Designation: E2788 – 11

Standard Specification for Use of Expanded Shale, Clay and Slate (ESCS) as a Mineral Component in the Growing Media and the Drainage Layer for Vegetative (Green) Roof Systems[1]

This standard is issued under the fixed designation E2788; 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 specification covers the quality and grading of the following materials for use as a mineral component of growing media and drainage layer for extensive and intensive vegetative (green) roof systems. The requirements are intended to cover only materials having normal or average gradation characteristics. Procedures covered in this specification are not intended for evaluating the performance nutrients associated with vegetative (green) roof growing media Where other materials are to be used, appropriate limits suitable to their use must be specified.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This standard 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C29/C29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

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

C127 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

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

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

C330 Specification for Lightweight Aggregates for Structural Concrete

C331 Specification for Lightweight Aggregates for Concrete Masonry Units

D75 Practice for Sampling Aggregates

D4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

D4767 Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

D5883 Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

D6739 Test Method for Silica—pH Value

E2114 Terminology for Sustainability Relative to the Performance of Buildings

E2399 Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems

3. Terminology

3.1 *Definitions:*

3.1.1 For terms related to Expanded Shale, Clay and Slate (ESCS), refer to Terminology D5883.

[1] This specification is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.24 on Sustainability.

Current edition approved Dec. 1, 2011. Published February 2012. DOI: 10.1520/E2788-11.

[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.

3.1.2 For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.3 *expanded shale, clay, and slate (ESCS), n*—a lightweight, ceramic material produced by expanding and vitrifying select shale, clay, or slate in a rotary kiln.

3.4 *extensive vegetative (green) roof system, n*—a vegetative (green) roof system that utilizes a narrow range of species limited to herbs, grasses, mosses, and drought tolerant succulents such as *sedum*. These types of plants can potentially be sustained in a shallow growing media layer usually six inches and under with generally less maintenance than *intensive vegetative (green) roof systems*.

3.5 *vegetative (green) roof system, n*—assembly designed to support vegetation growth above a waterproofed membrane.

3.6 *growing media (media), n*—the substrate in which plants take hold and develop.

3.7 *intensive vegetative (green) roof system, n*—a vegetative (green) roof system that utilizes a wide variety of plant species that require a growing media greater than six inches that may include lawns, trees, and shrubs.

3.8 *saturated surface dry (SSD), n*—condition after the aggregate is immersed in water for a minimum period of 72 hours with no visable water on the exposed surfaces of the aggregate.

3.9 *sedums, n*—a succulent plant known for its tolerance for extreme conditions.

4. Materials and Manufacture

4.1 ESCS is a lightweight, ceramic material produced by expanding and vitrifying select shale, clay or slate in a rotary kiln. It is a highly porous and low-density material. The raw shale, clay or slate used to produce ESCS is fired in the kiln at temperatures exceeding 1000°C. As it exits the kiln the material is sterile, inert, and ceramic. Some crushing may be performed to facilitate final screening in a screening system. ESCS is generally neutral in pH although the pH can vary somewhat depending on the raw material and the fuel used for processing. Test Method C29/C29M determines density (loose unit weight). Test Method C127 is used to determine the absorption after soaking the material. The particle distribution is determined with the appropriate sieves as stated in Test Method C136. The ESCS to be sampled in accordance with Practice D75.

TABLE 1 Gradation Requirements for ESCS (Specification C330 and Test Method C331)

Sieve Specification	Drainage Layer % Passing	Coarse Gradation % Passing	Fine Gradation % Passing
19 mm (¾ in.)	90 – 100	100	100
12.5 mm (½ in.)	90 – 100	100	100
9.5 mm (⅜ in.)	20 – 100	80 – 100	100
4.75 mm (No. 4)	5 – 40	5 – 40	85 – 100
2.36 mm (No. 8)	0 – 20	0 – 20	. . .
1.8 mm (No. 16)	0 – 10	0 – 10	40 – 80
0.6 mm (No. 30)	. . .	. . .	. . .
0.3 mm (No. 50)	. . .	. . .	10 – 35
0.15 mm (No. 100)	. . .	. . .	5 – 25
0.074 mm (No. 200)	0 – 2[A]	0 – 5[A]	0 – 20[A]

[A] The percentage of material passing 0.074 mm by volume also applies to any components including organic matter used as an amendment to the aggregate.

5. Requirements

5.1 The aggregates shall conform to the gradation requirements specified in Table 1. For the drainage layer no more than 2 % by volume of aggregate particles shall have a diameter of <0.075 mm (No. 200 screen). As a component in the total growing media the aggregate shall not contribute to the final gradation of the media having more than 5 % of particles with a diameter <0.075 mm for the media for extensive vegetative (green) roof plantings. No more than 20 % by volume of particles with a diameter <0.075 mm should be present in the total gradation of the media for intensive vegetative (green) roof plantings.

5.2 *Physical Properties*—The aggregate shall conform to the physical properties specified in Table 2.

5.3 *Chemical Properties*—The aggregate shall conform to the chemical properties specified in Table 3.

6. Keywords

6.1 drainage; ESCS; green (vegetative) roofs

TABLE 2 Physical Properties of ESCS

Physical Properties	Unit	Drainage	Coarse	Fine	Test Method
Bulk Density Dry Loose	lbs/cf	32 – 60	32 – 65	38 – 70	Test Method C29/C29M
Bulk Density (max. water holding capacity)	lbs/cf	<64.0	<68.0	<90.0	Test Method C29/C29M
Maximum Index Density	SSD lbs/sf	<70	<70	<78	Test Method D4254
Maximum Index Density	Vol %	>48.0	>40.0	>10.0	Test Method C29/C29M, see Note 1
Air Filled Porosity	Vol %	>30.0	>20.0	>10.0	Test Method E2399
Maximum Water-holding Capacity	Vol %	. . .	>12.0	>35.0	Test Method E2399
Water Permeability	cm per sec	>1.0 cm/s	>0.1 cm/s	>0.001 cm/s	Test Method E2399
Angle of Internal Friction (Compacted)	degree	32° – 48°	32° – 48°	32° – 40°	Test Method D4767
Frost-Resistance	% loss	<10 %	<10 %	<5 %	Test Method C88
Los Angeles Abrasion	% loss by weight	<35 %	. . .	. . .	Test Method C131, modified method FM 1-T096

TABLE 3 Chemical Properties of ESCS

NOTE 1—Care must be taken to specify what Test Method C29/C29M testing procedure is to be used for ESCS fines (rodding, jigging, or shoveling). Using the shoveling procedure to determine loose bulk density may result in the sample weighing less per volume moist than it will when dry because moisture tends to cause bulking of the ESCS fines that creates larger air pockets in the sample.

NOTE 2—ESCS is generally used in green roof systems as the mineral component of the media or as a granular drainage material. The hydraulic conductivity of the ESCS will differ depending on type and gradation. The gradation can vary from 1.9 cm (¾ in.) to fine sand like material. The media may require a blend of different sizes of ESCS with or without sand or an organic component, or both, depending on whether the application is for an Intensive or Extensive vegetative (green) roof. Variations in the media can be obtained by adjusting the gradation of ESCS to meet the desired porosity, weight or moisture retention requirement. The main adjustment that needs to be addressed is a correction for the weight and volume relationship of ESCS fines, that is, the minus 4.75 mm (No. 4) sieve size to a similar size of sand. The oven-dry or saturated surface dry/loose unit weight tests (see Test Method C29/C29M) can be performed to establish the weight-volume relationship.

NOTE 3—The pH values signify only the pH range for the ESCS aggregate portion of the media, the pH for the total blended media should fall between the range of 5.5 to 8.5 as best suited for the plant selection.

NOTE 4—Adapted from, "Diagnosis and Improvement of Saline and Alkaline Soils," USDA Agricultural Handbook 60, L.A. Richards (ed.), U.S. Gov. Print. Office, Washington, DC 1954.

Chemical Properties	Unit	Drainage	Intensive	Extensive	Test Method
pH	SI	. . .	5.5 – 10.5	5.5 – 10.5	D6739, see Note 3
Salt Content	mmhos/cm	<1.50 mmhos/cm	<0.60 mmhos/cm	<0.60 mmhos/cm	Saturated Paste Procedure Method, see Note 4.