

Structural glazed clay tile

Attractive, easy to clean, and chemical resistant, this traditional masonry material is being used to build prisons and high-traffic public buildings

By Christine Beall

Structural glazed tile has long had a place in commercial kitchens, bottling and food processing plants, schools, and hospitals because of its durable surface and low maintenance requirements. But more and more architects are turning to this handsome material for use in correctional facilities and in high-traffic public buildings such as airports, shopping malls, and sporting arenas.

Structural clay tile is distinguished from clay wall tile and flat clay floor tile by its ability to support its own weight and carry superimposed loads. It may be used with the cored cells running horizontally or vertically and for load-bearing and nonload-bearing applications.

Unlike glazed brick, glazed structural clay tile allows singlewythe construction of walls and partitions. Its cost is competitive with glazed concrete block.

Structural glazed tile is available in traditional pastels, in bold standard-run colors such as fire engine red and cobalt blue, and in custom colors. It comes with either smooth or textured surfaces

and in a variety of face sizes (Table 1). The 8x8-modular and 8x16 face sizes are most popular today because they course easily with other types of masonry. Scored 8x16 units also are available, which produce the look of 8x8 stack bond.

The once-dominant size, 12 inches long by 5½ inches high, is still produced for use in new construction and in restoration and renovation projects. Three vertical courses of this size tile equal two courses of concrete masonry or six courses of modular brick, so anchors and ties can be placed at regular intervals with either type of backup system.

Tile properties

There are four basic types of structural clay tile (SCT), each covered under an ASTM standard: structural clay load-bearing wall tile (ASTM C 34), structural clay nonload-bearing wall tile (ASTM C 56), load-bearing structural clay facing tile (ASTM C 212), and load-bearing ceramic glazed facing tile (ASTM C 126).

ASTM C 34 and C 56 tile are utilitarian units intended to receive plaster or another finish material, but C 212 and C 126 facing tile are intended for exposed locations. Today, most SCT used is glazed according to C 126 specifications to produce an impervious, ceramic surface.

ASTM C 126 (Ref. 1) includes requirements for compressive strength, absorption rate, number of cells, shell and web thickness, dimensional tolerances, and properties of the ceramic finish such as imperviousness, fire and chemical resistance, and crazing.

Units are designated Grade S (select) or SS (select sized or

ground edge) and Type I (single-faced) or Type II (double-faced, with two opposite faces glazed). Grade SS allows face size to vary only $\pm \frac{1}{8}$ inch for 8x8 and 8x16 units. Grade SS makes possible narrower mortar joints, which can be beneficial where chemical resistance is important. Type II allows bed depth to vary $\pm \frac{1}{8}$ inch for 4- and 6-inch-thick units and is used when both faces of the tile are to be exposed.

For exterior applications, glazed SCT units should meet the durability requirements for Grade SW hollow clay units as specified in ASTM C 652 (Ref. 2). Exterior applications also should be limited to vertical cell tile, since horizontal cells can easily trap moisture in the wall. Glazed tile generally is not recommended for exterior use in cold climates because moisture can be trapped behind the glaze, and repeated freeze/thaw cycles in the presence of moisture can pop the glaze off the unit. In fact, ASTM C 126 requires purchasers to check with the manufacturer for suitable materials if tile are for exterior use.

Structural capabilities

Structural glazed tile can be used to build load-bearing walls, with minimum compressive strengths of 3000 psi for vertical cell units and 2000 psi for horizontal cell units required by ASTM C 126. Bearing and nonbearing walls are governed by height-to-thickness ratios in both the ACI 530/ASCE 5 *Building Code Requirements for Masonry Structures* and the *Uniform Building Code (UBC)* (Table 2). For typical 6-inch, nonbearing interior partitions, the allowable height may range from 9 to 18 feet depending on the building code of

Table 1 Structural Clay Tile Standard Sizes

Series	Nominal Face Dimensions (inches)	Nominal Thickness (inches)
6T	5½ x 12	2, 4, 6, 8
4D	5½ x 8	2, 4, 6, 8
4S	2½ x 8	2, 4
4W	8 x 8	2, 4, 6, 8
8W	8 x 16	2, 4, 6, 8

All standard sizes of structural clay tile match up with brick or block coursings, so ties can be installed at regular intervals with either type of backup.

jurisdiction.

Grouting the wall solid increases the allowable height for bearing walls. Using analytical design and reinforcing steel in one or both directions increases flexural strength and permits even greater wall height.

Some designers use ladder-type joint reinforcement placed in $\frac{3}{4}$ -inch bed joints for both horizontal and vertical-cell tile construction. Vertical-cell tile also permits the use of vertical reinforcing bars, and special units with notched webs allow placement of horizontal rebar (Figure 1).

Fire resistance

Fire resistance of structural glazed tile, like other hollow masonry units, is based on equivalent solid thickness (EST), the gross volume minus the core area divided by the area of the exposed face. The National Bureau of Standards (NBS) tested some walls in the 1940s, and the ratings published in its test report (Ref. 3) still are used in the *Uniform Building Code* and the *Standard Building Code*. Because SCT coring patterns vary from one manufacturer to another, though, the codes permit calculation of the fire resistance of hollow units configured differently from those in the NBS-tested walls (Ref. 4).

Grouting substantially increases

Table 2 Empirical Design Requirements

Construction	Maximum H/T or L/T	
	ACI 530/ ASCE 5	UBC
Bearing walls		
Solid grouted	20	20
All other	18	18
Nonbearing walls		
Exterior	18	18
Interior	36	18

A typical 6-inch interior partition built of structural clay tile can be 9 to 18 feet tall, depending on which building code must be followed.

the fire resistance of all hollow unit walls. For instance, a 4-inch, 40%-solid hollow structural tile wall with an EST of 1.6 inches was tested to only 10 minutes. When the wall was grouted, however, the rating increased to 1 hour. Grouted 6-inch walls were tested to 2 hours, and 8-inch walls calculate from 3 to 4 hours depending on the ratio of tile thickness to grout.

Tested according to ASTM E 84 (Ref. 5), glazed structural tile also meets 0 flame spread, 0 smoke developed, and 0 fuel contribution requirements of ASTM C 126.

Durability and easy maintenance

Except for exterior use in cold climates, structural glazed tile

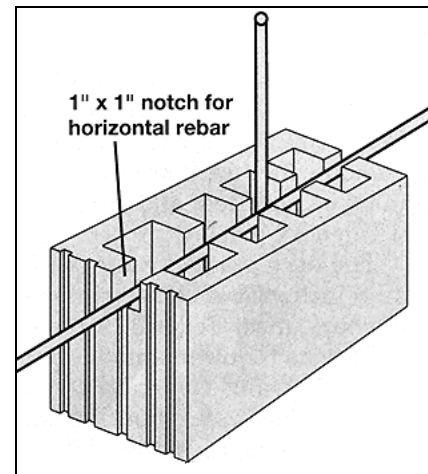


Figure 1. Units with notched webs allow horizontal rebar placement.

can be used whenever extreme durability is required. Glazed tile, like glazed brick, is impervious to stains, resistant to fading and crazing, and unaffected by many chemicals including hydrochloric acid and caustic cleaning solutions. Its abrasion resistance is greater than that of ordinary steel when rated on the MOHS Hardness Scale. As long as the mortar is designed to resist the same abuse expected of the units, a structural glazed tile wall will last the life of the building with no maintenance other than washing. Even when concrete masonry is used for walls, a structural glazed cove base provides better resistance to the abuse of floor cleaning equipment and traffic than ordinary block (Figure 2).

For applications requiring extremely sanitary conditions and

Structural Glazed Tile Well-suited for Correctional Facilities

The durability, appearance, and easy maintenance of structural glazed tile make it an excellent material for correctional facilities. One recent example is Cox/Croslin Architects' award-winning design for the Gardiner/Betts Juvenile Justice Center in Austin, Texas. Walls in the Juvenile Justice Center are reinforced, grouted, and pointed with epoxy mortar.

The fully grouted walls, with an 8-inch grid of No. 4 reinforcing bars, meet Federal Bureau of Prisons requirements for a "security wall." Not only do the reinforcement and grouting add strength, but the higher fire ratings that result are critical to safe-

ty because occupants are not free to exit the building or seek refuge in an emergency.

Epoxy mortar resists the deliberate abrasion often encountered in correctional facilities. The owners at the Gardiner/Betts center initially rejected the idea of any type of masonry walls because they knew that inmates sometimes scraped ordinary mortar from the joints. But when maintenance personnel tried unsuccessfully to scratch epoxy mortar from joints in a sample panel with keys, wire, knives, and other implements, Cox/Croslin's proposed designs based on structural glazed tile partitions were approved.

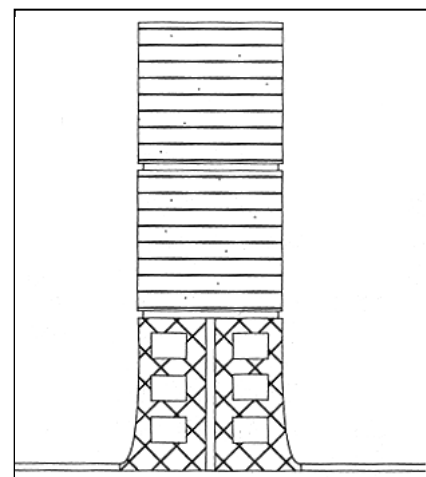



Figure 2. Structural glazed cove base below concrete masonry wall.

for high abuse areas, joints can be raked out and pointed with epoxy mortar. Walls can then be hosed down, scrubbed, or steam cleaned without damaging the mortar and without allowing moisture to enter the wall. The setting mortar, though, must cure for 24 hours before pointing with epoxy mortar.

Special shapes

Special shapes are needed for door and window openings, headers, and corners. In addition to full size stretcher units, shapes include half-lengths, half-heights, corner and jamb units, sills, caps, lintels, cove bases, and internal corners.

The nomenclature of shape numbers can be bewildering because of the number of possible combinations, but the system is really fairly simple. The prefix is a number/letter designation of length, height, and coring, followed by numbers denoting horizontal and vertical axis conditions (such as cove base, bullnose, or

stretcher) and bed depth, and a letter suffix denoting return and reveal, back surface finish, and right- or left-handed unit when required (see box). The supplier should provide detailed shop drawings identifying all special shapes and their locations. 

Christine Beall is an architect and consultant in Austin, Texas, and a regular contributor to Masonry Construction. She created all the drawings included in this article.

References

1. ASTM C 126, Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units, ASTM, 1916 Race St., Philadelphia, PA 19103.

SCT Shape Numbers

Shape nomenclature consists of a prefix, a number, and a suffix. **Prefix** denotes face size and coring. **Number** denotes horizontal axis and bed depth. **Suffix** denotes return, reveal, back face, and right- or left-handed shape. **X** denotes blank.
Example: 8W24CR

8W = 8" x 16"

2 = horizontal bullnose

4 = vertical bullnose

C = 4" bed, 4" return

R = right-handed unit

For a full explanation of all structural clay tile shape nomenclature, consult manufacturers' literature.

2. ASTM C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale), ASTM.

3. Report BMS 92, "Fire Resistance Classifications of Building Materials," 1942, National Institute of Standards and Technology, Gaithersburg, MD 20899.

4. "Calculated Fire Resistance," *BIA Technical Notes on Brick Construction*, Number 16B, Brick Institute of America, 11490 Commerce Park Dr., Reston, VA 22091.

5. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials, ASTM.

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