

Brick Veneer/Wood Stud Walls

Abstract: This *Technical Note* deals with the prescriptive design of anchored brick veneer over wood stud backing in new construction. The properties of the brick veneer/wood stud system are described, which lead to design considerations. Selection of materials, construction details and workmanship techniques are also included.

Key Words: air space, anchors, brick, flashing, foundations, lintels, veneer, weeps, wood frame.

SUMMARY OF RECOMMENDATIONS:

Support:

- Provide a noncombustible foundation to support veneer
- Where vertical support is provided by wood construction, provide steel angles properly attached to or supported by wood framing

Veneer Height Limitations:

- For residential construction (*IRC*), do not exceed height listed in [Table 1](#)
- For commercial construction (*IBC*) see “Additional Requirements for Buildings Covered by the *IBC*” and the “Wood” chapter of *IBC*

Air Space:

- Maintain a minimum 1 in. (25 mm) air space*
- Where corrugated anchors are used, maintain a maximum 1 in. (25 mm) air space
- Do not exceed 4½ in. (114 mm) between back of brick and sheathing unless anchors are rationally designed
- Completely fill the air space below wall base flashing with grout or mortar
- Where continuous insulation is placed between the veneer and backing, maintain 1 in. (25 mm) between the back of the brick and the face of the insulation

* An air space is allowed to be a 1 in. (25 mm) nominal dimension in the *IRC* and a 1 in. (25 mm) specified dimension in the *IBC* to account for construction tolerances.

Flashing:

- Install above grade at the wall base and extend to or beyond face of brickwork
- Extend base flashing at least 8 in. (203 mm) vertically
- Place at all points where air space is interrupted and at other locations where water removal is desired, such as under sills and copings
- Where flashing is discontinuous, form dams by turning ends up at least 1 in. (25 mm) into a head joint

Weeps:

- Open head joint weeps at 24 in. (610 mm) o.c. maximum are preferred
- Space wicks or weep tubes no more than 16 in. (405 mm) o.c.

Anchors:

- Do not space anchors more than 32 in. (813 mm) horizontally and 24 in. (610 mm) [*IRC*] or 25 in. (635 mm) [*IBC*] vertically
- Where corrugated metal anchors are installed, their minimum thickness should be No. 22 U.S. gage (0.03 in. [0.76 mm])
- Provide additional anchors within 12 in. (305 mm) of openings larger than 16 in. (406 mm) at a maximum spacing of 3 ft (0.91 m) o.c.

- Provide at least one anchor for each 2.67 sq ft (0.25 m²) of wall area
- Where veneer is laid in stack bond, install single wire joint reinforcement
- Secure anchors to the studs through the sheathing, not to the sheathing alone
- Fasten anchors with corrosion-resistant 8d common nail or equivalent, and within ½ in. (13 mm) of the 90 degree bend of corrugated anchors

Seismic Areas:

- For commercial construction (*IBC*) in Seismic Design Category (SDC) C or above, isolate sides and top of veneer from structure
- For buildings in SDC D or above and townhouses in SDC C, reduce maximum wall area per anchor by 25 percent
- For buildings in SDC D, fasten anchors with 8d ring shank nail or fastener with equivalent pullout strength
- For commercial construction (*IBC*) in SDC E or above, install single wire horizontal joint reinforcement in bed joints no more than 18 in. (457 mm) o.c. vertically, and mechanically fasten to anchors

High Wind Areas:

- For residential construction (*IRC*), provide one anchor for each 2 sq ft (0.25 m²) of wall area
- For commercial construction (*IBC*), reduce maximum wall area per anchor by 30 percent; space anchors no more than 18 in. (457 mm) horizontally and vertically; and place additional anchors within 12 in. (305 mm) of openings larger than 16 in. (406 mm) at a maximum spacing of 24 in. (610 mm) o.c.
- Rationally design commercial construction (*IBC*) when wind pressure exceeds 55 psf (2.63 kPa) or building height exceeds 60 ft (18.3 m)

Lintels:

- For residential construction (*IRC*), use sizes listed in [Table 2](#) or a 5 (vertical leg) by 3½ by ⅝ in. (127 by 89 by 8 mm) steel lintel installed in accordance with [Figure 6](#)
- Size horizontal leg to support a minimum of two-thirds the thickness of the brick wythe
- Provide at least 4 in. (102 mm) bearing at each end of lintels

Water-Resistive Barrier:

- Install No. 15 asphalt felt, building paper, house/building wrap or other approved water-resistive barrier over sheathing

Mortar:

- For typical veneer applications, use Type N mortar complying with ASTM C270
- Where basic wind speed exceeds 110 mph (177 km/h), use Type S mortar

INTRODUCTION

The brick veneer/wood stud wall system offers several advantages over other cladding systems. The system demonstrates superior performance in many of the specific areas of concern for designers, contractors and property owners, such as attractive appearance, high resistance to water penetration, low thermal transmission rate, ease of construction and low maintenance. In addition, the brick veneer provides a fire rating, reduces exterior noise transmission and resists damage from abrasion and flying debris. Dating to the Colonial era, the brick veneer/wood stud wall system has evolved into a successful construction method used in residential and light commercial structures. Buildings using this wall system are often designed with overhangs, eaves and gutters to help protect the wall assembly from wind-driven rain.

Anchored brick veneer with wood stud backing typically consists of a nominal 3 or 4 in. (76 or 102 mm) thick exterior brick wythe attached to a wood frame with corrosion-resistant metal anchors and a prescribed air space between the veneer and the backing system, as shown in [Figure 1](#). It is considered an anchored masonry veneer wall system by construction codes. An anchored masonry veneer is attached to and laterally supported by its backing through anchors and supported vertically by the foundation. The design of veneer ignores the brickwork's resistance to lateral loads and assumes the transfer of out-of-plane loads directly to the backing.

Brick veneer with wood stud backing is used in residential as well as commercial applications and consequently may be subject to provisions of either the *International Residential Code (IRC)* [Ref. 3] or the *International Building Code (IBC)* [Ref. 2]. In this *Technical Note*, general design requirements and considerations that apply to construction governed by the *IRC* are discussed first, followed by unique or additional requirements for buildings covered by the *IBC*. The *IBC* references provisions of the *Building Code Requirements for Masonry Structures (TMS 402/ACI 530/ASCE 5)* [Ref. 10] with a few modifications. [Table 3](#) provides a summary of differing requirements for brick veneer/wood stud walls found within the *IBC* and *IRC*.

The proper design, detailing and construction of anchored brick veneer walls ensure that they function as complete systems. It is important to understand that the failure of any part of the system, whether in design or construction, can result in improper performance of the entire system. Satisfactory performance of brick veneer/wood stud walls is achieved with the following: (1) an adequate foundation; (2) a sufficiently strong, rigid, well-braced backing system; (3) proper attachment of the veneer to the backing system; (4) proper detailing; (5) the use of proper materials; (6) good workmanship in construction; and (7) proper maintenance, as required. Other *Technical Notes* in this series cover brick veneer with different backing systems.

PROPERTIES OF BRICK VENEER/WOOD STUD WALLS

Moisture Resistance

Anchored brick veneer wall assemblies are typically constructed and classified as drainage walls. Walls of this type provide good resistance to rain penetration. The air space behind the brick wythe permits water that penetrates the veneer to drain down the back of the brickwork and be channeled out via flashing and weeps without wetting the rest of the wall assembly. It is essential to maintain the air space between the brick veneer and the backing to prevent the transmission of moisture and to ensure proper drainage. The protection provided by roof overhangs and relatively low wall heights characteristic of most structures using brick veneer on wood stud backing also aids in reducing water penetration. Buildings without some of these protection features may require design and detailing beyond the recommendations found herein. For additional information regarding water penetration resistance, see the *Technical Notes 7 Series*.

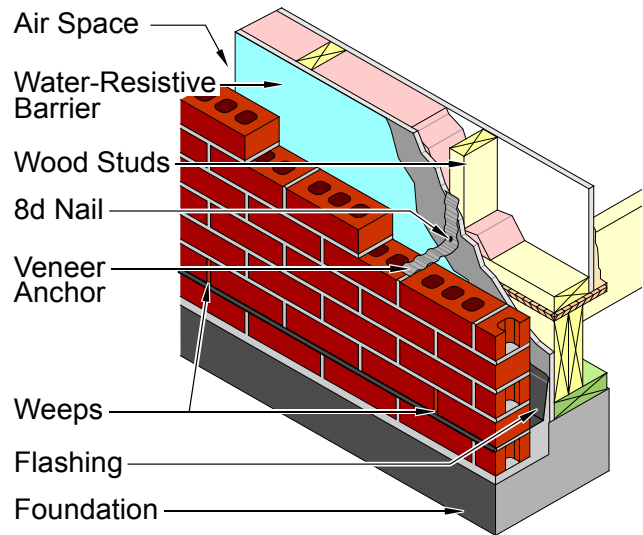


Figure 1
Brick Veneer/Wood Stud Wall

Thermal Performance

Batt insulation is typically placed between studs to provide the primary resistance to thermal transmission; however, wood studs act as thermal bridges, reducing the effectiveness of the batt insulation. Continuous insulation is often placed within an enlarged air space to improve thermal resistance. Brick veneer wall assemblies also incorporate an air space and have thermal mass characteristics that improve their resistance to heat loss or gain. The air space increases the resistance of the wall system to heat transmission by providing a thermal separation between the brick wythe and other system components. The thermal mass of the brickwork allows it to store and slowly release heat over time, which can lower and delay peak heating and cooling loads. For this reason, some energy codes and standards require less insulation in walls meeting minimum requirements for thermal mass. For further information regarding the thermal resistance of brick assemblies, refer to the *Technical Notes 4 Series* and to the *ASHRAE Handbook* [Ref. 1].

Fire Resistance

Brick veneer wall assemblies with wood stud backing routinely attain fire ratings of up to 2 hr. A nominal 4 in. (102 mm) brick wythe alone provides a 1 hr fire resistance rating for the exterior surface of the wall. The wood studs are typically protected from fire on the inside by fire-rated gypsum board, which can be layered to provide the required rating. The *UL Fire Resistance Directory* [Ref. 12] includes a 2 hr fire-rated brick veneer assembly with wood stud backing (U302) and two 1 hr assemblies (U356 and U371). See *Technical Note 16* for additional information on fire resistance and a method for calculating the fire resistance of an assembly.

Acoustical Properties

Brick veneer walls with continuous air spaces are well suited as sound insulators and reduce sound transmission by multiple means. The hard surface of the brickwork reflects the vast majority of sound waves, and the mass of the brickwork absorbs a portion of the sound energy. The remaining sound energy that makes its way through the brick wythe is dampened by the air space separating the brickwork from the remainder of the wall assembly. With only anchors bridging the air space, a minimal amount of sound energy is transmitted to interior wall elements. These properties make brick walls effective at resisting the passage of noises commonly in the range of speech, typically measured by the Sound Transmission Class (STC) rating, as well as insulating spaces against low-frequency outdoor noises such as traffic, aircraft, etc., as measured by the Outdoor-Indoor Transmission Class (OITC).

Brick veneer walls with wood stud backing similar to the one shown in [Figure 1](#) have achieved measured STC values as high as 56 [Ref 8]. Testing has established that a nominal 4 in. (102 mm) wythe of brick alone can achieve an STC rating of 40 or higher. In addition to testing, the STC rating of brick veneer can be estimated based on its weight, in accordance with *Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls*, TMS 302 [Ref. 9].

OITC, another measure of sound insulation, is receiving growing attention, particularly for exterior walls. OITC values around 40 can be expected for brick veneer walls with wood stud backing [Ref. 5]. Additional information on sound transmission can be found in *Technical Note 5A*.

Aesthetics

Brick is available in a large variety of colors, textures, glazes and coatings. In addition, many sizes are manufactured, as well as special shapes that can be used to create truly unique features. Add to this the ability to use multiple bond patterns, the use of colored mortars and interesting masonry detailing, and the creative possibilities are nearly endless. For further information on sizes and patterns, refer to *Technical Notes 10B* and *30*.

Ease of Construction

The wood studs and exterior sheathing of a brick veneer/wood stud wall can be constructed prior to laying the brick veneer wythe. This allows the building to be closed in and placed under roof quickly. Thus, interior work can begin with brick masonry construction following at a convenient time. Further, other trades can be scheduled to work and not interfere with the mason. Care should be taken to ensure that other wall system elements are not compromised prior to installation of the brickwork.

STRUCTURAL DESIGN CONSIDERATIONS

Vertical Support and Veneer Height

Anchored brick veneer carries its own weight and transfers it to a foundation or other vertical support. The type of vertical support and the Seismic Design Category (SDC) of the structure largely determine the maximum height of brick veneer permitted by building codes. Height limits are imposed because of differences in movement resulting from wood shrinkage and brick expansion.

Table 1 summarizes the height limits and related criteria within the *IRC* for brick veneer above noncombustible foundations. For height limits of brick veneer in other than one- and two- family dwellings, see “Additional Requirements for Buildings Covered by the *IBC*.”

TABLE 1
Height Limits for Anchored Brick Veneer above Noncombustible Foundations (*IRC*)

Building Type	Seismic Design Category (SDC)	Number of Stories	Maximum Height, ¹ ft (m)	Maximum Nominal Veneer Thickness, in.	Maximum Veneer Weight, psf (kg/m ²)
All Buildings	A, B or C	1, 2 or 3	30 (9.14)	5	50 (240)
One- and Two-Family Detached Dwellings ²	D ₀	1 or 2	20 (6.10) ³	4	40 (195)
		3	30 (9.14)	4	40 (195)
	D ₁	1, 2 or 3	20 (6.10) ³	4	40 (195)
	D ₂	1 or 2	20 (6.10) ³	3	30 (195)

1. An additional 8 ft is permitted for gable end walls.

2. Cripple walls (framed walls between the foundation and first floor framing) are not permitted.

3. The veneer is permitted to reach 30 ft (9.14 m) in height where the lower 10 ft (3.05 m) has a backing of concrete or masonry wall.

Wood Foundations. Preservative treated wood foundations should be used only in buildings that have no more than two floors, as dictated by the *IRC*. For buildings in SDC D and above, wood foundations must be designed by an engineer.

Other Wood Support Conditions. Brick veneer that is to be supported by other structural wood elements is subject to additional restrictions. These requirements apply to conditions such as where a lower roof abuts a taller brick veneer wall, (e.g., a one-story garage abuts a two-story residence) and where it is not possible or practical to transfer the weight directly to the foundation. Veneer supported by wood construction must be isolated from veneer supported by the foundation with an expansion joint. The deflection of wood members supporting brickwork should not exceed L/600 or 0.3 in. (8 mm).

Two methods for support on wood construction are prescribed by the *IRC*: support by steel angle and support by roof construction. In no case should the brick bear directly on roof sheathing. In each case, up to 12 ft-8 in. (3.9 m) of exterior brick veneer weighing 40 psf (195 kg/m²) or less may be supported if two-thirds of the brick thickness bears on the steel angle, a minimum 1 in. (25 mm) air space is maintained, and flashing is in accordance with Figure 2. Where the slope of the roof construction is 7:12 or more, steel plates at least 3 by 3 by ¼ in. (76 by 76 by 6 mm) must be welded to the angle at 24 in. (610 mm) o.c. to prevent sliding of the brickwork.

Support by Steel Angle. A steel angle with dimensions of at least 6 (vertical leg) by 4 by ⅝ in. (152 by 102 by 8 mm) and bolted to wood studs as required is designed to support the veneer weight, including the effects of deflection and rotation. The angle must be attached with a minimum of two ⅞ in. (11 mm) diameter by 4 in. (102 mm) long lag screws to double 2 × 4 wood studs spaced at a maximum of 16 in. (406 mm) o.c. A gap of not less than ⅛ in. (1.6 mm) must be maintained between the bottom of the steel angle and the underlying construction according to the code, although a ¼ in. (6 mm) gap is recommended.

Support by Roof Construction. A loose steel angle placed directly on top of roof construction may be used to distribute the load of the brickwork to the wood members below when the roof is supported by triple 2 × 6 wood rafters sized to support the weight of the masonry and attached to wall studs. The wood rafters' deflection must be less than L/600. The rafters must be anchored to each other using two 10d nails at every stud spacing and to the vertical stud construction with a minimum of three ⅝ in. (16 mm) diameter by 5 in. (127 mm) lag screws at every stud.

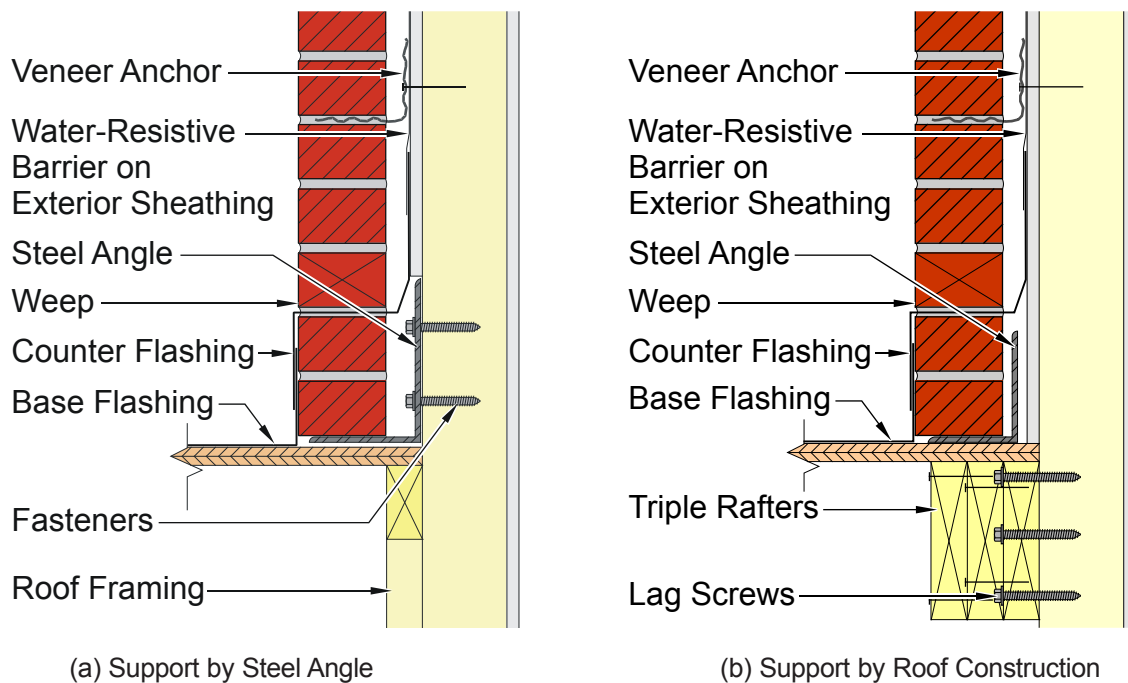


Figure 2

Wood Stud Deflection Criteria

Wood studs must provide adequate out-of-plane support for all loads imposed on the wall system. Wood stud sizing and spacing is dictated using appropriate design codes for wood along with provisions from the *IRC* or *IBC*. Brick veneer/wood stud walls have been used successfully on one- and two-family residential construction for many years due to the short span of the studs and multitude of interior perpendicular walls. For walls with taller stud spans or no intersecting walls, a deflection analysis following the $L/240$ *IBC* limit for the maximum deflection of exterior wall structural members supporting brittle finishes is prudent. This limits the crack size due to loading, thereby reducing the potential for water penetration.

Seismic Requirements

Building codes have included increasingly stringent provisions for brick veneer buildings in higher seismic categories. In the *IRC*, brick veneer in SDC D_0 , D_1 and D_2 has more restrictive height limits, maximum thickness and weight limits, in addition to the requirements in [Table 1](#) and those discussed earlier. The maximum wall area each veneer anchor can support in SDC D_0 , D_1 and D_2 and townhouses in SDC C is limited to 2 sq ft (0.2 m²). Anchors in SDC D must be fastened with an 8d ring shank nail. The *IRC* requires buildings in SDC E to meet the applicable requirements of the *IBC*, discussed later in [“Additional Requirements for Buildings Covered by the IBC.”](#)

High Wind Requirements

Where the basic wind speed exceeds 100 mph (49 m/s), brick veneer attachment must resist the component and cladding loads specified in the *IRC*, “Building Planning” chapter, adjusted for height and exposure. The *IRC* limits the maximum wall area supported by each anchor in areas where the wind pressure exceeds 30 psf (1.44 kPa) to 2 sq ft (0.2 m²). For buildings to which the *IRC* is not applicable, see [“Additional Requirements for Buildings Covered by the IBC.”](#)

Wall Bracing of Wood Frame Construction

Bracing is needed to stiffen wood-framed walls and to increase their resistance to lateral loads. The required length of braced wall lines and hold-down force of connectors increases with higher wind speeds and SDCs and is also dependent on the story of a structure being considered, alignment of braced wall panels and the type of brace selected. Although these requirements do not impact the brick veneer and are beyond the scope of this *Technical Note*, they may dictate wall location, opening locations or allowable sheathing materials. More information on wall bracing can be found in the *IRC* or in other references [Refs. 3 and 6].

DETAILING

Foundations for Brick Veneer

Typical foundation details for brick veneer are shown in [Figure 3](#). Although the support of brick veneer on wood foundations is permitted, concrete and masonry foundations or other noncombustible structural supports, such as attached steel angles, are recommended. At least two-thirds of the brick wythe thickness should be supported on the foundation.

Foundations must extend beneath the frost line as required by the local building code. Design of the foundation should consider differential settlement and the effect of concentrated loads, such as those from columns or fireplaces. Appropriate drainage must be provided in order to maintain soil bearing capacity and to prevent washout.

Brickwork Below Grade. Brickwork should extend below grade only when special provisions are made in detailing and construction to minimize water penetration. Since base flashing is required to be installed in the first course of masonry higher than finished grade above the foundation, as shown in [Figure 3](#), any space below the base flashing should be completely filled with grout or mortar to minimize water penetration. Anchors within the grout- or mortar-filled space should be located according to the same spacing as the brick veneer above grade. The finished grade should be sloped away from the wall to provide positive drainage.

The *IRC* and *IBC* do not explicitly address brick veneer below grade. To avoid extending brick veneer below grade, the brick shelf in the foundation may be constructed above the final grade. If brick veneer is desired to be below grade in Northern climates, then the soil immediately adjacent to the brickwork should provide adequate drainage. If the soil does not drain well, then a French drain may be installed between the soil and the wall, consisting of a gravel fill with a fabric filter surround and a drain pipe or tile below, sloped a minimum of $\frac{1}{8}$ in./ft (10 mm/m). Alternatively, a drainage medium may be installed on the surface of the brickwork below grade, such as a drainage mat or a drainage board.

Bond Breaks. Because brickwork expands and concrete foundations shrink, differential movement will cause shearing stresses to develop when these materials are bonded together. Bond breaks help to relieve the stresses caused by these movements between the brick veneer and the supporting foundation. Flashing at the base of the wall between the veneer and the foundation provides a sufficient break in the bond, as shown in [Figure 3b](#).

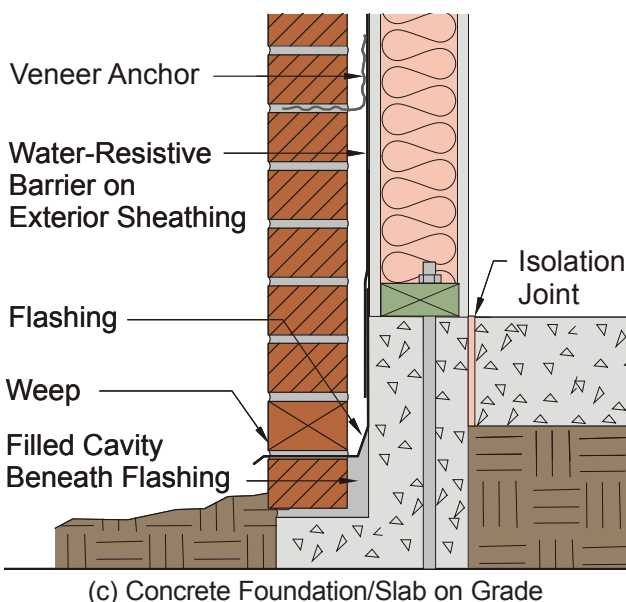
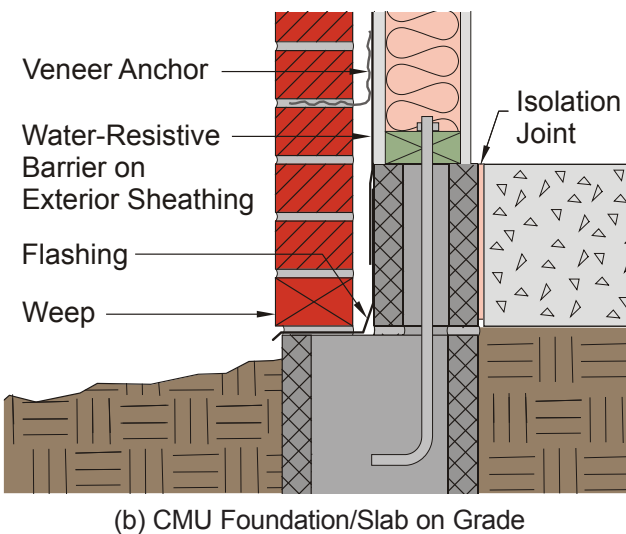
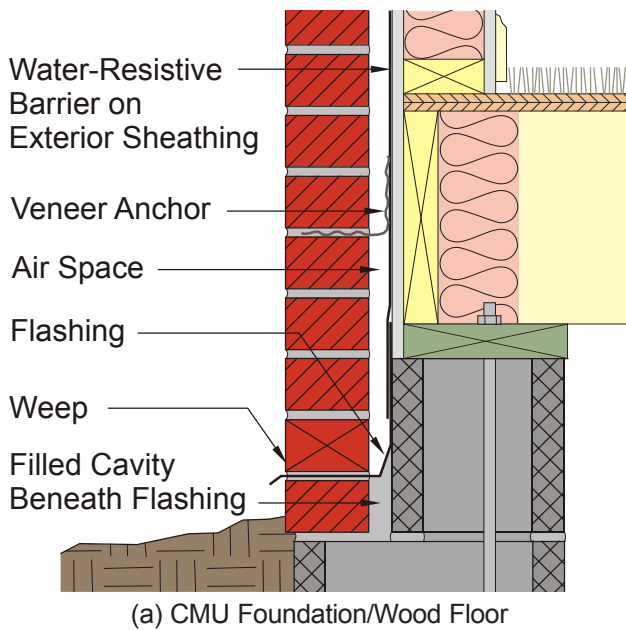


Figure 3
Foundation Detail

Sheathing and Water-Resistive Barrier

An exterior grade sheathing or insulation material is usually installed on the exterior side of the studs. A water-resistive barrier is required to be placed over the studs or sheathing. These membranes prevent liquid water from passing through them and should keep out any water that finds its way across the air space via anchors, mortar bridging or splashing. Examples include No. 15 asphalt felt and other materials, such as building paper and house/building wraps.

Air Space

The air space behind a brick veneer provides a means to drain water that penetrates the brickwork and inhibits the direct passage of water toward the interior. The width of the air space, the distance from the back of the brick to a material on the opposite side of the air space, should not be less than 1 in. (25 mm) wide. A 1 in. (25 mm) air space is customary in residential brick veneer/wood stud walls and has been used successfully for decades. Building codes also require a minimum 1 in. (25 mm) air space but use the terms “nominal” or “specified” to describe the distance. The *IRC* requires a minimum air space of a nominal 1 in. (25 mm), and the *IBC* requires a 1 in. (25 mm) minimum air space to be specified. “Nominal” or “specified” are used in order to acknowledge the construction tolerances and other field issues associated with installing the materials that surround the air space. These issues may cause the actual dimension of the air space to measure less than 1 in. (25 mm). The most important aspect of the air space is that it creates a separation and allows any water that has penetrated the brick veneer to drain downward to flashing and exit the wall system through weeps. In many cases, residential details such as those used at foundations, window jambs and anchors may not accommodate an air space wider than 1 in. (25 mm) without modification of details or changes in product selection. One- and two-family dwellings generally have larger overhangs and lower wall heights than commercial structures, which reduces their exposure to wind-driven rain. For commercial structures with brick veneer/wood stud walls, a wider air space of 2 in. (51 mm) is recommended.

When corrugated anchors are used, the distance from the back of the brick to the framing must not exceed 1 in. (25 mm) since these types of anchors do not provide adequate load transfer across larger distances. This maximum is allowed to be a nominal dimension of 1 in. (25 mm) in the *IRC* and a specified dimension of 1 in. (25 mm) in the *IBC* to acknowledge construction tolerances. With other types of anchors, a 4½ in. (114 mm) maximum distance is permitted between the back of the brick veneer and the wood framing. This distance may be exceeded if the anchor size and spacing are rationally designed.

In some cases, continuous insulation is used in place of sheathing or added to the exterior of the sheathing for added thermal resistance. As stated before, a 1 in. (25 mm) distance between the back of the brickwork and the face of the insulation should be provided. Consequently, accommodating the placement of continuous insulation within the air space precludes the use of corrugated anchors. Insulation should be attached to the backing by mechanical or adhesive means to ensure that it does not dislodge and block or bridge the air space.

Drainage Products. Products designed to prevent mortar bridging, ensure a clear drainage space or catch mortar droppings to prevent blocking of weeps may be installed in the air space. Some products perform more than one of the functions noted above. Such products may be beneficial when a high probability of mortar falling into or bridging the air space exists, such as for multi-story brick veneer without shelf angles. However, the use of drainage products should not preclude good workmanship and an effort to keep the air space clean of excess mortar droppings.

Flashing

Flashing is essential to collect water that has penetrated the veneer and to direct it out of the wall through the weeps at the bottom of the air space. Flashing and weeps must be placed at all locations where the air space is interrupted, including:

- beneath the first course of brickwork above final grade;
- at points of support, such as shelf angles, lintels and structural floors;
- at wall and roof intersections;
- at the heads, jambs and sills of exterior window and door openings;
- at the intersection of chimneys or other masonry construction with frame or stucco walls;

- under and at the ends of copings and sills; and
- where exterior porches, decks or stairs attach to a wall or floor assembly of wood frame construction.

Flashing should extend to the exterior face of the brick veneer, with the back edge turned up at least 8 in. (203 mm) vertically. When the flashing is installed after the moisture barrier or air barrier, the flashing should be attached to the wall with a termination bar. Extending flashing beyond the face of the brickwork to form a drip is recommended. When using a flashing that deteriorates with UV exposure, a separate drip edge can accomplish this. When a drip edge is not used, the flashing should stop, or be cut, flush with the face of the wall.

If drainage materials that catch mortar are placed at the bottom of the air space, then flashing at the base of the wall should extend farther up the backing. This ensures that the flashing extends above the height of the drainage material and helps deter water that migrates across mortar on top of the drainage material from entering the backing. The water-resistive barrier should lap the top of the flashing a minimum of 4 in. (102 mm). Where the flashing is not continuous, such as over and under openings in the wall, the ends should be turned up at least 1 in. (25 mm) into a head joint to form a dam. Typical flashing details are shown in [Figure 3](#), [Figure 5](#) and [Figure 7](#).

Weeps

Weeps permit water to exit the wall and must be located in the mortar joints immediately above all flashing. Weeps must have a minimum diameter of $\frac{3}{16}$ in. (4.8 mm) and may be spaced up to 33 in. (838 mm) o.c. However, larger, more closely spaced weeps provide better drainage and drying. Clear, open head joint weeps are preferred and should be spaced no more than 24 in. (610 mm) o.c. Noncorrosive metal, mesh or plastic screens can be installed in open head joint weeps if desired. Weeps formed with wick materials or with tubes should be spaced at a maximum of 16 in. (406 mm) o.c. Wicks used for drainage should extend horizontally along the length of the flashing and have one end extended up some distance above the anticipated level of mortar droppings.

Anchors (Wall Ties)

Brick veneer is supported laterally by anchors (often referred to as “wall ties”) and the wood stud backing. The anchors must provide out-of-plane support while allowing in-plane movement. They should resist tension and compression resulting from forces perpendicular to the plane of the wall, but not resist shear. This permits in-plane differential movement between the frame and the veneer without causing cracking or distress. The veneer may be attached to wood studs or framing with corrugated sheet-metal anchors, sheet-metal anchors, wire anchors or adjustable anchors. More common anchors used with wood stud backing are shown in [Figure 4](#).

Anchor Selection. Corrugated anchors have historically been used to attach brick veneer to wood stud backing. However, corrugated metal anchors are more susceptible to corrosion than wire anchors. Adjustable wire anchors provide better load transfer and permit differential movement in taller structures. Material requirements and installation of anchors are discussed later in this *Technical Note*. More detailed information on anchors can be found in *Technical Note 44B*.

Spacing. There should be one anchor for every $2\frac{2}{3}$ sq ft (0.25 m²) of wall area. The *IRC* permits horizontal spacing of anchors up to 32 in. o.c. Vertical spacing of anchors shall not exceed 24 in. (610 mm) o.c. Slightly different anchor spacing requirements for buildings covered by the *IBC* are discussed later in this *Technical Note* under the heading “**Additional Requirements for Buildings Covered by the IBC.**” Both the *IRC* and the *IBC* require additional anchors around openings larger than 16 in. (406 mm) in either dimension. In this case, anchors should be located within 12 in. (305 mm) of the opening and spaced at a maximum of 3 ft (915 mm) o.c.

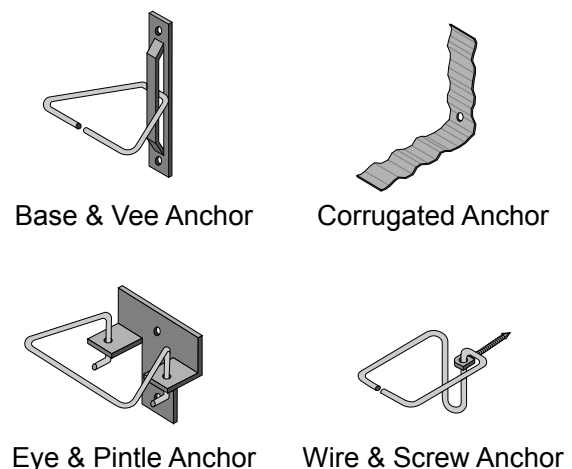


Figure 4
Unit Anchors for Wood Backing

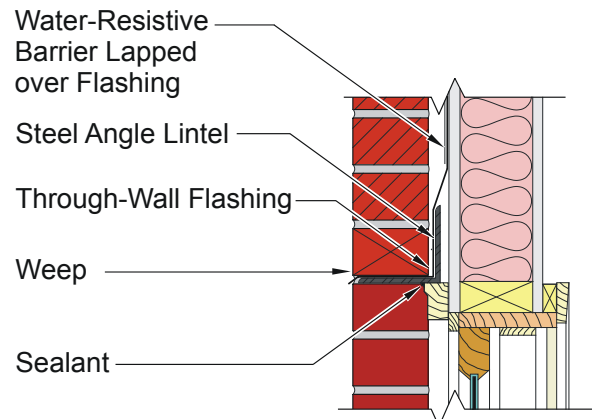
Lintels

Except when the masonry is self-supporting, brick veneer must be supported over openings by lintels. Lintels provide support of brickwork over masonry openings by bearing on the brickwork on each side of the opening, rather than attaching to the building structure, as is the case with shelf angles. Lintels may be reinforced brick masonry, reinforced concrete masonry or steel angles. Typical residential construction details for a steel and masonry lintel are shown in Figure 5. Lintel design information may be found in *Technical Notes* 17B and 31B. Steel, stone or precast lintels should bear at least 4 in. (102 mm) on brickwork on each side of the opening.

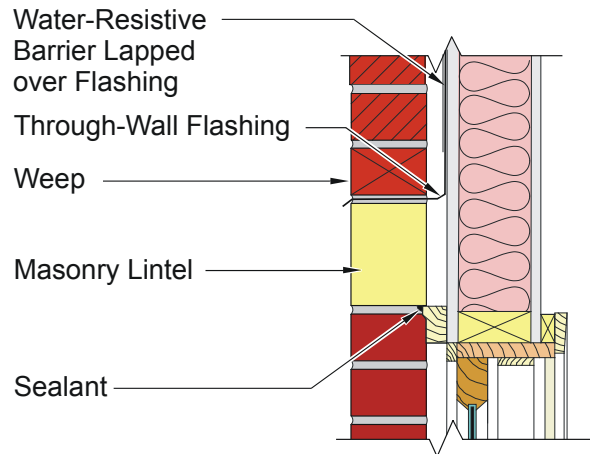
Lintels must be appropriately sized to carry the weight of the veneer. Prescriptive requirements within the *IRC* permit single lintels with maximum clear spans up to the values shown in Table 2. Alternatively, a steel lintel 5 by 3½ by 5/16 in. (127 by 89 by 8 mm) or larger can span up to 18 ft-3 in. (5.6 m) if the construction complies with Figure 6 and the following requirements, as taken from *IRC* Section 703.7.3.2:

- A minimum length of 18 in. (457 mm) of masonry veneer is provided on each side of the opening;
- The angle is shored for a minimum of seven days after installation of the brickwork above;
- Double-wire joint reinforcement, 3/16 in. (4.8 mm) in diameter must be placed in the first two bed joints above the opening and extend 12 in. (305 mm) beyond each side of the opening. Alternatively, 9 gage (0.144 in. [3.66 mm] diameter) joint reinforcement placed in the first three bed joints above the opening may be used. Splices in joint reinforcement must be lapped a minimum of 12 in. (305 mm).

Reinforced Brick Lintels. Reinforced brick lintels are also a viable option. Some of the advantages of reinforced brick lintels include more efficient use of materials; inherent fire resistance; elimination of differential movement, which may occur with steel lintels and brick veneer; and no required painting or other maintenance. The design of reinforced brick lintels is addressed in *Technical Note* 17B.



(a) Loose Steel Lintel



(b) Masonry Lintel

Figure 5
Lintel Details

TABLE 2
Allowable Spans for Lintels Supporting Masonry Veneer

Size of Steel Angle, ^{2,3} in.	Steel Lintels ¹			Masonry Lintels ¹
	No Story Above	One Story Above	Two Stories Above	No. of ½ in. or Equivalent Reinforcing Bars in Reinforced Lintel ⁴
3 × 3 × ¼	6 ft-0 in.	4 ft-6 in.	3 ft-0 in.	1
4 × 3 × ¼	8 ft-0 in.	6 ft-0 in.	4 ft-6 in.	1
5 × 3½ × 5/16	10 ft-0 in.	8 ft-0 in.	6 ft-0 in.	2
6 × 3½ × 5/16	14 ft-0 in.	9 ft-6 in.	7 ft-0 in.	2

1. Either steel angle or reinforced lintel shall span opening.
2. Long leg of the angle shall be placed in a vertical position.
3. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.
4. Depth of reinforced lintels shall not be less than 8 in., and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 in. into the support.

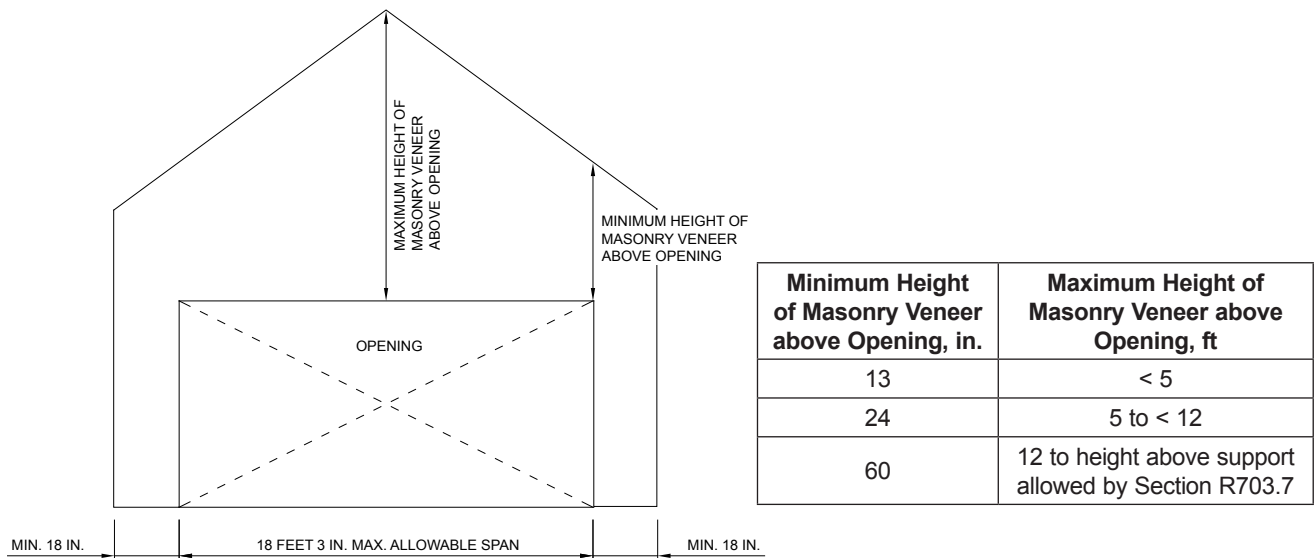


Figure 6
Veneer Opening Requirements

Steel Lintels. Steel angle lintels should be at least $\frac{1}{4}$ in. (6 mm) thick, with a horizontal leg sized to support a minimum of two-thirds the thickness of the brick wythe. A horizontal leg of at least $3\frac{1}{2}$ in. (89 mm) is recommended for use with nominal 4 in. (102 mm) wide brick veneer, and a horizontal leg of 3 in. (75 mm) for use with nominal 3 in. (75 mm) wide brick veneer. Steel lintels with spans greater than 8 ft (2.4 m) may require lateral bracing for stability. Space should be provided at the end of all steel lintels to accommodate expansion of the steel.

Head, Jamb and Sill Details

Openings in brick veneer walls should be carefully detailed to prevent water from entering. Window frames, door frames and openings for sleeves must be attached to the backing, not to the brick veneer. Provision should be made for movement between the brick veneer and the frame or backing. Window and door flashing must be integrated with the water-resistant barrier to provide a continuous barrier to moisture and/or air infiltration, as shown in [Figure 5](#) and [Figure 7](#). Sills that can be installed with few or no joints, such as stone or precast sills, result in fewer opportunities for water penetration to occur. All sills should be sloped to the outside to promote drainage. A minimum angle of 15 degrees from horizontal, approximately $\frac{1}{4}$ in./in. (25 mm/100 mm) is recommended for brick rowlock sills. Refer to *Technical Note 36* for further information.

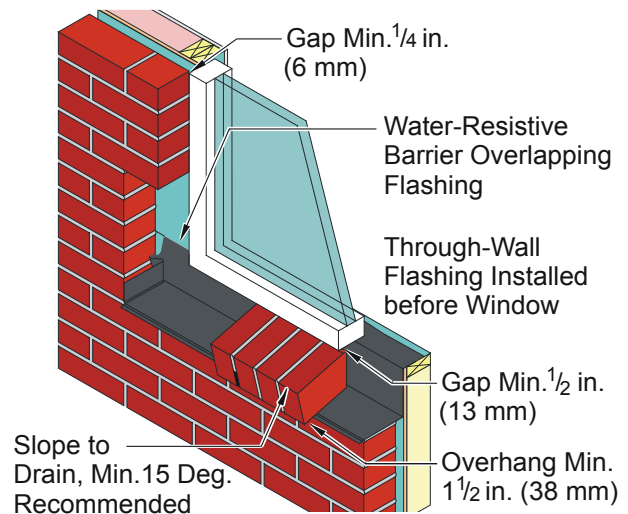


Figure 7
Window Jamb and Sill

Sealant Joints

Sealant joints are used at the perimeter of exterior door and window frames and at movement joints to resist water penetration. Sealant joints around window and door openings should be free of mortar for the entire thickness of the brick veneer and typically include a recessed, compressible foam backer rod covered by a sealant. If desired, a compressible material may be included behind the backer rod. Sealant joints around window and door openings should generally be no less than $\frac{1}{4}$ in. (6 mm) wide. A minimum of $\frac{1}{2}$ in. (13 mm) is recommended between the bottom of the window frame and the top of the sill below. Refer to *Technical Note 18A* for further information.

Eaves

A typical residential eave detail is shown in [Figure 8](#). This detail is suggested for the area at the top of the veneer. The space between the top of the brick veneer and wood framing is necessary to accommodate movement. Larger overhangs and gutters are helpful to keep water from contacting the wall below.

OTHER DESIGN CONSIDERATIONS

Movement Provisions

Like other building elements, brickwork will continually change in size during its life due to the combined effects of changes in temperature and moisture. Moisture expansion can continue for years, while thermal movement and mortar contraction will occur periodically, contingent upon temperature and moisture conditions.

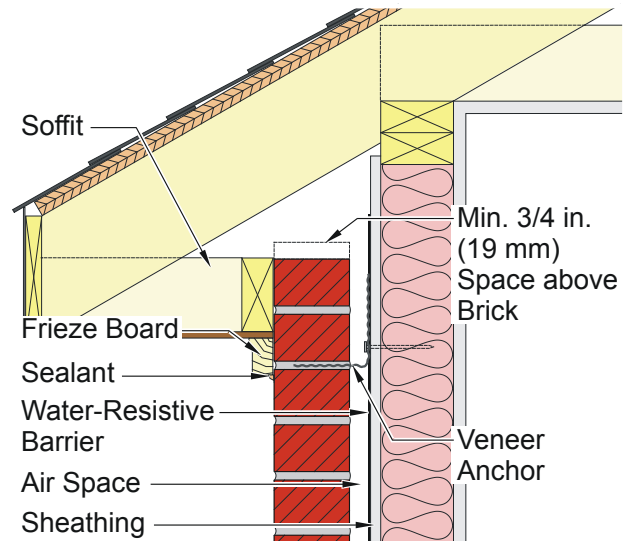


Figure 8
Eave Detail

Provisions for movement, which include bond breaks (discussed above), expansion joints and joint reinforcement, are not usually required for one- and two-family dwellings; however, they may be needed in specific situations. The designer should analyze each project to determine such need. The *IBC* requires design and detailing of brick veneer construction to accommodate differential movement.

Expansion Joints. The spacing and placement of vertical and horizontal expansion joints should be determined on a case-by-case basis. Expansion joints may be needed in brick veneer to accommodate horizontal movement in long walls, walls with returns, large openings (such as two-car garage openings), near corners and changes in support, among other conditions. These features influence how the brickwork reacts to movement in a wall. As noted above, additional expansion joints may also be needed to isolate the veneer from structural elements that impart lateral loads and veneer supported on wood construction. The placement of expansion joints and the materials used should be in accordance with the information given in the *Technical Notes 18 Series*. While expansion joints are rarely used in residential construction, their use should be considered in large expanses of brickwork or other areas as identified in *Technical Note 18A*.

Horizontal Joint Reinforcement. Masonry materials subject to shrinkage stresses, such as concrete masonry, require horizontal joint reinforcement for control of cracking. Brick is not subject to shrinkage; therefore, horizontal joint reinforcement is never required in brick masonry for this purpose.

It may be beneficial to use limited amounts of horizontal joint reinforcement to add strength to brick veneer above and below the corners of openings, to resist cracking from high internal stress due to movement.

Energy Efficiency

Brick veneer/wood stud walls must generally meet the energy efficiency requirements found in applicable building codes, energy codes or standards. The “Energy Efficiency” chapter within the *IRC* is typically used for one- and two-family dwellings. The *International Energy Conservation Code (IECC)* covers both residential and commercial buildings and is referenced by the *IRC* and the *IBC*. Both include specific requirements for wood-framed walls that depend primarily on the climate zone in which a building is located. A number of prescriptive and performance alternatives exist that permit a variety of materials and strategies to be used to meet energy requirements.

Batt insulation between studs is sufficient to meet energy requirements for above-grade walls in some climate zones; however, better performance results from the use of continuous insulation on the exterior of the sheathing adjacent to the air space, which reduces thermal bridging through the studs. In addition, insulating the foundation supporting brickwork reduces heat loss through that area. Specific insulation requirements may exist for basement walls, crawl space walls and the perimeter of on-grade slabs, which may include the depth or extension of the insulation, how it is to be protected if located on the exterior of the foundation or exemptions in areas of heavy

termite infestations. The horizontal portion of a foundation that supports brick veneer insulation is not required to be insulated. However, there are a number of ways insulation can be installed so that this area does not provide a path for heat loss. Figure 9 shows an example of a brick veneer wood stud wall employing continuous insulation within the air space and at the foundation to optimize energy performance. The U.S. Department of Energy's Building America website [Ref. 6] is one of many online resources that provide a wealth of information related to improving the energy efficiency of both above- and below-grade walls, including specific suggestions for various climates.

Condensation

Water or moisture found within the stud cavity of brick veneer/wood stud walls is sometimes due to condensation. Condensation occurs at the point in the wall where water vapor within the air reaches a surface with a temperature below the dew point. If this point is within the air space, then the condensation will find its way out of the wall via the drainage system; however, if it is on the inside of the stud wall with batt insulation, it may dampen or eventually saturate the surrounding materials and reduce the R-value of the insulation or lead to mold problems.

A condensation analysis is helpful in determining if the potential for condensation exists in a wall. Such an analysis is not typically conducted on walls of one- and two-family dwellings. If results indicate that it may occur within the sheathing or stud wall, then the wall design should be changed. Control of condensation can be achieved via various strategies, including improved thermal resistance, the use of continuous insulation and proper placement of vapor retarders or air barriers to control water vapor and air movement through the wall. See *Technical Note 47* for a more detailed discussion of condensation control.

MATERIALS

Brick

Brick most commonly used in anchored veneer applications conform to ASTM C216 [Ref. 4] for facing brick or ASTM C652 for hollow brick. However, building brick (ASTM C62), glazed brick (ASTM C126 and C1405) and other brick meeting minimum physical property requirements for exterior exposure may be selected as appropriate. Grade SW brick is recommended for exterior veneer applications due to its high and uniform resistance to damage caused by cyclic freezing when saturated with water. Grade MW may be used where moderate resistance to damage caused by cyclic freezing is permissible or where the brick may be damp, but not saturated, when freezing occurs.

In general, masonry constructed with salvaged brick may contain less-durable units than masonry constructed with new brick. Salvaged brick and considerations for its use are discussed in detail in *Technical Note 15*. The *IRC* permits the use of "second-hand" (salvaged/reclaimed) brick as an alternative material when approved by the building official or when they conform to ASTM standards for new brick, as required by the *IBC*.

Mortar

Mortar should comply with the requirements of ASTM C270, *Standard Specification for Mortar for Unit Masonry* [Ref. 4]. Three kinds of mortar are permitted: cement-lime, mortar cement and masonry cement. A designer should select the mortar with the lowest compressive strength that is compatible with the project requirements. The compatibility between a particular brick and mortar should also be examined when determining mortar type. Type N mortar is suitable for most brick veneer, although Type S may be used. Type S mortar is recommended where

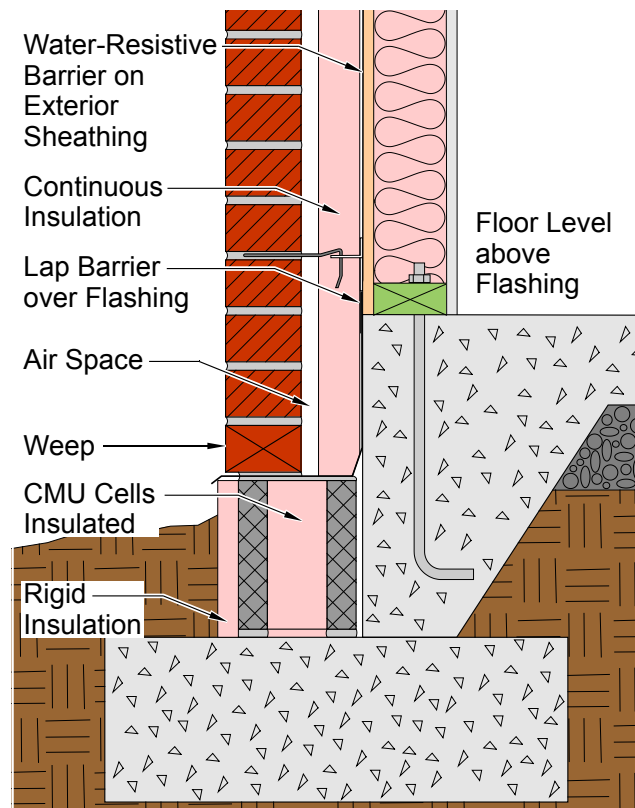


Figure 9
Continuous Insulation at Foundation

a high degree of flexural resistance is required. Where significant amounts of the veneer extend below grade, or where additional durability is desired, Type M or S mortar should be considered. Admixtures and additives other than pigments for color are not generally recommended, since they may adversely affect the properties of the mortar and the resulting brickwork. For further information on selection of appropriate mortar Types and materials, see *Technical Notes* 8 and 8B.

Water-Resistive Barrier

No. 15 asphalt felt complying with Type 1 of ASTM D226, *Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing* [Ref. 4], can be used as a water-resistive barrier; however, ASTM E2556, *Standard Specification for Vapor Permeable Flexible Sheet Water-Resistive Barriers Intended for Mechanical Attachment*, provides performance requirements for asphalt felt, building paper and house/building wraps. Polymer-based (plastic) house/building wraps, though designed primarily as air barriers, often perform the function of a water-resistive barrier. Some plastic membranes act as vapor retarders and hence can potentially trap water vapor inside the stud wall, where it can condense if the temperature gradient in the wall drops below the dew point. Thus, not all plastic membranes should be regarded as equivalent, and caution should be used when using them as a water-resistive barrier.

Sheathing

The type of sheathing required may be dictated by wall bracing requirements for residential construction. Generally, the sheathing should be one of the following:

- exterior grade gypsum sheathing or glass fiber mat-faced sheathing or cement board, not less than ½ in. (13 mm) in thickness;
- closed-cell insulating rigid foam not less than ½ in. (13 mm) thick conforming to ASTM C578 or ASTM C1289 [Ref. 4];
- oriented strand board (OSB) not less than ½ in. (13 mm) in thickness; or
- exterior grade plywood not less than ¾ in. (10 mm) in thickness.

Anchors

Anchors may be made from stainless or carbon steel. Carbon steel anchor components for exterior walls must be protected from corrosion by hot-dip galvanizing or epoxy coating. Galvanized (zinc) coatings on steel must be at least 1.5 oz per sq ft (458 g/m²). Epoxy coatings should be at least 20 mils in thickness. ASTM specifications for steel used to fabricate masonry veneer anchors and additional information are discussed in *Technical Note* 44B.

Corrugated Sheet Metal Anchors. Corrugated steel anchors should have a base metal thickness of at least 0.03 in. (0.8 mm, 22 gage) and a minimum metal width of ⅞ in. (22 mm). In many cases, thicker materials that are pre-bent perform better over time and during extreme events.

Wire Anchors. Steel wire for anchors must be at least wire size W1.7 (9 gage, MW11) and have the ends bent to form an extension at least 2 in. (51 mm) long.

Adjustable Anchors. Adjustable anchors must be detailed to prevent disengagement and have a ⅙ in. (1.6 mm) maximum clearance between the connecting parts. Pintle-type anchors are required to have one or more legs of W2.8 (MW18) wire, with a maximum offset of 1¼ in. (32 mm). Sheet metal and wire components of adjustable anchors must also meet the requirements for sheet metal and wire anchors, respectively. Plate portions of adjustable anchors are normally 14 gage (0.07 in., 1.9 mm) in thickness.

Sheet Metal Anchors. Anchors formed from sheet metal that do not meet the requirements for corrugated anchors are permitted but must be at least ⅞ in. (22 mm) wide; have a base metal thickness of at least 0.06 in. (1.5 mm); and be bent, notched or punched to provide equivalent performance to corrugated anchors in pull-out or push-through from the mortar joint.

Flashing

Many materials are suitable for use as flashing in brick veneer walls. Flashing materials should be waterproof, durable and sufficiently tough and flexible so as to resist puncture and cracking. Flashing should also be compatible with adjacent adhesives and sealants. Characteristics of some common flashing materials are discussed in *Technical Note* 7A. It is recommended that only superior materials be used, as replacement in the

event of failure is exceedingly expensive. Asphalt-impregnated felt, building paper and house/building wraps are not acceptable for use as flashing.

Lintels

Steel Lintels. Steel for lintels should conform to ASTM A36, *Standard Specification for Carbon Structural Steel* [Ref. 4]. Steel lintels should be shop coated with a rust-inhibitive paint, made of corrosion resistant steel or treated with a coating to provide corrosion resistance. For further information on lintels, refer to *Technical Note 31B*.

Brick Masonry Lintels. Reinforcing bars for reinforced brick masonry lintels should be steel bars conforming to ASTM A615, A706, A767, A775 or A996 [Ref. 4], Grades 40, 50 or 60, and should be at least No. 3 bar size. Joint reinforcement can also be used in reinforced brick masonry lintels.

Horizontal Joint Reinforcement

Horizontal joint reinforcement should meet the requirements of ASTM A951 [Ref. 4]. Corrosion protection of carbon steel joint reinforcement in exterior walls may be provided by hot-dip galvanizing or epoxy coatings. Joint reinforcement made of stainless steel wire should meet ASTM A580/580M [Ref. 4] and needs no further corrosion protection. Minimum thickness requirements and ASTM specifications for corrosion protection of joint reinforcement can be found in *Technical Note 44B*.

Joint Sealants

Sealants should be selected for their durability, extensibility, compressibility and compatibility with other materials. In addition, they should be able to maintain these qualities under the temperature extremes of the climate in which the building is exposed. Sealant materials should be specified to comply with ASTM C920, *Specification for Elastomeric Joint Sealants* [Ref. 4]. Superior sealants may have a higher initial cost, but their high flexibility and increased durability result in savings of maintenance costs due to the reduced frequency of reapplication. Good grades of polysulfide, butyl or silicone rubber sealants are recommended. Specific sealants recommended for brickwork include polysulfide, solvent-release acrylic, silicone and urethane sealants. Since acetoxic (acid-curing) silicone will attack cement in mortar, sealants of this type should not be applied to masonry. Oil-based caulking compounds should not be used, since they generally lack the desired flexibility and durability and may stain the adjacent brickwork. Follow the recommendations of the sealant manufacturer. For further information on sealants, refer to ASTM C1193, *Guide for Use of Joint Sealants* [Ref. 4], and *Technical Note 7A*.

ADDITIONAL REQUIREMENTS FOR BUILDINGS COVERED BY THE IBC

There are a number of requirements for brick veneer/wood stud walls that differ between the *IRC* and *IBC*. A summary of these is provided in [Table 3](#) and described in the following sections.

Vertical Support and Veneer Height

By reference to TMS 402, the *IBC*, like the *IRC*, generally limits the maximum height of brick veneer above noncombustible foundations to 30 ft (9.14 m), or 38 ft (11.58 m) at a gable. However, to achieve this height in other than SDC A, the “Wood” chapter of the *IBC* stipulates one or more of the following: additional wall bracing, the use of concrete or masonry backing for the lowest story of veneer or hold-down connectors between each story and to the foundation. Refer to the *IBC* “Wood” chapter for further information.

Wood Stud Deflection Criteria

L/240 is the maximum out-of-plane deflection permitted by the *IBC* for exterior wall structural members supporting “brittle finishes.”

Seismic Requirements

The “Exterior Walls” chapter of the *IBC* addresses seismic provisions for anchored veneers by reference to TMS 402. It stipulates that brick veneer built in SDC C should have its sides and top isolated from the structure to prevent seismic loads from being imparted to the veneer by the frame or other fixed elements of the building. This can be accomplished with expansion joints normally used in brick veneer structures. For veneer constructed

in SDC D, the requirements of SDC C must be met; the area of wall supported by each anchor must be reduced to 75 percent of the area permitted in a non-seismic condition; and the weight of the brick veneer must be supported independently at each story. Veneer in SDC E and SDC F must comply with the requirements of SDC D as well as provide continuous single wire horizontal joint reinforcement of wire size W1.7 (MW11) at a maximum spacing of 18 in. (457 mm) o.c. vertically that is mechanically connected to anchors with clips or hooks.

High Wind Requirements

The *IBC* and TMS 402 include the following prescriptive requirements for brick veneer in areas where wind pressure exceeds 40 psf (1.95 kPa) and the building's mean roof height does not exceed 60 ft (18.3 m):

- The maximum wall area supported by each anchor is limited to 70 percent of the area otherwise required.
- Anchor spacing may not exceed 18 in. (457 mm) both vertically and horizontally.
- Around openings larger than 16 in. (406 mm) in either direction, anchors are required within 12 in. (305 mm) of the opening; at a maximum spacing of 24 in. (610 mm) o.c. around the opening perimeter.

Where wind velocity pressure exceeds 55 psf (2.63 kPa) or the building's mean roof height exceeds 60 ft (18.3 m) the veneer should be rationally designed. The strength level wind velocity pressure trigger in TMS 402-11 is a change from the working stress level wind speed used in previous editions. Although the triggers are comparable in intensity, the strength level adjustment better corresponds with current wind speed maps.

Anchor (Wall Tie) Spacing

For commercial construction, the *IBC* generally permits anchors to be spaced at a maximum of 32 in. (813 mm) horizontally and 25 in. (635 mm) vertically. However, allowable wall area per anchor, horizontal and vertical spacing are reduced in areas of high winds, and additional anchors must be placed around openings, as discussed earlier.

Veneer Not Laid in Running Bond

The *IBC* requires the use of horizontal joint reinforcement to add integrity to brick veneer that is not laid in running bond (head joints in successive courses are horizontally offset at least one-quarter the unit length) or constructed in SDC E or SDC F. For veneer not laid in running bond, the minimum area of horizontal joint reinforcement is 0.00028 times the gross cross-sectional area of the wall using specified dimensions and may be spaced up to 48 in. (1.2 m) on center. It may be either single or double wire joint reinforcement. The veneer will require at least one W1.7 (MW11) wire at a maximum spacing of 18 in. (457 mm) o.c. vertically. In SDC E and SDC F, the wire should be mechanically connected to the veneer anchors. When using horizontal joint reinforcement, it must be discontinuous at all movement joints.

CONSTRUCTION

Construction requirements such as the general recommendations within this section are found in building codes and may also be contained in project manuals prepared for specific buildings. TMS 402 and the *IBC*, with some exclusions, invoke the construction requirements of TMS 602/ACI 530.1/ASCE 6, *Specification for Masonry Structures* [Ref. 11].

Preparation

All materials at the job site should be stored off the ground and under adequate cover to prevent damage, deterioration and contamination. Cement and lime should be kept dry. Foreign material must be kept out of sand. Brick should not be placed directly on the ground to preclude potential staining or contamination from dirt and mud. Plastic and asphalt-coated flashing materials should not be stored in direct sunlight.

Brick that have a field measured initial rate of absorption (suction) of more than 30 g/min/30 sq in. (30 g/min/194 cm²) should be wetted and permitted to surface dry prior to laying. This will increase the bond between the mortar and the brick by slowing the absorption of water from the mortar. For additional information, refer to *Technical Note 7B*.

TABLE 3

Comparison of IRC and IBC Requirements for Brick Veneer/Wood Stud Walls

Subject of Provision		IRC Requirement	IBC Requirement
Veneer Height	Above Noncombustible Foundation	30 ft (9.14 m) max. height. (38 ft [11.58 m] max height at gable)	30 ft max height (38 ft at gable) in SDC A; see IBC "Wood" chapter for additional requirements in other SDCs.
	Above Preservative-Treated Wood Stud Foundation	Building height limited to two floors. In SDC D and above, foundation must be designed by an engineer.	18 ft (5.49 m) max. height
	Above Other Wood Construction	12 ft-8 in. (3.9 m) max. height if (1) using prescribed steel angle or roof construction methods, and (2) veneer supported on wood is isolated by expansion joints.	12 ft (3.7 m) max. height if (1) there is no direct contact between veneer and wood, (2) deflection due to dead plus live loads \leq smaller of L/600 or 0.3 in. (8 mm) and (3) veneer supported on wood is isolated by expansion joints.
Stud Deflection (Out-Of-Plane)		—	L/240 max. for brittle finishes
Seismic Areas		See height and nominal thickness limits listed in Table 1.	In SDC C: Isolate sides and top of veneer from structure.
		In SDC D ₀ , D ₁ and D ₂ : (1) Max. wall area per anchor not to exceed 2 sq ft (0.2 m ²) and (2) fasten anchors with 8d ring shank nail or No. 10 screw.	In SDC D: (1) Meet SDC C requirements; (2) reduce wall area supported by each anchor by 75 percent; and (3) support the weight of the brickwork at each floor.
		In SDC E: Refer to IBC requirements.	In SDC E and F: (1) Meet SDC D and (2) provide horizontal joint reinforcement mechanically connected to anchors.
High Wind Areas		Where the wind pressure exceeds 30 psf (1.44 kPa), reduce wall area supported by each anchor to a maximum of 2 sq ft (0.2 m ²).	Where wind velocity pressure exceeds 40 psf (1.95 kPa) and the building's mean roof height does not exceed 60 ft (18.3 m): (1) reduce wall area supported by each anchor by 70 percent; (2) do not space anchors more than 18 in. (457 mm) vertically and horizontally; and (3) place anchors within 12 in. (305 mm) around the perimeter of openings larger than 16 in. (406 mm) at a maximum spacing of 24 in. (610 mm) o.c.
		Where basic wind speed is 110 mph (49 m/s) or higher, veneer attachment must resist component and cladding loads specified in IRC "Building Planning" chapter, adjusted for height and exposure.	Where wind velocity pressure exceeds 55 psf (2.63 kPa) or building's mean roof height exceeds 60 ft (18.3 m), rationally design the veneer.
Anchor Spacing (See additional requirements for seismic and high-wind areas)		Vertical: 24 in. (610 mm) max. Horizontal: 32 in. (813 mm) max. 2 $\frac{2}{3}$ sq ft (0.25 m ²) max. wall area per anchor.	Vertical: 25 in. (635 mm) max. Horizontal: 32 in. (813 mm) max.
Where Bond Pattern Is Not Running Bond		—	Include at minimum single wire joint reinforcement, size W1.7 (MW11) spaced no more than 18 in. (457 mm) o.c. vertically.
Secondhand (Salvaged/Reclaimed) Brick		Building official approval or meet IBC requirements.	Salvaged brick must meet the requirements of new brick.
Hot and Cold Weather Construction and Protection Measures		—	Employ hot/cold weather construction measures when temperature limits are reached (see Technical Note 1).
Material Handling (Initial Rate of Absorption)		—	Wet brick when the field IRA exceeds 30 g per 30 sq in. (19 355 mm ²) per min. or 0.035 ounce per sq in. (1 g/645 mm ²) per min., as determined by ASTM C 67.

Extreme temperatures (above 90 °F [32.2 °C] or below 40 °F [4.4 °C]) have a detrimental effect on the quality of masonry. Recommended construction and protection measures that reduce the effects of hot or cold temperatures are discussed in *Technical Note 1*. For buildings covered by the *IBC*, these measures are mandatory.

Material Installation

Flashing. Flashing subject to deterioration from UV light should be covered by brickwork as soon as possible after installation. Flashing should be installed carefully to prevent punctures or tears. Where several pieces of flashing are required to flash a section of the veneer, the ends of the flashing should be lapped a minimum of 6 in. (152 mm) and sealed so that no gaps are left for water to flow through. Further guidance related to the installation of flashing and weeps can be found in *Technical Note 7B*.

Water-Resistive Barrier. In general, water-resistive barriers should be covered by the brick veneer as soon as possible after installation, as prolonged exposure is more likely to result in damage and reduced performance. Care should be taken to reduce the likelihood of tearing the membrane or breaking the barrier. Such tears or breaks must be corrected prior to installation of brickwork.

Anchors. Anchors must be fastened to the wood frame with corrosion-resistant 8d common nails or fasteners with equivalent pull-out strength. In SDC D and above, the *IRC* requires anchors to be fastened with an 8d ring shank nail, which provides greater pull-out strength. Fasteners should penetrate the sheathing and be driven a minimum of 1½ in. (38 mm) into the studs. The nail attaching a corrugated metal anchor must be located within ½ in. (13 mm) of the bend in the anchor. The best location of the nail is at the bend in the corrugated anchor, and the bend should be 90 degrees.

Anchors should be placed so that the portion within the bed joint is completely surrounded by mortar, they extend a minimum of 1½ in. (38 mm) into the mortar bed, and they have at least ⅝ in. (16 mm) mortar cover to the exposed face.

Mortar. Care should be taken to completely fill all bed and head joints with mortar. Since brick veneer is typically less than 4 in. (102 mm) thick, water penetration through this outer wythe is largely determined by fullness of the mortar joints and compatibility between the brick and mortar. As mentioned in *Technical Note 7B*, clipping the brick ends with a minimal amount of mortar will result in incompletely filled head joints and leaky walls. Full mortar joints increase the resistance to water penetration. Conversely, any location not intended to receive mortar, such as air spaces, weeps and expansion joints, should be kept clean and free of mortar and mortar droppings. The thickness of mortar bed joints should be at least twice that of anchors placed within them.

Mortar joints should be properly tooled to enhance the water resistance of the wall by consolidating the mortar. Joints should be tooled when thumbprint hard with a jointer slightly larger than the joint. Concave, “V” and grapevine mortar joints are the most water resistant, since they do not provide a ledge for water to remain on the brickwork. These joint profiles also firmly compact the mortar against the edges of adjacent brick. Other joints are not recommended because they do not provide the necessary resistance to moisture penetration. Additional construction practices related to minimizing water penetration and recommendations that help to ensure mortar consistency are discussed in *Technical Note 7B*.

Protection of Unfinished Masonry

Protection of unfinished walls is extremely important. The entry of rain or snow into brickwork during construction may increase the potential for efflorescence in the finished wall. Partially completed masonry exposed to rain may become so saturated with water that it may require months after the completion of the building to dry out. To limit water absorption, it is recommended that all brick masonry be protected by covering it at the end of each workday and for shutdown periods. The cover should be a strong, weather-resistant membrane securely attached to and overhanging the brickwork by at least 24 in. (600 mm). As noted above, enhanced protection measures such as wind screens and enclosures may also be necessary in hot or cold weather.

MAINTENANCE

Most brickwork is virtually maintenance free. As with any exterior wall system, periodic observation allows minor issues to be identified and addressed prior to becoming worse. For additional information regarding maintenance, see *Technical Note 46*.

SUMMARY

This *Technical Note* is concerned primarily with the prescriptive design and conventional application of the anchored brick veneer/wood stud wall system in new buildings. This system is a versatile and cost-effective construction option when proper attention is given to design and detailing, material specification, construction and maintenance procedures. Slight differences exist in code requirements for residential and commercial construction, and the selection of materials may vary; however, typical details for wall sections, penetrations, terminations and flashings are the same for both types of construction. Other *Technical Notes* in this series consider brick veneer applied to existing structures, brick veneer with other backing materials and adhered thin brick veneer.

Technical Notes on Brick Construction are recommendations explicitly written for the design, installation and maintenance of masonry using fired clay brick. BIA does not advise the use of these recommendations with other products, including but not limited to those claiming to be similar to fired clay brick products. The information and suggestions contained in this Technical Note are based on the available data and the experience of the 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

For more detailed information on materials, design and construction procedures, the individual publications referred to herein should be consulted:

1. 2009 ASHRAE Handbook - Fundamentals (I-P Edition), American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 2009.
2. "2012 International Building Code," International Code Council, Inc., Country Club Hills, IL, 2012.
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4. ASTM International, *Annual Book of Standards*, West Conshohocken, PA, 2012.
5. Bradley, J.S., and Birta, J.A., "Laboratory Measurements of the Sound Insulation of Building Façade Elements," Institute for Research in Construction, National Research Council of Canada, 2000.
6. "Building America: Resources for Energy Efficient Homes," Energy Efficiency & Renewable Energy Building Technologies Program: Building America, U.S. Department of Energy, March 2012. http://www1.eere.energy.gov/buildings/building_america/index.html.
7. "Introduction to Wall Bracing," APA – The Engineered Wood Association, Tacoma, WA, December 2009.
8. Sabine, H.J., and Lacher, M.B., "Acoustical and Thermal Performance of Exterior Residential Walls, Doors and Windows," National Bureau of Standards (U.S.), Bldg. Sci. Ser. 77, 1975.
9. TMS-0302-07, "Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls," The Masonry Society, Longmont, CO, 2007.
10. TMS 402-11/ACI 530-11/ASCE 5-11, "Building Code Requirements for Masonry Structures," reported by the Masonry Standards Joint Committee, 2011.
11. TMS 602-11/ACI 530.1-11/ASCE 6-11, "Specification for Masonry Structures," reported by the Masonry Standards Joint Committee, 2011.
12. "UL Fire Resistance Directory," Underwriters Laboratories, Northbrook, IL, 2007.