



Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units¹

This standard is issued under the fixed designation C 1645; 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 test method covers the resistance to freezing and thawing of solid interlocking concrete paving units conforming to the dimensional requirements of Specification C 936. Units are tested in a test solution that is either water or 3 % saline solution, depending on the intended use of the units in actual service.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, in 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 limitation prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

C 936 Specification for Solid Concrete Interlocking Paving Units

3. Significance and Use

3.1 This test method is intended to determine the effects of freezing and thawing on units conforming to the dimensional requirements of Specification C 936 while immersed in a test solution. Other types of segmental concrete paving units that do not conform to the dimensional requirements of Specification C 936 may be tested using this method.

3.2 The results from this test method are not intended to provide a quantitative measure of the length of service from paving units conforming to the dimensional requirements of Specification C 936.

¹ This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.20 on Architectural and Structural Products.

Current edition approved on June 1, 2006. Published June 2006.

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.

4. Apparatus

4.1 *Freezing-and-Thawing Apparatus*—The freezing apparatus shall consist of suitable cabinet or cold room with controls to reach and maintain an air temperature of $-5 \pm 3^\circ\text{C}$ ($23 \pm 5^\circ\text{F}$) within 1 h of introduction of specimens. The thawing chamber shall maintain a controlled air temperature. This temperature shall never be greater than $+30^\circ\text{C}$ (86°F).

4.2 *Balance*—A balance capable of weighing 500 g with an accuracy of ± 0.1 g shall be used for measuring the mass of the fine spalled material.

4.3 *Oven*—The oven shall be vented and capable of being maintained at $60 \pm 2^\circ\text{C}$ ($140 \pm 4^\circ\text{F}$).

4.4 *Specimen Container*—The specimen container shall be made of non-corroding flexible material and have dimensions that allow complete submersion of the specimen in the test solution. The size of the container shall be less than or equal to three times the volume of the unit that is being tested. The container shall prevent evaporation of the test solution.

5. Sampling

5.1 *Selection of Test Specimens*—Select whole units representative of the lot from which they are selected. The units shall be free from visible cracks, chipped edges, and structural defects.

5.2 *Number of Test Specimens*—Sample according to the requirements of Specification C 936.

5.3 *Identification*—Mark each test specimen so that it is identifiable at any time.

6. Preparation of Test Specimens

6.1 *Curing and Conditioning*—Test specimens shall consist of full size units, a minimum of 28 days old. After sampling, all test specimens shall be cured for 14 days in a moist chamber (cabinet or room) at an air temperature of $23 \pm 2^\circ\text{C}$ ($73 \pm 4^\circ\text{F}$) and a relative humidity of at least 90 %. Moist curing shall be followed by air curing for a minimum of 14 days at $23 \pm 5^\circ\text{C}$ ($73 \pm 9^\circ\text{F}$) at a minimum 40 % relative humidity.

6.1.1 After air curing, specimens then shall be oven conditioned for $48 \text{ h} \pm 2 \text{ h}$ at $60^\circ \pm 2^\circ\text{C}$ ($140 \pm 4^\circ\text{F}$).

6.1.2 Before testing begins, the specimens shall be brushed clean with a stiff bristled brush and all loose burrs and edge shards shall be removed with a carborundum stone.

7. Procedure

7.1 *Freezing and Thawing Cycles*—One freeze-thaw cycle shall be completed every 24 h. The cycle shall consist of 16 ± 1 h of freezing followed by 8 ± 1 h of thawing. The specimens shall be subjected to continuous cycles. If for reasons beyond the operator's control, a freezing period cannot commence at the specified time, the specimens shall remain in a thawed condition until conditions are suitable for resumption of the test. The specimen temperature shall conform to $-5 \pm 3^\circ\text{C}$ ($23 \pm 5^\circ\text{F}$) for the last 2 h of the freezing cycle and a minimum of $+5^\circ\text{C}$ (40°F) for the last 1 h of the thawing cycle. The temperature shall be recorded at least every 15 min with a temperature probe inside a specimen.

7.2 *Specimen Containment*—Immediately following completion of the oven conditioning, each warm specimen shall be centered with the wearing surface facing upwards in individual containers. The supported bottom surface of the specimens shall rest on glass, stainless steel, ceramic, or plastic spacers approximately 5 mm (0.2 in.) high to ensure exposure of the entire bottom surface to the test solution. A minimum of 5 mm (0.2 in.) clearance shall be provided between the specimen and the container in all directions.

7.3 *Test Solution*—If the test solution is saline, containers shall be filled with $3 \pm 0.1\%$ NaCl solution. The test solution (tap water or saline) shall have a minimum temperature of 15°C (60°F). The level of the test solution shall be 5 ± 1 mm (0.2 ± 0.04 in.) above the surface of the specimens. Excess test solution volume shall be avoided in order to ensure rapid freezing of the specimens. After filling the containers they shall be immediately closed to minimize evaporation and the closed containers left at a minimum temperature of 15°C (60°F) for $24 \text{ h} \pm 1 \text{ h}$.

7.4 *Temperature Monitoring*—Following the 24-hour saturation period, the specimens shall be subjected to continuous freeze-thaw cycles. The ambient temperature in the freeze-thaw apparatus, as well as those of the specimen, shall be continuously measured at least every 15 min, recorded and reported. If for any reason, continuous 24-hour cycles cannot be maintained, then this shall be noted in the report.

7.5 *Collection of Residue*—After 10, 25, and (if necessary) 50 cycles, the specimens shall be washed with de-ionized water to remove all loose particles. These particles and spalled

material collected at the bottom of the containers shall be washed, filtered using an 80 μm filter paper, and dried to a constant mass. This residue shall be defined as mass loss expressed in grams. The residue shall be cumulatively weighed after 10, 25, and 50 (if necessary) cycles.

7.5.1 If the test solution is 3 % saline, provide a new solution of 3 % NaCl following each determination of loss of mass. The 24-hour presoaking period shall be waived following 10 and 25 cycles provided that the specimens are maintained in a saturated condition during mass determination.

7.5.2 The test shall continue until 25 freeze-thaw cycles have been completed or unless an individual test specimen has disintegrated, or lost more than 200 g/m^2 . If the loss of mass exceeds 200 g/m^2 from an individual specimen the test shall continue until 50 freeze-thaw cycles have been completed. If at any time losses exceed 500 g/m^2 or disintegration of an individual specimen necessitates termination of testing prematurely, the loss of mass shall be determined and added to the previously lost mass.

8. Calculation and Report

8.1 The loss of mass shall be calculated in grams per square meter of surface area to the nearest 0.1 g/m^2 . The total surface area of the paver shall be determined from the specified shape and dimensions shown in the manufacturer's mold drawings.

8.2 *The report shall include the following:*

- 8.2.1 name of client and manufacturer;
- 8.2.2 the date of manufacture and sampling;
- 8.2.3 plant or field sampling;
- 8.2.4 the batch number;
- 8.2.5 identification of specimens and color;
- 8.2.6 dimensions of the specimens;
- 8.2.7 dates of the beginning and end of the test;
- 8.2.8 mass lost by each specimen and the average results after 10, 25, and 50 (if necessary) cycles or at the time of termination of the test;
- 8.2.9 the number of cycles at termination;
- 8.2.10 a description of the damage suffered by the specimens, with photographs where possible; and
- 8.2.11 any deviations from this testing procedure.

9. Precision and Bias

9.1 Precision and bias data for this test method is not yet available.

10. Keywords

10.1 freeze-thaw durability; interlocking concrete pavers

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