Designation: C 216 – 07a

Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)[1]

This standard is issued under the fixed designation C 216; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers brick intended for use in masonry and supplying structural or facing components, or both, to the structure.

1.2 The property requirements of this specification apply at the time of purchase. The use of results from testing of brick extracted from masonry structures for determining conformance or nonconformance to the property requirements (Section 6) of this specification is beyond the scope of this specification.

1.3 The brick are prismatic units available in a variety of sizes, textures, colors, and shapes. This specification is not intended to provide specifications for paving brick (see Specification C 902).

1.4 Brick are manufactured from clay, shale, or similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). The heat treatment must develop a fired bond between the particulate constituents to provide the strength and durability requirements of this specification (see firing, fired bond, and incipient fusion in Terminology C 43).

1.5 Brick are shaped during manufacture by molding, pressing, or extrusion, and the shaping method is a way to describe the brick.

1.6 Three types of brick in each of two grades are covered.

1.7 The text of this specification 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.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 43 Terminology of Structural Clay Products

C 67 Test Methods for Sampling and Testing Brick and Structural Clay Tile

C 902 Specification for Pedestrian and Light Traffic Paving Brick

C 1272 Specification for Heavy Vehicular Paving Brick

E 835/E 835M Guide for Modular Coordination of Clay and Concrete Masonry Units

3. Grades

3.1 Grades classify brick according to their resistance to damage by freezing when saturated at a moisture content not exceeding the 24-h cold water absorption. Two grades of facing brick are covered and the requirements are given in Section 6.

3.1.1 *Grade SW (Severe Weathering)*—Brick intended for use where high resistance to damage caused by cyclic freezing is desired.

3.1.2 *Grade MW (Moderate Weathering)*—Brick intended for use where moderate resistance to cyclic freezing damage is permissible.

NOTE 1—Measurement of moisture content of brick in buildings indicates that, when the building is designed and constructed to reduce water penetration, the 24-h cold water absorption is unlikely to be exceeded.

4. Types

4.1 Three types of facing brick are covered:

4.1.1 *Type FBS*—Brick for general use in masonry.

4.1.2 *Type FBX*—Brick for general use in masonry where a higher degree of precision and lower permissible variation in size than permitted for Type FBS is required.

4.1.3 *Type FBA*—Brick for general use in masonry selected to produce characteristic architectural effects resulting from nonuniformity in size and texture of the individual units.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.02 on Brick and Structural Clay Tile.

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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.

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

TABLE 1 Physical Requirements

Designation	Minimum Compressive Strength psi, (MPa) gross area		Maximum Water Absorption by 5-h Boiling, %		Maximum Saturation Coefficient[A]	
	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual
Grade SW	3000 (20.7)	2500 (17.2)	17.0	20.0	0.78	0.80
Grade MW	2500 (17.2)	2200 (15.2)	22.0	25.0	0.88	0.90

[A] The saturation coefficient is the ratio of absorption by 24-h submersion in cold water to that after 5-h submersion in boiling water.

4.2 When the type is not specified, the requirements for Type FBS shall govern.

5. Ordering Information

5.1 Orders for facing brick under this specification shall include the following information:

5.1.1 *Grade (Section 3)*—Grade SW governs when Grade is not specified.

5.1.2 *Type (Section 4)*—Type FBS governs when Type is not specified.

5.1.2.1 For Type FBA, specify chippage (8.4), tolerances (Section 10), or approve a designated sample.

5.1.3 Color, color range, and texture (9.1) by approving a sample.

5.1.3.1 Finish on more than one face and one end (9.2).

5.1.4 *Size (10.1)*—Specify width by height by length.

5.1.5 *Sampling (12.2)*—Person to select samples and place or places of selection of samples for testing.

5.2 Orders for facing brick under this specification may include the following information:

5.2.1 *Strength (6.2)*—Specify only if above minimum compressive strength in Table 1.

5.2.2 *Coring (11.1)*—At option of manufacturer if not specified.

5.2.3 *Frogging (11.2)*—Frog permitted in one bearing face if not specified.

5.2.4 *Costs of Tests (Note 14)*—Party who will pay and conditions for payment of compliance testing.

NOTE 2—Color, color range, and texture are best specified by identifying a particular manufacturer and unit designation. Nominal dimensions should not be used to specify size.

NOTE 3—See sections 6.3 and 7 for optional information.

6. Physical Properties

6.1 *Durability*—When Grade is not specified, the requirements for Grade SW shall govern.

6.1.1 *Physical Property Requirements*—The brick shall conform to the physical requirements for the Grade specified as prescribed in Table 1. For the compressive strength requirements in Table 1, test the unit with the compressive force perpendicular to the bed surface of the unit, with the unit in the stretcher position.

6.1.2 *Absorption Alternate*—The saturation coefficient requirement does not apply, provided the 24-h cold water absorption of each unit of a representative sample of five brick does not exceed 8.0 %.

6.1.3 *Freezing and Thawing Alternative*—The requirements for 5-h boiling water absorption and saturation coefficient do not apply, provided a representative sample of five brick, meeting the strength requirements of Table 1, passes the freezing and thawing test as described in the Rating Section of the Freezing and Thawing test procedures of Test Methods C 67:

6.1.3.1 *Grade SW: Breakage and Weight Loss Requirement*—No individual unit separates or disintegrates resulting in a weight loss greater than 0.5 % of its original dry weight.

NOTE 4—The 50 cycle freezing and thawing test is used as an alternative only when the brick do not conform to either Table 1 requirements for maximum water absorption and saturation coefficient, or to the requirements of the Absorption Alternate in 6.1.2.

6.1.3.2 *Grade SW: Cracking Requirement*—No individual unit develops a crack that exceeds, in length, the unit's least dimension.

6.1.4 *Low Weathering Index Alternative*—If the brick are intended for use exposed to weather where the weathering index is less than 50 (see Fig. 1), and unless otherwise specified, the requirements given in Table 1 for 5-h boiling water absorption and for saturation coefficient shall not apply, but the minimum average compressive strength requirement of 2500 psi (17.2 MPa) shall apply.

NOTE 5—The effect of weathering on brick is related to the weathering index, which for any locality is the product of the average annual number of *freezing cycle days* and the average annual *winter rainfall* in inches (millimetres), defined as follows.[3]

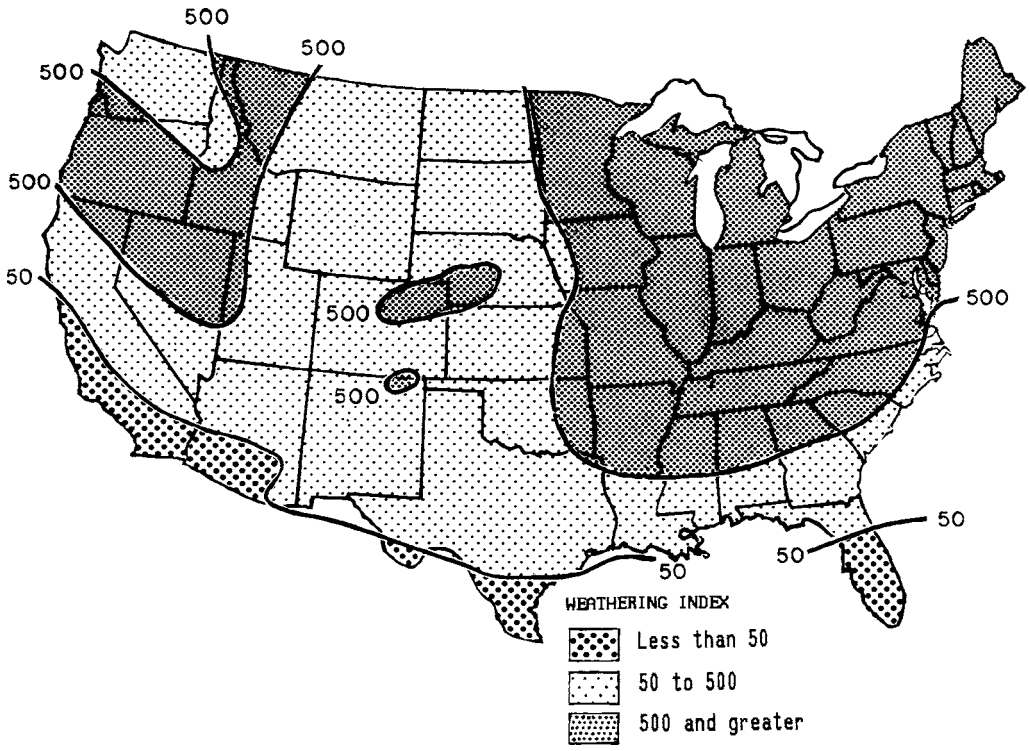
A Freezing Cycle Day is any day during which the air temperature passes either above or below 32°F (0°C). The average number of freezing cycle days in a year may be taken to equal the difference between the mean number of days during which the minimum temperature was 32°F or below, and the mean number of days during which the maximum temperature was 32°F or below.

Winter Rainfall is the sum, in inches (millimetres), of the mean monthly corrected precipitation (rainfall) occurring during the period between and including the normal date of the first killing frost in the fall and the normal date of the last killing frost in the spring. The winter rainfall for any period is equal to the total precipitation less one tenth of the total fall of snow, sleet, and hail. Rainfall for a portion of a month is prorated.

Fig. 1 indicates general areas of the United States which correspond to the weathering index categories listed. The index for geographic locations near the 50 line should be determined by analysis of weather bureau local climatological summaries, with due regard to the effect of microclimatic conditions, especially altitude.

The recommended correlation between grade of facing brick, weathering index, and exposure is found in Fig. 1. The specifier may use these recommendations or use the grade descriptions and physical requirements along with use exposure and local climatological conditions to select grade.

[3] Data needed to determine the weathering for any locality may be found or estimated from tables of Local Climatological Data—Annual Summary with Comparative Data available from the National Oceanic and Atmospheric Administration.



Grade Recommendations for Face Exposures		
Exposure	Weathering Index (Note 5)	
	Less than 50	50 and greater
In vertical surfaces:		
In contact with earth	SW or MW	SW
Not in contact with earth	SW or MW	SW
In other than vertical surfaces:		
In contact with earth	SW	SW
Not in contact with earth	SW or MW	SW

FIG. 1 Weathering Indices in the United States

6.2 *Strength*—When brick are required having strengths greater than prescribed by this specification, the purchaser shall specify the desired minimum compressive strength.

6.3 *Initial Rate of Absorption (IRA)*—Test results for IRA shall be determined in accordance with the IRA (Suction) (Laboratory Test) of Test Methods C 67 and shall be furnished at the request of the specifier or purchaser. IRA is not a qualifying condition or property of units in this specification. This property is measured in order to assist in mortar selection and material handling in the construction process. See Note 6.

NOTE 6—*Initial Rate of Absorption (Suction)*—Both laboratory and field investigation have shown that strong and watertight joints between mortar and masonry units are not achieved by ordinary construction methods when the units as laid have excessive initial rates of absorption. Mortar that has stiffened somewhat because of excessive loss of mixing water to a unit may not make complete and intimate contact with the second unit, resulting in poor adhesion, incomplete bond, and water-permeable joints of low strength. IRA of the units is determined by the oven-dried procedure described in the IRA (Suction) (Laboratory Test) of Test Methods C 67. IRA in the field depends on the moisture content of the masonry unit and is determined in accordance with the IRA (Suction)—Field Test of Test Methods C 67. Units having average field IRA exceeding 30 g/min·30 in.^{2}(30 g/min·194 cm^2) should have their IRA reduced below 30 g/min·30 in.^{2} prior to laying. They may be wetted immediately before they are laid, but it is preferable to wet them thoroughly 3 to 24 h prior to their use so as to allow time for moisture to become distributed throughout the unit.

NOTE 7—Loose sand, such as mold-release sand in molded brick and parting agents, used in the manufacturing process is not intended as a surface coating. Such loose sand is typically removed during the process of construction and cleaning and is not addressed in this specification.

NOTE 8—The cleaning procedures used on surface-coated brick can have an effect on the appearance of the surface coating. Manufacturers should be consulted for specific cleaning recommendations on these units.

7. Efflorescence

7.1 Brick are not required to be tested for efflorescence to comply with this specification unless requested by the specifier or purchaser. When the efflorescence test is requested by the specifier or purchaser, the brick shall be sampled at the place of manufacture, and tested in accordance with Test Methods C 67, and a rating for efflorescence shall be "not effloresced." If the

TABLE 2 Maximum Permissible Extent of Chippage From the Edges and Corners of Finished Face or Faces onto the Surface

Type	Percentage Allowed[A]	Chippage in in. (mm) in from		Percentage Allowed[A]	Chippage in in. (mm) in from	
		Edge	Corner		Edge	Corner
FBX	5 % or less	1/8 –1/4 (3.2–6.4)	1/4 –3/8 (6.4–9.5)	95 to 100 %	0–1/8 (0–3.2)	0–1/4 (0–6.4)
FBS[B] (Plain)	10 % or less	1/4 –5/16 (6.4–7.9)	3/8 –1/2 (9.5–12.7)	90 to 100 %	0–1/4 (0–6.4)	0–3/8 (0–9.5)
FBS[C] (Textured)	15 % or less	5/16 –7/16 (7.9–11.1)	1/2 –3/4 (12.7–19.1)	85 to 100 %	0–5/16 (0–7.9)	0–1/2 (0–12.7)
FBA	to meet the designated sample or as specified by the purchaser, but not more restrictive than Type FBS (rough)					

[A] Percentage of exposed brick allowed in the wall with chips measured the listed dimensions in from an edge or corner.
[B] Plain units are extruded brick with an unbroken natural die finish face and dry-pressed brick.
[C] Textured units are extruded brick with the face sanded, combed, scratched, scarified, or broken by mechanical means such as wire-cutting or wire-brushing, and molded brick.

rating for efflorescence is "effloresced," the brick represented by the testing do not meet the efflorescence requirements of this specification.

8. Material and Finish

8.1 Colors and textures produced by application of inorganic coatings to the faces of the brick shall be permitted with the consent of the purchaser, provided that evidence is furnished of the durability of the coatings. Brick that are colored by flashing or textured by sanding, where the sand does not form a continuous coating, shall not be considered as surface-colored brick for the purpose of this specification.

NOTE 9—When surface colored brick, other than sanded or flashed, are specified for *exterior* use, the purchaser should require that data be submitted showing that after 50 cycles of freezing thawing there is no observable difference in the applied finish when viewed from a distance of 10 ft (3.0 m) under an illumination of not less than 50 fc (538 lx) by an observer with normal vision.

Service records of the performance of the particular coated brick in exterior locations may be accepted in place of the freezing and thawing test, upon consent of the purchaser.

8.2 The brick shall be free of defects, deficiencies, and surface treatments, including coatings, that would interfere with the proper laying of the brick or significantly impair the strength or performance of the construction.

8.3 If any post-firing coatings or surface treatments are applied by the manufacturer, the manufacturer shall report the type and extent of these coatings or surface treatments in all certificates of compliance with this specification.

8.4 The face or faces that will be exposed in place shall be free of chips that exceed the limits given in Table 2. The aggregate length of chips shall not exceed 10 % of the perimeter of the face of the brick.

NOTE 10—Of all the units that will be exposed in place, a small percentage of the units may have chips that are larger in size than those chips allowed for the majority of the units. This special allowed percentage, listed in the second column from the left of Table 2 ranges up to 5 % for FBX, up to 10 % for FBS (Plain), and up to 15 % for FBS (Textured). The remainder of the units that will be exposed in place, listed in the fifth column from the left, must conform to the chip sizes listed in the sixth and seventh columns from the left.

Example: Type FBS (Plain) units will conform to the requirements of Table 2 if not more than 10 % of the units have edge chips greater than 1/4 in. (6.4 mm) but less than 5/16 in. (7.9 mm) or corner chips greater than 3/8 in. (9.5 mm) but less than 1/2 in. (12.7 mm) and the remainder of the units, in this maximum case 90 % (100 % – 10 %) do not have edge chips greater than 1/4 in. (6.4 mm) in from the edge nor corner chips greater than 3/8 in. (9.5 mm) in from the corner.

8.4.1 Other than chips, the face or faces shall be free of cracks or other imperfections detracting from the appearance of the designated sample when viewed from a distance of 15 ft (4.6 m) for Type FBX and a distance of 20 ft (6.1 m) for Types FBS and FBA.

8.5 The number of brick in a delivery that are broken or otherwise fail to meet the requirements for chippage and tolerances shall not exceed 5 %.

8.6 After brick are placed in usage, the manufacturer or the manufacturer's agent shall not be held responsible for compliance of brick with the requirements of this specification for chippage and tolerances.

9. Texture and Color

9.1 If brick having a particular color, color range, or texture are desired, these features shall be specified separately by the purchaser. At least one end of the majority of the individual brick shall have the same general texture and general color tone as the approved sample. The texture of the finished surfaces that will be exposed when in place shall conform to an approved sample consisting of not less than four stretcher brick, each representing the texture desired. The color range shall be indicated by the approved sample.

9.2 Where brick with other than one finished face and one finished end are required (brick with two finished faces or ends, or other types), all such special brick shall be explicitly specified by the purchaser.

NOTE 11—The manufacturer should be consulted for the availability of specialty units suitable for the intended purpose.

10. Size and Tolerances

10.1 *Size*—The size of brick shall be as specified by the purchaser (see Note 12). In a sample of ten brick selected to represent the extreme range of sizes of brick to be supplied, no brick shall depart from the specified size by more than the individual tolerance for the type specified as prescribed in Table 3, Column A. The average size of the ten brick sample shall be determined, and no brick in the job lot (delivered brick) shall vary from this average size by more than the individual tolerance for the type specified as prescribed in Table 3, Column B. No individual brick in the job lot shall fall outside of the dimensional tolerances of Table 3, Column A.

TABLE 3 Tolerances on Dimensions

Specified Dimension or Average Brick Size in Job Lot Sample, in. (mm)	Maximum Permissible Variation, in. (mm) plus or minus from:				
	Column A (for Specified Dimension)		Column B (for Average Brick Size in Job Lot Sample)[A]		
	Type FBX	Type FBS	Type FBX	Type FBS Smooth[B]	Type FBS Rough[C]
3 (76) and under	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)	1/16 (1.6)	3/32 (2.4)
Over 3–4 (76 to 102), incl	3/32 (2.4)	1/8 (3.2)	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
Over 4–6 (102 to 152), incl	1/8 (3.2)	3/16 (4.8)	3/32 (2.4)	3/32 (2.4)	3/16 (4.8)
Over 6–8 (152 to 203), incl	5/32 (4.0)	1/4 (6.4)	3/32 (2.4)	1/8 (3.2)	1/4 (6.4)
Over 8–12 (203 to 305), incl	7/32 (5.6)	5/16 (7.9)	1/8 (3.2)	3/16 (4.8)	5/16 (7.9)
Over 12–16 (305 to 406), incl	9/32 (7.1)	3/8 (9.5)	3/16 (4.8)	1/4 (6.4)	3/8 (9.5)

[A] Lot size shall be determined by agreement between purchaser and seller. If not specified, lot size shall be understood to include all brick of one size and color in the job order.

[B] Type FBS Smooth units have relatively fine texture and smooth edges, including wire cut surfaces and dry-pressed brick. These definitions relate to dimensional tolerances only.

[C] Type FBS Rough units are extruded brick with textured, rounded, or tumbled edges or faces, and molded brick. These definitions apply to dimensional tolerances only.

Tolerances on dimensions for Type FBA shall be as specified by the purchaser, but not more restrictive than FBS.

NOTE 12—For a list of modular sizes, see Guide E 835/E 835M. Sizes listed in this standard are not produced in all parts of the United States. Brick names denoting sizes may be regional and, therefore, may not be included in all reference books. Purchasers should ascertain the sizes of brick available in their locality and should specify accordingly, stating the desired dimensions (width by height by length).

10.2 *Warpage*—Tolerances for distortion or warpage of surfaces or edges intended to be exposed in use of individual brick from a plane surface and from a straight line, respectively, shall not exceed the maximum for the type specified as prescribed in Table 4. Tolerances on distortion for Type FBA shall be as specified by the purchaser.

10.3 *Out-of-Square*—The maximum permitted dimension for out-of-square of the exposed face of the brick is 1/8 in. (3.2 mm) for Type FBS brick and 3/32 in. (2.4 mm) for Type FBX brick. Tolerances on out-of-square for Type FBA brick shall be specified by the purchaser.

NOTE 13—Linear dimensions and flat surfaces of specially shaped brick shall meet the requirements for size and warpage, respectively, of the specified type. Tolerances for size and warpage of nonlinear dimensions and surfaces, and out-of-square shall be determined by agreement with the manufacturer.

11. Coring and Frogging

11.1 *Coring*—Brick are cored at the option of the manufacturer. Special coring configurations or 100 % solid units shall be specified and shall meet all other requirements of this section. The net cross-sectional area of cored brick in any plane parallel to the surface containing the cores shall be at least 75 % of the gross cross-sectional area measured in the same plane. No part of any hole shall be less than 3/4 in. (19.1 mm) from any edge of the brick.

11.2 *Frogging*—Brick are frogged at the option of the manufacturer; brick required to be without frogs shall be specified by the purchaser and shall meet all other requirements of this section. One bearing surface of each brick shall be permitted to have a recess (panel frog) or deep frogs, or both. The recess or panel frog shall not exceed 3/8 in. (9.5 mm) in depth and no part of the recess or panel frog shall be less than 3/4 in. (19.1 mm) from any edge of the brick. In brick containing deep frogs, frogs deeper than 3/8 in. (9.5 mm), any cross-section through the deep frogs parallel to the surface containing the deep frogs shall conform to the requirements of 11.1.

TABLE 4 Tolerances on Distortion

Maximum Dimension, in. (mm)	Maximum Permissible Distortion, in. (mm)	
	Type FBX	Type FBS
8 (203) and under	1/16 (1.6)	3/32 (2.4)
Over 8–12 (203 to 305), incl	3/32 (2.4)	1/8 (3.2)
Over 12–16 (305 to 406), incl	1/8 (3.2)	5/32 (4.0)

12. Sampling and Testing

12.1 The brick shall be sampled and tested in accordance with applicable sections in Test Methods C 67.

NOTE 14—Unless otherwise specified in the purchase order, the cost of tests is typically borne as follows: If the results of the tests show that the brick do not conform to the requirements of this specification, the cost is typically borne by the seller. If the results of the tests show that the brick do conform to the requirements of this specification, the cost is typically borne by the purchaser.

12.2 The manufacturer or the seller shall furnish specimens for tests. The place or places of selection shall be designated when the purchase order is placed.

13. Keywords

13.1 appearance requirements; clay; facing brick; fired masonry units; masonry construction; physical properties; shale; solid brick

APPENDIXES

(Nonmandatory Information)

X1. INTRODUCTION

X1.1 A thorough understanding of facing brick use begins with comprehension of this specification, ASTM C 216. This appendix is designed to explain the specification, noting subtleties and relationships that might not otherwise be clear. This specification provides requirements for brick as a product. It cannot cover all of the considerations for the uses of brick.

X1.2 Since this specification was first published in 1947, it has undergone many changes, and continues to do so under the jurisdiction of ASTM Committee C15.

X2. SCOPE (Section 1)

X2.1 This specification covers units made from clay or shale that are formed to a specific shape, dried, and fired. The brick may be extruded, molded, or dry-pressed. Brick covered by this specification must be fired at a temperature high enough to produce "incipient fusion," the start of a permanent, glassy bond between the clay particles. Adobe units, which are either sun-dried or stabilized with asphalt, are not covered by this specification. There is no ASTM specification for adobe units.

X2.2 Fired clay masonry units, commonly known as "brick," have been used extensively throughout the world for centuries as basic masonry building units. Brick are available in many colors, sizes, and textures, are made of fired clay or shale, and are usually in the form of rectangular prisms, of a size convenient to be installed by hand. Facing brick are used primarily for masonry elements requiring a finished appearance.

X2.3 Brick properties can change over time after bricks are placed in use. Properties of brick addressed by this specification that may change include cold and boiling water absorption, initial rate of absorption, saturation coefficient, efflorescence, size, and compressive strength. Properties can be affected by contact with mortar, paint, plaster, or other coatings. Brick increase in size due to irreversible moisture expansion or by freeze-thaw cycling when wet. Brick can decrease in compressive strength due to freeze-thaw cycling or salt crystallization. As a consequence, the property requirements of this specification apply only at the time of purchase. Although brick can be tested after removal from a structure, results of those tests should not be used to check compliance with this specification

X3. REFERENCED DOCUMENTS (Section 2)

X3.1 The specification lists five referenced documents, of which the most frequently used is Test Method C 67, Sampling and Testing Brick and Structural Clay Tile. Test Method C 67 outlines the procedures for sampling and testing brick to determine their physical and mechanical properties.

X4. GRADE DESIGNATIONS (Section 3)

X4.1 The grade of a face brick identifies its anticipated durability under freeze-thaw cycling, based upon certain physical properties. Two grades of face brick, Grade SW and Grade MW, are defined in this specification, and are related to anticipated durability. The "SW" in "Grade SW brick" is an abbreviation for "severe weathering"; and the "MW" in "Grade MW brick" is an abbreviation for "moderate weathering." The table accompanying Fig. 1 of this specification provides assistance in selecting a grade, based on the weathering index where the brick are to be used.

X4.2 In addition to weathering index, severity of exposure is also influenced by the orientation of the masonry's exposed surface, and whether or not that exposed surface will be in contact with the earth.

X4.3 Severe exposures include horizontal and sloped surfaces (non-vertical surfaces), free-standing walls, parapets, chimneys, wing walls, and brick in contact with the ground or within 6 in. (152 mm) of the ground. Although brick used in paving applications may experience such severe exposure, those brick are addressed by Specification C 902 or Specification C 1272, not by this specification.

X4.4 Wherever the weathering index exceeds 50, only Grade SW brick should be used. In severe exposures, even

Grade SW brick may spall under certain conditions of moisture infiltration, chemical action, or salt crystallization. In addition to the proper grade of brick, proper design details, good quality materials, quality workmanship, and maintenance are imperative in such exposure conditions.

X4.5 *Weathering Index* (Note 4)—The weathering index is an empirical description of the anticipated severity of exposure in a particular geographic location. It is defined as the product of the average annual number of freezing-cycle days and the average annual winter rainfall in inches. A freezing cycle day is any day during which the air temperature passes through 32°F (0°C). This definition results in values ranging from 0 to over 1000 across the US. Fig. 1 is a map depicting the geographic distribution of the weathering index in the U.S. Based on Fig. 1 and the accompanying table, Grade SW brick should be used on the exterior of structures in most areas of the U.S.

X5. TYPE DESIGNATIONS (Section 4)

X5.1 The type of face brick identifies its appearance characteristics. Three types of brick, FBS, FBX, and FBA, are defined by this specification and delineated by their requirements for dimensional tolerances, warpage, out-of-square, and chippage.

X5.1.1 Type FBS brick are general-purpose face brick, and constitute most of the C 216 brick sold in the U.S.

X5.1.2 Type FBX brick have more stringent appearance requirements, and are specified for applications such as stack bond masonry or soldier courses.

X5.1.3 Type FBA brick include handmade, tumbled, antiqued, and some wood-molded brick. Type FBA brick have a wider permitted variation in dimensional tolerances than Type FBS, and have no specified criteria for chippage, out-of-square, or warpage. Since Type FBA brick have unique appearance characteristics, their acceptance or rejection should be based on an approved sample panel. Construction with Type FBA brick may create a conflict with dimensional requirements (such as those for plumb and true) of project specifications.

X6. REQUIREMENTS FOR ORDERING INFORMATION (Section 5)

X6.1 Section 5 states the mandatory information that must be included in ordering brick specified under this specification and also states optional information that is intended to assist the purchaser in ordering such brick.

X7. PHYSICAL PROPERTY REQUIREMENTS (Section 6)

X7.1 C 216 brick must comply with the requirements of at least one of the grades permitted by the specification. One set of such requirements includes minimum compressive strength, maximum five-hour boiling water absorption, and maximum saturation coefficient. Such compliance can be verified by a manufacturer's certificate of compliance, or by testing conducted by the purchaser.

X7.2 As this specification notes, when the grade is not specified, the requirements for Grade SW govern. As long as the purchaser does not specifically request Grade MW, the brick manufacturer is permitted to supply Grade SW. Although this specification allows two grades of brick, more than 97 % of the C 216 brick in the U.S. is of Grade SW, with the remainder intended for interior applications, or in the few areas of the country with moderate weathering indices (primarily parts of California, Arizona, Louisiana, Texas, and Florida).

X7.3 Durability-related Physical Property Requirements (Section 6.1)

X7.3.1 Durability requirements of this specification are expressed indirectly, in terms of requirements for physical properties. While durability failures of brick are usually attributed to damage from freezing and thawing of water-saturated masonry, other possible causes could include inferior production, salt crystallization, poor brick-mortar compatibility, effect of some surface treatments, improper design details, improper construction practices, and poor workmanship. Furthermore, deterioration that imitates freeze-thaw damage can be due to other factors, such as spalling due to movement or pressures (Ref (**1**)).[4] Several approaches are now used to classify brick's freeze-thaw resistance.

X7.3.2 While no single property should be used to classify freeze-thaw durability, this combination of properties has proven effective in distinguishing durable from non-durable brick. Users of this specification are also urged to consider the requirements of each application, and the performance of locally available brick in similar applications.

X7.3.3 Compressive strength values alone can be an unreliable indicator of brick durability. While strengths below the specified minimum values generally indicate poor durability,

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

requiring higher compressive strengths than those minimum values may increase durability, but may also eliminate durable brick from consideration. Pore structure is much more significant to durability than compressive strength. Because water absorption and saturation coefficient are related to pore structure, they are used in combination with compressive strength to classify brick for durability.

X7.4 Absorption Alternate (Section 6.1.2)

X7.4.1 Instead of the above default combination of physical property requirements, brick are also permitted to be classified by grade based on cold water absorption and freeze-thaw testing. Compressive strength requirements must be met in any case. For this alternative, the required saturation coefficient need not be met, provided that the cold water absorption of each unit in a representative sample of five brick does not exceed 8 %. Some brick sold in the U.S. meet these requirements, and have performed well in service. Correlation of physical property test results and freeze-thaw tests have shown that the cold water absorption alternative is a viable method of indicating freeze-thaw durability.

X7.5 Freezing and Thawing Test Alternative (Section 6.1.3)

X7.5.1 Instead of the above default combination of physical property requirements, C 216 brick are also permitted to be classified by grade based on freeze-thaw testing. Compressive strength requirements must be met in any case. For this alternative, the saturation coefficient and the five-hour boiling water absorption requirements need not be met if a representative sample of five brick passes the freeze-thaw tests of Test Method C 67. The freeze/thaw test is an alternative means to verify durability and does not have to be performed. This test is costly, and takes at least 50 working days to conduct. Some brick sold in the U.S. meet these requirements, and have performed well in service.

X7.6 Research

X7.6.1 Research on the durability of brick began in the early 1800's (Ref (**1**)), and has included two particularly important projects. McBurney and Lovewell's 1933 research is the basis for many current C 216 requirements, including 5-h boiling absorption and saturation coefficient (Ref (**2**)). They reported on 15 brick produced from 255 brick plants (480 specimens) representing 37 % of the 1929 brick production of the United States. Their research compared brick's physical properties to 51 cycles of freezing and thawing. McBurney and Johnson's 1956 research, which included a five-year outdoor exposure test, addressed the properties and durability of de-aired brick, representative of current extruded brick (Ref (**3**)), Those two studies and others cited in Ref (**1**), established and corroborated current C 216 requirements related to durability. Research by Robinson, Holman, and Edwards in 1977 showed the limitations of some of those requirements (Ref (**4**)).

X7.6.2 Research is continuing to develop improved methods of assessing durability (Ref (**1**)), and also to address the role of design, construction, and maintenance. While the current durability-related physical requirements of this specification are believed by ASTM Committee C15 to provide the best means available to specify durable brick, they are not perfect, due to the wide variation in raw materials and methods of manufacture. Some brick not meeting the durability requirements of Grade SW may still have satisfactory durability in service; and conversely, some brick meeting those requirements may not perform satisfactorily in service. Because of this, and because current C 216 requirements do not address all potentially important properties, the service performance record of a particular product may be useful.

X7.7 Compressive Strength Requirements (Section 6.2)

X7.7.1 Brick must comply with the minimum compressive strength requirements for the particular grade (see X7.1 of this appendix). In some instances, a higher compressive strength may be required for individual jobs, usually for structural strength requirements.

X7.8 Initial Rate of Absorption (IRA) (Section 6.3)

X7.8.1 Although not a qualifying condition in this specification, the initial rate of absorption (IRA, or suction) is helpful in deciding which mortar to use or if brick should be wetted before use. Brick manufacturers can provide information on the brick's IRA. Note 6 of this specification recommends that a brick with a field-measured initial rate of absorption (IRA) greater than 30 g/min/30 in.^{2} (1.5 kg/min/m^2) be wetted 3 to 24 h before it is laid. Various surface textures and coatings may allow water to wick up the surface of the brick and cause an increase in IRA. The increase in IRA created by the texture or coating may not significantly reduce bond. Brick with high IRA laid in some mortars may allow increased water penetration and reduced flexural bond strength of the wall if they are not wetted before laying. Brick with low IRA should be covered on the job site to prevent them from getting wet. In all cases, good practices for construction and material handling should be followed.

X7.8.2 If wetting high-IRA brick is impractical, the specifier should consider changing the mortar type or mortar properties to achieve compatibility between brick IRA and mortar water retentivity. Brick with high IRA should be used with mortars with a high water retention. Brick with low IRA should be used with mortars with low water retention (Refs (**6**) and (**7**)).

X8. EFFLORESCENCE REQUIREMENTS (Section 7)

X8.1 Efflorescence is a coating, usually white, that sometimes appears on the surface of brick. Efflorescence is sometimes erroneously thought to be inherent to the brick. However, the location of efflorescence does not necessarily indicate the source of efflorescing compounds. Compounds deposited on the face of brick may come from the brick itself or from sources such as mortar, grout, adjacent materials, cleaning solutions, or contamination during shipment or storage (Refs **(8)** and **(9)**). When water is present in the masonry, it can dissolve soluble compounds from the materials listed above.

X8.2 Normally, the specifier must request an efflorescence test for brick, if its efflorescence rating is desired. Brick are typically sampled for efflorescence testing at the place of manufacture, tested for efflorescence in accordance with Test Method C 67, and rated as either "effloresced" or "not effloresced." Finished masonry may show efflorescence even if the brick in it are rated as "not effloresced;" conversely, finished masonry may show no efflorescence even if the brick in it are is rated as "effloresced."

X9. MATERIAL AND FINISH REQUIREMENTS (Section 8)

X9.1 Inorganic coatings such as engobes, slurries, or sand coatings are often applied to the surface of the brick before the brick are fired in order to achieve a desired color or texture. Other coatings, such as cementitious coatings applied after firing, are also used. Information should be supplied by the manufacturer to indicate durability of these coatings. When surface-colored brick, other than sanded or flashed, are specified for exterior use, the purchaser should request evidence for the durability of the coating. Such evidence could consist of data showing, after 50 cycles of freezing and thawing, no observable difference in the applied finish when viewed at a distance of 10 ft (3.0 m) under an illumination of not less than 50 fc (538 lx) by an observer with normal vision. Such evidence could also consist of service records showing satisfactory performance in similar applications and exposures.

X9.2 Brick that are coated or textured with sand that does not form a continuous coating are not considered "surfaced coated" under this specification. Residual sand left from the manufacturing process is not intended to be part of the brick's overall appearance. This loose sand will come off over time, perhaps when the building is washed down. Its loss does not mean that the brick is deteriorating.

X9.3 According to 8.2, coatings and surface treatments can be applied to the brick provided they do not "significantly" impair the strength or the performance of the masonry. The brick manufacturer must report any post-firing coatings in all certificates of compliance. Some coatings can increase water permeance; others can decrease it. Some coatings, if present on the bed surface, can reduce the flexural bond strength of the masonry. Purchasers should use an approved field panel as a standard of comparison for appearance of surface-coated brick.

X9.4 Chippage Requirements (Section 8.4)

X9.4.1 This specification imposes limitations on the permissible extent of chips on brick faces that will be exposed in use ("finished faces"). Chippage is more noticeable when the surface coating is a different color than the body of the brick. The permitted quantity and size of the chips vary with different types of brick.

X9.4.2 This specification imposes two kinds of chippage limitations on finished faces of brick. Both are illustrated in Fig. X9.1 of this appendix:

X9.4.2.1 For all brick types, the cumulative length of all chips on a finished face must be less than 10 % of the perimeter of that face.

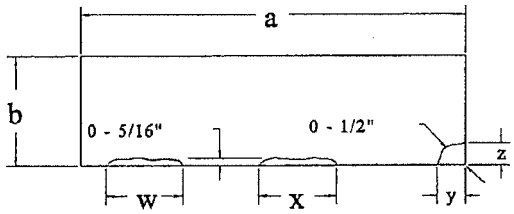
X9.4.2.2 Because chips start at the edges or corners of a finished face, Table 2 in the specification imposes statistical limits, which differ with each brick type, on the maximum distance that an edge chip is permitted to extend into the finished face, and on the maximum distance that a comer chip is permitted to extend into the finished face. That table is complex, and its application is illustrated by Fig. X9.1 of this appendix.

X9.4.3 As an example using the table, for Type FBS (textured) brick, up to 100 % of the shipment is permitted to have edge chips that extend no more than 5⁄16 in. (7.9 mm) from the edge(s) of finished faces, and to have corner chips that extend no more than ½ in. (12.7 mm) from the corner(s). A portion of the shipment is permitted to have larger chips. Up to 15 % of the shipment is permitted to have edge chips that extend no more than 7⁄16 in. (11.1 mm) from the edge(s) of finished faces, and to have comer chips that extend no more than ¾ in. (19.1 mm) from the corner(s).

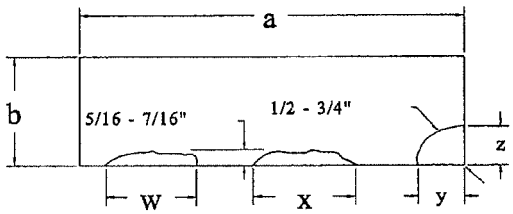
X9.4.4 Requirements for Type FBS and Type FBX brick are similar, with those for Type FBX being considered as restrictive as can be achieved in normal production. For Type FBA, in contrast, requirements are established by the specifier or purchaser, but are not permitted to be more restrictive than the C 216 requirements for Type FBS.

X9.4.5 The chippage limitations are relaxed slightly by 8.5 of this specification, which permits up to 5 % of a shipment to be broken or otherwise fail to meet the two kinds of chippage limitations noted above. In effect, the chippage limitations are permitted to be applied only to the "best" 95 % of a shipment. The 5 % allowance is based on possible waste when brick are shipped and handled.

X9.4.6 For FBS and FBA brick, material or finish imperfections other than chips, such as crazing, dryer cracks, or material inclusions, must not be visible on the designated brick sample from a distance of 20 ft (6.1 m) unless present in the



a) up to 100% of shipment



b) up to 15% of shipment

$w + x + y + z < 10\%$ of $(2a + 2b)$

NOTE—This figure represents extreme situations, not typical chippage.

FIG. X9.1 Chippage Tolerances

approved sample panel. For FBX brick, the distance is reduced to 15 ft (4.6 m). Although it is not stated, the intent is that the observer should have normal vision under normal lighting conditions.

X9.4.7 Unfortunately, in many cases, chippage requirements and other imperfections are often not considered until the brick are in place. Users of this specification should understand that this specification applies only to brick before they are placed in usage and not after. The reason for this is that after a shipment of brick is accepted, the manufacturer no longer has control over their condition, and cannot be responsible for protecting them against subsequent damage (Ref (**10**)).

X10. TEXTURE AND COLOR REQUIREMENTS (Section 9)

X10.1 The specifier or purchaser should designate the color, color range and texture of the brick. Each different range of colored or textured brick should be chosen based on at least a four-brick sample. An approved field panel is recommended to be used as a standard of comparison for texture, color, and color range (Ref (**10**)).

X10.2 In addition to the face, over 50 % of the brick must have at least one end with the same general texture and color as the faces in the approved sample. These brick may be used in applications where that end would be exposed to view. Brick that require additional finished faces, such as at corbels, are considered special shapes by the manufacturer and must be explicitly specified by the specifier or purchaser.

X10.3 Samples for Texture and Color

X10.3.1 The sample submitted by the seller to the purchaser for approval should represent as fairly as possible the range or blend of brick being considered. The minimum required sample of brick may not accurately and completely represent thousands of brick from the actual shipment; moreover, each production run of brick may vary slightly from other production runs. In jobs where appearance is critical, the purchaser should request a sample of brick from the actual production run, representing the full range of colors and textures, for approval or rejection prior to shipment to the job site. Such requests, however, typically require additional time.

X11. SIZE AND TOLERANCES (Section 10)

X11.1 Many sizes of brick are available (Ref (11)).The specifier or purchaser should specify the size of brick desired. This specification gives maximum permissible tolerances for dimensions, distortion, and out-of-square of a brick, based on brick type.

X11.2 Dimensional Tolerances (Section 10.1)

X11.2.1 Because of the way brick are made, there will be some slight variations in size. Size variation is due to shrinkage during drying and firing. The amount of variation in shrinkage and warpage depends on many factors, such as variations in raw materials and manufacturing techniques. Brick manufacturers attempt to control these factors. Variations in brick size are compensated for by the mortar joint thickness to achieve fixed dimensions of the masonry. These variations in size may help give brickwork its handcrafted appeal.

X11.2.2 The specification has two criteria for permissible dimensional tolerances for brick:

X11.2.2.1 The first criterion addresses the specified size. A 10-brick sample is taken from the brick produced for the project, and representing the extreme range of sizes to be supplied. No brick of that sample is permitted to vary from the specified dimension by more than the permissible dimensional tolerance of Column A of Table 3 of this specification. This criterion has always been a part of this specification, and remains unchanged.

X11.2.2.2 The second criterion addresses the permissible dimensional variation of brick delivered to the job site. The average dimensions of the above 10-brick sample are determined, and no brick delivered to the job site is permitted to vary from that average dimension by more than the permissible dimensional tolerance of Column B of Table 3 of this specification (which are as restrictive as or more restrictive than the tolerances of Column A). In addition, every brick delivered to the job site is required to meet the requirements of Column A. This second criterion essentially reduces the permissible variation in dimensions within a job lot for Types FBS and FBX brick.

X11.2.3 For example, suppose that a standard size, Type FBS (smooth) brick is specified with length of 8 in. (203.2 mm).

X11.2.3.1 A representative sample of 10 brick, representing the dimensional extremes of the brick to be delivered for that job, is measured for length along the face, back and bed surfaces of each brick. In accordance with Column A of Table 3, the length of any brick in that sample is permitted to vary from the specified length by at most ±¼ in. (±6.4 mm). As a result, the minimum permitted length for any brick in that sample is 7¾ in. (196.9 mm), and the maximum is 8¼ in. (209.6 mm).

X11.2.3.2 The average length of those 10 brick is then determined (for example) as 8$^{3}/_{16}$ in. (208.0 mm). In accordance with Column B of Table 3, the length of any brick delivered to the job site is permitted to vary from that average length by at most ±⅛ in. (3.2 mm). In addition, in accordance with Column A of Table 3, the length of every brick delivered to the job site is permitted to vary from the specified length by at most ±¼ in. (±6.4 mm). As a result, the minimum permitted length for any brick delivered to the job site is 8$^{1}/_{16}$ in. (204.8 mm) (governed by Column B), and the maximum is 8¼ in. (209.6 mm) (governed by Column A).

X11.2.4 As with chippage requirements, permitted dimensional tolerances for Type FBX are more restrictive than for Type FBS. Again, the permitted dimensional tolerances for FBA brick should be established by the specifier or purchaser, but cannot be more restrictive than those for Type FBS.

X11.2.5 As with chippage requirements, brick that do not meet the dimensional tolerance requirements of Table 3 are permitted to be considered part of the "5 % of the shipment" noted in 8.5. Again, compliance with dimensional tolerance requirements should occur before the brick are placed in usage, after which the manufacturer is no longer held responsible.

X11.2.6 In considering the effects of permitted dimensional tolerances on the finished masonry, special attention should be given to projects containing courses of different brick, especially those from more than one manufacturer. Each product will have its own associated dimensional tolerances, which must be considered. Differences in dimensional tolerances from product to product may result in variations in mortar joint thickness and head-joint alignment when those products are laid next to each other.

X11.3 Warpage (Section 10.2)

X11.3.1 "Warpage" (also referred to as "distortion") is the general term used to describe the distance that a brick face deviates from a plane, or the distance that an edge deviates from a straight line. Permissible tolerances for distortion or warpage are given in Table 4 for the different types of brick. As with other dimensional requirements, tolerances on distortion are more restrictive for Type FBX than for Type FBS, and tolerances for Type FBA brick must be specified by the specifier or purchaser.

X11.4 Out-of-Square (Section 10.3)

X11.4.1 "Out-of-square" is the general term used by this specification to describe the distance that a brick edge deviates from the perpendicular to an adjacent edge. The maximum permitted tolerance for out-of-square of the exposed face of the brick is ⅛ in. (3.2 mm) for Type FBS brick and $^{3}/_{32}$ in. (2.4 mm) for Type FBX brick. As before, the maximum permitted tolerance for Type FBA brick is to be specified by the purchaser.

X12. REQUIREMENTS FOR CORING AND FROGGING (Section 11)

X12.1 The manufacturer has the option of whether or not to core brick. Brick that are cored are considered solid as long as the net cross-sectional area of the cored brick in any plane parallel to the surface containing the cores is at least 75 % of the gross cross-sectional area measured in the same plane. No part of the core can be within ¾ in. (19 mm) of any edge. Extruded facing brick are usually cored, and enhancing production efficiency in at least three ways:

X12.1.1 They decrease the amount of raw materials needed to produce the brick;

X12.1.2 They increase the surface area of the brick for more uniform drying and firing; and

X12.1.3 They reduce the weight of the brick.

X12.2 A manufacturer of molded brick has the option of placing a panel frog (an indentation no deeper than ⅜ in. (10 mm) or a deep frog (an indentation deeper than ⅜ in. (10 mm)) in one of the bearing surfaces of the brick. No frog can extend closer than ¾ in. (19 mm) to any edge. A brick containing a deep frog is required to have a net cross-sectional area in any plane parallel to the surface containing the deep frogs that is at least 75 % of the gross cross-sectional area in the same plane. The distance from the face to the core or frog is critical when brick is used in corbelling, recessed courses or racking applications. If the purchaser desires, brick without cores or frogs can be specified.

X13. REQUIREMENTS FOR SAMPLING AND TESTING (Section 12)

X13.1 In most situations, the brick manufacturer selects brick for quality control purposes; sends the brick to an independent testing laboratory; receives a test report; and then uses that test report to certify that the brick complies with this specification. In the unusual situation that a brick specifier or purchaser would require a test of 30 brick in the actual production run, the specifier or purchaser has the brick sampled and tested soon after manufacture. If the brick comply with this specification, the purchaser usually pays for the testing; if they do not comply, the manufacturer usually pays. Many manufacturers commonly run continuous production quality control tests using their own facilities.

X13.2 Requirements for sampling, including the number of brick required, are given in Test Method C 67. When brick are sampled for testing, the specifier or purchaser must designate the person taking the samples. The samples are taken at a predetermined place and include specimens representative of the complete range of colors, textures, and sizes to be supplied. The specimens should be free of dirt, mud, mortar, or foreign materials unassociated with the manufacturing process.

REFERENCES

References are included as information only and are not a part of the specification.

(1) Grimm, C. T., "Durability of Brick Masonry: A Review of the Literature," *Masonry, Applications and Problems, ASTM STP 871*, ASTM International, 1985, pp. 202–234.

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(8) ASTM C 270, Specification of Mortar for Unit Masonry, Appendix X2.

(9) ASTM C 1400, Guide for the Reduction of Efflorescence Potential in New Masonry Walls.

(10) "Manufacturing, Classification and Selection of Brick, Selection—Part III," *Technical Notes on Brick Construction* 9B, Brick Industry Association, Reston, VA, December 1995.

(11) "Brick Sizes and Related Information," *Technical Notes on Brick Construction* 10B, Brick Industry Association, Reston, VA, June 2003.

SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (C 216 – 07) that may impact the use of this standard. (Approved Aug. 1, 2007.)

(*1*) Appendix X1 through Appendix X13 and a References section were added.

Committee C15 has identified the location of selected changes to this standard since the last issue (C 216 – 06) that may impact the use of this standard. (Approved Feb. 1, 2007.)

(*1*) The breakage endpoint for Grade SW in subsection 6.1.3 was set at a quantifiable percentage of dry weight.

Committee C15 has identified the location of selected changes to this standard since the last issue (C 216 – 05a) that may impact the use of this standard. (Approved Oct. 1, 2006.)

(*1*) Section 8.6 was changed to clarify that all tolerances are included.