**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

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**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

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**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

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**Manufacturing of Clay Masonry**

**Extrusion**

- Clay exiting extruder
- Core Holes
- Wire Cutter

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**Manufacturing of Clay Masonry**

- www.glengerybrick.com/about/manufacturing/index.html
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>
<th>Average of 5</th>
<th>Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td></td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>MW</td>
<td></td>
<td>2500</td>
<td>2200</td>
</tr>
</tbody>
</table>

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>

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

Cores add strength:
More uniform drying and shrinkage
Keying action between mortar and brick

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

Size and terminology vary from manufacturer to manufacturer.

<table>
<thead>
<tr>
<th>Thickness x height x length</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Size 3(\frac{1}{2}) x 2(\frac{1}{4}) x 8</td>
<td></td>
</tr>
<tr>
<td>Queensize 3 x 2(\frac{3}{4}) x 8</td>
<td></td>
</tr>
<tr>
<td>Engineer Size 3(\frac{1}{2}) x 2(\frac{3}{4}) x 8</td>
<td></td>
</tr>
<tr>
<td>Modular: 7(\frac{3}{8}) long</td>
<td></td>
</tr>
</tbody>
</table>

Standard size: __ courses / 8 in
Queensize: __ courses / 16 in

Density range: 80 - 140 lb/ft\(^3\)
Average density: _____ lb/ft\(^3\)
Approximately ___ psf per inch thickness

<table>
<thead>
<tr>
<th>Thickness (in)</th>
<th>Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>39</td>
</tr>
<tr>
<td>8</td>
<td>79</td>
</tr>
<tr>
<td>12</td>
<td>115</td>
</tr>
<tr>
<td>16</td>
<td>155</td>
</tr>
</tbody>
</table>

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>2(\frac{3}{8})</td>
<td>7(\frac{3}{4})</td>
</tr>
<tr>
<td>4D</td>
<td>5(\frac{1}{16})</td>
<td>7(\frac{3}{4})</td>
</tr>
<tr>
<td>6P</td>
<td>3(\frac{3}{4})</td>
<td>11(\frac{3}{4})</td>
</tr>
<tr>
<td>6T</td>
<td>5(\frac{1}{16})</td>
<td>11(\frac{3}{4})</td>
</tr>
<tr>
<td>6M</td>
<td>5(\frac{3}{4})</td>
<td>11(\frac{3}{4})</td>
</tr>
<tr>
<td>8W</td>
<td>7(\frac{3}{4})</td>
<td>15(\frac{3}{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/30in\(^2\) to 20 g/min/30in\(^2\)
- If IRA > 30 g/min/30in\(^2\), 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
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

\[ \frac{w_e}{(k_e + k_i \Delta T)} \times 100 \]

Mean value: 3x10^{-4} in/in
Characteristic value (95%) 5x10^{-4} in/in

4.2.3 Coefficient of Thermal Expansion

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

Mean value: 3.9x10^{-6} in/in/oF

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 (%)

3/8 in expansion joint
50% extensibility
5.8 in expansion joint
Temperature change of 100 °F
Required joint spacing approximately 22 ft

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.

Copper or plastic bellows
Compressible Filler

Backer rod and sealant (typical)

Shelf Angles / Horizontal Expansion Joints

Shelf angle
Flashing and weep holes
Sealant and backing rod

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