Clay Masonry

Brick
ASTM C62  Building Brick (formerly called common brick)
ASTM C216  Facing Brick
ASTM C652  Hollow Brick
ASTM C410  Industrial Floor Brick (dense brick, highly resistant to abrasion, use as finished floor surface)
ASTM C902  Paving Brick (low absorption)
ASTM C32  Sewer Brick (low absorption, abrasive resistant brick)

Clay Tile
ASTM C34  Load Bearing Wall Tile
ASTM C56  Non-Load Bearing Wall Tile
ASTM C126  Ceramic Glazed Structural Clay Facing Tile, Facing Brick and Solid Units
ASTM C212  Structural Clay Facing Tile
ASTM C67  Sampling and Testing Brick and Structural Clay Tile

Clay Masonry

Manufacturing of Clay Masonry

Material Preparation: Raw Materials

- Gathering: clays and shales from quarry
- Crushing: break up large chunks
- Grinding: pulverize material to fine consistency
- Screening: vibrating wire screens
- Mixing the raw materials: pug mill
  - Water added to provide proper plasticity
  - Materials, such as manganese, added to change the body color

www.glengerybrick.com/about/manufacturing/index.html

Manufacturing of Clay Masonry

Brick Shaping

- Hand Forming
- Machine Molding
- Extrusion
  - Material passes through vacuum chamber to reduce the amount of air: more homogeneous product
  - Mixture forced by means of auger through a die
  - Core holes placed in column
  - Texture produced on brick by scratching, scraping, rolling or sanding the surface of the column
  - Extruded column cut by wires to make individual brick

Manufacturing of Clay Masonry

Extrusion

Clay exiting extruder
Core Holes
Wire Cutter
Extruded column
Manufacturing of Clay Masonry

Drying and Firing

- Bricks placed on kiln carts
- Unfired or green bricks placed in dryer
  - Enclosed dryers use excess heat from kilns
- Continuous tunnel kiln
  - Preheating
  - Burning, up to 2000°
  - Cooling

Manufacturing of Clay Masonry

Packaging

- Broken, twisted and otherwise mechanically defective brick are discarded
- Brick color and range is carefully monitored
- Finished product is packaged and banded into cubes of approximately 500 brick

C 216 Face Brick Grades and Texture Types

- No weathering
- Moderate weathering; freeze, but not subject to water
- Severe weathering; resists frost action

Texture Types

- Standard Use
- High degree of mechanical perfection, narrow color range, minimum size variation. Typically not quoted in southeast as clay in this region easily chips.
- Architectural effects resulting from intentional nonuniformity of color, size, and texture.

Compressive Strength

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum compressive strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Area</td>
<td>Average of 5</td>
</tr>
<tr>
<td>SW</td>
<td>3000</td>
</tr>
<tr>
<td>MW</td>
<td>2500</td>
</tr>
</tbody>
</table>

Solid brick: Net area > ___% of the gross area.

Cores add strength: More uniform drying and shrinkage

Keying action between mortar and brick

Reported brick strengths

<table>
<thead>
<tr>
<th>Type</th>
<th>Average strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All molded</td>
<td>5290</td>
</tr>
<tr>
<td>Extruded, All</td>
<td>11300</td>
</tr>
<tr>
<td>Extruded, Fireclay</td>
<td>15350</td>
</tr>
<tr>
<td>Extruded, Shale</td>
<td>11260</td>
</tr>
<tr>
<td>Extruded, Other</td>
<td>9170</td>
</tr>
</tbody>
</table>

Modern day brick: minimum compressive strength of ____ psi.
### Brick Sizes and Weights

Size and terminology vary from manufacturer to manufacturer.

**Thickness x height x length**

- **Standard Size**: 3½ x 2½ x 8
- **Queensize**: 3 x 2³/₄ x 8
- **Engineer Size**: 3½ x 2¾ x 8

- **Modular**: 7³/₈ long

**Density range**: 80 - 140 lb/ft³

**Average density**: _____ lb/ft³

**Approximately** ___ psf per inch thickness

### C 652 Hollow Brick

- **H40V**: Void area >25%, but < 40%
- **H60V**: Void area > 40%, but < 60%

- Hollow brick used in reinforced masonry construction.
- Hollow brick increasingly being used for veneers.
- Same grades as C 216
- Textures: HBS, HBX, HBA

### Ceramic Glazed Structural Clay Tile

<table>
<thead>
<tr>
<th>Series Designation</th>
<th>Height (in)</th>
<th>Length (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S</td>
<td>2³/₈</td>
<td>7³/₄</td>
</tr>
<tr>
<td>4D</td>
<td>5½/₈</td>
<td>7¾</td>
</tr>
<tr>
<td>6P</td>
<td>3³/₄</td>
<td>11³/₈</td>
</tr>
<tr>
<td>6T</td>
<td>5½/₁₆</td>
<td>11½/₄</td>
</tr>
<tr>
<td>6M</td>
<td>5³/₄</td>
<td>11½/₄</td>
</tr>
<tr>
<td>8W</td>
<td>7³/₄</td>
<td>15³/₄</td>
</tr>
</tbody>
</table>

**Compressive Strength (Gross Area)**

<table>
<thead>
<tr>
<th>Direction of Coring</th>
<th>Avg. of 5</th>
<th>Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical (End Construction)</td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>Horizontal (Side Construction)</td>
<td>2000</td>
<td>1500</td>
</tr>
</tbody>
</table>

Average strength for horizontal coring is around 5000 psi.

### Initial Rate of Absorption (Suction)

- **ASTM test for initial rate of absorption (IRA)**
- Immerse dry brick to a depth of 1/8 in. in water for one minute
- IRA is difference in final weight and dry weight

- **Bond strength between masonry and mortar has been related to initial rate of absorption.**

- **Ideal range**: 5 g/min/30in² to 20 g/min/30in²
- If IRA > 30 g/min/30in², wet the units prior to placing
  - Wetting most effective when done about 24 hours before placement
  - Water will adequately reduce the IRA without leaving the surface wet

- **Simple field test for IRA**
  - Place 20 drops of water in a quarter-sized area
  - If it takes > 1.5 minutes for the water to be absorbed, the brick do not need to be wetted before laying

1/8 in
Absorption

Absorption: Weight of water a clay unit absorbs when immersed in either cold or boiling water for a stated length of time, expressed as a percentage of the dry unit weight.

C/B ratio, or saturation coefficient

C: cold water absorption during 24 hour test. Measure of free absorption.
B: additional absorption during a 5 hour boiling test. Measure of remaining pore space. The more remaining pore space, the more durable the brick, as there is open pore space to accommodate volume change as the water freezes.

Lower C/B ratio, the more durable the brick. Also limit on strict 5 hour boil test, which is a measure of total pore space.

Grade SW: C/B < 0.78; 5 hour boil < 17%
Grade MW: C/B < 0.88; 5 hour boil < 22%

Movement of Clay Masonry

4.2.4 Moisture Expansion

\[ k_e = 3 \times 10^{-4} \text{ in/in} \]

Mean value: 3 x 10^{-4} in/in

Characteristic value (95%) 5 x 10^{-4} in/in

Expansion Joints

\[ S_e = \frac{w_e e_j}{(k_e + k_i \Delta t)100} \]

\( S_e \) = spacing of expansion joints
\( w_e \) = width of expansion joint
\( e_j \) = extensibility of expansion joint material (%)

\( \frac{3}{8} \text{ in expansion joint} \)

50% extensibility

Temperature change of 100 °F

Required joint spacing approximately 22 ft

4.2.3 Coefficient of Thermal Expansion

\[ k_i = 4 \times 10^{-6} \text{ in/in/oF} \]

Mean value: 3.9 x 10^{-6} in/in/oF

Shelf Angles / Horizontal Expansion Joints

Shelf Angles

Horizontal Expansion Joints

Place below shelf angles. Needs to account for brick expansion, frame shortening, and shelf angle deflection.

Construction of Expansion Joints

Keep expansion joint free of foreign material that will keep it from compressing, particularly mortar protrusions.
Interrupt any joint reinforcing; it will buckle as joint closes.

Backer rod serves as surface to tool joint against.
Sealant must not adhere to backer rod.
Depth of sealant is typically one-half the expansion joint width.

www.sealantsandcoatings.com/