



Designation: C 1491 – 01

## Standard Specification for Concrete Roof Pavers<sup>1</sup>

This standard is issued under the fixed designation C 1491; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers concrete roof pavers that are machine-made from portland cement, water, and suitable mineral aggregates with or without the inclusion of other materials, for use as roof ballast and protection of roof membranes.

NOTE 1—The design of roof ballast systems for resisting wind uplift is beyond the scope of this specification. Building codes and other standards should be consulted in designing for wind uplift resistance.

1.2 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 33 Specification for Concrete Aggregates<sup>2</sup>
- C 140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units<sup>3</sup>
- C 150 Specification for Portland Cement<sup>4</sup>
- C 331 Specification for Lightweight Aggregates for Concrete Masonry Units<sup>2</sup>
- C 595 Specification for Blended Hydraulic Cements<sup>4</sup>
- C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete<sup>2</sup>
- C 989 Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars<sup>2</sup>
- C 1157 Performance Specification for Hydraulic Cement<sup>4</sup>
- C 1209 Terminology of Concrete Masonry Units and Related Units<sup>3</sup>
- C 1232 Terminology of Masonry<sup>3</sup>
- C 1262 Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Re-

lated Concrete Units<sup>3</sup>

### 3. Terminology

3.1 Terminology defined in Terminology C 1209 and Terminology C 1232 shall apply to this specification.

### 4. Material

4.1 *Cementitious Materials*—Materials shall conform to the following applicable specifications:

4.1.1 *Portland Cement*—Specification C 150.

4.1.2 *Modified Portland Cement*—Portland cement conforming to Specification C 150, modified as follows:

4.1.2.1 *Limestone*—Limestone, with a minimum 85 % calcium carbonate ( $\text{CaCO}_3$ ) content, shall be permitted to be added to the cement, provided the requirements of Specification C 150 are modified as follows:

(1) *Limitation on Insoluble Residue*—1.5 %.

(2) *Limitation on Air Content of Mortar*—Volume percent, 22 % max.

(3) *Limitation on Loss on Ignition*—7 %.

4.1.3 *Blended Cements*—Cement conforming to either Specification C 595 or Specification C 1157.

4.1.4 *Pozzolans*—Specification C 618.

4.1.5 *Blast Furnace Slag*—Specification C 989.

4.2 *Aggregates*—Aggregates shall conform to the following specifications, except that grading requirements shall not necessarily apply:

4.2.1 *Normal Weight Aggregates*—Specification C 33.

4.2.2 *Lightweight Aggregates*—Specification C 331.

4.3 *Other Constituents*—Air-entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in concrete roof pavers and shall conform to applicable ASTM standards or shall be shown by test or experience satisfactory to the purchaser to be not detrimental to the durability of the units or any material customarily used in concrete roof pavers.

### 5. Physical Requirements

5.1 At the time of delivery to the work site, the units shall conform to the physical requirements of Table 1 and shall have a minimum net area average compression strength (average of 3 units) of 3000 psi (20.68 MPa) with no individual unit compressive strength less than 2600 psi (17.93 MPa) when tested in accordance with 8.2.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

Current edition approved Jan. 10, 2001. Published February 2001.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.05.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.01.

**TABLE 1 Absorption Requirements for Concrete Roof Pavers**

Concrete Density, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Maximum Water Absorption, lb/ft <sup>3</sup> (kg/m <sup>3</sup> ) (average of 3 units)
95 (1522) or less	15 (240)
over 95 to 115 (1522 to 1842)	13 (208)
over 115 (1842) or more	10 (160)

5.2 *Resistance to Flexural Load*—The average resistance to flexural load for three paver units shall exceed 350 lb (1557 N) and resistance to flexural load of each individual unit shall exceed 280 lb (1246 N) when tested in accordance with 8.2.

5.3 *Ballast Weight*—Requirements for ballast weight per unit area shall be specified separately.

5.4 *Freeze-Thaw Durability*—In areas where repeated freezing and thawing under saturated conditions occur, freeze-thaw durability shall be demonstrated by test or by proven field performance that the concrete roof paver units have adequate durability for the intended use. When testing is required by the specifier to demonstrate freeze-thaw durability, the units shall be tested in accordance with 8.3.

5.4.1 Specimens shall comply with either of the following: (1) the weight loss of each of five test specimens at the conclusion of 100 cycles shall not exceed 1 % of its initial weight; or (2) the weight loss of each of four or five test specimens at the conclusion of 150 cycles shall not exceed 1.5 % of its initial weight.

NOTE 2—This specification does not include criteria for large hail stone impact. Where required, these criteria should be specified by the purchaser. Appendix X1 is provided as guidance to specifying hail-impact resistance.

## 6. Permissible Variations in Dimension and Weight

6.1 Overall dimensions for width, height, and length shall not differ by more than  $\pm \frac{1}{8}$  in. (3.2 mm) from the specified standard dimensions.

6.2 Ballast weight shall not differ by more than  $\pm 2.0$  lb/ft<sup>2</sup> (9.7 kg/m<sup>2</sup>) from the specified weight.

## 7. Finish and Appearance

7.1 All units shall be sound and free of cracks or other defects that would interfere with the proper placement of the unit or would significantly impair the strength or permanence of the construction. Minor cracks incidental to the usual

method of manufacture or minor chipping resulting from customary methods of handling in shipment and delivery are not grounds for rejection.

7.2 Five percent of the units in a shipment are permitted to contain chips not larger than 1 in. (25.4 mm) in any dimension, or cracks not wider than 0.02 in. (0.5 mm) and not longer than 25 % of the nominal height of the unit.

## 8. Sampling and Testing

8.1 The purchaser or authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lots ready for delivery.

8.2 Sample and test units for compressive strength, flexural load, absorption, density, ballast weight, and dimensional tolerance in accordance with Test Methods C 140.

8.3 When required, sample and test five specimens for freeze-thaw durability in water in accordance with Test Method C 1262. Freeze-thaw durability shall be based on tests of units made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 24 months prior to delivery.

## 9. Compliance

9.1 If a sample fails to conform to the specified requirements, the manufacturer shall be permitted to remove units from the shipment. A new sample shall be selected by the purchaser from remaining units from the shipment with a similar configuration and dimension and tested at the expense of the manufacturer. If the second sample meets the specified requirements, the remaining portion of the shipment represented by the sample meets the specified requirements. If the second sample fails to meet the specified requirements, the remaining portion of the shipment represented by the sample fails to meet the specified requirements.

NOTE 3—Unless otherwise specified in the purchase order, the cost of tests is typically borne as follows: (1) If the results of the tests show that the units do not conform to the requirements of this specification, the cost is typically borne by the seller. (2) If the results of the tests show that the units conform to the specification requirements, the cost is typically borne by the purchaser.

## 10. Keywords

10.1 absorption; aggregates; ballast weight; cementitious; compressive strength; concrete roof pavers; durability; limestone; portland cement

APPENDIX

(Nonmandatory Information)

X1. SPECIFYING RESISTANCE TO HAIL STONE IMPACT

X1.1 Where the purchaser's design criteria include resistance to impact from hail, hailstorm activity can be estimated from Fig. X1.1. As further guidance, a minimum energy-impact resistance to hail stones in areas potentially subjected to moderate to heavy hailstorm activity shall be 15 ft-lb (20.3 J). This impact energy is related to a hail stone of approximate diameter of 1.83 in. (46.5 mm), having a density 90 % of that of water, and falling at the terminal velocity for a spherical shape. Fig. X1.1 is based on hail storm activity reported by the National Weather Service for the time period between 1955

and 1995 and includes all reported hail storms with average hail stone diameter 1.8 in. (45.7 mm) or larger.

X1.2 Recommended testing for hail stone impact resistance entails impacting three specimens, supported as they would be in use, each to a series of three blows from a spherical ice ball of a size, configuration, and impact energy as outlined above. Failure of any specimen would be defined as the complete fracturing of the test specimen through the height of the paver. (Dents, chips, or cracks shall not be considered as failure of the test specimen.)

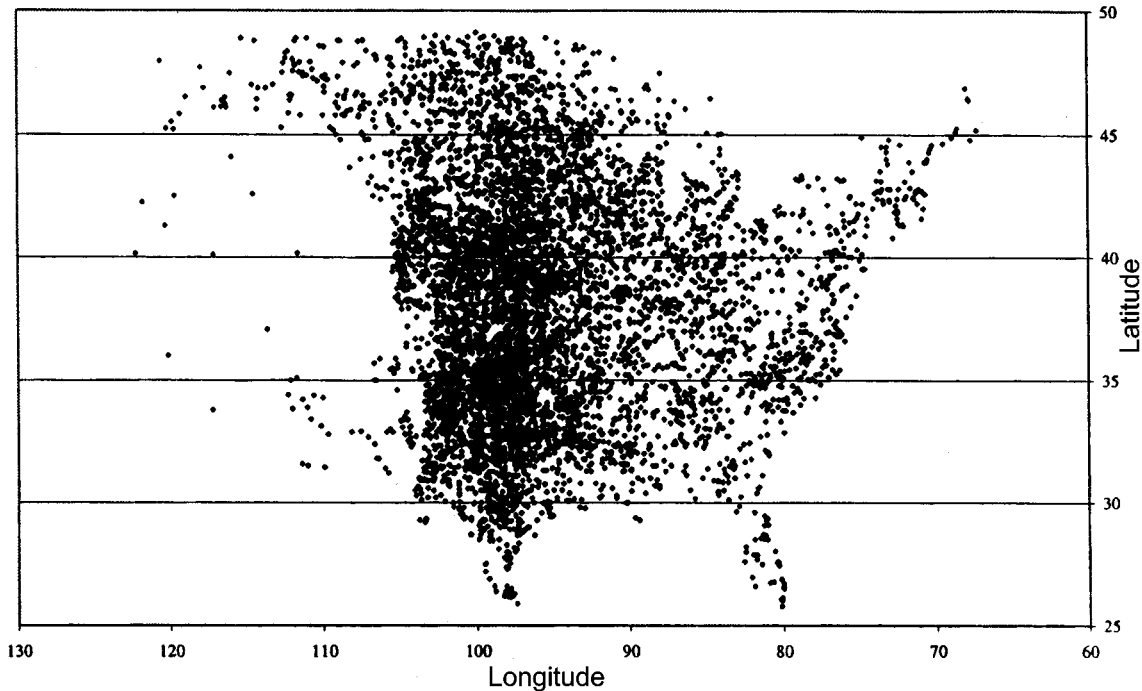


FIG. X1.1 Hail Storm Frequency

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*