

USGA Specifications in Athletic Field Construction

by Jim Puballa

United States Golf Association (USGA) specifications for the construction of putting greens have been used for sports field projects on many occasions. These specifications rely on sand that is amended with organic material such as peat. With some appropriate modifications, USGA specs can create a field that maintains its playability under a wide variety of weather conditions.

Originally developed for greens only, USGA specs aim to provide a growing medium that drains quickly and allows air to move to the roots of the plants. USGA greens also need to resist compaction caused by foot and equipment traffic.

These specifications have some limitations in sports field construction. USGA specs do not include enough fines to provide sufficient soil stability to support football. For the purposes of our discussion, we will define fines as particles small enough to pass through a 100-sieve screen.

Football places heavy mechanical stress on turf. A scrimmage on a golf green would quickly destroy the

Continued on pg. 33

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turf. The players' cleats would rip right through the canopy into the growing medium underneath.

Despite these limitations, USGA specs represent a good starting point for a successful amended-sand field. When properly designed and installed, these fields offer dramatically greater playability than typical native-soil fields.

Sand-based sports fields

USGA specifications were first published in 1960. Within a few years, planners began developing related methods to build fields for other sports.

Prescription Athletic Turf (PAT) specifications adapted from USGA specs were patented in 1969. Initial installations encountered a variety of problems, which have caused a lingering suspicion of sand sports fields in the minds of many field managers.

In many of these cases, it could be argued that designers followed USGA specs too closely. They failed to incorporate sufficient fines to provide stability for football.

This was less of a problem in the South. Dense mats of roots and stolons in the turfgrass canopy of bermudagrass fields allow them to resist divoting. Without these characteristics, northern varieties tended to blow out more easily.

As the financial stakes in professional and major college games increased, further development of sand-based fields continued to promise greater dependability.

Amended-sand fields provide excellent drainage, allowing play to continue at the desired level of performance. This capability proves most beneficial in a worst-case scenario of heavy downpours (three to five inches per hour) just prior to or during a game, or when heavy rain continues for several days prior to competition.

It's important to note that a sand-based root zone is not the answer for all fields. Appropriate circumstances include high-profile use, substantial funds for both construction and maintenance, and high player and owner expectations. In other cases, a properly designed and installed native-soil field is still the most practical choice.

USGA methods

USGA specs call for 12 inches of

USDA System of Classification	Sieve No.	Sieve Opening, (Millimeters)	Appro. Opening, (inches)	USGA Recommendations
gravel >2mm	6	3.36	1/8"	3% max.
	7	2.83		
	8	2.38		
very coarse 1-2mm	10	2.00	1/16"	7% max.
	12	1.68		
	14	1.41		
	16	1.19		
coarse .5-1mm	18	1.00	1/32"	60% min
	20	0.84		
	25	0.71		
	30	0.59		
	35	0.50		
medium .25-.5mm	40	0.42	1/64"	60% min
	45	0.35		
	50	0.30		
	60	0.25		
fine .1-.25mm	70	0.21	1/128"	20% max.
	80	0.177		
	100	0.149		
	120	0.125		
	140	0.105		
very fine .05-.1mm	170	0.088	1/256"	5% max.*
	200	0.074		
	230	0.062		
	270	0.053		
	325	0.044		
silt .002-.05mm				5% max.*
clay <.002mm				3% max.*

*Total particles in these ranges shall not exceed 10%

Figure 1. Particle size distribution of USGA root zone mix



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amended-sand root zone mix over a two- to four-inch intermediate layer of very coarse sand and fine gravel (between one and four millimeters). Under the intermediate layer, the specs call for a four-inch layer of 1/4- to 3/8-inch (six- to nine-millimeter) pea gravel, with an installed system of pipe drains. The intermediate layer can be eliminated if a finer grade of pea gravel (two

to six millimeters) is used for the bottom layer.

The different textures (coarse on the bottom and fine on the top) create a perched water table. Water will not move through the root zone mix until it's nearly saturated. At this point, gravity overcomes surface tension, and water begins to drain through the root zone mix, into the gravel, and finally to the

pipe drains.

A perched water table is desirable for sand fields. It holds moisture in the root zone, where it can be used by the turf plants.

Figure 2 (page 36) shows a typical profile that uses USGA specifications with an intermediate layer.

Sand fields operate primarily by internal-gravity drainage, which makes an installed drain system necessary. The system recommended by the USGA consists of pipe drains that are at least four inches in diameter. The drains are placed at 15-foot intervals, in trenches no more than six inches wide and eight inches deep.

Corrugated or plastic pipe works best. A geotextile filter cloth can be used to line the sides and bottom of the trench, but it should not be placed around the pipe or on top of the trench.

A filter cloth layer can also be helpful between the subsoil and the gravel layer, where the subsoil is comprised of expanding clay, sand, or muck soil. These subsoils can become unstable under some climatic conditions.

A four-inch gravel layer covers the drain pipe and the entire sub-base. Selection of gravel size is critical, since proper particle size keeps the root zone mix from infiltrating the gravel.

Proper-sized particles create a bridging effect to maintain vertical channels in the gravel so that the drainage system works as intended. According to the USGA, the best way to encourage bridging is to keep particle size in each layer a maximum of five-times larger than the layer above it.

The root zone mix should possess the following physical properties: 35 to 55 percent total porosity, 15 to 30 percent air-filled porosity, and 15 to 25 percent capillary porosity.

Water permeability should be six to 12 inches per hour in the normal range, and 12 to 24 inches per hour in the accelerated range. Organic matter should be one to five percent by weight.

If soil is used in the root zone mix, the mix must contain a minimum of 60 percent sand and a maximum of five to 20 percent clay. Final particle size distribution of the sand/soil/peat mix must meet the specifications shown in **Figure 1** (page 35).

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Modifications

Perhaps the most widely accepted modification has been the amount of silt and clay in the root zone mix. Levels can vary from three to 15 percent.

The wide range results from differences in geography and climate. A sand-based field in Oregon, where local rainfall is high, will need greater permeability than a field in Nebraska, where local rainfall is lower.

Different mixes are also required for different sports. A field designed with a sloped or crowned center will typically require less permeability than a flat, level field. Since surfaces for football require enhanced surface strength, more fines are desirable.

Field use schedules can also prompt modifications to USGA specs. Sand used to build a lightly used field can have more fines, while the same percentage of fines on a heavily used field would create compaction problems.

New Pennsylvania Design

Sports field managers in the Northeast have used another design for amended-sand fields. This method was drafted into a set of specifications by Penn State University faculty member Andrew McNitt.

This New Pennsylvania Design has many points in common with the USGA specifications, but it differs in one important respect. USGA specifies a maximum of 10 percent fines in the root zone mix, and the Pennsylvania Design allows up to 25 percent fines.

The New Pennsylvania Design requires a testing laboratory to ensure that the root zone mix has the following: 35 to 55 percent porosity; 15 to 30 percent air-filled porosity, and the same amount of capillary porosity; five to 10 inches per hour of water permeability; and one to four percent organic matter content by weight. The air-filled and capillary porosity should vary by no more than eight percent.

Maintenance

Maintenance techniques for sand fields are difficult, and they may require the expertise of a trained professional. A maintenance supervisor needs to be on the field every day to check for mowing and fertilization

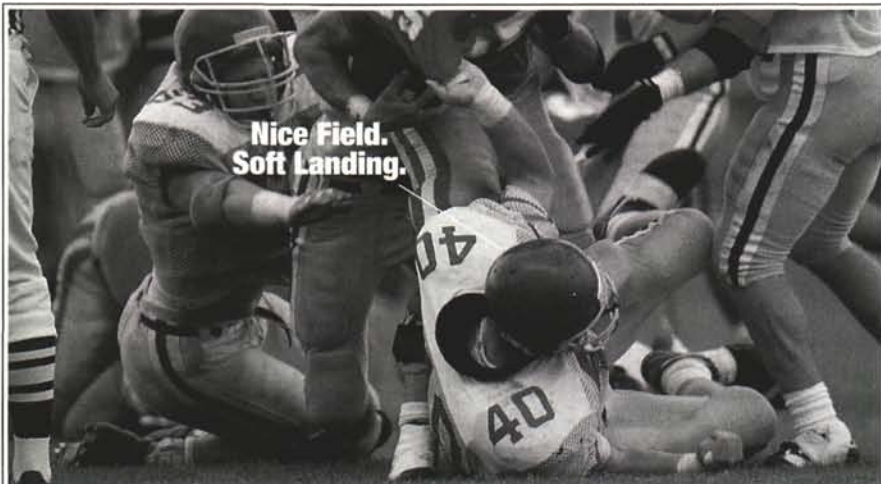
requirements, moisture, compaction, pests, and other stresses.

Mowing a sand field almost always requires a reel mower and cutting every day, or every other day. Remember that golf greens are usually cut every day.

Fertilization should use the spoon-feeding method, which applies small amounts of fertilizer at frequent intervals. Sandy soils

have low nutrient-holding capacity and they need nutrients faster. Frequent soil testing is also recommended for these fields.

For most native soils, one inch of water per week during the growing season is adequate to support turf growth. This amount will frequently prove insufficient for sand fields, which may need light watering daily during dry weather.



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Remember that exposed dry sand has poor soil strength and provides very poor traction and sod stability. When moist, the same sand performs much better.

Aeration equipment that works on native-soil fields may not work on sand-based fields. In some field trials, typical hollow-core aerators have proven to be too surface disruptive, tearing the turf canopy instead of pulling clean cores. Aerators with narrower, widely spaced tines can provide better results.

In terms of pests, nematodes can be a particular problem in sand fields. They prefer well-aerated, light-textured soil.

Amended-sand fields, such as those based on USGA specs, can be exceptional facilities when they're carefully built with appropriate materials. However, because of the special maintenance and construction demands of these fields, field planners would be wise to seek advice from qualified designers who are experienced in this method.

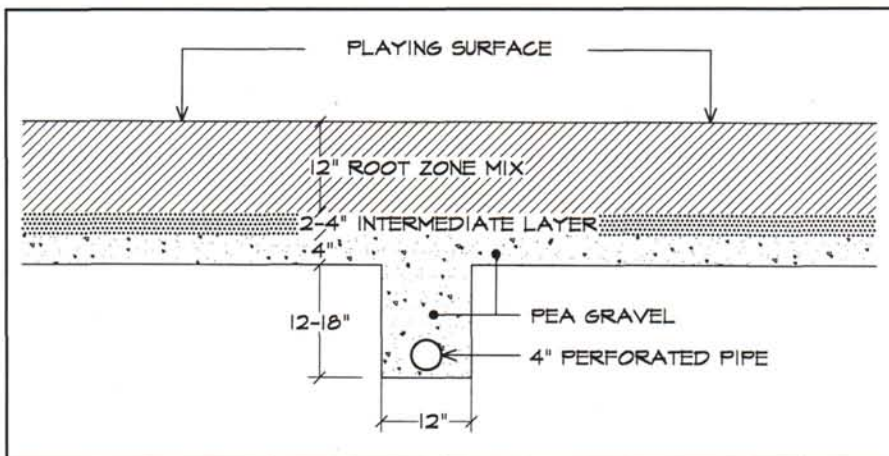
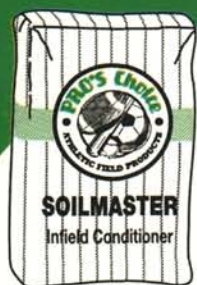


Figure 2. Typical profile of a USGA putting green

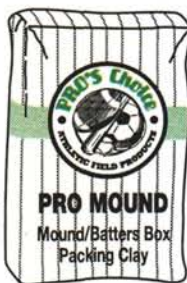
Jim Puhalla is president of Sportscape International, Inc., of Boardman, OH, and Dallas, TX. He is author, with Mississippi State University professors Jeff Krans and Mike Goatley, of *Sports Fields — a Manual for Design, Construction and Maintenance*. Material in this article

was adapted from that book.

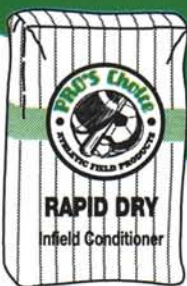
For more details on USGA specifications, call or write the organization and ask for their publication: "USGA Recommendations for Putting Green Construction." USGA, PO Box 708, Far Hills, NJ 07931; (908) 234-2300.



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