Measuring Saturated Hydraulic Conductivity of Coarse-textured Rootzone Mixes

She-Kong Chong
Southern Illinois University

Objectives:

1. To fine tune the procedures of measuring hydraulic conductivity, K_{sat}, of coarse-textured rootzone mixes.

Start Date: 2003
Project Duration: three years
Total Funding: $76,922

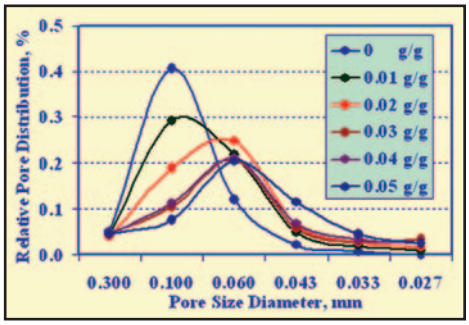
The 1993 USGA golf green recommendation requires that total porosity (P_t), air-filled porosity (P_a) and saturated hydraulic conductivity (K_{sat}) of the sand mix should meet specific values in order to be qualified as a USGA green. The procedures of measuring K_{sat} of a rootzone sand mix as suggested in the 1993 USGA recommendations were not clearly described. In order to have an accurate result, a simple and consistent method should be developed. In this study, the 1993 recommendation and ASTM F1815-97 method were re-examined and compared. Several procedures (refers as SIUC approach) have been developed and tested for the improvement of accuracy in K_{sat} measurement.

In this study, more than 750 sand mix columns were constructed and studied. Based on the results, the following conclusions can be made: (1) High peat moss content will increase high water retention capacity, but will slow water movement in the sand mix. In order to meet the USGA K_{sat} recommendation, it is suggested that the amount of peat moss added to sand be less than 0.02 g g^{-1}. In addition, sand mixed with peat moss was less vulnerable to compaction and resulted in a higher variation in bulk density and saturated hydraulic conductivity.

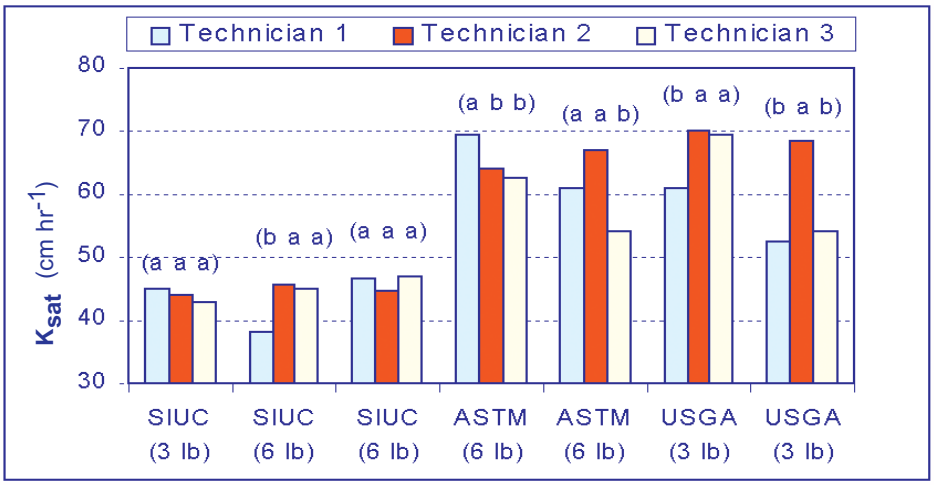
Soil-water-density tests indicated that optimal packing moisture content of sand and sand mix ranged from 0.05 to 0.07 g g^{-1}. Water content retained at -3 kPa (as suggested in ASTM F1815-97) was high and resulted in an unworkable condition for compaction. Since -40 cm water tension is equivalent to the lower boundary of macropore volume, air-filled porosity is suggested to be measured at -4kPa (-40 cm) tension of water.

Saturated hydraulic conductivity of sand was higher than sand mixed with peat moss, however the method of column construction can play a more significant role in the influence on the K_{sat}. Results revealed that for the same rooting material, the USGA method had the highest K_{sat} and variability followed by the ASTM method.

The modified Proctor's method (refers as SIUC 2-layer method) produced a more consistent and lower K_{sat} compared to previous methods. The SIUC 2-layer approach was tested by the laypersons to measure K_{sat} of the same rooting material. The result obtained by these laypersons was only about 10% different from that measured by the technicians. Therefore, for practical purpose, the SIUC 2-layer approach is suggested for packing sand mix columns for measuring K_{sat} of coarse-textured rooting material.



Comparison of pore size distribution of sand and sand mix amended with different amount of peat moss. The distribution curves indicate that when the amount of peat moss increases higher than 0.02 g g^{-1}, the number of macropore (pore size = 0.0375 mm) of sand mix drops drastically.



Results indicated that higher variation was found in both K_{sat} and porosity of soil columns constructed by the USGA and ASTM methods compared to the method developed at Southern Illinois University.

Summary Points

- Optimal packing sand mix moisture ranges from 0.05 to 0.07 g g^{-1}.
- Amount of peat moss to be added to sand mix should not be higher than 0.02 g g^{-1}.
- Air-filled porosity should be measured at tension of -4 kPa, since the -4 kPa is equivalent to the lower boundary of macropore volume based on the capillary equation.
- The SIUC permeameter can prevent air from reentering the saturated column and provide consistent K_{sat} values.
- The 2-layer approach is suggested for loading sample in packing the soil column.
- In the assessment of packing effort, 15 blows per layer of packing produced the highest bulk density as compared to 10 and 5 blows of packing.
- The SIUC 2-layer approach was tested by laypersons and was only about 10% different from that measured by technicians.