Wageningen University & Research

Reference Samples for Soil Physics

By: Harm Gooren, Gerben Bakker, Ad van Oostrum

WAGENINGEN
UNIVERSITY & RESEARCH

Why use Reference Samples (RS)?

- To be able to check the equipment in your own lab
- To compare the equipment between labs (inter laboratory control)

Requirements for Reference Samples

- The RS has at least 1 more or less reproducible pF value. It can be used in parts of the curve.

- Use different samples for different ranges:
  - -3 < h (cm) < -3000 (undisturbed samples)
  - -15000 < h (cm) < -3000 (disturbed samples)

Requirements for Reference Samples

range -3 < h (cm) < -3000 h (undisturbed samples)

1. Water release must be a clear measurable amount, preferably >= 0.05 (g/g) for each additional 0.5 pF change.
2. Water release in amount does not have to be comparable to those of the real samples.
3. Water release in time is comparable to those of the real samples.
4. RS needs to be robust, but does not necessarily have to be reproducible in a manufacturing sense

Requirements for Reference Samples

range -15000 < h (cm) < -3000 (disturbed samples)

a. Water release must be must be a clear measurable amount, preferably >= 0.05 (g/g) for each additional 0.5 pF change.

b. water release in amount does not have to be comparable to those of the real samples.

c. Water release in time is comparable to those of the real samples.

d. RS may be disturbed

e. RS must then be well mixed from a large bulk material, in order to be distributed among laboratories

f. Water release can be measured as a wetness decrease (ml/ms)

Requirements for Reference Samples

range -15000 < h (cm) < -3000 (disturbed samples)

- For this range a disturbed sample is useful, as macro pores hardly contribute. A well-mixed reference sample can be put on the pressure plate, and its wetness (mass liquid / mass dry solids ratio) can be monitored accordingly.

- This is a perfect check upon the well-functioning of the applied pressure and saturation of the ceramic plate. This workaround is already successfully used by the USDA NRCS Kellogg Soil Survey Lab in Lincoln USA.

Water Conductivity 1 of 2

- Saturated conductivity
  - Example is mentioned in Buchter et al., 2015: “Standard specimens to determine the hydraulic conductivity of saturated soils”
  - Uses a ‘one pore sample’ of which the Ksat can accurately be calculated and measured
- Unsaturated conductivity

Water Conductivity 2 of 2

- Unsaturated conductivity
  1. Water release must be a clear measurable amount, preferably >= 0.05 (g/g) for each additional 0.5 pF change.
  2. water release in amount does not have to be comparable to those of the real samples.
  3. Water release in time is comparable to those of the real samples.
  4. RS needs to be robust, but does not necessarily have to be reproducible in a manufacturing sense
  5. RS needs to have the availability to insert tensiometers.

Porosity

- Porosity
  - Effective porosity
  - Total porosity
  - Ideally For RS, the total porosity equals the effective porosity, but is not a necessity.

- Effective porosity constitutes the continuous pores. The total porosity additionally contains isolated pores. The effective porosity can be measured with pF measurements at saturation. The density of the solids and the dry bulk density can help to discover the difference between both parameters.

Immediately applicable

- The RS for Ksat (undisturbed) and Pressure Plate (disturbed samples) can be used as soon as they are ‘manufactured’.

- Who is going to take the lead? (WEPAL, others?).

Work in progress in Wageningen 1 of 4

- Possible principles:
  - Use of existing porous materials, e.g. bricks, ceramics, other.
  - Sintering texture mixtures to a robust RS with a predefined porosity
  - 3D-printing

Work in progress in Wageningen 2 of 4

- Use of existing materials:
- We put no effort in this yet, but is a possible cheap and fast first possibility. It is easy to saw a sample of different sizes and use it as an inter-laboratory RS. Materials should be checked upon
  - Water repellency
  - Effective porosity and total porosity
  - Applicability range

Work in progress in Wageningen 3 of 4

- Sintering texture mixtures:
- We did some literature research on the manufacturing of bricks and ceramics.
- A first attempt to sinter a clay type with additional charcoal to increase the porosity, did not result in a satisfactory RS.
- We now want to start simpler with sintering with a well-defined one size textured course sand, and when successful increase the complexity by adding other textures as well.
- Important are: Sintering temperature, Sintering time, Addition of $CaCO_3$, Water repellency, Other additions

Work in progress in Wageningen 4 of 4

- 3D printing:
- We did some literature research on 3D-printing with clay.
- The pores that can be printed are of a limited pore size: the smaller pores have to come from the inner pore size of the clay material.
- Together with the printed pores it should be possible to make a RS with a well spread pore size distribution.
- We found also a company that prints with clay.

Thank you for your attention!