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Standard Guide for Construction of High Performance Sand-Based Rootzones for Athletic Fields[1]

This standard is issued under the fixed designation F2396; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers techniques that are appropriate for the construction of high performance sand-based rootzones for sports fields. This guide provides guidance for the selection of materials, including soil, sand, gravel, peat, and so forth, for use in designing and constructing sand-based sports turf rootzones.

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 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 guide 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.

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

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]

C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

C1444 Test Method for Measuring the Angle of Repose of Free-Flowing Mold Powders (Withdrawn 2005)[3]

D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)[3]

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 Samples by Dry Mass

D2944 Practice of Sampling Processed Peat Materials

D2974 Test Methods for Moisture, Ash, and Organic Matter 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

D3080 Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

D4427 Classification of Peat Samples by Laboratory Testing

D4972 Test Methods for pH of Soils

F1632 Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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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
F2107 Guide for Construction and Maintenance of Skinned Areas on Baseball and Softball Fields
F2269 Guide for Maintaining Warm Season Turfgrasses on Athletic Fields
F2651 Terminology Relating to Soil and Turfgrass Characteristics of Natural Playing Surfaces

3. Terminology

3.1 *Definitions:*

3.1.1 Except as noted, soil-related definitions are in accordance with Terminology F2651.

NOTE 1—Particle size ranges for sand, silt, and clay used in this standard vary somewhat from ranges given in Test Method D422.

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. Sand is commonly used to construct high performance sports turf rootzone systems. Sand is chosen as the primary construction material for two basic properties, compaction resistance and improved drainage/aeration state. Sands are more resistant to compaction than finer soil materials when played upon within a wide range of soil moisture conditions. A loamy soil that may provide a more stable surface and enhanced growing media compared to sand under optimal or normal conditions will quickly compact and deteriorate in condition if used in periods of excessive soil moisture, such as during or following a rainy season. A properly constructed sand-based rootzone, on the other hand, will resist compaction even during wet periods. Once compacted, sands are easier to decompact with the use of mechanical aeration equipment. Even when compacted, sands will retain an enhanced drainage and aeration state compared to native soil rootzones under the same level of traffic. As such, sand-based rootzones are more conducive to providing an all-weather type of playing surface. Properties of both the soil and grass plants must be considered in planning, constructing, and maintaining a high quality sports turf 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. Unvegetated sand in and of itself is not inherently stable; 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. Sand does, however, have incredible load bearing capacity and if a dense, uniform turf cover is maintained, the sand-based system can provide a very stable, firm, smooth, and uniform playing surface. A successful sand-based rootzone system is dependent upon the proper selection of materials to use in the project. The proper selection of sand, organic amendment, soil and gravel is of vital concern to the performance of the system and this guide addresses these issues.

4.1.1 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.

4.1.2 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).

4.2 Those responsible for the design, construction, or maintenance, or a combination thereof, of natural turf athletic fields for high-performance, all-weather purposes will benefit from this guide.

4.3 A successful project development depends upon proper planning and upon the selection of and cooperation among design and construction team members. A high-performance, sand-based rootzone project design team should include a project designer, an agronomist or soil scientist, or both, and an owner's 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 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 field manager), an owner's testing agent (often an expansion of roles for the project's agronomist/soil scientist), and the contractor.

4.3.1 Planning for projects must be conducted well in advance of the intended construction date. This often requires numerous meetings to create a calendar of events, schedule, approvals, assessments, performance criteria, material sourcing, geotechnical reports, and construction budgets.

NOTE 2—Other specifications on soils for athletic field construction have been published and have been considered during the development of this guide.

5. Construction

5.1 The steps to be used in construction of a new athletic field include:

5.1.1 Survey and stake the site to establish subgrade and finish grade elevations.

5.1.2 Construct and prepare subgrade, and provide a correct and certified subgrade.

5.1.3 Install subsurface drainage system, frame out warning tracks, skinned areas, and so forth, as appropriate.

5.1.4 Install irrigation system (irrigation system may be installed prior to rootzone installation).

5.1.5 Prepare for rootzone installation.

5.1.5.1 Secure suitable sand, properly tested and approved.

5.1.5.2 Blend any amendments with sand to project specifications, approve using QC program.

5.1.5.3 Install approved gravel (if included in design).

5.1.6 Install rootzone blend.

5.1.7 Bring field to final grade and contour in accordance with specifications, compact to specifications.

5.1.7.1 A pre-plant fertilizer application may be applied at this point as specified.

5.1.8 Establish turf by appropriate methods (seed, sprigs, plugs or sod).

5.1.9 Fertilize the installation as appropriate based upon soil testing.

5.1.10 Turf is to be established based upon grow-in recommendations from a competent agronomist or soil testing laboratory, as appropriate for the turf species utilized and the climate of the site.

5.2 *Survey and Stake*—This procedure should be done to conform to the project designer's specifications as appropriate for the sport. In the case of the construction of a replacement field, this step may be deleted or modified as appropriate. Care should be taken to protect staking during the construction process.

5.3 *Construct and Prepare Subgrade*—Contour the subgrade in accordance with specifications at a suggested tolerance of ±12.5 mm (½ in.) within 3 m (10 ft) of linear direction as specified in 5.5.6. The subgrade should be installed at a depth such to accommodate the final profile depth of rootzone and any gravel layer (if included). The subgrade should be compacted sufficiently (suggested 85 % minimum to 90 % maximum proctor density) to prevent future settling. Subgrade should be designed to conform to surface contour of finished playing surface.

5.4 *Subsurface Drainage System*—Many types of designs exist for subsurface drainage most commonly including a grid or herringbone pattern. The project specifications should include a subsurface drainage design to facilitate drainage for a 25 year storm event. Most commonly used drainage systems for sand-based athletic fields include utilizing perforated drainlines 10 cm (4 in.) in a 4.5 m (15 ft) to 6 m (20 ft) spacing between drainline laterals.

5.4.1 *Drainline Trenches*—Trenches constructed for drainlines should be excavated into a properly prepared, graded, and compacted subgrade. Drainage trenches should be of a depth such to conform to the drainage contours. All drainage trenches and drainline installations should maintain a minimum positive slope gradient of ≥0.5 % toward drainage outlets with trench bottoms compacted to subgrade specifications. Drainage excavations should be made such that a minimum of 5 cm (2 in.) of bedding material can be contained around the installed drainline (below, to each side, and above). For example, a 10 cm (4 in.) diameter drainline installation will require a minimum dimension of 20 cm (8 in.) wide by 20 cm (8 in.) depth (for example, 10 cm drainline + (5 cm/side × 2 sides) = 20 cm; 10 cm drainline + 5 cm top + 5 cm bottom = 20 cm). Once drainage trenches are excavated, all excavated material should be removed from the subgrade surface and disposed off site. The subgrade should have no elevations of subgrade soil material such to hinder the flow of water along the subgrade interface into the drainage trench. Once drainage trenches have been excavated, the trench bottoms should be sufficiently compacted to the subgrade compaction specifications prior to installation of drainage system. Subgrade shall be re-surveyed and certified prior to gravel or rootzone import.

5.4.2 *Surface Drainage*—To maintain adequate surface drainage, all field installations should include a minimum of 0.5 % 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. It is recommended that an adequate number of small size surface drainage inlets be installed in the perimeter of the installation (in out-of-play areas) and tied into the drainage collection system for removal of surface runoff with the subsurface drainage water.

NOTE 3—In planning and designing projects, consideration shall be given to the permeability of the rootzone when determining the slope of the finished surface and the need for adjacent surface drainage systems. Further consideration shall be given in cold climates where frost penetration may impact the permeability of the rootzone when determining the slope of the finish surface and the need for adjacent surface drainage systems. Generally, the need for improved surface drainage increases as the permeability of the rootzone decreases.

5.4.3 *Sub-Surface Drainage Material*—Three recommended options exist for the use of drainage material. Option 1 could utilize sand rootzone material to backfill around drainlines within the drainage trenches. Option 2 could utilize gravel material to backfill around drainlines in the drainage trenches. Option 3 could include the use of gravel to backfill around drainlines in drainage trenches and to form a drainage layer overlying the subgrade before placement of rootzone sand blend. All backfill treatments shall be compacted to specifications prior to further installation procedures. It is recommended that backfill for trench bottoms is installed and compacted prior to installing drain pipe into the trenches. It is recommended that the trench bottom remain unobstructed as installed and no soil pilings, wood blocks, concrete or metal blocks are used to adjust and maintain slope of drainlines. Any blocks used for this purpose must be removed from under the drainlines and any cavities backfilled before proceeding. It is recommended that drainage trenches (bottom and sides *only*) should be lined with a woven geosynthetic filter fabric to prevent contamination (lateral movement of subgrade materials into trench fill). Geosynthetic filter fabric should *not* be used to cover the drainage trench. It is recommended that all drainlines are installed straight (without 'snaking') within the trenches. It is recommended that sleeves (of oversize PVC piping) should be installed across the drainage trenches at appropriate points as indicated by the irrigation design to facilitate irrigation pipe installation at points where the irrigation line crosses over the drainage trenches.

5.4.3.1 *Option 1*—Rootzone sand (with or without other rootzone amendments) may be utilized to backfill around drainlines. If sand is utilized for this purpose, the drainage pipe used in these installations must be of a type that utilizes slitted perforations with slit openings meeting a specification of D_{85} sand/slot width >1.5, to reduce the potential for particle migration into the drainage system (**1**).

5.4.3.2 *Option 2*—Gravel may be used for backfill of drainage trenches. If gravel is used for backfill, it should conform to the specifications in Table 1. Soft gravel minerals (such as limestone, sandstone, or shale) are not acceptable for