



PHYSICAL PROPERTIES THAT IMPACT BUNKER SAND PERFORMANCE

BY USGA GREEN SECTION

- Selecting bunker sand is highly subjective.
- Researchers characterized the physical properties of 26 bunker sands to identify simple metrics that consistently predict surface firmness.
- No single characteristic predicted surface firmness, but particle-size distribution and the shape of sand particles are important.
- The tendency for sand to adequately pack increases with the sand angularity.
- Sands with round particles should be avoided in favor of more angular sands that provide a firm surface.
- Use particle analyses in conjunction with assessments of sand appearance and golfer preference to select the most appropriate bunker sand.

Bunkers are an important part of golf and the subject of much discussion among golfers and golf course decision-makers. The design, location and construction method contribute to the daily condition of bunkers; however, the sand itself also plays a significant role in how bunkers play. While sand selection

is an important factor to consider, it can be highly subjective. Research conducted at Purdue University provides some objective information that can be used to help decide which sand is best for a given facility.

The researchers characterized the physical properties of 26 bunker sands from across the United States (see Table 1 in the USGA article “[Physical Analysis of Sands for Golf Course Bunker Use](#)”). Medium-course and medium-fine topdressing sands and round glass beads also were evaluated for comparison to bunker sands.

Surface firmness was determined by measuring the resistance of each sand to surface penetration. The researchers pushed a penetrometer modified with a golf ball into the sand samples until half of the golf ball was buried. This method is imperfect and variable, but it is currently the best method to directly assess the surface firmness of sand. Particle-size distribution, angle of repose, particle shape and color were also analyzed to see if there were any relationships between those characteristics and the results from the penetrometer testing.

The sands evaluated in this research varied widely in their characteristics, and no single factor was strongly related to the penetrometer values. Only ten of the evaluated materials resisted golf ball penetration enough to expect a firm playing surface that would be only slightly prone to buried lies. Sands with broad particle-size distributions and more angular particles provided the firmest surfaces. Materials with rounder, more uniformly sized particles provided less resistance to surface penetration.

Sand-particle-size distribution is commonly used to predict bunker sand performance. Traditionally, the best performing bunker sands are mostly composed of 0.25- to 1.0-millimeter particles. Particles that are finer than this range can impede drainage, and neither finer nor coarser materials blend well with putting green rootzone mixes if splashed out of bunkers and left on putting surfaces.

While no single characteristic adequately predicts surface firmness of bunker sand, this research suggests that particle-size distribution and the shape of sand particles are important. Sands composed of uniform, small, round particles are likely to produce soft conditions with increased potential for buried lies and erosion following rainfall. Use this research in conjunction with appearance and golfer preference to select the most appropriate bunker sand for your golf course.

Additional References:

[Physical Analysis of Sands for Golf Course Bunker Use](#)

[Physical Analysis of Sands for Golf Course Bunker Use: Are Current Laboratory Tests Good Predictors for Bunker Sand Performance in the Field?](#)

[How to Select the Best Sand for Your Bunkers](#)

[Making Low-Cost Bunker Sands Work](#)

[Managing Bunkers](#)