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Code-Required Inspections & Safety

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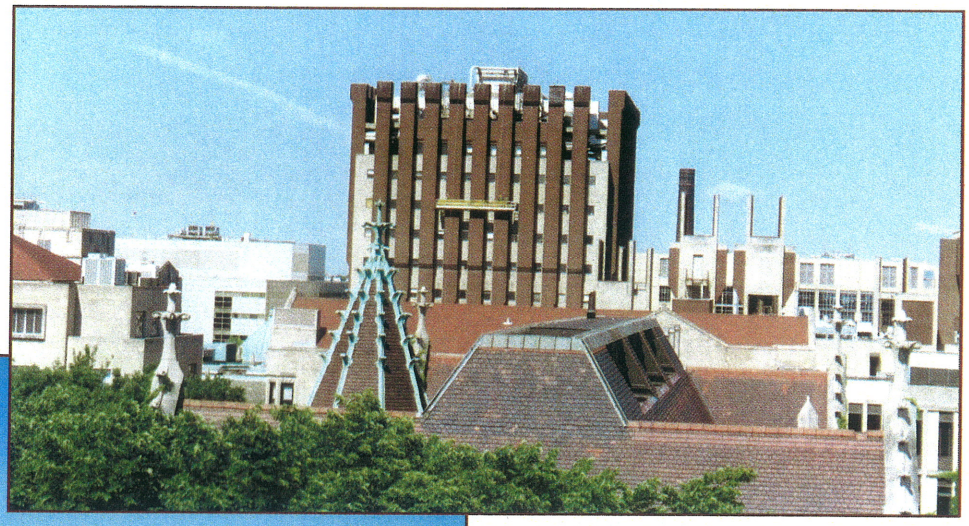
FAÇADE INSPECTIONS – BEYOND THE

Our built environment – more specifically the skyline of major metropolitan areas – is crowded with a variety of aging structures, each with its own signature in terms of architectural significance and end use. Within the past ten to twelve years, owners of these buildings in cities such as New York, Boston, Chicago, and recently Milwaukee, are required by municipal code to comply with some form of existing, recently established or revised "façade ordinance" inspection. The need for these inspections is derived from the assumption that the general public need not live in fear of, or be put at risk by, the ever-present danger of building components in disrepair falling to pedestrian thoroughfares below.

In very broad terms, most established ordinances require that building owners with structures meeting certain height requirements and exposures have some form of inspection performed on the varied cladding features to identify and categorize areas of localized distress. These conditions, according to the City of Chicago inspection protocol, are classified as either "safe," "safe with maintenance and repair,"



Above: Figure 2 – Suspended scaffolds are routinely used as a means to access the varied cladding features.

Figure 1 – Code language can require engineered "make-safe work" to mitigate hazardous conditions in the form of netting or temporary shoring.

VERTICAL PLANE

BY DON KILPATRICK

or "imminently hazardous." The final report submitted to the city establishes a repair timeframe by which the owner is required to execute either repairs or, in some instances, emergency stabilization of the identified distress conditions (*Figure 1*).

Through hands-on, tactile inspection of the building cladding features, the engineer of record establishes building condition indices, including the presence of isolated, widespread, or in some instances, systemic areas of distress in the componentd (*Figure 2*). The tools of the trade include sounding (pounding on the exposed surface of the cladding features with a hammer) dovetailed with a working knowledge of the mechanical elements of the exterior wall section. Moreover, it is required that the engineer of record performing the inspection have a depth of knowledge representing each type of cladding material and its respective nuances.

Following a visual inspection and review of original architectural and structural drawings, suspect areas may be targeted for inspection openings either required by code-specific language or determined as necessary by findings of the tactile inspection (*Figure 3*). Through these inspection openings, the engineer of record acquires detailed knowledge related to the anchoring and support mechanisms for the particular cladding features (*Figure 4*).

Figure 3 – Area of localized distress in cut limestone cladding.

Figure 4 – Inspection opening to establish as-built condition(s) contributory to the cause of the distressed cladding feature.

Figure 5 – Large-scale selective removals of cladding features.

Beyond the information obtained through a cursory, code-required inspection opening, the engineer of record may require a large-scale opening to gather additional information before designing the wall repair (*Figure 5*). Often, on the brick and mortar side of cladding construction, wall systems movement or out-of-plane conditions are driven by the corrosion of concealed support mechanisms (window-head lintels or header courses interfaced with primary structural steel framing).

Typically, out-of-plane conditions and areas of localized distress in exterior cladding assemblies comprised of brick, stone, terra cotta, and mortar are driven by cyclical exposure to moisture and the resultant processes of corrosion of concealed steel support mechanisms. This phenomenon is somewhat of a departure from water entry to a building interior, with which the roof consulting community routinely deals. Leakage to the building interior could be defined as "active leakage" resulting in disruption of occupancy.

Corrective measures for these types of leaks are usually repaired by competent roofing contractors working comfortably on the easily accessible horizontal plane of the roof deck. The free movement of water into the wall component of the building envelope may, in most instances, best be described as "passive leakage" – free moisture that breaches the building envelope, yet goes largely unnoticed relative to the daily activities of occupancy. The apparent success of this type of construction (beyond the shear mass of the wall section), is found in its inherent ability to act as a reservoir for water, cycling between wet and dry, depending on the ambient conditions. However, common to each of the above-mentioned water entry descriptors are time-weighted damages to and the ultimate demise of building envelope components.

Figure 6 – Typical conditions observed on the inboard face of multiple-wythe parapet wall.

Each of the varied types of cladding materials – most notably those comprised of brick, stone, terra cotta, and mortar – present a family of distress conditions that are often repeated on a typical elevation or exposure. These same defects can be further subdivided into categories, again defined by the type of construction. The identification, quantification, and repair design of these conditions require a basic working knowledge of the elements unique to the wall section. The survey team should recognize the potential for concealed steel support mechanisms that may have been subjected to years of "passive leakage," driving corrosion to an extent that the structural integrity of the wall section has been compromised. Much as the old, un-reinforced PVC shrank, and EPDM normalizes, each wall type may present distress conditions that could be considered signatures of its component assembly.

It is not being suggested that a similar standard of care or anything less is acceptable for roofing or other building envelope disciplines. It is, however, implied that this side of the industry presents a host of issues that require expertise and a standard of care beyond that which can be offered by a consultant whose income has been solely derived from his or her familiarity with low-sloped roof assemblies. In summary, no more were we born roof consultants than instant experts in the diagnosis and repair of wall cladding assemblies.

The distress conditions discussed in this paper represent a random sampling of conditions shown to be commonplace in solid wall construction consisting of clay-fired brick, stone, and terra cotta. Discussed are typical condition indices summarizing the varied predictable performance characteristics of a variety of cladding components as derived from notes in the field.

Figure 7 – Typical, overall poor condition of above-roofline parapet wall and coping.

Solid Wall Construction

Typical solid wall construction gains it strength through layered redundancy and mass. It is not unusual to see solid wall construction consisting of multiple wythes of brick (two to three feet thick) over-clad with cut or carved stone, either relying on or independent of structural steel framing, establishing the diaphragm of the building. Header courses and bond stones provide the essential bond between the redundant layers or wythes of material. Terra cotta cornice features add architectural flair, facilitated by largely concealed support elements affixed to steel framing. In many instances, it is cost prohibitive to replace these architectural features in kind. While pleasing to the eye and cherished as architectural triumphs, this type of construction exposed to the ravages of weather is usually lacking the standard of care it deserves.

Figure 8 – A lack in continuity of the 1930s-era through-wall flashing below the stone coping resulting in out-of-plane conditions.

Below: Figure 9 – Heavy corrosion of steel window head lintel. Note the minimal bearing tolerances at the end of the steel lintel and cut limestone "surround" of the window opening.

Above-Roof Line Features

Most have witnessed projects where a multiple-wythe masonry parapet, often capped by a clay tile or terra cotta coping, extends above the primary roofline (*Figure 6*). Few have stepped foot on a roof and been favorably impressed by the condition of same. It could be said that this is where the divide begins, at the interface of the wall and roof, where overall performance is measured and realized by one component relying on another, establishing the desired leak-free occupancy. Telltale signs of moisture-driven damages at this critical interface include spalled and cracked brick on the parapet interior and out-of-plane conditions, the limits of which are often isolated to the features of the building above the roofline. At this location, roof leaks get repaired (active leakage), and the above-roofline masonry is the receiving substrate for liberal applications of plastic cement (*Figure 7*).

The practice of surface-mounting sheet metal counterflashing to the inside face of masonry parapets should be avoided. Remember, the substrate (multiple wythe masonry wall) is a sponge with storage capacity for water. If the parapet is of a reasonable height, (nothing in excess of 24 inches), it could be recommended that the interior face be treated as a building feature deserving of protection from the elements. Many roof designs incorporate a concealed flashing (drainage plane) under the new sheet-metal cap or stone coping (through-wall flashing) in recognition of the likelihood that water getting through there will damage something (*Figures 8* and *9*). Understanding our fear of this common occurrence, it may be prudent to establish a continuum of the drainage plane from the

Figure 10 – Above-roofline masonry offered protection by sheet metal cladding interfaced with a new, continuous through-wall flashing below the limestone cladding.

Left: Figure 11A – Typical chimney damage due to water infiltration and subsequent freeze/thaw damage (2002).

Right: Figure 11B – Post repair water damage due to water infiltration (efflorescence and spalled brick).

Left: Figure 11C – Latent defects in mortar-topping material contributory to the cause of the efflorescence and spalled brick (2004).

underside of the sheet-metal cap flashing or stone coping, down the parapet wall interior, lapped on top of the finished membrane flashing (*Figure 10*). Many large expanses of masonry have been successfully over-clad with continuous concealed flashings and sheet metal counterflashing to minimize the predictable continual maintenance of the underlying masonry construction.

Chimneys, usually offset from the building perimeter, are also vulnerable to damage. The cause for damage to chimneys is usually found in a failure at the upper portion, where the flue(s) breach the topping material. Typically, the chimney is built with the flue extending a few inches above the top course of brick. A concrete topping is then installed, mounded to shed water similar to that of a pourable sealer pan on a roof. Predictably, the desired long-term performance of this type of detailing is rarely achieved. The concrete topping cures, shrinks, and cracks, establishing a path of least resistance for water, resulting in cracked flues, friable mortar joints, and spalled brick (*Figures 11A, 11B,* and *11C*). A properly designed and installed chimney cap can easily be fabricated using a variety of available sheet-metal products.

Figure 12 – Heavy concentration of efflorescence on the interior of outside walls is a clear indicator of moisture infiltration.

identified as free moisture that enters the confines of the wall-in section and is not presented on the building interior (*Figure 12*). These solid-wall structures were not afforded the benefit of current-era, cavity-wall construction; more specifically, the presence of a drainage plane intended to harmlessly discharge moisture from the component assembly. In some instances, efforts to introduce modern materials (through-wall flashings and weep systems) into the repair of solid wall construction may be impractical, as the surrounding components of the assembly fail to benefit from the perceived added value and cost of same.

Building Envelope Features

Building envelope features are defined as everything else in a given wall section – those portions of the vertical wall intended for shelter of the occupancy. Regarding the inspection of the façade, these features include but are not limited to terra cotta, granite, and sheet-metal cornice; window sills, heads, jambs, and multiple-wythe masonry construction. Many of the aforementioned rely on steel anchoring and support mechanisms, the majority of which (with the noted exception of window-head lintels) are usually concealed, buried in the very material for which it was originally installed, representative of a structural component of the assembly.

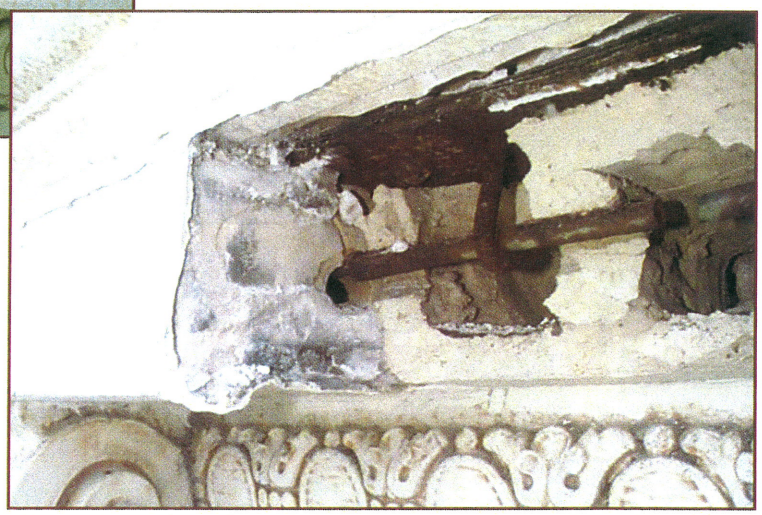
As discussed earlier, the strength of these buildings is found in their mass; unfortunately, the same favorable defining characteristic may be their Achilles heel. In the absence of a regularly scheduled maintenance program, these old buildings fall victim to time-weighted damage from passive leakage – that which is

Predictably, moisture-driven distress conditions in these components of the building envelope are most commonly seen at window heads where steel lintels are present, projections beyond the building foot-

Figure 13 – Damage to wood-framed, copper-clad cornice feature.

Left: Figure 14 – Terra cotta cornice classified as in an unsafe condition.

Below: Figure 15 – Concealed structural support mechanism for terra cotta cornice.



print in the form of cornice, and bands of alternating materials (where again, mild steel support mechanisms were commonly used as part of the original construction). Even wood-member joist heels set in pockets of the adjacent masonry that have rotted due to cyclical exposure to moisture may present unsafe conditions (*Figure 13*). Abandoned joist pockets not properly closed in conjunction with the removal of a projecting cornice feature can introduce free moisture into the wall section, accelerating damage to the building.

Terra cotta, by some measure the EIFS of the early 20th century (at the time, relatively inexpensive, affording the architects of the era creative license), may be considered one of the more vulnerable components of aged buildings. Widely used in projected cornices, some municipal codes contain terra cotta-specific language requiring scrutiny beyond that afforded cladding counterparts such as brick and cut limestone (*Figure 14*). An intricate pattern of J-hooks and steel rods (similar to re-bar) establishes the structural integrity of the assembly, tying the often cantilevered components to the balance of the building (*Figure 15*). Many historically significant buildings have cladding features fabricated of glazed and unglazed terra cotta. The repair of these ornate features often requires a mixed approach, utilizing salvaged pieces of the original construction in conjunction with selective replacement units made of GFRC (glass fiber reinforced concrete), pre-cast concrete or new cast terra cotta fabricated from molds representative of the original profile(s) (*Figure 16*). The most severely damaged terra cotta units are usually found at or below water tables in the assembly, locations that are increasingly vulnerable to damage from water entry.

Window-head steel lintels are a common source of wall distress conditions. These heavy steel angles were typically installed

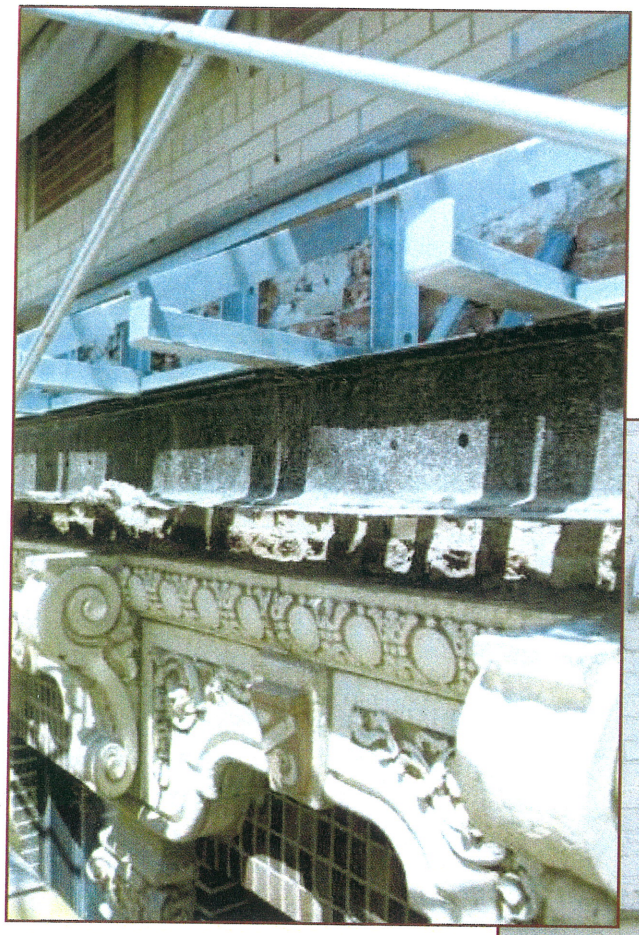


Figure 16 – Mock-up in area of removed terra cotta cornice with new steel framing intended as anchor points for replacement GFRC.

Figure 17 – Stair cracking common to window openings in solid wall construction.

as part of the original construction to carry the load of cladding materials across the span of a window-head opening. They can be affixed to the structural steel frame of the building, masonry back-up materials, or set loose, placed with the horizontal leg bearing on the exterior jamb-cladding component of the window opening. The process of corrosion and resultant volumetric expansion across the horizontal plane of the steel angle results in stair cracking, usually presented at the upper inside corners of the window opening (*Figure 17*).

Summary

Societal shifts have moved the emphasis from proactive maintenance – activities that might be viewed as an expense to the building owner – to a mindset centered on the perceived economies of little or no maintenance in the interest of the bottom line. It has long been said and generally accepted that roofs are an out-of-sight, out-of-mind component of the building envelope assembly. The findings of code-required inspections on wall-cladding features of existing buildings are clear indicators that the above-cited adage of complacency reigns on both the vertical (walls) and horizontal planes (roofs) of our built environment.

Undeniably, from the perspective of a building owner and service provider engaged in the practice of façade inspections, difficulties and limitations abound when considering the serviceability of the vertical plane or cladding features of our built environment. Most notably, the difficulties in access and the sheer extent of deferred maintenance and repair are of a magnitude that is deserving of a standard of care centered on providing the building owner with code compliance while recognizing potential budget limitations.

Clearly, some building owners have expressed discontent with the façade ordinance inspections as the attendant costs for rigging the building to facilitate the "hands-on" aspect of the work can range from $4,000 or $5,000 to tens of thousands of dollars. The repair and maintenance of defects identified through the inspection – a burden of cost passed on to the building owner – can easily range from a few thousand dollars to the millions. Building owners are encouraged to seek highly qualified engineers and masonry restoration contractors for assistance with these challenging projects.

Donald Kilpatrick

Donald Kilpatrick has been with INSPEC, Inc., since 1985. Don has performed numerous building envelope inspections on a variety of new and vintage structures. Information derived from the investigations has been used successfully in the development of design, repair strategies, and litigation support. Kilpatrick received the Horowitz Award for outstanding contribution to *Interface* journal in 2004.