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**THE HISTORY OF FLASHING AND ITS IMPORTANCE IN  
BOTH MODERN AND HISTORIC MASONRY CONSTRUCTION**

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## ABSTRACT

Through our firm's 23-year history as a specialty masonry restoration contractor, it is our observation that no single building component impacts the performance and/or the longevity of a building envelope more than the proper detailing and installation of workable flashing systems within a wall. Since the introduction of carbon steel into mass masonry structures during the late 1800s, the importance of proper flashing installation and its ability to reduce leakage, corrosion, and their consequences cannot be over emphasized. This paper will discuss the impact of flashing design and installation in buildings that include mass masonry, cavity walls, and terra cotta.

## SPEAKER

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JEFFREY L. ERDLY is the CEO of Masonry Preservation Services, Inc. (MPS). A member of ASTM International, his activities include cochairman of task group E 06.55.05, and co-editing of both STP (Special Technical Publication) 1314, "Water Leakage through Building Facades," and STP 1444, "Building Façade Maintenance, Repair, and Inspection." Erdly is also a past president of the SWR Institute and recently received an award of special recognition from ASTM Committee E-06 regarding his contributions to the society. Jeff has presented in excess of 100 technical seminars and original technical papers throughout the United States for other organizations, including RCI, APT, ICRI, the University of Wisconsin, and MIT.

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# THE HISTORY OF FLASHING AND ITS IMPORTANCE IN BOTH MODERN AND HISTORIC MASONRY CONSTRUCTION

## THE HISTORY OF FLASHING

Numerous technical manuals published during the early 20th century included detailing at masonry parapets requiring through-wall flashing at two levels. This detailing, contained in both of the most widely respected standards of the day, *Architectural Graphic Standards*<sup>1</sup> and *Brick Engineering Handbook of Design*,<sup>2</sup> required through-wall flashing at both the roof base flashing level and beneath copings (Figure 1). Further extensive detailing was also included in these manuals regarding the use of copper cups (thimbles) to be used when flashing or roofing was pierced by pinning that was required to secure copings or reinforce parapets (Figure 2). Additional flashing details for terra cotta assemblies were also recommended as best practice. The terra cotta industry as a whole ignored these recommendations, which eventually became a contributing factor to its near demise.

Many modern roof termination standards in use today violate these original principles by allowing the use of a termination bar surface-mounted onto masonry or other materials. These widely used flashing terminations fail to preclude moisture from circumventing the surface-mounted roofing termination and lead to leakage and accelerated roof and masonry failures (Figure 3). Other detailing errors commonly observed include: 1) improper use of EPDM membranes as parapet covering; and 2) the extension of base flashing above existing flashing necessitated by the addition of roof insulation.

An additional improvement to the original flashing details noted previously would be to extend all through-wall flashings beyond the face of the wall (daylight) to form a drip intended to divert water traveling down the wall out away from the wall below.

To protect parapets, through-wall flashing beneath copings is critical. Proper flashing should: 1) protect pinning with a thimble assembly; 2) integrate a flashing extension outboard that both daylight and includes a drip; 3) integrate a flashing extension inboard, including a receptor to accommodate roof counter flashing or rain screen; and 4) be permanently sealed with rubberized asphaltic flashing. See Figure 4 for a detail

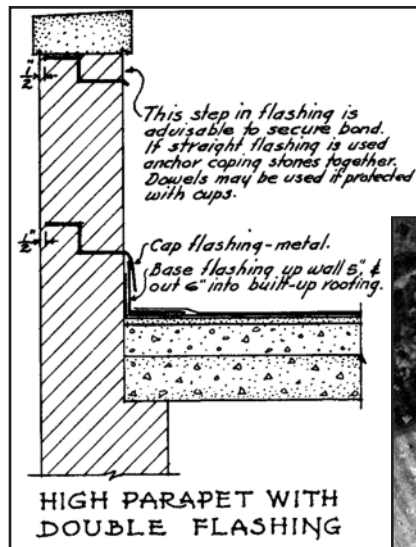


Figure 1 - Recommended flashing detail from architectural graphic standards. Facsimile of original edition.

Figure 2 - Copper cup (thimble) from a circa-1930s project.



## STANDARD DETAILING

Working in concert with many leading forensic engineers and architects, we have helped develop details that follow the original principles and provide for long-term preservation of masonry structures. Central to these goals is the concept that masonry repairs should be detailed using materials and strategies that acknowledge that masonry and flashing materials should be expected to perform for 50 to 75 years, while roofing membranes may require replacement every 20 to 30 years. Furthermore, it is often not possible or advisable to demolish and rebuild parapets to a level where roof-level through-wall flashing can be installed.

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showing these concepts. The authors of this paper have participated in the evaluation and repair of numerous masonry structures. Following the concepts outlined above, some of these structures were also

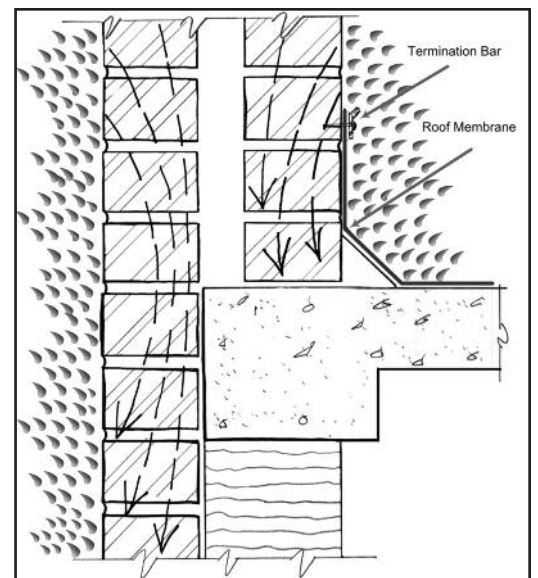


Figure 3 - Water penetration circumventing surface-mounted roofing termination.

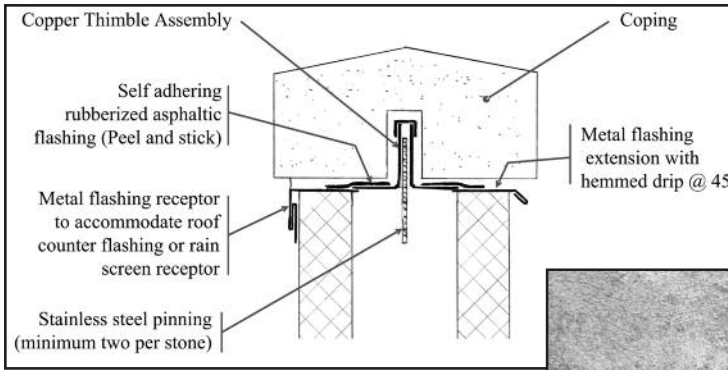


Figure 4 – Proper flashing beneath copings.

repaired incorporating provisions to accommodate future roofing installations.

### CASE STUDY 1

This academic building was constructed in the early 1920s and included multiwythe mass masonry walls with cast stone copings and trim, and a center tower composed of solid cast stone components. The masonry was constructed without through-wall flashing. The center tower, composed of solid cast stone, was reroofed using EPDM as a replacement roof, installed with a surface-mounted termination bar (Figure 5). The new roof termination leaked, and to repair this assembly, the copings were removed and pinned, and through-wall flashing was installed and the copings reset. On the inboard face, a receptor was installed to accommodate a rain screen panel, which also oversails the counter flashing, thereby protecting the deficient



Figure 5 – EPDM roof membrane terminated at cast stone parapet.

EPDM roof termination below (Figure 6).

### CASE STUDY 2

The two examples cited include a new brick/limestone-trimmed high-rise that experienced cyclical and widespread leakage since its completion, and a 1960s church clad with orchard stone. Both projects included flashing that was not improperly

detailed or constructed. The most labor-intensive and difficult masonry flashing interface detailing occurs when a raked roof adjoins a vertical masonry rising wall (Figure 7). Proper detailing at these interfaces requires 1) a through-wall stepped-pan-above-pan installation (Figure 8); 2) provisions to accommodate stepped surface counterflashing down the rake; and 3) detailing to accommodate sufficient wind clips and weeps. The proper installation of this detail requires a combination of masonry, sheet-metal, and roofing skills. This type of repair can become even more complicat-

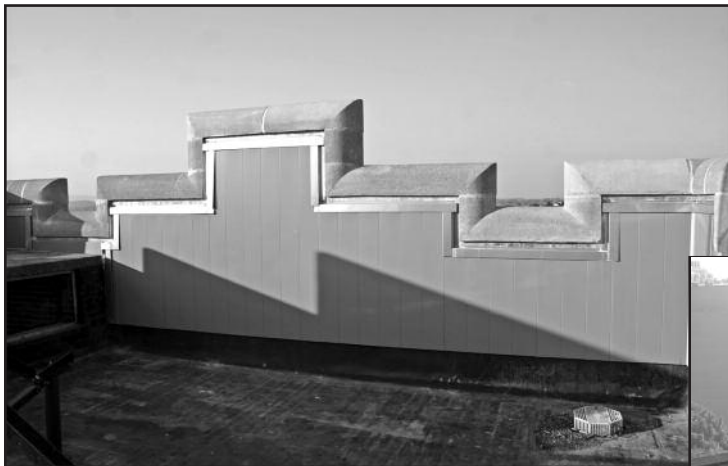


Figure 6 – Rain screen panel system interfaced with coping flashing and extending down over EPDM roofing termination.



Figure 7 – Copper roofing improperly terminated at raked masonry rising wall.



**Figure 8 – Installation of copper stepped-pan flashing at raked rising wall.**



**Figure 9 – Stepped pan flashing at raked stone rising wall.**

ed when natural stone masonry varying in coursing height and length requires a stepped-pan flashing installation (Figure 9).

### CASE STUDY 3

When restoring any masonry structure, it makes sense to first understand all of the causes of the deteriorative force prior to designing a repair. In the case of landmark structures, it is important to assess the value of introducing flashings into the remedial design, even if the end result is a slight change or the addition of a flashing line that will afford protection to the assembly and extend its service life. The exact reproduction of a detail prone to accelerated failure in the name of preservation seems wasteful and not congruent with the true intent of preserving significant architecture for future generations.

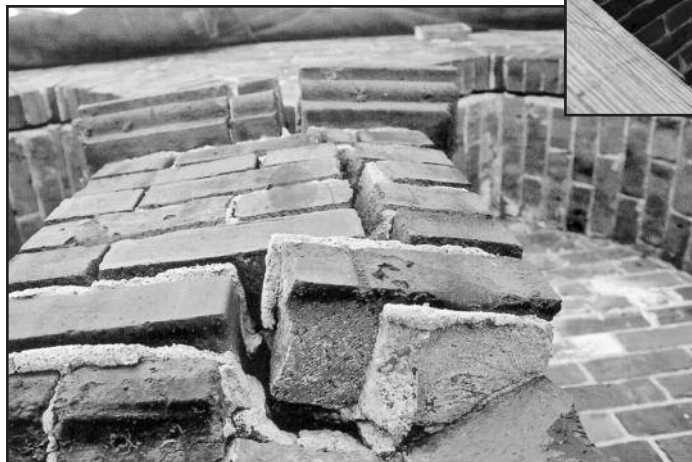
This landmark structure was modeled after the Italian Renaissance style and is rich in corbels, Gothic arches, and ornate brick and terra cotta. The 200-ft-tall smokestack tower, located within a federal penitentiary, was constructed as a mass masonry wall with embedded carbon-steel hanger assemblies. The steel hangers, in

direct contact with brick and mortar, corroded in the presence of moisture over time, and the volume change created by the exfoliating rust (oxide jacking) caused the masonry to split and become unstable (Figures 10a and 10b). Rebuilding these details without provisions to protect new steel (including the introduction of through-wall flashing) fails to address the original cause of the deterioration. For this project, the parapet was reconstructed to include new through-wall, lead-coated copper flashing above new steel hangers (Figure 11) and extended inboard to interface with new roofing, thereby providing a unified roof/flashing interface that extends through the historic masonry

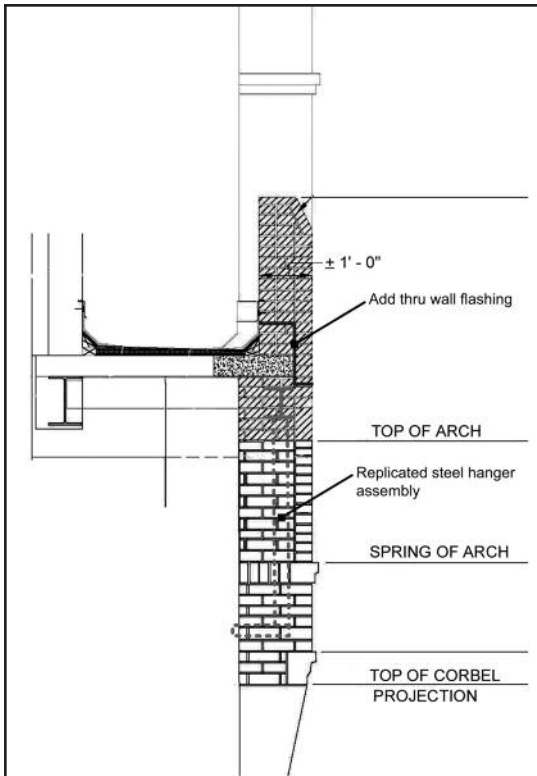
assembly (Figure 12).

### Flashing and Terra Cotta

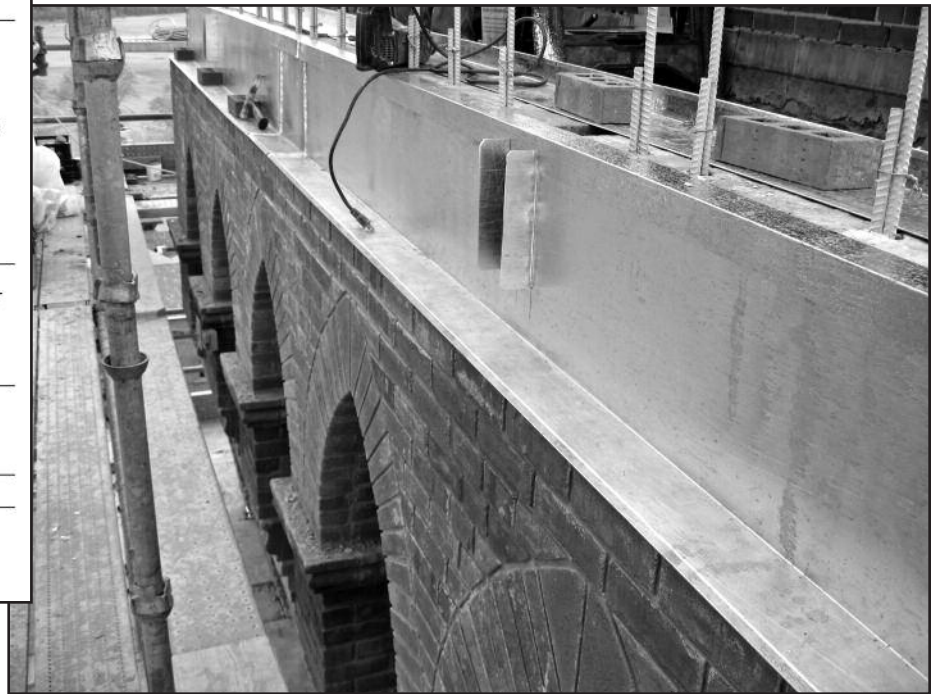
Glazed architectural terra cotta's use and the subsequent demise of this industry were partially caused by the failure of designers and manufacturers to understand the need for flashing. Because of terra cotta's use as a decorative material and alternative for cut stone, many decorative



**Figures 10a (left) and 10b (above) – Displaced brick masonry caused by oxide jacking of embedded steel hangers.**



**Figure 11 – Detailing of tower parapet with through-wall flashing added.**



**Figure 12 – Lead-coated copper flashing added to protect embedded steel.**

terra cotta assemblies were hung or suspended from mild steel anchors and hanger assemblies. Failure to protect these steel components (iron anchors) from moisture created a domino effect failure of entire assemblies as unprotected anchors expanded due to corrosion.

A consortium of terra cotta manufacturers (The National Terra Cotta Society) published *Architectural Terra Cotta Standard Construction* in 1914.<sup>3</sup> At that time, no recommendations for the use of flashings or the coating of iron anchors were made within this standard. Following is a portion of the foreword contained in the 1914 standard.

*The use of burned clay were [sic] in the form of brick, tile or pottery has been uninterrupted and universal from the dawn of civilization to the present day. The use of burned clay in the form of Architectural Terra Cotta has been more sporadic and local. Its unequalled merits as a building material were fully appreciated by the Greeks and Tuscans who, two thousand years ago, used it to face the perishable stone in some of their Temples. Centuries passed, during which the art of making Architectural Terra Cotta seems to*

*have been confined to short periods and to a few localities. In modern times the creator of the sky-scraper – the progressive American Architect – working with the responsive and enterprising Manufacturer, re-discovered, improved and gave to an appreciative Public this most durable and versatile of all building materials.*

*Today it is a matter of common knowledge among Architects that modern Terra Cotta possesses many superior qualities; that it may be economically made in an endless variety of forms and colors; that, if well made, properly set and carefully pointed it is permanently enduring and resists successfully the ravages of water and fire; that it combines lightness with strength and beauty with usefulness.*

This foreword clearly represents most manufacturers' thinking of the time, with bold statements regarding terra cotta's superior qualities, including its touted permanent endurance and resistance to the ravages of water. However, in a monthly newsletter published by *Atlantic Terra Cotta*, Volume I, Number 9, July, 1914,<sup>4</sup> an article entitled "Correct Terra Cotta Con-

struction" recommends that the manufacturer who knows terra cotta is best equipped to also install it. In this article, the following statements are made with regard to extreme exposure without deterioration.

*The greatest agent of deterioration is water, and water works in three ways: (1) in a smoky atmosphere it reacts with accumulated soot to form sulphurous and sulphuric acid; (2) inferior mortar is absorbent and swells under the action of water; (3) accumulated moisture in a freezing temperature will expand with sufficient force to shatter Terra Cotta or any other structural material.*

*Generally it is advisable to flash wash courses with copper, particularly in a cold climate. The flashing should be secured by lead plugs on the nib of the wash member, placed in the joints between the pieces of Terra Cotta or in plug holes provided for the purpose. Securing flashing by plugs is better than fastening in a raglet, because the raglet will have to be filled with some composition. If it is not completely filled, water will collect and oxidation of the metal result, and sometimes the very compositions*

used for filling raglets corrode and destroy the flashing instead of protecting it!

Iron anchors also require some attention. Ordinarily, they are fully protected by being imbedded in the masonry or concrete backing, but to insure [sic] complete protection from rust, they should be coated with some non-corrosive paint.

After reading the *Atlantic Terra Cotta* newsletter, also published in 1914, it is clear that problems within the terra cotta industry had already surfaced by that time.

The National Terra Cotta Society published a revised edition, entitled *Terra Cotta Standard Construction*, in 1927.<sup>5</sup> The following statements contained within the revised standard's introduction give a sense of problems identified within the industry.

*The changes made in this revision are the result of a more extended experience in manufacturing and in modern building methods, and are based on a careful study of the behavior and weathering properties of exterior building materials. The following are the most important of the structural principles upon which this revision has been developed:*

#### **Shelf Supports**

*In concrete or steel frame buildings, the veneer or facing material should be fully and continuously supported at each floor level on shelf supports of adequate strength and stiffness, rigidly connected to the structural frame. Steel shelf angles or supports, in all cases, should be located in mortar joints. The strength of the Terra Cotta should not be unnecessarily reduced by cutting the webs to receive the steel.*

#### **Expansion Joints**

*Proper provision should be made for expansion joints at shelf supports, over column caps, etc., to prevent the development of disruptive stresses caused by deflection, wind pressure, temperature changes, settlement and like forces.*

#### **Terra Cotta on Concrete Frames**

*The volume changes incident to the setting and hardening of concrete and the variations in volume of concrete due to humidity and temperature conditions, require provisions to allow free movement of the supporting frame and make it undesirable to completely fill a facing applied to a concrete structure.*

#### **Protection against Corrosion**

*Proper care should be exercised to prevent the corrosion of all steel sup-*

*ports, ties, etc. Where such protection cannot be permanently secured through encasement with mortar or concrete or through the use of corrosion resistant metallic coatings, non-corrosive metals should be employed.*

#### **Free-standing Construction**

*Exposed free-standing construction, subject to the absorption of water through mortar joints and liable to injury from subsequent freezing, or the expansion of improper filling material, should generally be left unfilled and should be ventilated by means of small, inconspicuously placed weep-holes (indicated by W. 11. on the plates).*

#### **Flashing and Drips**

*Properly constructed flashing should be provided to cover the top of large projecting horizontal courses, the backs and tops of parapet walls, wide-exposed sill courses, etc., and all projecting features should have drips.*

Most failures of glazed architectural terra cotta can be attributed to a misunderstanding of the vulnerability of carbon-steel anchors contained within terra cotta assemblies. Given modern materials (stainless steel hangers) with good flashing installation and detailing, glazed architectural terra cotta can provide long-term performance.

#### **CASE STUDY 4**

This historic structure, located in the Piedmont region of North Carolina, was constructed in 1921. The building used architectural terra cotta to form projecting balconies at two intermediate floors (*Figure 13*). The original construction did not incorporate any flashing and/or noncorrosive anchors consistent with the 1914 standard. After approximately 80 years of service, expansion (oxide jacking) of steel components has compromised the stability of the entire assembly (*Figure 14*). The authors of this paper partici-



**Figure 13 – Terra cotta balcony assembly.**

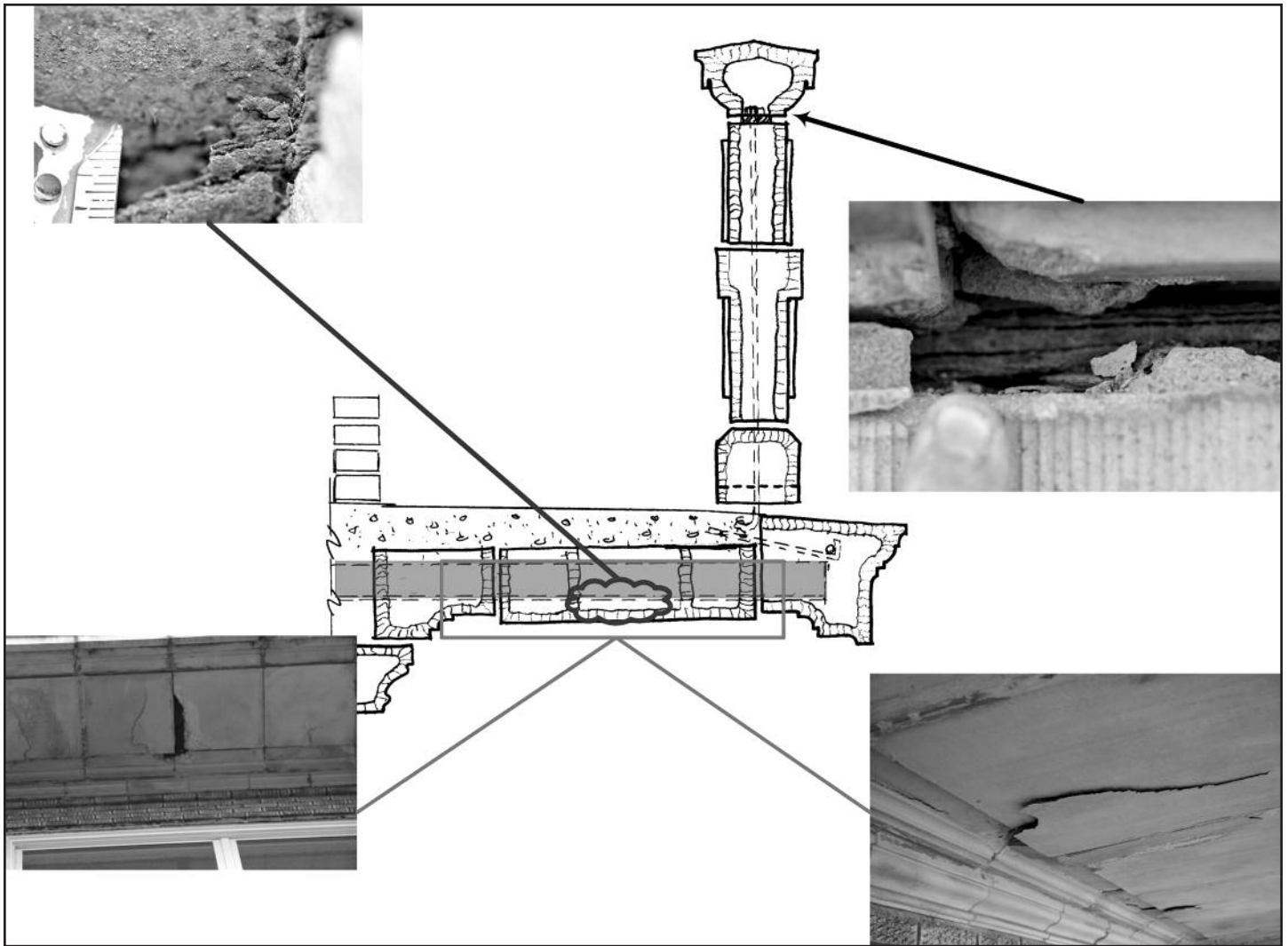



Figure 14 – Terra cotta components damaged by oxide jacking.

pated in only the review of the structure and did not participate in the repair or repair design.

## CONCLUSION

Buildings require proper flashing at many locations to withstand exposure to moisture and liquid water. Roofs, masonry parapets, and building envelopes are easily compromised by detailing that fails to protect components with workable flashings. Both building and design professionals within the repair, roofing, and preservation industries would be well-served to review standards published over 75 years ago, in which basic detailing and design concepts

recommended are still viable.

However, before jumping onto the flashing bandwagon, designers should also heed Plummer's quote contained in the *Principles of Brick Engineering Handbook of Design*, sited previously, as follows: "[A]t the outset, it might be stated that no flashing at all is better than poor flashing." 

## FOOTNOTES

1. C.G. Ramsey and H.R. Sleeper, *Architectural Graphic Standards*, facsimile of original edition, John Wiley & Sons, Inc., London, Chapman & Hall, Limited, New York, NY, March 1932, 1990.
2. H.C. Plummer and L.J. Reardon, *Principles of Brick Engineering, Handbook of Design*, Structural Clay Products Institute, Washington, DC, 1939.
3. *Architectural Terra Cotta Standard Construction*, National Terra Cotta Society, New York, NY, 1914.
4. *Atlantic Terra Cotta*, Volume I, Number 9, July 1914.
5. *Terra Cotta Standard Construction*, rev. ed., National Terra Cotta Society, New York, NY, 1927.