Industry Standard from

The National Concrete Masonry Association

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NCMA CMU-WR3-09

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

1. Scope

1.1 The purpose of this test is to evaluate the resistance of a concrete masonry unit to vertical moisture migration due to capillary action, a migration often referred to as wicking or water uptake.

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

1.2 The values stated in SI 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.

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:*

C90 Specification for Loadbearing Concrete Masonry Units

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

C1093 Practice for Accreditation of Testing Agencies for Unit Masonry

2.2 *NCMA Standards:*

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

CMU-WR2 Standard Test Method for Spray Bar Test of Concrete Masonry Units

2.3 *NCMA TEK*

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

3. Terminology

3.1 *Nomenclature:* The following are used throughout this standard:

U_X	=	water uptake of specimen at time X, g/100 cm^2 (lb/15 in^2)
$\%U_X$	=	relative water uptake of specimen at time X, %
U_S	=	saturated water uptake of specimen, g/100 cm^2 (lb/15 in^2)
H	=	average height of the specimen, mm (in.)
L	=	average length of the specimen, mm (in.)
X	=	time period at which water uptake measurement was taken, hours
t	=	thickness of water uptake specimen, mm (in.)

V_n = average net volume of specimen, mm^3 (in^3)

W_d = oven-dry weight of specimen, g (lb)

W_i = immersed weight of specimen, g (lb)

W_0 = weight of specimen at the beginning of water uptake test at start of test, g (lb)

W_s = saturated weight of specimen, g (lb)

W_X = weight of specimen at time *X*, g (lb)

D = density of concrete masonry unit, kg/m^3 (lb/ft^3)

4. Summary of Test Method

4.1 In this test method, oven-dried coupons removed from three separate concrete masonry units are placed in 3 mm (0.1 in.) of water. The amount of water that is absorbed through capillary action is measured at periodic intervals up to 24 hours and reported as a mass per unit area and as a percent of total saturation.

5. Significance and Use

5.1 This test method provides a method for assessing a concrete masonry unit's affinity to absorb water under negligible head pressure due to capillary action.

5.2 This test does not evaluate a concrete masonry wall assembly's resistance to moisture migration or water penetration.

Note 2: System performance for water penetration resistance is a function of a number of variables in addition to the characteristic of the units themselves, including, but not limited to: design considerations and detailing, workmanship, the characteristics of other materials used in the construction of masonry (mortar, coatings, flashing, weeps, joint sealants, primers, etc.), and the effect of adjacent materials, architectural elements, and building components.

Note 3: 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 concrete masonry unit.

5.3 Density, absorption, and equivalent thickness are calculated in this test. These properties, however, while similar to those calculated in Method C140, cannot be directly compared to the values obtained by Method C140, and cannot be used to determine compliance with Specification C90.

Note 4: Values from this method cannot be used to determine compliance with density and absorption requirements in accordance with Specification C90 because units are oven-dried at the start of testing.

Note 5: Other methods for characterizing the water absorbency characteristics of a concrete masonry unit are NCMA CMU-WR1 and NCMA CMU-WR2.

Note 6: 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 *Balance* – A balance sensitive to 0.1% of the specimen weight with a capacity sufficient to weigh the specimen when fully saturated.

6.2 *Container* - A watertight container with a minimum cross sectional area that is at least 50% greater than the face area of the specimen being tested and has a minimum depth of 50 mm (1.97 in.). The container shall include a cover to minimize evaporation. It shall be permitted to place more than one specimen in a container provided the requirements for water depth are maintained for each specimen at all times during the test.

6.2.1 The container shall be flat so that when a specimen is set on the supports the depth of immersion of 3.0 ± 0.5 mm (0.1 ± 0.2 in.) can be maintained and does not vary by more than 1 mm (0.04 in.) across the length or width of the specimen.

6.3 *Specimen Supports* - Specimen supports that allow a minimum of 3 mm (0.125 in.) clearance from the bottom of the container and that cover a maximum of 10% of the specimen surface area. Supports shall be made of a solid, noncorrosive, nonabsorptive material.

6.4 *Measuring Device* – The measuring device shall have divisions not greater than 0.25 mm (0.01 in.)

6.5 *Drying Oven* – The drying oven shall be ventilated, capable of holding the test specimens, and capable of maintaining a temperature of 110 ± 5 °C (230 ± 10 °F).

6.6 *Absorption Tank* – A watertight tank suitable for full submersion of the specimens for determining total absorption. The water in the tank shall be deep enough so that no part of the specimen is less than 50 mm from the surface of the water. The tank shall have the capability to weigh the coupons under water for determining the immersed weight. The temperature of the water in the tank shall be 21 ± 6 °C (70 ± 10 °F).

7. Specimen Sampling and Preparation

7.1 Sample three concrete masonry units of identical configuration for each test with at least one molded face available on each unit. Do not select units in which both faces have an architectural feature.

7.2 Saw-cut a solid, rectangular coupon from the unit such that the coupon contains a smooth, manufactured face. The specimen shall be rectangular, have a surface area of 160 cm^2 to 800 cm^2 (25 in^2 to 125 in^2), and lateral dimensions of no less than 200 mm (3 in.). The specimen shall have a thickness of 32 ± 6.3 mm (1.25 ± 0.25 in.). The thickness shall not vary by more than 10% over the length and width of the specimen.

7.2.1 Saw in an accurate, competent manner subjecting the specimen to as little saw vibration as possible. Use a water-cooled saw and a diamond saw blade of proper hardness.

7.2.2 Rinse each specimen under tap water to remove any loose, residual material from the sawing.

7.3 Dry the specimens in a ventilated oven at 110 ± 5 °C (230 ± 10 °F) for not less than 24 hours and until two successive weightings at intervals of 2 hours show an increment of loss not greater than 0.2% of the last previously determined weight of the specimen. Remove specimens from the oven and measure and record the oven dry weight, W_d, to the nearest 0.1 g (.0002 lb). Cool the specimens in ambient conditions (24 ± 8 °C [75 ± 15 °F] and a relative humidity of less than 80%) for a minimum of 2 hours and until the specimens reach ambient temperature. Begin water uptake testing within 24 hours after reaching ambient temperature.

7.4 One complete test set shall consist of three individual test specimens.

8. Procedure

8.1 Measure and record the height, length, and thickness of each test specimen to the nearest 0.25 mm (0.01 in.). See Figure 1. Take and record two measurements of each dimension, with each measurement being approximately 10 to 15 mm (0.4 to 0.6 in.) from opposite edges of the specimen.

8.2 Measure and record as W_0, the initial weight of the specimen, to the nearest 0.1 g of each individual specimen immediately prior to testing.

8.3 Place the uptake container on a level surface. Place the specimen(s) in the uptake container with their molded surface in contact with the specimen supports such that the specimens are level within the container.

8.4 Add water at a temperature of 24 ± 8 °C (75 ± 15 °F) to the uptake container so that the level of the water is 3.0 ± 0.5 mm (0.1 ± 0.2 in.) above the top of the supports, resulting in a partial immersion of the specimen(s) of 3.0 ± 0.5 mm (0.1 ± 0.2 in.).

8.5 Monitor the specimen(s) for the first minute to make sure the water level is adequate during the initial absorption phase. Add water as necessary to maintain an immersion depth of 3.0 ± 0.5 mm (0.1 ± 0.2 in.). Cover the uptake container to minimize evaporation.

8.6 At 0.25 hr ± 0.5 min, 1 hr ± 1 min, 4 hr ± 5 min and 24 hr ± 5 min from the time that the specimen(s) makes contact with water, measure the weight of the specimen to the nearest 0.1 g (0.0002 lb) and record as W_T, where T is the measurement of elapsed time in hours from the start of testing. At each interval, remove each specimen from the uptake container and blot visible surface water from bottom surface with a damp cloth prior to each weighing. Complete the blotting within 10 seconds of removal from contact with the water and complete weighing within 1 minute.

8.7 After each weighing, return the specimen(s) to the uptake container and add water as needed to maintain an immersion depth of 3.0 ± 0.5 mm (0.1 ± 0.2 in.). Re-cover the uptake container.

8.8 Immediately after the 24 hour measurement, fully submerge the specimen in the absorption tank. No part of the specimen shall be less than 50 mm (2.0 in.) from the surface of the water.

8.9 After 24 ± 2 hr in the absorption tank, weigh the specimens while suspended and completely submerged in water and record the immersed weight as W_i to the nearest 0.1g (0.0002 lb). Remove each specimen from the water, wipe off visible surface water with a damp cloth and weigh and record the saturated weight as W_S to the nearest 0.1g (0.0002 lb). Complete the wipe within 10 seconds of removal from contact with the water and complete weighing within 1 minute.

9. Calculations

9.1 For all specimens, calculate the following for each specimen and as an average for the set of three specimens:

9.1.1 Average height (H), length (L), and thickness (t) to the nearest 0.25 mm (0.01 in.).

9.1.2 Density (D) as follows:

$$\text{Density, g/mm}^3 = [W_d/(W_s - W_i)] \times 1000 \quad \text{(Eqn. 1)}$$

$$\text{Density, lb/ft}^3 = [W_d/(W_s - W_i)] \times 62.4 \quad \text{(Eqn. 2)}$$

9.1.3 Absorption as follows:

$$\text{Absorption, g/mm}^3 = [(W_s - W_d)/(W_s - W_i)] \times 1000 \quad \text{(Eqn. 3)}$$

$$\text{Absorption, lb/ft}^3 = [(W_s - W_d)/(W_s - W_i)] \times 62.4 \quad \text{(Eqn. 4)}$$

9.1.4 Moisture Content as follows:

$$\text{Moisture Content at Time 0, \%} = [(W_0 - W_d) / (W_s - W_d)] \times 100 \quad \text{(Eqn. 5)}$$

9.1.5 Water uptake, U_X , at each time period X, as follows:

$$U_X \text{ , g/100 cm}^2 = [(W_X - W_0)*10000] / [(H \times L)] \quad \text{(Eqn. 6)}$$

$$U_X \text{ , lb/15 in}^2 = [(W_X - W_0)*15] / [(H \times L)] \quad \text{(Eqn. 7)}$$

9.1.6 Water uptake at total saturation, U_s, as follows:

$$U_s \text{ , g/100 cm}^2 = [(W_S - W_0)*10000] / [(H \times L)] \quad \text{(Eqn. 8)}$$

$$U_s \text{ , lb/15 in}^2 = [(W_S - W_0)*15] / [(H \times L)] \quad \text{(Eqn. 9)}$$

9.1.7 Relative water absorption, $\%U_X$, in percent of total saturation, at each time period X, as follows:

$$\%U_X = (U_X / U_s) \times 100\% \quad \text{(Eqn. 10)}$$

10. Report

10.1 The report shall include the following

10.1.1 The information from Table 2 of ASTM C 1093.

10.1.2 Average height (H), length (L), and thickness (t) to the nearest 0.25 mm (0.01 in.) for each specimen and as an average for the set of specimens.

10.1.3 Density to the nearest 1 g/mm^3 (0.1 lb/ft^3) for each specimen and as an average for the set of specimens.

10.1.4 Absorption to the nearest 1 g/mm^3 (0.1 lb/ft^3) for each specimen and as an average for the set of specimens.

10.1.5 Moisture content at time 0 to the nearest 0.1% for each specimen and as an average for the set of specimens.

10.1.6 Water uptake, U_X , at each time period X to the nearest 0.1 g/100 cm^2 (0.0002 lb/15 in^2) for each specimen and as an average for the set of specimens.

10.1.7 Water uptake at total saturation ,U_s , to the nearest 0.1 g/100 cm^2 (0.0002 lb/15 in^2) for each specimen and as an average for the set of specimens.

10.1.8 Relative water absorption, $\%U_X$, in percent of total saturation, at each time period X, to the nearest 0.1% for each specimen and as an average for the set of specimens.

11. Precision and Bias

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

12. Keywords

12.1 absorption, capillary action, concrete masonry unit, water penetration, water uptake, wicking

Figure 1: Location of Test Specimen for Hollow Units