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Standard Guide for Construction or Renovation of Native-soil Athletic Fields[1]

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1. Scope

1.1 This guide covers techniques that are appropriate for the construction of athletic field rootzones using native-soil. This guide is also applicable to soils which are not native to the site but are natural (non-sand) imported soils. This guide provides guidance for the selection of soil materials, amendments, and methods for use in constructing these types of athletic field rootzones. Soils having a texture of Sandy Loam or coarser should be utilized for soil-based rootzone construction. Soils which are finer textured than listed above may be employed for rootzone construction but should be sand-modified to meet the performance criteria of this standard. If fields are constructed with soils which are finer textured, they will not be capable of meeting the performance criteria in this standard. Despite performance limitations, fields which are constructed with finer textured soils (due to logistics or budget constraints) may still be able to conform to the slope/grade criteria (see 5.1, 5.4, and Table 1). Sand modified rootzone constructions are not addressed by this standard.

1.2 Decisions in selecting construction and maintenance techniques are influenced by existing soil types, climatic factors, level of play, intensity and frequency of use, equipment available, budget and training, and the ability of management personnel.

1.3 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D1883 Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils

D1997 Test Method for Laboratory Determination of the Fiber Content of Peat and Organic Soils by Dry Mass

D2944 Practice of Sampling Processed Peat Materials

D2974 Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils

D2976 Test Method for pH of Peat Materials

D2980 Test Method for Saturated Density, Moisture-Holding Capacity, and Porosity of Saturated Peat Materials

D4373 Test Method for Rapid Determination of Carbonate Content of Soils

D4427 Classification of Peat Samples by Laboratory Testing

D4972 Test Methods for pH of Soils

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Recommended Slope/Crown Grade Elevations

Soil/site condition	Grade/Crown (%)
Loamy Sand, Sandy Loam or finer-textured	1.5 to 2.0 %
Sand texture	1.0 to 1.5 %
Primary-play season, during the wet season	1.25 to 2.0 %
Potential for frozen or heavy-frost cap soil	1.75 to 2.0 %

D6528 Test Method for Consolidated Undrained Direct Simple Shear Testing of Fine Grain Soils
F1632 Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes
F1647 Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes
F1815 Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Rootzones
F2060 Guide for Maintaining Cool Season Turfgrasses on Athletic Fields
F2269 Guide for Maintaining Warm Season Turfgrasses on Athletic Fields

3. Terminology

3.1 *Definitions:*

3.1.1 *native soil, n*—naturally occurring soil which is indigenous to a site.

4. Significance and Use

4.1 A dense, uniform, smooth and vigorously growing natural turfgrass sports field provides the ideal and preferred playing surface for most outdoor field sports. Such a surface is pleasing to the spectators and athletes. A thick, consistent and smooth grass cover also increases playing quality and safety by providing stable footing for the athletes, cushioning their impact from falls, slides or tackles and cools the playing surface during hot weather.

4.2 Sand is commonly used to construct high performance athletic field rootzone systems. Sand is chosen as the primary construction material for two basic properties; compaction resistance and improved drainage/aeration state. Although sand-based fields generally provide for a higher level of performance, the costs associated with constructing/developing a proper, high-performance sand-based field often precludes its use for many athletic field construction projects. In these instances soil-based fields constructed with either native or imported soils; either topsoil or subsoil material modified to mimic the properties of a natural topsoil (a manufactured topsoil). These soils are sometimes modified with amendments to improve their performance properties either at the time of original construction or during a subsequent renovation. Although not approaching the same performance properties of a proper sand-based field construction; the implementation of proper design, construction, and athletic field maintenance can produce soil-based athletic field rootzones with acceptable performance characteristics.

4.3 Properties of both the soil and grass plants must be considered in planning, constructing, and maintaining a high quality athletic field installation. Turfgrass utilized must be adapted to the local growing conditions and be capable of forming a thick, dense, turf cover at the desired mowing height. Soil-based fields provide varying levels of soil stability but such conditions often deteriorate rapidly under high soil moisture conditions. Therefore it is imperative that grasses with superior wear tolerance and superior recuperative potential are utilized to withstand heavy foot traffic and intense shear forces. The rootzone depth for athletic field constructions should be a minimum depth of 8 in.

4.4 Subgrade soils are typically site soils which are repurposed for this application. The use of stone, gravel, or coarse-sand for subgrade construction is typically not necessary and may be detrimental to the performance of the rootzone by the potential to impeded internal drainage and reduce air space from the creation of perched water effects. If an aggregate material is needed for stabilization purposes of a soft subgrade soil, the use of a fine stone dust should be considered.

4.5 A successful soil-based rootzone system is dependent upon the proper selection of materials to use in the project. The proper selection of soil materials or any amendments, or both, subsurface drainage and surface drainage/grade are the primary components which are vital concerns to the performance of the system and this standard guide addresses these issues.

4.5.1 During construction, consideration should be given to factors such as the physical and chemical properties of materials used in the area, freedom from stones and other debris, and surface and internal drainage (and subsurface drainage in areas subject to high water tables).

4.5.2 Maintenance practices that influence the playability of the surface include mowing, irrigation, fertilization, and mechanical aeration and are factors addressed in other standards. See Guides F2060 and F2269.

4.6 Those responsible for the design, construction, or maintenance, or a combination thereof, of natural turf athletic fields for multi-use and recreational purposes will benefit from this guide.

4.7 A successful project development depends upon proper planning and upon the selection and cooperation among design and construction team members. An athletic field rootzone project design team should include a Project Designer, an Agronomist or Soil Scientist, or both, and an Owner's Design Representative. Additions to the team during the construction phase should include an Owner's Project Manager (often an expansion of role for the Owner's Design Representative), an Owner's Quality Control Agent (often the personnel that is employed in advance with the intent of becoming the finished project's Sports Turf Manager), an Owner's Testing Agent (often an expansion of roles for the Project's Agronomist/Soil Scientist) and the Contractor.

4.7.1 Planning for projects must be conducted well in advance of the intended construction date. Often this requires numerous meetings to create a calendar of events, schedule, approvals, assessments, performance criteria, material sourcing, agronomic test reports, soil surveys, geotechnical reports, and construction budgets.

5. Critical Factors

5.1 *Surface Drainage*—To maintain adequate surface drainage, all native soil field installations should include a minimum of 1.0 % slope gradient (simple slope or crown) to remove water off of the playing field in case of a storm event with severe rainfall intensity and to facilitate the use of tarps. Surface drainage is required because most soil-based athletic fields do not have the inherent properties to allow internal drainage of excess water from heavy rainfall events. The surface grade should be adjusted to reflect the site/use factors as given in Table 1. However, it should be recognized that while increasing the slope gradient increases the surface drainage capacity, it also decreases the potential for rainfall or irrigation to infiltrate into the rootzone along the apex of the slope. Therefore, excessive slope could result in conditions where the apex area of the field may be found to be dry while at the same time the lower areas of the field are moist or wet. For irrigated fields, the irrigation design and installation should be parallel to the slope to allow differential irrigation rates. It is recommended that surface drainage inlets be installed in the perimeter of the installation (in the out of play areas) and tied into the storm drainage collection system for removal.

5.2 Additions of peat or compost, or both, may also be included in small proportions as part of the rootzone blend if the inclusion of these materials will not bring the resulting blend out of specifications and if they are uniformly blended together to form a homogeneous blend.

5.2.1 *Rootzone Components*—In addition to the use of an amending sand, there are two other types of organic amendments which are commonly included in a soil blend; which includes peat or compost, or both.

5.2.1.1 *Soil*—A native-type or manufactured topsoil which forms the basis of the rootzone blend should typically be sandy loam or sandier in texture. Finer-textured soils may be modified by sand inclusion to bring the resulting soil blend to a coarser soil texture. Soil textures of Loam (< ~50% sand content) and finer textured are generally not well suited for native-soil athletic field construction but are still often utilized. The recommended performance requirements of a soil or blended-soil rootzone are outlined in Table 2 and Table 3.

5.2.1.2 *Organic Amendment*—Compost or peat is commonly used as organic amending source in athletic field rootzones. Organic components also adds water and nutrient retention capacity. Mucks or mucky soils should not be used under any circumstances. Any organic amendment utilized should have a natural (unadulterated) pH between 4.5 and 7.0, an ash content of <40 %, and a Solvita stability index of > 6.[3]

TABLE 2 Recommended Physical Properties of the Athletic Field Rootzone (Test Methods F1815)

Physical Property	Specified Range
Total Porosity	35 – 50 %
Bulk Density (kg · m^{-3})	1.2 – 1.5
Air-filled Porosity	≥ 15 %
Capillary Porosity	≥ 15 %
Saturated Hydraulic Conductivity (cm/hr)	≥ 2.0
(Saturated Hydraulic Conductivity [inches/hr])	(≥ 0.75)

TABLE 3 Recommended Chemical Properties of the Athletic Field Rootzone

Chemical Property	Specified Range
pH (Test Methods D4972)	5.0 to 7.5
Calcium Carbonate Equivalent, preferred	< 5 %
Calcium Carbonate Equivalent, marginal	5 to 15 %
Organic Matter (Test Methods F1647), preferred	2 to 4 %
Organic Matter (Test Methods F1647), acceptable	1 to 6 %
Nutrient Content	Adjust for local conditions
Heavy metals or other phytotoxic ions	Adjust for local conditions, do not exceed regulated thresholds

NOTE 1—*Sand-Amendment*—The utilization of soil textures which are finer than Sandy Loam (< ~50 % sand) are not within the scope of this standard. However, if utilizing soils which are finer textured than Sandy Loam, the utilization of a sand amendment should be employed. Improvements to soil physical properties due to sand amendment will vary depending upon the amending sand properties (particle size distribution) and the volume inclusion of the amendment. Finer sands provide less benefit as an amending sand than do medium/coarse sands. Likewise, amending sand should be somewhat uniform in size distribution to provide for improved performance properties.

5.2.1.3 *Porous Inorganic and Other Amendments*—Porous inorganic amendments such as vitrified or calcined diatomites and clay, or zeolites are sometimes used in place of or in addition to peat, soil, or other organics in a rootzone mixture. However, the particle size of the amendment and the performance characteristics of the rootzone mixture must meet the recommendations in Table 2 and Table 3. It should be noted that these amendments have considerable differences among products and within the same product class. Also, many of these products also have closed internal porosity (pores which may not be open to the surface of particle) which imparts an effectively low particle density. As such, the internal air-filled porosity values may influence the air-filled porosity test value and indicate a level of porosity which is not available for soil-gas exchange.

5.2.1.4 Other amendments which are sometimes utilized as rootzone amendments include such materials as humates, biochar, seaweed products, vermiculture byproducts and similar. While these products may potentially add value, they are not a replacement for well-proven rootzone amendments. It is important that if these products are considered for inclusion in a rootzone blend, that lab testing is conducted which include these products at anticipated inclusion rate/s.

5.2.2 *Quality Control (QC) Program*—Every athletic field rootzone should be constructed using a well-designed and administered calibration and QC program. Such program should set the parameters to be included in the QC testing, the procedures for sampling, sampling intervals, handling the samples (chain of custody), the limits/tolerances or confidence intervals for accept/reject status within a sample, and the allowable variability of test parameters between samples.

[3] Seekins, W.D., Field test for compost maturity, *Biocycle*, 37, 1996, pp. 72-75.