Designation: C1026 – 13

Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling[1]

This standard is issued under the fixed designation C1026; 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 describes the procedures and equipment required to test either glazed or unglazed ceramic or glass tiles for resistance to repeated cycles of freezing and thawing. Tiles of any size or shape may be tested by this test method.

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

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C242 Terminology of Ceramic Whitewares and Related Products[2]

3. Summary of Test Method

3.1 A designated test load of tile specimens is saturated with water prior to being placed face-up in a metal water-filled container inside a freezer. The water level is adjusted such that the tile specimens are partially submerged. A thermocouple is inserted into the bottom of the metal container such that the water surrounding the thermocouple is the last location to freeze and thaw. Freezing is followed by a thawing cycle using water that flows over the test load. The number of freeze-thaw cycles is recorded and after 300 cycles, the test load is visually examined for damage and checked for total weight loss.

4. Significance and Use

4.1 The test for resistance to freezing and thawing functions as a guide to the selection of ceramic and glass tiles suitable for outdoor service in geographic areas subjected to freezing. It can serve as a test method to verify compliance with specifications for ceramic and glass tiles, and provides a control test for determining the freeze/thaw resistance of tiles being manufactured for exterior installations.

5. Apparatus

5.1 *Freezing Chamber.* The freezing chamber for this test method may be of any type provided it has the capacity to cool the test load to 27 ± ½ °F (-3 ± ¼ °C) within a period of 3 to 6 h. By adjusting the mass of the test load, any freezer can be used in this test as long as a 3- to 6-h period to reach 27 ± ½ °F (-3 ± ¼ °C) is achieved. See Figs. 1 and 2.

5.2 *Freezing Container.* A freezing container of such design and shape that it fits inside the freezing chamber and will allow the test specimens to be laid flat on a tile support rack at the bottom of the container. The freezing container may be of any convenient size or shape (a stainless steel sink works well). It must have a low point in which the thermocouple can be securely located such that the water around the thermocouple freezes last (typically near the bottom center of the container). The water level inside the container is maintained throughout the test by adjusting the height of an overflow drain. See Fig. 3.

5.3 *Tile Support Rack.* A rack capable of supporting the test specimens a minimum of ¼ in. (6 mm) above the bottom of the freezing container in a consistent, level manner. It should be rustproof, unaffected by freeze/thaw cycling and with sufficient openings that the thawing water passes easily over and around the frozen tile specimens during the thawing cycle. See Fig. 4.

5.4 *Water Reservoir.* A reservoir of sufficient volume, in which water is maintained at a temperature of 60 ± 20°F (16 ± 11°C) and used to raise the temperature of the test load to 40 ± ½ °F (5 ± ¼ °C) during the thawing cycle. See Fig. 5.

5.5 *Water Pump.* A low-pressure water pump of sufficient capacity to pump water from the water reservoir into the freezing chamber in such manner that it can flood water over the test load. A flow or pressure reduction valve may need to be installed between the water pump and the flooding assembly to prevent spraying. See Fig. 6.

[1] This test method is under the jurisdiction of ASTM Committee C21 on Ceramic Whitewares and Related Productsand is the direct responsibility of Subcommittee C21.06 on Ceramic Tile.

Current edition approved March 1, 2013. Published April 2013. Originally published in 1984. Last previous edition approved in 2010 as C1026 – 10. DOI: 10.1520/C1026-13.

[2] *Annual Book of ASTM Standards*, Vol 15.02.

FIG. 1 Freezing Chamber, Front View

5.6 *Flooding Assembly.* PVC pipe or similar which assembled to spread thawing water throughout the freezing container. Holes ⅛ in. (3 mm) in diameter are drilled in the bottom of the flooding assembly. Holes ¼ in. (6 mm) in diameter are drilled in the top to maintain the flow of water in the event the bottom holes become frozen. No holes shall be drilled in the flooding assembly which would allow water to fall directly on the thermocouple. See Figs. 7-9.

5.7 *Controller.* A device capable of receiving input from a thermocouple and accurately measuring and displaying the temperature of the water around the thermocouple within ½ °F

FIG. 2 Freezing Chamber, Top View
Includes Inlet Hose from Water Pump and Control Box Housing the Temperature Controller and Cycle Counter

FIG. 3 Freezing Container
Includes Low Point for the Thermocouple and Adjustable Overflow Drain in the Corner

(¼ °C). The controller must have an electric relay triggered by

FIG. 4 Freezing Container with Tile Support Rack Installed

FIG. 5 Water Reservoir, Includes Water Line Which Goes Through the Top of the Freezer

FIG. 6 Water Pump

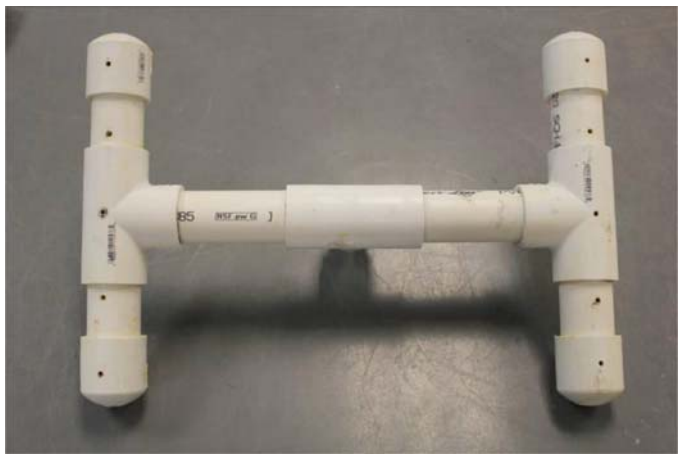

FIG. 7 Flooding Assembly, Bottom View

change in temperature to engage and disengage the water pump and to record how many freeze thaw cycles have been completed.

5.8 *Thermocouple.* A thermocouple calibrated to 27°F (-3°C) against a thermometer of known accuracy.

5.9 *Oven.* An oven capable of maintaining a temperature of 302 ± 9°F (150 ± 5°C).

5.10 *Boiling Container.* A pot or pan in which the specimens may be submerged in boiling water.

5.11 *Test Water.* Deionized water shall be used for the saturation procedure, and potable water shall be used for the freezing and thawing.

5.12 *Weighing Instrument.* A scale of adequate capacity, accurate to 0.00002 lb (0.01g).

6. Test Samples

6.1 Select five samples at random to be tested. Specimens larger than 3 × 3 in. (76 × 76 mm) shall be cut to 3 ± ¼ × 3

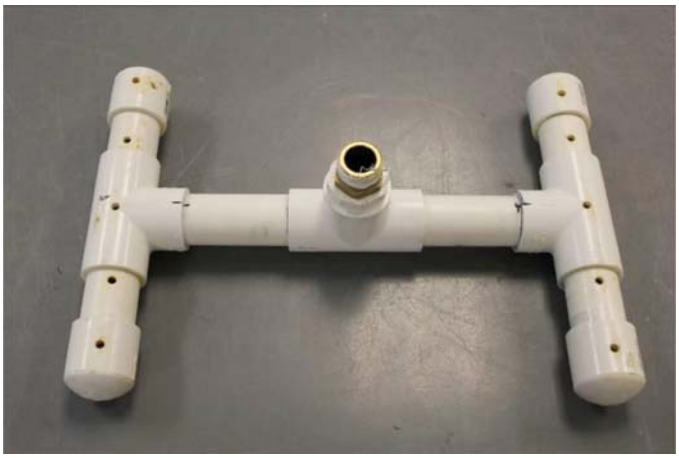

FIG. 8 Flooding Assembly, Top View

FIG. 9 Flooding Assembly, Installed

± ¼ in. (76 ± 6 × 76 ± 6 mm) from the center of the tile. Great care must be exercised when collecting or cutting specimens, or both, so that no specimens with visible damage or cracks prior to testing are included as part of the test load.

7. Procedure

7.1 *Test Load Preparation:*

7.1.1 Dry each specimen in the oven at 302 ± 9°F (150 ± 5°C) for 24 h. Allow the specimens to cool in the desiccator until they can be safely handled. Record the dry weight (W_1) of each specimen. Place the specimens in a container of boiling deionized water for 5 h, taking care that the specimens are covered with water at all times. Use setter pins, a rust-proof rack, or equivalent to separate the specimens from the bottom and sides of the container and from each other. After the 5-h boil, allow the specimens to soak for at least an additional 24 h. Continue to immerse the treated tiles in water until ready for 7.1.3.

7.1.2 Clamp or fasten the thermocouple to the low point in the freezing container, near the center of the load and underneath the tile specimens and support rack.

7.1.3 Arrange all of the specimens on the support rack in the freezing container so they are horizontal with the wear surface facing up. Adjust and level the support rack such that the specimens will be a minimum of ¼ in. (6 mm), not to exceed 1 in. (25.4 mm), above the bottom plane of the freezing container. Add potable water to the freezing container and adjust the overflow device to maintain a water level such that the specimens are submerged at least ½ their thickness, but not fully submerged.

7.1.4 Ensure that the water reservoir is maintained at 60 ± 20°F (16 ± 11°C). Adjust the pressure on the water-flooding assembly to flood water directly over the test specimens during the thaw cycle. High pressure spraying or splashing of the thawing water can cause ice or frost to build up on the freezing chamber walls and on the sides of the freezing container resulting in the need to defrost the freezer during the test cycle. If the cycle must be stopped to defrost the chamber or container, maintain the water level described in Section 7.1.3. Then continue with the remaining cycles after defrosting is completed.

7.1.5 Set the temperature range on the temperature controller from 27 to 40°F (-3 to 5°C), such that the water pump engages when the test load reaches 27 ± ½ °F (-3 ± ¼ °C) and the pump disengages when the test load reaches 40 ± ½ °F (5 ± ¼ °C).

7.1.6 Set the cycle counter on the temperature controller to 300 cycles and start the process.

7.1.7 After one freeze-thaw cycle, at the beginning of the second cycle, check the test load temperature inside the freezer, displayed on the controller, and record.

7.1.8 Continue to record the temperature on an hourly basis until the test load reaches 27°F (-3°C).

7.1.9 Prepare a table that shows temperature in relation to time for one freezing cycle or until such time that no adjustment to the load is needed (see 7.1.10).

7.1.10 The total time will be affected by the size of the freezer, the size of the test load, and the recovery rate of the freezer. The load is the only one of these three that can be varied easily, so in order to maintain the specified rate of freezing, adjust the load, while continuing the test, so that the total time required to reach 27°F (-3°C) on the thermocouple in the load falls between 3 and 6 h. No more than three adjustments to the load may be made without restarting the test.

7.2 At the end of 300 cycles, dry the specimens in the oven at 302 ± 9°F (150 ± 5°C) for 24 h. Allow specimens to cool in a desiccator.

7.3 Record the dry weight (W_f) of each specimen.

7.4 Visually inspect each specimen carefully for cracks, disintegration, or spalling, or combinations thereof. The visual inspection shall be conducted at a standard distance of 10 ± ½ inches (250 ± 13 mm) under sufficient lighting with a minimum of 28 foot candles (300 lux) of illumination. Record observations.

8. Report

8.1 Calculate the total weight loss for each specimen as follows:

$$Total\ weight\ loss\ percentage = [(W_I - W_F)/W_I] \times 100 \quad (1)$$

where:

W_I = initial dry weight, and
W_F = final dry weight

Report the number of tile damaged. A damaged tile is defined as one which shows evidence of cracking, disintegration, spalling, or toal weight loss > 0.5 %.

8.2 Note specimens which exhibit signs of crazing, taking care not to confuse crazing with cracking. Crazing is not to be considered a damaged tile by this method.

8.3 Note any observations on the suggested form (see Appendix X1). Tests involving fewer than 300 cycles shall be noted in the report.

9. Precision and Bias

9.1 *Precision and Bias*—No information is presented about either the precision or bias of Test Method C1026 for measuring resistance of tile to freeze-thaw cycling since the test result is non-quantitative.

APPENDIX

X1. TEST RESULTS, SAMPLE TABLE

Specimen #	Dry WT, (W_I)	Dry WT, (W_F)	Observations After 300 Cycles	Total WT, Loss (%)	Pass or Fail
1					
2					
3					
4					
5					