# How to Select the Best Sand for Your Bunkers

*There's a lot to learn about the sand you select for your course.*

**by JAMES FRANCIS MOORE**

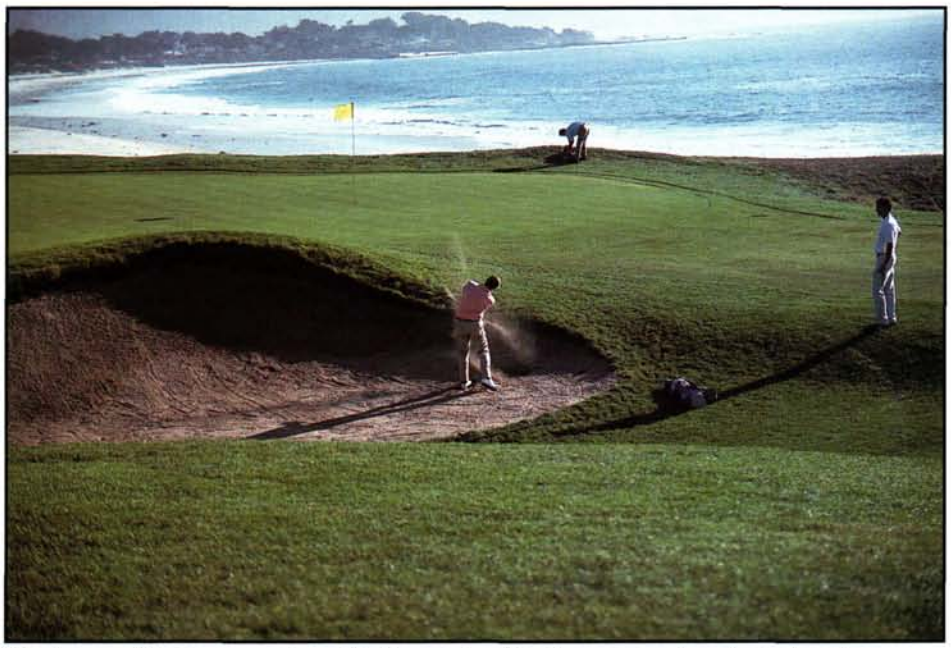
WITH THE possible exception of green speed, sand bunkers are the most controversial and discussed features on golf courses, regardless of the golfer's ability. Predictably, opinions vary widely on issues such as design, location, playing quality of the sand, and even what color is best. Generally, there are four major areas that must be considered when evaluating bunkers. These are sand selection, architecture, construction, and maintenance.

Selecting the proper sand for bunkers is arguably the most difficult of these four areas. The makeup of the sand strongly impacts maintenance and playing quality. The sand can also influence the architecture and style of construction of bunkers.

There are seven factors that should be considered when selecting the sand.

- Particle size.
- Particle shape and penetrometer value
- Crusting potential
- Chemical reaction (pH) and hardness
- Infiltration rate
- Color
- Overall playing quality

Values for and interpretation of particle size, shape and penetrometer value, crusting potential, chemical reaction and hardness, and infiltration rate all should be determined by an accredited physical soil testing laboratory. Color and overall playing quality are highly subjective values that are based on personal preference.



*Playing quality is unquestionably the most subjective parameter when choosing bunker sand. The most important component in the selection process is allowing an adequate amount of time to fully evaluate the various factors.*

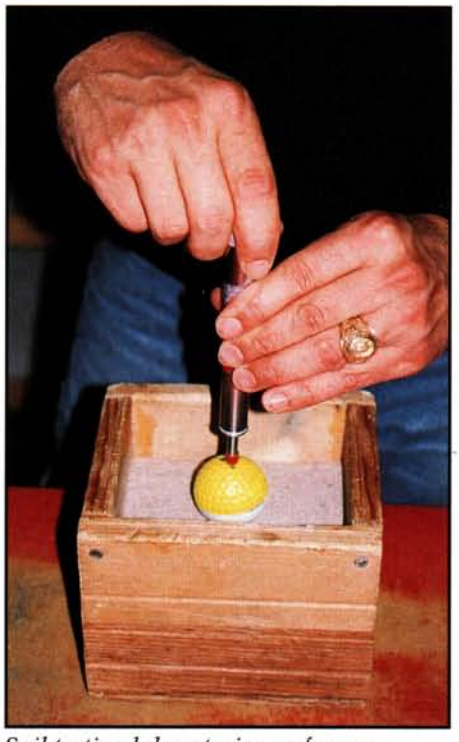
### Particle Size

As a general guideline, a sand used in bunkers should be composed of particles with a large majority in the range of 0.25-1.00mm. Silt and clay (particles below 0.05mm) should be kept to a minimum, since they are associated with surface crusting. Note that this size range should be utilized only as a first step in determining whether the sand is likely to be acceptable overall. In other words, it is unlikely that a sand that falls significantly outside this range will perform well in terms of crusting, hardness, porosity, and/or playing quality. On the other hand, it would be a mistake to assume that a sand will be appropriate for bunker use simply because it falls within this particle size range. For example, depending on particle shape, some sands that fall in this range would be considered too firm or too soft for play. Since particle size screening is a simple, inexpensive test that is performed by most sand suppliers, it is the best first step in determining if the sand is worthy of further testing.

When evaluating the particle size range of the sand for bunker use, keep in mind that bunker sand often ends up on the green in surprisingly large quantities. As golfers blast their way free of the hazard, the sand is thrown onto the adjacent green. **Therefore, when selecting sand for use in green-side bunkers, the makeup of the green's rootzone must also be considered.** The best rule of thumb is to avoid using a sand in the green-side bunkers that is significantly finer in gradation than that used in the rootzone of the green. This is the same basic rule used for selecting greens topdressing materials. You can safely lay a coarser material over a finer rootzone mix without creating significant drainage problems, but just a few topdressings with a finer material over a more coarsely graded rootzone can cause drainage problems.

If a bunker sand is selected that is significantly finer in gradation than the rootzone mixture used in the greens, additional aerification should be practiced on the affected areas of the green. Backfilling the aerifier holes with a more coarsely graded sand helps mover water more rapidly into the rootzone.

Material that is too coarse also can create problems. Particles greater than



*Soil testing laboratories perform a penetrometer test to measure a sand's resistance to compression. The value from this test is used to predict the sand's potential for fried-egg lies.*

2.00mm are classified as gravel. If present in large quantities, particles in this range damage mowing equipment and cause the ball to deflect off line.

### Particle Shape and Penetrometer Value

The shape of the sand particles has a strong influence on playing quality and maintenance. A sand particle's shape is classified by examining both the relative sharpness of the particle's edges and the overall shape of the particle itself. By referring to Figure 1 — Angularity and Sphericity of Sand Particles, it can be seen that the surface of particles can range from *very angular* (many sharp, well-defined edges) to *well rounded* (smooth surfaces). The shape of the particle can range from *low sphericity* (an elongated particle) to *high sphericity* (a particle that is nearly round).

The angularity and sphericity of the particles have a strong influence on the playing quality of the sand. For example, a low-sphericity, very angular sand generally has high resistance to *fried-egg* lies. Such sands also tend to stay in place better on the face of the bunker. However, this same sand would produce very firm bunkers that some players may find objectionable. Well-rounded, high-sphericity sands can produce fried-egg lies and are more likely to move off the bunker face during maintenance and irrigation rainfall.

Sands usually consist of a mixture of particle shapes and sizes. This is important to the stability and playing quality of the sand. Again, as a general rule, sands that are highly uniform in size range and shape (particularly if rounded with high sphericity) tend to be less stable than a sand that has a wider range of particle dimensions.

Determining a sand's angularity and sphericity is helpful in predicting the ultimate playing quality of a bunker, but is by no means an exact science. The USGA currently is funding research to attempt to develop better measurement techniques to aid in the selection of sands for rootzone mixtures and bunkers.

The angularity of the sand is determined by examining the particles with a microscope and comparing them to the chart in Figure 1 — Angularity and Sphericity of Sand Particles. After measuring the angularity, the laboratory performs the penetrometer test to determine the sand's tendency to produce fried-egg lies. The penetrometer measures the sand's resistance to compression. The values are reported in kg/cm$^2$. The potential for fried-egg lies is based on penetrometer values as described in Table 1 — Potential for Fried-Egg Lies (Thomas Turf Services).

**Table 1**
**Potential for Fried-Egg Lies**
**(Thomas Turf Services)**

| Penetrometer Reading | Fried-Egg Potential |
|---|---|
| Greater than 2.4 kg/cm$^2$ | Very low tendency to bury |
| 2.2 to 2.4 kg/cm$^2$ | Slight tendency to bury |
| 1.8 to 2.2 kg/cm$^2$ | Moderate tendency to bury |
| Less than 1.8 kg/cm$^2$ | High tendency to bury |

### Crusting Potential

Crusting is the formation of a layer of dried, stiff sand on the surface of the bunker. Such layers typically are ⅛ to ¼ inch in thickness, and they severely decrease the playing quality of the bunker. Sands that are prone to crusting require more frequent raking to maintain good playing quality. If the crusting potential is high, the bunkers will require raking following each irrigation and rainfall event. This greatly increases the labor required to keep the bunkers in good condition.

Crusting is directly related to the percentage of silt and clay in the sand. As silt and clay increase, the severity of crusting increases as well. To test for crusting potential, the laboratory wets a thin layer of sand and allows it to dry overnight. They then attempt to lift the layer on the edges using a spatula. Whether or not a crust has formed will be recorded on the lab test results and is usually reported as N (none), L (light), M (moderate), or S (severe).

### Chemical Reaction and Hardness

Some laboratories also test the sand for its chemical reaction (pH). This value is much less important overall than the other test results and, on its own, should not be used to disqualify a sand being considered for use. The pH value provides insight into the chemical makeup of the sand. A sand with an extremely high pH (> 8.0) is likely to be strongly calcareous and therefore subject to physical and chemical weathering.

Sand particles also can change in shape and size due to mechanical wear. Sand particles that are very soft can be crushed into smaller particles during raking. A soft sand may play and drain perfectly at first, only to degrade in quality as the particles are broken down. Some laboratories now perform a hardness test to determine the likelihood of this type of degradation.

### Infiltration Rate

Infiltration rate refers to the sand's ability to drain. It is also referred to by laboratories as *saturated hydraulic conductivity.* This measurement is most relevant to rootzone mixes for use in putting greens, but it is also used by some labs to evaluate bunker sands.

Since straight sand is used in bunkers, the initial infiltration rate measurement is likely to be very high — often in excess of 50 inches per hour. As a

general guideline, a sand being considered for use in bunkers should drain at a minimum rate of 20 inches per hour.

Infiltration rate measurements are more useful when evaluating the suitability of a sand that has been in the bunker for some time. In most cases, the sand in the bunker gradually becomes contaminated with the soil from the base and sides of the bunker. This process occurs more rapidly in bunkers with steep faces and in areas subject to heavy, frequent rains. A sand that has become heavily contaminated with soil and organic debris will drain much more slowly than a sand that is clean. Simply installing new or additional drainage pipe would be only partially effective under such circumstances. Complete removal and replacement of the contaminated sand may be the only complete solution.

*Proper sand selection is one of four components in evaluating bunker sands. An improper choice at this course resulted in cement-like slabs that required complete removal soon after installation.*

### Color

Unfortunately, bunker sands occasionally are selected based primarily on their color. Although sand color is important, since it strongly impacts the appearance of the course, it should not be given greater consideration than particle size, particle shape, or crusting potential.

Laboratories measure the color of sand by comparing it to the Munsell Color Chart. As a general rule, lighter-colored sands are preferred since they contrast beautifully with the green grass. Color measurements are also useful when evaluating the visual compatibility of two sands. An annual task on many courses is to add an inch or two of sand to existing bunkers to replace what is lost from explosion-type shots and water and wind erosion. If the new sand is a markedly different color from the existing sand, it can take months of raking for the two sands to blend into a uniform color.

### Overall Playing Quality

Without question, playing quality is the most subjective evaluation of bunker sands. Players vary widely in their assessment of what constitutes good playing quality. One of the few shared opinions seems to be a desire for all the bunkers on the course to play in a consistent manner. For this reason, when adding sand to existing bunkers it is a good practice to perform the work on all of the bunkers on the course.

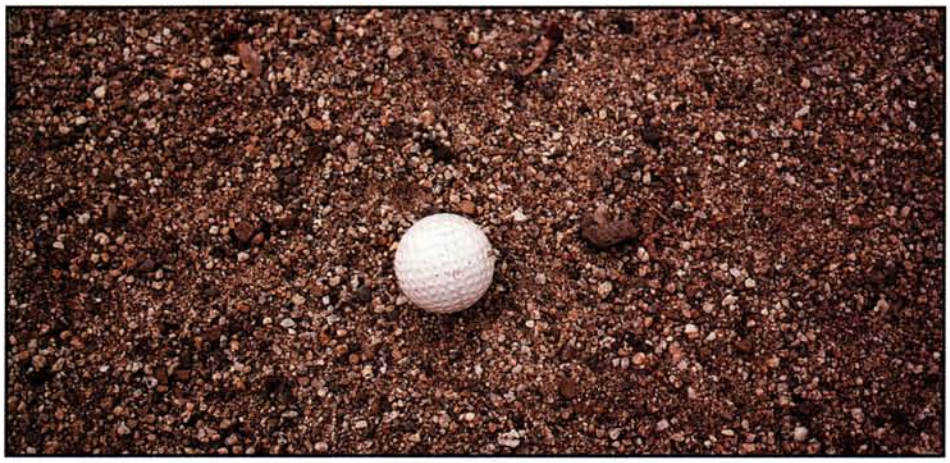
From a testing standpoint, particle size, particle shape, crusting potential, and infiltration rate all provide insight as to how the sand will play. However, other factors that have nothing to do with the makeup of the sand have equal if not greater impact on playing quality. The other factors include:

- Raking frequency.
- Raking method.
- Green-side irrigation coverage.
- Depth of the sand.
- Length of time the sand has been in the bunker.

The number of times per week the bunker is raked has impact on playing quality. On courses that rake daily, the possibility of even minor crusting is eliminated. The upper few inches of the sand remains loose. The sand also tends to be drier as a result of increased evaporation.

Machine versus hand-raking also affects playing quality. Hand raking usually results in sand that is firmer and less prone to fried-egg lies. Machine raking can be either deep (useful to prevent weed establishment) or very light, depending on the attachment used.

*Heavy rains wash soil into the bunker, detracting from the appearance and playability of the sand.*



*Evaluating the particle size range of the sand for bunker use is an important component in the selection process. A coarse sand will impact maintenance and playability.*

The green-side irrigation system almost always overlaps into the bunkers. Thus, during times of the year when it is necessary to water the greens frequently, the sand in the bunkers will be wetter. And, since the irrigation system is designed to apply water as evenly as possible to the surface of the green rather than the surrounding areas, it is likely the bunkers adjacent to the green will receive varying amounts of water.

The depth of the sand usually varies even within the same bunker. The sand is almost always deeper on the low, flat portion of the bunker and shallower on the faces and slopes. It would be a mistake to attempt to maintain a consistent depth throughout the bunker. Golfers should gauge the depth and firmness of the sand while taking their stance and adjust their shot accordingly.

Sands often change significantly in their playing quality over the first few months as they become compacted and contaminated with soil and organic debris. Newly installed sand may seem soft at first, but soon will become more firm. The speed at which this firming occurs depends on the angularity and particle sizing of the sand, as well as raking practices. Since most bunkers are subject to at least some erosion during irrigation and heavy rainfall events, the sand will gradually become contaminated with the underlying and surrounding soil. As a result, the playing quality of the bunker gradually changes as the bunker ages. The sand particles can also change in size and shape due to mechanical weathering, as discussed earlier.

Determining which sand yields the best playing quality is such a subjective process that a test bunker is often constructed to allow golfers to field-test the sands for themselves. Assuming three sands are being considered (each of which has already been evaluated by an accredited physical soil testing laboratory), use 2 × 6's to divide the test bunker into three areas. Evaluate the sands for a period of at least two to three months to allow the sand to compact and better simulate what will happen on the course. Unfortunately, while this testing process will demonstrate the playing quality of each prospective sand, it cannot guarantee a unified opinion among the golfers. The USGA currently is funding research to better predict the playing characteristics of sands through laboratory testing.

Several soil testing laboratories provide bunker sand evaluation services. Usually, a complete analysis can be obtained for less than $200. The laboratory will need a gallon of dry sand to perform all of the tests. Be sure to submit a sample of each sand that is being considered. Allow at least two to three weeks for the laboratory to complete the tests.

## Conclusion

Clearly, there is more to selecting the right sand for your bunkers than calling the local sand plant and ordering a few truckloads. Today's golfers (at least in the United States) are becoming increasingly more demanding of bunkers that play consistently, drain rapidly, and provide additional beauty to the course. One of the most important pieces of advice this article can offer is to remember that *time* is a necessary component to achieve these goals. Allow plenty of time for testing to narrow your choices to sands that are properly sized, stable, and easier to maintain. Time also is needed for the construction and use of a test bunker to allow golfers to evaluate the different sands for playing quality. Finally, time will be required for the newly installed sand to firm up and take on its final playing characteristics.

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JIM MOORE *joined the USGA Green Section in 1985, spending his time conducting Turf Advisory Service visits in the Mid-Continent Region. In 1996, he assumed the duties of director of the newly formed Construction Education Program.*

*Personal preference is one of the most influential factors in bunker sand selection. Allow golfers to try several sands to assess their playing qualities.*