



Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units¹

This standard is issued under the fixed designation C1262; 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 dry-cast segmental retaining wall (SRW) units (see Specification C1372) and related concrete units. 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.

NOTE 1—Related concrete units include units such as hollow and solid concrete masonry units, concrete brick, and concrete roof pavers.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI 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.*

2. Referenced Documents

2.1 ASTM Standards:²

C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

C1093 Practice for Accreditation of Testing Agencies for Masonry

C1232 Terminology of Masonry

C1372 Specification for Dry-Cast Segmental Retaining Wall Units

3. Terminology

3.1 Terminology defined in Terminology C1232 shall apply for this test method.

¹ This test method 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.

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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.

4. Significance and Use

4.1 The procedure described in this test method is intended to determine the effects of freezing and thawing on SRW and related units in the presence of water or saline solution.

4.2 The procedure is not intended to provide a quantitative measure to determine an expected length of service for a specific type of concrete unit.

NOTE 2—The testing laboratory performing this test method should be evaluated in accordance with Practice C1093.

5. Apparatus

5.1 *Freeze-Thaw Chamber*—Use a chamber that has:

5.1.1 Forced air circulation,

5.1.2 A programmable air-temperature controller capable of automatically performing at least two freezing and thawing cycles per 24-h period during testing,

5.1.3 A temperature range of at least –10 to 100°F (–24 to 38°C), and

5.1.4 The capability of maintaining the air temperature throughout the chamber within the specified temperature ranges for the duration of the test cycle.

5.2 *Containers*—Use containers that are:

5.2.1 Made of non-rigid plastic,

5.2.2 Of sufficient size to contain each test specimen and specimen supports as illustrated in Fig. 1,

5.2.3 Of sufficient size to provide a minimum of 1/8 in. (3 mm) and a maximum of 1 1/2 in. (38 mm) of test solution surrounding the sides of the specimen,

5.2.4 Supplied with a tightly-fitting lid to reduce evaporation, and

5.2.5 Flat enough so that the specimen will not deviate from level by more than 1/16 in. (2 mm) from one end of the specimen to the opposite end when placed on the support rods.

5.3 *Specimen Supports*—Support the specimen above the container bottom. Use supports that are:

5.3.1 Rods having dimensions of 1/8 ± 1/24 in. (3 ± 1 mm),

5.3.2 Made of a solid, non-corrosive, non-absorptive material (brass, plastic, and so forth), and

5.3.3 Capable of supporting the specimen in both the longitudinal and transverse directions (see Note 3).

*A Summary of Changes section appears at the end of this standard

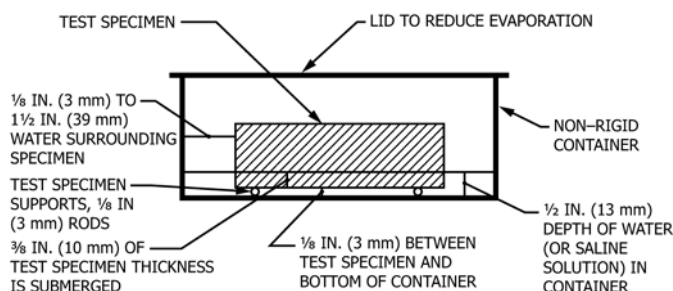


FIG. 1 Test Specimen in Freeze-Thaw Container

NOTE 3—Examples of longitudinal and transverse support configurations including placing the supports in the I, Z, or box configurations.

5.4 Temperature-Measuring Equipment:

5.4.1 *Reference Temperature-Measuring Device*—The reference temperature-measuring device shall be readable and accurate to $\pm 0.5^{\circ}\text{F}$ (0.2°C) within the range of use. A certificate or report that verifies the accuracy shall be available in the laboratory for review. Verify the accuracy of liquid-in-glass reference temperature measuring devices at least once. Verify the accuracy of direct-reading resistance reference temperature-measuring devices every twelve months. The certificate or report shall provide documentation that the reference standard used in the verification is traceable to the National Institute of Standards and Technology (NIST).

5.4.2 *Temperature Recorder*—Equip the chamber with a device to record the air temperature every 15 min or less; this device shall be accurate and readable to 2°F (1°C). Verify the accuracy of the temperature measuring device at least every six months. During testing, evaluate the data from the temperature recording device at least once every twenty cycles to ensure that cycles meet the temperature requirements of 7.2.1 and 7.2.2. A record of this evaluation documenting the date checked, a confirmation that the data is within the required temperature range, and the name of the individual performing this evaluation shall be maintained in the laboratory.

NOTE 4—This requirement may be satisfied by an initialed and dated temperature recorder chart. Brief changes in the temperature due to door openings should be ignored.

NOTE 5—A convenient time to evaluate the temperature results is when the chamber is stopped for residue collection.

5.4.3 To verify the accuracy of the temperature-measuring devices, position the reference temperature-measuring device in the chamber in a readable position as near to the temperature-measuring device probe as possible. Close the door and leave undisturbed for at least 5 min. Read the temperature immediately after opening the chamber door. Record the temperature readings of both devices. If the temperature readings differ by more than 2°F , adjust or replace the temperature-measuring device.

5.5 *Scales*—Scales for weighing full-size specimens shall have a capacity of at least 50 % greater than the weight of the largest specimen tested and shall be accurate to at least 1 g (0.002 lb). Scales for weighing the filter paper and specimen residue (spall), as required in 7.2.3, shall be accurate to at least 0.2 g (0.0005 lb).

6. Sampling and Preparation of Test Methods

6.1 *Selection of Units*—Select five whole SRW units representative of the lot from which they are selected. The units shall be free from visible cracks or structural defects.

6.2 *Freeze-Thaw Test Specimens*—Test specimens shall consist of solid coupons saw-cut from full sized units. Do not saw-cut test specimens from units that have been previously oven-dried. Do not subject test specimens to oven-drying prior to completion of freeze-thaw testing.

6.2.1 Cut one coupon from each of the five sampled units. Cut the coupon from the exposed surface of the unit as the unit is used in service unless the exposed surface is an architectural or other nonplanar surface (see Note 6). In the case of a unit with an exposed architectural or other nonplanar surface, cut the coupon from another flat molded surface ideally as far as possible from the architectural or other nonplanar face and in no case less than 2 in. (50 mm) from that surface. Immediately following saw-cutting, remove loose particles and residue from the coupon by rinsing in tap water and brushing with a soft bristle brush. Do not fully immerse coupons in water. Each specimen shall be marked with a unique identification number on the non-molded surface of the specimen.

NOTE 6—Split-faced surfaces are the most common surfaces used to provide an architectural appearance to segmental retaining walls. However, other means could be used to obtain similar architectural effects like tumbling, grinding, and slumping.

6.2.2 Sawing shall be performed in an accurate, competent manner, subjecting the specimen to as little saw vibration as possible. Use a diamond saw blade of proper hardness.

6.2.3 Place the coupons on edge on a $\frac{3}{8}$ in. (10 mm) or coarser mesh such that there is an air space of not less than 1 in. (25 mm) between coupons. Allow the coupons to dry for not less than 48 h in laboratory air at a temperature of $75 \pm 15^{\circ}\text{F}$ ($24 \pm 8^{\circ}\text{C}$) and a relative humidity of less than 80 %.

6.2.4 The thickness of each coupon shall be $1\frac{1}{4}$ in. (32 mm) $\pm \frac{1}{16}$ in. (2 mm), unless the unit does not permit this minimum thickness, in which case the thickness shall be the maximum thickness that can be obtained from the unit. The thickness of the coupon shall not be less than $\frac{3}{4}$ in. (19 mm).

6.2.5 The area of the submerged surface of the test specimen shall be at least 25 in.² (161 cm²) and shall not exceed 35 in.² (225 cm²), unless the unit does not permit a coupon meeting the minimum area, in which case the test specimen shall consist of two coupons. The combined area of the two coupons shall be at least 25 in.² (161 cm²) and shall not exceed 35 in.² (225 cm²). These two coupons shall be tested as and considered to be a single specimen.

6.3 When compression and absorption testing will be conducted in addition to freeze-thaw testing, obtain a specimen (coupon) for each test from each of five SRW units to facilitate correlation among the properties. If this is not possible, then obtain compressive strength and absorption specimens from different units manufactured in the same production lot as the freeze-thaw specimens. Take compressive strength and absorption specimens in accordance with Test Methods C140. Specimens used for Test Methods C140 tests shall not be used as specimens for freeze-thaw tests.

NOTE 7—While compressive strength and absorption values by themselves have been shown by research³ to not be reliable indicators of durability, they have been shown to be good reference values for units manufactured from a given set of materials.

7. Procedure

7.1 Specimen Conditioning:

7.1.1 After preparation of the freeze-thaw test specimens in accordance with Section 6, place the specimen in the container face down on the specimen supports such that the non-saw-cut surface of the specimen is in contact with the specimen supports. Add a sufficient amount of test solution at a temperature of 60 to 80°F (16 to 27°C) to the container to achieve a test solution depth of $\frac{1}{2} \pm \frac{1}{16}$ in. (13 ± 2 mm) (see Note 8 and Note 9). Do not pour test solution directly onto the specimen. The test solution shall be either potable tap water or a 3 ± 0.1 % (by weight) sodium chloride saline solution (see Note 10). Close the container lid tightly and store the container on a level surface in laboratory air as defined in 6.2.3.

NOTE 8—The submerged portion of the specimen is $\frac{3}{8}$ in. (10 mm) of its thickness. There is $\frac{1}{8}$ in. (3 mm) of test solution between the bottom of the container and the face of the specimen.

NOTE 9—One way to repeatedly achieve the specified water depth is to add a consistent volume of water which has been calibrated for a given specimen and container size combination to yield the specified depth.

NOTE 10—The 3 % saline solution can be prepared by adding 0.03 lb of sodium chloride to each 0.97 lb of water.

7.1.2 After $1 \text{ h} \pm 15 \text{ min}$, open the container and add test solution as necessary to maintain the water level required in 7.1.1. Reseal the container. After another $23 \text{ h} \pm 1 \text{ h}$, remove the specimen from the test solution and allow to drain for 1 min by placing it on a $\frac{3}{8}$ -in. (10-mm) or coarser sieve, removing visible surface test solution with a damp cloth. Immediately weigh the specimen to the nearest 1 g (0.002 lb) and record as W_p .

NOTE 11—The weight W_p as determined in 7.1.2 is not required to be reported at the conclusion of the test, nor is it used to calculate the reported weight loss of the specimen throughout the test. However, because the initial dry-weight of the specimen is not determined until the completion of freeze-thaw testing by adding the dry-weight of the collected residue to the dry-weight of the remains of the specimen (see 7.3.5), this W_p weight is needed as a reference weight to be used during the testing to estimate percentage weight loss and to predict relative performance between test specimens.

7.1.3 Return the specimens to the container and adjust test solution level as required in 7.1.1.

7.1.4 Test solution added to the containers shall be at a temperature of 60 to 80°F (16 to 27°C).

7.2 Cyclical Testing:

7.2.1 Begin the test with a freezing cycle. Place the containers into the freezing test chamber such that each container is surrounded by a minimum air space of $\frac{1}{2}$ in. (13 mm) on all sides. During testing the container shall be level within $\frac{1}{16}$ in. (2 mm). During the freezing cycle, maintain the air temperature in the chamber at $0 \pm 10^\circ\text{F}$ ($-18 \pm 5^\circ\text{C}$) for a period of not less

than 4.0 h and not more than 5.0 h. The cycle time does not include the time required for the air temperature in the chamber to reach the prescribed temperature. Periodically, at the end of a freezing cycle, open the containers and visually inspect the specimens to determine if all the test solution surrounding the specimen is frozen solid. If not, extend the length of the freezing cycle to ensure that all test solution is frozen solid.

NOTE 12—Temperature probes should be used to monitor the air temperature throughout the chamber. If warm units are placed into a freezing chamber, the air temperature within the chamber rises. The start of the freezing cycle time period begins only after the temperature of the air within the chamber is within the permissible range. Typically, constant temperature monitoring is not necessary, but it should be preformed through the first several cycles to ensure that the specimens remain in the freezing chamber for the appropriate length of time to comply with the cycle requirements. The same procedures should also be used to verify compliance with thawing cycle requirements in 7.2.6.

7.2.2 After the freezing cycle, immediately begin the thawing cycle. During the thawing cycle, maintain the air temperature around the containers at $75 \pm 10^\circ\text{F}$ ($24 \pm 5^\circ\text{C}$) for a period of not less than 2.5 h and not more than 96 h. The cycle time does not include the time required for the air temperature around the specimens to reach the prescribed temperatures. Each container shall be surrounded by a minimum air space of $\frac{1}{2}$ in. on all sides. If the air surrounding the containers is not continuously circulated during the thawing cycle, the containers shall be laid out in a single layer without stacking in the vertical direction. Periodically, at the end of a thawing cycle, open the containers and visually inspect the specimens to determine if no ice remains. If ice is still present, extend the length of the thawing cycle to ensure that all ice has thawed.

7.2.3 One freeze-thaw cycle is defined as a completed freezing cycle followed by a completed thawing cycle.

7.2.4 At 20 cycle intervals for those specimens tested in water and at 10 cycle intervals for those specimens tested in saline solution, remove containers from the test chamber and collect residue in accordance with 7.3. Open containers to visually inspect the condition of the specimens and to adjust the test solution level to comply with 7.1.1.

NOTE 13—There is some evidence that frequency of sampling influences results. Therefore, variations from cycle intervals for residue sampling are only appropriate when this method is used for research purposes rather than compliance purposes. Collecting and reporting residue at regular intervals provides information about the performance of the specimens throughout the duration of the test and also permits plotting results of weight loss relative to number of cycles of exposure.

7.2.5 Every time a container is replaced into a multi-level freezing test chamber, the container shall be placed on the level immediately above the level on which it was previously located. If the container was previously located on the top level of a multi-level freezing chamber, replace it onto the bottom level. Also rotate containers front-to-back and left-to-right when moving to a new shelf.

7.2.6 If the test method is being used to document compliance of a set of specimens with specific freeze-thaw durability criteria, repeat the freeze-thaw cycle to reach the specified number of cycles. After the specified number of cycles have been completed, collect residue in accordance with 7.3.

7.3 Collection of Residue:

³ Chan, C., Hover, K. C., Folliard, K. J., Hance, R. M., Trejo, D., *Durability of Segmental Retaining Wall Blocks: Final Report*, Federal Highway Administration Report No. FHWA HRT-07-021, April 2007, pp. 42–55.

Available from <http://www.tfhrc.gov/structur/pubs/07021/index.htm>.

7.3.1 Weigh to the nearest 0.2 g (0.0005 lb) and record as W_f a filter paper of high wet strength and smooth surface that has come to equilibrium temperature with the lab environment. Remove a single specimen from its container. Immediately rinse the specimen with water (if the specimen is tested in saline solution, use saline solution to rinse the specimen) using a squeeze bottle, being careful to collect in the specimen container the rinse water (or saline solution) and all loose particles from the specimen. Consider any pieces that separated from the specimen as part of the residue. Pour the test solution from the specimen container through the filter paper to collect the residue (spall) from the test specimen. Replace the specimen in the container. Using fingertips and a squeeze bottle, remove loose particles from all surfaces of the specimen, again being careful to collect all rinse water (or saline solution) and loose particles in the specimen container. The top surface of the specimen shall not be immersed in test solution at anytime and the collected rinse water (or saline solution) shall not exceed a depth of 1/2 in. (13 mm) in the container. Remove the specimen from the container, pour the rinse water (or saline solution) through the filter paper, and rinse the specimen container until all residue (spall) in the specimen container is collected on the filter paper. Rinse the residue from specimens tested in saline solution three times with water to remove any soluble salt.

NOTE 14—The filtering may be expedited by using filter paper rated at a faster speed or vacuum filtration, or both. This is acceptable as long as the test solution that passes through the filter paper (filtrate) is clear to the naked eye. If it is cloudy, then filter papers of increasingly slower speeds should be used until the filtrate is clear.

7.3.2 If testing is to be continued, return the specimen to the container positioned on its supports. Check that the specimen container still meets the flatness requirement of Section 5. If it fails to meet the flatness requirement, use a different container. Add fresh test solution to the container in accordance with 7.1.1, and close the container lid tightly.

7.3.3 Repeat the procedures described in 7.3.1 and 7.3.2 with each remaining specimen.

7.3.4 Dry all the filter paper and residue (spall) collected from each specimen at 212 to 239°F (100 to 115°C) for not less than 4 h and until two successive weighings at intervals of 2 h $\pm$ 15 min show an increment of loss not greater than 0.2 % of the last previously determined weight. Place the filter paper and residue in a draft-free location within the laboratory for a period of 2 h $\pm$ 15 min to allow the filter paper and residue to come to equilibrium temperature with the laboratory environ-

ment. Weigh the filter paper and residue to the nearest 0.2 g (0.0005 lb) and record as W_{f+r} . Calculate the residue weight, W_r , as follows:

$$W_r = W_{f+r} - W_f \quad (1)$$

where:

W_r = weight of residue (spall), g (lb),
 W_{f+r} = weight of the dried residue and filter paper, g (lb), and
 W_f = initial weight of the filter paper, g (lb).

7.3.5 At the completion of the freeze-thaw testing, dry each specimen at 212 to 239°F (100 to 115°C) for 24 $\pm$ 1 h. Weigh to the nearest 1 g (0.002 lb) the final oven-dried specimen and record as W_{final} . Calculate the initial weight of the specimen, $W_{initial}$, as follows:

$$W_{initial} = W_{final} + W_{residue} \quad (2)$$

where:

$W_{initial}$ = calculated initial weight of the specimen, g (lb),
 W_{final} = final weight of the specimen, g (lb), and
 $W_{residue}$ = total accumulated residue weight (equal to the sum of the residue weight, W_r , from each evaluation period, g (lb)).

8. Calculation and Report

8.1 Determine and report the cumulative weight loss of each residue collection interval expressed in terms of g (lb) and as a percent of the calculated initial weight of the specimen, $W_{initial}$, determined in accordance with 7.3.5. Where the coupon thickness is less than 1.25 in. (32 mm), the percentage and cumulative weight loss shall be multiplied by a value equal to the actual thickness in inches (mm) divided by 1.25 in. (32 mm). Report these values for each specimen as well as the average of the specimens tested.

NOTE 15—If compressive strength and absorption test results (determined in accordance with Test Methods C140) from representative specimens are available, it is recommended that these values be reported for reference purposes.

9. Precision and Bias

9.1 Precision and bias data for freeze-thaw durability is not available.

10. Keywords

10.1 absorption; compressive strength; dry-cast segmental retaining wall unit; freeze-thaw durability; freeze-thaw resistance; manufactured concrete units

SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (C1262 – 09) that may impact the use of this standard. (Approved June 1, 2010.)

- (1) Subsection 5.4.2 was revised to require the temperature measuring device to record the temperatures. Note 4 and Note 5 were added.
- (2) Subsections 6.2.1 and 6.2.2 were modified to make saw requirements the same as Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- (3) New keywords were added.

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