Tempe-cell based static capillary pressure – saturation relationships for sands: Conventional averaging method vs. point measurement

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Abstract. For laboratory measurement of capillary pressure – saturation curves (retention curves) of soils, a Tempe cell or similar is often used. Typical height of such cell is 3-10 cm. Average water saturation is calculated from the amount of water removed from or injected into the cell and is assumed to represent the water saturation in the soil sample in the cell. Artifact of this averaging method is that displacement pressure may be under-estimated and the shape of the curve near displacement pressure becomes more rounded [Liu and Dane, 1995], which leads to an inaccurate representation of the retention curve and thus errors in numerical simulations. We have modified a Tempe cell by replacing the brass ring with a 10 cm-high acrylic pipe (O.D. = 8.9 cm, I.D. = 8.3 cm) onto which a tensiometer and a TDR probe are installed in the middle of its height. We used a 3-rod probe with rod diameter = 2.38 mm, separation = 1 cm, length = 9 cm. With these dimensions, the sampling volume should roughly be limited within a layer of 1 cm, which is thin enough for the water content to be a point-measured value. Using the modified Tempe cell, we have measured retention curves for different well-sorted sands. The results showed that the conventional averaging method tends to result in more rounded curve near displacement pressure than the point-measured curves. This is more distinct for coarse sands with lower displacement press values. These findings are consistent with the theoretical consideration by Liu and Dane, [1995].