

Clay Masonry Units



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C1232-12



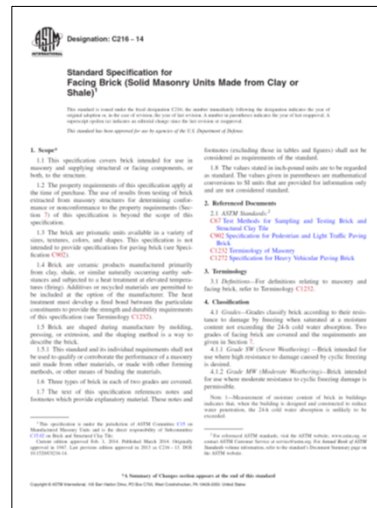
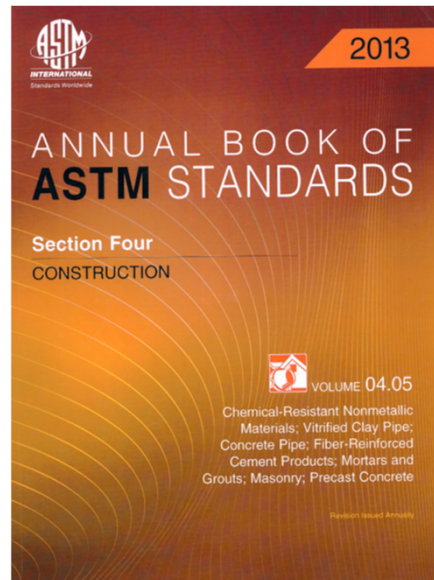
brick, n – a solid or hollow masonry unit of clay or shale, usually formed into a rectangular prism, then burned or fired in a kiln; brick is a ceramic product.



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American Society for Testing and Materials



www.astm.org

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Designation: C216 - 14

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

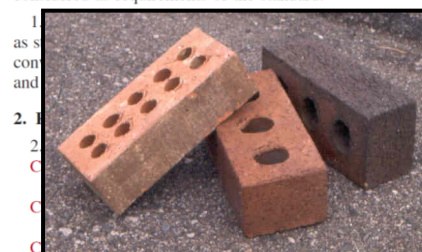
This standard is issued under the fixed designation C216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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



stances and subjected to a heat treatment at elevated tempera-

footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.



C1272 Specification for Heavy Vehicular Paving Brick

3. Terminology

3.1 Definitions—For definitions relating to masonry and

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1. Scope

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

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Manufacturing



Types of Clay

- **Surface Clays**
- **Shales**
- **Fire Clays**



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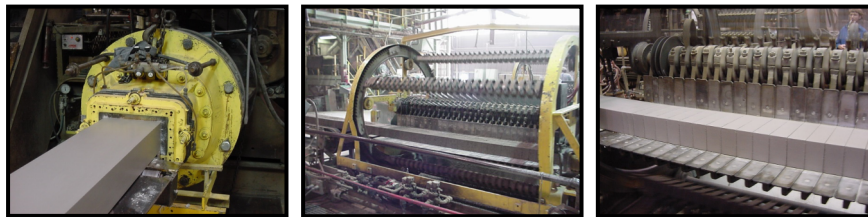
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Manufacturing



Forming

Stiff-Mud Process – In the stiff-mud or extrusion process, water in the range of 10 to 15 percent is mixed into the clay to produce plasticity.



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Manufacturing



Forming

Soft-Mud Process - The soft-mud or molded process is particularly suitable for clays containing too much water to be extruded by the stiff-mud process. Clays are mixed to contain 20 to 30 percent water and then formed into brick in molds. To prevent clay from sticking, the molds are lubricated with either sand or water to produce “sand-struck” or “water-struck” brick. Brick may be produced in this manner by machine or by hand.



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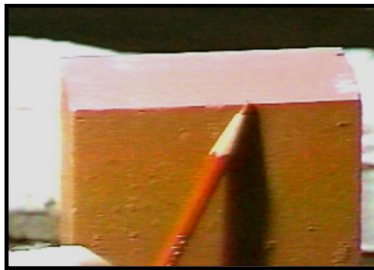
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Manufacturing



Forming

- **Dry-Press Process** - This process is particularly suited to clays of very low plasticity. Clay is mixed with a minimal amount of water (up to 10 percent), then pressed into steel molds under pressures from 500 to 1500 psi by hydraulic or compressed air rams.



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Manufacturing



Firing (10-40 hours)

Melting takes place in three stages:

- 1) **incipient fusion**, when the clay particles become sufficiently soft to stick together in a mass when cooled;
- 2) **vitrification**, when extensive fluxing occurs and the mass becomes tight, solid and nonabsorbent; and
- 3) **viscous fusion**, when the clay mass breaks down and becomes molten, leading to a deformed shape.

The key to the firing process is to control the temperature in the kiln so that incipient fusion and partial vitrification occur but viscous fusion is avoided.

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C216-14**4. Classification**

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

- Grade SW has the highest level of durability and is used in Michigan
- Default: When Grade is not specified, the requirements for Grade SW shall govern.



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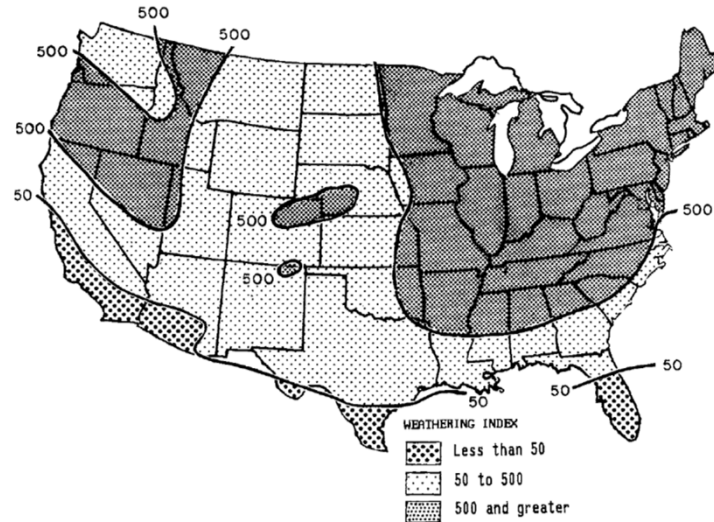
4.1.2 *Grade MW (Moderate Weathering) Brick*
**intended for use where moderate
 resistance to cyclic freezing damage is
 permissible.**

- Grade MW is used in southern Florida, California, Arizona, Louisiana, and Texas.



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C216-14**Fig. 1 - Weathering Indices in the US**

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C216-14**Fig. 1 - Weathering Indices in the US**

Grade Recommendations for Face Exposures		
Exposure	Weathering Index	
	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

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4.2 Types – Three types of facing brick are covered:

4.2.1 Type FBS – Brick for general use in masonry.



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4.2.2 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.

- Limited Choices
- Default: When the type is not specified, the requirements for Type FBS shall govern.



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4.2.2 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.

- Tumble
- Hand-Made
- Clinker
- Default: When the type is not specified, the requirements for Type FBS shall govern.



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C216-14**TABLE 1 Physical Requirements**

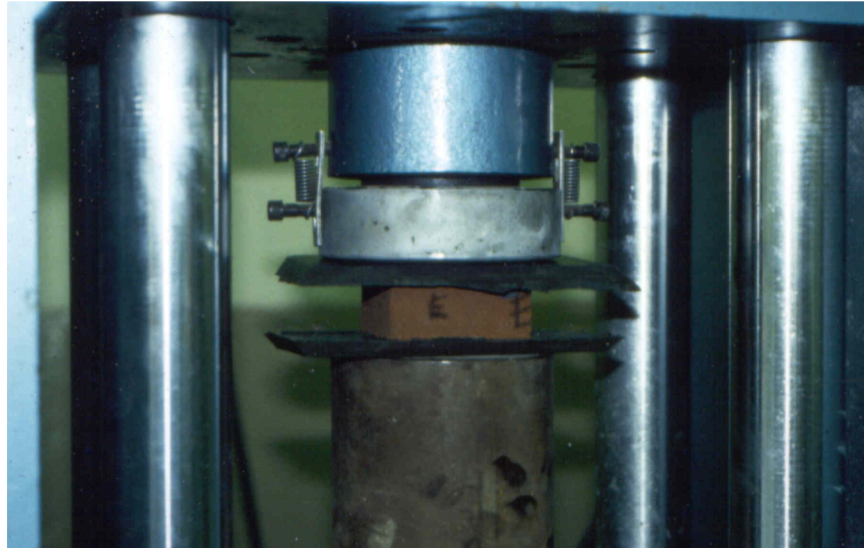
Designation	Minimum Compressive Strength psi, gross area		Maximum Water Absorption by 5-h Boiling, %		Maximum Saturation Coefficient ^A	
	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual
Grade SW	3000	2500	17.0	20.0	0.78	0.80
Grade MW	2500	2200	22.0	25.0	0.88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

^AThe saturation coefficient is the ratio of absorption by 24-h submersion in cold water to that after 5-h submersion in boiling water.

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Compressive Strength



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Water Absorption



24-h Cold Water



5-hr Boil

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Saturation Coefficient



Example - Grade SW

$$\text{Sat Coef} = \frac{24\text{hr, \%}}{5\text{hr, \%}} = \frac{\text{Cold}}{\text{Boil}} = \frac{C}{B} \leq 0.78 \text{ max}$$

$$\text{Sat Coef} = \frac{\text{Partially}}{\text{Saturated}} = \frac{1.00}{0.22} = 4.55 > 0.78 \text{ max}$$

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Saturation Coefficient



Example - Grade SW

TEST: COMPRESSION								
BRICK NUMBER	WIDTH (INCHES)	LENGTH (SQ. IN.)	AREA FAILURE	LOAD AT FAILURE (POUNDS)	COMPRESSIVE STRENGTH, (PSI)			
1A	3.73	3.94	14.70	246,000	16,730			
2A	3.77	4.15	15.65	255,000	16,330			
3A	3.77	4.15	15.65	291,000	18,590			
4A	3.74	4.10	15.33	295,250	19,260			
5A	3.76	4.18	15.72	297,7	18,940			
AVERAGE					17,970 > 3000PSI MIN			
TEST: ABSORPTION								
BRICK NUMBER	DRY WEIGHT	24 HOUR IMMERSION		5 HOUR BOIL		SATURATION COEFFICIENT		
		WET WEIGHT	PERCENT ABSORPTION	WET WEIGHT	PERCENT ABSORPTION			
1B	987.2	1026.3	3.9	1038.9	5.2	.76		
2B	936.9	972.0	3.7	986.0	5.2	.71		
3B	898.7	935.6	4.1	947.3	5.4	.76		
4B	914.9	937.3	2.4	950.5	3.9	.63		
5B	932.5	971.5	4.2	982.4	5.4	.78		
AVERAGE			3.7	5.0 < 17% MAX		.73 < .78 MAX		
TEST: INITIAL RATE OF ABSORPTION (SUCTION)								
BRICK NUMBER	DRY WEIGHT	WET WEIGHT	WIDTH (INCHES)	LENGTH (INCHES)	GROSS AREA	NET AREA	ACTUAL GAIN	CORRECTED GAIN
6	1911.2	1918.0	3.74	8.10	30.29	6.8	24.63	8.3
7	1907.8	1914.5	3.75	8.10	30.38	6.7	24.67	8.2
8	1949.0	1958.8	3.73	8.13	30.32	9.8	24.56	11.9
9	1891.0	1896.4	3.70	8.00	29.60	5.4	23.98	6.8
10	1907.2	1914.8	3.68	8.03	29.55	7.6	23.65	9.6
							8.9	
TEST: EFFLORESCENCE								
Rating: Not effloresced								

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Grade SW



- **MIM suggests a 24hr cold water of 4-5% or less**
- **Due to the severe weathering conditions often found in Michigan, the two alternates in ASTM C216 do not deal strongly enough with the number of freezing cycle days which coupled with precipitation, may cause distress in brick.**

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How Do You Compare?



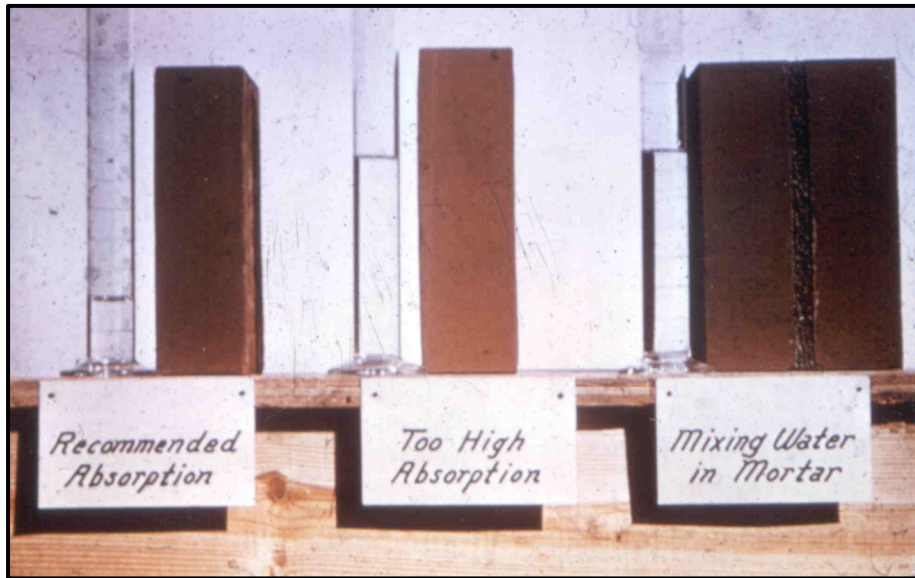
Compressive Strength		Mean	Saturation Coefficient		Mean
All Molded		5293	All Molded		0.60
C216 Extruded			C216 Extruded		
all		11302	all		0.76
5 Hour Boiling Water		Mean %	Initial Rate of		Mean
Absorption			Absorption		gm/min/30 sq in.
All Molded		12.2	All Molded		36.6
C216 Extruded			C216 Extruded		
all		7.2	all		16.1
24 Hour Cold		Mean %			
Water Absorption					
All Molded		7.4			
C216 Extruded					
all		5.4			

Engineering & Research, BIA News June 1993

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Initial Rate of Absorption (IRA)



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Initial Rate of Absorption (IRA)



- Not a qualifying condition
- Request test results
- Select compatible mortar
- IRA > 30g (high suction) well wetted



The Masonry Institute of Michigan is not aware of any procedure for consistently wetting high suction brick.

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Efflorescence



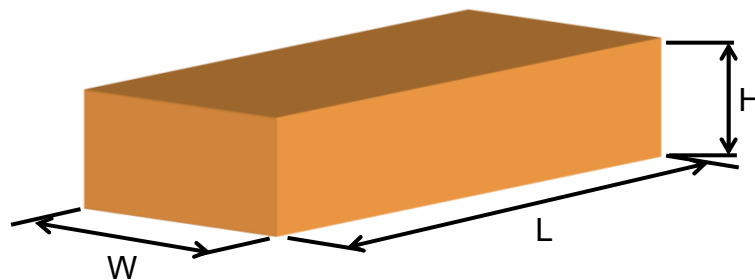
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9. Dimensions and Permissible Variations

9.1 The size of brick shall be as specified by the purchaser (see Note 10)...



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Manufacturing



Size Variation

Because clays shrink during both drying and firing, allowances are made in the forming process to achieve the desired size of the finished brick. Both drying shrinkage and firing shrinkage vary for different clays, usually falling within the following ranges:

Drying shrinkage: 2 to 4 percent

Firing shrinkage: 2.5 to 4 percent

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Table 3 Tolerances on Dimensions

Specified Dimension or Average Brick Size in Job Lot Sample, in.	Maximum Permissible Variation, in. 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 and under	1/16	3/32	1/16	1/16	3/32
Over 3-4, incl	3/32	1/8	1/16	3/32	1/8
Over 4-6, incl	1/8	3/16	3/32	3/32	3/16
Over 6-8, incl	5/32	1/4	3/32	1/8	1/4
Over 8-12, incl	7/32	5/16	1/8	3/16	5/16
Over 12-16, incl	9/32	3/8	3/16	1/4	3/8

^ALot 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.

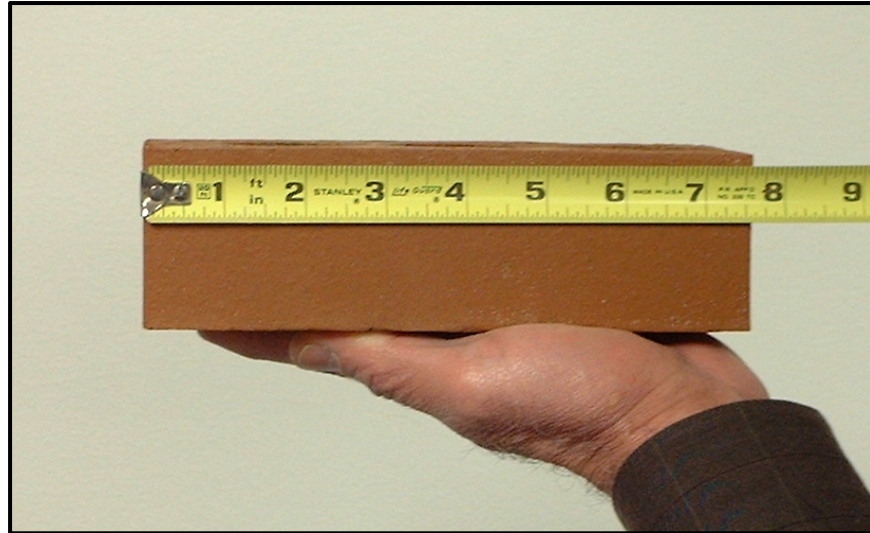
^BType FBS Smooth units have relatively fine texture and smooth edges, including wire cut surfaces and dry-pressed brick. These definitions relate to dimensional tolerances only.

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

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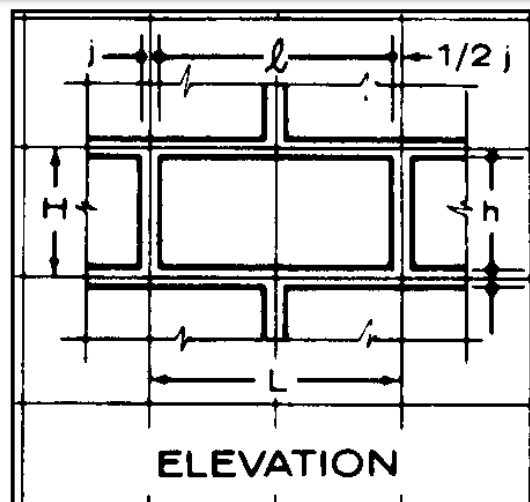
Brick Size



Actual Size = Specified Size \pm Tolerances

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Brick Size



Nominal Size = Specified Size + Specified Mortar Joint Thickness

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Brick Sizes and Nomenclature

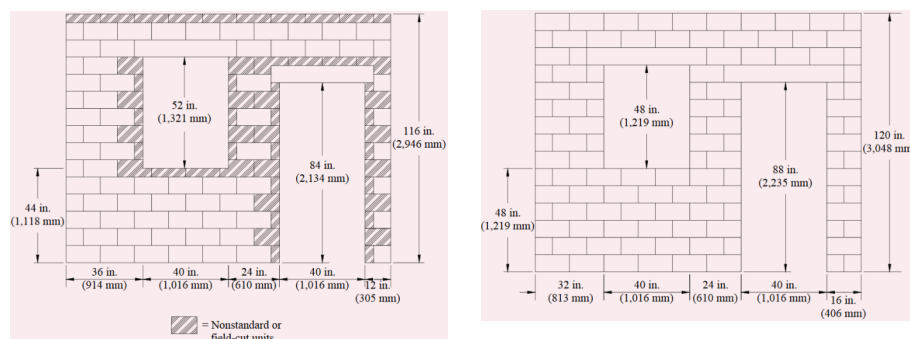


Modular Masonry Unit - One whose nominal dimensions **are based on the 4-in. module.**

Non-Modular Masonry Unit - One whose nominal dimensions **are not based on the 4-in. module.**

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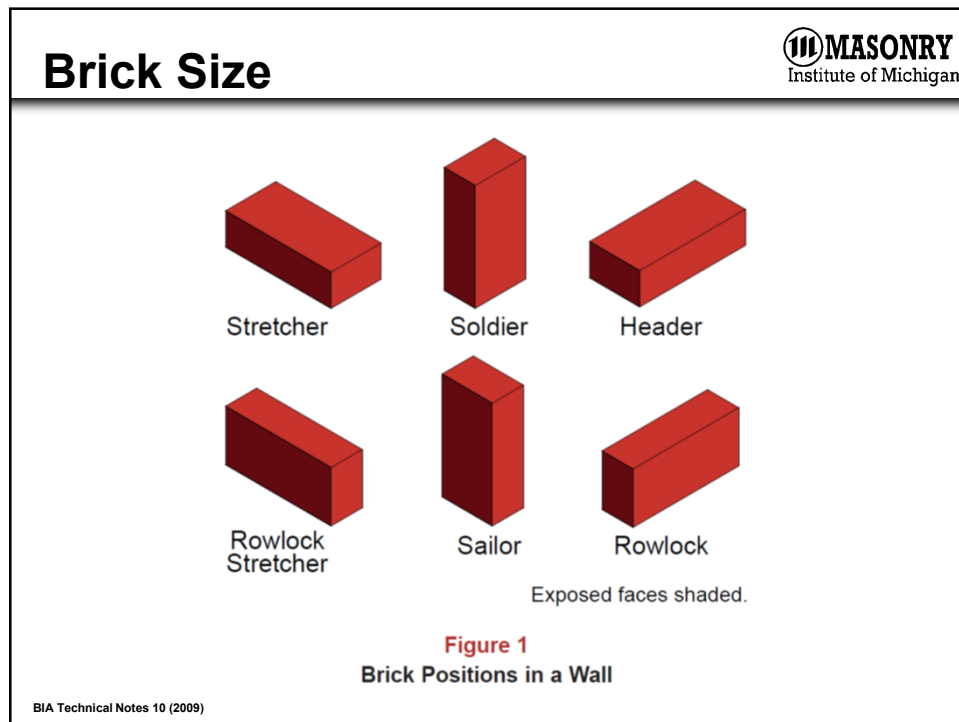
Brick Sizes and Nomenclature



NCMA TEK 5-12 (2008)


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10. *Finish and Appearance*

10.1 The face or faces that will be exposed in place shall be free of chips that exceed the limits given in Table 4. The aggregate length of chips shall not exceed 10 % of the perimeter of the face of the brick.

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Table 4 Maximum Permissible Extent of Chippage from the Edges and Corners of Finished Face or Faces onto the Surface

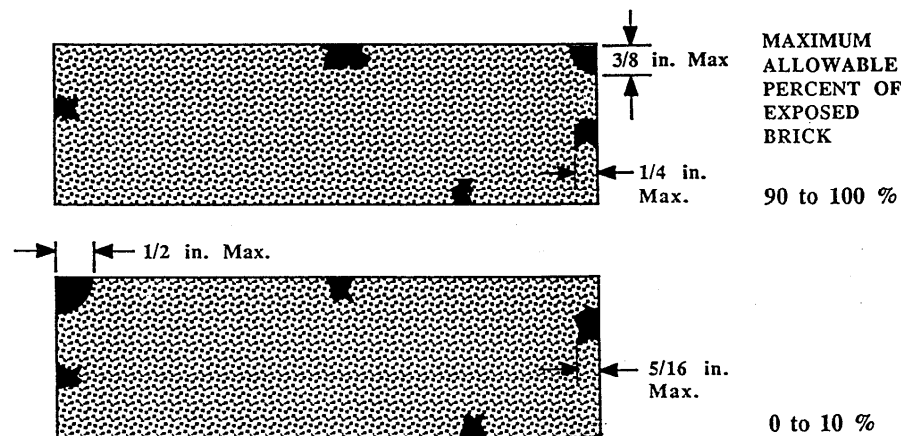
Type	Percentage Allowed ^A	Chippage in in. in from		Percentage Allowed ^A	Chippage in in. in from	
		Edge	Corner		Edge	Corner
FBX	5% or less	1/8 – 1/4	1/4 – 3/8	95 to 100%	0 – 1/8	0 – 1/4
FBS ^B (Plain)	10% or less	1/4 – 5/16	3/8 – 1/2	90 to 100%	0 – 1/4	0 – 3/8
FBS ^C (Textured)	15% or less	5/16 – 7/16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

^APercentage of exposed brick allowed in the wall with chips measured the listed dimensions in from an edge or corner.

^BPlain units are extruded brick with an unbroken natural die finish face and dry-pressed brick.

^CTextured units are extruded brick with the face sanded, combed, scratched, scarified, or broken by mechanical means such as wire-cutting or wire-brushing or molded brick.

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Chippage - Type FBS (smooth)

**MAXIMUM TOTAL LENGTH OF CHIPS = 10% OF UNIT PERIMETER
TYPE FBS (SMOOTH)**

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- 10.1.1 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 under diffused lighting 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.**
- 10.2 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 %.**

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Designated Sample

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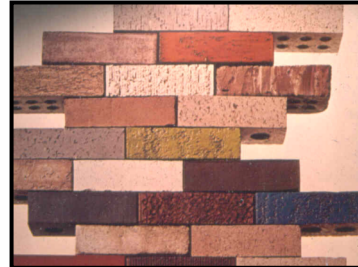
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Color



Depends on:

- Chemical Composition (additives)
- Method of Firing
- Surface Treatments



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Color



Mixing of two or more different products to create a third product is called a “blend.”



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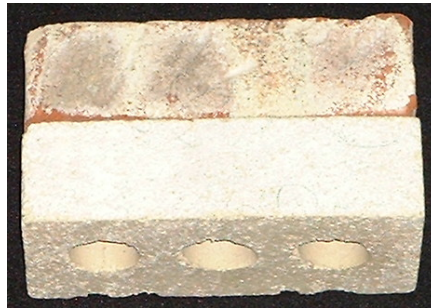
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Manufacturing



Textures, Coatings and Glazes

Today many plants apply engobes (slurries) of finely ground clay, coloring agents and water to the roughened column.



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Manufacturing



Textures, Coatings and Glazes

Although not produced by all manufacturers, glazed brick are made through a carefully controlled ceramic glazing procedure. There are two basic variations of glazing; single-fired and double-fired.

Unlike engobes, glazes are impervious to water and water vapor.



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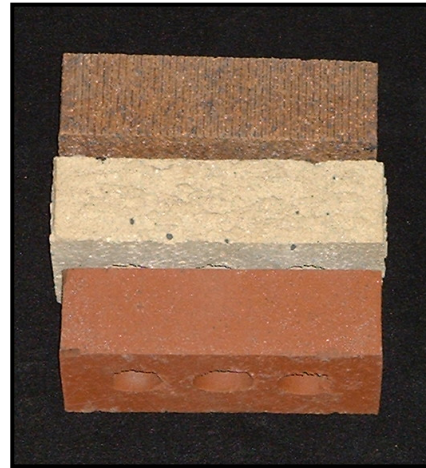
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Textures

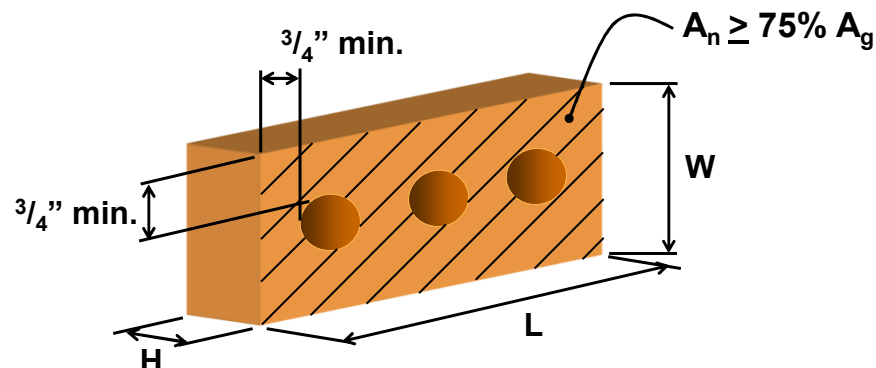


In the extruded process, many textures may be applied by attachments which cut, scratch, roll, brush or otherwise roughen the surface as the clay column leaves the die. Sands can be rolled into the coatings to create patterns in the finished product.



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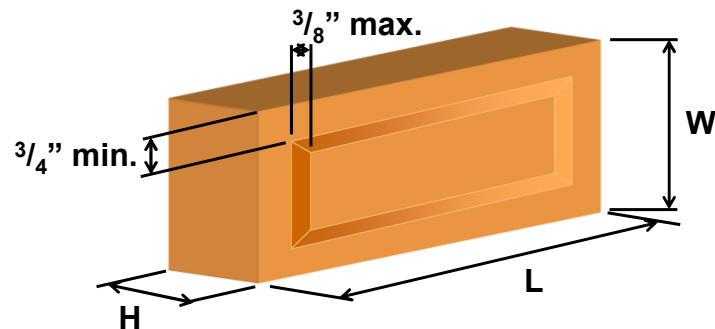
Coring-Extruded Brick



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Frogging-Molded



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Modern Brickmaking



■ Belden Brick – An Inside Look

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