

Ceramic Glazed Brick Exterior Walls

Abstract: Buildings and other structures employ glazed brick in a variety of uses, from decorative bands to entire wall systems. Due to the imperviousness of its ceramic glazed surface, a vented air space is recommended behind the glazed brick wythe. Proper wall design, detailing and material selection, along with quality construction, will result in attractive glazed brick applications exhibiting durability, structural stability and virtually maintenance-free aesthetics.

Key Words: ceramic, condensation, drainage, expansion joints, flashing, glaze, moisture, movement, vents, weeps.

SUMMARY OF RECOMMENDATIONS:

General:

- Consult manufacturers for assistance with special shapes and to determine the property requirements of double-fired glazed units
- Specify surfaces other than stretcher faces to be glazed

Wall System Design:

- Use vented drainage walls to ensure the most rapid removal of moisture that enters the wall
- Specify concave, “V” or grapevine mortar joint profiles

Air Space:

- 2 in. (51 mm) minimum air space recommended; required to be no less than 1 in. (25.4 mm)

Flashing:

- Extend flashing to the face of the brickwork or beyond
- Install at all horizontal interruptions to the air space
- Turn flashing ends into head joint a minimum of 1 in. (25.4 mm) to form end dam

Drip Edge:

- A drip edge is recommended where flashing exits masonry
- Separate metal drip edge for flashing unable to hold an edge is recommended

Weeps:

- Open head joint weeps spaced no more than 24 in. (610 mm) o.c. recommended
- Most building codes permit weeps no less than $\frac{3}{16}$ in. (4.8 mm) diameter and spaced no more than 33 in. (838 mm) o.c.
- Wick and tube weep spacing recommended at no more than 16 in. (406 mm) o.c.

Vents:

- Place vents at the tops of walls and below horizontal interruptions such as shelf angles and flashing locations
- Use open head joint weeps as vents; if weeps are not open head joints, then vents are needed one or two courses above weeps
- Space vents 24 to 48 in. (610 mm to 1.22 m) o.c.
- Stagger vents in relation to overlying weeps

INTRODUCTION

Glazed brick can be used in both interior and exterior applications, as accent brick, as shown in [Photo 1](#), or as the field brick covering the entire facade, as shown in [Photo 2](#). Glazed units have been integral parts of buildings for decades and have performed well under all climatic conditions. Glazed brick are often selected for use because of the many characteristics that make them distinct among brick products. One of these is the wide variety of colors that are not available in standard brick production. These may be applied to special shapes or brick of different sizes to further enhance visual interest. It is even possible to apply multiple glazes to a single brick unit, as shown in [Photo 3](#). Glazes may be clear, translucent or opaque, and are available in almost any color with a glossy, satin or matte finish.

Glazed brick also typically provide an impervious surface that is extremely durable and resistant to staining, which results in easy maintenance.

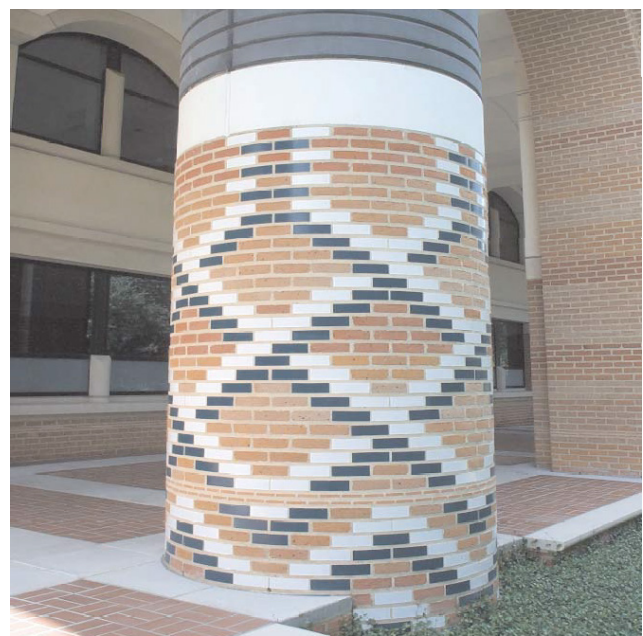


Photo 1
Glazed Brick Used as Accents



Photo 2
Glazed Brick Used for Entire Facade



Photo 3
Multiple Glazes, Shapes and Sizes Add Variety

Resistance to scratching and abrasion, as well as fire resistance of the glaze, also enhance the durability of glazed brick units.

Successful performance of exterior glazed brick walls can be ensured by using vented drainage wall systems that allow water to evaporate from the unglazed back surface of the brick, as well as through mortar joints. Other wall systems using glazed brick are possible and serviceable, but are outside the scope of this *Technical Note*.

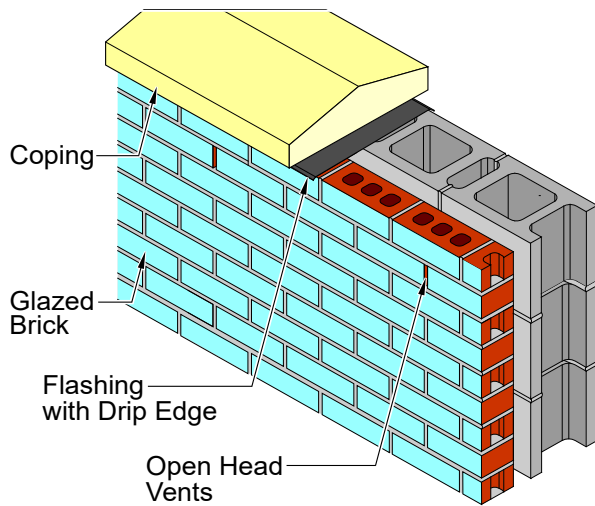
Attention must be given to proper material selection, detailing and construction practices to ensure successful performance. Proper design and installation of exterior glazed brick walls allows water drainage and minimizes the possibility of water being trapped behind the glazed surface, which may lead to efflorescence or spalling. As in all brick construction, stress concentrations due to restrained movement must also be minimized. This *Technical Note* addresses these concerns and offers recommendations to ensure proper performance.

WALL SYSTEM DESIGN

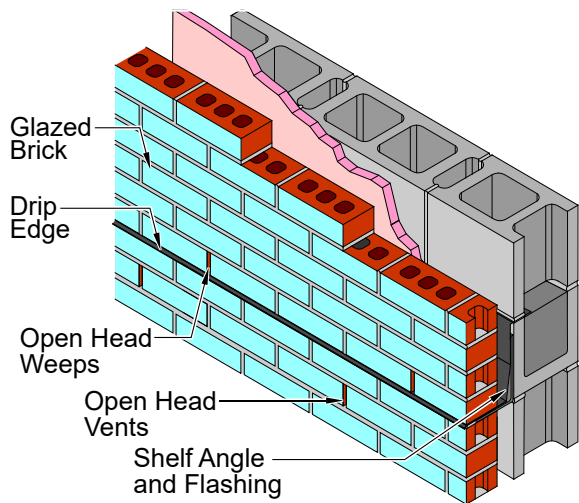
Moisture Resistance

It is recommended that exterior glazed brick walls be designed to drain water that enters the wall system and to allow moisture from wind-driven rain or condensation to evaporate from behind the brickwork. Therefore, a vented drainage wall system is recommended. Drainage walls must be designed, detailed and constructed properly to accommodate the flow of water collected within the wall. Common examples of drainage walls include brick and block cavity walls, brick veneer and rain screen walls. See *Technical Note 7* for more information on water penetration resistance.

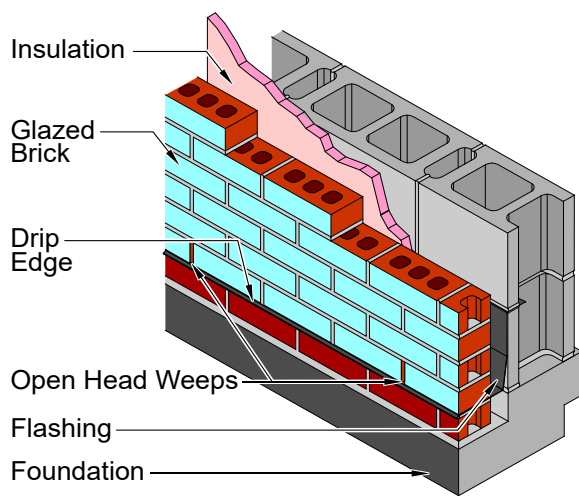
In drainage wall design, penetrant water is intended to drain down the back of the brick, which is separated from interior wall elements by an air space. While a minimum of 1 in. (25.4 mm) air space is required, 2 in. (51 mm) is recommended. Flashing and weeps are needed at horizontal interruptions in the air space to collect water and direct it out of the wall system; refer to [Figure 1](#). They are typically provided above lintels and shelf angles, beneath sills, under copings and masonry or stone caps, and at the wall base. Discontinuous flashing, such as at window sills and loose lintels, should be constructed with end dams to ensure that collected water is directed out



(a) Glazed Brick at Top of Wall



(b) Glazed Brick at Shelf Angle



(c) Glazed Brick at Foundation

Figure 1
Glazed Brick Wall Sections

of the brickwork. End dams are also recommended where stepped flashings are used, such as at sloped grades, above arches and above sloped roofs. Weeps are required in head joints directly above the flashing. Open head joint weeps are recommended with a spacing of no more than 24 in. (610 mm) on center. Spacing of wick and tube weeps is recommended at no more than 16 in. (406 mm) on center. Most building codes require weeps to have a minimum diameter of $\frac{3}{16}$ in. and permit weeps to be spaced up to 33 in. (838 mm) on center.

Drip Edge for Flashing. A drip edge is recommended for exterior glazed brick masonry where flashing exits the wall. Drip edges promote drainage of moisture from the wall and direct moisture away from vents that may be located below the flashing. For flashing that is unable to hold an edge, a separate metal or stainless steel drip edge is recommended. More information about drip edges can be found in *Technical Notes 7* and *7A*.

Mortar Joints. Mortar joints affect the moisture resistance of brickwork since they can account for up to 20 percent of the brickwork surface. Selecting mortar joint profiles that are most resistant to water penetration and cover the bed surface of the brick unit further minimizes water intrusion and the possibility of water being trapped behind the glazed surface. Thus concave, “V” and grapevine tooled mortar joints are recommended.

Vents. Vents placed at the top of glazed brick wall segments, as shown in [Figure 1\(a\)](#) and [Figure 1\(b\)](#), encourage air circulation and help to dissipate moisture within the air space. These vents should be located a course or two below horizontal interruptions of the air space such as shelf angles and flashing locations and should be spaced 24 to 48 in. (610 mm to 1.22 m) on center. The vent should be an open head joint and may include a weep vent or louvered insert to deter insect access. In multistory construction, the horizontal placement of vents and weeps should be staggered, or louvered inserts may be used to prevent draining water from entering vents. When wick or tube weeps are used at the base of a wall, additional vents should be added no more than two courses above weeps to best ensure air movement through the air space.

Caps, Copings and Sills. Glazed brick units should not be used in locations where they are likely to be saturated. Rowlock courses of brick used as caps, copings or sills are vulnerable to water penetration, especially when the slope is not sufficient to drain water away quickly. Therefore, glazed brick should

be avoided in favor of concrete, stone or metal elements that reduce the potential for water penetration at these locations. More information about caps and copings can be found in *Technical Note 36A*.

Movement

Brick masonry walls expand or contract with changes in temperature and moisture content. Brick expansion and other building movements typically are accommodated by expansion joints, placed vertically and horizontally, which divide the wall into rectangular segments and limit cumulative movement. Segment lengths and heights will vary with the building and wall design; however, expansion joints must be placed beneath all shelf angles.

Expansion joints typically are needed near corners, at changes in wall height, at offsets in the wall plane, and at the ends of elements rigidly anchored to the backing or structure. The segments formed by expansion joints should be limited to a maximum length of approximately 20 ft (6.1 m) for brickwork with multiple openings and 25 ft (7.62 m) for brickwork without openings. Segment lengths in building parapets should be limited to approximately 15 ft (4.57 m). The building geometry will also dictate locations for vertical expansion joints in glazed brick walls. Vertical expansion joints should extend full height from the foundation to the roof, or between locations of horizontal support.

Brick masonry expansion joints must be formed with highly compressible materials and be free of mortar and obstructions. Expansion joints are typically $\frac{3}{8}$ in. (9.5 mm) or $\frac{1}{2}$ in. (12.7 mm) wide with a foam backer rod and elastic sealant at the wall face to prevent air and water penetration from the exterior. See the *Technical Note 18 Series* for more discussion regarding building movements and expansion joints.

Structural Design

Glazed brick can be used in load-bearing, cavity or veneer walls and should be designed in accordance with *TMS 402-16 Building Code Requirements for Masonry Structures* (TMS Code) [Ref. 2]. Design can be based on either the prescriptive requirements or the alternative requirements for veneer listed in Chapter 12. In either case, the preferred design should be based on minimizing the potential for cracking of the glazed brick wythe under applied loading. More detailed information on structural design of veneer walls and cavity walls can be found in the *Technical Note 28 Series* and *Technical Note 21 Series*, respectively.

The TMS Code and *TMS 602-16 Specification for Masonry Structures* (TMS Specification) [Ref. 3] also contain material, size and spacing requirements for wall ties in cavity walls and anchors in veneer walls. Anchor and wall tie spacing in the TMS Code depends on the wall design method and anchor type. See the *Technical Note 28 Series* for anchor spacing in veneer walls and the *Technical Note 21 Series* for spacing of wall ties in cavity walls.

MATERIALS

Glazed Brick

Two methods are used to apply glazes to brick bodies: a single-firing process and a double-firing process. In the single-firing process, the glaze is applied to the unfired brick body and is fused to the body when fired. In the double-firing process, brick that have been fired previously have a glaze applied and are fired again to fuse the glaze onto the brick. For some glazes with certain compositions or color pigments, double-firing is necessary to ensure the proper firing of the brick body at a higher temperature and the proper color and finish of the glaze at a lower temperature. Both methods result in quality glazed brick. ASTM standards for glazed brick include requirements for both brick bodies and the glazes.

Body Properties. The physical properties of brick vary depending on raw material, method of forming and the degree of firing. ASTM standards establish indicators of durability based only upon physical property requirements that correlate with freeze-thaw testing.

Single-fired glazed brick must meet the requirements of ASTM C1405, *Standard Specification for Glazed Brick (Single Fired, Brick Units)*. This standard establishes minimum criteria for the glaze as well as for solid and hollow brick bodies. Single-fired glazed brick intended for exterior exposure should meet the property requirements for Class Exterior. These include prescriptive requirements for minimum compressive strength, maximum cold water

absorption and maximum saturation coefficient as shown in Table 1. The saturation coefficient requirement does not apply provided that the average compressive strength of a random sample of five brick equals or exceeds 8000 psi (55.2 MPa) with no individual strength less than 7500 psi (51.8 MPa) and that the 24 hr cold water absorption of each unit does not exceed 6.0 percent. The saturation coefficient and water absorption requirements do not apply if a sample of five brick passes the freezing and thawing alternative test in ASTM C67.

TABLE 1
ASTM C1405 Physical Requirements of Clay Bodies for Glazed Units

	Min. Compressive Strength, psi (MPa), Gross Area		Max. Water Absorption by 24-h Cold ¹ , %	Max. Saturation Coefficient ^{1,2}	
	Average of 5 Brick	Individual	Individual	Average of 5 Brick	Individual
Class Exterior	6000 (41.4)	5000 (34.8)	7.0	0.78	0.80
Class Interior	3000 (20.7)	2500 (17.2)			

1. The saturation coefficient and/or cold water absorption requirement(s) may not apply when other criteria are met. See the "Body Properties" paragraph for more information.
2. The saturation coefficient is the ratio of absorption by 24 h submersion in cold water to that after 5 h submersion in boiling water.

Currently, proper specification of double-fired brick units requires the specifier to either adopt the appropriate body standard only (if the glaze is a decorative coating) or adopt two separate ASTM standards: ASTM C126, *Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units*, to cover applicable properties of the ceramic glaze finish, and ASTM C216, *Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)*; ASTM C652, *Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)*, or ASTM C1088, *Standard Specification for Thin Veneer Brick Units Made from Clay or Shale*, to cover requirements for the brick body.

Specifying glazed brick in this manner addresses material concerns necessary for exterior use.

Conformity to the requirements of the appropriate standard is an indication of the ability of the brick to withstand internal stresses caused by freezing of moisture within its body.

Glaze Properties. Ceramic glazes produce a durable, aesthetically pleasing surface feature on brick. ASTM standards C126 and C1405 set minimum property requirements for glaze finishes. Both standards cover finish requirements for glazes applied to the body before the brick unit is fired (single-firing). ASTM C126 also covers double-fired glazed brick when the glaze is fused to the brick unit at temperatures over 1500 °F (816 °C) making them inseparable, excluding natural salt-glazed ware.

The ASTM C126 and C1405 property requirements for glaze finishes are listed below. One or more of the properties listed may not be applicable to some special decorative and textured glazes. Manufacturers should be consulted for the property requirements of these.

- **Imperviousness:** A wet cloth and water must be able to remove permanent blue-black ink that has been allowed to dwell on the finish for 5 min, with no stain remaining on or beneath the surface, except a slight discoloration in the depressions on matte, stippled or mottled finishes.
- **Scratch resistance and hardness:** Glaze must resist scratching by ordinary glass or steel and be rated above 5 on the Mohs hardness scale.
- **Resistance to crazing:** Glazes may not craze, spall or crack when subjected to one cycle of autoclaving.
- **Fire resistance:** The brick body and glaze shall be rated "noncombustible" and must withstand temperatures up to 1900 °F (1038 °C) without melting or distorting. They must also measure 0 flame spread index and 0 smoke density index when tested in accordance with ASTM E84.
- **Resistance to fading/chemical resistance:** Glaze colors must not change from the approved sample after a 3 hr submersion in prescribed acidic and basic solutions.
- **Opacity:** When specified, ink applied to the brick body must not be visible through the glaze.
- **Thermogravimetric analysis:** In a flowing air atmosphere, weight loss due to release of gases from the body and glaze finish shall not exceed 0.2 percent of dry weight at temperatures up to 1800 °F (982 °C).

Appearance. Aesthetic characteristics of glazed brick are specified by Grade and Type in ASTM C126 and ASTM C1405. The two Grades, S and SS, limit dimensional variations and distortion, and set squareness criteria of the exposed face. The requirements of Grade S are used in most glazed brick projects. Where a higher degree of precision is necessary, the more precise Grade SS units should be specified. When Grade is not specified, the requirements for Grade S govern.

The Type of a glazed brick indicates the number of glazed faces on the brick. Type I units have one glazed face, and Type II units are glazed on two opposite faces. When Type is not specified, Type I requirements govern. Unless specified otherwise, the stretcher face (or exposed face of shapes) is coated with the glaze finish. When glazed surfaces other than those identified by Type I or Type II are required, the additional surface(s) should be specified. Brick that will be exposed on their ends, or on their bed surfaces as in recessed courses or quoins, should also be explicitly specified. Consultation with the brick manufacturer is advised to determine if the proposed glazed brick can be made.

Mortar

Mortar should conform to ASTM C270, *Standard Specification for Mortar for Unit Masonry*. Type N mortar is typically recommended for exterior walls above grade. Type S may provide better flexural bond strength to brick having initial rates of absorption (IRA) under $5 \text{ g/min} \cdot 30 \text{ in.}^2$ ($5 \text{ g/min} \cdot 194 \text{ cm}^2$). Use of admixtures and additives is not usually recommended unless their effect on the masonry, masonry units and items embedded in the brickwork is known, and they do not detrimentally affect plastic or hardened mortar. ASTM C1384, *Standard Specification for Admixtures for Masonry Mortars*, provides methods to evaluate the effect of admixtures on mortar properties. See *Technical Note 8B* for more information on mortar selection.

Anchors and Wall Ties

Acceptable connectors for anchored masonry veneer and cavity wall applications include adjustable ties, unit ties, and ladder-type or tab-type joint reinforcement. Connectors may be of stainless steel conforming to ASTM A580, carbon steel protected from corrosion by hot-dipped galvanizing conforming to ASTM A153, or epoxy coatings conforming to ASTM A884, Class A, Type 1, minimum 7 mils (175 μm) for joint reinforcement and ASTM A899, Class C, minimum 20 mils (508 μm) for wire items. For more information on selection of anchors and ties, see *Technical Note 44B*.

Flashing

Flashing materials should be sufficiently tough and flexible to resist puncture and cracking. In addition, flashing should not degrade when exposed to ultraviolet light or when placed in contact with metal, mortar or sealants. Flashing materials are generally formed from sheet metals, bituminous-coated membranes, rubber or combinations thereof. The selection is largely determined by cost and suitability. Asphalt-impregnated felt is not acceptable as a flashing material. The cost of flashing materials varies widely. It is suggested, however, that only superior materials be selected, since replacement in the event of failure is difficult. See *Technical Note 7A* for a more detailed discussion of flashing materials.

Drip Edge

Metal drip edges should be used with flashing materials that cannot hold an edge. Most metal drip edges are made of non-corrosive stainless steel or of copper or lead-coated copper. Different widths are available, along with preformed inside and outside corners.

SUMMARY

As with any brick masonry wall system, performance is the result of successful material selection, design detailing and construction practices. While the recommendations contained in this *Technical Note* are similar to those for non-glazed brick, it is important to consider the imperviousness of the glazed brick surface. Consequently, attention to each aspect of design and construction is essential to obtain the intended service life of the structure. Therefore, some glazed brick designs may entail more thorough detailing, as they may be less forgiving of detailing and construction deficiencies than non-glazed brick. Ceramic glazed brick can present a bright, bold, colorful statement with a durable brick surface.

The information and suggestions contained in this Technical Note are based on the available data and the combined experience of engineering staff and members of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this Technical Note are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.

REFERENCES

1. *Annual Book of ASTM Standards*, ASTM International, West Conshohocken, PA, 2016:
 - Volume 1.03: A580/A580M, Standard Specification for Stainless Steel Wire
A899, Standard Specification for Steel Wire, Epoxy-Coated
 - Volume 1.04: A884/A884M, Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
 - Volume 1.06: A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - Volume 4.05: C126, Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
C652, Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
C1088, Standard Specification for Thin Veneer Brick Units Made from Clay or Shale
C1384, Standard Specification for Admixtures for Masonry Mortars
C1405, Standard Specification for Glazed Brick (Single Fired, Brick Units)
2. *TMS 402-16 Building Code Requirements for Masonry Structures*, The Masonry Society, Boulder, CO, 2016.
3. *TMS 602-16 Specification for Masonry Structures*, The Masonry Society, Boulder, CO, 2016.