Golf Green Construction Using Perlite As An Amendment

In the lab and on the course, a pair of studies reflect encouraging results that merit attention.

Wayne Crawley and David Zabcik
K. W. Brown and Associates, Inc.
College Station, Texas

Golf green surfaces are among the most highly managed parcels of ground in common use today. An ideal golf green mixture should have physical properties that allow continuous use with minimum maintenance. Thus, desirable characteristics include infiltration rates high enough to absorb heavy rainfall, adequate water and nutrient holding capacity, resistance to compaction, and adequate aeration. Also, it is important that these characteristics remain relatively constant over long periods of time.

Since sand is the ideal medium to resist compaction while providing excellent internal drainage, today's golf greens are commonly constructed with 75 to 90 percent sand by volume. When sand is blended with other materials - conventionally, soil and organic matter - in proper proportions, it forms an exceptional plan growth medium that retains adequate amounts of nutrients and water. In other words, amendments can counteract the tendency of sand to be nutrient-deficient and droughty.

One potential amendment for golf green mixes is perlite, a volcanic glass material which is mined and reheated to create uniform granules with many void spaces. Perlite is a commonly used horticultural amendment whose benefits include uniform particle size and an inherent sharpness (i.e., more surface area and resistance to degradation).

The following is a presentation of both a lab study using perlite in mixtures with different sand sizes and a case study of golf greens constructed with perlite as an amendment.

Lab Study

Since the texture of the sand is very important in the overall analysis of sand quality, mixtures containing three sand sizes (fine, medium and coarse) with varying clay content (1.5, 3.0 and 4.5 percent) were each mixed with 0 to 40 percent perlite to assess the physical characteristics of the greens mixtures. It is important to remember that sand particle size distribution ranges from a diameter of 0.05 mm to 2.00 mm a 40-fold increase. This vast range in sand size creates a big difference in the inherent characteristics of very fine, medium and very coarse sands.

Table 1.	**USGA Specifications for Physical Measurements of Greens Mixtures***
Bulk Density	1.20 - 1.60 g/cm^3
Porosity	
Total	40 - 55%
Noncapillary	≥ 15%
Water Retention	12-25%, by weight
Infiltration rate	2 - 10 inches/hour
Silt Content	≤ 5%
Clay Content	≤ 3%
* *USGA, 1973.*	

Table 1 lists the USGA specifications for greens mixtures, and Figure 1 compares these specifications to the physical measurements obtained from the treatments evaluated in the study. An examination of

Figure 1 shows that the golf green mixtures prepared using medium sands and perlite best fit the USGA specifications.

Regardless of the kinds of amendments and the relative proportions of perlite that are tried, a poor quality of sand is difficult to overcome. In particular, while the perlite amended mixtures with coarse and fine sands meet some of the USGA specifications, they do not meet them all.

Infiltration rate is the biggest problem for these two sands, and perlite additions could overcome neither the low infiltration rate of fine sand nor the extremely high infiltration rate of coarse sand. Although the addition of perlite did improve these mixtures, it did not negate the influence of sand particle size.

The problems with both fine and coarse sands are inherent and are the basic reason medium sands are recommended for green construction. The discussion that follows, therefore, emphasizes the results and implications of adding various percentages of perlite to golf green mixtures composed of medium sands.

Soil compaction is probably the most serious problem on intensively used turf areas such as golf greens. The addition of perlite to the greens mixtures generally decreased bulk density for the treatments evaluated. Although little effect on bulk density was noted for the medium sand treatments with 10 percent perlite, a 20 percent perlite addition decreased the bulk density from 1.62 g/cm^3 to 1.42 g/cm^3, a level which falls in the middle of the range that the USGA recommends to reduce problems associated with compaction.

Both the water retention and infiltration rates for greens mixtures are important to the overall management of golf greens: the ideal soil mixture should retain enough water to meet turf needs but at the same time be sufficiently aerated to allow excess water to drain quickly. With the total porosity around 35-40 percent for all three medium sands, regardless of clay content, the addition of 20 percent perlite by volume yielded the greatest total porosity among the medium sand samples; the greatest noncapillary porosity among the medium sands also occurred in the 20 percent perlite mixture.

It should be noted again that while perlite amendments improved the infiltration rates for both the fine and the coarse sands, in neither case was the improvement sufficient for the mixtures to meet the USGA specifications. In fact, the high silt content in the fine sands caused the infiltration rate to remain very low, even with the addition of 40 percent perlite.

Used with medium sands, however, perlite amendments decreased the infiltration rate to within the recommended range of two to 10 inches per hour regardless of clay content: the medium sands with 20 percent perlite also had acceptable water retention values. These observations indicate that the soil will retain enough water to promote a healthy turf while controlling the potential for problems with waterlogged soil.

By contrast, medium sands without perlite were at or below the 12 percent USGA recommendation for water retention. Thus, perlite raised this value to between 12 and 16.5 percent - depending on clay content - and, in general, water retention increased in proportion to increased clay content in medium sand treatments.

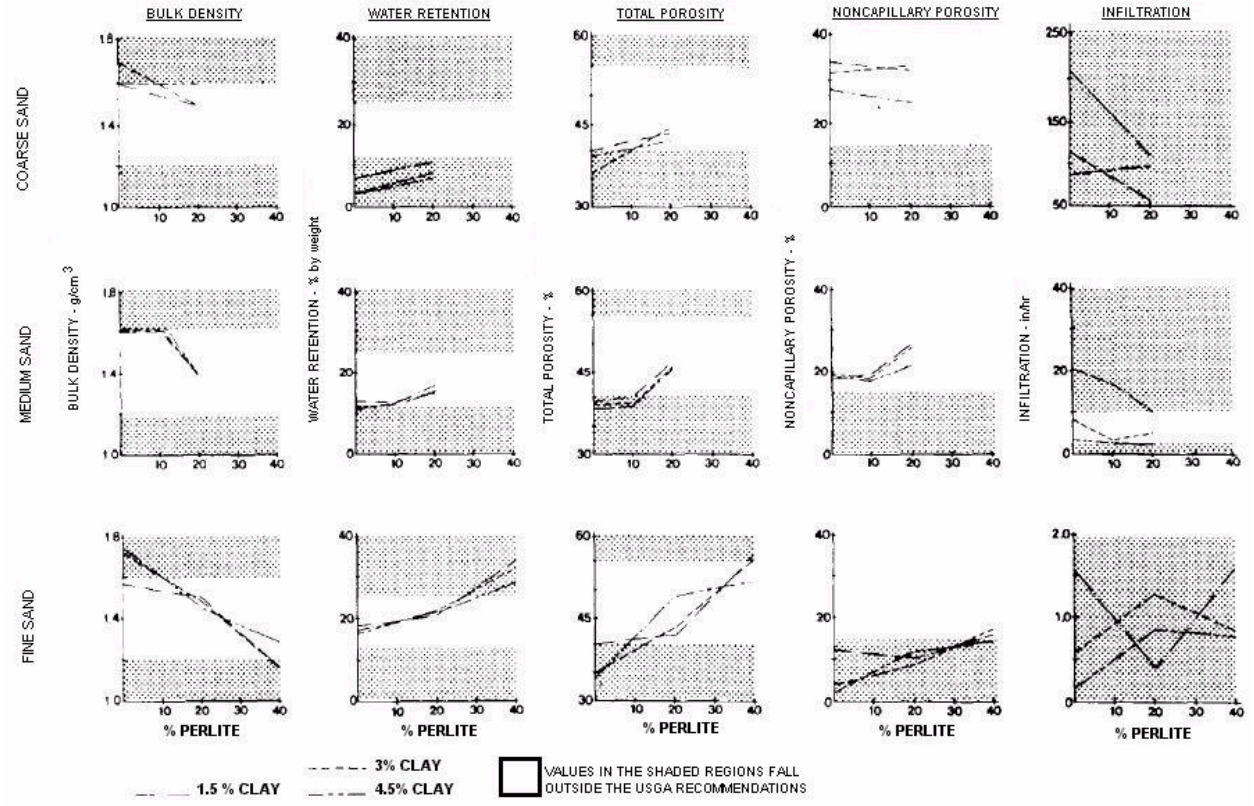
Because of the variations in particle size distribution and shape, even among sands classed as medium, any specific sand proposed for golf green mixtures must be tested with amendments before a mixture can be recommended reliably. Although the addition of perlite on a 20 percent by volume basis provided some benefit to all treatments evaluated, these benefits proved adequate only when the mixture was prepared using the medium sand selected for the study. Of the three sands tested, only the medium sand with 1.5 percent and 3.0 percent clay and the coarse sand with 1.5 percent clay met the USGA recommendations for silt and clay contents.
The medium sands with clay contents ranging from 1.5 to 4.5 percent and 20 percent perlite by volume met all of the recommended USGA physical measurements for greens mixtures. Unlike those prepared with medium sands, none of the treatments prepared with fine or coarse sands could meet all of these standards.

Results demonstrate that perlite admendments benefit the physical characteristics of soils that are important to green performance.

The results of this laboratory study demonstrate that perlite amendments benefit the physical characteristics of soils that are important to green performance. Another advantage of perlite is that - unlike organic matter amendments which gradually decompose - perlite is inert in the soil mixture, and therefore does not change significantly over time. Finally, because it is a manufactured product, perlite is of consistent quality and does not vary as organic amendments do.

Table 2.	**Physical Measurements of the Sand and Perlite Greens at Several Golf Courses in Los Angeles***									
			Field Data			Laboratory Data				
									Porosity	
Golf Course	Green number	Green Age (years)	Bulk Density (gm/cm3)	Water Retention (% by weight)	Infiltration (in/hr)	Bulk Density (Gm/cm3)	Water Retention (% by weight)	Infiltration (in/hr)	Total (% by volume)	Capillary
Griffith	2 15	<1 <1	1.29 1.17	18.5 17.6	-- --	1.13 1.18	17.1 16.8	91.6 98.5	57.4 55.5	19.4 19.8
Encino	2 16	2 2	1.45 1.56	17.3 13.8	15.5 9.5	1.42 1.50	18.5 14.4	10.5 10.9	49.4 43.4	26.3 21.6
Hensen Dam	10 13	7 7	1.48 1.57	14.2 13.6	25.2 17.4	1.43 1.29	17.6 26.2	11.4 8.4	46.0 57.3	25.2 33.8
Woodley	2	>10	1.55	15.9	--	1.53	11.6	12.3	42.3	17.8
* Compare these data with USGA specifications given in Table 1.										

Figure 1.	Physical measurements for golf green mixtures using three sands with various percentages (by volume) of perlite added.



Case Study

Given the positive results of laboratory testing, a question that remains is, "How does a perlite-amended green perform in the field. especially over the long term?" The answer to this question should be evident from the following case study of perlite-amended greens that have been in use for several years.

Sand and perlite greens will continue to maintain a good physical condition with time and heavy traffic.

In 1974, the Los Angeles Department of Recreation and Parks (LADRP) began using perlite as an amendment in the construction of public golf courses. To date, perlite has been used at four locations: Encino, Griffith, Hensen Dam and Woodley. The topmix for the greens consisted of 70 percent plaster sand, 20 percent horticultural perlite of fine sand size (Horti-Perl #27) and 10 percent nitrohumus. At Woodley, the first set of eleven greens to receive this perlite-amended mixture in place of the original native soil material has supported a healthy turf and excellent play for more than 10 years. Because of this initial success, other greens that needed renovation were rebuilt with greens mixtures composed of sand, perlite and organic matter.

Penncross bentgrass and improved varieties of bermuda grass are being grown on these unique greens. In fact, the greens have remained in good physical condition after as many as 100,000 rounds of play each year at the course, according to assistant manager Steve Ball of Encino.

In addition, golfers may resume play with only a short delay after a fairly heavy rain, as witnessed by the authors when an intense storm occurred during a site inspection at the Encino course. During this inspection and during visits to the other three courses, samples of sand and perlite-amended greens were collected so that their physical conditions could be compared to the USGA specifications.

The positive effects of perlite... should help both the golf course manager and the player meet their mutual goal: to maintain quality playing conditions for as much of the year as possible.

The results of the laboratory and field testing are presented in Table 2. which includes the green number and its approximate age. A comparison of these data (Table 2) with the USGA specifications (Table 1) provides a good explanation of why the greens have performed so well.

Except for Griffith, all the greens are either within or slightly above the recommended range. The Griffith Greens, the most recently reconstructed, were not yet open for play at the time of the inspection; there the high infiltration rate will decrease with time as the turf becomes established and play begins.

The other greens all exhibit physical properties that are very favorable for turf growth and play. Finally, this analysis indicates that the field and laboratory data correspond quite well and that the sand and perlite greens will continue to maintain a good physical condition with time and heavy traffic. The Los Angeles Parks and Recreation Department's innovative use of perlite clearly shows that perlite-amended greens perform well, even with the extended use after heavy play. The chief golf maintenance supervisor of the LAPRD reports that the greens whose "performance has exceeded . . expectations" have been well received by golfers and maintenance personnel alike. Indeed, the greens have exhibited excellent durability and playing performance from the first day of use to the present.

Because perlite does not degrade... the soil should remain relatively constant over many years of play, thereby reducing the costs associated with remedial work and replacement of the greens.

The positive effects of perlite on the physical conditions of soil should help both the golf course manager and the player meet their mutual goal: to maintain quality playing conditions for as much of the year as possible. A sand and perlite greens mixture may indeed be an alternative to conventional mixtures for long-term quality performance, especially for golf courses that must withstand unusually high traffic and frequent inclement weather.

Because perlite does not degrade, the physical characteristics of the soil should remain relatively constant over many years of play, thereby reducing the costs associated with remedial work and replacement of the greens. The water retention and good drainage that perlite provides should also reduce operating costs by limiting the amount of irrigation necessary, while allowing rapid recovery of playing conditions after rainfall. Thus, sand and perlite mixtures may be expected to provide years of satisfactory performance under both favorable and adverse climates and traffic.

References

USGA. 1973 Refining the Green Section specifications for Putting Green Construction. USGA Greens Section Record 11:1-8.

The green shown here (Woodley Golf Course) was constructed with a 70/10/20 (sand/nitromus/perlite) topmix