Technical Notes on Brick Construction

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MOISTURE RESISTANCE OF BRICK MASONRY MAINTENANCE

Abstract: Even though one of the major advantages of brick masonry construction is durability, periodic inspections and maintenance can extend the life of brickwork in structures. This *Technical Notes* addresses the use of suggested inspection programs and specific maintenance procedures. Information is presented on remedial cleaning and various repair methods. Included in the latter category is the replacement of sealant joints, grouting of mortar joint faces, tuck-pointing of mortar joints, removal of plant growth, maintenance and repair of weepholes, replacement of brick units, installation of a dampproof course, as well as the installation of flashing in existing walls.

Key Words: cleaning, **dampproof course**, efflorescence, flashing, grout, **inspection**, **maintenance**, **moisture penetration**, mortar, sealant, **tuck-pointing**, weepholes.

INTRODUCTION

This is the seventh *Technical Notes* in this series addressing moisture control in brick masonry. In this *Technical Notes*, maintenance of brick masonry to counteract moisture penetration is discussed. Generally, if brickwork is properly designed, detailed and constructed, it is very durable and requires little maintenance. However, many of the other components incorporated in the brickwork, i.e., caps, copings, sills, lintels, sealant joints, etc., may require periodic inspection and repair.

Maintenance of buildings may be broken into two general categories: 1) general inspection and maintenance to prolong the life and usefulness of a building; and 2) specific maintenance to identify and correct problems which may develop. This *Technical Notes* addresses both general and specific maintenance procedures. A checklist is provided for general inspections and specific repair techniques are described.

GENERAL INSPECTION

A good, thorough inspection and maintenance program is often inexpensive to initiate and may prove advantageous in extending the life of a building. It is a good idea to become familiar with the materials used on a building and how they perform over a given time period. Table 1 lists various building materials and their estimated life expectancies with normal weathering.

It is suggested that periodic inspections be performed to determine the condition of the various materials used on a building. These inspections can be set for any given time period, i.e., weekly, monthly, yearly, etc. A suggested inspection period is "seasonal" so that the behavior of building materials in various weather conditions can be noted. Inspection records, including conditions and comments, should be kept to determine future "trouble spots", problems and needed repair. The checklist in Table 2 is not all-inclusive; however, it may establish a guideline for use during inspections.

SPECIFIC MAINTENANCE

General

Problems resulting from moisture penetration may include: efflorescence, spalling, deteriorating mortar joints, interior moisture damage, etc. Once one or more of these conditions becomes evident, the direct source of moisture penetration should be determined and action taken to correct both the visible effect and the moisture penetration source. Table 3 lists various problems appearing on brickwork due to moisture and the most probable source of moisture penetration. The items checked in the table

TABLE 1
Estimated Life Expectancy of Materials Exposed to Normal Weathering

Material	Use	Estimated Life Years
Brick	Walls	100 or more
Caulking	Sealer	8-10
Metal	Coping/Flashing	20-40
Mortar	Walls	25 or more
Plastic	Flashing	25 or more
Finishes		
Paint	Waterproofing	3-5
Plaster	Waterproofing	3-5
Sealers	Dampproofing	1-5
Silicone	Dampproofing	1-5
Stucco	Waterproofing	3-5
Waxes	Waterproofing	1-5

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TABLE 2
Brick Masonry Inspection Checklist

MASONRY WALLS	NORTH	SOUTH	EAST	WEST
Above Grade				
Masonry				
Cracked Units				
Efflorescence				
Loose Units				
Missing/Clogged Weepholes				
Deteriorated Mortar Joints				
Plant Growth				
Deteriorated/Torn Sealants				
Out-of-Plumb				
Spalled Units				
Stains				
Water Penetration				
Flashing/Counterflashing				
Bent				
Missing				
Open Lap Joints				
Stains				
Caps/Copings				
Cracked Units				
Drips Needed				
Loose Joints				
Open Joints				
Out-of-Plumb				
Below Grade				
Foundation Walls				
Cracks				
Deteriorated Mortar Joints				
Inadequate Drainage				
Differential Movement				
Water Penetration				
Retaining Walls				
Cracked Units				
Decayed Mortar Joints				
Damp				
Inadequate Drainage				
Out-of-Plumb				
Spalled Units				

represent each source that should be considered when such problems occur in brick masonry.

After investigating all of the possible moisture penetration sources, the actual source may be determined through the process of elimination. Many times the source will be self-evident as in the cases of deteriorated and missing materials; however, in instances such as improper flashing, differential movement, etc., the source may be hidden and determined only through some type of building diagnostics. In any case, it is suggested to first visually inspect for the self-evident source before retaining a consultant as it may save time and money in the detection of the moisture penetration source.

Once the source is determined, measures can then be taken to effectively remedy the moisture penetration source and its effects on the brickwork. This *Technical Notes* discusses suggested techniques for the reduction of moisture penetration.

Remedial Cleaning

Moisture penetration is a contributing factor to the formation of efflorescence (see *Technical Notes* 23 Series). Generally, efflorescence is easily removed by natural weathering or by scrubbing with a brush and water. In some cases, acid may be used to remove stubborn efflorescence (see *Technical Notes* 20 Revised). Improper acid cleaning, i.e., absence of pre-wetting, insufficient rinsing and strong acid concentrations, may be a cause of further moisture penetration in brick masonry. Cement is soluble in hydrochloric acid (muriatic acid); therefore, if any hydrochloric acid remains on the brickwork, the mortar joints may become etched and/or deteriorated. This

TABLE 3
Possible Effects and Sources of Moisture Penetration

Effects of Moisture Penetration / Sources of Moisture Penetration	Previous Acid Cleaning *See Technical Notes 20 Revised*	Previous Sandblasting *See Technical Notes 20 Revised*	Plant Growth	Deteriorated Sealants/Caulks	Missing/Clogged Weepholes *See Technical Notes 21B*	Incompletely Filled Mortar Joints *See Technical Notes 7B Revised*	Capillary Rise	Broken/Loose Units	Differential Movement *See Technical Notes 18 Series*	Missing Flashing *See Technical Notes 7 Series*
Efflorescence See TN 23 Series	√		√	√	√	√	√	√		√
Deteriorated Mortar	√	√	√			√	√	√		
Spalled Units		√		√	√	√	√		√	√
Cracked Units				√	√	√	√		√	√
Rising Moisture					√		√			√
Corrosion of Back-up Materials	√			√	√	√	√	√	√	√
Mildew/Algae Growth	√			√	√	√	√	√	√	√
Damaged Interior Finishes	√			√	√	√	√	√	√	√

situation becomes evident by the formation of one of two types of efflorescence which are not water-soluble. One type is a white efflorescence, composed of either sodium chloride or potassium chloride. The other is a white or grayish haze, referred to as "white scum", composed of silicic acid or other silica compounds. Each of these two types of efflorescence has unique removal solutions.

The first case, where sodium chloride or potassium chloride is formed, can be corrected by applying a solution of sodium hydroxide and water to the dry wall. The solution should consist of 12 oz (350 ml) sodium hydroxide to 1 qt (950 ml) water. The solution should be allowed to dry on the wall. The sodium hydroxide will penetrate the wall surface and neutralize the remaining hydrochloric acid. The wall will effloresce heavily upon drying. These new water-soluble salt deposits can be removed by natural weathering or by scrubbing with a brush and water.

If "white scum" has formed on the wall, the methods of removal as discussed in *Technical Notes* 20 Revised may be effective. Table 4 summarizes the removal methods presented in *Technical Notes* 20 Revised.

After cleaning, the mortar joints should be inspected. Tuck-pointing of the joints, as discussed later in this *Technical Notes*, may be necessary. It should be noted that these and all cleaning procedures should first be tried in an inconspicuous area at different concentrations and judged on effectiveness.

Repair Methods

Sealant Replacement. Missing or deteriorated caulking and sealants in contact areas between brickwork and other materials, i.e., window and door frames, expansion joints, etc., may be a source of moisture penetration. The sealant joints in these areas should be inspected. If the sealant is missing, a full bead of high-quality, permanently elastic sealant compound should be placed in the open joints. If a sealant material was installed, but has torn, deteriorated or lost elasticity, it should be carefully cut out. The opening must be clean of all old sealant material. A new sealant should then be placed in the clean joint. All joints should be properly primed before the new sealant material is applied. A backer rope material should be placed in all joints deeper than 3/4 in. (19 mm) or wider than 3/8 in. (10 mm).

Grouting of Mortar Joints. If the mortar joints develop small "hairline" cracks, surface grouting may be an effective measure in sealing them. One recommended grout mixture is 1 part portland cement, 1/3 part hydrated lime and 1 1/3 parts fine sand (passing a No. 30 sieve). The joints to be grouted should be dampened. To ensure good bond, the brickwork must absorb all surface water. Clean water is added to the dry ingredients to obtain a fluid consistency. The grout mixture should be applied to the joints with a stiff fiber brush to force the grout into the cracks. Two coats are usually required to effectively reduce moisture penetration. Tooling the joints after the grout application may help compact and force the grout into the cracks. The use of a template or masking tape

TABLE 4
Suggested Solutions to Remove White Scum

SOLUTION	CONCENTRATION	APPLICATION	REMARKS
Proprietary	As Recommended	As Recommended	Consult mfr.
Masking			
A. Linseed Oil & Varsol	10-25% linseed oil	Brush on Allow to Dry	May darken light-colored brick
B. Paraffin Oil & Varsol	2-50% paraffin oil	Brush on Allow to Dry	

may prove effective in keeping the brick faces clean.

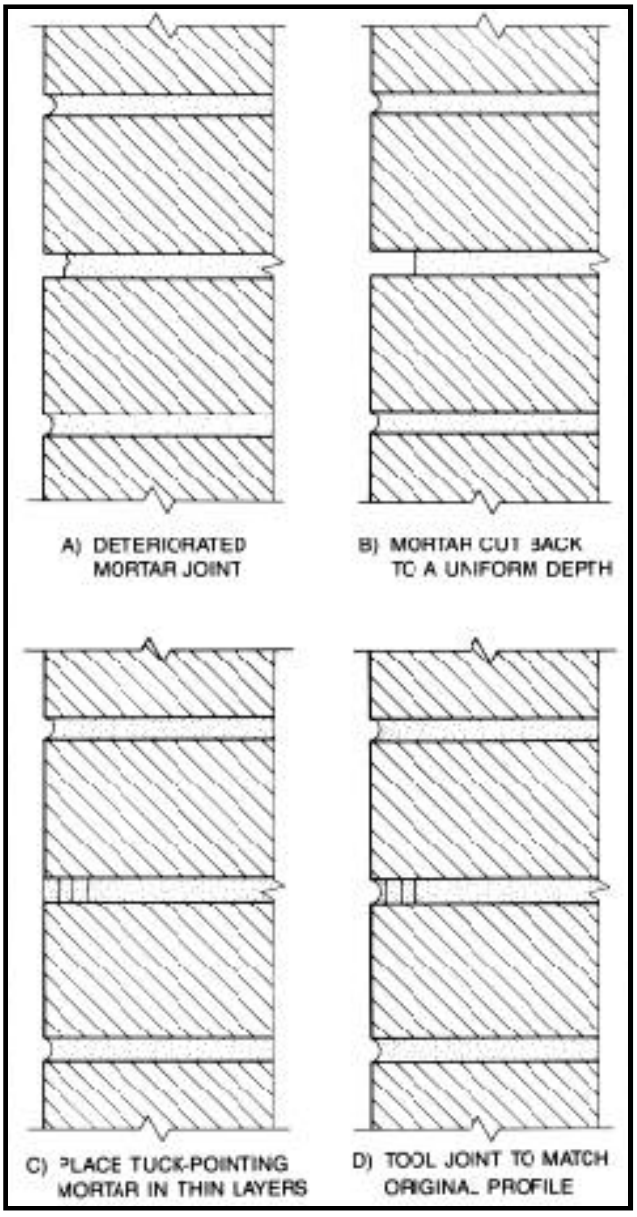
Tuck-pointing Mortar Joints. Moisture may penetrate mortar which has softened, deteriorated or developed visible cracks. When this is the case, tuck-pointing may be necessary to reduce moisture penetration. Tuck-pointing is a process of cutting out old mortar to a uniform depth and placing new mortar in the joint (see Figure 1).

Prior to undertaking a tuck-pointing project, the following should be considered: 1) Whether or not to use power tools for cutting out old mortar. The use of power tools may damage the brick units surrounding the mortar being cut out. 2) Any tuck-pointing operation should only be done by a qualified and experienced tuck-pointing craftsman. An individual who is an excellent mason/bricklayer may *not* be a good tuck-pointing craftsman. Skills should be tested and evaluated prior to the selection of the craftsman. 3) For tuck-pointing for historic preservation purposes, refer to ENGINEERING AND RESEARCH DIGEST on "Repointing (Tuck-Pointing) Brick Masonry", Brick Institute of America, August 1993.

The old mortar should be cut out, by means of a toothing chisel or a special pointer's grinder, to a uniform depth of 3/4 in., or until sound mortar is reached (see Fig. 1B). Care must be taken not to damage the brick edges. All dust and debris must be removed from the joint by brushing, blowing with air or rinsing with water.

Tuck-pointing mortar should be carefully selected and properly proportioned. For best results, the original mortar proportions should be duplicated. If this is not possible, Types N or O mortar should be used, as mortars with higher cement contents may not properly bond to the original mortar. Table 5 lists the proper proportions for Types N and O mortars.

The tuck-pointing mortar should be pre-hydrated to reduce excessive shrinkage. The proper pre-hydration process is as follows: All dry ingredi - ents should be thoroughly mixed. Only enough clean water should be added to the dry mix to produce a damp, workable consistency which will retain its shape when formed into a ball. The mortar should stand in this dampened condition for 1 to 1 1/2 hr.



Tuck-Pointing Mortar Joints
FIG.1

TABLE 5
Mixing Proportions for Types N and O Mortar

Mortar Type	Parts by Volume Portland Cement	Type S Hydrated Lime	Aggregate, Measured in a Damp, Loose Condition
N	1	1	4-1/2 to 6
O	1	2	6-3/4 to 9

The joints to be tuck-pointed should be dampened, but to ensure a good bond, the brickwork must absorb all surface water. Water should be added to the pre-hydrated mortar to bring it to a workable consistency (somewhat drier than conventional mortar). The mortar should be packed tightly into the joints in thin layers (1/4 in. [6 mm] maximum). Each layer should become "thumbprint hard" before applying the next layer (see Fig. 1C). The joints should be tooled to match the original profile after the last layer of mortar is "thumbprint" hard (see Fig. 1D). As it may be difficult to determine which joints allow moisture to penetrate, it is advisable to tuck-point all mortar joints in the affected wall area.

Ivy Removal. Ivy growth may be a contributing factor to moisture penetration. Ivy shoots, sometimes referred to as "suckers", penetrate voids in mortar and may conduct moisture into these voids. If this is the case, ivy removal may be necessary.

To effectively remove ivy, the vines should be carefully cut away from the wall. The vines should never be pulled from the wall as this could damage the brickwork. After cutting, the shoots will remain. These suckers should be left in the wall until they dry up and die. This usually takes from 2 to 3 weeks. Care should be taken not to allow the suckers to rot and oxidize as this could make them difficult to remove. Once the shoots die, the wall should be dampened and scrubbed with a stiff fiber brush and water. Laundry detergent or weed killer may be added to the water in small concentrations to aid in the removal of the shoots. If these additives are used, the wall must be thoroughly rinsed with clean water after scrubbing.

TABLE 6
Recommended Spacing of Weepholes

WEEPHOLE	RECOMMENDED MAXIMUM SPACING (Center to Center)
Wick Material	16 in.
Open Head Joints	24 in.
Other:	
Inserts	24 in.
Tubes	
Oiled Rods (removable)	

It is suggested that a small portion of the ivy (5-10 sq ft [0.5 to 1.0 m^2]) be removed from an inconspicuous area first to determine how the masonry wall will appear once the ivy is removed. Tuck-pointing of the mortar joints may be necessary if the mortar has cracked or deteriorated.

Opening Weepholes. In some instances, moisture may penetrate walls but is unable to escape to the exterior. If this is the case, the weepholes should be inspected to determine if they are clogged or insufficiently spaced. If the weepholes are clogged, they can be cleaned out by probing with a thin wood dowel, or stiff wire. If the weepholes were not properly spaced, drilling new weepholes may be necessary. *Technical Notes* 21B outlines suggested types and spacing of weepholes. Table 6 is a summary of the recommended spacing requirements included in *Technical Notes* 21B.

It should be noted that weepholes are placed directly above flashing; therefore, care must be exercised not to damage the flashing whenever probing or drilling. The use of a stopper to limit the depth of penetration of the probe or drill bit may be effective in reducing the possibility of damaging the flashing.

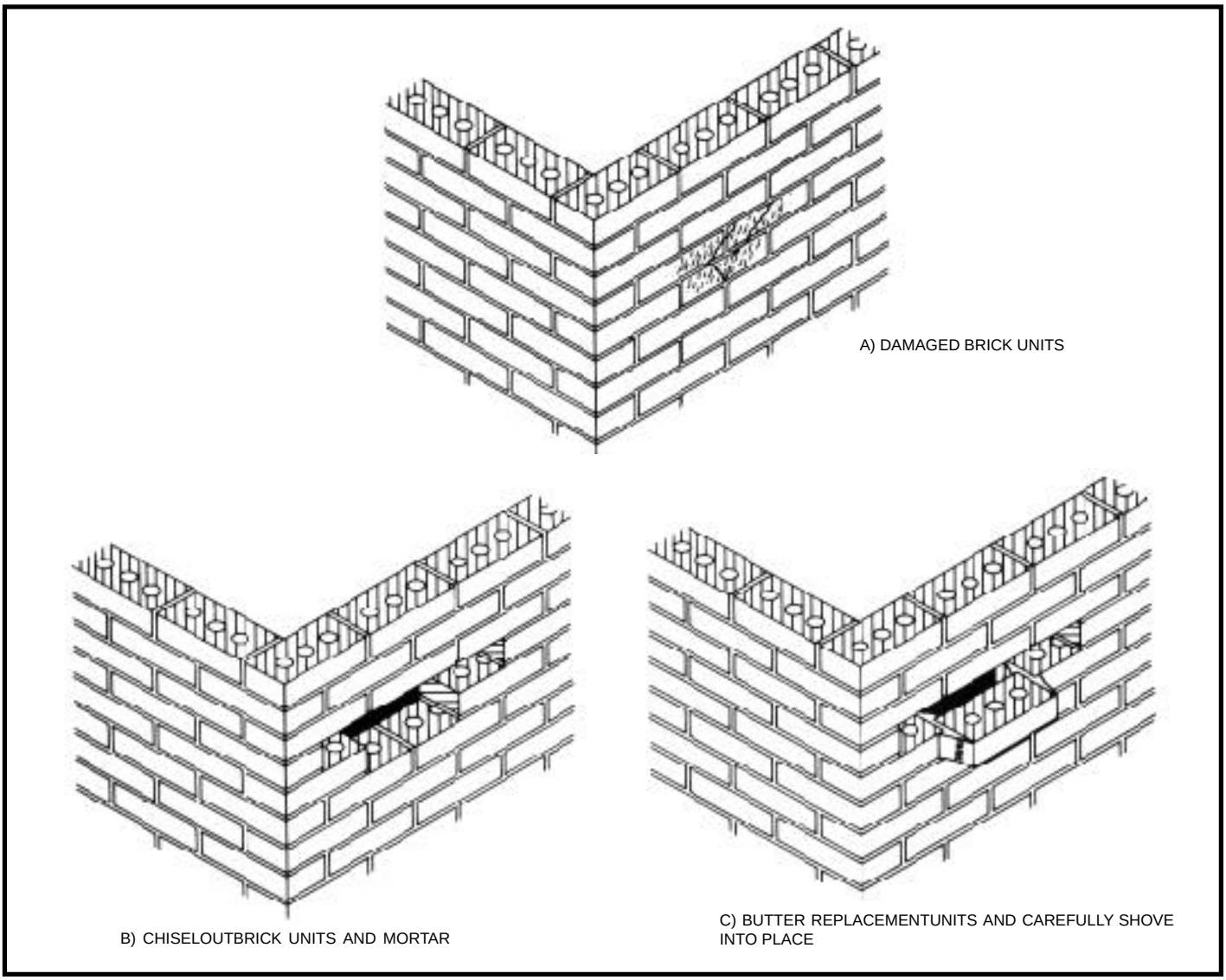
Replacement of Brick Units. Moisture may penetrate brick units which are broken or heavily spalled. When this occurs, replacement of the affected units may be necessary. The following procedure is suggested for the removal and replacement of masonry units (see Fig. 2).

A tuck-pointer's toothing chisel should be used to cut out the mortar which surrounds the affected units. For ease of removal, the units to be removed can be broken. Once the units are removed, all of the old mortar should be carefully chiseled out, and all dust and debris should be swept out with a brush (see Fig. 2B). If the units are located in the exterior wythe of a cavity wall, care must be exercised not to allow debris to fall into the cavity.

The brick surfaces in the wall should be dampened before new units are placed, but the masonry should absorb all surface moisture to ensure a good bond. The appropriate surfaces of the surrounding brickwork and the replacement brick should be buttered with mortar. The replacement brick should be centered in the opening and pressed into position (see Fig. 2C). The excess mortar should be removed with a trowel. Pointing around the replacement brick will help to ensure full head and bed joints. When the mortar becomes "thumbprint" hard, the joints should be tooled to match the original profile.

Installation of a Dampproof Course. Moisture may migrate upward through brickwork by capillary action. This condition appears as a rising water line or "tide mark" on the wall.

All building codes require the use of a dampproofing material on below-grade masonry walls. If this was omitted or improperly installed, the insertion of a dampproof course at a level above the ground, but below the first floor, may stop the rising moisture. The installation procedure can take one of two forms. One form is the injection



Replacement of Brick Units
FIG. 2

of a chemical dampproof course directly into the masonry wall. Holes are drilled into the masonry into which a synthetic material is inserted. Through a process based on electro-osmosis, the synthetic material forms a continuous dampproof barrier at this level. The other form of installation is the removal of an entire brick course. A dampproof material, i.e., plastic, metal or flashing is inserted, and the brick course is replaced. The brick should be replaced as described in the preceding section.

Installation of Flashing. Flashing, which has been omitted, damaged or improperly installed, may permit moisture to penetrate to the building interior. If this is the case, a costly procedure of removing brick units, installing flashing and replacing the units may be required. See *Technical Notes* 7 Revised.

To install continuous flashing in existing walls, alternate sections of masonry in 5 to 10 ft (1.5 to 3 m) lengths should be removed. The flashing is installed in these sections and the masonry is replaced. The replaced masonry should be properly aged (5 to 7 days) before the intermediate masonry sections are removed. The flashing can then be placed in these sections. The lengths of flashing should be lapped a minimum of 6 in. (150 mm) and be completely sealed to function properly. The masonry is then replaced.

A Method of Installing Continuous Flashing in Existing Walls
FIG. 3

SUMMARY

This *Technical Notes* has presented maintenance procedures to reduce moisture penetration in brick masonry. It is suggested that routine inspections of the building be carried out to determine where future "trouble spots" may occur. Once a problem resulting from moisture penetration occurs, the actual source of moisture should be determined and corrected before any repairs are initiated. Many moisture control procedures have been presented; however, all buildings are unique and may experience individual problems. No one solution will remedy similar problems on different buildings. It is therefore suggested that a repair method which will effectively suit the particular needs of a building be selected when a problem occurs.

The information contained in this *Technical Notes* is based on the available data and experience of the technical staff of the Brick Institute of America. This information should be recognized as recommendations which, if followed with good judgment, should result in masonry walls that are resistant to moisture penetration. Final decisions on the use of this information are not within the purview of the Brick Institute of America, and must rest with the project designer, owner or both.

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