Sand – The Building Block

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SAND IS ONE of the most common naturally occurring resources at our disposal today. It is used by turfgrass managers in all sorts of manners, from making concrete to filling bunkers, to mixing with other materials for topdressing and putting green construction. Sand holds tremendous benefits for the golf course superintendent, and yet, how little we know about it!

To begin with, the term sand is very vague. These individual rock or mineral fragments found in soils are characterized by their particle sizes, ranging from 2.00 mm to 0.5 mm. Sand grains usually consist chiefly of quartz, but they may be of any composition. If the particle size ranges listed above are divided into one another, one will see a 40-fold increase in sand particle diameter. Although this is a significant difference in particle size, any particle within this range is classified as a sand. This is important in understanding behavior differences within sands. To the soil scientist, any soil that contains 85 percent or more of sand and not more than 10 percent of clay is texturally classified as a sand. Thus, we can see that there are all kinds of sands. No wonder the confusion.

Keep in mind that turfgrass roots are not grown *in*, but *between* the soil particles. By necessity, however, our discussion of sand will center on particle size and distribution, silt and clay content, infiltration rates, bulk density, and the interrelationships between them. In other words, while our primary interest may be in pore spaces, we must understand the particles that surround them if we are to make any progress!

Sand is the ideal medium to resist compaction on the golf course. It also provides excellent internal drainage, and, when it is properly blended with other materials in proper proportions, it forms an exceptional growing medium that retains adequate amounts of nutrients and water. Sand has indeed evolved today as a primary constituent of turfgrass management practices.

RESISTANCE TO compaction is the major factor when formulating a good root zone soil mixture for golf tees and greens, because these areas receive continuous concentrated traffic. For good turf, every means possible must be used to resist soil compaction and poor drainage. Sand solves the problem. Its physical characteristics remain constant within the soil profile. When the right sand is mixed with a compatible source of organic matter and/or small amounts of topsoil, a high-quality growth medium is produced that maintains its physical characteristics indefinitely.

Accompanying this resistance to compaction are the excellent drainage characteristics needed on golf courses. Poor drainage creates long shutdown periods during rainy seasons, decreasing revenues significantly. Good internal drainage is not only important in putting greens and tees, but also in bunkers and throughout fairways as well. The use of a proper sand in conjunction with proper construction techniques can alleviate such drainage problems.

Turfgrasses, as other plants, grow best when soil moisture approximates field capacity. Properly blended soils for turfgrass growth, which can be formulated by a physical soil laboratory, are designed to provide adequate soil moisture levels. Unfortunately, the soil moisture levels optimal for growth are also optimal for compaction. Therefore, an interaction is seen again between soil and nutrient/moisture retention. Properly blended soil components maintain proper degrees of soil moisture that, in turn, maintains proper soil nutrition levels. This does not, however, eliminate the need for frequent and thorough soil testing to determine nutritional and soil pH levels.

PARTICLE SIZE determines the number of particles in a gram of soil. A good example of differences in number of particles per gram based on particle size is illustrated in *Table 1.* Both sands have the same percentage of medium sand. The sand on the left, however, has the second-highest percentage of sand particles in the coarse

TABLE 1
PARTICLE SIZE DISTRIBUTIONS

Sand	% by wt	Particles/g	% by wt	Particles/g
Very Coarse	10	9	5	4
Coarse	25	180	15	108
Medium	45	2,560	45	2,560
Fine	15	6,900	25	11,500
Very Fine	5	36,000	10	72,200
		45,649		86,372

TABLE 2
PARTICLE SIZE ANALOGY

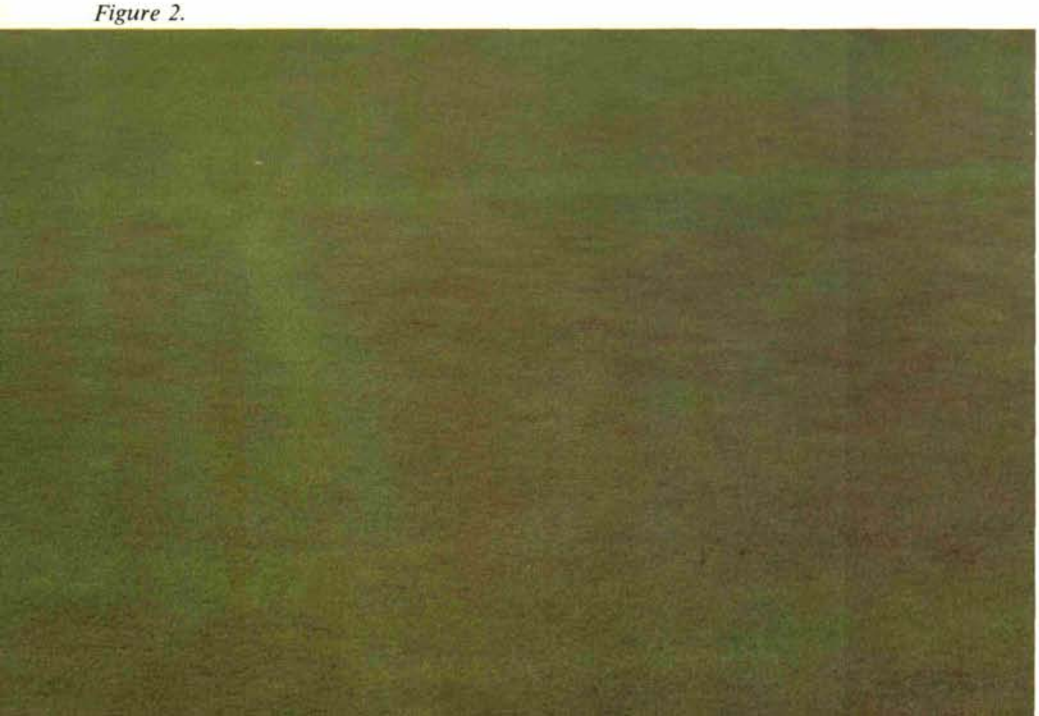
VERY COARSE SAND	8 FT. DIA. BEACHBALL
COURSE SAND	4 FT. DIA. BEACHBALL
MEDIUM SAND	MEDICINE BALL
FINE SAND	BASKETBALL
VERY FINE SAND	SOFTBALL
SILT	POKER CHIPS
CLAY	OATMEAL

and very coarse range compared to the sand on the right, having the same percentages of particles in the fine and very fine category. Consequently, the ratio of coarse to fine is simply reversed from sand 1 to sand 2. Notice that in switching the percentages from coarse to fine, with medium sand constant, the number of particles per gram is approximately doubled. This has tremendous impact on the physical behavior of these two sands. The sand on the right has more particles and a lower infiltration rate, giving it greater nutrient and moisture retention, as well as making it more susceptible to compaction.

Table 2 shows a good analogy for determining particle sizes of the various soil separates. If clay were in relation to oatmeal flakes, then coarse sand would have the same relation as eight-foot-diameter balls. Now imagine these seven soil separates combined in a large swimming pool. The finer flakes will filter down through the larger particles. If these various components are mixed at improper ratios, a tremendous settling occurs that causes development of a layer of material that is impermeable to water and very susceptible to compaction. The same is true in the soil profile when an improper sand is used under putting green situations. Foot traffic, aerifications, watering, and equipment traffic cause migration of fine particles, creating an impermeable barrier below the soil surface.

Figure 1.

Figure 2.



ATTEMPTS TO improve soil conditions are often made by rototilling sand into the soil. Unfortunately, soil physics does not always permit the addition of small amounts of sand to improve the overall soil profile. On the contrary, large amounts of sand must be added to a heavier soil before soil porosity and compaction resistance improvements are experienced. Small amounts of additional sand create hardpans within the soil as the small particles filter into the larger pores, creating a soil interface. This is the principle behind cement setting up, and this same phenomenon can occur in a heavy soil when small amounts of sand have been incorporated.

Next, consider water movement through a soil profile and its relation to the perched water table system of the Green Section Specifications. As water moves vertically through the soil profile, it also moves laterally at about the same rate. However, once the water uniformly infiltrates the 10 to 12 inches down to the coarse sand layer, it does not move into or through this textural barrier. A law of soil physics, i.e., surface tension, is at work. The water backs up and will not move into the coarse sand until saturation occurs immediately above it in the upper soil mix. Only then, when the weight of the water above the coarse sand layer becomes great enough to overcome the tension force, will it move into and through the sand layer.

Theoretically, after field capacity is reached in the upper soil mixture, any water added beyond this point will drain into the coarse sand and on into the gravel-drain system. This principle allows the perched water table to maintain the desired moisture levels in the growing medium, yet not maintain saturated conditions in the soil profile.

Figure 3.

Figure 4.

The soil profile will, of course, be wetter at the lower extremities than at the higher, so therefore a uniform 12 inches of mix is necessary to maintain a uniform moisture content throughout the green. Final contours of a putting green must first be established in the subgrade, keeping the various construction layers constant and giving uniform conditions in the low as well as high areas.

THE PRINCIPLE that water will not readily move from soil of one texture into a soil of entirely different texture affects surface drainage functions as well. Remember, a larger-particle medium must be exposed to free water to allow water penetration from surrounding areas. Tile drains, French drains, or slit trenches use this principle in draining areas such as greens, low areas in tees and fairways, and underground drainage systems for bunkers. If installed with a thick sod cover, these drains will be of little or no use. Placing sod over tile drains prevents contact with free water, prohibiting lateral water movement into them.

A properly constructed drainage system may be installed with or without tile, but most important, the trench bottom must maintain a definite 1½ to 2 percent slope from the trench high point to the exhaust area. Gravel is used in the trench bottom and around the tile. The gravel may be overlayed with sand at a depth according to location. In greens, this depth must be enough for cup changing, and in tees and fairways it must accommodate aeration. However, in roughs or out-of-play areas, the sand cover may be only 1-2 inches, or even absent, providing maximum surface exposure for the gravel. Again, proper sand particle size selection prevents migration into the gravel and possible drainage system blockage.

Figures 1 and 2 illustrate the results of improperly and properly constructed drains installed in turfgrass areas. *Figure 1* shows a drainage system having a much too coarse sand, producing hydrophobic conditions. *Figure 2*, however, shows a properly constructed drain system having a proper sand medium over gravel, thus producing good drainage and the best-quality turf on the entire putting surface. Upon examination of the two soil profiles, the rooting depth will be as much as three times greater above the drain than in the adjacent poorly drained soil. Both drainage systems handle surface and subsurface drainage well, but a properly selected sand mixture prevents drought conditions above the drainage system itself, consequently preventing an eyesore on the putting green.

Figure 5.

FINDING THE right sand for a putting green or a soil mix is not as easy as it may first seem. As we have learned, sand is not just sand! There are tremendous differences within the sand classifications — indeed, within sand sources themselves. A laboratory mechanical and physical analysis is essential if you are to determine the actual behavior and benefits of a sand before actual use. The USGA Green Section laboratory (telephone Agri-Systems, 713-846-6543) can save a tremendous amount of money and time by eliminating the guesswork in sand, soil, and organic matter component determinations and ratios. After all, the desired soil characteristics of drainage, moisture/nutrient retention, and resistance to compaction are better determined by a laboratory than by guess and by gosh. The first step to better soils, therefore, is through the soil testing lab.

The next controversial step encountered is frequently between the practice of on-site vs. off-site mixing of the soil components. In reality, if one is interested in a uniform soil mix, there is no controversy at all. Off-site mixing is the key to producing a well-blended and uniform growing medium. On-site mixing is barely second best!

Figure 3 shows only one way, but it is a most effective way to achieve a consistent soil blend. A very thorough job is accomplished by blending materials in this manner. Contrast this with the problem facing the golf course superintendent in *Figure 4*. A sand with a high infiltration rate was used in this putting green construction, with sphagnum peat rototilled into the upper soil profile. The result was a mix in which turfgrass establishment and proper maintenance was nearly impossible. Attempting to mix a heavier material (such as sand) uniformly with a lighter material (such as peat) with a rototiller is virtually impossible. Even where this type of mechanical mixing is done in different directions and with many replications, pockets of sand and concentrations of organic matter are unavoidable. The final product is less than one should accept.

SAND IS ALSO vitally important in the make-up of topdressing materials and for bunker use.

Topdressing has always been one of the most important practices in putting green management. It is a factor in maintaining smoothness, uniformity, and relief from compaction, and it improves internal characteristics in the soil profile as well. Topdressings reduce thatch accumulation. Light, frequent topdressings improve putting green quality and speed.

In a number of cases, sandy topdressings have been used to improve the original upper soil profile. Such efforts are in vain, however, unless the sandy material has the proper physical characteristics. Of equal importance is the incorporation of the sandy material into the original soil profile through aerification. Topdressing the surface alone is not sufficient, as layering will result. This has caused serious problems in the past. However, incorporating the sand into the open aeration holes by dragging or matting develops good rooting. It also prevents development of a soil layer. *Figure 5* is a good example of proper sand/soil incorporation.

Choosing the proper bunker sand is often neglected when considering bunker management and playability. Important qualities for bunker sand include a firm surface, lack of fried-egg lies, proper drainage, resistance to compaction and movement from water or wind. If the proper sand is used, excellent playing conditions result. On the other hand, if improper sand is selected, bunker maintenance costs are going to increase.

Oftentimes, the major consideration for a bunker sand is color. Although color is a poor judging point for sand quality for most golf course purposes, it is of major importance when it comes to bunker use. *Figure 6* reflects the problems an improper sand creates in bunkers. This sand has a very white color and provides good playing conditions but is very fine and has tremendous wind movement problems. This creates another problem for the golf course crew and increases the overall budget.

IN CLOSING, reconsider two earlier statements: Sand is not just sand, and turfgrass roots grow between, not in, the soil particles. We have seen what the right and wrong sands can do to golf course turfgrass management operations. With what seem to be insignificant changes in the proportions of sand particle sizes, organic matter, and soil components, we find significant differences in the way a soil mix reacts. We have seen the detrimental effects of hydrophobic sands and how and why some sand mixes and topdressings have received an undeserved bad reputation. We have tried to point out the value of a laboratory physical soil analysis — not only for construction, but for topdressings and bunkers as well. If a high-sand mixture is of good quality, then a physical analysis will quickly show its attributes. If the mixture does not have the necessary physical properties, a physical analysis can point this out before high expenditures and bad results develop.

A well-constructed putting green is expensive, but the proper use of a scientifically formulated sand mixture is not an expense — it is an investment for the future. *Sand is the building block.*

Figure 6.