The Influence of the Sand Layer On Available Water Retention In a Golf Green

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AN INCREASE IN pore diameter at some depth below the surface will disrupt the capillaries, which conduct the downward-moving drainage water, and thus will slow the drainage, even of wet materials, to nearly negligible rates. Thus, a layer of gravel under the top mixture used in the construction of athletic fields will result in the retention of water in the profile in excess of that which would be possible if free drainage were allowed to continue into a deep uniform profile.

The USGA greens specifications call for the inclusion of a two-inch layer of coarse sand between the top mixture and the gravel drain. This layer is to prevent the migration of soil particles into the drain field and to assist in the retention of water in the profile. The layer is difficult and expensive to install, and a reevaluation of its function was therefore undertaken. A previous report (Brown *et al.*, 1980) demonstrated that if appropriate size gravel is utilized, particle migration is minimal and the presence of a sand layer does not decrease the movement of particles. Over an eight-year period in the field, particle migration only decreased the available pore space in the gravel by 9.7 percent, and it is likely that most of this occurred during the construction. The present study was undertaken to evaluate the influence of the sand layer on water retention.

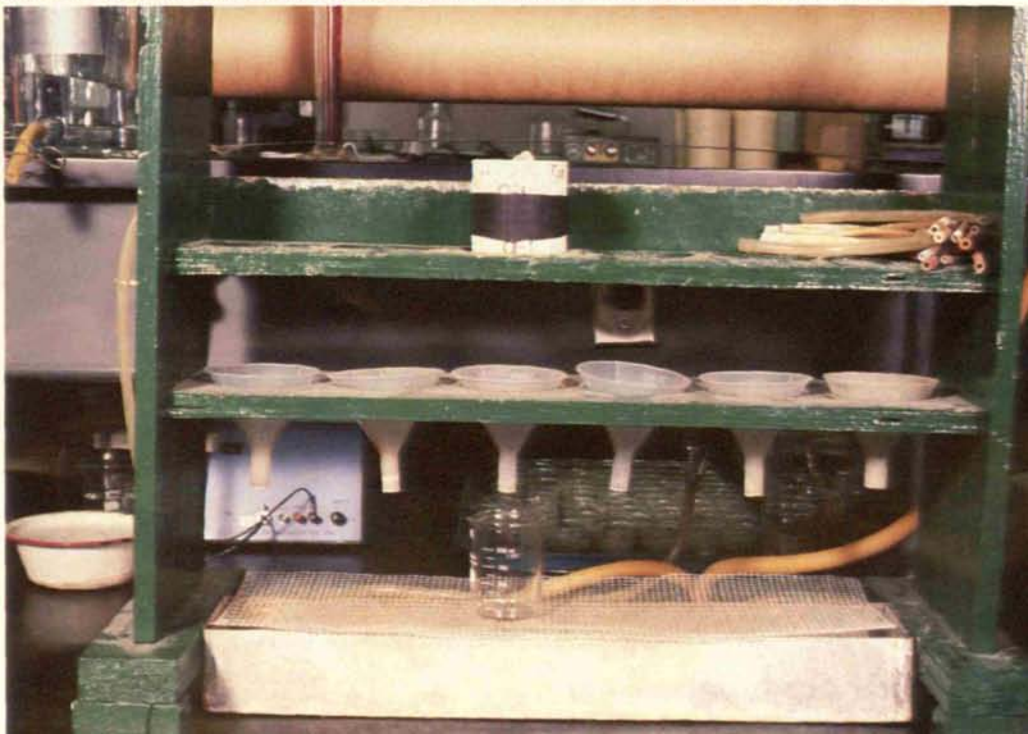
PROCEDURE

The amount of water retained in the top mixture above a layer of gravel can be calculated from water retention and unsaturated conductivity data of the gravel layer. This procedure, first suggested by Miller and Bunger (1963), utilizes the potential at which drainage in the gravel decreases to negligible amounts. For pea gravel, this occurs at a potential of 5 cm (Figure 1). The material immediately above the gravel layer is assumed to drain freely to this potential, and each layer above the first layer drains to a potential equal to -5 cm plus the elevation above the top of the gravel layer. Thus, retention data can be used to calculate the amount of water remaining in each layer when drainage becomes negligible. The water retention at the -15 bars wilting point can then be subtracted to give the plant available water. The bulk density is then used to convert the weight percentage of available water to the volumetric water content, which when multiplied by the depth of the layer gives the depth of water retained.

Water retention was measured on undisturbed cores 5.4 cm diameter x 2.9 cm thick, taken at the end of the experiment from containers of brick sand (BS), concrete sand (CS), 5 percent Houston Black clay (HB5) and 20 percent Houston Black clay (HB20). At potentials greater than -50 cm of water, a tension table was used while at lower potentials, the ceramic pressure plate extraction technique was used.

The slopes of the water retention curves shown in Figure 2 are sufficiently similar to indicate that the pore size distribution between even the finest mixture and the coarse sand do not differ greatly. Furthermore, the differ-

Constant head infiltration rack used to measure infiltration rate of compacted cores.



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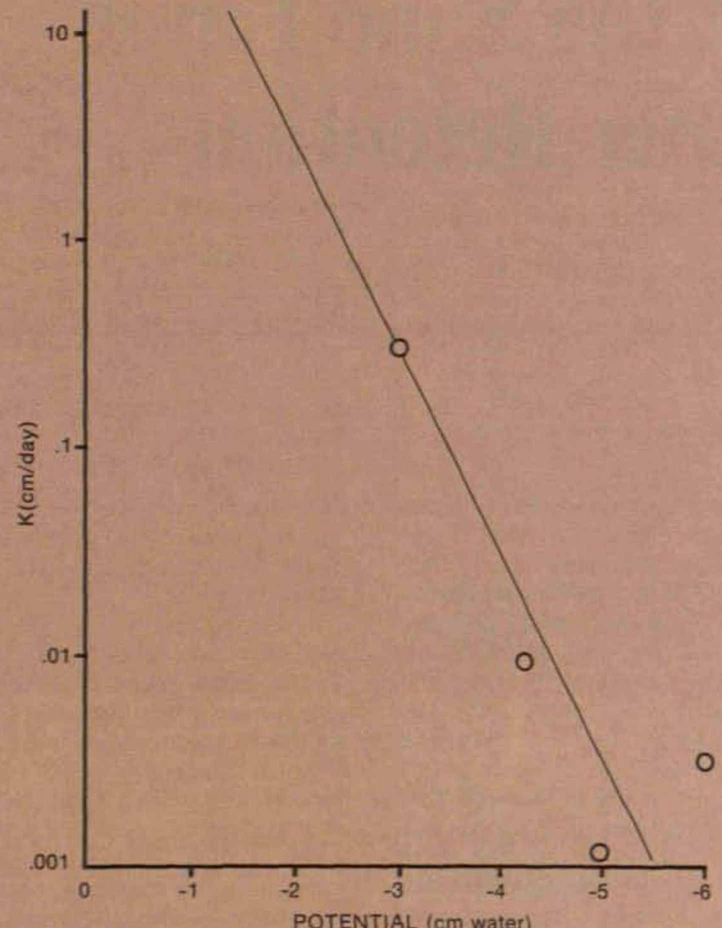


Figure 1. The unsaturated conductivity of pea gravel.

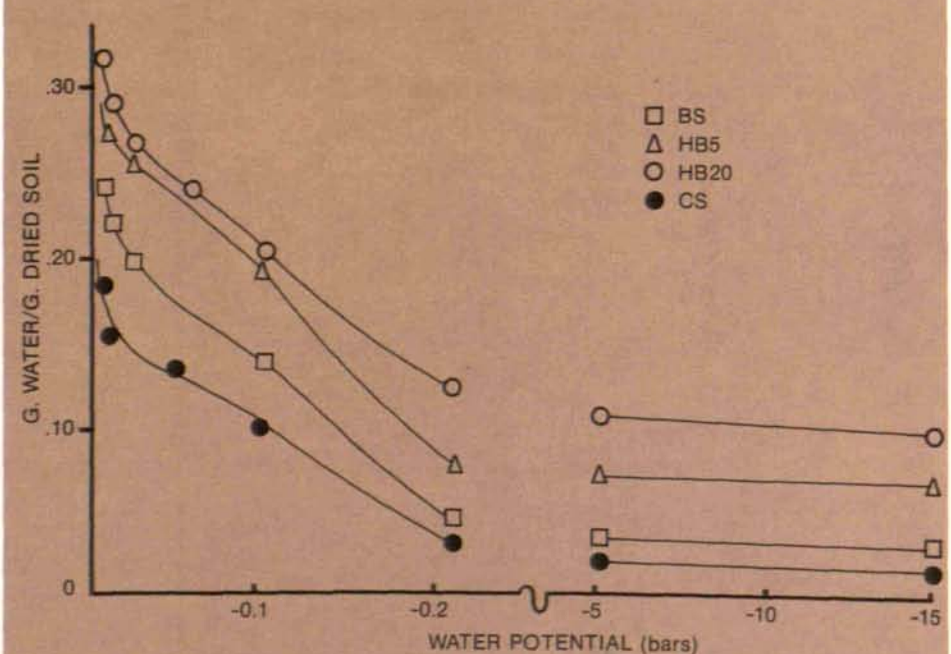


Figure 2. Water retention as a function of water potential.

ences in pore size distribution between either of the mixtures or of the sands and the gravel are very large and are the predominant factor controlling the water retention. Therefore, the calculation can be done utilizing on the gravel interface as a water flow control, whether or not there is a sand layer above.

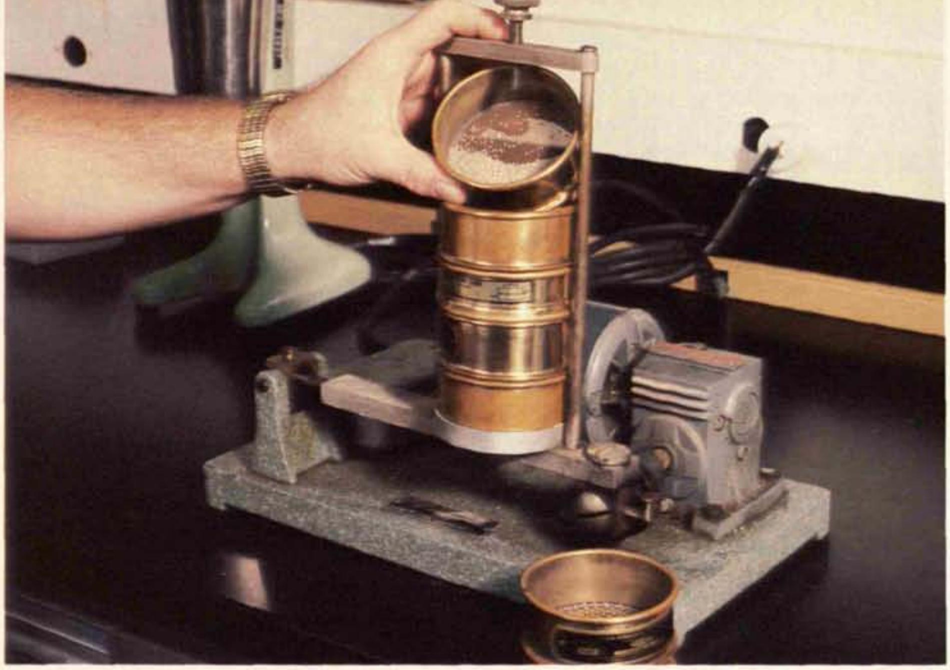
This was done for two different materials (BS and CS) and two mixtures (HB5 and HB20) for which water retention and bulk density data were available. The profile densities are shown in Figure 3. Of the four materials, the coarse sand represents a material which could be used for a sand layer. The other three materials could be considered as top mixes, but the brick sand has too high an infiltration and too low a water retention to meet the USGA standards for a top mixture, while the HB20 has too low an infiltration to be suitable. Thus, only the HB5 mix meets the USGA specifications. The calculations were done, however, on all three materials to provide a range of data, with and without a sand layer. Calculations were performed assuming a 30-cm thick layer of compacted topmix above a pea gravel, without a sand layer, and a 25-cm thick top mixture underlain by a 5-cm thick sand layer on top of the gravel layer. The results given in Table I indicate only minimum differences between the retention with and without sand layers, and in all cases the water retention with the sand layer is slightly less.

Thus, the data from the report of Brown *et al.*, 1980, and this report suggest that the sand layer can be omitted without damaging the gravel under drainage and without reducing the amount of water available to the turf.

LITERATURE CITED

Brown, K. W., J. C. Thomas and A. Almodares. 1980. To investigate the necessity of a sand layer between the top mixture and gravel layer in golf green construction. Final Report to the USGA Green Section. See previous article, this issue.

Miller, D. E., and W. C. Bunger. 1963. Moisture retention by soil with coarse layers in the profile. SSSAP 27:586-589.



Sieves and shaker used to analyze sand fraction of putting green topmix.

TABLE 1
Calculated Amounts of Available Water in 30 cm Profiles Of Three Top Mixtures with and without Sand Layers

Mixture	Sand Layer	cm of Available Water in a 30 cm Profile
BS	with	7.30
	without	7.52
HB5	with	6.62
	without	6.69
HB20	with	7.23
	without	7.46

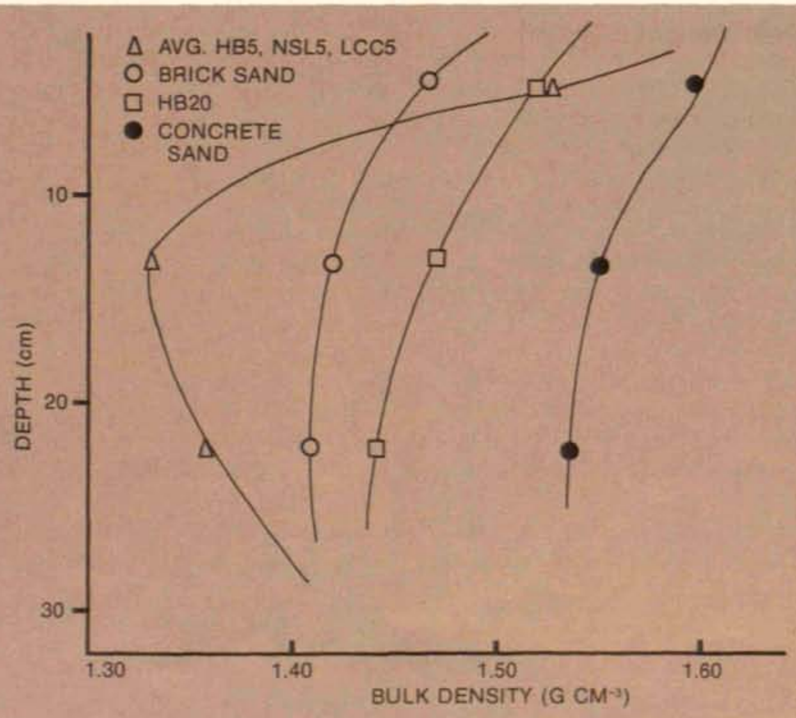


Figure 3. Soil bulk density as a function of depth.

Green Section Educational Conference

The annual USGA Green Section Educational Conference will be held at the Anaheim Convention Center, Anaheim, California, on Thursday, January 29, 1981. Because of a conflict in conference dates, the Golf Course Superintendents Association of America has graciously invited the USGA to use the entire day Thursday to present the Green Section's Educational Program. The USGA salutes this fine gesture of cooperation. We look forward to being at Anaheim and hope that we can significantly contribute to the success of the GCSAA's 52nd International Turfgrass Conference and Show.

Golf Course Superintendents Association of America

James E. McLoughlin recently began his new duties as Executive Director of the Golf Course Superintendents Association of America, in Lawrence, Kansas. Since 1966, McLoughlin had been Executive Director of the Metropolitan Golf Association, composed of clubs in the area around New York City, in New York, New Jersey, and Connecticut. He is also a member of the USGA's Handicap Procedures Committee.

The GCSAA was founded in 1926. It is composed of 4,700 members in the United States, Canada, Mexico, and 17 other countries.