Topic 3: Unveiling the "Root Effect": An Experimental Investigation of Vegetated Soil

Preliminary research question: To what extent do plant root traits systematically enhance the shear strength and consolidation behavior of reinforced soils?

Background & Motivation

Vegetation is frequently assumed to "hold soil together," but geotechnical engineers need quantifiable parameters (apparent cohesion c, friction angle ϕ, stiffness modulus E) to design safe structures. How much does root architecture actually stiffen soil against shear and volumetric deformation? This experimental thesis brings biological elements directly into the geotechnics lab to test physical specimens to failure.

Research Objectives & Methodology

1. **Specimen Preparation & Controlled Growth:** Prepare laboratory specimens testing variables such as root density, species architecture, and growth duration.
2. **Laboratory Testing Campaign:**
    - **Direct Shear Tests (DST):** Evaluate apparent shear strength increase across different shear box scales.
    - **Oedometer / Consolidation Tests:** Measure compressibility, pre-consolidation pressure, and void ratio changes induced by root volume.
3. **Matchmaking Matrix:** Correlate specific plant traits (root area ratio, tensile flexibility) with measured mechanical gains.

What You Will Deliver

- High-quality experimental datasets of stress-strain and shear behavior comparing bare soil to vegetated one.
- An engineering property lookup matrix linking root traits directly to mechanical shear parameter increases.
- High-resolution failure plane observations highlighting root pull-out vs. root tensile rupture.

Key Skills You Will Gain

- Practical geotechnical laboratory testing (DST, Oedometer, specimen compaction).
- Experimental campaign design, sensor calibration, and data acquisition.
- Bio-mediated soil mechanics and data processing.

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