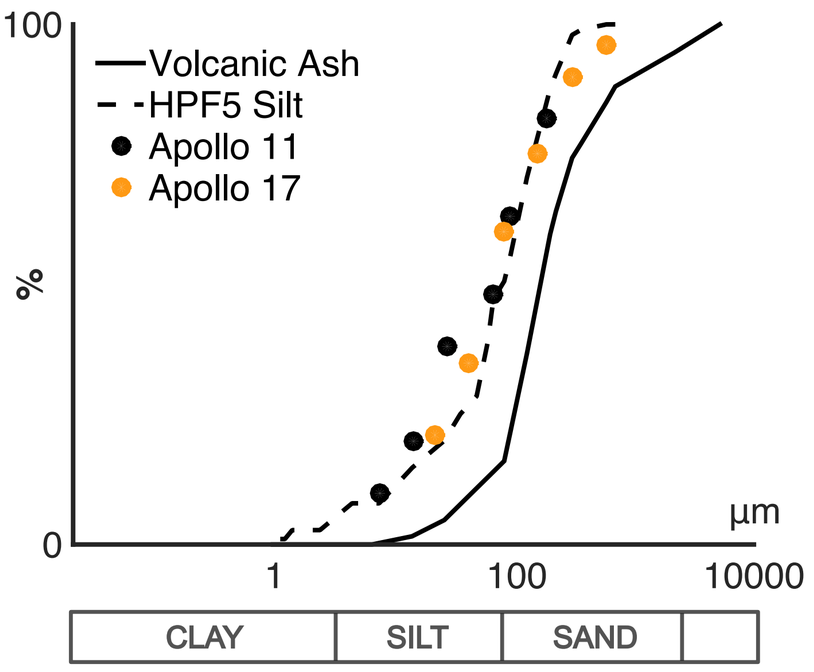
ASH 1350 - 1560 LUNAR 1300 - 1800

HPF5 1190 - 1740

PARTICLE SIZE DISTRIBUTION

Hydrometer testing and QICPIC image analysis were used to obtain PSD curves. The hydrometer data is presented here.

The HPF5 provides a narrower and closer fit to lunar regolith than the coarser and more variable volcanic ash.



OEDOMETER TESTS

Used for determining compressibility index C_c for a densely and a loosely compacted sample. Both terrestrial samples underpredict the magnitude of compression of lunar regolith.

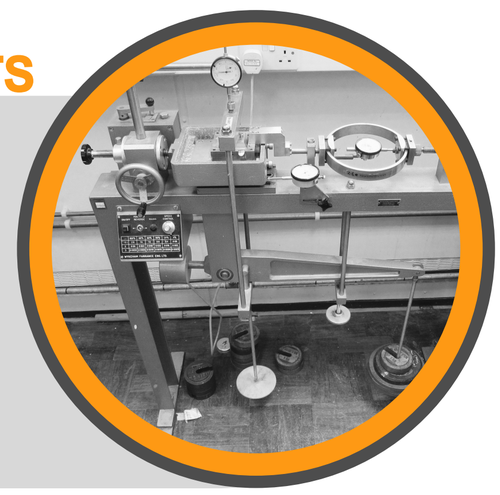
LUNAR C_c=0.05 HPF5 & ASH C_c= 0.03

SHEAR BOX TESTS

Used to determine the Mohr-Coulomb failure envelope and angle of internal resistance Φ' for a dense and a loose sample at three levels of normal stress.

ASH Φ' = 35° HPF5 Φ' = 38°

LUNAR Φ' = 42 - 49°



4. CONCLUSIONS

Both samples exhibit geotechnical characteristics similar to lunar regolith and would be suitable as a lunar analogue for geotechnical engineering purposes. The volcanic ash is preferable for properties such as particle density, minimum density, void ratio and porosity. HPF5 silt more accurately simulates lunar failure envelopes and is excellent in terms of particle size and shape. Both materials are deemed suitable analogues and should be used based on parameters of interest on a case-by-case basis.

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6. REFERENCES

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