PS 277 X

Introduction

Building ID	X277
School Level	PS
Address	519 Street Ann's Avenue Bronx, NY 10455
Cross Streets	E 147th & 148th Streets
NYC DOE District	07
SHPO Status	Eligible
SHPO ID	02PR3147
Flood Zone	Zone 6
FEMA Map	3604970083F
Architect	C.B.J. Snyder
Year Built	1897
Plan Form	Type-A
Style	English-Flemish Renaissance Revival
Internal Sq Ft	88,750
Classrooms	50
Stories	5 + Cellar
Structural System	Composite Masonry/Frame
Columns	Cast Iron
Beams	Steel
Floors	Round Terracotta Vaults
Roof	Copper, BUR (2011)
Cladding	Brick, Limestone, Terracotta
Backup	Brick, Terracotta

Between 1895 and 1897 C.B.J. Snyder designed and administered construction of what is now PS 277 Bronx, located on St. Ann's Avenue in the South Bronx. PS 277 X is 5 stories high, and distinguished by its light-colored face-brick, limestone, terracotta ornamentation, mansard roof and the spire at its center which served as a ventilation tower in the original design. The mansard roof was originally slate and was replaced with a standing seam copper roof at some point. The ventilation tower was sheet metal that was painted to look like oxidized copper. The structural system of PS 277 X is an example of early frame construction in Snyder's public schools; face-brick with brick and terracotta backup are supported by steel spandrel beams and cast iron columns.

Snyder attempted frame structures with terracotta infill to lighten supported loads in some of his 1890s schools. The experimental nature of this construction system appears to have proved problematic at an early date. The hollow brick-sized terracotta backup used, provided an easy path for water to pass through the building enclosure.

Years of moisture infiltration degraded the original mortar to an alarming extent, which contributed to the failure of all masonry elements. By 2008, emergency work was needed due to extensive leaking at the fifth floor and stairwells, leading to conditions of spalling and falling plaster that was deemed to be unsafe.

Fig. 6.1.1 - Before Rehabilitation

Fig. 6.1.2 - After Rehabilitation

Fig. 6.1.1 & 6.1.2
A 'before and after' image of PS 277 X highlighting the rehabilitation at the spire and ornamental features at the front facade. The building's composite French Renaissance/Gothic style was intended to reference the great institutions of old world Europe. These inspirational structures stand in stark contrast to the dark, unsanitary schoolhouses common in New York City throughout the 19th century. Courtesy: Sylvia Hardy

Methodology

Research

Prior to any definitive breadth of scope or design, information was obtained regarding the building's original construction and its history of remediation, alteration and addition. The SCA's Alchemy Database yielded original design drawings from 1895, as well as drawings from 16 other projects carried out at the school between 1920 and 2003.

In the SCA's Alchemy data base, only 19 drawings from the original design have survived, though some are not entirely legible due to their age. Readable drawings prove to be invaluable in the evaluation and design for the rehabilitation of these buildings and should be consulted, if possible. Drawings from more contemporary projects at the school also informed the evaluation.

The original design drawings of PS 277 X gave insight into observed design and construction flaws, while simultaneously guiding the rehabilitation and replacement of elements, which had fallen into disrepair. They also served as base drawings for diagramming and analyzing observed conditions, as well as a guide to the creation of construction documents.

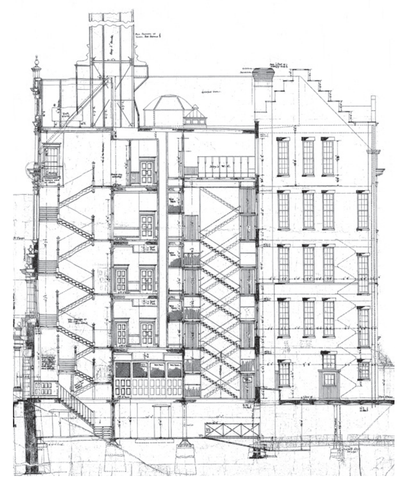


Fig. 6.1.3 (above)
Original 1895 building section, cut through the center of PS 277 X. The two central stair cores and the ventilation spire can be seen. Courtesy: SCA Alchemy

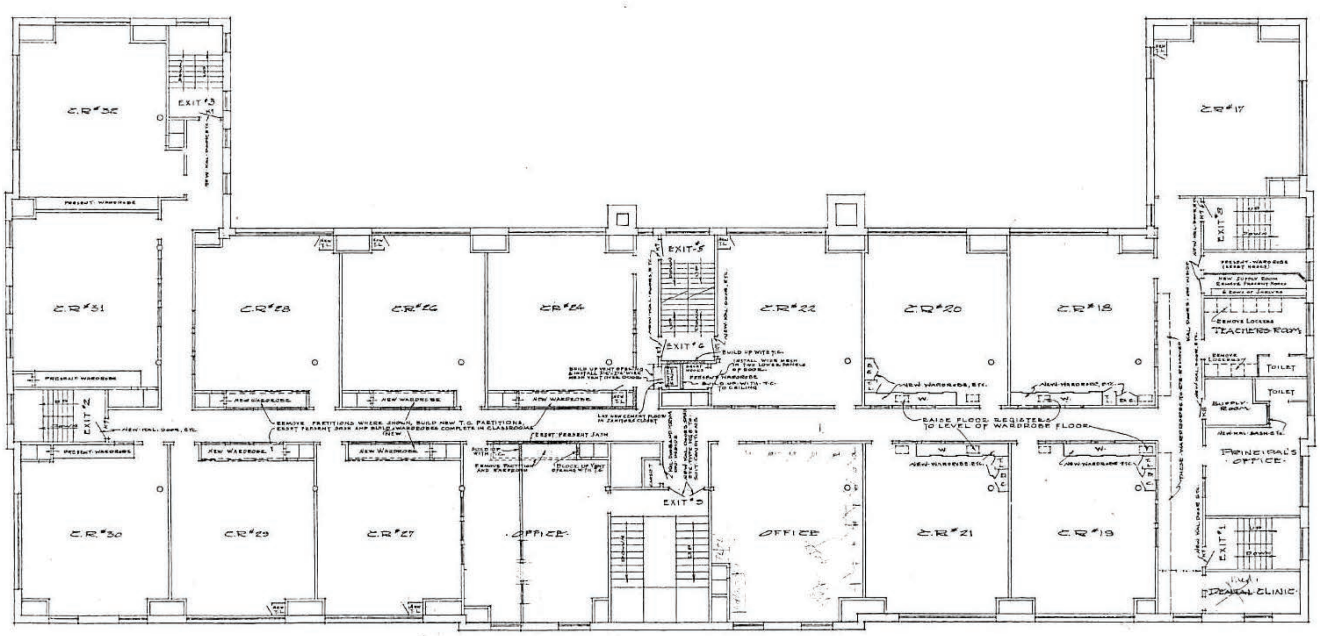


Fig. 6.1.4 (above)
Original 1895 third floor plan. Courtesy: SCA Alchemy

Observation & Mapping

Building Condition Assessment (BCAS) Reports were consulted, and two visual surveys of interior and exterior damage were performed; one survey was completed in July 2008 and the other in August 2009. Comparison of these surveys confirmed the continual and advancing water-damage at the school, and also helped to confirm where damage was due to water and where it was a matter of deferred maintenance. Extensive photographs and detailed field notes were processed into damage maps of the facades and floor plans using the existing original design drawings as base drawings. These damage maps facilitate the quantification of deficiencies and aid in determining the breadth of scope.

Fig. 6.1.5 (right)
Incomplete step flashing at the dormers, noted in a photographic survey, where thought to be a primary cause of water infiltration at fifth floor classrooms (see Fig 1.6). Courtesy: Nelligan White Architects

Fig. 6.1.6 (far right)
Water damage in a fifth floor classroom at the interior of the dormers. Some damage had been cosmetically repaired, however constant water infiltration as a result of improper flashings causes continual damage. Courtesy: Nelligan White Architects

Fig. 6.1.7 (below)
Damage mapping diagrams using the original 1985 elevations as base drawings. Courtesy: SCA Alchemy & Nelligan White Architects

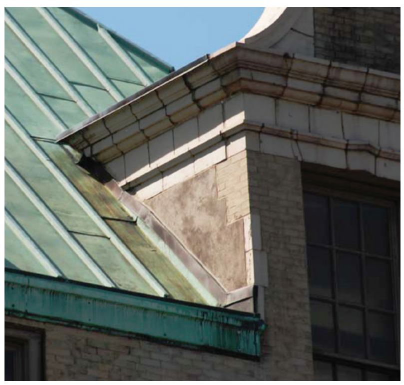


Fig. 6.1.5

Fig. 6.1.6

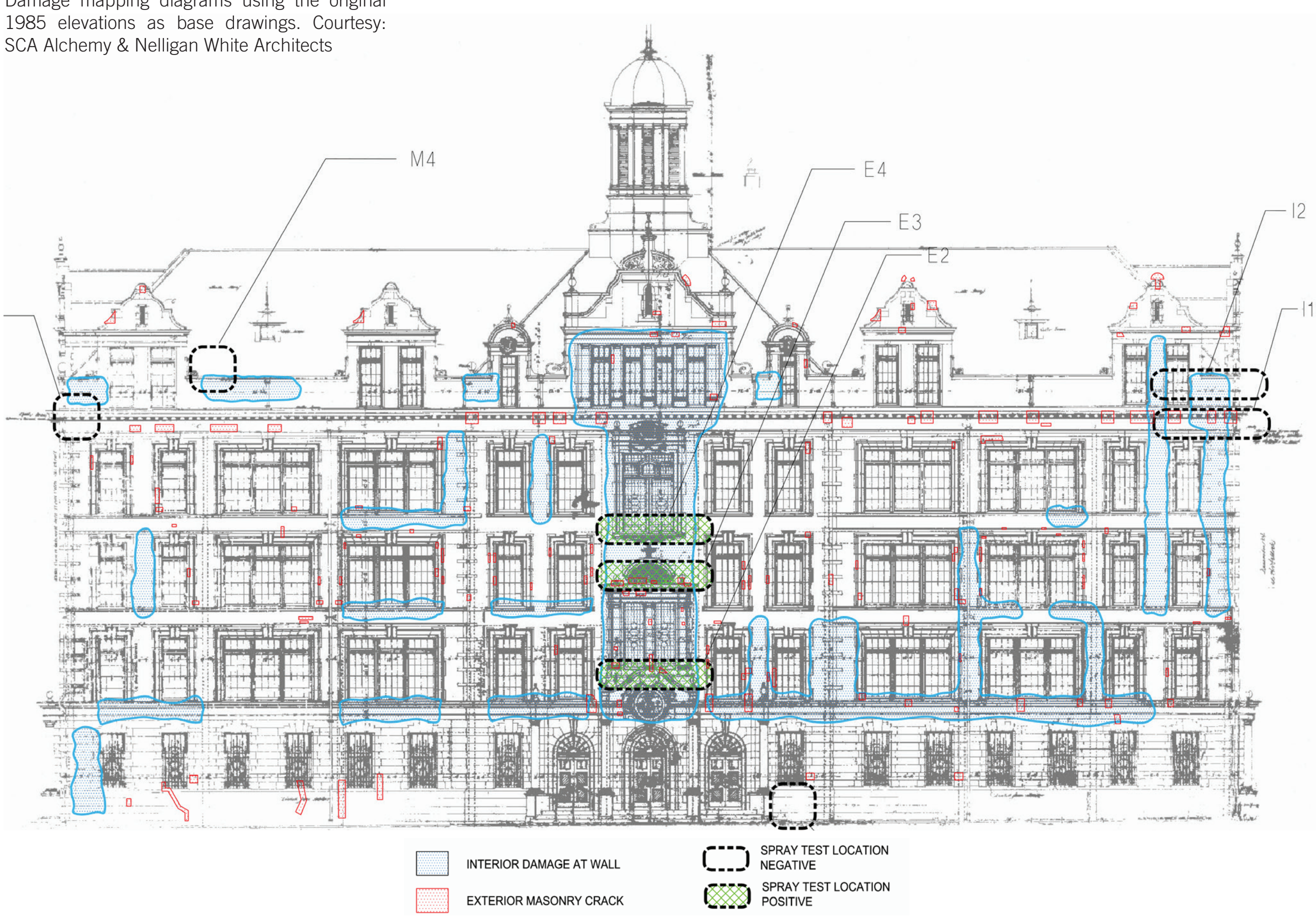


Fig. 6.1.7

Non-Destructive Testing

Early in the scoping phase, the SCA provided copies of an existing field report and an Assessment of Water Ingress Report, both completed by consultants in early 2008. The Assessment of Water Ingress Report presented the findings of a spray test regimen performed at PS 277 X. Using moisture metering and thermal imaging, these tests help to determine where water is penetrating the interior. While these tests are typically performed after the observation and damage mapping phase, in this case, the results of these early tests helped to confirm the validity of the damage mapping exercise, and further define the breadth of scope. For example, extensive damage was observed in the walls and ceiling of the central stairwell at the front of the building.

The Assessment of Water Ingress Report confirmed the continual infiltration of moisture, leading to the advance damage present. Additionally, water tests performed at the parapets and dormers confirmed that the cause of damage observed in fifth floor classrooms was ,partially, the result of observed deficient flashing techniques.

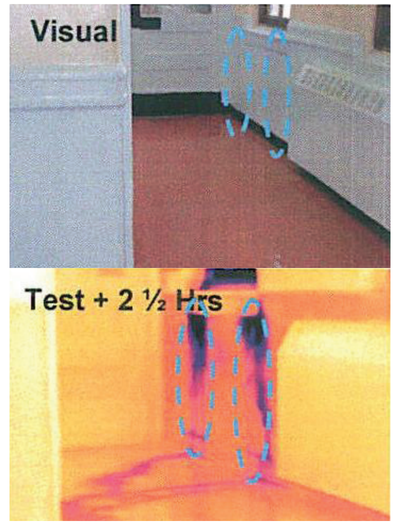


Fig. 6.1.8 (above)
Water damage visible below a window sill at the interior during a spray test. Infrared images note the differences in surface temperature, a strong indicator of moisture. Courtesy: GBG USA Inc.

Fig. 6.1.9 & 6.1.10 (bottom left - below))
Two images taken at the same location approximately a year apart indicate quickly progressing damage. Courtesy: Nelligan White Architects

Fig. 6.1.9

Fig. 6.1.10

Fig. 6.1.11
Exploratory probes revealed backup masonry and mortar to be mostly in poor condition. Courtesy: Nelligan White Architects

Fig. 6.1.12 (right)
Certain probes revealed wood blocking in locations where backup masonry should have been present. Courtesy: Nelligan White Architects

Fig. 6.1.13 (far right)
Lintels at the window heads were found to be rusted. Courtesy: Nelligan White Architects

Fig. 6.1.14 (below)
Probes were taken at selected locations in order to observe multiple conditions on the building. Courtesy: Nelligan White Architects

Exploratory Probes

Both the results of observation mapping and the Assessment of Water Ingress Report obtained from the SCA, guided the choice of locations for further investigation by exploratory probes. Using a boom lift, 17 probes were performed in October 2009, with the intent of evaluating the existing conditions of the building, inspecting the backup masonry and steel/iron framing, and to examine the condition of less accessible areas high on the buildings facades. Many of the observations were as expected; crumbing and disintegrating backup masonry and mortar, corroded steel, and moisture present inside the walls. In one location, century-old wood framing was found supporting masonry units. Recent repairs to the copper gutters at the upper portion of the building were observed to be ineffective, as there were underlying issues of failing masonry and cracked terracotta. Despite these deficiencies, the larger sections of cast iron columns were found to be in better than expected condition.

Fig. 6.1.12

Fig. 6.1.13

Fig 6.1.14

Materials Testing

During the inspection of probes, material samples of face-brick, backup brick, and mortar were collected for laboratory testing of compressive strength, absorption and chemical composition. These tests indicated that the mortar used for the face-brick, backup and terracotta is Type-O mortar, a weak mortar with high lime-putty content, typically used at the turn of the 20th century, but is not currently recommended for climates that go through regular freeze-thaw cycles, like that of the Northeastern United States. Type-O mortar is more susceptible to wash-out than other mortars with lower lime putty content, and this mortar was mixed with a slightly high water-to-cement ratio. The laboratory tests also show that the mortar is completely carbonated, which results in the lowering of the pH around ferrous elements, including steel cramp anchors. This lower pH reduces the alkaline protection that cementitous materials provide to ferrous metals. The corrosion of steel and to a lesser extent cast and wrought iron elements has accelerated in the presence of water.

Testing of the face-brick and backup brick showed that both conformed to modern compressive and absorption standards. These tests indicated that it was not the masonry itself, but poor workmanship and hollow cores of the terracotta backup which provided conduits for moisture travel through the masonry. These deficiencies caused washout of the mortar and degradation of all masonry and steel elements as an effect.

Fig. 6.1.15 (above)
During the evaluation of exploratory probes, samples of backup masonry and mortar were extracted for testing. Courtesy: Nelligan White Architects

Fig. 6.1.16 (below)
The results of material testing include a breakdown of the chemical makeup of masonry and mortar. Courtesy: SOR Testing Laboratories, Inc.

Fig. 6.1.17 (far below)
Material testing pointed to washout of the mortar as a main cause of degradation, caused by holes in the terracotta backup. Courtesy: Nelligan White Architects

Properties (*)	Results
% Total Air Voids	14.0
Water/Cement Ratio	Slightly High
Paste Quality	Poor (Weak)
Bond of Paste to Sand	Poor
Cement Hydration	Fully Hydrated
Secondary Deposits	Present – High
Alkali/Silica Reaction	None
Carbonation	Entire Sample Carbonated
Sand Type	Granitic

Fig. 6.1.16

Fig. 6.1.17

PS 277 X

Fig. 6.1.19 (below)
Construction document showing the scope of work at the dormers, roof and ventilation tower. Courtesy: Nelligan White Architects

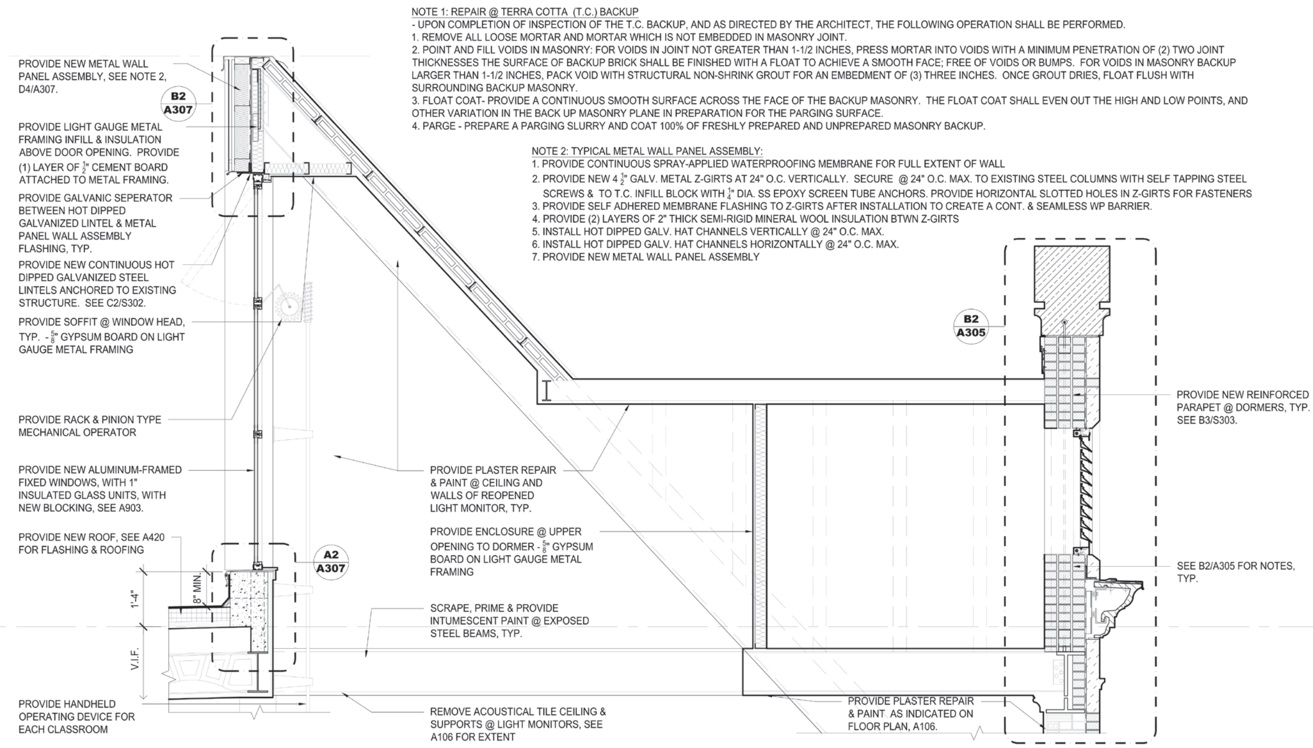


Fig. 6.1.18 (below)
Construction document showing the scope at the light monitors. Courtesy: Nelligan White Architects

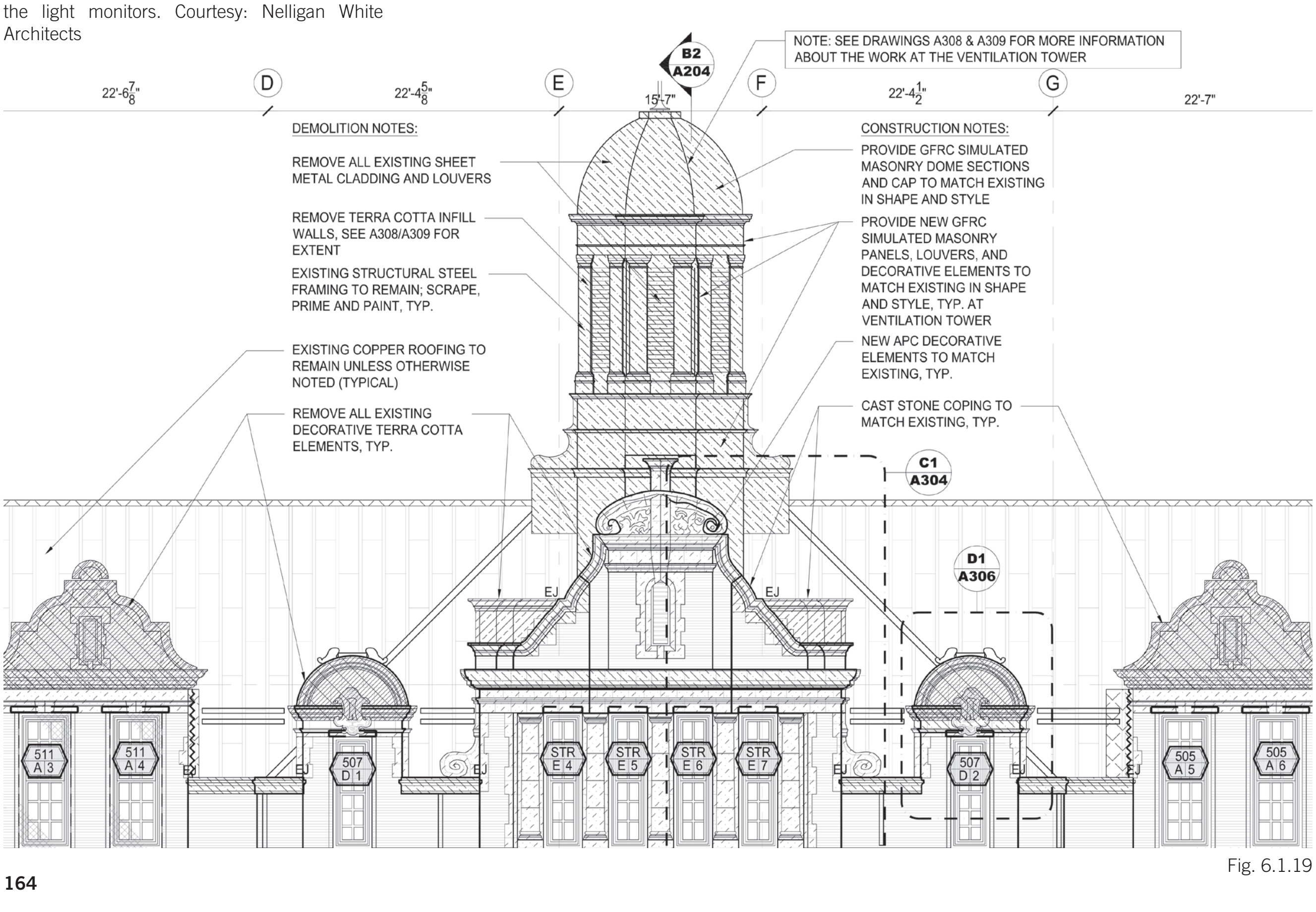


Fig. 6.1.19

Recommendations & Design

LLW No. 052210 – Roofs

Findings in the visual inspections, which were confirmed by the Assessment of Water Ingress Report, indicated that incomplete step flashing at the dormers was a major source of water infiltration thought fifth floor classrooms and stairwells. Standing water and split seams were observed at gutters; and leaders were observed to be in poor condition. The copper mansard roof was found to be in fair condition, thought the low-slope roof behind it was observed to be in very poor condition, by evidence of bubbling, cracking and missing ballast on the surface. Contact of dissimilar metals at several locations was noted, which may cause galvanic reactions and eventual deterioration as an effect. These findings prompted the following recommendations:

Fig. 6.1.20
Back side of the mansard roof before rehabilitation. Courtesy: Nelligan White Architects

1. **Mansard roof, flashing, gutters and leaders**
   - Replace gutters and leaders around the mansard roof.
   - Replace flashing at dormer returns and gable end walls.
   - Provide for replacement of batten seam copper roofing as necessary to install flashing and gutters.

2. **Back side of mansard light monitor and ventilation tower**
   - Remove all existing galvanized steel cladding & existing aluminum siding covering original light monitors.
   - Removal galvanized cladding from back of mansards, existing light monitors, flashings and framing where damaged.
   - Remove existing acoustic tile ceilings and light fixtures in rooms below the light monitors to allow for this work.
   - Repair or replace the damaged metal panels and components of the ventilation tower.
   - Expose, scrape, inspect, repair, paint, flash and fire protect existing exposed steel beams in 5th floor classrooms below light monitors, and replace if necessary.
   - Install additional height to existing concrete curb to comply with roofing manufacturers requirements, install stainless steel curb flashing.
   - Install new aluminum-framed tempered insulated glazed light monitor in original location.
   - Install new metal sliding, flashings and sealant at remaining walls behind the mansard roof as required.

Fig. 6.1.21
3D printed model of the ventilation tower structure, used in the design process of the tower's replacement. Courtesy: Nelligan White Architects

3. **Low-Slope Roof**
   - Remove and replace existing roof ballast, membrane, flashing, insulation and sheathing.
   - Install new base flashing.
   - Repair fill and screed as necessary to achieve proper pitch and surface for new roof.

Fig. 6.1.22
Newly installed lead-coated copper at facade elements. Courtesy: Nelligan White Architects

Fig. 6.1.23
Masonry and architectural precast concrete mock-up. Courtesy: Nelligan White Architects

Fig. 6.1.24
Narrow cavity drainage plane and copper flashings in construction. Courtesy: Nelligan White Architects

Fig. 6.1.25
Spray applied membrane installation. Courtesy: Nelligan White Architects

Fig. 6.1.26 (right)
Construction document detailing the components and sequence specified for masonry cavity walls. Courtesy: Nelligan White Architects

LLW No. 052211 – Exterior Masonry

Findings based on visual inspection, and confirmed by non-destructive and material tests prove that a major cause of water infiltration is through the backup masonry and failing mortar. Though exterior face-bricks were found to be in fair condition, the surrounding mortar, backup brick, and terracotta were found to be in a state of advanced deterioration. Some lintels and sills were also found to be deteriorated, which contributes to cracking of the masonry through rust jacking. Terracotta ornament of the exterior was observed to be cracked and deteriorated in some places. These findings prompted the following recommendations:

1. **Facades**
   - Remove and replace all face brick on North, East, and South facades.
   - Fill voids in the face of the masonry backup, point and parge.
   - Spray, apply liquid membrane waterproofing, attach narrow cavity drainage plane and weeps.
   - Install relieving angles at each floor spandrel.
   - Remove and replace terracotta ornament at string courses, dormers, windows and entrances.
   - Scrape, paint and flash existing iron/steel at all columns and spandrels exposed at exterior walls, provide steel repairs when necessary.
   - Repair stucco at West façade, incorporate spray applied membrane waterproofing, 3” mineral wool insulation, drainage fabric and 3 coats stucco on furring channels and stainless steel lath with control joints.
   - Replace sills and exposed lintels on west facade.

2. **Limestone Base**
   - Repair cracks and other damage at limestone base with limestone repair mortar.
   - Strip all paint, re-point and coat limestone base with vapor-permeable pigmented elastomeric coating.

3. **Interior finishes**
   - Repair all interior finishes at walls/ceilings, including plaster and paint.

4. **Cellar**
   - Strip existing paint, repair and repoint brick foundation walls, coat with vapor-permeable pigmented elastomeric coating.

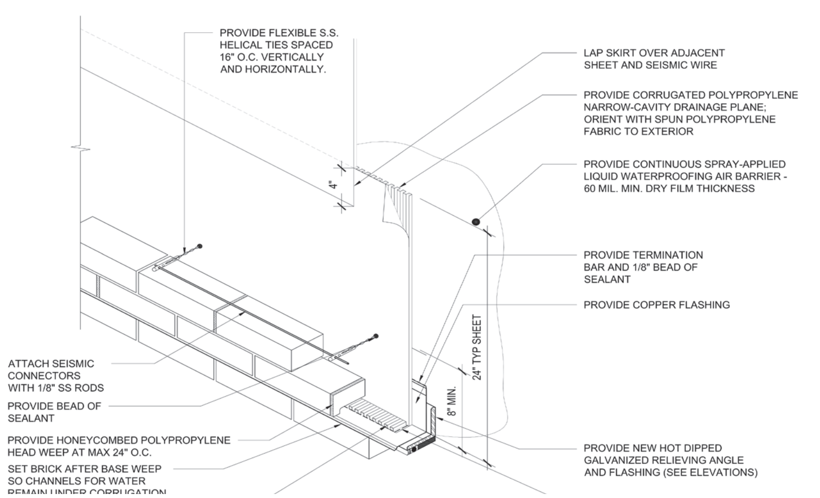


Fig 6.1.27

LLW No. 064691 - Parapets

Original design drawings, visual observations and probe investigations confirmed the absence of through-wall-flashing at the parapets. Probes along with the Assessment of Water Ingress Report confirmed that water passing through the back side of the parapet, was a significant source of damage at the top floor. These findings prompted the following recommendations:

1. Parapets

- Remove and replace existing masonry parapet with expansion joints, through-wall flashing, coping stones and scupper drains.

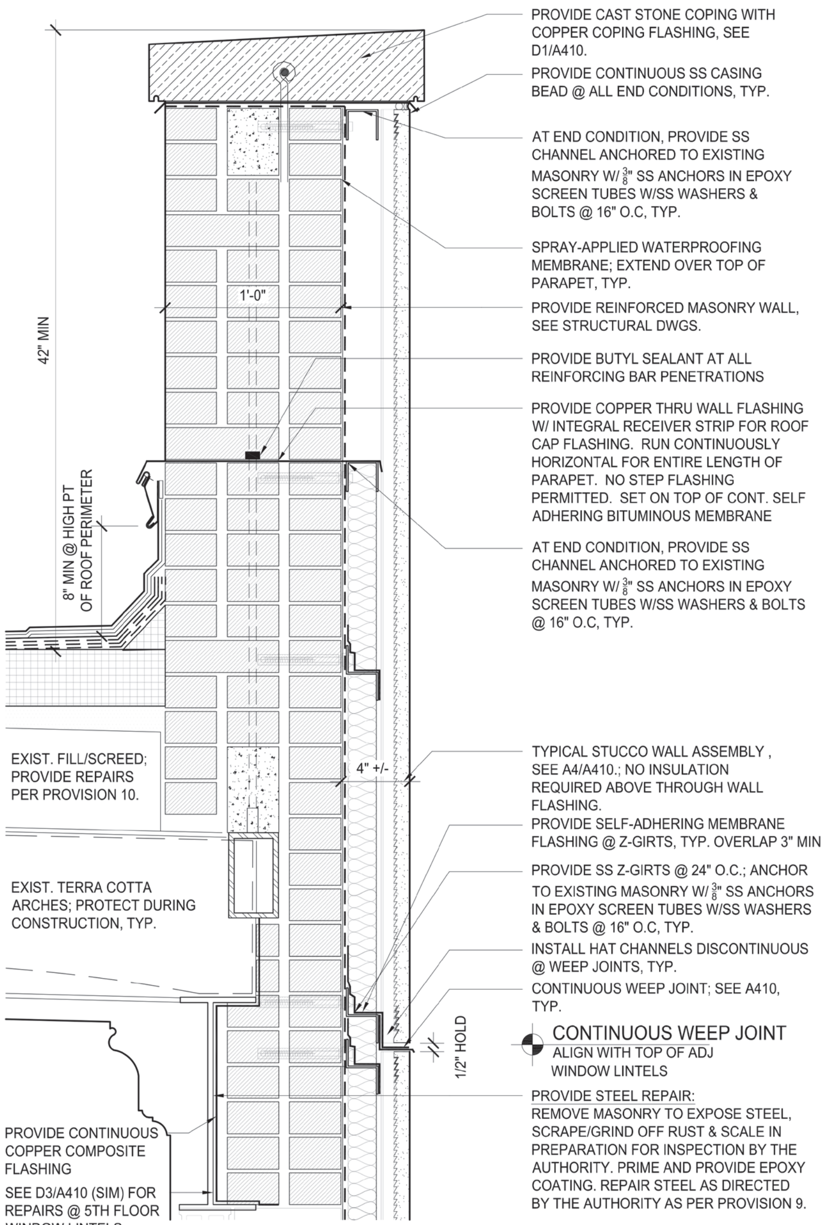


Fig. 6.1.30

Fig. 6.1.27
Before rehabilitation, base flashing at parapet was not continuous. Courtesy: Nelligan White Architects

Fig. 6.1.28
Through-wall flashing during installation. Courtesy: Nelligan White Architects

Fig. 6.1.29
Parapet mock-up with through wall flashing and truss reinforcing. Courtesy: Nelligan White Architects

Fig. 6.1.30 (left)
Construction document, assemblies at the parapet and stucco wall. Courtesy: Nelligan White Architects

PS 277 X

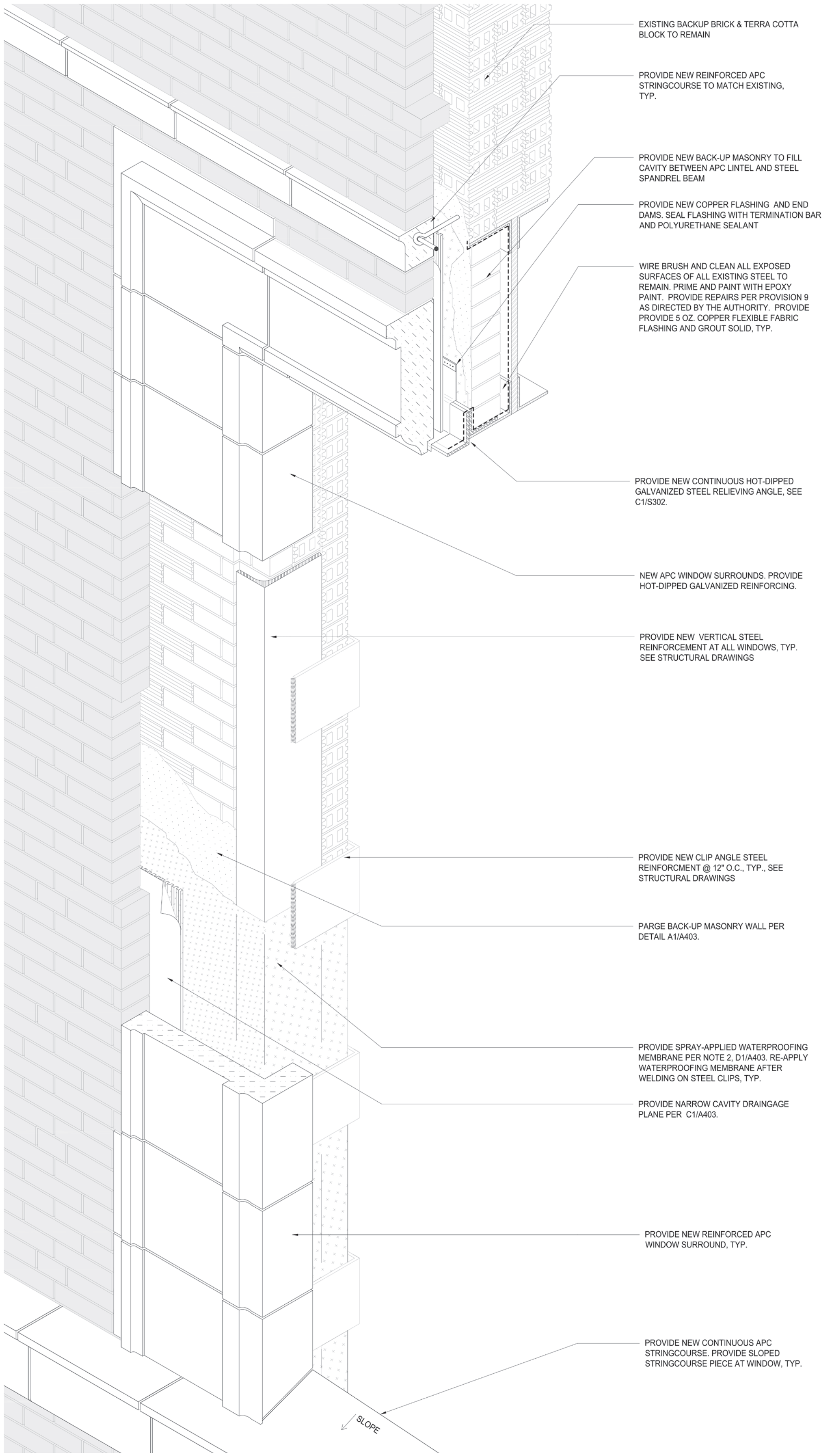


Fig. 6.1.33

LLW No. 064169 – Windows

Findings based on visual inspection and building history revealed that the windows were not original, but aluminum replacements, and were observed to be in fairly good condition. However, spray tests confirmed the sources of water damage below windows observed during the visual inspection. In many instances where aluminum windows have been installed, the original wood casements were left in place and used as blocking. These casements included the vertical hollow sections required for the original counterbalances.

Leaving these hollow frames in place has proved a nearly universal conduit for water to travel, whether it has entered through the surrounding masonry, or through faults in the perimeter window or aluminum window assembly. This kind of failure often exhibits itself as a "plume" of damage to the interior finish below the window at each end and below intermediate mullions. Thermal imaging of spray tests at PS 277 X confirmed this as one of the primary sources of interior water damage. These findings prompted the following recommendations:

Fig. 6.1.31
Peel and stick flashing and wind girts at the window opening during installation. Courtesy: Nelligan White Architects

Fig. 6.1.32
Two wind girts at window openings during installation. Courtesy: Nelligan White Architects

1. Window Openings

- Remove, store and protect all windows.
- Clean and parge the sides of all masonry openings.
- Install continuous pressure treated wood blocking, with self adhered flexible flashing and injection foam insulation, reinstall windows.
- Repair damaged plaster at interior, install and paint new wood trim, stool and apron.
- Test, remove, store, retest and reinstall existing air conditioning units with new brackets.
- Remove, scrape, paint and reinstall existing window guards.
- Remove, store and reinstall window shades.

It has been observed that many frame-constructed buildings from the late 19th century, and even some constructed as late the 1950s, had no provision for transferring wind loads from the building enclosure to the frame. At PS 277 X, the backup terracotta masonry simply sat within the frame of iron columns and steel spandrels and had stayed in place by gravity and good fortune. Where long spans of masonry occur between the floors, deflection under design wind loads would allow the masonry to crack. The short "knee-wall" below window openings provided almost no resistance to wind loads at the windows.

Cracking and flexing of the structure over the years has contributed to water penetration into the building. When face masonry is removed, the new building enclosure must be designed to accommodate code wind loads. At PS 277X this new structure has taken the form of "wind girts" – steel angles spanning vertically from spandrel to spandrel at each window opening and horizontal angles below each window sill. The intention of these girts it to reduce the span of each section of masonry to reduce its deflection under wind loads to a very small value, less than L/600, in order to prevent cracking of the masonry.

Fig. 6.1.33 (far left)
Assemblies for rehabilitation at the window openings. Courtesy: Nelligan White Architects

Fig. 6.1.34
Interior of the ventilation tower before cleaning. The ventilation system was abandoned decades prior, and nesting birds in the tower and shaft system contributed to concerns regarding poor/dangerous air quality. Courtesy: Nelligan White Architects

Fig. 6.1.35 (overleaf)
Construction document detailing the replacement of the ventilation tower. Courtesy: Nelligan White

Fig. 6.1.36
Structure at the interior of the new ventilation tower. Courtesy: Nelligan White Architects

LLW No. 064692 – Heating Plant Upgrade/Ventilation/Mechanical

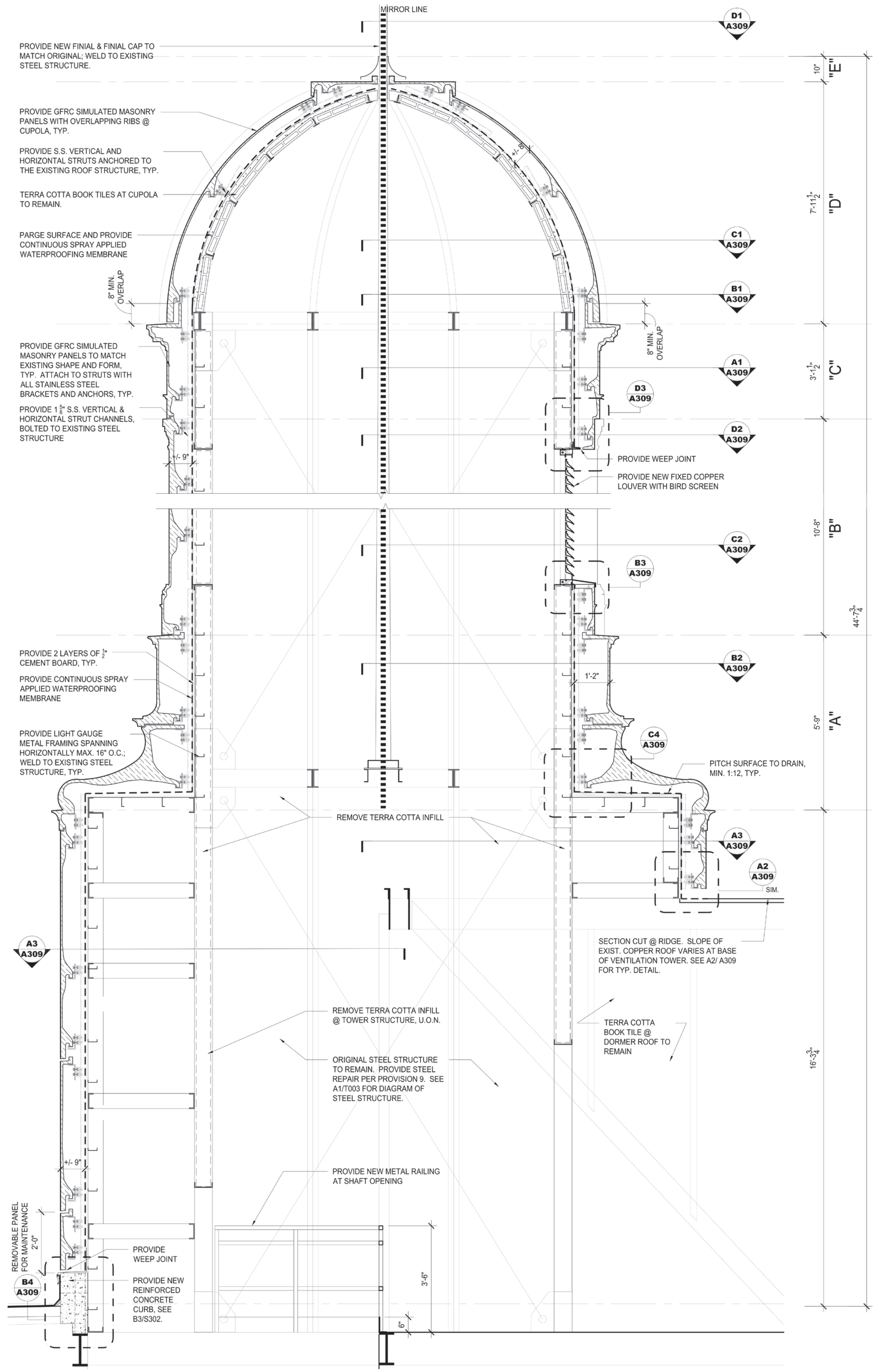
Under the original 1895 design, ventilation of occupied spaces was accomplished using a mechanical system with distribution in the cellar, vent risers in a central shaft connected to the spire which doubles as a ventilation tower, and horizontal distribution to classrooms. But the entire distribution system in the cellar had been removed at some point, leaving the duct risers abandoned. Registers in each classroom were covered with sheet metal or filled with concrete.

There presently exists no system for ventilation to classrooms and assembly spaces throughout the building, which stands as a code violation. It was observed that pigeons were nesting in the main duct risers, and had filled the ducts with large amounts of waste which posed a health hazard. While installing new mechanical ventilation systems was beyond the scope of this exterior rehabilitation, it was agreed that this project should address the breach in fire separation between the floors of the building created by the original exhaust ventilation shafts, which had open louvers at each floor. These findings prompted the following recommendations:

1. Duct Work

- Clean ventilation tower using industry and SCA accepted methods.
- Remove covers on existing register shaft openings.
- Provide new fusible link fire dampers and sheet metal covers at each exhaust register location.

Fig. 6.1.36



MIRROR LINE
PROVIDE NEW FINIAL & FINIAL CAP TO MATCH ORIGINAL; WELD TO EXISTING STEEL STRUCTURE.
PROVIDE GFRC SIMULATED MASONRY PANELS WITH OVERLAPPING RIBS @ CUPOLA, TYP.
PROVIDE S.S. VERTICAL AND HORIZONTAL STRUTS ANCHORED TO THE EXISTING ROOF STRUCTURE, TYP.
TERRA COTTA BOOK TILES AT CUPOLA TO REMAIN.
PARGE SURFACE AND PROVIDE CONTINUOUS SPRAY APPLIED WATERPROOFING MEMBRANE
8" MIN. OVERLAP
PROVIDE GFRC SIMULATED MASONRY PANELS TO MATCH EXISTING SHAPE AND FORM, TYP. ATTACH TO STRUTS WITH ALL STAINLESS STEEL BRACKETS AND ANCHORS, TYP.
PROVIDE 1 5/8" S.S. VERTICAL & HORIZONTAL STRUT CHANNELS, BOLTED TO EXISTING STEEL STRUCTURE
+/- 9"
PROVIDE WEEP JOINT
PROVIDE NEW FIXED COPPER LOUVER WITH BIRD SCREEN
PROVIDE 2 LAYERS OF 1/2" CEMENT BOARD, TYP.
PROVIDE CONTINUOUS SPRAY APPLIED WATERPROOFING MEMBRANE
PROVIDE LIGHT GAUGE METAL FRAMING SPANNING HORIZONTALLY MAX. 16" O.C.; WELD TO EXISTING STEEL STRUCTURE, TYP.
1'-2"
PITCH SURFACE TO DRAIN, MIN. 1:12, TYP.
REMOVE TERRA COTTA INFILL
SIM.
SECTION CUT @ RIDGE. SLOPE OF EXIST. COPPER ROOF VARIES AT BASE OF VENTILATION TOWER. SEE A2/ A309 FOR TYP. DETAIL.
REMOVE TERRA COTTA INFILL @ TOWER STRUCTURE, U.O.N.
TERRA COTTA BOOK TILE @ DORMER ROOF TO REMAIN
ORIGINAL STEEL STRUCTURE TO REMAIN. PROVIDE STEEL REPAIR PER PROVISION 9. SEE A1/T003 FOR DIAGRAM OF STEEL STRUCTURE.
PROVIDE NEW METAL RAILING AT SHAFT OPENING
REMOVABLE PANEL FOR MAINTENANCE
2'-0"
PROVIDE WEEP JOINT
PROVIDE NEW REINFORCED CONCRETE CURB, SEE B3/S302.
3'-6"
6"
D1 A309
C1 A309
B1 A309
A1 A309
D3 A309
D2 A309
C2 A309
B3 A309
B2 A309
C4 A309
A3 A309
A2 A309
B4 A309
10" "E"
7'-11 1/2" "D"
3'-1 1/2" "C"
10'-8" "B"
5'-9" "A"
16'-3 3/4"
44'-7 3/4"

Fig. 6.1.35

Constructability & Lessons Learned

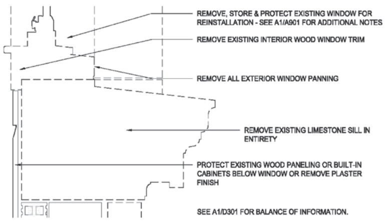


Fig. 6.1.37
Recommended details for the second floor window sill. Courtesy: Nelligan White Architects

Fig. 6.1.38 (overleaf - top) & 6.1.39 (overleaf - bottom)
Extreme corrosion in the gables. Courtesy: Nelligan White Architects

While means and methods are strictly beyond the responsibility of the designer, more thought must be given to constructability at buildings belonging to this age, than for new construction projects, or for rehabilitation of more recently constructed existing buildings. Because of its age, experimental construction, and the limited number of available original drawings, PS 277 X provided some surprises in the form of discovered conditions, and some challenges in terms of construction, phasing and constructability.

Removing the existing masonry from the outside-in, rather like removing layers of an onion, provided something new at every turn. Because this is so often the case, this guide recommends that contract documents require a survey of the existing facade be prepared by a licensed surveyor and provided at the contractor's expense, both before and after demolition.

The purpose of the survey is to determine how straight level and plumb the existing conditions are – and to determine variation between the face masonry and backup masonry in this regard. This provides the project team the opportunity to solve problems in construction tolerances early on, and to head off potential change order claims if sloppy removals 'create' out-of-plumb, or out-of-plane conditions at the backup. At PS 277 X, a number of conditions quickly revealed themselves:

1. In many locations, parts of the masonry construction showed this building to be more composite in nature and not conceived as a pure frame and enclosure structure as a modern building would be.

2. Rather than being embedded one or two wythes into the backup masonry, hollow terracotta window sills extended entirely through the walls, supporting the windows and the terracotta surround. These sills were hollow, fragile, and in many cases cracked and broken. They were removed and backup masonry was used from the project provisions to re-mediate the problem.

    - Variation in details – Even though there were few original drawings available, there was substantial departure from them in the actual construction of the building, and variations from one place to another on the building. These examples show instances where these discoveries increased the project scope, reduced it or had no effect upon it.
    - Similarly, where the pitched mansard roof meets the street facade, no spandrel beam was installed, and the roof beams bear directly upon the exterior masonry and not the iron and steel frame. A steel spandrel beam was installed as a change order to correct this existing condition.
    - The building has three entry porticoes constructed of limestone bases with terracotta above the street level. The small entries at the north and south are apparently identical, but constructed quite differently – the one side there is steel framing, at the other load-bearing masonry. This could be the result of two different crews building the two different sections.
    - At the west facade, the window lintels were made up of several parts: an exposed steel channel and a concealed lintel supporting the backup. These backup lintels varied, some were made from steel, others from cut bluestone, with no particular pattern to their variation.

Fig. 6.1.38

Fig. 6.1.39

Fig. 6.1.40 & 6.1.41 (above - below)
Cast iron columns and the very heavy built-up spandrel beams were in remarkably good condition. Courtesy: Nelligan White Architects

3. Three conditions were discovered at the terracotta quoins at the outside corners of the building. First, the masonry cover over the corner of the iron column was minimal – less than 1 inch thick. The detail had to be adjusted to allow for flashing and a minimum allowed thickness – 3" – for the new APC quoin. Second, the iron columns were I-shaped but had large openings in the webs which required new attachment details. Third, one of the iron columns was discovered to be cracked – evidently a manufacturing flaw rather than a failure in service. As cast iron cannot, practically, be welded, bolted connections were required for the APC attachments and for the crack repair. Such connections required drilling holes through the flanges of the iron column, an operation that required specialized equipment and training to drill at very slow RPM to avoid cracking the iron.

4. The cast iron, wrought iron, and steel throughout the building exhibited a range of conditions. The cast iron columns and the very heavy built-up spandrel beams (with angle flanges thicker than 1") were in remarkably good condition – in some areas the original red-lead primer was still intact. Lighter steel sections – particularly the channels and angles used to frame the dormers were severely corroded to the point where they were almost non-existent. (See image) Wrought iron cramps fared better than light steel sections, however, even moderate corrosion where they were embedded in terracotta caused 'rust-jacking' failures.

Fig 6.1.41

5. The most significant discovery was the extent to which the terracotta backup had contributed to the building's water related failures. Probes show the terracotta to be brick sized, and hollow with the cores oriented in the long direction of the tile rather than up-and-down like modern cored brick. Thus, any headers present the cores running perpendicular to the facade. Some of these were seen in probes and considered a source of water infiltration. When the face brick was removed, it was discovered that a header course was installed in the backup every 5^{th} or 6^{th} course,creating continuous lines of leaks through the building envelope.

6. Window removal and re-installation, just like the installation of new windows is always challenging from a construction phasing point of view. At PS 277 X, the school originally offered to provide one classroom at a time as "swing space", to allow the contractor to proceed with this work in a timely manner. During the course of the project, the school's space needs changed and the swing space was simply unavailable. This forced the contractor to perform all the window removal and reinstallation during the summer recess, which made this a significant component of the project schedule's critical path.

7. The wind-girts were designed as angles running from spandrel to spandrel at each window opening, with a cross angle set below the window sill. One leg of each angle is set flush with the backup masonry, the second leg set perpendicular – between the window jamb and the backup masonry, and between the window sill and the backup masonry. The angles were designed to clamp the wall with short pieces set from the inside of the wall and welded to the girts. Even though this piece of work could be most easily performed with the windows removed, to maintain any progress at all, it was essential to de-couple this piece of work from the removal and re-installation of windows. It proved to be possible to chop the terracotta backup with the windows in place and slide one leg of the angle into the cut. The cut was grouted and temporary dowels installed until the windows were removed during the summer and the clip angles were installed. This allowed the masonry work to be completed before the removal and re-installation of windows.

8. One of the most effective components of the entire approach to this rehabilitation is the installation of a continuous spray applied air/water barrier. Spray application is essential to avoid voids and holes (i.e.,"leaks") and the best systems come with a peel-and-stick membrane flashing for terminations and penetrations. Such systems compensate for a host of deficiencies in the existing backup that must necessarily remain, and truly keep water out of a building. Better yet, they reduce air infiltration through masonry walls nearly to zero, which has a profound effect on the comfort and energy use of these schools.

Fig. 6.1.42
Probe observing terracotta backup. Courtesy: Nelligan White Architects

Fig. 6.1.43
Aluminum window reinstalled. Courtesy: Nelligan White Architects

Fig. 6.1.44
Existing backup prior to spray application. Courtesy: Nelligan White Architects