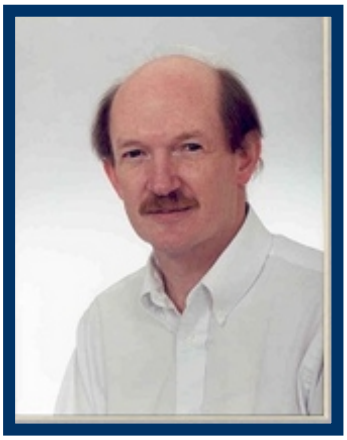
Superintendents' Korner



OSU Innovation: Passive Capillary Drainage of Turf Soil Profiles—Dr. Ed McCoy

Layering is a common occurrence in putting green soils. Frequently this layering consists of a sandy root zone overlying a finer textured native soil. Other instances, as in a USGA putting green, have a sandy root zone over gravel. When such a distinct difference in soil texture occurs across a defined boundary, there is also a sharp discontinuity of pore sizes throughout the soil profile. Consequently, these systems may not completely drain as excess water becomes perched above the layer interface. And, if the layer interface is too near the soil surface, as in a push-up green, or if the root zone sand is just a bit too fine, then either case can result in a myriad of "wet soil" problems for the turf.

Draining such a situation is problematic because even though the soil is saturated this perched water is held in the soil at a slight suction. Consequently, the perched water would not readily enter any channel of pipe one could install. What is needed is a drainage material that closely matches the soil pore sizes of a sandy root zone and one that can speedily convey this excess water to an outlet. Then, by using the natural contours of the site together with purpose installed elevation drops on the material, a suction can be created through the drainage element such that the perched water can be removed. This is the essence of passive capillary drainage (PCD).

In an actual installation, PCD employs a treated and appropriately woven fiberglass rope as the drainage material. Since fiberglass is wettable and the pores within the weave are sized similar to that of a root zone sand, our research has shown there is a continuum of water attracting pores from the root zone through the fiberglass drainage material. Also, our testing has determined that certain specifications of PCD fiberglass rope have a permeability of about 1000 inches per hour, typical of fine gravel. This large permeability relative to pore size results from the highly oriented nature of the pores between the fibers. In a lab-scale testing of the PCD concept, soil water suction in a sand-over-gravel profile containing PCD was greater than without (Figure 1), and the suction increase was about 70% of the actual elevation drop.

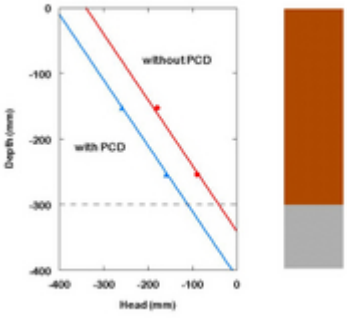


Figure 1. *Soil water suction (negative head) with depth in a sand over gravel soil profile. At 24-hours after complete soil saturation, the PCD treated profile showed greater suction due to removal of perched water.*

Subsequently, design equations show that when placed at 3 ft spacing, and for elements not exceeding about 90 ft, a PCD system would be capable of reducing soil water content by 5 to 10% within a 24 hour period. While modest in comparison to storm water drainage techniques, this was deemed adequate to remove excess water perching and introduce air into the soil in a sufficiently timely fashion for improved turf health.

Recent studies on putting green drainage have shown that the drainage problem due to layered soils is localized to the lower elevation regions of the green. Knobs or steeply sloped areas within a green do not contain persistently perched water because of down slope flow within the root zone. So it makes little sense to place drainage elements within these portions of a green. For this reason, an installation protocol was developed to custom install the PCD system according to contours of an individual green.

The result of our testing, design calculations, and protocol development is the PCD system for putting greens illustrated in Figure 2. An array of 1-inch-diameter PCD fiberglass elements are installed following the green slope and below cup-set depth. At the edge of the green, individual elements connect to a small diameter plastic pipe also containing PCD fiberglass rope. Short sections of the array elements extend into the pipe and are held in contact with the rope running through the pipe. This establishes a hydraulic connection between the drainage array and the collector. The collector extends to a nearby outlet, typically a buried drainpipe, where the PCD rope drops into the buried pipe. Using natural contours of the greens complex as well as vertical drops between system components, a "hanging-water-column" suction is established throughout the highly conductive pores of the PCD system.

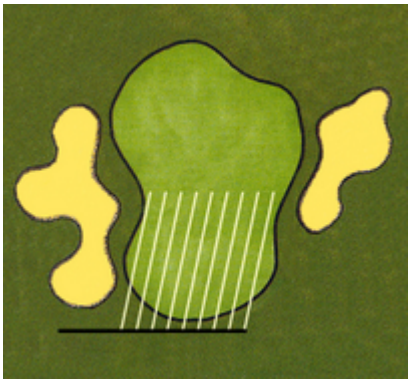


Figure 2. *Diagram illustrating the belowground components of a PCD system including the array of fiberglass elements and a plastic/fiberglass collector. The system is only located where soil wetness problems are evident.*

On the green surface, the PCD fiberglass elements are pulled into the soil using a thin-bladed vibratory plow at 9 to 10 inches depth. In deeper root zones such as a USGA or California green, this placement of the PCD elements is sufficient to establish direct contact between the fiberglass rope and the root zone sand. For shallower root zones as found in push-up greens, a sand channel needs to be established between the base of the root zone and the PCD elements. This is accomplished either by following the installation with DryJect sand injection or by installing a 3/8th inch curtain of sand coincident with PCD installation. Installation of the sand curtain, however, does not extend to the soil surface. This is to help ensure that PCD installation is minimally invasive and that the green is playable immediately after the job is finished. At present, installation for a typical green requires about 4-hours.

The system has been installed in both push-up and USGA style greens where soil wetness problems were evident. Superintendents of the respective courses have responded favorably to this technology.

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