Designation: F2747 – 19

An American National Standard

Standard Guide for Construction of Sand-based Rootzones for Golf Putting Greens and Tees[1]

This standard is issued under the fixed designation F2747; 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 golf greens and tees. This guide provides guidance for the selection of materials, including soil, sand, gravel, peat, etc., for use in designing and constructing sand-based golf 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 given in parentheses are for information only.

1.5 *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

D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

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

D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

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

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 Field Rootzone Mixes

[1] This guide is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.64 on Natural Playing Surfaces.

Current edition approved Oct. 1, 2019. Published November 2019. Originally approved in 2010. Last previous edition approved in 2010 as F2747 – 10, which was withdrawn January 2019 and reinstated in October 2019. DOI: 10.1520/F2747-19.

[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.

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
F2397 Specification for Protective Headgear Used in Combative Sports
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 Terminologies D653 and F2651.

4. Significance and Use

4.1 A dense, uniform, smooth and vigorously (or healthy) growing natural turfgrass golf green or tee provides the ideal and preferred putting or teeing surface for golf. Sand is commonly used to construct high performance putting green and tee rootzone systems. Sand is chosen as a primary construction material due to its compaction resistance and improved drainage and aeration compared to other soil materials. 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 rain event. A properly constructed sand-based rootzone on the other hand will resist compaction even during wet periods. 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 putting or teeing surface. Once compacted, sands are also easier to decompact with the use of mechanical aeration equipment.

4.2 Properties of both the soil and grass plants must be considered in planning, constructing, and maintaining a high quality putting green or tee installation. Turfgrasses 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 is not inherently stable and therefore it is imperative that grasses are utilized to withstand the rigors of play. Sand does however have incredible load bearing capacity and if a dense, uniform turf cover is maintained the sand-based system can provide a firm and uniform playing surface.

4.3 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 amendments, soil, and gravel is of vital concern to the performance of the system. This standard guide addresses these issues.

4.3.1 During construction, consideration should be given to factors such as the physical and chemical properties of rootzone materials, surface and internal drainage as well as stones and other debris.

4.3.2 Maintenance practices that influence playability include mowing, irrigation, fertilization, and mechanical aeration. These factors are addressed in other standards (Guides F2060, F2269, and F2397).

4.4 Those responsible for the design, construction, or maintenance, or a combination thereof, of golf putting greens and tees will benefit from this guide.

4.5 A successful project development depends upon proper planning and upon the selection of and cooperation among design and construction team members. A sand-based putting green/tee rootzone project design team should include a golf course architect/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 golf course superintendent/greenskeeper), an owner's testing agent (often an expansion of roles for the project's agronomist/soil scientist) and the contractor.

4.5.1 Planning for projects must be conducted well in advance of the intended construction date. Often this planning requires numerous meetings to create a calendar of events, schedule, approvals, assessments, performance criteria, quality control (QC) protocols, material sourcing, geotechnical reports, and construction budgets.

NOTE 1—Other specifications on soils for golf green and putting green construction that have been published were considered during the development of this standard.

5. Construction

5.1 The steps involved in the construction of a new putting green or tee include:

(1) Survey and stake the site to establish subgrade and finish grade elevations,

(2) Construct and prepare subgrade, subgrade being correct and certified,

(3) Install subsurface drainage system,

(4) Frame out putting green/tee perimeter as appropriate,

(5) Install irrigation system (irrigation system may be installed prior to rootzone installation),

(6) Prepare for rootzone installation,

(a) secure suitable sand, properly tested and approved,

(b) blend any amendments with sand to project specifications, approve using QC program,

(c) install approved gravel (if included in design),

(7) Install rootzone blend,

(8) Bring green/tee to final grade and contour as per specifications, compact to specifications,

(a) a pre-plant fertilizer application may be applied at this point as specified,

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

(10) Apply fertilizer as appropriate based upon soil test recommendations, and

(11) Turf to be established based upon grow-in recommendations from a competent agronomist for the turf species utilized and the climate of the site.

5.2 *Survey and Stake*—This procedure should be done to conform to project Golf Course Architect's specifications as appropriate for the grade contour. When constructing a replacement green or tee, 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 to specifications at a suggested tolerance of +25 mm (1 in.) within 3 m (10 ft) of linear direction as specified in 5.5.7. The subgrade should be installed finished to a depth such to accommodate the final profile depth of rootzone and a gravel layer (if included). The subgrade should be compacted sufficiently (suggested 85 % minimum to 90 % maximum standard proctor density (Test Methods D698)) to prevent future settling. Subgrade should be designed to conform to the surface contour of finished putting surface.

5.4 *Subsurface Drainage System*—Many types of designs exist for subsurface drainage with the most common including a grid or herringbone pattern. Most commonly used drainage systems for sand-based putting greens and tees utilize perforated drainlines with 10 cm (4 in.) diameter in a 4.5 to 6 m (15 to 20 ft) spacing between drainline laterals. This spacing typically depends upon site conditions such as height above groundwater, surface grading, and soil type of the subgrade.

5.4.1 *Drainline Trenches*—Trenches constructed for drainlines should be excavated into a properly prepared, graded and compacted subgrade. Drainage trenches should be deep enough to conform to the drainage contours. All drainage trenches and drainline installations should maintain a minimum positive slope gradient of >0.5 % towards 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 the green or tee construction 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 green/tee installations should include a minimum of 0.5 % slope gradient (contours) to remove water off of the putting green/tee in case of a storm event with severe rainfall intensity.

NOTE 2—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 finished 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: sand rootzone material is utilized to backfill around drainlines within the drainage trenches. Option 2: gravel material is utilized to backfill around drainlines in the drainage trenches. Option 3: gravel is utilized to backfill around drainlines in drainage trenches and to form a drainage layer overlying the subgrade before placement of rootzone sand blend. Option 3 is the method recommended by the USGA for putting green installations. 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 and no soil pilings, wood blocks, concrete or metal blocks are utilized to permanently adjust and maintain the slope of drainlines. Any blocks which were temporarily used for this purpose must be removed from underneath 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. Many geosynthetic filter fabrics are prone (or designed) to plug from fine particulates as they "filter" them from passing through the fabric. Therefore, these fabrics should never be used to wrap a drainline, cover a drainage trench, to cover a gravel drainage layer, or to separate the rootzone from a gravel layer. Other geosynthetic fabrics (non-woven, heat-set needle-punched geotextiles) which are designed not to clog may be used with caution with studies and field experience having shown that these materials have been used successfully for these applications. 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 drainage trenches. If sand is utilized for this purpose, the drainage pipe used in these installations must be of a type that has slitted perforations with slit openings meeting a specification of