Designation: D6817/D6817M – 13a

Standard Specification for Rigid Cellular Polystyrene Geofoam[1]

This standard is issued under the fixed designation D6817/D6817M; 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 types, physical properties and dimensions of rigid cellular polystyrene intended for use as geofoam.

1.2 This specification does not cover the layout, placement and workmanship for proper installation and performance of rigid cellular polystyrene geofoam.

1.3 Rigid cellular polystyrene geofoam covered by this specification may need protection from certain chemicals, environmental exposure, and concentrated loads. Additional design considerations may include thermal conductivity and buoyancy. Guidelines regarding these end use considerations are included in Appendix X1.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

C203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

D1621 Test Method for Compressive Properties of Rigid Cellular Plastics

D1622 Test Method for Apparent Density of Rigid Cellular Plastics

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

D4439 Terminology for Geosynthetics

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*

3.1.1 Terms used in this specification are defined in Terminology D4439.

3.1.2 *geofoam*—block or planar rigid cellular foam polymeric material used in geotechnical engineering applications.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *EPS, XX*—number designation for expanded polystyrene geofoam type(s) having a minimum density of XX kg/m^3 [lb/ft^3].

3.2.2 *XPS, XX*—number designation for extruded polystyrene geofoam type(s) having a minimum density of XX kg/m^3 [lb/ft^3].

3.2.3 *RCPS*—letter designation for EPS and XPS rigid cellular polystyrene geofoam covered by this specification.

4. Ordering Information

4.1 Acquisition documents shall specify the following:

4.1.1 Title, number and year of this specification.

4.1.2 Type, as per Table 1, or minimum density required.

4.1.3 Total product volume required of each type, or minimum density.

5. Materials and Manufacture

5.1 RCPS geofoam shall be formed by the expansion of polystyrene resin beads or granules in a molding process (EPS)

[1] This specification is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.03 on Permeability and Filtration.

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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 Physical Property Requirements of RCPS Geofoam[A]

Type	EPS12	EPS15	EPS19	EPS22	EPS29	EPS39	EPS46	XPS20	XPS21	XPS26	XPS29	XPS36	XPS48
Density, min., kg/m^3 [lb/ft^3]	11.2 [0.70]	14.4 [0.90]	18.4 [1.15]	21.6 [1.35]	28.8 [1.80]	38.4 [2.40]	45.7 [2.85]	19.2 [1.20]	20.8 [1.30]	25.6 [1.60]	28.8 [1.80]	35.2 [2.20]	48.0 [3.00]
Compressive Resistance, min., kPa [psi] at 1 % strain	15 [2.2]	25 [3.6]	40 [5.8]	50 [7.3]	75 [10.9]	103 [15.0]	128 [18.6]	20 [2.9]	35 [5.1]	75 [10.9]	105 [15.2]	160 [23.2]	280 [40.6]
Flexural Strength, min., kPa [psi]	69 [10.0]	172 [25.0]	207 [30.0]	240 [35]	345 [50.0]	414 [60.0]	517 [75.0]	276 [40.0]	276 [40.0]	345 [50.0]	414 [60.0]	517 [75.0]	689 [100.0]
Oxygen index, min., volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0

[A] For products that have an external skin, testing shall be undertaken with skins intact.

or by the expansion of polystyrene base resin in an extrusion process (XPS). RCPS geofoam may be manufactured with reprocessed polystyrene foam (regrind).

5.2 RCPS geofoam shall be of uniform density and have essentially closed cells. RCPS geofoam is an organic material and is considered combustible. It should not be exposed to flames or other ignition sources.

6. Qualification Requirements

6.1 The physical properties listed in Table 1 constitute the minimum product qualification requirements for commonly manufactured types of RCPS geofoam. The compressive resistance at 1 % strain is typically within the elastic limit of the geofoam product types in Table 1 and is accepted as the compressive resistance to limit long-term deformation under structural load.

6.2 *RCPS Geofoam Types*—It is the users responsibility to specify the required type as in Table 1 and to obtain supporting documentation regarding physical properties from the material supplier.

6.3 The compressive resistance properties in Table 2 are provided for applications where compressive resistance requirements for intended end-use applications are beyond the elastic limit of geofoam.

NOTE 1—The application of sustained load to geofoam beyond the elastic limit will result in significant deflections beyond the values provided in Table 2.

6.4 *Combustibility Requirements*—All RCPS geofoam shall contain sufficient flame retardants to meet a minimum Oxygen Index as required in Table 1.

6.5 *Curing*—Unless otherwise specified in the contract, RCPS geofoam shall be cured for a minimum of 24 h before delivery and inspection.

7. Availability and Dimensional Tolerance

7.1 *Availability*—The RCPS geofoam materials covered by this specification are commonly available in the size range shown in Table 3. Specific RCPS geofoam block dimensions vary by manufacturer equipment characteristics.

7.2 *Dimensional Tolerance*—Unless otherwise specified, the acceptable length, width, thickness, flatness and squareness tolerance criteria on RCPS geofoam shall not exceed ±0.5 %.

8. Damage and Degradation

8.1 *Damage*—RCPS geofoam as delivered to the project site shall have no defects that will adversely affect its service and workability qualities. Material units that manifest unacceptable surface or volumetric damage shall be replaced.

8.1.1 *Surface Damage*—Damage to load bearing RCPS geofoam surfaces shall be limited to less than 20 % of the equivalent load bearing area of the unit.

8.1.2 *Volume Damage*—Volumetric damage of RCPS geofoam shall be limited to less than 1 % of the volume of a single unit.

8.1.3 *UV (Ultra-Violet) Degradation*—Discoloration and dusting of RCPS geofoam caused by the extensive exposure to sunlight is a defect that will adversely affect its service and is grounds for rejection. Refer to X1.6.

9. Inspection

9.1 *Sampling*—Unless otherwise specified in the purchase order or contract, the material shall be sampled for inspection in accordance with Practice C390.

9.2 *Weight*—Determine the weight of selected full size units in accordance with Test Method D1622, or as specified.

9.3 *Dimensions*—Verify specified dimensions and tolerances, as prescribed in Test Method D1622 and 7.2 of this specification.

9.4 *Density*—Compute the density of test samples in accordance with Test Method D1622.

10. Acceptance or Rejection

10.1 Material that fails to conform to this specification shall be rejected promptly in writing. The manufacturer or supplier shall have the right to re-inspect the rejected shipment and resubmit selected units for acceptance under tightened inspection.

TABLE 2 Additional Physical Property Requirements of RCPS Geofoam[A,B]

Type	EPS12	EPS15	EPS19	EPS22	EPS29	EPS39	EPS46	XPS20	XPS21	XPS26	XPS29	XPS36	XPS48
Density, min., kg/m^3 [lb/ft^3]	11.2 [0.70]	14.4 [0.90]	18.4 [1.15]	21.6 [1.35]	28.8 [1.80]	38.4 [2.40]	45.7 [2.85]	19.2 [1.20]	20.8 [1.30]	25.6 [1.60]	28.8 [1.80]	35.2 [2.20]	48.0 [3.00]
Compressive Resistance, min., kPa [psi] at 5 % strain	35 [5.1]	55 [8.0]	90 [13.1]	115 [16.7]	170 [24.7]	241 [35.0]	300 [43.5]	85 [12.3]	110 [16.0]	185 [26.8]	235 [34.1]	335 [46.6]	535 [77.6]
Compressive Resistance, min., kPa [psi] at 10 % strain[A]	40 [5.8]	70 [10.2]	110 [16.0]	135 [19.6]	200 [29.0]	276 [40.0]	345 [50]	104 [15.0]	104 [15.0]	173 [25.0]	276 [40.0]	414 [60.0]	690 [100.0]

[A] If yield occurs prior to 10 % deformation, report compressive resistance and deformation at yield in addition to the compressive resistance at 1 %, 5 %, and 10 % deformation.
[B] For products that have an external skin, testing shall be undertaken with skins intact.

TABLE 3 Common Manufactured Dimensions of RCPS Geofoam

Dimension, mm [in.]	All EPS Types	All XPS Types
Width	305 to 1219 [12 to 48]	406 to 1219 [16 to 48]
Length	1219 to 4877 [48 to 192]	1219 to 2743 [48 to 108]
Thickness	25 to 1219 [1 to 48]	25 to 102 [1 to 4]

11. Certification

11.1 Unless otherwise specified in the purchase order or contract, the manufacturer or supplier shall furnish third party certification that representative material has either been tested or inspected as directed in the specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

12. Product Marking

12.1 The following shall be marked on each whole unit of product:

12.1.1 Manufacturers Identification,

12.1.2 Date of Manufacture,

12.1.3 Type, (See Table 1), and

12.1.4 Weight, or Density.

13. Test Methods

13.1 *Conditioning:*

13.1.1 Samples shall be conditioned at a standard laboratory temperature of 23 ± 2°C [73.4 ± 4°F] for a minimum of 24 h prior to the start of tests.

13.2 *Dimensions and Density*—Test in accordance with Test Method C303 or Test Method D1622.

13.3 *Compressive Resistance*—Test in accordance with Test Method C165 or Test Method D1621 using 50 mm [2 in.] cubes. The rate of cross-head movement shall be 5.0 ± 0.5 mm/min [0.2 ± 0.02 in./min] equivalent to 10 % strain per minute.

13.4 *Flexural Strength*—Test in accordance with Test Method C203.

13.5 *Oxygen Index*—Test in accordance with Test Method D2863.

14. Precision and Bias[3]

14.1 The precision of this test method is based on an interlaboratory study of 13.3 of Specification D6817, conducted in 2011. A total of seven laboratories participated in this study, testing three materials at 1 %, 5 %, and 10 % compressive resistance. Each "test result" reported represents an individual determination, and all participants were asked to report five test results for each area tested. Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. RR: D35-1014.

14.1.1 *Repeatability limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "r" value for that material; "r" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

14.1.1.1 Repeatability limits are listed in Tables 4-6.

14.1.2 *Reproducibility limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "R" value for that material; "R" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

14.1.2.1 Reproducibility limits are listed in Tables 4-6.

14.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

14.1.4 Any judgment made in accordance with statements 14.1.1 and 14.1.2 would have an approximate 95 % probability of being correct.

14.2 *Bias*—As there were no available standard reference materials at the time of this study, bias cannot be determined.

14.3 The precision statement was determined through statistical examination of 315 test results, submitted by seven laboratories, recording compressive resistance measurements of three materials.

14.3.1 The three materials were all described as expanded polystyrene.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D35-1014.

TABLE 4 1 % Compressive Resistance (units)

Material	Average[A] $\bar{x}$	Repeatability Standard Deviation S_r	Reproducibility Standard Deviation S_R	Repeatability Limit r	Reproducibility Limit R
A	4.564	0.333	0.647	0.933	1.812
B	9.855	0.381	1.144	1.068	3.203
C	21.591	0.850	2.310	2.379	6.467

[A] The average of the laboratories' calculated averages.

TABLE 5 5 % Compressive Resistance (units)

Material	Average[A] $\bar{x}$	Repeatability Standard Deviation S_r	Reproducibility Standard Deviation S_R	Repeatability Limit r	Reproducibility Limit R
A	11.021	0.480	0.631	1.344	1.767
B	19.956	0.454	0.527	1.270	1.474
C	42.664	0.932	1.152	2.610	3.226

[A] The average of the laboratories' calculated averages.

TABLE 6 10 % Compressive Resistance (units)

Material	Average[A] $\bar{x}$	Repeatability Standard Deviation S_r	Reproducibility Standard Deviation S_R	Repeatability Limit r	Reproducibility Limit R
A	12.660	0.532	0.701	1.490	1.962
B	22.051	0.510	0.609	1.427	1.705
C	46.705	1.080	1.343	3.023	3.760

[A] The average of the laboratories' calculated averages.

14.4 To judge the equivalency of two test results, it is recommended to choose the material that is closest in characteristics to the test material.

15. Keywords

15.1 block; board; cellular polystyrene; EPS; expanded polystyrene; extruded polystyrene; foam plastic; geofoam; RCPS; reprocessed; rigid cellular polystyrene; XPS

APPENDIX

(Nonmandatory Information)

X1. END-USE CONSIDERATIONS

X1.1 Thermal Resistance

X1.1.1 RCPS geofoam also functions as a thermal insulation. The thermal insulation properties of RCPS geofoam are as specified in Specification C578, and may impact the end use design of applications subject to different exposure conditions. Consult the RCPS geofoam manufacturer for specific recommendations.

X1.2 Solvent Exposure

X1.2.1 RCPS geofoam must be protected from petroleum based solvents and their vapors. Examples of these solvents are: gasoline, diesel fuel, concrete curing compound, coal tar pitch, and asphaltic mastic compounds.

X1.3 Equipment Traffic

X1.3.1 Equipment traffic that can impose contact pressures in excess of the allowable design stress for RCPS geofoam should be restricted. Protective materials such as sheathing or planks may be placed on the material to allow light rubber-tired equipment use.

X1.4 Buoyancy

X1.4.1 RCPS geofoam becomes buoyant when submerged in water and adequate ballast must be provided to resist expected uplift forces.

X1.5 Design

X1.5.1 The design and installation of RCPS geofoam is the responsibility of the user.

X1.5.2 RCPS geofoam can be supplied precut to specified dimensions to fit specific project needs. Desired shapes and sizes can also be field cut with a hot wire, saw, or other cutting tool.

X1.6 Ultra-Violet Degradation

X1.6.1 Discoloration and dusting of load bearing surfaces of RCPS geofoam caused by extended exposure to sunlight shall be removed by pressure washing.