Industry Standard from
The National Concrete Masonry Association

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NCMA CMU-WR2-09

Standard Test Method for Spray Bar Test of Concrete Masonry Units

1. Scope

1.1 The purpose of this test is to visually assess the migration of water through the exposed surfaces of a hollow or solid concrete masonry unit when multiple streams of water are applied to its outer face for an extended period of time.

Note 1: The migration of water through a concrete masonry unit cannot be directly correlated to the water penetration resistance of a wall assembly.

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

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard. Information contained in the Appendix is not a requirement of this standard.

1.4 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 1093 Practice for Accreditation of Testing Agencies for Unit Masonry

2.2 *NCMA Standards:*

CMU-WR1 Standard Test Method for Water Stream and Water Droplet Tests of Concrete Masonry Units

CMU-WR3 Standard Test Method for Assessing Water Uptake Potential of Concrete Masonry Units

2.3 *NCMA TEK*

19-7 Characteristics of Concrete Masonry Units with Integral Water Repellent

3. Terminology

3.1 *Definitions*

3.1.1 Pinhole – a single point source of moisture observed on any surface of a concrete masonry unit other than the surface being subjected to water from the spray bar. Pinholes are found in some concrete masonry units when water migrates through a series of interconnected pores through the matrix of a concrete masonry. Pinholes are characterized by observing water at single point of exit from the CMU, the presence of visible water (not just dampness on the surface), and a vertical trickle of water down the surface of the unit from its point of exit.

Note 2: Figure X1.1 in Appendix X1 illustrates a series of typical pinholes in a concrete masonry unit.

3.1.2 Damp – For the purpose of this test method, a surface, or a select portion of a surface, of a concrete masonry unit is considered damp when the color of the unit has darkened in a given area as a result of moisture.

Note 3: Figure X1.2 in Appendix X1 illustrates typical dampness of a concrete masonry unit.

3.2 *Nomenclature:*

H = Height of specimen, in. (mm)

L = Length of specimen, in. (mm)

$L_{FS\ (left)}$ = Length of left face shell test area when looking at the interior of the exposed face shell, in. (mm)

$L_{FS\ (right)}$ = Length of right face shell test area when looking at the interior of the exposed face shell, in. (mm)

$W_{initial}$ = Weight of specimen at start of test, lb. (kg)

W_{final} = Weight of specimen at end of test, lb. (kg)

A_{FS} = Total face shell test area, in^2 (mm^2)

A_{solid} = Total test area for solid specimen, in^2 (mm^2)

$D_{FS,T}$ = Dampness on face shell test area at time T, %

$D_{solid,T}$ = Dampness on solid unit test area at time T, %

W_{abs} = Weight of water absorbed during test, lb. (kg)

Note 4: See Figure X1.3 in Appendix X1 for examples of length and width locations for a typical concrete masonry unit.

4. Summary of Test Method

4.1 In this test method, the face of a concrete masonry unit is exposed to multiple streams of water at a constant rate from a spray bar and a visual assessment of the amount of moisture migration through the unit in the form of pinholes or damp surfaces is performed. The weight of absorbed water is also determined.

5. Significance and Use

5.1 This test does not evaluate a concrete masonry wall assembly's resistance to moisture migration. It is used to evaluate the characteristics of the concrete masonry unit itself.

Note 5: System performance for water penetration resistance is a function of a number of variables in addition to the characteristics of the unit itself, including, but not limited to: design considerations and detailing, workmanship, the characteristics of other materials used in the construction of masonry (mortar, coatings, flashings, weeps, joint sealants, primers, etc), and the effect of adjacent materials, architectural elements, and building components.

5.2 This method is intended to visually determine the moisture migration characteristics of a concrete masonry unit when subjected to multiple streams of water.

Note 6: Integral water repellent admixtures can be used in the production of concrete masonry units. Other variables, such as manufacturing methods and constituent materials, can have an effect on the water repellency of individual concrete masonry units. This method does not distinguish effects of separate variables on water repellency, only on the overall characteristics of the CMU.

Note 7: Other methods for characterizing the water absorbency characteristics of a concrete masonry unit are NCMA CMU-WR1 and NCMA CMU-WR3

Note 8: For more information on concrete masonry units with integral water repellent admixtures, as well as performance guidelines and specifications, please see NCMA TEK 19-7.

6. Apparatus

6.1 *Container* – The container shall be of a sufficient size to contain a submersible pump and the necessary amount of water to fulfill the flow requirements of Section 7.1. The configuration of the container and orientation of the specimen shall be such to prevent water from splashing out of the container or onto the specimen.

Note 9: Rectangular plastic containers with minimum dimensions of 23 x 16.5 x 6 in. (584 x 420 x 152 mm) have been found to be sufficient for testing of most CMU. Use an open container to collect the water or support the specimen over a closed container in which drainage holes are provided in the top of container and other holes are provided for tubing and power cords for the submerged pump within the container.

6.2 *Spray Bar* – A minimum ½ inch (12.7 mm) diameter rigid pipe suitable for use in wet conditions. The spray bar shall have at least one rigid T-section to evenly divide the spray bar into sections and shall be sealed on both ends. The spray bar shall contain a series of 1/8 inch (3.2 mm) diameter holes each spaced 1 inch (25.4 mm) apart along a single, straight line the length of the spray bar. The holes shall be drilled at an incidence angle such that the drill would pass directly through the center of the pipe. Any holes less than 1 in. (25 mm) from the end of the specimen shall be plugged during testing. The spray bar length shall be no less than the length of the specimen.

Note 10: For a concrete masonry unit having a nominal length of 16 inches (406 mm), the spray bar will have 14 holes to apply water.

6.3 *Connection pipes* – A minimum of ½ inch (12.7 mm) diameter pipe and flexible hose with fittings to connect the spray bar to the submersible pump.

6.4 *Submersible Pump* – A pump regulated or controlled to yield a constant discharge capacity of 2.0 ± 0.1 gallons (7.6 ± 0.4 L) per minute.

Note 11: A flow control meter is recommended to verify consistent discharge during testing.

7. Preparation of Apparatus

7.1 *Flow Control* – If a flow control meter or other means of regulating, controlling, and/or monitoring is not used, the submersible pump shall be calibrated prior to each use to ensure a flow of 2.0 ± 0.1 gallons (7.6 ± 0.4 L) per minute. If a flow control meter is used, calibrate the meter prior to initial use and every six months thereafter.

7.2 *Specimen Support* –Support the specimen to preclude contact with splashing water, the related plumbing which may induce unintended contact with water, and the reservoir of water. The supports shall be made of a non-absorptive, non-corrosive material to support the specimen.

Note 12: Placement of the specimen support near the front edge of the unit has been found to reasonably limit water curling under the bottom of the unit. Rope caulk or other compressible, non-absorbent material placed on top of the unit support may provide better contact between the support and the unit and further limit water curling. Shields, adhesives, sealants, or caulk at the top, sides, and/or base can also be used to reduce curling and splashing.

7.3 *Specimen Position* – Position the specimen so that the orientation is as the specimen will be placed in a wall.

7.4 *Spray Bar Attachment* – Firmly attach the spray bar apparatus on top of the specimen so that the spray bar is 1.0 ± 0.125 inch (25.4 ± 3.2 mm) from the face and 1.0 ± 0.125 inch (25.4 ± 3.2 mm) below the top of the specimen when measured to the center of the spray bar. Position the holes in the spray bar toward the test surface in such a way that water impacts the face 0.5 ± 0.05 inch (12.7 ± 1.2 mm) below the spray bar holes (See Note 12) and projects a stream of water that is onto the face of the specimen.

Note 13: When the spray bar is properly positioned, water shall impact the specimen surface approximately 1.5 inches (38.1 mm) from the top of the specimen

7.5 *Filling the Container* - Place tap water in the container to cover the submersible pump. The water level shall be at least 1 inch (25.4 mm) below the bottom of the specimen. Do not reuse water for multiple tests.

8. Specimen Sampling, Conditioning and Preparation

8.1 Sample three concrete masonry units of identical configuration and properties representative of the lot for each test.

8.2 The minimum nominal length of a test specimen shall be 8 in. (203 mm).

8.3 Prior to testing, store units in laboratory air at 75 ± 10°F (24 ± 5 °C) and a relative humidity of 50 ± 15 % for a minimum of 48 hours. Units shall have no visible moisture prior to initiation of testing.

8.4 It is permitted to remove the back face shell of hollow concrete masonry units may be removed by saw-cutting to assist in visual observations and documentation of performance. When the back face shell of the specimen is removed, the width of the test specimen shall be a minimum of 50% of the full size unit width. If specimens are wetted during saw-cutting, allow the specimens to dry to equilibrium with laboratory air conditions before testing, using the procedures outlined in 8.3.

8.5 Measure the height of the specimen to the nearest 0.1 inch (2.5 mm) across the test face at mid-length and record as H.

8.6 For solid units, measure the length of the specimen to the nearest 0.1 inch (2.5 mm) across the test face at mid-height and record as L.

8.7 For hollow units, measure the inside length(s) of the face shells between the webs at mid height to the nearest 0.1 inch (2.5 mm) and record as $L_{FS(left)}$ and $L_{FS(right)}$, respectively. When inside surfaces of hollow units such as from a front face shell include (a) rounded inside edge(s), the end(s) of the length(s) of that inside surface shall be considered to be along the line at the intersection of the center of the arc that makes up that inside rounded edge.

Note 14: See Figure X1.4 in Appendix X1 for examples of face shell length measurement locations for a typical concrete masonry unit.

8.8 Weigh the specimen to the nearest 0.01 lb (0.005 kg) and record as $W_{initial}$ within five minutes of the start of the test.

9. Procedure

9.1 Position the specimen as required in Section 7. Turn on the pump to apply water to the face of the specimen at a flow rate of 2.0 ± 0.1 gal per minute (7.6 ± 0.4 L per min). Ensure that water is flowing uniformly over the face of the unit. Maintain specified water flow for a period of not less than 4 hours.

9.2 At the conclusion of testing, weigh the specimen to the nearest 0.01 lb (0.005 kg) and record as W_{final}.

10. Measurement of Results

10.1 After 4 hours elapsed time from the start of water flow, observe and record measurements as specified in Sections 10.2-10.4. Observations at other times are permitted, so long as the water flow is not interrupted within the first four hours of testing.

10.2 For hollow units, pinholes and dampness shall be evaluated on the inside of the front face shell. For solid units, pinholes and dampness shall be evaluated on the back face.

10.3 The number of pinholes shall be observed and recorded prior to turning the water off.

10.4 Photographs of the observed surface shall be taken immediately prior to turning the water off.

10.5 Immediately after turning the water off, observe and record the area of dampness on the surfaces specified in Section 10.2 to the nearest 0.25 $in.^2$ (160 mm^2). When inside surfaces of hollow units such as from a front face shell include (a) rounded inside edge(s), the end(s) of the length(s) of that inside surface shall be considered to be along the line at the intersection of the center of the arc that makes up that inside rounded edge. See Note 13.

Note 15: One method of measuring area is found in Appendix X1.

10.5.1 When evaluating damp areas, do not include water that has trickled vertically down from a pinhole. If, however, water trickling from a pinhole becomes absorbed into the surface of the unit such that the width of the water mark is greater than the width of the damp area immediately surrounding the pinhole, that greater amount of surface area shall be considered damp and shall be measured.

11. Calculations

11.1 For hollow units, calculate the total face shell test area as for each unit as:

$$A_{FS}, \text{ in.}^2 \text{ (mm}^2\text{)} = (L_{FS(left)} + L_{FS(right)}) * H \qquad \text{(Eqn. 1)}$$

11.2 For solid units, calculate the total test area as:

$$A_{solid}, \text{ in.}^2 \text{ (mm}^2\text{)} = L * H \qquad \text{(Eqn. 2)}$$

11.3 For hollow units, calculate the percentage dampness inside the face shells at any time *T* as:

$$D_{FS,T}\ \% = ((\text{Area of dampness})/A_{FS}) *100) \qquad \text{(Eqn. 3)}$$

11.4 For solid units, calculate the percentage dampness of the test area at any time *T* as

$$D_{solid,T}\ \% = (\text{Area of Dampness}/A_{solid}) * 100 \qquad \text{(Eqn. 4)}$$

11.5 Calculate the weight of water absorbed by the test specimen during the test as

$$W_{abs}, \text{ lb (kg)} = W_{final} - W_{initial} \qquad \text{(Eqn. 5)}$$

12. Report

12.1 A complete report shall include the following:

12.1.1 The information from Table 2 of ASTM C 1093.

12.1.2 Number of pinholes in each surface at each time measured for each unit individually.

12.1.3 W_{abs} to the nearest 0.01 lb (0.005 kg) for each specimen individually and as an average for the set of three specimens.

12.1.3.1 For hollow units, $D_{FS,T}$ at 4 hours and any other time greater than 4 hours measured to the nearest 0.1% for each specimen individually and as an average for the set of three specimens.

12.1.3.2 For solid units, $D_{solid,T}$ at 4 hours and any other time greater than 4 hours measured to the nearest 0.1% for each specimen individually and as an average for the set of three specimens.

12.1.4 A photograph of each specimen showing the location and nature of dampness and pinholes (if applicable) at 4 hours and any other time greater than 4 hours measured.

13. Precision and Bias

13.1 There is no precision and bias information available for this method.

14. Keywords

14.1 concrete masonry unit, spray bar, water penetration, pinhole, damp, dampness

APPENDIX X1 – Procedure for Dampness Measurement Using a Flexible Grid
(Non-mandatory Information)

X1.1 Introduction

X1.1.1 This appendix outlines a procedure that can be used to determine the dampness on the non-exposed surface of a concrete masonry units evaluated using this test method.

X1.2 Apparatus

X1.2.1 *Dampness Measurement Grid* – a flexible, clear plastic sheet containing a grid having divisions of not greater than 0.25 ± 0.05 inch (6.3 ± 1.2 mm) on a side. The size of the sheet shall be sufficient to cover the surface being evaluated. See Figure X1.2.

Note X1.1 – Transparency sheets as used with overhead projectors have demonstrated to work well for reproducing measurement grids. These can be cut to fit the units with which they are being used.

X1.3 Procedure

X1.3.1 Immediately after turning the water off, outline the visible damp areas on the surface to be evaluated using a pencil, marker, or other suitable device.

X1.3.2 Place the dampness measurement grid over each surface to be evaluated. Be sure that the measurement grid covers the entire area to be measured. Evaluate the visibly damp areas by counting the total number of squares and partial squares that make up the damp areas. Estimate the number of partially filled squares needed to combine to make a full square that can be counted along with other full squares. Record the number of squares for each area measured.

X1.3.3 To calculate the area of dampness, use the following equation:

$$\text{Area of dampness, in}^2\ (\text{mm}^2) = (\text{total number of damp squares}) * (\text{area of grid squares})$$

Figure X1.1: Example of tested specimen with pinholes on the inside of the front face shell

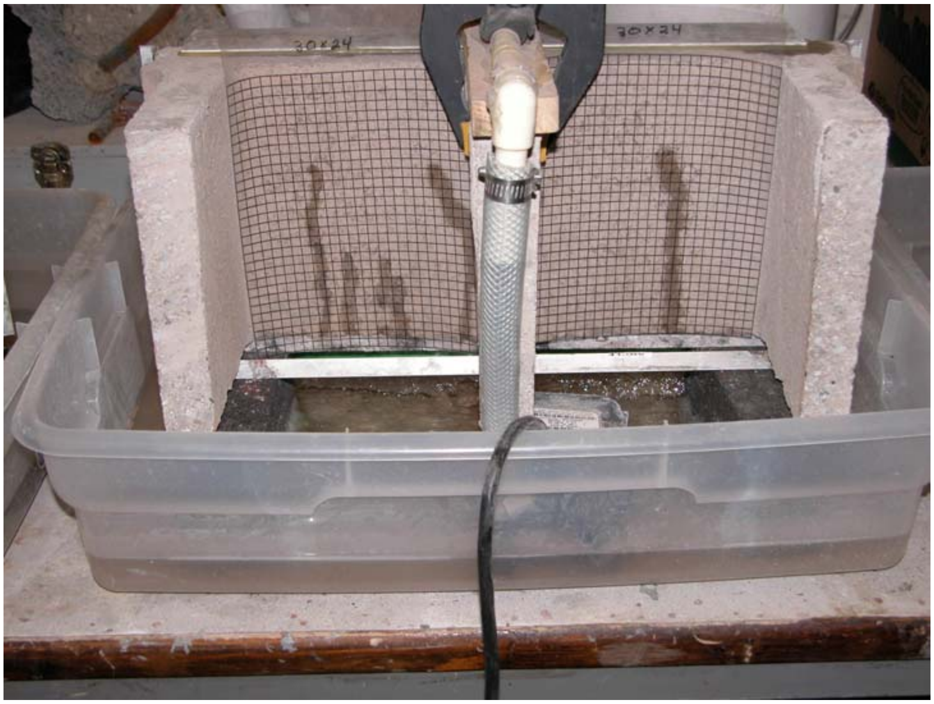

Figure X1.2: Example of tested specimen with dampness on the inside of front face shell

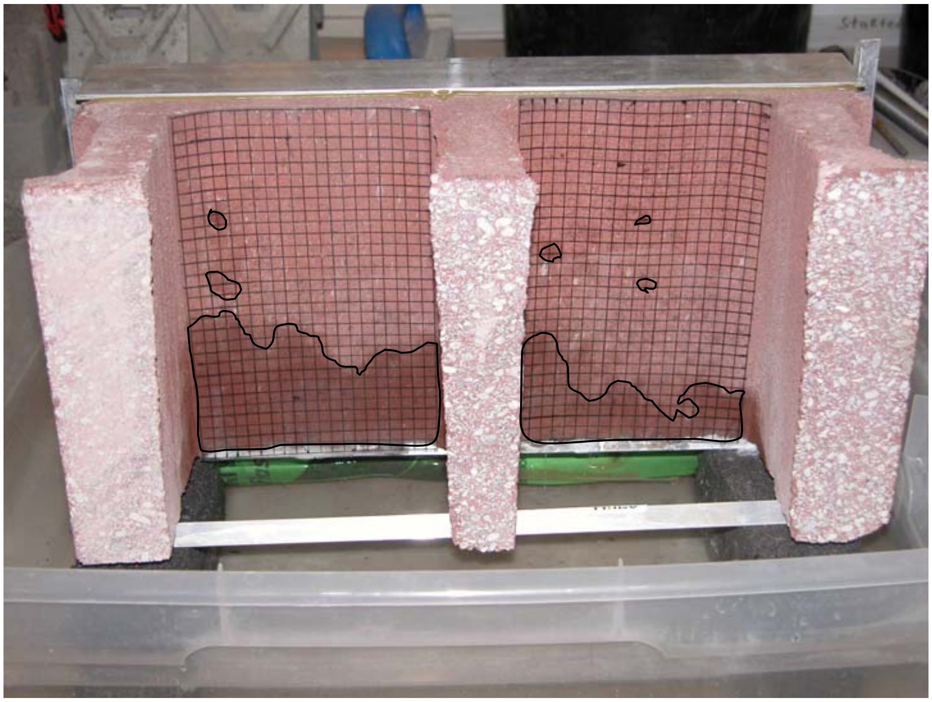

Figure X1.3: Example for determining dimensions of surfaces with rounded edges for calculating areas for those surfaces

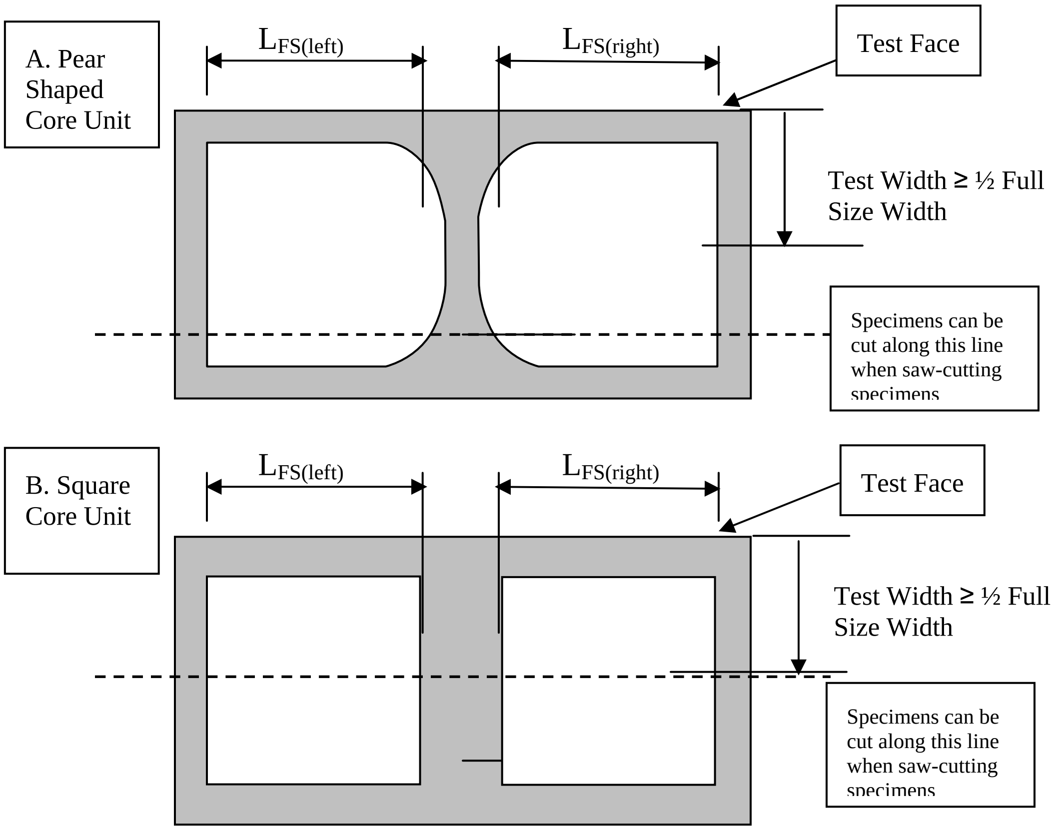

Figure X1.4: Specimen undergoing testing