Using Cubical Triaxial Testing for Determining the Bulk Mechanical Behavior of Sand for Rootzone Mixtures

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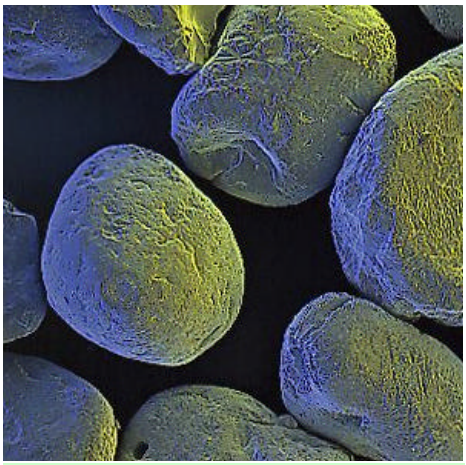
Objectives:

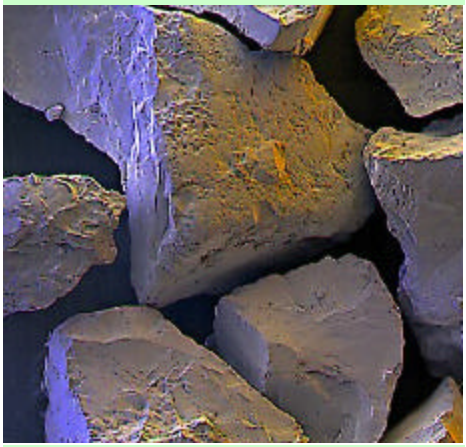
1. To determine the mechanical behavior of four rootzone sands having different shapes with and without peat.
2. To determine how moisture content (under 30 cm of tension) affects the mechanical behavior of the rootzones.

Start Date: 2000
Project Duration: 1 year
Total Funding: $16,358

The first two-year project began with a series of experiments to determine a method for assessing the shape of sand grains in a non-subjective manner. Methods tested in the past included the direct shear strength method, the rotatable drum method, dense soil angle of repose, and cone penetrometry. These methods were not capable of separating all classes of sand according to shape.



Round sands tend to resist compaction over time; however, round uniform sands may not provide a stable playing surface for putting greens.



Angular sands have a tendency to pack tighter and have better strength over time. However, this can result in higher bulk density measurements.

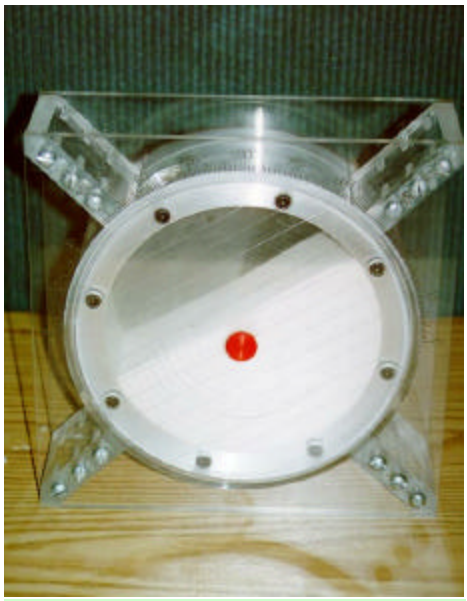
A cubical triaxial tester was used with the four sands to measure bulk mechanical behavior and how it relates to grain surface texture. The tester showed substantial differences between the sands with the sub-round sand having the best compaction resistance.

The angular sand was the most compressible with the round and sub-angular materials being intermediate. In regards to soil strength, at lower pressures the subround sand was strongest while the round sand was weakest. At higher pressure, it was the angular sand and sub-rounded sand with the highest strength. Overall, the sub-round and sub-angular sands had the best combination of compaction resistance and strength.

This precursor study using monosize and binary sand mixtures demonstrated the usefulness of PSU's cubical triaxial tester. A new one-year study was initiated on sixteen different rootzone mixtures (with varying quantities of moisture and peat contents) using medium pressure on the cubical triaxial tester. Parameters measured with the device included: shear modulus, failure profile, failure strength , compression profile, and bulk modulus.

Initial results indicate that dry samples have a higher initial bulk density compared to the wet samples. A linear increase in bulk modulus was observed with isotropic pressure. Wet sand samples also have greater volumetric strain compared to dry samples at any given isotropic pressure.

The shear modulus values of wet samples were lower than the dry samples. Finally, the dry samples exhibited a brittle-type behavior whereas the wet samples exhibited a ductile-type response.



The rotatable drum method determines the critical angle that an uncompacted sand can reach before it begins to avalanche.

Summary Points

- Sub-round sand has the best compaction resistance. The angular sand was the most compressible with the round and sub-angular materials being intermediate.
- In regards to soil strength, at lower pressures the subround sand was strongest while the round sand was weakest.
- At higher pressure, it was the angular sand and sub-rounded sand with the highest strength.
- Overall, the sub-round and sub-angular sands had the best combination of compaction resistance and strength.
- Dry samples had higher initial bulk density compared to the wet samples.
- Wet sand samples have greater volumetric strain compared to dry samples.
- Shear values of wet samples were lower than the dry samples.
- Dry samples exhibited brittle-type behavior whereas wet samples exhibited ductile-like response.