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Solving Glazed Brick Deterioration Problems

Arthur L. Sanders

For more than a century, glazed brick has offered architects and building owners a pleasing alternative to the traditional red brick of New England architecture, without losing the textural and structural qualities of brick itself. Some of our most recognizable architectural icons use glazed brick as a distinctive design element. Just imagine the Chrysler building without its speckled grey and white glazed brick facade.

Glazed brick is an essential element of the Chrysler building's distinctive facade.

Structurally sound and highly durable with its water-impermeable face, glazed brick can be a relatively low-maintenance building material, if properly maintained.

Of course, no building material is impervious to the ravages of time and deterioration; improper construction and poor maintenance will only speed up the inevitable decay. In fact, proper installation and maintenance of glazed brick is even more critical than with other building materials. Even minor deterioration is of great concern. That's because the same glazed face that keeps water from getting in also prevents it from getting out. That is a big problem if water has penetrated through the joints into the brick itself. The effects of expansion from moisture penetration and freeze-thaw cycles, coupled with normal thermal expansion, can be highly destructive to glazed brick facades. (Please see the related sidebar, "The Expansion Factor," on page 8.)

As Project Manager and Group Leader, Arthur L. Sanders oversees masonry, curtain wall, and roofing rehabilitation projects for Hoffmann Architects.

So, if your glazed brick facade is starting to show signs of deterioration, act quickly. No matter how minor the damage seems, it is essential that the source of decay or damage be identified and resolved, and the damage repaired.

Puzzling Out the Clues

Solving deterioration problems is a methodical process, much like playing detective: First, gather clues at the scene of the crime: What's the damage and how extensive is it? Next, identify and track down the culprit. Finally, take steps to prevent the crime from happening again.

In this kind of detective story, identifying the villain is the easy part. The culprit? **Water penetration**. First and last, water is the number one enemy of the built environment. Were it not for the inevitable entry of moisture, glazed brick walls would probably stand unbowed for eternity.

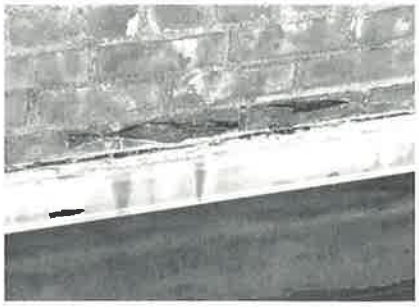
The real work comes in tracking down just how and where the water got in. That, by the way, is Rule #1 of building renovation and repair: Find and treat causes, not just symptoms.

To do so, you must look at the clues – the symptoms of decay in glazed brick. Often, the type of damage can help pinpoint the source. The chart and photos on page 2 show some common indicators of deteriorating conditions in glazed brick.

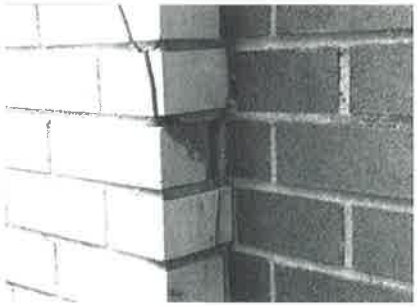
The Clues

Organic growth.

Deterioration and missing mortar at joints.



Missing weep holes.



Cracked brick.

Shift or bowing of walls.

Spalling of glazed brick.

The Modus Operandi

The next step is to identify the source of water entry. Water has some favorite spots for breaking-and-entering. Here are five most likely areas for moisture penetration:

1. Pores in building materials
2. Mortar joints
3. Parapet walls
4. Coping sills and belt courses
5. Flashing conditions

There are few simple axioms to bear in mind when investigating root causes of water damage:

1. If the problem is at the roof level, the cause most likely lies in the roofing membrane.
2. If cracking occurs at corners of the building, the problem can usually be traced to failing mortar joints and/or inadequate expansion joints to accommodate thermal movement.
3. If problems are at the flashing points (lintels, relieving angles, foundations, etc.), the source is most likely inadequate flashing and waterproofing to prevent the capillary action of water moving through the masonry and to prevent water from leaving the wall system.
4. Condensation of water vapor from within the building can also be an insidious source of damage that is often overlooked. One surprising cause? Failed mechanical piping.

An Ounce of Prevention . . .

The ideal solution is to keep water from entering in the first place. Realistically, of course, that's not entirely possible. But there are ways to minimize the problem.

For new construction, the Brick Institute of America offers a number of stringent construction guidelines that, if followed, will minimize or eliminate the potential for masonry deterioration down the road. (Please see the related sidebar, "Building it right . . . the second time around", on page 6.)

Unfortunately, many of those recommendations are too costly to implement as corrective measures in existing glazed brick facades. For example, construction of a continuous cavity between the facing and its supportive wall system would provide an ideal escape avenue for trapped moisture. This, however, would entail rebuilding the entire facade, offset from its original position, to create such a cavity wall – a very expensive undertaking.

There are, of course, other measures. The overall strategy is to give water the fastest, most convenient, and least damaging escape route possible. So take two tacks . . . keep out what you can and provide easy escape routes for what you can't.

Listed below are some strategies for preventing water entry and for facilitating water escape from within the brick in existing buildings.

The Best Moisture Escape Routes

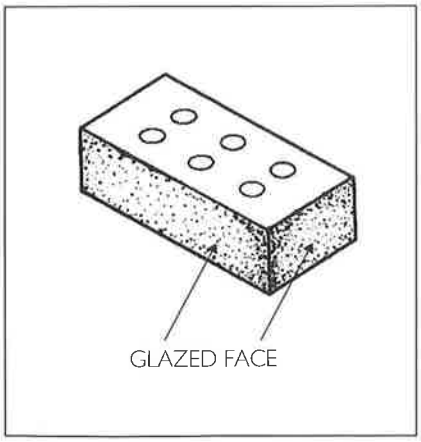
1. Ventilate cavity for walls to breathe.
2. Install weep holes and/or clean existing weep holes that may have become clogged.
3. Correct improperly installed flashing and/or install additional flashing at problem areas.

The Best Barriers to Water Entry

1. Create water infiltration barriers, such as cap flashings.
2. Install adequate expansion and control joints to accommodate expansion due to thermal movement, moisture absorption, and freeze-thaw cycles.
3. Replace spalled brick.
4. Repoint deteriorating joints.

A word of caution: when replacing glazed brick, do not use corner brick in any location other than corners. With its two glazed sides, corner brick will fail to provide a proper bond on one side.

Let's look at some specific problem areas in more detail, addressing both causes and recommended solutions.



Glazed corner bricks should be used at corners only to ensure a proper bond.

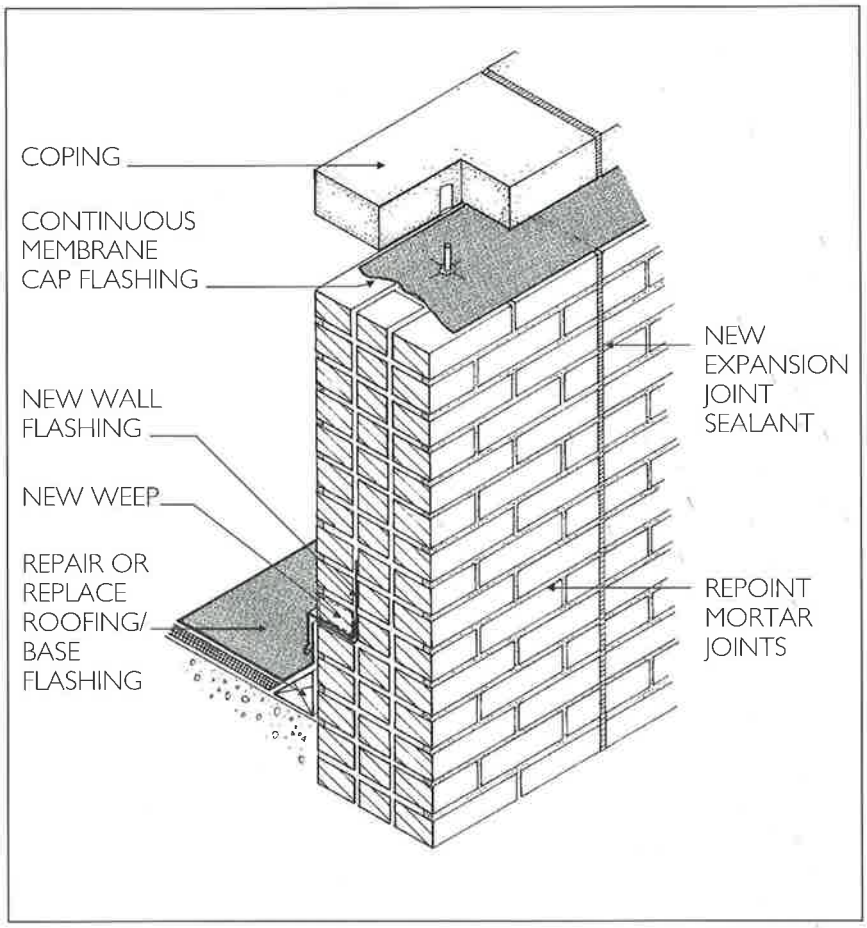


Illustration A: Proper parapet wall construction.

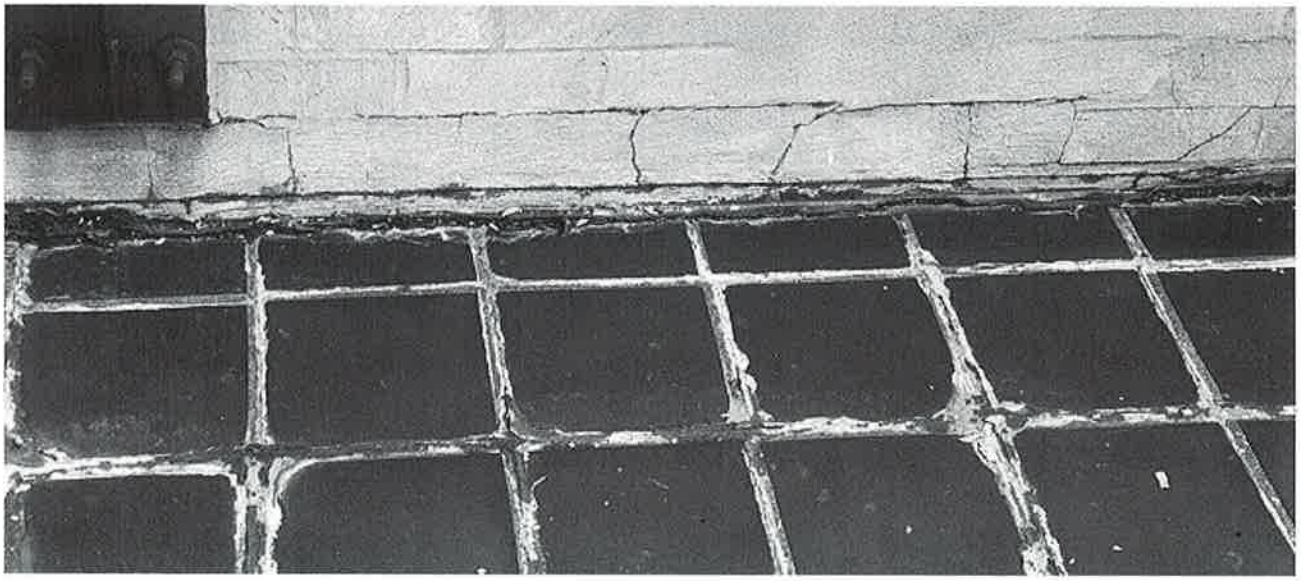
At the Roof Level

A majority of moisture problems are found at the roof level. Parapet walls, exposed on two sides and not tempered by the moderate interior environment, are subject to greater temperature variations and expansion movement.

This uncontrolled movement can cause walls to crack at both the mortar joints and through units. Damaged mortar joints offer an open invitation to water entry, which in turn increases the expansion problems in the glazed brick. Failed roof or edge flashings create another entry point for moisture, which can then be absorbed into the units.

Where roof levels are used at plazas, problems are often found at the inside face of the parapet walls, usually one or two courses above the deck. In an improperly designed plaza, water remains standing at the membrane level. Because the brick coursing also begins at this level, the first several courses stand "knee-deep" in water.

As well, water tends to wick upward into the brick courses, causing progressive damage. The inability of the glazed facing to allow moisture evaporation only exacerbates the problem. Damage is evidenced by spalling, bowing, and crumbling or failed mortar joints.



These parapet walls, already "knee-deep" in water, were covered with a cementitious coating, further trapping moisture.

Specific strategies for protecting and repairing parapet walls include:

1. Controlling wall expansion by creating joints for relief of expansion;
2. Creating continuous, watertight barriers at the top of the walls;
3. Replacing failed base flashings and roofing;
4. Repointing mortar joints;
5. Maintaining or creating weeps.

Illustration A on page 3 shows proper parapet wall construction techniques to prevent water entry.

A common error in attacking these problems usually involves ignoring any one of these strategies and/or the addition of an element that exacerbates the problems. For example, applying a surface cementitious membrane material on the back side of the parapet wall, without replacing failed cap or base flashing, will only serve to trap more moisture, intensifying the problem.

Another incorrect solution that traps moisture within the wall is to repoint the last mortar joint above the metal through-wall flashing with a hard, water-impermeable mortar.

Even worse, this joint is often caulked as a result of mortar cracking from metal movement. Rather than solving the problem, both approaches are guaranteed to keep moisture in.

At Flashing Conditions

Another common location for problems in glazed brick is at flashing locations, such as lintels, relieving angles, and the base of walls. These areas usually have a membrane installed to collect water that has penetrated the interior face. Frequently, however, no weep holes or other venting mechanisms are installed at these flashings to allow relief of this moisture buildup. In these cases, the moisture-laden brick expands, leading to spalling, cracking, bowing, and deterioration of joints.

Strategies for protecting and preserving flashing locations include the following:

1. Unclog existing weep holes or create new ones.
2. Repoint mortar joints.
3. Where damage is severe, rebuild 3 or 4 courses above the flashing.
4. Lintels and relieving angles may need repair or replacement.

At Mortar Joints

Mortar joints probably offer the greatest opportunity for water to work its way into the facade. In fact, once water penetration occurs, the damage multiplies geometrically, with every crack and separation from the brick creating yet another avenue for water entry.

You know it's time to repoint when:

- Mortar has eroded to expose the brick behind the glazed face.
- Mortar has crumbled from the joint.
- Hairline cracks have appeared in the mortar.
- The bond between the mortar and the glazed brick is broken.

Strategies for maintaining mortar joints include the following:

1. Remove the old mortar by cutting out to a depth of at least 5/8"; remove more if necessary to eliminate unsound mortar.
2. Clean joints of old mortar, dust, and dirt prior to repointing.
3. Avoid damaging brick edges when removing old mortar.
4. Use a mix ratio of 1 part portland cement: 1 to 1-1/2 parts hydrated lime: 6 parts sand for a flexible but durable mortar.
5. Day and evening temperatures should be above 40°F during repointing; the area of work should be protected from the weather when not being worked on.
6. All excess mortar, smears, and droppings should be cleaned up before the mortar sets.
7. Joint configuration must be designed so that the mortar meets the top edge of the glaze and so that the joint easily sheds water. (Illustration B shows some examples of acceptable and unacceptable joint configurations.)

Protecting Against Recurrence

The best approach, of course, is to prevent problems before they begin. One incentive for preventive maintenance is a financial one: correcting minor problems now will usually save money in the long run.

Once the damage has been corrected and the source of water entry eliminated, it's prudent to prevent recurrence. That means being ever vigilant, performing regular and routine maintenance, with an eagle eye out for any potential source of water entry into the brick.

One preventive measure to avoid, however, is the application of a waterproof coating. It may sound like a good step, but in reality, it's an inexpensive 'remedy' that costs plenty in the long run. Water vapor can and will continue to condense inside the wall, even with a waterproof coating. The coating, however, adds just one more barrier against moisture escape, a condition already created by the glazed brick face. In effect, the waterproof coating seals off the only avenue left for evaporation: through the mortar joints. This is obviously not in the building's best interest and is strongly discouraged.

With proper care, glazed brick facades can last a lifetime, providing aesthetic delight as well as a sound, weathertight enclosure for the building. ■

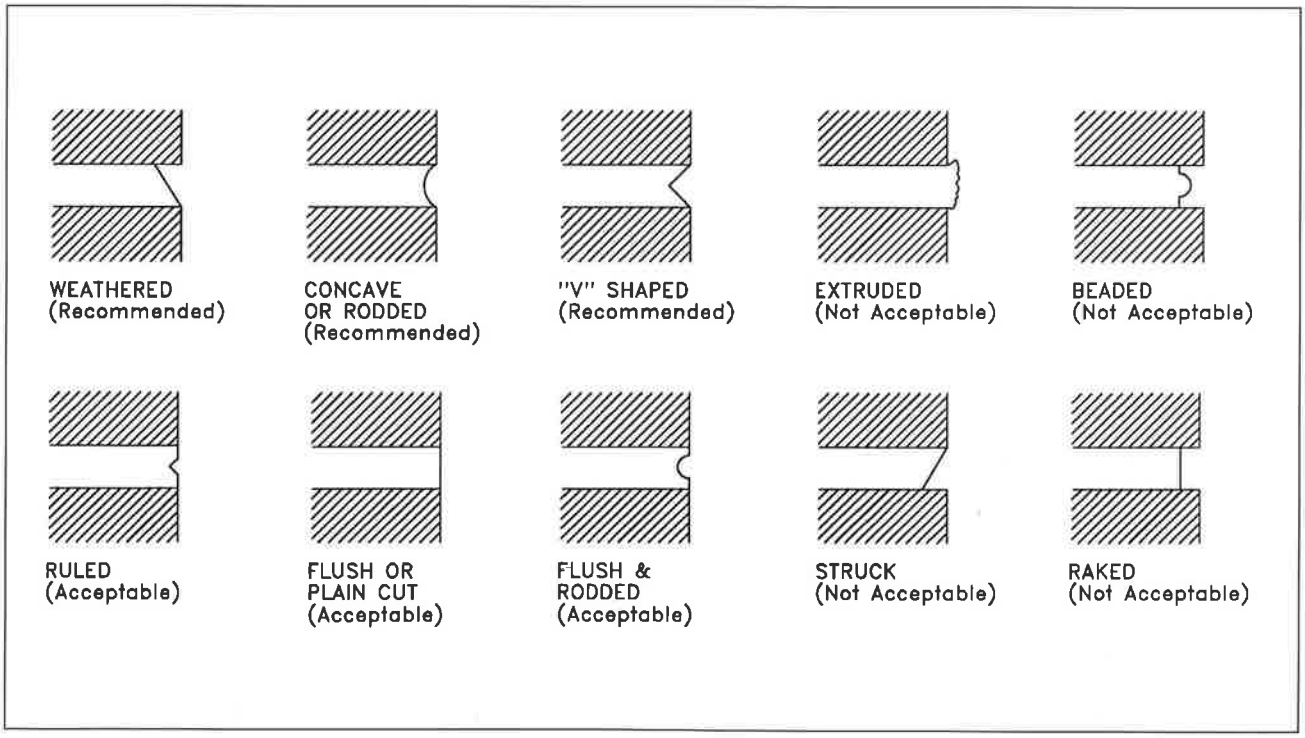


Illustration B: Types of mortar joints (Weatherability).

Building it right... the second time around

The Brick Institute of America offers a number of sound recommendations for proper installation of glazed brick. If these guidelines weren't followed during original construction, you may find yourself involved in some rebuilding. If so, these rules still apply; take the time to do it right the second time around.

Design Issues

- Cavity wall construction is recommended.
- Provide vapor barriers on the warm side of the walls enclosing heated areas.
- Ventilate the cavity for walls exposed on both sides. Examples of these include free-standing, wing, and parapet walls.
- Provide adequate flashing.
- Provide adequate expansion joints (3/4" per 100 feet of wall) and an expansion joint on each side of each corner, located not more than 10 feet or less than 4 feet from the corner.
- Provide flexible anchorage to columns and beams.

Specifications

- Specify highly plastic mortar: the recommended mix is 1 part cement: 1 part type S lime: 6 parts sand. The mix can go as high as 1-1/2 parts type S lime, with all other amounts remaining the same.
- Specify full head and bed joints. Ensure that the cavity is kept clean and weep holes kept open.
- When using ceramic glazed units for exterior situations, consult the manufacturer, indicating the geographic location of the project, the type of construction (i.e.; enclosure walls, parapets, etc.) and the wall design, including flashing details and type of mortar.

(Technical data abridged with permission of the Brick Institute of America). ■

The Facility Manager's Bookshelf: **Glazed Brick**

A. Brick Institute of America
11490 Commerce Park Drive
Reston, VA 22091
(703) 620-0010

1. *Technical Notes on Brick Construction.* No. 13: "Ceramic Glazed Brick Facing for Exterior Walls."

B. ASTM
1916 Race Street
Philadelphia, PA 19103-1187
(215) 977-5585
(Credit card orders accepted)

1. ASTM C126-86 *Standard Specifications for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.* $10.00
2. STP 1063 *Masonry: Components to Assemblages.* Editor: J. Matthys. 450 pps. 1990. ISBN 0-8031-1453-2. $42.00
3. Kellermeyer, Kenneth B. and Ian R. Chin. "Lessons Learned From Investigations of Over 500 Distressed Masonry and Stone Facades." *Building Performance: Function, Preservation, and Rehabilitation.* ASTM STP 901. 1986. pps. 152-164. Total pps: 202. Price for entire book: $39.00. ISBN 0-8031-0458-8.

C. Facing Tile Institute
P.O. Box 8880
Canton, OH 44711
(800) 321-0662 (216) 488-1211

1. *Design Data for Structural Facing Tile and Ceramic Glazed Brick: Technical Notes.*

D. Construction Specifications Institute
Specifier Reprints
601 Madison Street
Alexandria, VA 22314-1791
(703) 684-0300

1. Beall, Christine. "Controlling Moisture Movement in Masonry Walls." *The Construction Specifier,* June 1988, p. 36.
2. Carrier, Gerald J. and Stephen Szoke. "Avoiding Cracks in Brickwork." *The Construction Specifier,* August 1986, p. 44.
3. Monk, C.B., Jr. and Paul V. Johnson. "Effect of Brick Texture on Water Permeability of Walls." *The Construction Specifier,* October 1954, p. 58.
4. Richter, Robert J. "Masonry Failures: A Look at Trade Practices." *The Construction Specifier,* January 1991, p. 44.
5. Smith, Wayne J. "Ceramic Glazed Brick - Its Beauty and Temperament." *The Construction Specifier,* July 1976, p. 42.

Cost: $4.00 each, $10.00 minimum. VA residents add 4.5% tax.

E. General References
Ashurst, John and Nicola Ashurst. *Practical Building Conservation, English Heritage Technical Handbook, Volume 2: Brick, Terra Cotta, and Earth.* New York: Halstead Press, 1988.

Compiled by Alan P. Eddy, Records and Information Manager ■

REPRESENTATIVE PROJECTS

Glazed Brick Restoration

Hoffmann Architects specializes in the restoration and rehabilitation of exteriors of existing buildings. A major portion of the firm's work is in the rehabilitation of glazed brick facades, as well as other masonry exteriors.

Each project is evaluated based on its individual and unique needs and problems. The firm's professional architects and engineers investigate existing conditions, specify quality materials, detail construction drawings, and administer construction contracts for all aspects of glazed brick repair.

Repair solutions can range from minor repointing to restoration and replacement of brickwork and support systems.

Hoffmann Architects has provided glazed brick rehabilitation services for a range of corporate and institutional facilities, including:

360 Lexington Avenue
New York, New York
(Prudential Insurance Company)

61 Broadway
New York, New York
(Cushman & Wakefield)

Atochem Building
Philadelphia, Pennsylvania
(Goldman Sachs)

The Hartford Insurance Group Headquarters
Hartford, Connecticut
(ITT Hartford)

CBS Broadcast Center
New York, New York
(CBS, Inc.)

Southern New England Telephone
Central Office #2
Norwalk, Connecticut
(Southern New England Telephone)

NYNEX
120 Bloomingdale Road
White Plains, New York
(NYNEX Properties Co.)

825 Third Avenue
New York, New York
(Durst Organization)

Prentice-Hall Building
Englewood Cliffs, New Jersey
(Simon & Schuster, Inc.)

Southern New England Telephone
Saybrook TSPS
Old Saybrook, Connecticut
(Southern New England Telephone)

17 Battery Place
New York, New York
(Edward S. Gordon, Inc.)

15 Broad Street
New York, New York
(Morgan Guaranty Trust Co.)

Belfer Education Center
Albert Einstein College of Medicine
Bronx, New York
(Yeshiva University)

Hartford Hospital
85 Jefferson Street
Hartford, Connecticut
(Hartford Hospital)

Executive Terrace
King of Prussia, Pennsylvania
(Teachers Insurance) ■

100 Park Avenue, New York, New York

Chrysler Building, New York, New York

The Expansion Factor

It's quite clear that water infiltration is the leading cause of building demise. But just how does it deal the death blow? We call it the "expansion factor." All building materials change in volume over a period of time. This expansion occurs in three ways: expansion from thermal changes, expansion from moisture absorption, and expansion from freezing of retained moisture. Anticipating and accommodating this potential for expansion is a key principle of building design and construction. In glazed brick construction, a system of expansion joints is typically required to manage the anticipated rate of change in volume a brick building is expected to undergo over time.

All too often, unfortunately, there are too few expansion joints installed, leaving the building at the mercy of the expansion factor.

Most glazed brick buildings of reasonable size can survive ordinary thermal expansion with the aid of just a few expansion joints. However, once water begins to enter and saturate the brick, the potential for damage increases geometrically. In fact, the rate of expansion from the combined effect of moisture absorption and freeze-thaw cycles is more than double that of thermal expansion alone. Without adequate expansion joints, unrelieved glazed brickwork will most likely tear itself apart over time.

How many expansion joints are enough? There's no single formula or design for placement of expansion joints that can be applied to all structures. Each building is unique in its design, location, and construction. It's essential that a building be analyzed to anticipate the range of expected movement, and that expansion be calculated using accepted formulas. Generally, the spacing of expansion joints is determined by considering the amount of expected wall movement and the size and compressibility of the expansion joint and expansion joint materials.

It's also essential that the expansion joints remain free and clear of mortar or joint reinforcing material; otherwise, the expansion joint will not perform its task adequately. ■

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