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FEATUREarticles

Testing, testing, testing

Vigilant testing during root-zone mix production is a key step in putting green construction.

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Editor's note: The USGA updated its putting green construction recommendations in 2004. The data in this report meet both the recommendations that were in effect in 2003 and the current recommendations.

Before hosting qualifying for the PGA Tour's Western Open, the Village Links of Glen Ellyn (Ill.) rebuilt its greens in 2003 to meet USGA recommendations. The USGA recommends that laboratories perform tests on root-zone mixes before seeding begins on a golf course construction project. Photos by Sam Ferro

Laboratory testing plays two very important roles whenever new greens are constructed or existing greens are renovated. The first role is to provide an initial evaluation of the root-zone materials proposed for the project to determine whether they meet the project specifications. Using materials that meet project specifications helps to ensure the greens will perform as desired. The second role of testing is to monitor quality control. Quality-control testing should be performed throughout the production of the root-zone materials to ensure the use of consistent materials throughout the golf course.

When should testing be performed?

The initial evaluation of materials may involve testing multiple samples to find desirable root-zone materials. This testing should be performed before construction begins in order to avoid delays. The final choice of materials is often based on conformance with project specifications, availability, price and proximity to the golf course.

The quality-control testing program begins at the start of the mix preparation. The root-zone blender (usually a company specializing in blending root-zone mixes for golf courses or a specialist at the sand plant) will be attempting to calibrate its equipment. Initial calibration samples are sent to the lab to determine when a mix has been prepared that meets project specifications and/or the wishes of the superintendent. Once an acceptable material has been prepared, the testing data for this mix is used as a benchmark for future quality-control samples. The ongoing production samples are then compared to the benchmark results, and they are rejected or approved based on their consistency.

Quality-control testing is usually performed at a rate of one sample for every 1,000 tons of root-zone mix. This equates to five to 10 quality-control samples for an 18-hole golf course. Other testing frequencies may be used depending on project requirements or concerns about the materials being used. Frequency of quality-control sampling is very important for ensuring consistent material throughout a construction site. A good rule of thumb for determining sampling frequency for greens and sports fields is the following formula:

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(Number of inches of material) × 84 = Tons of material per QC sample

Therefore, for a 12-inch root-zone, one quality-control sample should be taken for every 1,000 tons of material.

Sampling

Root-zone production should take place off-site, away from the golf course, and typically occurs at the plant that is producing the root-zone sand. Off-site production lessens the possibility that an inconsistent root-zone mix will be delivered. The root-zone mix should be stocked in piles of approximately 1,000 tons (or whatever the specified testing interval) on a clean location to prevent potential contamination of the stockpile from the environment and during the loading of trucks.

At the start of the project to rebuild greens at the Village Links of Glen Ellyn, assistant superintendent Dave Buckley obtained sand from local suppliers to submit for testing. After particle size results passed both USGA recommendations and project requirements, a peat-to-sand ratio was determined according to lab mixes.

Stockpiled materials are tested before shipment to the project site to ensure they meet project specifications. The superintendent or the owner's representative should perform the sampling or at least be present whenever construction materials are sampled. An accurate representative sample is critical to getting valid testing results, and the ability to extrapolate the laboratory results to the field depends on how accurately the sample represents the bulk material.

As described by the USGA Green Section, the process of obtaining an accurate sample is fairly simple. A PVC pipe about 45 to 50 inches long, cut at a 45-degree angle at one end, is used as a sample collection tube. A rubber mallet is useful for tapping samples out of the pipe. At least eight sampling locations should be randomly selected for a 1,000-ton stockpile. Samples should be taken from the top to the bottom and around the circumference of the pile. To take a sample, brush away the outer 6 inches of the pile and push the clean pipe as far as possible into the stockpile. Pull the pipe out and tap the sample into a clean bucket. Thoroughly mix the material after all the samples are taken. Remove one gallon of material from the bucket to fill a zip-lock bag. Label the sample with a permanent marker, indicating from which stockpile the sample was taken.

To protect the samples during shipment, it's usually best to send the samples double bagged in a sturdy box with sufficient packing material included. Sample identifications should always be on the outside of the sample bag or container. A letter or testing request form should also be included with the sample submittal. The letter should include any pertinent sampling information, testing required, information on how to contact you and where to send the report.

Testing

The USGA Web site recommends that testing should be performed by a laboratory that is accredited by the American Association for Laboratory Accreditation (A2LA) and provides a list of laboratories that have been shown to have an "ongoing competency in testing materials specified in the USGA's Recommendations for Putting Green Construction."

The initial evaluation phase involves prequalification of the root-zone materials. Sand obtained from local sources is sent in to the lab for gradation testing according to USGA procedures. Once acceptable materials are found, the

chosen root-zone sand and amendment are mixed in the lab (usually in two different ratios). An experienced lab should have the knowledge to prepare test mixes that will meet the project specifications based on the sand particle size and amendment characteristics.

Soil blender Jim Drew samples a stockpile of fresh root-zone mix to be tested to ensure compliance with project specifications.

USGA physical evaluation tests are then performed on the mixes. Physical evaluation testing includes infiltration rate (saturated hydraulic conductivity), particle density, bulk density, porosities, organic matter content (if applicable) and pH. After the testing is completed, a report comparing the results to the USGA recommendations and/or project specifications is then prepared. This report should be distributed to all interested parties (superintendent, architect, builder and blender).

These results are evaluated to determine which mix ratio best meets the project needs.

The second stage of testing is the field calibration phase, which sets the baseline for the mix that is being prepared in the field and delivered to the golf course. For calibration, 200 tons of root-zone mix is prepared and sampled, and the sample is sent to the lab for testing. Particle size, organic matter and performance evaluation tests are performed to verify that the mix meets USGA recommendations or project specifications. If the results for the calibration sample are approved, they are used to establish the target values for the quality-control program. If they are not approved, the blender needs to recalibrate and send another sample.

Quality-control testing is the final testing phase. Quality-control testing can include the complete series of tests performed in stages one and two, or only tests for particle size and organic matter. The results of the quality-control samples are compared to the calibration sample results. If the results for a stockpile are consistent with the target values, then that stockpile is considered acceptable, and it can be delivered to the site. If a quality-control sample is not consistent, then the entire stockpile may be rejected.

Evaluating the data

What do test results look like? How do we know if the mix meets specs? How do we know if the quality-control results are consistent? What tests are performed for quality-control? These questions can best be answered by looking at some real-world data.

In 2003, the Village Links of Glen Ellyn (Ill.) embarked on a complete renovation of its 18-hole course. This public facility, which had hosted the Western Open qualifying since 1980, was going to rebuild its greens to meet USGA recommendations. The facility's veteran staff included head superintendent and 26-year GCSAA member Tim Kelly (Class A) and assistants Dave Buckley and Chris Pekarek. As the project progressed, Buckley was designated to obtain sand from local suppliers and submit them for testing. Particle size results indicated that the submitted sand met USGA recommendations and project requirements. Then two laboratory mixes were prepared from the sand and peat preferred by the golf course and the construction contractor. From these lab mixes, a desirable sand-to-peat ratio was determined.

Entire root-zone mixes can be rejected if quality control samples are not consistent.

Once field blending began, Buckley obtained a sample of root-zone mix from the first 100-ton stockpile that was prepared. The results for this calibration sample and the subsequent quality-control samples are shown in **Table 1** and **Table 2**. In addition to the actual data results, the tables include acceptance tolerances for several of the test parameters.

The particle size and performance test results for the first 100-ton sample met the USGA recommendations for putting green construction. The results for these samples were also acceptable to the parties involved in the construction at the Village Links of Glen Ellyn. The first 100-ton sample was thus used as the baseline sample for the quality-control program. Tolerances (also known as acceptance limits) were calculated based on confidence intervals developed by the USGA to aid in determining the consistency of the prepared root-zone mix. The calculated tolerances indicate guidelines for evaluating acceptable deviations from the calibration sample.

Throughout the remainder of the root-zone blending for the Village Links project, Buckley obtained samples as the 1,000-ton stockpiles were prepared. Samples were then sent to the lab for testing and comparison to the acceptance limits. As can be seen in Table 1, the gravel and/or fine sand fractions were outside of tolerance for some of the quality-control samples. Table 2 also shows some of the porosities outside of limits. Since these results are outside of the tolerances, the results were further evaluated to determine whether the mix was acceptable or should be rejected. It was decided that the mixes were still acceptable. The gradation deviations were very small, and the overall data set was quite consistent. The porosity differences were also considered small, and no significant difference in performance was expected from the various stockpiles.

Once the testing results were approved, then the stockpile material was shipped to the golf course. Buckley advises visually examining the material that is actually delivered to the site to check for potential contamination during loading and/or shipping.

Samples for quality control were taken from piles of mixes containing a determined peat-to-sand ratio at the Village Links of Glen Ellyn.

The decision to accept or refuse a stockpile mix that is outside of tolerances is critical to the golf course and to the suppliers. Acceptance of an inconsistent or improper mix can result in having greens that are inconsistent and difficult to properly maintain. Rejecting a greens mix that should have been accepted can result in increased cost to the project or to the vendors. All available data, as well as any field observations that can be made, should be evaluated when making decisions regarding results that are slightly outside of tolerances.

Conclusion

By performing a complete analysis on all the quality-control samples, the staff at the Village Links of Glen Ellyn was able to make comprehensive informed decisions concerning the root-zone stockpiles. The complete performance parameters from each stockpile also can be used to aid future maintenance programs. Many quality-control programs, however, use only particle size and organic matter data to determine consistency. This type of quality-control program is suitable for many projects, because if the materials being used are consistent and mixed in a consistent manner, then the performance of the resulting mix should be consistent. In this type of quality-control program, a complete analysis may be used to aid in acceptance or rejection of mixes that are slightly outside of tolerances.

The root-zone testing program performed for the Village Links of Glen Ellyn demonstrates that diligent sampling and testing provides assurance that the mix will meet the project's needs. Two years after construction, the staff is pleased with the performance of their new greens. Others must be noticing, too, because in summer 2005, the golf course held U.S. Open qualifying in addition to its normal schedule.

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