



# Technical Notes on Brick Construction

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## ANCHORED BRICK VENEER WOOD FRAME CONSTRUCTION

**Abstract:** This *Technical Notes* deals with the prescriptive design of brick veneer with wood frame construction in buildings limited to three stories in height 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 included. The minimum requirements given have proven successful for this type of wall construction.

**Key Words:** brick, flashing, foundations, lintels, ties, veneer, weepholes, wood frame.

### INTRODUCTION

Anchored brick veneer construction consists of a nominal 3 in. (75 mm) or 4 in. (100 mm) thick exterior brick wythe anchored to a backing system with metal ties in such a way that a clear air space is provided between the veneer and the backing system. The backing system may be wood frame, steel frame, concrete or masonry. By definition, a veneer wall is a wall having a facing of masonry units, or other weather-resisting, noncombustible materials, securely attached to the backing, but not so bonded as to intentionally exert common action under load. The brick veneer is designed to carry loads due to its own weight, no other loads are to be resisted by the veneer.

For many years brick veneer construction was limited principally to wood frame houses. It is now being used on low-rise commercial and institutional construction and is used frequently for high-rise buildings, especially with concrete masonry or steel stud backing systems. This *Technical Notes* discusses the prescriptive design of brick veneer on wood frame buildings three stories or less in height. Other *Technical Notes* in this series cover brick veneer with different backing systems.

The minimum requirements given in this *Technical Notes* are based on successful past performance of brick veneer anchored to wood frame systems. The proper design, detailing and construction of anchored brick veneer walls ensure that these walls 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 frame systems is achieved with: (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, and (6) good workmanship in construction.

### PROPERTIES OF BRICK VENEER

#### Strength

Factors that affect the strength of brick veneer are the type of brick and mortar used, the span of the veneer and the backing, the stiffness of the backing, and the tie system. Although the brick veneer is not designed to carry lateral load, it does carry a proportionate share. In fact, due to the relatively low stiffnesses normally achieved in wood frame construction, the brick veneer usually carries the majority of any lateral load.

#### Support

With wood framing the brick veneer must carry its own weight and transfer this weight to a noncombustible foundation. The weight of brick veneer should not be supported by wood framing or other types of wood construction. Table 1 contains empirical height limitations for brick veneer and wood frame construction. These limits, which are found in model building codes, are imposed because of the differences in relative stiffnesses of the brick veneer and the wood frame. Further, differences in movement resulting from wood shrinkage and brick expansion are controlled by these limits.

TABLE 1  
Empirical Height Limitations for Brick Veneer

Nominal Thickness of Brick Veneer, in. (mm)	Number of Stories	Height at Plate, ft (m)	Height at Gable, ft (m)
3 (75)	2	20 (6.10)	28 (8.53)
4 (100)	3	30 (9.14)	38 (11.60)

## Fire Resistance

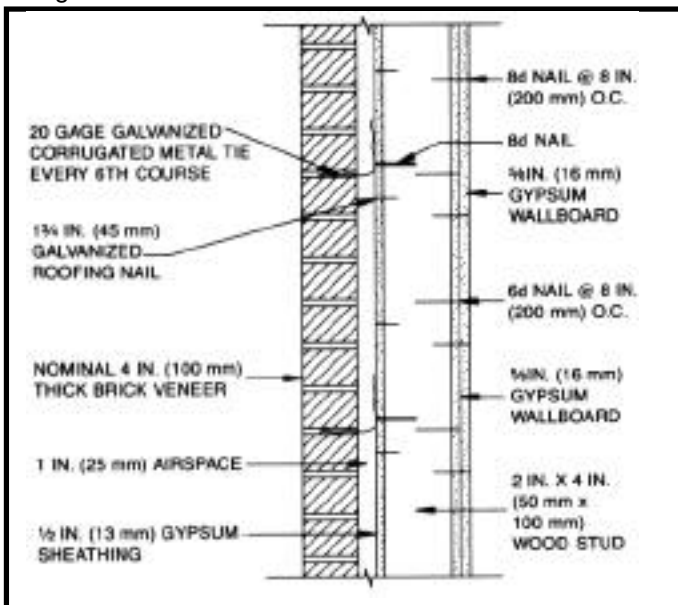
Brick veneer wall assemblies can attain fire ratings of up to 2 hr. Figure 1 shows a brick veneer wall assembly with a 2 hr fire rating. The combustible wood stud must be protected from fire on each side by noncombustible materials which meet the required fire rating. A 4 in. (100 mm) nominal brick wythe provides a 1 hr fire rating.

## Moisture Resistance

Brick veneer wall assemblies are classified as drainage type walls. Walls of this type provide good resistance to rain penetration. It is essential to maintain the clear air space between the brick veneer and the backing to ensure proper drainage. Flashing and weepholes work with the air space to provide moisture penetration resistance. Refer to *Technical Notes 7 Series* for more information. Brick veneer with wood frame backing has historically been built with a 1 in. (25 mm) minimum air space. The protection provided by roof overhangs and the relatively low wall heights aid in reducing water penetration.

## Resistance to Heat Transmission

Brick veneer wall assemblies provide resistance to the transmission of heat and capacity insulation. The overall coefficient of heat transmission, U-value, of these walls can be easily calculated using the procedure given in *Technical Notes 4* or the *ASHRAE Handbook, Fundamentals Volume*. The mass of the brick veneer provides capacity insulation. It effectively lowers and delays the peak heating and cooling loads. The overall U-value obtained for the wall assembly can be adjusted by the capacity insulation correction factor (M factor) given in *Technical Notes 4B*, Fig. 1. This adjustment of the overall U-value will help the designer to more accurately predict the performance of the building envelope. The actual performance of brick masonry buildings shows that this adjustment is very conservative, but it is an improvement over the steady-state assumptions normally used in calculating heat flow.



2 Hr. Fire Rated Brick Veneer Wall Assembly  
FIG. 1

## Acoustical Properties

Brick veneer wall assemblies reduce sound transmission by several means. The mass of the veneer reduces sound transmission by absorbing the energy of the sound vibrations. The discontinuity between the brick veneer and the wood backing prevents vibrations of the exterior brick wythe from directly vibrating the rest of the wall assembly, thereby retarding sound transmission to the interior. Further, a high percentage of the sound is reflected by the brick wythe.

Although there are no specific data available on the sound transmission characteristics of brick veneer wall assemblies, the brick veneer wall system shown in Fig. 1 has an estimated Sound Transmission Class (STC) in excess of 45. See *Technical Notes 5A* for more information on the STC.

## DESIGN AND DETAILS

### Foundations for Brick Veneer

Brick veneer with wood frame backing must transfer the weight of the veneer through the veneer to the foundation. Typical foundation details for brick veneer are shown in Fig. 2. It is recommended that the foundation or foundation wall supporting the brick veneer be at least equal to the total thickness of the brick veneer wall assembly. Many building codes permit a nominal 8 in. (200 mm) foundation wall under single-family dwellings constructed of brick veneer, provided the top of the foundation wall is corbeled as shown in Fig. 2(c). The total projection of the corbel should not exceed 2 in. (50 mm) with individual courses projecting beyond the course below not more than one-third the thickness of the unit nor one-half the height of the unit. The top course of the corbel should not be higher than the bottom of the floor joist and shall be a full header course.

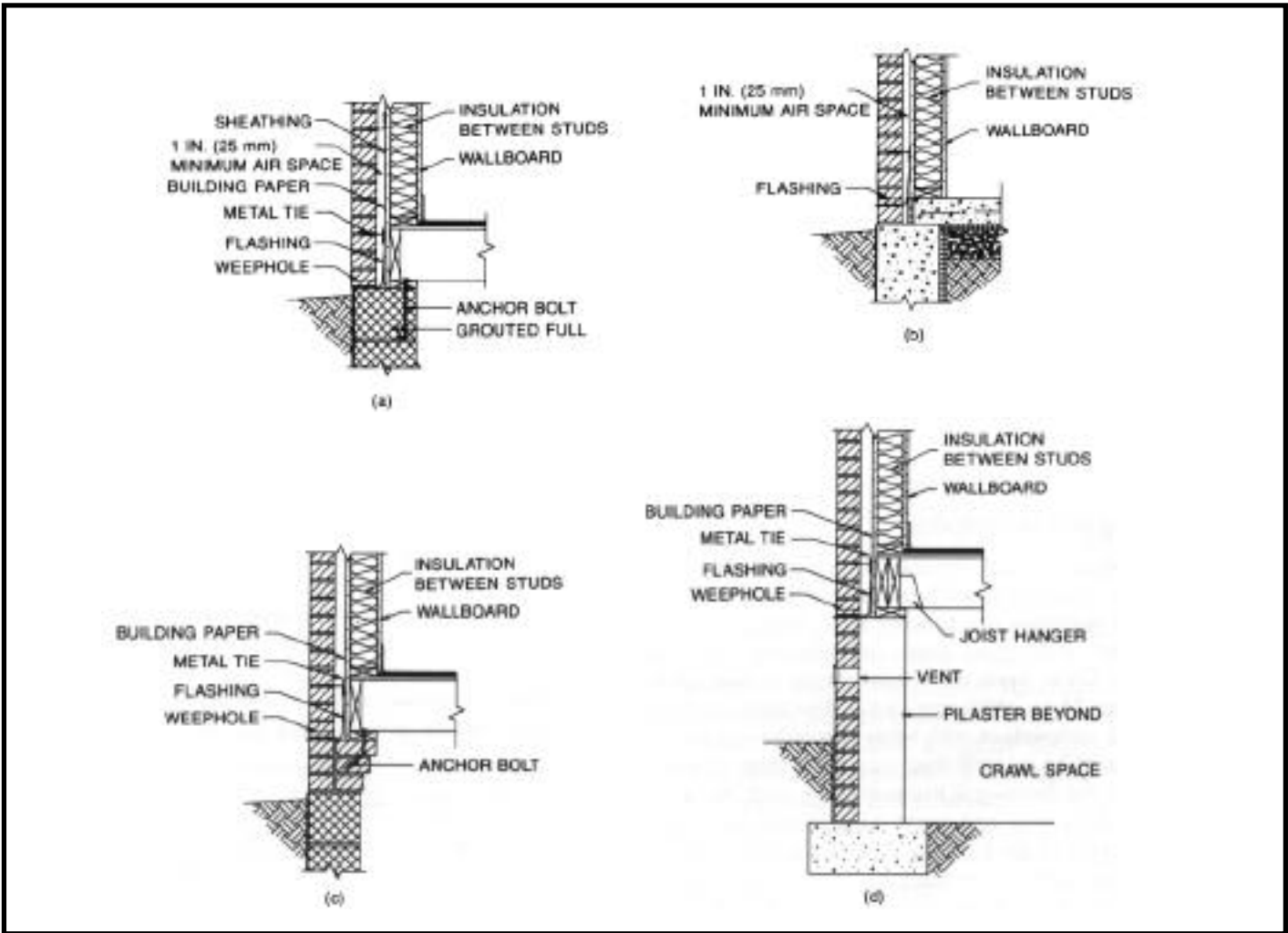
Foundations must extend beneath the frost line as required by the local building code. Design of the foundation should consider differential settlement and the effect of concentrated loads such as those from columns or fireplaces. Appropriate drainage must be provided in order to maintain soil bearing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

Brick walls which enclose crawl spaces must have openings to provide adequate ventilation. Openings should be located to achieve cross ventilation.

### Ties

Ties typically used with wood framing are shown in Fig. 3. There should be one tie for every  $2 \frac{2}{3}$  sq. ft. ( $0.25 \text{ m}^2$ ) of wall area with a maximum spacing of 24 in. (600 mm) o.c. in either direction. The nail attaching a corrugated tie must be located within  $\frac{5}{8}$  in. (16 mm) of the bend in the tie. The best location of the nail is at the bend in the corrugated tie, and the bend should be  $90^\circ$ .

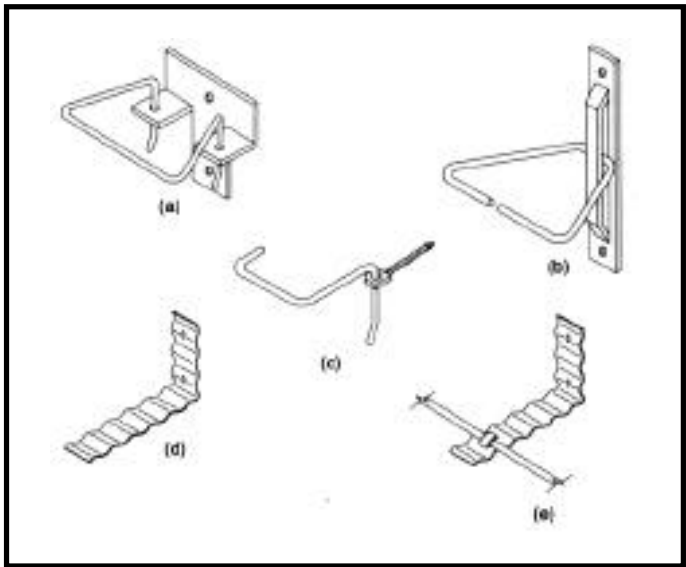
Wire ties must be embedded at least  $\frac{5}{8}$  in. (16 mm) into the bed joint from the air space and must have at least  $\frac{5}{8}$  in. (16 mm) cover of mortar to the exposed face. Corrugated ties must penetrate to at least half the veneer thickness and have at least  $\frac{5}{8}$  in. (16 mm) cover. Ties should be placed so that the portion within the bed joint is completely surrounded by the mortar.



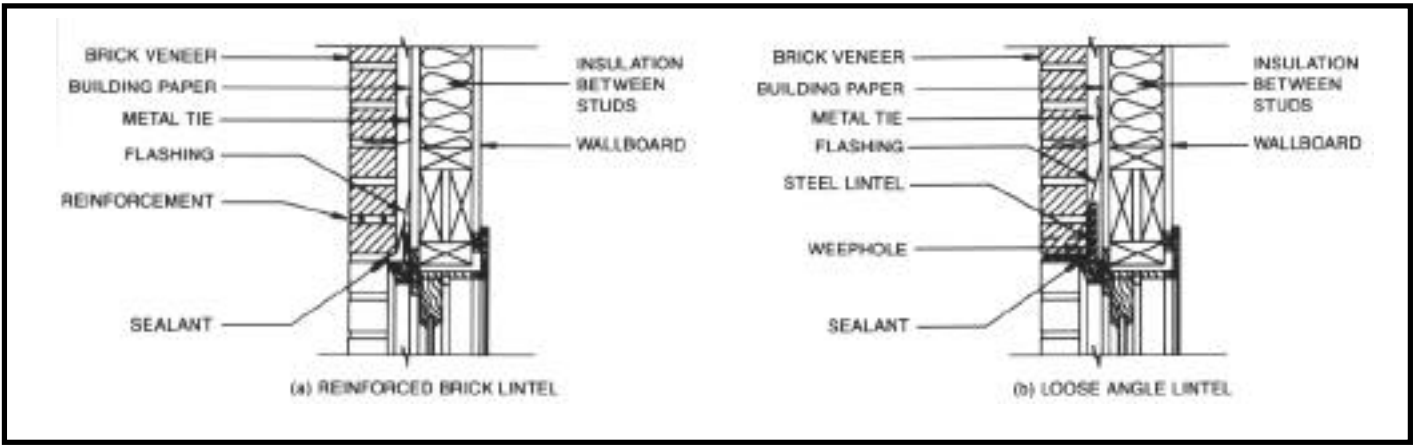
Typical Foundation Details  
FIG. 2

**Flashing and Weepholes**

Flashing and weepholes should be located above and as near to grade as possible at the bottom of the wall, above all openings, and beneath sills. Weepholes must be located in the head joints immediately above all flashing. Clear, open weepholes should be spaced no more than 24 in. (600 mm) o.c. Weepholes formed with wick materials or with tubes should be spaced at a maximum of 16 in. (400 mm) o.c. If the veneer continues below the flashing at the base of the wall, the space between the veneer and the backing should be grouted to the height of the flashing. Flashing should be securely fastened to the backing system and extend through the face of the brick veneer. The flashing should be turned up at least 8 in. (200 mm). Typical flashing details are shown in Figs. 2, 4 and 5. Flashing should be carefully installed 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. (150 mm) and the joints properly sealed. Where the flashing is not continuous, such as over and under openings in the wall, the ends of the flashing should be turned up into the head joint at least 2 in. (50 mm) to form a dam.



Unit Ties  
FIG. 3



Lintel Details  
FIG. 4

### Lintels, Sills and Jamb

Brick veneer backed by wood frame must always be supported by lintels over openings unless the masonry is self-supporting. Lintel design information may be found in *Technical Notes 17H and 31B*. Loose steel, stone or pre-cast lintels should bear at least 4 in. (100 mm) at each jamb. All lintels should have space at the end of the lintel to allow for expansion. The clear span for 1/4 in. (6.3 mm) thick steel angles varies between 5 ft (1.5 m) and a maximum of 8 ft (2.4 m), depending on the size of the angle selected. Steel lintels with spans greater than 8 ft (2.4 m) may require lateral bracing for stability. The maximum clear span may be restricted by the fire protection requirements of some building codes. Concrete, cast stone and stone lintels must be appropriately sized to carry the weight of the veneer.

Reinforced brick lintels are also a viable option. Some of the advantages of reinforced brick lintels are: more efficient use of materials; built-in fireproofing; elimination of differential movement which may occur with steel lintels and brick veneer; and no required painting or other maintenance. Typical residential construction details for a lintel, sill and jamb using wood stud backing are shown in Figs. 4 and 5.

### Eave Details

A typical residential eave detail is shown in Fig. 6. This detail is suggested for the area at the top of the veneer. The air 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.

### Movement Provisions

Design provisions for movement which include bond breaks, expansion joints, and joint reinforcement are not usually required in residential and low-rise brick veneer construction. However, they may be required in specific situations and the designer should analyze the project to determine such need.

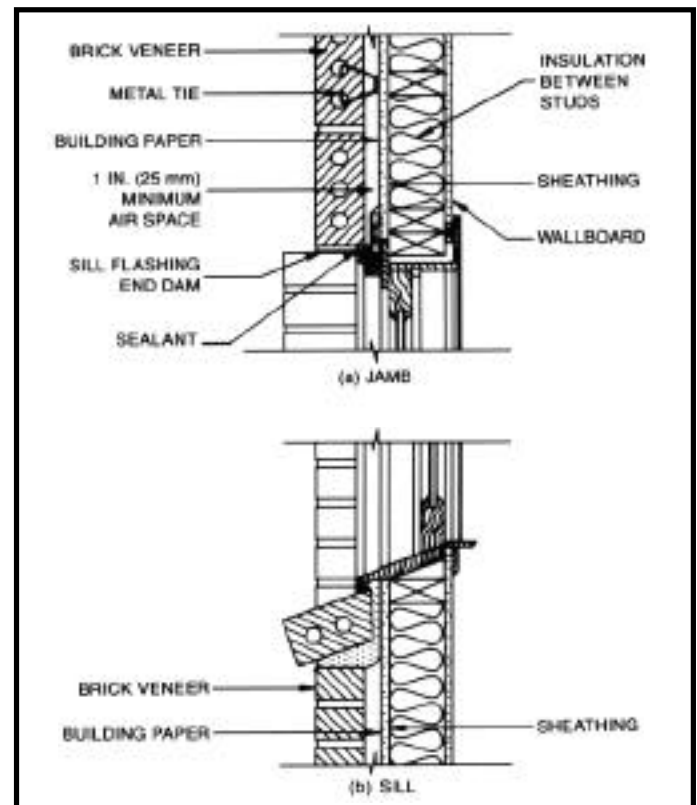
**Bond Breaks.** Significant differential foundation settlement and horizontal movement may cause cracking in walls rigidly attached to the foundation. Bond breaks will

help to relieve the stresses caused by these movements between the wall and the supporting foundation. Flashing at the base of the wall between the veneer and the foundation will provide sufficient break in the bond.

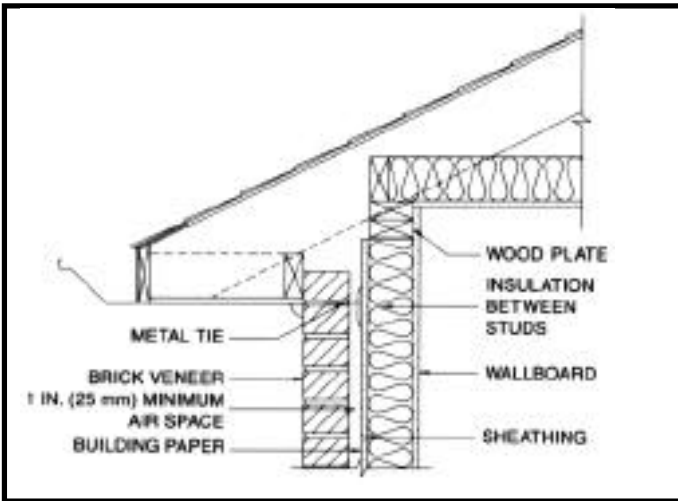
**Expansion Joints.** Expansion joints to allow for horizontal movement may be required in brick veneer when there are long walls, walls with returns or large openings. The placement of expansion joints and the materials used should be in accordance with the information given in *Technical Notes 18 Series*.

### Horizontal Joint Reinforcement

Masonry materials subject to shrinkage stresses, such as concrete masonry, require horizontal joint reinforce-



Jamb and Sill Details  
FIG. 5



Eave Detail  
FIG. 6

ment for control of cracking from such movement. 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 in brick veneer for added strength at the corners of openings and at locations where running bond in the masonry is not maintained.

Horizontal joint reinforcement should be used to add integrity to veneer constructed in locations with intermediate and higher seismic activity or when the units are laid in stack bond. It may be either single or double wire joint reinforcement. The wire should engage the veneer ties as shown in Fig. 3(e) in seismically active areas. When using horizontal joint reinforcement, it *must* be discontinuous at *all* movement joints.

### Sealant Joints

Exterior joints at the perimeter of exterior door and window frames to be filled with sealant should be formed by the adjacent materials or be a reservoir type joint. The joint should be no less than 1/4 in. (6.3 mm) nor more than 1/2 in. (12.7 mm) wide and 1/4 in. (6.3 mm) deep. If wider joints are required, the sealant depth should be one-half of the joint width. A compressible backer rod or sealant bond break tape must be used. Fillet joints are not recommended, but if used, should be at least 1/2 in. (12.7 mm) across the diagonal. Fig. 7 shows typical sealant joints. These joints should be solidly filled with an elastic sealant forced into place with a pressure gun. All joints should be properly prepared before placing sealants. Appropriate primers should be applied as necessary. Expansion joints must be clear of all material for the thickness of the veneer wythe and closed with a backer rod and sealant.

## SELECTION OF MATERIALS

### Brick

Brick should conform to ASTM C 62, C 216 or C 652 for Building Brick, Facing Brick and Hollow Brick, respectively. Grade SW is required where high and uniform resistance to damage caused by cyclic freezing is desired

and where the brick may be frozen 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.

The brick selected should have an average initial rate of absorption (suction) of not more than 30 grams per 30 in.2 (1.5 kg/m<sup>2</sup>) per minute at the time of laying. Units having average initial rates of absorption exceeding this value may be wetted immediately before they are laid. Alternately, the units may be wetted thoroughly 3 to 24 hours prior to their use so as to allow moisture to become distributed throughout the unit. With either method the units should be surface dry when laid.

*The use of salvaged brick is not recommended.* In general, masonry constructed with salvaged brick contains some weaker and less durable units than masonry constructed with new brick. Salvaged brick and the reasons against its use are discussed in detail in *Technical Notes 15*.

### Mortars

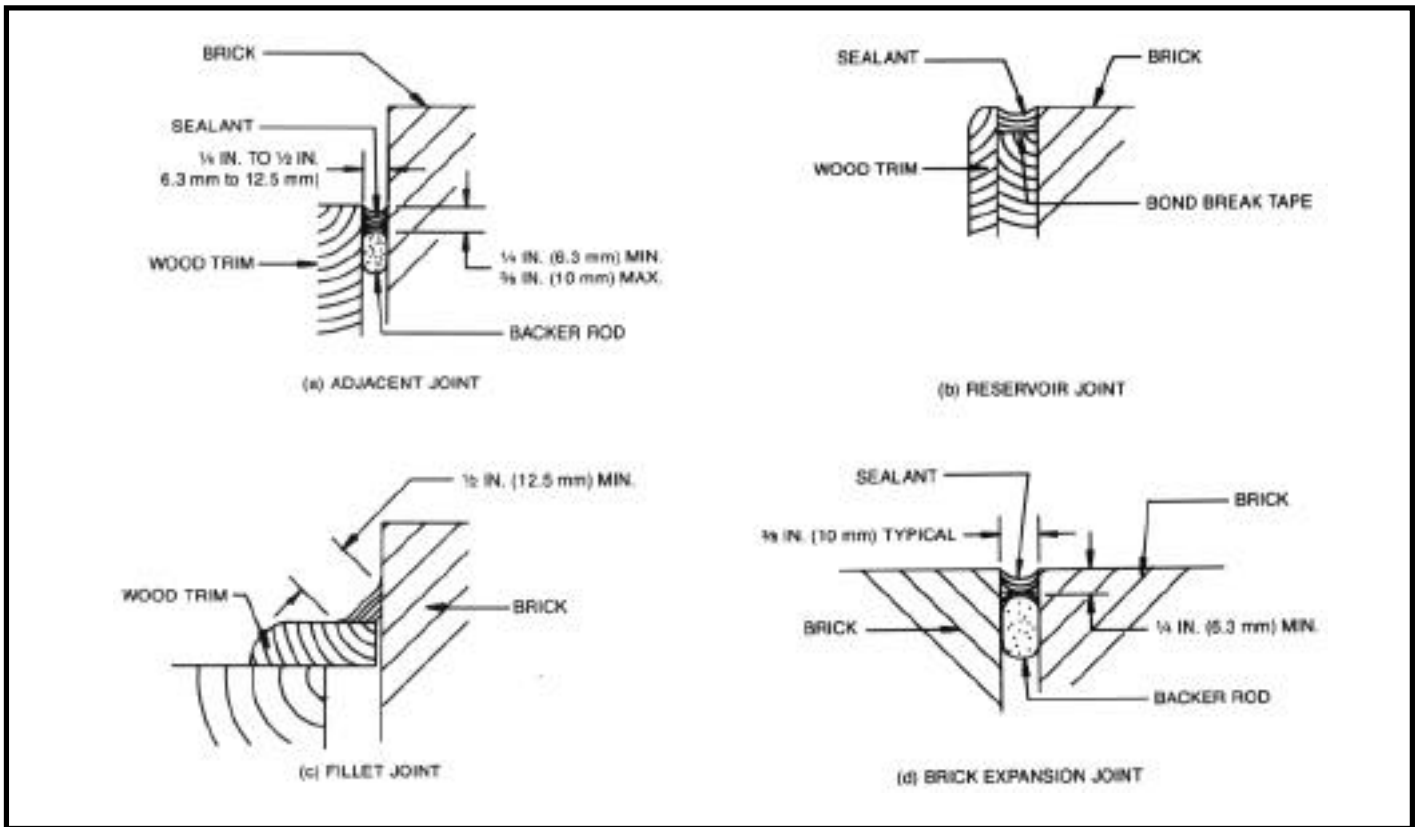
Mortar materials should comply with the requirements of ASTM C 270 Standard Specification for Mortar for Unit Masonry. Two types of cementitious materials are permitted: portland cement-lime and masonry cement. portland cement-lime mortars made with non-air-entrained materials have greater strength than those made with air-entrained materials and masonry cement. Proprietary mortar mixes, masonry cements, are widely used because of their convenience and good workability. Masonry cements usually contain portland cement, ground limestone and additives which provide workability, water retentivity and air entrainment. See *Technical Notes 8* for information on both portland cement-lime mortars and masonry cement mortars.

Type N mortar is suitable for most brick veneer although Type S or Type M may be used. Type S mortar is recommended where a high degree of flexural resistance is required and may be required in areas of high seismic activity. Type M is recommended where the brick veneer is in contact with earth. For further information on the selection of mortar see *Technical Notes 8B*.

### Ties

Brick veneer with wood frame backing is supported on the foundation with lateral support provided by the ties and backing system. The ties must be capable of resisting tension and compression resulting from forces perpendicular to the plane of the wall. More information on wall ties is found in *Technical Notes 44B*.

Corrugated steel ties, at least 22 gage, 7/8 in. (22 mm) wide, 6 in. (150 mm) long, as shown in Fig. 3(d) have historically been used to attach brick veneer to wood frame backing. However, corrugated metal ties are more susceptible to corrosion than wire ties. Adjustable ties provide better load transfer and permit differential movement in taller structures. Wire for such ties is either wire gage W1.7, 9 gage, or wire gage W2.8, 3/16 in. (4.8 mm) diameter. Wire ties should be fabricated from wire conforming



Sealant Joints  
FIG. 7

to ASTM A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement. Plate portions of adjustable ties are normally 14 gage in thickness. Steel used to fabricate plate portions and corrugated ties should conform to ASTM A 366 Standard Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

All tie components must be corrosion resistant. Zinc coating on steel must be at least 1.5 oz per square foot ( $458 \text{ g/m}^2$ ). This corresponds to ASTM A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, Class B-2.

Ties are usually fastened to the wood frame with corrosion-resistant nails that penetrate the sheathing and are driven a minimum of 1 1/2 in. (38 mm) into the studs.

### Flashing and Weepholes

There are many types of flashing available which are suitable for use in brick veneer walls. Sheet metals, plastics, laminates or combinations of these have been used successfully. Plastic flashing should be at least 30 mil thick. Asphalt impregnated felt (building paper) or an air-infiltration barrier is *not* acceptable for use as flashing. These materials serve other purposes in the wall assembly. Building paper is applied as a moisture barrier to the sheathing. Air-infiltration barriers function as their name implies and may also serve as a moisture barrier.

Selection of flashing is often determined by cost; however, it is recommended that only superior materials be used, as replacement in the event of failure is exceedingly expensive.

Weepholes can be made in several ways. Some of the most common ways are leaving head joints open, using removable oiled ropes or rods, using plastic or metal tubes, or using rope wicks. There are also plastic or metal vents which are installed in lieu of mortar in a head joint. Clear openings without obstructions produce the best weepholes. For further discussion on flashing and weepholes see *Technical Notes 7A*.

### Horizontal Joint Reinforcement

Horizontal joint reinforcement should be fabricated from wire conforming to ASTM A 82. It should have a corrosion-resistant coating which conforms to ASTM A 153, Class B-2.

### Lintel Materials

Lintels may be reinforced brick masonry, reinforced concrete, stone or steel angles. Reinforcement for reinforced brick masonry lintels should be steel bars manufactured in accordance with ASTM A 615, A 616 or A 617, 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.

Steel for lintels should conform to ASTM A 36 Standard Specification for Structural Steel. Steel angle lintels should be at least 1/4 in. (6.3 mm) thick with a horizontal leg of at least 3 1/2 in. (89 mm) for use with nominal 4 in. (100 mm) thick brick veneer, and 3 in. (75 mm) for use with nominal 3 in. (75 mm) thick brick veneer. Steel lintels should be painted before installation.

## Sealants

There are numerous types of sealants available that are suitable for use with brick veneer. The material selected should be flexible and durable. 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. Oil-based caulking compounds are *not* recommended since most lack the desired flexibility and durability, see *Technical Notes 7A*. Regardless of the type of sealant chosen, proper primers and backer rods must be selected. Follow the recommendations of the sealant manufacturer.

## CONSTRUCTION

### Protection of Materials

**Masonry.** Prior to and during construction, all materials should be stored off of the ground to prevent contamination by mud, dust or other materials likely to cause stains or defects. The masonry materials should also be covered for protection against the elements.

To limit water absorption, it is recommended that all brick masonry be protected by covering 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). 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. This saturation may cause prolonged efflorescence. See *Technical Notes 23 Series* for more information.

**Flashing.** Flashing materials should be stored in places where they will not be punctured or damaged. Plastic and asphalt coated flashing materials should not be stored in areas exposed to sunlight. Ultraviolet rays from the sun break down these materials, causing them to become brittle with time. Plastic flashing exposed to the weather at the site for months before installation should not be used. During installation, flashing must be pliable so that no cracks occur at corners or bends.

### Workmanship

Good workmanship is as essential in constructing brick veneer as it is in all types of brick masonry construction. All joints intended to receive mortar, including head joints with hollow brick, should be completely filled. Joints or spaces not intended to receive mortar should be kept clean and free of droppings. Courses of brick laid on foundations or lintels must have at least two-thirds of the brick thickness on the support.

The joints should be tooled with a jointer as soon as the mortar has become thumbprint hard. The types of joints recommended for exterior use with brick veneer are concave, "V" and grapevine. These joints firmly compact the mortar against the edges of the adjoining brick. Other joints are not recommended because they do not provide the necessary resistance to moisture penetration. See *Technical Notes 7B Revised* for further information.

It is essential when constructing brick veneer, to keep

the 1 in. (25.4 mm) minimum air space between the veneer and the backing clean and free of all mortar droppings, so that the wall assembly will perform as a drainage wall. If mortar blocks the air space, it may provide a bridge for water to travel to the interior. In addition, all flashing, weepholes, ties and other accessories must be properly installed and kept clean.

## SUMMARY

This *Technical Notes* is concerned primarily with the prescriptive design and conventional applications of anchored brick veneer in new wood frame buildings limited to three stories in height. Other *Technical Notes* in this series consider brick veneer applied to existing structures, brick veneer with different backing materials for mid- and high-rise structures, and adhered thin brick veneer.

The information and suggestions contained in this *Technical Notes* are based on the available data and the experience of the engineering staff of the Brick Institute of America. The information and recommendations contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry and related construction materials. Final decisions on the use of the information contained in this *Technical Notes* are not within the purview of the Brick Institute of America, and must rest with the project architect, engineer, owner or all.

## REFERENCES

For more detailed information on materials, design and construction procedures, the individual *Technical Notes* referred to herein should be consulted.