New York City's Historic Schools

A History and Guide to Rehabilitation

NYC SCHOOL CONSTRUCTION AUTHORITY

NYC School Construction Authority

Courtesy: Sylvia Hardy

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FOREWORD

The New York City School Construction Authority, through its technical design and construction departments and with the assistance of the technical professional community, acts as steward of the physical fabric of New York City's public schools. Since its creation in 1989, the Authority has been responsible for the design and construction of capital replacement and rehabilitation projects for the 1,400 school buildings under the jurisdiction of the NYC Department of Education.

This Guide has been developed as a practical and technical resource to assist in the evaluation and design for the restoration of historic school buildings (more than 45 years old). It is worth noting that over half of our public school buildings are more than 60 years old! It is our intention to facilitate strategies for these projects that will target cost effective solutions while at the same time respecting their historic standing as landmarks in the community.

New York City has a broad variety of historically significant schools of varying architectural and structural styles, and the so the Guide gives advice as to methodologies for the rehabilitation or replacement of similar historic systems and materials. While we see some recurrence of materials and systems, the historic schools designs were continually improved and updated, so it is safe to say that no two schools are identical. The case studies included here provide insights for Architects and Engineers for design and construction practices.

I want to thank the staff at SCA, our consultant design partners, and the New York State Historic Preservation Office for all of their input and professionalism on the many renovation projects we have undertaken to benefit our historic schools building. Special thanks go to Bruce Nelligan, Architect, who has not only been involved in many renovations, but also wrote and coordinated this Guide, and to the firms of RKT&B and Superstructures who contributed case studies. Putting together this guide could not have been accomplished without the input of key SCA staff: George Roussey, Tom Nielsen and Effie Tsitiridis.

It is all of our hope that this guide offers an opportunity for technical professionals to better understand school design and construction of the past, so that they may apply the lessons learned to restoration work of historic schools in the future.

E. Bruce Barrett
Vice President, Architecture & Engineering
New York City School Construction Authority

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INTRODUCTION

Fig. 1.1
Education. Courtesy: Google Images

Fig. 1.2
Voting for local/federal elections. Courtesy: Google Images

Fig. 1.3
Civic life (Opera Dolce performed at Washington Irving High School). Courtesy: Google Images

The New York City Department of Education is currently the largest school district in the US, serving 1.1 million students in 1,620 buildings and additions located throughout the five boroughs of New York. More than half of these buildings are over 50 years old; throughout the city century-old buildings are still essential resources for education and civic life. Many of these buildings are historically significant, because of their architectural qualities, or because of their association with significant people or events. They enhance our lives and contribute to the rich fabric of New York.

For the entire nation, public schools are part of an aging infrastructure, where many buildings have outlasted any useful lifespan that might have been imagined when they were constructed, and are in need of rehabilitation and modernization.

This guide has been created to assist in the SCA's stewardship of these buildings, in support of its mission *"to design and construct safe, attractive and environmentally sound public schools for children throughout the many communities of New York City".* It documents the SCA's efforts of the last two decades to rehabilitate and modernize some of these schools to continue to serve the purpose for which they were conceived.

The Guide is organized into three main parts:

1. The first section is a history of public schools in NYC, including a history of architectural styles and plan typologies.

2. The second section is a technical guide for rehabilitation which includes the evolution of structural typologies; an overview of materials and systems; an overview of the Secretary of the Interiors Standards for the Treatment of Historic Properties; and recommendations for design methodology.

3. The third section includes 17 case studies of completed rehabilitation projects that illustrate a range of solutions for buildings of different age and construction.

Additionally, there is an epilogue and bibliography, to allow readers to go to the original sources for the material and a searchable Microsoft Excel database of the buildings to allow easy extraction of data on the individual buildings.

It is hoped that in the future, more case studies will be added to the guide to help build the SCA's institutional knowledge of its historic schools.


Courtesy: Sylvia Hardy

OVERVIEW

Fig. 1.1.1 (Below)
Graph depicting NYC Public Schools built every decade, juxtaposed to the respective era of school organizations and the rise in population. The figure also indicates the period of documentation covered by the 1937 AIA Report. Retrieved from:

- Migration Policy Institute. *US Immigration trends and History.* Web. *(http://www.migrationpolicy.org/programs/data-hub/us-immigration-trends#history)*
- Snyder, Thomas. D. (1993). *120 Years of American Education: A Statistical Portrait.* Washington, D.C.: United States Department of Education. Web. *(https://data.cityofnewyork.us/City-Government/2020-population/t8c6-3i7b)*
- New York City Planning. *Decennial Census - Census 2000 & Historical Population information. Web. (https://www1.nyc.gov/site/planning/data-maps/nyc-population/historical-population.page)*
- 2020 Population (2000). *New York City Open Data. Web. (https://data.cityofnewyork.us/City-Government/2020-population/t8c6-3i7b)*
- Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London.

In examining the portfolio of buildings in the New York City School system, the existing buildings fall into three readily identifiable chronological groups which correspond to three booms in school construction. These periods span, roughly, from 1890 to 1930, from 1950 to 1970 and from 1990 to today. Separating the booms are two periods (the first was the 1930s and 1940s, the second in the 1970s and 1980s), during which school construction slowed down dramatically. Some of the older schools have been demolished or have been decommissioned as schools and adapted to other uses, but a surprising number of schools dating from the first three decades of the 20th century are still in service.

Of the schools constructed prior to 1900, only 53 schools are still existing and active, and of those, only 14 date before 1890. The distribution of school buildings by age reflects the historical demand, namely population growth, and particularly population growth of school-aged children.

During the 20th Century, the population of United States grew from about 75 million to over 280 million people. In New York, the growth at the turn of the 20th century was remarkable. Between 1892 and 1924, the peak years of immigration[1] to the United States, 22 million immigrants, passengers and crew entered through Ellis Island and the Port of New York. While most people passed through New York and relocated elsewhere, many remained. New York City in 1890, which then included Manhattan and the Bronx, had a population of 1.5 million.

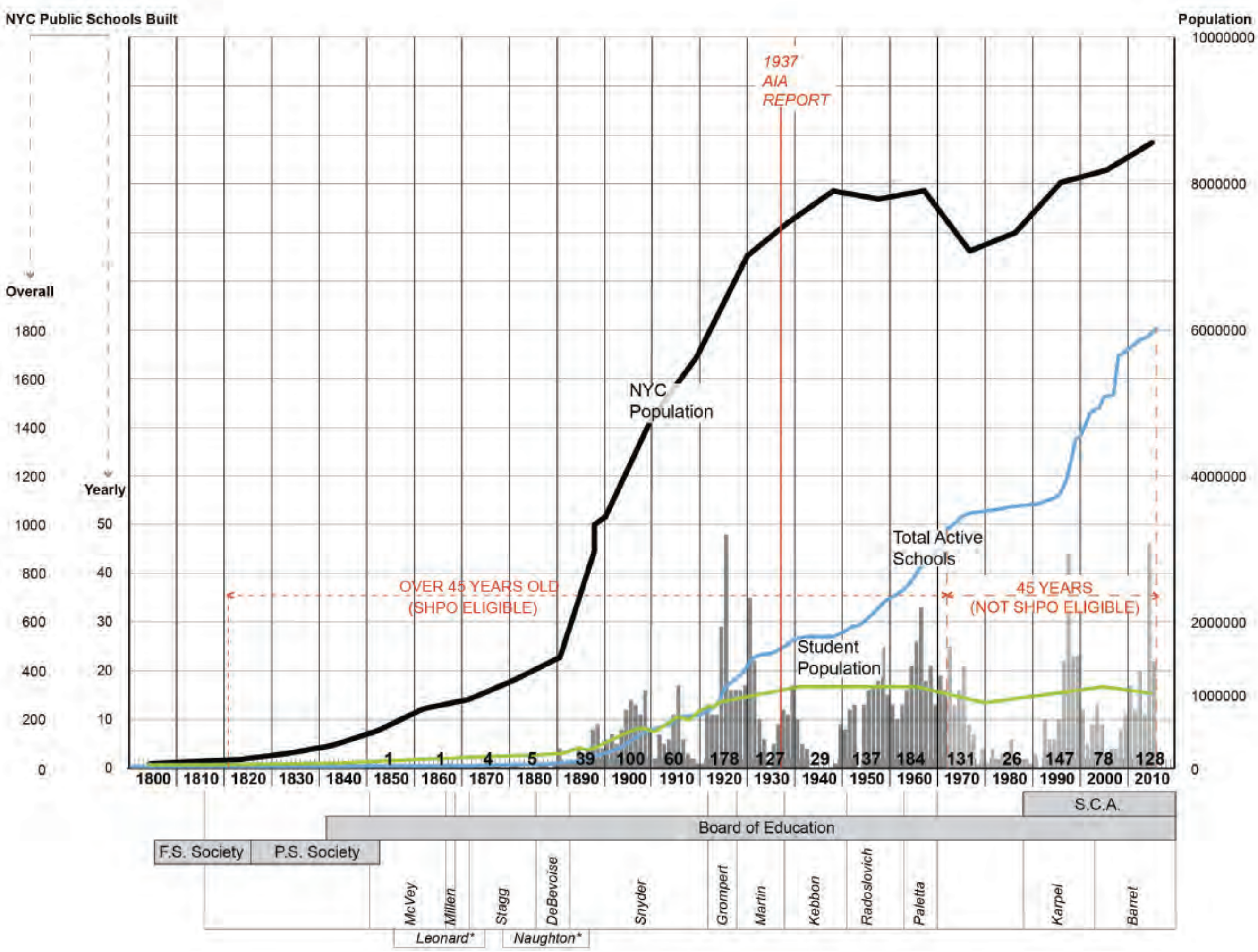

Fig. 1.1.1

Dramatic rates of immigration, and the consolidation of the five counties into the City of Greater New York, spurred population growth to 3.4 million by 1900, 5.6 million by 1920, and to 6.9 million by 1930.

To accommodate this growth, construction of new infrastructure was essential. After the consolidation[2] in 1898, bridges, subways and elevated trains knit together the five boroughs and paved way for an easier commute to new skyscrapers that rose in Manhattan (Fig. 1.1.2 & Fig. 1.1.3). Infrastructure reached out to these boroughs and new neighborhoods were planned and developed around mass-transit and public schools. Between 1891 and 1929 (1891-1923), over 570 schools were constructed or expanded, to accommodate a growth in enrollment from 140,000 to 906,000 students. The innovative building designs and construction techniques revolutionized public school education. By 1929, New York's public schools were considered to be the best schools in the country.

By the end of the 1920s, three factors contributed to a '*demographic trough'* that eliminated demand for new school construction. The Immigration Act of 1924 reduced immigration to a trickle; the Great Depression reduced birthrates as families could not afford to raise children; and during World War II, human and economic resources were focused on the war effort.

Birth rates rebounded by 1946, and were sustained in the Baby Boom until 1964, during which time 76.4 million children were born comprising almost 40% of the nation's population[3]. These years were also the most sustained period of economic prosperity for the nation as a whole. The renewed demand prompted the Post War School Building/Planning Program which anticipated a need for 169 new schools by 1954 and delivered its first design in 1948. The pace of construction increased until the mid-1960s.

By the late 1960s, the City's population began to decline in a trend that continued for about a decade. The rate of school construction, already responding to lower demand, dropped precipitously as a result of the 1975 Fiscal Crisis. This second trough lasted through the 1980s, and ended truly with the creation of the SCA in 1988, and in the 1990s as the City's economic recovery gained momentum.
The third sustained boom in school construction began in the 1990s and has continued to this day, driven by population increase and the continued economic strength of the City's economy, even through the recession of 2007-2009.

Fig. 1.1.2
Williamsburg Bridge under construction in 1896.
Courtesy: Google Images

Fig. 1.1.3
Elevated subway under construction in Brooklyn.
Courtesy: Google Images

ELIGIBILITY FOR THE NEW YORK STATE REGISTER OF HISTORIC PLACES

Buildings that are 50 years old or older can be listed on the National or New York State Registers of Historic Places. Buildings which are not listed can be designated as eligible for listing on the State Register. Such buildings are commonly referred to as being *"SHPO Eligible"*. The New York State Office of Parks Recreation and Historic Preservation, often referred to as the State Historic Preservation Office, or 'SHPO' for short, makes this determination. The four criteria for eligibility include a building's association with an important historical event, an important historical person, significant architecture, or significant archaeological findings. The SCA and SHPO have agreed that for capital improvement projects planned for school buildings 45 years and older, the SCA will consult with SHPO on the eligibility of the building and on the potential impact any particular project may have on an eligible building.

[1] Migration Policy Institute. *US Immigration trends and History.* Web. *(http://www.migrationpolicy.org/programs/data-hub/us-immigration-trends#history)*

[2] Chapter XXXIII: The Consolidation of 1898 Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 244, 261, 272

[3] New York City Planning. *Decennial Census - Census 2000 & Historical Population information.* Web. *(https://www1.nyc.gov/site/planning/data-maps/nyc-population/historical-population.page)*

PIO, J. G. *History & 1800 Fast Facts.* United States Census Bureau. Retrieved from *https://www.census.gov/history/www/through_the_decades/fast_facts/1800_fast_facts.html*

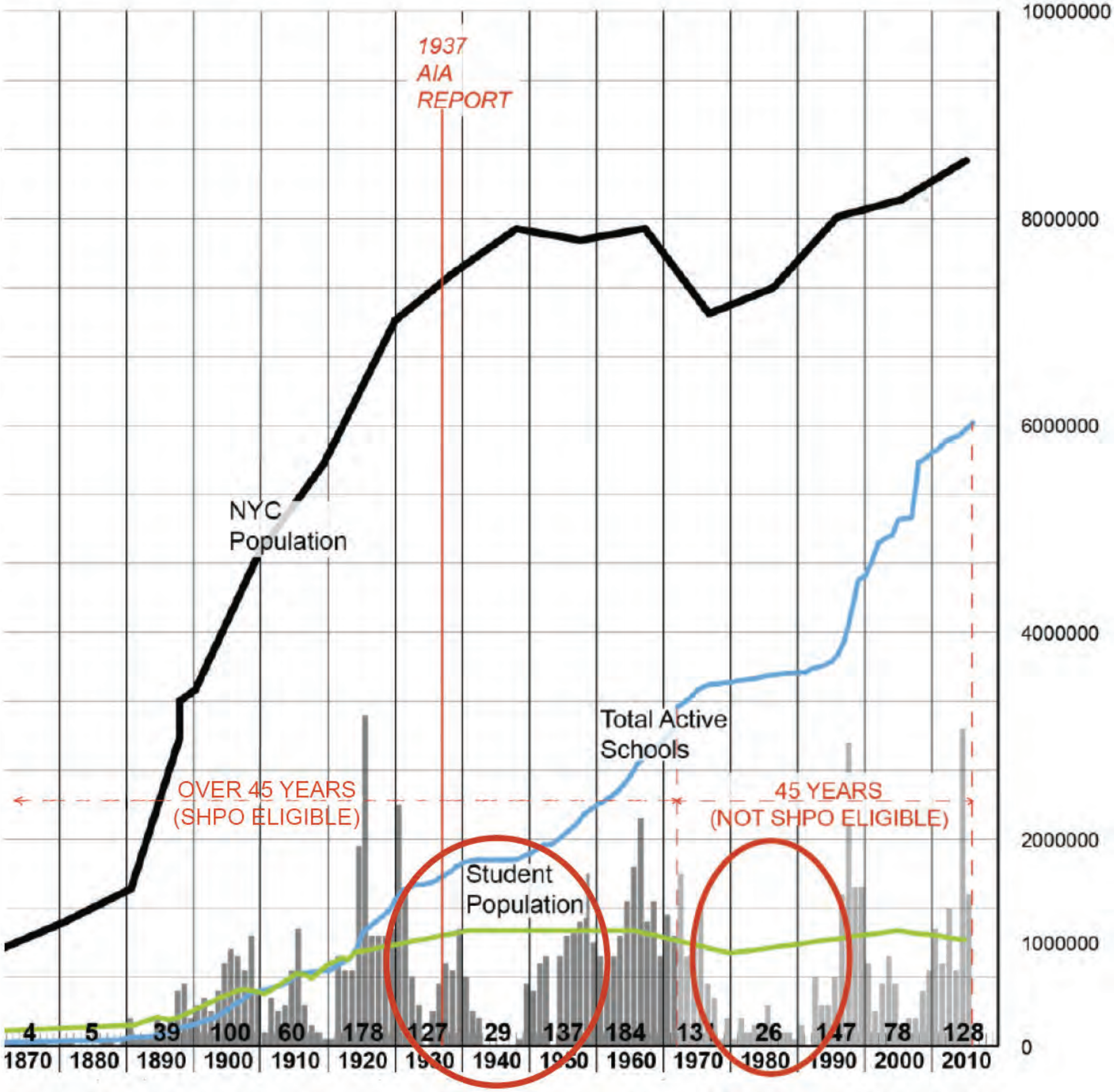

Fig. 1.1.4 (Above)
Graph depicting the two main troughs where there was little or no school constructions. The circled regions highlight the period of decline in school constructions.

As of this writing, schools that are potentially SHPO Eligible were constructed in 1972 or earlier. With each passing year, a new class of buildings joins those ranks. This guide is intended to address all buildings constructed 45 years old and older, whether they have been designated as eligible or not. These buildings currently total approximately 860 in number, just over half of all the buildings in the SCA portfolio.

As a consequence of this cut-off date, the buildings which are under consideration for historic designation mostly fall into the first two chronological groups of buildings described above, including the 14 buildings that pre-date 1890[4]. These two groups result from two booms in school construction, from 1890 to 1930, and from 1950 to 1970. For the purposes of this guide we have divided the groups into all buildings dated 1937 and earlier, and all buildings dated from 1938 to 1972.

Fig. 1.1.4
P.S.201 Q, located in the 65-11 155th Street in Queens. Courtesy: Google Map

THE AIA REPORT OF 1937

While the date of 1937 corresponds to the trough in school construction that occurred during the Great Depression and World War II, there exists a clear distinction between the two building groups. The first tranche, approximately 447 schools buildings constructed before 1937, includes mostly buildings designed under C.B.J. Snyder or continuing the legacy of his work. The second tranche from 1937 to 1972 includes 396 mid-century schools. 1937 marks a watershed in the design of New York's Public Schools. In November of that year, the Board of Education, working with the New York Chapter of the AIA, published the report of a Commission whose charge was evaluate the design of schools in NYC and make recommendations to assure that new school buildings would be *"up-to-date from the standpoints of design, utility and economy"* [5]. The Commission was *'composed exclusively of (5) eminent school architects'* with a technical staff of five. Two major changes in direction were implemented as a result of this study by the new Chief Architect of the Board of Education's Bureau of Construction, Eric Kebbon and his successors.

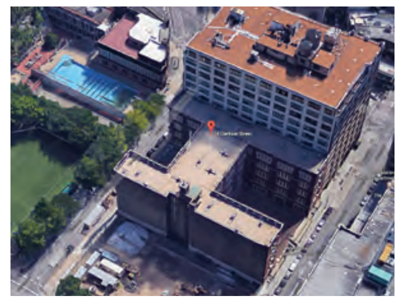

Fig. 1.1.5
P.S.721 M, located in 16th Clarkson Street in Manhattan. Courtesy: Google Map

Fig. 1.1.6
New Explorations into Science, Technology & Math School, J.H.S. 22, designed by Kelly and Gruzen. Courtesy: Google Images

The first change was the overhaul of the standard school designs[6]. Recommendations included selecting sites near new mass transit; not building rigidly to the property line; asymmetrical building massing generally 2 or 3 stories tall, rather than 4, 5 or 6 stories tall; locating assembly spaces at street level with independent entries to allow easier access for community uses outside of school hours, and increased classroom sizes. In concert with the enactment of the 1938 code, fire-stairs in rated enclosures were provided and the double scissor-stairs, introduced by Snyder in the 1890's, was abandoned. This significantly affected the building design and cost, because the scissor-stairs, as designed by Snyder, required a minimum floor to floor height of 15'-6". Floor-to-floor heights could be and were reduced, first to 13'-9" in 1939, and later to 12'-6".

The second significant outcome from this study was the shift from the Board of Education's policy of designing all schools *'in-house'* under the direction of the Superintendent or Chief Architect, to a policy where many of the schools were designed by architects in private practice working as consultants for the Bureau of Construction. This shift continues to this day at the SCA, where projects are designed by consultants, as well as by in-house architects and engineers. Over 50 firms were employed including Edward Durell Stone, Harrison & Abramowitz, Kelly & Gruzen, and Paul R. Williams. This significant change brought a great deal of heterogeneity to the design of schools both in their planning, massing and use of materials.

[4] New York City School Construction Authority schools list, Alchemy and Nelligan White Architects School list Excel Database

[5] New York City. (1937-1938). *Board of Education AIA Annual Report*, City of New York. Introduction. Page 7.

[6] New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York. Page 26-41.

Fig. 1.1.7
P.S.34 Manhattan, designed by Harrison and Abramowitz. Courtesy: Google Images

Fig. 1.1.8
P.S.721 Manhattan. Courtesy: Google Images

Because of World War II, the pace of school construction did not effectively resume until the 1950s. Only 63 existing schools date from the 12 years between 1937 and 1949, compared to 158 schools dating from the 1950s[7]. Practically, the division of the two groups of schools can be thought of as pre-war schools and post-war schools.

Generally, the construction and systems of the pre-war schools, designed under Snyder, Gompert, and Martin are less familiar to contemporary architects and engineers. However, a systematic use of standard design types and construction details provides was employed during those years, and with some effort, a ready understanding of those buildings can be gleaned.

By comparison, the post-war schools are more varied organizationally, and in the materials employed, yet their design, systems, and construction details are typically more familiar to the modern designer.

The resources of this guide are provided to assist in the understanding and rehabilitation of theses buildings.

[7] New York City School Construction Authority schools list, Alchemy and Nelligan White Architects School list Excel Database

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SECTION 2

HISTORY OF PUBLIC SCHOOL ARCHITECTURE IN NEW YORK CITY

THE BOARD OF EDUCATION

1842 - 1891

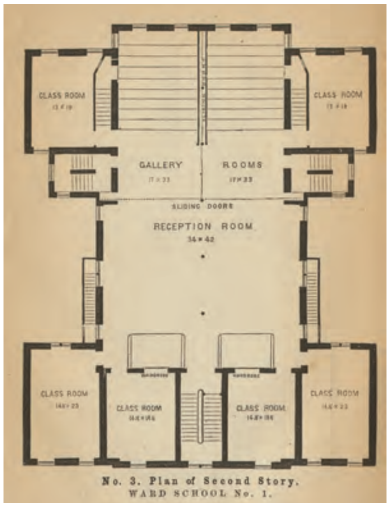


Fig. 2.1.1
Ward school No. 3, plan of second story Courtesy: NYC Municipal Archives

Fig. 2.1.2
Ward school No. 1, front elevation. Courtesy: NYC Municipal Archives

The roots of New York City public school system began immediately after the turn of the 19th century. By the commencement of the Legislature Act of 1813[8], the distribution of Common School Funds in New York City was proportioned between the Free School Society, Orphan Asylum Society, Society of the Economical School and the African Free School. The Free School Society's first school opened in 1806, in a rental apartment with 42 students attending[9]. Over the next 36 years, the Free School Society erected 18 school-houses, roughly corresponding to the number of New York City wards. All these buildings were designed with the typical one-room floor plan. School No. 2, located on the Henry Street, opened in November 1810, School No. 3 on the corner of Hudson and Christopher Streets in 1818, and School No. 4 on Rivington Street in 1819.

Schools in the areas that now comprise the five boroughs, varied considerably, both in their physical structure and size. Isolated towns and villages that now constitute the Queens, The Bronx and Staten Island, had small wood-framed schoolhouses occupying about 15 to 30 children. Some of these buildings remained in use until the early 20th century. But in the young cities of New York, at the lower end of Manhattan Island and Brooklyn across the East River, population densities were higher and individual schools served much larger numbers of students. As both cities grew rapidly, popular concern for fire safety and public health led to the enactment of new building laws which affected the layout and construction of schools as well as other public structures. All these pressures, when combined with a thriving economy and the importance of education in an industrializing society, would inspire the design of innovative schools that set national precedents.

The physical form of the building centered on a single large classroom, which was a direct influence of the instruction system employed in these schools. The rudimentary premise of this scheme was based on the monitorial system of instruction also known as the *'Lancasterian'* System[10] of instruction, after Joseph Lancaster, one of its two prime proponents. Under this system the older students would teach and monitor the younger students, who were in turn supervised by the Schoolmaster. Groups of about 30 students would engage in various exercises together; some of them would be engaged in reading, some in writing. Nevertheless, every young student will be monitored as a group by the senior students. The first and second classes would write on sand, spread across a large table, the middle classes would write on slates and only the higher classes had the privilege of using paper and ink. While this system was intended to provide constant guidance to all the students, its principal benefit was to do so under the direction of a single school master, resulting in significant cost savings. This was the predominant method of instruction employed at schools operated by the Free School Society, and its successor, the Public School Society from the opening of the first school in 1806, until 1853.

Governor William H. Seward signed legislation on April 11, 1842, to create the Board of Education[11], with the intention of extending the State Common School System to the City. The two systems operated side by side until a bill was passed on June 4, 1853, following which, all the schools and properties held by the Society (along with the associated debts) would pass on to the City, and be controlled by the Board of Education. By 1846, the Society was operating about 115 Schools in 18 buildings. At other venues, they were operating a total of 46 primary schools, including five schools for African-American children.

The first school was opened in the 12th Ward on 3rd Avenue, near 49th Street, and was privately funded, due to the lack of capital during the initial phase of the Board of Education's formation. The necessary modifications were made by a local carpenter and the school was considered to be *"the best building to be found in the neighborhood for a schoolhouse"*[12]. The first new school, called Ward School No. 1, located in the 19th Ward, was erected in 1844 at Lexington Avenue and 51st Street.

8 Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 47

9 Medina, Miriam. (2012). *History of the Schools and the Public School Society of New York City 1872*. Retrieved from *http://thehistorybox.com/ny_city/nycity_schools_history_1872_article00855.htm*

10 Reigart, John Franklin. (1916). *The Lancasterian system of instruction in the schools of New York City.* Teachers College, Columbia University, New York City.

11 Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 105.

12 Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 133.

The school was later renamed to No. 19 after consolidating with the Public School Society.

During the initial ten years, the Board of Education coexisted with the Public School Society[13]. However, the two had an antagonistic relationship since the Board's mandate was to centralize the diversified school network, while still controlled by the Public School Society. The last schoolhouse erected by the Society was Public School No. 18, completed in 1846 on 47th Street, near 8th Avenue. When the Public School Society was finally dissolved in 1853, it turned over all of its 18 school buildings to the Board of Education[14]. To avoid confusion, buildings erected by the Society (then called *'Free Schools'*) were renamed *'Ward Schools'*[15] and the numbering of the newer Board of Education buildings was changed to follow the sequence that matched the older buildings, thus, maintaining historic continuity. In 1849, three new schools were opened with a capacity of nearly 2000 students each and marked a significant improvement in the quality of the buildings.

The schools, constructed by the Public School Society and then by the Board of Education, were located on areas where the land was cheap; their often unwholesome locations coincided with the densest populations of the poorest residents of the City. Newer schools that came up, separated the children by sex, which otherwise did not differ greatly from those of the Public School Society. A typical primary school would have been a three-story rectangular brick structure with a stair extending to the rear. The ground floor, with a mere 7'-6" high ceiling, was used as an interior *'playground'*, while the upper two floors with 12' ceilings were 23'x 60' assembly spaces; one floor for boys and the other for girls. The austere, utilitarian design of this structure reflected the Lancasterian teaching methods, which was still followed at that time.

[13] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 115.

[14] Dissolution of the previously consolidated groups, Public School Society and Board of Education, happened in 1853. Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 140.

[15] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 141.

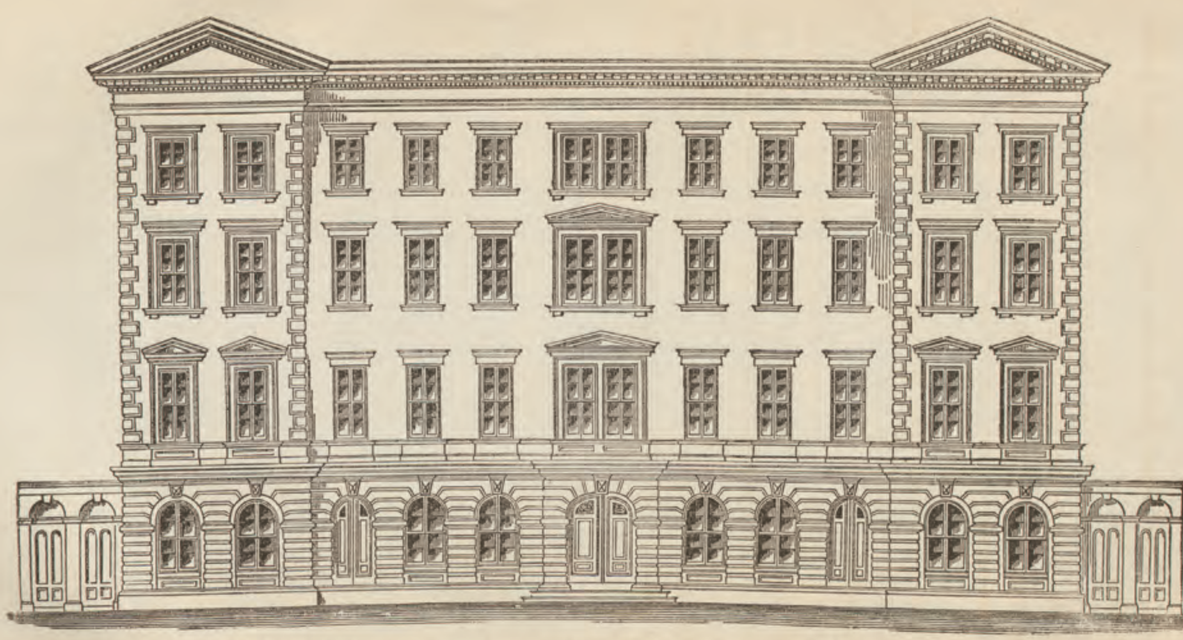

FRONT ELEVATION OF WARD SCHOOL No. 33, WEST TWENTY-EIGHTH STREET, NEAR NINTH AV., TWENTIETH WARD.

Fig. 2.1.3 (above)
Ward school No. 22, located at West 28th street near 9th Avenue. Courtesy: NYC Municipal Archives

Fig. 2.1.3

1842 - 1891

Fig. 2.1.4
Ward school No. 56 for females, built in 1869
Courtesy: NYC Municipal Archives

Fig. 2.1.5
Ward school No. 57, built in 1868
Courtesy: Board of Education Journal

During the 19th Century, the population of the City[16] increased from over 75 thousand in 1805 to 3.4 million in 1900, a 45-fold increase. By 1826, the total number of pupils in all schools, public and private, was only 24,952. Throughout the 19th and into the 20th Century, available accommodations for students was unable to keep up with demand for classroom space, and overcrowding in schools was the rule and necessity of the day.

Despite inadequate facilities, enrollment at Board of Education schools steadily increased from 2,079 students in 1843 to 23,273 in 1852, and eventually surpassed the enrollment of the Public School Society in 1851. The schools were first called *'District Schools'.* By the 1850's, the educational reformers had made significant progress towards incorporating new, more humane teaching methods and employed more teachers. These methods were quickly adopted by the Board of Education and were reflected in the design of new schoolhouses.

The most notable change during this epoch was the addition of smaller individual classrooms that allowed smaller class sizes. Typically, these new classrooms were grouped around a large assembly hall, continued to be the central focus of the school (Fig. 2.1.10). This allowed maximum light in the classrooms, while simultaneously creating outdoor playground areas. Stair cores were also arranged symmetrically around the assembly space to provide efficient fire egress. Adding classrooms and floors to the building meant enlarging the schoolhouse from the standard of 200-500 pupils to well over 2,500 pupils per school. Windows and playground-courtyards were placed on side elevations, a clear indication of how open city lots still were at the time. Rear and side-yard playgrounds allowed the street facade to be built up to the front lot line, for an imposing and dignified design, was consistent with the placement of other institutional buildings as well as homes of the era (Figs. 2.1.4 & 2.1.5).

The original act that created the Board of Education, was amended on several occasions to address its flaws, and in 1851, a new act was passed to *"reduce to one act, the various acts relative to the Common Schools of the City of New York."*[17] An important provision of this act was to enable the Board of Education to appoint a Superintendent and Assistant Superintendents for the Schools. The first Superintendent of School Buildings was Amnon Macvey, who had first begun working for the Public School Society in 1837 as Superintendent of Repairs. He was elected by the Board of Education on May 1, 1854, defeating Patrick MacAuliffe, a contractor responsible for the construction of several schools. Mr. Macvey was not an architect, and evidently architects for schools were selected on a case-by-case basis. For example, when a new schoolhouse was to be constructed on the site Ward School No. 18, the Board of Education resolved that the *"said Schoolhouse [is] to be built under the superintendence and direction of the Superintendent of School Buildings, in connection with any architect the School Officers have appointed or may appoint…"* [18]

By 1867, overcrowding and deficiencies in ventilation and other necessities in most schools demanded improvement[19]. The Board of Education appointed a special committee to address this concern by abolishing the office of the Superintendent of School Buildings, creating the Department of Buildings and Repairs, and unanimously electing James L. Miller as the Superintendent[20]. Miller served in the capacity for 1867 and 1869. Macvey was re-elected in 1869, 1870, and 1871. The nature of Macvey's duties can were well described in the Journal of the Board of Education: *"Resolved, that Mr. Macvey, Superintendent of Buildings and Repairs, be directed to see that the soil-pipes in Grammar School Building No. 53 be put and kept in proper order; also that Mr. Macvey be directed to provide sixty-five additional desks in the Primary Department of Grammar School No. 53"* [21]. Macvey continued with the Board of Education until his death in 1872.

[16] PIO, J. G. *History & 1800 Fast Facts.* United States Census Bureau. Retrieved from *https://www.census.gov/history/www/through_the_decades/fast_facts/1800_fast_facts.html*

[17] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 144.

[18] Journal of the Board of Education of the City of New York, page 125, minutes for May 24, 1854.

[19] Journal of the Board of Education of New York, page 228, October 16, 1867.

[20] Curiously, Macvey was elected as the Assistant Superintendent of Buildings and Repairs, defeating David J. Stagg, who received only one vote.

[21] Journal of the Board of Education of New York, November 23, 1871.

Across the East River, the independent city of Brooklyn was expanding rapidly, beginning with the consolidation of the towns of (old) Brooklyn, Williamsburg and Bushwick, thus, creating the City of Brooklyn[22] in 1855, which at that time had a total of 27 school buildings. Brooklyn's size and status was reflected in the fact that, it also had its own Board of Education. As in New York, the person in charge of school buildings had the title of Superintendent of Repairs, a post held by Samuel B. Leonard from 1856 to 1875. In 1876, the title was changed to Superintendent of Buildings[23], and in 1879, the position was taken over by James W. Naughton, who held the position until the Consolidation of Greater New York[24] in 1898. Naughton was a skilled designer who oversaw the construction of a distinguished set of Brooklyn schools that still remain in use today.

During this period, Leonard's and Naughton's counterpart in New York was David Stagg, former assistant of Macvey from 1870 to 1886. Stagg remained as the Superintendent of Buildings and Repairs until his death in 1886. Six buildings constructed during Stagg's tenure still survive; PS 6, PS 107, PS 79, PS 72, PS 36 and PS 48, all of which is located in Manhattan. PS 72 was closed in 1975, and was converted into the Julia de Burgos Cultural Center in 1994 (Fig. 2.1.3).

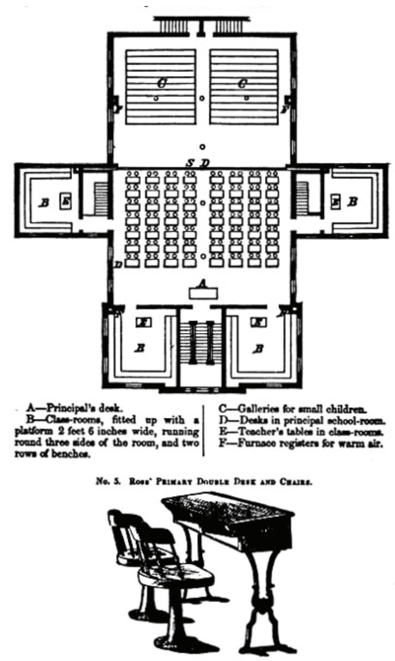


Fig. 2.1.6 (above)
Plans and Diagrams for Ward School No. 30, 1852. A central classroom surrounded by smaller rooms for younger children and a staircase. The furniture is the typical Ross' Primary double desk and chair. Courtesy: Board of Education Journal

[22] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 220.

[23] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 235.

[24] Chapter XXXIII: The Consolidation of 1898 discusses the Greater New York Charter and consolidation. Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 272.

THE SNYDER ERA

1891 - 1900

Charles B. J. Snyder (1860-1945)

Born in 1860 in Saratoga Springs, Charles B. J. Snyder came to New York City at 18. He first worked as a notary in the publishing firm of an in-law, as an apprentice to master-carpenter William Bishop, and attended Cooper Union from which he earned two three-Year Certificates; in Practical Geometry (1881) and Elementary Architectural Drawing (1884). Snyder had no experience designing schools, and in the seven years between his time at Cooper Union and his appointment to the Board of Education, he mostly designed commercial alterations.

With the centralization of schools in the 1894 School Reform Bill, and with the 1898 consolidation of the boroughs, New York became the world's second largest city, intent on improving its schools by providing unprecedented budgets for new sites and buildings. The new buildings offered facilities such as kindergartens, physical and manual training rooms, gymnasiums, rooftop playgrounds, heated cloakrooms and adjustable desks. Snyder put forced-air heating and ventilation systems in the buildings, fireproofed them, and used steel-frame instead of masonry construction, allowing for banks of large windows. Many new features were designed by Snyder himself, then put out for contract, as purchasing patents was prohibitively expensive. He would continue to hone these transformations for two more decades.

He later designed the first academic public high-school buildings in New York, followed by specialized ones – vocational, commercial, teacher training. He also continued to develop ever more diversified spaces – libraries, study halls, science laboratories, music rooms, art studios with north-facing skylights, open-air classrooms, and assembly rooms with movable partitions which transformed back into classrooms, and Kindergartens became standard features. Snyder's final decade as Superintendent could be viewed as an effort to establish a sustainable system. By the time he retired in 1923, he had built 46 H-plan schools and 24 high schools.

When Charles B. J. Snyder took over the position of New York City's Superintendent of School Buildings[25] from George Debevoise in 1891, the City was just beginning its second great wave of immigration; the first, taking place between 1825 and 1875. The period leading up to the 1890s, was an epoch of sustained growth, characterized by projects such as the Brooklyn Bridge and the system of elevated railroads, both of which had begun construction during the 1870s. The prosperity of the 80's ended with the economic depression in 1893, shortly after Snyder assumed his new role as the Superintendent.

In the early 1890s, both Snyder and his Brooklyn counterpart, James W. Naughton continued to design school buildings in the Romanesque Revival manner (Fig. 2.2.1 & 2.2.2). This base model had not changed in any appreciable way, since mid-19th century. A symmetrical layout was configured, such that outdoor play-courts and classroom windows were located at the sides or at the rear yards of the schools. The city's population density increased, however, the buildings on adjacent lots grew in number and size, resulting in the decreasing levels of natural light into classrooms and courtyards.

Influenced by a trip to Europe in the mid-1890s with the intention of visiting state-of-the-art school facilities, Snyder conceptualized the idea of re-orienting school buildings on mid-block sites, so that their courtyards would be centralized at the front and/or back, instead of being located on the sides. This idea resulted in an H-shaped plan for through-block sites with courtyards on each street, or a U-shaped plan for sites facing only one street. Classroom windows opening into the court along with the courtyard itself, benefited from this arrangement. Windowless rooms on lot line walls were eliminated. In addition to resolving the problem of lighting, the H-plan (Fig. 2.2.3) designed for mid-block sites offered more freedom in site-selection and were generally less expensive to acquire than end-block sites facing the avenues.

Snyder introduced improvements[26] in the school buildings during his first ten years of office, which were widely praised, especially by progressives who had alerted the public to the functional problems of schools as early as the 1830s. Some of his more significant innovations included the following:

- Fireproof iron and steel skeleton framing was employed, which meant less massive masonry walls and speedier construction. The resulting shallower returns at window openings, also allowed more light to penetrate into classrooms.
- Scissor-stairs were used, allowing for the up-staircase and the down staircase so characteristic of the era. In the event of a fire, all stairs became down-staircases, effectively doubling egress capacity. Standing headroom of 7 feet at the mid-stair landings controlled the stair height and thus floor-to-floor height, creating a minimum floor-to-floor height of 15 feet 6 inches. This height also allowed for tall windows, necessary for daylight in the years before electric lighting became the standard.
- Mechanical ventilation was used in New York schools for the first time. Adding a fifth (top) floor that would be used for physical instruction and other classes which required more space and light, such as art classes.
- Roof-top playgrounds, especially where site conditions precluded grade-level playgrounds.

[25] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the NYCSCA. Part II, 3-2

[26] Chapter 3: Construction and Mechanical Innovations for Health and Safety. *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 36,-52, 59.

Besides solving planning issues and introducing functional innovations[27], Snyder presented changes in stylistic details by placing more emphasis on ornamentation[28], thus, extending a new dignity to the character of the school buildings. Influenced by his trip to Europe as well as the reflection of the cultural changes in the United States after 1893 World Columbian Exposition in Chicago, Snyder began experimenting with a broad range of historic styles (Fig. 2.2.4 & 2.2.5).

Following the lead of the architectural firm McKim, Mead and White, Snyder moved away from the 'picturesque' manner that had dominated school designs since the 1870s, and began adopting a more orderly, classical approach. Of the various styles he experimented with, he was particularly inclined to the English Tudor and Renaissance styles, presumably, because of their symbolic association with the traditional higher institutions of learning.

The year 1897 witnessed the establishment of the first high school(s) in City of New York, though they were in the existing school buildings; Boys' High in PS 35 on 13th Street, Girls' High School in PS 47 on 12th Street, and Mixed High School in PS 62 on 157th Street in Bronx. Prior to that year, high schools and the city's first training school existed only in City of Brooklyn. By 1898, Snyder had prepared plans of the new buildings for all three of these high schools, each designed in a very different style; Wadleigh (1902) in French Renaissance, Morris (1904) in Collegiate Gothic, and DeWitt Clinton (1906) in a English-Flemish 19th Century Style. All three schools were given special attention by Snyder, since they were his first designs for higher-level education.

In addition to the new high schools, a host of other new types of schools and curriculum were introduced in the late 1890s. Kindergartens, manual training schools, trade schools, truant schools, evening schools, schools for mixed-race pupils, special English language classes, and free lectures for working people – the diversification of schools embodies the progressiveness of this era. The resulting increase in administration prompted the establishment of Borough School Boards and a Central Board in 1897, with the aim of centralizing the decision-making process within the Boroughs and the City as a whole. Until that time, these responsibilities laid in the hands of lay-people in the local districts.

1898 was the year of the City's consolidation. While construction projects were permitted to continue during this transitional year, no new building projects were allowed to proceed due to the temporary lack of funds. The next three years saw funding soar to $500,000 (~$14.8 million in 2017 adjusting for inflation). 53 new schools, plus additions to existing facilities were built, comprising of 1440 new classrooms with a total of 65,788 new seats[29]. Despite the rapid expansion, demand outstripped supply and children were placed on part-time schedules over morning and afternoon class shifts.

When the five boroughs were created prior to 1898, Snyder was in charge of erecting and maintaining schools only in the City of New York. The boundaries of New York City had already been extended North to include Harlem and parts of the Bronx. Consolidation effectively gave him the authority over all the outlying suburbs, including the already well-developed city of Brooklyn.

Fig. 2.2.1 (above) & 2.2.2 (below)
Romanesque revival detailing at Jacqueline Kennedy Onassis High School, formerly the High School of Performing Arts on West 47th street near Times Square, Completed in 1894. Courtesy: NYC Municipal Archives (Fig.2.2.1), Nelligan White Architects (Fig. 2.2.2)

Fig. 2.2.3
PS 150 K, fourth floor plan, completed in 1907 in the East New York neighborhood of Brooklyn. Courtesy: SCA Alchemy

27 Arrington, Jean. (2012). *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 38, 60, 69, 74, 79 & 92.

28 Arrington, Jean. (2012). *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 79-100.

29 Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the NYCSCA. Part II, 3-2

1900 - 1910

Fig. 2.2.4
French Renaissance/Gothic Composite detailing at PS 171 M, completed in 1900 in the East Harlem neighborhood of Manhattan. Courtesy: Sylvia Hardy

Fig. 2.2.5
Renaissance Revival detailing at PS 277 X, completed in 1897 in the Mott Haven neighborhood in the southern Bronx. Courtesy: Sylvia Hardy

By 1901, the Borough School Boards were abolished[30]. Like the earlier decentralized system it had previously replaced, the Borough School Board system was still seen as an inefficient way to achieve reforms that were necessary to deal with exploding population and radical socio-economic changes prevailing at that time. Difficulty in fixing responsibilities, duplication of labor, lack of uniformity in educational standards and conflicts of authority, together, contributed to the reorganization of the Board of Education into a new and more centralized body in January, 1902. The new Board of Education was made up of 46 Local School Board Districts, each with seven members and an Executive Committee with fifteen members.

Once in place, the new Board moved quickly to streamline the process of decision-making and deal with the problem of meeting the demand by increasing the number of new schools[31]. Funding for new sites and buildings for the three years from 1902-1904, nearly doubled from what had been authorized in the previous three years, to over $900,000 ($26 million in 2017, adjusting for inflation). In addition to the numerous elementary schools being built in the 1902-1904 period, there was a noticeable increase in high schools being constructed[32]. These included the High School of Commerce (1903), Girls Technical (Wadleigh) High School (1901), Stuyvesant High School (1907), Morris High School (1904), Brooklyn Manual Training High School (1904). DeWitt Clinton High School (1905), Long Island City High School (1904), and Curtis High School (1904). Despite the 49 new schools and 30 additions built during this three-year period, the demand for space was still higher than what the new spaces could accommodate.

A survey of school designs of this period, however, clearly revealed that Snyder was inconsistent with regard to the question of style, while it has become commonplace to equate Snyder with the Collegiate Gothic Style, just as many of his schools were designed using classical motifs[33]. Oscillating between medieval and classical modes, Snyder appeared unsure of what historic style was appropriate for school buildings. In some cases, these two very different modes of design, Gothic and Classical, were mashed into the same building. Moreover, tension rippled through his work, hedged between civic monumental design and designs with a more intimate feeling of neighborhood. These opposing strands would remain and be reflected throughout his career.

By 1910, the continuing problem of overcrowding demanded a more rational, standardized approach to design; a design approach that corresponded with the growing bureaucracy and centralized control that was needed to manage the city's resources. Thus, the curvilinear, romantic lines of the picturesque[34], began to give way to straighter lines, simpler massing, and repetitious elements. The result was the development of the Type-A school.

The Type-A was utilized in relatively open sites, where adjacent buildings did not preclude the use of windows alongside walls. Type-A schools soon outnumbered those using the H-plan, since many schools erected in this period were located in as-yet undeveloped areas of the city. In fact, after 1910, only a handful of H-plan schools were built, most likely because they were never designed with flexibility or future expansion in mind.

By contrast, Type-A school was a natural outgrowth of the traditional rectangular plan school, that may or may not have included end-wings. Some of Snyder's early school buildings reveal traces of the Type-A origin as the basic layout of spaces is already present. The ground floor was mostly devoted to a large playroom (later the cafeteria) space, while the upper floors were reserved for classrooms and offices, grouped around a double loaded corridor (Fig. 2.2.6 & 2.2.7).

[30] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 299.

[31] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the NYCSCA. Part II, 3-3

[32] Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 307.

[33] Classical motifs included cornice, rusticated base and quoins, trabeated columns, etc. *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 89.

[34] The Picturesque is epitomized by the Collegiate Gothic Design.

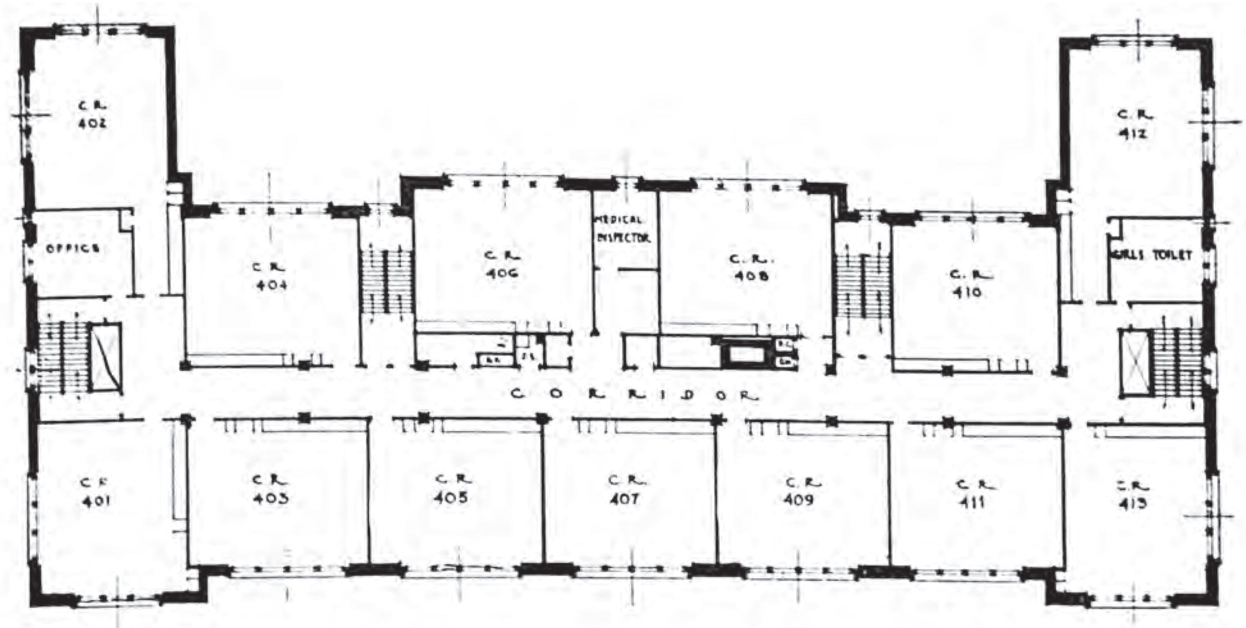


Fig. 2.2.6

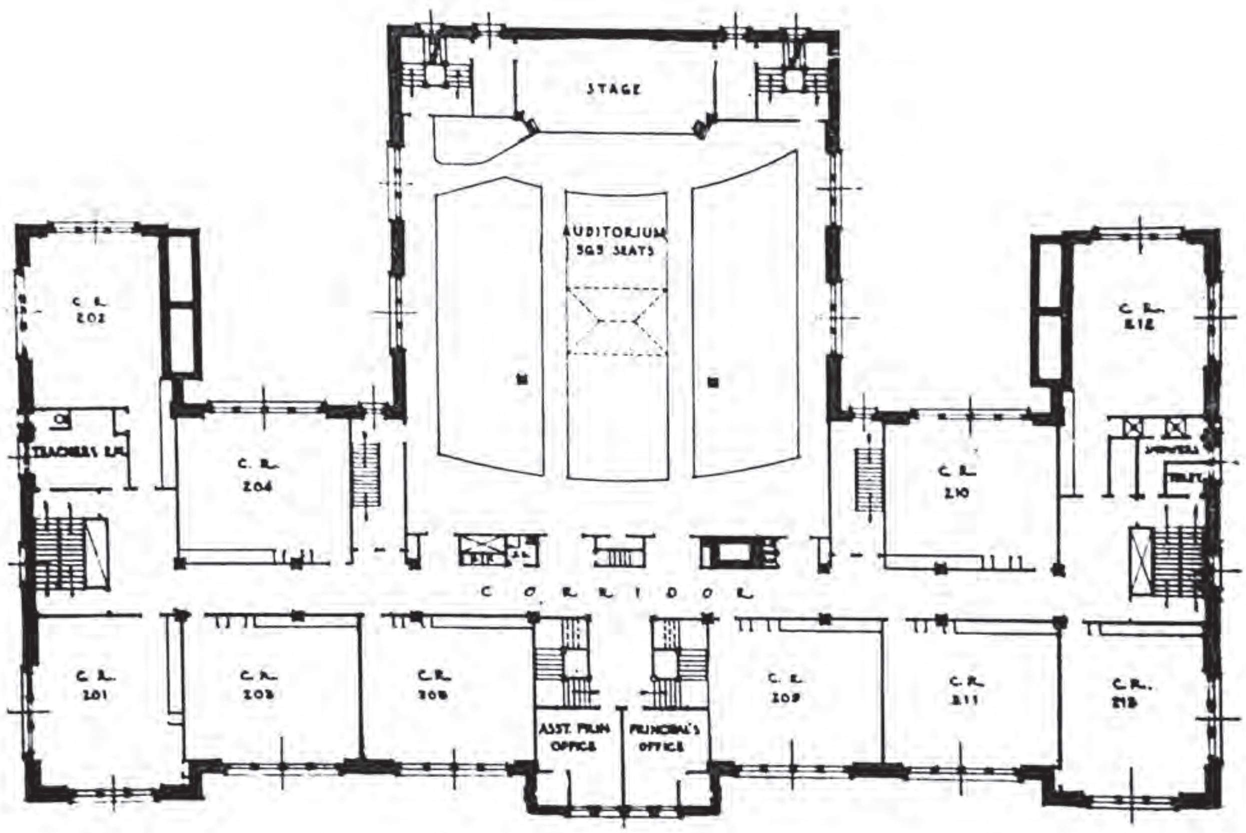


Fig. 2.2.7

Fig. 2.2.6 & 2.2.7 (far above - above)
Basic layout of the first/upper floor and ground floor of the Type-A school. Courtesy: Board of Education Journal.

1900 - 1910

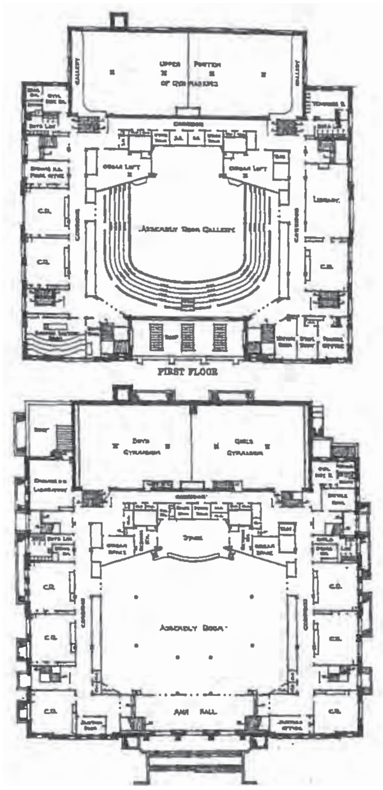


Fig. 2.2.8
Floor plans of the lower levels of a typical high-rise school, showing the auditorium and assembly spaces. Courtesy: Beyer, Blinder, Belle LLP

Fig. 2.2.9 (overleaf)
The Manhattan Trade School of Girls, a typical high-rise school, now called *'The School of the Future'* located at 127 East 15th Street, completed in 1915. Courtesy: Board of Education Journal

The end-bays of some early rectangular plan schools were made to project slightly towards the street facade, in order to provide a visual anchor to the building. End-bays also typically extended towards the rear, to expand the floor area as required by the program. These characteristics at the ends of the floor plan were natural expansion points, inherently built into Type-A, eventually making the H-plan school obsolete. The Type-A school was quickly adopted in New York City. While a swarm of other plan types were developed over the next 30 years to meet various program requirements, they were mostly derivations of the basic Type-A model.

One requirement of modern public school design was to provide large assembly or auditorium spaces, which were first introduced in the early high schools[35]. To meet this need, Snyder developed two types of high schools; one based on Type-A plan, and the other based on Type H-plan[36]. The Type-A was modified to include a centrally located assembly space, forming an E-shaped plan (Figs 2.2.7). The H-plan was also modified to include a centralized assembly space, under a raised courtyard.

A third basic type was created right after the turn of the century, the high-rise school[37], which were developed for older sections of the city, where overcrowding was at the greatest (Fig. 2.2.8). The high demand for space in these sections drove land values up and created the need for a limited number of these non-traditional multi-story school buildings. Square in plan with a centralized auditorium, these new urban schools, typically, required elevators and multiple fire stairs to safely evacuate occupants, which could number 4,000 or more. Rooftop playgrounds were also common features of these schools as adjacent undeveloped land were practically non-existent.

Any school built after the turn of the century designed to be two stories or higher, were constructed as fireproof structures. Typically, this meant that any structural iron or steel framing in the building was enclosed in masonry, with floors constructed of structural vaults or reinforced concrete. Stairways were enclosed in non-combustible construction, including steel stairs with stone or asphalt treads, steel and wire glass partitions, walls and door assemblies. These building types had first floor playrooms with floors typically paved with rock asphalt and the walls covered with a glazed brick wainscot 5'-6" high.

Stylistically, the period leading up to 1910 is marked by a profusion of ornamentation and historic motifs[38]. The degree to which Snyder employed elements such as sculpted stone, moldings, and terracotta trim was unprecedented. While Snyder complained of inadequate funds to keep up with the demand for more schools during these years, he did not reduce the high level of architectural detailing and, hence, the cost of the buildings. However, the end result was that, this period of New York City public school history remains distinguished by the richness of its architecture.

[35] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the NYCSCA. Part II, Section 3-2

[36] Stylistic Innovation: H-Plan. Arrington, Jean. 2012. *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 92.

[37] Board of Education, City of New York. (1923). *Twenty third and Twenty fourth Annual Reports of the Superintendent of Schools 1920-1922: Report of Construction and Maintenance. New York.* Page 38-39.

[38] Arrington, Jean. (2012). *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 89.

Fig. 2.2.9

1910 - 1918

Fig. 2.2.10
February 2, 1918 - The morning after a fire ravaged the top three floors of the Hall of the Board of Education. Courtesy: NYC Municipal Archives

Fig. 2.2.11
February 2, 1918 - Icicles hang from the Interior of the Hall of the Board of Education the morning after fire ravaged its top three floors. Drawings of most of the schools existing, in planning and construction were destroyed either from fire directly or water damage. Courtesy: NYC Municipal Archives

Fig. 2.2.12 (overleaf - top)
Table showing the recommendations for the four types of Type-A buildings. Courtesy: NYC Municipal Archives

Fig. 2.2.13 (overleaf - bottom)
PS 29 Brooklyn. Courtesy: NYC Municipal Archives

By 1908, 594 schools had been erected to accommodate 620,000 students[39]. Despite the new schools, overcrowding continued to persist as the annual increase in student enrollment continued to fluctuate between 23,000 and 36,000. Snyder was, thus, under pressure to streamline the production of new buildings beyond just reusing the same basic floor plan as the model. The exterior wall treatment of the most frequently used plan, Type-A, was thereafter, simplified by reducing or eliminating some of its architectural detailing. In this way, cost reduction could be achieved and the construction process could be sped up.

These changes led to a new generation of school buildings that were more uniform in appearance (Fig. 2.2.13). In his 1913 Annual Report, Snyder describes the four variations on the standard Type-A model, each sized according to total student capacity; 10 classroom, 26 classroom, 36 classroom, and 51 classroom buildings. While the report does not mention architectural aesthetics, the illustrations clearly reveal a simplification of the exterior through either reduction or elimination of features, such as the rusticated base, quoins, and window trims. Ornamental treatment is now relegated primarily to the entrance. Most striking, was the elimination of the projecting cornice in favor of a relatively flat parapet. In addition, Snyder now grouped the window bays vertically, not only to achieve visual unity, but also to enforce the standardization of the window units themselves.

Public criticism of functionality and the variety of types of school buildings being erected by the Board of Education, prompted the Board to commission the New York Chapter of the American Institute of Architects to undertake a survey of recently built schools. In 1915, the AIA submitted its report, which concluded with an endorsement of the operations and designs produced by the Board of Education's Bureau of Buildings.

A more highly publicized survey was conducted at the same time known as the *'Hanus Survey'*. It was undertaken between 1911 and 1913, to investigate why the Board of Education was unable to furnish data on its expenditures, which, in turn had resulted in the Board of Estimate and Apportionment denying funds for improvement and expansion of school services for several years. In general, the Hanus Survey sought to reorient the curriculum towards vocational preparation rather than traditional academics, particularly in High Schools. The report prompted the Board of Education to broaden the types of courses offered, which meant the expansion of the types of activities accommodated within an elementary or high school. These programmatic changes led to an increase in the number as well as types of spaces that needed to be provided.

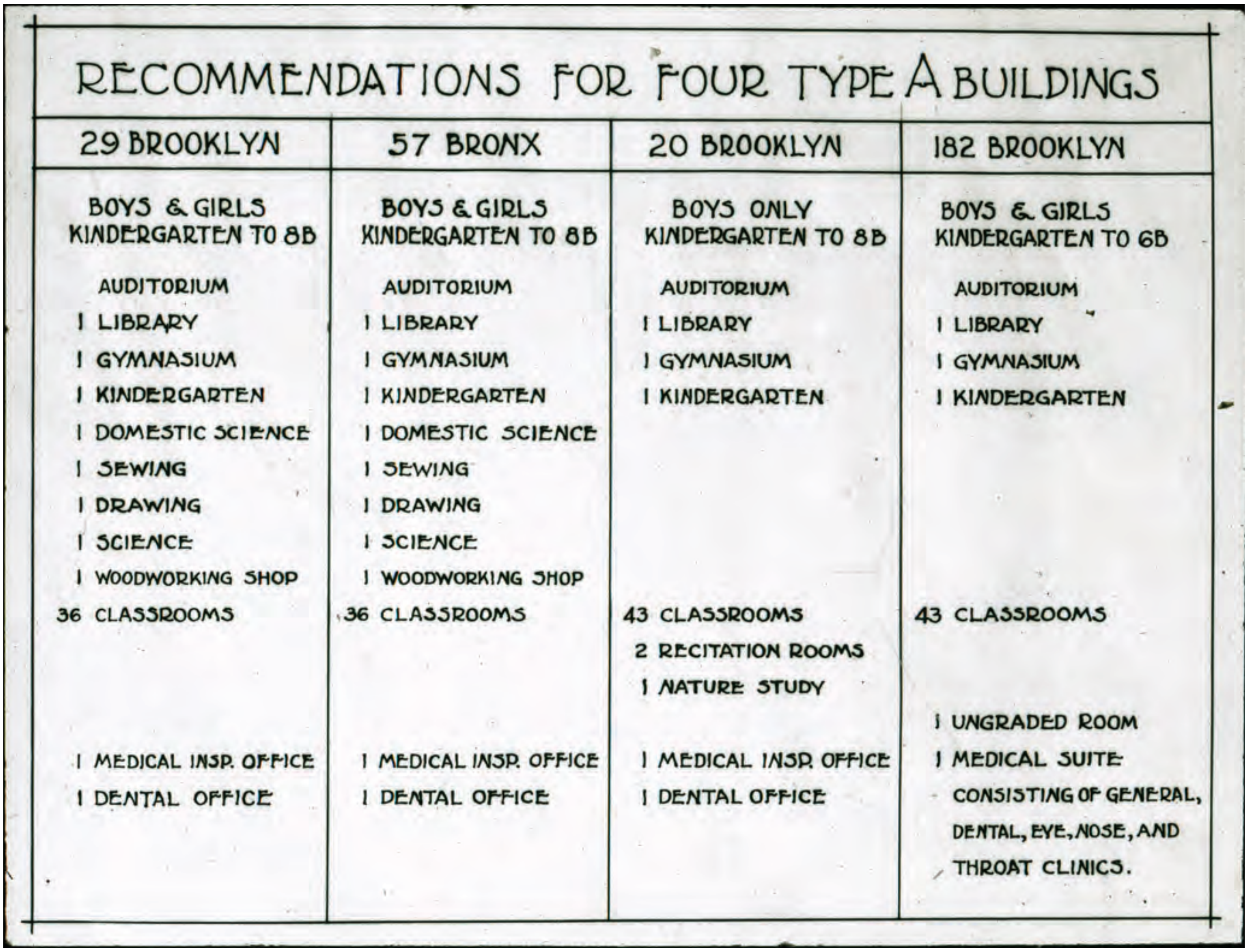
Junior high schools[40] were also officially created during this period; the first ones being opened in PS 43 M, PS 69 M, and PS 85 K. In 1916, seven more intermediate schools were established throughout all the boroughs, except Queens.

Limitations on new school building production during World War I meant that the Board of Education could focus on developing new school types that could be duplicated on different sites with minimum time and labor. Thus, in 1917, the Board of Education officially adopted a new policy of standardization.

On February 1, 1918, less than a year into this new planning initiative, a fire broke out in the Board of Education building (located at 57th Street and Park Avenue), which gutted the top three floors (Fig. 2.2.10 & 2.2.11). Unfortunately, the fire destroyed most of the plans that were then being prepared and, also destroyed many other drawings of the Snyder and Pre-Snyder era. This devastating event explains why many of the older drawings are missing from the SCA archives today.

[39] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City*. Prepared for the NYCSCA. Part II, Section 3-4

[40] It should be noted that Intermediate Schools, first introduced in 1905, were actually the forerunner to the Junior high school.



RECOMMENDATIONS FOR FOUR TYPE A BUILDINGS			
29 BROOKLYN	57 BRONX	20 BROOKLYN	182 BROOKLYN
BOYS & GIRLS KINDERGARTEN TO 8B	BOYS & GIRLS KINDERGARTEN TO 8B	BOYS ONLY KINDERGARTEN TO 8B	BOYS & GIRLS KINDERGARTEN TO 6B
AUDITORIUM	AUDITORIUM	AUDITORIUM	AUDITORIUM
1 LIBRARY	1 LIBRARY	1 LIBRARY	1 LIBRARY
1 GYMNASIUM	1 GYMNASIUM	1 GYMNASIUM	1 GYMNASIUM
1 KINDERGARTEN	1 KINDERGARTEN	1 KINDERGARTEN	1 KINDERGARTEN
1 DOMESTIC SCIENCE	1 DOMESTIC SCIENCE		
1 SEWING	1 SEWING		
1 DRAWING	1 DRAWING		
1 SCIENCE	1 SCIENCE		
1 WOODWORKING SHOP	1 WOODWORKING SHOP		
36 CLASSROOMS	36 CLASSROOMS	43 CLASSROOMS	43 CLASSROOMS
		2 RECITATION ROOMS	
		1 NATURE STUDY	
			1 UNGRADED ROOM
1 MEDICAL INSP. OFFICE	1 MEDICAL INSP. OFFICE	1 MEDICAL INSP. OFFICE	1 MEDICAL SUITE CONSISTING OF GENERAL, DENTAL, EYE, NOSE, AND THROAT CLINICS.
1 DENTAL OFFICE	1 DENTAL OFFICE	1 DENTAL OFFICE	

Fig. 2.2.12

Fig. 2.2.13

1918 - 1922

Fig. 2.2.14
Typical Type-A school. Courtesy: NYC Municipal Archives

Fig. 2.2.15
Typical smaller sized Type-A school Courtesy: NYC Municipal Archives

Snyder's tenure as Superintendent of School Buildings continued for another few years, until he retired in 1922. There was very little new construction during these years; first, because of World War I, and then an economic depression which followed lasting from 1919-1921. Buildings that were built, deviated very little from the Type-A that had become the accepted standard by 1910. Other styles and plan layouts continued to be employed sporadically in outlying districts, while the Type-A predominated[41].

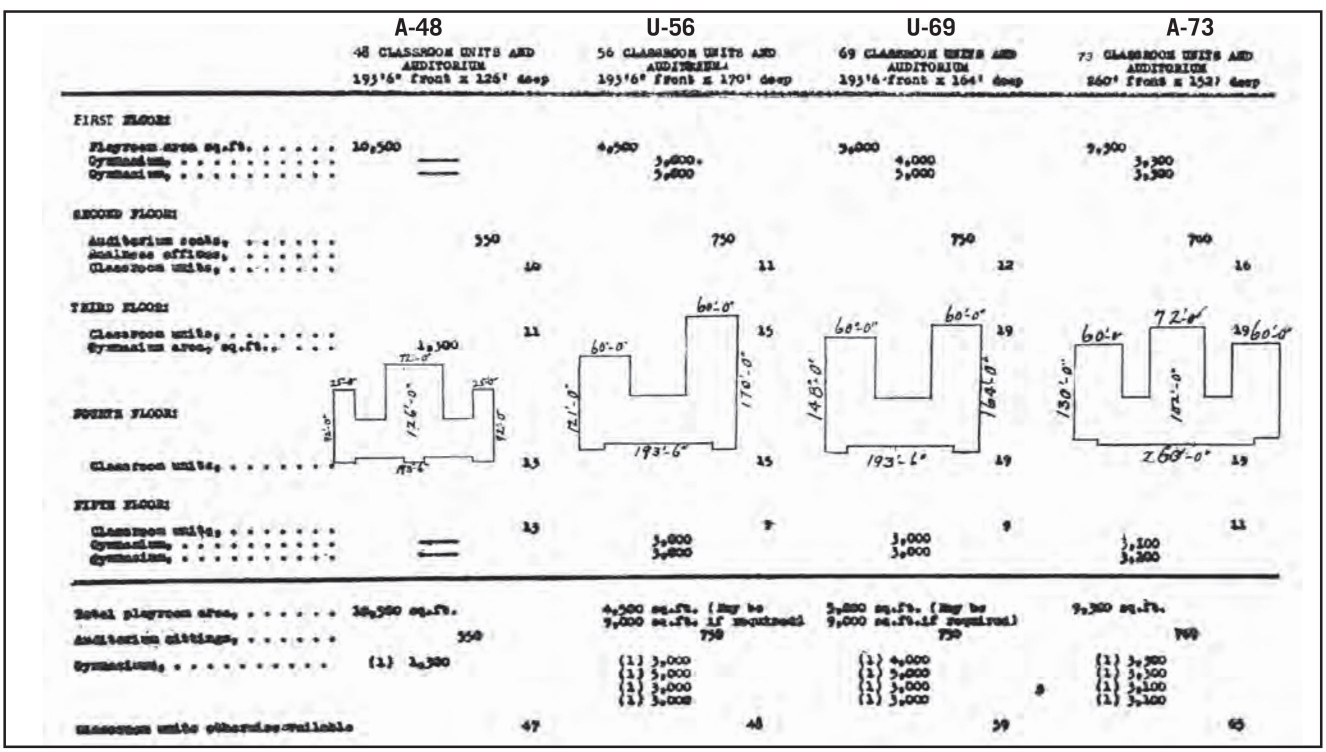
The standardized designs that Snyder was asked to produce in 1917 were, in effect, the continuation of a process that began many years earlier. The Type-A school that resulted was, indeed, very successful. But it was a static design with three versions generally in use by 1917; a 50 classroom, five-story version for high-density areas; a 36 classroom, four-story version for medium-density suburban neighborhoods made up of detached houses; and a 12 classroom, three-story version for low-density areas.

The slowdown in construction during World War I allowed Snyder the time to develop a more comprehensive solution to standardization. The results were presented in his 1921-1922 Annual Report[42], which was his last report before retiring as the Superintendent. The report begins with an analysis of the optimal classroom size (Fig. 2.2.17). These basic classroom units were then used to develop the overall plan of the building. New designs did not need the new curriculum requirements to be taken into account, such as the need for more gymnasium space, and typical site constraints, which were most notably the maximum (standard) lot width dimension of 193'-6".

The study resulted in the formulation of four plan types (Fig. 2.2.16); of which, two of them followed the traditional Type-A configuration. The other two offered, for the first time, a new U-shaped building that provided an auditorium/assembly space wing on one side and an extended classroom wing on the other. As in the past, each of the four plans was designed to accommodate a desired maximum capacity of

[41] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the NYCSCA. Part II, Section 3-4

[42] Board of Education, City of New York. *(1923). Twenty-fourth Annual Report of the Superintendent of Schools: 1921-1922 Report on Construction and Maintenance.* Page 8-9



	A-48 48 CLASSROOM UNITS AND AUDITORIUM 193'6" front x 126' deep	U-56 56 CLASSROOM UNITS AND AUDITORIUM 193'6" front x 170' deep	U-69 69 CLASSROOM UNITS AND AUDITORIUM 193'6 front x 164' deep	A-73 73 CLASSROOM UNITS AND AUDITORIUM 260' front x 152' deep
FIRST FLOOR:				
Playroom area sq.ft.	10,500	4,500	5,000	9,300
Gymnasium,	—	3,000	4,000	3,300
Gymnasium,	—	3,000	5,000	3,300
SECOND FLOOR:				
Auditorium seats,	550	750	750	700
Business offices,				
Classroom units,	10	11	12	16
THIRD FLOOR:				
Classroom units,	11	15	19	19
Gymnasium area, sq.ft.,	1,300			
FOURTH FLOOR:				
Classroom units,	13	15	19	19
FIFTH FLOOR:				
Classroom units,	13	7	9	11
Gymnasium,	—	3,000	3,000	3,100
Gymnasium,	—	3,000	3,000	3,100
Total playroom area,	10,500 sq.ft.	4,500 sq.ft. (May be 9,000 sq.ft. if required)	5,000 sq.ft. (May be 9,000 sq.ft. if required)	9,300 sq.ft.
Auditorium sittings,	550	750	750	700
Gymnasium,	(1) 1,300	(1) 3,000 (1) 5,000 (1) 3,000 (1) 3,000	(1) 4,000 (1) 5,000 (1) 3,000 (1) 3,000	(1) 3,300 (1) 3,300 (1) 3,100 (1) 3,100
Classroom units otherwise available	47	48	59	65

Fig. 2.2.16

students or classrooms. Thus, the two Type-A plans were designated A48 and A73, the numbers denoting the amount of classrooms. The U-shaped plans were similarly designated as U56 and U69.

In addition to providing space for new curricular requirements, these plans located the heating and ventilation ducts above the corridors, instead of placing them in the partitions between classrooms. This centralized ducting arrangement allowed more flexibility in configuring classrooms, including creating double-sized classrooms, where desired. However, the most significant innovation to come out of the study was in the expansion potential of the new U-shaped plans (Fig. 2.2.18). Unlike the Type-A, the classroom wing of the U-shaped plan was a double-loaded corridor that could be extended at the back, to increase the capacity of the school.

Evidently, Snyder was enticed by the possibilities of the new plan. He said, *"I consider this plan to be one of the most important which I have contributed in my service to the department, and feel safe in venturing the opinion that, because of adaptation without change in block front location, unrestricted natural light and enlargement to any extent desired without expense for changes and alteration to the then existing building, ease of administration, as well as economy in plan and in cost of construction, it will quickly take its place as the standard type for New York City schools."* [43]

Thus, Snyder continued to introduce innovation in the city school design, consistently like how he did throughout his career. Even after 30 years of demanding work, he continued to display extraordinary ability, both as a designer and an administrator. In his final chapter, he sets the stage for completing the process of standardization that had begun over ten years before[44].

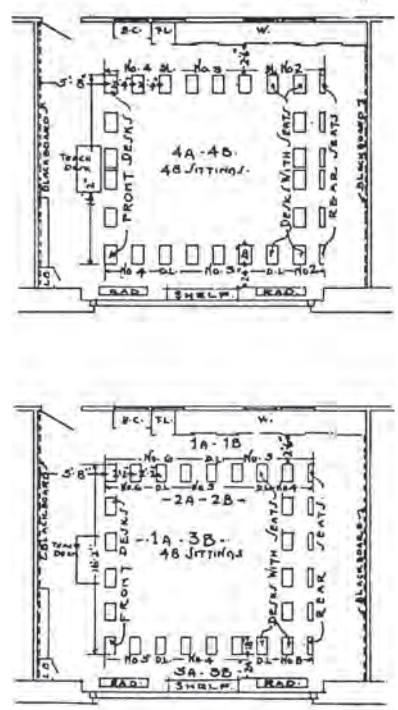


Fig. 2.2.18 (above)
Sketches during the early planning of Thomas Jefferson High School in Brooklyn, a U-shaped plan. Courtesy: Board of Education Journal

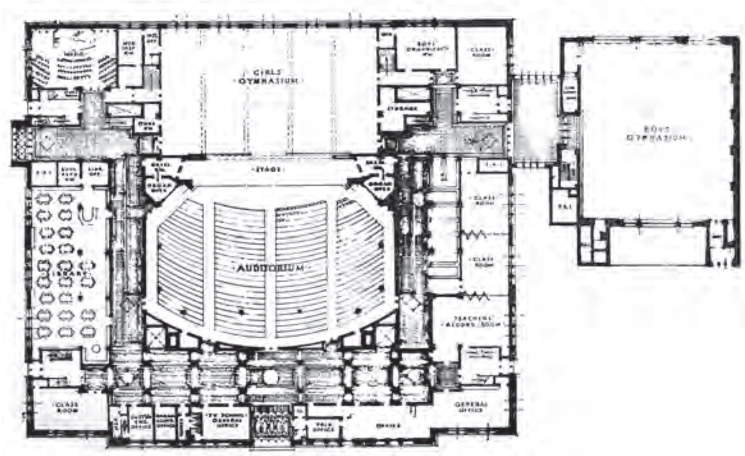


Fig. 2.2.17

Fig. 2.2.17
Sketches during the early planning of Thomas Jefferson High School in Brooklyn, a U-shaped plan. Courtesy: Board of Education Journal

Fig. 2.2.16 (overleaf - bottom)
A spread sheet from Snyder's 1921-22 Annual Report showing the evolution of plan types based on requirements. Courtesy: Board of Education

43 Twenty-fourth Annual Report of the Superintendent of Schools: 1921-1922 Report on Construction and Maintenance, Page 62.

44 Arrington, Jean. (2012). *A Revolution in Public School Design: The Legacy of New York City's Charles B. J. Snyder.* Page 104.

THE GOMPERT ERA

1922 - 1928

Fig. 2.3.1
PS 48 X. Courtesy: Nelligan White Architects

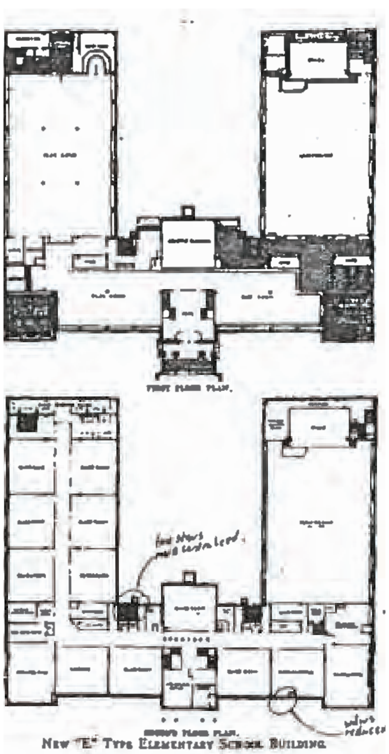


Fig. 2.3.2
Type-E Plan. Courtesy: Beyer, Blinder, Belle LLP

World War I and the economic depression overshadowed the last years of Charles Snyder, and the school constructions was understandably slow. In 1923, when William H. Gompert took over as the Superintendent of School Buildings, the economy was just beginning to pick up again. This marked the advent of one of the most prosperous decades in New York's history.

As with previous periods of expansion, explosive population growth created high levels of consumer demand and a boom in construction. But unlike the earlier periods, the 1920s saw a decline in the population of older congested parts of the city as residents migrated to the outer boroughs. This shift was propelled by the continued extension of transportation lines. Moreover, just as the school construction program was beginning to meet population demand in the older areas, the population moved out of the city and into the outer boroughs.

Consequently, the city embarked on an even greater building program than the one that had occurred in response to the massive wave of immigration around 1900. The Board of Education, in describing the massive building program of the 1920s, stated that, *"New accommodations were built for 475,000 children in 304 elementary and junior high schools, and in thirty-one high schools."* They added that, *"In one fifteen month period, from May 1924 to July 1925, fifty three new buildings, additions and temporary structures were completed, and during the following twelve months, ninety permanent and nine temporary buildings were opened."*[45]

Snyder created the 'U'-plan during his final years in office, but it was left to his successor, William H. Gompert, to fully explore the possibilities of the type. The subsequent development of the U-plan was in response to further changes made in the curriculum. For example, while Snyder was asked to accommodate four gymnasiums in one school building, Gompert's task was to reduce this number to two. Other changes involved optimizing the floor layouts, such as centralizing the core elements like the fire stairs.

Further development of the U-plan fulfilled Snyder's prediction, that the new model would supersede the Type-A, which had been considered the standard for over ten years. The U-shaped plan as redesigned by Gompert, clearly represented a new generation of schools, and so it was named the Type-E school[46].

As with the interior, the exterior of the building was also redesigned to further meet the objective of standardization, again, continuing the work of Snyder (Fig. 2.3.3). Redesigning the facades also meant rejuvenating the look of the school, which, after years of repetition, had become monotonous to the public eye.

Overall, school facades became noticeably flatter as a result of the stripping away of details and ornament, where these were traditionally found; around windows, at the corners, along the base and roof-line. The vertical emphasis that Snyder had achieved by unifying the window bays, was replaced with a horizontal belt course at the third floor sill-line and cornice at the fifth floor sill-line. Both of these courses were made an early form of precast concrete called *"cast marble"* with relatively simple detailing.

The varied treatment of the roof-line was also been simplified with straight, flat coping stones. The parapet is flat, but punctuated by inset balustrades and low-relief stone or terracotta panels. The principal elevation, now radically simplified, relied heavily on the main entrance for visual interest. Here, the projecting portico with its columns and entablature also made of cast marble, lends a certain dignity to the facade. It's also the most visible indication of the stylistic return to classically inspired 18th century Neo-Colonial American design.

[45] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the New York City School Construction Authority. Part II, Section 3-5

[46] Snyder's later building designs, Type-A and it's derivatives continued to be built throughout the first half of the 1920s presumably because they were already in the administrative pipeline when he retired.

This return to Neo-Colonial motifs is particularly evident in a special school type that was developed during the 1920s. Referred to as the Type-F, this elementary school was designed to fit into communities where traditional colonial style architecture predominated. Both the style and scale of these schools were intended to blend into the surrounding context. Characteristic features of this type includes two-story Georgian entrance bay, cast marble trim and cornice, gable roof, and lantern. Another type of school, Type-J, was also designed to fit into lower-density neighborhoods using a Neo-Colonial style.

The Gompert schools reflect a noticeable change in the size of the window openings. Compared to Snyder's school windows, they are now much smaller, which were normally two window units wide and not as tall. The extra-large window bay, introduced by Snyder as early as 1897 and used consistently until his final designs of 1921, is a signature feature of a Snyder school.

By contrast, the Type-E window, with its smaller size and minimal trim, is now simply a punched-opening in the flat masonry wall. Furthermore, this window type is very common and also an indication of the repetitiveness that was a typical characteristic of these modern designs. The reduction in the size of window openings was possible as a result of the shift from classrooms with day lighting and supplemental gas light, to classrooms fully lit with incandescent electric light.

Fig. 2.3.4

William H. Gompert (1875-1946)

Born to immigrant parents from Bavaria, he spent his boyhood at 85 Bleecker Street, his father making a comfortable living in retail tobacco. As an adolescent, his parents moved to East New York. He attended three institutions associated with the industrialist Charles Pratt – the private Adelphi Academy, Pratt Institute from which he graduated in 1892, and the Brooklyn Institute of Arts and Sciences, forerunner of the Brooklyn Museum.

Gompert worked for the firms of McKim, Mead & White, Maynicke & Franke and Harding & Gooch before opening his own office around 1906 at Broadway and 73rd street where he specialized in commercial and institutional building. He re-purposed an apartment house at Broadway and 70th Street into a hotel, arguing for the environmental efficiency of readapting buildings rather than tearing down and building again. In 1923 he was elected president of the Brooklyn Chapter of the American Institute of Architects. That same year he started working for the Board of Education. Brought in by Mayor Hylan to fulfill a second-term campaign promise of "A Seat for Every Child," Gompert was a political appointment foisted on the Board of Education.

Many of the elementary schools Gompert designed were mammoth, such as PS 70 and PS 82 in the Mt. Eden and Morris Heights sections of the Bronx, or PS 196 on Bushwick Avenue in Brooklyn. Instead of the Simplified Gothic style Snyder had proliferated, Gompert turned to the country's Federal roots, enlivening the expanses of red brick with Classical motifs – a portico of white two-story columns to mark the entranceway, tall, round-arched windows along the sides of the auditorium, round-arched niches for the Board of Education and City of New York seals, and garlanded plaques at the roof-line corners with balustrades built into the brick wall surrounding the roof. The towered and turreted PS 101 in Forest Hills is considered his masterpiece. Gompert also added many high schools to the system including the landmarked New York Training School for Teachers (later the High School of Music and Art, now A. Philip Randolph HS) in Manhattan; James Madison High School in Brooklyn; the landmarked Jamaica High School (1927) and Far Rockaway High School (1929) in Queens, and in the Bronx, Theodore Roosevelt (1929) and DeWitt Clinton High Schools (1930).

Fig. 2.3.3
PS 121 Q, a prime example of the Type-E school. Courtesy: Sylvia Hardy

Fig. 2.3.4 (left)
PS 121 Q. Courtesy: NYC Municipal Archives

THE MARTIN ERA

1928 - 1938

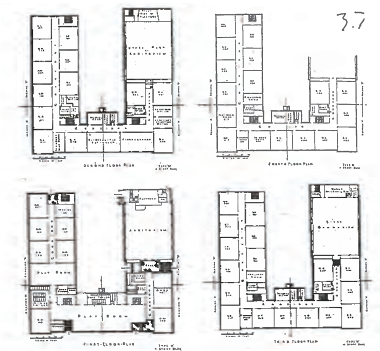


Fig. 2.4.1
Type-M plan. Courtesy: Beyer, Blinder, Belle LLP

Walter C. Martin took over as the Superintendent of School Buildings in 1928, just before the Stock Market Crash in 1929. The effects of the crash did not immediately affect the rate at which schools were built. The construction boom which began earlier in the decade appeared to have reached its peak around 1925, and then dropped and stabilized in the late 1920s[47]. Immediately following the crash, in 1930, the figures rose quite dramatically, only to fall by mid-decade and remain depressed until after World War II.

During this time, the standard Type-E school, which had only recently been introduced by Gompert, underwent further modifications[48]. The new Type-M building that resulted, like its predecessor, was repeatedly erected throughout the city with very slight variation (Fig. 2.4.1 & 2.4.4). Despite the notable differences between the two types, the overall impression is a factory system that emphasizes the need to accommodate as many students as possible, at the expense of variety in design. The sheer number of these schools erected in the 1920s and 1930s, renders them monotonous in their ubiquity, even though the quality of design and construction in these years is not without merit.

On the surface, a comparison between the typical Type-E and Type-M plans does not reveal any major changes. Its basic U-shaped plan that comprised of an auditorium wing (always on the right side) and classroom wing (always on the left side) remained unchanged. The most significant change in the floor plan is the placement of the entrance. Two separate entrances now replace the centralized entrance on the principal street elevation. This switch to two entrances telegraphs plan modifications through the exterior and is a tell-tale feature of the newer design.

The other distinguishing features of the newer Type-M design are subtler, involving the underlying mechanical and electrical systems of the building. The key innovative feature of the previous Type-E plan was its provision for future expansion of the building. However, Type-E did not take into account the heating, ventilating, plumbing, and electrical systems, which also needed to expand to accommodate the increasing size of the building. The newer type addressed these issues by providing adequate space to run larger numbers and sizes of new lines as the building expanded.

Fig. 2.4.2
PS 89 X. Courtesy: Sylvia Hardy

Changes to the exterior of the building involved further simplification of architectural details and ornamentation. The building exhibited a simplified Classical style using a tripartite scheme, while the basic massing of the building remained the same, varying only in the number of stories. Significant changes to the general composition and architectural features of the standard school building involved switching from one centralized entrance to two entrances on the principal street elevation. This meant, substituting the dignified two-story portico of the previous design with two diminutive entrances.

Fig. 2.4.3
PS 89 X. Courtesy: NYC Municipal Archives

Another important change that prevailed was the elimination of windows and creation of blank walls at the end pavilions of the principal elevation. This change, combined with the decision to move the cornice (which now included a frieze) up to the roof-line (Fig. 2.4.2, 2.4.3 & 2.4.4), and to rusticate the entire first floor, had a beneficial effect on the overall design of the building. The composition of the main street facade in particular, was rendered more balanced as a result of the solid end-walls that now acted as anchoring devices, and the cornice, which now properly terminates the facade. Thus, while the exterior was simplified, partially to achieve cost savings, the overall design now has a clear look which appeared more coherent.

[47] New York City School Construction Authority schools list, Alchemy and Nelligan White Architects School list Excel Database

[48] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the New York City School Construction Authority. Part II, Section 3-5

This modulation of the Gompert design was, in fact, a reflection of the general shift in public tastes, away from the traditional and more classically inspired styles, and ultimately towards the modern, progressive Art Deco style. In fact, Art Deco was essentially a style that was based on the compositional principles of classic design. However, its clean lines and bold forms are deceptive, as it often incorporates a fair amount of ornament and high standards of craftsmanship.

In the late 1920s, there were isolated examples of individual schools that were designed in a purer version of Art Deco. One of the finest examples is Herman Ritter High School in the Bronx, now a designated landmark. However, the incorporation of this distinctly modern style was few and far between.

In 1937, the Board of Education commissioned the New York Chapter of the American Institute of Architects, to undertake a study of schools to evaluate the appropriateness of standard school designs that had changed very little over the previous thirteen years[49]. The study was prompted by few chief concerns. School buildings were becoming increasingly inadequate to meet the needs of new educational practices. They were often without or not located near parks or recreational facilities. Also, they did not adequately provide for community use of the facilities, and their designs did not harmonize with the surrounding neighborhood.

The study recommended numerous changes ranging from locating buildings near train stations, pulling the buildings back from the street, changing the design and arrangement of the interior spaces, and increasing the size of classrooms and windows. The Board responded by creating separate bureaus for Plant Operations and Construction, whilst replacing the Bureau of Construction and Maintenance, in 1938. Unfortunately, the Board was barely able to begin planning for the necessary changes in building design before the United States entered World War II in 1941.

Fig. 2.4.4

Walter C. Martin (1887-1977)

Martin was a lifetime Bronx-ite, residing in the 175th Street neighborhood that was ultimately disrupted by Moses' Cross-Bronx Expressway. He attended public schools and trained at Cooper Union. After having worked for a Bronx architect from 1901-1914 and spent four years in private practice, he became the city's Tenement House Commissioner for ten years. It was the following decade, 1928-1938, that he held the position of Superintendent of School Buildings.

After a century of historicist school buildings, Walter C. Martin brought in a "Modernistic Turn in School Design," declared a New York Times headline (3 September 1929). Many of his schools are characterized by the Art Deco look of so many Bronx apartment houses at the time. Even though he was working during the Depression, Martin pioneered purpose-built junior high schools in New York and made a huge advance in the number of high schools in the system.

Martin designed an all-time high number of high schools for a single decade. "Five high schools will be opened next fall, more that ever before at one time," declared one article (NYT 13 July 1930). Technical high schools Martin designed include the mammoth Brooklyn Tech, the Brooklyn Girls Industrial HS, the Textiles HS in Manhattan, and in the Bronx the Samuel Gompers Industrial HS for Boys, a dramatic, severe two-towered building on a factory-like campus. Academic high schools include Seward Park and Benjamin Franklin in Manhattan; Abraham Lincoln, Lafayette, and Samuel J. Tilden in Brooklyn; Bayside, Woodrow Wilson, Grover Cleveland, and John Adams in Queens; Franklin K. Lane on the Brooklyn/ Queens border; and Walton in the Bronx. Martin located schools in outlying locations not only because of population shifts but in order to have lower buildings on larger sites with more play and garden space.

Fig. 2.4.4 (left)
PS 89 X. Courtesy: Sylvia Hardy

[49] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City*. Prepared for the New York City School Construction Authority. Part II, Section 3-5

THE KEBBON ERA

1938 - 1951

Fig. 2.5.1
PS 200 Q, a redbrick mid-century modern type found in the outer boroughs, used early curtain window-wall systems at its entry facades. Courtesy: Nelligan White Architects

Eric Kebbon's tenure as the Architect for the Board of Education, coincided with an overhaul of standard school designs as per the recommendations of the American Institute of Architects, which were solicited by the Board in 1937. These recommendations included site-selection (near mass transit), site-planning (not building rigidly to the property line), building-massing (generally 2 and 3-story buildings rather than 4, 5 and 6-story buildings with asymmetrical massing), building organization to place assembly spaces at street level with independent entries to allow easier access for community uses outside of school hours, and increased classroom sizes. Notably, fire stairs in rated enclosures were provided and the double scissor stair, introduced by Snyder in the 1890s, was abandoned[50]. This significantly affected the building design and cost, because the scissor stair as designed by Snyder required a minimum floor to floor height of 15'-6". Floor-to-floor heights could be and were reduced, to 13'-9" in the 1939 design for PS 118M, and later to 12'-6".

38 school buildings constructed between 1937 and the start of World War II in 1941, are still used by NYC Public Schools[51]. While some of these schools were designed in Classical Revival style, the majority are of Art Deco style and incorporated design and construction techniques more familiar to 21st century architects and builders. Kebbon's PS 118M, Joan of Arc Junior High School[52], was described, at the time, as the first skyscraper school at a lofty 11 stories.

This limestone and brick-clad Art Deco building has largely abandoned the use of terracotta block for its backup masonry, and instead, uses lightweight concrete (cinder) block. The ubiquitous counterbalanced double-hung wood windows found in the schools of Snyder, Gompert, and Martin, were replaced with cold-formed steel double-hung windows, which were similar to those found in the Empire State Building, the iconic Art Deco skyscraper completed in 1931. The structure of the building is steel framed, with concrete floor slabs and concrete encasement of steel members for fireproofing.

During the World War II period (1941-45), construction of new schools ceased altogether. The onset of war meant that many of the schools which had been planned in the 1930s, were never completed. The expandable Type-M School, with its core building section facing the street, was often erected as a first phase of work with the auditorium and gymnasium wing following closely thereafter. In 1948, there were approximately 50 schools, where this second phase wing had not yet been constructed[53].

Fig. 2.5.2 (right)
Rendering of Corona Vocational High School in Queens. Courtesy: NYC Municipal Archives

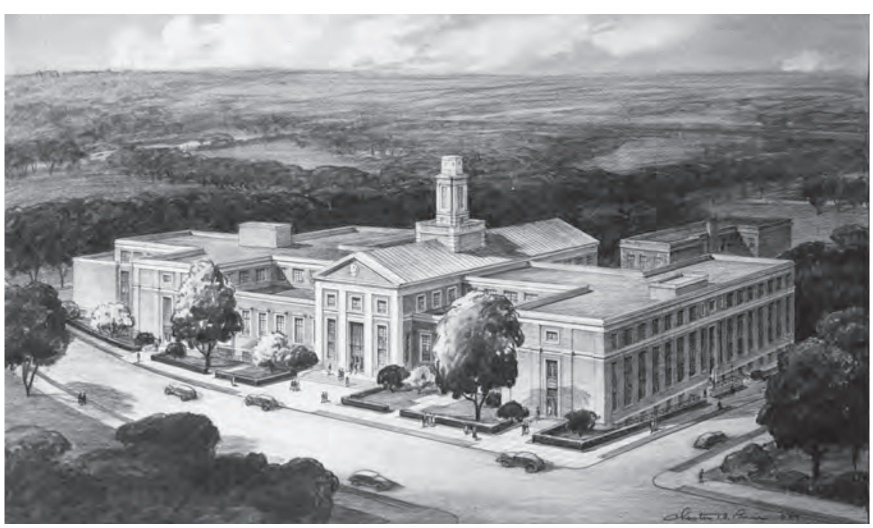


Fig. 2.5.2

[50] New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York. Page 33-35, 56-59, discusses the removal of scissor stairs designed by CBJ Snyder, as well as the disadvantages and cost issues.

[51] New York City School Construction Authority active schools list

[52] Joan of Arc Junior High Shool is now known as JHS 333 M

[53] New York City School Construction Authority schools list, Alchemy and Nelligan White Architects School list Excel Database

A program to replace older buildings which were not in compliance with code requirements for fireproof construction, was also put on hold during the war years. A survey conducted in 1943 identifying 207 such buildings, served to reinforce the need for such a program. However, the high cost of construction brought upon by a scarcity of materials and labor, immediately following the war, forced the Board of Education to reconsider its intentions[54]. By 1948, the Board of Education had adopted a program of modernization instead.

The Board's five-year capital program of 1948, which anticipated the need for 169 schools to be built by 1954, was based on a several important post-war trends. The dramatic increase in birthrates immediately following the war, new large scale public and private housing developments in and around the city, and a continuation of the migratory trend towards the outer sections of the city, all contributed to the need for more schools. In projecting the post-war school growth, the Board of Education was also influenced by the survey of schools that had been conducted by the American Institute of Architects, prior to the war in 1937.

Part of the post war initiative involved hiring '*out-of-house'* architects to design schools. The recommendations[55] from the 1937 AIA report were taken into action during this post war era. The first public school designed by an outside consultant architect was PS 133M in 1948. The architect, Archibald Gilbert, was the first to be involved in an initiative called the Post-War School Building Planning Program. Though the hiring of outside consultants started during Kebbon's tenure, the policy came into full effect under Kebbon's successor, Radoslovich.

Fig. 2.5.3

Eric Kebbon (1891-1964)

Born in New York, Eric Kebbon gained experience in numerous places before returning to his home state. President of his class, he graduated from Massachusetts Institute of Technology in 1912. After study abroad, he returned to MIT as resident architect and associate of architect Welles Bosworth, with whom he wrote Building the "New Technology" in 1916. A year later he joined the Army Corps of Engineers, for which he designed base hospitals and camp buildings. After having returned from World War I, he designed housing developments, private homes, and two courthouses in Florida and South Carolina; was a consultant architect for the United States Treasury Department; designed six post offices for the government, including the Colonial Revival Chelsea Station on West 18th Street; worked on projects for Case Western Reserve University and Brown University; and collaborated with Edward Durrell Stone and Morris Ketchum among others on the Food Building at the 1939 New York World's Fair.

As Superintendent of School Buildings for the Board of Education for 14 years, Eric Kebbon designed more than 100 schools and additions. Some reaffirm American Renaissance ideals; some continue the H-plan lay-out that had been developed by the earlier Superintendent of School Buildings, C. B. J. Snyder. H-plan schools include the Colonial Fort Hamilton HS in Bay Ridge, Brooklyn and the Machine and Metal Trades HS and PS 108 (1950) in East Harlem.

Other high schools include Forest Hills HS in Queens and the super-large Benjamin Franklin HS (1941) whose columned entranceway and Colonial cupola sit dramatically at the east end of 115th Street. The Machine and Metal Trades HS (1941), at 96th Street and 1st Avenue, combines Modernist details with Classical composition. Historian and critic Talbot Hamlin called it "perhaps the most effective, even the most beautiful of New York City schools built within recent years. The clean neatness of its detailing has some of the quality of good machines."

Fig. 2.5.3 (left)
PS 333 M (also known as the Manhattan School for Children, formerly the Joan of Arc Junior High School). Courtesy: Nelligan White Architects

54 New York City. *Board of Education AIA Annual Report*, City of New York.

55 New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York.

THE RADOSLOVICH ERA

1951 - 1963

Michael L. Radoslovich (1902-1977)

Born in Boston, Radoslovich earned both a Bachelor's and Masters Degree in Architecture from M.I.T. Before joining the Board of Education, he worked with Max Urbahn's architectural practice, and resigned from the Board in 1963 in order to join Emery Roth and Sons. He was active with the New York Chapter of the American Institute of Architects, becoming a Fellow in 1959, and with the New York State Association of Architects. He resided in Forest Hills, Queens.

Whereas, traditionally the Superintendent of School Buildings had been personally responsible for designing all schools built during his tenure, or signing off on his staff's designs, Michael L. Radoslovich was hired to the position in 1952 with a different understanding. He was brought in with the lofty mandate to "reinvent the design of public schools" and to apply to schools the principles of European modernism. In addition to designing schools himself, he reorganized the in-house architectural team and brought in outside architects. Suddenly, New York had public schools being designed by some of the country's leading architects. Radoslovich's vision was that schools no longer be designed exclusively for teacher-led, lecture-learning, but be flexible and adaptable, able to accommodate various types of learning experiences.

Recommendations[56] of the 1937 report were quickly adopted after the war, resulting in substantial revisions to the design of schools. In addition to addressing new functional requirements, the new designs reflected a stylistic turn towards modernism. The Board of Education clearly welcomed the new architecture, as is evident in its 1948 Annual Report that said, *"One of the greatest changes between the earlier school buildings and those designed, planned and built during the last ten years has been the high quality of the aesthetic result. They satisfy practical needs and, at the same time, express beauty of proportion in their external form."*[57]

While isolated examples of the modern architecture can be found in the 1930s and even the 1920s, it was not until the late 1940s and 1950s that the Bureau of Construction[58] began consistently applying the new planning and design principles in a consistent manner. The Mid-Century Modern style that emerged after the war, was characterized by lack of ornamentation. In this sense, it is distinguishable from the Art Deco of the 1920s and 1930s. Art Deco style was also modern[59], but, like it's classically inspired predecessor, continued to rely on decorative elements such as low relief sculpted panels, color, etc. for visual interest. The new approach broke away from the basic principle of standardization that had come to dominate the form and the functions of the average school building throughout the 1920s and 1930s. Moreover, new educational methods demanded a more varied and flexible arrangement of spaces in order to adapt to local requirements, including physical (site) conditions and individual teaching methods.

This tailoring of the building to local conditions and new functions was reflected in a freer, bolder manipulation of architectural massing. Reducing the height of a building, so that it conformed to the scale of the surrounding (usually residential) neighborhood, evidently, had a positive effect. However, the lower profile tended to make the buildings look disproportionately long, relative to the length of the site. To mitigate this problem, vertical entry-bays or portals were introduced, thereby, providing rhythm and visual relief to the elevation. The post-war aesthetics, sometimes, incorporated long ribbon-type windows, in order to maximize the amount of light entering the building.

Michael Radoslovich's eleven-year tenure (1952-1963) as the Chief Architect for the Bureau of Construction of the Board of Education, brought more significant stylistic and technical changes in the design and construction of public schools. While the structural systems of these buildings were typically concrete-encased steel frames with concrete floor slabs, like buildings designed under Kebbon, Radoslovich began experimenting with a greater variety of asymmetrical plan arrangements and introduced curtain wall construction to the buildings' enclosures. These designs were largely influenced by the design of the Dessau Bauhaus (completed in 1926) and its designer, Walter Gropius, as well as Ludwig Mies Van der Rohe and Le Corbusier. In 1937, both Gropius and Van der Rohe arrived in the United States from Germany. Gropius settled in Harvard, Boston, and Van der Rohe in Chicago. Corbusier was present in New York during his collaborative work in the design of the United Nations after World War II. Like Kebbon, Radoslovich was educated in Cambridge, Massachusetts at MIT. Similar to many American architects in the 1950s, his work expresses a closer affinity with the *'Teutonic Modernism'* of Gropius and Van der Rohe's, than with Le Corbusier's more expressive *'Mediterranean Modernism'*.

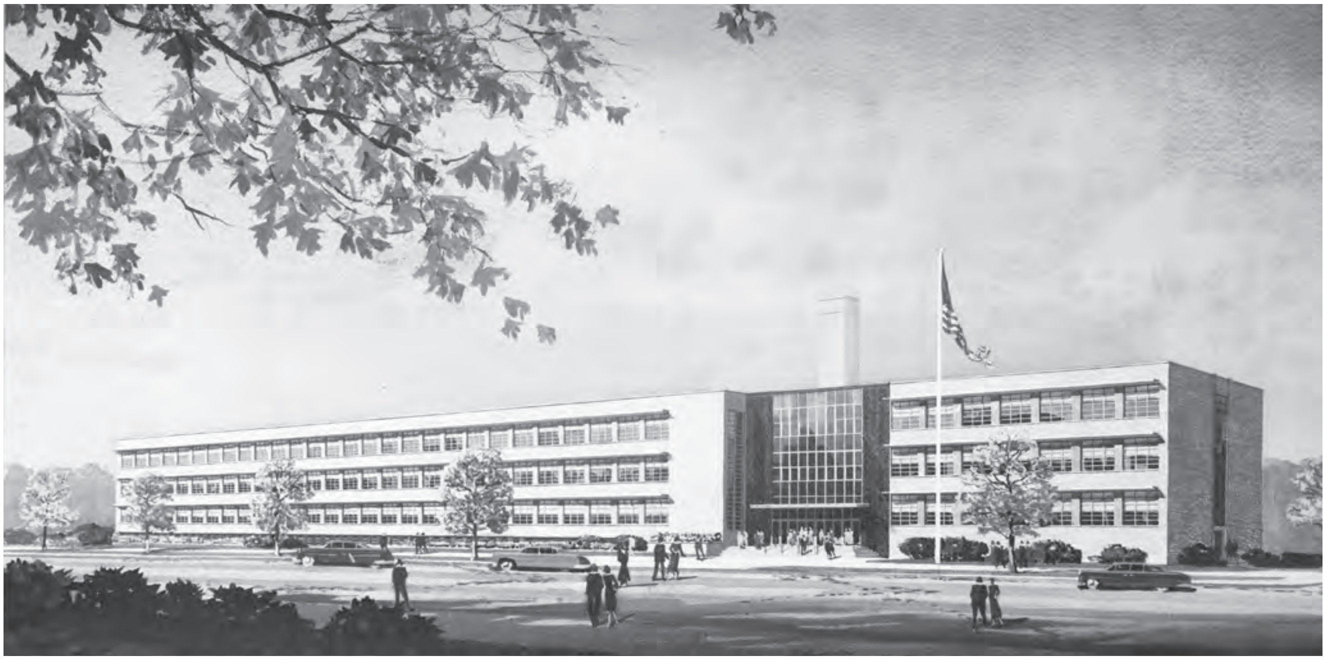
Another significant event that prevailed during this period, was the shift from the Board of Education's policy of designing all schools *'in-house'* under the direction of the Superintendent or Chief Architect, to a policy where many of the schools were designed by architects in private practice working as consultants for the Bureau of Construction. Though this policy started under Kebbon, the full effects were not felt until Radoslovich's era. This shift continues to this day at the School Construction Authority, where designs for both Capacity Projects (new schools and additions) and

56 New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York.

57 New York City. (1948) *Board of Education AIA Annual Report*, City of New York.

58 The Bureau of Construction was reorganized in 1938.

59 Art Deco style was characterized by its bold, simplified, and mostly geometrical forms.



Capital Improvement Projects were prepared by architects and engineers working both in-house at the SCA and by privately-owned architectural firms, working as consultants to the SCA. More than 50 firms were employed, including Edward Durell Stone, Harrison & Abramowitz, Kelly and Gruzen, Giorgio Cavaglieri, Welton Daniel Becket, Chapman, Evans & Delehanty, Katz, Waisman, Blumenkrantz, Stein, Weber, Frederick Frost Jr. & Associates and others.

In addition to differences in the scale, one other major distinctive feature of the mid-century modern schools is their use of materials. As they were often employed in residential neighborhoods, some modern schools continue with the traditional use of masonry as its basic building material. Others, intended to be more avant-garde and corporate looking, used modern industrial materials and high-tech assemblies such as metal panels incorporated into curtain-wall construction.

Fig. 2.6.1 (above)
A rendering for PS 172 Q shows the typical 1950s emphasis on vehicular access in the outer boroughs, as well as a facade inspired by International Style Design. Courtesy: NYC Municipal Archives

Consultant Firms under Radoslovich:

- *Percival Goodman*
- *Welton Daniel Becket*
- *Giorgio Cavaglieri*
- *Chapman, Evans & Delahanty*
- *Harrison & Abramovitz*
- *Katz, Waisman, Blumenkrantz, Stein, Weber*
- *Paul R. Williams*
- *Kelly & Gruzen*
- *Edward Durell Stone*
- *William Gehron*
- *Perkins & Will*
- *Ballard, Todd & Snibbe*
- *Morris Ketchum, Jr., & Associates*
- *Frederick G. Frost Jr., & Associates*
- *Warner, Burns, Toan & Lunde*
- *Bloch & Hesse*
- *Archibald F. Gilbert*
- *Eggers & Higgins*
- *Belluschi & Catalano*
- *Charles Luckman Associates*
- *Brown, Guenther, Battaglia & Galvin*
- *David Todd & Associates*
- *Robert J. Reiley & Associates*
- *Aurthur C. Holden & Associates*
- *Voorhees, Walker, Foley & Smith*
- *Rosario Candela & Paul Resnick*
- *Raymond Irrera & Associates*
- *Ferrenz & Taylor*
- *Wechsler & Schimenti*
- *Carson & Lundin*
- *Gehron & Seltzer*
- *Maurice Courtland & Sons*
- *S.J. Kessler & Sons*
- *Urbahn-Brayton & Burrows*
- *Kahn, Jacobs & William Lescaze*
- *Unger & Unger*
- *Pomerance & Breines*
- *Lester G. Tichy*
- *Sheerwood, Mills & Smith*
- *Sharp & Hadren*
- *George J. Sole*
- *Curtis & Daivs*
- *Kiff, Voss & Franklin*
- *Feldman-Mishopoulos Associates*
- *Shreve, Lamb & Harmon Associates*
- *Holowitz & Chun*
- *William Tubby*
- *Caudill, Rowlett & Scott*
- *Pederson & Tilney*
- *Holden & McLaughlin Associates*

THE PALETTA ERA

1964 - 1970

Arthur G. Paletta (1909-1984)

Born the youngest of three children to Italian immigrant parents, Arthur Paletta (1909-1984) grew up at 334 East 119th Street in East Harlem. Because of his father's death, by age 21 he was working as a clerk in the construction industry and studying at the Columbia University School of Architecture. During the 1930s he worked with several architectural firms and then for the Parks Department, the Triborough Bridge Authority, and the 1939 Worlds Fair. By age 29, he was successful enough to have taken a summer cruise to the Bahamas. Two years later by the 1940 census, he and his wife Mildred were living on East 234th Street in the Kingsbridge section of the Bronx. They went on to have three children and move to Port Chester, with a summer house in Hawthorne, northwest of Tarrytown.

Paletta had 26 years of service in the city school system. He started his career as an assistant architect in 1937, but not until the 1960s did he become the architect of record for a number of schools including the following in Manhattan: PS 180 at 370 West 120th (1960), the white-and blue-glazed brick PS 9 at 100 W 84th (1964), PS 83 at 219 East 109th (1964), PS 96 at 216 East 220th (date unknown), PS 35, the Manhattan School, at 317 West 52nd (1969), and PS 153 at 1730 Amsterdam (1975). The auditorium foyer of PS 9 displays an 8-by-21-foot glass mosaic by Vincent Cavallaro entitled "Men in Space." Paletta's PS 16 at 80 Monroe Avenue in Staten Island (1967) was featured in the January 1967 Staten Island Issue of the Empire State Architect. PS 16 consists of a classroom building and a separate building for the gymnasium, auditorium, and lunch/playroom, the two buildings joined by a central corridor, thus forming an H-plan layout.

Arthur Paletta's time as the Director of Architecture was a time of transition for both the SCA and New York City as a whole. The introduction of privately-owned architectural firms during Kebbon's tenure, continued during Paletta's time in office and culminated in the diversification of public school design in New York City. The beginning of the *'Historic Preservation Movement'* also occurred during Paletta's time in the office and the first *'Modernization'* projects[60] instigated during this period, as well. It is a logical conclusion that the SCA reallocated their resources from in-house design of new schools and towards rehabilitation of existing schools.

Paletta had been a drafter for Eric Kebbon in the early 1940s, although, later he left Kebbon and became a consultant himself and commenced working for other government offices. By the 1960s, there was no use of standardized school types, and Paletta was the Architect of Record for fewer schools than his immediate predecessors.

Though the influence of the SCA director had waned, it does not mean the quality of architecture suffered. Schools built by Paletta and other outside consultants explored several different styles. Materiality and structural systems grew in variety; terracotta and metal panels were departures from masonry systems and gave schools from this era, a distinctive appearance.

One notable school from this era is the PS 199 M by Edward Durell Stone (Fig.2.7.1). This school addresses verticality as well as a larger building footprint, in ways that public school architecture had not explored before. The cadence of columns sits proudly on the windows, yet, this layout does not limit light from entering the classrooms.

During Paletta's era, the National Historic Preservation Act was instituted by Lyndon B. Johnson. The act was signed in 1965 and earmarked a significant milestone for the Historic Preservation movement, which had started after the demolition of Penn Station in 1962. The State History Preservation Office (SHPO) was created as a product of this act, and the SCA started commissioning architecture preservation projects. These projects were called *'Modernizations'* and they began in the mid 1960's.

Schools from the Snyder era and onwards were subjected to renovations. PS 42Q in 1968 was one of the earliest examples. These modernizations mostly revolved around the architectural and MEP infrastructure. Materials and details were replaced, but these projects placed an emphasis on matching the existing conditions. Modernizations began to lay the framework for the Capital Improvement Projects that still exist today.

[60] Mollon, Erica. (2013). *Mid-Century Modern Schools in Manhattan*. do.co,mo.mo_us, 17 Sep 2013. Web. Date accessed 26 Dec 2013. Retrieved from *http://www.docomomo-us.org/news/mid-century-modern-schools-in-manhattan*

Fig. 2.7.1 (below)
PS 199 M built in 1962 by Edward Durell Stone.
Courtesy: Google Images

Fig. 2.7.2
PS 111 M from the mid 1950s incorporates metal-panel window wall systems at the lunchrooms, as well as architectural terracotta at a window infill system in the main classroom block. Courtesy: Nelligan White Architects

SECTION 3

ARCHITECTURAL STYLE TYPOLOGIES

19TH CENTURY SCHOOL STYLES

1800 - 1891

James W. Naughton (1840-1898)

Born in Ireland in 1840, James W. Naughton moved to New York City with his family at age of eight. He attended Brooklyn public school until the death of his father, after which he went to work at the Brooklyn dry-goods firm of Sweetzer & Bro. One year later, at age fifteen, he went towards the west, settling in Milwaukee, where he began a four-year apprenticeship at the prominent architectural firm of J. A. Douglas. From age 19 to 21, he is reported to have studied architecture at the University of Wisconsin at Madison and then, having returned to Manhattan, at Cooper Union in the evenings while working in the building industry during the day, although he is not listed in the records of either school. Active in Brooklyn politics, he was elected a ward supervisor in 1871 and served as the city's Superintendent of Buildings from 1874-1876 and then as the Superintendent of Construction and Repair for Kings County until 1879. In that year he succeeded Samuel B. Leonard as Superintendent of School Buildings for the Brooklyn Board of Education and held the position until his death in 1898. All the schools built in Brooklyn during his 20-year career were designed by Naughton, amounting to more than 100.

Fig. 3.1.1
Widely considered as one of the premiere Richardsonian Romanesque buildings in New York City, Boys' High School features an abundance of picturesque elements including rounded bays, towers, cupolas, embellished dormers and ornate reliefs around windows and doorways.

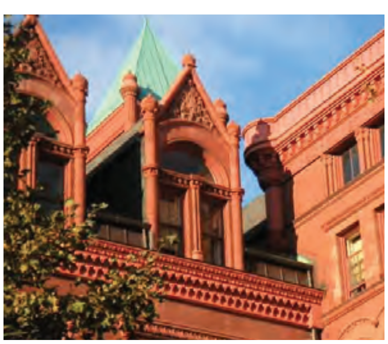


Fig. 3.1.2
Boys' High School in Brooklyn.

School design generally reflected popular shifts that affected all public buildings throughout the 19th Century. By mid-19th century, architectural taste had begun to shift from the Federal and Greek Revival to the more flexible Anglo-Italianate style[61]. Characteristic features of the new style included symmetrical compositions with wings or pavilions, a prominent cornice with widely spaced brackets, pedimented roof-line, rusticated brownstone base, arched and/or flat window and door lintels, raised brownstone trim, double-hung window sash, and pressed-brick with tight joints.

From the 1850s through the late 1860s, Anglo-Italianate styles remained the popular style of schoolhouse designs. The severe economic slump of the early 1870s, precipitated the decline of this style, and by the 1880s, there were several alternatives such as the Second Empire (Mansard), Neo-Greco, Richardsonian Romanesque, Victorian Gothic and Queen Anne Revival. Collectively making up what has been commonly viewed as a diverse period, these so-called styles are better described as *'modes of design'*, since they each tend to draw on a variety of historical motifs, both classical and medieval.

By the late 19th century, the basic floor plan of Romanesque Revival schoolhouses had, for the most part, not changed since the middle of the century when the Board of Education began adding individual classrooms around an assembly hall core. However, the buildings were increasing in size as the population and density of the city continued to grow. School architecture of this period exemplifies a shift in public taste away from the formal classically inspired motifs and towards a more orderly form of picturesque. The term *'Order'* derives from the massing and window openings of symmetrical plan, and *'Picturesque'* derives from the bolder use of arches and multi-gabled roofs. Moreover, the most distinguishing feature of the earlier schools, the pedimented cornice, was gradually deemphasized and eventually eliminated after the Civil War, in favor of a prominent multi-gabled roof with dormers and tall chimneys.

Designed by James Naughton and erected in 1891, the Boys' High School in Brooklyn is a prime example of the picturesque schools that still remain in use today (Figs. 3.1.1 & 3.1.2). Boys' High is recognized as a particularly good example of the Richardsonian-Romanesque style, characterized by prominent massing of elements, including rounded bays, towers, a steeply pitched conical roofs, round-arched openings, and contrasting smooth and rough-faced stonework. Technically, Boys' High School was the second school building that was erected as a high school in Brooklyn as the City of New York at this time did not have a high school. The first high school building was built on Nostrand Avenue, between Macon and Halsey Streets in 1886. It accommodated both boys and girls, though the boys division moved to a new building in 1891, while the girls remained in the older building. Thereafter, that building was called Girls' High and still today remains in use as an adult education center.

Naughton schools can be described as some of the most beautiful and significant buildings in Brooklyn. Some of these schools refer to the earlier 19th century styles used by Leonard, while others follow the form of the 'layered palazzo scheme' of the 1850s, with details such as *Rundbogenstil* pilaster strips and corbeling along with Neo-Greco style, incised ornament and brick paneling. Some Naughton schools have a central section and flanking pavilions that belong to the French-Second Empire style. The others that followed are Romanesque Revival, characterized by powerful massing, round-arched openings, and contrasting smooth and rough-surfaced stonework.

Eight of Naughton's schools have been landmarked; perhaps the largest number of 19th century buildings by a single architect. Among his most famous schools are the Bedford-Stuyvesant high schools, which includes the Victorian Gothic-

Fig. 3.1.4

Fig. 3.1.5

Fig. 3.1.3
While many late-19th century schools featured ornate designs, not all were so spectacular. This temporary school building dating from the turn of the century, located beneath the Williamsburg Bridge, resembles a tenement rather than a place of higher learning. Courtesy: NYC Municipal Archives

Fig. 3.1.4 (above left)
Now the Julia de Burgos Latino Cultural Center, former PS 72 and former PS 107 was completed in 1882 by architect David I. Stagg in East Harlem in the Neo-Greco style. Courtesy: NYC Municipal Archives

Fig. 3.1.5 (left)
Girls' High School in Brooklyn, built nearby Boys' High School features a Romanesque Revival style. Courtesy: NYC Municipal Archives

Second Empire Girls' High School[62], the flamboyant PS 9 in Prospect Heights which sits across the street from Leonard's elegantly restrained PS 111, PS 71[63]in Williamsburg, PS 73 in Crown Heights, PS 86 and PS 116 in Bushwick, and PS 108 in Cypress Hills. At least another nine of his buildings survive, though they are not landmarked; they are the PS 26 in Crown Heights, the abandoned PS 52 in Bushwick, PS 70 in Stuyvesant Heights, former PS 78 in Cobble Hill, PS 89 in Ditmas Park, former PS 98 in Sheepshead Bay (currently a Jewish school), PS 106 in Bushwick, PS 107 in Park Slope, and PS 110, which overlooks McCarren Park in Williamsburg. Out of the eighteen extant Naughton school buildings mentioned above, interestingly, fourteen of them still function as schools.

[61] Beyer, Blinder, Belle Architects & Planners LLP (2002). *A Guide to Preservation of Historic Schools in New York City.* Prepared for the New York City School Construction Authority. Part I, Section 3-2

[62] Victorian Gothic-Second Empire Girls' High School was the first purpose-built public high school in New York

[63] PS 71 in Williamsburg is currently a private school

QUEEN ANNE REVIVAL

Fig. 3.2.1
PS 5 X, located in the West Bronx, directly adjacent to what is now Fordham Plaza, features Mansard roofs on all sides and corners emphasized by piers capped with spires. There is also a porch at the front as well as a cupola at its center. Courtesy: NYC Municipal Archives

Fig. 3.2.2 (below)
PS 25 K, located in the Williamsburg neighborhood of Brooklyn, features a high central tower along with a Mansard cap. Courtesy: NYC Municipal Archives

General Description/Significance

The last half of the 19th century saw a revival of British architectural styles, popular in the 18th century during the reign of Queen Anne. Public schools shifted between the Queen Anne Revival and Romanesque Revival styles until about 1890, when C.B.J. Snyder became the Superintendent of School Buildings.

Queen Anne Revival, a style first popularized in the homes of American aristocrats, became a trend in institutional buildings as authorities came to prefer styles that are free of ecclesiastical references, like Gothic Revival styles. Few decades before this style became popular, political wars regarding public education had been taking place in the city, between the various religious factions. Queen Anne Revival represents a picturesque statement on equality and secularism in the American schools.

Character Defining Architectural Features

- Symmetrical elevations emphasizing central towers, capped by cupolas
- Mansard roofs with extensive use of dormers
- Steeply sloped roofs that terminate into the flat upper roof area
- Large window bays with multiple divisions, originally double-hung windows with transoms above
- Facades horizontally divided with string courses and continuous drip molds
- Basic wall materials: brick, limestone and terracotta trim (lintels, sills, etc.)
- Limestone building-base
- Intricate cornice with gutters built in
- Projected front entrance with porch or stoop
- Exterior downspouts.


Fig. 3.2.4


Fig. 3.2.3

Fig. 3.2.3 (above), 3.2.4 (left) & 3.2.5 (below)
PS 116 M (above), Ward School 26 (left), and PS 117 K (below) feature central towers with Mansard caps, dormers and string courses separating the facade horizontally. Courtesy: NYC Municipal Archives


Fig. 3.2.5

ROMANESQUE REVIVAL

Fig. 3.3.1
Former PS 23 K (demolished), located in the East-Williamsburg neighborhood of Brooklyn features arched windows at the top of each bay, and tall, ornamental chimneys. The roof is complex and steeply sloped, terminating at the front-central bay in a pediment. Courtesy: NYC Municipal Archives

Fig. 3.3.2 (below)
The old Boys' High School (now Brooklyn Academy High School), located in the Bedford-Stuyvesant neighborhood of Brooklyn, is considered one of the most important examples of Romanesque Revival architecture in New York City. Courtesy: NYC Municipal Archives

General Description/Significance

After gaining popularity during the second half of the 19th century, Romanesque Revival styles were used extensively in the design of institutional buildings in northern United States, until the turn of the 20th century. These school buildings are heavily associated with James Naughton, during his term as Brooklyn's Superintendent of School Buildings, prior to the consolidation of New York City. C.B.J. Snyder also designed several schools in the Romanesque Revival style, earlier in his career. The most notable example of Romanesque Revival school design is the old Boys' High School in the Bedford-Stuyvesant neighborhood of Brooklyn, which now houses Brooklyn Academy High School. The building's rounded windows, towers, spires, ornate masonry work and picturesque details contribute to it's reputation as one of the premier Romanesque Revival buildings in New York City.

Character Defining Architectural Features

- Symmetrical elevations emphasizing central and end-bays
- Wide bays that end in gables, capped with terracotta coping
- Steeply sloped roofs terminating in flat upper-roof area
- Gables and dormers
- Tall, prominent chimneys of terracotta or brick
- Large window bays with multiple divisions; originally double-hung windows with transoms above
- Facades horizontally divided with water tables, string courses and continuous drip molds
- Basic wall materials - brick, limestone and terracotta trim (lintels, sills, etc.). Decorative panels were kept to a minimum
- Rusticated limestone building-base
- Central tower, turrets and balustrades
- Exterior downspouts

Fig. 3.3.4

Fig. 3.3.3

Fig. 3.3.3 (above), 3.3.4 (left) & 3.3.5 (below)
Jacqueline Kennedy Onassis High School near Times Square in Manhattan (above), P.S. 38 K (left), and P.S. 116 K in Bushwick, Brooklyn (below) are both typically Romanesque Revival, with rounded windows at the top of bays as well as complex, steeply pitched roofs. Courtesy: Nelligan White Architects (Fig. 3.3.3), NYC Municipal Archives (Fig. 3.3.4 & 3.3.5)

Fig. 3.3.5

ENGLISH-FLEMISH RENAISSANCE REVIVAL

Fig. 3.4.1
The innovative Renaissance style of former PS 31 X in the Southern Bronx may be attributed to C.B.J. Snyder's 6 month tour of Europe, funded by the Board of Education, to study successful school design. Snyder visited London, Brussels, Paris, and many cities in Germany. Courtesy: NYC Municipal Archives

Fig. 3.4.2 (below)
The old Dewitt Clinton High School (now the Haaren Hall of the John Jay College of Criminal Justice) in the Hell's Kitchen neighborhood of Manhattan, features high-Flemish Renaissance-style parapets, centered at the head of each window bay. Courtesy: NYC Municipal Archives

General Description/Significance

The Renaissance Revival styles are best associated with public schools built between the years 1891-1910. By the mid 1890s, C.B.J. Snyder's stylistic schemes began to reflect a popular shift, away from Romanesque and Queen Anne revival towards Classical Revivalism, known as the *'American Renaissance'*. PS 31 X is a strikingly well-composed example of this shift in architectural style. Snyder was especially drawn to renaissance architecture in northern Europe, where he studied school design on a six-month tour, funded by the Board of Education. The characteristic features of the English-Renaissance Revival buildings include Flemish style gables, high chimneys, prominent central tower, and Tudor-Gothic entrances window details.

Character Defining Architectural Features

- Symmetrical elevations emphasizing central and end-bays
- Wide bays end in gables, capped with terracotta coping
- Gables and dormers incorporate English/Flemish motifs
- Steeply sloped roofs terminating in flat upper-roof area
- Tall, prominent chimneys made of terracotta or brick
- Large window bays with multiple divisions, originally double-hung windows with transoms above
- Facades horizontally divided with water tables, string courses and continuous drip molds
- Basic wall materials - brick, limestone and terracotta trim (lintels, sills, etc.). Decorative panels are kept to a minimum
- Limestone building-base
- Central tower with turrets and balustrades
- Exterior downspouts with decorative heads

Fig. 3.4.4

Fig. 3.4.3

Fig. 3.4.3 (above), 3.4.4 (left) & 3.4.5 (below)
PS 27 X in the Mott Haven neighborhood of the Bronx (above - left) and former PS 150 M (now the Life Sciences Secondary School) (below) on Manhattan's Upper East Side feature Flemish-style gables and parapets, and Renaissance detailing across the facade including cornices, window surrounds and quoins. Courtesy: NYC Municipal Archives (Fig. 3.3.4 & 3.4.5), Sylvia Hardy (Fig. 3.4.3)

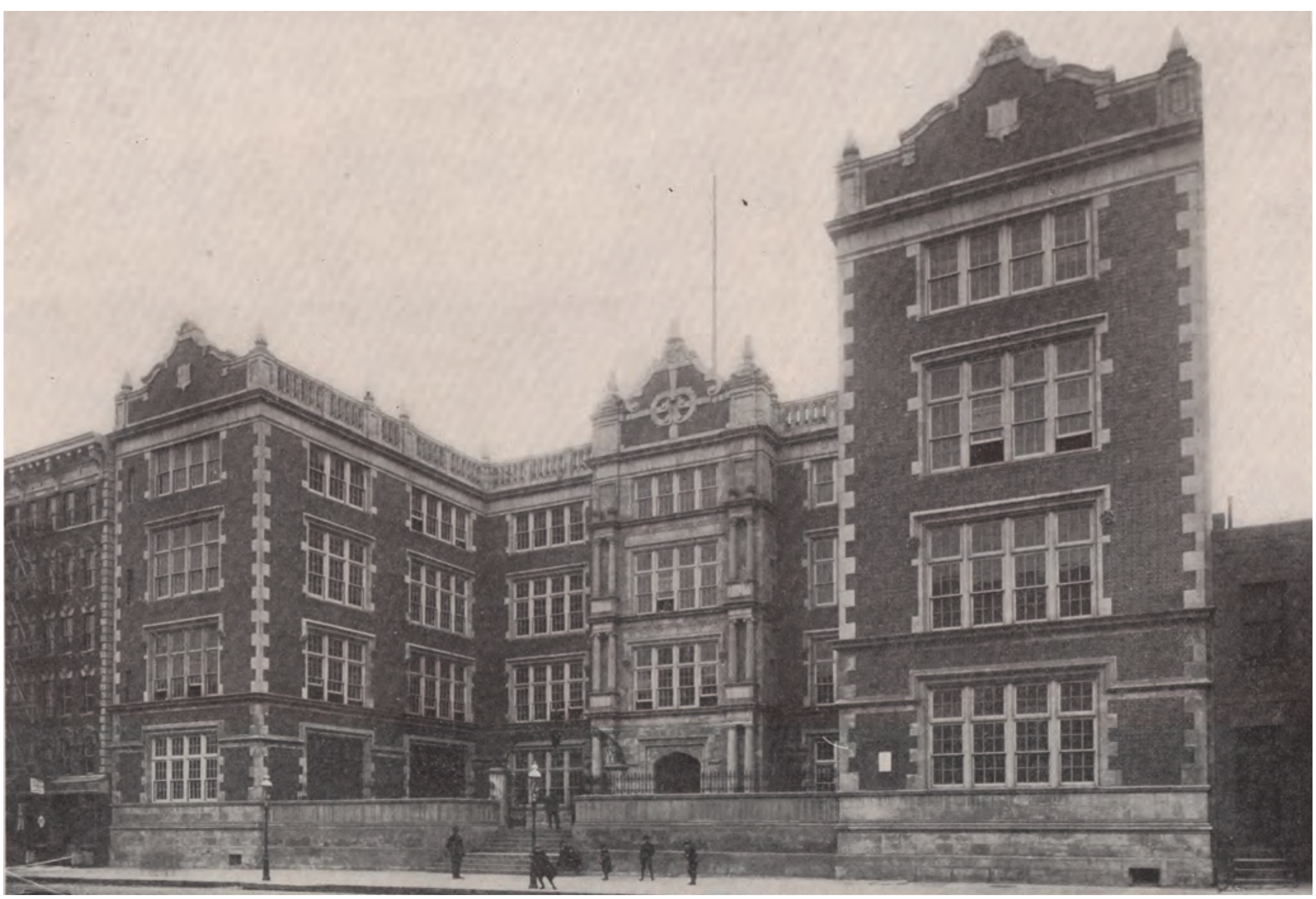


Fig. 3.4.5

FRENCH RENAISSANCE REVIVAL

Fig. 3.5.1
The innovative Renaissance styles of PS 165 M on Manhattan's Upper West Side may be attributed to C.B.J. Snyder's six-month tour of Europe, funded by the Board of Education, to study successful school design. Snyder visited London, Brussels, Paris, and many cities in Germany. Courtesy: NYC Municipal Archives

Fig. 3.5.2 (below)
The Wadleigh High School (now a secondary school) on Manhattan's Upper West Side, features Gothic inspired dormers, steeply pitched roofs, and spires reminiscent of churches throughout France. Courtesy: NYC Municipal Archives

General Description/Significance

The Renaissance Revival styles are best associated with public schools built by C.B.J. Snyder between the years 1891-1910. By the mid-1890s, Snyder's stylistic schemes began to reflect a popular shift away from Romanesque and Queen Anne revival towards Classical revivalism, known as the American Renaissance. Snyder was especially drawn to renaissance architecture in northern Europe, where he studied school design on a six- month tour funded by the Board of Education. Characteristic features of the French Revival buildings include high towers, turrets and spires, which double as the air intake for ventilation systems, Gothic inspired dormers, steep pitched roofs, and skylights at the top floor.

Character Defining Architectural Features

- Symmetrical elevations emphasizing central and end-bays
- Wide bays end in gables capped with terracotta coping
- Gables and dormers incorporate French Renaissance motifs
- Steeply sloped roofs terminating in flat upper-roof area
- Tall, prominent chimneys of terracotta or brick
- Large window bays with multiple divisions; originally double-hung windows with transoms above
- Facades horizontally divided with water tables, string courses and continuous drip molds
- Basic wall materials - brick, limestone and terracotta trim (lintels, sills, etc.). Decorative panels kept to a minimum
- Limestone building-base
- Central tower with turrets and balustrades
- Exterior downspouts with decorative heads

Fig. 3.5.4

Fig. 3.5.3

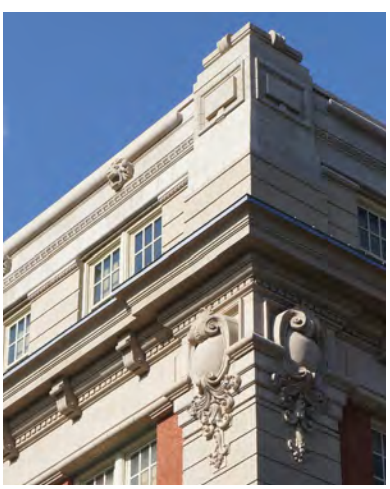
Fig. 3.5.3 (above), 3.5.4 (left) & 3.5.5 (below)
PS 171 M (above - left - below) located in East Harlem in Manhattan features a steeply pitched tile roof and multiple spires which originally served as exhaust for the building's ventilation systems. Courtesy: NYC Municipal Archives (Fig.3.5.5), Sylvia Hardy (Fig. 3.5.4 & 3.5.5

Fig. 3.5.5

BEAUX-ARTS

Fig. 3.6.1
P.S. 183 M, located on Manhattan's Upper East Side, originally featured a massive cornice across its front, and large pilasters across the front facade. The base uses the same channeled rustication as the pilasters. Courtesy: NYC Municipal Archives

Fig. 3.6.2 (below)
Beaux-Arts detailing at J.H.S 142 K in the Caroll Gardens neighborhood of Brooklyn relies heavily on sculpted ornamentation and dramatic changes in scale for visual interest. Courtesy: Nelligan White Architects



General Description/Significance

After 1900, the varied historic revival and composite styles of the Victorian era faded in popularity. For institutional buildings in urban settings, influential American architectural firms like McKim, Mead & White, as part of the new *'City Beautiful'* movement, now favored classically inspired details and symmetrical plans, as interpreted by the Ecole des Beaux-Arts in Paris. Although it was not the only style he worked in, C.B.J. Snyder used Classical references for the facades of numerous schools, built during the first fifteen years of the 20th century. Perhaps for economic reasons, ease of maintenance as well as aesthetics, flat, rectangular roofs and monumental projecting cornices now replaced the more complex roof-lines and drainage systems of earlier schools. These designs were built several times on similar sites around the city. This reflected the pressure on the Board of Education to standardize school construction for a burgeoning student population, as quickly as possible.

Character Defining Architectural Features

- Full cornice with deep water table, dentils/brackets, plain frieze
- Wide, rusticated quoins - generally brick with reveals at joints
- Building-base treated as an extension of quoins with channeled rustication.
- Attic story, often above cornice, with detailing related to that at base-quoins and flat roofs.
- Segmented window lintels at main facade, usually flat-arched in stone or terracotta
- Slightly projected classically-detailed stone entrance
- Decorative stone panels/cartouches

Fig. 3.6.4

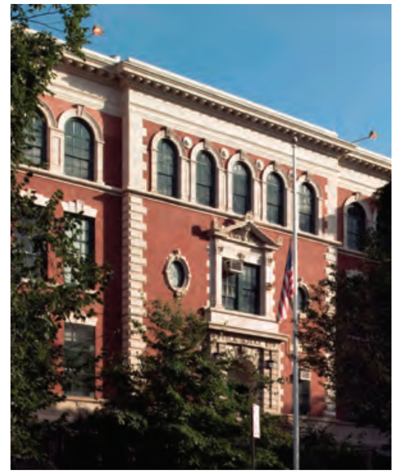


Fig. 3.6.3

Fig. 3.6.3 (above), 3.6.4 (left) & 3.6.5 (below) PS 84 Q (above) in the Ditmas neighborhood of Queens, PS 149 K (left) in East New York, and PS 158 M (below) in the Yorkville neighborhood of Manhattan, both differ in their appearance, although they feature the channeled rustication, quoins, and intricate sculptural detailing associated with the Beaux-Arts style. Courtesy: NYC Municipal Archives (Fig.3.6.4 & 3.6.5), Nelligan White Architects (Fig. 3.6.3)

Fig. 3.6.5

MONUMENTAL BEAUX ARTS

Fig. 3.7.1

Fig. 3.7.1 & 3.7.2 (above - below)
Jamaica High School, ca. 1927. Courtesy: NYC Municipal Archives

General Description/Significance

The Monumental Beaux-Arts schools include a number of buildings located in the outer boroughs. Many are built from the same basic floor plans, a cost-saving measure incorporated during the economic depression of the 1930s. Sprawling on the scale of a legislative body or governmental office, these buildings integrate classically-inspired facades as interpreted by the Beaux-Arts movement of the early 20th century.

While some are Greco-Roman and others are more Colonial in their expression of the Beaux Arts Style, and they share the same decorative elements, including a highly ornamental main entrance with columns and pediment, engaged columns at every bay across their facades, as well as reliefs at the spandrel panels.

Character Defining Architectural Features

- Highly symmetrical, sprawling elevations that emphasize the central and end-bays.
- Tall, prominent chimneys of terracotta or brick.
- Large window bays with multiple divisions; originally double-hung windows with transoms above.
- Facades horizontally divided with water tables and string courses.
- Basic wall materials - brick, limestone and terracotta trim (lintels, sills, etc.). Decorative panels at floor spandrels.
- Limestone building-base.
- Sometimes incorporate a central tower.

Fig. 3.7.3 (above) & 3.7.4 (below)
Far Rockaway High School, shortly after completion, ca. 1930. Courtesy: NYC Municipal Archives

Fig. 3.7.4

PRESIDENTIAL

Fig. 3.8.1
Originally designed as the Brownsville High School under C. B. J. Snyder, the building was constructed under William H. Gompert. The completed school was renamed Thomas Jefferson High School. This patriotic emphasis is consistent with Gompert's design approach, as his original school designs referenced Colonial-American vernacular architecture. Courtesy: NYC Municipal Archives

General Description/Significance

The Presidential style schools were designed under C.B.J. Snyder, but were mostly constructed under his predecessor, William H. Gompert. Towards the end of his career, as schematic plans for the Presidential High Schools[64] were under way, Snyder expressed his extreme satisfaction with the design. He also expressed his belief that, this type would eventually succeed the Type-A as the established standard. When work had already begun, Gompert would see these designs through construction. However, the Presidential High Schools were quickly retired, and Gompert devised an entirely new set of standard schools, based on the successes of Snyder's school types. As such, the new designs that would become standard building types for the Board of Education though most of the 1920s, were based heavily of the Presidential Type schools as designed by Snyder.

Five stories high with red face-brick at their facades, the Presidential Style schools can be described as almost monumental, in their reference to classical design. The front is separated by massive pilasters between each window bay. At the fifth floor window sill, a projecting copper-covered cornice incorporates a frieze below, which has the name of the school inscribed.

Character Defining Architectural Features

- Symmetrical elevations with 5 front-central bays at the property line and two bays on either side set-back from the sidewalk.
- Projecting copper-clad cornice at the fifth floor window sill which circles the entire building.
- Monumental classical motifs.
- Wide pilasters between window bays.
- String course with dentils circles the entire building at the first floor window head, and is only interrupted the street facade pilasters.
- Large window bays with multiple divisions; originally double-hung windows with transoms above.
- Typically named after past presidents, hence, the style names, these schools are sometimes named after prominent politicians.

64 Board of Education, City of New York. *(1923). Twenty-fourth Annual Report of the Superintendent of Schools: 1921-1922 Report on Construction and Maintenance.* Page 64-72

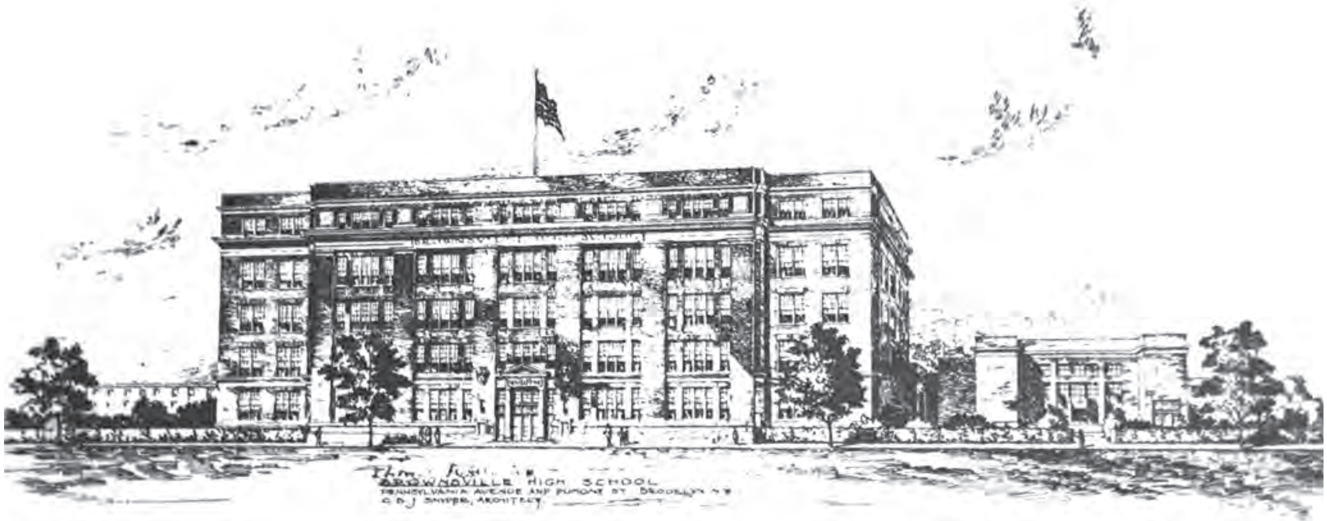


Fig. 3.8.2

Fig. 3.8.2 & 3.8.3 (above - below)
The original rendering of Brownsville High School completed under Snyder (above) and the completed building as constructed under Gompert (below) are uncanny in their similarity. After administering the construction of these designs, Gompert introduced his own set of standard blueprints, based heavily on the successes of Snyder's schools, especially the Presidential buildings. Courtesy: NYC Municipal Archives (Fig.3.8.2)

Fig. 3.8.3

COLLEGIATE GOTHIC

Fig. 3.9.1

Fig. 3.9.1 & 3.9.2 (above - below)
Morris High School in the southern Bronx (above) and Flushing High School (below) in Queens, both feature High-Gothic Revival elements and massing. The central tower above the main entrance is reminiscent of the buildings found at many of America's most prestigious universities. This was one of the many styles employed with the intention of inspiring students to continue in their education at a time when most Americans did not attend high school. Courtesy: NYC Municipal Archives

General Description/Significance

Following the 1898 consolidation of New York City, at a time when only a small proportion of students continued past elementary school, the Board of Education built a series of highly visible and elaborate high schools in each of the five boroughs. To emphasize the importance of these new, academically rigorous institutions, C.B.J. Snyder used the Collegiate Gothic style. The style of these high schools is meant to be evocative of the Seven Sister Schools, the Ivy League Schools and other top Western institutions.

Programmed for larger student bodies than neighborhood elementary schools, the new high schools were set within landscaped sites evoking a university campus, and included separate, almost church-like auditoriums that also accommodated community functions. However, they outgrew quite swiftly from their original quarters and required a series of additions.

Character Defining Architectural Features

- Prominent central tower with turrets and crenelation.
- Gabled end pavilions.
- Gothic detailing in stone and terracotta concentrated at central tower.
- Large multi-paned, double-hung windows with terracotta trim and mullions.
- Bay or oriel multi-story windows.
- Pitched or flat roofs.
- Formal entry lobby with hand-painted murals.

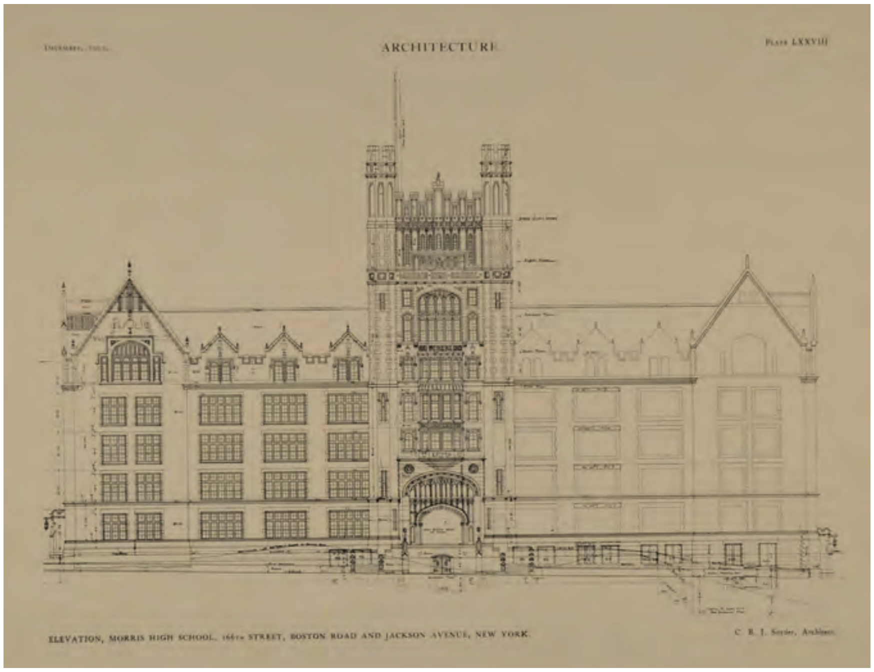


Fig. 3.9.4

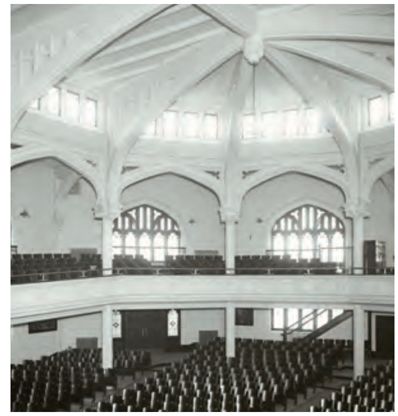


Fig. 3.9.3 (above) & 3.9.4 (left)
Morris High School (above - left) features an entry tower with crenelated parapets and Gothic windows throughout the building. The auditorium includes a balcony, clerestory lighting, and ribbed construction, reminiscent of older European theaters and churches. Courtesy: NYC Municipal Archives (Fig, 3.9.3), Board of Education Journal

Fig. 3.9.5 (below)
Eastern District High School in Brooklyn. Courtesy: NYC Municipal Archives

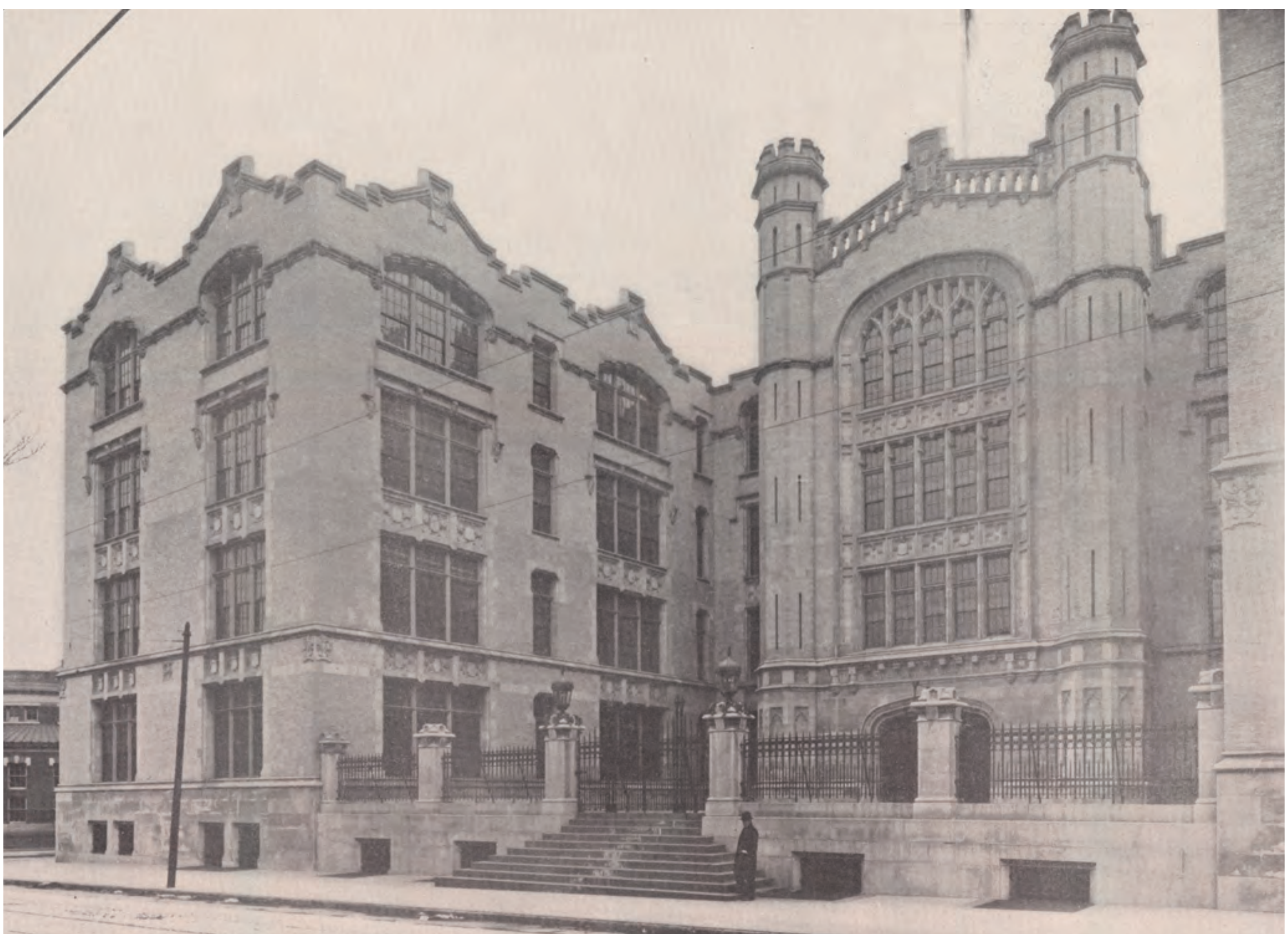


Fig. 3.9.5

SIMPLIFIED GOTHIC

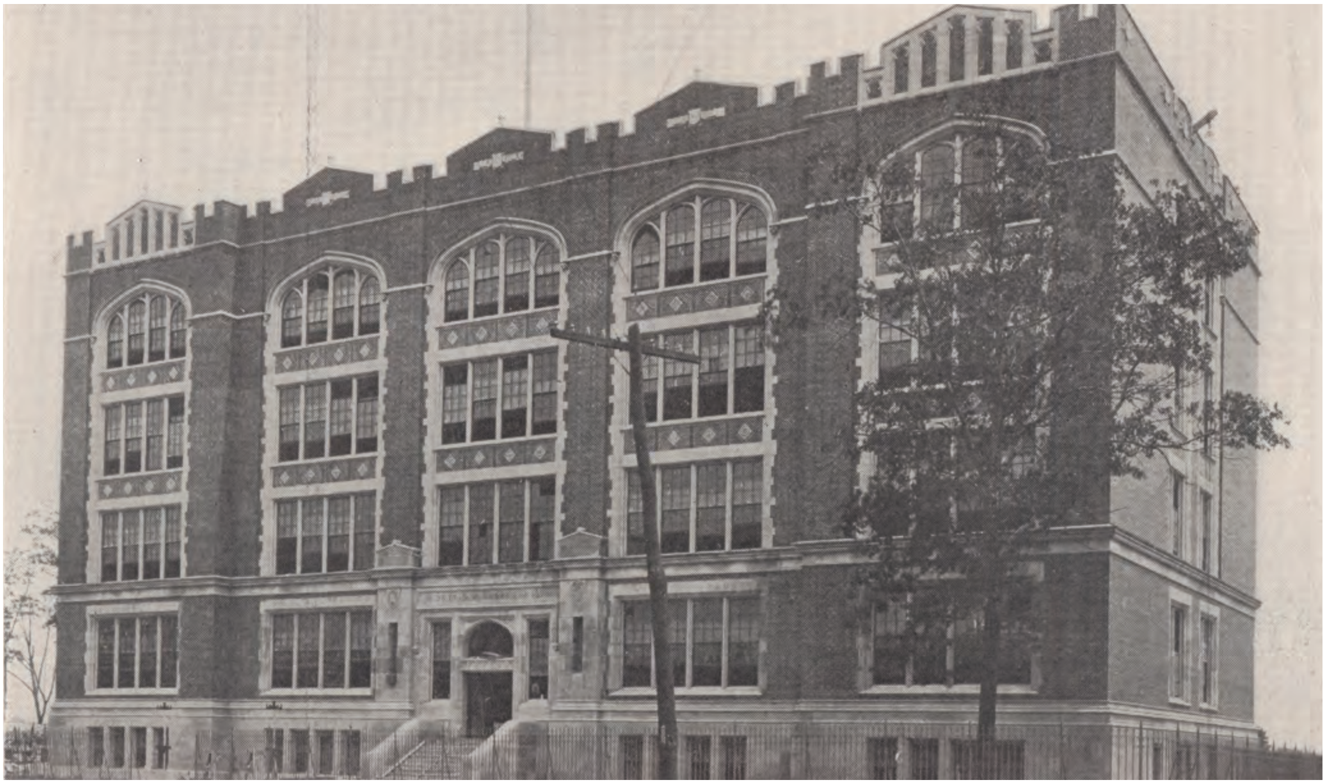


Fig. 3.10.1
PS 160 K in the Borough Park neighborhood of Brooklyn features a crenelated parapet and pointed arches at the top of each window bay. The Gothic Revival style was meant to be reminiscent of the buildings found at many of America's most prestigious universities, however the rapid demand of schools meant that ornament at many of these buildings was kept to a minimum. Courtesy: NYC Municipal Archives

Fig. 3.10.2 (below)
PS 48 X in the Hunts Point neighborhood of the Bronx features a red brick facade and limestone/terracotta ornamentation at the crenelations and window surrounds. Courtesy: Sylvia Hardy

General Description/Significance

Simplified Gothic was the most frequently used style during the later years of C.B.J. Snyder's tenure as Superintendent of Buildings for the Board of Education. Often constructed on *'end-block'* sites in growing neighborhoods made accessible by an expanding public transportation system, these schools were most often built in the Type A plan typology. This design typically incorporated a central two-story rear extension in which a cafeteria was housed on the ground flood, an auditorium on the second, and a caged rooftop outdoor play area on the roof.

These buildings feature high parapets and vertical bays of multiple double hung windows, with ornamental terracotta banding and window surrounds. Several versions of this basic design were erected during the epoch where building methods and materials were changing rapidly, and hence, the construction detailing varies considerably from school to school despite a similar appearance. Probably because of the high volume of construction and demand for materials at the time they were built, some later examples have had problems resulting from the poor or uneven quality of the face brick.

Character Defining Architectural Features

- Flat roof with high, crenelated parapet.
- Shallow pointed arches terminate vertical window bays - recessed bays with flat vertical piers and spandrel panels are often used for earlier designs.
- Symmetrical end pavilions.
- One or two-story projected front entrance structure.
- Wide window bays - 3 to 4 windows per lintel opening.
- Belt course/cornice at top of first floor windows.
- Decorative details concentrated around main entrance with typical Collegiate Gothic motifs in terracotta.
- Stone or terracotta base below first floor window sills.

Fig. 3.10.4

Fig. 3.10.3

Fig. 3.10.3 (above),3.10.4 (left) & 3.10.5 (below) IS 77 Q in Ridgewood, Queens, PS 48 X in Hunts Point, and the former Eastern District High School in Williamsburg in Brooklyn, both feature pointed arch windows and crenelated parapets. Courtesy: Sylvia Hardy (Fig. 3.10.3 & 3.10.4), NYC Municipal Archives (Fig. 3.10.5)

Fig. 3.10.5

ART DECO

Fig. 3.11.1
Rendering of the original design of PS 48 Q, located in Jamaica, Queens. Courtesy: NYC Municipal Archives

Fig. 3.11.2 (below)
Located on Manhattan's Upper West Side, PS 333 M (also known as the Manhattan School for Children, formerly the Joan of Arc Junior High School) is a high-rise Art Deco school building completed in 1940. Designed by Eric Kebbon, its features include emphasis on verticality and abstracted relief work at the entry. Courtesy: Nelligan White Architects

General Description/Significance

Describing what is currently the Fashion Industries High School in Manhattan, the Superintendent of Schools Annual Report for 1937-1938 expressed, *"The design is along the modern trend, having a decided horizontal feeling in the central part and a vertical feeling in the two end bays."*[65]

Art Deco, which derived from the European Art Nouveau of the turn of the century, was essentially a style that was based on the compositional principles of classical design. However, its clean lines and bold forms can be construed as deceptive, since it often incorporates a fair amount of ornament and high standards of craftsmanship.

Although elements of Art Deco were employed on public schools as early as 1930, the style was incorporated most fully on the facades of a limited number of schools built between 1936 and 1938. However, it was not as widely used as the more standard designs, most likely because the style incorporated costly decorative panels and cut stone. These ornamental elements are subordinated to the streamlined massing of the building, resulting in a refined, elegant aesthetic. Several Art Deco schools share a plan type which would best be described as a Type-M.

Character Defining Architectural Features

- Symmetrical massing and composition.
- Continuous piers and banding emphasizing the verticality.
- Roof-line modulated by extension of piers above parapet and pedimented end pavilions.
- Granite building base, and carved granite surround at main entrances.
- Decorative stone panels sculpted in low relief.
- Polychromatic terracotta and brick panels.
- Multi-paned, double-hung wood windows.

[65] New York City. (1937-1938) *Board of Education AIA Annual Report,* City of New York.

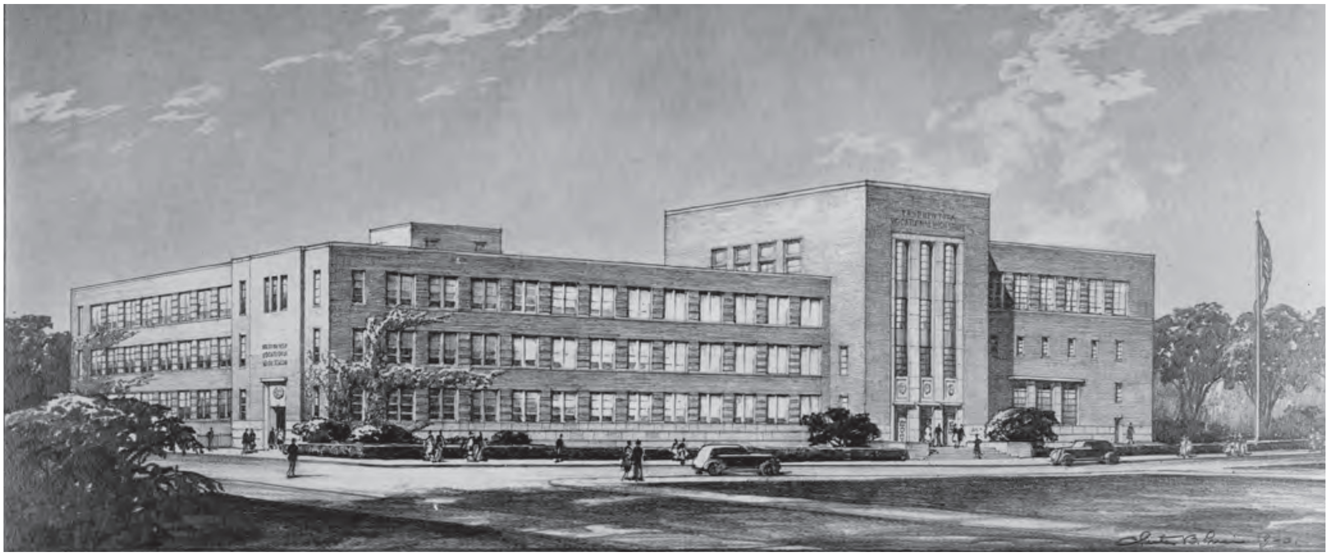


Fig. 3.11.3 (above)
Rendering of East New York Vocational High School. Courtesy: NYC Municipal Archives

Fig. 3.11.4 (below)
PS 60 Q. Courtesy: NYC Municipal Archives

Fig. 3.11.4

CLASSICAL REVIVAL

Fig. 3.12.1
PS 154 K, located in Windsor Terrace neighborhood of Brooklyn. Courtesy: NYC Municipal Archives

General Description/Significance

Historically, reference to Classical styles is common practice in educational buildings. New York Public Schools incorporated these styles in their designs from the 19th century onward. Some of the more distinctive styles, including Beaux-Arts, Neo-Colonial, and the Renaissance Styles reference Classical Design on their own. Certain schools however, are purer examples of Classical Revivalism.

C. B. J. Snyder used Classical Revival styles intermittently, along with the other styles he pioneered for use in schools. By 1928, when Walter C. Martin became Superintendent of Buildings, the floor plans and facades of new schools were stiflingly standardized. He devised the Type-M, which was a clean design, using a classical tripartite scheme in most of its iterations, and included a rusticated base, middle section which forms the bulk of the school, and a cornice which includes a frieze and clay-tile overhang. Ornamentation in these schools is often kept to a minimum, as the design relies on the classical proportions in the design scheme for harmony. String courses separates each section of the tripartite scheme, and window/door surrounds are often present. Elaborate details are often confined to the frieze and cornices at these buildings

Fig. 3.12.2
Cornice of PS 89 X. Courtesy: Sylvia Hardy

Character Defining Architectural Features

- Symmetrical elevations emphasizing central and end bays
- Steeply sloped roofs terminating in flat upper roof area
- Facades horizontally divided with water tables, string courses and continuous drip molds
- Basic wall materials: brick facades with limestone and terracotta trim
- Decorative panels kept to a minimum

Fig. 3.12.4

Fig. 3.12.3

Fig. 3.12.3, 3.12.4 & 3.12.5
Front view of PS 89 X. Cornice of PS 89 X. Front view of PS 106 Q. Courtesy: NYC Municipal Archives (Fig. 3.12.4 & Fig.3.12.5), Sylvia Hardy (Fig. 3.12.3)

Fig. 3.12.5

NEO-COLONIAL

Fig. 3.13.1
IS 109 Q in Queens Village features a red brick facade with minimal ornament, except at the cast marble portico denoting the entrance. This type often features banisters at the parapet, though sometimes it incorporates only ornamental medallions. Courtesy: Sylvia Hardy

Fig. 3.13.2
Ornament at IS 109 Q and its associated types is mostly concentrated at the cast marble columns and portico at the entrance. Courtesy: Sylvia Hardy

General Description/Significance

Neo-Colonial schools, mostly associated with the Type-E and F schools in the 1920s, differ significantly in appearance from earlier schools. Window openings were smaller and more repetitive, reflecting a reduced concern for daylighting and lower costs for shorter lintels; parapets were lower in height though still quite detailed. Ornamentation in these schools kept to a minimum, centered around a projected cast-marble portico at the main entrance and balustrades at the parapet.

Some smaller schools built in the outer boroughs feature gables roofs and a cupola at the center, and a slightly projected two-story entrance pavilion topped with a shallow arched dormer.

Character Defining Architectural Features

- Continuous belt course above second floor lintels; projected water table above fourth floor
- Flat parapet with decorative balustrades
- Window openings primarily square with paired double-hung windows
- Arched first floor windows at auditorium wing
- Flat arched terracotta window lintels
- Marble base below first floor window sills

Fig. 3.13.4

Fig. 3.13.3 & 3.13.4 (above - left)
A lantern at the entrance of PS 109 Q highlights the level detailing above the entrance door in this Neo-Colonial type. At Forest Hills High School, the cupola is a prominent feature. Courtesy: NYC Municipal Archives (Fig. 3.13.3), Sylvia Hardy (Fig. 3.13.4)

Fig. 3.13.5 (below)
PS 131 Q in the Jamaica Hills neighborhood of Queens is a smaller type building intended to assimilate with the lower buildings of the far outer boroughs. Courtesy: NYC Municipal Archives

Fig. 3.13.5

MID-CENTURY MODERN

Fig. 3.14.1

Fig. 3.14.1 & 3.14.2 (above - below)
PS 111 M and PS 36 M after rehabilitation. Courtesy: Sylvia Hardy

General Description/Significance

In 1937, the Board of Education commissioned the AIA to conduct a survey of school buildings. The resulting report urged the Board to adopt a more modernist approach to school design[66]. However, by the start of World War II nearly all building stopped. Following the end of the War in 1945, a Baby Boom signaled the need to build many new schools by the mid-1950's to accommodate the growing youth population. These post-war schools took lead from the 1937 AIA report, adopting a style heavily influenced by the European International Style. Methods and materials were also borrowed from innovative, industrial building types which came out of the war effort. Features include reinforced concrete frame structures, curtain wall and window infill systems, and low, boldly massed, horizontally oriented campuses rather than the monumental buildings of the 1920s and 1930s.

Character Defining Architectural Features

- Reinforced concrete frame structures
- New types of window systems: Early curtain wall/window wall systems, window infill systems, punched window systems.
- Brake-formed steel windows rather than wood.
- Typically fewer than four stories.
- Emphasis on horizontality and bold composition of building parts into a campus, rather than a massive, monumental building.
- Different programmatic areas separated: gym, auditorium, classrooms all placed in distinct areas, rather than fit into a building enclosure.
- Exterior cavity walls.
- Flat roofs

[66] New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York. Page 26

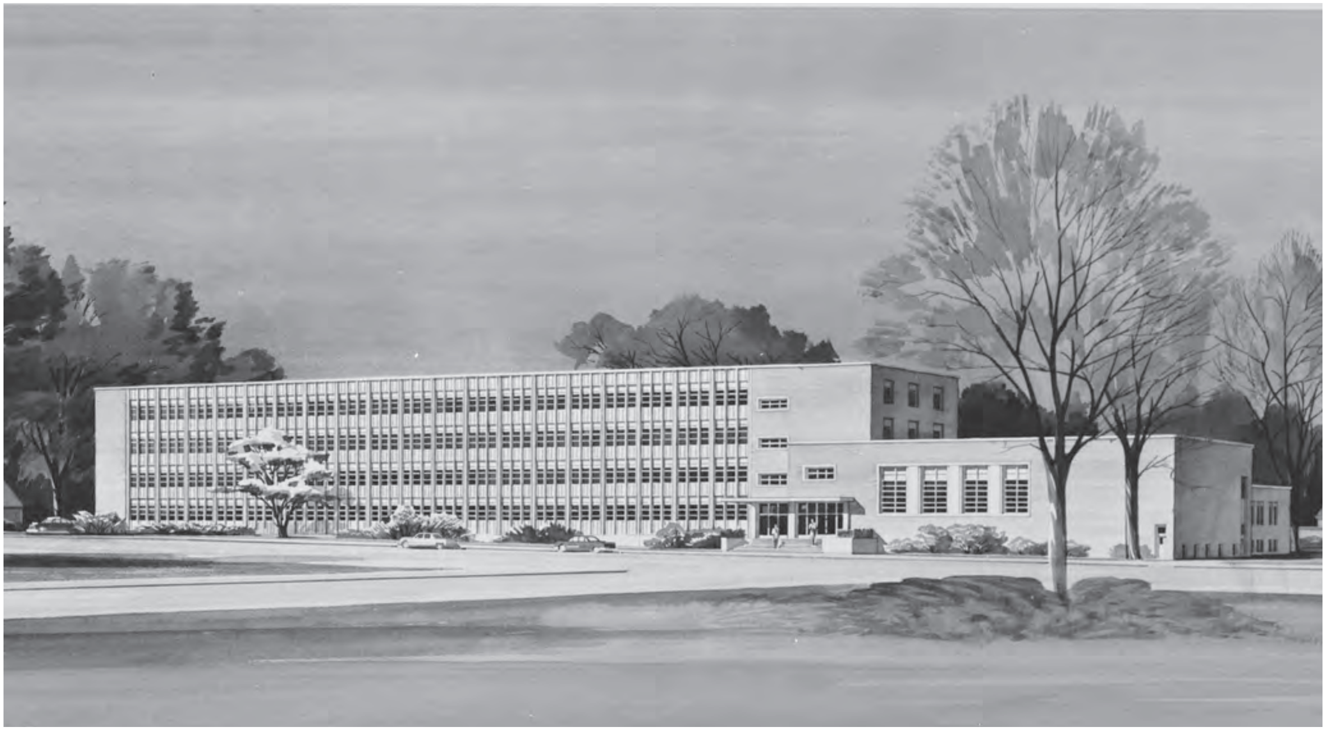


Fig. 3.14.3 (above)
Rendering of PS 59 Q. Courtesy: NYC Municipal Archives

Fig. 3.14.5

Fig. 3.14.4 (above)
PS 200 Q after rehabilitation. Courtesy: Sylvia Hardy

Fig. 3.14.5
PS 36 M after rehabilitation. Courtesy: Nelligan White Architects

STYLE - PLAN MATRIX

	Central Plan	Rectangular Plan	Type A	H-Plan	U-Plan	Type E	Type M	Hybrid H/E	Midcentury L	Midcentury Campus	Highrise
Qeen Anne Revival	●										
Romanesque Revival	●	●									
English-Flemish Renaissance Revival		●	●	●							
French Renaissance Revival		●	●	●							
Beaux Arts		●	●								
Monumental Beaux Arts								●			
Presidential					●						
Collegiate Gothic		●									
Simplified Gothic		●	●	●			●				
Art Deco	●						●				●
Classical Revival			●				●	●			
Neo-Colonial						●	●				
Mid-Century Modern									●	●	

SECTION 4

PLAN TYPOLOGIES

PLAN TYPOLOGIES

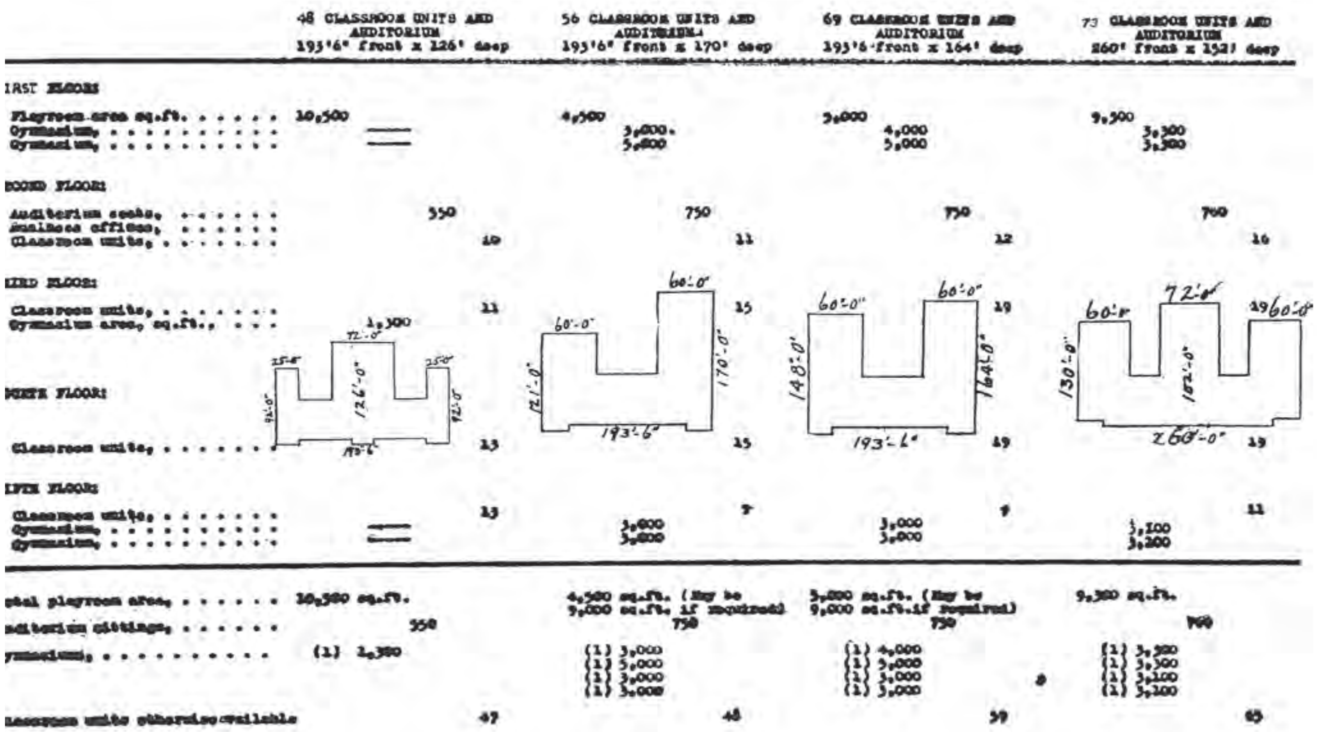


Fig. 4.1.1 (above)
Excerpt from Charles B. J. Snyder's 1921-22 Report on Construction and Maintenance shows the standardization of plans achieved during Snyder's term as the Superintendent of School Buildings. Based on the demand for classrooms and the site allotted, a sufficient plan type could be chosen with minor changes in design. Courtesy: Board of Education Journal

Fig. 4.1.2 (overleaf-top) & 4.1.3 (overleaf-bottom)
Prototypical images of the Presidential Type Schools, which incorporate a U-Plan typology. The basement level of the U-Plan (Fig 4.1.3) is completely filled, with a gymnasium and auditorium occupying the central courtyard, while the rest of the school rises above in a U-shape, allowing light and air into each classroom. Courtesy: NYC Municipal Archives

Introduction

In this section, the major plan typologies used in New York City Public Schools, from the late 19th Century through the Post World War II era, are outlined with an explanation of their driving forces and existing examples. The structural systems associated with each plan type have also been noted with references to the Structural System Typologies section of this book.

For much of their history, New York City Public Schools have been justifiably subject to a high level of scrutiny. In terms of architecture alone, the constraints of public educational facility designs include functionality, safety, educational and sanitary requirements, costs, location, and constituency, to name a few.

Public schools exhibit a wide variety of plan typologies, reflecting the input and limitations which were established as a basis of design at any given time. For example, the first new school building opened by the Free School Society in 1808, was a two-story brick structure[68]. The top floor was a single classroom with a capacity of up to 150 children, while the first floor was an apartment for the school's teacher. This plan was partly the result of the *Lancasterian* System[69] of education, in which older students taught younger students, acting as *'helpers'* to the head teacher. As this educational system fell out of fashion and more professional teachers became available, schools began to separate children by age group in smaller classrooms and housing for teachers was no longer a requirement.

By building smaller classrooms, these schools would begin to resemble what the 20th century recognized as a public school. However, the growing population of the city and increasingly higher educational standards would drastically alter the size and specialization of school buildings and the classrooms within them, while their location and massing would be effected by urban growth patterns in the outer boroughs.

[68] *Chapter III: The Free School Society's First School Opened.* Palmer, A. Emerson. (1905). *New York Public School: Being a History of Free Education in the City of New York.* Macmillan & Co. Ltd., London. Page 24

[69] Reigart, John Franklin. (1916). *The Lancasterian system of instruction in the schools of New York City.* Teachers College, Columbia University, New York City.

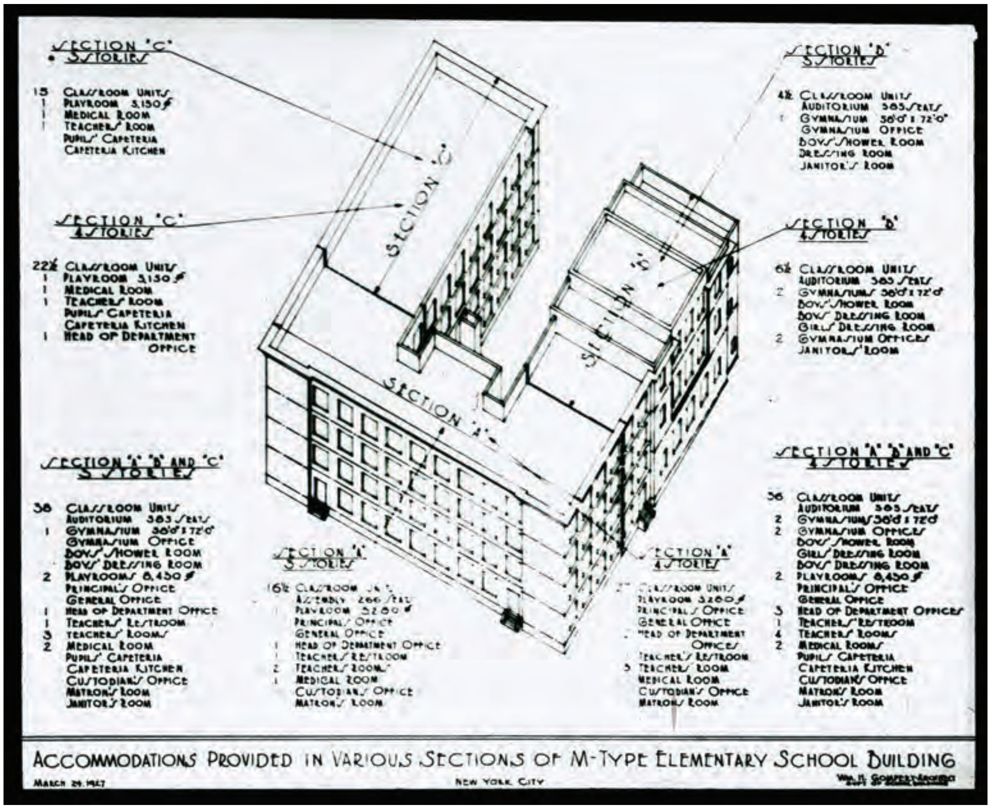
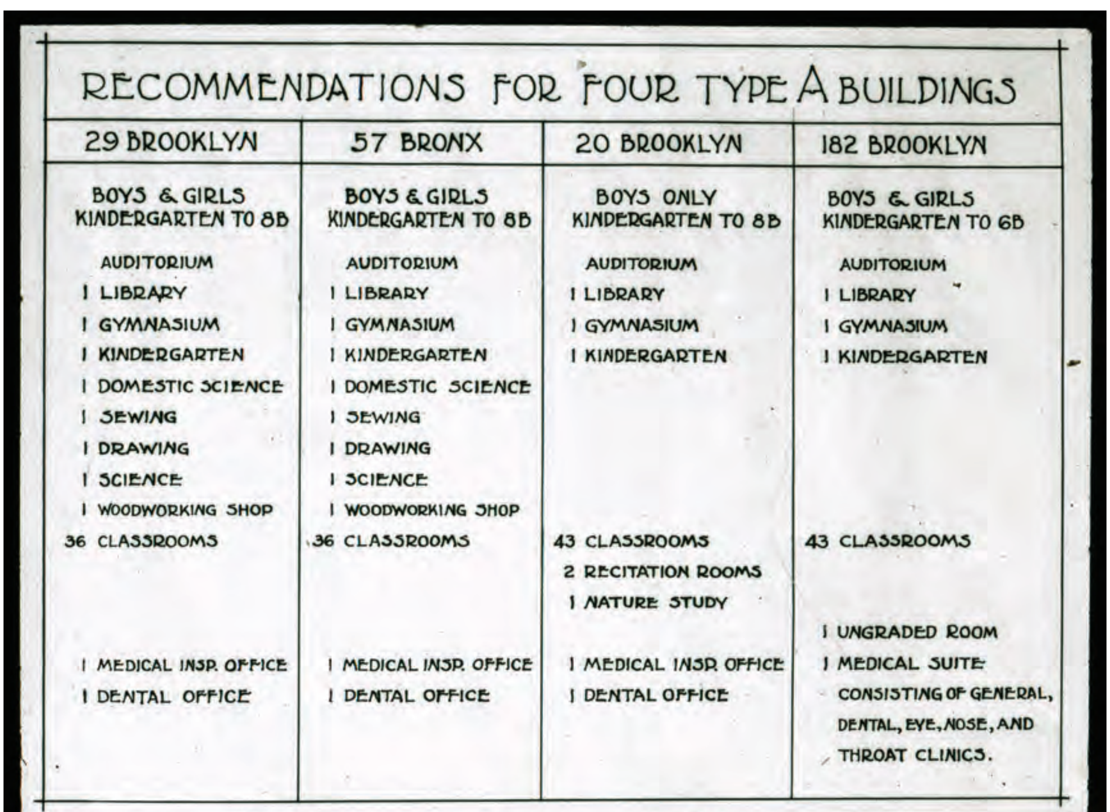


Fig. 4.1.2



RECOMMENDATIONS FOR FOUR TYPE A BUILDINGS

29 BROOKLYN	57 BRONX	20 BROOKLYN	182 BROOKLYN
BOYS & GIRLS KINDERGARTEN TO 8B	BOYS & GIRLS KINDERGARTEN TO 8B	BOYS ONLY KINDERGARTEN TO 8B	BOYS & GIRLS KINDERGARTEN TO 6B
AUDITORIUM	AUDITORIUM	AUDITORIUM	AUDITORIUM
1 LIBRARY	1 LIBRARY	1 LIBRARY	1 LIBRARY
1 GYMNASIUM	1 GYMNASIUM	1 GYMNASIUM	1 GYMNASIUM
1 KINDERGARTEN	1 KINDERGARTEN	1 KINDERGARTEN	1 KINDERGARTEN
1 DOMESTIC SCIENCE	1 DOMESTIC SCIENCE		
1 SEWING	1 SEWING		
1 DRAWING	1 DRAWING		
1 SCIENCE	1 SCIENCE		
1 WOODWORKING SHOP	1 WOODWORKING SHOP		
36 CLASSROOMS	36 CLASSROOMS	43 CLASSROOMS	43 CLASSROOMS
		2 RECITATION ROOMS	
		1 NATURE STUDY	
			1 UNGRADED ROOM
1 MEDICAL INSP. OFFICE	1 MEDICAL INSP. OFFICE	1 MEDICAL INSP. OFFICE	1 MEDICAL SUITE CONSISTING OF GENERAL, DENTAL, EYE, NOSE, AND THROAT CLINICS.
1 DENTAL OFFICE	1 DENTAL OFFICE	1 DENTAL OFFICE	

Fig. 4.1.3

PLAN TYPOLOGIES

CENTRAL PLAN

Fig. 4.2.1 (above)
PS 23 (now demolished) located in East-Williamsburg, Brooklyn. Courtesy: NYC Municipal Archives

Fig. 4.2.2 (overleaf-above), 4.2.3 (overleaf-bottom left) & 4.2.4 (overleaf-bottom right)
Grammar School 56 - 1869
West 18th Street between 8th and 9th
Courtesy: NYC Municipal Archives

Queen Anne Revival and early Romanesque Revival schools were often designed centrally, with smaller rooms clustered around a large central assembly space, which was often the focus of the schools activities. These plans were evidently designed for the old City, where buildings were seldom higher than 2 or 3 stories high.

These schools were often built right up to the lot line with windows on all sides, allowing maximum light into the classrooms and yards in the back and on either side. The light and air of these outdoor spaces would quickly be extinguished once buildings were built higher using iron, steel and other structural innovations of the late 19th century.

While virtually none of the original Queen Anne Revival buildings are still in use, several Romanesque Revival Buildings are still occupied by public schools.

ASSOCIATED STRUCTURAL TYPES:
Type 1 - Page 112
Type 2 - Page 113
Type 4 - Page 115

Front View.

Fig. 4.2.2

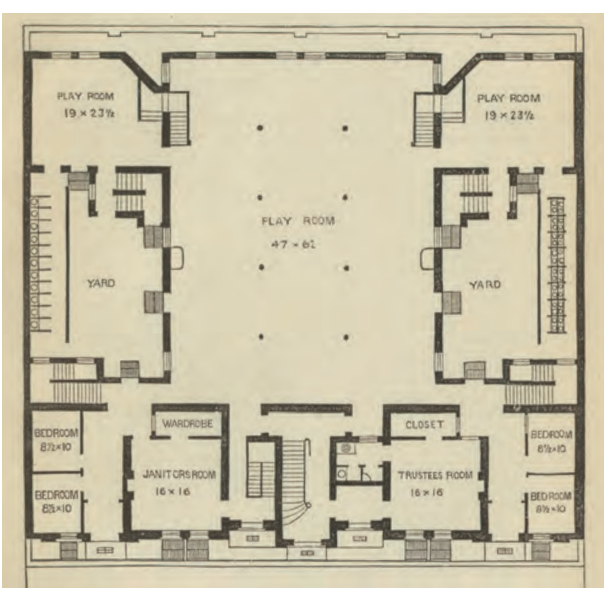
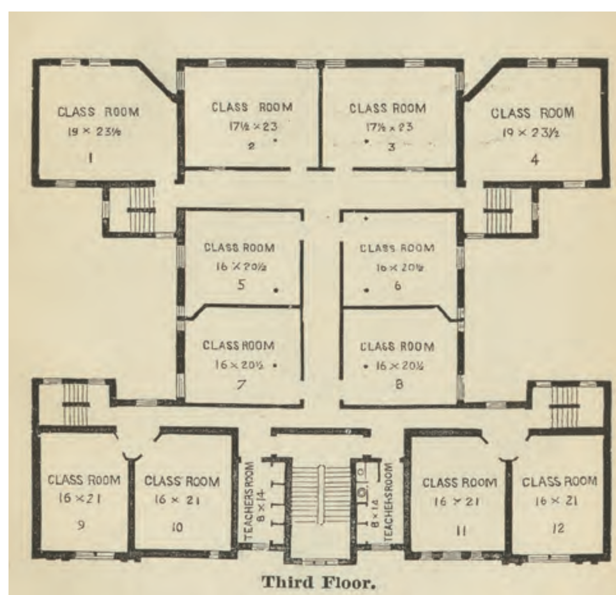


Fig. 4.2.3



Third Floor.

Fig. 4.2.4

RECTANGULAR PLAN

Fig. 4.3.1 (above)
PS 183 M located on the Upper East Side of Manhattan, an example of the rectangular plan in Beaux-Arts styling. Courtesy: Sylvia Hardy

Fig. 4.3.2 (overleaf-top) & 4.3.3 (overleaf-bottom)
Prototypical sketches of the plans (4.3.2) and contemporary plans of PS 183 M (4.3.3) show slight variations in the configuration of spaces, though the general arrangement of spaces in reference to circulation remains consistent throughout this plan type. Courtesy: NYC Municipal Archives (Fig. 4.3.2), Board of Education Journal (Fig. 4.3.3)

[70] Basements often have a differing layout which included a cafeteria/assembly space

ASSOCIATED STRUCTURAL TYPES:
Type 3 - Page 114
Type 4 - Page 115

The rectangular plan school buildings are straightforward in their design; a single, double loaded hallway leads from a stair column, located at one end of the building, to a stair column on the opposite side. The walls of the main hallway are partitions between the two rows of columns which run longitudinally across the building as its main internal structural element. All typical classrooms[70] are located directly off this hallway and have windows which face outwards towards the street, or the buildings behind and to the side. Restrooms and offices are often stacked on one side of the hallway at each floor.

In the original building plans, the central hallway may sometimes be cut short at certain floors by assembly rooms with sliding panel walls for conversion to additional classrooms. These rooms have mostly been eliminated due to fire safety concerns or for permanent classroom space. There is a single main entrance at the center of the front facade. Other entries are located on the back side, often leading to a school yard which takes up the remainder of the lot through the block.

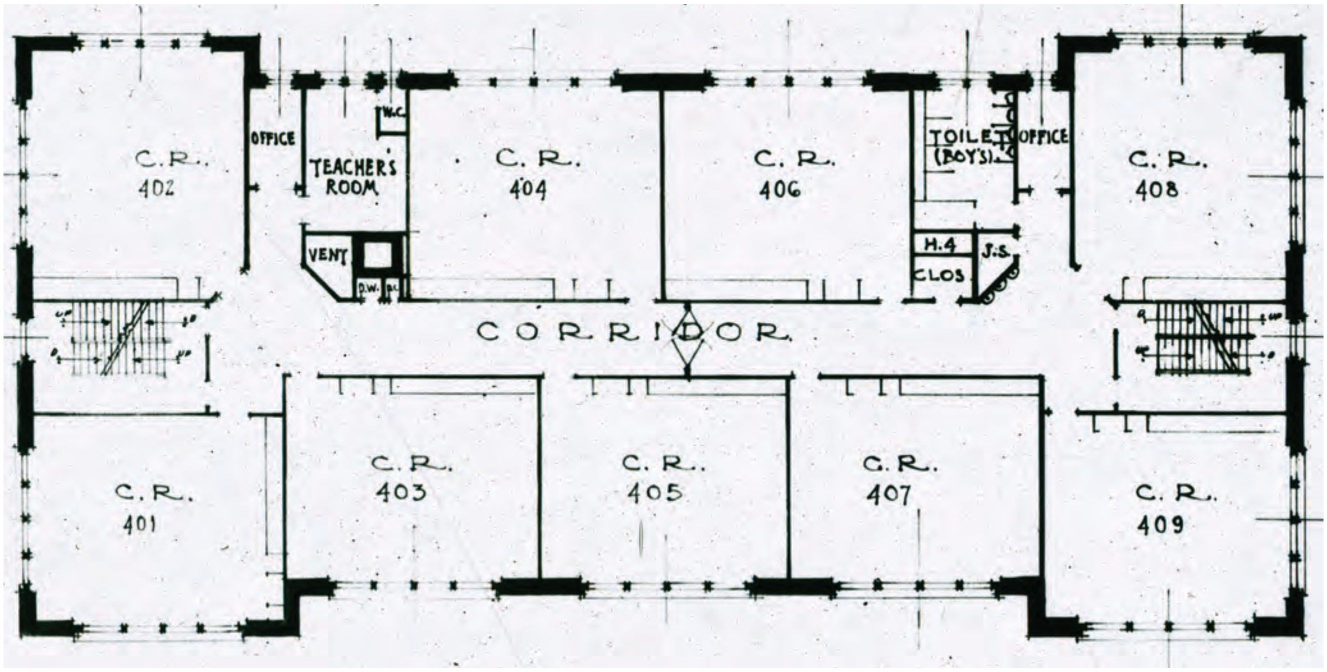


Fig. 4.3.2

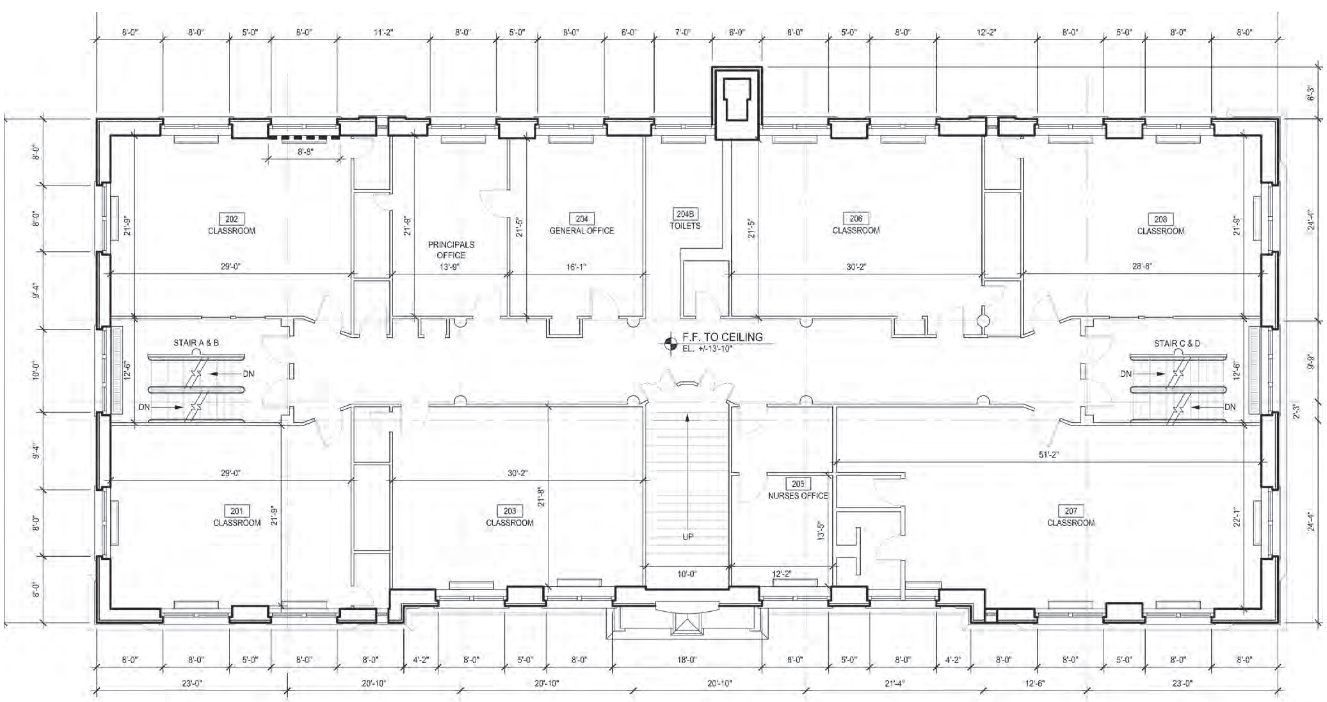


Fig. 4.3.3

TYPE-A

Fig. 4.4.1 (above)
A typical 48 classroom Type-A school in Simplified Gothic styling. Courtesy: Board of Education Journal

Fig. 4.4.2 (overleaf-top) & 4.4.3 (overleaf-bottom)
The ideal Type-A (4.4.2) from Snyder's 1921-22 Annual Report, compared to a contemporary drawing of the auditorium floor of PS 277 X, a Type-A school (4.4.3). While the plans follow the same footprint, one can see how each site required some modification of the type. Courtesy: Board of Education Journal

The Type-A is an evolution of the Rectangular Plan; a centrally located, double loaded corridor, and circulation at either end. Additional stair columns are added near the center of the Type-A configuration. At either end of the building, the central hall turns 90 degrees, resolving in small wings and an extra classroom at each end. There are some variations where an auditorium or a gym takes up half of the floor plate of any given floor.

The Type-A configuration was used extensively and considered the standard for school buildings in the years leading up to World War I due to the efficiency of its design and construction. Designed on a maximum frontage of 193'-6", corresponding with the maximum frontage of the average block, the type was made available wherever required, without the expenditure of time needed for entirely new plans. This type was developed in to multiple sub-types based on the number of classrooms, including a 10, 26, 36, 51, 48 and 73 classroom version to meet the demand of a given site.

ASSOCIATED STRUCTURAL TYPES:
Type 1 - Page 112
Type 3 - Page 114

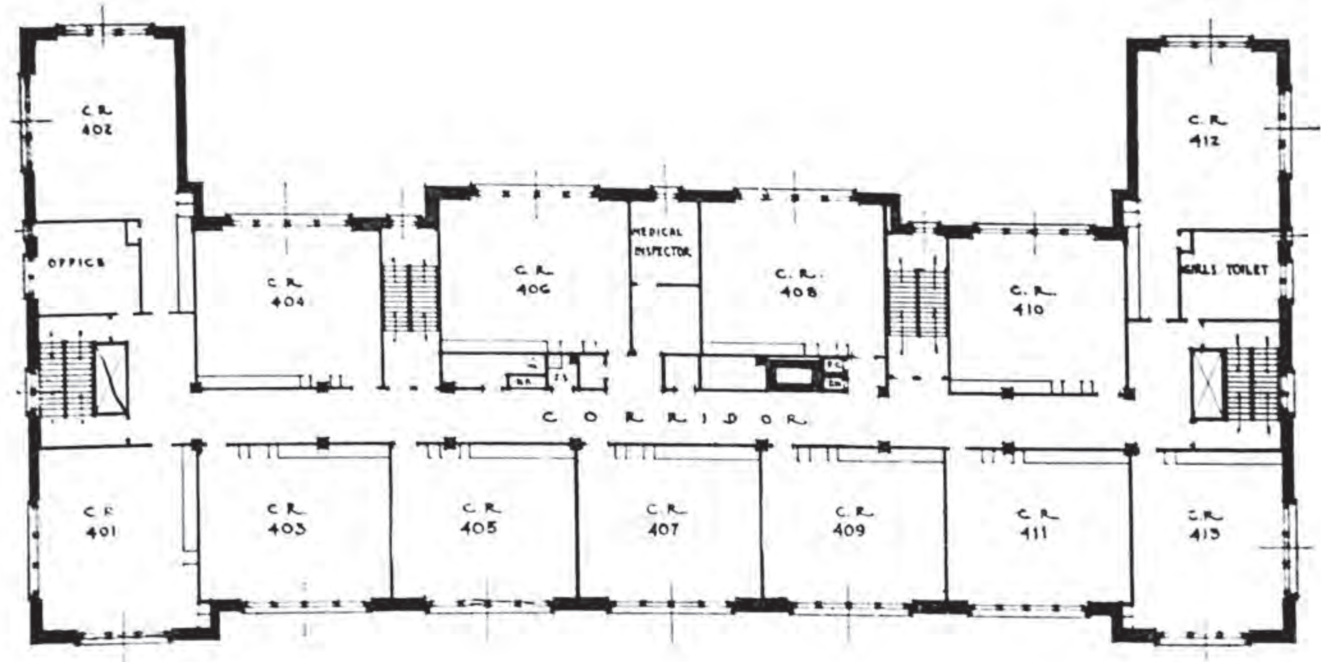


Fig. 4.4.2

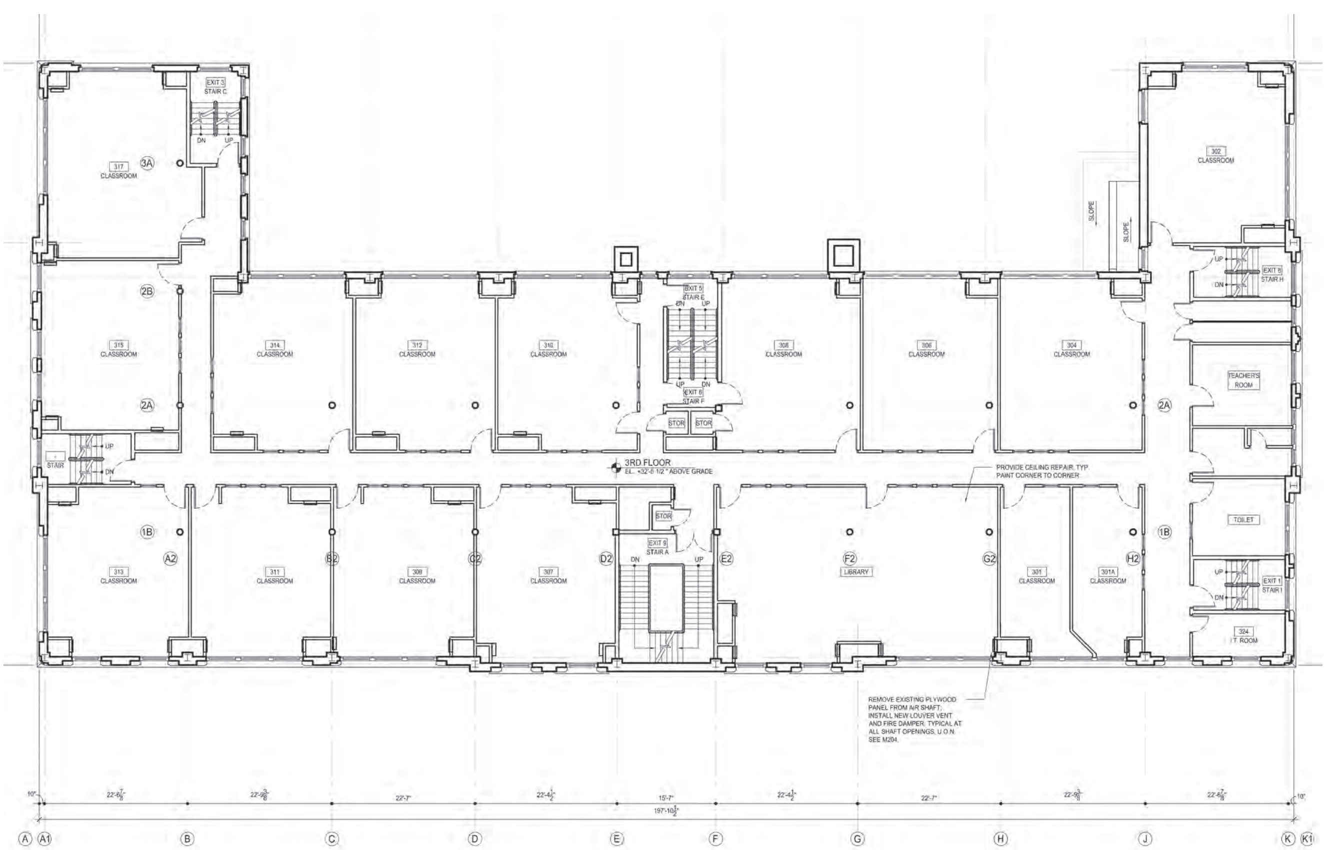


Fig. 4.4.3

H-PLAN

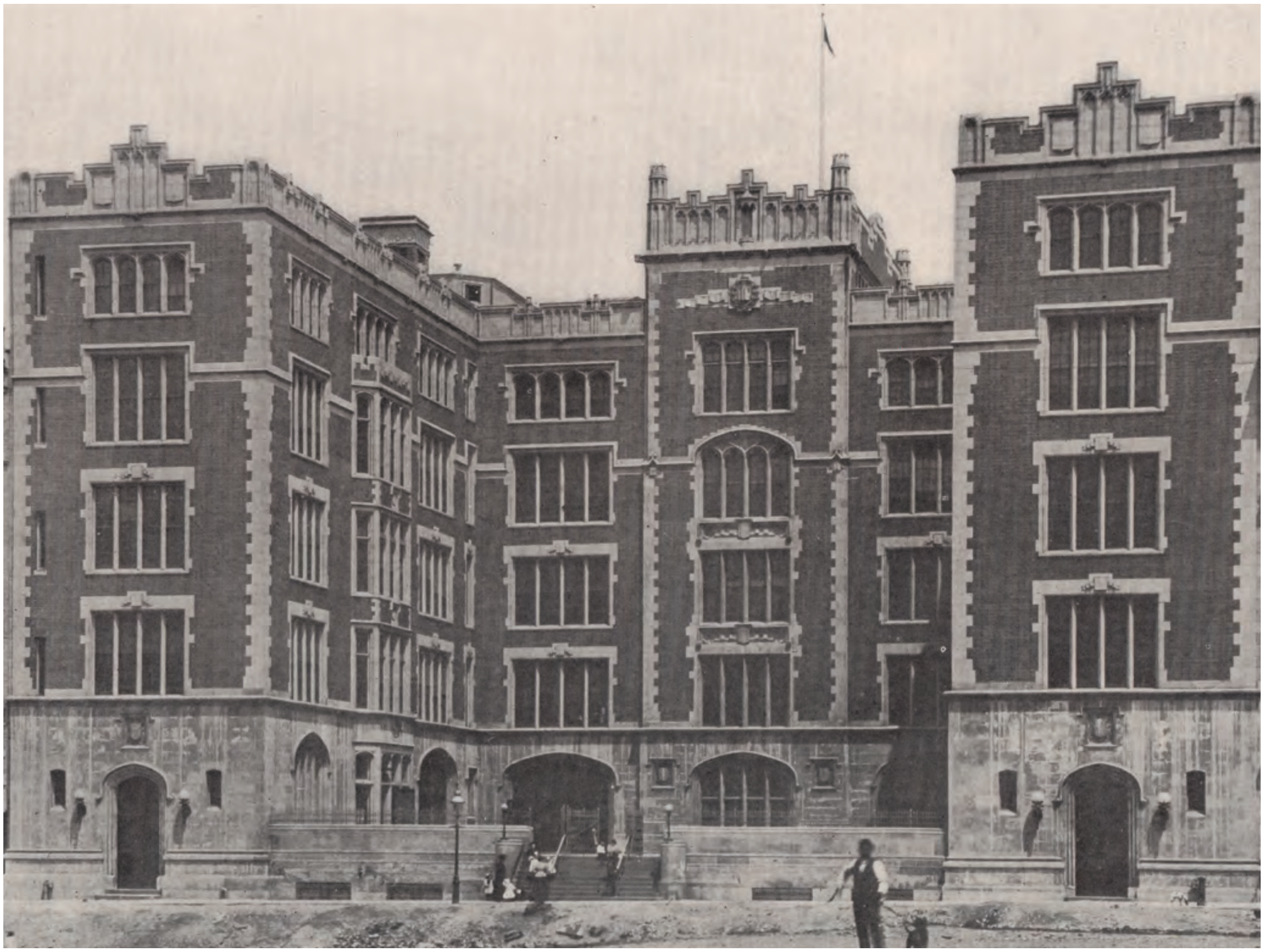


Fig 4.5.1 (above)
PS 90 M located in Upper Manhattan, is no longer a public school building, but is a prime example of the H-Plan configured with the English-Flemish Renaissance Revival style. Courtesy: NYC Municipal Archives

Fig 4.5.2 (overleaf-top) & 4.5.3 (overleaf-bottom)
Original (4.5.2) and contemporary (4.5.3) drawings of H-Plan schools shows slight variations in the arrangement of rooms between individual buildings. Courtesy: SCA Alchemy (Fig.4.5.2), Nelligan White Architects (Fig. 4.5.3)

ASSOCIATED STRUCTURAL TYPES:
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The Superintendent of Buildings, C.B.J. Snyder, developed the H-Plan after touring the cities of northern and central Europe, funded by the Board of Education to study successful school design. The resulting design was planned for cheaper and quieter mid-block sites, for use in the older, more expensive areas of New York City.

This plan is an evolution of the Type-A; four large wings project 90 degrees from each corner of the building, forming an H-shaped plan. These wings contain single loaded corridors with classrooms facing the interior courts created by the wings. The connective center of the building contains a short double loaded corridor with classrooms or offices on either side.

The building's shape ensures that new buildings would be unable to block light to the interior courtyard and classrooms. This type was designed with two typical sub-types for 56 and 72 classrooms, though variations in these numbers exist.

Where the H-Plan is recognized for its quality design and its extremely effective use of site, it was ultimately discontinued by the beginning of World War I, as it could not be feasibly expanded to meet the demands of New York's exploding population through the early 20th century.

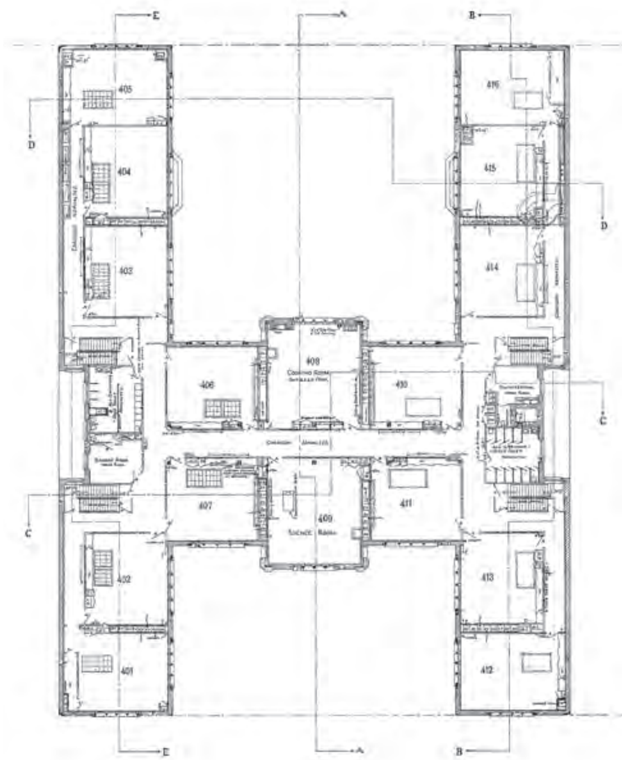

Fig. 4.5.2

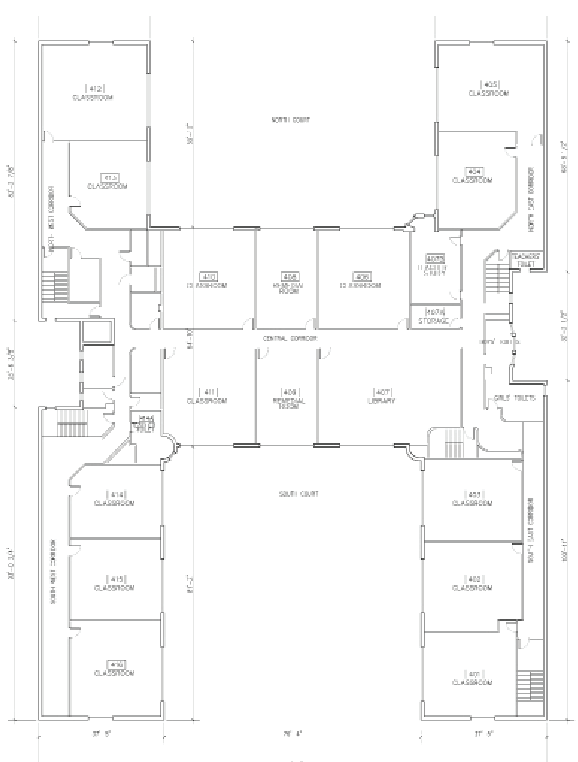

Fig. 4.5.3

U-PLAN

· FRONT · ELEVATION · ON · PENNSYLVANIA · AVENUE ·

Fig. 4.6.1 (above)
Thomas Jefferson High School. Courtesy: Board of Education Journal

Fig. 4.6.2 (overleaf-top) & 4.6.3(overleaf-bottom)
Rendering and fourth floor plan of Thomas Jefferson High School. Courtesy: Board of Education Journal and SCA Alchemy

The U-Plan typology represents a selected number of buildings, which include the Presidential High Schools designed by C.B.J. Snyder. The success of this plan is best summarized in the architect's own words from his 1921-1922 Annual Report on Buildings and Maintenance:

"I consider this plan to be one of the most important which I have contributed in my service to the department, and feel safe in venturing the opinion that, because of adaptation without change in block front location, unrestricted natural light and air to every room used either for instruction of administration, enlargement to any extent desired without expense for changes and alterations to the then existing building, ease of administration, as well as economy in plan and in cost of construction, it will quickly take its place as the standard type for New York City schools."[71]

The U-Plan, as first designed by Snyder, did not become the standard during his tenure as Superintendent of Buildings. However, his predecessor William Gompert adopted and altered the design as part of a program for increased standardization. The resulting design was the widely used Type-E, which in turn became the most commonly built of all types, the Type-M.

[71] Charles B J Snyder describes the significance of U-Plan typology in the Annual Report on Buildings and Maintenance 1921-1922

ASSOCIATED STRUCTURAL TYPES:
Type 1- Page 112

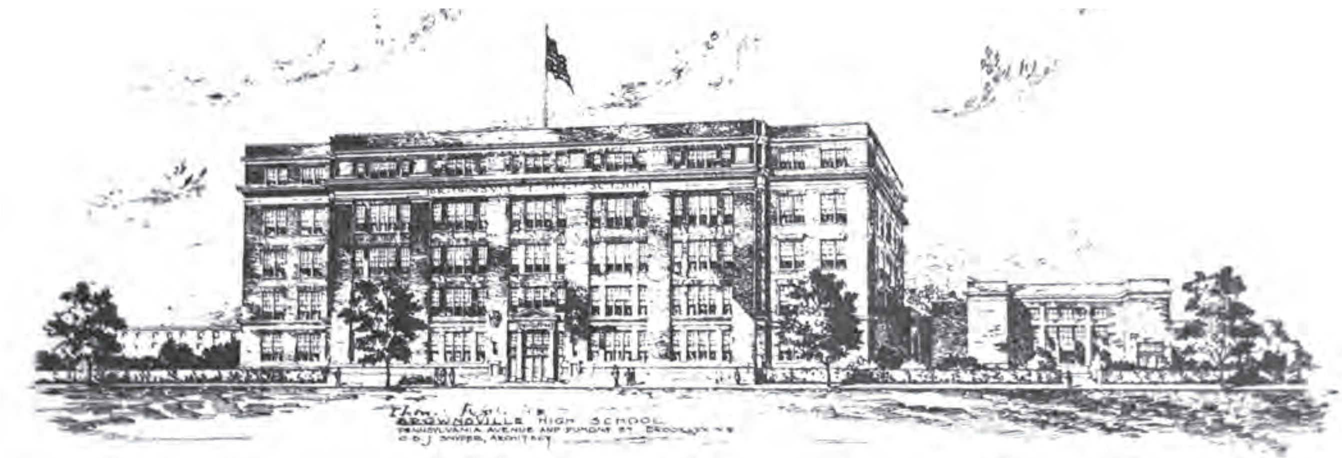
BROWNSVILLE HIGH SCHOOL

Fig. 4.6.2


CLASS ROOM
OFFICE
CLASS ROOM
FREE-HAND DRAWING
CLASS ROOM
DOMESTIC SCIENCE
CLASS ROOM
L W
L W
CLASS ROOM
CORRIDOR
FREE-HAND DRAWING
CLASS ROOM
OFFICE
CLASS ROOM
TOILET
CLASS ROOM
TOILET
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
ELEV
ELEV
CORRIDOR
OFFICE
MEN TEACHERS' ROOM
MEN TEACHERS' TOILET
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
OFFICE
WOMEN TEACHERS' TOILET
GIRLS' REST RM

TYPE-E

Fig. 4.7.1 (above)
PS 121 Q in Queens, built in 1923, a typical Type-E School built in the Neo-Colonial Style. Courtesy: Sylvia Hardy

Fig. 4.7.2 (overleaf-top) & 4.7.3 (overleaf-bottom)
Comparison of the original design (4.7.2) and contemporary rehabilitation (4.7.3) drawings of different Type-E buildings reveal the standardization of the design and consistency with which they were built. Courtesy: SCA Alchemy (Fig. 4.7.2), Nelligan White Architects (Fig. 4.7.3)

ASSOCIATED STRUCTURAL TYPES:

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The Type-E was created as an effect of the construction stand-still during World War I, when materials and workers were in short supply. This gave C.B.J. Snyder time to develop a set of more standardized plans. Between the end of World War I and Snyder's retirement in 1922, poor economic conditions resulted in few new buildings being built. Conversely, Snyder's successor William H. Gompert saw a massive rise in the demand for school buildings through the rest of the 1920s. The Type-E evolved out of Snyder's U-plan, which was never fully realized during his term as Superintendent, and as an evolution of the Type-A with four sub categories; 48, 56, 69, and 73 classrooms and the option to increase size to any extent, if applicable.

Central hallways are always double-loaded; though when gymnasia or assembly spaces exist, they are always in the building's right wing. Auditoriums in the Type-E are always placed on the first floor for fire safety and for public ease. This represents a radical change from types which previously existed, where the assembly spaces are not on the central axis of the building, thus, allowing more natural daylight to enter.

Intended for large, end-block sites, the Type-E was used extensively in the outer boroughs. Minimal ornamentation is present, a result of the ever increasing need for standardization to keep up with growing demand. Ornamentation is typically reserved for the cast marble portico at the front entrance, banisters at the parapet, and streamlined string courses. Jack-arches above windows are, sometimes, embellished with relief.

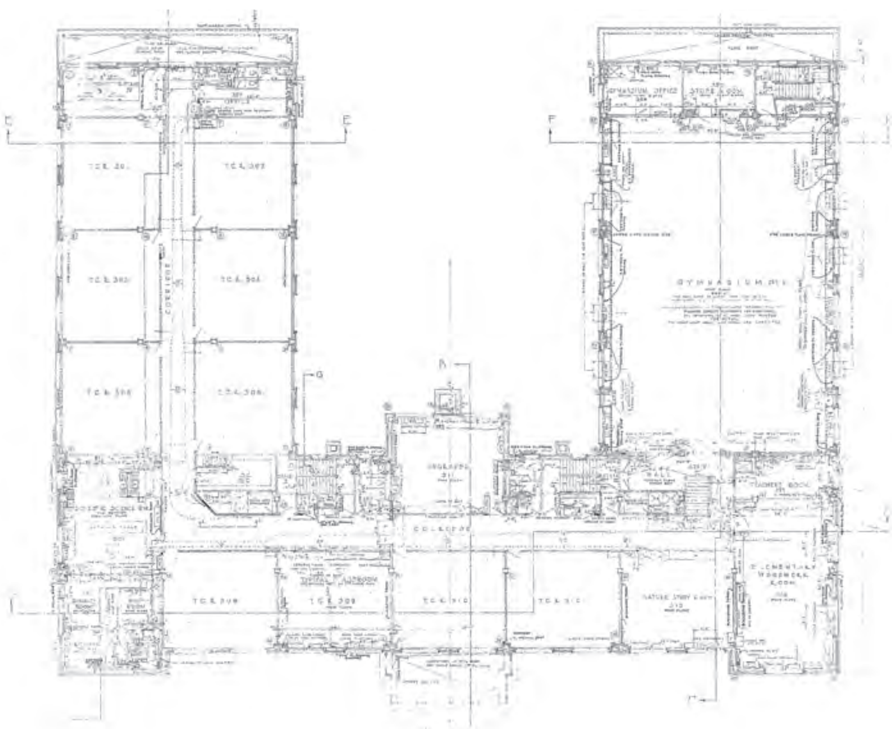

Fig. 4.7.2

Fig. 4.7.3

PLAN TYPOLOGIES
TYPE-M

Fig. 4.8.1 (above)
PS 89 X, located in the Williamsbridge neighborhood of the Bronx, is a typical example of Type-M school. Courtesy: Sylvia Hardy

Fig. 4.8.2 (overleaf-top) & 4.8.3 (overleaf-bottom)
Comparison of the original (4.8.2) and contemporary (4.8.3) drawings of different schools show how these schools begin with the single, rectangular module, and may expand to a full U-Plan based on their needs. Courtesy: SCA Alchemy (Fig. 4.8.2), Nelligan White Architects (Fig. 4.8.3)

ASSOCIATED STRUCTURAL TYPES:

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The Type-M school was designed for use in the outer boroughs, with a systematic expansion in mind. The intention of this design was to build a basic module, and later add pre-designed wings as the school's population grew.

The basic module of the Type-M is similar to the Type-A; with a single double-loaded corridor that turns 90 degrees at either end and dead-ends at a window, allowing the main corridor to be extended to any additional wings with minimal demolition. Often the foundations for additional wings were built along with the basic module in anticipation of their construction. Another noticeable innovation was the use of two main entrances rather than one, mitigation strategy for traffic and to increase egress routes.

Though the main corridor in the Type-M is double-loaded, at its most basic module, classrooms only occupy the front and side facades of the hall. The interior side of the hall contains bathrooms, offices, mechanical space, storage, teacher's lounges, windows to the exterior and vertical circulation. Considering the diversity of program found on the interior side of the hallway, the plan is noticeably efficient.

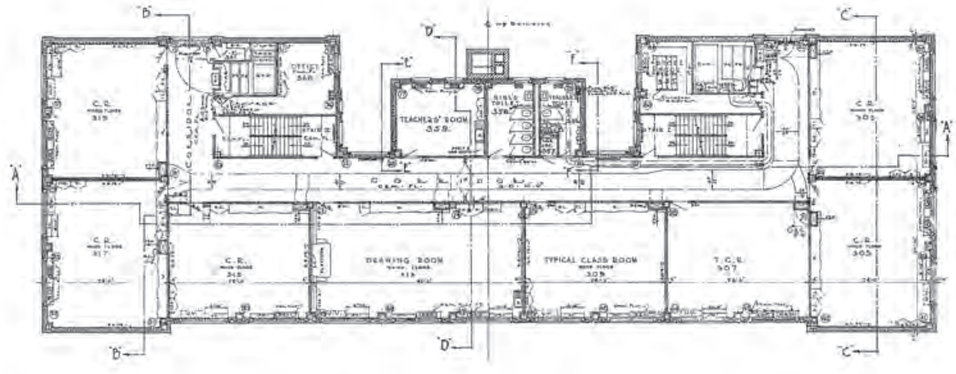

Fig. 4.8.2

Fig. 4.8.3

HYBRID TYPE-M & E

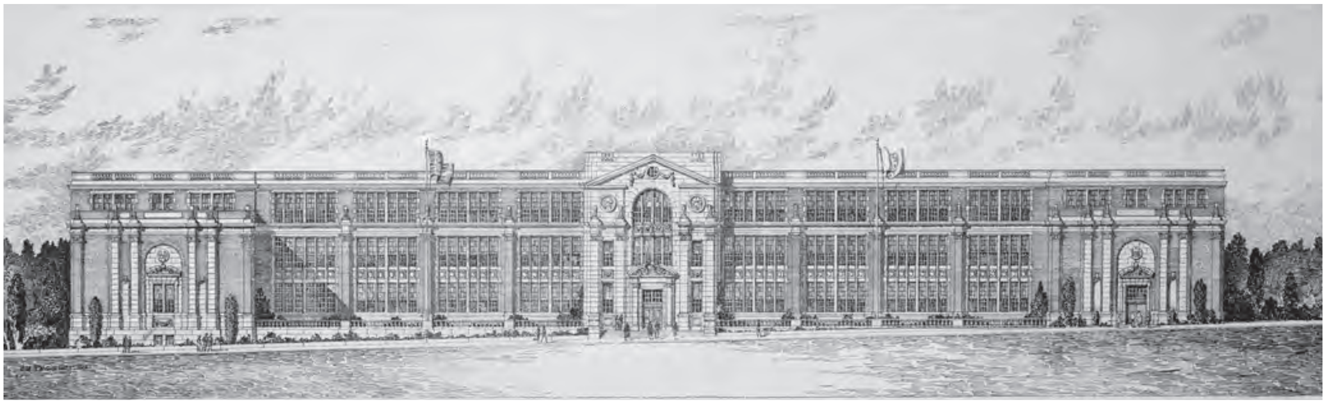

Fig. 4.9.1

Fig. 4.9.1 (far above) & 4.9.2 (above)
Far Rockaway and John Adams High School utilized the same plans. Courtesy: NYC Municipal Archives

Fig. 4.9.3 (overleaf-top)
Floor plan of Bayside High School. Courtesy: SCA Alchemy

Fig. 4.9.4 (overleaf- bottom)
Axonometric view of John Adams High School. Courtesy: NYC Municipal Archives

ASSOCIATED STRUCTURAL TYPES:
Type 1 - Page 112

The Hybrid Type-M & E, specifically formulated for high schools in outer boroughs incorporates elements from the Type-M and Type-E plan typologies. The similarities include the locations of vertical circulation and large-scale programs; gyms, auditoriums, and natatoriums. It should be noted that this plan type places exceptional emphasis on physical and health education programs; two entire wings, one for male facilities and one for female facilities, are flanked off the back of the school. These include large locker and store rooms, as well as separate emergency care, health training rooms, even a rifle shooting range. The two wings are connected by the shared natatorium, which is furnished with a host of supplementary programs to its own.

Found only in the outer boroughs where people were moving, land was cheap, and more space was available, this plan type resembles a sprawling campus, rather than a single building. These high schools were built from one set of plans, a cost saving measure devised during the depression of the 1930s. This accounts for the startling similarity between all schools of this type.

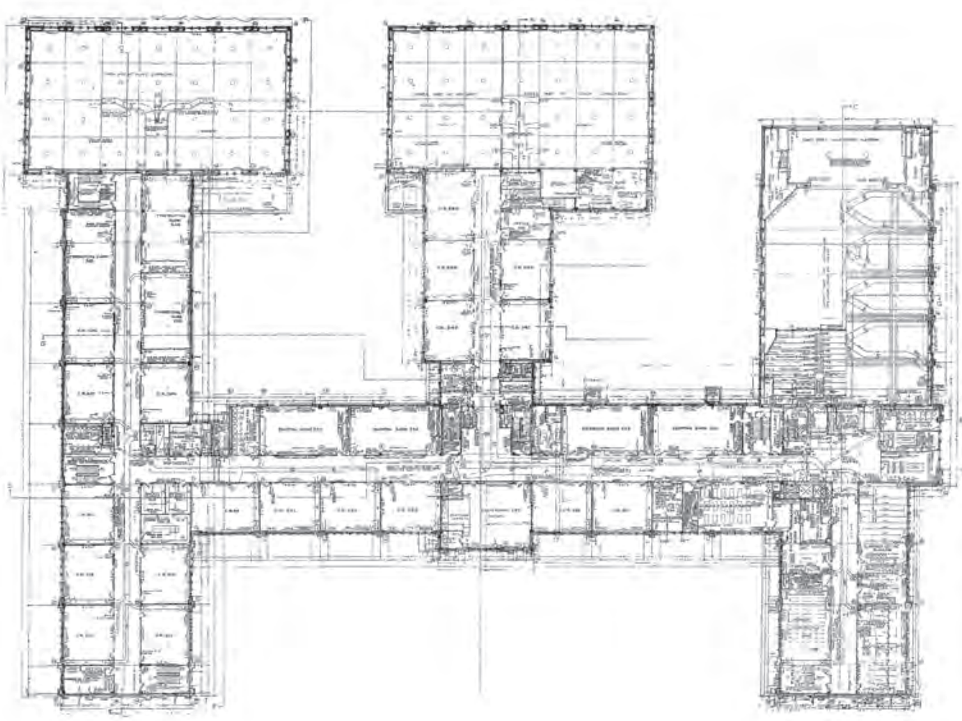

Fig. 4.9.3

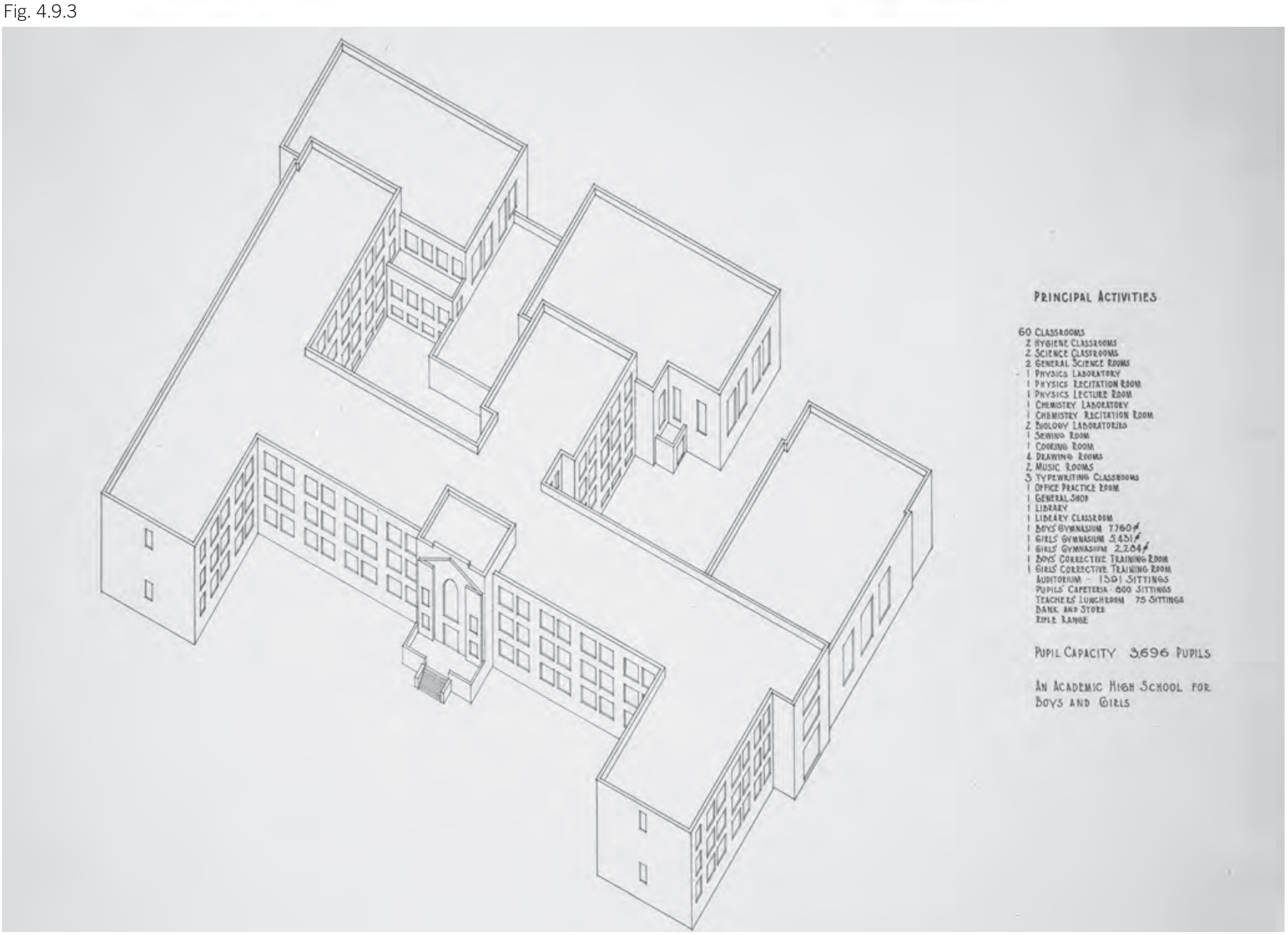

Fig. 4.9.4

MID-CENTURY L-PLAN

Fig. 4.10.1 (above)
PS 200 Q in the Pomonok neighborhood of Queens is a standard example of the Mid-Century L-Plan. Courtesy: Sylvia Hardy

Fig. 4.10.2 (overleaf-top) & 4.10.3 (overleaf-bottom)
Comparison of original (4.10.2) and contemporary (4.10.3) plan drawings highlight the L-shape of the building, and the way in which additions may have been added. Courtesy: SCA Alchemy (Fig. 4.10.2), Nelligan White Architects (Fig. 4.10.3)

ASSOCIATED STRUCTURAL TYPES:

The L-plan schools of the 1940s and 1950s were used extensively throughout the outer boroughs, as people migrated from the crowded city center. Most of them have a similar design; one long wing comprising of classrooms on either side of a double-loaded corridor, while a short wing containing an auditorium and gymnasium that forms a 90 degree angle on an end-block site.

The introduction of modernist ideas in the massing and configuration of these schools was novel in New York City. Just before the start of World War II, a survey was conducted by the American Institute of Architects, which resulted in a push for more modern design methodology in school design. These recommendations included lower building heights to better suit the smaller scale of buildings in the outer boroughs, zoned HVAC and lighting systems and increased attention to acoustics in classrooms and assembly spaces.

These buildings were also the first public schools in New York to begin experimenting with curtain wall design at their entrances. Though these systems are not considered actual curtain walls in the modern technical sense, they represent the first steps toward a window-wall system, used in public schools.

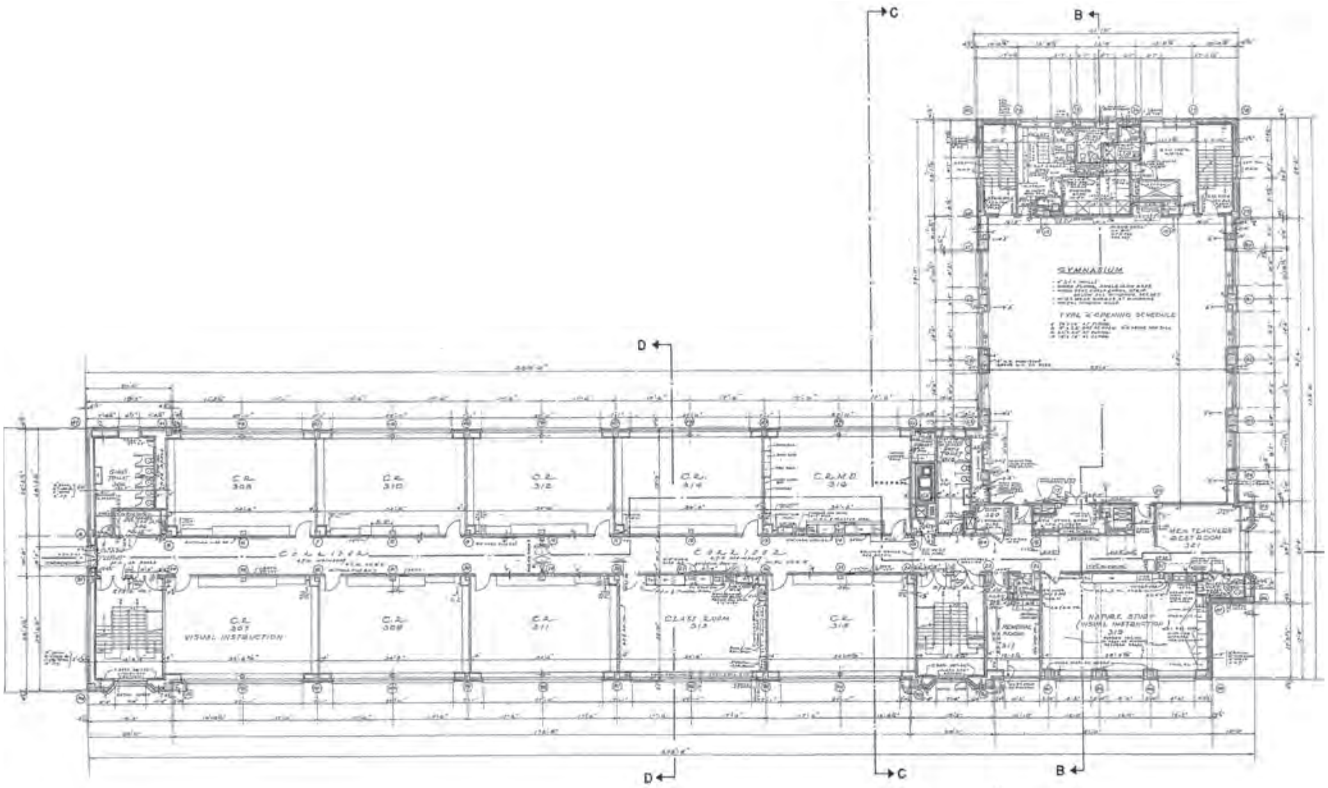

Fig. 4.10.2

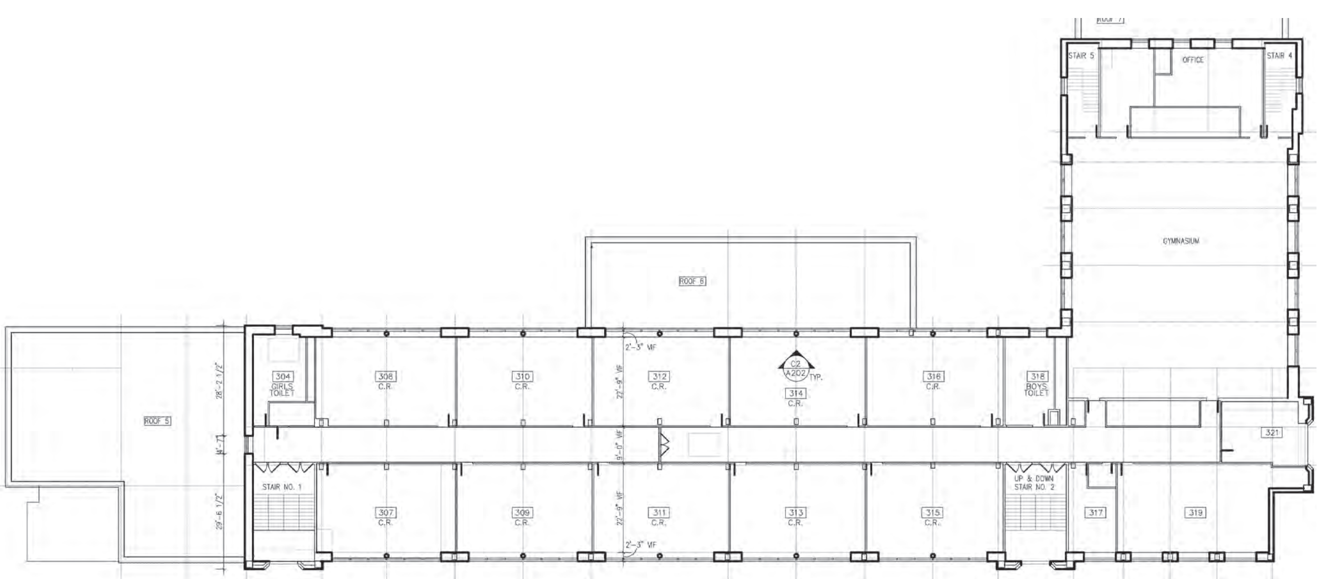

Fig. 4.10.3

MID-CENTURY CAMPUS

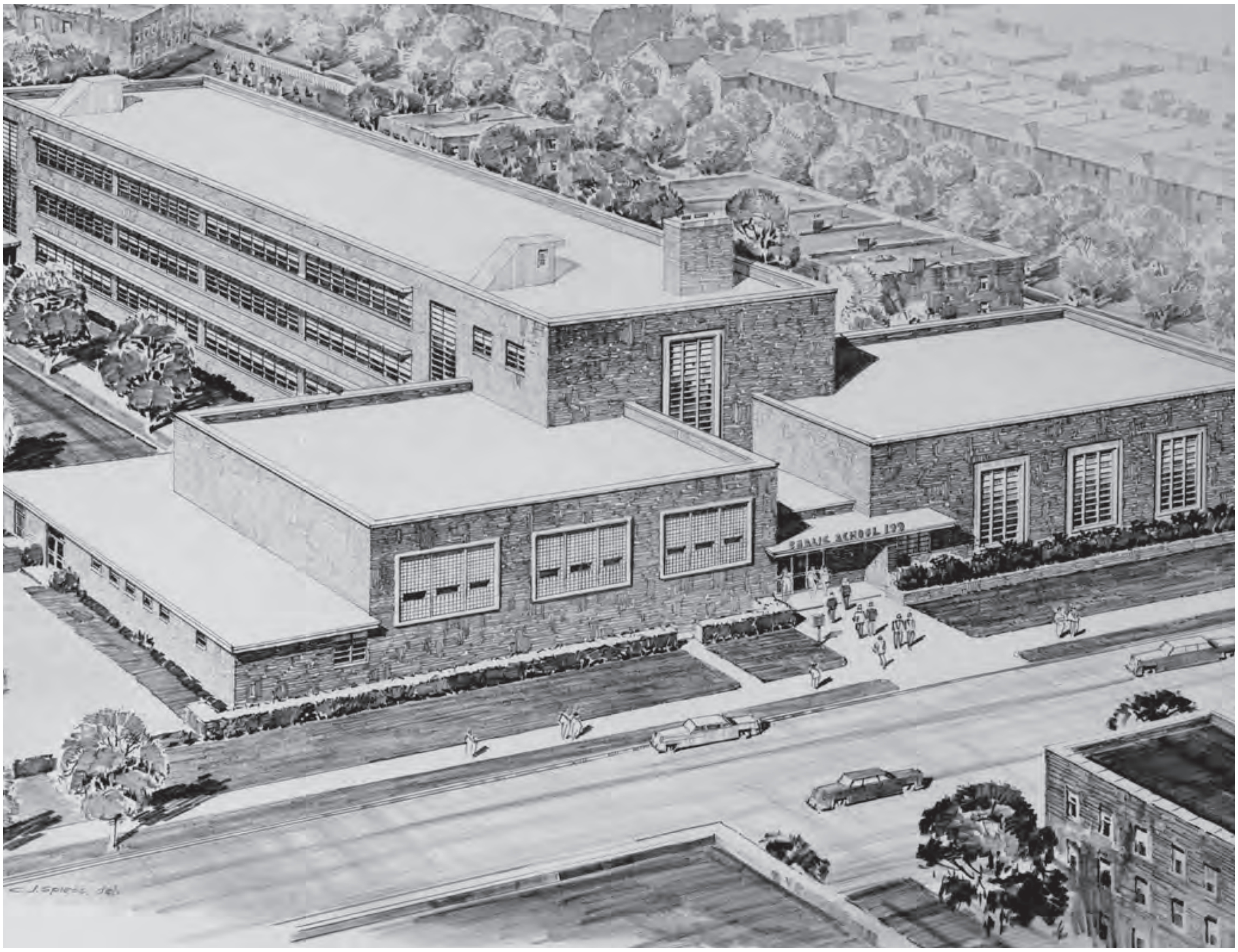

Fig. 4.11.1 (above)
PS 199 Q in Queens, a prime example of the Mid-Century L-Plan. Courtesy: NYC Municipal Archives

Fig. 4.11.2 (overleaf-top) & 4.11.3 (overleaf-bottom)
Comparison of the original (4.11.2) and contemporary (4.11.3) drawings, show the way in which additions were added on to this type. Courtesy: SCA Alchemy (Fig. 4.11.2), NYC Municipal Archives (Fig. 4.11.3)

[72] New York City. *Board of Education AIA Annual Report, City of New York.*

ASSOCIATED STRUCTURAL TYPES:

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Traditionally, the Superintendent of School Buildings had been responsible for designing all of the schools built during his tenure, however, Michael L. Radoslovich was hired in 1952[72] to *"reinvent the design of public schools"* and apply European modernist design principles to the new buildings. The intention was that schools were no longer be exclusively teacher-led lecture learning, but to be flexible and adaptable to accommodate various types of experiences. Radoslovich pioneered the hiring of consultant architects for new school designs, rather than producing designs in-house.

The Mid-Century *'Campus'* schools represent a large and very diverse type, which are related to one another in the composure of their plans. While they tend to be sprawling outer borough schools, even those in dense midtown Manhattan, share the bold masses and division of program, which relate this large group of buildings. Typical classrooms are often confined to one large, cohesive, double-loaded super-block. Cafeterias, gyms and other large-scale programs are often in their own wings, flanked from either side in an asymmetrical configuration. Horizontality is emphasized in these *'campus'* buildings, which are rarely taller than four stories at any part.

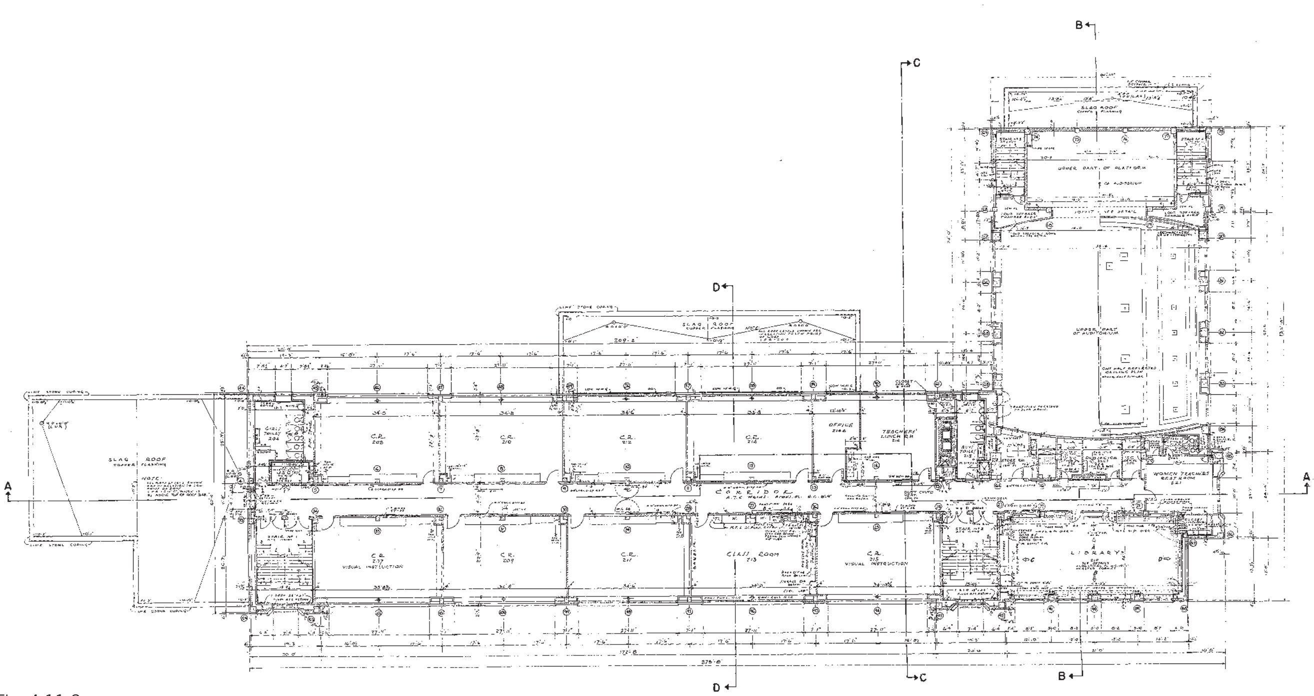

Fig. 4.11.2

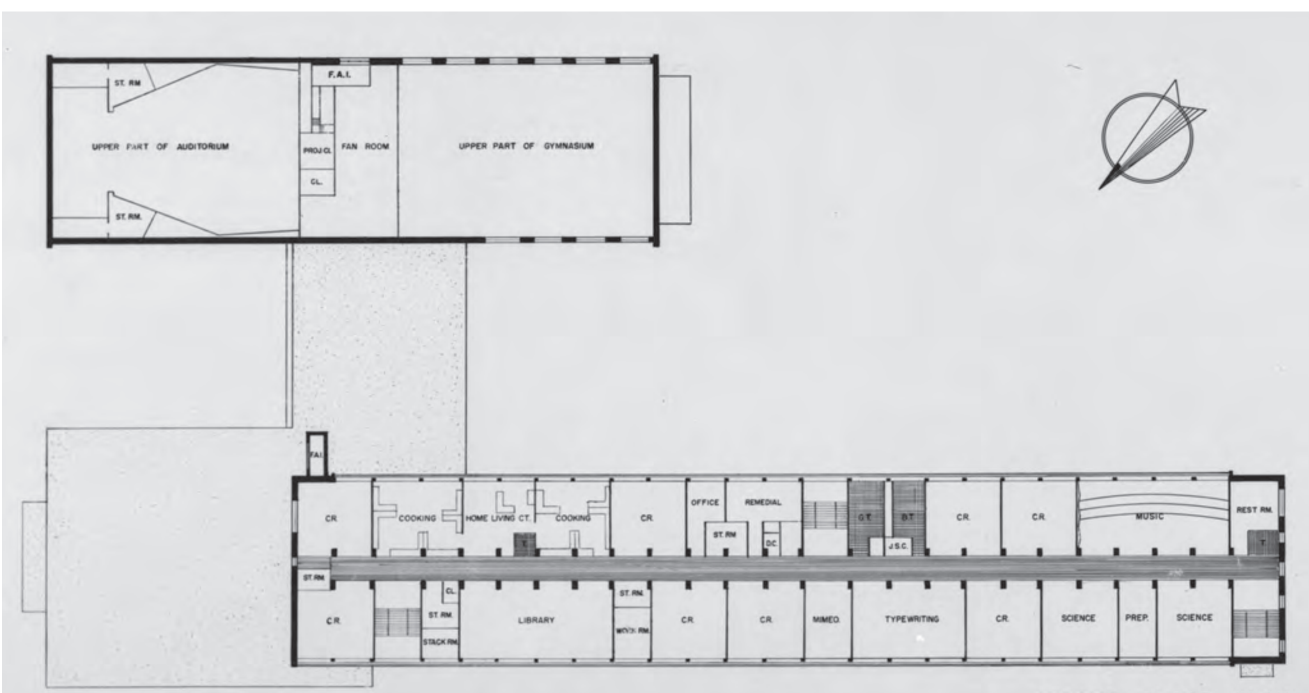

Fig. 4.11.3

HIGH-RISE

Fig. 4.12.1 (right)
Washington Irving High School in the Gramercy neighborhood of Manhattan, built in 1913, is one of the early examples of a High-rise schools. Courtesy: Board of Education Journal

Fig. 4.12.2 (overleaf-top) & 4.12.3 (overleaf-bottom)
Comparison of the second (4.12.2) and sixth floor (4.12.3) plans. Courtesy: SCA Alchemy (Fig. 4.12.2), Nelligan White Architects (Fig. 4.12.3)

ASSOCIATED STRUCTURAL TYPES:

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High-rise schools were originally developed for older sections of the City, where overcrowding was the greatest. The high demand for space in these sections drove land values up and created the need for a limited number for these non-traditional, multi-story school buildings.

Early schools of this type reached 10 or more stories and were often square in plan, with a centralized auditorium. These new urban schools typically required elevators and multiple fire stairs to safely evacuate occupants, which could now accommodate 4,000 or more. Rooftop playgrounds was one of the typical features of these schools, since land was mostly scarce.

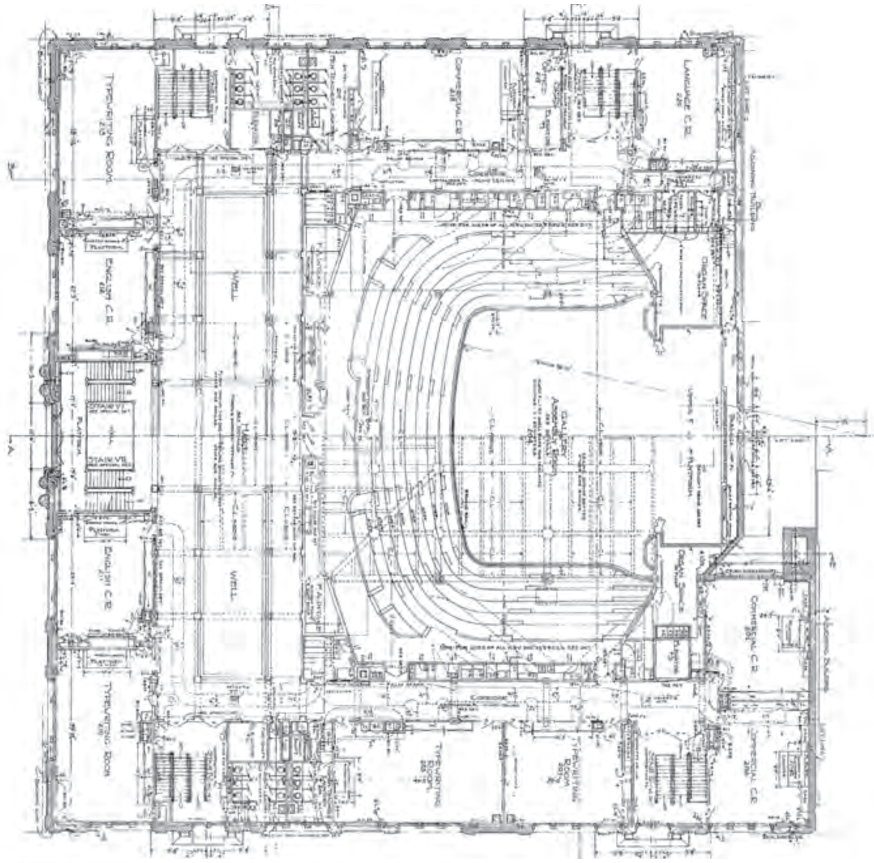


Fig. 4.12.2

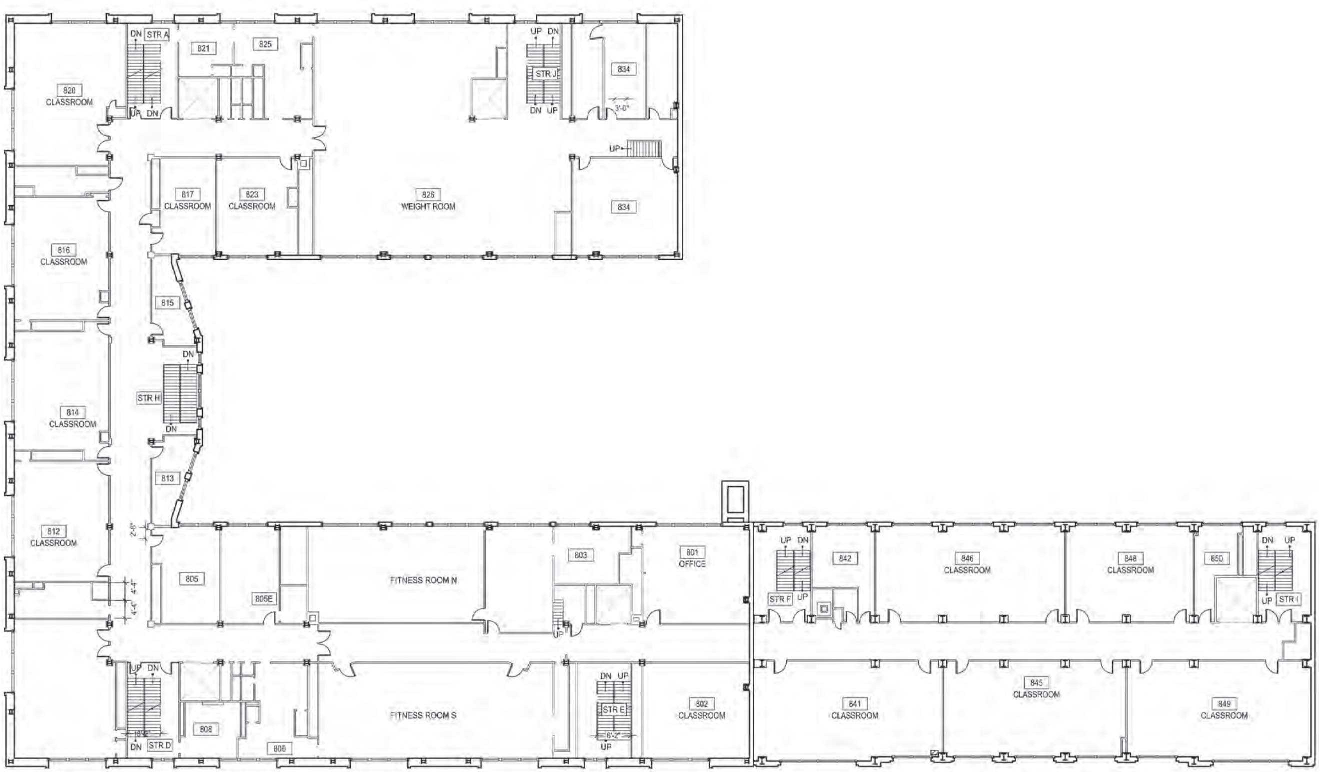


Fig. 4.12.3

SECTION 5

TECHNICAL GUIDELINES FOR REHABILITATION

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.1
PS 171 M located in East Harlem is an H Plan building with a French Renaissance Revival Style. The structural system incorporates an iron and steel frame clad with brick masonry. Courtesy: Sylvia Hardy

Fig. 5.1.2
PS 721 M located in the Hudson Square neighborhood of Manhattan is an H Plan building with a Simplified Gothic Style. The structural system incorporates load bearing brick piers as its main compressive element. Courtesy: Nelligan White Architects

While the brief history of the New York City Public School, the architectural styles and plan typologies included in the first part of this guide are intended to give an overview of the context, style and, programmatic use of 19th and 20th century public schools, the technical guidelines intends to provide practical information in the design, construction, evaluation, and rehabilitation of these buildings.

Just as the stylistic variation in schools reflects both the times in which they were designed and built, and architectural experimentation as needs and fashion changed, so the technical design and construction of the public school evolved, but not in lock-step with the developments in style and plan-type. Prior to Snyder's tenure, each building was essentially unique. After 1891, Snyder made great efforts to standardize[73] the design and construction of schools, yet architectural style, plan typology, and construction system varied independently from each other. An obvious example would be in Snyder's H-plan schools. In some early instances, they were iron and steel frame construction, over-clad with brick masonry in the French Renaissance Revival Style. Later on, they were load-bearing brick masonry pier construction in the Simplified Gothic Style. Among sister schools, minor variations in the construction systems is common, and even radical difference occur; one later type of sister school was constructed in both steel frame and cast-in-place concrete frame construction.

It is the interaction of the construction materials and structural systems, as well as the relative ages of the schools that have largely determined the way in which they have stood the test of time, weathered and deteriorated. It is these factors, and not their architectural style, that best inform their rehabilitation.

The narrative is subdivided into seven sections. First, a description of the evolution of school building structural and enclosure systems; second, a description of the mechanisms of failure; third, a description of the materials and systems typically used; fourth and overview of the Secretary of the Interiors Standards for the Treatment of Historic Structures; fifth, an outline of our recommended scoping methodology – specifically as it pertains to SCA Phase 1 design services; sixth, a description of remediation techniques; and seventh, recommendations for preparation of contract documents used for SCA projects to best communicate the necessary scope of these projects, with some suggestions that may help streamline the construction process.

[73] Board of Education, City of New York. *(1923). Twenty-fourth Annual Report of the Superintendent of Schools: 1921-1922 Report on Construction and Maintenance.*

The fundamental trajectory in the technical development of the public school is the transition from load bearing masonry construction with combustible floor and roof framing, where the structure and enclosure of the building were one and the same; to steel or concrete frame construction with cladding of virtually any material where the structure and enclosure of the building are largely independent.

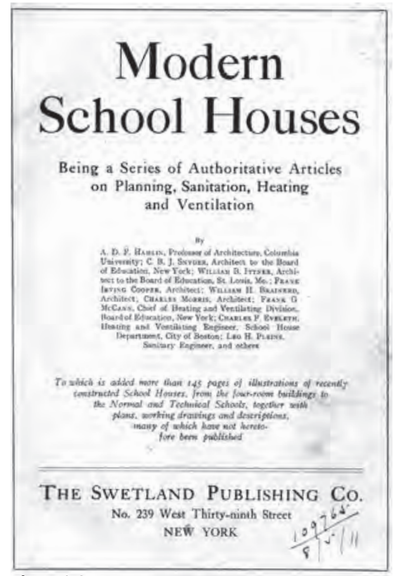
Most of this development occurred between the mid-19th century and the mid-20th century, and coincides with the time-frame of this guide. In the case of these public schools, this development followed many twists and turns, with success followed by failure, and success again when some of the 'dead ends' were later revived and proven to be successful as technologies developed. In their development, these buildings paralleled the technological developments of modern architecture both in Europe and North America.

In fact, James Naughton, C. B. J Snyder, and their peers saw themselves as *modern*[74] architects and strove to innovate and revolutionize the design and construction of these schools.

The demand placed upon the school system by increased population, forced Snyder to attack a host of problems nearly too lengthy to comprehend. Snyder undertook this challenge – his life's work in fact – with an enthusiasm that reveals a remarkable idealism and strength of will. He believed both in the power of education, and in his ability to succeed despite very real obstacles of bureaucracy, politics and corruption. Snyder's contribution of over 400 schools (over 120 primary schools) offered an almost laboratory-like opportunity in the similarity of program, environmental conditions, etc. Economics, site conditions, availability of materials and of expert labor, and the invention of new materials, all influenced by world events over three decades forced this experimentation, with the mixed results one might expect from such large-scale trial and error. The architects' and builders' response to these trials and errors effectively produced and almost Darwinian evolution in the construction of these buildings. A century later, we find ourselves faced with the legacy of this innovation and experimentation.

By the time any of these schools is handed to an SCA design consultant, the nature of the deterioration of the building has typically gone far beyond the scope of any simple repair. This is a result of a century of weathering, hard use, and during times of economic shortfalls, deferred maintenance. At the same time, these buildings' very survival, is a testimony to the success of the original designs; i.e., that it is possible to even consider the rehabilitation of these structures. Prior to the 1890s, the construction of schools employed load bearing masonry walls with arched openings, or a combination of shallow or flat arches (jack arches) and stone lintels. Floors and roofs were typically framed in wood.

In the first decade of his work with the Board of Education, Snyder introduced structures that were framed in iron and steel with non-combustible floor structures made with steel beams and brick or terracotta vaults. The building exteriors were comprised of masonry infill in the frame – usually brick-sized terracotta – and brick and decorative terracotta cladding. This momentous step was undoubtedly the result of both programmatic need and inspiration. Load-bearing masonry buildings were reaching the limits of their technology. Chicago's Monadnock Building completed in 1891 is 197 feet tall. The North half of this early skyscraper has load-bearing masonry walls that are 6-feet thick at the base. Philadelphia's City Hall of 1901 – arguably, the world's tallest load-bearing masonry building - is 548 feet tall at the tower, and boasts masonry walls up to 22 feet thick. At these dimensions, masonry became increasingly expensive, and such thick walls could not accommodate large openings for daylighting so essential in a 19th century school building.



Modern School Houses

Being a Series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation

By

A. D. F. Hamlin, Professor of Architecture, Columbia University; C. B. J. Snyder, Architect to the Board of Education, New York; William B. Ittner, Architect to the Board of Education, St. Louis, Mo.; Frank Irving Cooper, Architect; William H. Brainerd, Architect; Charles Morris, Architect; Frank G McCann, Chief of Heating and Ventilating Division, Board of Education, New York; Charles F. Eveleth, Heating and Ventilating Engineer, School House Department, City of Boston; Leo H. Pleins, Sanitary Engineer, and others

To which is added more than 145 pages of illustrations of recently constructed School Houses, from the four-room buildings to the Normal and Technical Schools, together with plans, working drawings and descriptions, many of which have not heretofore been published

The Swetland Publishing Co.
No. 239 West Thirty-ninth Street
New York

Fig. 5.1.3
C.B.J. Snyder and his contemporaries considered themselves to be modern designers based on the new structural and programmatic ideas they implemented, as well at their novel use of building systems. Courtesy: Modern School Houses

Fig. 5.1.4
Old PS 72 M (now the Julia de Burgos Cultural Center) located in East Harlem is a load bearing structure which incorporates shallow jack arches to form window openings. Courtesy: Sylvia Hardy

Fig. 5.1.5
The Monadnock Building of Chicago was completed in 1891, and is still one of the tallest modern load bearing masonry buildings in existence. Courtesy: Google Images

[74] Through the students educated in these schools, they hoped to change the world – the New York City public school system has produced more than 25 Nobel Prize Laureates.

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.6
At 548 ft in height and with walls up to 22 ft thick, Philadelphia's City Hall is considered to be the tallest modern load bearing masonry buildings in the world.

Edison's Pearl Street (DC) Dynamo began operating in 1882 and only a small area of downtown Manhattan was first supplied with electricity for lights. Even 28 years later, architects still felt obliged to make the case for electric lighting over gas lighting, as Charles U. Thrall wrote about Snyder's PS 77 Queens in the 1910 book *"Modern School Houses"*[75]. Daylight was essential to the basic function of schools and pure load-bearing masonry construction with relatively small arched window openings simply could not do the job.

If daylighting was the need, then Snyder's alma mater provided the inspiration. Peter Cooper had been a trustee of the Public School Society from 1838 until its dissolution, and was Vice President from 1852-1853. Cooper Union's Foundation Building opened in 1859. With cast iron columns and the first rolled iron beams[76], which supported the vaulted brick floor structure, the Foundation Building is,

Fig. 5.1.7 (right) & 5.1.8 (below - right)
Edison's Pearl Street Dynamo was the worlds first central power station to supply power for lights to a given district. In this case, it was a small area of lower Manhattan serving 400 lamps for 85 customers. Courtesy: Google Images

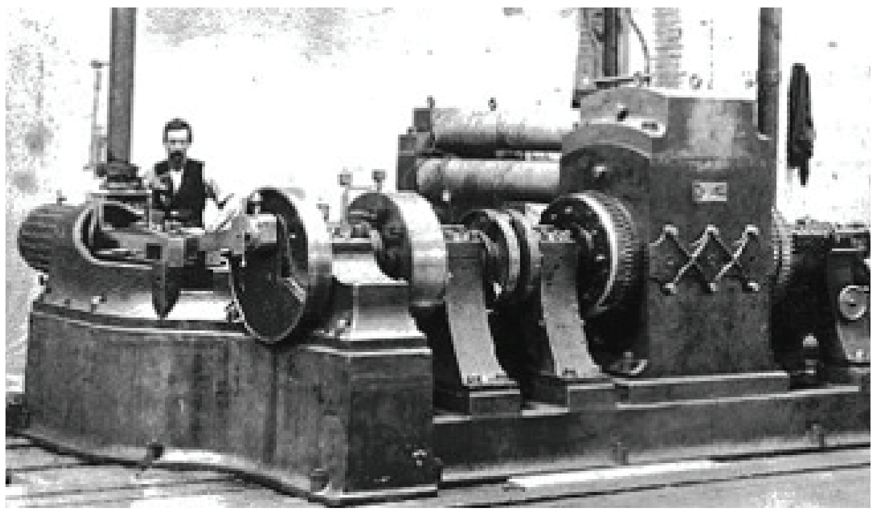


Fig. 5.1.7

Fig. 5.1.9
The Cooper Union Foundation Building was the first all modern skeleton-framed building in the world, built in 1859.

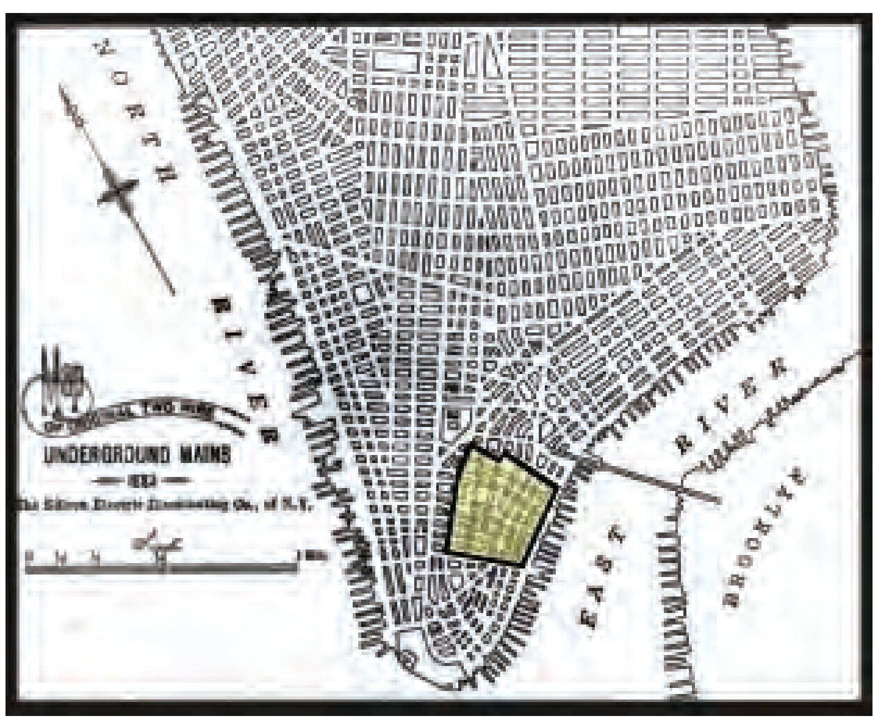


Fig. 5.1.8

[75] Hamlin, A. D. (1910). *Modern School Houses: Being a series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation.* New York: Swetland Pub. Co. Page 61

[76] These iron beams were actually rolled railway rails from Cooper's Trenton iron rolling mill.

literally, the progenitor of all modern skeleton-frame buildings. Importantly, Snyder (and reportedly also James Naughton) attended the Cooper Union and received a certificate in architectural drawing in 1884. Snyder, who began attending classes when the building was 20 years old and still cutting edge technology, introduced nearly the same innovative techniques in public schools within a decade of his graduation. The skeleton structure allowed Snyder to maximize the window area and daylight necessary in his early buildings which still depended on gas lighting.

None of the early buildings constructed during this period of technological transition were *'pure'* structures. That is, there was no pure compression masonry structures, no pure iron or steel frame structures, no entirely reinforced concrete structures, etc. They were mostly *'composite'* structures, made of several or many materials and the enclosures of these buildings are often referred to as *"Transitional Facades."* As they developed, their performance was better understood, and as the roles of architect and engineer became more narrowly defined (e.g., the structural engineer designs the structure, the architect designs the enclosure), the design of the structures became more technologically *'pure'.*

While masonry clad buildings with steel or concrete frames ultimately became the standard of school construction, and Snyder designed some frame buildings throughout his tenure with the Board of Education, in the first decade of the 20th Century, he retreated from this more technically advanced structural system for the majority of the smaller buildings, particularly for primary schools. Snyder remarked on this trend in 1910 describing PS 33 R; *"Public School 33, Richmond, is one of a very few frame buildings erected by the Board of Education during the past few years…"* [77]

The Annual Reports of the Board of Education from the turn of the century note the unavailability of both steel, and steel workers, for the construction of schools. Evidently the construction of large city wide infrastructure projects such as bridges and subways, plus construction of early skyscrapers, created so much demand that a shortage of both materials and labor existed. Thus, for the first decade of the 20th Century, steel frames were largely reserved for larger showcase projects, such as Morris High school. Steel and iron use at primary schools, particularly at the ubiquitous A-Type schools, was restricted to floor beams and a double row of columns at the central corridor. Even in projects like Morris High, use of steel was minimized and load bearing masonry was employed where possible, creating hybrid structures that are quite surprising to the contemporary eye.

In contrast, Hudson River Brick was plentiful, and immigration brought many Europeans who were skilled as masons, or who could be trained in short order. Additionally, new electric lighting may have lessened the imperative to increase window area to the absolute maximum, and the frame buildings with terracotta backup may have exhibited early on some technical problems, including a vulnerability to water penetration.

Whatever the combination of reasons may have been, the early 1900s marked a return to load-bearing masonry construction for the building exteriors. However, these exteriors were not a complete return to solid facades with small arched openings and gloomy interiors. Rather, the typical structure was a composite of load bearing masonry piers with large openings made for windows by steel beams which spanned between the piers.

This kind of structural system is found predominantly in primary schools constructed from the early 1900s until the end of World War I. Its use corresponded to the proliferation of the "A-Type" plan, which was employed extensively because of its simplicity and economy.

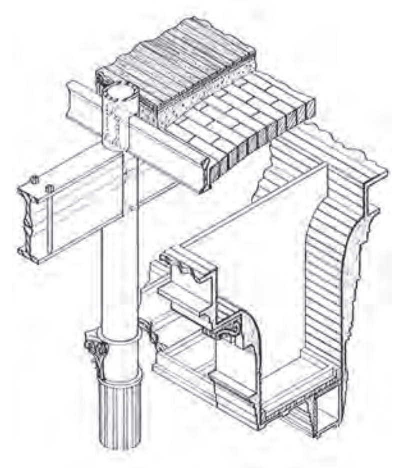


Fig. 5.1.10
The rolled iron beams of the Cooper Union Foundation Building are actually railway rails. These rails support brick vaults which form the structure of the floor. Courtesy: Nelligan White Architects

Fig. 5.1.11
Original gas piping visible in the attic of PS 277 X. Courtesy: Nelligan White Architects

[77] Hamlin, A. D. (1910). *Modern School Houses: Being a series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation.* New York: Swetland Pub. Co. Page 57

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.12
Cast Iron columns commonly found at the interior of schools which use load-bearing brick masonry exterior walls support the beams on which the floors span. Courtesy: Nelligan White Architects

Snyder and his peers expressed particular concern about fire safety in schools and many elements of the schools were developed expressly to create fireproof structures, and to allow rapid egress in the event of a fire or other emergency. Thus, terracotta blocks, cut in half, with their ridged surface facing the interior of the spaces, serve in lieu of wood lath. Similarly, ceilings are plaster laid on metal lath, supported on *"channel iron furring, attached to the [steel] beams by special clips"* [78], a kind of *"black iron"* system still employed today.

The structural systems for the floors developed in parallel with the systems for the building enclosure. Typically, in plans with classrooms double-loaded along a central corridor, two lines of columns support girders that coincide with the corridor walls and run parallel to the exterior walls. In buildings prior to 1900, these columns were typically made of cast iron. Girders and floor beams were typically steel. Spanning between the girders and between the girders and the exterior walls are steel beams, set typically between 5 and 6 feet on center. In the earlier buildings, some kind of vault spans between these beams, and a variety of these have been observed in New York public schools. At the Cooper Union, shallow brick vaults were used, and a similar system using dry-laid bricks on rolled sheet metal girts has been observed at some schools. These dry-laid brick vaults were then covered by a loose slag or cinder concrete. At the floors, wood sleepers were wedged snug with cinders. Sub-flooring and finished hardwood flooring, was attached to these sleepers.

At the roof, the cinder concrete fill was finished with a screed of cement and sand, 2 to 3 inches thick that served as the *"deck"* to which the built-up roofing was applied. The roof beams are typically pitched down and away from girders at the corridor line to drains or scuppers near the parapet. Some pitch, at the center and elsewhere when needed is achieved by building up cinder fill and screed. Once the cinder concrete set up over the dry-laid brick, it effectively functioned as an unreinforced pure compression slab/vault. More often the vaults are constructed of segmented terracotta blocks that are set with mortar. Two kinds of terracotta vaults have been observed, flat-arched vaults and true arched vaults. In both instances, the floors were laid upon sleeper set in cinders. Roofs were constructed as described above.

While both the flat arch and true arch systems have been observed, Snyder himself wrote that by 1910, *"none of the flat arch systems however [were] being used"* [79]. A fourth kind of vault that has been observed employs rolled corrugated sheet iron or steel set between the beams to support cinder concrete fill. Finally, by 1910, one-way reinforced concrete flat slabs were used rather than vaults supported by brick, terracotta, or corrugated sheet metal.

Fig. 5.1.13 (right)
Two types of terracotta vaults: flat (top) and true arched (bottom). Courtesy: Board of Education Journal

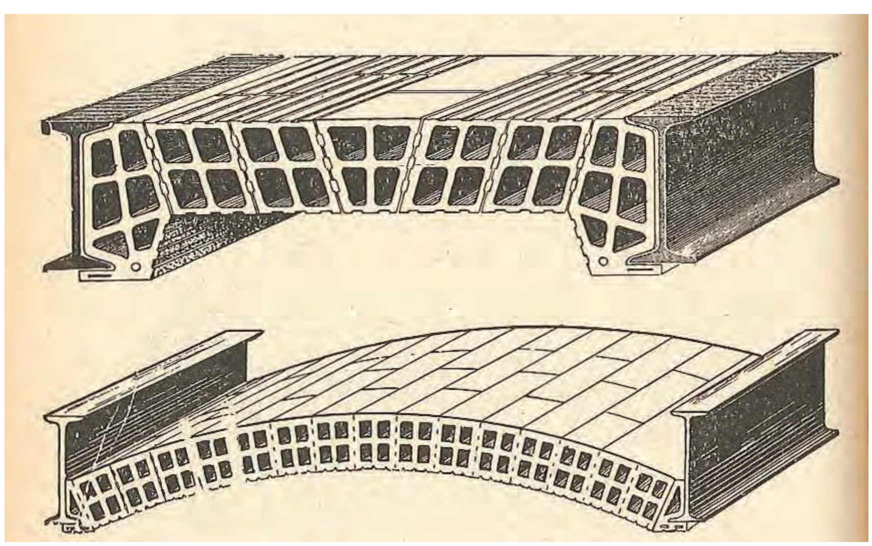


Fig. 5.1.13

[78] Snyder describes the level ceiling details in the Chapter *'Public School Buildings in the City of New York'*. Hamlin, A. D. (1910). *Modern School Houses: Being a series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation.* New York: Swetland Pub. Co. Page 46

[79] Hamlin, A. D. (1910). *Modern School Houses: Being a series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation.* New York: Swetland Pub. Co. Page 46

Like the development of exterior enclosure and structural systems, the use of the different materials in the floor structure follows no clear linear pattern. For example, at two sister schools built at virtually the same time, PS 142 K and PS 183 M, two different systems were used – true arched terracotta vaults at 142 K, and corrugated iron vaults at 183 M.

Different floor systems were also used within the same school to accommodate different floor loading requirements. Snyder wrote that at Morris High School, the *"floor arches for the shops are concrete – broken stone, sand and Portland cement; while 6 inch segmented terracotta arches are used elsewhere in the building."* [80] The concrete vaults supported a floor load of 300 pounds per square foot at the shops and 600 pounds per square foot at the foundry. The terracotta vaults used for the rest of the building were designed to support 75 pounds per square foot.

Consequently, at the start of any capital project at these schools, the designer should not assume that conditions found at similar schools or sister schools will necessarily be the same. Even additions constructed a few years apart more often than not employ different construction methods. At PS 158 M for example, the original building designed in 1897 by C.B.J Snyder was constructed with cast iron columns and steel beams with flat-arch terracotta vaults. The addition, designed in 1905 also by C.B.J. Snyder was constructed with load bearing masonry piers, steel beams, and true-arch terracotta vaults.

The slowdown in construction during and after World War I allowed Snyder to evaluate alternate school plan typologies; significantly the early U-shaped plans. However, it was largely up to his successors William H. Gompert and Walter C. Martin to realize these developments in the Type-E and Type-M plan typologies. When they did, the structures of the schools had reverted to frame systems, with the exterior walls infilled with large (8" x 8" x 4") terracotta block and clad with brick. Floor systems were typically concrete encased steel beams and one way flat concrete slabs.

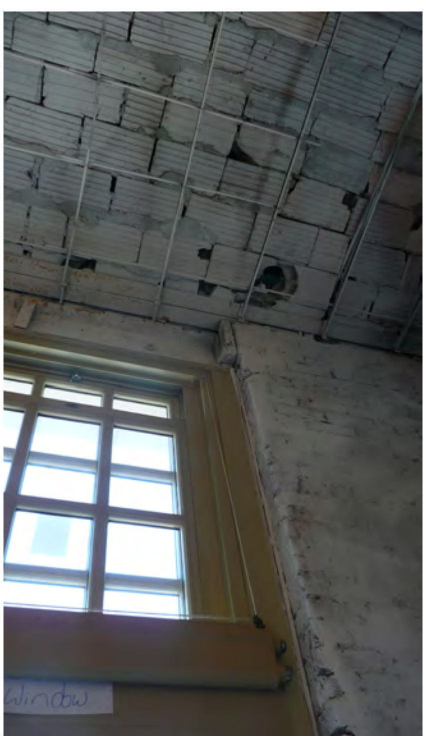


Fig. 5.1.14

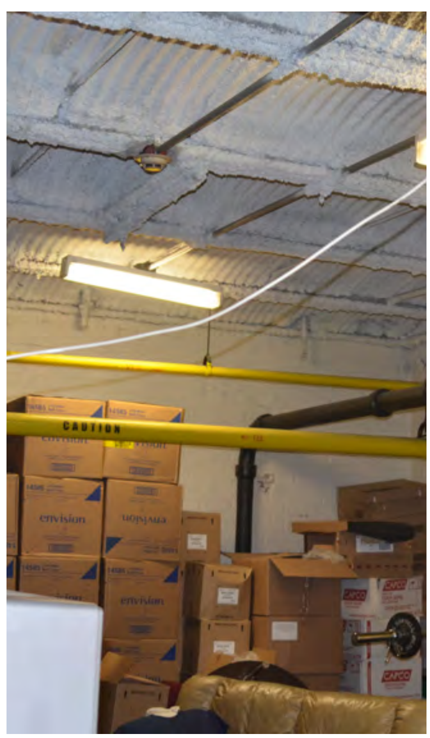


Fig. 5.1.15

Fig. 5.1.14 & 5.1.15 (far left - left)
Flat terracotta vaults exposed during construction at PS 142 K. Corrugated iron vaults in the basement at PS 183 M. Courtesy: Nelligan White Architects

[80] Snyder writes about floor arches in the Chapter '*Public School Buildings in the City of New York'*. Hamlin, A. D. (1910). *Modern School Houses: Being a series of Authoritative Articles on Planning, Sanitation, Heating and Ventilation.* New York: Swetland Pub. Co. Page 48

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.16
Probes performed at PS 19 Q revealed conditions contrary to the original design drawings. Probes identified a steel columns and spandrels just beneath the facade, however the original drawings depict a structure of pure load bearing masonry. Courtesy: Nelligan White Architects

Fig. 5.1.17
Type-E school PS 121 Q. Courtesy: Nelligan White Architects

Fig. 5.1.18 (right)
Elevation of Washington Irving High School, from the original 1910 drawings. Steel columns are found at the perimeter by the exterior walls are self supporting. Courtesy: SCA Alchemy

One notable characteristic of these schools is the layer of damp-proofing placed in the assembly, no doubt, installed as part of the original construction to stop water penetration through the terracotta backup from reaching and damaging the interior finishes. This damp proofing – a continuous course of building paper and asphalt has been observed in two places, between the terracotta and the face brick, or more frequently at the interior of the terracotta directly underneath the plaster.

Even in the post World War I period, there have been many exceptions to the typical construction systems. In some cases, the backup / infill masonry is constructed of brick rather than the typical and less expensive terracotta. In other cases, there is a load bearing masonry facade, as well as a bearing steel frame, which sits just inside the line of the facade.

One example of this is at PS 19 Queens, a late 1922 design by C.B.J Snyder. The drawings for this building show load bearing masonry construction similar to many Snyder designs, yet probes and construction show a steel frame that includes columns and spandrels at the facade. As constructed, the load bearing masonry facade carries only itself – all the floor loading is carried by the steel frame. At Washington Irving High School, the 1910 Snyder design for the original portion of the building has steel columns at the perimeter, but the exterior walls of this tall building are self supporting, perhaps due to the atypical height of this building.

By the 1920s, the role of cast-in-place concrete was expanding. In 1923, William H. Gompert was using reinforced concrete beams and columns at PS 42 Queens and its sister schools, in a design essentially adapted from Snyder's Simplified Gothic Type-A. Steel and concrete encased steel was still used at the stairs, and at spandrel and long span/high load beams and columns in locations such as the auditorium, but these are true cast-in-place structural concrete frame buildings. Interestingly, one drawing for this school is labeled *"Alternate Skeletal Steel Construction with Curtain Walls"* (sheet 30). [81] The SCA has reported that some of these sister schools were in fact constructed in steel – with only shop drawings showing the record of this departure from the original design.

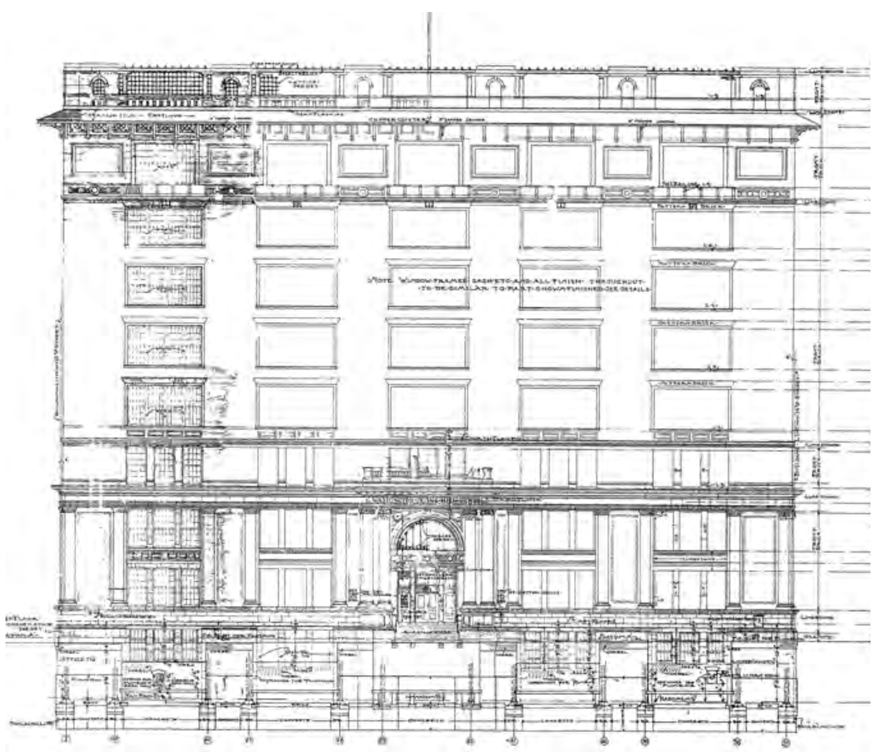


Fig. 5.1.18

[81] SCA Alchemy list

Walter C. Martin served as the Superintendent of School Buildings from 1928 until 1938, and largely continued the trends established under Gompert. While larger high schools and vocational schools continued to vary in their use of premium materials, and more extensive structural and mechanical systems to accommodate their programs, the plan typology of the Primary Schools stabilized in the U-shaped plan, and its modifications; the Type-E and Type-M. The construction of these schools is virtually identical – steel frames with terracotta block infill, brick and decorative terracotta cladding, one way flat concrete slabs spanning between concrete encased steel floor beams. Occasionally, solid brick masonry is found as the backup material rather than the typical and less expensive terracotta block.

In 1936, the Chairmen of the Committee of Buildings and Sites solicited an evaluation by the AIA on how the buildings about to be planned as part of a new twenty five million dollar campaign could be made *"up-to-date from the standpoints of design, utility and economy"* [82]. This report was delivered in November of 1937, and recommended a dramatic overhaul of the design and method of procuring design for public schools. These recommendations were strongly critical of many of the fundamental principles by which schools had been constructed since the 1890s, particularly of constructing standardized schools and schools that were five stories tall.

Fig. 5.1.19
Type-M school PS 89 X. Courtesy: Sylvia Hardy

Fig. 5.1.20 (below)
Type-M school PS 89 X. Courtesy: Sylvia Hardy

Fig. 5.1.20

[82] New York City. (1937-1938) *Board of Education AIA Annual Report*, City of New York.

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.21
The former Joan of Arc Junior High School (now JHS 333 M), at 11 stories, was considered the first 'skyscraper' school. The building incorporates progressive Art Deco styling, which emphasizes this verticality. Courtesy: Nelligan White Architects

Fig. 5.1.22
Art Deco relief on a pilaster at the entrance of PS 333 M. Courtesy: Nelligan White Architects

Kebbon's charge, then, was to implement changes recommended by the AIA study. These recommendations included site selection (near mass transit); site planning (not building rigidly to the property line); building massing (generally 2 and 3-story buildings rather than 4, 5 and 6-story buildings with asymmetrical massing); building organization to place assembly spaces at street level with independent entries to allow easier access for community uses outside of school hours, and increased classroom sizes. The report places special emphasis on reducing the height and massing of the schools: On pages 26 and 27 of the report, 11 paragraphs are dedicated to make the case for larger more open sites and lower buildings, and to critique 5-story schools typical in Manhattan and states, *"One of the most serious defects in the majority of schools in the City of New York is due to the restricted area which requires excessive story heights"* [83]. To this point, fire stairs in rated enclosures were recommended and the double scissor stair introduced by Snyder in the 1890s was abandoned. This significantly affected building design and cost, because the scissor-stair as designed by Snyder required a minimum floor to floor height of 15'-6". Floor-to-floor heights could be and were reduced, to 13'-9" in the 1939 design for PS 118M, and later to 12'-6".

Kebbon was well-suited for this transformative role. He co-authored *"Building the New Technology"* with Welles Bosworth in 1916, and designed base hospitals and camp buildings in the Army Corps of Engineers during World War I. Also, he was an MIT graduate, like 3 of the 4 main authors of the 1937 report and may have more or less directly represented the point of view of those authors.

38 schools constructed between 1937 and the start of World War II at the end of 1941, are still in use by as NYC Public Schools. While some of these schools were designed in Classical Revival style – no doubt, already on the boards in 1937 - the majority are Art Deco in style and incorporate design and construction techniques more familiar to 21st Century architects and builders. Kebbon's PS 118 M, Joan of Arc Junior High School (now JHS 333 M), was described at the time as the first skyscraper school at a lofty 11 stories. This limestone and brick clad Art Deco building has largely abandoned the use of terracotta block for its back-up masonry, and uses instead lightweight concrete block (cinder block). The ubiquitous counterbalanced double-hung wood windows found in the schools of Snyder, Gompert, and Martin, were replaced with cold-formed steel double-hung windows, more similar to those found in the Empire State Building, the iconic Art Deco skyscraper completed in 1931. The structure of the building is steel framed, with concrete floor slabs and concrete encasement of steel members for fire-proofing.

While these buildings are "pre-war' buildings, they are recognizably modern in design and construction. As significant as the design recommendations of the AIA study on schools, and the appointment of Eric Kebbon as a reform-minded architect both in terms of design and technique, was the adoption of the 1938 New York City Building Code. This code regulated design and construction in New York City from 1938 until it was replaced with the 1968 code. It is still used as the "old code" for alterations to existing buildings constructed before 1968. The building booms of the 1950s and 1960s, during which the greater part of New York's modernist fabric was constructed took place under the authority of this code; its significance in the changes in design cannot be overstated.

Still, one should resist the temptation to view these three significant events - the AIA study; Kebbon's appointment; and the introduction of the 1938 code – as some sort of extraordinary coincidence. Kebbon was 46 years old, young as architects go, but no spring chicken, and his book on 'new technology' was already 21 years old. Many of the stylistic and technical advances now adopted for the design of public schools had been pioneered over a decade earlier in New York's first crop of skyscrapers, culminating with the Empire State Building. This apex of 1920s aspirations coincided with the first years of the Great Depression, which virtually halted private

[83] New York City. *Board of Education AIA Annual Report (1937-1938)*, City of New York. Page 26 & 27.

[84] Joan of Arc Junior High School is currently JHS 333 M

development in New York City and elsewhere. Wright's use of asymmetrical massing started in the late 19th century, and his Wasmuth portfolio[85] was published in 1910 and arguable sparked the Modern Movement in Architecture in Europe. By 1937, the work of Snyder, Gompert, and Martin must have seemed thoroughly anchored in or even chained to the 19th century. The stylistic and technical sea change in the design of New York's public school must have seemed long overdue. The more audacious embrace of modernism was left to private individuals and the *"captains of industry"*. A large civic bureaucracy, like the Board of Education, would have found it virtually impossible to alter its momentum quickly, or to shift too radically towards the next new thing.

By comparison to the then-moribund classical revival schools constructed at the end of Martin's tenure, Kebbon's streamlined art deco buildings seem a relief. Some of his buildings, like 118 M are individually significant, but the most typical buildings are the brick clad schools with monumental windows at entries and stairs, punched smaller windows at classrooms and a heavy projecting coping that functions like a vestigial cornice. While these schools have a certain horizontal elegance, and certainly are a marked break from work before 1937, they still continue the tradition of brick masonry, and much red-brick masonry in school construction.

As significant an event during this period was the shift from the Board of Education's policy of designing all schools 'in-house' under the direction of the Superintendent or Chief Architect, to a policy where many of the schools were designed by architects in private practice working as consultants to the Bureau of Construction. This fundamental change in policy was a direct result of criticism voiced in the 1937 report.

These recommendations were only partly heeded. During Kebbon's tenure, the Board of Education began consulting with architects in private practice for a portion of the designs for new schools, but continued to design many schools in-house – particularly those standardized schools so strongly criticized[86] in the 1937 report. This shift continues to this day at the School Construction Authority, where designs for both Capacity Projects (new schools and additions) and Capital Improvement Projects are prepared by architects and engineers working in-house at the SCA, and by privately owned architectural firms working as consultants to the SCA[87].

Fig. 5.1.24

Fig. 5.1.23
PS 200 Q, a 1950's design, features a steel window wall system at its entry bays. Courtesy: Nelligan White Architects

Fig. 5.1.24 (left) & 5.1.25 (above)
School designs of the early post-war era were clearly influenced by the Art Deco and International styles popular in Europe. Following a report produced for the Board of Education by the AIA in 1937, schools became lower, and more horizontal. This coincided with increased building in outlying districts, where space was cheaper and more available, and buildings had the freedom to spread out set back from the street. Courtesy: Sylvia Hardy

[85] Modern School Houses was published in 1910, the same year as Wasmuth portfolio.

[86] New York City. *Board of Education AIA Annual Report (1937-1938)*, City of New York

[87] See a partial list of outside consultants employed in school design between 1937 and 1970 in Section 2.

EVOLUTION OF STRUCTURAL TYPOLOGIES

Fig. 5.1.26 (above)
Mid-Century Modern design methodologies came into use at New York public schools after World War II. PS 111 M represents a premier example of these designs in school architecture. Courtesy: Sylvia Hardy

Fig. 5.1.27 (right)
Multiple window types present at PS 111 M represent the changes in design from previous standard school types. Punched, double hung windows were replaced with curtain wall/window wall systems, and window infill systems. By the 1950's wooden windows had been abandoned in favors of rolled steel windows. Courtesy: Sylvia Hardy

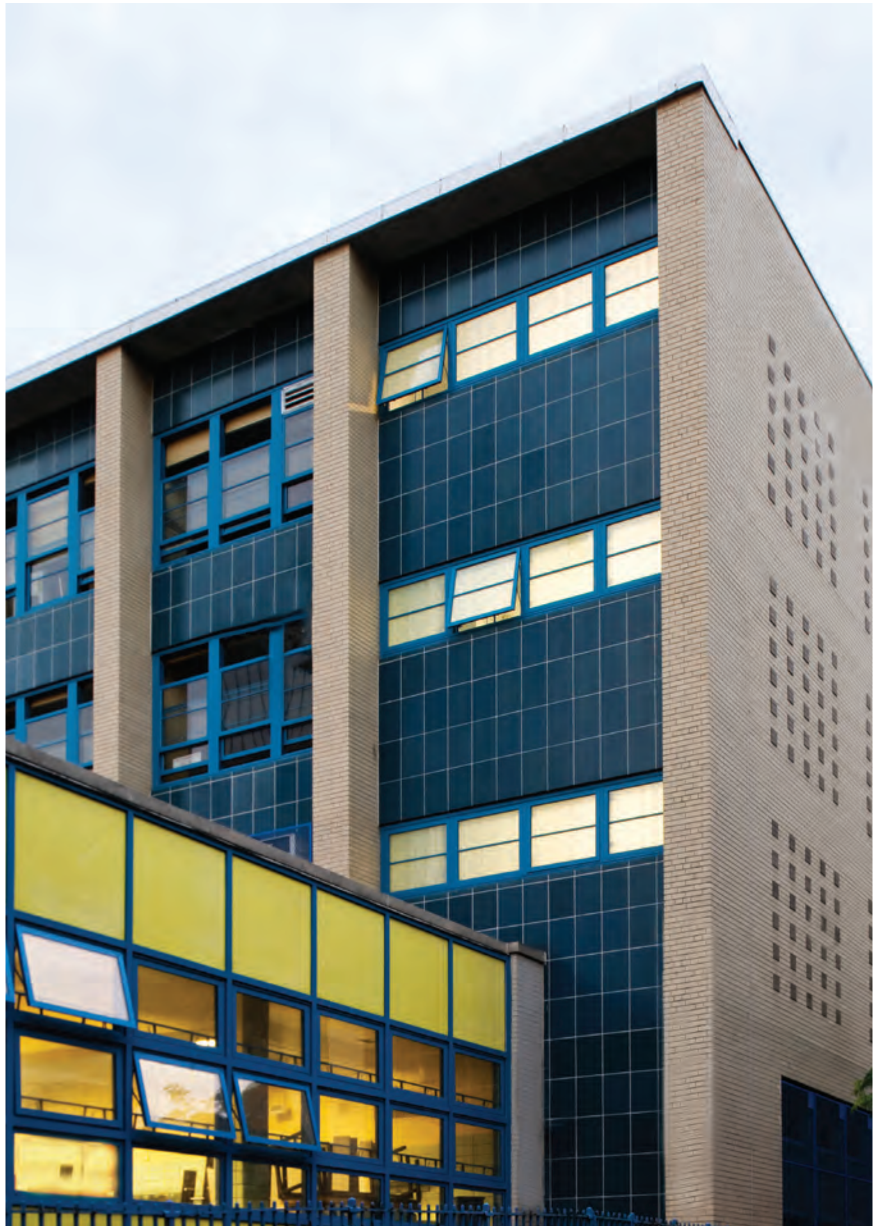


Fig. 5.1.27

Fig. 5.1.28 (below)
A 1937 AIA report commissioned by the Board of Education produced a series of recommendations which pushed for more modern design. Because of the slow-down in construction through World War II, these recommendations were not implemented until after 1945. They included a call for lower building heights, and separation of programs including the placement of public (assembly) spaces on the ground floor. Courtesy: Board of Education Journal

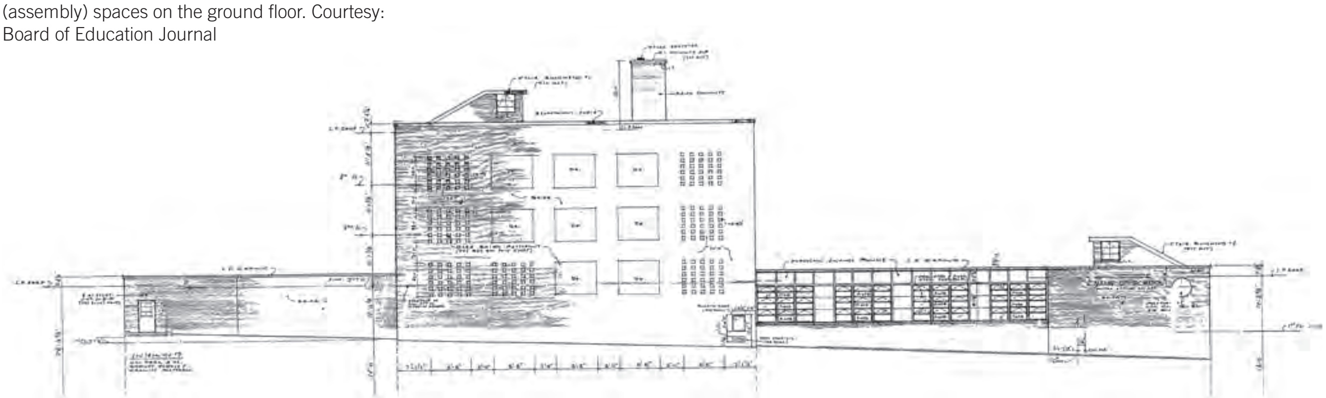


Fig. 5.1.28

Michael Radoslovich's eleven-year tenure (1952-1963) as the Chief Architect for the Bureau of Construction of the Board of Education, brought more significant stylistic and technical changes in the design and construction of public schools. While the structural systems of these buildings were mostly concrete-encased steel frames with concrete floor slabs, like buildings designed under Kebbon, Radoslovich began experimenting with a greater variety of asymmetrical plan arrangements and introduced curtain wall construction to the buildings' enclosures. These designs were largely influenced by the design of the Dessau Bauhaus (completed in 1926) and its designer, Walter Gropius, as well as Ludwig Mies van der Rohe and Le Corbusier. In 1937, both Gropius and Mies van der Rohe arrived from Germany in the United States. Gropius settled in Cambridge MA at Harvard, and Mies van der Rohe in Chicago. Corbusier had been a presence in New York during his collaboration in the design of the United Nations after World War II. Radoslovich was educated in Cambridge, Massachusetts at MIT, like Kebbon. Like many American architects in the 1950s, his work expresses a closer affinity with the *'Teutonic'* modernism of Gropius and Mies van der Rohe's than with Le Corbusier's more expressive *'Mediterranean'* modernism.

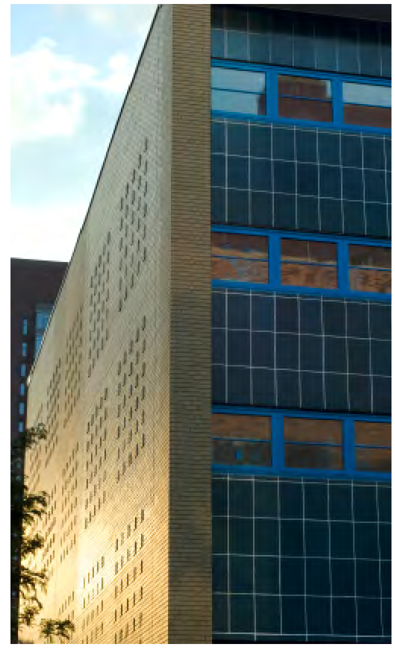


Fig. 5.1.29
PS 111 M**.** Courtesy: Sylvia Hardy

Arthur G. Paletta's tenure as Director of Architecture, beginning in 1963 completes the stewardship of design and construction of public schools constructed before 1970. Paletta largely continued the trends started under Kebbon and established under Radoslovich; a mix of in-house designed schools combined with schools designed by outside consulting architects.

In terms of the technical character of post-war buildings, the most significant aspect was continuing parallel development on in-house designs, and designs by outside consultants.

The in-house designs developed under each of the three post-war Architects (titles varied; Superintendent/Chief Architect/Director of Architecture) tended strongly towards standardization – *"sister schools"* and near sisters with a few construction types. Designs by outside consultants varied significantly and were in most cases unique.

Fig. 5.1.30 (below)
A conceptual rendering for PS 172 Q shows a design which differs significantly from public schools which had been built over the previous 50 years. The emphasis is clearly on large sites in outlying districts, where the design has the freedom the be grow horizontally rather than vertically. Influences of European Modernism and the International Style are clearly present in the designs. Courtesy: NYC Municipal Archives

Fig. 5.1.30

STRUCTURAL SYSTEM TYPOLOGIES

Structural Type: 1

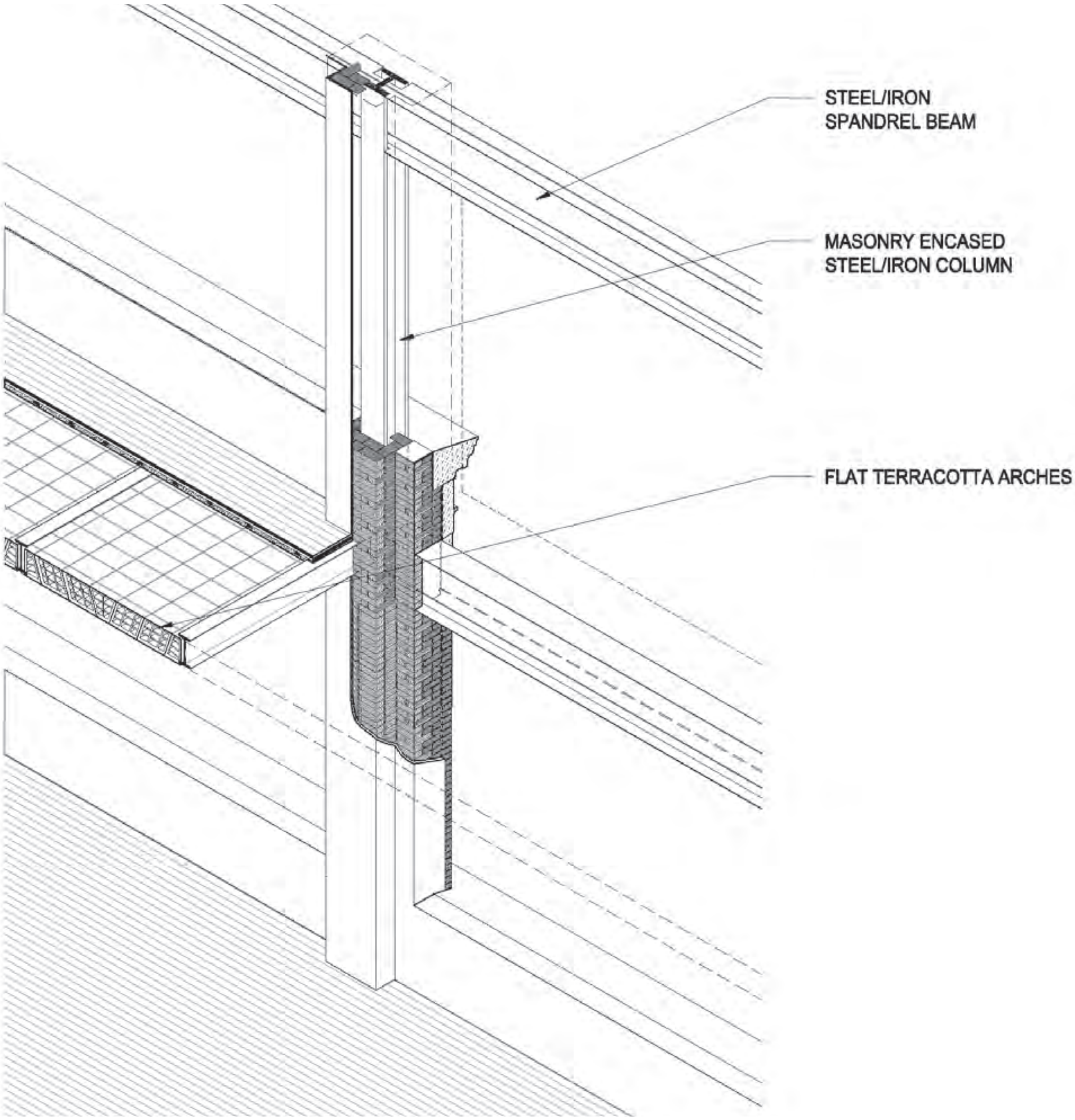


Fig. 5.2.1: Courtesy: Nelligan White Architects

Structural Type 1 is characterized by steel/iron spandrel beams, masonry encased steel/iron columns, and flat terracotta arches which span between floor beams.

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PS 3 M - Page 215

Structural Type: 2

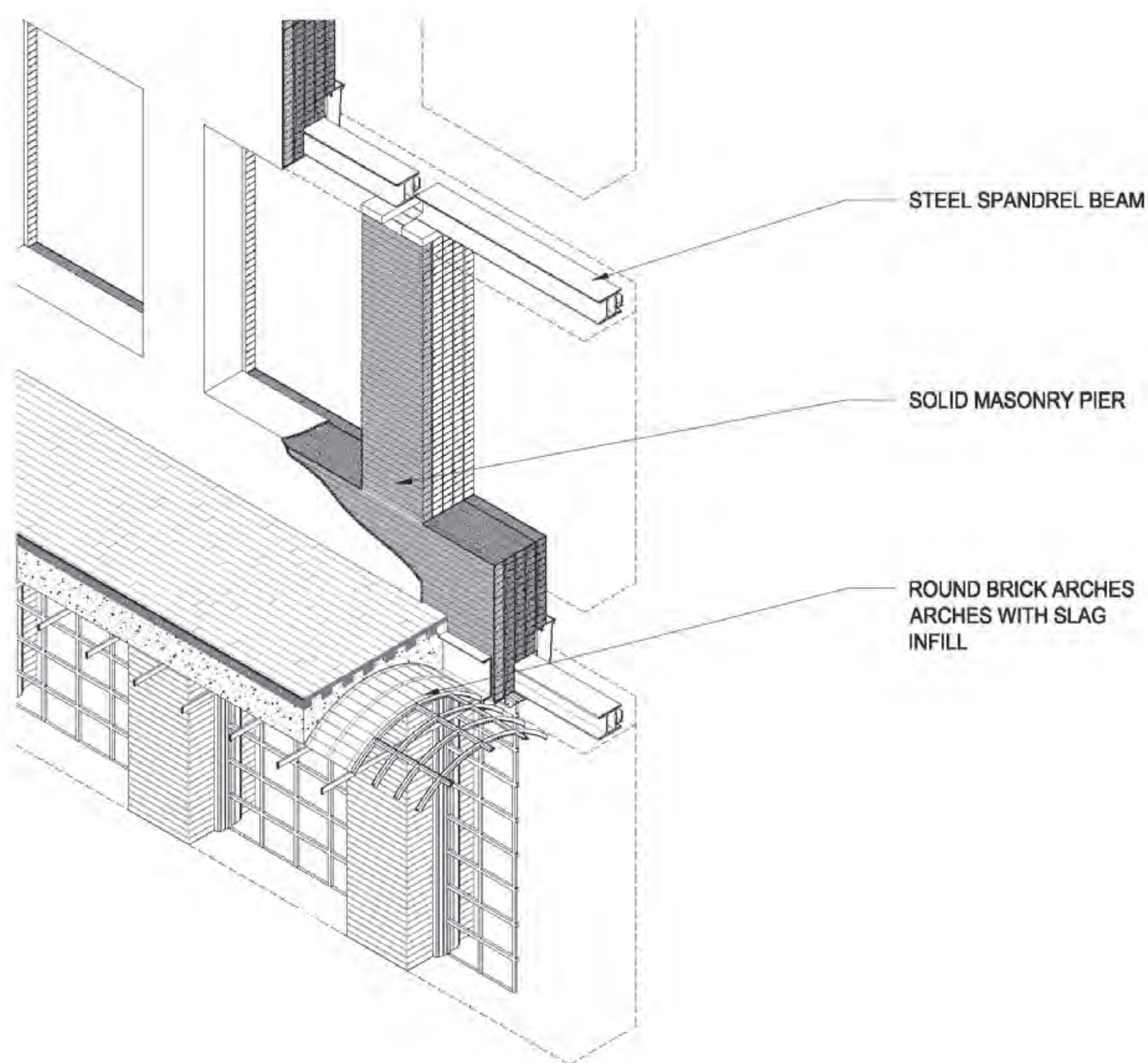

Fig. 5.2.2: Courtesy: Nelligan White Architects

Structural Type 2 is characterized by solid masonry piers at the exterior, steel spandrel beams, and round brick vaults with slag infill between floor beams.

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STRUCTURAL SYSTEM TYPOLOGIES

Structural Type: 3

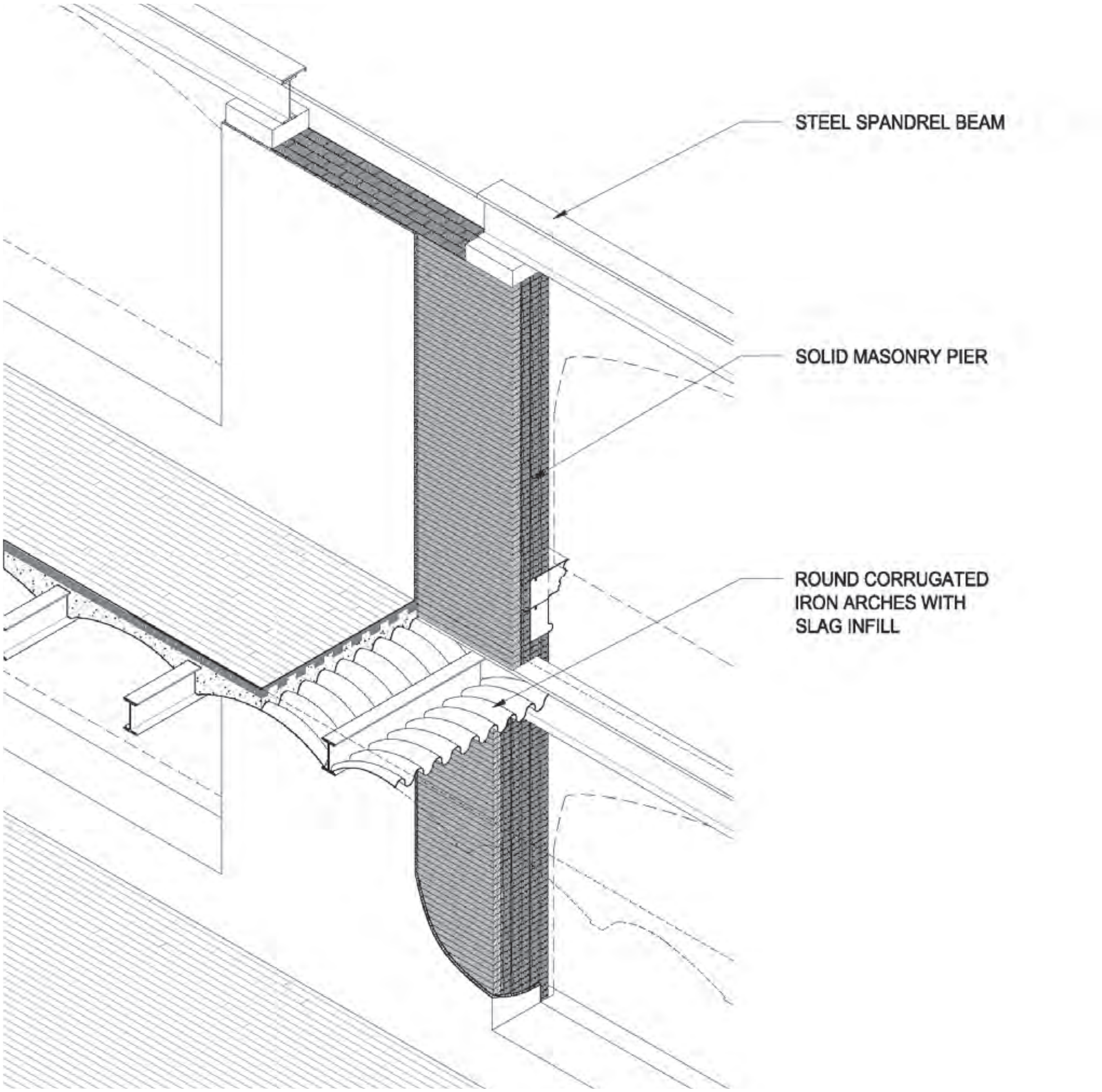

Fig. 5.2.3: Courtesy: Nelligan White Architects

Structural Type 3 is characterized by steel spandrel beams, solid masonry piers, and round corrugated metal arches with slag infill which span between floor beams.

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Structural Type: 4

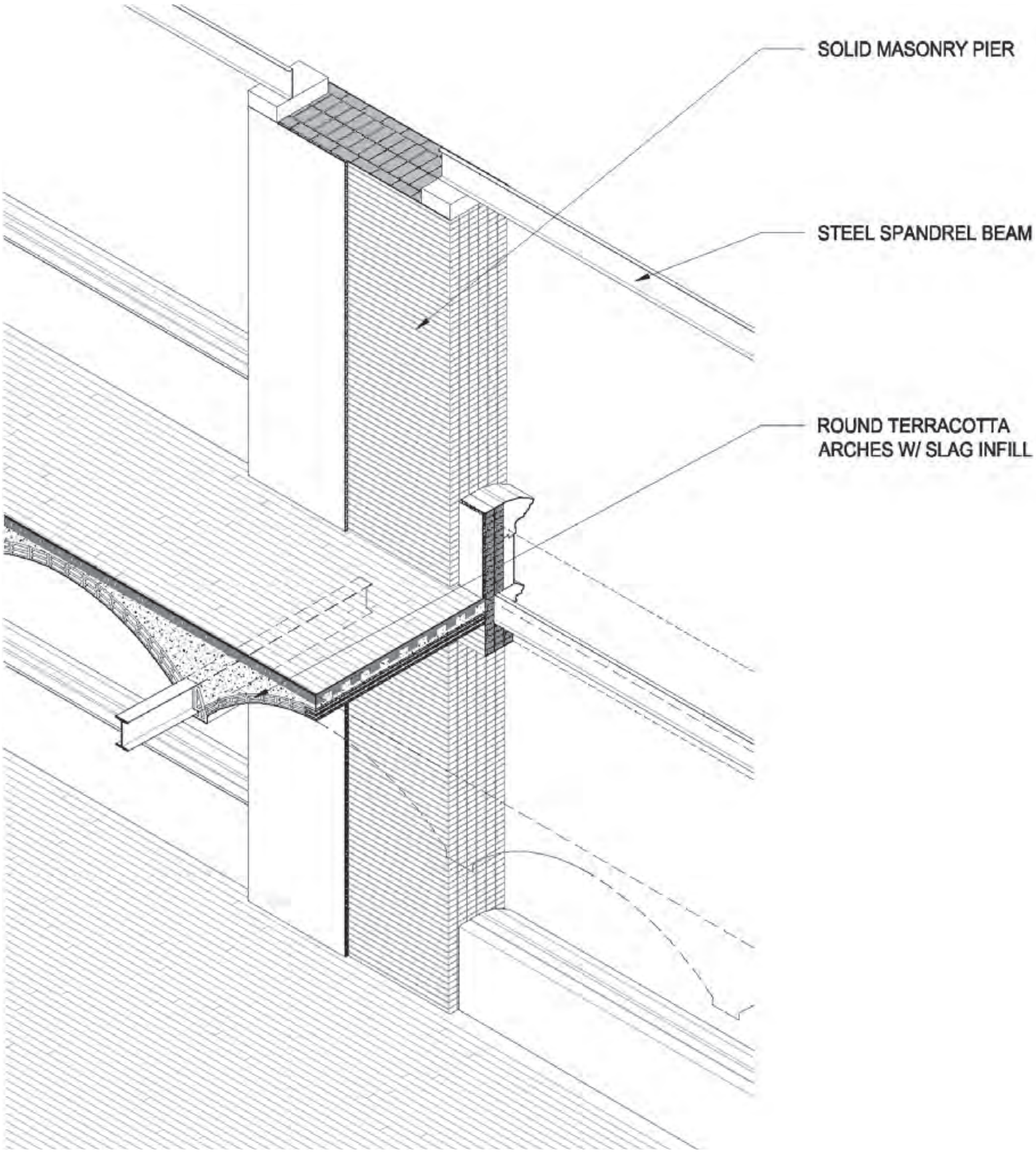

Fig. 5.2.4: Courtesy: Nelligan White Architects

Structural Type 3 is characterized by steel spandrel beams, solid masonry piers, and round terracotta arches with slag infill which span between floor beams.

ASSOCIATED CASE STUDIES

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MECHANISMS OF FAILURE

INTRODUCTION

This section outlines the most common mechanisms which result in the failure of materials and systems found in New York City's Historic Public School buildings. As such, it serves as a general guide to failures in most of New York's building stock, majority of which were built before 1950, out of similar materials, and are subject to the same climatic conditions. New York City lies in IECC (International Energy Climate Code) Climate Zone 4, subject to hot, humid summers and cold, icy winters. These factors effect building materials, especially after decades of seasonal change. There are also properties inherent to the building materials, some of which are augmented by the climate, some which are effected regardless of the geographic location. The nine categories designated below represent the most common mechanisms of failure observed in the course of school rehabilitations:

Fig. 5.3.1
Water damage below a skylight at PS 277 X has caused plaster to spall, paint to crack, and metal to rust, staining the finishes below. Courtesy: Nelligan White Architects

WATER

One can confidently say that, the most common agent, if not the root cause of damage in historic public school buildings, is water. Water in all forms – drizzling and wind-driven rain, ground water, water vapor, ice – penetrate the building enclosure and cause or aggravate damage to the enclosure, structure, interior finishes and building systems. This can result in the corrosion and disintegration of materials, leaking on the interior, and mold growth in damp locations.

New York City is surrounded by water and is subject to average annual rainfall of 43 inches per year, which is almost 27 gallons/SF of rain for each square foot of the City's total area per year. Whether as a liquid by gravity or differential pressure, capillary flow in cracks less than 0.4 mm in width, or as vapor condensing in cavities or beneath roofing membranes, or as ice that expands just before freezing water resulting in freeze-thaw spalling, one can guarantee that water has in some way effected these buildings.

Fig. 5.3.2
Moisture present on the underside of a bastion cap along the parapet at PS 183 M. Observed during a routine probe examination, the moisture indicates that water is able to infiltrate the building enclosure with ease. Courtesy: Nelligan White Architects

EXPANSION OF BRICK

The second most commonly observed failure is a result of thermal and moisture induced expansion of brick, and for the failure of the design or construction to accommodate this movement. Bricks expand through their lifetime, though the majority of this expansion occurs in the first six months after placement, expanding up to $^{1}/_{10}{}^{th}$ of 1% of their original size. While this may seem insignificant, over the length of a wall this expansion can be readily visible. Most of these buildings, especially the oldest of the stock, were not built with expansion in mind. This expansion is, especially, noticeable when new repairs have not taken expansion into account, resulting in cracking of the surrounding masonry.

Fig. 5.3.3
An out of plumb parapet, deformed as a result of brick expansion. New brick at the face was installed with no joints, resulting in expansion and deformation. Courtesy: Nelligan White Architects

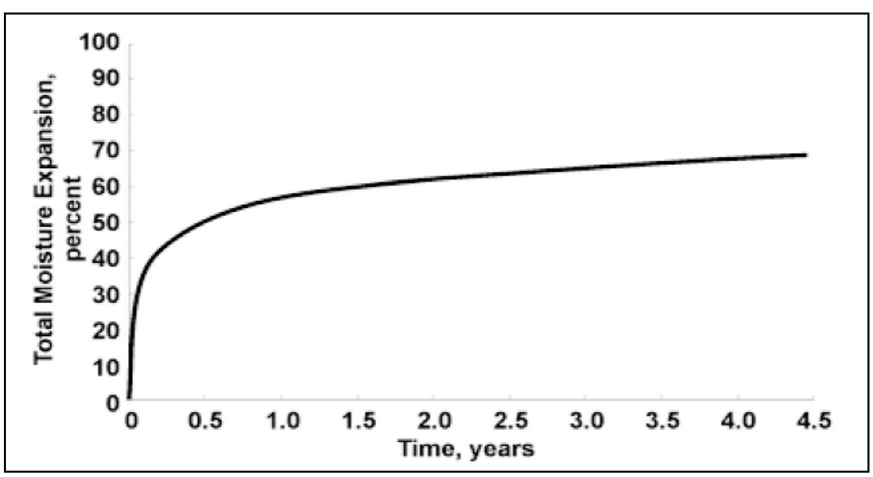


Table. 1

Table. 1 (right)
The graph to the right shows the rate at which newly placed masonry will expand. *TN 18 - Volume Changes : Analysis and Effects of Movement*. The Brick Industry Association. Page 3. *http://www.gobrick.com/Portals/25/docs/Technical%20Notes/TN18.pdf*

DIFFERENTIAL MOVEMENT

The third most common mechanism – closely related to the expansion of brick, or perhaps the bigger family to which expansion belongs is the differential movement of the (different) materials that make up these composite structures. Differential movement is especially noticeable in buildings which have a concrete-frame clad in brick masonry. Concrete shrinks over the course of its life, while bricks expand. Cracks at the face brick are common in this scenario, though it can also aggravate the concrete structure.

LATERAL LOADS

Lateral loading on these buildings, typically, means wind loads, but also includes seismic loads caused by rare earthquakes. These loads are often given second priority in low-rise buildings in New York, but in September 2010 tornadoes in Staten Island, Brooklyn and Queens, were a graphic reminder that the area can experience severe wind loads. In fact, many public schools are the designated shelters where we would go in the event of a disaster. Additionally, in August 2011, an earthquake centered in Virginia was felt in the New York City area, causing minor structural damage.

A century ago, most buildings were not designed for lateral loads, though current code requires that buildings be able to resist a wind load of 30-40 pounds per square foot, in case of an unfavorable scenario. In the case of load bearing masonry buildings, the actual weight of the masonry is usually adequate to resist wind loads. In frame buildings, the frame is usually adequate to resist lateral loads, but the terracotta backup is usually just set into the frame with mortar, brick cladding is bonded to the backup, and the windows are set just within the cladding. The attachment to the frame is limited to the dead weight of some of the masonry, and a perimeter mortar joint that is questionable at best and often non-existent.

Deflection is measured as a fraction of a span called by the lower case letter “l”. Thus, a beam that spans 15 feet between two columns and bends 1 foot at the center of the span has a deflection of $^{1'}/_{15}$’ or “$^{1''}/_{15}$. Most beams would fail and collapse before they could deflect so much and is usually limited to much smaller numbers to keep plaster and paint from cracking and falling. Deflection allowances of $^{1}/_{180}$, $^{1}/_{240}$ and $^{1}/_{360}$ are usually used. This translates to 1” in 15 feet, ¾” in 15 feet and ½” in 15 feet respectively. 15 feet is a typical vertical floor to floor span for one of our schools.

However, it is surprising to note that a brick wall deflect, even ½” without cracking. In fact, our engineers recommend a deflection criterion of $^{l}/_{600}$, or only $^{3}/_{10}$” in 15 feet as an acceptable deflection for brick masonry. Experienced engineers say that, since these buildings are still standing, that itself is evidence that these buildings must have *’found’* some mechanism to resist these loads and that the lateral loading is not a problem, though this is questionable.

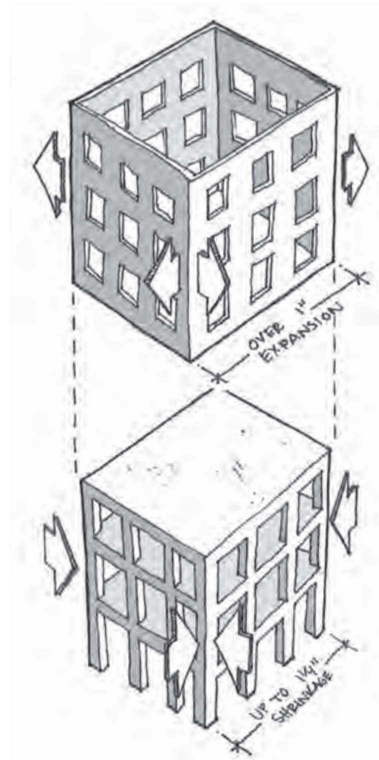


Fig. 5.3.4
Differential movement as explained by the above illustration. The concrete superstructure shrinks as it ages, while the brick facade expands. Properly placed expansion and movement joints can mitigate the effects of differential movement. Courtesy: Google Images

Fig. 5.3.5
Joints at terracotta backup is often not fully mortared on all edges, and it is sometimes left to the shear weight of the backup to keep itself in place. Strong winds can cause deflection of these backup walls when there is insufficient lateral support. While this rarely results in a catastrophic failure, it can cause cracking over time, increasing the wall’s susceptibility to moisture infiltration. Courtesy: Nelligan White Architects

MECHANISMS OF FAILURE

ENVIRONMENTAL CONDITIONS

While this may include failure as a result of water damage in New York's moist climate, in some cases this is especially aggravated by extreme head and cold. For example, water, which makes its way below roofing membranes in a built-up-roofing assembly will be super-heated in the hot summer sun. It will expand into vapor, or steam, and force the roofing membranes upwards, separating the membrane from it's substrate and creating a bubble in the surface. This may lead to further moisture infiltration, especially if it occurs in close proximity to a one of the membrane seams.

Conversely, extreme cold extreme cold effects other materials. Bricks and other types of masonry are especially vulnerable to the effects of freeze-thaw cycles. When even the smallest cracks fill with water followed by freezing temperatures, the water expands and forces the crack wider. This condition only worsens once it has begun, so it is important to quickly address these issues.

Other factors may include lack of sunlight in an alley way or exterior corner. If too much moisture is present in these locations, it is unlikely that the water will evaporate. This may lead to mold, or other biological growths which damage masonry and other surfaces with their anchoring systems, and induces the retention of water, which, in turn may aggravate damages during freeze-thaw cycles.

CARBONATION OF CEMENTITOUS MATERIALS

Carbonation of cementitous materials has two effects; it increases the compressive and tensile strength of concrete, but also decreases its alkalinity that is essential to the corrosion-resistance of steel reinforcement. For this reason, it is typically considered to be a problem. Once steel reinforcement begins to corrode, it will expand and crack the surrounding concrete, further aggravating corrosion and may pose a life safety concern in structural members.

Carbonation is a chemical effect of cementitous materials in exposure to air. The reaction occurs when carbon dioxide from the air reacts with calcium hydroxide in the cement, forming calcium carbonate. Carbonation is a slow, continual process, progressing from the exterior inward.

FOUNDATION AND GROUND WATER PROBLEMS

Leaking of ground water into basements and ground floor spaces may be a continual problem at certain sites. Leaks of this type have often been affecting the building for may years, with no full comprehension of the water's source. Historic references should be consulted in this case. Many of New York's older public schools were built from standard sets of plans for each school type, and only modified based on distinguishable site differences. We can infer that there was little research devoted to understanding the geographical history of a given site before a school was constructed.

Before the New York had been fully developed, streams, marshes and entire bays were filled-in, in and around Manhattan, and the boroughs to create level land for building. However, we now know that just because a stream has been filled-in does not mean the water has stopped flowing. At times, basements are built directly in the path of underwater streams which may have occurred naturally, or where a stream was filled in, but flowing water is still present.

LIGHTNING STRIKES

Lightning strikes are a relatively rare occurrences, though they can effect decorative building elements, which, in turn may lose strength and fall from any high location inciting a life safety hazard. At PS 89 Bronx, large piece or terracotta fell four stories from the cornice at the corner of the building into the school yard. While no one was injured, it did highlight issues of structural stability at the cornice. This was thought to be the effect of a lightning strike. When tested, large areas of the cornice were found to be deficient, in some cases breaking off as a result of the testing procedure.

MISGUIDED MAINTENANCE

By the time a consultant design professional has begun to scope a project at any of these historic buildings, often the school maintenance staff or previous repair campaigns by other design professionals have been carried out. These repairs are often local, and the scale or source of the of the problem is sometimes misunderstood. In these cases, remediation is typically insufficient; and in many cases, detrimental to the building.

One example is the coating of brick to prevent moisture infiltration. Paint, or the bituminous coatings often used at the backsides of parapets, may have moisture infiltration in the short term, but it will severely aggravate spalling, as any moisture trapped beneath the coatings has not way of escaping. This can effectively destroy and entire wall, or cause expansion and a parapet to the point of failure.

Another example is the painting of metal window frames to keep them from rusting. After several coats of paint of the years, these windows become jammed and effectively inoperable.

Fig. 5.4.1 (above) & 5.4.3 (overleaf-bottom)
Cast iron columns at PS 277 X were mostly in good condition, and showed little corrosion, especially compared to thinner steel members in the assembly. Courtesy: Nelligan White Architects

CAST IRON - MATERIAL PROPERTIES

Cast iron construction began with its use in facades. Simple post and beam construction using cast iron began in the 1830s. James Bogardus was an early promoter of cast iron's use and he filed a patent for an all cast iron frame building, including cast iron floor plates, in 1850, although no known example of the complete cast iron frame building was constructed. Cast iron columns and girders and wrought iron beams were later introduced. In many cases, they were used in conjunction with masonry bearing wall construction and interior wood joist floors in buildings most typically up to five stories tall. The Cooper Union building in Manhattan was one of the first examples of this type of construction that paved the way for the steel frame structures, now commonplace in any multi-story construction. Some early public schools built by Snyder, and perhaps some of Naughton's Brooklyn school buildings used cast iron columns in conjunction with steel at the spandrels, floor beams, and other miscellaneous framing elements.

Cast iron construction was promoted for its speed of erection, increased access for natural light (in the case of facades), space saving and fire safety. The late claim, however, while initially promoted was later shown not to be the case with a number of notable collapses due to expansion and brittle failure of connections in the late1800s. This led to a New York City Building Code requirement to use fireproof columns comprising a cast iron column surrounded by plaster and an outer shell or terracotta tiles.

Another drawback to cast iron construction was the relative weakness of the minimal bolted connections. This was particularly problematic in terms of its resistance to lateral loads. Early use of cast iron in conjunction with masonry bearing wall construction overcame this drawback as did the relatively low, squat construction of the early buildings. However, in cases where buildings were constructed with taller and/or with fewer or no masonry walls reliance on the cast iron relied entirely on the large safety factors applied to cast iron construction, typically 6 to 10.

One of the oldest ferrous metals used in construction is cast Iron, which is primarily composed of iron, carbon, silicon, with traces of sulfur, manganese, and phosphorous. Its relatively high carbon content (2-5%) makes it hard, brittle, non-malleable and more fusible than steel.

Cast iron is comparable to some types of steel in compression, but is brittle and has low tensile strength. Its structure is crystalline and may fracture under excessive tensile loading with little prior distortion. Since columns in the 19th century were designed with little consideration of lateral loads, cast iron was an ideal material. Today, however, design for lateral and seismic loads is a requirement, mandated by New York's Building Code. Failure has been noted in the rehabilitation of some New York's school buildings, mostly associated with fracturing, and assumed to be the result of unanticipated lateral loads.

In the later part of the 1800's frame construction, in both cast iron and steel came to the fore, initially in the form of so-called *'cage'* type construction. Cage construction consisted of a frame to support gravity loads, generally, with little or no designed ability to support lateral loads, surrounded by self-supporting masonry walls. This type of construction was potentially catastrophic when combined with the use of cast iron, particularly during construction, due to the previously mentioned lack of ability of cast iron to resist lateral loads. As frame construction became taller and more slender, the limits of this type of construction were tested until a series of collapses of cast-iron framed cage buildings during or immediately after construction. The most notable of these was the Darlington apartment building, which collapsed during construction on March 3rd, 1904, killing twenty-five construction workers. This, and the availability of more versatile affordable and reliable steel, led to the decline in its use substituted by steel in the early 1900s.

It is worth noting that large cast iron sections, though brittle and prone to cracking in tension, have weathered remarkably well, often showing less corrosion than steel sections in the same conditions.

CAST IRON - PROBLEMS & DETERIORATION

Rusting, or oxidation, is the most frequent and easily recognizable form of cast iron deterioration. Cast iron is highly susceptible to rusting when the humidity is higher than 65%. If rusting occurs at a rapid rate, it can result in severe damage or total loss of a component in a short amount of time; therefore, the presence of any rust should alert the observer to the presence of a serious problem. Certain pollutants, especially sulfur dioxide, ammonia sulfates and even body oils from hands have been noted to aggravate rusting. The presence of rust indicates that some original iron material has been converted to iron oxide, and irreversibly lost from the member.

Visual inspection may enable detection of mechanical failures as they begin to occur. Stress cracks in paint or metal may be symptomatic of this problem. Failures may begin as gradual separations which are visible upon inspection, and may be detected prior to the total, catastrophic failure of a piece. Line cracks in paint or metal should be investigated and monitored to determine if they are active.

Large cast iron pieces are generally systems composed of smaller castings, mechanically connected. One of the more common failures which is the failure of the connections or joints. Loose, missing or broken screws, clamps or bolts may result in loose, failed or missing components. It is especially important to detect connectors which are in danger of imminent failure if not corrected.

Another mechanical problem may be caused by inappropriate mechanical repairs of broken pieces. Repairs which create openings that allow water penetration or *'pockets'* which collect water are potential problems. Castings which have been filled with concrete are also a potential problem since they may promote *'crevice corrosion'* due to entrapped water.

Fig. 5.4.2 (above)
One of the cast iron columns as PS 277 X was found to be cracked across its section. It was determined that this crack occurred during or just after original construction, and that its condition was stable. Regardless, a remediation effort was undertaken which included drilling holes through the webs with a low-RPM drill, and plates were bolted to the crack to splice the column. Courtesy: Nelligan White Architects

Fig. 5.4.3

Fig. 5.4.4 (right)
Steel framing at the pitched roofs of PS 171 M. The 110-year old roof was under-designed by today's standards. Deflection saw compounded by the insufficient knee-joint connection to the main wall structures. Courtesy: Nelligan White Architects

Fig. 5.4.4

Fig. 5.4.5

Fig. 5.4.5 (right)
Most steel members in early school buildings were encased in either brick or concrete. Encasement of the steel was not only a fire protection measure, but also provided lateral stability to the members as they were designed primarily as compressive elements. Courtesy: Nelligan White Architects

STEEL

Now the standard material for multi-story construction, steel frames were first used in public school design in the early 1890s. Due to issues of reliability and quality in its manufacture as the building industry was booming, steel was slow to fully replace iron as the standard material for structural frames. The Board of Education also notes increasing difficulty finding steel and steel workers in their annual reports from the turn of the century . As a result, public schools essentially abandoned frame structures until approximately 1910, at which point steel completely replaced cast iron as the primary element of structural frames.

Steel is able to resist increasingly high loads in compression and tension. It is more elastic than cast iron, meaning it is more tolerant of deformation under unexpected loading and can recover its original shape and strength when loads are removed. It is this quality that makes steel a more suitable material for compressive elements which may be subject to unexpected lateral loading.

The first steel frame structures were used to support brick and terracotta infill walls, providing additional stiffness to the steel frame. The two materials work in conjunction to maximize strength and are thus considered composite structures, as loads are not entirely bearing on masonry or exclusively reliant on the frame. By the 1920's evolution of frame structures drove further separation of the bearing structure from building enclosure systems, culminating in the brick cavity and curtain wall systems commonplace in schools by the 1950s.

Inspection of school buildings from approximately 1890-1900, has confirmed that smaller steel sections are often in very poor condition, and may be experiencing dangerous levels of corrosion. This may be attributed to the fact that designers were simply unsure how to design steel, resulting in under designed structures.

Fig. 5.4.6
A corroded steel lintel at IS 77 Q. During inspection of steel lintels during construction, each was pounded with a hammer to remove excess rust and determine the solidity of the section as well as a rough idea of its sectional loss. Most were deemed sufficient, but several areas were selected for repair. Courtesy: Nelligan White Architects

Fig. 5.4.7
At PS 36 M, steel reinforcement was exposed in locations over all facades. It was determined that this was a effect of insufficient concrete cover, causing the concrete to spall once the rebar started to rust and expand. Courtesy: Nelligan White Architects

Fig. 5.4.8
Rust stains at the surface, an indication of the building-wide problem of insufficient concrete cover at PS 36 M. In remediation of this building included hydro-scrubbing all rebar clean and splicing where rebar was too corroded for safe inclusion. Two inches of concrete were cast over all cleaned concrete components, and a migrating corrosion inhibitor was then applied to protect the existing rebar. Courtesy: Nelligan White Architects

REINFORCED CONCRETE

Although unreinforced concrete was in use as an alternative to other forms of masonry construction (brick, stone etc), it was not until 1890 – 1910 that the development of complete reinforced concrete frame buildings (wall, columns, beams, slabs) occurred. The history of reinforced concrete began in the mid-1800s in Europe, but it did not begin in the U.S. until the late 1870s. By circa 1890, both steel skeleton and concrete-framed buildings began. However, concrete-framed buildings in this era were experimental, whereas steel-framed were in general use. It was not until after 1900 that concrete-framed buildings entered general use. This meant that steel had a head start and became the predominant material for framed buildings in the U.S. throughout much of the 20th century.

Fireproofing, initially, gave concrete an edge over steel, which was recognized in Europe – concrete was used for fireproofing steel in the U.K. – however, in the U.S. fireproofing of structural steel was achieved principally using terracotta in the first half of the 20th century or so.

These concrete structures mimicked masonry and steel-framed construction. Development of two-way concrete slabs produced a structural form unique to concrete building construction. Unlike the development of steel framing which was used initially in conjunction with prior technologies - for example steel beams supporting a wood joist floor, supported by cast iron columns and masonry bearing walls - reinforced concrete was not widely used until complete concrete framing systems were developed (wall, columns, beams, slabs).

Details and design methodology for steel-framed construction began with the use of wrought-iron before 1870 preceding development of national specifications and building codes. The fundamentals of modern steel framing were established before 1900, prior to the existence of national standards such as ASTM and AISC and before early building codes such as the 1899 New York City Building Code and the 1900 Chicago Building Code addressed the new technologies in any detail. Conversely fundamentals of concrete framed construction emerged after 1900, largely after 1910, by which time relevant standards organizations such as ASTM and ACI were already established (1902 and 1904 respectively), such that they played a significant role in their development. Starting 1903, ASCE, ASTM, ACI and others formed a joint committee *"for the purpose of investigating current practice and providing definite information concerning properties of concrete and reinforced concrete and to recommend necessary factors and formulas required in the design of structures in which these materials are used"*.[88]

Building designers and owners, gradually, saw benefits in concrete frame construction relative to steel frame in terms of potentially lower cost, faster construction, resistance to vibration and fire, acoustic insulation and lower insurance costs. However, it was not until the 1920s and 1930s that the competition between the two became more intense in building construction.

The development of rebar and design concepts for reinforced concrete enabled the construction of structural forms not possible in other materials such as two-way spanning flat slabs and thin shells.

Initially, the concrete construction was used together with other forms of construction. An example of this is the use of welded wire mesh reinforced *'lightweight'* cinder concrete (aka. Gritcrete) for slabs used in conjunction with steel frames in lieu of prior forms of fireproof construction such as terracotta *'flat arch'* construction. This form of reinforced concrete was proportioned empirically, i.e. based on representative tests, rather than a comprehensive theory enabling designers to maximize its unique characteristics.

[88] Friedman, Donald. (2010). *Historical Building Construction. 2nd edition.* New York: W. W. Norton & Company. Print.

Development of rebar and design concepts for its use were pioneered by Ernest Ransome, beginning in the 1870s with twisted square bars, which he patented in 1884. During the late 1800s, there was such rapid growth in the development of reinforced concrete design, that it often left building codes behind. It was not until 1903 that an amendment to The New York City Building Code was passed that legalized rational design (rather than empirical design) of concrete construction in New York City. Concrete-framed buildings initially mimicked masonry bearing wall construction, which developed into concrete skeleton frames (columns, beams and slabs) in the early 1900s.

Many early concrete-framed buildings were factories. Early concrete design and construction had limited capacity to deal with high bending and shear demands such as those associated with column transfers, resulting in excessively deep members. Structural steel was sometimes used to address such situations. Taking advantage of the continuity of monolithic concrete flat-slab construction was the first uniquely concrete form of structure. Initially proposed by Orlando Norcross in 1901, Claude Turner, one of the founders of Turner Construction and a former employee of Ernest Ransome, constructed the first documented flat-slab building, the five-story Johnson-Bovey Building in Minneapolis in 1906.

Turner was forced to justify its structural adequacy to The Minneapolis Building Department via a full scale load test due to lack of accepted rational design methodology. He built and tested at least another twelve flat-slab buildings between 1906 and 1908 which earned him considerable success and a strong client following. He called his system *'The Mushroom System'*. Turner collaborated with Henry Eddy to develop a theory for rational design of his system. The system claimed advantages over more conventional beam and slab construction of reduced story height, simplified form-work, potentially finished ceilings, saving in labor and time of construction and less steel. Unlike the later flat-slab systems, Turner's Mushroom System utilized a draped reinforcement configuration - similar to that used in the previously mentioned *'Gritcrete'* construction - and a unique arrangement of reinforcing at the columns, in part the genesis of the *'Mushroom'* name he gave it.

Various flat-slab systems followed and the majority of buildings constructed using them between 1900 and 1930 were factories or warehouses. Early flat-slab systems of various patented types were developed by numerous companies, many using proprietary types of reinforcing with unique configurations particular to their system.

Plain, non-deformed rebar, was used initially and phased out during the 1910s and early 1920s. Deformed rebar had the advantage that it created a mechanical bond with the surrounding concrete rather than a purely chemical one and was less susceptible to the condition of the surface of the bar. Numerous types of deformed bar were developed initially before standardization occurred, which precluded development of standard details. However, types of reinforcing in common use dwindled during the 1920s and 1930s, thus, leading to development of standard details, but it was not until 1946 that ACI and CRSI published the *'Proposed Manual of Standard Practice for Detailing Concrete Structures'.*

As with other forms of construction, there was a considerable hiatus in building construction from the 1930s through the mid-1940s, due to The Great Depression and The Second World War. The resulting concrete building construction was much closer to that with which we are familiar today with well-recognized rational analysis and standardization.

Fig. 5.4.9
Arched brick vaults use rolled steel ribs spaced on center at the wide of one brick. Bricks are then vaulted across the span. A cinder concrete slag is poured on top of the vaults to seal them in place and provide a level floor surface. Courtesy: Nelligan White Architects

Fig. 5.4.10
Corrugated iron vaults use rolled steel ribs spaced on center at the wide of one brick. Bricks are then vaulted across the span. A cinder concrete slag is poured on top of the vaults to seal them in place and provide a level floor surface. Courtesy: Nelligan White Architects

Fig. 5.4.11 (below)
Segmented terracotta vaults can either be rounded, or flat as shown below. They work on the same principle of a jack arch, using a key stone at its center as a wedged member to keep all other components in place. Courtesy: Board of Education Journal

BRICK VAULTS

One of the three segmented arch systems used in New York's public schools from the late 19th century until approximately 1920, brick vaults are comprised of a rolled steel rib structure, into which brick masonry is lined up in an arch formation. The arch is loaded with a layer of slag concrete, into which wooden sleepers are set. Wood floors are nailed to the sleepers as a finished walking surface.

ROUND TERRACOTTA VAULTS

One of the three segmented arch systems used in New York's public schools form the late 19th century until approximately 1920, round terracotta vaults are comprised of a manufactured set of hollow terracotta pieces laid between steel floor beams forming an arch. The arch is loaded with a layer of slag concrete, into which wooden sleepers are set. Wood floors are nailed to the sleepers as a finished walking surface.

FLAT TERRACOTTA VAULTS

One of the three segmented arch systems used in New York's public schools form the late 19th century until approximately 1920, flat terracotta vaults are comprised of a manufactured set of hollow terracotta pieces laid between steel floor beams forming a flat jack arch. The arch is loaded with a layer of slag concrete, into which wooden sleepers are set. Wood floors are nailed to the sleepers as a finished walking surface.

CORRUGATED IRON VAULTS

Separate from the segmented arch systems, corrugated iron vaults are comprised of ribbed iron vaults which span between steel floor beams. The arch is loaded with slag concrete, into which wooden sleepers are set. Wood floors are nailed to the sleepers as a finished walking surface.

REINFORCED CONCRETE SLAB

First used in the 1920s in school construction, reinforced concrete slabs quickly became the standard by the start of World War II.

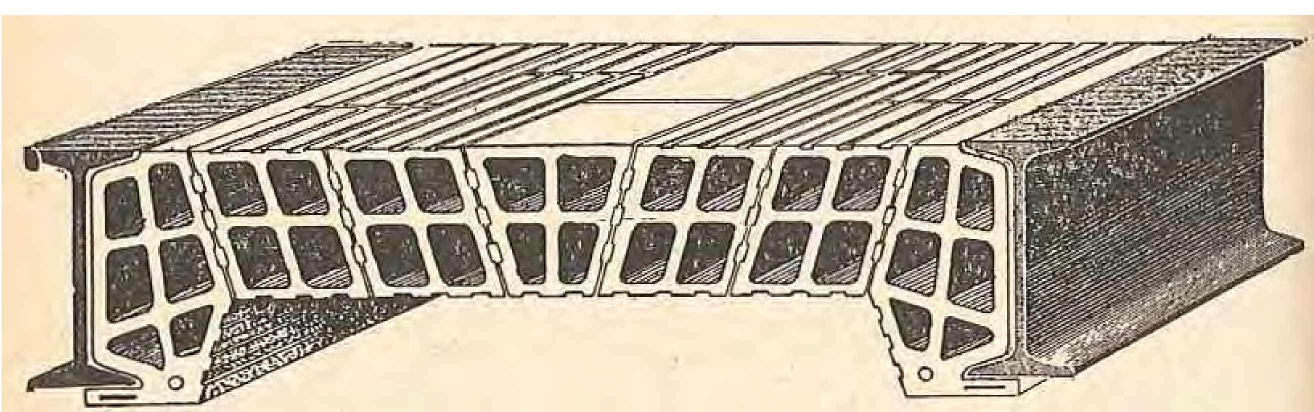


Fig. 5.4.11

1. LOAD-BEARING BRICK PIERS

This system incorporates load bearing masonry piers, with steel lintel beams spanning in between to allow large window openings. The thick masonry piers on all exterior sides support an internal structure of iron or steel for floor spans.

This structural system was widely used through the 19th century, though by 1891 Charles B. J. Snyder began experimenting more heavily with frame structures. Several schools were built by Snyder between 1891 and 1900 which incorporated frame elements, though between approximately 1900 and 1910 a shortage of material and steel workers forced the Department of Education to revert back to load bearing brick pier buildings. By the end of World War I, however, almost all school buildings incorporated frame elements as part of their composite structure.

Fig. 5.4.12
Load bearing brick pier structural systems use large, thick columns composed of brick masonry as the primary compressive elements. All loads (except those at the center of the building, which may be served by a series of cast iron columns) are brought back to these masonry piers. Courtesy: Nelligan White Architects

2. COMPOSITE FRAME

This structural system refers to masonry encased brick columns as the primary compressive element in a cast iron or steel frame. In this composite system, the frame takes the majority of the load, enabling thinner exterior walls and wider window openings, while the masonry which encases the columns adds stiffness to the structure.

This system typically incorporates brick and terracotta infill walls. Between columns, brick and terracotta are set on the spandrel beam as wall infill. These walls support no loads except themselves and sometimes windows. Terracotta infill was used alongside brick in order to keep loads to a minimum, as terracotta units are lighter. Lighter loads require less steel, an effective cost saving measure. In front of the backup, covering the entire structure is a layer of face brick, sometimes of a different color or incorporating decorative elements, which were traditionally held to the backup with a mortar filled collar joint and metal anchors.

Fig. 5.4.13
Composite frame structures often have some type of iron or steel frame which is encased in either concrete or brick masonry. This stiffens and provides extra compressive strength to the frame, while also providing an effective form of proofing. Courtesy: Nelligan White Architects

3. BRICK CAVITY WALL

This system came into existence as a response to true frame structures – the full separation of structure from the building enclosure system, mostly found in post-World War II school buildings. The brick cavity wall is simply a veneer which hangs from the main structural frame, typically covering columns, spandrel beams and CMU infill walls. Between this veneer and the structure/ infill walls is a thin cavity which allows any moisture which penetrates the brick veneer to escape through weeps at the bottom of the wall.

Fig. 5.4.14 (left)
Brick cavity walls became popular after World War II, as the structural components of buildings began to be separated from its enclosure. Courtesy: Nelligan White Architects

Fig. 5.4.15
Probes are performed at load bearing brick masonry walls to determine the condition of the masonry backup; face brick may appear to be dry, but backup could be saturated. If this condition has been present for years, it maybe degrading the mortar or masonry units. Courtesy: Nelligan White Architects

Fig. 5.4.16
Three different shades of brick can be seen at the face brick, indicating several repair campaigns. Courtesy: Nelligan White Architects

Table. 2 (right)
Brick and Structural Clay Tile Unit Compressive Strengths. Retrieved from "*Technical Notes 3A - Brick Masonry Material Properties." Technical Notes on Brick Construction* (1992).The Brick Industry Association. Web. *<http://www.gobrick.com/Portals/25/docs/TechnicalNotes/TN3A.pdf>*.

Fig. 5.4.17
Brick masonry mock-up at the parapet wall. Reinforcing and through-wall flashing can be seen in the assembly for lateral support and to mitigate moisture infiltration. Courtesy: Nelligan White Architects

This section includes information relating to all shale and clay based masonry[23] units, including common brick and structural clay tile (terracotta). Masonry structures or any singular masonry assemblage are considered monumental, homogeneous pieces bonded into and integral mass by mortar and grout. As such, it is important to the individual properties of each material in the construction:

1. CLAY & SHALE MASONRY UNITS

The raw materials of most brick masonry include a combination surface clays, fire clays, and shales formed by extrusion, molding, or dry pressing then fired in a kiln at temperatures between 1800°F to 2100°F (980°C and 1150°C). Variations in manufacturing produce a wide range of aesthetic and physical properties available, making brick and structural clay tile both visually appealing and durable due to their high compressive strength.

Brick and Structural Clay Tile Unit Compressive Strengths

Unit Type			Mean Unit Compressive Strength, psi (Mpa)	Standard Deviation of Compressive Strength, psi (MPa)
Solid brick	Forming Method	Extruded	11305 (77.9)	4464 (30.8)
		Molded	5293 (36.5)	1822 (12.6)
	Raw Material[1]	Fire clay	15346 (105.8)	5065 (34.9)
		Shale	11258 (77.6)	3487 (24.0)
		Other[2]	9169 (63.2)	3988 (27.5)
Hollow Brick[3]			6736 (46.4)	2447 (16.9)
Structural clay tile[3]		Vertical coring	10057 (69.3)	5578 (38.5)
		Horizontal coring	5119 (35.3)	2067 (14.3)

Table. 2

Increasing the compressive strength of a unit will increase the compressive strength and elastic modulus of a masonry assemblage. Unit texture and absorption properties affect the bond strength of the masonry assemblage. Generally, mortar bonds better to rough surfaces. Cores and frogs provide a means of mechanical interlocking of units. Bond strength of smoother surfaces depends primarily on the absorption rate at the time of laying. Units should be wetted to reduce the rate of absorption, as this sucks water from the mortar and alters its chemical properties in curing.

Additionally, brick is porous and will absorb particles of any cementitous materials in which it is laid. It is virtually impossible to completely clean these absorbed particles from the surface of brick units and may greatly affect the bond between the brick and mortar if reused . Thus, the use of salvaged brick in any structural application is not recommended.

2. MORTAR

The material properties which influence the structural performance of masonry are compressive strength, bond strength, and elasticity. Common types of mortar are listed in their section, along with their recommended applications:

TYPE-N - Specifically recommended for chimneys, parapet walls, and exterior walls subject to sever exposure. It is a medium bond and compressive strength mortar suitable for general use in exposed masonry above grade.

TYPE-S - Recommended for use in reinforced masonry and unreinforced masonry where flexural strength is required. It has a high compressive strength and high tensile bond strength with most brick units.

TYPE-M - Specifically recommended for masonry below grade or in contact with earth such as foundation walls, retaining walls, sewers and man holes. Has a high compressive strength and better durability in these environments than Type-N or S mortars.

3. GROUT

Grout is used in brick masonry to fill cells of hollow units or spaces between wythes of solid unit masonry. Grout increases the compressive, shear and flexural strength of the masonry element and bonds steel reinforcement and masonry together.

ASTM C 476 Grout Proportions by Volume

Grout Type	Portland Cement or Blended Cement	Hydrated Lime or Lime Putty	Fine Aggregate[1]	Coarse Aggregate[1]
Fine	1	0 to 1/10	2 1/4 to 3 times the sum of the volumes of the cementitious materials	NONE
Coarse	1	0 to 1/10	2 1/4 to 3 times the sum of the volumes of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

Table. 3

The amount of mixing water and its migration from the grout to the brick or structural clay tile will determine the compressive strength of the grout and the amount of shrinkage. Grouts with a high initial water content exhibit more shrinkage than those with low initial water content. As such, use of non-shrink grout is recommended for most applications, unless otherwise specified.

4. STEEL REINFORCEMENT

Steel reinforcement for masonry construction consist of bars, wires and other manufactured components. They are typically used in bed joints to reinforce individual masonry wythes or to tie multiple wythes together.

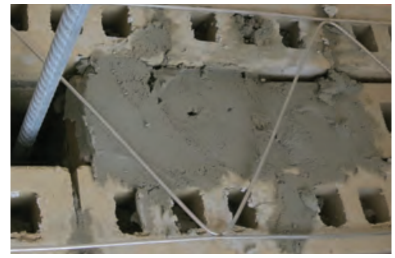


Fig. 5.4.18
Voids in the masonry are filled solid with grout at the parapet wall. Truss reinforcement is incorporated for additional support. Courtesy: Nelligan White Architects

Fig. 5.4.19
Inspection of probes can reveal deficiencies which many of the school types share. Often the collar joint between the face-brick and backup wall is not filled solid with grout, which may augment migration of moisture to the interior. Courtesy: Nelligan White Architects

Table. 3 (left)
ASTM C 476 Grout Proportions by volume. Retrieved from *"Technical Notes 15 – Salvaged Brick." Technical Notes on Brick Construction* (1988).The Brick Industry Association. Web. *<http:// http://www.gobrick.com/Portals/25/docs/Technical%20Notes/TN15.pdf>.*

Fig. 5.4.20
Voids in the masonry are filled solid with grout at the parapet wall. Truss reinforcement is incorporated for additional support. Courtesy: Nelligan White Architects

GRANITE

Granite[89] is often chosen when permanence, freedom from deterioration and maintenance are required. Compared to calcareous sandstones (marble and limestone), granite is not acid soluble and much more resistant to the effects of acidic solutions, rainwater or cleansing agents. In general, igneous building stones including granite have a more inert composition, show lower rates of deterioration, have lower water absorption and are harder than marbles, limestone and sandstone. For these reasons, granite is often found at the base of school buildings, either at the water table or border elements where the building meets grade. Where other types of stones would spall after years of freeze-thaw cycles and de-icing salts, granite is able to retain it strength. Common problems associated with granite may include:

Blistering – Swelling of the surface followed by rupture of a thin, uniform skin. Typically caused by de-icing salts or ground water, usually localized near ground level. Condition may stabilize or remain constant, though it typically precedes additional problems such as spalling.

Cracking – Various causes including structural overload, wrong choice of mortar or a flaw in the material. Cracks may be a point of moisture entry into the interior of the stone promoting salt migration.

Detachment – Not a failure of material per se, but a failure of the construction system, connections or joints. May be caused or accelerated by moisture penetration causing rust and corrosion to the anchoring systems.

Efflorescence – Whitish deposit at the surface, efflorescence is a soluble deposit of salts. Can originate from mortar, improper cleaning agents, rising damp, de-icing salts, chemical landscaping treatments or air pollution, and should be investigated thoroughly to identify its source. May occur naturally with new stone mortar, and installation materials, though this is typically removed by rain or washing. Related to sub-florescence, the potentially harmful internal accumulation of salts under the masonry surface.

Erosion – A less serious problem, inspections should be carried out in any area where loss of edge or detail is problematic.

Flaking – Typically, the early stage of a more serious problem, is evidenced by the detachment of small, flat pieces of outer layers. Usually caused by capillary moisture or freeze-thaw cycles which occur within the masonry. Applications of water-repellent coatings may result in flaking by trapped moisture beneath the surface. May also occur due to sub-florescence, and should be inspected as soon as symptoms appear to determine if salt crystallization is occurring in the flaked areas.

Rising Damp – The suction of ground water into the base of masonry through capillary action. Moisture is drawn up into the stone, the level may rise and fall due to conditions of temperature, humidity, site grading, or treatments to the surface which affect evaporation. Rising damp may be visible during wet weather conditions, though its continued presence can lead to more severe problems requiring the elimination of the source of water or the interruption of its path by physical or chemical damp-proofing.

Spalling – The separation and breaking away of layers or small pieces of stone due to sub-florescence, freeze-thaw, improper repointing with too hard a mortar mix, or structural overloading. Spalling is less common with granite than with softer sedimentary stones.

Staining – May be cause by the following sources: bird droppings, corroded iron or steel connectors within the masonry, efflorescence, run-off from bronze or other metal, dirt/soot particulates, graffiti.

Fig. 5.4.21
Rust stained granite beneath a metal vent. Courtesy: Nelligan White Architects

Fig. 5.4.22
Cracked and broken granite veneer at a low curb wall. Granite is known for its extreme resilience, but improper installation will impede its longevity. Courtesy: Nelligan White Architects

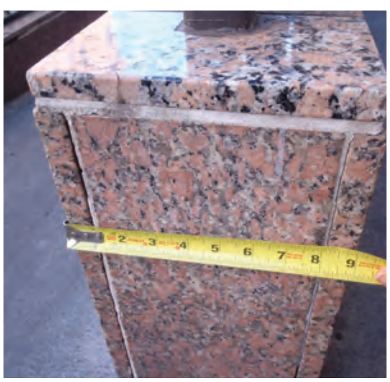


Fig. 5.4.23
Cracked and spalling mortar joints increase the amount of water which gets behind veneer, inciting cracks, efflorescence and other forms of moisture related deterioration. Courtesy: Nelligan White Architects

[89] *"Stone Fact Sheets - Granite." Building Stone Institute.* Web. 27 Mar. 2015.

"Granite: Characteristics, Uses and Problems." Historic Preservation - Technical Procedures. U.S. General Services Administration, 13 June 2012. Web. 3 Mar. 2015.

LIMESTONE

It's very uniform texture and grade and its workability has gained limestone[90] worldwide acceptance as a premier dimensional stone. Limestone is a sedimentary rock composed of calcium carbonate, plus calcium and/or magnesium. It is formed when layers of minerals, particularly calcite, fine sediment, and the skeletons/shells of marine organisms undergo lithification. Terrestrially-formed limestone is known as travertine. Often at building entrances, window surrounds, jack arches, string courses, and other decorative/sculptural elements where it is subject to weathering on more than one side. In some cases, limestone is used at the base of school buildings. When purely for decorative purposes, limestone is often interchangeable with terracotta between schools of the same type. Common problems associated with limestone may include:

Weathering – Though extremely durable, limestone is a carbonate rock, thus highly reactive when exposed to acids, or even mildly acidic rain. This can cause substantial deterioration, typically resulting in the loss of precise edge or detail.

Erosion – May be the result of general weathering, or a more localized phenomena based on handling or exposure. Wind-driven airborne abrasives may selectively wear away detailing on certain elevations, based on the direction of prevailing winds. Where there is evidence of recurring damage, steps should be taken to protect the stone.

Staining – Common types of staining and causative agents include:

- **Oil/Grease Stains** – See GSA Specification 04455-11-R
- **Dyes/inks** – See GSA Specification 04455-18-R
- **Organic Stains** – Caused by direct contact with decomposing organic matter, tending to be a slight reddish-brown in color. Frequently disappears after the source has been removed. See GSA Specification 04455-14-R.
- **Rust Stains** – Reddish-brown, caused by the oxidation of iron. The source is usually structural or connecting components. Examination of the stain should include rubbing to determine if it is only a surface deposit. 04400-06-R
- **Bronze & Copper Stains** – Range in color from light green to dark brown. Results from dissolved copper salts which run-off onto the stone and oxidize. Pattern of staining is likely to be localized, streaked and in the bath of the run-off from the metallic source. 04400-07-R

Crumbling – Indicative of a certain brittleness of the stone to break, an inherent weakness or the gradual breakdown of the binder. May be caused by de-icing salts or any source of salt migration. Early detection of potential problems and elimination of sources of salts is critical to arresting the process.

Chipping – The separation of small pieces or larger fragments from a masonry unit, frequently at the corners, edges or mortar joints. Generally caused by deterioration, repointing with wrong mortar, accidental impact or vandalism. Repairs include patching and splicing. If chipping is due to occasional impact, steps should be taken to prevent further damage. 04455-03-R

Spalling – The separation and breaking away of layers or small pieces of stone due to sub-florescence, freeze-thaw, improper repointing with too hard a mortar mix, or structural overloading. Spalling is less frequent with limestone than with sedimentary stones which are also less hard. Limestone is hard enough to resist internal forces which would cause spalling in other natural stones or fabricated masonry.

* For information on **Cracking**, **Detachment**, **Efflorescence**, **Flaking**, or **Rising Damp** in limestone, see common problems associated with granite on page 124.

Fig. 5.4.24
Limestone is commonly used for both is durability and workability in decorative applications. Courtesy: Nelligan White Architects

Fig. 5.4.25
Original window surrounds at PS 171 M were of limestone. Courtesy: Nelligan White Architects

Fig. 5.4.26
Limestone is very durable, but can be subject to erosion due to weather, wear, pollution, de-icing salts or exposure to other corrosive environments. Courtesy: Nelligan White Architects

[90] *"Stone Fact Sheets - Limestone." Building Stone Institute.* Web. 27 Mar. 2015.

"Limestone Material Fact Sheet." Genuine Stone. Natural Stone Council. Web. 27 Mar. 2015.

Fig. 5.4.27 & 5.4.28 (above - below)
As a form of maintenance, metal windows are often painted over to mitigate rust. Several coats of paint over many years can result in build-up which can leave window jammed in their frames. Courtesy: Nelligan White Architects

WOOD

Most school buildings erected before the 1950s used wooden framed double-hung window systems, and in most cases, these have been replaced with extruded aluminum windows. Problems associated with wood windows includes susceptibility to rotting and wear, requiring routine maintenance to keep in good condition. When these widows are not properly maintained, they can degrade quickly, leaving the window prone to draftiness, further water rotting, or problems with operability as the wood shrinks or expands from humidity. Additionally, counterweights in older double-hung sash windows prove difficult to service: weights which are jammed or have been disconnected from their chains will leave the window unable to be fully opened or closed.

While it is possible to restore wooden windows, the expense is considerable in both up-front costs and maintenance over the window's lifetime. Replacement of wooden windows with double glazed aluminum windows has become the accepted SCA standard for replacement, though exceptions may result due to issues of historic preservation.

ALUMINUM

All new windows installed in historic public school buildings today are extruded aluminum windows. Extruded aluminum windows were first used by the Board of Education in the 1950s, becoming the standard by the 1970s.

STEEL

Manufacturing jobs boomed during World War II as a result of the wartime economy. This included assembly of ships, airplanes, and other equipment, requiring a multitude of metal workers to be trained and put into service. After the war, ten of thousands of highly skilled metal workers were left with no work, as production of equipment for the Wart ceased. This shift from war to peace time economy eventually created a boom in manufacturing, which included products which were previously too expensive, or entirely non-existent.

Out of this boom, came cheap, durable cold-rolled double-hung steel windows. These became the standard for Board of Education by the 1950s as part of an effort to modernize the design of schools.

Steel windows are strong and require less maintenance than wooden windows. Today however, schools which used steel windows exhibit extensive problems associated with operability, corrosion and energy efficiency. Most maintenance programs have simply painted over these windows to protect them. Years of wear over multiple, uneven coats of paint have left the windows nearly inoperable. These windows also have no effective thermal break and are extremely conductive, meaning the temperature of the frames will be virtually the same on either side of the building enclosure.

Fig. 5.4.29 (below)
Window wall systems and early curtain walls were first used in Public School designs after World War II. Courtesy: Sylvia Hardy

CURTAIN WALL/WINDOW WALL SYSTEMS

While early examples of curtain walls in public schools cannot be considered true curtain walls by today's standards, these window wall systems are comprised of the elements which make up true curtain walls and are used in similar applications. The use of these early systems is associated with the increase use of cold-rolled steel framed elements after World War II. Early systems originally included steel framing, enamel covered steel panels, and steel window units. Later systems from the 1960s or early 1970s may incorporate aluminum framing units and windows.

REPLACEMENT WITH ALUMINUM WINDOWS

1. Remove the Existing Window.
2. Repair the existing masonry opening to achieve a structurally sound, smooth finished opening. This may include wrapping the blocking with flashing, or flashing the opening, installing blocking, the flashing the blocking.
3. Install solid blocking, secured to the masonry opening with courter-bored stainless steel threaded rods set in epoxy with screen tubes. Attachments should be calculated to adequately transfer and wind loads of the window to the masonry. The contractor should provide shear tests, then signed and sealed calculations for size, number and spacing of anchors between the windows, the blocking, and the masonry opening.
4. Fill voids in and between blocking and the masonry opening with closed cell urethane foam.
5. Flash over the blocking and the masonry opening. A peel-and-stick polyethylene film with rubberized asphalt backing is recommended, as they are designed to be integrated with a spray applied water/air barriers applied over the backup.
6. Be sure to spray the water/air barrier over the joint between the flashing and the substrate, to assure there is virtually no place for water to go.
7. Install the window. Typically aluminum windows are attached to the rough opening with angle clips at the inside face of the frame or receptor system. These clips accept interior snap trim, and accept self-tapping screws at the interior of the frame where they will not create holes in the window assembly.
8. Fill voids between the panning, blocking and masonry with closed cell urethane foam. While theoretically any water that gets past the sealant should drain out through the sill, large spaces behind panning may collect water. Therefore, these spaces should be filled to minimize the space where water may collect.
9. Install sealant while allowing for weeps at the sills. With properly installed sealants, new windows have three barriers for water penetration: the sealant, the first step/dam in the blocking, and the second dam at the angle clips. Silicone sealants are extremely resistant to UV exposure and should last up to 20 years, and should be used rather than polyurethane sealants.

REINSTALLATION OF WINDOWS

Some projects at older buildings may call for existing windows to be removed and reinstalled over new blocking and flashing. This is most likely because the window is relatively new, but the opening is still leaking. The interior wood trim and snap trim is removed, clip attachment at the interior is unscrewed, sealant is cut and the window is removed from the outside leaving the panning on. Windows must be handled as if they were new, stored safely and reinstalled.

1. Provision should be held to replace balances with double balances when the existing are not sufficient for the weight of the sash.
2. Sometimes panning is damaged in the removal. Provisions should be held to replace a certain linear footage of panning, as well as to replace any damaged or missing hardware.
3. Some windows may be in too poor a condition to be reused. Some provision should be held to replace a certain percentage of windows on the overall project.

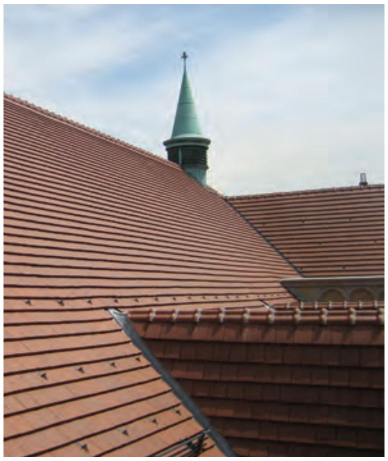


Fig. 5.4.30
Clay tile roofing at PS 171 M. This roofing type is fairly uncommon, even in the oldest schools, where pitched roofs were often clad in slate tile. Courtesy: Nelligan White Architects

Fig. 5.4.31
Slate roofing is extremely durable and typically holds the longest warranty of roofs used in public schools. Courtesy: Nelligan White Architects

Fig. 5.4.32 (right)
Built-up-roof (BUR). Courtesy: Nelligan White Architects

Fig. 5.4.33 (overleaf - right)
Metal roofs continue to be used frequently in designs because of their visual appeal, durability, and relatively low cost compared to more expensive historically used materials like slate. Courtesy: Nelligan White Architects

CLAY TILE

Clay tile roofing was used at the roofs of a select number of historic public schools built before 1940. These include the French Renaissance Revival school buildings which feature steeply pitch roofs over the entire structure, and the Type-M schools of the 1920s and 1930s, which feature a strip of clay tile roofing between the edge of the projecting cornice and the parapet wall.

SLATE

Slate roofs are used mostly in older school buildings – typically before 1920, especially in a selection of buildings from the Romanesque, Beaux-Arts and Gothic Revival styles. Slate roofs are extremely durable, though they are extremely expensive to install, repair, and maintain.

METAL

Metal roofing is used at many older school buildings, notably the English-Flemish Renaissance Revival schools, and is still used on smaller roofs, including bulkheads and penthouses.

BUILT-UP-ROOF (BUR)

Built-up-roofs are an assembly, typically made up of four components: the structural deck, vapor barrier, insulation and built-up membrane . These are the most common roofing systems, not only in historic public school buildings, but of all buildings in New York City.

Fig. 5.4.32

Fig. 5.4.33

STANDARDS FOR REHABILITATION

STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES

Initially developed by the Secretary of the Interior to determine the appropriateness of proposed project work on registered properties, the Standards are a series of concepts about maintaining, repairing, and replacing historic materials, as well as designing new additions or making alterations. The guidelines offer general design and technical recommendations to assist in applying the standards to a specific property. Together, they provide a framework and guidance for decision-making about work or changes to a historic property.

The Standards and Guidelines can be applied to historic properties of all types, materials, construction, sizes, and use. They include both the exterior and the interior and extend to a property's landscaping features, site, environment, as well as related new construction.

Federal agencies use the standards and guidelines in carrying out their historic preservation responsibilities. State and local officials use them in reviewing both Federal and non-federal rehabilitation proposals. Historic district and planning commissions across the country use the Standards and Guidelines to guide their design review processes.

The Standards offer 4 distinct approaches to the treatment of historic properties-preservation, rehabilitation, restoration, and reconstruction with guidelines for each:

PRESERVATION

Defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction.

New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.
2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material

will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archaeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

REHABILITATION

Defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archaeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

STANDARDS FOR REHABILITATION

STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES

RESTORATION

Defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.

1. A property will be used as it was historically or be given a new use which reflects the property's restoration period.
2. Materials and features from the restoration period will be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period will not be undertaken.
3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate and conserve materials and features from the restoration period will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Materials, features, spaces, and finishes that characterize other historical periods will be documented prior to their alteration or removal.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved.
6. Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials.
7. Replacement of missing features from the restoration period will be substantiated by documentary and physical evidence. A false sense of history will not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.
8. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
9. Archaeological resources affected by a project will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
10. Designs that were never executed historically will not be constructed.

RECONSTRUCTION

Defined as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.

1. Reconstruction will be used to depict vanished or non-surviving portions of a property when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property.

2. Reconstruction of a landscape, building, structure, or object in its historic location will be preceded by a thorough archaeological investigation to identify and evaluate those features and artifacts which are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures will be undertaken.
3. Reconstruction will include measures to preserve any remaining historic materials, features, and spatial relationships.
4. Reconstruction will be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed property will re-create the appearance of the non-surviving historic property in materials, design, color, and texture.
5. A reconstruction will be clearly identified as a contemporary re-creation.
6. Designs that were never executed historically will not be constructed.

STANDARDS FOR REHABILITATION

INTERPRETATION OF THE STANDARDS FOR REHABILITATION

Initially developed by the Secretary of the Interior to determine the appropriateness of proposed project work on registered properties, the Standards for Rehabilitation[91] have been widely used by historic district and planning commissions across the country. The intent of the Standards is to assist in the long-term preservation of a property's significance through the preservation of historic materials and features.

The standards pertain to historic buildings of all materials, construction types, sizes and occupancy, and encompass the exterior and interior of buildings. They also encompass related landscape features and the building's site and environment, as well as attached, adjacent, or related new construction.

The treatment *"rehabilitation"* assumes that at least some repair or alteration of the historic building will be needed, in order to provide for an efficient contemporary use; however, these repairs and alterations must not damage or destroy materials, features or finishes that are important in defining the building's historic character. For example, certain treatments – if improperly applied – may cause or accelerate physical deterioration of the historic building. This can include improper repointing or exterior masonry cleaning techniques, or introducing insulation that damages historic fabric.

Similarly, exterior additions that duplicate the form, material and detailing of the structure to the extent that they compromise the historic character of the structure will fail to meet the Standards.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION

1. *A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.*
2. *The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.*
3. *Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.*
4. *Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.*
5. *Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.*
6. *Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.*
7. *Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.*
8. *Significant archaeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.*
9. *New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall*

[91] Weeks, Kay D., & Grimmer, Anne E. (1995). *The Secretary of the Interiors Standards for the Treatment of Historic Properties: With Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Properties.* US Department of the Interior National Park Service, Cultural Resource Stewardship and Partnership, Heritage Preservation Services.

be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. *New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.*

Most of the work undertaken during the rehabilitation of New York City Public Schools falls under Standard number 6:

6. *Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.*

The first sentence of Standard 6 describes the most recommended approach, and fortunately it describes the approach actually taken in much of the work done on these buildings over their life time. There are of course notable examples where historic features were altered or simply removed (cornices in particular). However, by the time these buildings get to a consultant, repair is often no longer an option. Additionally, Standards 5 & 7 offer more detail where Standard 6 does not give sufficient guidance:

5. *Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.*

7. *Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.*

STANDARDS FOR REHABILITATION

REHABILITATION STRATEGIES

1. ***Repair historic features in place – new material will match the old in design, color, texture, and where possible material.***

   As noted above, in-place repair work is the kind of work that usually occurs before or until design professionals are brought on board. This does nothing to address the inherent deficiencies of some historic materials used, nor does it address design deficiencies that are inherent in century old construction.

2. ***Replace historic features in kind and match the old in design, color, texture, and material (Modular Replacement matching original material). The enclosure system will function and perform as originally constructed.***

   This is simply the substitution of new materials for the original – terracotta for terracotta, brick for brick, iron for iron, mortar for mortar. This is often impossible because the original material is not available, e.g., mortars made of Rosendale natural hydraulic cement, horsehair and oyster shells, wrought iron cramp anchors; 100-year old bricks. Salvaging bricks is often not a good solution for a number of reasons – absorption, efflorescence, etc. Also, in reconstructing with original materials and techniques, many assemblies do not meet contemporary code requirements, for example, structural requirements for lateral loading at parapets, windows and walls, or using hazardous materials, like lead paint, which are no longer allowed.

3. ***Replace historic features and match the old in design, color, and texture, but substitute some modern materials for the original (Modular Replacement with material substitution). The enclosure system will function and perform as originally constructed, with improved performance where modern materials are used. Substitution may occur because original material is unavailable, unaffordable, or because original material cannot meet the necessary safety or performance or programmatic requirements.***

   The distinction between the 3rd and 4th strategies is blurry. Because of the issues noted previously, we rarely replace original material without the introduction of some new materials and systems. For example, whenever structural steel or iron is exposed, new epoxy mastic paint is applied; and flashing is added whether or not it was there originally. Iron anchors are replaced with stainless steel. Similarly, a parapet cannot prudently be reconstructed without vertical and horizontal reinforcing to meet code, or without expansion joints, even if the existing masonry below has none. This is because the existing brick masonry has already expanded, [about $^1/_{10}$ of 1%] and the new brick parapet will undergo most of its irreversible expansion in the first 6-months after installation.

4. ***Replace historic features and match the old in design, color, and texture, but substitution of some modern materials for the original and partial transformation of the enclosure system to improve performance, meet modern safety and programmatic requirements and to reduce expense.***

   When the existing conditions, previous reconstruction campaigns, budgetary limitations or other factors make a complete rehabilitation unnecessary or impractical, we have often made partial system redesigns. This usually responds to the pattern of damage found on a building. Most typical is replacement of roofs, parapets or cornice, and face masonry down to the windows at the top floor of a building, or a string course or other appropriate location. A second strategy is to make repairs in a vertical swath from the base to the parapet. A third strategy to make an interior repair to replace a damp-proofing membrane that has deteriorated over time.

5. ***Replace historic features and match the old in design, color, and texture, but substitution of modern materials for the original and transform way the enclosure system functions to improve performance, meet modern safety and programmatic requirements and to reduce expense.***

   When a building suffers from extensive, severe deterioration, and has not received interim repairs for decades or even generations, a systemic approach to reconstruction is often needed to make such a building safe for occupants and passers-by, make it possible to continue to occupy the building, and to cure DOB violations. This typically involves the removal and replacement of face-wythe of all brick masonry as well as all the decorative building elements.

Over the years, the approach to the replacement of this removed materials has changed. In older rehabilitations the backup was repaired, flashed columns, beams, and lintels, and new masonry were placed over the original with a solid filled collar joint using stainless steel anchors and reinforcements. This methodology has changed as a result of several realizations/observations.

1. In the latter frame buildings with terracotta infill and brick cladding, it was determined that these walls have never been effective at keeping water out all by themselves. By the early 1920s, C.B.J. Snyder and later William H. Gompert were applying a building paper and asphalt damp-proofing course at the interior face of the 8" x 8" x 4" terracotta. This has not been found to be present in earlier frame buildings like PS 227 Bronx which used brick-sized terracotta tile units. It's assumed that 20+ years of experience demonstrated to those Architects that this damp-proofing was in fact necessary to keep water from easily passing through the large-cored terracotta tile. Thus, simply putting back what was there was unlikely to be effective.

2. At both solid masonry and frame & infill buildings the backup masonry is almost always badly deteriorated – in fact the condition of the backup masonry, never accessible for maintenance like the face masonry which could be repointed, or replaced is often the primary culprit in the failure of these buildings. Voids big enough to put your arm into, pieces of wood installed instead of large areas of brick, mortar where the binder, has washed out leaving the walls essentially as stacks of bricks with layers of sand in between. Once the face-wythe is removed, we can restore the structural integrity of the backup from the outside without demolishing what is left, but we cannot eliminate entirely its water-permeable condition. So in effect with solid masonry buildings we're trying to restore the water-resistance capacity of an entire 16" or 20" thick wall in the first 4" of thickness. Real water resistance in the cladding had never existed, except as an interior application of building paper and hot tar.

3. As mentioned earlier brick masonry goes through a non-reversible expansion of about $^{1}/_{10}$ of 1% of its length after it has been installed[92] mostly through the absorption of water. Brick then goes through a much smaller expansion and shrinking cycle through the year based upon thermal and moisture driven expansion. This amount of movement is not much, but the forces involved are tremendous and are enough to tear a building apart, and make cracks big enough to let water pour in. The backup masonry and portions of the building that are to remain – and the steel frame of a frame building- are essentially fixed in dimension. Steel building frames remain at a more or less constant temperature and concrete frames undergo their shrinkage and creep early on. Brick masonry has done most of its shrinking and also doesn't change size. Thus, to avoid structural failure of the new material due to differential movement, we must design for differential movement or our new work will start to fail in its first two or three years of service.

[92] Refer Table. 1. on page 116 (Mechanism of failure) which shows about 60% of total movement in first two years. *Technical Note 18 - Volume Changes: Analysis and Effects of Movement*. The Brick Industry Association. *http://www.gobrick.com/Portals/25/docs/Technical%20Notes/TN18.pdf*

DESIGN METHODOLOGY

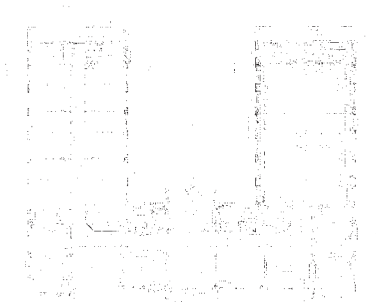


Fig. 5.6.1 & 5.6.2 (above - below)
Original design drawings of a particular building or its sister schools are an invaluable resource when researching historic public school buildings. Courtesy: SCA Alchemy (Fig. 5.6.1), NYC Municipal Archives (Fig. 5.6.2)

RESEARCH

The proper and intensive research of any building or building type is an increasingly worth-while investment of time when scoping a project for any historic school building. This is supported by the fact that once a consultant is aware of the actual existing conditions, it may be possible to fully detail a project without destructive testing.

Extensive use of the SCA's Alchemy Database may yield original design drawings of school buildings, and the sister school list may point a consultant to other buildings of a similar type which may yield more information. The Alchemy Database file for a given building will also contain drawings from remediation efforts, modernizations and any additions present at that building. These drawings are helpful in determining the existing conditions vs original conditions, or for verifying materials and dimensions, as older drawings are often sparsely detailed, or have aged poorly rendering them illegible.

Additionally, consultants should use the resources provided by the New York City Municipal Archives, located at the Hall of Records building (31 Chambers Street) in lower Manhattan. These archives contain the entire Board of Education Archive, which includes tens of thousands of original drawings, photographs and records. Photographs are especially helpful in determining which original features have been removed.

Consultants should keep in mind that the Board of Education building suffered an extensive fire in 1918, destroying many original documents. As a result there are certain periods of time where scant information exists. Consultants may also browse the Board of Education image galleries in the Municipal Archives Luna Internet Database[93]. Additionally, under the 'Books' section on the category pages is a 181-page document, listing all properties owned by the Board of Education in 1908. This book includes photographs, site plan, and a listing of appraisal and sale history for each property.

OBSERVATION & MAPPING

Observation by way of site survey is important to the scoping process, as it can confirm those items identified or overlooked during the research process and the condition of spaces and elements. An extensive photographic catalogue should be collected for every building element under question. This is especially important during the creation of base drawings and to confirm or augment any findings, as well as the production of any necessary reports.

Alongside a photographic survey a damage mapping exercise should be carried out. Using base drawings of facades and floor plans created using discovered information during research, damage should be diagrammed in location as precisely as possible. Photographs of the building should be reviewed in order to augment the maps with any deficiencies overlooked.

The value of damage mapping lies in the strength of it graphic communication, the ability to quantify the extent of deficiencies into a square footage for estimating, and the ability to use the collected information to determine whether failures are isolated conditions or systematic in nature. Information obtained from the damage mapping exercise may also be used to determine the locations of destructive and non-destructive tests.

[93] Municipal Archives Luna Internet Database *(http://nycma.lunaimaging.com/luna/servlet)*

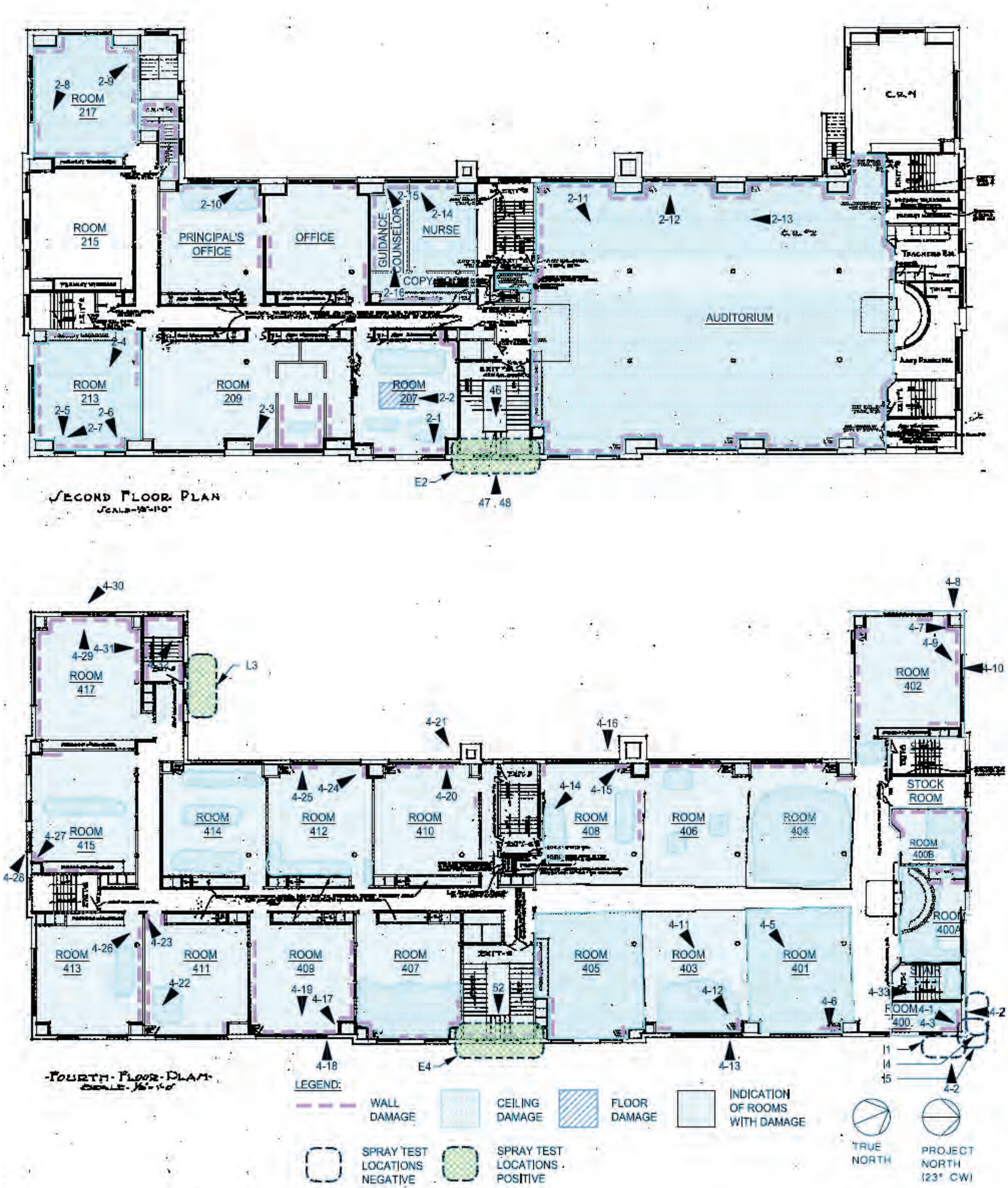


Fig. 5.6.3
Observation mapping is a strong graphic communication tool, and is instrumental in determining the full extent of scope. These maps can also help to quantify deficient areas for estimates. Courtesy: Nelligan White Architects

NON-DESTRUCTIVE TESTING

Fig. 5.6.4
Spray testing typically involves hanging a rig over the roof edge, and spraying water over a designated area for a set duration. Moisture levels at the interior are then observed with thermal imaging to determine where water is entering. Courtesy: Nelligan White Architects

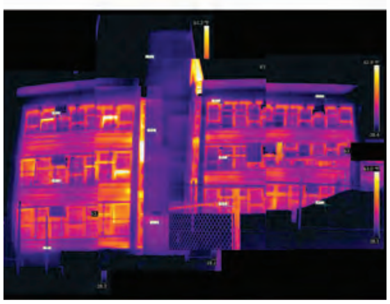


Fig. 5.6.5
Thermal imaging measures surface heat levels. Anomalies in surface temperature can be a strong indication of moisture present. Courtesy: Nelligan White Architects

Fig. 5.6.6
Capacitance testing involves sending a low electrical current into the roofing assembly to measure the amount of electrical resistance in the test location. These tests are typically performed in a grid so the data gathered can be mapped for comparative analysis. Courtesy: GBG USA Inc.

NON-DESTRUCTIVE TESTING

Non-Destructive testing as concept is self-explanatory, encompassing a broad range of tests which are non-invasive, and pose no harm to the materials or operability of a building. In reference to historic public schools, this type of testing most commonly consists of the following procedures:

1. **SPRAY TESTING -** Refers to a series of tests typically performed at specified areas on the exterior including but not limited to: the facade, windows, curtain walls, joints, parapets, decorative elements, and roofs. These tests are intended to simulate the effects of driving rain, after which the interior is inspected visually, often in conjunction with thermal imaging techniques and moisture metering.

   During spray testing a series of nozzles are rigged together and attached to a hose. They are then lowered from the roof to the testing locations as specified. Water is sprayed onto the facade for a given amount of time, after which the interior is inspected. The areas should be documented before and after testing, so that results can be determined by way of comparison.

2. **FLOOD TESTING -** Similar to spray testing, flood testing a method used to determine whether the roof is leaking, and if so where the leak originates. This method involves plugging drains and flooding the roof to a certain height. The flood is left for a specified amount of time, after which the water level and the interior is inspected to determine if any moisture has penetrated through the roofing membrane.

3. **INFRARED SCANNING & THERMAL IMAGING -** These imaging techniques record the amount of heat radiating off a given surface. They are sometimes conducted on their own but are typically used in conjunction with another testing method, often a spray testing regimen. Using a long-wave infrared camera, areas in question are assessed, producing images that use comparative color palates to differentiate between the range of temperatures present.

   When conducted as part of a spray testing regimen, a control image should be taken at interior locations before any spraying occurs. This is so that any changes noted after the spray test can be definitively attributed to moisture infiltration during the testing period in question.

   Infrared scanning/thermal imaging techniques are also used on roof surfaces to determine if moisture is present beneath the roofing membrane. These tests typically occur after the sun has set: this is because water holds heat with high efficiency: after the sunset set, the roofing membrane will cool down quickly, but areas where moisture is present beneath the membrane will remain warm. Infrared images will indicate warmer areas, which should undergo further testing to determine the cause.

4. **CAPACITANCE TESTING -** Capacitance tests are used primarily at low slope built-up-roofs, often to collect comparative data for thermal/infrared imaging results. These tests place a low electrical current into the roof membrane, measuring how conductive, or what capacity of electricity it can hold: an area of increased moisture content will generate a higher capacitance reading than a drier area. By collecting data over a grid the readings can be generated into a visual map of potential areas of retained moisture within the roof insulation. This map can be easily compared to the results a thermal imaging survey.

5. **MOISTURE METERING -** Moisture metering is a testing method often used in conjunction with a primary testing regimen, either for confirmatory or comparative data. A fairly straightforward method, this test typically involves a hand held electrical meter which gives a moisture reading from the point of a needle. This test can be used before and after spray testing for comparative data, or as a stand-alone test recording several locations throughout a building to identify which areas are wetter than others.

6. **RADAR (GPR) & X-RAY -** GPR Radars and X-rays are used as non destructive tests and can determine the exact location of concrete scanning.

7. **CRACK METERING -** Crack meters are used to measure movement of existing cracks. Placed on either side of the crack, any change in distance or location from the established reference point may be recorded.

8. **SOUNDING -** Specifically used to determine the strength of terracotta elements, sounding involves striking each unit with a rubber mallet and analyzing the sound made. Undamaged terracotta units will produce a distinct ringing noise when struck, while damage terracotta units will produce a flat, hollow sound. This is not always the most reliable method and may result in damaging existing terracotta units, thus is arguably a 'destructive' testing method.

Fig. 5.6.7
Moisture meters are devices which provide data on surface moisture levels. The device typically has two pins which should be in contact with the material in question for proper readings to occur. Courtesy: GBG USA Inc.

Fig. 5.6.8
Crack meter is used to monitor crack activity. Courtesy: Courtesy: WSNY Engineering Design P.C.

Fig. 5.6.9
Sounding is a method used to determine the structural stability of architectural terracotta. It involves hitting the test piece with a rubber mallet and listening to the sound. Undamaged terracotta will produce a distinct rining noise, while a damaged piece will sound flat and hollow. Courtesy: Nelligan White Architects

EXPLORATORY PROBES

Fig. 5.6.10 & 5.6.11 (above - below)
Exploratory probes involve the removal of facing elements to inspect the conditions beneath. Standard probes at historic Public Schools include exterior probes through face brick, interior probes through finish plaster to inspect backup, or probes through the ceiling finishes to inspect the floor structures. Courtesy: Nelligan White Architects

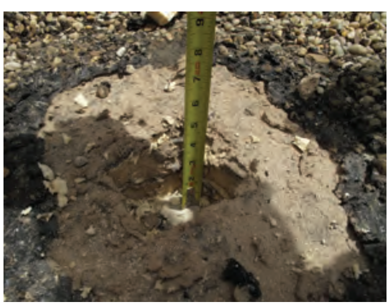


Fig. 5.6.12 (above)
Roof cuts are typically performed at built-up-roofs to inspect the condition of and verify the location roofing membranes, insulation, air barriers and substrate. Courtesy: Nelligan White Architects

EXPLORATORY PROBES

Exploratory probes are a destructive form of investigation, which involves removing portions of the building envelope to inspect the condition of elements that not otherwise accessible. Most exploratory probes fall into one of three categories:

1. **EXTERIOR EXPLORATORY PROBES -** With most buildings which are of concern to this guide, exterior exploratory probes involve the removal of the face-element of the facade. This may include face-brick, brick-veneer, and ornamental elements on the facade to inspect the condition of backup masonry, structural frames, to note any unusual levels of moisture and to collect material samples for laboratory testing.

   Because they are expensive and destructive, exterior exploratory probes are best performed after visual surveys have been assessed, and a round of non-destructive testing has been carried out. This preliminary data will best inform the consultant as to where exploratory probes should be conducted, or even whether they are necessary at all.

2. **INTERIOR EXPLORATORY PROBES -** Similar to exterior probes, interior exploratory probes mostly involve the removal of finishes to inspect the interior condition of walls and ceiling structures. With most of the historic school buildings in question, this entails removal of plaster, lath, furring elements and terracotta *'soaps'* to get to at the masonry backup or a structural component. These probes may be performed at interior ceiling as well to inspect the condition of floor arches, framing and concrete slabs.

3. **ROOF CUTS -** Roof cuts involve the stripping away of a specified area of roofing membrane at built-up-roofs for the purpose of inspecting the condition of insulation, waterproofing membranes, and substrate. After the roofing membrane is stripped away, a small area of insulation is cut out to view the substrate. The contractor performing the roof cut should proceed with caution to avoid penetrating any waterproofing membranes adhered to the substrate.

Exploratory probes are especially helpful when they confirm suppositions made based on the data gathered in previous testing regimens. Inspectors should note if the interior elements are moist, or there is condensation present. Deficient backup should be observed, including spalling, weak areas of masonry and mortar. Irregular construction techniques should also be noted; these buildings often differ from their original design drawings in ways which may contribute to deficiencies, or which may be deemed unsafe. Sometimes large voids are present, which may prompt additional scope recommendations.

MATERIALS TESTING

The purpose of material testing is to formulate generalizations about the characteristics of those building elements in question. Material samples may be collected independently or during the inspection of probes, often including face-brick and mortar, backup brick and mortar, steel coupons, stone samples and concrete. As many samples from across the building should be taken as is practical to ensure that results are not representative of some isolated condition. These samples are then analyzed by specialized laboratories, and their properties are evaluated to determine the stability of these materials.

In terms of historic public school buildings, the following represent the most common types of tests:

1. **PETROGRAPHIC ANALYSIS -** Analysis of this type involves the study of samples under a polarized-light microscope at magnifications up to 400 X, to determine aggregate and paste mineralogy, micro-structure, and the general composition of the concrete. Laboratories are able to estimate the water-cement ratio of the given sample based on properties including color, hardness, luster, paste-aggregate bond and paste mineralogy of the sample.

2. **CONCRETE TESTING -** Cover meter testing, half-cell potential and corrosion section loss measurements, tests, and Windsor Pin.

3. **ABSORPTION TESTING -** This testing method, which is conducted on brick, terracotta, mortar and concrete, measures the amount of moisture which is retained by any of these materials. The absorption levels have a determining influence on the compressive strength and also the permeability of the material to water or liquid flow . There are several types of absorption tests, including a 5-hour boiling tests, and a 24-hour and a 30-minute immersion tests.

4. **COMPRESSIVE STRENGTH TESTING -** This testing method, which is conducted on brick, terracotta, mortar and concrete, measures the compressive strength of any of these materials.

5. **STEEL ANALYSIS -** Steel coupons taken from original steel members are tested for their tensile and compressive strength, their weldability, and their composition. Steel made a century ago, typically, has a different composition than contemporary steel. This information can be used to determine the best route for remediation of corroded steel members, whether they are of sufficient strength, or whether they should be entirely replaced.

6. **MAGNIFICATION -** Color analysis

7. **ACM/PCB TESTING -** Asbestos Containing Materials (ACM) and Polychlorinated Biphenyl (PCB), common in older construction materials, though they are now known to pose a threat to environmental and public health. These tests are often required, depending on areas of the building where demolition will occur.

COMPUTER MODELING

Computer modeling of structural conditions is helpful in determining the cause of certain types of deficiencies. Cracks along exterior walls, interior columns, or noticeable deflection of a structural members may be explained by a software driven structural analysis. Older steel frame structures were often designed using smaller sections than would be chosen today. As loads have shifted over the years, they have found new ways of revolving themselves, often finding routes in the surrounding masonry. The masonry infill in these school buildings was not designed to bear load beyond its own weight, resulting in cracks, deflections and other anomalies. Specialized computer software can analyze the structural situation with great accuracy so remediation of parts of failed structure can be accurate and effective.

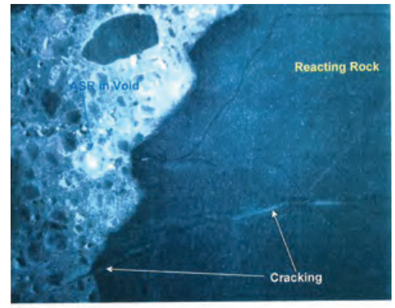


Fig. 5.6.13
A petrographic analysis often includes enlarged photos of tested materials, indicating its composition and structure. Courtesy: Future Tech Consultants of New York, Inc.

Fig. 5.6.14
Several types of absorption tests are used in the analysis of existing building materials. This method involves the installation of an open beaker to the brick face, and noting the water loss in the beaker after set intervals of time. Courtesy: GBG USA Inc.

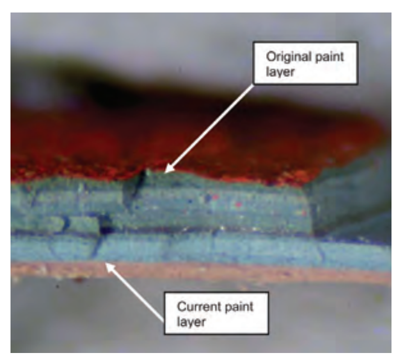


Fig. 5.6.15
This paint chip taken from a door frame installed in the 1950's was magnified in order to match its original color to a new paint samples. Courtesy: SuperStructures Engineers + Architects

DESIGN METHODOLOGY

One of the principle purposes of this guide is to help designers of future projects to avoid *'starting from scratch'* and to use the experience gleaned over many years and hundreds of projects, to develop the best solution for a given building in the shortest time. At the same time, the condition and circumstances of each building is unique, and the professional responsible for its design must use their own best judgment in developing a particular solution.

We employ here two useful filters in discussing rehabilitation strategies. First, we will discuss rehabilitation, relative to the Secretary's Standards for Rehabilitation, specifically Standards 5 & 6. Second, we will discuss the specific components of the building enclosure using the SCA's Capital Categories of Roofs, Parapets, Exterior Masonry, Doors & Windows, Flood Elimination, and collateral work, necessary to perform the work of the Capital Categories.

From the Secretary of the Interior's Standards for Rehabilitation of Historic Buildings:

"5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved."

"6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence."

The projects for which this guide is intended are most typically Capital Improvement Project undertaken by the SCA. Frequently, by the time a project is assigned for scoping and design, the opportunity for preserving or repairing historic features has passed. However, the specific direction for a project should be based upon a thorough analysis employing methods like those described in Part 2 of this section. Once this is properly complete, a decision can be made as to how *"deep"* or invasive the rehabilitation will need to be, in order to stem the deterioration of an individual building. It is important to note that the age of the building, the type of construction system, the materials used, and the quality of the original construction and subsequent rehabilitation all affect the necessary level of intervention. Careful evaluation and lessons learned from experience are the best tools used in this evaluation. While this guide is intended to share the author's experience, there is no replacement for the careful evaluation of an individual building.

We identify here five conceptual levels of intervention that can be applied in part or globally for a particular project. The levels are described with some explanatory annotation added:

LEVEL 1 - Repair historic features in place - new feature will match the old in design, color, texture, and where possible material.

As noted above, in-place repair work is the kind of work that often occurs before design professionals are brought on board. This does nothing to address the inherent deficiencies of some historic materials used, nor does it address design deficiencies that are inherent in century-old construction. However, for buildings of more recent construction, particularly post-war buildings, this can be an important part of any rehabilitation program. Significantly, it is certainly SHPO's preferred approach as it retains and preserves more original building fabric than replacement treatments.

LEVEL 2 - Replace historic features in kind and match the old in design, color, texture, and material (Modular Replacement matching original material). The enclosure system will function and perform as originally constructed.

This is simply the substitution of new materials for the original – terracotta for terracotta, brick for brick, iron for iron, mortar for mortar. This is often impossible because the original material is not available, e.g., mortars made of Rosendale natural hydraulic cement, horsehair and oyster shells, wrought iron cramp-anchors; 100-year old bricks. Salvaging bricks is often not a good solution for a number of reasons – absorption, efflorescence, etc. Also, in reconstructing with original materials and techniques, many assemblies do not meet contemporary code requirements, for example, structural requirements for lateral loading at parapets, windows and walls, or using hazardous materials, like lead paint, which are no longer allowed.

LEVEL 3 - Replace historic features and match the old in design, color, and texture, but substitute some modern materials for the original (Modular Replacement with material substitution).

The enclosure system will function and perform as originally constructed, with improved performance where modern materials are used. Substitution may occur because original material is either unavailable, unaffordable, or because original material cannot meet the necessary safety or performance or programmatic requirements. The distinction between the 3rd and 4th strategies is slightly blurry. Because of the issues noted previously, we rarely replace original material without the introduction of some new materials and systems. For example, whenever structural steel or iron is exposed, new epoxy mastic paint is applied; and flashing is added, whether or not it was there originally. Iron anchors are replaced with stainless steel. Similarly, a parapet cannot prudently be reconstructed without vertical and horizontal reinforcing to meet code, or without expansion joints, even if the existing masonry below has none. This is because the existing brick masonry has already expanded, [about 1/10 of 1%] and the new brick parapet will undergo most of its irreversible expansion in the first six months after installation.

LEVEL 4 - Replace historic features and match the old in design, color, and texture, but substitution of some modern materials for the original and partial transformation of the enclosure system to improve performance, to accommodate differential movement of materials, to meet modern safety and programmatic requirements and to reduce expense.

When the existing conditions, previous reconstruction campaigns, budgetary limitations or other factors make a complete rehabilitation unnecessary or impractical, partial system redesigns can be effectively employed. This usually responds to the pattern of damage found on a building. Most typical is replacement of roofs, parapets or cornice, and face masonry down to the windows at the top floor of a building, or a string course or other appropriate location. A second strategy is to make repairs in a vertical swath from the base to the parapet.

LEVEL 5 - Replace historic features and match the old in design, color, and texture, but substitution of modern materials for the original and transform way the enclosure system functions to improve performance, meet modern safety and programmatic requirements and to reduce expense.

When a building suffers from extensive, severe deterioration, and has not received interim repairs for decades or even generations, a systemic approach to reconstruction is often needed to make such a building safe for occupants and passersby, make it possible to continue to occupy the building, and to cure DOB violations. This typically involves the removal and replacement of the face-wythe of all brick masonry and the removal and replacement of all decorative building elements.

In practice, the majority of work undertaken as part of Capital Improvement Project falls under Levels 3, 4 and 5 described above.

REHABILITATION STRATEGIES BY CAPITAL CATEGORY:

The first step to remediation is the careful demolition and removal of those elements which are deemed deficient. Backup is inspected, any damaged mortar, brick masonry or terracotta is removed. This is evident by broken, spalling units, and mortar which is completely washed out and can easily removed with a finger. Additionally, any unanticipated voids present in the original construction should be assessed and filled with new masonry to complete the backup.

ROOFS

The majority of roofs found in historic schools are low slope roofs built-up roofs comprised of hot applied asphalt, fiberglass felts with stone ballast set in a hot applied asphalt flood coat, or a rubberized asphalt cap sheet with a mineral finish. None of these roofs is original, nor do the materials employed match the original, which would have used wood fiber felt, and often slag ballast. This is because roofs have required replacement on a regular basis, technologies have changed, and SHPO has expressed no concern for matching the original material used in replacing low-slope roofs. Additionally, since the 1970s, insulation has been added to reduce heat loss / gain through the roofing assembly.

COLLATERAL WORK AT ROOFS:

- **PARAPET HEIGHT**
- **TRAFFIC SURFACES**
- **ASBESTOS ABATEMENT**
- **ROOF ACCESSORIES**
- **DUNNAGE**
- **WARRANTABLE PENETRATION SEALS**
- **REPAIRS TO INTERIOR FINISHES**

PARAPETS

Parapets are the building element most exposed to the action of rain, wind or thermal variation. Sometimes the parapet condition might be worsened by the detailing and construction of the joining to the roofing system.

EXTERIOR MASONRY

Since the 1850s, to protect against spread of fire, building regulations in New York City have required the use of masonry as a building separation material. As a result of brick and stone have become the basic buiding materials used in New York CIty facades from bearing masonry to infil masonry and to cavity wall as well as curtain wall systems.

WINDOWS

DOORS

FLOOD ELIMINATION

Fig. 5.7.1 (overleaf)
Built-up roofing systems requires to be replaced fairly often (approximately every 20 years), hence, original roofs are virtually never existing. Replacing these roofs in kind is often impractical or entirely unfeasible. Insulation was not part of most original roof assemblies, and the materials used may have been inadequate or dangerous by today's standards. Courtesy: Google Images

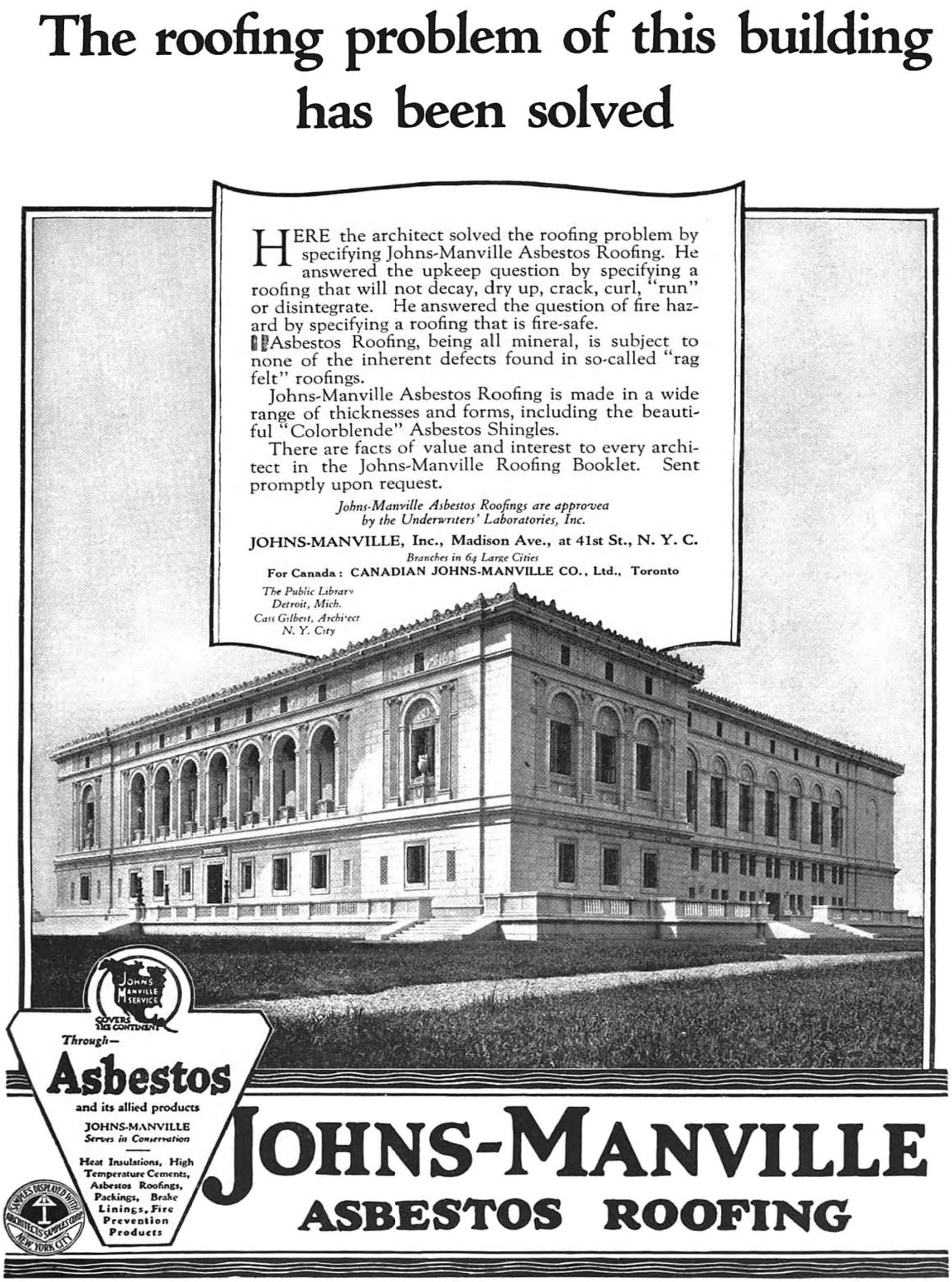

The roofing problem of this building has been solved
HERE the architect solved the roofing problem by specifying Johns-Manville Asbestos Roofing. He answered the upkeep question by specifying a roofing that will not decay, dry up, crack, curl, "run" or disintegrate. He answered the question of fire hazard by specifying a roofing that is fire-safe.
Asbestos Roofing, being all mineral, is subject to none of the inherent defects found in so-called "rag felt" roofings.
Johns-Manville Asbestos Roofing is made in a wide range of thicknesses and forms, including the beautiful "Colorblende" Asbestos Shingles.
There are facts of value and interest to every architect in the Johns-Manville Roofing Booklet. Sent promptly upon request.
Johns-Manville Asbestos Roofings are approved by the Underwriters' Laboratories, Inc.
JOHNS-MANVILLE, Inc., Madison Ave., at 41st St., N. Y. C.
Branches in 64 Large Cities
For Canada: CANADIAN JOHNS-MANVILLE CO., Ltd., Toronto
The Public Library Detroit, Mich. Cass Gilbert, Architect N. Y. City
Johns Manville Service
Covers the Continent
Through—
Asbestos
and its allied products
JOHNS-MANVILLE
Serves in Conservation
Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products
JOHNS-MANVILLE
ASBESTOS ROOFING

Fig. 5.7.1

DEMOLITION

The first step to remediation is the careful demolition and removal of those elements which are deemed deficient. Backup is inspected, any damaged mortar, brick masonry or terracotta is removed. This is evident by broken, spalling units, and mortar which is completely washed out and can easily removed with a finger. Additionally, any unanticipated voids present in the original construction should be assessed and filled with new masonry to complete the backup.

STABILIZATION & REPAIR OF BACKUP

The stabilization and repair of backup is critical to the rehabilitation of historic school buildings. This involves repointing any spalling or missing areas of mortar and filling of discovered voids in the masonry. After repointing, a series of procedures should be carried out to completely seal the backup before the installation of new face brick:

1. **AT FRAME & INFILL BUILDINGS, INSTALL AND GROUT ‘WIND COLUMNS’**

   Wind columns installed at the backup relieve lateral wind loads imposed on the structure, bringing the assembly in compliance with current seismic code. These steel girts are welded to the spandrel beams, often located at the window frames to maximize support at the opening.

2. **PARGE BACKUP**

   The parge coat is intended to seal the backup and provide a smooth surface for the vapor barrier to be installed on. Prior the parge coat, a float coat should be provided for a continuous surface which evens out the high and low points, or any other variations in the brick plane. A cementitous parging slurry is then coated over the entire backup plane.

Fig. 5.7.2 & 5.7.3 (above - below)
Steel ‘wind girts’ installed in unreinforced backup walls for lateral support. These are typically installed at the window openings, where walls are the most vulnerable to lateral deflection. Courtesy: Nelligan White Architects

Fig. 5.7.4 (above)
Parged backup at brick masonry walls. Courtesy: Nelligan White Architects

Fig. 5.7.5 (right)
Parge coats help to seal the backup and provide an even surface for the application of air membranes and cavity wall assemblies. Courtesy: Nelligan White Architects

Fig. 5.7.5

3. **MOCK-UPS**

To ensure that all components of the assembly are properly installed, mock-ups should be built for approval by the architect. The wall systems used in contemporary remediation efforts are complex systems, depended on each part functioning properly to keep the walls dry and stable. Discrepancies in the assembly represent a weak link, and potential location for moisture infiltration. Mock-ups should be thoroughly evaluated to ensure that the assemblies and craftsmanship are sufficient.

4. **SPRAY APPLIED MEMBRANE WATERPROOFING, FLASHING, WEEPS**

Over the smooth parge layer an elastomeric liquid applied membrane should coat the entire backup. Where the backup becomes a window or door frame, a peel-and-stick applied flashing should be installed, as recommended by the elastomeric membrane manufacturer. Weeps must also be installed periodically along at the bottom of the assembly at the relieving angles to drain any moisture from the wall cavity (drainage plane).

Fig. 5.7.6
Spray applied waterproofing membranes provide protection against air and moisture leakage through the wall. Membranes should be continuous to provide the best protection. Courtesy: Nelligan White Architects

SUBSTITUTE MATERIALS FOR DECORATIVE TERRACOTTA: CAST STONE, APC, GFRC

Decorative terracotta elements at string courses, window surrounds and cornices are not typically replaced in-kind due to observed failures and less than optimal performance in the New York City climate. Rather, one of several materials with preferable qualities is cast to mimic the colors and texture of terracotta. Cast stone, architectural precast concrete, or glass-fiber reinforced concrete are used instead. These engineered materials are stronger, perform better thermally, and are generally reinforced with a polymer admixture or fiberglass to increase their tensile strength. These units are typically supported and attached with a large steel/aluminum sub-structure, rather than older terracotta units which are treated like masonry in their installation.

SECTION 6.1

CASE STUDIES:
PS 277 X

CASE STUDIES:

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.

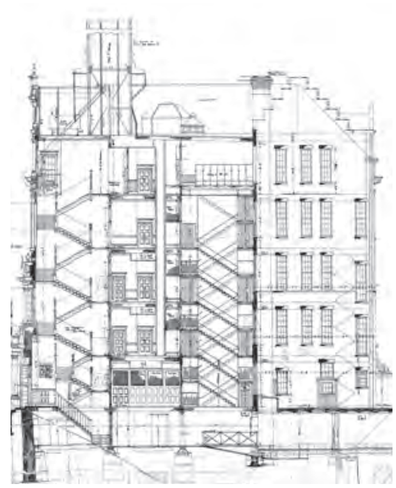


Fig. 6.1.3 (above)
Original 1895 building section, cut through the center of PS 277 X. The two central stair cores and the ventilation spire can be seen. Courtesy: SCA Alchemy

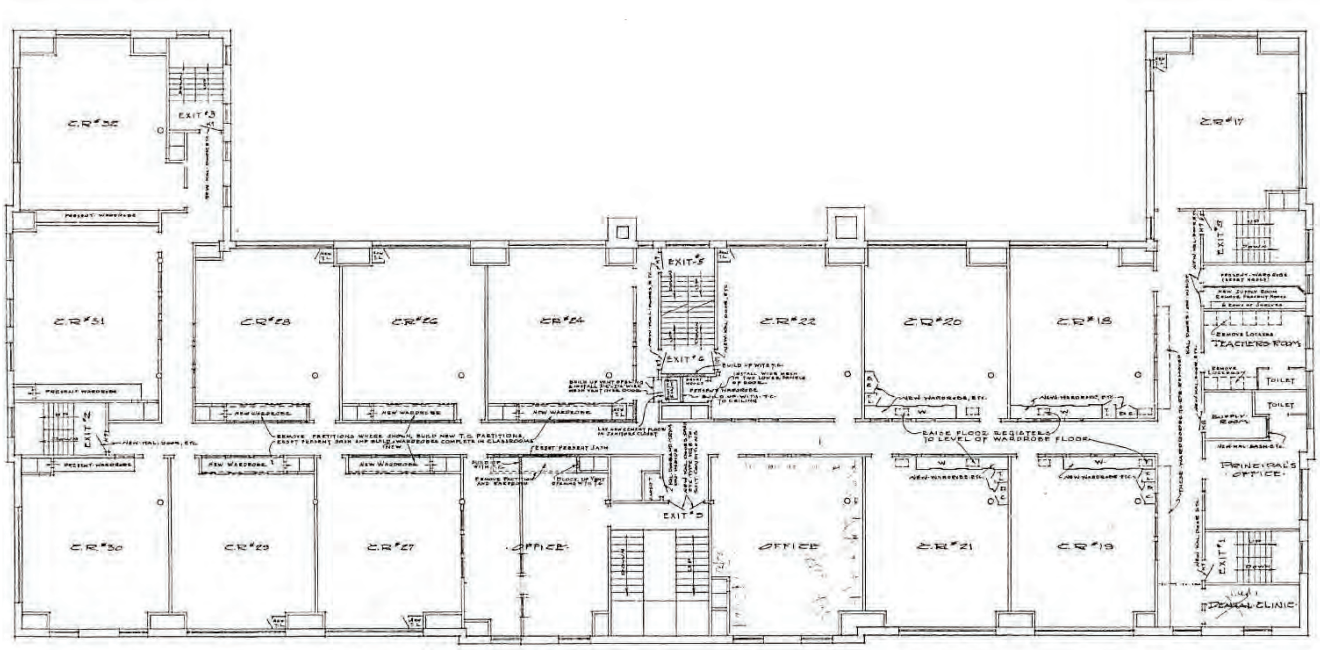


Fig. 6.1.4 (above)
Original 1895 third floor plan. Courtesy: SCA Alchemy

PS 277 X

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

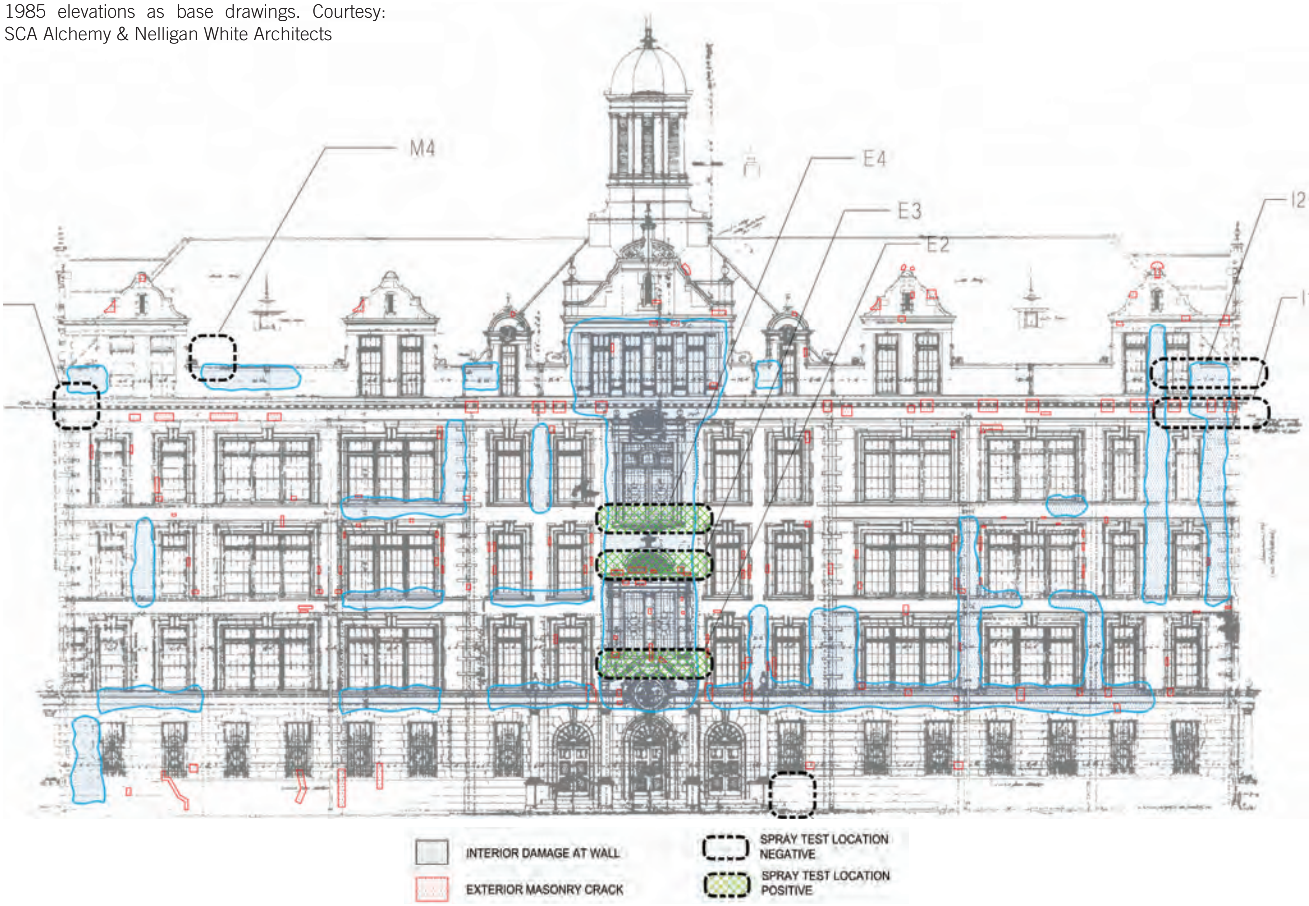


Fig. 6.1.7

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.

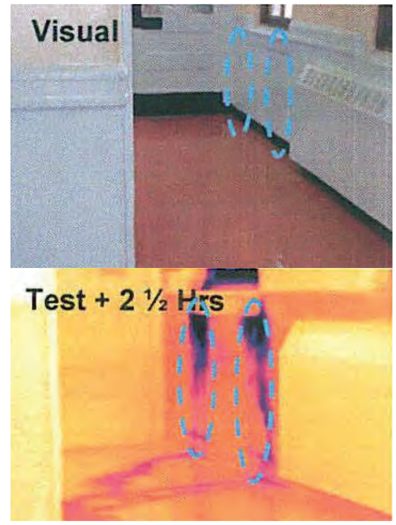


Fig. 6.1.8 (above)
Water damage visible below a window sill at the interior during a spray test. Infrared images note the differences in surface temperature, a strong indicator of moisture. Courtesy: GBG USA Inc.

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

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

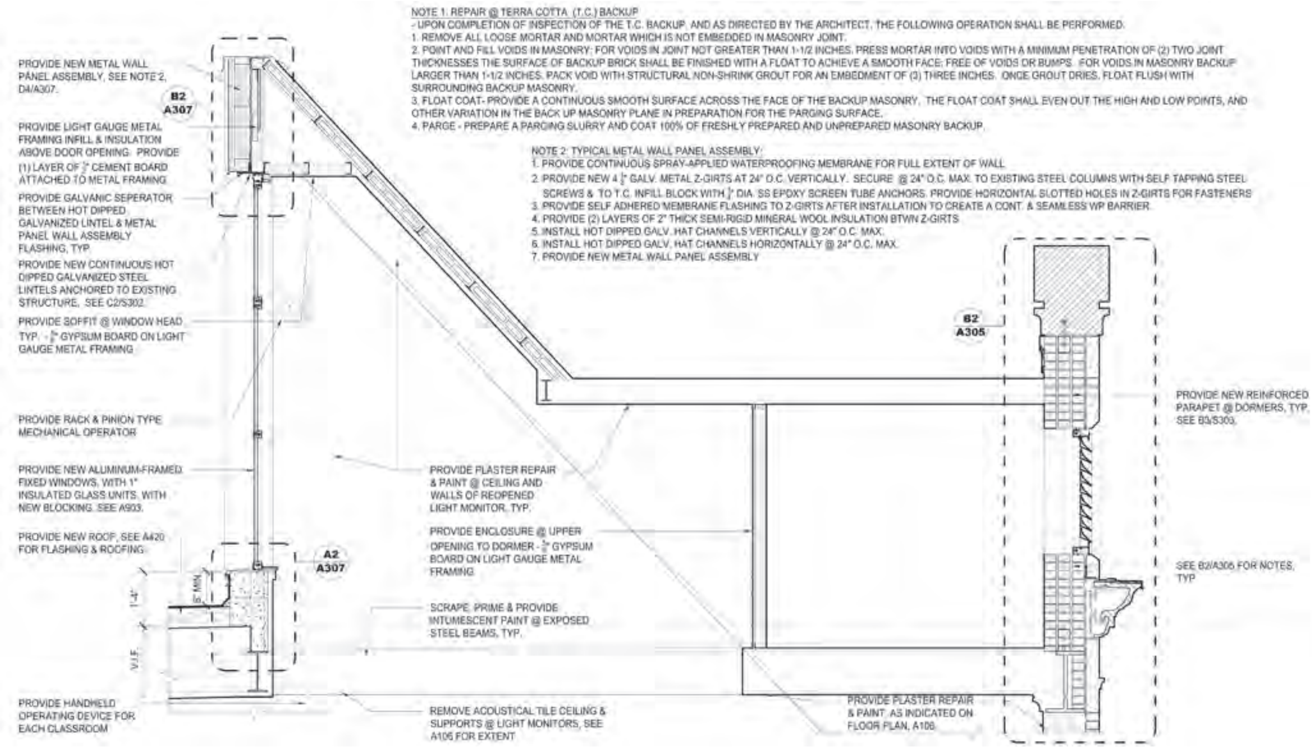


Fig. 6.1.18 (below)
Construction document showing the scope at the light monitors. Courtesy: Nelligan White Architects

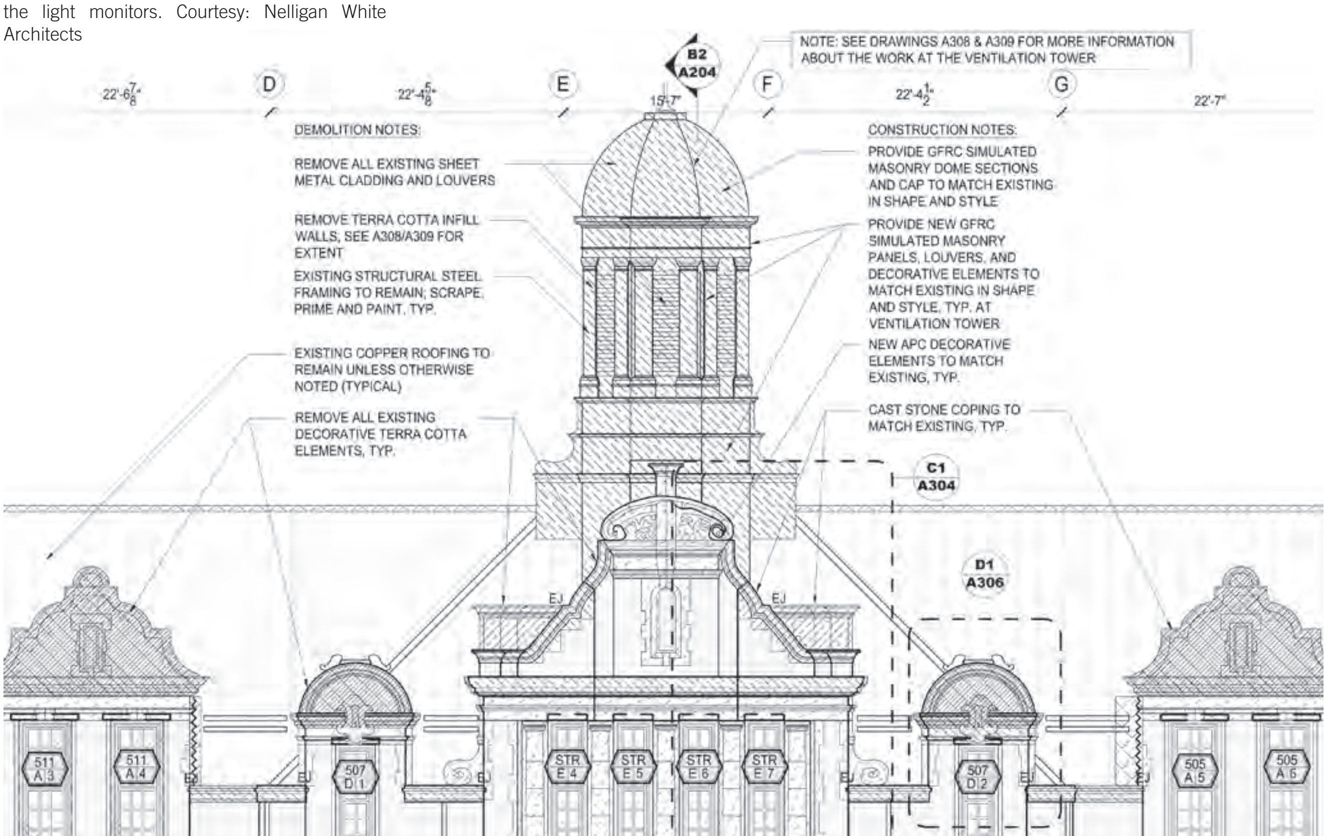


Fig. 6.1.19

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.

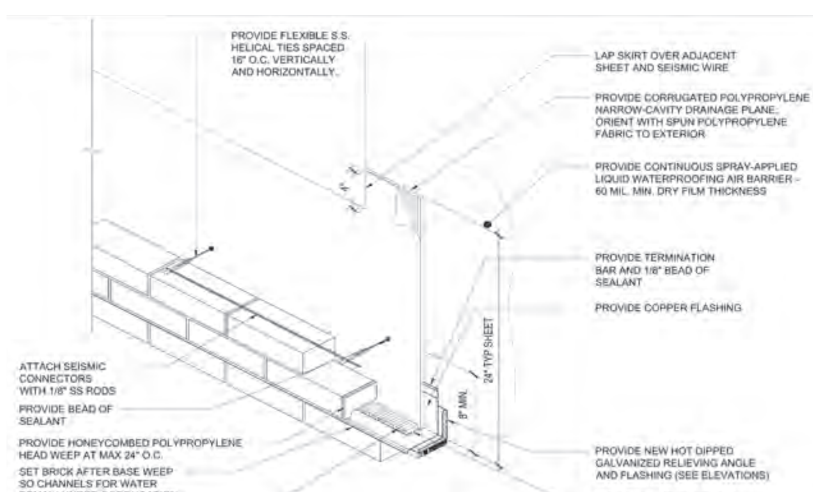


Fig 6.1.27

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.

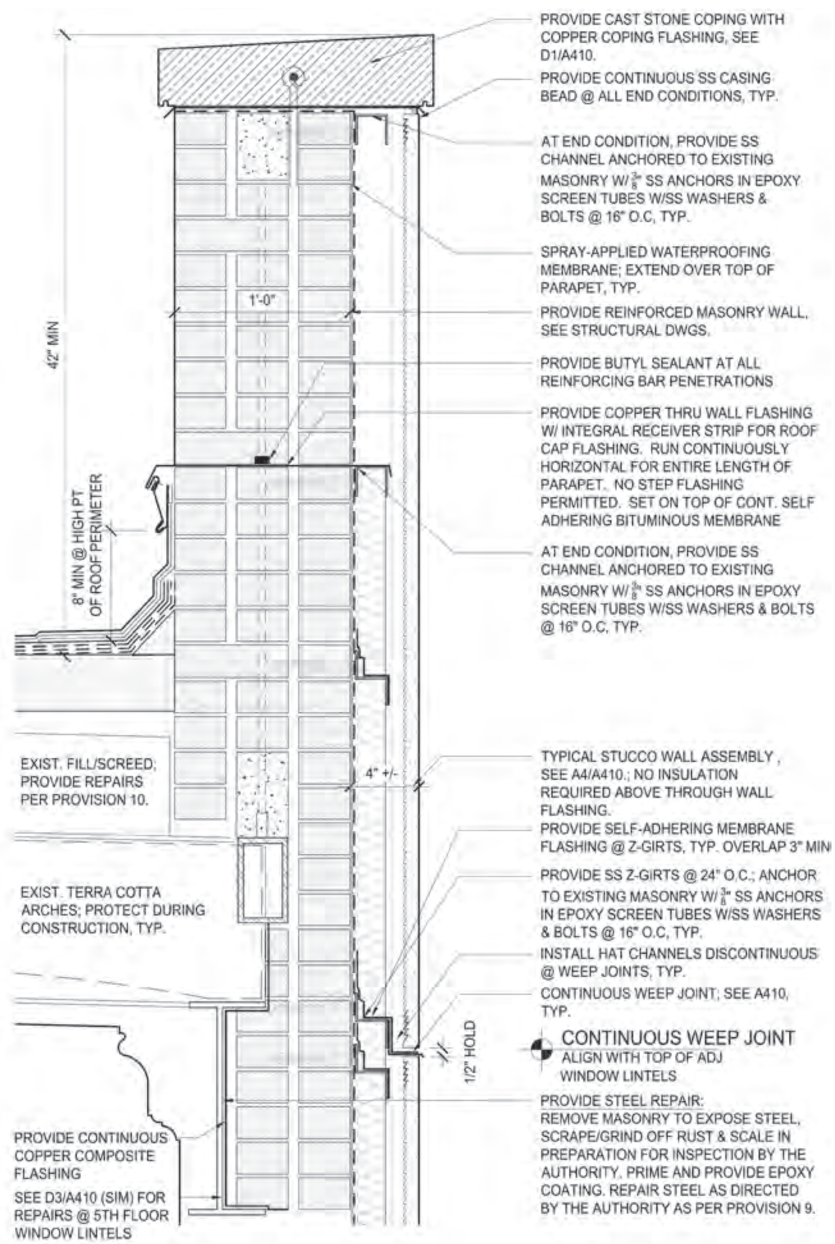


Fig. 6.1.30

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

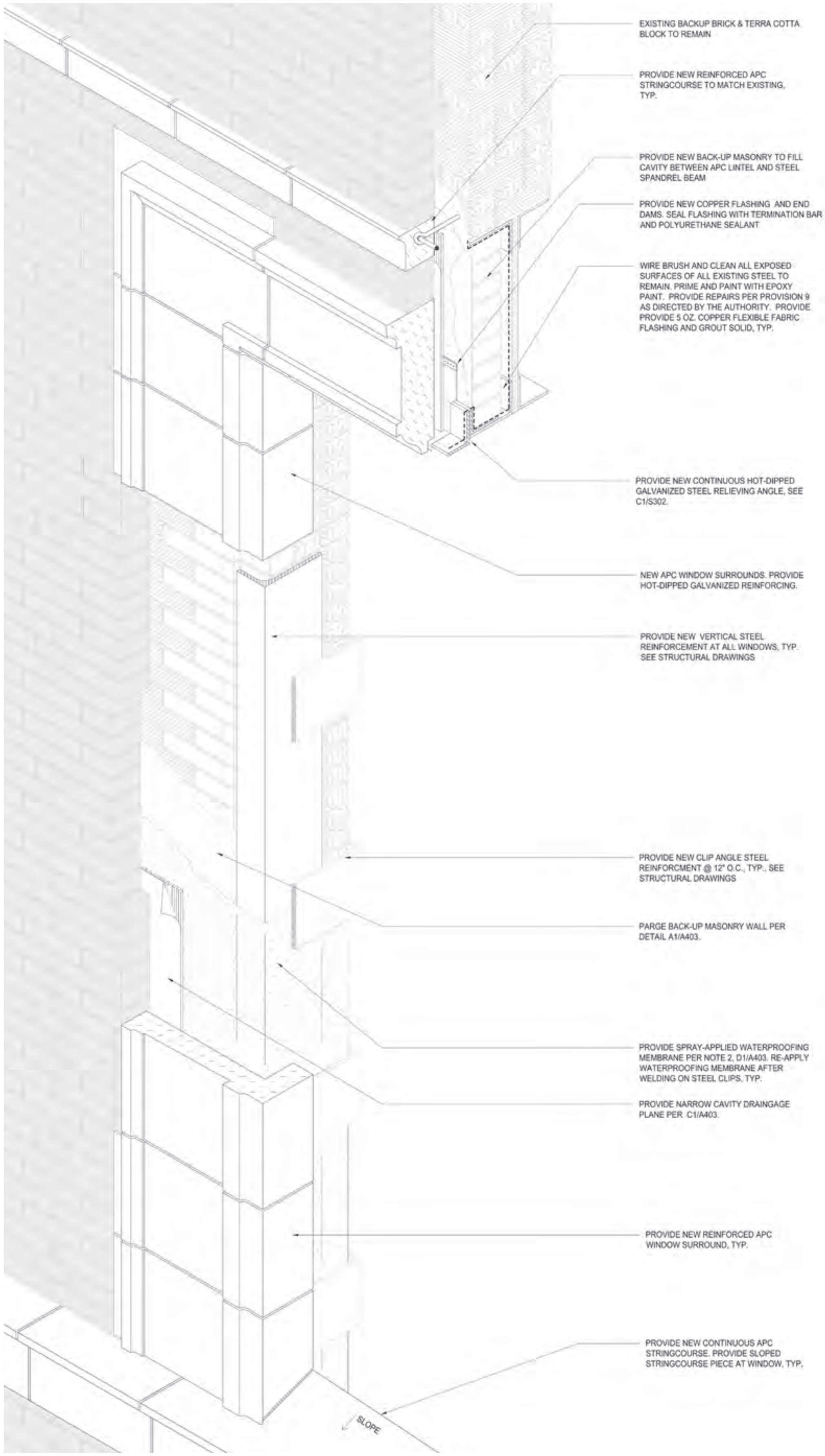


Fig. 6.1.33

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

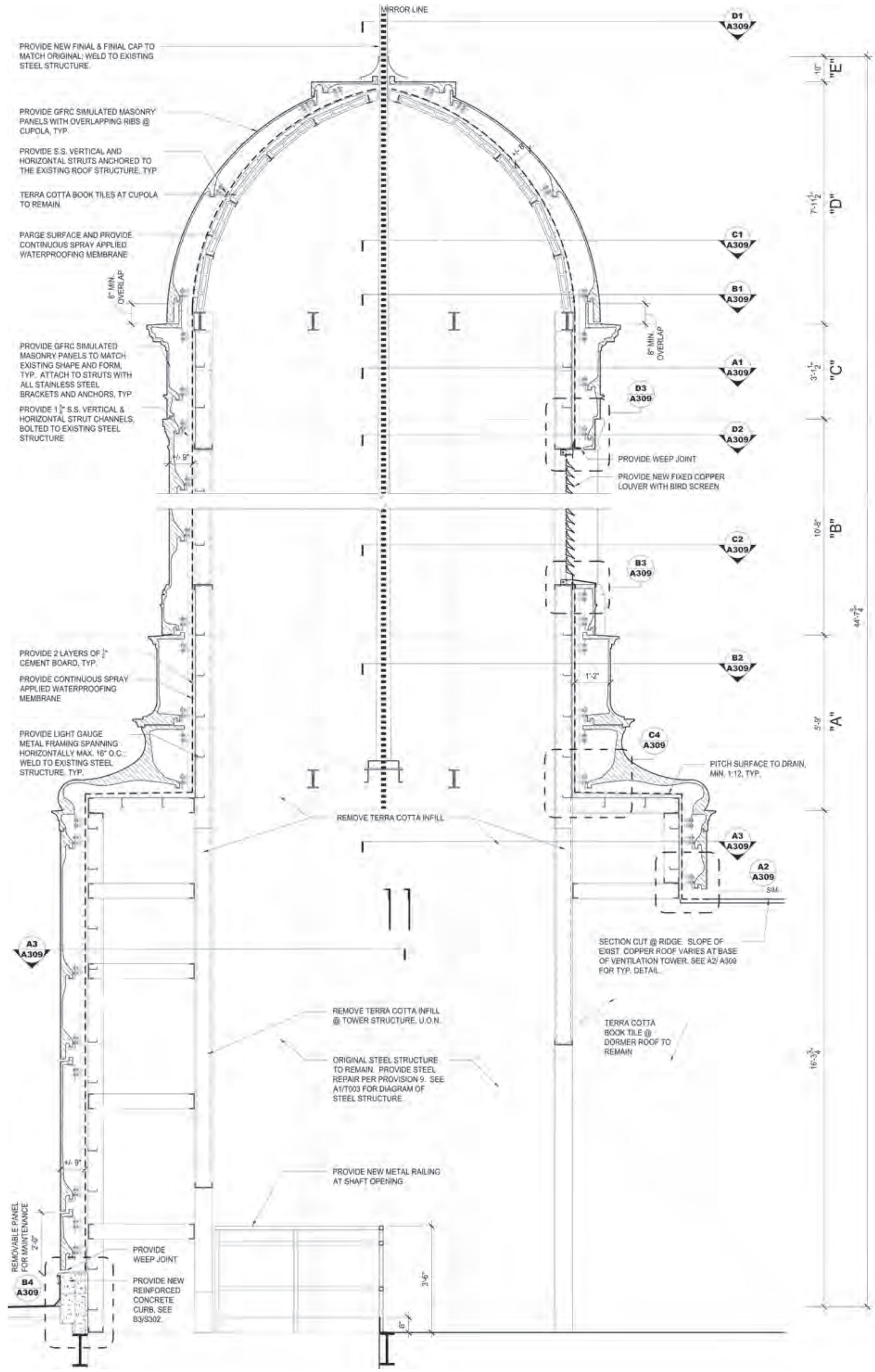

MIRROR LINE
PROVIDE NEW FINIAL & FINIAL CAP TO MATCH ORIGINAL; WELD TO EXISTING STEEL STRUCTURE.
PROVIDE GFRC SIMULATED MASONRY PANELS WITH OVERLAPPING RIBS @ CUPOLA, TYP.
PROVIDE S.S. VERTICAL AND HORIZONTAL STRUTS ANCHORED TO THE EXISTING ROOF STRUCTURE, TYP.
TERRA COTTA BOOK TILES AT CUPOLA TO REMAIN.
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
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
"E"
"D"
"C"
"B"
"A"
10"
7'-1 1/2"
3'-1 1/2"
10'-8"
5'-5"
16'-3 3/4"
44'-7 3/4"
1'-2"
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.
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"

Fig. 6.1.35

Constructability & Lessons Learned

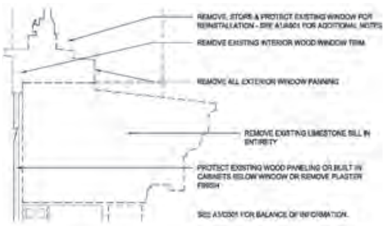


Fig. 6.1.37
Recommended details for the second floor window sill. Courtesy: Nelligan White Architects

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


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

SECTION 6.2

CASE STUDIES:
PS 171 M

CASE STUDIES:

PS 171 M

Introduction

Building ID	M171
School Level	PS
Address	19 East 103rd Street Manhattan, NY 10029
Cross Streets	E 104th St & 5th Ave
NYC DOE District	04
SHPO Status	Eligible
SHPO ID	99PR3561
Flood Zone	6
FEMA Map	3604970087F
Architect	C.B.J. Snyder
Year Built	1900
Plan Form	H-Plan
Style	French Renaissance Revival
Internal Sq Ft	95,000
Classrooms	65
Stories	5 + Cellar
Structural System	Composite Masonry/Frame
Columns	Steel
Beams	Steel
Floors	Flat Terracotta Vaults
Roof	Clay Tile, Copper, BUR
Cladding	Brick, Limestone, Terracotta
Backup	Brick, Terracotta

Fig. 6.2.2 - After Rehabilitation

Located on East 103rd Street between Fifth and Madison Avenues in the East Harlem neighborhood of Manhattan, PS 171 M is an H-plan school built in the French Renaissance Revival style. Designed by C.B.J. Snyder, it was completed in 1900, standing five stories high with a cellar and attic.

Designed for mid-block infill lots, the schools H-shaped plan places court yards on either street facade to the north and south, as well as a basketball court in the eastern side yard adjacent to Madison Avenue. It is distinguished by its light colored face brick, limestone, and terracotta ornamentation, but its most defining feature is the pitched red terracotta tile roof and the conical patinated copper spires, placed at each wing to vent the attic spaces. Structurally, PS 171 M is an example of early composite masonry construction in New York City public school buildings; a riveted, bolted steel frame with masonry backup, buff-colored face-brick, and terracotta cladding at dormers, spandrels, lintels and copings.

The H-shaped plan of PS 171 Manhattan and other buildings of its type represent one of the more innovative typologies of Snyder's early career as Superintendent of Buildings for the Board of Education. In a city where land was expensive, and closely spaced buildings grew higher every year, this plan typology accommodated large schools on less costly mid-block sites. Classroom windows faced the raised courtyards that opened to the street and could not be overshadowed by new adjacent construction. The strength of the H-Plan is its effective use of site, though it was quickly realized that it was practically impossible to expand these schools, and they were discontinued by 1916.

By 2007, water infiltration had caused significant damage to the interior of rooms at the top floors of PS 171 M with the most significant damage in the hallways and gymnasium at the fifth floor. An emergency repair campaign was pursued in 2006, which repaired the improperly installed roof drains, however, a systemic leak problem remained which was too wide spread and expensive to address at the time.

Fig. 6.2.1 & 6.2.2 (below - right)
The innovative H-plan, as well at the composite French Renaissance/Gothic style of PS 171 M may be attributed to Charles B. J. Snyder's 6 month tour of Europe, funded by the Board of Education, to study successful urban public school design in London, Paris, Amsterdam and Brussels. His studies provided a basis for the programmatic, morphological and stylistic reforms Snyder brought to New York City public school architecture. Courtesy: Sylvia Hardy

Fig. 6.2.4 - Before Rehabilitation

Fig. 6.2.3
Continuous skylights along the roof line bring light into hallways, classrooms, and the gymnasium located at the fifth floor. Among the programmatic innovations Snyder incorporated into the H-plan schools was to place rooms which required more light, like art rooms, at the upper floors to avoid light blockage by surrounding buildings. Courtesy: Sylvia Hardy

Fig. 6.2.4 (above - left)
PS 171 M before rehabilitation. Courtesy: Sylvia Hardy

Fig. 6.2.5

Fig. 6.2.5 (left)
The building's composite French Renaissance/ Gothic style was intended to reference the great institutions of old world Europe. These inspirational structures stand in strong contrast to the dark, unsanitary schoolhouses common in New York City throughout the 19th century. Courtesy: Sylvia Hardy

Methodology

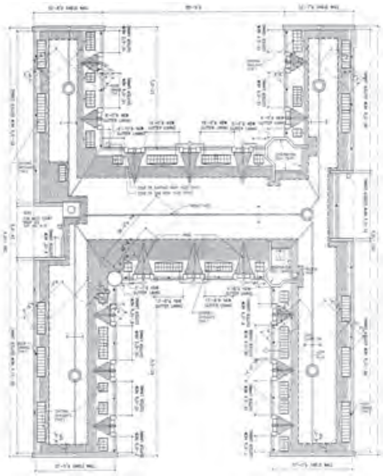


Fig. 6.2.6
A roof plan from a 1999 roof and window replacement shows the locations of all skylights and dormers, and shows the extent of work under this project. Courtesy: SCA Alchemy

Fig. 6.2.7 (below)
Elevations from a 1958 modernization effort.
Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope or design, research was carried out to obtain information about the school's original construction and its history of remediation, alteration and addition. The SCA's Alchemy Database yielded original design drawings from 1899, as well as drawings from 15 other projects carried out at the school between 1906 and 2002. Eight drawings from the original design exist, consisting of four floor plans; some of which are not entirely legible due to their age. However, drawings from a 1958 modernization provided a comprehensive set of floor plans, and a 1999 roof and window replacement offered elevations and helpful details regarding the construction of the existing parapet.

These drawings outlined previous work campaigns, giving a comprehensive view of the buildings history and a direction to start scoping from observed design and construction flaws. These clues guide the rehabilitation and replacement of elements which have fallen into disrepair. They also aide in the production of base drawings to begin recording damage and producing construction documents.

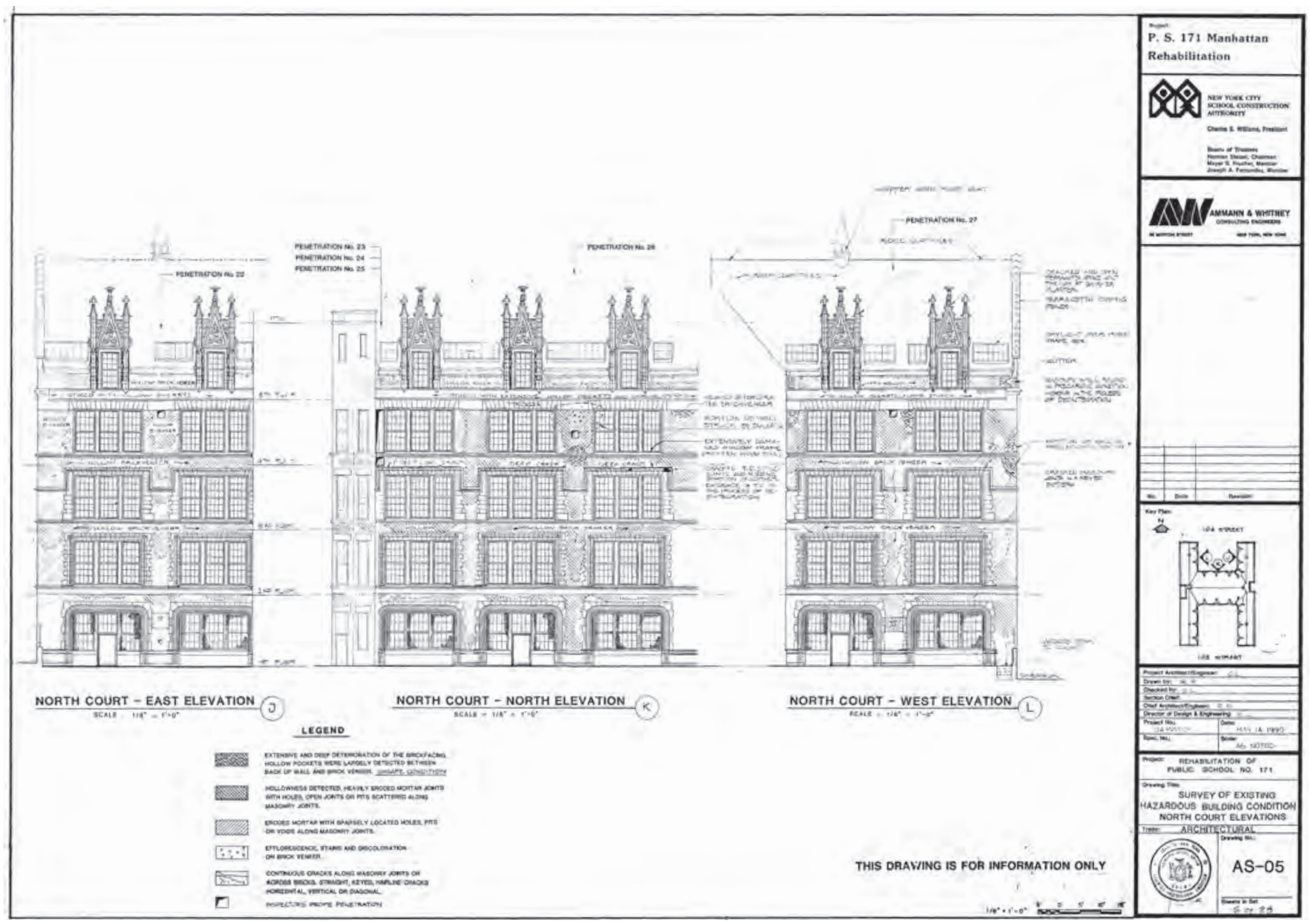


Fig. 6.2.7

Observation & Mapping

In addition to Building Condition Assessment Survey (BCAS) numerous site visits and photographic surveys carried out between August 2006 and February 2008 confirmed the continual and advancing water damage at PS 171 M. Prior to surveys, school administrators observations should be reviewed by the consultant so areas of concern can be quickly assessed.

At PS 171 M, water related damage was primarily concentrated to the fifth floor hallways and Gymnasium, though some water related damage was noted on all upper floors. Deteriorated and improperly installed materials from contemporary remediation efforts were found during roof and exterior surveys.

Extensive photographic catalogs and detailed field notes were processed into damage maps of the facades and floor plans. These damage maps facilitate the quantification of deficiencies, aiding in the determination of scope and the production of estimates.

Fig. 6.2.8 & 6.2.9 (above - below)
Efforts to patch water damage were visible at the fifth floor interior hallways. While patching may have temporarily subdued the problem, it does not solve the source of leaks. Courtesy: Nelligan White Architects

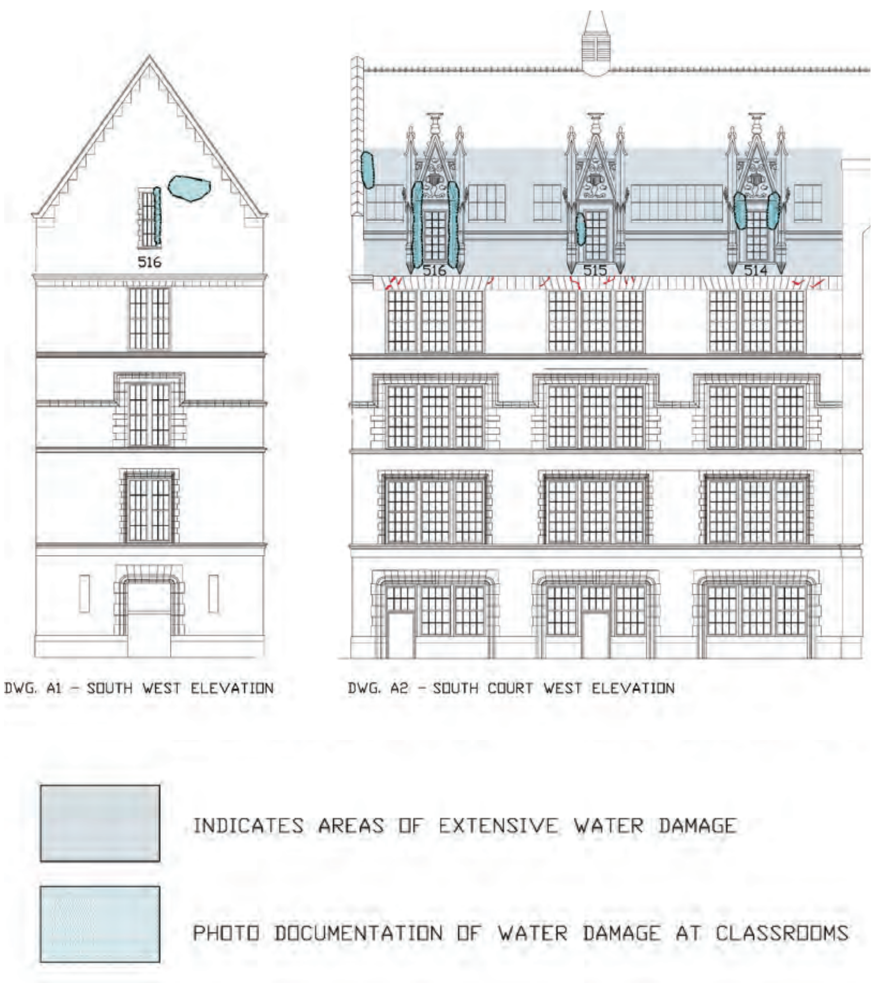


Fig. 6.2.10

Fig. 6.2.10 (left)
Using the drawings found in research, base drawings were created and used during the damage mapping exercise. Leaks, water damage, visible cracks, and other deficiencies are carefully noted. This results in a diagram which helps to quantify, justify and convey scope in a clear manner. These base drawings will evolve into the final construction documents. Courtesy: Nelligan White Architects

CASE STUDIES:

PS 171 M

Fig. 6.2.11
Water damage visible at the interior during the moisture meter survey. Courtesy: Nelligan White Architects

Fig. 6.2.12 (right-center)
Infrared images showed little variation in temperature, which could be attributed to ambient temperature changes rather than moisture infiltration. A truly positive moisture reading would show- p in the photograph withing the spectrum of red-orange-purple. Courtesy: Nelligan White Architects

Fig. 6.2.13 (below)
A damage survey notes moisture readings at specific locations to help determine the point of moisture entry. Courtesy: Nelligan White Architects

Non-Destructive Testing

Early in the scoping of PS 171 M, a limited spray testing regimen was carried out to help determine which elements were allowing water to pass to the interior. Water was sprayed on specific areas of the exterior for approximately 24 hours. Then an infrared camera was used at the interior to record temperature differences in the wall which may indicate moisture. These tests did not reveal moisture entry through the face-brick, narrowing the probable causes.

A survey was then carried out using a moisture meter at areas of observed damage; it was noted that many of the damaged areas had a high moisture reading, corresponding to infiltration of water from the exterior. The causes of infiltration were determined to be systemic in nature, related to the existing roof system and cracks on the upper part of the building.

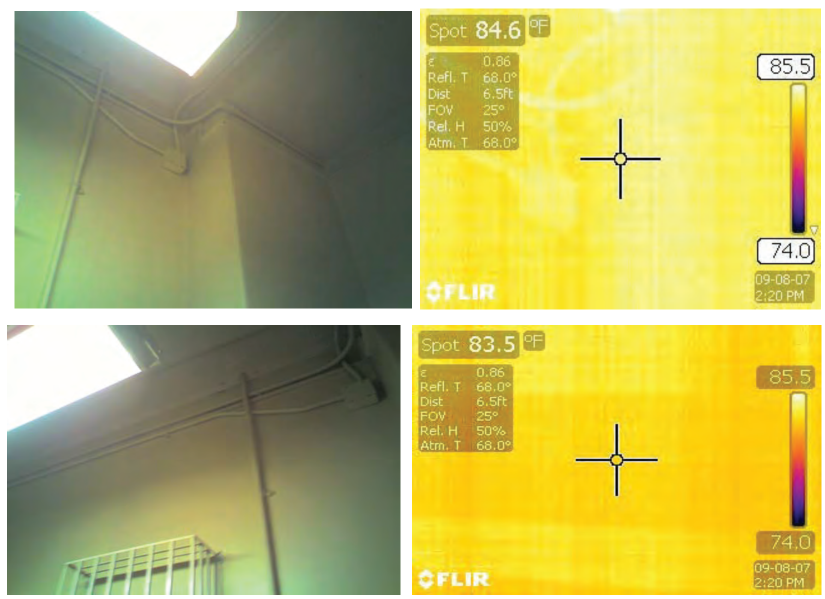


Fig. 6.2.12

Location #	Floor	Side	Location	Damage Type	Wall/Ceiling	Moisture Reading
1	5	East	South East Corridor - Outside Stair A	Bubbling	Wall	6.0% - HIGH
2	5	West	South West Corridor - Outside 514	Bulging	Wall	1.3% - HIGH
3	4	East	North East Corridor - Outside 404	Bulging	Wall	0.10%
4	4	West	North West Corridor - Outside 412	Bubbling	Wall	0.10%
5	3	East	South East Corridor - Outside 303	Peeling	Wall	0.40%
6	3	East	Teacher's Bathroom	None - previously repaired	Wall	0.70%
7	3	East	North East Corridor - Outside Teacher's Bathroom	Bubbling	Wall	0.10%
8	1	East	South East Corridor between windows	Bubbling	Wall	.3% - .7%
9	1	East	South East Corridor at South window	Bubbling	Wall	5.6% - HIGH
10	1	East	Library - East wall	Peeling and Cracking	Wall	.3% (nearby damage)
11	1	West	South West Corridor	Bulging and Cracking	Wall	.3% - 2.1%
12	5	East	Boy's Bathroom	Bubbling, cracking	Ceiling	0.20%
13	4	East	North East Corridor - @ Teacher's Bathroom - Beam	Bubbling	Ceiling	.9% - 1.2%
14	4	East	North East Corridor - @ Teacher's Bathroom - Ceiling	Bubbling	Ceiling	0.10%
15	4	East	South East Corridor	None - previously repaired	Wall	0.30%
16	3	East	South East Corridor @ column	None - previously repaired	Wall	.2% - .5%
17	2	East	South East Corridor	Bubbling	Wall	0.10%

Fig. 6.2.13

Exploratory Probes

Exploratory probes are typically carried out during the scoping phase of a project, but initial lack of access while scoping at PS 171 M, made observation of certain areas unsafe or impossible. Upon observation of the dormers via scaffolding early in construction, it was clear that terracotta at the dormers exhibited signs of distress and would require repair beyond the scope indicated in the contract documents. The original scope of work at the dormers only specified cutting and re-pointing of masonry joints, but as work began, portions of terracotta broke away, revealing dangerously corroded steel beneath. A visual inspection revealed that even recently replaced elements were cracking. As a result of these observed conditions, exploratory probes were carried out during the construction phase to determine any additional scope.

After inspection through exploratory probes, it was clear that most of the steel post and lintel type supports and their connections were in a state of advanced disrepair. Similar probes were also carried out at the knee braces for roof trusses at the Gymnasium, after the initial scope phase. It was determined that material testing must be carried out to analyze the condition of steel.

Fig. 6.2.14
Much of the cracking visible at limestone and terracotta around the dormers was not observable until scaffolding was in place once work had begun. Courtesy: Nelligan White Architects

Fig. 6.2.16

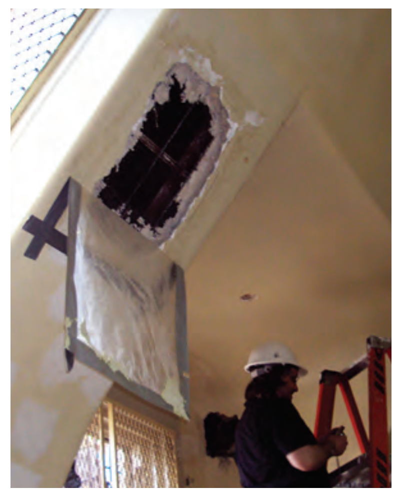


Fig. 6.2.15
Probes taken at the knee braces for the roof trusses were inspected. Corroded areas allowed for excessive lateral deflection trusses at these connections. Courtesy: Nelligan White Architects

Fig. 6.2.16 (left-above)
Post and lintel connections at the dormers were in an advanced state of corrosion. This deficiency was not observed until the demolition had begun. Courtesy: Nelligan White Architects

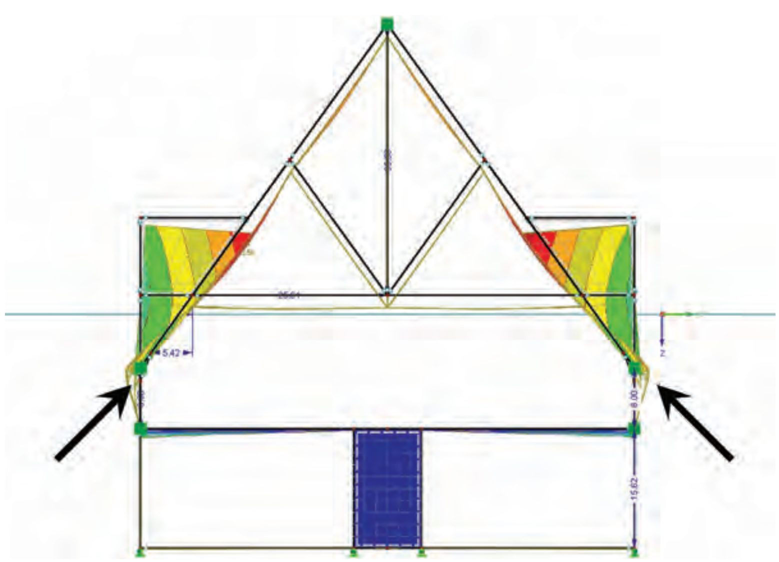


Fig. 6.2.17

Fig. 6.2.17 (left)
Based on the results of the probe inspections, computer models were created for a complete structural analysis. Lateral loading is shown deflecting at the knee joints (deflection is exaggerated graphically for clarity). Courtesy: WSNY Engineering Design P.C.

Fig. 6.2.18
The web stiffener of this dormer spandrel had corroded through buckled at the base. Courtesy: Nelligan White Architects

Fig. 6.2.19 (right)
Spandrels at the dormer were deflecting up to 5/8" at midspan, well over the limit for masonry supporting beams. The beams appeared to have been stressed over the yield point by ASD Load Case 6 (9%), assuming A9 steel, the standard in 1900. Courtesy: WSNY Engineering Design P.C.

Fig. 6.2.20 (right)
Estimated existing spandrel section (left) and estimated original section (right). Courtesy: WSNY Engineering Design P.C.

Fig. 6.2.21 (below)
Knee brace connection to truss post shows corrosion. Courtesy: Nelligan White Architects

Materials Testing

In addition to tests for PCBs, lead-containing and asbestos-containing materials at the specific locations of proposed work, testing was carried out at the steel supports for the dormers and knee braces for roof trusses at the Gymnasium. It was observed that many of the dormer spandrels had yielded beyond the point of elasticity; spandrels were permanently and visibly deflected. Steel was also de-laminating and buckling at multiple locations.

Tests were administered to determine the weldability and tensile strength of samples. Analyzation of steel tests and visual inspections by engineers revealed that some steel members had lost up to 15% of their original sectional area, resulting in a significant loss of strength. Some sections were pitted, while others had holes rusted through, increasing and aggravating sectional loss.

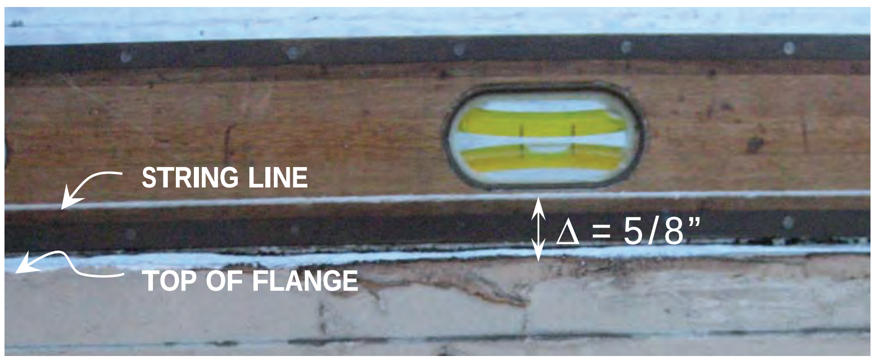
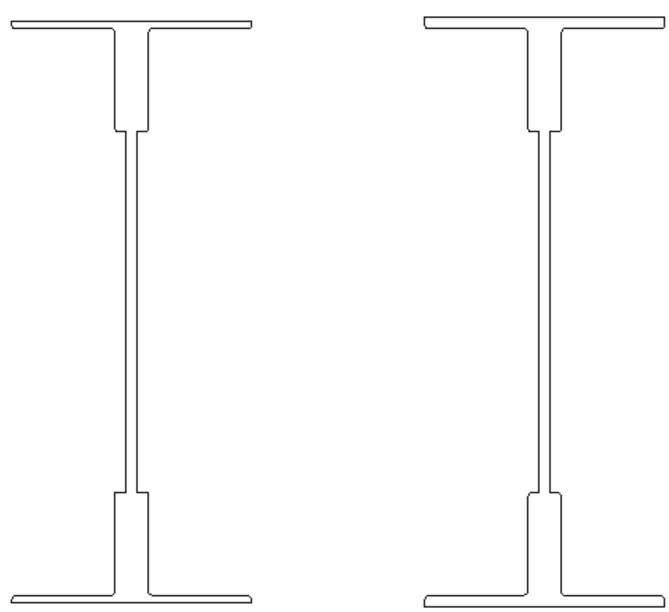


Fig. 6.2.19



SPANDREL SECTION, CURRENT CORRODED

Area:	16.5245 sq in
Moments of inertia:	X: 939.8022 sq in sq in
	Y: 23.0179 sq in sq in
Radii of gyration:	X: 7.5414 in
	Y: 1.1802 in

SPANDREL SECTION, ESTIMATE OF ORIGINAL

Area:	18.5491 sq in
Moments of inertia:	X: 1140.1448 sq in sq in
	Y: 34.1905 sq in sq in
Radii of gyration:	X: 7.8400 in
	Y: 1.3577 in

Fig. 6.2.20

Recommendations & Design

It was officially determined that there was no single cause of water penetration to the interior, rather a number of deficiencies where each contributed. Leaking gutters and roof drains had been repaired in a 2006 emergency repair. This did not address the water penetration of a less pronounced sort due to its widespread character. It was determined that this work should resolve all problems which contribute to water penetration thought the following recommendations:

Fig. 6.2.22
New steel at spandrels to augment the deteriorated existing steel. Existing spandrel have been scraped and painted with a high-build epoxy paint (white) to deter further corrosion.

LLW No. 048114 – Exterior Masonry

1. **Brick and Stone Masonry**
   - Remove all cementitious coatings and paint from east facade using a chemical paint stripper.
   - Replace spalled brick in kind.
   - Replace fourth floor string course with cast stone replica.
2. **Structural Steel**
   - Remove and replace failing terracotta lintels with cast stone replicas.
   - Repair steel behind lintels with plate steel, primed and painted.
   - Provide additional provisions for steel and cast stone for discovered conditions.
   - Provide additional provisions for power tool cleaning of existing steel, priming and painting with high-build epoxy paint.

Fig. 6.2.23 (below)
Construction documents detailing the scope of work at the upper portion of the building. All detailing at the fifth floor was replaced after discovered conditions during construction. Courtesy: Nelligan White Architects

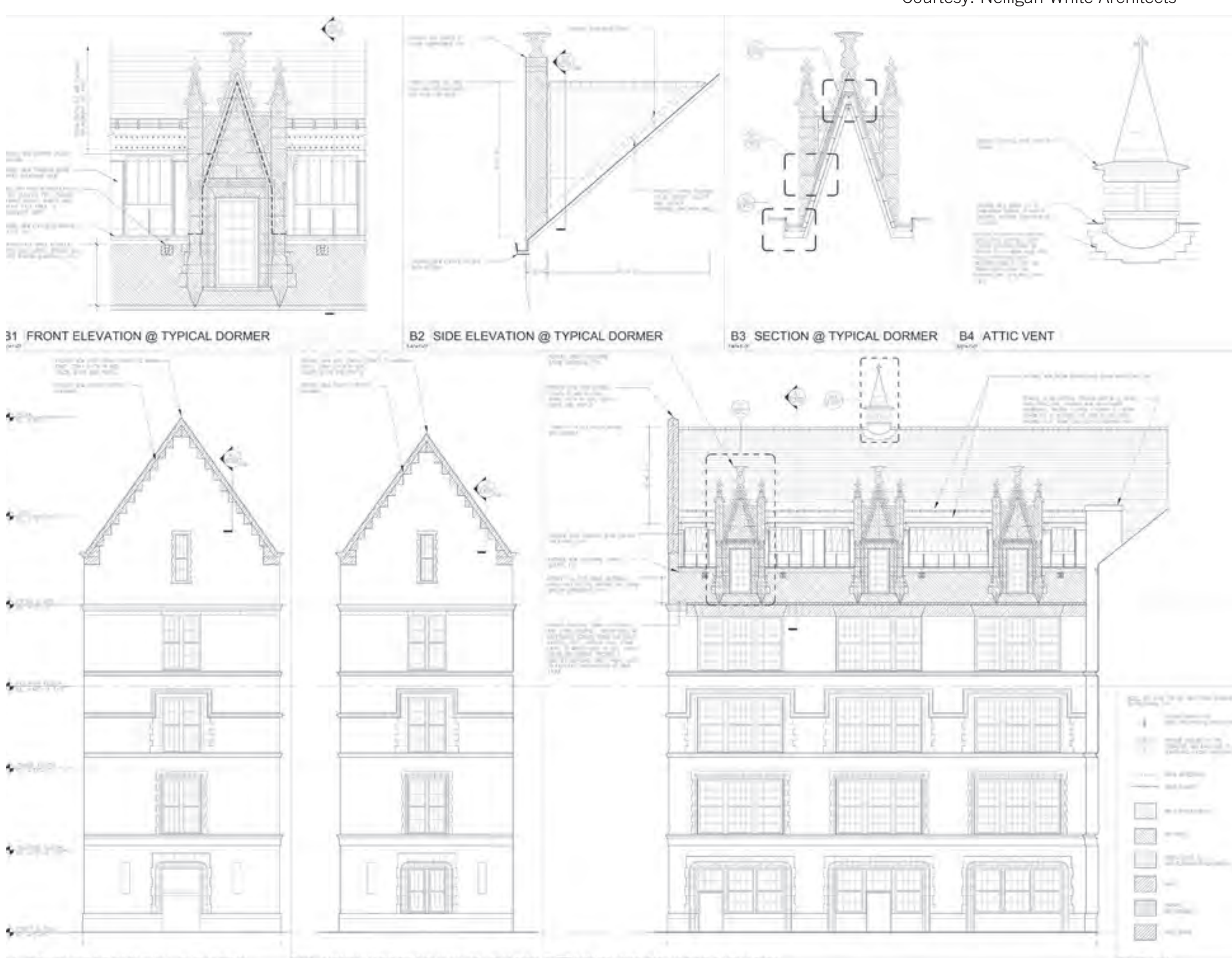


Fig. 6.2.23

Fig. 6.2.24
Roof scuttle, scraped and painted. Courtesy: Nelligan White Architects

Fig. 6.2.25
Finished interior painting and plaster repair at the fifth floor gymnasium. Courtesy: Nelligan White Architects

Fig. 6.2.26 (right-center)
Fifth floor plan, showing locations of plaster and painting repair. Courtesy: Nelligan White Architects

3. Windows, Doors and Skylights

- Existing window are to remain, include provision for replacement of window and masonry sealants
- Replace sealant at skylights
- Existing doors are to remain, scuttle door at observation tower to be scraped and painted.

4. Related Interior Work

- Remove plaster finishes where water damage is present at the fifth floor.
- Provide galvanized furring to hang fiberglass-faced gypsum wallboard.
- Provide level 5-finish skim coat, prime and paint.

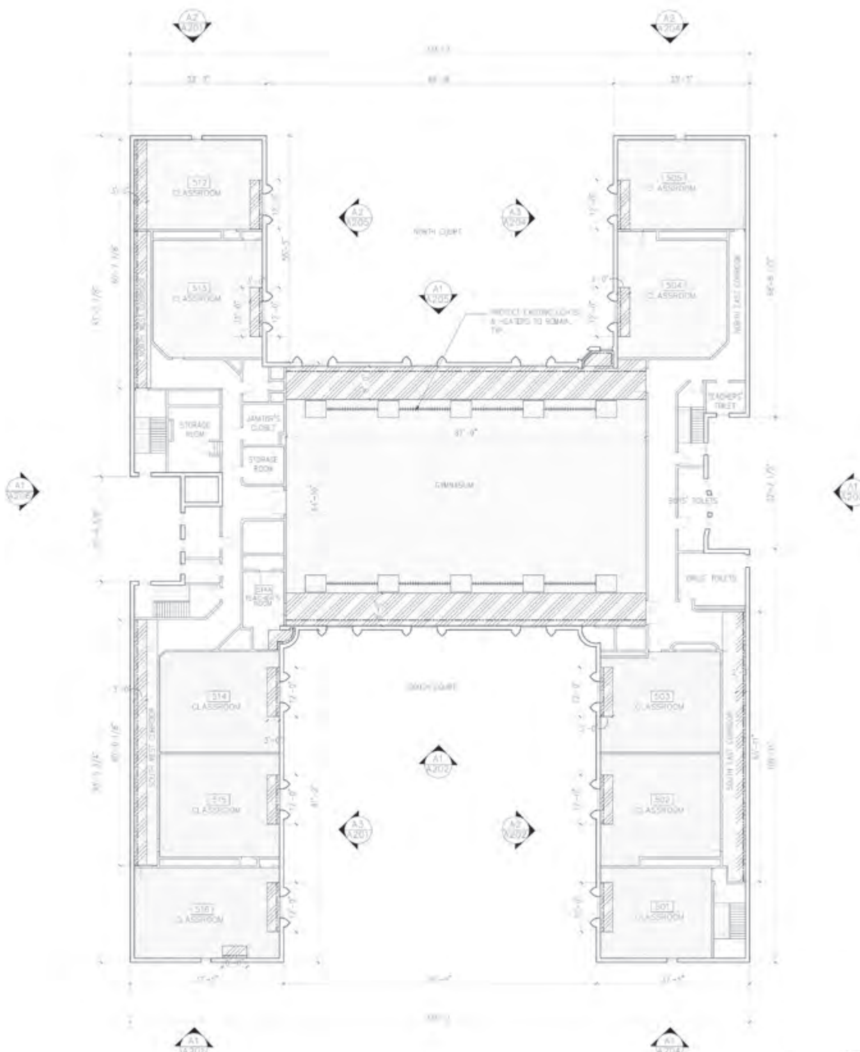


Fig. 6.2.26

Additional Recommendations

1. Roofs

- Remove and replace copper flashing at the dormers on the fifth floor.
- Remove and replace copper flashing at the gable ends of the four wings of the school.
- Remove and reinstall terracotta roof tile as needed to replace flashings, provide provision for replacement of broken tiles.
- Replace existing roof membrane as required.
- Remove and replace snow arrestors at all roofs.
- Flat roofs at the towers are to be replaced.

2. Parapets

- Remove all masonry parapets at the gables.
- Install stainless steel through wall flashing.
- Install new reinforced brick parapets with stainless steel cap flashing
- Replace the demolished terracotta fascia and coping pieces with cast-stone replicas.

Fig. 6.2.27
Roof membrane has been replaced before reinstalling new terracotta tiles. Courtesy: Nelligan White Architects

Fig. 6.2.28 (below)
Construction documents detailing the scope of work at the upper portion of the building. All detailing at the fifth floor was replaced after discovered conditions during construction.
Courtesy: Nelligan White Architects

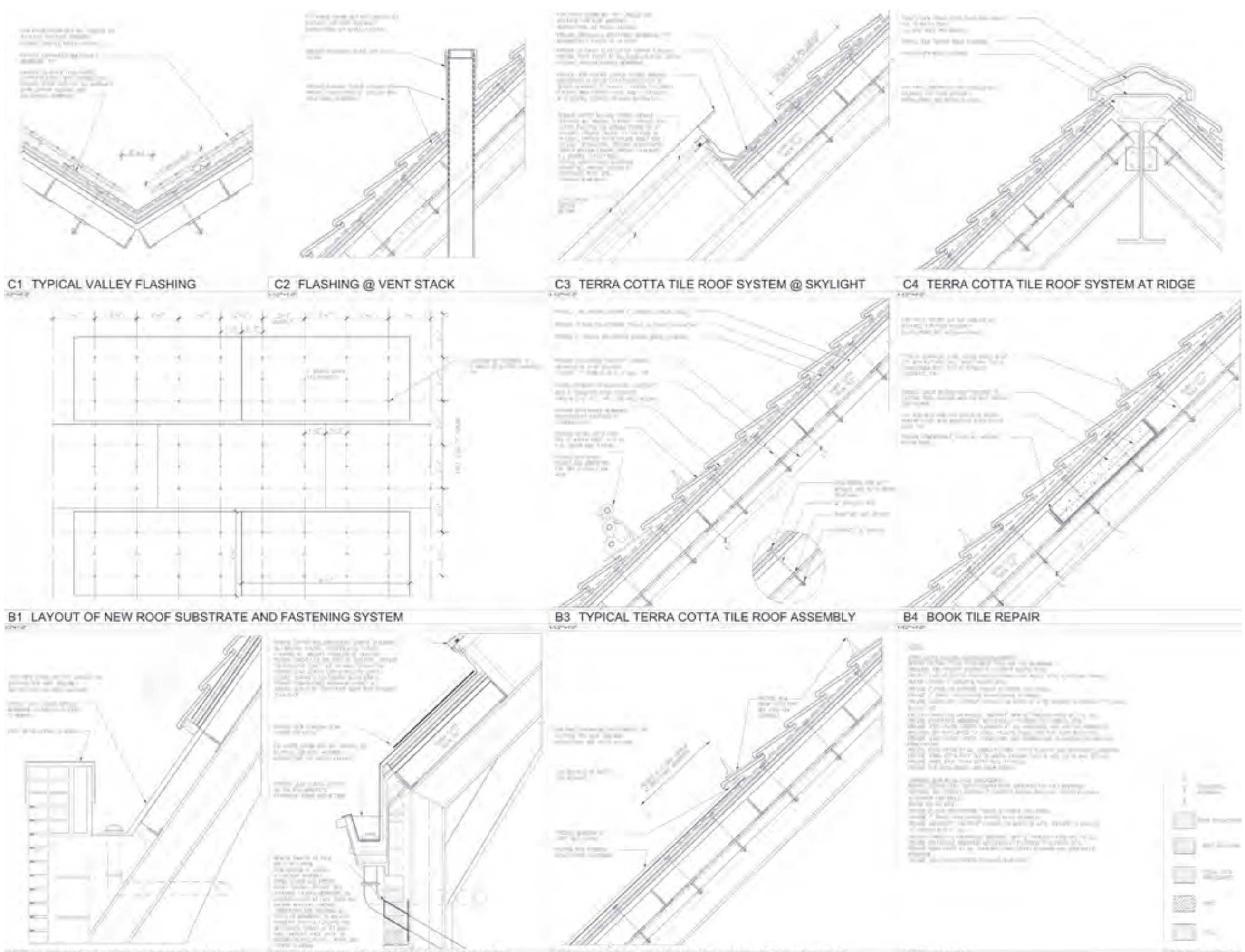


Fig. 6.2.28

Constructability & Lessons Learned

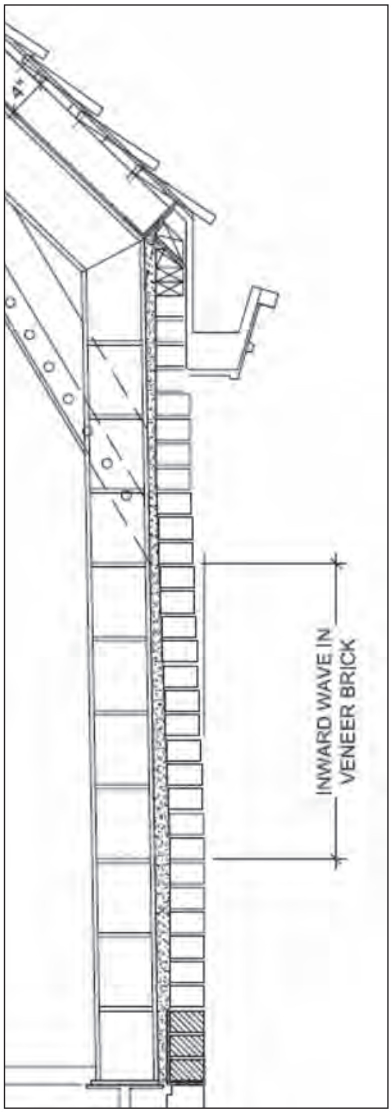


Fig. 6.2.29
Diagrammatic section developed by engineers to explain the condition of the face-brick. Courtesy: Nelligan White Architects

Fig. 6.2.30 (right)
The area where waves were observed, with lines superimposed, making difference in the face-brick obvious. Courtesy: Nelligan White Architects

As discussed in the Methodology section of this case study, a sizable portion of the final scope arose from discovered conditions in construction. This is because a complete survey was not performed, as the boom crane required could not be supported by the schools courtyard deck. The deficiencies first noted at the building were thought to be clear.

Most of these discovered conditions were at locations at the fifth floor or on the roof which were inaccessible or unsafe to inspect without the use of a boom crane. It was not until scaffold had been put up, and construction had begun that severely corroded steel framing was discovered in areas – particularly, at the dormer steel framing and the support spandrels on the fifth floor. Specifically, these conditions included:

Face-Brick

Waves in the wall were observed where face-brick was falling inward at the fifth floor. It was assumed that some lateral movement occurred in the steel framing after initial construction, which was accompanied by the infill wall leaning with it, possibly to the point of cracking the veneer. This was caused by weakness of the corroded knee braces at the roof trusses. Face-brick had been replaced at some point because of cracking; however, this did not solve problems associated with the corroded steel.

Fig. 6.2.30

Masonry

During the plaster repair of a brick-encased column, a crack was discovered. The crack ran through the brick, from the floor to approximately 1' below the ceiling, measuring ¾" in width. Upon removal of masonry, a corroded steel flange was found. Further inspection revealed that the steel was actually in fair condition. It was agreed that the crack may have been caused by racking and vertical deflection of the roof trusses loading the masonry.

Fig. 6.2.31
Cracked masonry wall. Courtesy: Nelligan White Architects

Concrete

When finishes were removed from the southwest observation tower (Fig 6.2.32) during construction, it was observed that the concrete slab which formed its roof was deflected and disintegrating. The structure was originally constructed of a 4" slab with welded wire reinforcing fabric, however, in its existing state there were holes in the concrete large enough to put a foot through (Fig 6.2.33), and fallen pieces of concrete were observed directly below. In the classroom below this roof, recurring water damage had been noted at the repaired surfaces. This discovered condition confirmed one of the many causes of moisture infiltration.

Fig. 6.2.32 (above) & 6.2.33 (left)
Concrete roof. Courtesy: Nelligan White Architects

Fig. 6.2.33

SECTION 6.3

CASE STUDIES: MORRIS HIGH SCHOOL

MORRIS HIGH SCHOOL

Introduction

Building ID	X400
School Level	High School
Address	1110 Boston Post Road Bronx, NY 10456
Cross Streets	East 166th St. & Home St.
NYC DOE District	78
SHPO Status	Listed
SHPO ID	00501.000530
Flood Zone	Outside of Flood Zone
FEMA Map	3604970084F
Architect	C.B.J. Snyder
Year Built	1902
Plan Form	Modified H or E Shape
Style	Collegiate Gothic
Internal Sq Ft	216,625
Classrooms	78
Stories	5 Stories + Basement + Sub-Basement, 8 Story Central Tower
Structural System	Solid load-bearing masonry walls with steel framing supporting concrete slabs
Columns	Steel
Beams	Steel
Floors	Concrete Slabs
Roof	Hybrid Built-Up/SBS, Fluid Applied, Batton Seam Copper
Cladding	Brick, Terracotta, Limestone, Granite Base
Backup	Brick, Terracotta

Fig. 6.3.1

Fig. 6.3.1 (above right)
Original facade before construction. Courtesy: Sylvia Hardy

Morris High School is a collegiate Gothic style New York City Landmarked building located in the Bronx. Designed by C.B.J. Snyder, the original building was constructed between 1901-1904. An addition was constructed in 1955 under the design of Eric Kebbon, who was then the current Superintendent of School Buildings. This addition moved away from the original style of Morris High School, favoring the more modern style common of 1950s schools.

The original building is constructed of exterior load-bearing solid masonry walls with internal steel framing supporting concrete floor slabs. It consists a five-stories (plus basement and sub-basement) and an eight-story tall ornate central tower. There is a two-story, six-sided auditorium wing extending from the center of the building at the rear. The entire main portion is clad in buff-colored brick laid in Flemish bond and has extensive ornamental terracotta, particularly around the windows and doors, along the roof gables and at the central tower which also displays a quartet of terracotta turrets with crenelated tops. Limestone clads the base of the building with a single course of bluestone at grade. The sloped roofs are clad in batten-seam copper (formerly slate shingle), the larger flat roofs utilize Hybrid Built-Up/SBS, and the smaller ones are fluid-applied. The main entrance, centered on the East 166th Street facade at the base of the central tower, is served by a large, formal double staircase.

The three-story (including basement) addition is a rectangular building connected to the east wing of the original building and runs along Jackson Avenue. It is a steel frame structure with concrete floor and roof slabs. The exterior is clad in buff brick laid in common bond and has limestone accents. Hybrid Built-UP/SBS roofing is utilized. The addition houses cafeterias for students and staff, a gymnasium and additional classrooms.

The school has suffered from moisture infiltration resulting from the deteriorated roofs, masonry and foundations. In early 2007, a new campaign was started to address theses issues. During construction, additional deterioration at the gable levels was uncovered and required immediate attention. A new design project was initiated in November 2011 and is substantially completed. The combined scope of these two projects included:

- Replacement of all of flat roofs, full masonry reconstruction of all gables and gutters including steel replacement and reinforcing
- Full wall reconstruction at the eighth floor of the tower including terracotta replacement
- Miscellaneous terracotta and limestone unit replacement and repairs
- 100% pointing of terracotta and limestone to remain
- Spot brick pointing
- Fenestration perimeter sealant replacement
- Foundation waterproofing via injection
- Areaway slab replacement and/or waterproofing
- Interior finish repairs.

Fig. 6.3.2 (below)
Rear view before construction. Courtesy: Sylvia Hardy

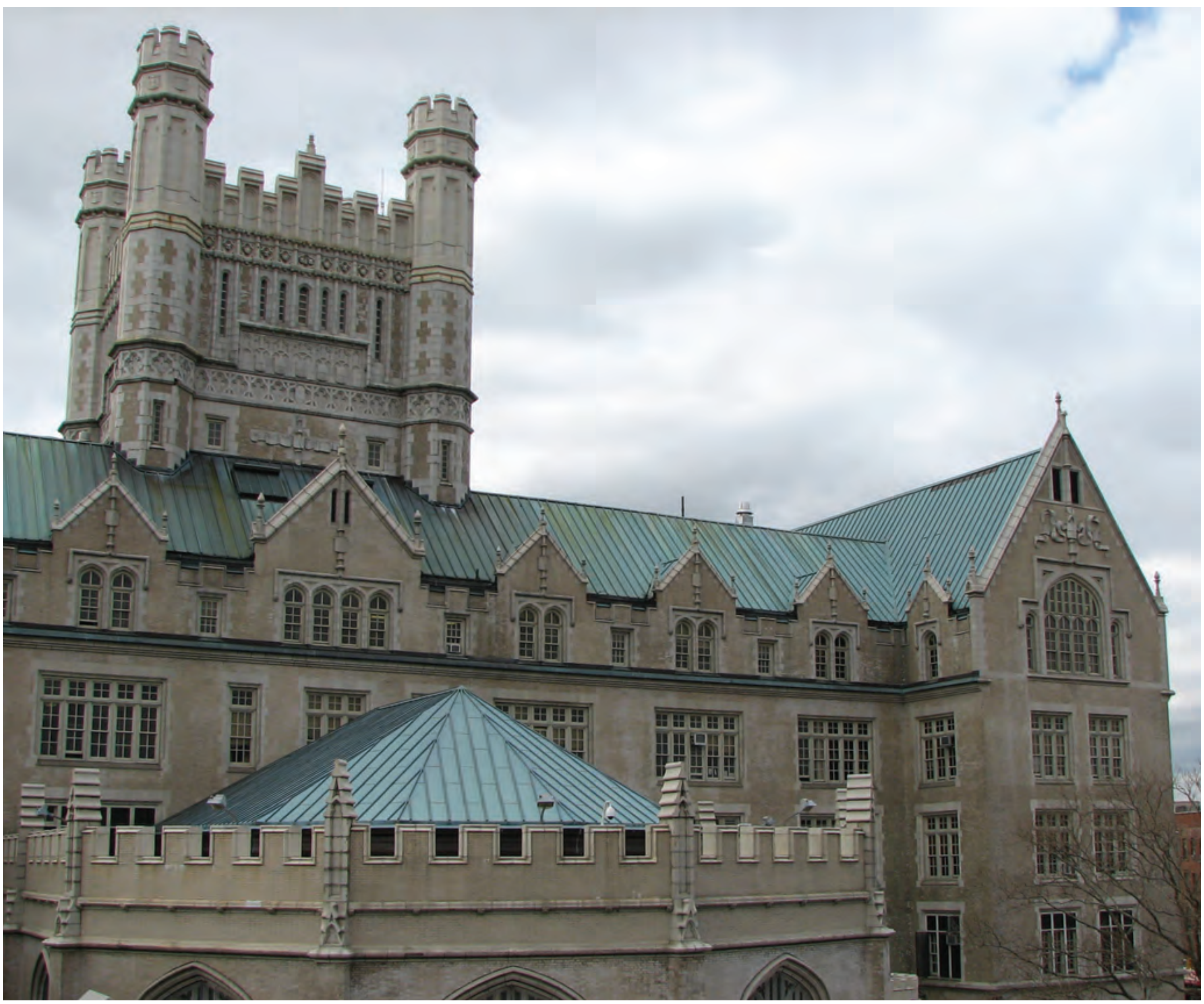


Fig. 6.3.2

Methodology

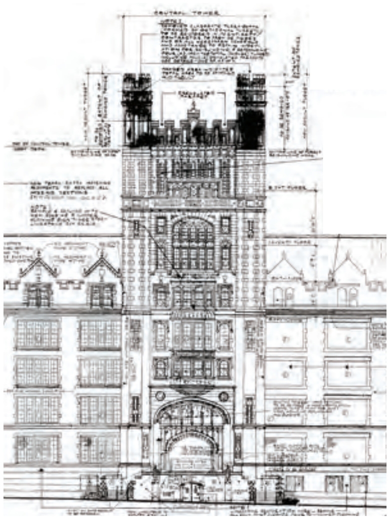


Fig. 6.3.3
Partial front elevation from the 1985 campaign. Courtesy: SCA alchemy

Research

The School Construction Authority's Alchemy database was reviewed to obtain all available historic drawings. There were no original design drawings available for the building, but it was discovered that Flushing High School was a sister school to Morris, and the design drawings were utilized. These drawings provided valuable information in determining the building's internal structural system.

The drawings for the addition were available and in legible condition. They were reviewed and provided significant information regarding its construction as well as the conversion work performed at the main building at the same time.

Alchemy also had portions of drawing sets from subsequent repair and renovation campaigns which enabled the development of a time line of miscellaneous work performed. This included the 1985 campaign that replaced the original wood windows and rebuilt the terracotta turrets along with the parapets. An interior restoration was carried out in 1992 as well as an accessibility improvement campaign in 2001.

Overall, the quality of historic drawings was lacking. This increased the importance of performing accurate and detailed field surveys to develop usable base drawings.

In addition, the Alchemy documents review of the NYC Department of Buildings & Environment Control Board Violations and NYC Department of Education prepared Building Condition Assessment Survey (BCAS) reports were reviewed. These resources provide a starting point for review of the general conditions of the building as well as highlight previously observed damage and non-compliant conditions.

Fig. 6.3.4 (below)
Plan of the 1950s addition. Courtesy: SCA alchemy

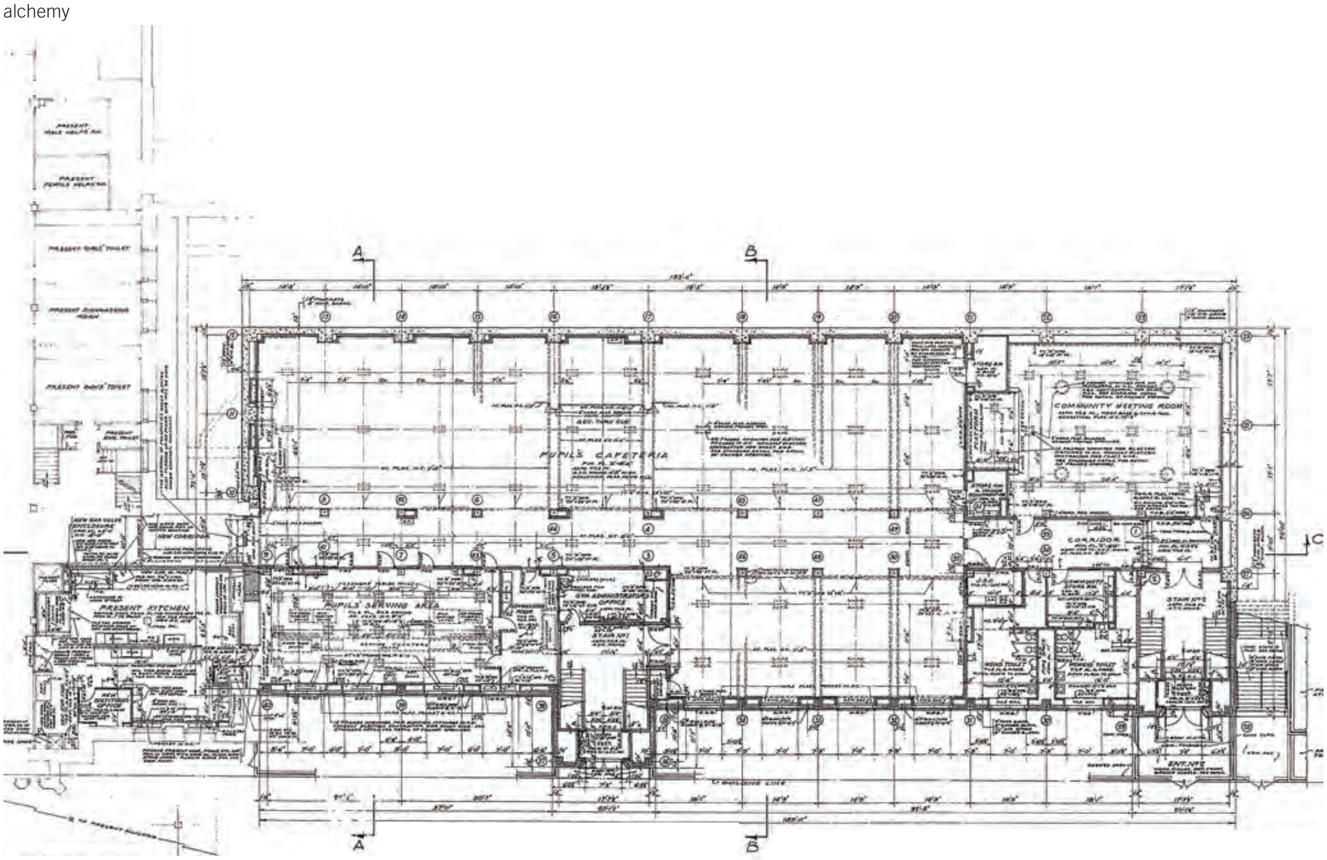


Fig. 6.3.4

Observation & Mapping

In order to identify patterns of deterioration and correlate the interior damage to exterior conditions, the findings in the field were documented on plans and elevations. These images were reviewed in tandem to correlate interior damage with the causal exterior conditions. This exercise also facilitates the recognition of potential patterns in deterioration occurring within specific building systems.

Fig. 6.3.5 & 6.3.6 (below - far below)
Sub-basement and first floor damage mapping.
Courtesy: Nelligan White Architects

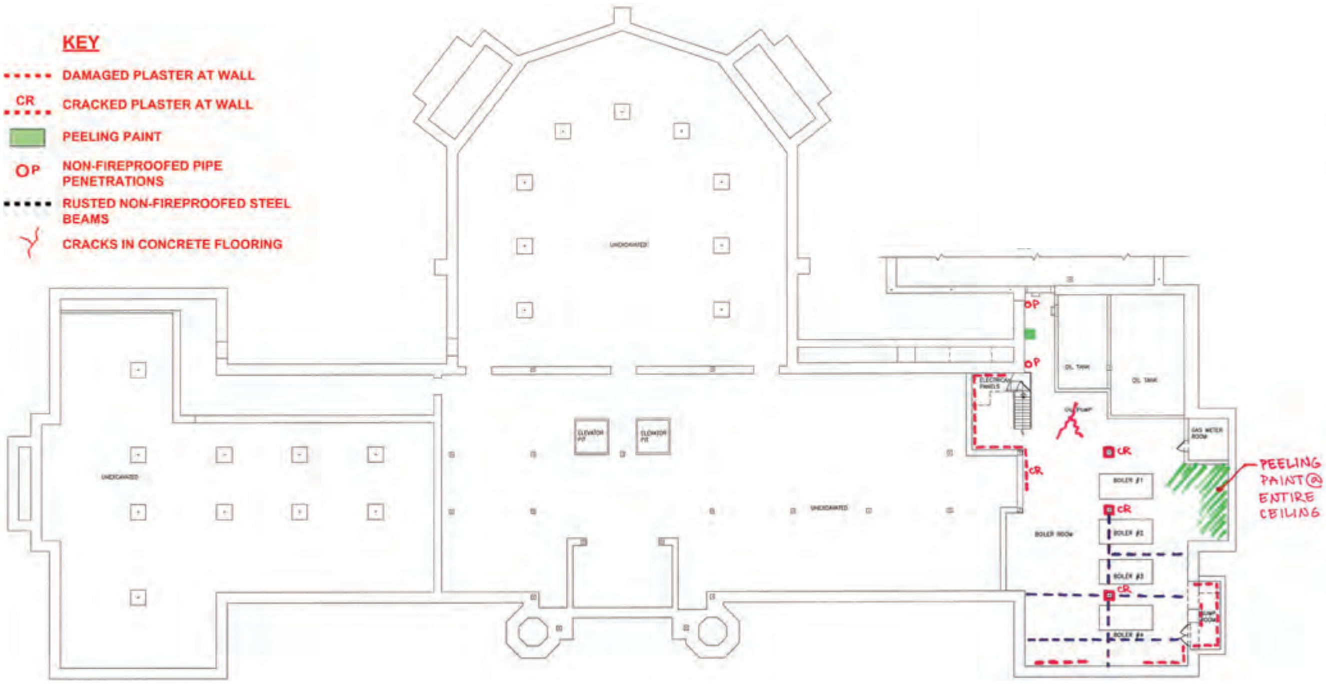


Fig. 6.3.5

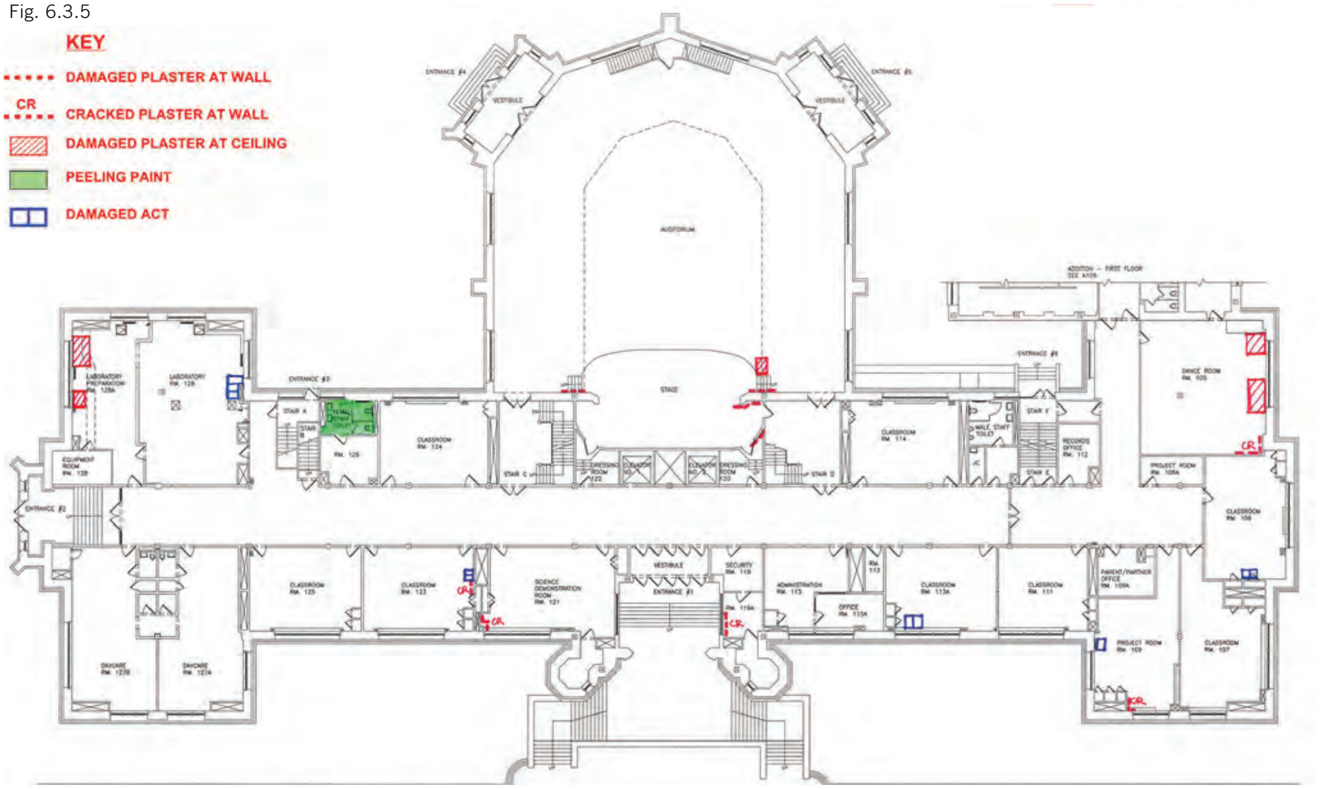


Fig. 6.3.6

Fig. 6.3.7
Probe at the original 1901-1904 building. Courtesy: Nelligan White Architects

Fig 6.3.8 (below)
Probe at the 1950s addition. Courtesy: Nelligan White Architects

Exploratory Probes

Besides visual observations and assessment of the building's existing condition, early in the scoping phase of the project probes were initiated. Due to the lack of drawings related to the construction of the original building the probes were vital in determining the existing conditions in order to develop restoration details. Of the thirty-three probes requested only eighteen were performed, this was in part due to the difficulty of reaching the upper portions of the building.

When the brick masonry was removed at the probe locations the steel deterioration was observed.

Fig. 6.3.8

Recommendations & Design

Overall, the bricks, in both the original building and the addition, was in fair condition. However, vertical cracking at corners, step cracking, and falling mortar were observed. Deterioration around spandrels resulted in masonry cracking and displacement. Damage at interior finishes was due to water infiltration. Additionally, previous pointing work masked the true conditions of slightly bulging and displaced masonry during the investigation phase.

Terracotta damage was observed throughout the facades of the original building with the worst conditions being at the eighth floor of the tower and the gable copings. Severe cracking, spalling and failing joints were commonly observed.

Fig. 6.3.9
Deteriorated steel spandrel at gable. Courtesy: Nelligan White Architects

LLW No. 048539 - Masonry Facade

1. Terracotta

- Replace in kind, all terracotta at the eighth floor of the tower and all the gable copings.
- Replace cracked, spalled, and any other damaged portions of the original facade; re-glaze as needed

Fig. 6.3.10
Deteriorated gutter and gable roof framing. Courtesy: Nelligan White Architects

2. Brick Masonry

- Replace face brick and back-up at corners
- Reconstruct spandrel at corners, including preparation, coating and flashing of existing steel (reinforce as necessary)
- Replace any severely deteriorated lintels, including the installation of flashing
- Prepare and coat lintels exhibiting minor deterioration
- Replace face brick at step cracks
- Repoint any falling joints
- Repair interior finishes in-kind

Fig. 6.3.11
Typical terracotta deterioration at gable copings. Courtesy: Nelligan White Architects

Fig. 6.3.12
Lintel distress at addition. Courtesy: Nelligan White Architects

Fig. 6.3.13

Fig. 6.3.13 (left)
Typical terracotta deterioration at eighth floor of tower. Courtesy: Nelligan White Architects

Fig. 6.3.14
Typical roof membrane cracking. Courtesy: Nelligan White Architects

Fig. 6.3.15
Typical interior damage due to water infiltration below areaway. Courtesy: Nelligan White Architects

Fig. 6.3.16 (below)
Stepped interior of gable wall. Courtesy: Nelligan White Architects

LLW No. 050029 - Roofs

The steep-sloped copper roofs were in good to fair condition, with the exception of the deteriorated gutters. Built-up roofs were found to be in fair to poor condition, and all had expired warranties. Notable defects in the flat roofs included cracking throughout the membrane, punctures, missing gravel, bubbled bitumen and deteriorated seams, exposed fiberglass reinforcement tape; standing and trapped water below membranes, and interior water damage.

- Replace all large flat roofs with new built-up membrane
- Replace all associated flashings
- Replace smaller roofs with new fluid applied systems
- Replace all drains at flat roofs in conjunction with roof work

LLW No. 050030 - Flood Elimination

Occupied basement rooms adjacent to all (4) areaways exhibited interior finish damage. The observed damage was thought to be related to site issues including insufficient slab pitch, standing water/clogged drains, plant growth at the areaway slab's junction with main building wall, and areaway grating supported by wooden shoring.

- Remove and replace deteriorated areaway slabs
- Remove and replace drains
- Clean drain lines
- Replace deteriorated areaway grating

The steel within the gables was severely deteriorated due to ongoing moisture infiltration. Clogged gutter drains and scupper overflows were found to be the main culprit. The gutters would fill up with water which then traveled under the batten seam copper roofing and into the attic crawlspace and wall structure below.

A secondary source of the moisture infiltration was observed to be the connection of the batten seam roof to the back of the gable wall. The stepped nature of the gable wall led to the bases of the copings extending below the gable roof and the copper roofing was turned up the face of the copings. This did not provide for a tight connection and water was able to enter between the roof flashing and the back of the copings.

LLW No. 071590 - Exterior Masonry

- Remove upper masonry walls at gables and gutters down to the steel lintel at window
- Replace or reinforce steel lintels based on level of deterioration
- Reinforce ends of gable roof framing
- Replace steel framing of gutter structure

Fig. 6.3.17

Fig. 6.3.17 (left)
Original copper flashing terminating behind gable coping. Courtesy: Nelligan White Architects

Fig. 6.3.18 (below)
Detail of gutter replacement. Courtesy: Nelligan White Architects

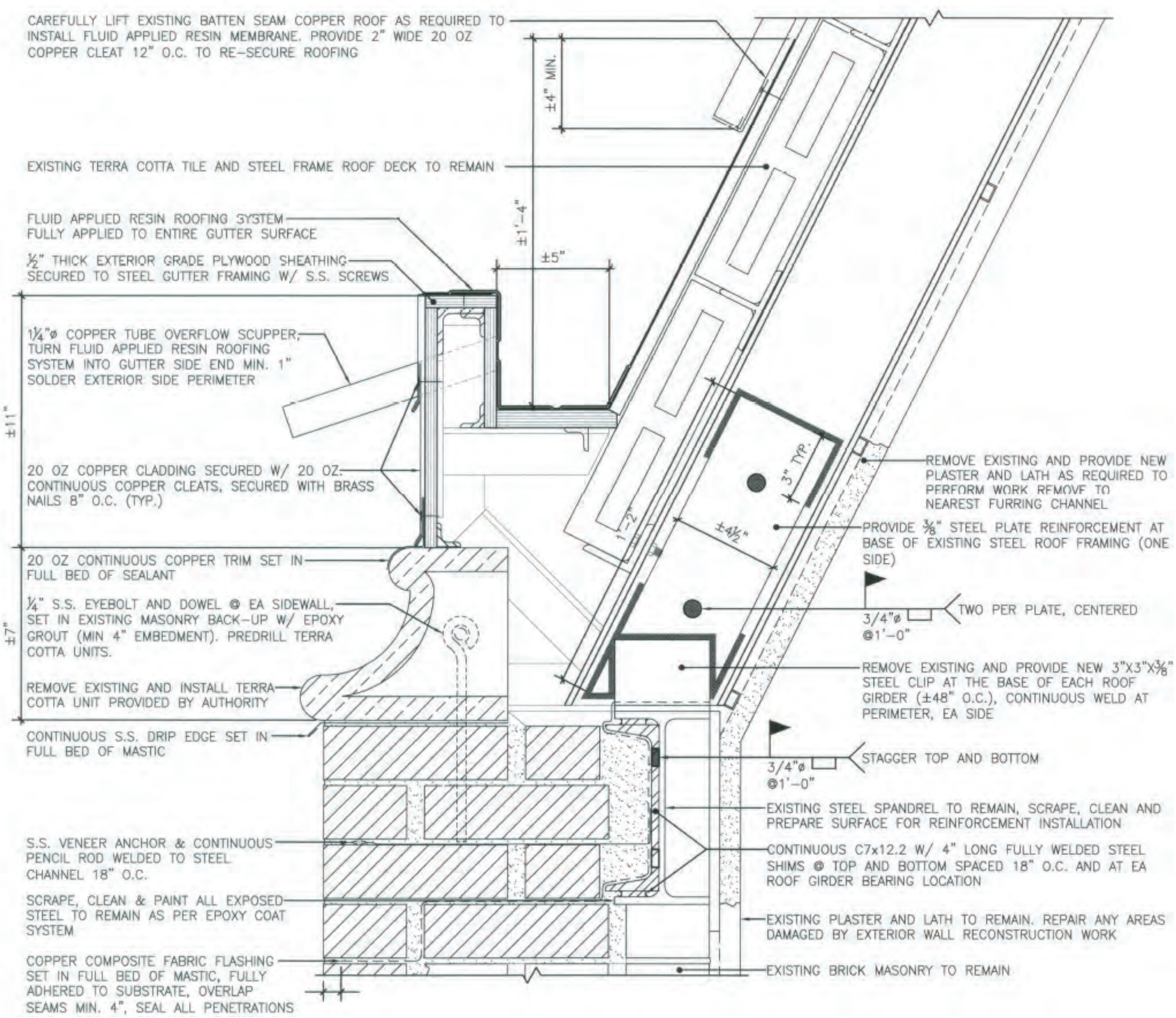


Fig. 6.3.18

Constructability & Lessons Learned

Exterior Masonry

The remaining fifteen probes that were not preformed, were located in areas that were difficult to access at the upper parts of the building near the gables. It was at these particular areas where significant revisions to the scope of work were necessary during the construction phase as deterioration, much more severe than anticipated, was uncovered. The timing of this discovery played a role in the decision to issue new Contract Documents to comprehensively address the newly discovered unforeseen conditions. This only reinforces the importance of obtaining as much information during the investigation phase as possible.

In situations like Morris HS, where the probes cannot be performed during the investigation or design phases, it is advisable to ensure that probes are included in the Contract Documents and require the contractor to perform them at the outset of the construction phase, so there is ample time to address any discovered conditions.

Roofs

While the roofing scope was fairly straight-forward, there were some issues which arose. One was the coordination with another ongoing project. The concurrent project at Morris HS incorporated new ventilation system work. During the design phase, the roofing scope was coordinated with the proposed layout of the new equipment. Coordination had to continue throughout the installation as there were significant changes to the proposed HVAC layout. In addition, the timing of the work had to be coordinated to allow for multiple contractors to work in the same areas under different contracts and to perform the work in the most logical sequence to avoid work having to be revised or redone.

There was also the addition of the replacement of two large portions of the batten-seam copper roof due to damages suffered during Hurricane Sandy in 2012. Roofing in these two areas was dislodged in the sustained winds. The existing roofing appeared to be in fair condition during the scoping phase, but after the storm it was discovered that the roofing was cleated into the exiting structural terracotta ceiling tiles with nails. It is never good practice to anchor into terracotta in this fashion as the material is brittle, susceptible to cracking at the points of anchorage and does not provide a strong connection.

To address this condition the damaged terracotta units were replaced and new plywood sheathing was installed, as there was no sheathing under the existing roofing. The sheathing was anchored into the terracotta units with material appropriate toggle bolt type anchors that were carefully installed and enable to anchor to distribute the loads across more of the surface area of the terracotta units. The plywood was also secured to the steel roof framing wherever possible. The cleats for the replacement copper roofing were then nailed into the plywood providing for a significantly more secure installation. It has been recommended to the SCA that the remaining portions of the copper roofing be replaced in the same manner.

Flood Elimination

The flood elimination work was performed according to the design documents with the exception of some injection areas which were expanded. Often with injection, once a problem area is addressed, the water begins to penetrate walls in new, untreated locations. In order to address this the Contract Documents provide provision quantities to be used at the potential additional areas. It is advised to direct the contractor (via the Contract Documents) to perform the injection work at the early stages of the construction phase to allow for significant time to monitor the areas to be sure the injection was successful and to see if there are any additional areas that may require treatment.

Interior Finish Work

The replacement of the interior finishes presented a challenge. Walls were extremely moist after years of infiltration that they required significant time to dry. The contractor, originally, attempted to remove damaged plaster and immediately install new plaster, but this approach resulted in the damage quickly recurring. Per the contract documents the contractor was directed to strip all of the damaged plaster down to the masonry back-up and allow it to dry out.

Moisture testing was performed to monitor the drying process and identify when the masonry had dried sufficiently to allow installation of new plaster. The contractor brought industrial size dehumidification units to the site to expedite the drying out process. By following this process, the recurrence of damage was eliminated. Another obstacle to the proper completion of this work was that, the rooms were often unusable for durations up to two weeks as the drying process took place. The school could not afford to turnover some of the spaces for the required amount of time, therefore, some of the rooms were not able to be properly repaired.

Fig. 6.3.19 (below)
Detail of gable reconstruction. Courtesy: SuperStructures Engineers + Architects

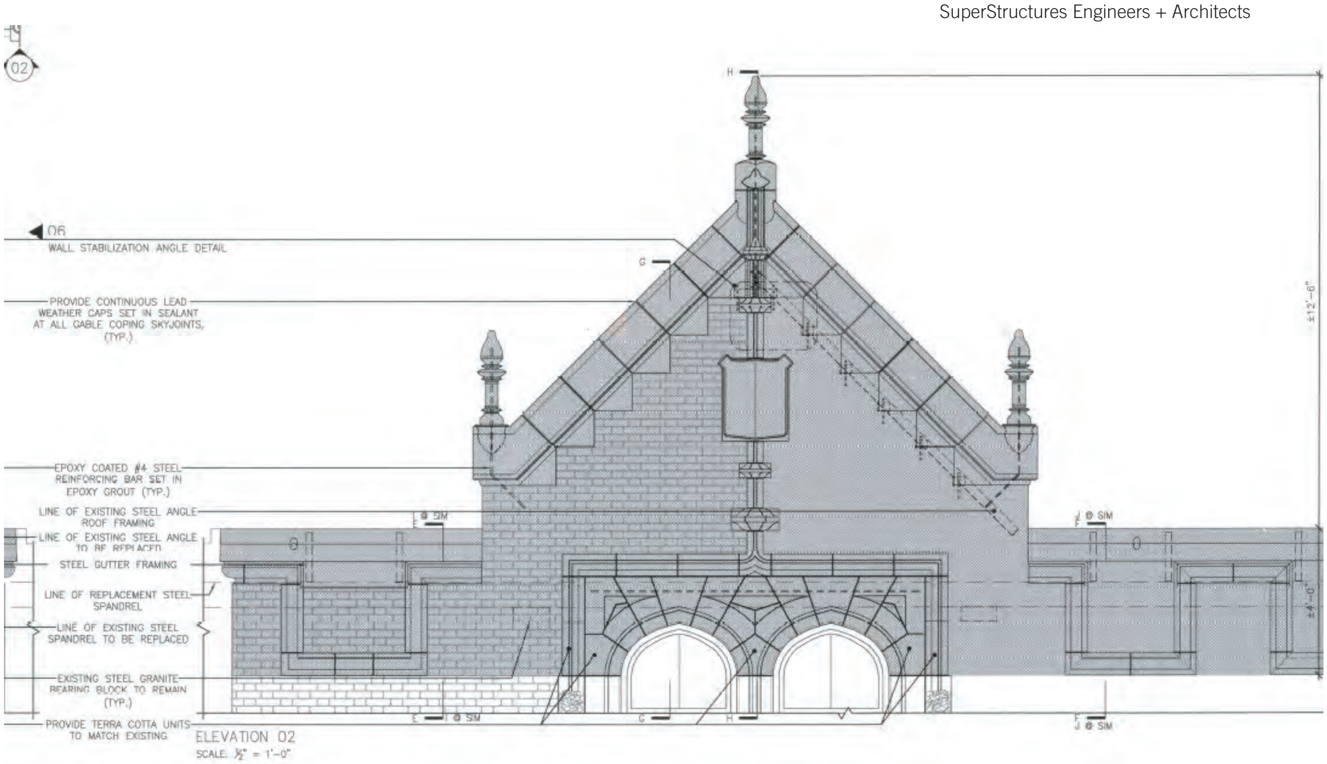


Fig. 6.3.19

SECTION 6.4

CASE STUDIES:
PS 183 M

CASE STUDIES:
PS 183 M

Introduction

Building ID	M183
School Level	PS
Address	419 East 66th Street Manhattan, NY 10065
Cross Streets	1st Ave & York Ave
NYC DOE District	02
SHPO Status	Eligible
SHPO ID	00PR00419
Flood Zone	Outside Flood Zone
FEMA Map	364970089F
Architect	C.B.J. Snyder
Year Built	1903
Plan Form	Rectangle
Style	Beaux Arts
Internal Sq Ft	49,000
Classrooms	24
Stories	5 + Basement
Structural System	Solid Masonry
Columns	Masonry
Beams	Masonry
Floors	Metal corrugated arch/slag fill
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.4.2

Fig. 6.4.1 & 6.4.2 (above - right)
The symmetrical plan as well as the simplified form in the classical style was utilized to build schools quickly and with simpler construction techniques. Built in an established residential neighborhood the dropped cornice matched the height of the existing tenement buildings that once stood near by. Courtesy: Nelligan White Architects

Constructed in 1903, PS 183 M, along with various sister schools built in the years to follow (five of which survive), represent a return to a classically inspired style - the Beaux Arts Style. Paired with the rise of the "City Beautiful" movement, loss of interest in the historic revival styles, and the need for standardized school designs, architect C. B. J. Snyder utilized Beaux Arts style to create simplified and symmetrical forms that could be quickly constructed to meet the needs of the ever expanding student population.

Located on East 66th Street in Manhattan, PS 183 M was constructed in an established residential neighborhood that for much of the early 20th century dwarfed the neighboring buildings. It stands 5 stories high, and is distinguished by its slightly projected stone entrance surround, full cornice, and flat roof. The facade features nine window bays arranged in a tripartite composition of 5 bays in a slightly recessed red-brick center portion with two slightly projecting *"wings"* of red brick, two bays wide each (Figure 6.4.2). Like many schools built in Beaux Arts style, the original projecting cornice was removed. The other major changes to the school were the addition of an annex in 1938, a detached 5,000 square foot gymnasium in 2005, the altering of the parapet to meet contemporary code height of 42", and the partial painting of all facades.

Deficiencies in the modern masonry repair work and the deterioration of backup masonry/mortar was found to be the main sources of water penetration and building-wide damage to interior finishes. The school staff was quick to repair water damage, but in most cases, the same areas had recurring water infiltration problems.

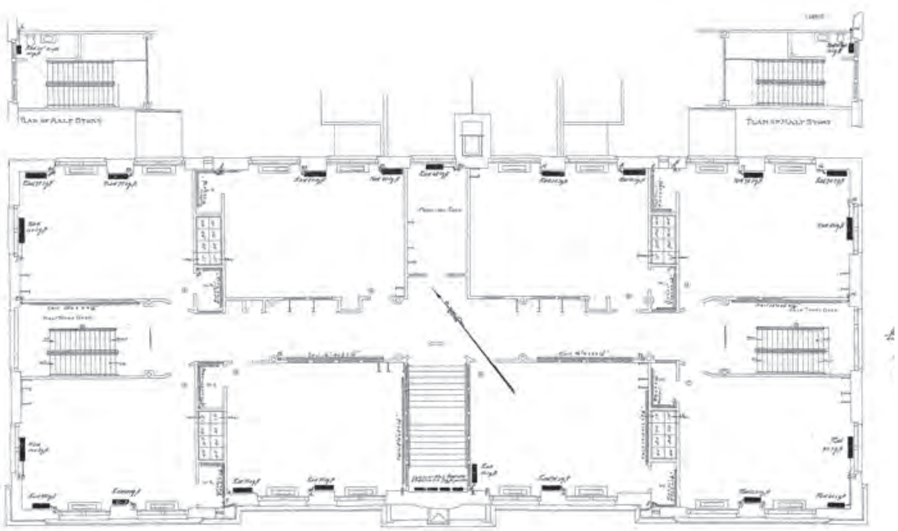


Fig. 6.3.4

Fig. 6.4.3 (above)
A detached gymnasium, constructed in the rear of the site in 2005, was the only major change to the overall footprint. Courtesy: Nelligan White Architects

Fig. 6.4.4 (above-left)
First floor plan 1903. The original building occupies nearly half of the site allowing for open space behind. Its facade consists of a tripartite composition with 5 bays in a recessed center portion and two bays flanking on either side. Courtesy: SCA Alchemy

Fig. 6.3.5

Fig. 6.4.5 (left)
The Beaux Arts classically inspired style coincided is associated with changing tastes of the turn of the 20th century, away from the use of historic revival and eclectic motifs popular though the 19th century. Courtesy: Nelligan White Architects

Methodology

Research

Prior to any definitive breadth of scope, 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 1903, as well as drawings from 13 other projects carried out at the school between 1906 and 2010. The complete list of existing original design drawings includes floor plans, riser diagram, sections, and depiction of original gas lighting fixtures. Drawings from the 13 projects carried out at PS 183 M between 1906 and 2010 include elevations, details, floor plans, interior elevations, and sections.

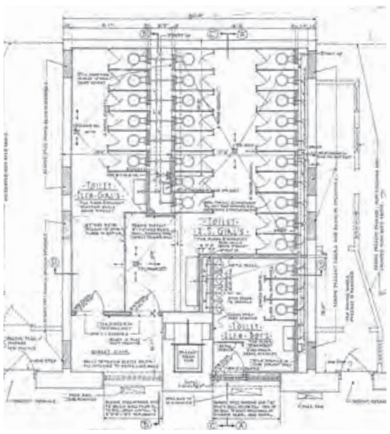


Fig. 6.4.6 (above)
Plans for 1938 1-story annex in the rear of the building that provided modern restroom facilities. Courtesy: SCA Alchemy

Fig. 6.4.7 (right)
Entry detail at the front of the building. Courtesy: SCA Alchemy

Fig. 6.4.8 (below)
Elevation from a 1996 campaign depicting repointing and replacement of masonry. By 2013 all repairs were found to be defective. Courtesy: SCA Alchemy

Fig. 6.4.7

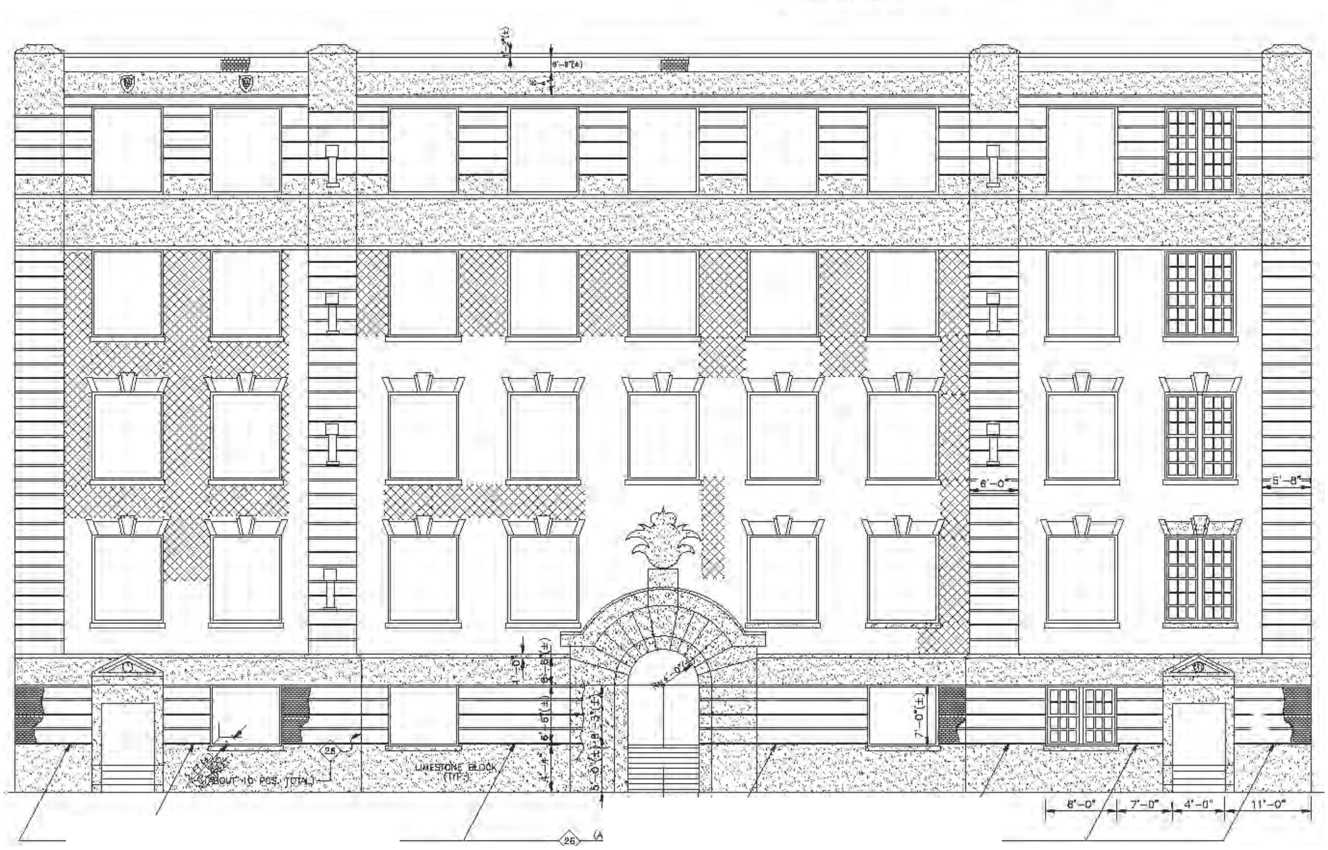


Fig. 6.4.8

Observation & Mapping

In addition to the Building Condition Assessment Surveys (BCAS) which can be found at each school's Department of Education website, visual surveys of interior and exterior damage were performed. Observations of damage suggest that water intrusion is extensive and random, and that the primary source of leakage is the masonry. Piecemeal approaches to repair, and in some cases, deficient workmanship, are evident.

Damages noted at the interior included cracked and spalling finishes, bubbling paint, exposed backup and ceiling structures where deteriorated finishes had been removed as a safety precaution. Efflorescence was visible at large areas of the exterior, as well as brick stitching where contemporary repair efforts took place. Some areas were cracked and spalled, but overall the face-brick was observed to be in fair condition. Windows were also observed to be in fair condition. At the roofs, ponding and organic growth was noted in the ballast, coping stones were cracked, and efflorescence was present at the parapet. At the alley ways on either side of the building, standing water was present as a result of improper slope towards drains.

Photographs and field notes of deficiencies were processed into damage maps of the facades and floor plans using the existing design drawings as base drawings. These maps are a strong graphic tool expressing the nature of damaged, facilitate the quantification of deficiencies, aid in determining a breadth of scope.

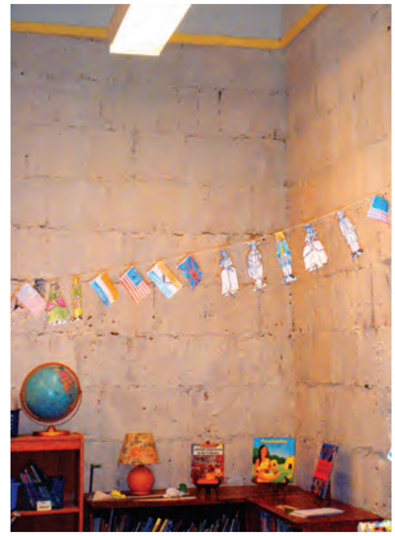


Fig. 6.4.9 & 6.4.10 (above - below)
Exposed backup masonry in a classroom after repeated leaks prompted the removal of plaster as a safety precaution. Efflorescence is present on much of the exterior especially on the north facades. Courtesy: Nelligan White Architects

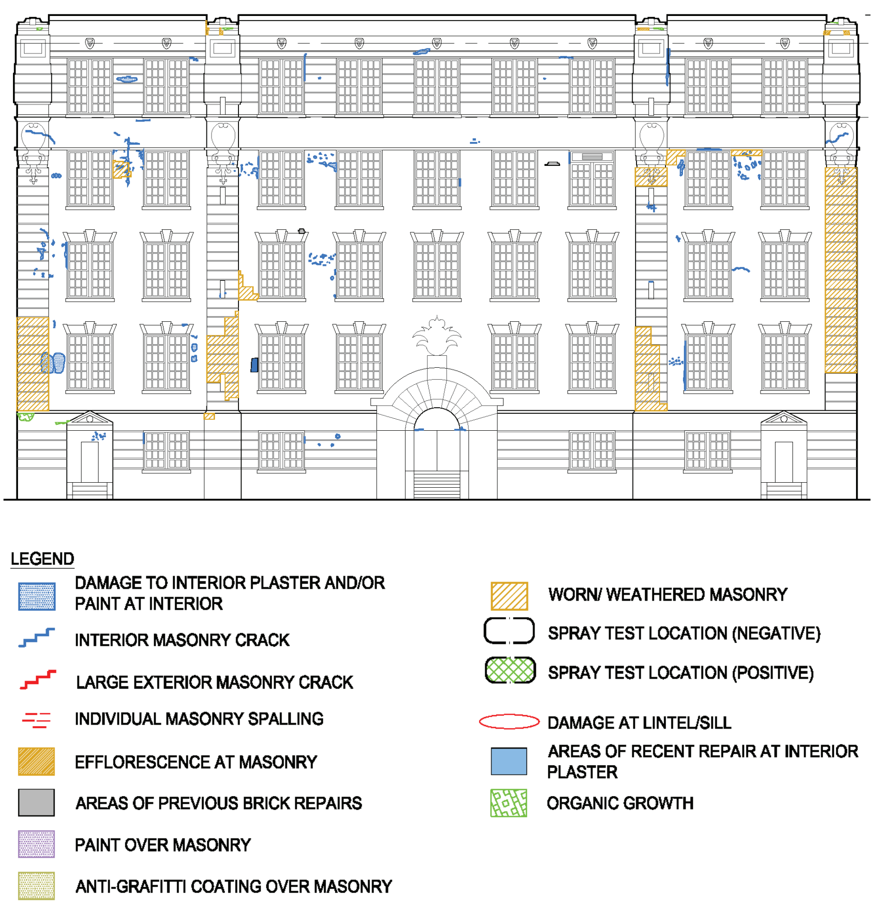


Fig. 6.4.11

Fig. 6.4.11 (left)
Using the original design drawings, base drawings were created and used during the damage mapping exercise. Leaks, water damage, visible cracks, and other deficiencies are carefully noted. This results in a diagram which helps to quantify, justify and convey scope in a clear manner. These base drawings will evolve into the final construction documents. Courtesy: Nelligan White Architects

Fig. 6.4.12
Water damage visible at the interior of a classroom. Courtesy: Nelligan White Architects

Non-Destructive Testing

Moisture metering, thermal imaging, and spray tests helped to determine the main sources of moisture penetration and building-wide damage. The results of spray tests indicated that water does not flow rapidly through the masonry, but that slow saturation of the face-brick and seepage into the backup is the main route of moisture. Out of 61 total tests, 10 locations confirmed positive; these results pointed to deficiencies in on both the contemporary masonry repair work, as well as deteriorated backup masonry and mortar over a century of existence.

Infra-red Scanning and Electrical Capacitance were performed at all roofs. The most probable area for moisture retention was found to be at the main roof, along the north parapet and near the bulkhead. At the smaller roof it was found that the area most likely to retain moisture was also along the north parapet. This anomaly was believed to be a result of thin ballast. The results of the roof scans suggested a high likelihood of moisture retention in both roofs. Reviewing data from all non-destructive tests in coordination with recorded interior damage, it was deemed likely that leaking through the masonry parapet allows water into the perimeter of the roof assembly.

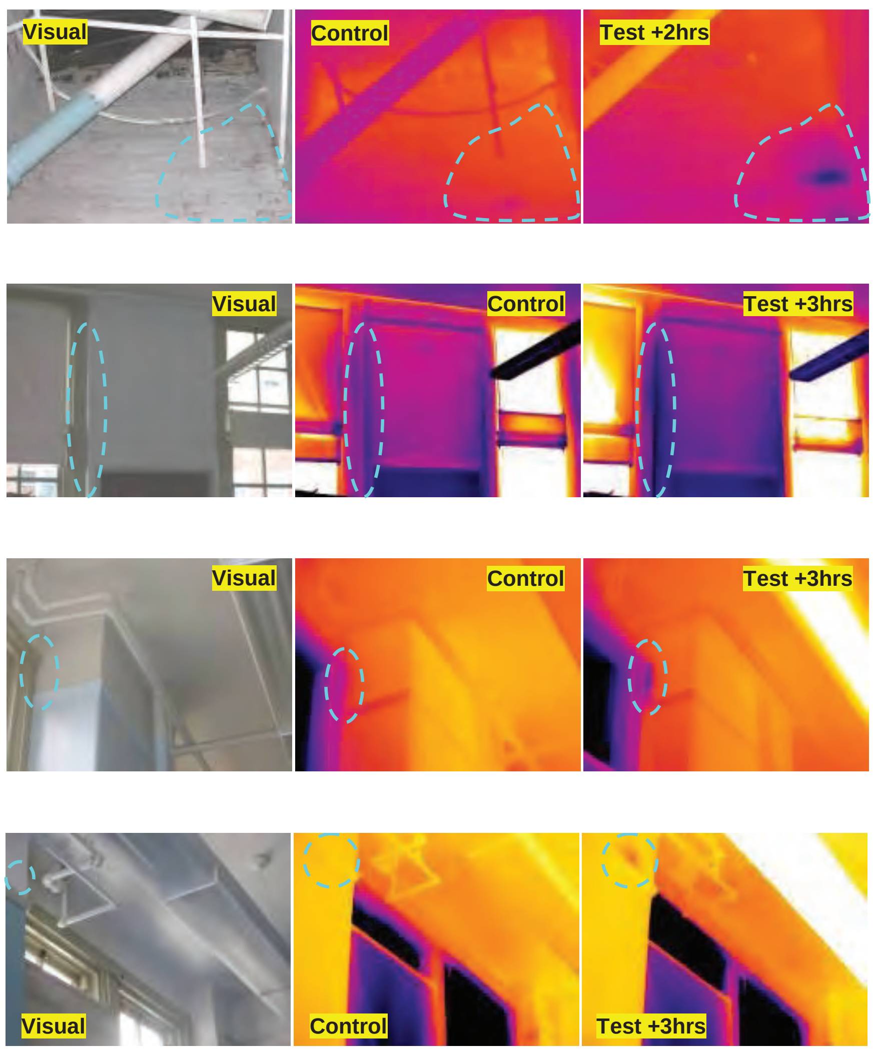


Fig. 6.4.13

Fig. 6.4.13 (right)
Infrared images showed positive water infiltration at multiple locations in the interior and confirmed with a moisture meter. Courtesy: Nelligan White Architects

Exploratory Probes

Probes were performed in the summer of 2012 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 building facades. Many of the observations were as expected; crumbling and disintegrating backup masonry and mortar, and moisture present inside the walls. Voids in the collar joints were observed in probes on the south elevation where earlier repairs took place during a 2008 campaign in non-compliance with SCA standard specifications.

In this same campaign, the brick masonry, terracotta and stone base were repointed entirely on all elevations below the fifth floor sill. As observed in the probes on the south elevation, this repointing mortar appeared to be applied at an inadequate depth and contain voids. The four bastion caps at the parapet were replaced in the 2008 campaign as well. They are believed to be significant sources of water infiltration at the roof level. Efflorescence was observed on the exterior of all of the caps. A probe at one of the caps verified that it was hollow and wet on the interior with extensive damage in the area directly below.

The backup masonry was quickly determined to be a source of water infiltration. Voids in the masonry and mortar were observed in four of the six exterior probes on the south elevation. Brick-sized terracotta headers with longitudinal hollow cores were used throughout the backup masonry and serve as conduits for water. The backup mortar appeared very damp and highly deteriorated where the lime has washed out. The remaining mortar is brown and soft enough to remove with a finger, the effect of slow moisture infiltration over many years directly through the face brick. Leaking appears to be occurring randomly throughout the building, mostly on the upper floors, but at the middle and lower floors as well, particularly on the north and south elevations that are more exposed to the elements (east and west sheltered by adjacent buildings).

Fig. 6.4.14
During the probe explorations voids were found throughout the masonry assembly. It was also discovered that voids existed in the collar joints where earlier repairs had taken place in 2008, against SCA standard specifications. Courtesy: Nelligan White Architects

Fig. 6.4.15
Repointing that took place during the 2008 campaign appeared to be at an inadequate depth and contain voids. Backup masonry was found to be deteriorated and damp. Courtesy: Nelligan White Architects

Fig. 6.4.16

Fig. 6.4.16 (left)
The bastion caps, replaced in the 2008 campaign, were found to be hollow with visible water droplets present. Drawings from that repair did not indicate these caps to be hollow yet the detail was changed during construction. They are believed to be significant sources of water infiltration at the roof level. Courtesy: Nelligan White Architects

Fig. 6.4.17
Deteriorated back up brick at probe 3. Courtesy: Nelligan White Architects

Fig. 6.4.18
Mortar sample provided, the mortar is uniform in appearance and nearly white in color. The arrow indicates a residue of brownish gray material identified as a natural cement mortar. Courtesy: Nelligan White Architects

Materials Testing

As part of the probe inspection, twelve bricks and four mortar samples were removed from two locations. Generally, the backup brick is more highly absorptive and lower in strength than the face-brick. This is a typical condition for backup brick, though the levels of absorption in the backup brick were consistently well above recommended ASTM levels. These higher levels may have been contributing factors to water infiltration of the building envelope. The face-brick from both locations appears sound, although, red brick from one probe shows high initial rates of absorption. High initial rates of absorption could affect the bond between the bricks and new mortar, as the bricks will absorb water from the mortar before it has properly cured. During repointing bricks should be thoroughly pre-wetted to minimize the absorption of water from the mortar. The buff brick appeared to be the least absorptive of the bricks.

Petrographic analysis provided a breakdown of the mortar's contents; a cement-lime mortar with quartz sand and relatively high lime content. The mortar is soft and relatively absorptive, but no evidence of cracking due to physical deterioration was observed. Gray portland cement was identified in this mortar. A portion of the submitted sample contained residue of the backup brick bedding mortar, which was found to contain natural cement. The four mortars from the probe locations used four distinct sands, which may account for the slight variations in color between the similar backup or face-brick mortars.

Backup brick mortars both appear to have used natural cement which resulted in elevated percentages of fine elements in these mortars as well as the darker color of the mortars themselves. Natural cement mortars are consistent with construction practices from the 1903 period, when the building was constructed. There are some minor pack-set clots of portland cement, but these are generally no greater than one millimeter in diameter. Most of the portland cement is well distributed throughout the matrix. The original mix water was also well incorporated and there is no sign of inappropriate re-tempering. The mortar is well-compacted and well-consolidated and the air content is estimated at only 4-6% by volume. Type N mortar was recommended as a replacement mortar by the laboratory which provided the analysis.

Recommendations & Design

Findings based on visual inspection, and confirmed by non-destructive testing, and material testing prove that a major cause of water infiltration is through the backup masonry. Probes through original face brick construction and recent rehabilitation show the backup to be heterogeneous in material, with large voids in head, bed and collar joints. A main component for creating the weather tight integrity of the building enclosure and restoring its historic character is the restoration of the cornice at the street facade. The removal was the single most significant lost architectural element of the building, and served to shelter the lower floors of the facade from rainfall. Its removal was a significant contributing factor to the deterioration of the masonry structure. Terracotta ornament of the exterior was observed to be cracked and deteriorated in some places. These findings prompted the following recommendations:

Fig. 6.4.19
Samples of replacement face brick for the piers on the south elevation. Courtesy: Nelligan White Architects

LLW No. 077931 – Exterior Masonry

1. Facades (Fig. 6.4.19, 6.4.20 & 6.4.21)

- Remove and replace all face brick on all facades
- All exposed backup masonry shall be repaired, repointed, and parged
- Spray apply liquid membrane waterproofing, and attach narrow cavity drainage plane and weeps
- Provide new Micro-cotta simulated stone cornice with galvanized support
- Provide new APC window lintels and new cast stone window sills at all elevations on the fifth floor
- Provide expansion joints and continuous relieving angles at all elevations
- Install horizontal soft joints at all elevations.
- Install masonry stabilization (SS rods set in back up masonry) throughout entire face wythe
- Repair stucco at West facade, 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

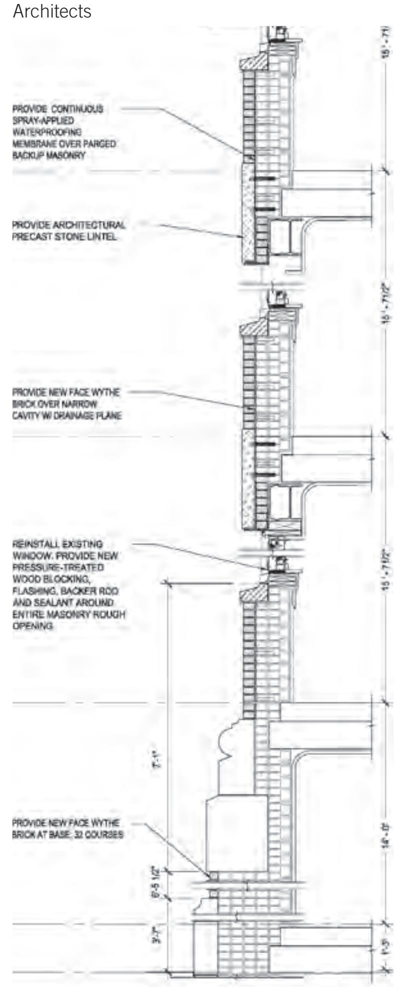


Fig. 6.4.20 (above)
Lower wall section detailing replacement of face brick. Courtesy: Nelligan White Architects

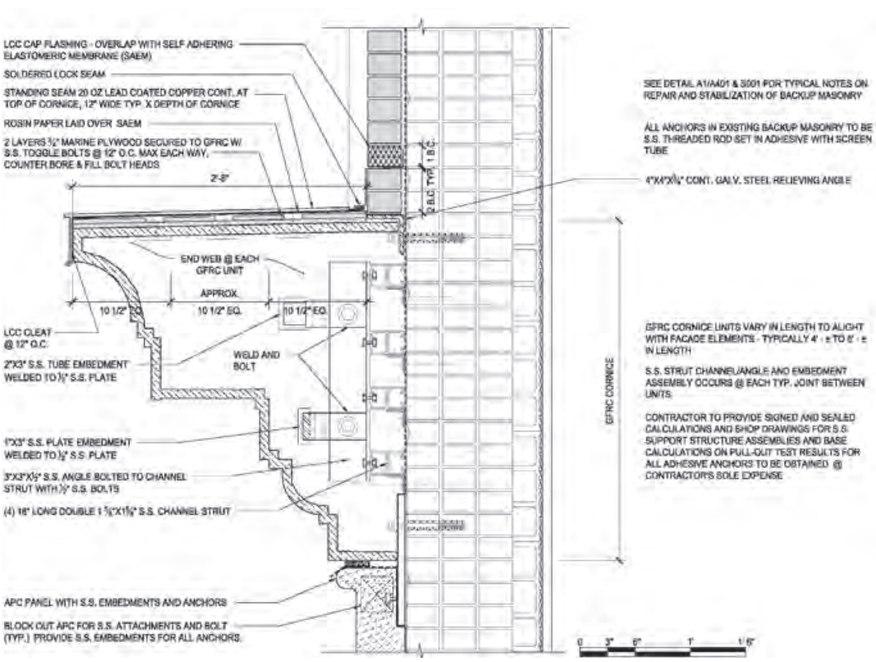


Fig. 6.4.21

Fig. 6.4.21 (left)
Detail of cornice restoration. Courtesy: Nelligan White Architects

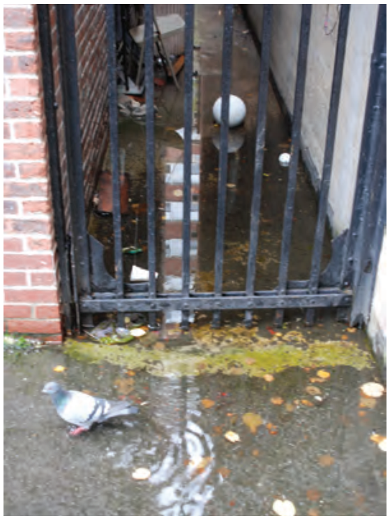


Fig. 6.4.22
Ponding observed at west alley, caused by improper slope. Courtesy: Nelligan White Architects

Fig. 6.4.23 (below)
Detail showing new pavement in west alley. Courtesy: Nelligan White Architects

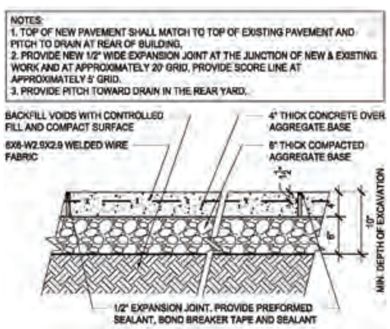


Fig. 6.3.24 (below)
Detail showing and scope of work for hatch at areaway. Courtesy: Nelligan White Architects

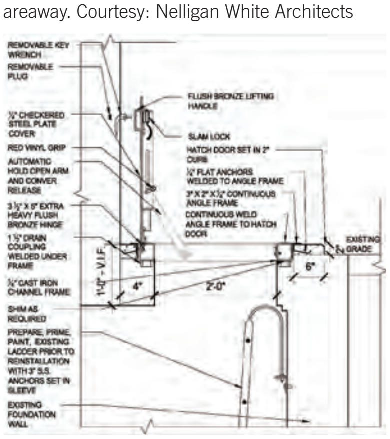


Fig. 6.4.25 (right)
Partial plan showing proposed scope of work to cellar. Courtesy: Nelligan White Architects

The foundation walls below the toilet room annex on the north side of the building are old stone walls. Mortar was damp and loose enough to remove with a finger. The walls were not damp at the time of observation, but the custodian indicated that water infiltrates the stone walls. The BCAS report indicated improper slope of paving on the northwest side of the building at the alley which resulted in ponding. At the time of observation, this ponding was still occurring. It appears that the west alley is indeed not sloped toward the sidewalk or the rear yard, where there are two existing drains. A new escape hatch and waterproofed concrete slab was installed on the south side of the building as part of a 2010 campaign. There was evidence of water infiltration from one of the corners of the hatch. Existing drawings indicate that a waterproof membrane was installed at the new slab. It appears that it was incorrectly installed. These findings prompted the following recommendations:

LLW No. 087591 – Flood Elimination

1. **Foundation** (Fig. 6.4.25)
    - Repair the mortar, parge and provide an elastomeric coating at the stone foundation walls under the toilet room annex

2. **Sitework** (Fig. 6.4.22, 6.4.23 & 6.4.24)
    - Remove and replace the paving at the west alley with a new concrete slab sloped toward the rear yard where there are two existing drains
    - Provide backer rod, compressible filler and sealant, and joints adjacent to buildings
    - Remove and replace the areaway grate and frame
    - Clean and hydro-scrub the existing drains
    - Remove and reinstall the escape hatch and frame
    - Remove the existing slab and provide a new waterproofed slab at escape-hatch

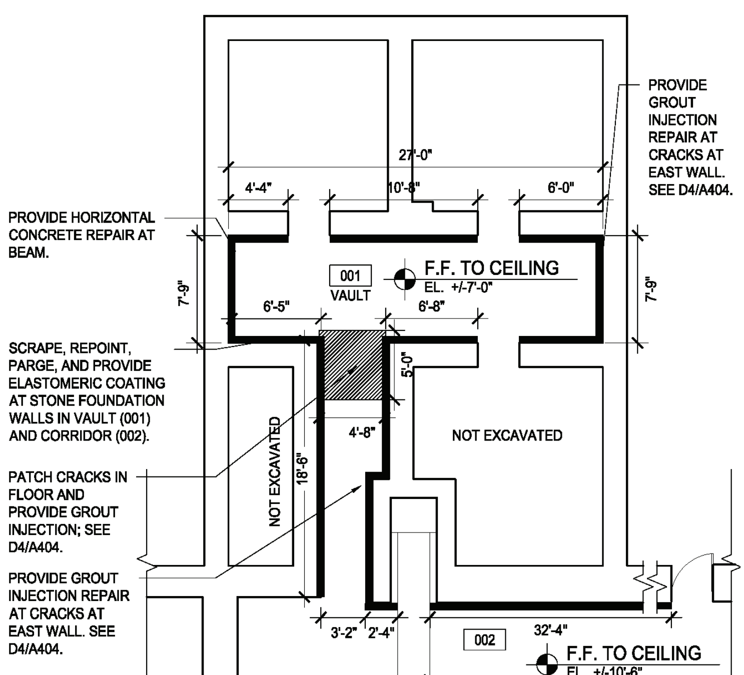


Fig. 6.4.25

Coinciding with the removal of the projecting cornice the parapet was modified to comply with contemporary code requirement of 42” in height. The original parapet brick has a high absorption rate, as indicated by the laboratory report, and can compromise the bonding between these bricks and new mortar. It is assumed this may have compromised the performance of previous repointing campaigns in controlling water penetration, specifically at the 5th floor. The added height to the original parapet also negatively affects the composition of the facade and its historic character. These findings prompted the following recommendations:

Fig. 6.4.26
Efflorescence, staining, and organic growth present at current parapet, bastion cap, and cornice. Courtesy: Nelligan White Architects

LLW No. 087591 – Parapets

1. **Parapets** (Fig. 6.4.26 & 6.4.27)
    - Remove all parapet elements down to roof slab
    - All exposed backup masonry shall be repaired, repointed and parged and subsequently protected with new SS through wall flashing
    - Install a new reinforced parapet set on a continuous relieving angle
    - Install new SS coping flashing and coping stones on parapet
    - Remove and replace the existing masonry at the buttress parapet wall and bastion caps with new GFRC caps on stainless steel flashing over a poured in place concrete slab with a closed cell foam solid infill
    - Replace the existing terracotta string course and panels at the bastion caps at the south elevation.
    - Remove and replace 3’ perimeter roof and base flashing associated with parapet replacement at the main roof
    - Remove and replace slag/corrugated arches at buttress area.

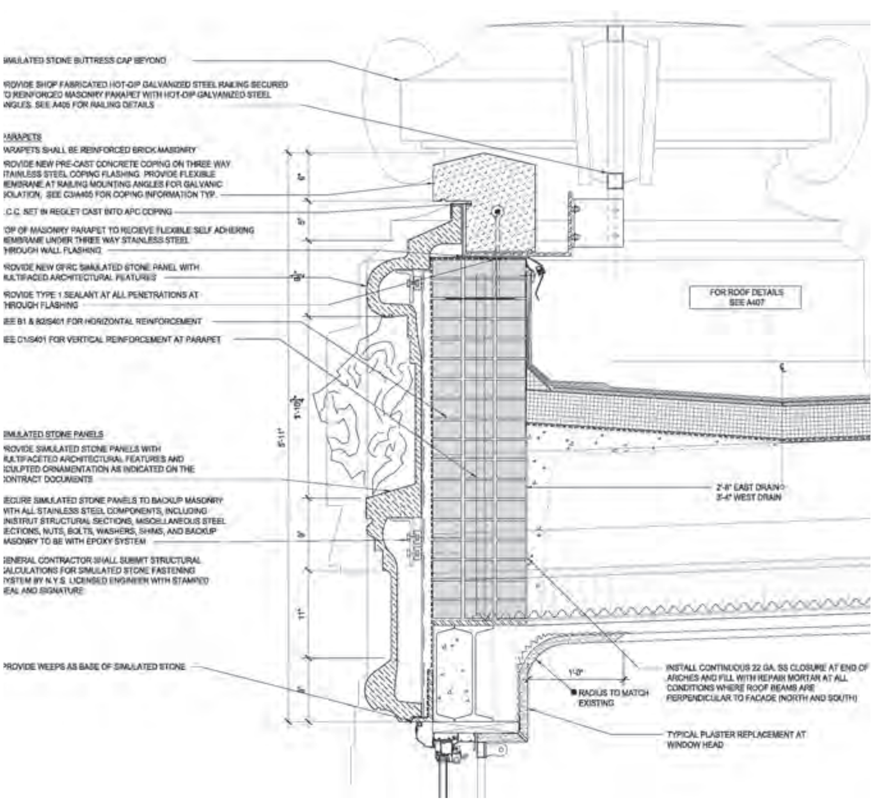


Fig. 6.4.27

Fig. 6.4.27 (below)
Construction documents detailing the scope of work at the parapet and cornice through window. Courtesy: Nelligan White Architects

SECTION 6.5

CASE STUDIES:
PS 3 M

Introduction

Building ID	M003
School Level	PS
Address	490 Hudson Street, New York, NY 10014
Cross Streets	Christopher St & Grove St
NYC DOE District	02
SHPO Status	Eligible
SHPO ID	05PR5904
Flood Zone	5
FEMA Map	3604970182F
Architect	C. B. J. Snyder
Year Built	1905
Plan Form	Irregular Rectangular
Style	Beaux Arts
Internal Sq Ft	83,000
Classrooms	55
Stories	5 + Cellar
Structural System	Solid Masonry
Columns	Cast Iron
Beams	Steel
Floors	Steel Beam with Block Slab
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.5.2

Fig. 6.5.1 & 6.5.2 (below - above right)
The auditorium entrance of the 1916 addition. PS 3 M is located in an older part of the city where the streets are not ordered based on a grid, in contrast to the northern parts of Manhattan. Courtesy: Sylvia Hardy

Nestled in the heart of the West Village in lower Manhattan is PS 3 M, constructed in 1905, under the design of C. B. J. Snyder. The school occupies about half of a city block; an irregular shape dictating the footprint of the school. It stands five stories tall, plus a basement and can be described as a Beaux arts style building. Over the years, it has remained relatively unchanged, except for a 1916 addition to the north containing an auditorium and rooftop playground as well as a variety of upgrades and renovations in the later years.

PS 3 M utilizes a solid load-bearing masonry structure with steel floor beams. It features a mansard roof that runs the perimeter of the building with both barrel and gable roof dormers. The larger gable roof dormers denote entry points, with the main entry on Hudson Street. Other features include the rusticated basement, a string course, and jack arches.

The building was found to be in generally fair condition. Three campaigns were undertaken starting in 2006 to provide repairs to masonry deterioration and upgrades to auditorium and playground spaces. Masonry at the northeast facade was coated with an elastomeric waterproofing sealant, which was found to be deteriorated and peeling in multiple locations. Additionally, vertical cracks were observed at the masonry along the northeast corner. Other minor areas of deterioration were also found at the rear facade vent tower and a lintel above the 2nd floor playground door at the northeast facade. Interior damage was also observed, most likely due to the failures of the elastomeric sealant and cracks found in the masonry.

The auditorium space located in the 1916 addition was found to be in generally fair condition but an upgrade was desired by the school. General wear and tear was observed throughout. Its biggest problems were found to be in the inadequate lighting/sound system and poor acoustics (Fig. 6.5.4, 6.5.5, 6.5.6 & 6.5.7).

Atop the 1916 addition, the current playground was found to be in fair condition, but was not serving the student population as well as it could. Two zones were requested to accommodate the mix of elementary and middle school students.

Fig. 6.5.3
Finished playground upgrade. Courtesy: Sylvia Hardy

Fig. 6.5.4, 6.5.5, 6.5.6 & 6.5.7
(below - below left)
Before and after of auditorium upgrade. Courtesy: Sylvia Hardy

Fig. 6.5.4

Fig. 6.5.5

Fig. 6.5.6

Fig. 6.5.7

Methodology

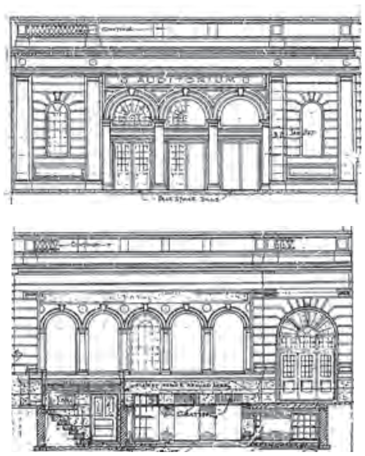


Fig 6.5.8
Facades of auditorium addition from the 1916 drawings. Courtesy: SCA Alchemy

Fig. 6.5.9 (right)
Grove Street facade from the original 1905 drawings. Courtesy: SCA Alchemy

Fig. 6.5.10 (below)
Full plan using the 1905 first floor drawing on bottom and the 1916 auditorium addition drawing. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1905, as well as drawings from 14 other projects carried out at the school between 1916 and 2003. The complete list of existing original design drawings includes floor plans, framing plans, details, sections, and exterior elevations (Fig. 6.5.9 & 6.5.10). Drawings from the 14 projects carried out at PS 03 M between 1916 and 2003 include elevations, details, floor plans, framing plans, interior elevations, and sections (Fig. 6.5.8).

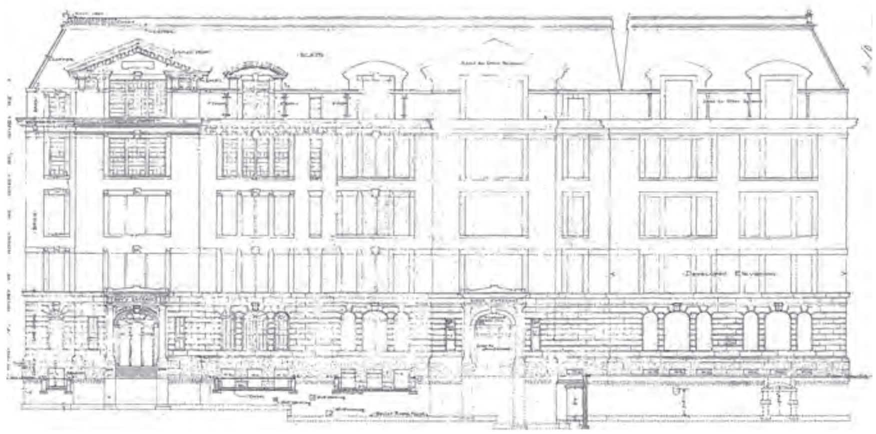


Fig. 6.5.9

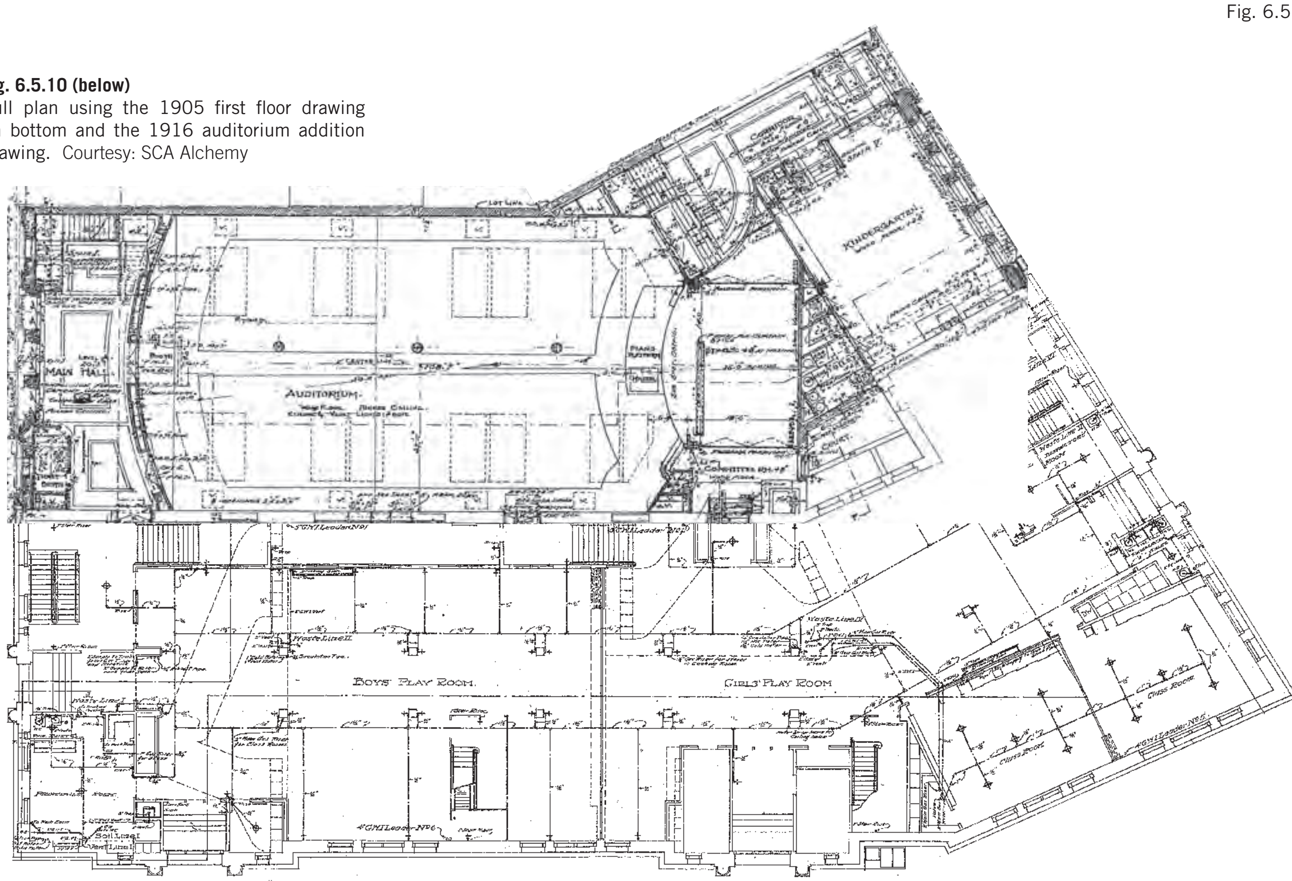


Fig. 6.5.10

Observation & Mapping

Visual surveys were performed of interior and exterior damage as well as where upgrades were desired. Existing load bearing masonry walls vary from 24-inches thick at the lower floors to 16-inches from the 3rd floor up, including the parapets. The masonry at the entire north-east facade at the end of the main building had been coated with an elastomeric waterproofing sealant. Deterioration and peeling of the sealant was observed in multiple locations (Fig. 6.5.11). Additionally, vertical cracks were found in the masonry along the north-east corner. Where the coating was bubbling and peeling off of the building, the face of the brick behind the coating, was badly deteriorated as a result of the coating ripping off fragments of brick as it detached. Around the perimeter of the building, the masonry was in good condition.

All of the masonry, from the head of the 3rd floor windows up, has been repointed in a 1996 campaign and several areas show signs of recent brick repair/replacement and stitching. Small areas of deteriorated masonry were noted around the louvers and scupper at the rear facade vent tower (Fig. 6.5.12). Cracks were also observed at the ends of the lintel above the 2nd floor playground door at the north-east facade, most likely indicative of a failing door lintel.

Minor chips were noted in the coping stones, and cracks were identified in the finial sphere. The sphere and its pedestal appear to have been coated with a glaze that was not evident on the coping stones. This glaze may have been masking the severity of the cracks in this terracotta. Although, found to be in fair condition, areas of cracking and spalling at the coping stones were observed from the building roof. It was also noted that no cap-flashing existed under the roof copings, and flashing was poorly detailed where the slate mansard roof meets the parapet wall. Step-flashing along the mansard roof however, and the mansard gutter, appeared to be in good condition.

The building has two parapet walls approximately 15-feet high; one at the north-east corner and the other at the north-west corner. Cracks were observed at both parapets on the exterior and interior/roof facades. Both parapets were braced with structural steel channels that bear directly against the masonry without any base plates. The rear of the north-west parapet wall had been coated with asphaltic tar waterproofing, which was causing the masonry to spall in some locations and was likely masking cracks in the parapet (Fig. 6.5.13). Similarly, the rear of the north-east parapet wall was coated with stucco parging that is also spalling. Original building drawings showed no vertical reinforcing in the parapets, other than the observed steel braces. At the north facade (rear elevation), the existing parapet dropped to a height of less than 30-inches above the existing roof in five locations between the existing arched dormers. The low height of this portion of the parapet presented a potentially hazardous condition.

The existing main building roof membrane was a hot-applied BUR. Although the original roof was replaced entirely in 1991 and additional portions were replaced in March 2005 (according to the Custodian), the roof was noticeably spongy, soft, and springy underfoot. The manufacturer was contacted, and no existing warranty could be found. All three existing roof drains and ten vent stacks were located too close to the parapet walls, resulting in poorly flashed conditions. Additionally, pitch pockets at steel channel bracing were badly deteriorated. The existing slate mansard roof and flashing, however, appeared to be in generally good condition.

Fig. 6.5.11 & 6.5.12 (above - below)
Deteriorating sealant on north-east facade. Deteriorated masonry around the louvers and scupper at the rear facade vent tower. Courtesy: Nelligan White Architects

Fig. 6.5.13
North-west parapet coated with asphaltic tar, braced with structural steel channels that bear directly against the masonry without any base plates. Courtesy: Nelligan White Architects

Fig. 6.5.14 & 6.5.15 (above - below)
Damaged ceramic tile in bathroom. Existing lighting and speaker in auditorium. Courtesy: Nelligan White Architects

Fig. 6.5.16 (above)
Water damage at ceiling and acoustical tiles on wall. Hooks were observed from ceiling acoustical tiles that were removed. Courtesy: Nelligan White Architects

Interior water-damaged plaster was observed in the bathrooms at the north-east end of the building on all floors. The damage appeared to be the result of the failure of the elastomeric-coated masonry. Water has also damaged portions of the ceramic wall tile in these bathrooms (Fig. 6.5.14). Additional water-damage was observed along the entire north wall of the 5th floor. This damage was likely the result of both cracks in the exterior masonry and the failing roof system.

The existing wood windows were replaced in a 1997 campaign and were in fair condition, although many were inoperable due to swelling of the jambs and thick layers of paint. Some windows have been subject to water damage from the failures of the exterior building components identified. Additionally, it was reported that approximately ten windows had broken chains and balances.

In the 1916 auditorium, the wooden stage is elevated from the main auditorium floor and is enclosed on 3 sides by floor to ceiling wood paneling with built-in doors. It was observed that the stage floor was in fair condition. There are two existing storage rooms, located to either side of the stage. From the current use of the space, it was determined that fixed seating in the auditorium would not be suitable. Folding chairs were currently used for seating needs and were stored in a storage closet to the left of the stage. These folding chairs were observed to be in poor condition. Wood flooring of the auditorium was in fair condition, with some patches of wear observed in the finish. The floor slopes down from the lobby entrance to the middle of the room, where it levels out. The south wall of the auditorium was painted with a mural spanning the majority of the wall. Remaining walls were painted off-white with a blue trim. Proper occupancy signage was observed to be lacking.

Current stage lighting was limited, including a row of PAR-type spotlights located behind the stage curtain and rudimentary spot lighting mounted on arms to either side of the stage proscenium. (Fig. 6.4.15). Sufficient electrical power for theatrical lighting was either nonexistent or too antiquated for current requirements. An unused projection booth was observed opposite the stage, on the west wall. A total of 26 enclosed two-lamp fluorescent fixtures were surface mounted along the lengths of the existing plaster-encased ceiling beams. Additional lighting was provided by 6 sconce uplights, all protected by wire guards, which were located along the north and south walls of the auditorium. The electrical panel serving the stage, auditorium, and possible other areas was located in the west property room.

Plaster ceilings were painted off-white. Eight original skylights were filled in to be in line with the existing ceiling. Water-damage was observed from continual infiltration during the last four months of 2007. Damage was concentrated along one beam at the north-west corner of the space. Acoustic panels, similar to the existing wall panels, had been hung from the recesses of the filled in skylights in the ceiling, but were removed when the panels began to fall off of the ceiling. (Fig. 6.5.16).

A series of large rectangular acoustic panels are hung from the top edge of the north, south and west walls. Other areas appear to have had acoustic panels that had become detached and/or been removed. The acoustics of the space was observed to be very poor, as the space was composed of hard, sound-reflective surfaces. The existing sound system was functional it was functional as a sound system, but the lack of interface with the PA can only be remedied with new sound equipment.

The student load and the varied uses of the auditorium required that the space be divided occasionally. Structural engineers studied the original framing plans and the existing space; they estimated that the auditorium is framed with steel filler beams spaced approximately 5’-2” on center with a cinder slab spanning between. These beams then frame into a deeper steel girder which is supported by a series of cast iron columns. There also appears to be a dropped ceiling below the bottom of the framing.

At the existing playground, equipment consisted of a movable basketball hoop located at the eastern side of the rooftop and a piece of playground climbing equipment was located on the child safety surfacing on the western half of the site. (Fig. 6.5.17 & 6.5.19). The play area was requested to include two zones for running and climbing to accommodate the different age groups of the elementary and middle school students. Dark gray rubber child safety surfacing covered approximately 1600-square feet of the western half of the rooftop.

Local lighting was observed at both stair bulkheads, at the northeast and northwest sides of the roof. At each bulkhead, there were two surface-mounted fixtures of approximately 200W each, one double headed emergency remote fixture and one emergency exit sign. All existing light fixtures were protected by wire guards.

For the rooftop paving, asphaltic concrete pavers are laid over a modified bituminous membrane. Concrete pavers and roof were observed to be in fair condition. Due to the slope of the roof, it was noted that water collects and freezes in the winter and remains frozen because the roof is in shade. This results in the space becoming unusable for most of the season. Metal chain-link fences were located in the open spaces at the north, east, and west edges of the playground.

Fig. 6.5.17 & 6.5.18 (above - below)
Existing basketball hoop. North facade of main school building from playground. Courtesy: Nelligan White Architects

Fig. 6.5.19 (below)
Existing playground equipment. Courtesy: Nelligan White Architects

Fig. 6.5.19

Non-Destructive Testing

Due to the water infiltration observed at the auditorium, ceiling spray tests and thermal images were utilized to ascertain the cause of the infiltration. It was thought there were two possible causes for the infiltration; deterioration of the parapets and/or the removal of the roof assembly to allow for installation of new rooftop playground equipment.

The parapet testing did not result in visible water ingress, but the existing damage to the walls below suggests that a longer testing period may result in some water infiltration at that location. Taking the lack of water ingress at the parapets into account, the findings definitively illustrated that the main source of water infiltration at the beam originated from the area of the play roof, approximately 9'-6" in from the interior edge of the north parapets, directly above the beam. Since this location falls well within the new roof assembly, a possible explanation was that the detail for the installation of the new roof assembly at the edge of the existing roof was not executed properly and was now resulting in water infiltration. Due to the extent of water damage throughout the ceiling of the Auditorium, it was recommend that additional infrared tests be conducted at a number of locations around the perimeter of the new roof assembly to ascertain if there were further weaknesses (Fig. 6.5.20 & 6.5.21)

Estimating a volume of 78,000 cubic feet, the acoustical engineer calculated a mid-frequency reverberation time of 3 seconds during low occupancy times, such as gym classes. The reverberation time is slightly improved in full occupancy situations, but is still lacking. According to the acoustical engineer, for a room of this volume to achieve satisfactory conditions for lower occupancy situations such as gym class, adequate sound absorption should be provided to reduce the mid-frequency reverberation time to approximately 1 second.

Fig. 6.5.20 & 6.5.21 (below - far below)
Thermal control image and again at 15 minutes into the spray test. Courtesy: Nelligan White Architects

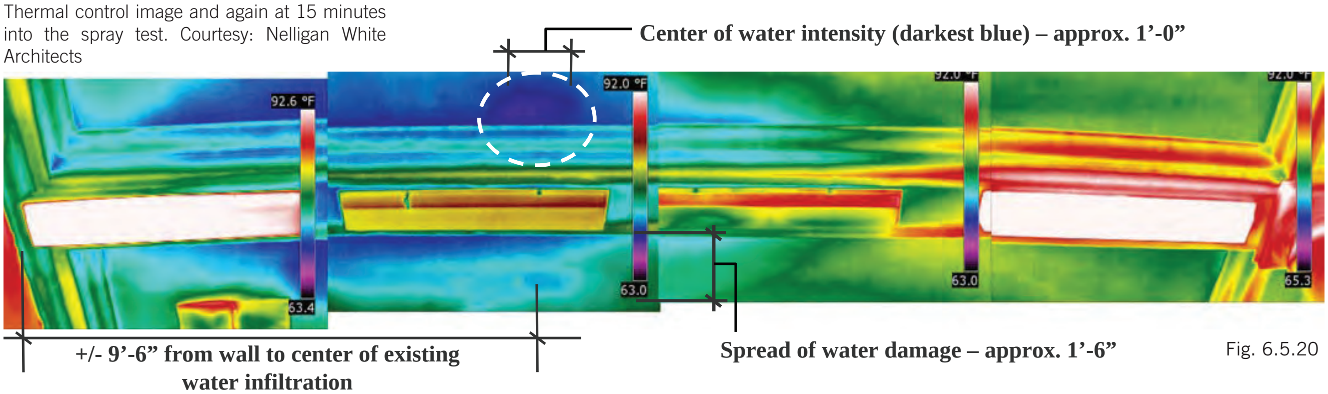


Fig. 6.5.20

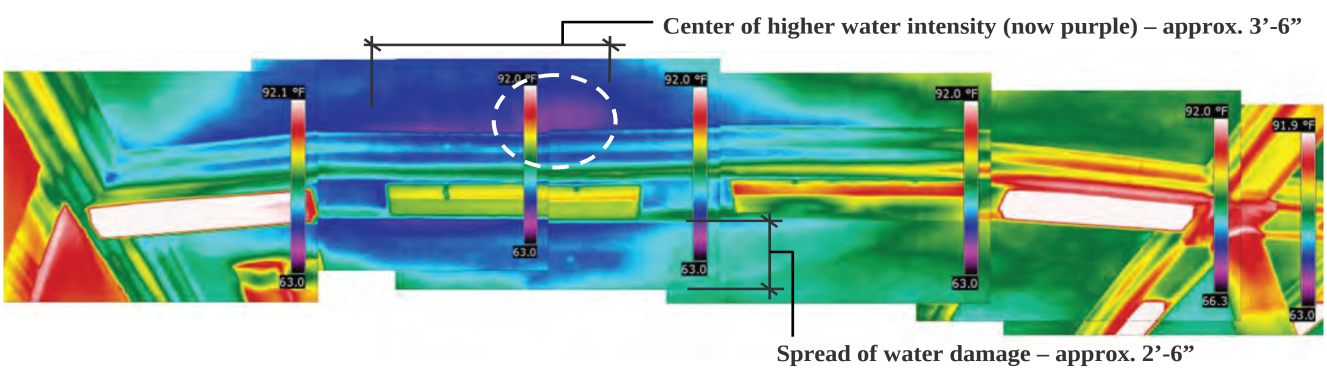


Fig. 6.5.21

Exploratory Probes

Two probes were opened at vertical cracks observed in the masonry of the north-east corner; one at the third floor (Fig. 6.5.24), and the other at the fifth floor. Where the crack aligned with the mortar joints of the back-up masonry, the depth was measured at up to 8-inches (Fig. 6.5.25). In all other observed areas, however, the crack did not extend beyond the face-brick. The interior probe of the plaster in the fourth floor Girl's Toilet Room confirmed that the cracks observed on the building exterior do not extend through to the building interior. Inspection of the exterior probed areas revealed generally damp masonry behind the elastomeric coating. (Fig. 6.5.23). These damp conditions appeared to be the result of moisture trapped behind the impermeable coating. The backup masonry at the probe locations was in relatively poor condition, and the mortar and collar joints were open and/or washed out. A probe was taken at the location of the water damage at the auditorium ceiling, and it was found that the concrete encasement of the steel beam had been saturated with water and dripped to the ceiling below. (Fig. 6.5.22)

Fig. 6.5.22 & 6.5.23 (above - below)
Saturated concrete encase steel beam at the auditorium. Interior probe revealed crack observed on the north-east facade did not go through the wall, however, the observed mortar was damp. Courtesy: Nelligan White Architects

Fig 6.5.24

Fig. 6.5.36

Fig. 6.5.24 & 6.5.25 (top left- left)
Crack at north-east corner facade at 3rd floor. Probe at north-east corner crack at 3rd floor. Courtesy: Nelligan White Architects

Materials Testing

A survey was conducted in order to determine the presence of asbestos containing materials (ACM). All past available Board of Education (BOE) and SCA files detailing ACM were reviewed from both the facility files and SCA headquarters. These included AHERA, OCH, and ICH files. ACM, which may be affected by the scope of work, were positively identified at various locations throughout the building (Fig. 6.5.27)

Polychlorinated Biphenyl (PCB) suspect materials were also tested at the rooftop playground. Of the samples collected including flashing materials and caulking it was determined that PCBs were not found (Fig. 6.5.26)

Fig. 6.5.26 & 6.5.27 (below - far below)
Partial PCB and ACM report. Courtesy: Louis Berger & Assoc. P.C., New Environmental & Material Testing Laboratories, Inc.

HA	Location	Material Description	No. of Samples	Results [ppm]	Quantity affected by SOW	Comments
A	Rooftop Playground Parapet Wall	White/Beige Caulking To Metal Coping Cover	3	Non-PCB	---	
B	Rooftop Playground Parapet Wall	Grey/Black Flashing Material b/w bot. & top of Copper Parapet Wall	3	Non-PCB	----	
C	Rooftop Playground Parapet Wall	Black Caulk Sealant b/w Parapet Wall & Roof Pavers	3	Non-PCB	---	
D	Rooftop Playground Parapet Wall	White/Green Caulk to Metal Coping Cover	3	Non-PCB	---	

Fig 6.5.26

Proposed Work:	Homogenous Area No.	Location	Material	No. Of Samples	Results	Affected ACM Quantity	Notes
Auditorium Upgrade LLW# 046783	1	Basement, Electrical / Boiler Room	Red Fire stopping at Wall Penetration	3	ND	0	
	9	Basement, Electrical / Boiler Room	Wall Brick	0	Not Suspect Material	0	
	10	Basement, Electrical / Boiler Room, Electrical Distribution Panel	Ceiling Plaster, Brown Coat	0	No ACM	0	1999 AHERA
	2	Basement, Electrical / Boiler Room, Electrical Distribution Panel	Electrical Wire Insulation and Backer Panel	0	Assumed ACM	0	See note 3
	11	Basement Boiler Room	Thermal System Boiler, Breaching and Pipe Insulation	0	ACM	0	1999 AHERA Should not be impacted by planned scope of work
	3	Basement	Blue Floor Paint	3	ND	0	
	4	Basement	Gray Wall Brick Mortar	3	ND	0	
	4.1	Basement	Wall Brick	0	Not Suspect Material	0	
	12	Basement, Throughout	Wall Plaster, White and Brown Coats	0	No ACM	0	1999 AHERA
	13	Basement, Throughout	Ceiling Plaster, White and Brown Coats	0	No ACM	0	1999 AHERA
	14	Basement Throughout	Soffit Plaster, White and Brown Coats	0	No ACM	0	1999 AHERA
	5	1st Floor, Auditorium	Door Core Insulation within Oak Doors	0	Assumed ACM	0	See Notes 1 & 4

Fig. 6.5.27

Recommendations & Design

Deteriorated elastomeric-waterproofing sealant was observed at the north-east facade. This deterioration is also causing spalling of the face-brick. Cracks were also observed at the north-east corner, probes found the cracks did not extend beyond the face-brick or to the interior. Damp masonry behind the sealant was found as well as deteriorated back up masonry. The collar joints were found to be open and/or washed out. Around the perimeter of the building brick repairs were observed as well as small areas of deterioration around the louvers and scupper at the rear facade vent tower.

Cracks at a lintel above the second floor playground door were observed. Terracotta coping stones and finals were found to suffer from minor chips and cracks. No cap-flashing was found under the roof copings. The step-flashing at the mansard roof and gutter were found to be in good condition. Interior damage ranged from damaged plaster and tiles at the bathrooms at the north-east end. Additional interior damage was observed along the entire north wall of the fifth floor. These findings prompted the following recommendations:

LLW No. 045602 – Exterior Masonry

1. Exterior Walls

- Replace face-brick of all elastomeric-coated masonry at the north-east facade of the main building
- Special precaution should be noted due to the deteriorated backup masonry when performing the demolition of the face-brick (Fig. 6.528)
- Additional reinforcing at the building corners at Grove Street is to be considered to prevent future cracking of the replacement face brick
- Replace the face-brick around the failing scupper and rusting louvers at the rear playground vent tower facade
- Replace scupper, flashing, and metal louvers
- Remove existing lintel above the 2^{nd} floor playground door at the north-east facade
- Provide new galvanized loose lintel with copper composite flashing
- Replace existing door and frame with new hollow metal door and frame
- New masonry should match existing

Fig. 6.5.28
Exposed backup brick awaiting new face-brick wythe. Courtesy: Nelligan White Architects

2. Copings, Finials, & Cap Flashing

- Remove all damaged and/or deteriorated terracotta copings and finials
- Replace copings and finials with cast stone to match existing
- Remove and reset all existing copings to install new continuous lead coated copper cap flashing
- Caulk all coping stone joints

3. Painting/Plastering

- Repair all interior water damaged plaster on all floors at the north-east building corner
- Paint entire affected surfaces
- Replace deteriorated ceramic wall tile in affected bathrooms

Fig. 6.5.29
New structural steel parapet bracing under construction. Courtesy: Nelligan White Architects

Additional Recommendations

1. Parapets

- Remove and replace existing 16-inch wide solid masonry parapets including vertical rebar and truss wythe reinforcing
- Provide new galvanized structural steel parapet bracing and bearing plates (Fig. 6.5.29)
- Repair existing slate mansard roof and copper step flashing at parapets
- Coordinate parapet work with roofing work
- Provide galvanized steel guardrail, 42-inches tall, inset from parapet and hidden from sight lines at the low portions of parapet along the north facade

2. Roofs (Fig. 6.5.30)

- Replace entire main building roof with new insulated built-up roofing
- Provide three new roof drains, ten new vent stacks, and plumbing to offset existing leaders
- Locate new drains and stacks a minimum of 3 feet from perimeter parapets
- Pitch roof with tapered insulations
- Provide new counter flashing at parapets
- Provide upturned membrane with collar clamp flashing at new structural steel parapet braces, vent stacks, and new parapet guardrail
- Repair all interior water damaged plaster along the north wall of the 5th floor and wall/ceiling plaster at relocated roof drains and stacks
- Paint entire affected surfaces

3. Windows

- Recondition all 249 existing wood windows
- Remove stiles and interior trim as required to service hardware and sand finishes
- Replace broken chains and balances
- Remove all existing sealant and provide new sealant between windows and exterior masonry

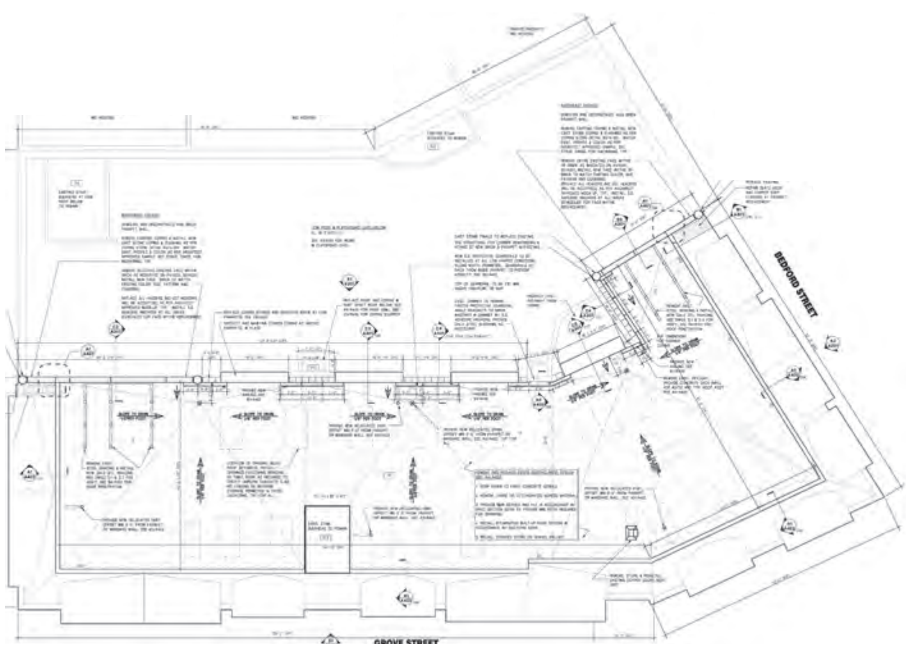


Fig. 6.5.30

Fig. 6.5.30 (right)
Roof plan showing extent of work. Courtesy: Nelligan White Architects

The 1916 auditorium was found to be in generally fair condition but an upgrade was desired by the school. General wear and tear was observed throughout. Its biggest problems were found to be in the inadequate lighting/sound system and poor acoustics. These findings prompted the following recommendations:

LLW No. 046783 – Auditorium Upgrade

1. Architectural

- Refinish stage floor
- Restore wood paneling surrounding the stage (Fig. 6.5.31)
- Investigate new folding or movable seating systems, including storage implications
- Purchase three 9-foot collapsible risers for use in school productions
- Refinish and patch floor as necessary
- Remove existing hooks from the filled in ceiling surface of former skylights
- Investigate feasibility of raising the height of the infill
- All walls are to be repainted after plaster repair is completed

2. Electrical

- Remove all existing lighting in the auditorium
- Remove abandoned surface mounted conduit
- Provide new lighting system consisting of stage spotlights, border lights, dimming controls, portable control console, and a stage control panel
- Include one backdrop rigging bar at the rear of the stage
- Provide a new 300 amp, 208/120V, 3 phase feeder from the main switchboard in the basement electrical room for the dimmer control panel
- Control console will be located in front of the stage
- One additional DMX outlet shall be place onstage for movement of the lighting board
- One panel with Master Fader and Preset faders shall be located on stage in a lockable metal enclosure
- Three panels of Preset buttons shall be located at the entrances to the auditorium in a lockable metal enclosure
- Provide switches for all lighting fixtures to avoid use of circuit breakers for switching
- Provide electrical service to projection booth

3. Structural

- Install one new electrically operated Panelfold Moduflex panel partition system (Fig. 6.5.32)
- Provide two safety key switches, one at each side of partition in compliance with specifications
- Reinforce as necessary the exiting filler beam to support new partition
- If partition does not line up with an existing beam provide a new cross supporting piece

4. Acoustical

- Provide sound absorptive areas in ceiling coffers and the north, west and south walls of the auditorium to achieve a noise reduction coefficient (NCR) or sound absorption average (SAA) of 1.0 or higher

Fig. 6.5.31
Panel partition folds into niche when open. Courtesy: Nelligan White Architects

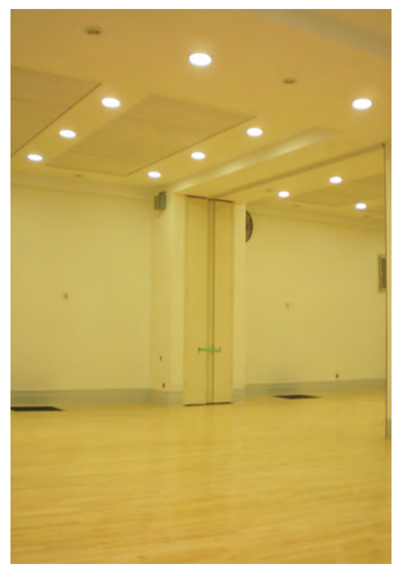


Fig. 6.5.32
Refinishing of wood paneling surrounding the stage nearing completion. Courtesy: Nelligan White Architects

Additional Recommendations

1. Sound System

- Install one SCA standard auditorium sound system and provide connection to future installation of school-wide PA and FA systems

Fig. 6.5.33 & 6.5.34 (below - far below)
Section and floor plan showing extent of work.
Courtesy: Nelligan White Architects

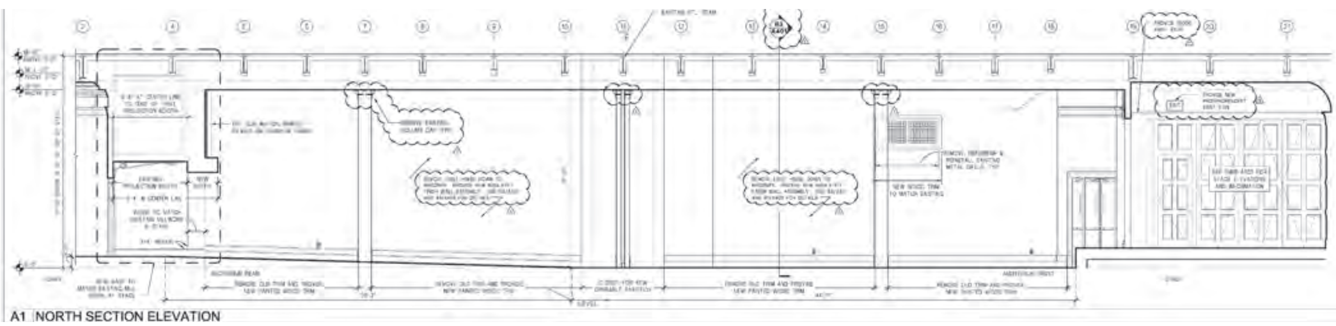


Fig. 6.5.33

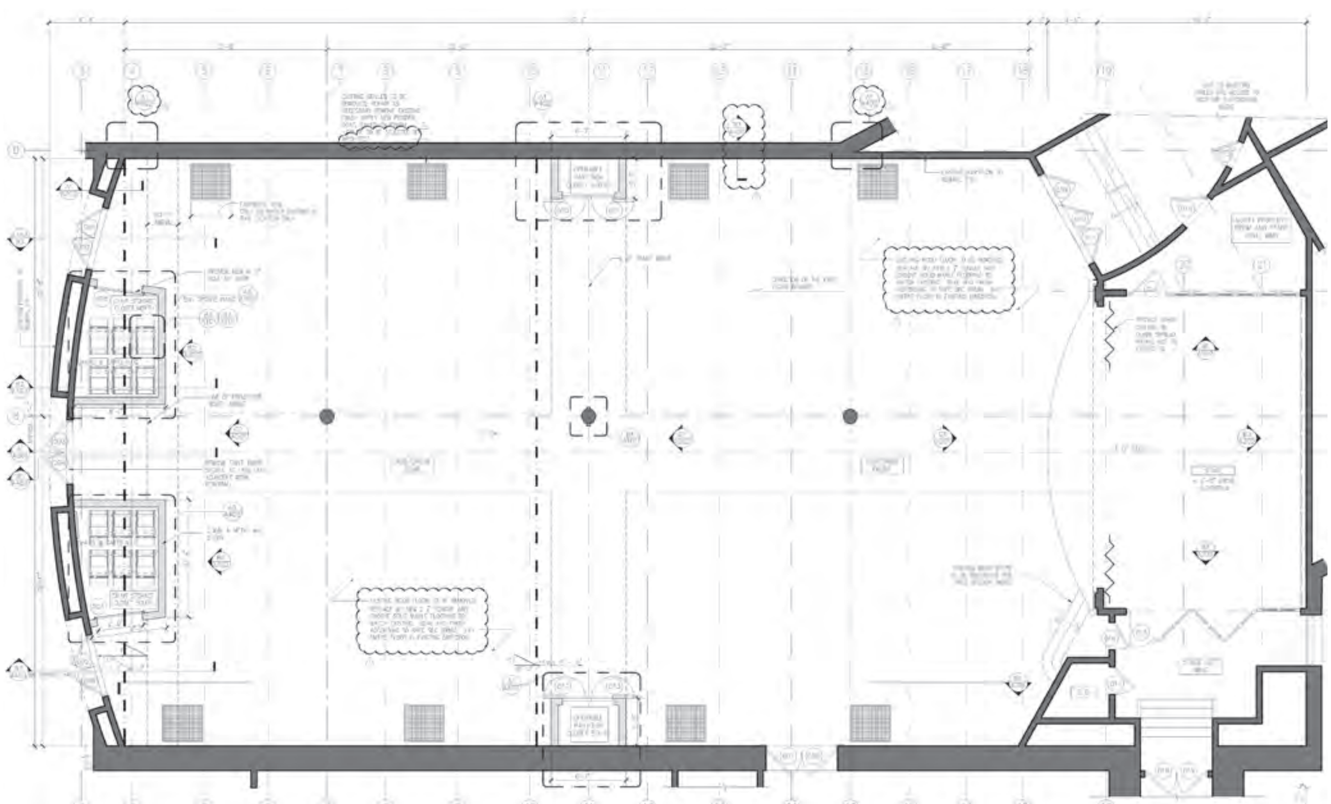


Fig. 6.5.34

While the playground was in fair condition, it was not suiting the needs of the current mixture of elementary and middle school students. One of the major problems is the collection and freezing of water in the winter, rendering the space unusable. This is due to the sloping of the roof. These findings as well as requests from the principals prompted the following recommendations:

Fig. 6.5.35
Roofing repair at playground. Courtesy: Nelligan White Architects

LLW No. 044973 – Rooftop Playground

1. Equipment

- Provide three additional basketball hoops
- Provide one new Kid Builders All Steel playground equipment system from Little Tykes Commercial Play Systems, Inc
- Provide ample space for running

2. Child Safety Surfacing

- Replace existing padding with Spectralock Safety Tiles as manufactured by PlaySafe Surfaces, Ltd to accommodate the new design of the playground

3. Lighting

- Bring present illumination to 50 foot-candles
- Surface mount 12 metal halide fixtures to main school building's north facade
- Replace 2 emergency exit signs and its applicable hardware
- Replace 2 double headed emergency remote fixtures
- Install one Watt Stopper Smartwired pre-assembled panel with 365-day scheduling exterior photocell, astronomic control, and timed override.
- Install new electrical sub-panel adjacent to new auditorium panel in north property room, adjacent to stage
- Install interior conduit in EMT with bushings and exterior conduit in screwed water tight conduit per SCA design requirements

4. Rooftop Quality

- Retain the existing asphaltic concrete pavers where possible

Fig. 6.5.36 (below)
Typical playground equipment connection to roof. Courtesy: Nelligan White Architects

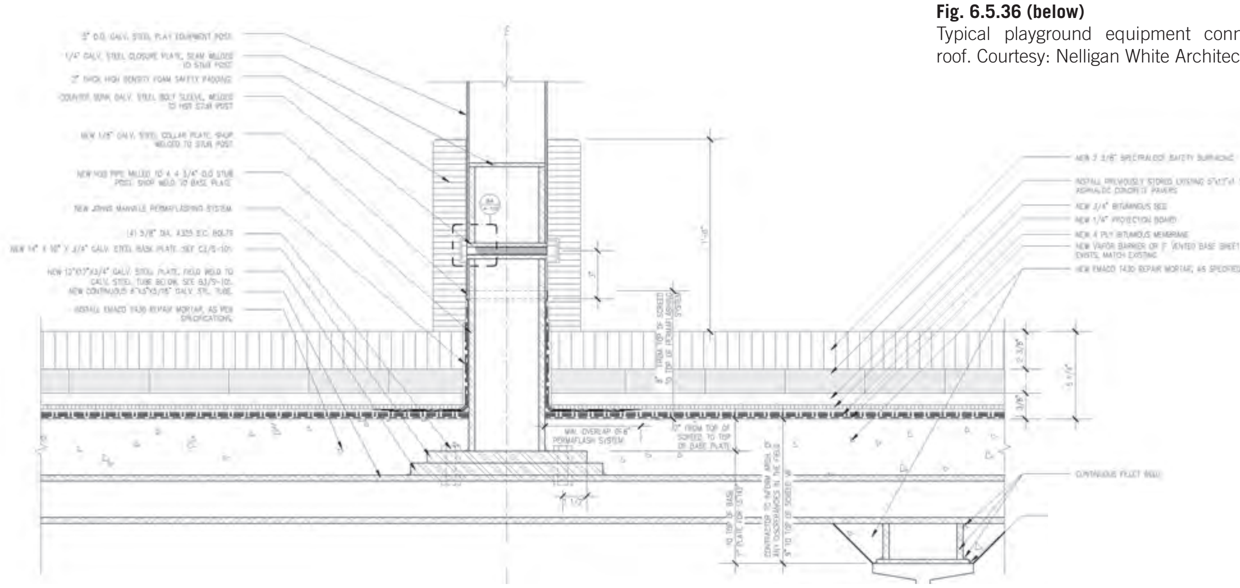


Fig. 6.5.36

Constructability & Lessons Learned

Fig. 6.5.37
Netting was installed to prevent more sealant and brick from falling off. Courtesy: Nelligan White Architects

Fig. 6.5.38 (below)
Deteriorated brick at north-east facade. Courtesy: Nelligan White Architects

For being just over 100 years old, PS 03 M was found to be in overall fair condition. A campaign was undertaken to repair water damage at the interior, largely corresponding with the damage observed at the northeast facade. Upgrades were also undertaken, specifically the upgrade of the auditorium and rooftop playground.

Masonry

An elastomeric-waterproofing sealant had coated the entire north-east facade at the end of the main building. Overall the sealant was in poor condition; peeling and bubbling was observed throughout. As a result, brick that was exposed was also in poor condition, as the sealant had been fraying off fragments when it peeled away. Vertical cracks that aligned with the mortar joints were also observed at the north-east facade.

Through investigations, it was determined that moisture was becoming trapped behind the impermeable elastomeric coating causing the deterioration. While the masonry was found to be damp along with mortar and collar joints open the cracks observed were not found to extend beyond the face-brick.

Repair of the coating, as was first suggested, could have resulted in a continual trapping of moisture that would lead to progressive freeze/thaw spalling and deterioration. Additionally, removal of the coating was not possible without causing major damage to the surface of the face-wythe masonry.

Fig. 6.5.38

Auditorium

The auditorium space in the 1916 addition was in fair condition, but was not serving the school well. Its current use dictated that the space not only be used as intended, but for other activities as well. Upgrade to the lighting and sound equipment were done as well as addressing the acoustical issues. In order to better serve the multi-purpose uses of the space, the installation of panel partition system was included to divide the space when necessary. Additionally, the use of fixed seating was not considered, only the replacement of existing chairs.

Before work began on the auditorium, leaking was observed at the ceiling in the last few months of 2007. This leaking was a new occurrence and had not been observed before. While the water-damage was visible throughout the ceiling finish, the primary concentration of water was located along one beam at the north-west corner of the space. A probe taken at this location found that the concrete encasement of the steel beam had been saturated with water and dripped to the ceiling below.

Two possible causes were targeted for investigation:

1. Water infiltrating from the deteriorated parapet above or
2. Due to issues with the playground installation.

Parapet repairs were already included in the extent of work for the auditorium. As for the playground, portions of the existing roof assembly were removed and then replaced once the equipment posts had been securely fastened to the roof structure. Spray tests were performed in the suspected area. At the parapet, testing did not result in visible water ingress, but the existing damage to the walls below suggests that a longer testing period may result in some water infiltration at that location.

Taking the lack of water ingress at the parapets into account, the findings definitively illustrated that the main source of water infiltration at the beam comes from the area of the play roof, approximately 9'-6" in from the interior edge of the north parapets, directly above the beam. Since this location falls well within the new roof assembly, it was most likely that the detail for the installation of the new roof assembly at the edge of the existing roof was not executed properly and was resulting in water infiltration.

Fig. 6.5.39
Water-damage at auditorium ceiling. Courtesy: Nelligan White Architects

Fig. 6.5.40
Area of roof above most significant leaking. Courtesy: Nelligan White Architects

Fig. 6.5.41

Fig. 6.5.41 (left)
Interior scaffolding in auditorium. Courtesy: Nelligan White Architects

SECTION 6.6

CASE STUDIES:
PS 159 K

CASE STUDIES:
PS 159 K

Introduction

Building ID	K159
School Level	PS
Address	2781 Pitkin Avenue Brooklyn, NY 11208
Cross Streets	Hemlock St, Crescent St
NYC DOE District	19
SHPO Status	Ineligible
SHPO ID	
Flood Zone	Outside Flood Zone
FEMA Map	
Architect	C. B. J. Snyder
Year Built	1907
Plan Form	Modified Rectangular Plan
Style	Classical Revival
Internal Sq Ft	65,000
Classrooms	36
Stories	4 + Basement
Structural System	Load Bearing Masonry
Columns	Steel (Interior Only)
Beams	Steel
Floors	Terracotta Arches, Cinder Slab
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.6.1

Public School 159 K is a rectangular plan building constructed between 1907 and 1908, designed by architect C. B. J Snyder. The walls are load-bearing masonry with interior steel columns. RKTB was assigned a Parapet, Exterior Masonry, and Flood Elimination Job at the school in 2007.

Fig. 6.6.1 (above right) & 6.6.2 (right)
PS 159 K after "over-cladding" rehabilitation. Courtesy: RKTB Architects, P.C.

Fig. 6.6.3 (below)
Close-up of 4th floor banding with cornice removed Also notice the flaking coating at brick. Courtesy: RKTB Architects, P.C.

Fig. 6.6.2

Fig. 6.6.5

The goal of this case study is to focus on *"over-cladding"* as an alternate to common face-brick replacement on load bearing masonry buildings. The term *"over-cladding"* is used to describe the process of adding a layer of brick masonry to an existing structure. The exterior envelope becomes approximately 4 ½" thicker in areas of over-cladding. RKTB Architects developed over-cladding as a design solution to resolve many of the problems encountered when replacing face-brick on load bearing masonry buildings. We have successfully used the process on several schools, including PS 174 K, PS 159 K, and PS 088 K.

Pros:

- Significant cost savings because face-brick removal is not required.
- The building is load bearing masonry, subsequently, the face brick is also part of the structure. Any removal of existing face-brick is therefore removing a portion of the structural load-bearing wall.
- Before adding the new layer of face-brick, we recommend parging and adding an air barrier, and drainage mat to the existing wall. This prevents water from traveling through the wall and into the building.

Cons:

- Replacement of stone headers and sills with additional depth is required to accommodate the new wall thickness (This is only a con if existing headers and sills are in good condition).
- Some excavating may be required to provide a brick shelf at the base of the building, however many schools have an existing stone ledge at the first floor that is an adequate depth for the proposed additional layer of face-brick.
- If the existing building wall aligns with the property line, over-cladding is not possible.
- SHPO has objected to over-cladding on eligible schools. After much discussion we were able to have them approve the design with some caveats, see the full discussion in the *"Constructability and Lessons learned"* section.

Fig. 6.6.4 (above)
Typical Interior Plaster Damage. Courtesy: RKTB Architects, P.C.

Fig. 6.6.5 (left)
PS 159 K before exterior over-cladding job. Courtesy: RKTB Architects, P.C.

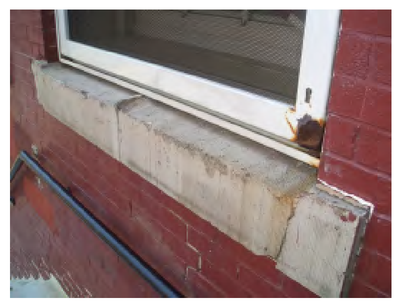


Fig. 6.6.6
Damaged terracotta sill. Courtesy: RKTB Architects, P.C.

Fig. 6.6.7
Existing steel header resting on coated blue stone bearing block. Courtesy: RKTB Architects, P.C.

Methodology

Fig. 6.6.8
Cracking over an area of masonry with a non-breathable coating, which was later found to contain asbestos. Courtesy: RKTB Architects, P.C.

Fig. 6.6.9 (below)
Close-up of face brick showing discoloration, inconsistent mortar joints, and flaking paint at the limestone below. Courtesy: RKTB Architects, P.C.

Exterior Masonry Findings:

The school had severe interior water damage on the fourth floor and moderate damage on the lower floors. Water damage consisted of plaster damage in most rooms. In the most severe areas the plaster and 2" interior layer of terracotta block had collapsed exposing a damp brick wall.

- During previous jobs, parapets had been replaced and galvanized iron cornices at parapet were removed. In addition the cornice between third floor window heads and fourth floor window sills had been removed and covered with a stucco layer.
- Brick masonry was coated with a non-breathable masonry coating. The coating was spalling in many areas, with large flaking pieces falling off of the building surface. Later ACM testing found the building coating to be asbestos containing.
- There were numerous open joints, as well as chips, spalling, and crazing at terracotta sills.
- Some window heads were cracked and stained due to rusting lintels and hangers. Some heads were shifted out of alignment due to corrosion of hangers. Probes later indicated near total corrosion of steel anchors. Steel window heads on the rear elevation were also rusting and allowing water into the building.
- The granite and limestone base was in fair condition but coated with multiple layers of paint.

Fig. 6.6.9

Parapets Findings:

- The original parapet was replaced during a 1991 parapet replacement project. Existing parapet was in very poor condition. A large part of the parapet facing Pitkin Avenue had shifted and was structurally unsound. After the initial site visit sidewalk bridging was requested in areas of hazardous masonry.
- Caulking at parapet expansion joints had failed.
- Parapet masonry was saturated with moisture and moss growth was found on the mortar joints.
- A large portion of the parapet interior had a black coating.
- Through-wall flashings and cap flashings were in poor condition.

Fig. 6.6.12

Non Destructive Testing:

A water ingress investigation was requested and performed using nondestructive testing methods such as spray and thermal imaging. The test concluded that water infiltration occurred at multiple locations of the exterior envelope, including:

- Poorly jointed brickwork at the corner quoins.
- The non-breathable coating caused water to become trapped behind the coating, slowly saturating the solid masonry walls.
- Open joints at terracotta sills.
- The area between third and fourth floor where the cornice was previously removed had multiple positive spray tests.
- Parapet spray tests showed water penetrating the masonry, coping joints, through-wall flashing and cap flashing and traveling down the wall and emerging at the interior wall finishes of rooms below.

Fig. 6.6.10
Failed expansion joint and shifted parapet. Courtesy: RKTB Architects, P.C.

Fig. 6.6.11
Vegetation at parapet mortar joints. Courtesy: RKTB Architects, P.C.

Fig. 6.6.12 (above left)
Black coating at parapet interior. Courtesy: RKTB Architects, P.C.

Fig. 6.6.13 (below)
A typical positive spray test results at a 4th floor classroom. Courtesy: RKTB Architects, P.C.

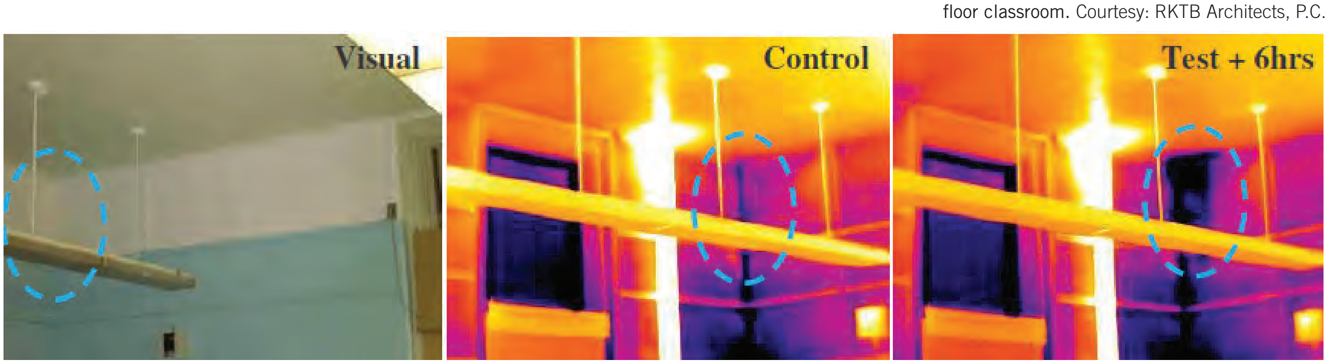


Fig. 6.6.13

Fig. 6.6.14
Probe showing the bearing end of steel beam. Courtesy: RKTB Architects, P.C.

Probes:

- Exploratory probes revealed open collar joints and washed out mortar cavities in the masonry back up.
- Exploratory probe openings were performed to verify the condition of the existing steel lintels and headers.

1. **Window header beams:** Probes showed that the existing steel had no flashing except in areas where the new parapet was installed. Most of the exposed steel was found rusted but not deteriorated.
2. **Lintels:** Existing lintels were deteriorated to varying degrees throughout the building.
3. **Floor beams:** Floor beams at masonry piers bear directly onto masonry walls. Some beams were installed directly behind the face bricks. In these areas, the ends of the floor beams had rusted causing cracks in the face brick.

Fig. 6.6.15 (below)
PS 159K original 1907 elevation. Courtesy: SCA Alchemy

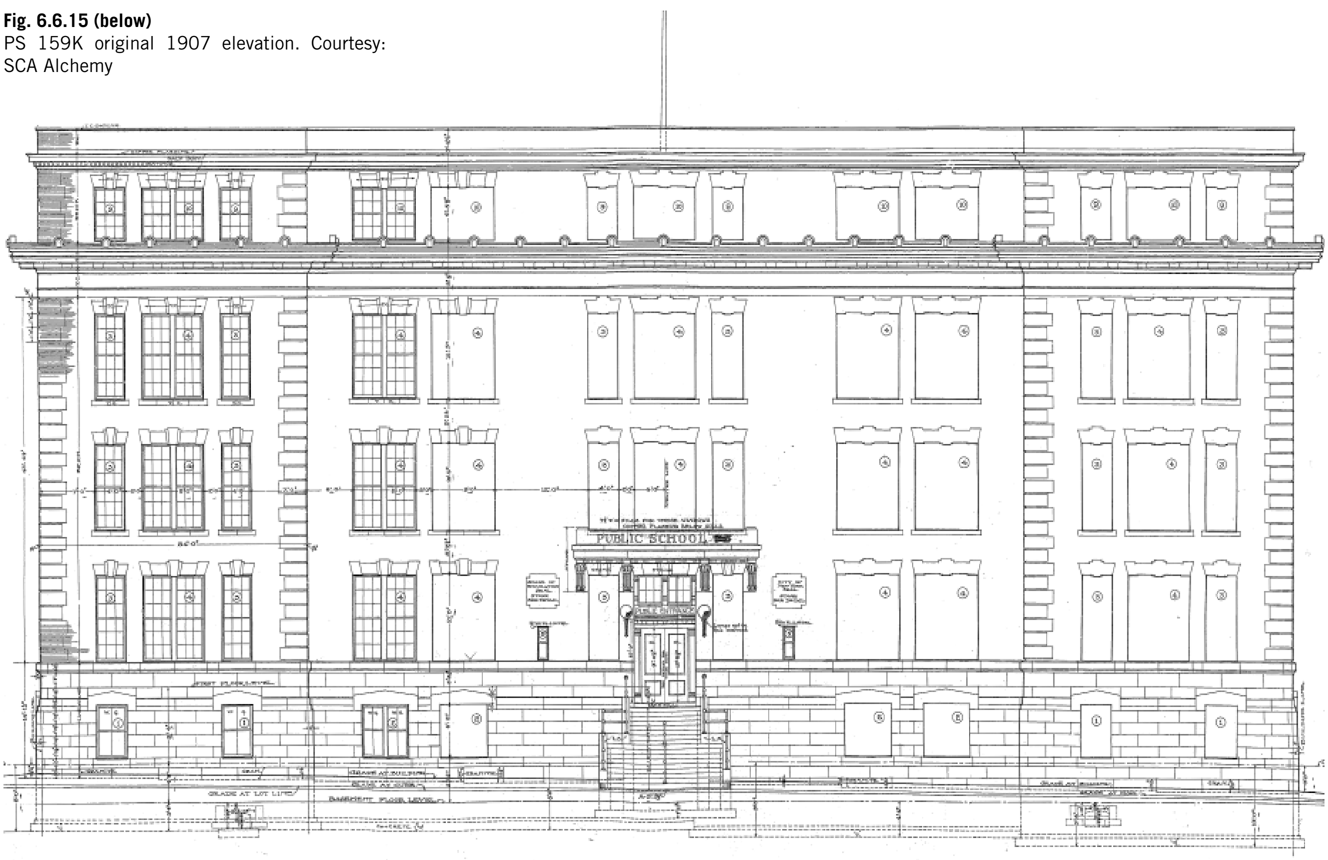


Fig. 6.6.15

Recommendations & Design

Initial investigations showed major water infiltration at the exterior due to: poorly constructed parapets, poorly detailed patching at old cornices, and coatings that caused more harm than good. In addition, the necessary removal of asbestos containing coatings on many of the elevations would further damage the face-brick. As water penetrated the masonry walls through the weak joints and parapets, the freeze thaw cycle caused even more damage to the 100 year old mortar. RKTB recognized that a significant intervention was required to provide a lasting solution and finally stop the water infiltration at the school. We recommended "over-cladding" because it was more cost efficient than face brick replacement and wouldn't require removing a portion of the load bearing wall. Aesthetically, the project provided a great opportunity to replicate the historic cornices that had been previously removed.

Recommendations - Exterior Masonry

Over-Cladding Scope of work:

1. All existing coatings were removed by abrasive method from all masonry surfaces. (Note: Some coatings can be removed by chemical methods).
2. Existing cracks in masonry were stitched and all surfaces were parged.
3. A layer of vapor barrier was applied to the masonry similar to Tyvek. (Note: in future projects we use liquid vapor barrier).
4. The top stones of the limestone base were replaced to provide a bearing surface for the new wythe of face-brick (Fig. 6.6.16)
5. A layer of prefabricated drainage composite mat with filter fabric facing new bricks was installed over the vapor barrier.
6. A new layer of face brick was applied to the entire building using masonry S.S "V" ties and veneer anchors with continuous S.S wire @ 16" O.C
7. New masonry window surrounds were installed. At existing window jambs it is critical to fill the voids between old window frames and masonry. Provide flashing to prevent moisture infiltration inside the window frame. Do not rely only on perimeter caulking.
8. Existing quoins were chipped back flush to existing adjacent face brick. New quoins were installed to align with the new face-brick. The top surface of the quoins was sloped with mortar to shed water.
9. A bearing angle was provided for the face-brick at the level of the 4th floor window head. Below the 4th floor masonry bears on the existing granite shelf at the level of the 1st floor window head.
10. Window guards were removed, cleaned, painted, and reinstalled.

Additional Exterior Masonry Scope of Work:

1. Damaged terracotta and bluestone window sills were replaced with cast stone.
2. Headers at front and side elevations were able to remain. (Note, on future SHPO projects, headers were replaced, see discussion page 235)
3. At the third floor window heads, the existing stucco, flashing, and terracotta band stone was completely removed and replicated with GFRC.
4. The Glass Fiber Reinforced Concrete (GFRC) ornamental cornices were replicated using the original drawings.
5. The existing limestone balcony above main entrance was restored.
6. All exposed steel was inspected by a structural engineer. Steel in good condition is was cleaned and painted. A provision was added for steel reinforcement.
7. All areas of water damage were repaired.

Fig. 6.6.16
The above wall section shows the line of the original face-brick and the line of the new face-brick. It also shows the proposed modification of the base stones. The new stones provide a bearing surface for the additional wythe of brick. The red dashed line represents the original profile. Courtesy: RKTB Architects, P.C.

PS 159 K

Fig. 6.6.17 (above)
Replication of historic seal with cast stone. Courtesy: RKTB Architects, P.C.

Fig. 6.6.18 (right)
View from 4th floor scaffold after installation of brick over-cladding and GFRC cornices. Courtesy: Nelligan White Architects

Fig. 6.6.19 (below right)
Installation of GFRC cornice. Courtesy: RKTB Architects, P.C.

Fig. 6.6.20 (below far right)
Installation of expansion joints, interlocking flashing, and coping stone at parapets. Courtesy: RKTB Architects, P.C.

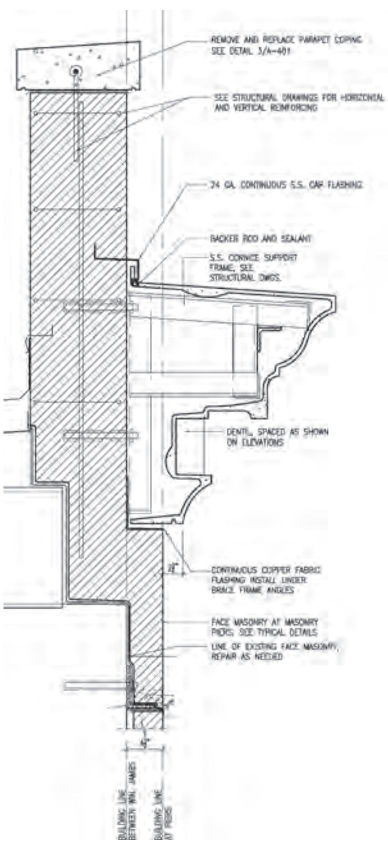


Fig. 6.6.21 (above)
Typical parapet section at cornice. Note that the face of the parapet walls steps back to align with the original face-brick. The extra wythe of brick is not required at the parapet. Courtesy: RKTB Architects, P.C.

Parapet Scope of Work:

1. Parapets were replaced.
2. A new Glass Fiber Reinforced Concrete (GFRC) cornice was installed above fourth floor windows.
3. New through-wall copper fabric flashings, expansion joints, coping stones, coping flashing, and cap flashing were provided at the parapet
4. The existing roof was 20 years old and showing signs of aging. Because the parapet work already triggered partial roof replacement we recommended complete roof replacement as an additional recommended item. This request was approved and roof replacement was added to the scope of work.

Fig. 6.6.18

Fig. 6.6.19

Fig. 6.6.20

Constructability & Lessons Learned

1. SHPO and Over-cladding:

RKTB's first two over-cladding jobs, PS 174 K and PS 159 K, were not SHPO eligible. More recently, RKTB was assigned two additional projects, PS 9 Q and PS 88 Q, both sister schools of PS 159 K. They had very similar problems, with PS 88 Q being in an even more detrimental condition than PS 159 K. Both PS 88 Q and PS 9 Q are SHPO eligible.

RKTB presented over-cladding as a solution to SHPO and they objected to the design stating that the historic fabric should be preserved. They suggested repointing as a solution. Unfortunately both jobs had been repointed multiple times. After much discussion with SHPO and a site visit to PS159K, we were able to agree that while over-cladding does conceal the historic fabric, it is less destructive than face-brick replacement. The final resolution was that over-cladding can be used in extreme cases. In addition, SHPO had several additional requests included in the final letter of resolution:

1. Over-cladding entire facade versus over-cladding at load bearing "piers" only: At PS 159 K the design intent was to over-clad only at the structural portions of the walls. Subsequently, the brick panels above and below windows (which are not load bearing) were replaced, not over-clad. This allows you to keep the original headers and sills, but it also resulted in a 4 ½" depression above and below the windows, which alters the elevation slightly. SHPO objected to this and requested that we fill in these panels for the proposed SHPO eligible schools. This also preserves the angled termination of the header.
2. SHPO requested that the Flemish bond brick pattern as well as color and texture, must be carefully matched.
3. PS 9 Q and PS 88 Q have decorative terracotta seals above the second floor. SHPO requested that these be replaced with terracotta, not cast stone.
4. All original missing cornices and details were to be replicated.

Fig. 6.6.22
Fluid applied vapor barrier has been installed at the existing face-brick. Copper Fabric flashing and blue skin is installed at the windows, preventing water from traveling through the wall. Courtesy: RKTB Architects, P.C.

Fig. 6.6.23
At PS 88 Q, to comply with SHPO comments, the masonry is flush between window sills and headers. Courtesy: RKTB Architects, P.C.

Fig. 6.6.24

Fig. 6.6.25

Fig. 6.6.24 & 6.6.25 (far left - left)
PS 88 Q, original terracotta seals, cornices have been removed. PS 159 after over-cladding. At sister schools PS 88 Q and PS 9 Q, SHPO objected to the recessed panels at window bays. Courtesy: RKTB Architects, P.C.

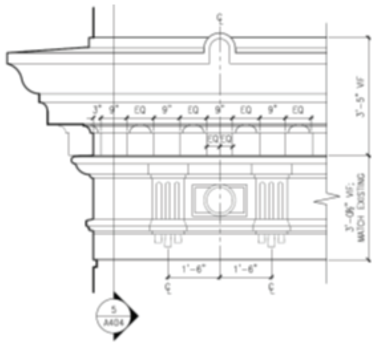


Fig. 6.6.26
Construction detail at cornice. Courtesy: RKTB Architects, P.C.

2. Sister Schools:

An important part of any exterior restoration project is research. SCA's alchemy server is a great resource; however the most historic buildings often have the fewest original drawings. Fortunately, with PS 159 K, we had original structural plans and exterior elevations. With PS88Q, we had plans only. Initially, we assumed that the elevation details would match 159K, but in reality, the elevations had many differences. Luckily, the Municipal Archives had an original photo of PS 88 Q showing the original condition. PS 88 Q had pediment gables at each end of the building. The photo was dark and blurry, so our next step was to research sister schools. There are 14 sister schools for this particular plan, but the number of floors and decorative details vary between schools. Some only have four floors instead of five. We found that PS 16 Q, which had much better alchemy drawings, also originally had the same pediment style parapet gables and we were able to use the original PS 16 Q drawings, to replicate the details for PS 88 Q.

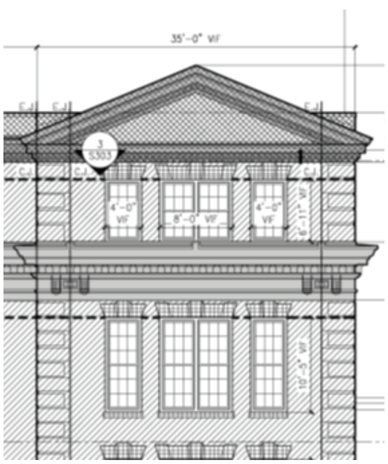


Fig. 6.6.27 (above)
PS 88 Q Elevation details show restoration of original details including cornices and parapet gables. Courtesy: RKTB Architects, P.C.

Fig. 6.6.27

Fig. 6.6.28 (right)
Historic photo of PS 88 Q, a sister school of PS 159 K. Courtesy: Board of Education Journal

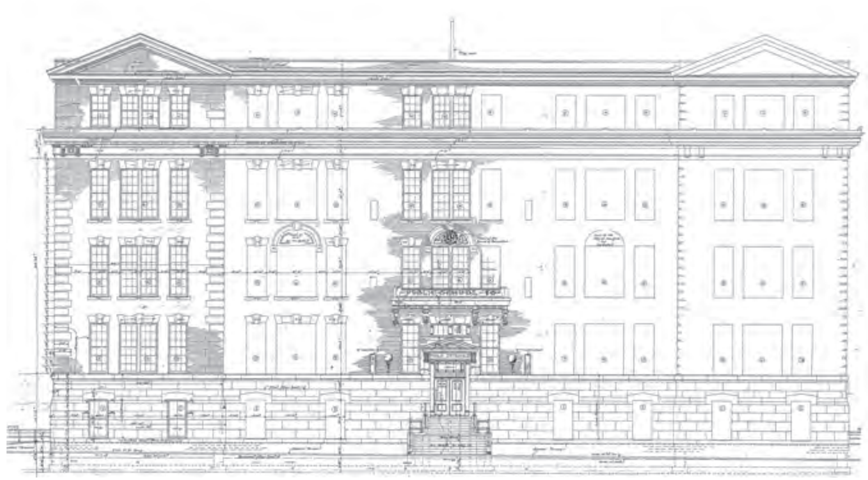


Fig. 6.6.29

Fig. 6.6.29 (right)
Original elevation of PS 16 Q, compare with sister school PS 159 K (Fig. 6.6.15) and original image of PS 88 Q (Fig. 6.6.27). Courtesy: SCA Alchemy

3. Installation of a Parapet ring beam:

At PS 159 K,there were two cornices replicated to match the original elevation; one small cornice along the roof level and a larger cornice at 4th floor level. At PS 9 Q and PS 88 Q, the roof level cornices are much larger. In order to properly support the cornice, and to provide lateral structural reinforcement at parapets we have incorporated a reinforced concrete ring beam into the parapet design.

The ring beam usually consists of a channel welded to the existing roof beams with a concrete beam poured over the channel. The size of the beam varies depending on existing conditions. GFRC steel framework as well as parapet re-bar is anchored into the concrete ring beam. The ring beam is wrapped with copper fabric through-wall flashing to keep moisture away from new and existing steel and to create tight barrier at the base of the parapet.

Fig. 6.6.31

Fig. 6.6.30 (above)
Installation of concrete ring beam at PS 88 Q. Courtesy: RKTB Architects, P.C.

Fig. 6.6.31 (left)
PS 159 K after over-cladding. At sister schools PS 88 Q and PS 9 Q, SHPO objected to the recessed panels at window bays. Courtesy: RKTB Architects, P.C.

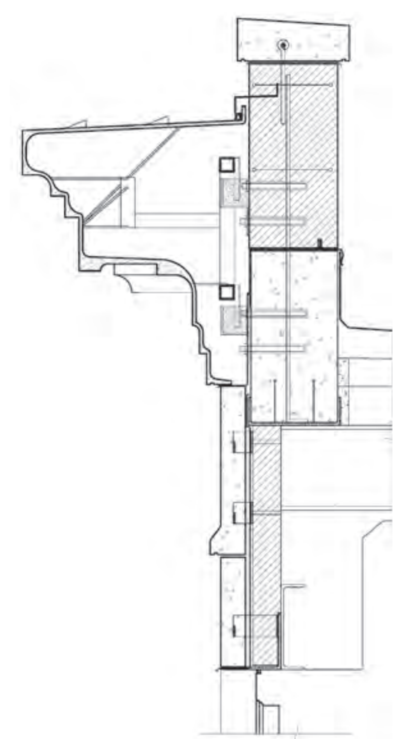


Fig. 6.6.32 (above)
Parapet section showing ring beam. Compare with Figure 6.6.21. Courtesy: RKTB Architects, P.C.

SECTION 6.7

CASE STUDIES:
PS 154 K

CASE STUDIES:
PS 154 K

Introduction

Building ID	K154
School Level	PS
Address	1625 11th Ave Brooklyn, NY 11215
Cross Streets	Sherman St & Windsor Pl
NYC DOE District	15
SHPO Status	Ineligible
SHPO ID	04PR0985
Flood Zone	Outside Flood Zone
FEMA Map	3604970211F
Architect	C.B.J. Snyder
Year Built	1908
Plan Form	Modified Rectangular Plan
Style	Classical Revival
Internal Sq Ft	48,000
Classrooms	27
Stories	4 + Cellar
Structural System	Solid Masonry
Columns	Steel
Beams	Steel
Floors	Brick Arches with Slag Infill
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.7.2

Fig. 6.7.1 & 6.7.2 (above - right)
PS 154 K is a reduced version of its other contemporary sister schools. While not as tall, the building utilizes a simplified classical style seen in many schools of the time. The building's most prominent features including the cornice and brick quoins had been removed in prior remediation campaigns. Courtesy: Sylvia Hardy

Fig. 6.7.3 (right)
Rear view of PS 154 K, before renovation. Similar to other schools of the era, the building features two end pavilions and a rear extension for the auditorium and gym. Courtesy: Sylvia Hardy

Located two blocks from Prospect Park in the Windsor Terrace neighborhood of Brooklyn, PS 154 K is a modified Rectangular Plan school, built in a Simplified Classical style. Designed by Charles B. J. Snyder, it was completed in 1908, standing three stories high with a basement and cellar level. Over the decades, its facades were altered extensively from the removal of the cornice to the elimination of the brick quoins at the building's main corners and edges of the end bays.

Despite a 2004 campaign which included repairs to exterior masonry, windows and roofs, moisture infiltration was continually observed. A visual investigation was carried out in August 2008 to determine the cause of the water damage. Between the initial 2008 investigation and a second investigation in October 2009, interior finish damage had become so bad at the rear facade that new gypsum wall board had been installed to enclose the continuing infiltration in all third floor classrooms and at one second floor classroom. Further investigation to determine the routes of water infiltration and appropriate scoping measures were carried out.

Fig. 6.7.3

Fig. 6.7.5

Fig. 6.7.3 (left)
Front facade of building in 2015 after rehabilitation. The masonry facade has been fully replaced, original cornice and quoins have been replicated to be historically accurate. Courtesy: Sylvia Hardy

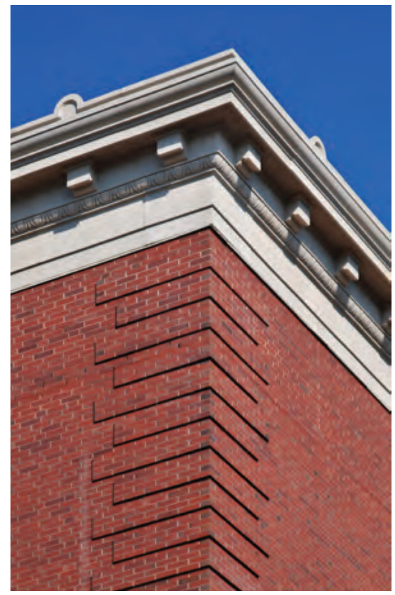


Fig. 6.7.4 (above)
Close up of the restored cornice and brick quoins. Courtesy: Sylvia Hardy

Fig. 6.7.5 (below)
Front elevation from the original 1907 design drawings. Courtesy: SCA Alchemy

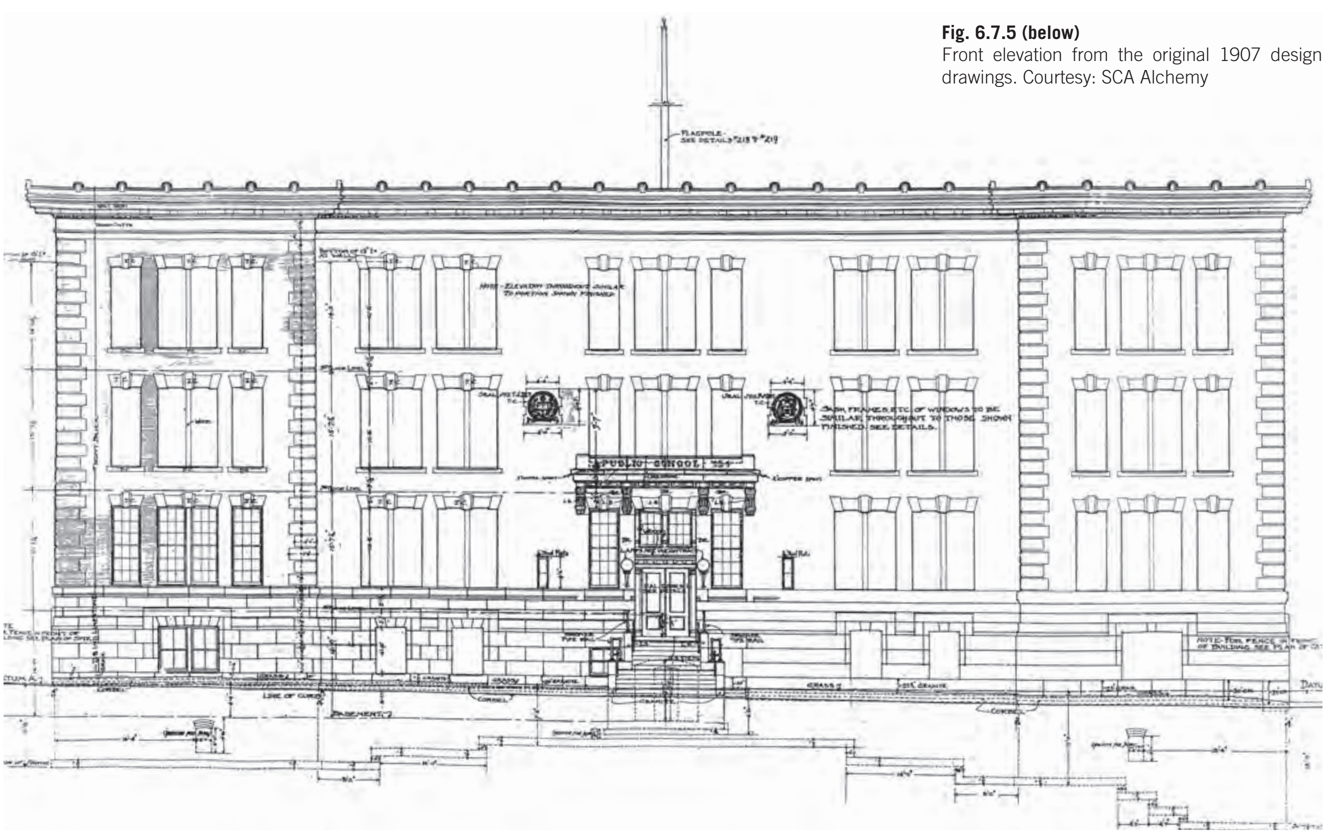


Fig. 6.7.5

Methodology

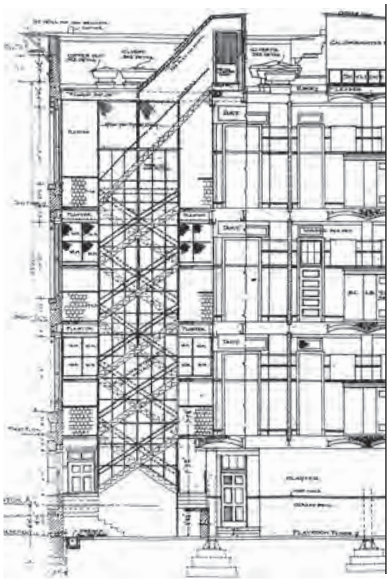


Fig. 6.7.6
Partial section through stairwell from the original 1907 drawings. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope or design research was carried out to obtain information regarding the school's original construction and its history of remediation, alteration and addition. The SCA's Alchemy Database yielded original design drawings from 1907, as well as drawings from 15 other projects carried out at the school between 1976 and 2004. Original design drawings consist of 34 drawings - site plans, floor plans, framing plans, sections, and mechanical details. Most existing drawings were of good quality and in a readable condition.

Drawings were also available from the 2004 campaign, which provided a more contemporary reference for dimensions and details, as well as a possible guide to any repair induced failures found in inspection. These drawings outlined previous work campaigns, giving a comprehensive view of the building history. They also aided in the production of base drawings to begin recording damage and producing construction documents.

Fig. 6.7.7 (below)
First floor from the original 1907 drawings. Courtesy: SCA Alchemy

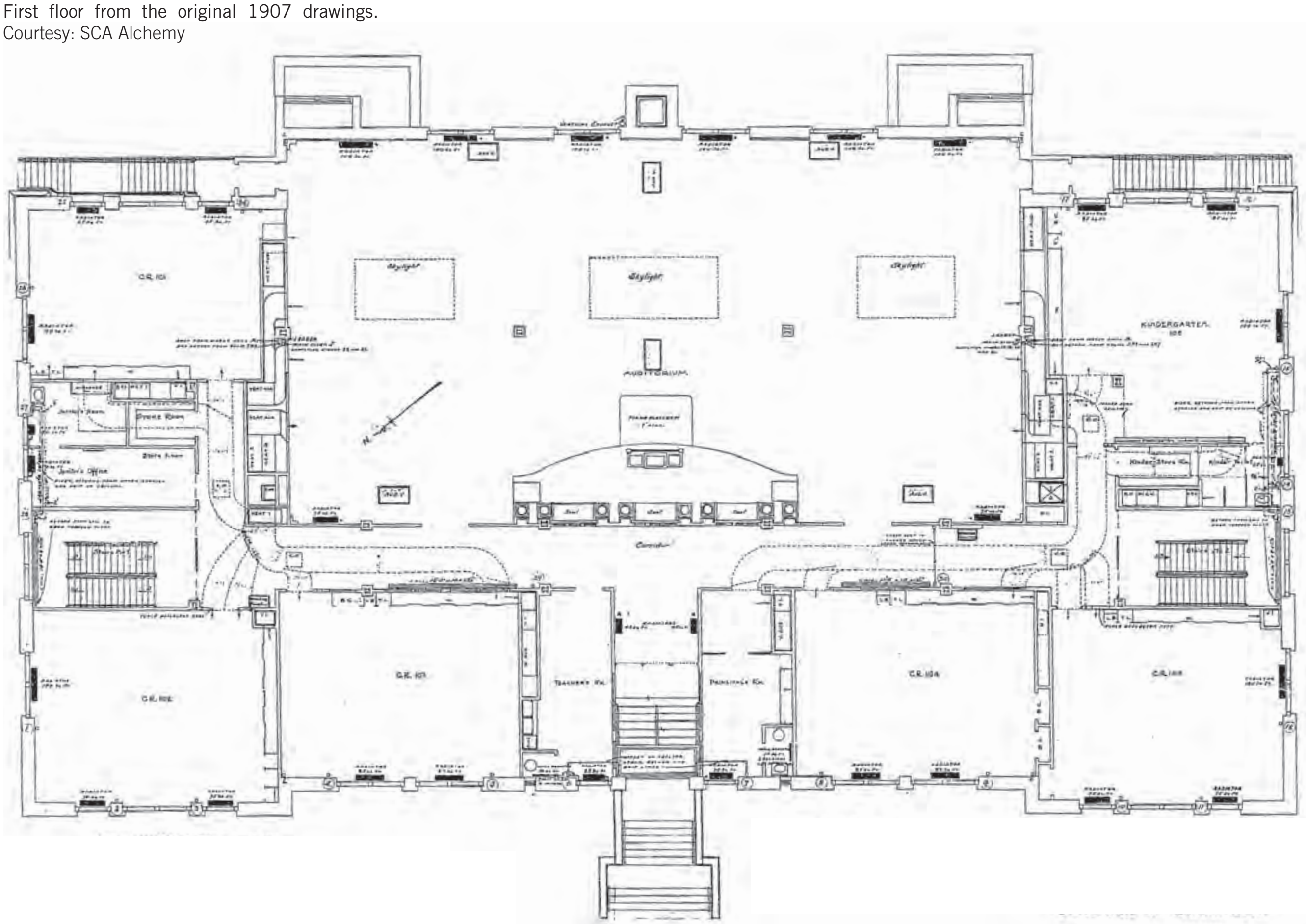


Fig. 6.7.7

Observation & Mapping

In addition to Building Condition Assessment (BCAS) Reports, numerous site visits and photographic surveys carried out between August 2008 and November 2009, confirmed the continual and advancing water damage at PS 154 K. Prior to surveys, school administrators observations were reviewed by the consultant to allow for quick assessment of damaged area. At PS 154 K water related damage was widespread and observed throughout the building, with multiple specific causes. Damage to the interior finishes was heaviest at the rear (south) façade, but it was by no means limited to that side of the school. To some extent, water-damage was observed at each of the schools 27 classrooms.

At the exterior deficiencies in the face brick were observed on all facades. These included cracked bricks, missing mortar, and inconsistent/overly large mortar joints at patches, all of which amplify any moisture infiltration associated with other building elements.

An extensive catalogue of site photographs and detailed field notes were synthesized into a set of damage mapped elevations and floor plans. These damage maps facilitate the quantification of deficiencies, aiding in the determination of scope and the production of estimates.

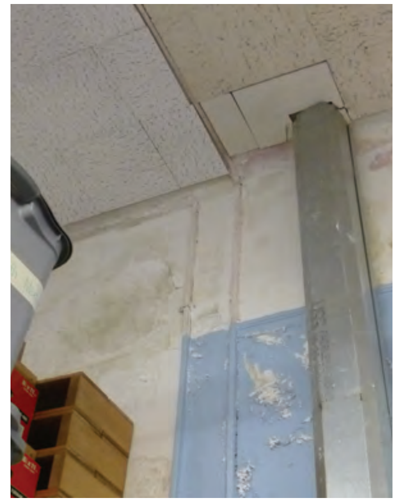


Fig. 6.7.8
Peeling and bubbling plaster along exterior wall in classroom 101. Courtesy: Nelligan White Architects

Fig. 6.7.9 (left)
Damage map for front elevation. Courtesy: Nelligan White Architects

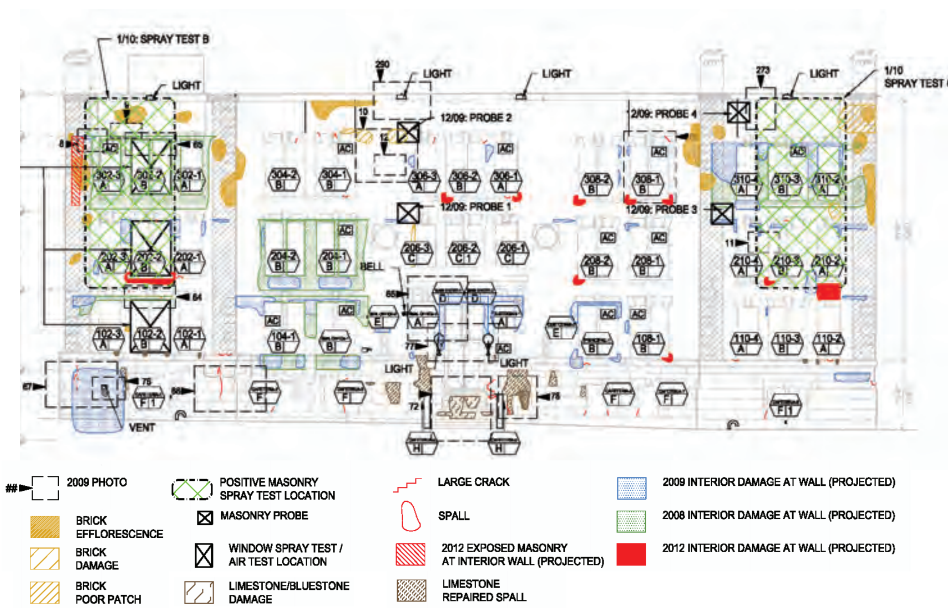


Fig. 6.7.9

Fig. 6.7.10 & 6.7.11 (below- bottom left)
Ceiling and wall damage in classroom 109. At the exterior mismatched brick, cracks, and inconsistent mortar joints were observed. Darker brick on the left was associated with the 2004 campaign. Courtesy: Nelligan White Architects

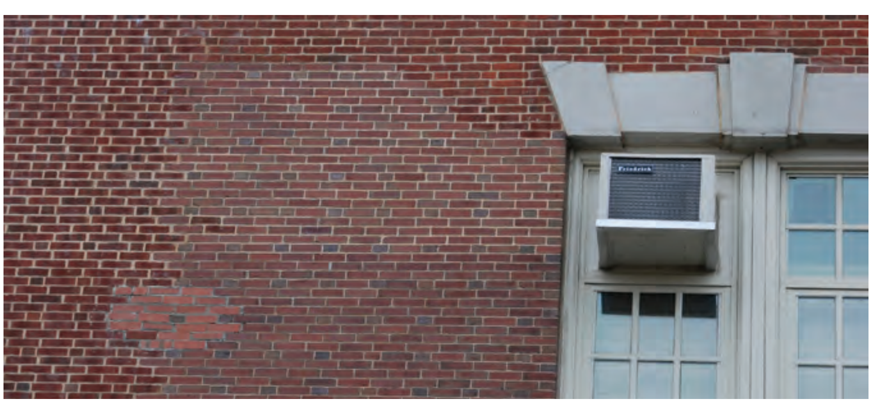


Fig. 6.7.11

CASE STUDIES:
PS 154 K

Fig. 6.7.12

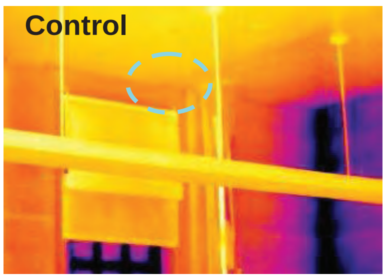


Fig. 6.7.12, 6.7.13 & 6.7.14 (far above - above - below)
Spray tests showing positive results for classroom 302. Courtesy: GBG USA Inc.

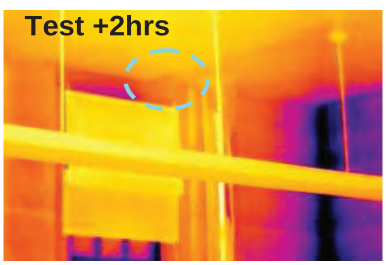


Fig. 6.7.15 (below)
Contour plot showing the electrical capacitance test results for the main roof. The most significant responses are labeled. Courtesy: GBG USA Inc.

Non-Destructive Testing

An extensive Non-Destructive testing regimen was carried out at PS 154 K, including three rounds of spray testing (August 2007, November 2009, March 2011), and investigations using Thermal Imaging and Electric Capacitance Field Testing.

All areas investigated during the first round of spray testing in August 2007, tested positive for moisture infiltration. This confirmed water intrusion through the roof surface, the interior and exterior face of the parapet, the exterior brick masonry from the parapet down to the 2nd floor level, cast stone coping and flashing, recently replaced window units, and the perimeter of new windows.

The second round of spray testing in November 2009, focused on the windows and window openings. Of the windows and window openings 75% tested positive for moisture infiltration. The third round of spray testing in March 2011, focused on various isolated masonry corners on the building's exterior to determine if a previous repair campaign was deficient. Results found a strong indication of moisture infiltration at 6 of the 7 areas tested with Thermal Imaging, including visual confirmation of moisture at 2 of those locations.

Further investigations of the facades using Thermal Imaging revealed several inconsistencies in the brickwork. This is a strong indication of heat penetration through the facade as a result of voids and inconsistencies in the backup masonry.

An investigation of the roof included Thermal Imaging, Moisture Metering and Electrical Capacitance Metering. These methods were used in conjunction with one another to provide comparative data, further confirming results. The tests identified anomalies with a combined surface area equating to approximately 21% of the total roof. While these tests does not identify a source of water intrusion, the anomalies observed are a strong indication of moisture retention beneath the roofing membrane.

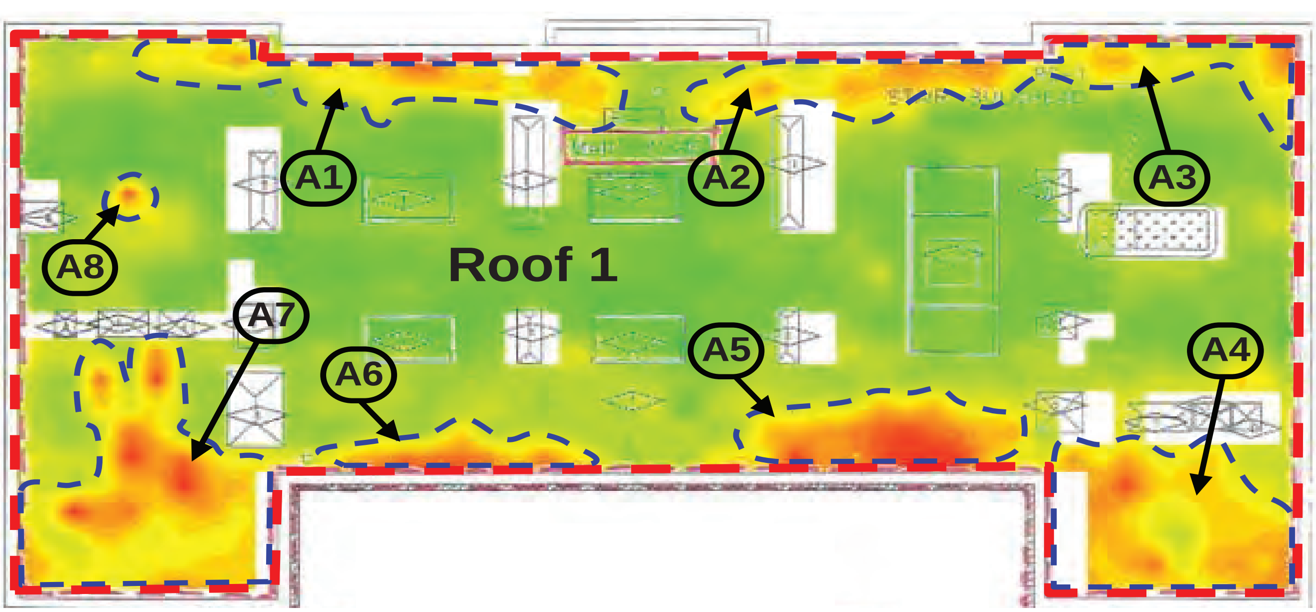


Fig. 6.7.15

Exploratory Probes

Four separate Exploratory Probe campaign s were performed at PS 154 K between February 2008 and January 2010. The first sets of probes were opened in September 2007 in an effort to observe a recently installed brick veneer, including flashing and drainage systems. These probes revealed a lack of weep holes and drainage system in all areas observed. Additionally, no flashing or end-dams were observed at the window lintels to stop the flow of water to the interior.

In January 2009, another set of probes were opened to inspect the existing construction of the original brickwork, including the collar joint and the backup. This inspection revealed crumbling mortar, and that backup masonry was in poor condition with intermittent voids. The collar joint was only partially filled, allowing water to infiltrate the wall. A series of roof cuts were also performed in January 2009, though all assemblies were observed to be dry.

In December 2009, a third set of probes further inspected the condition of backup masonry and steel lintels at three areas of the building, representative of the original 1908 construction and two reconstruction campaigns in 1988 and 2004. These probes also confirmed the differing methods of masonry construction between each area.

Fig. 6.7.16
It was observed the mortar and backup were wet and crumbling. The backup masonry was laid uniformly but there were intermittent voids, which was a likely source of water infiltration. Courtesy: Nelligan White Architects

Fig. 6.7.17 & 6.7.18 (left - bottom left)
Probes at the 1988 parapet replacement. The steel was found to be in poor condition. Space under the steel between the bluestone supports appeared to be unfilled. Courtesy: Nelligan White Architects

Fig. 6.7.17

Fig. 6.7.18

Fig. 6.7.19 (belove)
The 1988 replacement parapet was out of plumb with the original construction, with a slight lean inward toward the roof. Courtesy: Nelligan White Architects

Materials Testing

In addition to tests for PCBs, lead-containing materials (Fig 6.7.19), and asbestos-containing materials throughout the building, a petrographic analysis of mortar samples from the 2008 brick replacement was carried out. These tests did not reveal that the incorrect mortar type was used, thus, the choice of mortar in the 2004 brick replacement campaign was not a contributing to the moisture infiltration. This helped to confirm that any moisture infiltration associated with newer work was an effect of repair induced deficiencies rather than improperly specified items.

Fig 6.7.20 (right)
Partial lead-based paint report. Courtesy: Nelligan White Architects

Location	Paint Component	Substrate	Color	No of Location Screened	Results	Comments
Exterior	Window Guard	Metal	Beige	5	Non-LBP	The paint was observed in fair to good condition.
Exterior	Stair Wall - Lower	Concrete	White	1	Non-LBP	The paint was observed in fair to good condition.
Exterior	Stair Wall - Upper	Concrete	White	1	Non-LBP	The paint was observed in fair to good condition.
Exterior	Handrail	Metal	Black	1	Non-LBP	The paint was observed in fair to good condition. Non-ACM
Exterior	Handrail Post	Metal	Black	1	Non-LBP	The paint was observed in fair to good condition. Non-ACM
Exterior	Sign Base	Metal	White	1	Non-LBP	The paint was observed in fair to good condition.
Exterior	Gate	Metal	Black	1	Non-LBP	The paint was observed in fair to good condition. Non-ACM
Exterior	Louver Guard	Metal	Beige	1	Non-LBP	The paint was observed in fair to good condition.
Exterior	Conduit	Metal	Yellow	2	LBP	The paint was observed in fair to good condition.
Cafeteria	Lower Wall	Plaster	Yellow	6	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Upper Wall	Plaster	White	6	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Lower Column	Metal	Yellow	2	LBP	The paint was observed in fair to good condition.
Cafeteria	Upper Column	Brick	White	2	LBP	The paint was observed in fair to good condition.
Cafeteria	Ceiling	Plaster	White	4	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Wall Trim	Wood	Purple	5	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Conduit	Metal	White	1	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Pipe	Metal	Red	1	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Pipe	Metal	White	1	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Pipe Jacket	Metal	Yellow	1	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Pipe Jacket	Metal	White	1	Non-LBP	The paint was observed in fair to good condition.
Cafeteria	Door Frame	Wood	Purple	4	LBP	The paint was observed in fair to good condition.
Cafeteria	Door	Metal	Purple	4	LBP	The paint was observed in fair to good condition.
Cafeteria	Baseboard	Rubber	Black	2	Non-LBP	The paint was observed in fair to good condition.

Fig. 6.7.19

Recommendations & Design

It was officially determined that there was no single cause of water penetration to the interior, rather a number of deficiencies which contributed to a building-wide systemic leaking. A comprehensive repair campaign was recommended, in order to provide greater certainty that the solution was effective. To arrest the escalating cycle of water infiltration, it was recommended that the face-wythe brick and terracotta on all facades be removed. Backup should be repaired, parged, and fitted with a waterproof membrane and narrow cavity drainage plane to fully waterproof the building. These repair strategies consisted of the following recommendations:

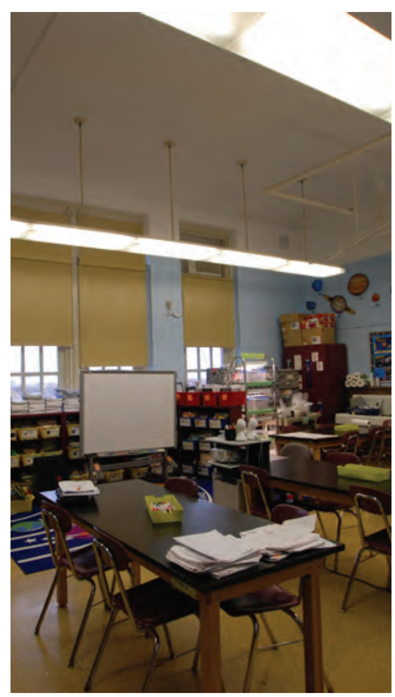
Fig. 6.7.21
Construction underway to restore the brick quoins. Courtesy: Nelligan White Architects

LLW No. 062650 – Exterior Masonry

1. Exterior Masonry

- Remove all face-wythe brick at facades and returns
- Remove backup masonry as necessary to expose steel beams
- Remove steel channels above windows at third floor
- Scrape, repair, and paint all exposed steel beams scheduled to remain and install non-asphaltic copper composite flashing with end-dams
- Install new steel channels above windows at third floor
- Install ½" galvanized steel plate reinforcing straps with threaded stainless steel anchors set in epoxy at piers to restrain each end of beams at 4th floor/roof framing at west and east facade
- Install new backup masonry (1 wythe typically) at the web of exposed beams
- Install new brick masonry in voids or where existing brick is damaged or out of plumb at backup, replace with new brick masonry
- At backup masonry, cut out soft or damaged mortar and repoint
- Install ¼" stainless steel threaded rods set in epoxy with screen tubes at 16" on center horizontally, and vertically to stabilize backup masonry
- Parge backup masonry
- Spray apply waterproofing membrane at backup masonry
- Install continuous 4"x 6" x 5/16" galvanized relieving angles/lintels at 2nd, 3rd, and 4th floor window heads
- Install narrow cavity drainage plane at entire area of backup masonry with corrugated weeps at each relieving angle
- Install new face wythe brick, with seismic reinforcing, vertical expansion joints and horizontal "soft" joints under relieving angles
- Install brick quoins at corners and return corners to match original (Fig. 6.7.20)

Fig. 6.7.22 (below)
Gypsum wall board at rear of building, installed as a quick remedy to water infiltration. Courtesy: Nelligan White Architects



2. Interior Finishes

- Remove interior wall finishes at exterior wall surfaces to expose masonry at locations of damaged plaster
- Remove existing furring channels and gypsum wall board at east and south facade (Fig. 6.7.21)
- Provide 3 coats of plaster at exterior wall surfaces with damaged plaster
- Prime and paint interior partitions
- Prime and paint ceilings
- Replace damaged acoustical ceiling tile at north facade
- Repair damaged ceramic tile at floor at west facade
- Repair damaged concrete screed at floor at west facade

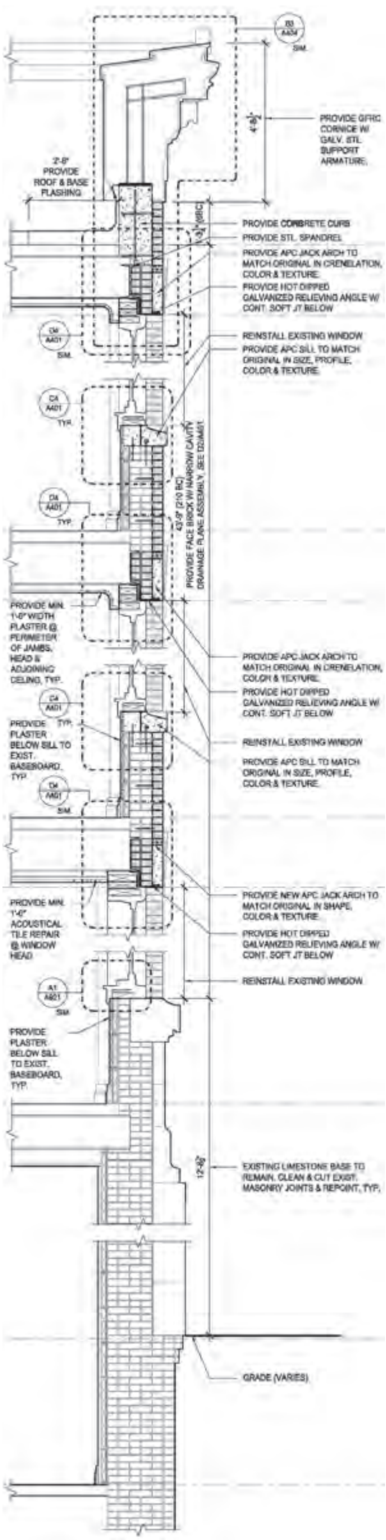


Fig. 6.7.23
Wall section showing extent of repairs. Courtesy: Nelligan White Architects

3. Decorative Terracotta & Limestone

- Remove all decorative terracotta jack arches and sills at north facade and returns
- Remove decorative medallions at north facade
- Remove balcony at north facade
- Install new architectural precast concrete (APC) jack arches and sills to match original terracotta in form, color, and texture
- Clean and repoint the limestone entry portico

4. Exterior at Limestone Base

- Strip any paint or graffiti at limestone base
- Clean limestone base with a low-pressure water/detergent wash
- At cracks in limestone end-walls, cut out area ½" deep minimum with square *"shoulder"* and repair with custom colored limestone repair mortar
- Apply a transparent, breathable, protective coating (silane or siloxane) to limestone base as an anti-graffiti coating

5. Interior Finishes at Basement

- Remove interior wall finishes at exterior wall surfaces to expose masonry at locations of damaged plaster
- Provide 3 coats of plaster at exterior wall surfaces with damages plaster
- Prime and pain exterior walls
- Repair out-of-line window sash at north facade
- Repair damaged tile at exterior and interior walls at west and east facades

6. Exterior at Front entry stairs at Front/North Facade

- Remove iron picket fence and sidewalk
- Remove existing limestone and bluestone stair and sidewalls retaining existing sub-grade foundation.
- Remove existing railings
- Provide new concrete foundation wall and footing, 3 ft deep
- Provide new stair structure with galvanized-reinforced concrete sidewalls and stepped platform
- Provide liquid-applied waterproofing membrane and drainage mat
- Clad entire stair in APC/cast stone to match the appearance of the original limestone and bluestone
- Provide bronze posts and railing to match the original
- Provide new iron picket fence with gate
- Restore sidewalk

7. Interior Finishes at Electrical Closet at Front/North Facade

- Remove all MEP items to facilitate masonry replacement then reinstall
- Blank off existing open vent (18"x18") at the basement's north-east corner
- Test, disconnect, remove, store, protect, and reinstall the existing wall sconces at the main entrance with 10' of ¾" conduits and no. 12 wiring for each light and commission to operating conditions
- Remove and provide temporary supports and extension for existing PA speaker; reinstall and commission to operating conditions
- Remove and provide temporary supports and extensions for existing miscellaneous service boxes for telephone, cable, security, and communication networks, connected wiring and conduits; reinstall and commission to operating conditions.

8. MEP at Interior

- Test, disconnect, remove, store, protect, and reinstall existing steam radiators with new replacement branch piping, valves and controls to allow replacement of interior finishes
- Remove any abandoned radiators
- Test, disconnect, and remove existing power and control wiring, conduits, raceways, receptacles, and switches located on the plaster at the exterior walls
- Remove any abandoned conduit
- Protect, temporarily support, and reinstall the existing electrical service panels and meter and the fire call system at North Facade
- Provide new steam heated unit ventilators with outside air capability connected to new outside air louvers and sleeves and new roof exhaust fans with wiring and controls to maintain the code required ventilation for auditorium at South Facade

9. MEP at Exterior at all facades except the North Facade

- Test, disconnect, remove, store, protect, and reinstall the existing security lights above the exit doors with 10' of ¾" conduits and no. 12 wiring for each light and Remove and provide temporary supports and extensions for existing miscellaneous service boxes for telephone, cable, security, and communication networks, connected wiring and conduits; reinstall and commission to operating conditions
- Remove blanked off unit ventilator vents at South Facade
- Provide new outside air louvers and sleeves at South Facade
- Remove and provide temporary supports and extension for existing PA speakers and alarm/bell; reinstall and commission to operating conditions at South Facade
- Test, disconnect, remove, store, and protect the existing 2" oil tank fill-line with lock box, 10' of the 2", overflow line and the overflow alarm; reinstall and commission to operating conditions at South Facade Test, disconnect, remove, store, and protect the 1" exterior boiler gas vents and piping: reinstall and commission to operating conditions at South Facade

10. Chimney at South Facade (Fig. 6.7.23)

- Repoint and clean all brick masonry
- Cut out area 1/2" deep minimum with square "shoulder" and repair with custom colored sandstone repair mortar at cracks and spalls in bluestone band; clean

11. Planting/Site

- Protect the existing trees during construction
- Replace at contractor's expense any trees killed or injured during construction
- Replace grass between fences and building on North, East, and West facades with new sod
- Protect existing memorial garden during construction
- Replace at contractor's expense any plants killed or injured during construction
- Protect site drains from silt and brick dust, in accordance with SCA standards

Fig. 6.7.24
Chimney before repointing. Courtesy: Nelligan White Architects

Fig. 6.7.25
Existing 1978 inline fan to be replaced. Courtesy: Nelligan White Architects

12. Play Yard

- Protect all play equipment, and newly painted asphalt surface
- Replace equipment, asphalt, or surface painting damaged by construction at contractor's sole expense
- Provide compressible filler and pourable sealant at joint between playground and masonry at South facade

13. Window Units

- Remediation taking place of the deficiencies is covered for labor and materials under the original construction contract
- Remove, store, and protect all existing windows and remove all existing wood blocking
- Clean and parge perimeter of each masonry opening
- Install self adhering flexible flashing at perimeter of each masonry opening
- Reinstall all existing windows
- Install urethane spray foam insulation at perimeter of each masonry opening
- Install backer rod and sealant at perimeter of each masonry opening
- Repair damaged plaster and paint at perimeter of each masonry opening
- Install painted 5/4" x 6" wood trim, stools, and aprons at perimeter of each masonry opening
- Remove, store, protect, scrape, paint, and reinstall existing window guards
- Remove, store, protect, and reinstall existing window shades
- Following as new non-warranty:
- Remove the old wood counterbalance casings which were used as blocking
- Provide new solid pressure treated blocking covered with self adhering flexible flashing

14. Air Conditioning Units

- Test, remove, store, protect, reinstall and retest existing A/C units and brackets
- Adjust windows with A/Cs installed in lower sashes for re-installation of A/C units and brackets at upper sashes
- Relocate electrical outlets to upper wall for relocated A/C units; patch and repair plaster and paint as required

15. Toilet Rooms

- Remove existing 1978 design in-line fans and residential wall fan assembly at toilets (Fig. 7.6.24)
- Confirm condition, continuity, and runs of the 1907 ventilation system for toilets
- Reactivate the original 1907 ventilation system for toilets by using existing ductwork, new exhaust fans on roof and providing new controls to make the system code compliant
- Remove existing ¾" hose bibs with attached piping
- Provide a new opening in the exterior wall for a ¾" hose bib with 40' of ¾" piping on the north and west facades

LLW No. 062649 – Parapets

1. Masonry at Roof 1/Main Roof

- Remove existing parapets at high roof
- Provide 42" high , 3 wythe reinforced brick parapet with through-wall flashing at all high-roof parapets
- Provide GFRC simulated stone cornice with galvanized and stainless steel supports

2. Copings at Roof 1/Main Roof

- Remove existing coping and coping flashing at high roof
- Provide new cast stone coping and stainless steel coping flashing at high roof

3. Cap Flashing at Roof 1/Main Roof

- Remove existing cap flashing at high roof
- Provide new stainless steel cap flashing at minimum 8" above the roof surface, as required by most manufacturers, receiver and through-wall flashing at high roof

4. Associated Roof Work at Roof 1/Main Roof

- Remove a 3 foot swath of existing roofing system and base flashing system at perimeter of roof
- Repair existing fill and screed as necessary
- Provide new 4-ply BUR with 3" polyisocyanurate rigid insulation to match existing at perimeter of high roof
- Provide base flashing at perimeter of high roof
- Provide warrant-able penetration seals at existing drains and vent stacks within 3 feet of perimeter of roof

5. Railings at Roof 1/Main Roof

- Remove existing railing at high roof at South facade

6. MEP at Roof 1/Main Roof

- Test, disconnect, remove, store, protect, and reinstall the existing security lights above the exit doors with 10' of ¾" conduits and no. 12 wiring for each light and commission to operating conditions also at the Auditorium Roof
- Remove and provide temporary supports and extensions for existing miscellaneous service boxes for telephone, cable, security, and communication networks, connected wiring and conduits; reinstall and commission to operating conditions
- Replace one drain and the adjoining leader pipe
- Allow for concrete patching

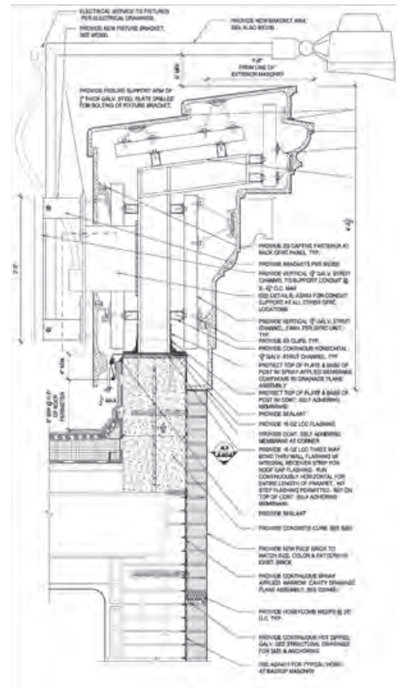


Fig. 6.7.26
Section through parapet showing extent of work. Courtesy: Nelligan White Architects

Constructability & Lessons Learned

Fig. 6.7.27
Exterior masonry construction work underway. Courtesy: Nelligan White Architects

Fig. 6.7.28 (below)
Incorrectly installed back up masonry from the 2004 campaign. Courtesy: Nelligan White Architects

This 2008 campaign was initiated to solve the continued water-infiltration problems, as deficiencies attributed to age. Also included in the scope of work was the restoration of historic elements that were removed.

Backup Masonry

Upon removal of the face-wythe masonry at four corners on the West Wing and two corners on the East Wing, the backup masonry was discovered to be poorly constructed. This construction was attributed to the previous campaign in 2004. A majority of the backup masonry in these areas was installed in the shiner position (on its side) with unfilled cores oriented perpendicular to the plane of the wall (Fig. 6.7.27). To re-mediate this condition, the contractor was directed to replace the first wythe of backup masonry at all of the affected corners, grind down, and replace as necessary the second wythe of backup masonry to achieve a plumb wall.

Fig. 6.7.26

Parapet & Brick Quoins

The original cornice was PS 154 K's most prominent feature, however, it was removed and replaced with a simpler parapet in the 1988 campaign. Overall, the replacement parapet was designed to be built solid. Voids and missing construction elements were observed. In addition the replacement parapet was out of plumb with the old. When a straight edge was aligned with the old brick, the replacement parapet was set back from the face of the original brick and leaned slightly inward. The new parapet of the 2008 campaign was meant to restore the appearance of the building similar to its 1908 construction (Fig. 6.7.29).

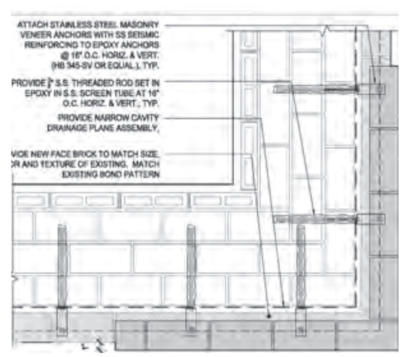
The brick quoins were removed and replaced in the 2004 campaign, however, this did not completely address the masonry issues. The replacement brick did not match the existing brick, adding to the mismatched appearance of the facade (Fig. 6.6.28). Correcting the deficient work as well as restoring the brick quoins was a part of the 2008 campaign (Fig. 6.7.29).

Fig. 6.7.30

Fig. 6.7.29 (above)
Mismatched brick at corners. Courtesy: Nelligan White Architects

Fig. 6.7.30 (left)
Mock-up of new, more historically accurate parapet. Courtesy: Nelligan White Architects

Fig. 6.7.31 (below)
Partial plan showing extent of work to restore brick quoins. Courtesy: Nelligan White Architects



SECTION 6.8

CASE STUDIES:
IS 77 Q

CASE STUDIES:
IS 77 Q

Introduction

Building ID	Q849
School Level	IS
Address	976 Seneca Avenue Queens, NY 11385
Cross Streets	Centre St & George St
NYC DOE District	24
SHPO Status	Eligible
SHPO ID	
Flood Zone	Outside Flood Zone
FEMA Map	3604970209F
Architect	C.B.J. Snyder
Year Built	1910-1911
Plan Form	Type A
Style	Simplified Gothic
Internal Sq Ft	135,000
Classrooms	42
Stories	5 + Cellar
Structural System	Steel Frame
Columns	Steel
Beams	Steel
Floors	Metal corrugated arch/slag fill
Roof	4-Ply, BUR
Cladding	Brick, Limestone
Backup	Brick, Terracotta

Fig. 6.8.2

Fig. 6.8.1 & 6.8.2 (above - right)
The high demand of new schools warranted a simplistic design in which schools like IS 77 Q fulfilled. This school is an early example of the Type A ornamented in a Gothic style. Front view of the school before renovations. Courtesy: GBG USA Inc, Nelligan White Architects

By the second decade of the 20th century, school designs began to become more simplified, in order to be constructed rapidly to serve the growing neighborhoods. The most common of these schools became known as Type-A. It had a standardized rectangular layout of classrooms and accommodated as many as 1500 students. Typically, Type-A schools were constructed on *'end-block'* sites and had a rear extension that housed the cafeteria, auditorium, and a steel-caged rooftop outdoor play area. They feature high crenellated parapets and vertical bays of multiple double-hung windows with terracotta banding and window surrounds. Window bays terminate at the top with a shallow pointed arch. Two symmetrical window bays flank the recessed middle portion. The main entries are a one or two story built out structure ornamented in the typical Simplified Gothic motif with terracotta ornament (Fig. 6.8.1 & 6.8.2).

IS 77 Q represents an early example of the Type-A school. Located on Seneca Avenue in Ridgewood, Queens and designed by C. B. J. Snyder in 1909, the school was constructed in the years 1910-1911. This school stands five stories high, plus a cellar. The structure is a steel frame with slag-filled floors on corrugated steel arches and exterior walls of solid brick with decorative limestone masonry. While this school was constructed on an *'end block'* site and had a rear extension, the extension is only one story containing the auditorium and lacks a rooftop play area. Overall, the style can best be described as Tudor-Gothic. It has an overall lighter complexion, with its use of beige toned face-brick and light gray limestone. The main entry is denoted by a built out structure that extends to the top of the building. IS 77 Q received its first addition in 2001; this contained a cafeteria, gymnasium, and atrium (Fig. 6.8.3 & 6.8.4).

IS 77 Queens was experiencing extensive water-infiltration damage to the interior finishes at the upper floors. While the school exterior walls were repointed in 1993 and in 2003, neither campaign addressed the entire building to arrest the water infiltration. The parapets had deteriorated badly and required replacement. It was recommended that the parapets and face brick be replaced from the third floor window lintels and above at the entire 1911 building. Repointing of the facade as well as waterproofing work on the roof was also recommended. Additionally, there was extensive water infiltration at the connection of the existing 1911 building and the 2001 addition.

Fig. 6.8.3
At the rear of the school on the western side an addition was added in 2001 containing a cafeteria, gymnasium, and atrium. This addition keeps within the same color scheme of the original 1911 building. Courtesy: Nelligan White Architects

Fig. 6.8.4
Inside the atrium of the 2001 addition, it partially wraps around the auditorium and rear facade juxtaposing the original 1911 construction with the new construction. Courtesy: Nelligan White Architects

Fig. 6.8.5

Fig. 6.8.6

Fig. 6.8.5 & 6.8.6 (above left - left)
Front view and main entry of school after renovations in 2013. Courtesy: Sylvia Hardy

CASE STUDIES:
IS 77 Q

Methodology

Fig. 6.8.7
Side elevation from original 1909 drawings. Courtesy: SCA Alchemy

Fig. 6.8.8 (right)
First floor plan from original 1909 drawings showing footprint before addition. Courtesy: SCA Alchemy

Fig. 6.8.9 (below)
2001 plan showing new addition on the right and the original 1911 building on the left. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1909, as well as drawings from seven other projects carried out at the school between 1993 and 2002. The complete list of existing original design drawings includes floor plans, framing plans, details, sections, and exterior elevations (Fig. 6.8.7 & 6.8.8). Drawings from the seven projects carried out at IS 177 Q between 1993 and 2002 include elevations, details, floor plans, and sections (Fig. 6.8.9).

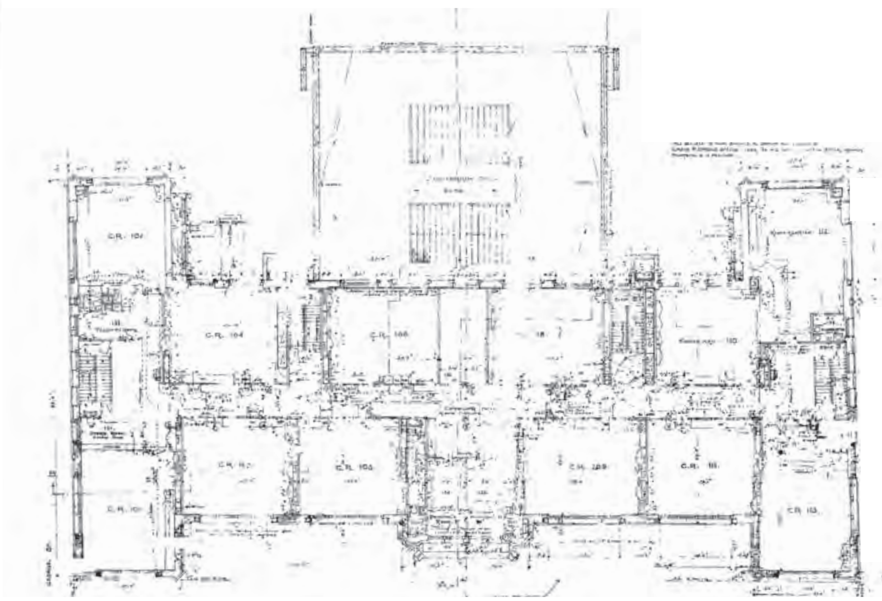


Fig. 6.8.8

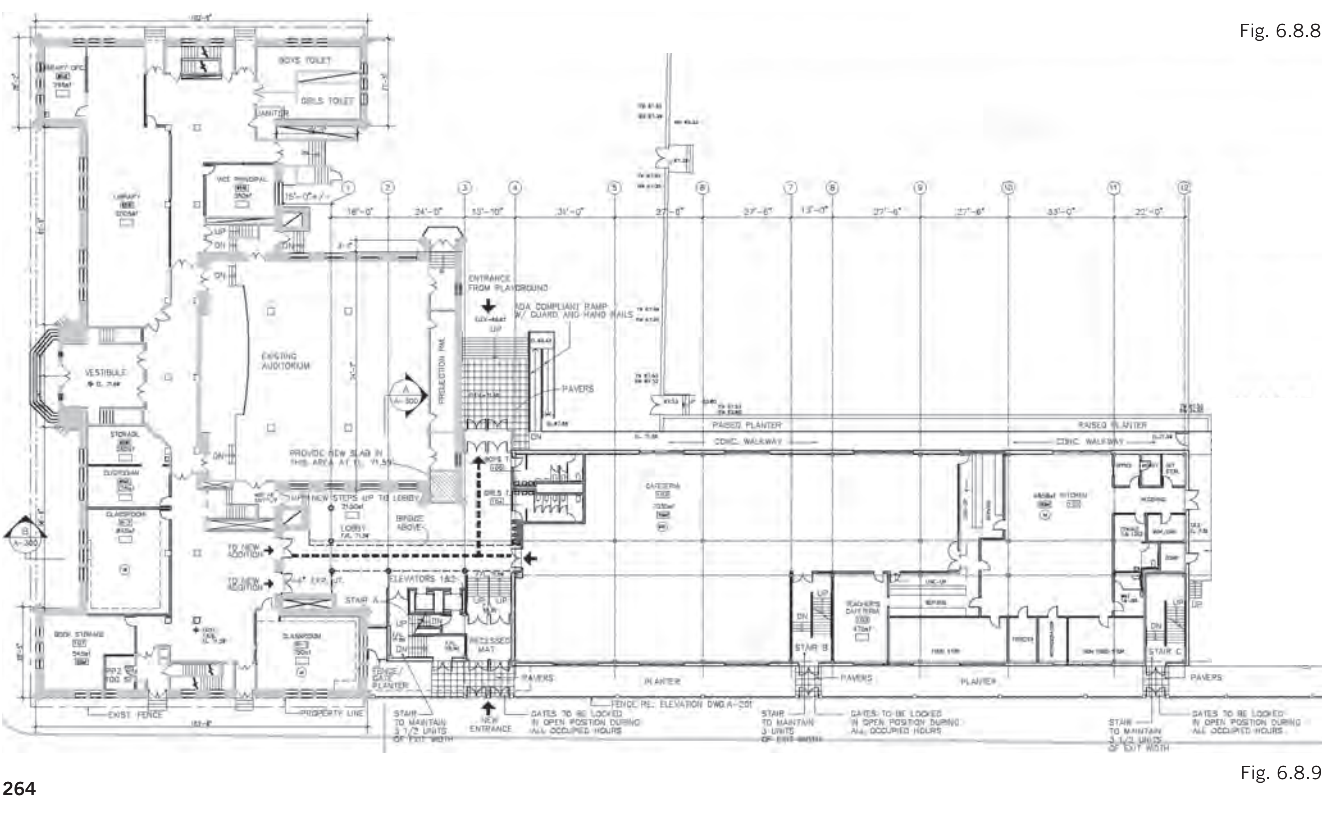


Fig. 6.8.9

Observation & Mapping

Visual surveys of interior and exterior damage were performed at the 1911 building and damage maps were produced (Fig. 6.8.13). On the upper levels of the original building and its auditorium building, there were variations in the brick color. Prior partial brick-replacement campaigns had resulted in a masonry field that was inconsistent throughout (Fig. 6.8.10). Masonry at the chimneys had also been periodically patched and coping stones were cracked. Lightning had struck the chimney at some point resulting in repair work and according to the staff, this was not the first time. Repeated deterioration and replacement of the face-brick was due to the continued presence of water in the masonry wall. The type of damage observed indicated some amount of steel deterioration may have occurred. Comparable schools that suffered from similar damage were found to have steel deterioration (Fig. 6.8.11).

Damage was also observed on the interior surfaces, especially, around the exterior windows (Fig. 6.8.12) and ceiling wall juncture. Plaster-damage and staining at the fourth floor walls and ceiling were observed to be closely correlated with the location of the expansion joint (Figure 6.8.15). The existing aluminum windows were not original to the 1911 building and drawings did not indicate that these windows were flashed. There was extensive staining around fourth floor windows. Rooms 401, 405, 408 and 410, among many others, exhibited plaster damage below, to the sides, and above the windows. The steel window guards were in fair to poor condition. Window guards that were made of regular carbon steel were rusting, and paint on the galvanized guards was peeling off in sheets. All window guards were observed to be in operable condition.

Extensive water-damage was observed on the majority of areaway walls and cellar foundation walls. Areaway grating had some deterioration and rust. The cellar walls were wet, paint was peeling, and had a buildup of crystallized salt deposits on the inside surface. Additionally, there was a large amount of water penetrating the foundation wall in the electric service room. The existing stone stair at the south elevation of the original building was in poor condition; the bluestone was chipping and cracked creating a potential tripping hazard. Welded steel fences enclosing the entire front of the original building showed signs of rust throughout. An area of the fence was bent, presumably from the impact of a car. Some exterior lighting fixtures were damaged and inoperable.

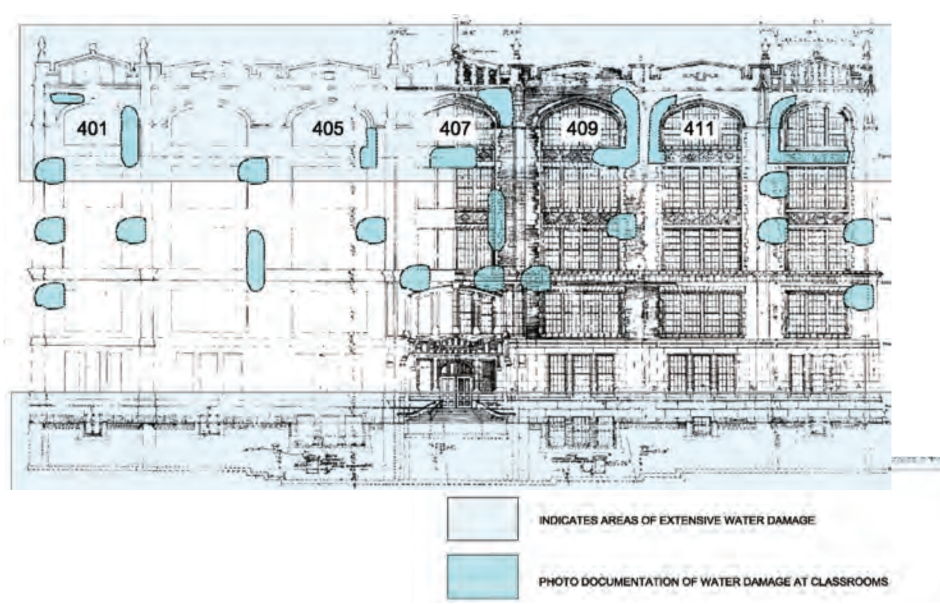


Fig. 6.8.13

Fig. 6.8.10
Masonry repair over the years had led to an overall appearance that was not uniform in color. Courtesy: Nelligan White Architects

Fig. 6.8.11
Rusting of corrugated metal arch. Courtesy: Nelligan White Architects

Fig. 6.8.12
Significant water damage at wall adjacent to window. Courtesy: Nelligan White Architects

Fig 6.8.13 (left)
Damage map of front elevation. Courtesy: Nelligan White Architects

CASE STUDIES:
IS 77 Q

Fig. 6.8.14
Expansion joint past chimney and beyond is the temporary stop-gap measure installed to prevent further interior water damage. Courtesy: Nelligan White Architects

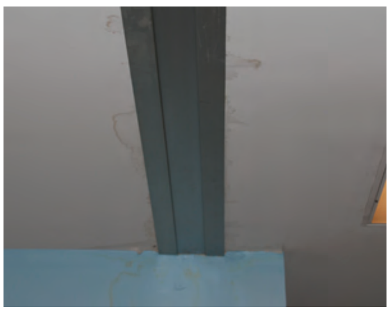


Fig. 6.8.15
Water damage at ceiling area on either side of expansion joint, direct reference to above. Courtesy: Nelligan White Architects

Fig. 6.8.16 (right)
Crenellated parapets at roof were sheathed with lead-coated copper on the roof side. Gaps between the sheathing and masonry were observed as well as soldered seams were cracked. Courtesy: Nelligan White Architects

Fig. 6.8.17 (below)
Abandoned stub-ups and dunnage at original building's roof. Courtesy: Nelligan White Architects

The roof on the 1911 building was built up roof with gravel ballast and was in fair condition, albeit some missing or damaged flashing. At the 2001 addition, built-up roofing was used along with a standing seam copper barrel roof. They were in fair condition, though the gutter and drains on the barrel roof were blocked. Near the expansion joint between the original building and addition, an EPDM membrane had been installed over plywood mounted on metal studs, covering an extended length of parapet. The custodial staff had implemented this as a temporary measure to prevent water intrusion at that location (Fig. 6.8.14).

Adjacent to this were abandoned stub-ups and dunnage for mechanical equipment that once resided there (Fig. 6.8.17). These stub-ups were considered to be another source of water-infiltration. A steel flue on the chimney was damaged when it was struck by lightning, resulting in the installation of a temporary enclosure on the opening. The stair bulkhead on the main building was clad in standing seam lead-coated copper and water damage on the interior plaster was present. When pressure was applied to the roof at the threshold of the bulkhead door, water seeped out indicating that water was trapped beneath the roof membrane at this bulkhead, and likely elsewhere.

The crenellated parapets had been partially sheathed with lead-coated copper in order to prevent water ingress (Fig. 6.8.16). However, the sheathing was applied to the roof side of the parapets, which protected half the parapet from water infiltration, leaving the façade vulnerable to water. There were gaps between the sheathing and masonry on the outside face and exposed soldered seams were cracked. As the sheathing had been integrated with the roof flashing system, it would have been impossible to remove the roof without removing the lead-coated copper sheathing. At the addition, the base flashing on the parapets was damaged.

Fig. 6.8.16

Non-Destructive Testing

In addition to visual observation, spray tests were conducted over four sessions in November 2007. Targeted areas were located around the perimeter of the building, around terracotta moldings (Fig. 6.8.18 & 6.8.22) or associated with the areas of the basement level where water damage was evident. Cellar light wells were found to be one of the main sources of water infiltration, both existing light wells and back-filled light wells (Fig. 6.8.23). They suffered from poor drainage, deteriorated joints, and seals.

As for the above grade walls, deterioration and poorly finished facade brickwork had allowed water to filter directly through the exterior walls resulting in damage to internal plastered walls and ceilings through the full height of the building. Terracotta water courses and window lintels appeared to exacerbate the problem by trapping and diverting water towards the interior. A total of 23 water ingress tests were carried out in 8 separate areas with 7 of the tests yielding positive results as confirmed by thermal imaging and moisture meter readings (Fig. 6.8.19, 6.8.20 & 6.8.21).

Fig. 6.8.18
Location of spray test at façade between the two terracotta moldings above the 4th floor windows. Courtesy: GBG USA Inc

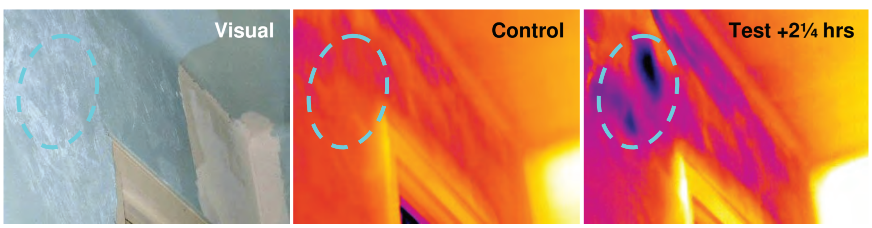


Fig 6.8.21

Fig 6.8.22

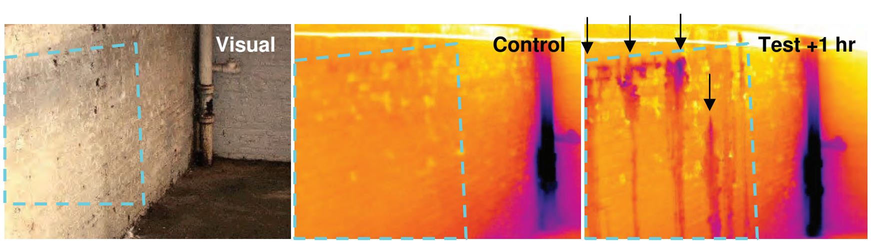


Fig. 6.8.23

Fig. 6.8.19
Location of spray test for classroom 409. Courtesy: GBG USA Inc

Fig. 6.8.20
Location of spray test at back-filled light well. Courtesy: GBG USA Inc

Fig. 6.8.21 (top left), 6.8.22 (left center) & 6.8.23 (left bottom)
Thermal images results for above the 4th floor windows, classroom 409, and at a back-filled light well in the cellar. All were positive for water infiltration. Courtesy: GBG USA Inc

Fig. 6.8.24
Probe preformed between the two terracotta moldings above the 4th floor windows. Deteriorated mortar and voids in the back up mortar was observed. Courtesy: Nelligan White Architects

Fig. 6.8.25 & 6.8.26 (right-below right)
A corroded spandrel beam was observed in an exterior probe. The backup masonry was generally found to be in poor condition. Courtesy: Nelligan White Architects

Exploratory Probes

Exploratory probes were performed between December 2007 and January 2008. Positive reading from spray tests dictated where many of the probes would be made (Fig. 6.8.24, 6.8.25 & 6.8.26).

Fig 6.8.25

Fig. 6.8.27 (below)
Interior probe of classroom 409, voids and deteriorated mortar was observed. Courtesy: Nelligan White Architects

Fig. 6.8.26

Materials Testing

Asbestos-containing materials (ACM), which may have been affected by the scope of work, was identified at various locations throughout the building. Results were achieved through visual inspection and sampling of suspect materials. Also utilized were past reports, including AHERA, OCH and IEH (Fig. 6.8.28).

Fig. 6.8.28 (below)
Partial results of the ACM testing. Courtesy: SCA

Homog. Area No.	Material	Location	# of Samples	Results	ACM Quantity	Notes
21.	Interior Window Caulk	4th floor (Top floor) Windows	3	Non-ACM	--	
22.	Exterior Window Caulk	4th floor (Top floor) Windows	3	Non-ACM	--	
23.	Exterior Window Sill Caulking	4th floor (Top floor) Windows	3	Non-ACM	--	
24.	Beige Window Guard Paint	4th floor (Top floor) Windows	3	Non-ACM	--	
25.	Exterior Window Sill Caulking	3rd floor Windows	3	Non-ACM	--	
26.	Beige Window Guard Paint	3rd floor Windows	3	Non-ACM	--	
27.	Exterior Window Sill Caulking	2nd floor Windows	3	Non-ACM	--	
28.	Beige Window Guard Paint	2nd floor Windows	3	Non-ACM	--	
29.	Exterior Window Sill Caulking	1st floor Windows	3	Non-ACM	--	
30.	Beige Window Guard Paint	1st floor Windows	3	Non-ACM	--	
31.	Exterior Window Sill Caulking	Ground floor Windows	3	Non-ACM	--	
32.	Beige Window Guard Paint	Ground floor Windows	3	Non-ACM	--	
33.	Type I Brick Mortar	Main Roof Parapet	3	Non-ACM	--	
34.	Type II Brick Mortar	Main Roof Parapet	3	Non-ACM	--	
35.	Type I Brick Mortar	Chimney	3	Non-ACM	--	
36.	Type II Brick Mortar	Chimney	3	Non-ACM	--	
37.	Interior Window Caulk	3rd floor Windows	3	Non-ACM	--	
38.	Exterior Window Caulk	3rd floor Windows	3	Non-ACM	--	
39.	Interior Window Caulk	2nd floor Windows	3	Non-ACM	--	
40.	Exterior Window Caulk	2nd floor Windows	3	Non-ACM	--	
41.	Interior Window Caulk	1st floor Windows	3	Non-ACM	--	
42.	Exterior Window Caulk	1st floor Windows	3	Non-ACM	--	
43.	Interior Window Caulk	Ground floor Windows	3	Non-ACM	--	
44.	Exterior Window Caulk	Ground floor Windows	3	Non-ACM	--	
45.	Interior Window Caulk	Basement floor Windows	3	Non-ACM	--	
46.	Exterior Window Caulk	Basement floor Windows	3	Non-ACM	--	
47.	Caulks at wall penetrations	Basement	3	Non-ACM	--	
48.	Vinyl wire insulation	Throughout	0	Non-ACM	--	Non Suspect Material
49.	Unpainted metal railings	Addition building	0	Non-ACM	--	Non Suspect Material
50.	Fiberglass insulations	Main building	0	Non-ACM	--	Non Suspect Material
51.	Fiberglass insulations	Addition building	0	Non-ACM	--	Non Suspect Material
52.	**Braided wire insulation**	**Main and Auditorium roof lighting**	**0**	**Assumed ACM**	**5 SF**	**9 light fixtures**
53.	**Concealed window caulking**	**Bulkhead**	**0**	**Assumed ACM**	**--**	**May be found between window frame and masonry opening. Will not be disturbed by scope of work.**
54.	**Concealed window caulking**	**4th floor (top floor)**	**0**	**Assumed ACM**	**--**	
55.	**Concealed window caulking**	**3rd floor**	**0**	**Assumed ACM**	**--**	
56.	**Concealed window caulking**	**2nd floor**	**0**	**Assumed ACM**	**--**	
57.	**Concealed window caulking**	**1st floor**	**0**	**Assumed ACM**	**--**	
58.	**Concealed window caulking**	**Ground floor**	**0**	**Assumed ACM**	**--**	
59.	**Concealed window caulking**	**Basement**	**0**	**Assumed ACM**	**--**	
60.	**Coping stone flashing/ mastic/ rust inhibitor**	**Main roof**	**0**	**Assumed ACM**	**1400 SF**	

Fig. 6.8.28

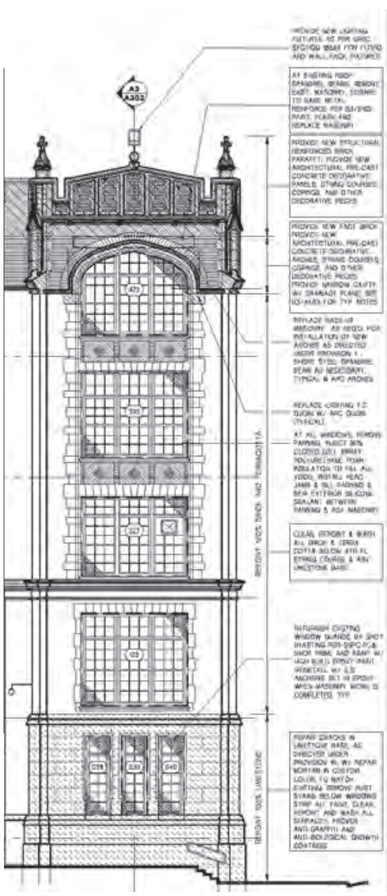
CASE STUDIES:

IS 77 Q

Recommendations & Design

Fig. 6.8.29
Interior demo of classroom 409 adjacent to window. Courtesy: Nelligan White Architects

Fig. 6.8.30 (below)
Partial elevation showing extent of facade work. Courtesy: Nelligan White Architects



Water infiltration had caused extensive damage to the interior finishes of the upper floors of the 1911 building. Previous campaigns have attempted to remedy this, but failed. The repeated deterioration and repair of the masonry indicate that water was still able to infiltrate and remain in the walls. Additionally, these past campaigns utilized varying brick colors that resulted in an appearance that was not overall uniform. As compared with similar schools, it was suspected that some steel deterioration had occurred. Multiple lightning strikes over the years have repeatedly damaged the chimney. Near the expansion joint at the 1911 original building and 2001 addition, extensive water infiltration was observed. Damage was also found on a majority of the areaway walls and cellar foundation. These findings prompted the following recommendations:

LLW No. 049095 – Exterior Masonry

1. **Areaway Walls**
   - Repoint all brick masonry
   - Remove all interior wall-damaged wall and ceiling paint finish
   - Provide chemical grout injection waterproofing at entire north and west walls, then repaint
   - Replace cracked or spalled brick
2. **Areaway Grating**
   - Scrape and repaint all exterior areaway steel gratings
   - Provide steel frame replacement
3. **Exterior Walls** (Fig. 6.8.30)
   - Clean and repoint entire original building
   - Remove and replace all face brick and terracotta panels, string courses, and decorative details from the third floor lintel up to the base of parapet of the 1911 building, including auditorium building unless noted otherwise
   - Scrape, paint, reinforce with steel channel or plat and flash any damaged steel spandrel beam
   - Provide new steel supports, clips, and straps as necessary
   - Remove existing damaged terracotta at entrance awning and canopies at Seneca Avenue and auditorium entryway
   - Replace damaged decorative masonry at the canopied entrance on Seneca Avenue and at the auditorium entryway with Glass Fiber Reinforced Concrete
   - Wash all limestone, brick, and terracotta surfaces
   - At the 1911 building repair cracks at limestone base with grout
   - Remove and replace back-up masonry and terracotta
   - Replace and flash steel lintel relieving angles, supporting face-brick at 3rd floor
   - Provide steel reinforcing plate, including all necessary preparations for structural reinforcement of spandrel beam
   - Remove rust stains on limestone
   - Repair cracks at original building with injection grout
   - At auditorium remove damaged terracotta string courses and replace with cast stone to match original
   - Remove all interior plaster and paint finishes at top floor and the auditorium of 1911 building
   - Provide liquid waterproofing membrane at top floor walls
   - Install 1-inch XPS rigid insulation, metal furring channels, $^5/_8$" Densglass Gold (glass mat faced gypsum wall board), plaster skim coat and latex to all exposed interior wall surfaces

- Remove & replace damaged coping stones at east chimney with cast-stone
- Remove and replace all face brick from chimney from ground up to coping
- Provide lightning protection to chimney
- Replace exterior stair with cast stone to match existing
- Remove, scrape, and paint all exterior welded fencing, replace if needed
- Replace inoperable flood and wall pack lighting fixtures on the exterior

LLW No. 049167 – Exterior Windows

1. Exterior Windows (Fig. 6.8.31)

- Spray test and mechanically assess operability
- At the 1911 building, remove sealant and inject foam insulation and reinstall exterior silicone sealant
- Remove window guards; shop blast, repaint, and reinstall
- Remove existing windows on top floor and anywhere else, when deemed necessary;install flashing at window openings then reinstall existing windows
- Replace panning at areas of window removal
- Provide provision for replacement of 10% of windows to be removed for potential damage to existing windows during their removal

Fig. 6.8.31
Repairs underway at windows. Courtesy: Nelligan White Architects

Additional Recommendations

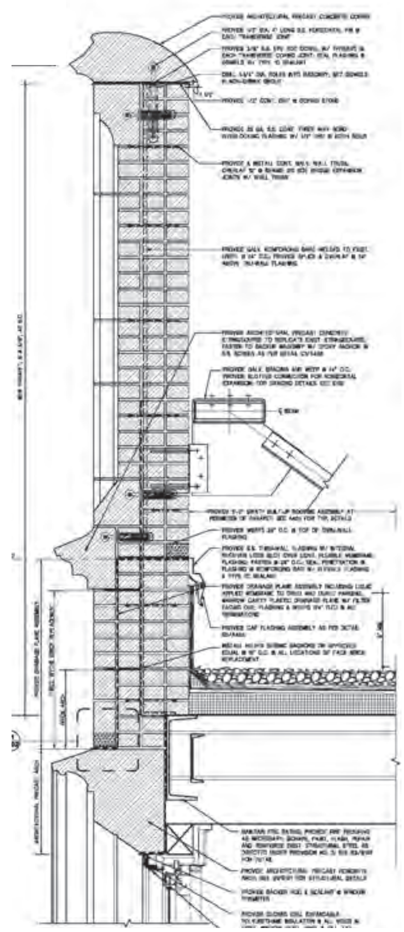
1. Roofs

- Replace damaged or missing flashing
- Remove and replace expansion joint between original 1911 building and 2001 addition
- Repair and replace a 36" swath of built up roofing assembly at entire perimeter and around bulkheads
- Obtain warranty extension from manufacturer for roof
- Remove abandoned stub-ups and dunnage, repair and replace built-up roof where necessary
- Replace all lead-coated copper at bulkhead
- Replace 1 bulkhead window
- Install a liquid waterproofing membrane, rigid insulation, Densglass Gold, plaster skim coat, and latex paint to all exposed interior surfaces
- Provide additional roof replacement as needed
- Provide lightning protection

2. Parapets (Fig. 6.8.32)

- Remove and replace all parapets, including terracotta panels and string course from base of parapet up
- Remove stone coping and lead-coated copper flashing
- Provide new structural reinforced brick parapets with through-wall flashing to match existing
- Replace all existing decorative terracotta panels, stringcourses, copings, gargoyles and other decorative pieces with Glass Fiber Reinforced Concrete (GFRC) on Unistrut steel support ladders to match existing terracotta panels
- Provide new structural steel bracing at high parapets
- Repair and replace built-up roofing assembly where necessary
- Adjust height of railing with the installation of pipe extensions to comply with contemporary code

Fig. 6.8.32 (below)
Parapet section showing extent of work. Courtesy: Nelligan White Architects



Constructability & Lessons Learned

Fig. 6.8.32
Two of the three wythes of brick were removed, resulting in a significant part of the roof load to rest only on one wythe of brick. Courtesy: Nelligan White Architects

Fig. 6.8.33 (right)
Masonry back up stabilization sketch. Courtesy: Dewberry

Fig. 6.8.34 (below)
Plaster and lath observed when one common brick was removed. Courtesy: Nelligan White Architects

At the time of this campaign, IS 77 Q was nearly 100 years old. For much of its history, the building remained relatively unchanged, until a 2001 addition that increased its footprint. The previous repair campaigns to remedy water-damage were unsuccessful as masonry and other building components continued to be vulnerable. This campaign was performed in order to repair damage and to prevent future water-infiltration for the foreseeable future.

Exterior Wall

During a walk-through in April 2009, it was observed that the masonry was demolished outside of what was specified in the contract documents. Two wythes of brick at the top floor along the south facade were removed. The contract documents only called for one wythe of brick to be removed. As an effect, significant portions of the roof were left supported by 1 wythe of brick. This was substantiated when workers removed one common brick to reveal interior plaster and lath.

The structural system of the roof consisted of a concrete slab resting on steel beams affixed to blue stone; with this entire load transferred to the back-up masonry. There were no vertical steel columns utilized during the original design and construction. With the erroneous removal this tremendous load was resting on a single layer of common brick and presented a life safety hazard, potentially jeopardizing the structural integrity of the building. A secondary concern, was that the backup-masonry was no longer tied together through the header bricks as the header bricks were chopped back to create a flush plane resulting in the necessity for alternative methods to tie all the layers of back-up masonry together. The engineer of record was directed to provide details for emergency stabilization.

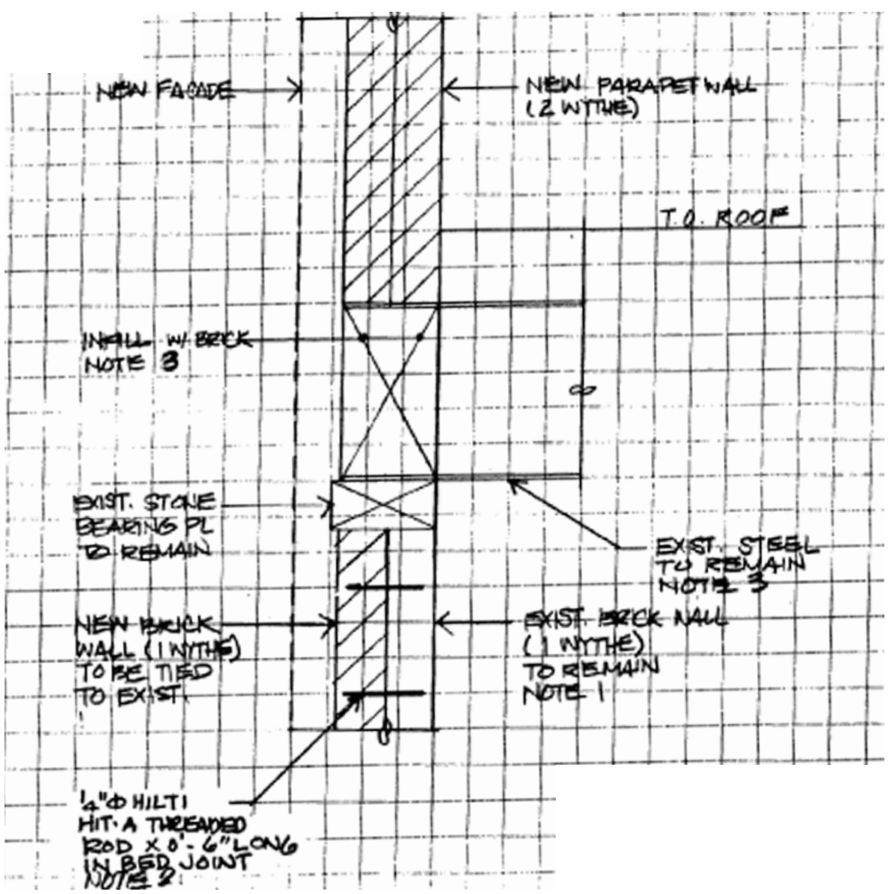


Fig. 6.8.33

Architectural Pre-cast Coping Stones

Out of all the replacement architectural pre-cast coping, 69 stones were found to be damaged at the parapet. Including two stones that were rejected, not just because they weren't on the shop drawings, but were cut to fit. Spalling was observed at the edges of the coping stones through out (Fig. 6.8.35). Stress cracks were also apparent in many of the units (Fig. 6.8.37).

In addition to replacing the newly installed units, a post construction testing of the APC coping stones was conducted. In January 2012, three triangular cast stone pieces were tested for compressive strength, absorptions and freeze-thaw resistance. The cast-stone was found to be in general conformance with the freeze thaw resistance requirements as specified.

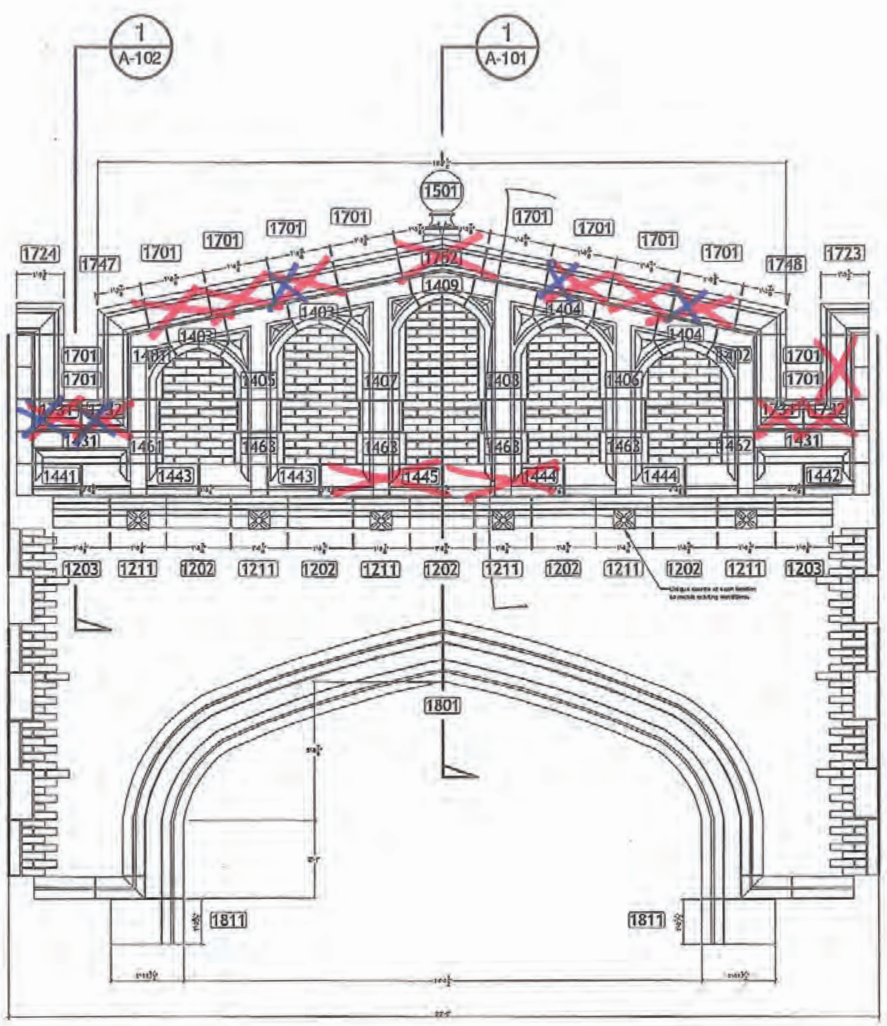


Fig. 6.8.36

Fig. 6.8.35
Spalling was observed on many of the replacement coping stones. Courtesy: Nelligan White Architects

Fig. 6.8.36 (left)
Partial elevation of damage mapping for coping stones. The "X" denotes damage of replacement coping stones. Courtesy: Nelligan White Architects

Fig. 6.8.37 (below)
Stress cracks observed on coping stone. Courtesy: Nelligan White Architects

SECTION 6.9

CASE STUDIES:
PS 60 X

CASE STUDIES:
PS 60 X

Introduction

Building ID	X060
School Level	PS
Address	888 Rev. J. A. Polite Ave. Bronx, NY 10459
Cross Streets	1st Ave & York Ave
NYC DOE District	08
SHPO Status	Eligible
SHPO ID	10PR0867
Flood Zone	Outside Flood Zone
FEMA Map	3604970084F
Architect	C. B. J. Snyder
Year Built	1920, annex 1938
Plan Form	Type A
Style	Simplified Gothic
Internal Sq Ft	113,000
Classrooms	36
Stories	5 + Cellar
Structural System	Reinforced Concrete Frame
Columns	Reinforced Concrete
Beams	Reinforced Concrete
Floors	Concrete Slab
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.9.2

Fig. 6.9.1 & 6.9.2 (below - above right)
As a part of the need for standardized schools, PS 60 X is a variation of the Type-A school in the Gothic styling. Courtesy: Sylvia Hardy

Located at 888 Reverend James A. Polite Avenue in the Bronx, the five-story PS 60 X was designed by C. B. J. Snyder, and constructed in 1920. In the last years of Snyder's tenure as the Superintendent of Buildings, schools like PS 60 X represent a later example of Type-A and the continuation of simplified school designs often for *"end-block sites"*. These schools were constructed in neighborhoods with expanding populations and were made newly accessible by an extended public transportation system.

This standardized design allowed for as many as 1500 students in about 48 classrooms. Typically, a two-story center rear extension housed the cafeteria, auditorium, and a fenced in rooftop outdoor play area. PS 60X was built in the Simplified Gothic Style, as most Type-A buildings were, featuring high crenellated parapets and vertical bays of multiple double-hung windows with terracotta banding and window surrounds. Window bays terminate at the top with a shallow pointed arch. Two symmetrical window bays flank the recessed middle portion. The main entries are a one or two-story built-out structure, ornamented in the typical Gothic motif in terracotta (Fig. 6.9.1 & 6.9.2).

Structurally, the school utilizes a reinforced concrete-framed structure. Construction of PS 60 X and similar schools occurred at a time when building methods and materials were changing rapidly, leading to varying construction details despite their similar appearance. Common problems of Type A schools, especially the latter examples, result from the poor or uneven quality of the original face brick. At PS 60 X a three story annex, in a similar style, was added in 1938 under the New Deal agency - the Public Works Administration (Fig. 6.9.3 & 6.9.4). It is a steel-framed, concrete encased structure with reinforced concrete one way floor slabs. The annex is clad in masonry with brick coursing laid identically to the original adjoining 1920 building, the decorative elements are limestone.

Water-infiltration was the biggest problem at PS 60 X, which was remedied in 3 phases starting with a 2010 campaign. In early site visits, extensive standing water was observed in the southern blower and engine room as well as an actively flowing leak through the wall at the south-eastern corner in the cellar. It was reported that water backed up through the boiler room floor drain outlet during rain storms filling to a depth of 2”-3” of standing water. IEH Laboratory testing had revealed that the standing water was neither chlorinated nor contained any sewage content; it was clean ground water. The initial site visits to the 1938 annex showed no evidence of water infiltration in the cellar.

Interior and exterior damage, in both the 1920 and 1938 buildings, was repaired in phases 2 and 3 of the 2010 campaign. Overall the exterior of the 1938 annex was in better condition, than the 1920 building despite some level of deterioration.

It was believed that faulty roof work, coupled with failing parapet masonry, let in most of the water that caused interior damage. In addition, the brick was likely unacceptably absorbent and the pointing was badly deteriorated. Exacerbating these problems, the existing masonry had an open collar joint and many voids that acted as avenues for water, additionally, windows were not flashed.

Fig. 6.9.3
An annex, in the foreground, was constructed in 1938 at the rear of the original building replicating the original style. Courtesy: Sylvia Hardy

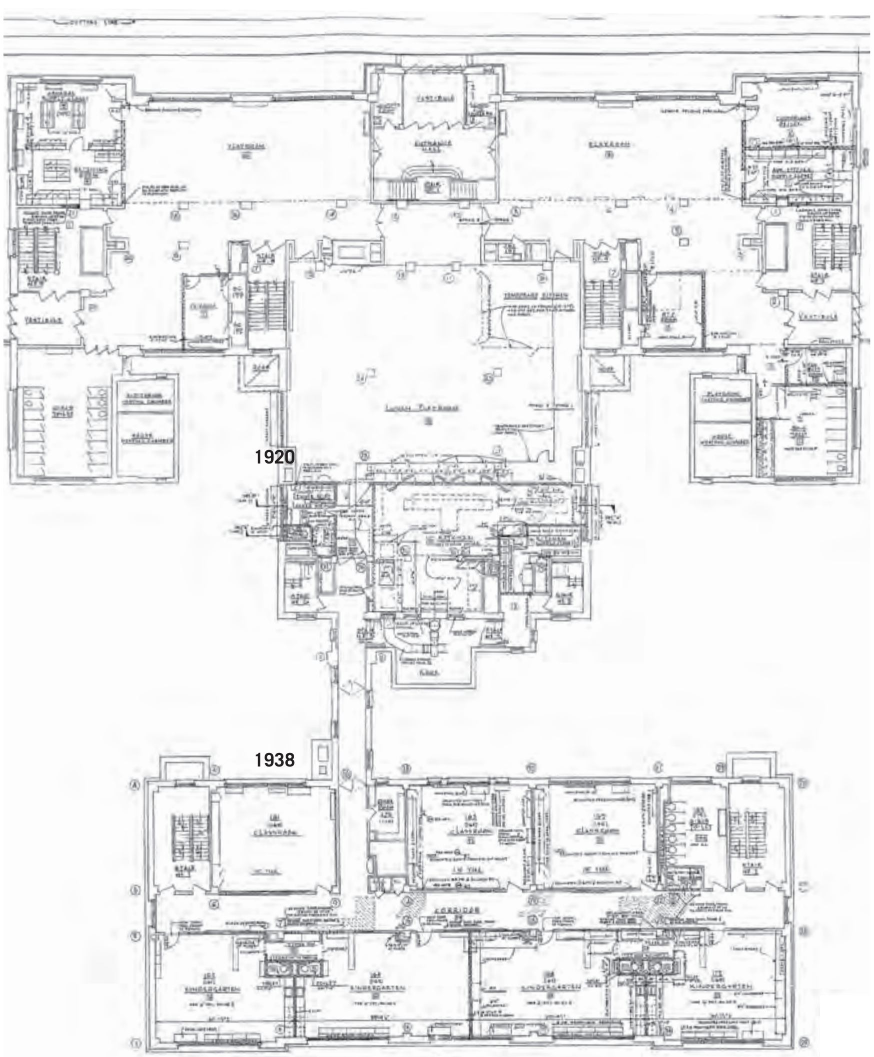


Fig. 6.9.4

Fig. 6.9.4 (left)
1964 plan showing the 1920 building and the 1938 building. Courtesy: SCA Alchemy

CASE STUDIES:

PS 60 X

Methodology

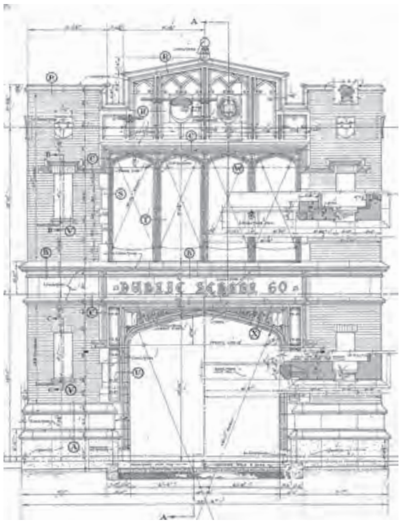


Fig. 6.9.5
Entry elevation from the 1920 original drawings. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1920, as well as drawings from eight other projects carried out at the school between 1938 and 2005, including the 1938 drawings for the three-story annex. The complete list of existing original design drawings includes floor plans, details, sections, exterior/interior elevations, structural, HVAC, and plumbing (Fig. 6.9.5, 6.9.6 & 6.9.8). Drawings from the eight projects carried out at PS 60 X between 1938 and 2005 include elevations, details, floor plans, interior elevations, and sections (Fig. 6.9.7).

Fig. 6.9.6 & 6.9.7 (right - below right)
1920 Front elevation and façade details from the 1938 annex drawings. Courtesy: SCA Alchemy

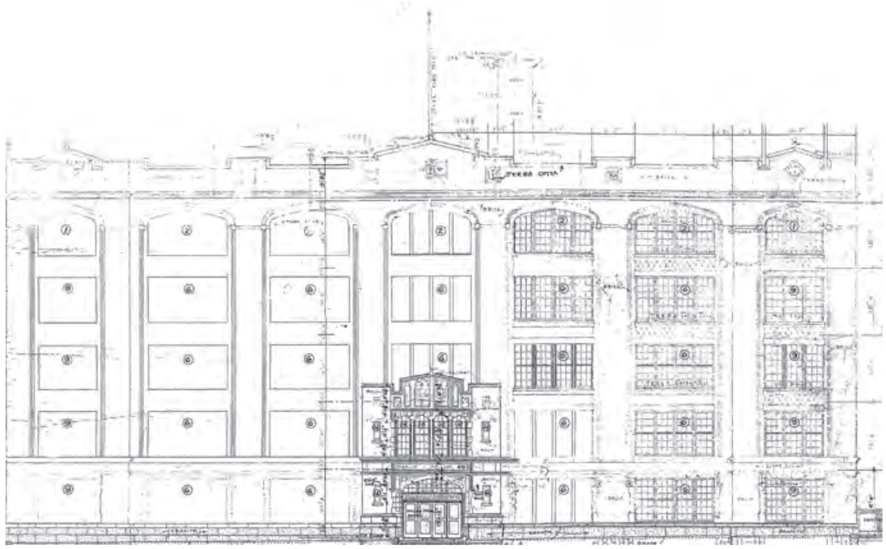
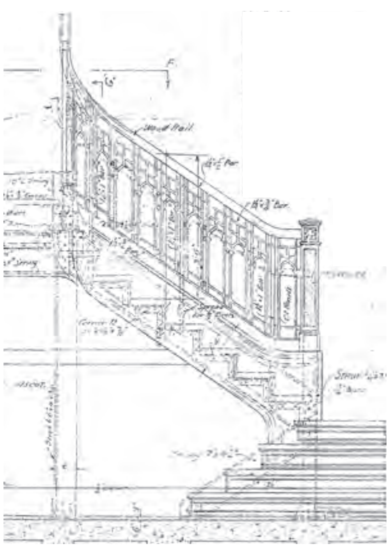


Fig 6.9.6

Fig. 6.9.8 (below)
Interior stair detail from the 1920 original drawings. Courtesy: SCA Alchemy



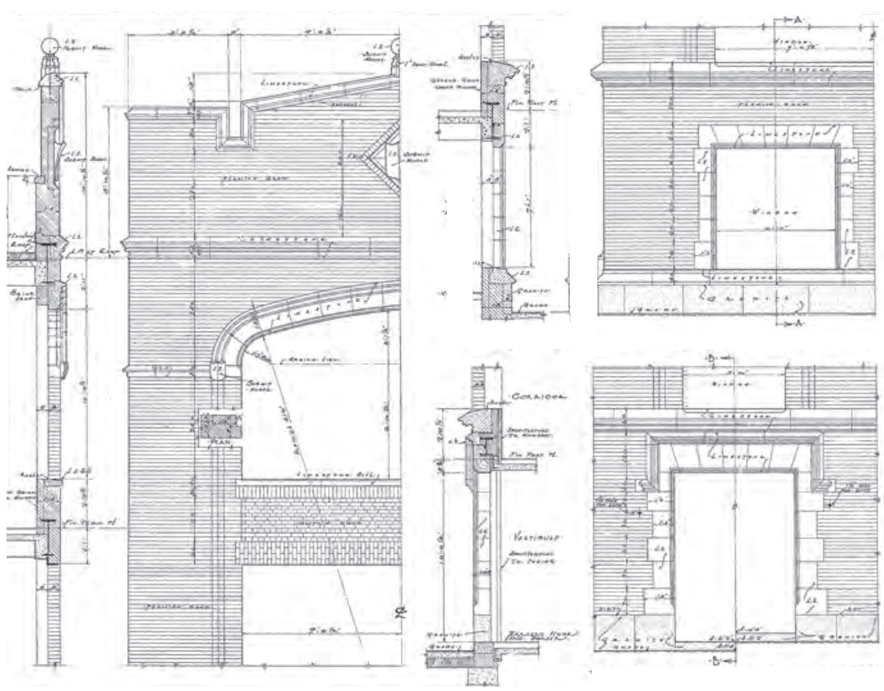


Fig. 6.9.7

Observation & Mapping

Water-infiltration was observed along the northern, western, and southern walls in the 1920 cellar. The custodian stated that the connected storm-water and sewer lines back up forcing water up through the drain in the boiler room and through the cellar bathroom fixtures, during rainy weather. At the northern and southern ends trenches were cut into the floor slab, channeling the continuously running water to the sump pumps.

Regular flooding in the electrical room, observed by the staff, rusted the base legs of the panels risking collapse. At the south-eastern corner of the southern wall, water was constantly flowing from a break in the wall and was spreading across the floor eventually flowing to the floor slab channel. A crawl space runs the full length of the western facade with a floor level of 6'-5" above the adjoining cellar floor level. While there was no visible water observed; there was extensive water staining on the slab and bulging of the slab along its axis either because of hydrostatic pressure or some other force.

Damage from water intrusion was evident on all floors of the interior in the 1920 building. (Fig. 6.9.9). On the exterior face, efflorescence was observed in the areas where water infiltration was suspected. (Fig. 6.9.10). The BCAS report gave the exterior masonry a rating of 2 (indicating an overall condition of between good and fair), specifically noting areas that required remediation. Spalled bricks were evident on each facade along with extensive deterioration of mortar joints. This type of damage to the brick masonry was an indication that moisture was collecting in the masonry.

Terracotta arches at the top floor windows and the terracotta string courses at upper level were heavily stained, cracked, and spalled. Various patches and coatings to the terracotta were observed, as well as replacement of individual units, indicating that deterioration was previously addressed at least once, and was ongoing. Aside from dirt, grime, and some less pronounced deterioration, the granite, limestone, and brick of the west entry portico, appears to be in good condition.

Fig. 6.9.9
Damage is most pronounced at the upper floors at the north-east corner of the building. In some areas regular patching of the damaged areas was undertaken and as a result some of the damage was not apparent. Courtesy: Nelligan White Architects

Fig. 6.9.10
Large amounts of moisture in the masonry will exert great force on the assembly if frozen. As there were no expansion joints, the mortar joints should have absorbed the force, leaving the bricks intact. However, the mortar joints and the face-brick were both damaged, an indication that the mortar type is inconsistent and exceeds the strength of the brick at certain locations. Courtesy: Nelligan White Architects

Fig. 6.9.11 (below)
Damage map of the 1920 cellar. Courtesy: Nelligan White Architects

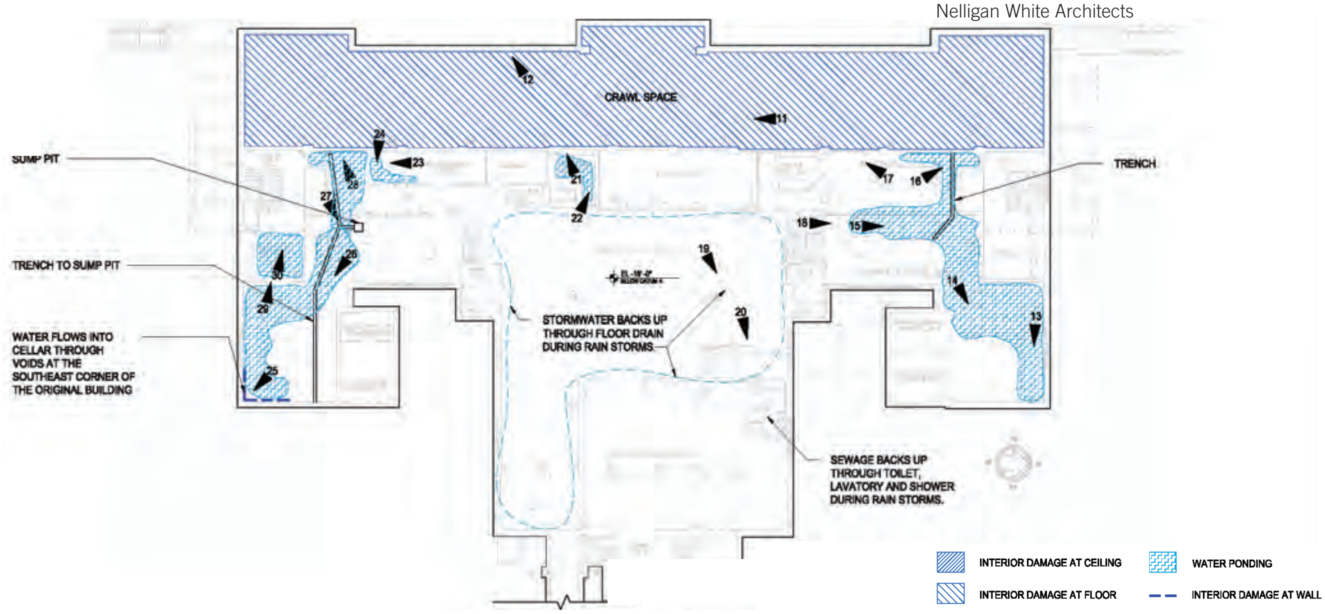


Fig. 6.9.11

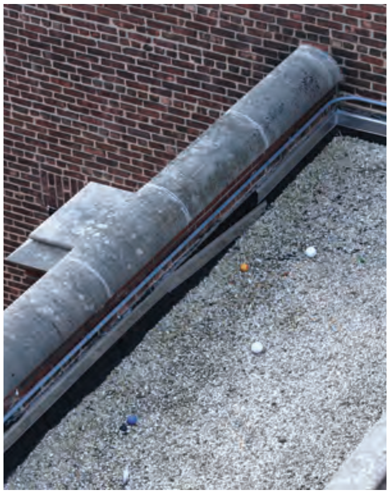


Fig. 6.9.12
Roof of corridor between the 1920 and 1938 buildings. Parapets were below the height requirements. Courtesy: Nelligan White Architects

In the 1938 annex, the cellar did not appear to have any of the water-infiltration problems. Observations at the exterior of the 1938 annex revealed several spalled and chipped terracotta window sills. A 4'-0" long vertical crack in the chimney masonry located above the parapet was observed. Like the 1920 building there were no expansion joints at any facade. The original structural drawings of the 1938 annex showed internal steel reinforcement of the parapet to a height of 5'-0" above the roof beams.

However, the unbraced parapet may not have had sufficient capacity to resist lateral loads. It appears that the masonry at these parapets was the original, indicating that the parapet remediation work that occurred at the 1920 building was limited to that location. The interior face of the parapet contains numerous cracked bricks, open joints, spalling and water stained bricks. Decorative elements are of limestone rather than terracotta. The limestone coping and emblem surface was rough and pitted from acid corrosion due to environmental pollutants. At some locations, panels have cracked all the way through due to movement in the parapet. Corrosion of steel parapet reinforcing was suspected.

There was a continuous horizontal crack at the interior face of the parapet wall at approximately 34" above the finished roof. This appeared to coincide with the parapet horizontal reinforcing bars shown on the original structural drawings. It was believed the bar had corroded and expanded, jacking the parapet up and opening this joint. The only reliable solution for this condition was removal and re-installation. Leaving this steel in place would had led to an accelerated cycle of failure as the entire parapet would be destabilized and become dangerous.

At both the main annex roof and the roof of the corridor to the original building the parapet walls were below the 42" minimum building code requirement. (Fig. 6.9.12). A panel of the stainless steel counter flashing between the roof and parapet had dislodged and required repair. There is also organic growth present on the coping stones.

Extensive photographs and detailed field notes were processed into damage maps of the facades and floor plans using the existing design drawings as base drawings. These damage maps facilitate the quantification of deficiencies and aid in determining a breadth of scope (Fig. 6.9.11 & 6.9.13).

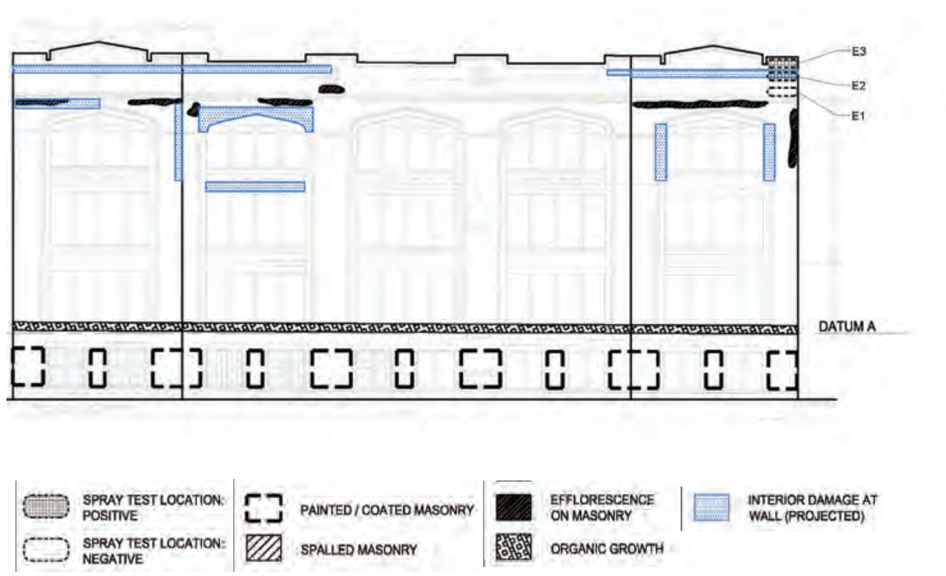


Fig 6.9.13

Fig. 6.9.13 (right)
Damage map of the east elevation of the 1938 annex. Courtesy: Nelligan White Architects

Non-Destructive Testing

Roof scans, spray tests, flood tests and observations were employed in the non-destructive phase of testing (Fig. 6.9.14). In early April 2010, roof scans and spray tests were conducted to locate potential areas of moisture retention beneath the roof membranes and at various locations where water damage was evident. Of the 33 spray tests, 15 were positive for water ingress. The investigation was carried out using infrared thermal imaging (Fig. 6.9.15) and electrical capacitance combined with visual inspection and relative moisture content assessment using a hand held moisture meter probe. A total of fourteen Electrical Capacitance anomalies were identified over the five roof areas, investigated with a combined surface area of approximately 4395 sq ft; this equates to approx 17.7% of the total roof area. A total of seven thermal anomalies were identified over the five roof areas investigated with a combined surface area of approximately 5780 sq ft; this equates to approximately 23.2% of the total roof area. The electrical capacitance and thermal anomalies have been found to coincide at 11 locations over the five roof areas, investigated with a combined surface area of approximately 2360 sq ft; this equates to approx 22.4% of the total roof area.

Fig. 6.9.14
Spray tests in progress at roof. Courtesy: Nelligan White Architects

Areas tested in parapet brick produced positive results and close visual inspection identified a number of sources of water-ingress. The condition of the parapet brickwork was generally poor, with open and cracked mortar joints, spalling bricks, severely weathered/eroded mortar and cracking throughout the areas tested (Fig. 6.9.16). Eight of ten tests at the inside of the parapets where there was no cladding were positive, as was the only test at the coping above the cladding. Two of the three tests at the outside of the parapets were positive. Notably, the metal cladding on the inside of the parapets on the original building did not leak at all.

Spray testing was provided at the outside face of the 1920 original building's parapet at two locations. Both locations where spray racks were aimed, yielded positive for water-infiltration. The results were observed through thermal photography within the 5th Floor classroom 502 and server room 551. As seen in the damage mapping, the interior damage is more pronounced at the north end of the fifth (top) floor of the original building, than elsewhere in this building.

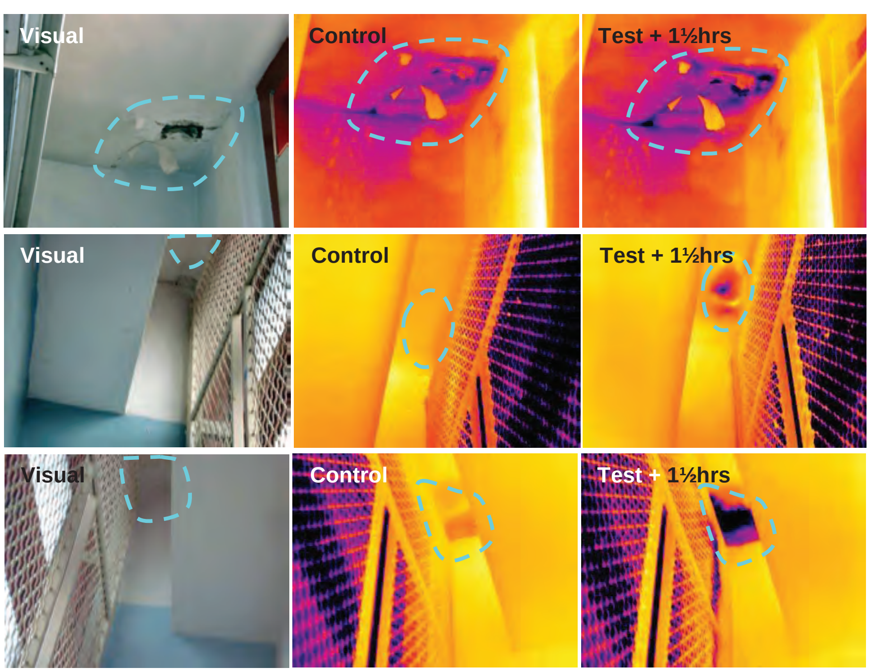


Fig. 6.9.15

Fig. 6.9.15 (left)
Infrared images showed positive water infiltration at multiple locations in the interior and confirmed with a moisture meter. From top to bottom, Rm 502, 2nd floor boys bathroom, and 2nd floor girls bathroom. Courtesy: GBG USA Inc

Fig. 6.9.16 (below)
Damaged parapet observed during spray tests. Courtesy: Nelligan White Architects

Fig. 6.9.15
During the probe explorations voids were found throughout the wall assembly. Courtesy: Nelligan White Architects

Exploratory Probes

Exploratory probes in the 1920 building showed deficiencies common to failing masonry. The collar joint (between the face wythe and the backup masonry) was observed to be devoid of mortar. This void allowed any moisture that got through the face masonry to travel into the wall. The backup masonry had many voids, providing a further avenue for moisture infiltration (Fig. 6.9.15). In several locations, the mortar crumbled when touched.

There was no through-wall flashing at the parapet, beams, columns, lintels, or around windows. These deficiencies allowed water to travel freely through the wall once inside. Any water in the wall has the potential to cause corrosion of steel without impediment. Exterior masonry probes revealed that in several areas there was a 2" gap between the spandrel beam and window head which was a direct route for water to flow to the interior.

In the 1938 annex, a low probe was opened just above the baseboard in the north-east corner of a 3rd floor classroom. It revealed approximately 6 ½" of white/gray brick masonry and mortar; which were believed to be the back of the column. A black building paper or adhesive was observed between the brick masonry and the concrete masonry. The high probe, opened directly above, revealed the same condition. Additionally, the metal lathe the plaster was installed on was exposed.

Another probe in the north-east corner of a 2nd floor classroom revealed the same construction as the third floor classroom. The crack observed in the finish plaster appeared to project from the transition between the block partition wall and the brick column encasing (Fig. 6.9.16). Blue and white plaster coated wires were also observed installed within the concrete block.

Fig. 6.9.16
In the 1938 annex, the probe showed a crack in the plaster correlated with a transition between block and brick directly behind. Courtesy: Nelligan White Architects

Fig. 6.9.17 (right)
Corroded steel member revealed during probe. Courtesy: Nelligan White Architects

Fig. 6.9.13

Materials Testing

All available DOE and SCA files were reviewed, from both the facility files and SCA headquarters, for lead based paint (LBP) reports. No pertinent information was found. A close visual inspection of all accessible areas for the presence of LBP was conducted. The results positively identified LBP at various locations on the exterior side of the building which would be affected by the scope of work.

The asbestos inspection was conducted in November 2010 and involved a thorough visual examination of all accessible areas and sampling of suspect materials, which would be affected by the proposed work. Asbestos-containing materials, which will be affected by the scope of work, were positively identified at various locations throughout the building. Laboratory analysis confirmed no presence of asbestos in the amount greater than 1% in the all of the samples collected. Visually inspected materials that were not tested, were assumed to contain asbestos while various other materials tested for less than 1% asbestos.

Fig. 6.9.18
Asbestos protection in suspected areas in the 1920 cellar. Courtesy: Nelligan White Architects

Fig. 6.9.19 (below)
Excerpt of LBP report. Courtesy: KAM Consultants Corp.

Scope of Work	Location	Material (Building Component)	Substrate	Color	# of Samples	# of XRF Readings (mg/cm^2)	Result	Comments
D#013494 Exterior Masonry	1920 Bldg - 5th Floor Girl's Bathroom	Pipe Jacket	Metal	Light Blue	-	1	LBP	Paint in Fair Condition
		Floor	Concrete	Grey	-	1	Non-LBP	Paint in Fair Condition
		Ceiling	Plaster	White	-	1	LBP	Paint in Fair Condition
	1920 Bldg - 4th Floor Girl's Bathroom	Door	Wood	Blue	-	1	Non-LBP	Paint in Fair Condition
		Door Frame	Wood	Blue	-	1	LBP	Paint in Fair Condition
		Wall (Upper)	Plaster	Light Blue	-	4	LBP	Paint in Fair Condition
		Wall (Lower)	Ceramic Tile	Blue	-	4	LBP	Paint in Fair Condition
		Radiator	Metal	Light Blue	-	1	Non-LBP	Paint in Fair Condition
		Radiator Cover	Metal	Blue	-	1	Non-LBP	Paint in Fair Condition
		Pipe Riser	Metal	Blue	-	1	LBP	Paint in Fair Condition
		Pipe Jacket	Metal	Blue	-	1	Non-LBP	Paint in Fair Condition
		Ceiling	Plaster	White	-	1	Non-LBP	Paint in Fair Condition
		Floor	Concrete	Grey	-	1	Non-LBP	Paint in Fair Condition
		Ceiling Pipes	Metal	White	-	1	LBP	Paint in Fair Condition
	1920 Bldg - 4th Floor Boy's Bathroom	Door	Metal	Blue	-	1	Non-LBP	Paint in Fair Condition
		Door Frame	Metal	Blue	-	1	Non-LBP	Paint in Fair Condition

Fig. 6.9.19

Recommendations & Design

Fig. 6.9.20
Excavation of play yard for storm water detention system. Courtesy: Nelligan White Architects

Fig. 6.9.21
Standing water in 1920 cellar. Courtesy: Nelligan White Architects

Fig. 6.9.22 (below)
Cellar plan of 1920 building showing partial extent of work. Courtesy: Nelligan White Architects

Much of the 1920 building's cellar was being affected by water-infiltration. During rain storms, water backed up through the boiler room floor drain. Flowing water drained into a 4" wide trench, cut into the floor slab leading to a sump pump. Testing competed by IEH showed the infiltrating water was clean ground water.

It was thought the flooding could be attributed to two discreet causes; the first source is storm-water and sewage that overflows from the cellar drains. The second possible source of flooding was attributed to ground water entering through the cellar foundation walls, slab, un-slabbed crawl spaces under entry vestibules, and through the rat slab at the elevated crawl space along the west facade. Sewer issues as well as existing site conditions are likely the sources of the water.

No evidence of flooding was observed in the 1938 annex cellar. A sump pit adjoining the southern wall of the gym was observed. It contained a small amount of water and an electric pump which was functioning. These findings prompted the following recommendations:

LLW No. 060112 – Flood Elimination

1. **Cellar** (Fig. 6.9.22)
    - Waterproof foundation walls and cellar slabs
    - Reinforce foundation walls, cellar slab, and crawl space slabs to resist measured hydrostatic pressure
    - Remove and replace equipment whose bases are substantially water damaged
    - Install 5,000 cubic foot storm water-detention system beneath the south play-yard (Fig. 6.9.20)
    - Disconnect toilet fixtures from the sanitary house drain and connect the fixtures to new duplex ejector system

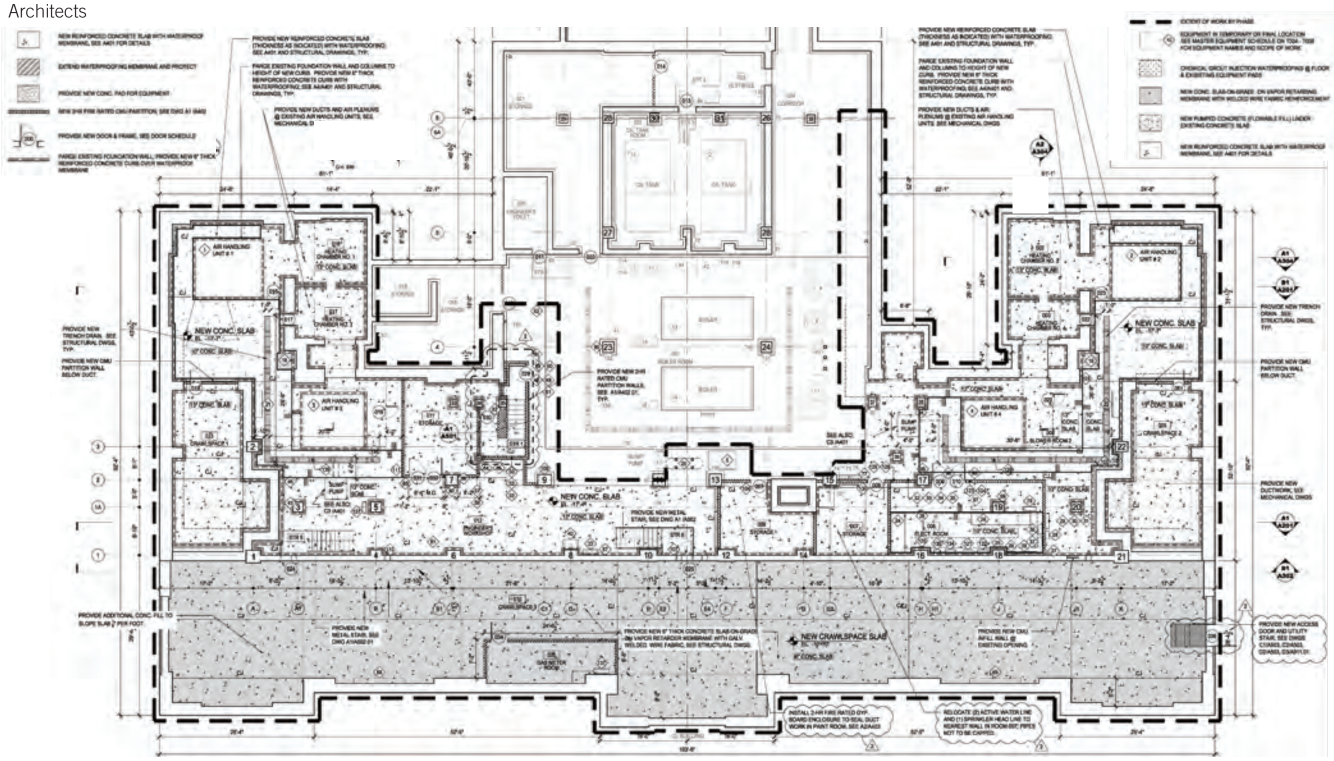


Fig. 6.9.22

The type of damage to the brick masonry observed at the 1920 building, was an indication that moisture was collecting in the masonry. The brick may, therefore, have had an unacceptably high absorption rate. Widespread efflorescence and spalling observed at times, lends credence to this supposition. Exploratory probes showed deficiencies common to failing masonry, the collar joint (between the face wythe and the backup masonry) was observed to be devoid of mortar. The backup masonry also had many voids, providing further avenue for water to travel. There was no through-wall flashing at the parapet, or at beams, columns, and lintels, or around windows. Routinely performed plaster repairs to the damaged areas on an annual basis were evident. It was observed that the water infiltration damage primarily occurs near the windows, in close proximity to the lintels.

Fig. 6.9.21
Spalling damage at facade. Courtesy: Nelligan White Architects

Significant water-infiltration damage was observed in the annex building. The location of water damage was observed around un-flashed window lintels in several classrooms. Other ceiling and wood floor damage was identified in the damage survey and was believed to be resultant of deficiencies in the roof and radiators, respectively. These findings prompted the following recommendations:

LLW No. 062895 – Exterior Masonry

1. **Exterior Walls - 1920 Building** (Fig. 6.9.22)
   - Remove masonry down to the terracotta arches above windows at the fifth floor
   - Protect terracotta arches to remain
   - Repair damage to the steel spandrel beams
   - Provide new composite copper flashing and brick masonry
   - Repair chipped and spalled terracotta arches
   - Remove and replace masonry associated with vertical cracks at selected columns
   - Flash columns at those repaired locations
   - Repair finishes, prime and paint at locations of interior damage associated with water penetration and cracking
   - Repoint entire building below fifth floor string course
   - Clean all facades

2. **Exterior Walls - 1938 Annex**
   - Remove brick masonry down to the limestone arches above windows at the third floor
   - Protect limestone arches to remain
   - Repair damage to the spandrel beams, replace hung lintels, install new flashing, and brick masonry
   - Repair chipped and spalled limestone arches
   - Remove and replace masonry and interior finishes associated with vertical cracks at selected steel columns
   - Repair, paint, and flash steel columns at repaired locations
   - Repair finishes and paint at locations of interior damage associated with water penetration
   - Repoint entire building below 3rd floor string course including exterior of building connection corridor
   - Clean all facades

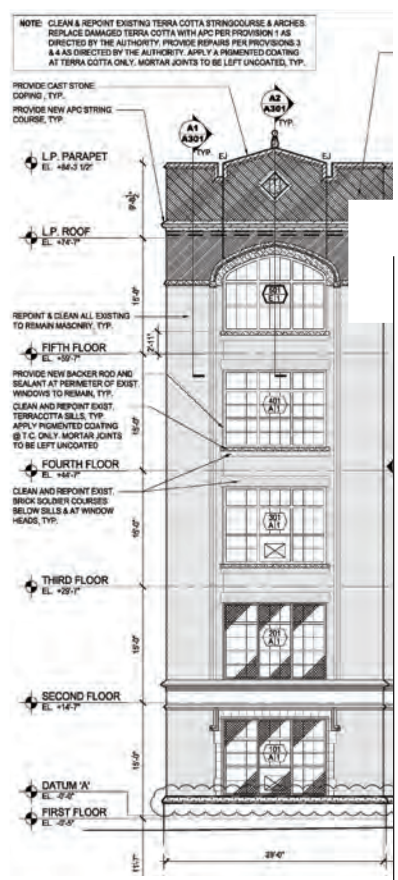


Fig. 6.9.22
Partial elevation showing extent of repairs. Courtesy: Nelligan White Architects

Fig. 6.9.23
Terracotta coping damage and failing remediation at 1920 parapet. Courtesy: Nelligan White Architects

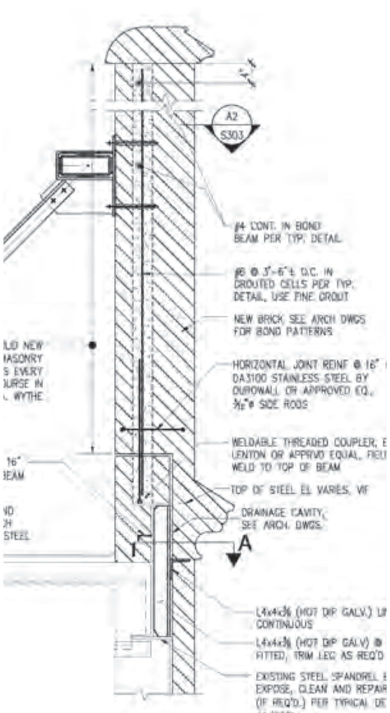


Fig. 6.9.24
Wall section through parapet showing extent of repairs. Courtesy: Nelligan White Architects

Previous repair work to the 1920 parapets resulted in mismatched colors. It was found that the parapet wall did not contain any structural steel bracing possibly affecting its capacity to resist lateral loads. Terracotta coping stones were chipped and cracked at several locations and crazed throughout. There was no flashing under the copings. The custodial staff had attempted to patch these deficiencies with sealant, however, this remediation was failing. Deterioration caused the caulking to detach from the terracotta thereby opening the joints to water infiltration. The roof-side of the parapets was clad in sheet metal siding. Spray tests showed that it was effective in keeping water out of the back of the parapet wall (spray tests on the outside were positive, however).

Cracking, spalling, staining, and other deterioration were found through out the parapets. Unlike the 1920 building, the parapets of the 1938 annex were most likely original. The lack of reinforced steel above a height of 5'-0" above the roof beams may have diminished the capacity to resist lateral loads. Cracks appeared to coincide with the parapet horizontal reinforcing bars shown on the original structural drawings. It was believed the bar had corroded and expanded, jacking the parapet up and opening this joint.

Leaving this steel in place would have led to an accelerated cycle of failure as the entire parapet would be destabilized and become dangerous. Overall the height of the parapets from the roof slab were found to be below the 42" minimum require height per the building code. These findings prompted the following recommendations:

LLW No. 0634931 – Parapets

1. **Parapets - 1920 Building** (Fig. 6.9.24)
   - Construct new reinforced brick parapets at selected length of north wing, with through-wall flashing (3 wythe thick, maximum height 8'-0")
   - Provide new structural steel bracing at new parapet
   - Provide new cast stone coping and stainless steel coping flashing

2. **Parapets - 1938 Annex**
   - Construct new reinforced brick parapets at perimeter with through-wall flashing (3 wythe thick, maximum height 8'-0")
   - Provide new cast stone coping and stainless steel coping flashing
   - Provide new structural steel bracing at high parapets
   - Provide new guardrails at non code compliant parapets

Additional Recommendations

1. Roofs - 1920 Building*

- Repair or replace approximately 12" high base flashing at the parapets for the perimeter extending 3'-0" into the built-up roofing
- Remove flag pole and replace the base and four pitch pockets with new galvanized steel brackets and provide warrantable penetration seals
- On the northern vent shaft remove the plywood sheeting, framing and curb, and install new insulated curb, fan and hood
- On the dumbwaiter shaft, remove the existing copper framed glazed cover including two ventilation units and replace with new insulated metal roof including two new ventilation units.
- Install new flashing to surrounds
- Remove and reinstall gutters and install new flashing at edge of roof membrane into gutter
- Replace the roofing and flashing at the leaking roof-drain above classroom 509
- Provide spray applied membrane and metal cladding on outside of fan room
- Replace windows in fan room bulkhead; provide flashing (Fig. 6.9.25)

Fig. 6.9.25
Windows in fan room bulkhead to be replaced. Courtesy: Nelligan White Architects

2. Roofs - 1938 Building* (Fig. 6.9.26)

- Replace the entire built-up roof at the annex
- Reinstall lead coated copper standing seam roofing at the annex bulkhead

*It was noted that both roofs were still under warranty until 2020 and that the manufacturer would be contacted to initiate the warranty.

3. Windows & Doors - 1920 Building & 1938 Annex

- Remove and reinstall the existing windows at the 5th floor of the 1920 building and the 2nd and 3rd floors of the annex building to allow installation of self-adhering bituminous membrane over the existing blocking at each of the masonry openings.

Fig. 6.9.26 (below)
Roof plan showing extent of roof repairs to 1938 annex. Courtesy: Nelligan White Architects

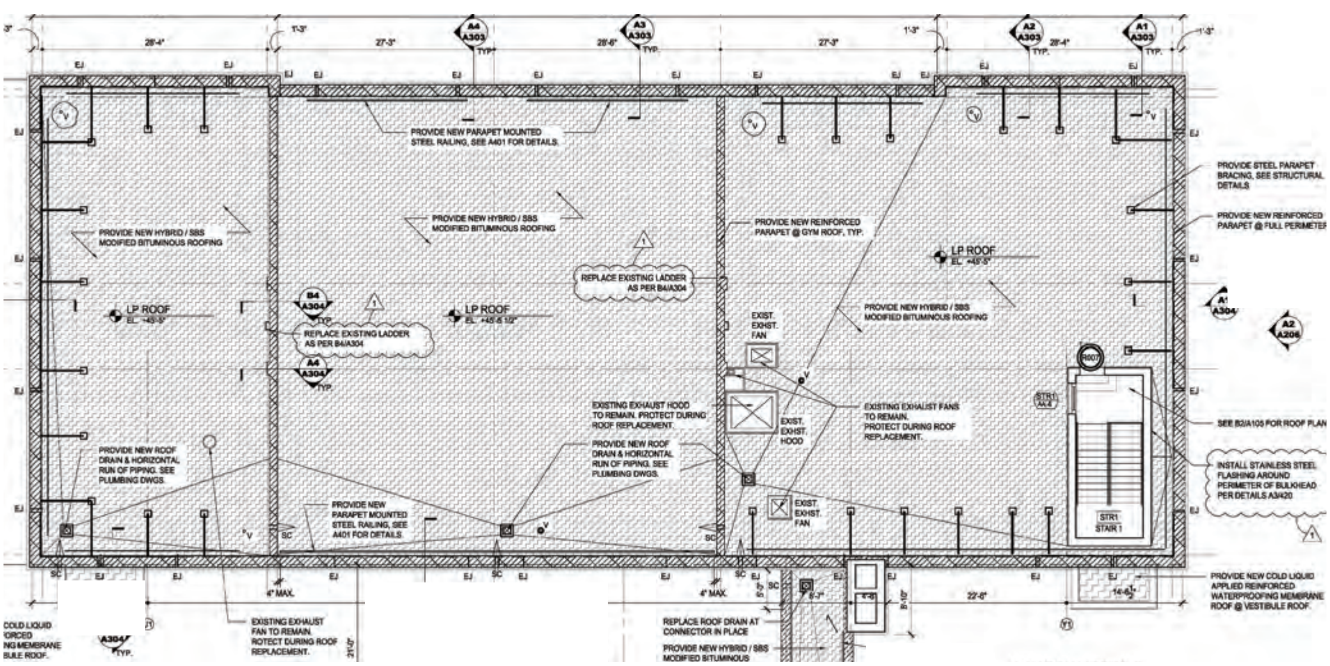


Fig 6.9.26

Constructability & Lessons Learned

Fig. 6.9.27
Detention system awaiting installation. Courtesy: Nelligan White Architects

Fig. 6.9.28
Heating chamber during demolition phase. Courtesy: Nelligan White Architects

Fig. 6.9.29 (right)
Nearly complete cellar in the 1920 building. Courtesy: Nelligan White Architects

At PS 60 X, moisture infiltration was affecting the entire school, including standing water in the cellar and interior damages in the floors above. Existing site conditions at the ground level, including evidence of pre-existing streams/wetlands, or malfunctioning sanitary/storm sewer lines were thought to be contributing to damage in the cellar, and damage at the upper floors was attributed to flaws in workmanship and materials on the roof, as well deterioration of the parapet.

Flood Elimination

Constant infiltration of water from the walls and backed-up drains in the cellar was a highly visible problem. The focus of the contract scope was to waterproof and reinforce the foundation walls and cellar slab to resist hydrostatic pressure and the installation of a new structural concrete slab and knee wall to help form a water-tight bathtub at the cellar elevation.

An additional remedy to the moisture infiltration problem, was the construction of two detention systems under the play yards. This would act as temporary water storage during storm events in which water would be held until the public sewer could handle the surplus. Borings conducted during the design phase indicated that bedrock could be anticipated at approximately 11.5 feet below the level of the existing paved surface. Instead, bedrock and very large boulders were encountered above this elevation at intermittent locations below the south playground. The contractor was directed to provide excavation and removal of rock as required to achieve the depths required for correct placement of site piping, manholes, detention tanks, and the interior sump.

Fig. 6.9.29

Parapet

It was found that the 1920 parapet wall did not contain any structural steel bracing, affecting its capacity to resist lateral loads. Similarly, the 1938 parapets only contained reinforced steel for part of their full height.

The proposed new parapets were to receive steel bracing, anchored back to steel stub posts, attached to existing supporting beams. At the 1920 building, the steel stubs were installed without first locating the existing supporting beams, as requested on construction documents and shop drawings. The GC had reported that wire mesh and other embedded ferrous elements in the roof slab made it unfeasible to located the existing beams using a magnetic detector. It was unclear if the new stub posts were supported by roof beams as intended, or just by the roof slab. This was concerning, as the existing concrete slab did not have the capacity to resist the imposed loads from the posts, and the anchors holding the posts would not be embedded the full 8" minimum deep requested on the drawings since the structural roof slab is about 4" thick. The GC was required by the construction drawings and shop drawings to verify the locations of all existing cast-in-place concrete roof beams that are to support stub posts, confirm the plan locations of the as-built stub posts relative to these existing beams, and move any stub posts not supported by beams, to their correct locations. In contrast, in the 1938 annex, the stub posts were able to be attached to field verified supporting beams.

For the 1920 building, it was discovered that the existing concrete curb assumed to exist based upon the original drawings was not present along the 90% of the roof perimeter. Where it did exist above the four east elevation windows, it was short in height and thicker in width than indicated on the contract documents. An alternate construction detail was submitted, in order to make up for the missing curb.

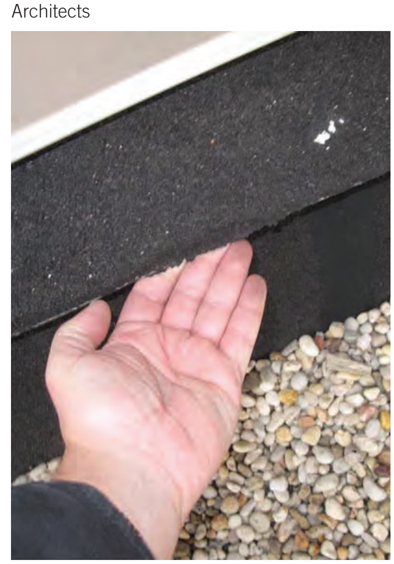
Roof

The perimeter of the roof at the1920 building, as well as the entire roof of the 1938 annex was recommended for replacement. As both roofs were under warranty until 2020, the manufacturer was reasonably expected to provide the following repairs at their expense; replace entire 1938 annex roof, repair or replace all perimeter roofing and base flashing at the parapets on the 1920 building, replace pitch pockets with warrantable penetration seals at flag pole and other penetrations on the 1920 building, and replace the roofing and flashing where it was leaking at the roof drain on the 1920 building.

The manufacturer inspected the roofs and its report enumerated a number of failures of the building envelope independent of their roof system (and thus, not within their obligation to fix), roof system failures that are not their responsibility, and some open seams and a slit that they will repair. They found poorly patched probes, however, the photos included do not show probes made during the current campaign and were most likely previous leaks with roofing cement over them. They found multiple open masonry joints and missing sealant, presumably at the adjacent parapets. The manufacturer seemed to imply that the roof was leaking because the parapets were leaking. While the parapets did leak, spray/infrared testing and electrical capacitance testing of the roof showed water in the assembly throughout, the roof was failing systemically. The report identified only 257 squares (257,000 square feet of roofing), while the roofs total closer to 280 squares. Few photos referred to the Annex, where the worst failures were. The report did not identify or comment on non-standard pitch pocket details that were allowed by the manufacturer and have failed. Furthermore, fixing the split seams and slit would not address the larger failures of the roof system, and would be redundant to the complete replacement necessary to truly fix the roof.

Fig. 6.9.30 & 6.9.31 (above - below)
Parapet of 1920 building, no structural steel evident. Partial curb above window on east elevation was found to be shorter and thicker than indicated. Courtesy: Nelligan White Architects

Fig 6.9.32 (below)
At many locations, the base flashing was improperly installed with horizontal seams. These seams have split open over time, allowing water to infiltrate. Courtesy: Nelligan White Architects



SECTION 6.10

CASE STUDIES:
PS 121 Q

CASE STUDIES:

PS 121 Q

Introduction

Building ID	Q121
School Level	PS
Address	126-10 109^{th} Street Queens, NY 10065
Cross Streets	126^{th} St & 127^{th} St
NYC DOE District	28
SHPO Status	Eligible
SHPO ID	07PR0468
Flood Zone	Outside Flood Zone
FEMA Map	3604970229F
Architect	William H. Gompert
Year Built	1923-1924
Plan Form	Type-E
Style	Neo - Colonial
Internal Sq Ft	77,000
Classrooms	34
Stories	5 + Cellar
Structural System	Steel Frame
Columns	Steel
Beams	Steel
Floors	Concrete Slab
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.10.2

Fig. 6.10.1 & 6.10.2 (below - above right)
Moving away from the classical styling, schools after Snyder began to utilize elements from colonial United States. The portico serves as a focal point to direct users to the main entry. Smaller windows at a repetitive pattern reflect the changing technologies and more reliance on artificial light. PS 121 Q is shown in 2006, where the parapet is an obvious renovation. Courtesy: Sylvia Hardy

By 1923, William H. Gompert had succeeded C. B. J Snyder as the Superintendent of School Buildings. While there was a shift in leadership, Gompert continued Snyder's work to standardize the design of school buildings. The standardized school design continued to be a necessity as the city's population grew even more through the 1920s and spread out further from the industrial and commercial centers. Like its predecessor, Type-A, the floor plan of PS 121 Q and its sister schools were suited for end-block sites. However, the difference was the placement of the auditorium, instead of at the center-rear, Gompert placed the auditorium at the end of one of the wings (Fig. 6.10.3). This plan came to be known as Type-E. The Type-E floor plan could also be versatile starting as an L-shape, but more often becoming U-shaped, depending on the immediate and anticipated needs of the neighborhood (Fig. 6.10.4).

The overall appearance of Type-E was significantly different, even from the last designs under Snyder. Electricity use was more common by this time leading to a reduced concern for daylighting. Smaller openings and shorter lintels also proved to be a cost saving measure. The parapets were lower though still quite detailed. Ornamentation remained around the main entrance and at the top of the building, which by the 1920s reflected the rising popularity of the Neo-Colonial style (Fig. 6.10.2). From SCA records, there appears to be 26 sister schools to PS 121 Q.

Located on 109^{th} Avenue in Queens, PS 121 Q was constructed in the years 1923-1924. It stands five stories high, plus a cellar. This school is the L-shaped floor plan variety of Type-E. It is distinguished by a two-story Neo-Colonial portico over the main entrance (Fig. 6.10.1). A continuous belt course above the 2^{nd} floor lintels, along with a projected water table above the fourth floor are also distinct features. Decorative terracotta panels and wrought iron grilles adorn the flat parapet along with decorative balustrades. Window openings are primarily square with paired double-hung windows and flat-arched terracotta lintels. Steel frame construction is utilized with reinforced concrete floors and exterior walls of solid brick and terracotta.

Water-infiltration had caused damaged throughout the interior, most significantly along the eastern and northern building facades, and some along the west, leading to a repair campaign in 2007. Spot-repointing, most likely associated with a 1996 campaign, left the building with non-matching patches of gray mortar next to the historic tan mortar. This gray mortar was the same color used for the replacement masonry at the upper portions of the building. The new mortar was layered over the top of the old, as opposed to cut in, therefore, poorly bonded and began to fall off. Mortar applied in this way provides poor resistance to water intrusion. Cracking of terracotta string courses, lintels, and relief panels were observed throughout. These pieces are original, and evidence suggests were repointed in the 1996 campaign. Staining is observed, from the face of the second floor string course to the portico. Much of the repair work done in a previous 1996 campaign was found to be defective.

A following 2011 campaign was performed on the architrave of the entrance portico. Cracks observed at PS 121 Q and several of its sister schools, led to an analysis to determine if a hazard existed. The existing portico consists of pre-cast concrete columns supporting steel beams, which in turn, are clad in and support a pre-cast concrete architrave, frieze, and cornice. This pre-cast concrete has partially exposed marble-chip aggregate and in some drawings referred to as *"cast marble"*. The analysis showed that the steel reinforced architrave should have been able to support its own weight without cracking, and it was concluded that there must have been additional loads superimposed that caused it to crack.

Variations in construction most likely caused some portion of the load from the cornice and frieze, as well as the entry roof slab, to pass down to the architrave causing the crack. It is believed that, as the pre-cast architrave cracked and deflected slightly the various loads imposed on it were able to transfer to the steel reinforcement. Due to the adequate reinforcement of the architrave with steel, the steel's reasonably good condition, and the cracking reaching equilibrium the removal or replacement of the architrave was not recommended. It was believed that the cracking and deflection observed will not increase, as the loads are presumed to be supported by another load path.

Fig. 6.10.3
The wing part of the Type-E plan houses the gymnasium and auditorium along with more classrooms. Courtesy: Sylvia Hardy

Fig. 6.10.4 (below)
The Type-E plan started out as L-shaped but could be expanded in a U-shape for more classrooms depending on the needs of the school and neighborhood. PS 121 Q remained L-shaped but was able to expand if needed.

Fig. 6.10.5

Fig. 6.10.5 (left)
The school in 2009, showing a more seamless transition between the new parapet and masonry with the historic. Courtesy: Sylvia Hardy

CASE STUDIES:

PS 121 Q

Methodology

Fig. 6.10.6
Detail of entry portico from the original 1924 drawings. Courtesy: SCA Alchemy

Fig. 6.10.7 (right)
Second floor plan from the original 1924 drawings. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1924, as well as drawings from eight other projects carried out at the school between 1926 and 2000. T

he complete list of existing original design drawings includes floor plans, details, sections, and exterior/interior elevations (Fig. 6.10.6 & 6.10.7). Drawings from the eight projects carried out at PS 121 Q between 1926 and 2000 include elevations, details, floor plans, interior elevations, and sections. This also included drawings for a never-executed 1936 campaign to build an addition and complete the U-shape.

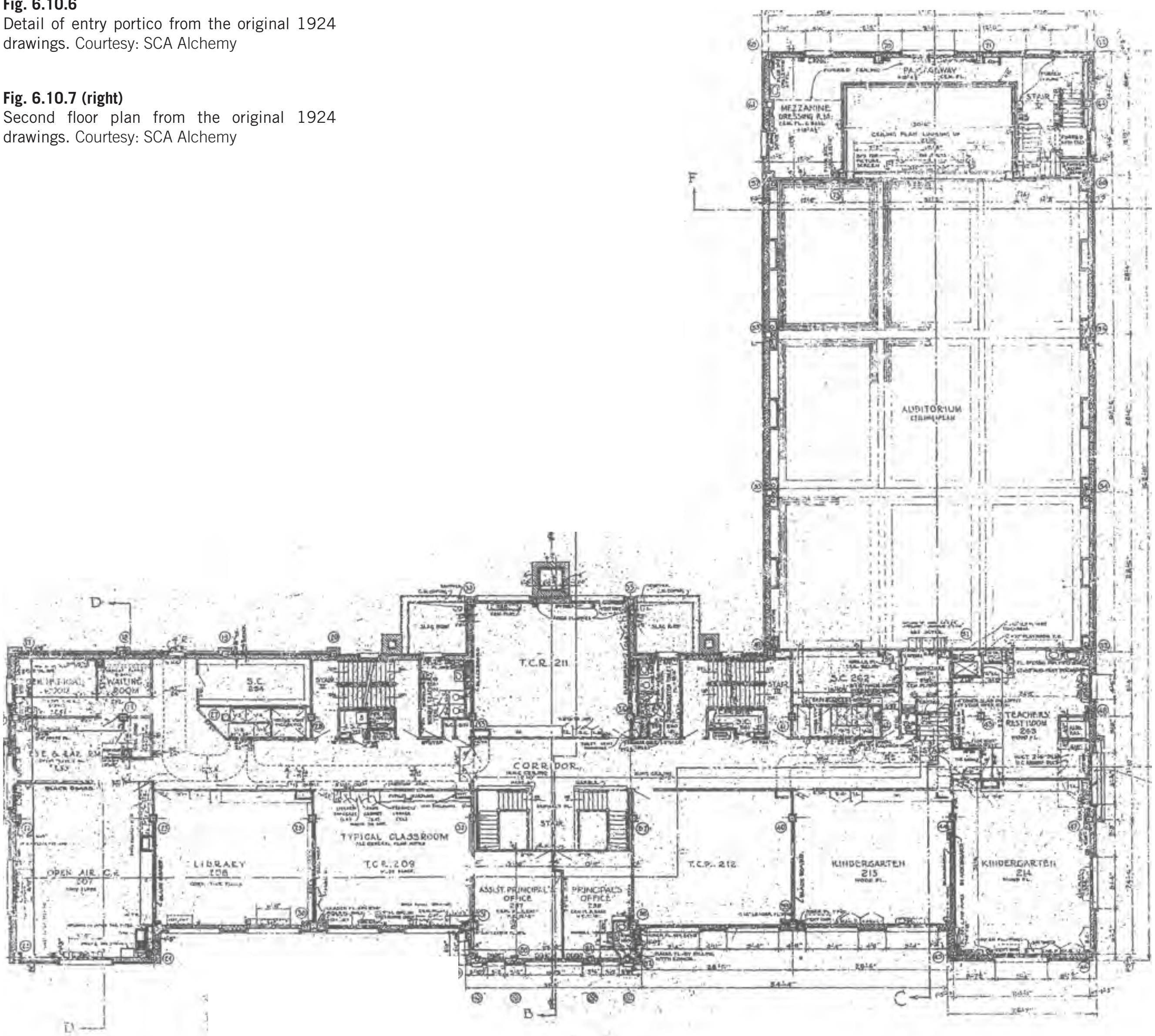


Fig. 6.10.7

Observation & Mapping

Visual surveys of interior and exterior damage were performed. On the exterior the inaccurate mortar from the 1996 campaign was disintegrating. Cracking of the terracotta string courses, lintels, and relief panels was also observed. Rust stains were below most window jambs down the face of the second floor string course (Fig. 6.10.8). The cause of the staining was unknown as there were no window guards at that floor to rust.

Steel grates over areaways at the front of the building were in fair condition, with surface rusting. The parapets and roofs, replaced in the 1996 campaign showed signs of deterioration. Poor installation and often incomplete work from the 1996 campaign led to the degeneration of the parapets. Much of the roof was in fair condition except for the southwestern wing in which bubbling of the asphalt was observed. The current bulkheads were in poor condition, as evidence from the surrounding interior damage. A concrete wheelchair ramp leading to the main entry was visibly cracked and spalled in many locations.

Interior water-damage was observed at ceilings and walls throughout the fourth and fifth floors, from plaster deterioration and staining. Repairs were apparent but already showing signs of new staining (Fig. 6.10.9).

During the 2011 campaign, observations found cracking at the center of the portico at the architrave (Fig. 6.10.11). The same was true for many of the PS 121 Q sister schools. This cracking was found to date back to at least 2006, and had not grown appreciably over the years. Exposed rebar was also observed in the capital. The crack appeared to be from excessive flexure (downward deflection), as it was widest at the bottom of the architrave and diminishing towards the top. There was some evidence, from the cracked patching mortar at the seam between the architrave and the frieze, supporting the possibility that the architrave was sagging on its own, without the frieze block above sagging as well. Exposed rebar was found at the top of an already once repaired capital.

Fig. 6.10.10

Fig. 6.10.8
Gray mortar repointing did not match the original tan mortar and staining was found on the string courses. Courtesy: Nelligan White Architects

Fig. 6.10.9
Previously repaired water-damage at interior. Courtesy: Nelligan White Architects

Fig. 6.10.10 (left)
Front elevation showing extent of repairs and interior damage in blue. Courtesy: Nelligan White Architects

Fig. 6.10.11 (below)
Crack in the architrave component of the portico. Courtesy: Nelligan White Architects

Non-Destructive Testing

In October 2008, the General Contractor performed a mock-up in the east courtyard, showing the ground mortar joints and it was discovered that there were voids in the mortar joints, which would allow for water-infiltration. Based on these findings, infrared thermal imaging was utilized to determine if the extent of repointing could be reduced along the north and west facades. Specific locations between the first and fourth floor were selected for the testing. A moisture-meter was also used to provide supplementary information to the thermal findings, by determining whether elevated moisture levels in the plaster and brickwork were present. All, but one location tested, were negative. Water-infiltration was positive in one classroom, where beam no. 3 meets the north facade.

Flood-testing was preformed around a single roof drain along the north elevation above a fifth floor classroom for three hours (Fig. 6.10.12). The conclusion reached was that the roof drain and surrounding roof membrane, do not represent sources of water-infiltration into the classroom below. It was deemed probable, based on the testers' experience of water-testing at numerous New York school buildings, the source of water infiltration and subsequent damage is most likely associated with the parapet wall directly above the damage.

In the 2011 campaign, Ground Penetrating Radar (GPR) and x-ray radiograph was employed in the non-destructive phase of testing. The cracked portion of the architrave was scanned with GPR in March of 2012. Vertical and horizontal reinforcing was located in the frieze and architrave stones. Two areas on the bottom of the architrave showed approximately 3" wide bands of a ferrous metal, which may indicate the presence of steel or wrought iron hangers. The three initial X-rays of the architrave were inconclusive.

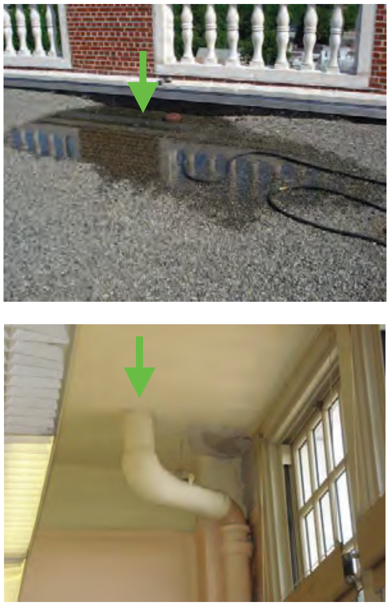


Fig. 6.10.12
Flood testing conducted around roof drain along the north elevation above classroom 512. Courtesy: GBG USA Inc

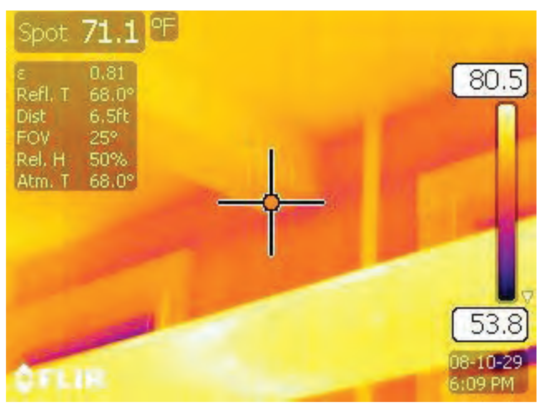


Fig. 6.10.13

Fig. 6.10.13 (right)
Infrared images tested negative for water-infiltration at all locations such as in Room 309. Courtesy: GBG USA Inc

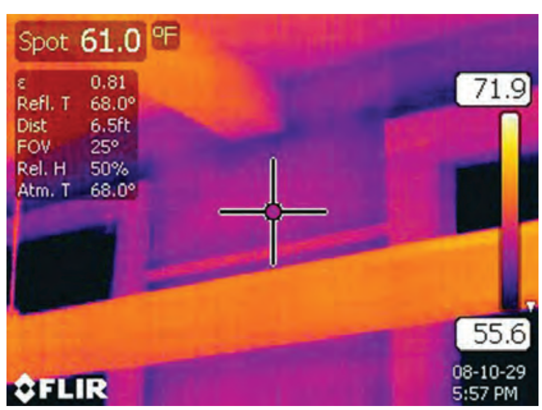


Fig. 6.10.14

Fig. 6.10.14 (right)
Infrared images tested positive for water infiltration at Room 408 where beam no. 3 meets the north facade. Courtesy: GBG USA Inc

Exploratory Probes

In the 2011 campaign, six core samples, each 6" diameter, were examined in July 2012. All reinforcement and hooks inspected via the open core holes looked to be in good condition, with little evidence of corrosion (Fig. 6.10.16 & 6.10.17). Paired with the results of the radar scan, all embedded reinforcement has a significant depth of cover from the exterior, which protect it from moisture-infiltration and prevent corrosion. No exploratory probes were performed in the 2007 campaign.

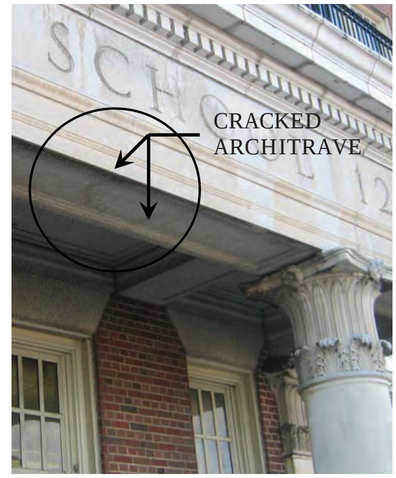


Fig. 6.10.15
Close up of cracked architrave in entry portico. Courtesy: Nelligan White Architects

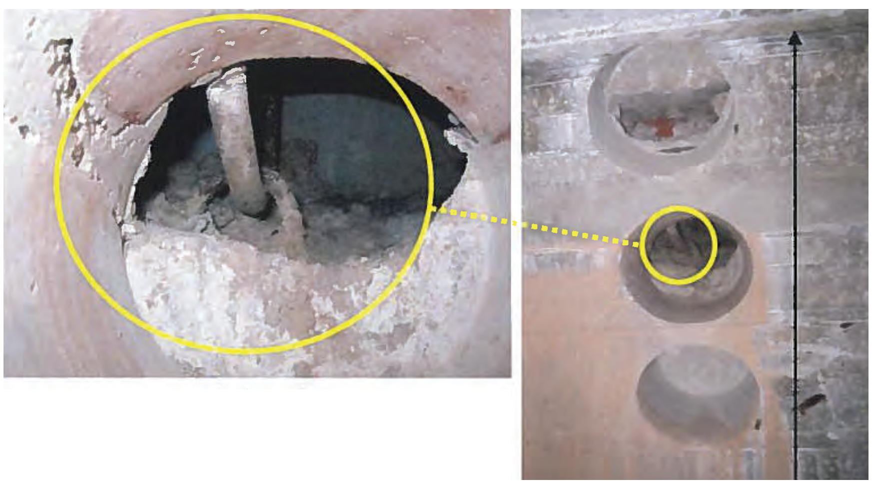


Fig. 6.10.16

Fig. 6.10.16 (left)
Close up of middle core showing position of steel hook that connects to the steel hanger above. Courtesy: Nelligan White Architects

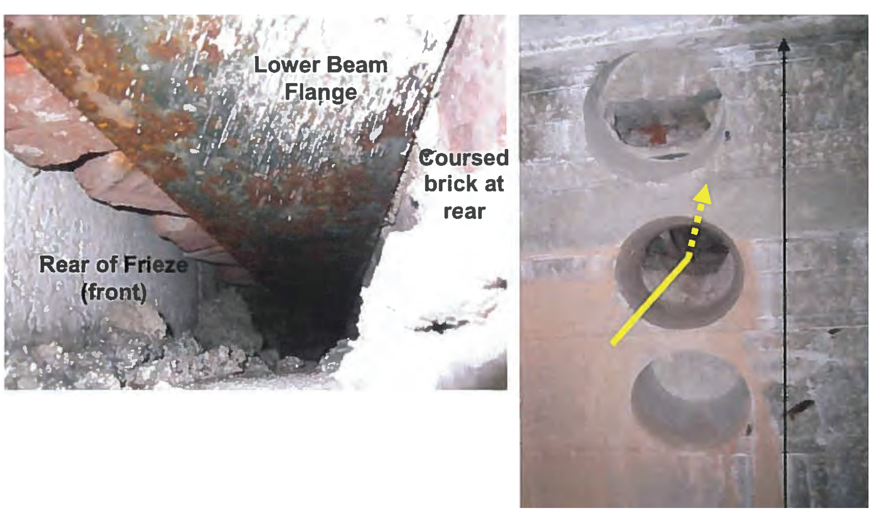


Fig. 6.10.17

Fig. 6.10.17 (left)
Close up of inside void space above architrave showing bottom flange of steel beam, cast marble frieze (left) and brickwork loosely laid at front and coursed to rear. Image on right shows point of view. Courtesy: Nelligan White Architects

Recommendations & Design

Fig. 6.10.18
Construction progress of exterior masonry repairs. Courtesy: Nelligan White Architects

Water-infiltration caused damaged throughout the interior, most significantly along the eastern and northern building facades, and some along the west. The face wythe brick unit masonry was in fair condition, with little spalling of the individual units observed, but some cracking was apparent at window heads. Areas of brick-stitching from a 1996 campaign were evident and in fair condition. Spot-repointing left the building with mismatched mortar; the historic in tan and the replacement in gray. Not only was the color incorrect, but disintegration observed was most likely due to it being layered on instead of cut in.

In keeping with typical construction of this school and its sister schools of that time, a collar joint between the face-wythe brick and the backing masonry was not properly executed. Cracking was observed in the terracotta string courses, lintels, and relief panels. Rust stains ran down the face of the second floor string course below most window jambs; the cause was unknown as there are no window guards to rust above it. The portico over the entry was in fair condition, albeit with extensive staining. Cracks and the general poor condition of the wheelchair ramp was observed. The limestone base was in fair condition, but had been painted throughout. These findings prompted the following recommendations:

LLW No. 047247 – Exterior Masonry

1. **Exterior Walls and Structural Steel** (Fig. 6.10.18)
   - Replace brick at localized areas of damaged brick (Fig. 6.10.20 & 6.10.22)
   - Replace deteriorated steel lintels at fifth floor (Fig. 6.10.21)
   - No terracotta is to be replaced under this LLW No.
   - Refinish areaway grates; blast clean paint, shop prime and repaint with high build epoxy paint; reinstall with stainless steel anchors set in epoxy

2. **Chimney** (Fig. 6.10.19)
   - Terracotta string course at chimney and cap shall be replaced with cast-stone replicas
   - Properly flash and secure all cast stone replicas with stainless steel anchors
   - Adequately saturate with water prior to setting to achieve proper mortar bond
   - Remove spark arrestor; blast clean paint and rust, shop prime and repaint with a high build epoxy paint
   - Reinstall spark arrestor with stainless steel anchors set in epoxy in the existing concrete

3. **Interior**
   - Repair water damaged ceiling with fiberglass-mat faced gypsum wall board (mold-resistant), skim coat then prime and paint to the nearest corner
   - Remove plaster finish from floor to ceiling on every floor from nearest window on the east facade to 10' off the corner of the south facade on the southeast corner of the building; must be removed down to bare terracotta block and a spray applied liquid acrylic membrane provided
   - Plaster should be applied over stainless steel lath to align with existing plaster surfaces

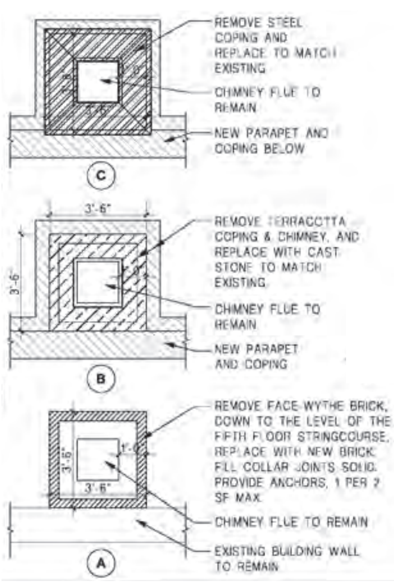


Fig. 6.10.19 (above)
Chimney repairs. Courtesy: Nelligan White Architects

Fig. 6.10.20
Backup masonry exposed during demolition. Courtesy: Nelligan White Architects

Fig. 6.10.21
Fifth floor lintels to be replaced. Courtesy: Nelligan White Architects

Fig. 6.10.22
Weep cavity installation. Courtesy: Nelligan White Architects

Fig. 6.10.23
Cast-stone balustrade replica installation. Courtesy: Nelligan White Architects

Fig. 6.10.24
Steel reinforcing for new parapets. Courtesy: Nelligan White Architects

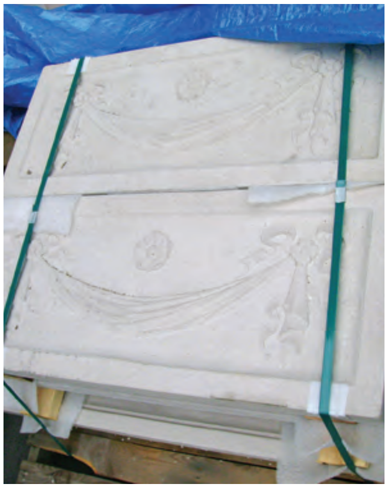
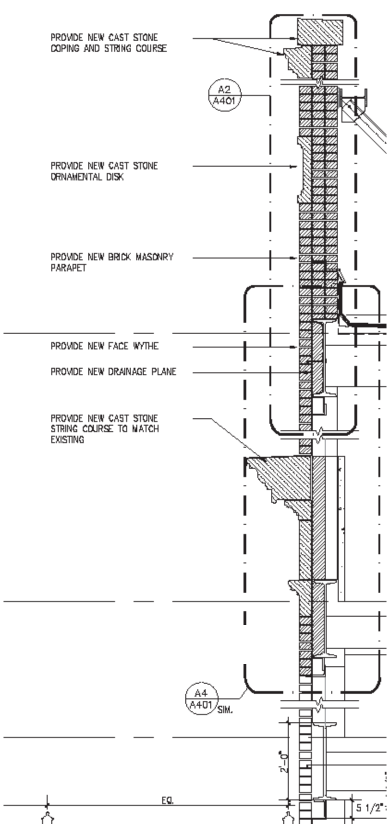


Fig. 6.10.25
Cast stone replicas stone panels ready for installation. Courtesy: Nelligan White Architects

Fig. 6.10.26 (below)
Wall section showing parapet and coping repairs. Courtesy: Nelligan White Architects



Additional Recommendations

1. **Parapets and Copings** (Fig. 6.10.25 & 6.10.26)

- Demolish parapets down to roof level
- Remove face-wythe down to fifth floor window lintels and rebuild completely
- Include properly wept narrow-cavity drainage plane and membrane
- Include copper composite through-wall flashing from counter-flashing at roof down to the window lintels at the fifth floor
- Replace deteriorated steel lintels at fifth floor
- Provide vertical steel reinforcing for new parapets
- Replace balusters, emblem panels, and disks with cast-stone replicas; properly flash and secure with stainless steel anchors; adequately saturate with water, prior to setting to achieve proper mortar bond
- Replace adjacent string course and coping with cast stone replicas, use stainless steel anchors
- Probes shall determine if existing balusters, emblem panels, disks, copings, and string course can be reused
- Replace steel shapes, plates, etc; including welding, grinding, and cleaning of steel and painting of new and existing steel

2. **Roofs**

- Recommend replacement of entire roof
- Minimum replacement of three foot wide swath of roofing at the perimeter; remove down to screed to facilitate parapet work
- Provide temporary membrane in this zone during parapet work
- Provide new vapor barrier and insulated 4-ply built-up roofing in perimeter zone; integrate with existing roof
- Provide replacement of some of the concrete screed to repair damaged locations and correct areas of inadequate slope
- Replace roof at main entrance portico along with damaged or improperly sloped concrete screed
- Relocate roof drains and plumbing vents to a minimum 36" from parapet
- Replace pitch-pockets with warrantable penetration seals certified by roofing manufacturer

3. **Bulkheads**

- Replacement of steel will be carried under the provision outlined in the *"Exterior Masonry"* section
- Replacement of bulkhead roof is recommended
- Brick masonry work is not recommended at this time

4. **Windows**

- Remove window guards; blast clean paint, then shop prime and repaint with high-build epoxy paint
- Reinstall guards with stainless steel anchors set in epoxy in the existing masonry

5. **Doors**

- Exterior doors shall remain throughout
- Clean paint, then prime and repaint with high build epoxy paint
- Hardware, including lock-sets and door closers, are to be replaced at the bulkhead

6. **Accessibility Ramp**
   - Repair concrete ramp and walls
   - Remove existing railing and provide new aluminum railing
   - Fill holes of existing railing as a part of the concrete repair
   - Provide new stainless steel anchors in epoxy

In the 2011 campaign findings, based on visual inspection and confirmed by non-destructive testing, proved that the architrave was not in need of removal or replacement at the time. Through analysis, it was determined that variations in construction caused at least a portion of the load of the cornice and frieze, as well as the entry roof slab, to pass down to the architrave, as the probable cause of the cracking observed. The overall structure of the architrave is steel reinforced and in reasonably good condition. It is believed that the cracking and deflection observed will not increase, as the loads are presumed to be supported by another load path. Corrosion of the reinforcing due to water penetration at the crack is the primary risk in the future for this architrave and for similar conditions at sister schools. These findings prompted the following recommendations:

Fig. 6.10.27
Routing out of crack for repair. Courtesy: Nelligan White Architects

LLW No. 074950 – Cracked Marble Beam Frieze

1. **Architrave** (Fig. 6.10.27, 6.10.28 & 6.10.29)
   - Repair cracks to prevent moisture ingress and resultant freeze/thaw stress
   - Install and observe crack monitors and/or periodically survey the deflection using control points, to determine if the cracks and deflection increase
   - Additional probes at this school or a sister school would be required, if further validation of the assumptions above are required by SCA.

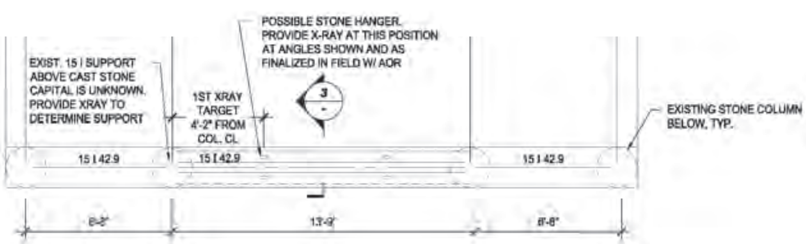


Fig 6.10.28

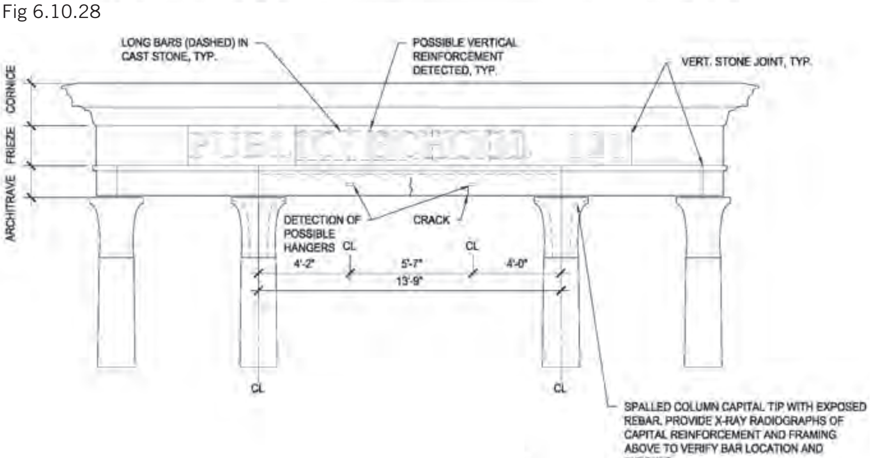


Fig. 6.10.29

Fig. 6.10.28 & 6.10.29 (top left - left)
Plan and elevation showing existing structure and damage to be repaired. Courtesy: Nelligan White Architects

Constructability & Lessons Learned

Fig. 6.10.30
Fire damage at the fourth floor. Courtesy: Nelligan White Architects

This 2007 campaign, worked to correct deficiencies attributed to age and past repairs. The overall scope was largely known, thanks to the non-destructive testing and existing drawings. As with any project, some issues did arise during the construction process and some unexpected damage did occur. A later campaign would be undertaken to repair the entry portico.

Mortar

An infrared thermal imaging inspection was conducted to determine if repointing could be removed from the original scope of work. Based on the findings, it was concluded that the repointing could be removed from the north and west facades of the school. It was, however, strongly recommended that the repointing work remain at the south and east facades. The contractor objected to the repointing work due the hardness of the mortar, and as a result potential sub-contractors were requesting a substantially high fee to perform the work. After months of contesting this portion of the work, the contractor began repointing, however, after work resumed after the stoppage caused by the fifth floor fire, the contractor stated again that the repointing work can't be performed; although, this time it was because it would create conflicts with school officials. Much of the repointing work was removed from the scope of work.

Fire and Repairs

In October 2008, a fire erupted on the scaffolding on the fifth floor. It was found by the SCA, as well as confirmed by field observations, that the fire was started by the construction operations related to exterior masonry work. In a concerted effort to make the school functional again, work proceeded rapidly. This made a review of all damage impossible, as most of the heavily damaged areas had already been demolished and much of the fourth floor smoke and water-damage had already been painted over. Three existing windows were damaged and the replacements that were installed by the SCA's emergency contractor, did not match the finish of the existing windows and did not possess the same number of window panes (Fig. 6.10.31). In addition to the wrong color and number of panes, the sealant around the windows was not properly installed and would likely be a source of water-penetration. It was understood that the damage caused by the fire required decisive and immediate action in order to minimize the stress placed on the teachers and students, however, the inadequate installation of the windows compromised the integrity of the work in the exterior masonry contract.

Fig. 6.10.31 (below)
The two windows toward center of the photo were a part of the emergency repairs after the fire. These windows not only was inaccurate in color and pane number but also suffered from poorly done seals. Courtesy: Nelligan White Architects

Fig 6.10.31

Efflorescence

Efflorescence on the surface of the new masonry from the fourth floor string course up to the top of the new parapets on each facade was observed in January 2010 (Fig. 6.10.33). Efflorescence is the result of salt contaminates present in the construction materials during construction or embedded during the manufacturing process. The presence of efflorescence could signify that substandard masonry was used for the face-wythe, there is a significant source of water in the masonry wall creating a condition known as *"super-saturation,"* or that the flashing, anchors, etc., have become contaminated. The contractor's brick submittals were reviewed, confirming that they meet all the required SCA quality standards. In light of this confirmation, the possibility of substandard masonry being delivered to the project site was present. Another potential cause of the efflorescence could be that the masonry was simply cleaned at the wrong temperature. The existing efflorescence was to be removed with a stiff fiber brush and an SCA approved masonry cleaner. In conjunction with the cleaning, a probe was recommended to be conducted and samples taken for laboratory testing to verify if contaminates are present in the masonry and determine whether efflorescence would be a continued problem.

Entry Portico

In 2011, a campaign was undertaken to analyze a significant crack in the architrave of the entry portico. After Ground Penetrating Radar (GPR), X-ray radiograph, and along with visual observations were employed, it was determined that the cracking and deflection observed would not increase, as the loads are presumed to be supported by another load path. Interior probes of the portico also confirmed this was the primary risk in the future for this architrave and for similar conditions at sister schools was corrosion of the internal structure if left untreated. At the time, it was recommended that the architrave not be replaced only repaired. The first repair of the architrave and column yielded unsatisfactory results. Mortar used did not match the existing. The crack in the architrave was routed out and replaced with appropriate color (Fig. 6.10.32).

Fig. 6.10.32
After the first repair, the mortar used did not match the approved color. It would be routed out and an approved color used. Courtesy: Nelligan White Architects

Fig. 6.10.33 (below)
Efflorescence became apparent on the newly installed face brick. It was to be cleaned off and samples taken for further testing to determine if any further repairs were needed. Courtesy: Nelligan White Architects

Fig. 6.10.33

SECTION 6.11

CASE STUDIES:
PS 89 X

CASE STUDIES:
PS 89 X

Introduction

Building ID	X089
School Level	PS
Address	980 Mace Avenue Bronx, NY 10469
Cross Streets	Williambridge Road & Colden Avenue
NYC DOE District	11
SHPO Status	Eligible
SHPO ID	00PR2591
Flood Zone	Outside Flood Zone
FEMA Map	3604970101F
Architect	Walter C. Martin
Year Built	1927
Plan Form	Type-M
Style	Classical Revival
Internal Sq Ft	98,000
Classrooms	40
Stories	4 + Cellar
Structural System	Steel & Concrete Load Bearing Masonry/Frame
Columns	Steel
Beams	Steel
Floors	Steel
Roof	Asphalt Waterproofing Membrane, Loose Aggregate
Cladding	Brick Masonry Face-Wythe
Backup	Terracotta

Fig. 6.11.1

Fig. 6.11.1 (right)
The school after renovations. Courtesy: Sylvia Hardy

Fig. 6.11.2 (below)
Decorative panels of terracotta and brick are featured in between the head and sill of the windows. Courtesy: Sylvia Hardy

Situated in the Baychester neighborhood of the east Bronx, PS 89 X is an early example of the "M-Type" school building typology, widely used between the years 1929-1942. Designed by Walter C. Martin, PS 89 X was constructed in 1927, with additions following in 1929 and 1938. The present 98,000 sq ft structure stands four stories tall, plus a cellar and provides for a student population of approximately 1,220 students.

The U-shaped "M-Type" style of PS 89 X and over 120 similar schools of its type represent Martin's dedication to continuing the work of his predecessor, after succeeding former Superintendent of Buildings, William Gompert. Developed by Gompert, the Type-M plan derived as a modification of the "Type-E" U-plan, which would be Snyder's final contribution to the field of urban school design and construction. Gompert's development of the U-plan was prompted by the City's rapid population growth and prosperous economy during the 1920s. The style was noted for its systematic expandability, an innovation first explored with Type-E buildings. This layout anticipated the growth of the school with space for two wings to be added, as student population increased.

The SCA has conducted several major projects at PS 89 X in recent years, including window replacement and exterior masonry work in 1999 and a full exterior modernization in 2002, including roofs, parapets and exterior masonry. Despite the repair campaigns carried out at PS 89 X, water-infiltration continued to cause damage throughout the building interior, most significantly along the eastern and northern facades. Cracking and deterioration of the face-brick masonry, terracotta cornice elements and rusting lintels were apparent throughout.

The deterioration of the cornice became severe enough, that a large piece of the terracotta fell from the south-east corner of the building (Fig. 6.11.9). Sidewalk sheds were erected immediately. After that damage, a new campaign and investigation was launched.

Fig. 6.11.3

Fig. 6.11.3 & **6.11.4 (left - above)**
New terracotta cornice, string course and exterior masonry after rehabilitation. Courtesy: Sylvia Hardy

Fig. 6.11.5 (below)
Rear of PS 89 X. Courtesy: Sylvia Hardy

Fig. 6.11.5

CASE STUDIES:

PS 89 X

Methodology

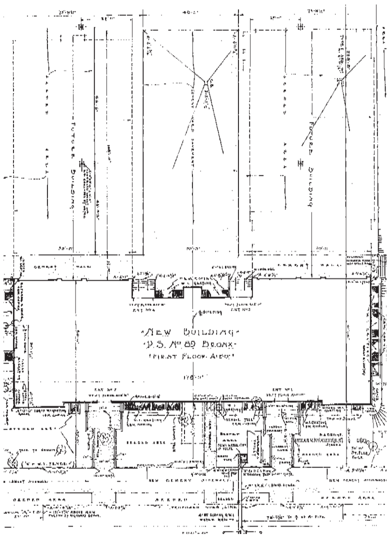


Fig. 6.11.6
Roof plan from original design drawings depicting new building with outlines for additional wings that could be added in the future. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1926, as well as drawings from the building's main additions and other projects that took place at PS 89 X.

Existing drawings from the original design by William Gompert include floor plans, sections and elevations of the new school building as well as roof plan, cellar/basement and boiler room floor plans and diagrams of columns, masonry, ductwork and heating/ventilation details (Fig. 6.11.6, 6.11.7 & 6.11.8). Drawings from the nine other projects carried out between 1929-2002 include plans, sections, elevations and detail diagrams corresponding to the various additions, modifications and modernization efforts at PS 89 Bronx, over the years since its construction.

Fig. 6.11.7 (right)
Front elevation from original 1926 drawings. Courtesy: SCA Alchemy

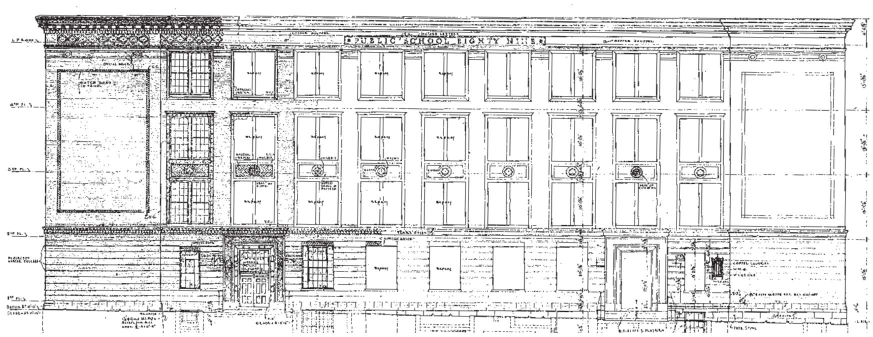


Fig. 6.11.7

Fig. 6.11.8 (below)
Second floor plan from original 1926 drawings. Courtesy: SCA Alchemy

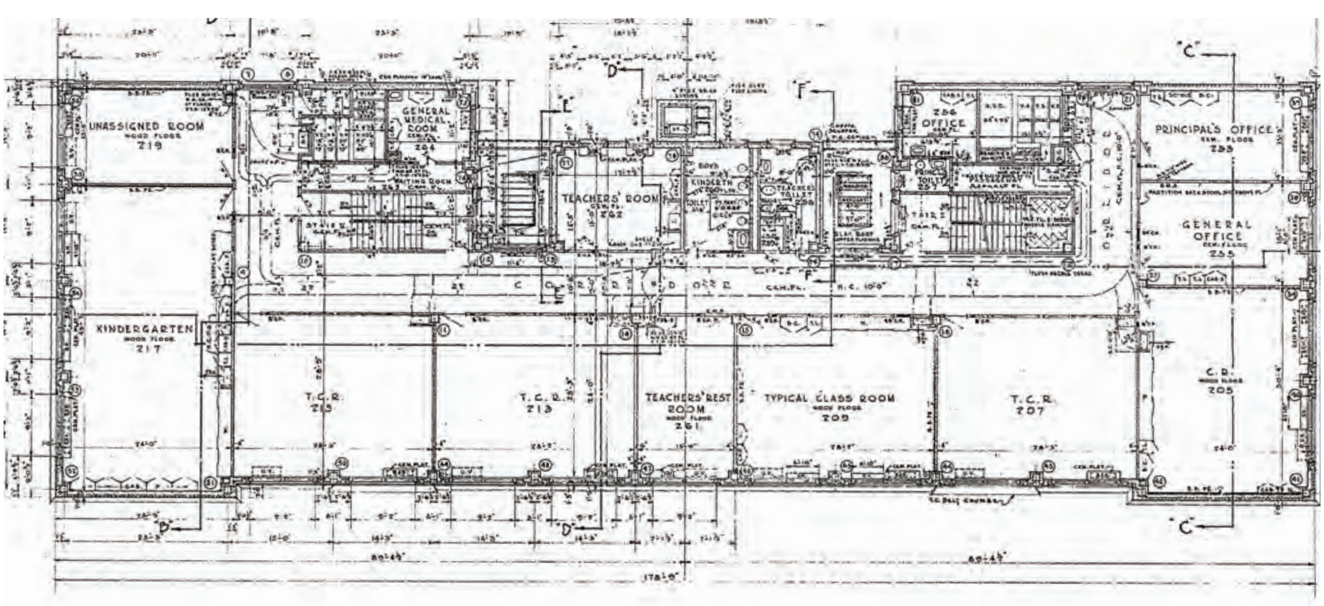


Fig. 6.11.8

Observation & Mapping

Although probes would be required for full evaluation, visual inspections of the existing roof parapets and terracotta cornice were conducted to determine their condition. Initial inspections of the terracotta cornice from ground level and adjacent rooftops showed no signs of significant cracking or spalling. Original building drawings indicated that the terracotta was secured to vertical support angles with metal straps which were welded with a steel plate to the top of the roof spandrels (Fig. 6.11.10). The steel plate appeared to be unprotected prompting the need for probes to assess the extent of rusting and structural deterioration that may have occurred. It was noted that the possibility of a lighting strike may have been responsible for the fallen terracotta.

Further inspection of the building envelope indicated that the parapets were probably reconstructed during repairs between 2000-2003 to meet contemporary code height of 42". Additionally, the original terracotta coping stones were likely replaced after reconstruction of the parapets. Inspection of the roof and flashing showed small areas of ponding, though it appeared to be in good condition.

Within the building's interior, approximately 1,555 sq-ft of water-damage was observed in several locations throughout. Along the north facade, considerable damage was observed near the ceiling. Similar damage on the facade was observed at two fourth floor classrooms. Additional water-damaged plaster was found in the rooms and corridor below the stair two bulkhead at the south-east corner of the building's courtyard facade. Inspection of the stair two bulkhead from roof level revealed water damage on the interior plaster.

A lift was used to conduct a closer inspection of the existing terracotta cornice. Cracks were noted in the terracotta throughout, particularly at the support scrolls. Most joints in the cornice have been repointed or caulked as part of previous repair campaigns. Despite these repairs, new cracks have surfaced, most likely as a result of the progressive rusting of the structural steel supports.

Fig. 6.11.9
South-east corner of the building where a large piece of terracotta fell in 2004 prompting sidewalk sheds to be erected immediately. Courtesy: Sylvia Hardy

Fig. 6.11.10 (above)
Observation of the east wing, courtyard facade revealed several areas where the building masonry had been secured in place using structural wall ties to compensate for the missing brick headers. Courtesy: Nelligan White Architects

Fig. 6.11.11

Fig. 6.11.11 (left)
Visual inspection of the building masonry showed evidence of replacement work in multiple areas. Portions of the building's exterior appear to have original brick, while in other areas there appeared to be brickwork from the 1929 & 1937 additions, from the 1961 modernization and also from the 2000-2003 repair work. Courtesy: Nelligan White Architects

Fig. 6.11.12
Cracked terracotta string course at the base of the cornice. Courtesy: Nelligan White Architects

Fig. 6.11.13
South-west corner of building where a large piece of the decorative terracotta cornice fell in 2004. The remaining cavity could be inspected to gather more information about the deteriorating structural steel anchorage system supporting the cornice. Courtesy: Nelligan White Architects

Fig. 6.11.14 (right)
Building deterioration found in the diamond patterned brick-band wrapping the south elevation. Joint separation at both ends of the patterned brick band was noted. Courtesy: Nelligan White Architects

Fig. 6.11.15 (below - right)
Typical rusted lintel, east elevation. Within the interior near the rusting lintels, typical instances of water-damage were found at the window heads. Courtesy: Nelligan White Architects

Fig. 6.11.16 (below)
Interior water-damage observed at window heads opposite rusted lintels on the west elevation. Courtesy: Nelligan White Architects

Directly below the cornice, additional building deterioration was noted in the diamond patterned decorative brick band. Separation of the joint between the corners and the start of the patterned brick was observed at each of the building corners that were inspected. The patterned brick was typically uneven, with open and separated joints and cracked bricks. This damage also appeared to be the result of the rusting, structural steel parapet system (Fig. 6.11.12 & 6.11.14).

Cracking of the exterior brick masonry was observed at the building corners which appeared to have been the result of rusting, structural steel corner columns. Despite having been replaced before, corner cracks in the face-brick were observed extending up and down the height of the building at the north-east, south-east and north-west building corners and returns.

A closer inspection of the metal window lintels from the lift revealed rusting at most locations which had not been repaired previously (Fig. 6.11.15). This observation was a strong indication that rusting of the lintels had been the cause of the jacking and cracking occurrences, observed in the terracotta window surrounds. Within the interior of the building near the rusting lintels, typical instances of water damage were found at the window heads (Fig. 6.11.16). Deeper inspection throughout the school's interior, uncovered additional water-damage found in the stairwell at the rear south-east corner of the west wing. Final observations noted additional cracks found in the terracotta copings at the parapets along the west wing.

Fig. 6.11.14

Fig. 6.11.15

Non-Destructive Testing

In May of 2006, the decorative terracotta cornice was sounded and inspected from a lift along the entire north, east and west building elevations. Sounding is a method often used to test architectural terracotta units. The method involves striking each unit with a rubber mallet which produces a sound. An undamaged terracotta unit produces a distinct ringing noise when struck, an indication of its sound internal condition. Conversely, damaged terracotta units will produce a flat, hollow sound when struck, meaning a unit has likely suffered damage due to deterioration within its hollow core (Fig. 6.11.18).

When sounded, several of the support scrolls broke apart entirely and fell from the building (Fig. 6.11.17, 6.11.19 & 6.11.20). Cracks were also noted in the terracotta string course at the base of the cornice, around the entire sounded area of the north elevation.

Fig. 6.11.17
Cavity left where a support scroll broke away during sounding tests, exposing part of the rusted steel straps securing the cornice to the top of the building. Courtesy: Nelligan White Architects

Fig. 6.11.18

Fig. 6.11.19

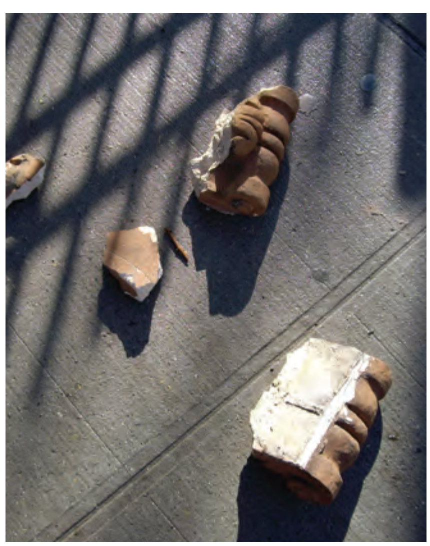


Fig. 6.11.20

Fig. 6.11.18 (top left), 6.11.19 (far left) & 6.11.20 (left)
Sounding of terracotta around parapets. Several of the support scrolls broke apart entirely and fell from the building. Courtesy: Nelligan White Architects

PS 89 X

As part of the overall refurbishment at PS 89 X, it was required that the roof system, made up of an asphalt waterproof membrane and loose aggregate, be inspected and analyzed to determine whether or not it would be possible to secure a roof warranty extension from the manufacturer. To make this assessment, geotechnical consultants were commissioned to carry out a *'Ground-Based'* survey.

The surveyor, using a thermal imaging camera, locates and maps out specific areas of thermal anomaly. Areas of thermal anomaly are usually indicative of either wet insulation or variation in its performance. This investigation was carried out using these thermal imaging techniques, combined with visual inspection and moisture content assessment using a hand-held moisture meter probe.

Thermal images were collected at night during the first survey session. As each thermal anomaly was identified, it was delineated on the roof surface by a second geotechnical site engineer using spray-paint. The areas marked as thermal anomalies were then tested/verified using a moisture meter, to determine whether or not it was associated with wet insulation materials beneath the waterproof membrane.

It was noted that due to the presence of building materials and debris that were being stored on the roof at the time of the survey, only about 85% of the roofing areas were accessible to the survey team (Fig. 6.11.21). To assist in interpreting the result of the survey, it was also noted that on its own this method was not able to specifically determine either the cause of the moisture and its specific point of entry or the efficiency of the roofing system, its waterproof membrane or insulation.

Fig. 6.11.21 (below)
General view of Roof Area A looking South-east. Several regions of each roof area were blocked by obstructions and had to be worked around when scanning for wet insulation in the roof membrane. Courtesy: Nelligan White Architects

Fig. 6.11.21

After surveying each of the five different roof areas of the school building, a total of 16 thermal anomalies were identified totaling approximately 3325 sq ft. (13% of roof area that was surveyed). Of the 16 detected anomalies, 14 were confirmed (using the moisture meter) as wet insulation. Although these methods are unable to specifically identify the point of moisture-ingress through the membrane which caused the anomaly, a number of possible explanations were put forward.

Most anomalies are associated with the perimeter of the roof along the foot of the parapet walls. It is assumed that the waterproofing/flashing at the base of the parapet walls may be at fault in allowing rainwater to get below the waterproof membrane (Fig. 6.11.22). A few patches of wet insulation that occurred in isolation from the parapets may be due to small, localized failures within the membrane.

Most anomalies occurred on the western side of the building. In order to determine points of failure in the membrane and measure the extent of damage caused by moisture ingress, probes would need to be taken through selected areas.

Fig. 6.11.22
Break in flashing observed at roof parapet replacement. Improper waterproofing done by previous repair work, may be at fault for wet insulation identified around perimeter of roof membrane. Courtesy: Nelligan White Architects

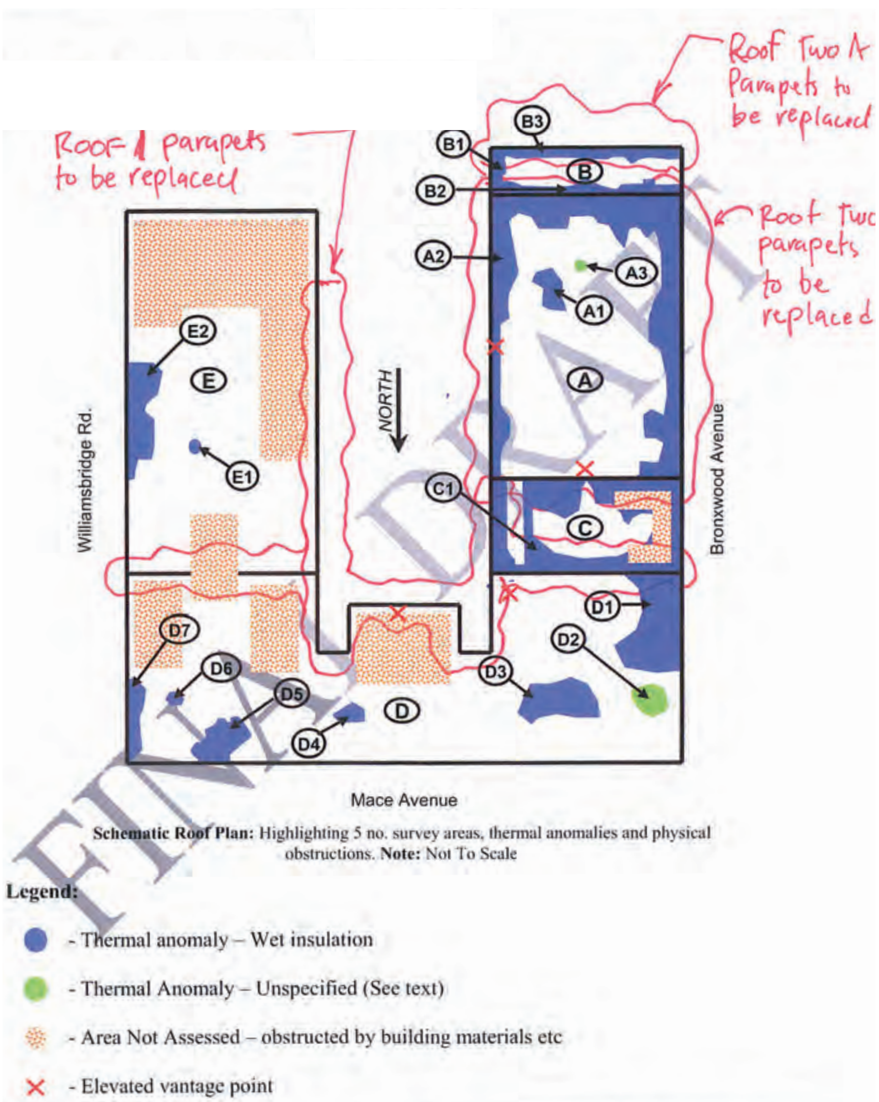


Fig. 6.11.23

Fig. 6.11.23 (left)
Roof Plan diagram depicting the results of a thermal imaging survey, conducted in order to assess the condition of the roof membrane. Highlighted in blue are regions where thermal anomalies were identified by thermal imaging and later confirmed as wet insulation using a moisture meter probe. The majority of wet insulation was identified at the base of the parapet walls around the perimeter of the roof . Poor waterproofing/flashing at the parapet base was assumed to have been partially responsible for allowing moisture to penetrate the roof membrane. Courtesy: GBG USA Inc.

Fig. 6.11.24
Inspection of the cavity left where a piece of cornice fell from the south-east corner of the building revealed rusting steel anchorage rods and ties. Courtesy: Nelligan White Architects

Fig. 6.11.25
Considerable deterioration found on steel members within the parapet support system. The extent of deterioration was so much that the flange of one of the angle eroded entirely through. Courtesy: Nelligan White Architects

Exploratory Probes

Following the preliminary site visit in October of 2005, probes were requested at PS 89 X to evaluate the condition of the existing terracotta cornice, structural steel anchorage system and building columns, spandrels, and lintels at areas where considerable water infiltration was observed on the building's interior. Probes were opened in the exterior face-brick and terracotta at the building's south-east corner revealing rusting on the top flange of the roof spandrel. Closer inspection of the probed terracotta where a large piece of the cornice had fallen in 2004, revealed rusting steel anchorage rods and ties (Fig. 6.11.24).

Additional probes were opened from the roof side at the back of the parapet cornice. Upon opening, extensive rust and deterioration of the primary horizontal support channel and cantilevered angles was discovered. Between the backs of the support angles, roughly one inch of rust scale was measured (Fig. 6.11.25 & 6.11.26).

In an attempt to learn more about the causes of the interior water damage, probing was conducted at the third floor spandrel opposite of the damaged ceiling in a second floor classroom. Rusting along the entire spandrel was discovered, which appeared to have no flashing or protective coating of any kind. Further interior inspection at the west side of the north elevation within another second floor classroom revealed additional interior water-damage indicative of similar failures.

Having discovered substantial evidence of building deterioration in or around areas of the building that were repaired in the past, a probe was conducted at a typical fourth floor lintel replacement to evaluate the work of the previous lintel and window replacement campaign. Copper composite flashing was found correctly installed over a painted lintel, hung by angles off of the roof spandrel. No deterioration of the steel was observed and all members were adequately protected from water-infiltration. An additional probe was opened, to observe the top flange of the roof spandrel, which was also observed to be in good condition.

Opposite the probes of the lintel and roof spandrel, two additional openings were made to evaluate the parapet steel support system of the original building. Similar to what was found within probes of the roof spandrel and terracotta anchorage system, considerable deterioration was discovered on each member of structural steel. The extent of deterioration was so much that the flange of one of the angle had eroded entirely through.

Fig. 6.11.26 (right)
Roof side, at the back of the parapet cornice, rust and deterioration of the primary horizontal support channel and cantilevered angles was discovered upon opening. Courtesy: Nelligan White Architects

Fig. 6.11.26

Recommendations & Design

Past repair campaigns had not proven successful in preventing moisture penetration at PS 89 X. Cracking at the cornice and parapet, along with missing or loose joints were observed. Deterioration was severe enough that a piece of the terracotta at the cornice had fallen off. Corroded and/or broken steel anchorages were found to be the cause. Interior water damage was found at several locations throughout. These findings prompted the following recommendations:

Fig. 6.11.27 & 6.11.28 (above - below)
Roof parapets and cornice as seen before sounding was conducted or any repairs had begun. Courtesy: Sylvia Hardy

LLW No. 045367 – Roof Parapets

1. **Roof Parapets** (Fig. 6.11.29)
    - Remove entire existing terracotta cornice and brick masonry down to top of existing steel spandrel; scrape, reinforce, paint and flash existing structural steel upright angles and roof spandrels
    - Provide new brick back-up, steel channel anchorage, and glass fiber reinforced concrete (GFRC) thin-shell replacement units to match color and texture of existing terracotta
    - Cut-back and repair existing roof membrane and flashing to allow for replacement of parapets
    - Remove all existing galvanized straps and replace with LCC
    - At high parapet walls, replace terracotta copings with cast-stone to match existing
    - Provide lightning protection system and grounding at all building corners
    - Replace terracotta coping at southern half of the west facade

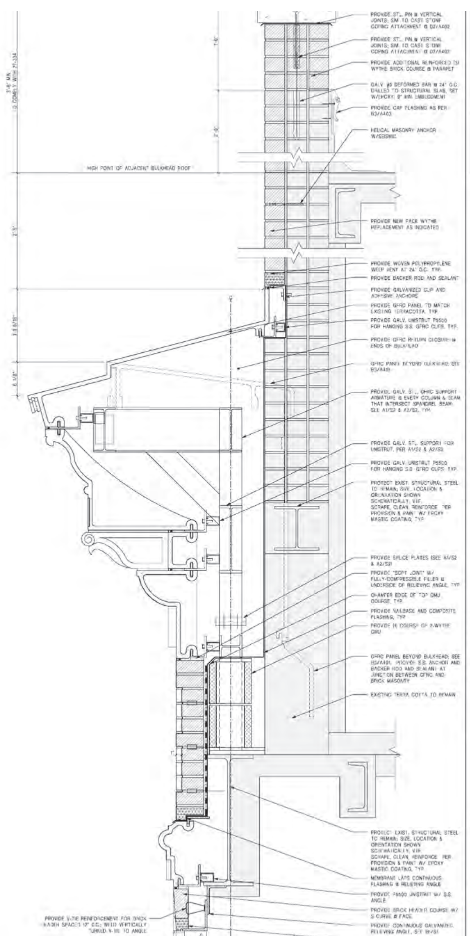


Fig. 6.11.29

Fig. 6.11.29 (left)
Construction documents detailing scope of work surround parapets at roof bulkhead above stair No. 2. Courtesy: Nelligan White Architects

Fig. 6.11.30
Exterior masonry on west elevation after extensive repair work was finished. Courtesy: Nelligan White Architects

Fig. 6.11.31
Exterior windows, brick surrounds and stone work along the north elevation after window repairs were completed. Courtesy: Nelligan White Architects

Fig. 6.11.32 (right)
Construction documents detailing the scope of work at the north and south elevations of the building. Shaded regions correspond to the areas where deteriorated face brick and terracotta were replaced. Courtesy: Nelligan White Architects

Additional Recommendations:

1. **Exterior Masonry** (Fig. 6.11.32)
   - Remove existing original brick face-wythe at locations of water-infiltration
   - Provide new face-brick to match existing
   - Replace all exterior face-brick at roof top louvers and bulkheads
   - Replace existing louvers and provide new backup dampers
   - Scrape, reinforce, and paint existing structural steel columns and spandrels where exposed by face-brick replacement
   - Replace all loose window lintels at areas of face-brick replacement

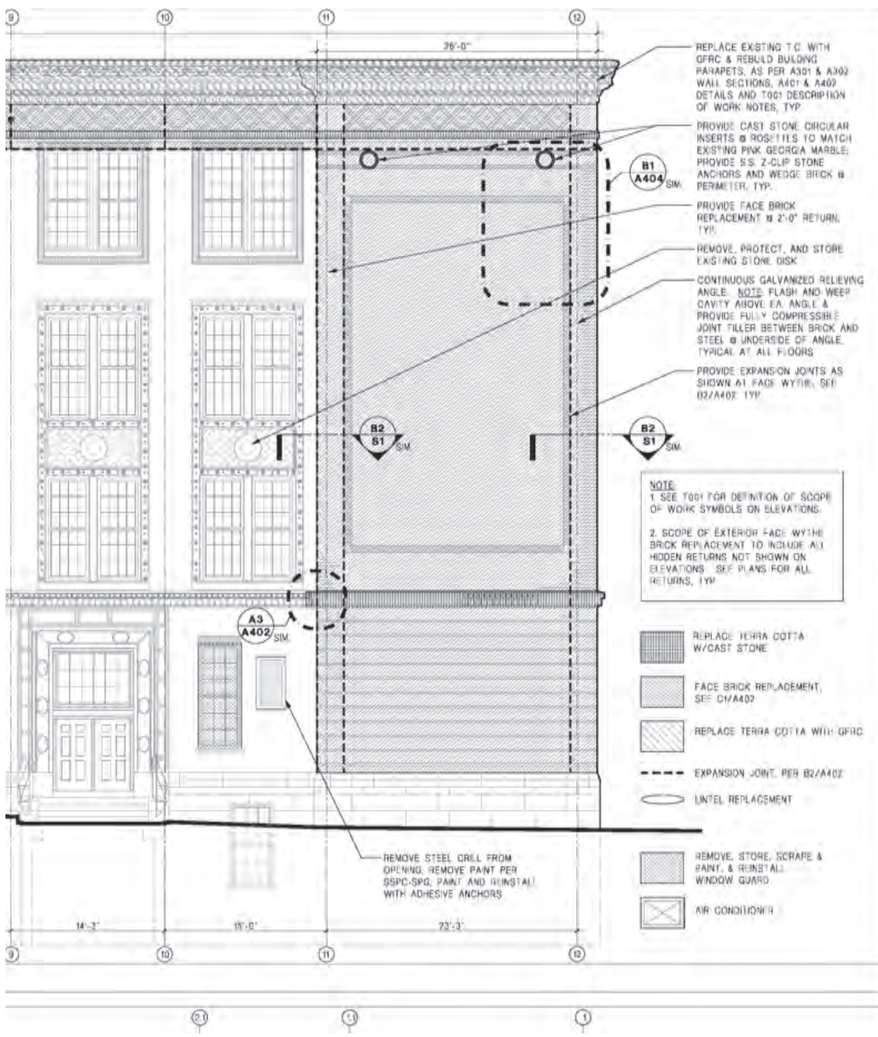


Fig. 6.11.32

2. Painting/Plastering

- Determine presence of structural steel; scrape, paint, reinforce and flash with composite copper as noted
- Remove all interior water damaged wall plaster and finishes
- Install liquid waterproofing membrane, 1-inch XPS rigid insulation, metal furring channels, 5/8" Densglass Gold, plaster skim coat, and latex paint to all exposed interior wall surfaces
- Paint ceilings where affected

Fig. 6.11.33
Water-damaged paint/plaster found in a stairwell beneath water-damaged roof bulkhead. Courtesy: Nelligan White Architects

Fig. 6.11.34 (above)
Typical water damaged paint/plaster observed within several classrooms due to extensive deterioration discovered throughout the buildings structural members. Courtesy: Nelligan White Architects

Fig. 6.11.35

Fig. 6.11.35 (left)
Interior water damage opposite third floor spandrel in Room No. 205, north elevation. Courtesy: Nelligan White Architects

Fig. 6.11.36

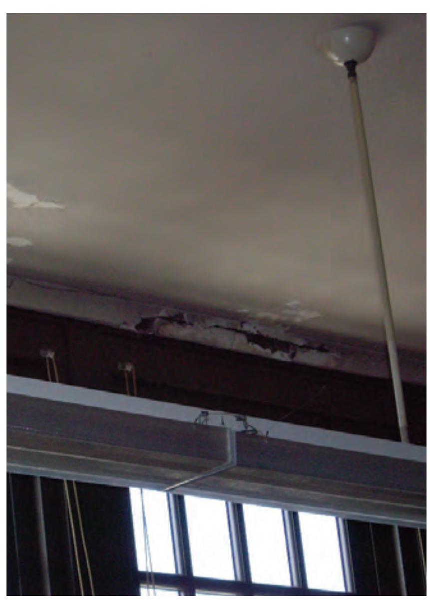


Fig. 6.11.37

Fig. 6.11.36 & 6.11.37 (far left - left)
Water-damage visible at the interior discovered in stairwell at roof bulkhead and in ceiling of Room No. 217. Courtesy: Nelligan White Architects

Constructability & Lessons Learned

Fig. 6.11.44
Replacement terracotta and structural support during construction. Courtesy: Nelligan White Architects

With two additions over the years, PS 89 X is a fully realized U-Shaped Type-M school. Major campaigns had been undertaken around 2002 to upgrade and replace windows, facade, and roofs. Despite the recent repairs, water-infiltration still continued to be problematic. The most significant damage to warrant an immediate investigation was the deterioration of the cornice. A large piece of the terracotta had severed and fallen prompting the immediate assembly of sidewalk sheds for protection, during the ongoing investigation and repair. A part of the investigation was to determine the deficiencies, if any, of past repairs and if that was a contributor to the damage observed.

Parapets

The parapets appeared to have been replaced around 2002. In late 2004, a large piece of the decorative terracotta on the cornice fell off, prompting a new campaign to begin, in addition to the ongoing water damage. Probes were made as well as sounding tests conducted. During the probing, it was observed that cracks had formed around many of the joints at the terracotta, which had been repointed or caulked during the past campaign. The probes revealed significant rust at metal supports, some pieces were weak and even broken as was the case at the broken terracotta. Patterned brick just below the terracotta, was found to be uneven and suffer from open and separated joints. During the sounding, many pieces of the terracotta failed, even breaking or crumbling the instant they were struck.

Later, upon further inspection and partial thermal imaging of the roof, parapets at the courtyard were added to the schedule of replacement. During the visual inspection of the parapets at the courtyard, it was determined that they were similar in construction to the parapets that were being replaced and it was reasonable to assume that the same water saturation would be found adjacent to those parapets.

During the construction phase, it was found that many of the GFRC (Glass Fiber Reinforced Concrete) suffered from defects during the manufacturing process and needed to be replaced (Fig. 6.11.46). In addition, many other pieces were damaged during installation and suffered from efflorescence. These pieces were also ordered to be replaced.

Fig. 6.11.45 (right)
Replacement parapet nearing completion. Courtesy: Nelligan White Architects

Fig. 6.11.46 (below)
Damaged GFRC to be replaced. Courtesy: Nelligan White Architects

Fig. 6.11.45

Roofs

During the initial construction process, only the perimeter of the roof was to be replaced in relation with the new parapets. Thermal imaging was only able to be done on part of the roof due to the staging and storage of construction materials (Fig. 6.11.47). Further investigations revealed the roof to be 25% saturated, harming the performance and life span of the roofing assembly.

Additionally, the underside of the roof slab had collapsed at classroom 461 in June 2007 (Fig. 6.11.48). Spot probes were conducted around the area and found the collapse to be an isolated incident. The collapse and presence of water found prompted the addition of full roof replacement to the scope of work.

Fig. 6.11.47
Staging and storage of construction material had made it impossible to fully inspect the roof with thermal imaging. Courtesy: Nelligan White Architects

Fig. 6.11.48

Fig. 6.11.48 (left)
Inspection of the collapsed slab. Courtesy: Nelligan White Architects

SECTION 6.12

CASE STUDIES:
PS 14 X

PS 14 X

Introduction

Building ID	X014
School Level	PS
Address	3041 Bruckner Boulevard Bronx, NY 10461
Cross Streets	Crosby Ave & Hollywood Ave
NYC DOE District	08
SHPO Status	Not Eligible
SHPO ID	N/A
Flood Zone	6
FEMA Map	3604970104F
Architect	William H. Gompert
Year Built	1928
Plan Form	Irregular Type-M
Style	Classical Revival
Internal Sq Ft	48,000
Classrooms	25
Stories	4 + Cellar
Structural System	Steel Frame
Columns	Steel
Beams	Steel
Floors	Concrete Slab
Roof	4-Ply, BUR
Cladding	Brick, Terracotta
Backup	Brick, Terracotta

Fig. 6.12.2

Fig. 6.12.1 & 6.12.2 (below - right)
One of the two entries on the front facade in the center portion of the building. Overall, ornamentation is simple and restrained, the cornice was removed and replaced with a lower and unornamented parapet. Courtesy: Nelligan White Architects

Constructed in 1928, PS 14 X represents a variation of the Type-M school. It was designed in the last years of the William H. Gompert's administration. Located on Bruckner Boulevard in the Bronx, the school stands four stories tall, plus a cellar. The building replaces an older PS 14 that was located in an adjacent lot. It utilizes a steel frame with exterior walls of a brick masonry face and terracotta block back-up. In contrast to the typical Type-M school, which usually features two smaller identical entries on the front and can be configured into a U-shape, PS 14 X has an off-center rear extension (Fig. 6.12.4) and as well as an area for possible expansion along the street-front (Fig. 6.12.3).

One entry is located in the left center portion (Fig. 6.12.1) and another one at the north end pavilion. Its style can best be described as a variation of Classical Revival, with a partially rusticated base and restrained use of classical ornament. The biggest alteration was the removal of the cornice and lowering of the parapet in a 1981 campaign (Fig. 6.12.2).

Generally, the building was in good condition, although water-infiltration had caused damage throughout the interior, most significantly along the eastern and northern building facades. Despite three previous repair campaigns to replace the windows (1990), roof and parapets (1998), and provide grout injections (2002), water-infiltration persisted. A retrofit new wall assembly was proposed to quell the infiltrations.

Fig. 6.12.4

Fig. 6.12.3
Second entry on the front facade located at the rusticated base of the north-end pavilion. Courtesy: Nelligan White Architects

Fig. 6.12.4 (left)
Rear of school showing rear extension. Courtesy: Nelligan White Architects

Fig. 6.12.5 (below)
Front elevation from the original 1927 design drawings, note the original cornice design. Courtesy: SCA Alchemy

Fig. 6.12.5

Methodology

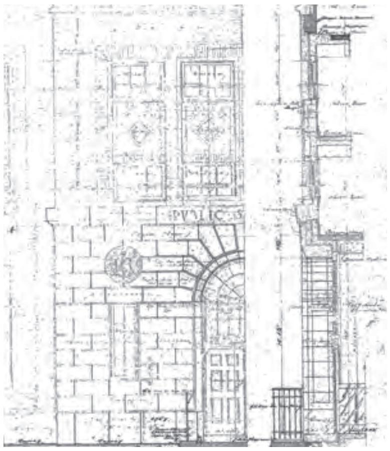


Fig. 6.12.6 & 6.12.7 (above - below)
Detail of entry and first floor plan from the original 1927 drawings. Courtesy: SCA Alchemy

Research

Prior to any definitive breadth of scope, 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 1927, as well as drawings from eight other projects carried out at the school between 1930 and 2005.

The complete list of existing original design drawings includes floor plans, details, sections, and exterior/ interior elevations (Fig. 6.12.6 & 6.12.7). There are multiple copies of many of the original drawings in varying quality and legibility. Drawings from the eight projects carried out at PS 14 X between 1930 and 2005 include elevations, details, floor plans, interior elevations, and sections.

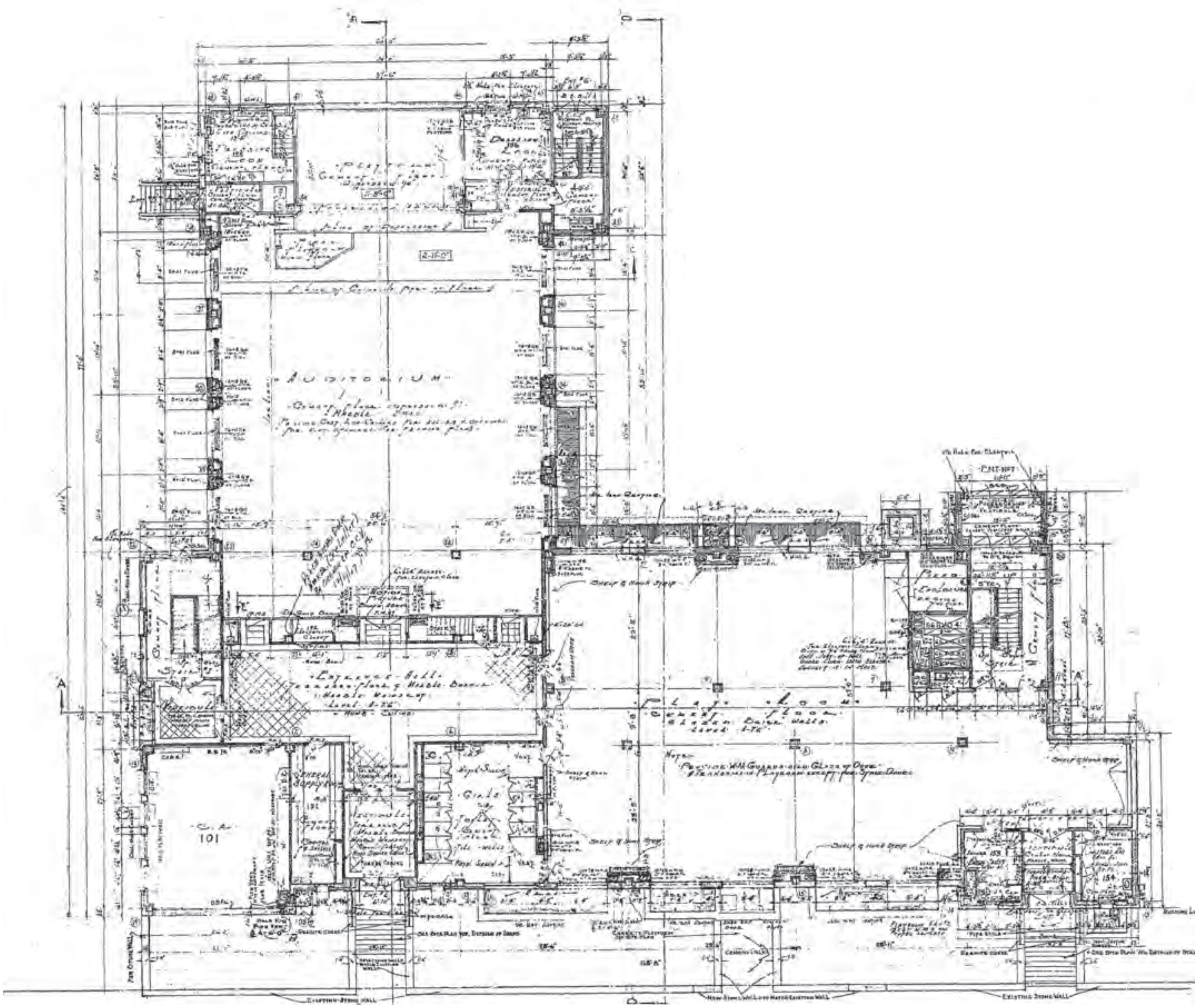


Fig. 6.12.7

Observation & Mapping

Visual surveys of exterior and interior damages were performed. Observations found the roof to be in general good condition, however, areas of soft and bulging roofing were noted. Stainless steel cap-flashing was under all coping stones, and most of the stainless steel counter flashing at the roof, appeared to be installed per typical SCA details. Construction documents from previous SCA modifications also identify copper composite through-wall flashing, which was observed terminating at the lintels above the top floor windows and along the length of the parapets. At the parapet expansion joints, however, the original base counter-flashing was discontinuous, and installed without the required 6" lap. These original joints were covered by corrective pieces of stainless steel flashing, approximately 12" long. However, the corrective pieces were typically fastened with rivets on both sides of the joint and as a result, did not allow for differential movement (Fig. 6.12.8).

Additional problems with the base flashing membrane were identified in isolated areas along the roof perimeter. It appeared that, although some corrective work had occurred on the roof and flashing, the work was inconsistent and poorly executed. Flashing at the roof scuppers was incorrectly installed in multiple locations. The roof membrane was wrapped to the inside of the scuppers, allowing for the possibility of water to migrate under the membrane. In one location above the guidance office, a backward tilt to the scupper was identified which, consequently, could invite water directly under the roof membrane.

A potential life-safety hazard was identified where cabling was attached to a roof top vent stack. The vent was cracking under the weight of the cables (Fig. 6.12.9). Even with the deficiencies observed the roof was not believed to be the primary source of water-infiltration.

Water-damaged paint and plaster were noted in classrooms along exterior walls, throughout the school (Fig. 6.12.11). The damage was most predominant along the entire east facade on the third and fourth floors, at the north-east & south-east corners on the second, third, fourth floors, at the Guidance Office on third floor, and large portions of the walls adjacent to stairwells along the north facade. Despite the efforts of previous repair projects, the school confirmed that these areas are in a constant state of repair.

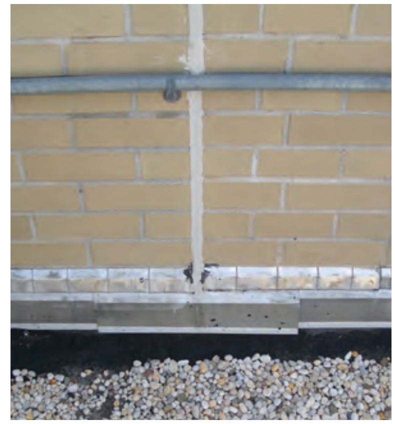
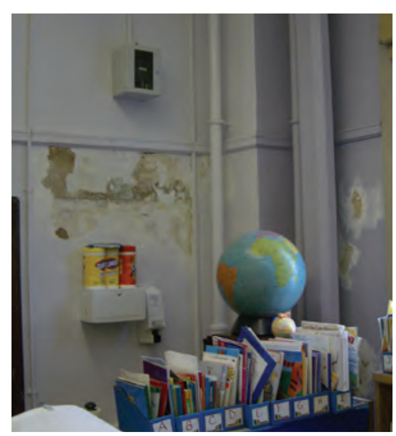


Fig. 6.12.8
Corrective piece of flashing over expansion joint at parapet, did not allow for differential movement. Courtesy: Nelligan White Architects

Fig. 6.12.9
Potential life-safety hazard, cables attached to vent stack. Courtesy: Nelligan White Architects

Fig. 6.12.10 (left)
Damage map of front elevation. Courtesy: Nelligan White Architects

Fig. 6.12.11 (below)
Damaged interior surfaces. Courtesy: Nelligan White Architects



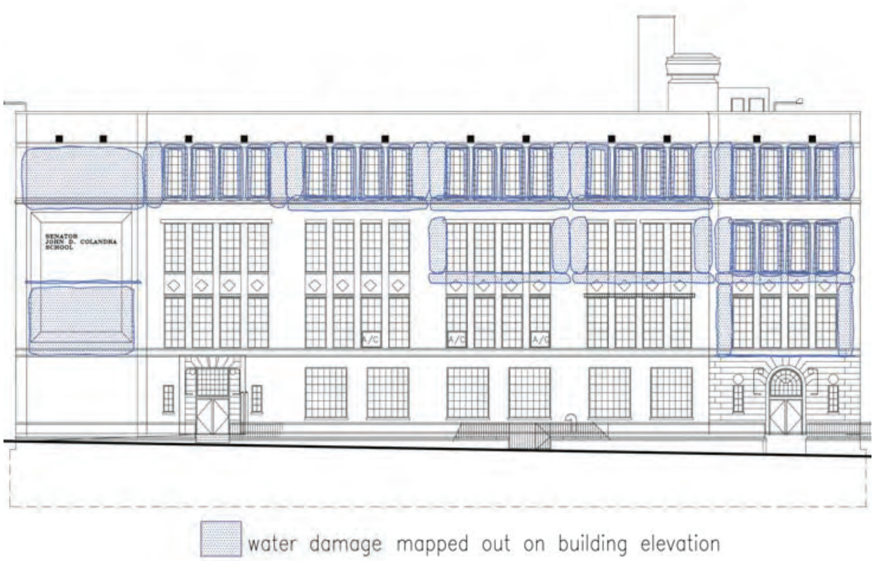


Fig. 6.12.10

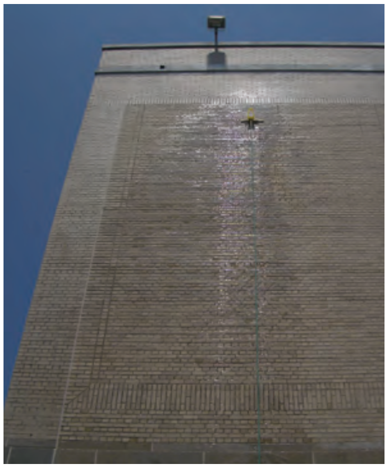


Fig. 6.12.11
Spray testing conducted at exterior walls. Courtesy: Nelligan White Architects

Non-Destructive Testing

Impulse radar was used to scan portions of the east elevation that had previously been randomly selected for quality control. Areas of scanning were predetermined to be 5 by 10 feet. In areas where the scan incorporated a window, the window jambs and all masonry within the predetermined area were scanned with the radar antenna. No significant voids were found in the investigation of 23 scans with a combined area of 1,150 square feet.

In addition, spray testing was conducted at the school and no moisture was observed to be penetrating directly though the previously repaired masonry (Fig. 6.12.11). However, the moisture tests performed identified approximately 43 windows that appeared to be leaking (Fig. 6.12.12). Leaks were identified at the joint between the panning and frame, and at the lower frame miter joint. Remedial measures had included injecting the void between the panning, window frame, and the masonry opening with sealant, which did not appear to have been successful.

Indoor air quality tests were also performed at the third and fourth floor. The overall air quality was determined to be generally similar to the conditions outside. Levels of carbon monoxide and carbon dioxide were well below levels required. Negative pressure was observed, though not measured, in classrooms throughout the school. This negative pressure was thought to be a significant driving force behind the liquid water entering the building, particularly at the perimeters of the windows that were leaking. The air deficit is considerable – approximately 4500 cfm for a classroom floor.

Noise from the Bruckner Expressway had made opening windows for ventilation and makeup air, intolerable. Poor air-circulation, combined with the previously noted issues of water-infiltration, had resulted in musty smells, stagnant air, and ideal conditions for mold growth. The school principal requested a need for central air conditioning, as classrooms tend to get unacceptably hot in the warmer months.

Fig. 6.12.12 (right)
Moisture-leakage noted during testing in classroom 211. Courtesy: Nelligan White Architects

1. At 26 minutes into the test, water was seen weeping from the bed joint shown, at a horizontal crack in the mortar joint.
2. At 29 minutes into the test, a damp spot appeared in mortar beneath sill.
3. At 36 minutes into the test, water begin to flow down the jamb and dripping at sill.
4. Spraying concentrated on the metal frame members led to leaks at the lower window corner.

Fig. 6.12.12

Exploratory Probes

In areas where the impulse radar found suspected voids, a hole was drilled into the masonry and the hole inspected with a fiber optic borescope camera. These holes confirmed the lack of significant voids.

Sensors were installed at four locations: The north wall of Stair E to measure the performance of the existing wall; the north wall of room 411 to measure the performance of a proposed retrofit; and two locations on the south wall of the Guidance Office, one to measure the existing wall and one to measure a proposed retrofit. These sensors recorded relative humidity and temperature, and were installed in pairs; one inserted at the interior finish, and one inserted at the back of the exterior brick in a hole made with a core drill.

The tests with the sensors installed lasted 22 days, from July 26th through August 17th. Performance of the wall was recorded for nine days and then the wall was soaked on the exterior using common lawn sprinklers on August 4th and 5th. The wall was allowed to dry out and was soaked again on August 16th and 17th, this time, above the elevation of the roof flashing. Moisture readings were taken and visual inspections were performed.

During the soak tests, damp areas and dripping were observed. In some of these areas, there were obvious cracks in the terracotta. In one case, there was a hole into one cell of the terracotta and a void in the injection grout at that location. This, obviously, has demonstrated that drainage, i.e., liquid water traveling through the wall driven by gravity or wind pressure was the significant source of the building's water problem, in direct contradiction to the results of the impulse radar tests.

Observations made during the demolition for testing revealed a number of conditions. An existing vapor barrier of organic felt impregnated with asphaltic material adhered to the terracotta was found. It was observed to be in poor condition, thus, no longer effective. Wall cores drilled out for placement of the sensors showed, although the terracotta was normally filled with grout the terracotta itself was found to be full of pores, cracked, friable, and sponge-like. A proper bond between the grout and terracotta was not found throughout (Fig. 6.12.13). In some places, the grout fell away showing that cracks exist between the terracotta and grout.

The windows were installed in a 1990 campaign and a face-brick was removed from a typical lintel to reveal the wall construction. It was observed that the lintel tipped towards the interior of the building allowing water to become trapped (Fig. 6.12.14). In the area between the metal jamb sections of the window against the old wood weight pockets, loose batt insulation was observed without any vapor barrier. As observed the original wood had become saturated by the failure of the window panning/flashing, and subject to mold, mildew, rot and decay. No flashing was installed nor identified at the head, jambs, or sill.

It was also observed that, typically, the panning extended to the masonry opening and sealant was installed as filler between the masonry and the panning. The filler sealant appeared to be re-caulked and was in generally good condition. Details of the four windows replaced during a 2000 campaign, however, show a better detail where the jamb extender created a reveal between the panning and masonry, which allowed for the insertion of a backer rod and sealant between the parallel surface of the masonry and the return on the jamb extender.

Fig. 6.12.13
Core sample taken shows while the terracotta was typically filled with grout the terracotta was found to be full of pores, cracks, and sponge like. The grout and terracotta did not have a proper bond throughout. Courtesy: SWN Architects, LLC

Fig. 6.12.14 (below)
Lintel above window was observed to be tipped toward the interior allowing water to become trapped. Courtesy: Nelligan White Architects

Recommendations & Design

Despite the injection of cementitious grout and testing that seemed to demonstrate that the injection was successful, it was determined that water penetration continued through the masonry. Water was able to flow through the smallest cracks and holes that the injection grout was not able to fill. In addition 42 of the 192 windows were found to be leaking adding to the water infiltration problems.

Adding to this was minor leakage of the roof, particularly at the overflow scupper. Ventilation was also found to be a problem, possibly contributing to the water infiltration by creating negative pressure within the building. This negative pressure could draw water in especially at the perimeter of the leaking windows. Musty mildew type smells were also noted, attributed to the lack of air movement. These findings prompted the following recommendations:

Fig. 6.12.15 (below)
Plan showing extent of roof repairs. Courtesy: Nelligan White Architects

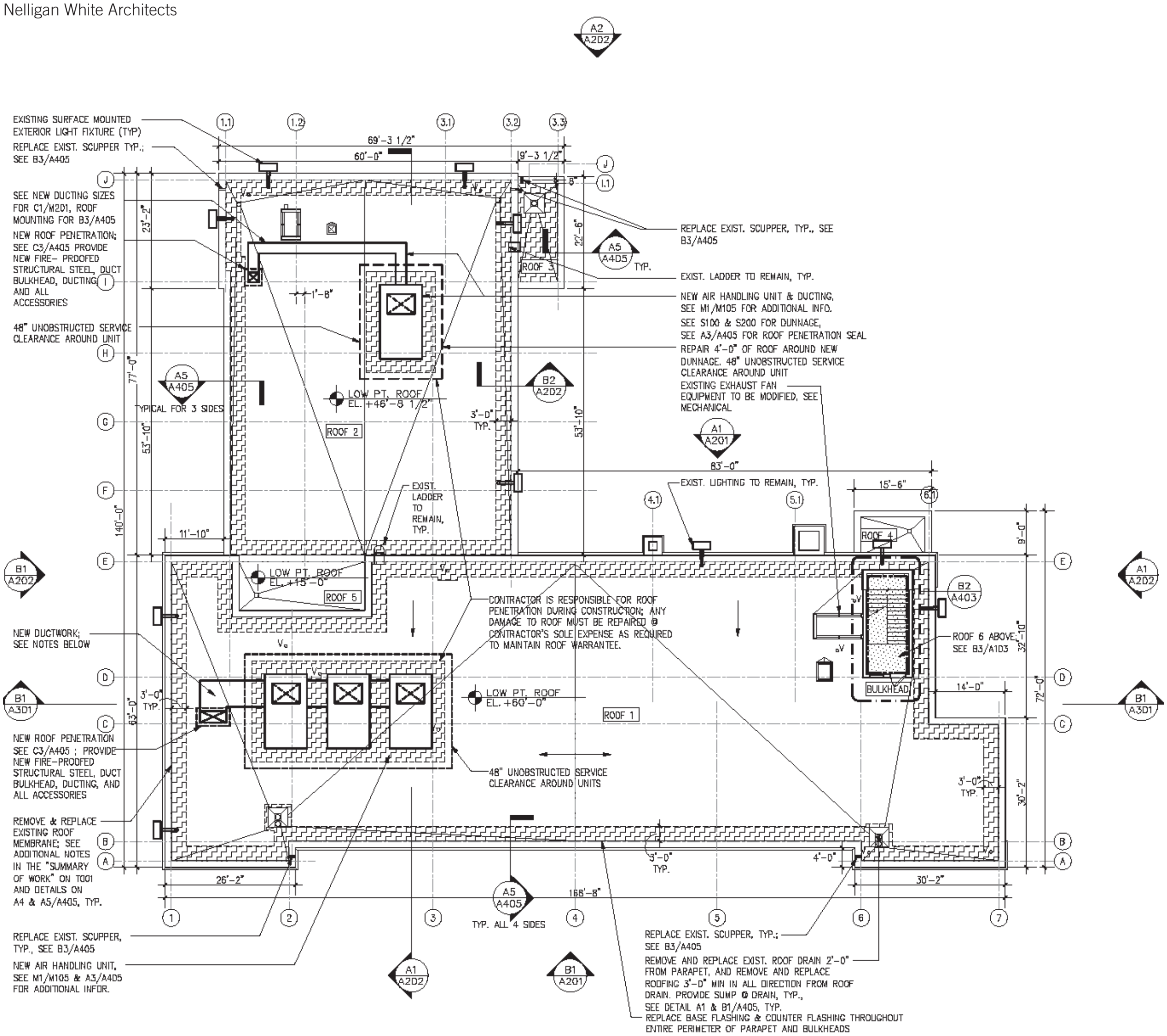


Fig. 6.12.15

LLW No. 044309 – Roofs

1. **Roofs** (Fig. 6.12.15)
   - Schedule roof inspection by manufacturer under the existing warranty
   - Along the entire roof perimeter parapets replace two courses of brick, one wythe deep, to allow for inspection and repair of base flashing and install new continuous stainless steel cap flashing
   - Any repairs shall be performed under the manufacturer warranty
   - Provide new steel flashing at expansion joints per typical SCA details
   - Remove all existing scuppers
   - Provide new scuppers and flash as per typical SCA details
   - Reroute cabling at vent stack by carrier and properly secure to the building

Fig. 6.12.15
Construction progress of interior retrofit. Liquid applied membrane and metal stud installation complete. Courtesy: Nelligan White Architects

Additional Recommendations

1. **Painting/Plastering** (Fig. 6.12.15)
   - Remove finishes of interior to expose terracotta back up
   - Clean exposed terracotta, patch any visible holes or voids
   - Retrofit interior surfaces with a liquid applied membrane, 1" XPS rigid insulation, metal studs, 5/8" Densglass Gold, skim coat, and latex paint
   - Every measure should be taken to allow for the installation of the insulation, even if the assembly is laminated or if 1" deep Z-shaped furring is used to eliminate the studs
   - In locations where bulk water leaks are identified, the drainage plane and gutter installation should be made with 1" XPS rigid insulation, studs, Densglass, skim coat and paint
   - Remove, store, and reinstall existing 96 radiators along exterior walls
   - Test all radiators before removal and after re-installation
   - Install new 4" pipe extensions at each location to relocate radiators at a distance adequate for installation of new wall retrofit

2. **Windows**
   - Remove, store all 192 existing aluminum windows, discard existing panning
   - Remove and replace all 192 existing wood window casings with pressure treated lumber
   - Install new elastomeric flashing over new existing wood casing, and new LCC or stainless steel pan-flashing with weeps at all sills
   - Reinstall all 192 windows with new panning, which should be provided with extension "F" trim, to allow a proper installation of backer rod and sealant
   - Provide for replacement 10% of windows with new windows to account for any damage that occurs
   - Apply sealant over backer rods

Fig. 6.12.16 (below)
New rooftop HVAC system. Courtesy: Nelligan White Architects

3. **Ventilation** (Fig. 6.12.16)
   - Provide new rooftop ventilation make-up air unit of 100% tempered outside air; 11,700 cfm for classrooms, 5000 cfm required for balance of school
   - Unit shall be custom type constant volume, with gas-fired heating section and chilled water cooling coil, pre-filter and 90% secondary filters
   - Provide new ductwork, exposed in corridors from rooftop ventilator with fused fire dampers at all floor penetrations and supply register in classrooms
   - Provide new rooftop acoustic mechanical enclosure and all necessary structural dunnage and flashing, for unit's proper mounting and waterproofing.

Constructability & Lessons Learned

Fig. 6.12.17
Depth of core taken from wall. Sensors would be placed in wall to monitor humidity and temperature. Courtesy: Nelligan White Architects

Three previous repair campaigns were undertaken to repair and prevent future water-infiltration. The windows were replaced in 1990, roof and parapets replaced in 1998, and grout was injected into the walls to fill any voids in 2002. Despite all the repair attempts, water still continued to infiltrate the wall.

Grout Injection and Continued Leaks

Cementitious grout was injected into the walls during a 2002 campaign to fill any voids and cracks. Despite the injection, water damage continued to be observed throughout the interior. Impulse radar tests were utilized to determine the effectiveness of the injections. The tests found no significant voids or cracks throughout the 1,150 square feet testing area of exterior wall, indicating the injection grout repair was successful.

Spray tests were carried out in addition to the impulse radar tests. Water-infiltration was found at 43 windows. Leaks were identified at the joints between the panning and the frame as well as the lower frame miter joint, indicating that a previous repair of sealant injections at the windows was unsuccessful.

Further testing involved the placement of sensors into the walls, existing interior finishes were removed at parts of several rooms and a hole was made with a core drill to place the sensor (Fig. 6.12.17). These sensors recorded relative humidity and temperature for 22 days.

During the testing, on two separate occasions, the exterior walls were soaked at locations near the sensors. On the interior moisture was observed and in some locations water was observed pouring through the wall. These tests demonstrated that water driven by gravity or wind pressure through the wall was the significant cause of the water infiltration despite the results of the impulse radar tests.

When the wall cores were removed to place the sensors, it was revealed that grout normally filled the terracotta cores, but the terracotta itself was found to be full of pores, cracked, and friable. Improper bonds were also found in some places in which the grout fell away from the terracotta.

Paired with these deficiencies it was determined that water was able to flow through the smallest cracks and holes where grout was not able to fill. While the grout was able to pass the impulse testing it was ultimately found to be unsuccessful.

Fig. 6.12.18
Classrooms have large windows letting in plenty of light, but the opening of them was intolerable due to the highway adjacent to the school. Courtesy: Nelligan White Architects

Ventilation

Schools like PS 14 X were typically provided ventilation via an exhaust ventilation system. Each classroom typically has two exhaust registers. At PS 14 X, makeup air was provided, by opening the windows to replace the exhausted air. While the exhaust system was functioning, the windows were kept shut to reduce the noise and possible pollution from the Bruckner Expressway built decades after the school was (Fig. 6.12.18).

While testing showed the air quality to be similar to the outside and posed no real health hazard, negative air pressure was observed. This negative air pressure was thought to be a contributor to the water infiltration particularly at the leaking window perimeters. The lack of makeup air had resulted in poor circulation, leading to musty stagnant air throughout the building. In order to provide the necessary makeup air to balance out the pressure, improve circulations, and eliminate the need for the windows to be opened rooftop ventilation make-up air units were provided. In addition, the new rooftop units would provide heating and cooling.

Wall Assembly Retrofit

A solution to quell the water-infiltration was the use of a wall assembly retrofit on the interior. This started with the spray application of a waterproofing membrane on the exposed terracotta backup. The wall assembly consisted of XPS rigid insulation, metal studs, and finally a finish of Densglass and paint. This was intended to create a barrier to prevent any water-ingress into the interior.

The retrofit was created in response to combat two separate problems: first, the transportation of moisture in capillary and vapor form, and second, the penetration of bulk-water through leaks as observed during the testing phase. Originally, two retrofit strategies were created and tested through mock-up as well as computer simulation. The first strategy applied rigid XPS insulation to the interior face of the terracotta with the intention to seal the perimeter and joints of the XPS, so that it could form an effective vapor barrier. The second strategy replaced the XPS with membrane and an interior drainage plane to capture bulk-water leaks.

A year-long simulation was created of the existing wall (red), the existing wall with the retrofit application of a membrane only (dark blue), and the existing wall with the retrofit application of 1" XPS only (light blue). This simulation showed that while either retrofit substantially improves the performance of the wall in comparison to the existing grouted wall, the XPS retrofit clearly performed better over the course of a year (Fig. 6.12.21).

The mock-ups were tested over a short duration to mimic yearlong conditions. At the Guidance Office, the first strategy using the XPS, was overwhelmed by bulk-water leaks. Water began to pour onto the floor around the edges of the XPS a short time after the test began. While water and vapor cannot pass through the XPS itself, the joints have limited resistance to bulk-water penetration. This was further compromised by the quality of installation that can be expected, even with reasonably adequate supervision. For this reason, it was decided that a membrane needed to be placed on the interior face of the terracotta to stop bulk-water penetration, and if the water penetration was significant, the membrane needed to provide drainage back to the outside of the wall. At the same time, it was clear that the application of rigid insulation is the best method to reduce humidity at the interior finish in general. A further simulation was created combining both strategies; the use of liquid applied membrane and XPS rigid insulation. It was found that the performance of the wall was not affected negatively with the combination of the membrane with the XPS (Fig. 6.12.19 & 6.12.20)

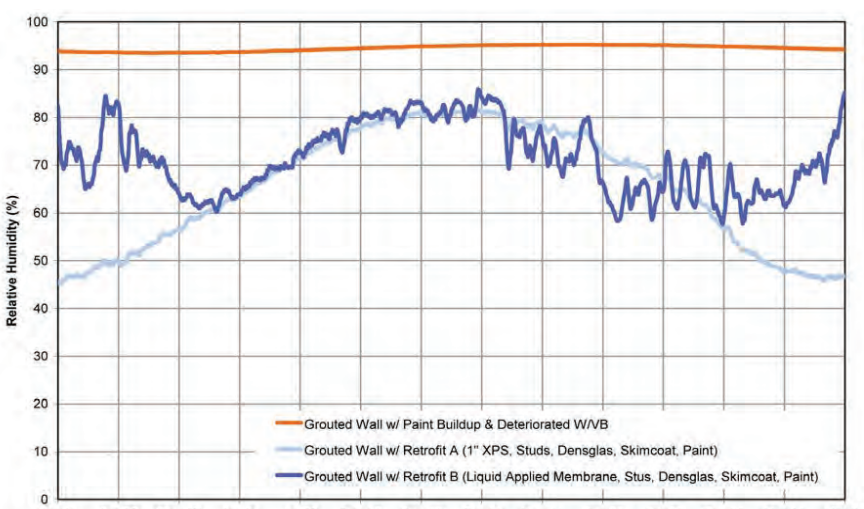


Fig. 6.12.21

Fig. 6.12.19
Progress of wall assembly retrofit. Densglass gypsum wall board is installed over the XPS. Courtesy: Nelligan White Architects

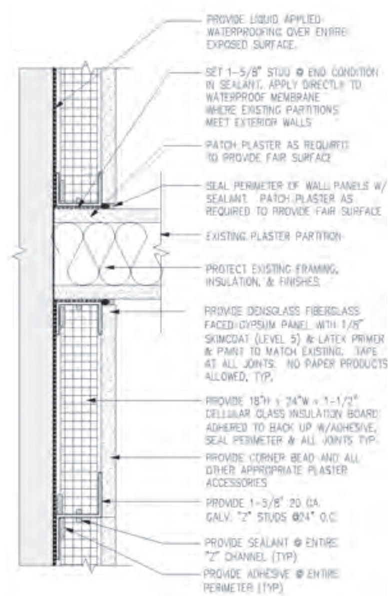


Fig. 6.12.20
Detail in plan of wall assembly retrofit. Courtesy: Nelligan White Architects

Fig. 6.12.21 (left)
Simulation displaying existing wall performance along with the two separate wall strategies. Courtesy: SWN Architects, LLC

SECTION 6.13

CASE STUDIES: BAYSIDE HIGH SCHOOL

CASE STUDIES:

BAYSIDE HIGH SCHOOL

Introduction

Building ID	Q405
School Level	HS
Address	32-24 Corporal Kennedy St. Queens, NY 11361
Cross Streets	32nd St, 33rd Ave, 208th St.
NYC DOE District	26
SHPO Status	Eligible
SHPO ID	06PR0652
Flood Zone	Outside Flood Zone
FEMA Map	3604970118F & 3604970119F
Architect	Walter C. Martin
Year Built	1936
Plan Form	Hybrid M & E
Style	Classical Revival
Internal Sq Ft	382,000
Classrooms	65
Stories	3 + Basement & Cellar
Structural System	Concrete encased frame
Columns	Concrete encased steel
Beams	Concrete encased steel
Floors	Concrete slab
Roof	BUR
Cladding	Brick, Limestone, Terracotta, Granite base
Backup	Brick

Fig. 6.13.1

Fig. 6.13.1 (right)
View of main entry of the Bayside High School. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.2 (below)
Top of Bayside High School's front entry taken from the main roof level before renovation. Courtesy: SuperStructures Engineers + Architects

Bayside High School consists of a single school building designed by Walter C. Martin in 1934. The building has three stories, plus a basement at the west elevation where it fronts Corporal Kennedy Street and Raymond O'Conner Park. Tall single-story gymnasiums on the east elevation facing 208th Street are joined with a lower single story pool, and a tall single-story auditorium on the south elevation facing 32nd Avenue. Structurally, the building utilizes concrete-encased steel framing, poured-in-place concrete floor slabs and solid masonry backup walls.

At the street-facing elevation a profiled limestone string course is featured at the first and third floor, along with a terracotta string course at the third floor. Brick masonry pilasters are located between windows bays with decorative terracotta finials, capitals, and bases. The street elevation also features paired or ganged windows with terracotta window surrounds, intermediate terracotta mullions and decorative terracotta spandrel panels between floors.

At the entries, decorative limestone elements incorporate stone window surrounds with pediments, framed panels and niches. The overall building is set upon a granite base at grade level. At the secondary elevations window openings feature brick soldier courses at lintels and terracotta sills.

On all the facades, windows are arranged primarily, but not exclusively, in sets of six. The original wood windows were replaced in 2004, with aluminum double-hung insulated units and some casement and hopper windows with fixed transoms. Windows at the Natatorium were replaced with glass block.

Prior to the 2013 repair campaign, the school Natatorium was served by an Heat and Ventilation Unit, installed in 1937, with all major components of the original system in place. The system was a heating only constant air flow, recirculation system with pneumatic controls. Since 2013, the HVAC system has undergone a complete upgrade through the installation of a new air distribution and chlorine exhaust ventilation system.

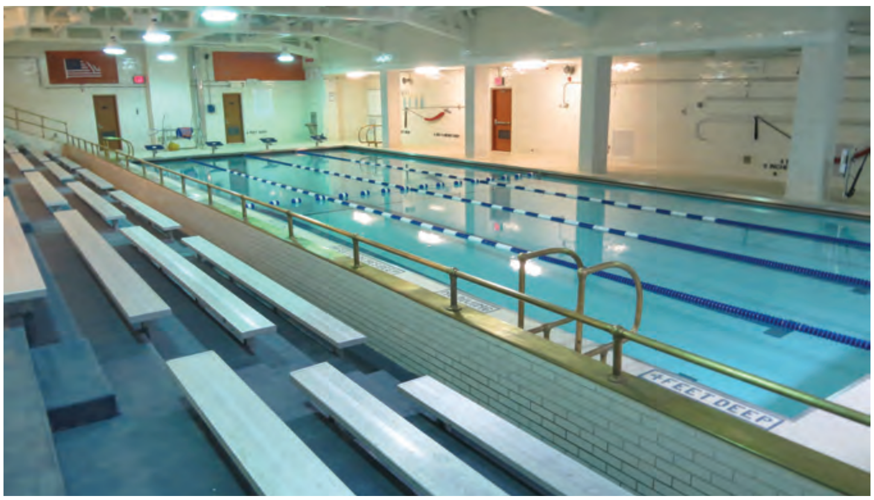


Fig. 6.13.3

Fig. 6.13.3 (left)
Bayside's Natatorium after renovation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.4 (below)
View of the southern facade before renovation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.4

Methodology

Fig. 6.13.5
Original 1933 building elevation drawing detailing the front entry of Bayside High School with an accompanying building section directly adjacent to the elevation. Courtesy: SCA Alchemy

Fig 6.13.6 (below)
Original 1933 second floor plan. Courtesy: SCA Alchemy

Research

Prior to proceeding with scope and design, information regarding the building's original construction was obtained through the School Construction Authority's Alchemy database. The database contained 186 drawings from the original 1934 design as well as drawings from ten other repair campaigns carried out at the school between 1985 and 2009.

The majority of the original design drawings were legible and provided a comprehensive understanding of the building's architectural, structural and mechanical design systems. This aided in the ability to properly analyze the necessary rehabilitation strategies, in order to provide comprehensive construction documents.

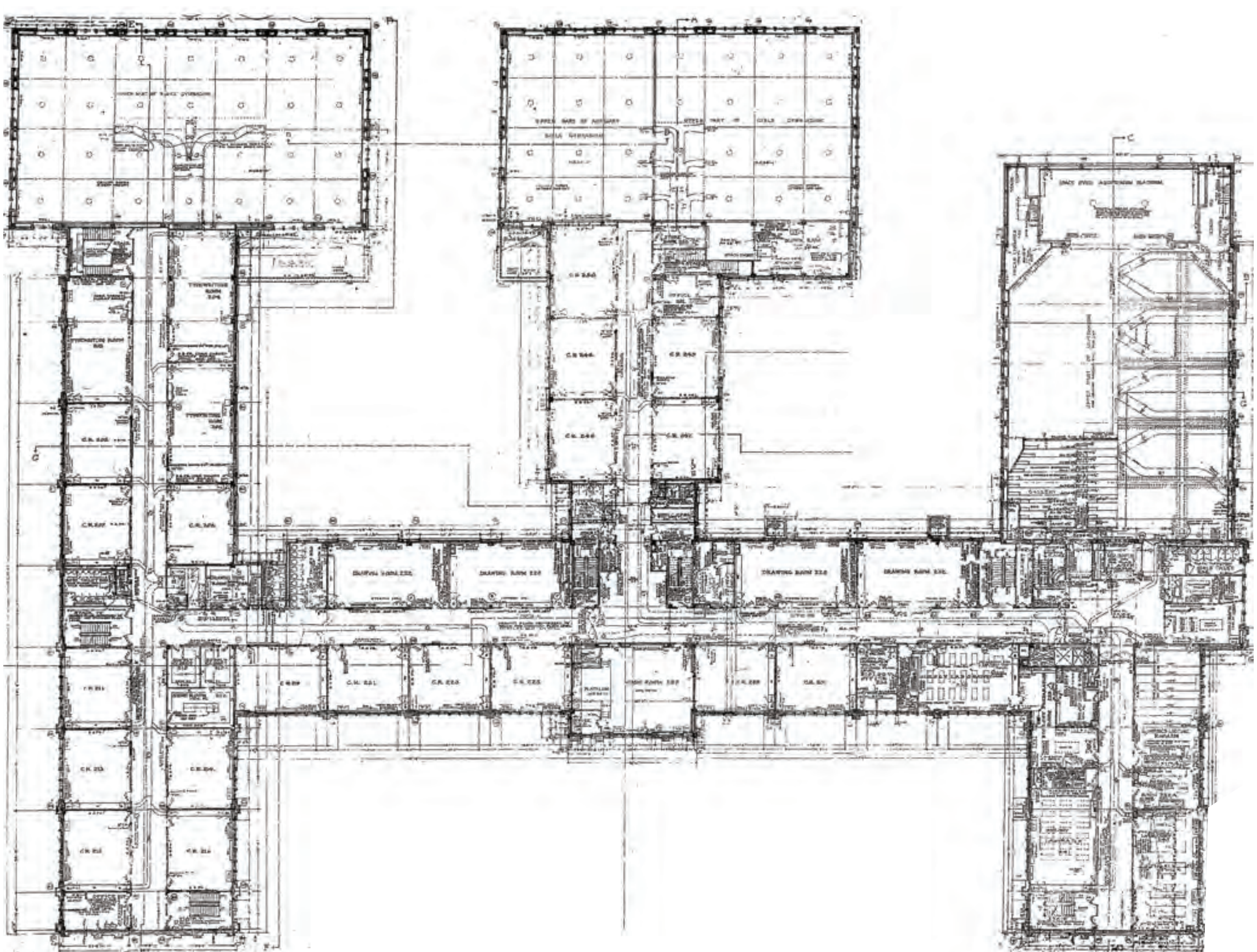


Fig. 6.13.6

Observation & Mapping

The first overall analysis using the Building Condition Assessment Survey (BCAS) reports were obtained through the NYC DOE website. BCAS reports were issued for Bayside High School in June 2011. Items within the report relating to the exterior building envelope were evaluated in the field through extensive photography and field-note documentation, using the original design drawings as base drawings. These investigations aided in the facilitation of quantifying deficient items and determining the scope of work at the site.

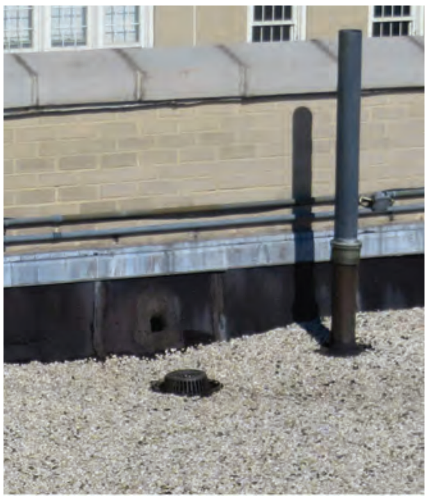


Fig. 6.13.7

Fig. 6.13.8

Fig. 6.13.7 (far left)
Roof system failures at base flashing adjacent to the existing roof drain on Roof I was found to be the primary cause of water infiltration and subsequent damage to interior finishes within the 3rd Floor Library. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.8 (left)
Water damage at the ceiling of the 3rd Floor Library. Custodial staff repeatedly repaired the area but without stopping the cause of the water infiltration, continuous damage of this area was imminent. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.9 (below)
Damage mapping drawing of the 3RD floor. Courtesy: SuperStructures Engineers + Architects

PLAN RESTORATION SCHEDULE

CODE	DESCRIPTION	KEY
ACT 01	ACOUSTIC CEILING TILE REPLACEMENT	
CLN 01	CLEANING: MASONRY	
COA 01	COATING: PAINT AT CEILING/WALL	
COA 02	COATING: CONCRETE FLOORS	
COA 03	COATING: CORROSION INHIBITOR	
COA 04	COATING: BREATHABLE MASONRY	
CON 01	CONCRETE: SPALL REPAIR	
CON 02	CONCRETE: HANDBALL COURT REPAIR	
CON 03	CONCRETE: CRACK INJECTION	
CON 04	CONCRETE: CEILING REPAIR	
CON 05	CONCRETE: REPAIR AT SPALL AND REBAR	
CON 06	CONCRETE: ENCASEMENT	
DOR 01	DOOR: REPLACEMENT	
DRN 01	DRAIN: REPLACEMENT	
DRN 02	DRAIN: SCUPPER	
EXC 01	EXCAVATION	
FLA 01	FLASHING: MASONRY WALL PERIMETER	
GRA 01	GRADE: LANDSCAPE	
JNT 04	JOINT: HORIZONTAL SEALANT	
LAD 01	LADDER: REMOVAL / REINSTALLATION	
MAS 02	MASONRY: INFILL WALL REPAIR	
MAS 03	MASONRY: CMU WALL REPLACEMENT	
MAS 04	MASONRY: GLAZED FACE BRICK	
MEM 01	MEMBRANE: 4 PLY HYBRID BUILT-UP	
MEM 02	MEMBRANE: LIQUID APPLIED ROOF SYSTEM	
PAV 01	PAVEMENT: AT HANDBALL COURTS	
PEN 01	PENETRATION: PLUG INJECTION WATERPROOFING	P.P.
PLA 01	PLASTER: INTERIOR REPAIRS	
SAD 01	SADDLE: DOOR THRESHOLD REPLACEMENT	
SHT 01	SHEET METAL: STANDING SEAM COPPER	
SHT 02	SHEET METAL: AT BULKHEAD	
SHT 03	SHEET METAL: FLAT SEAM COPPER	
SHL 01	SHELVING	
STL 01	STEEL: BEAM REINFORCEMENT	
STL 02	STEEL: STAINLESS STEEL MESH	
TIL 01	TILE: TERRA COTTA GLAZED	
WTP 01	WATERPROOFING: FLUID APPLIED	
WTP 02	WATERPROOFING: MEMBRANE AT POOL	
WTP 03	WATERPROOFING: FOUNDATION	

Fig. 6.13.9

Non-Destructive Testing

Field observation notes were collected and documented during non-destructive terracotta sounding at the south-east corner of the building's east facade via a mechanical lift. Two other locations were sounded and the results were proportionally assessed to quantify deficiencies for the whole building as gaining access to the entire facade during the design phase was not a viable or cost efficient option.

Ultimately, during the construction administration phase when access to the facades were provided by the contractor, and prior to commencement of any demolition, additional sounding of the existing conditions was performed.

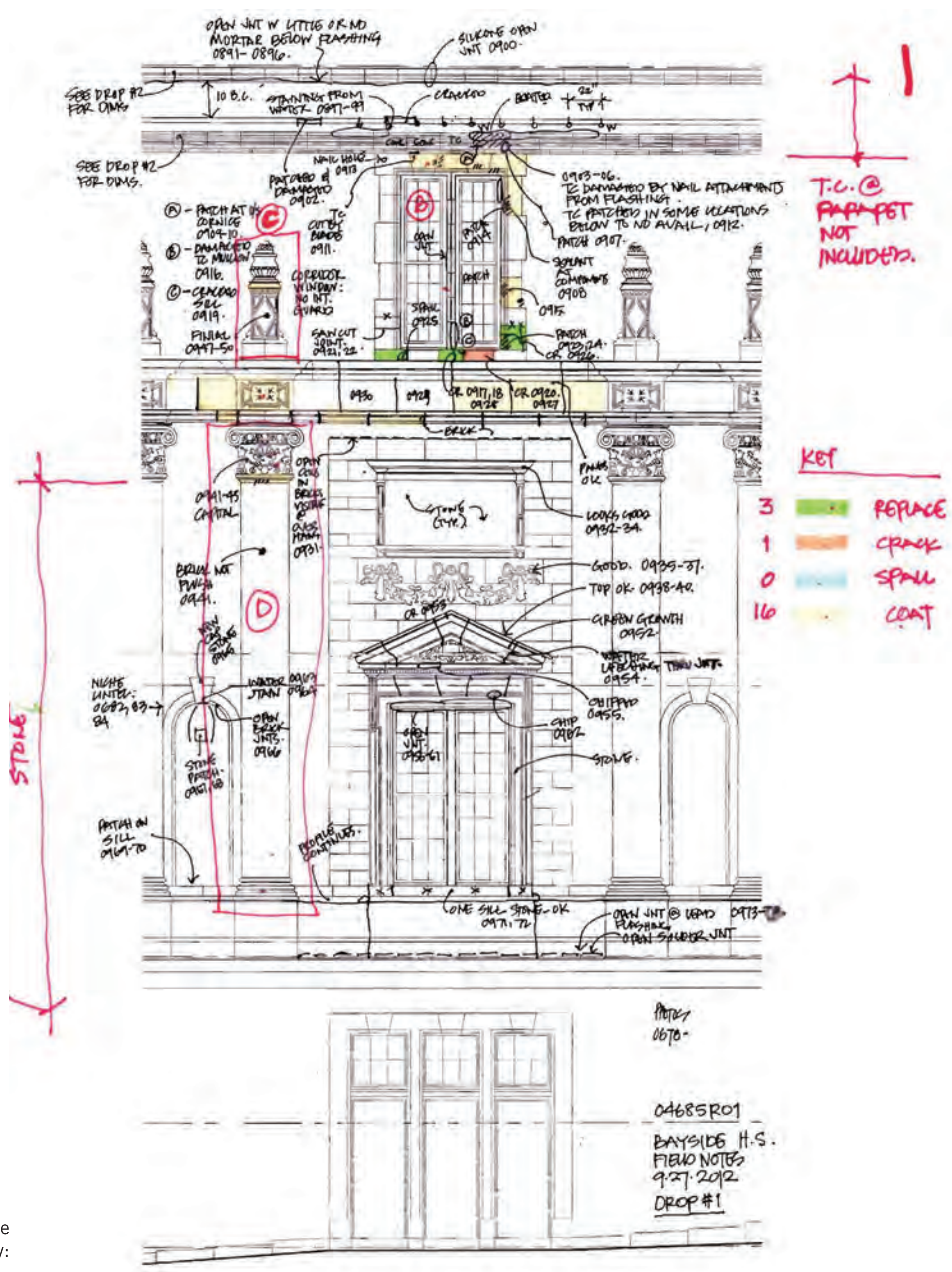


Fig. 6.13.10

Fig. 6.13.10 (right)
Field observation notes of a portion of the south-east corner of the east facade. Courtesy: SuperStructures Engineers + Architects

Subsurface moisture testing was performed at fourteen of the existing twenty roof levels. At the basement, four wall regions were inspected through thermographic means. Ground penetrating radar mapping was utilized at the pool's concrete enclosure. Video-scoping of seven existing drain lines at the exterior rear yard were also performed. These were the specific non-destructive testing technologies requested and obtained for Bayside High School.

These tests were used to validate or in some cases nullify the visual predictions made during the observation mapping phase of the project. In the case of the data presented below the terracotta sounding, subsurface moisture testing at the roof levels and thermographic inspection of a basement location validated our assumptions.

Fig. 6.13.11

Fig. 6.13.11 (left)
Sub-surface moisture testing results for the fourteen roofs tested. Courtesy: SuperStructures Engineers + Architects

Fig 6.13.12 (below)
Thermal anomalies as well as electrical capacitance readings were observed and recorded during the thermographic inspection testing at a basement location containing a considerable amount of visible water damages to the interior finishes. Courtesy: SuperStructures Engineers + Architects

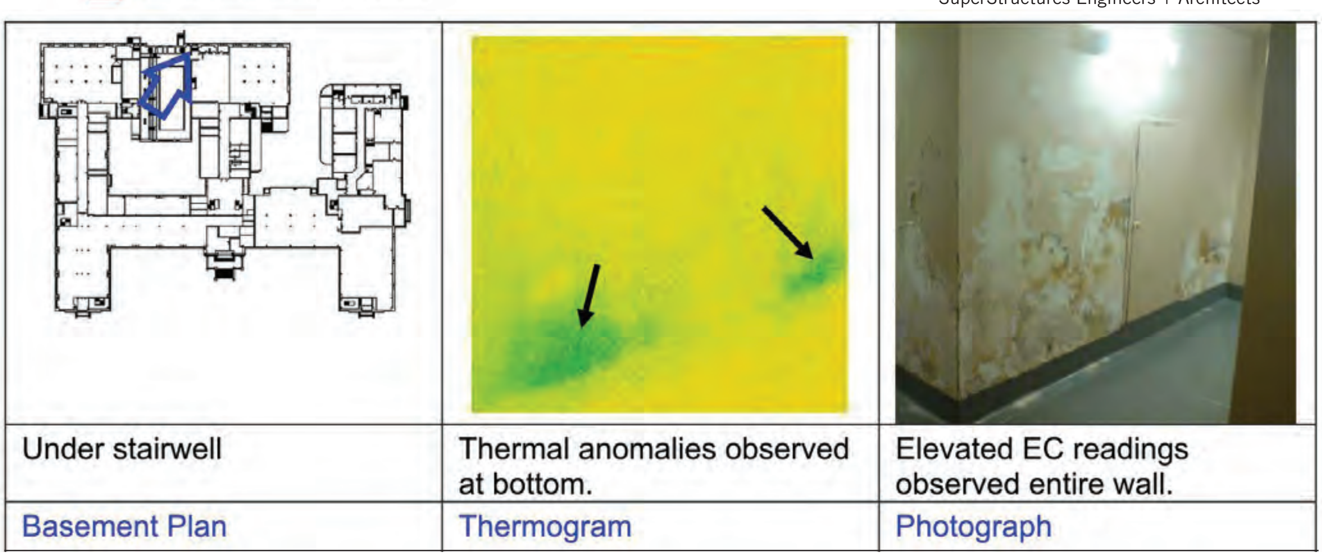


Fig. 6.13.12

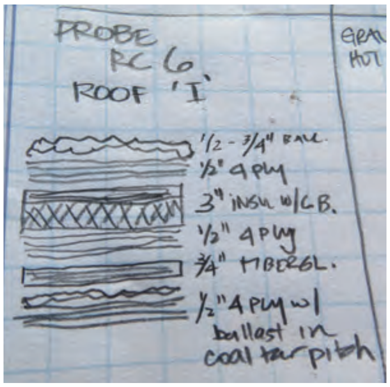


Fig. 6.13.13
Field notes containing roof cut information detailing the multiple systems observed during this exploratory probe. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.14 (below)
Except from the exploratory probe request package provided to the SCA. Courtesy: SuperStructures Engineers + Architects

Exploratory Probes

Exploratory probe requests provided to the SCA consisted of roof cuts, coping stone removals, masonry probes at parapets, terracotta unit removals at spandrel locations, and masonry probes at corner locations. The locations were selected by both evaluating the existing conditions at the site, as well as analyzing what was missing in the original 1934 design documents obtained from the Alchemy Database.

Most areas chosen demonstrated some form of construction failure. The deficiency observations were as expected; corroded steel, lack of anchorage, saturated backup wall/in-wall masonry conditions, crumbling backup masonry conditions some of which contained numerous voids, false expansion joints cut into the face-brick masonry through previous repair campaigns. Notwithstanding the findings, the spandrel steel was found to be in better condition than expected.

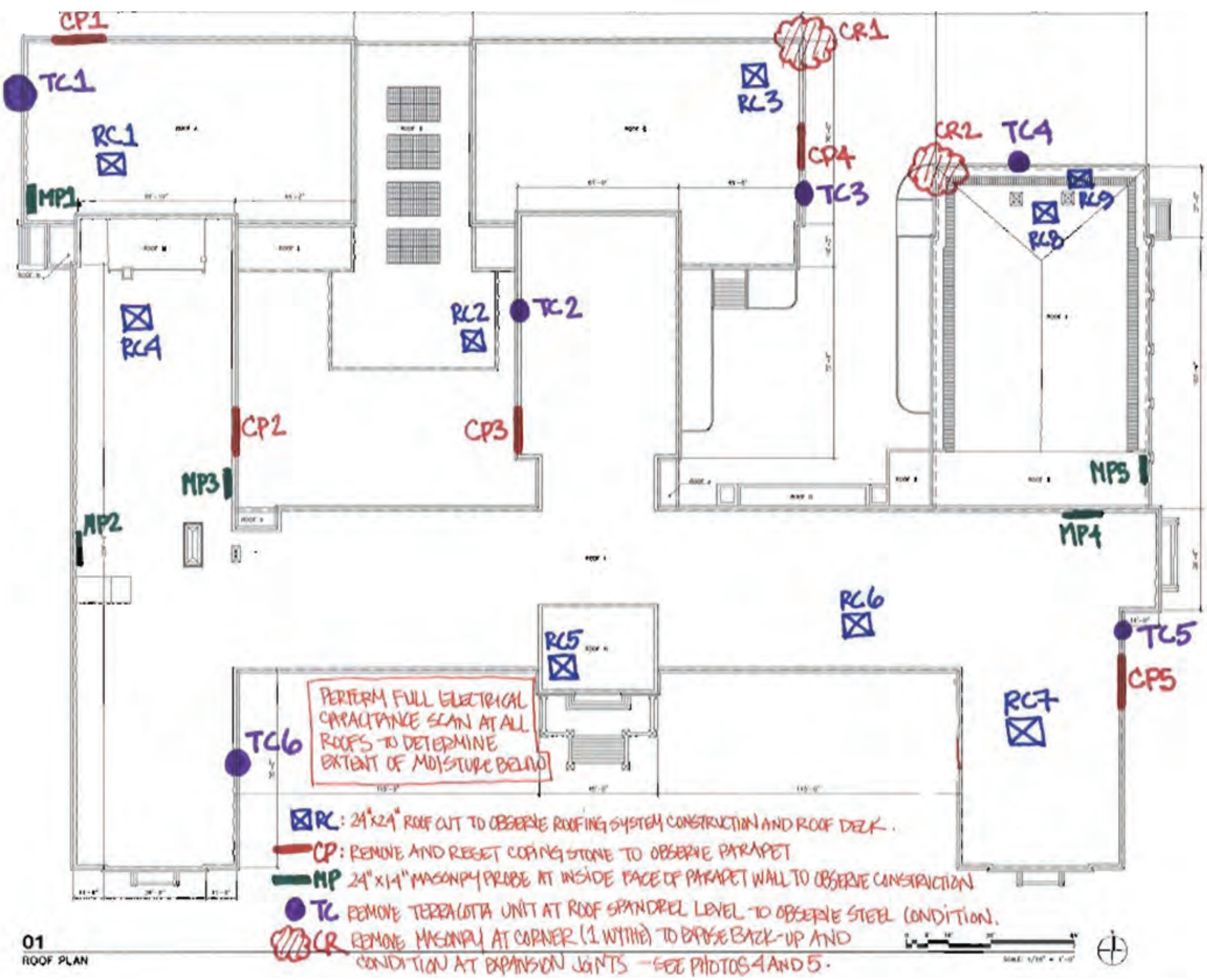


Fig. 6.13.14

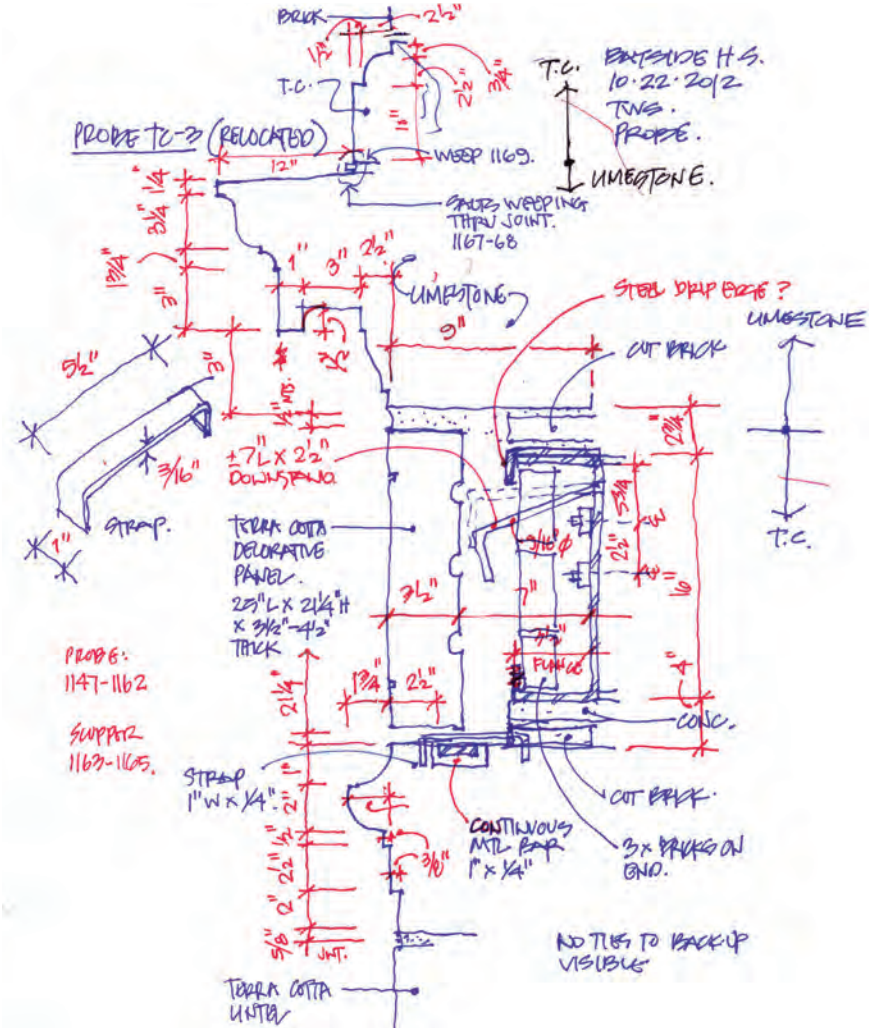


Fig. 6.13.176

Fig. 6.13.15
Measurements taken of the existing roof system; exploratory probe revealed 3 different roof systems. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.16 (left)
Field sketch/documentation of the probe opening location exposing the steel spandrel. Courtesy: SuperStructures Engineers +

Fig. 6.13.17

Fig. 6.13.17 (left)
Exploratory probe at spandrel revealed the decorative terracotta panels had no visible ties to the back-up. Voids in the back-up masonry can be observed at the base of the spandrel. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.18
Images of the steel coupons to be tested after extraction from the building. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.19 (right)
Material testing report detailing the chemical analysis of the two steel coupons extracted, to determine the wedability of the existing steel. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.20 (below)
Condition of the existing steel beams within the Blower Room beneath the Natatorium. Courtesy: SuperStructures Engineers + Architects

Materials Testing

In addition to non-destructive and exploratory probes, material testing samples were requested. This type of testing was selected as a means to analyze the feasibility of being able to weld new steel reinforcement members to the existing structure. Samples were extracted from the steel framing beneath the Natatorium. Continued water-infiltration from the pool deck above, considerable high humidity and continued deterioration from the caustic chlorine environment were all factors leading to the breakdown of the steel.

The process of testing materials aided in preparation of the scope work. Results were found to be positive from a design standpoint - the existing steel's composition was found to be readily weldable, therefore, reinforcement of the delaminating beams as the repair campaign would be achievable.

TABLE 1
CHEMICAL ANALYSIS RESULTS (WT. %)

Element	AISI Grade 1010	Coupon 3	Coupon 4
Al	-	0.005	0.004
B	-	0.001	0.001
C	0.08 – 0.13	0.12	0.12
Co	-	0.022	0.022
Cr	-	0.028	0.028
Cu	-	0.15	0.15
Mn	0.30 – 0.60	0.38	0.38
Mo	-	0.016	0.016
Ni	-	0.046	0.045
P	0.040 Max	0.008	0.008
S	0.050 Max	0.025	0.025
Si	-	0.037	0.036
Sn	-	0.010	0.010
V	-	0.001	0.001

Fig. 6.13.19

Recommendations & Design

Based on the building code requirements, extensive failures observed at roof membranes throughout, confirmation of membrane saturation through destructive and non-destructive site testing and visual observations of biological growth, and considering at least 11,000 SF of roof replacement would be required directly adjacent to the parapet edge to facilitate proper replacement, full roof system replacement was recommended. Additional discoveries at roof levels throughout prompted the following additional recommendations:

Fig. 6.13.21
Biological growth observed. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.22
Exposed, cracking roofing membrane. Courtesy: SuperStructures Engineers + Architects

LLW No. 078067 - Roofs

- Provide flashing at all piping penetrations at roof levels
- Provide flashing for all roof exhaust fan curbs
- Provide leaders and downspouts
- Provide new copper access hatch with hardware, installed in conjunction with copper siding at roof F
- Remove, prepare, prime, coat with epoxy paint system and reinstall all existing access ladders
- Provide flat and standing seam roofing at bulkhead A with integrated gutter system and concrete splash block
- Prepare, prime, and coat with epoxy paint system existing lintels at bulkheads A and B; remove existing and provide new backer rod and sealant at the bulkhead window perimeters
- Remove existing and provide new stainless steel threshold pan-flashing at bulkhead A and B doors
- Prepare, prime, and coat with epoxy paint system existing rain screens at bulkheads A and B
- Provide brick masonry cleaning at extents of bulkheads A and B
- Provide dunnage at Roof B installed directly to the deck
- Remove protective mesh screens from existing skylights on Roofs B and H; provide new galvanized screens, finished with an epoxy coat paint system
- Repair interior finishes at locations of damage due to roofing leaks

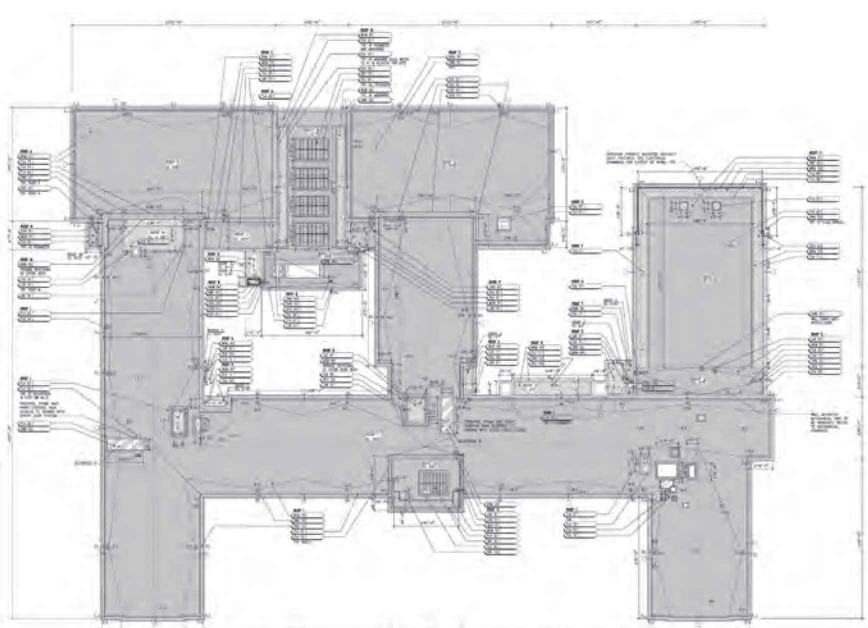


Fig. 6.13.24

Fig. 6.13.23 (left)
Roofing scope of work. Courtesy: SuperStructures Engineers + Architects

BAYSIDE HIGH SCHOOL

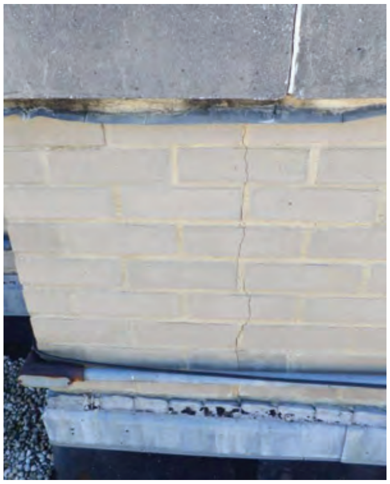


Fig. 6.13.24
Existing parapet deterioration. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.25
Biological growth beneath coping stone sealant. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.26 (right)
Parapet reconstruction detail. Courtesy: SuperStructures Engineers + Architects

Findings at the parapets through visual inspections included horizontal, vertical and step cracks in brickwork; expansion joint failure; mortar joint leeching at interior and exterior faces; aliphatic membrane installations over brickwork installed in an attempt to reduce water-ingress, and parapet heights less than the NYC Building Code requirements of 3’-6” minimum at high points. Coping stone observations included spalled and cracked units, which were leading to biological growths. Failed sealant throughout allowed water-ingress into joints and ultimately traveled under flashing into the coping mortar bed and further into the parapet’s interior wythes. Sandy mortar beds and mortar beds were not fully bonding to the coping stones. Exploratory probes confirmed saturation at the interior of parapets, insufficient or improperly installed flashings, voids within the mid-wythe masonry construction, and insufficient sealant thickness at expansion joint installations. These discoveries prompted the following recommendations:

LLW No. 078068 - Parapets

- Provide full replacement of the existing brick parapet, down to the lintel level of specified roofs and portions of parapets on others; including new reinforcement, new terracotta copings, new terracotta cornices, and through-wall flashing
- Provide brick replacement, repointing at the outboard faces and expansion joint repair at specified parapets to remain
- Provide lead weather caps at all terracotta cornice sky joints
- Remove biological growth at cornices
- Remove and replace cap-flashing at existing limestone cornice
- Remove, label, protect and store existing parapet mounted security lights; reinstall upon completion of parapet reconstruction
- Provide leaders and downspouts
- Repair interior finishes at walls and ceilings damaged by water-infiltration through parapets

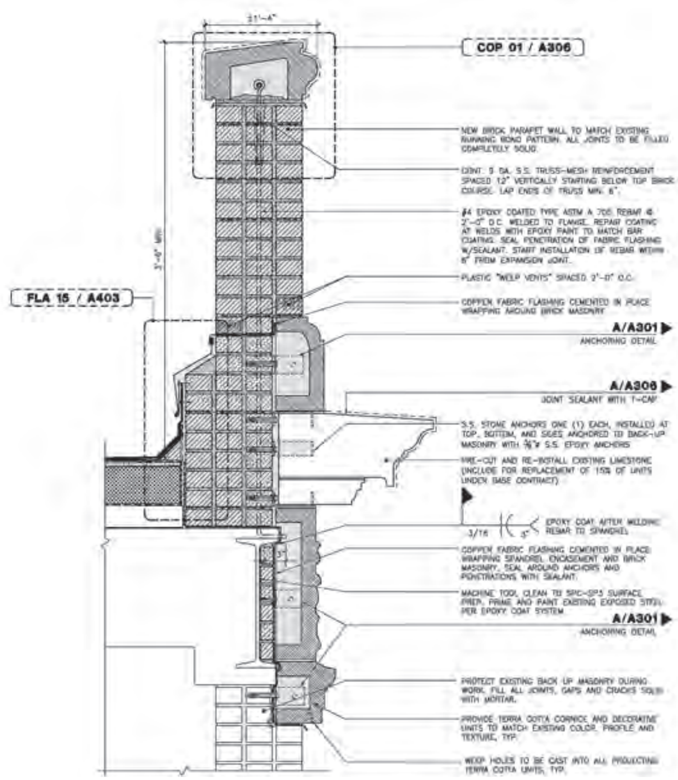


Fig. 6.13.26

Visual inspections were performed within the Natatorium and the cellar mechanical room directly below. Heavily damaged concrete in the form of cracking and spalls were observed at and below the bleachers, at the foundation walls of the pool enclosure, and at the underside of the pool deck. Lack of waterproofing beneath the pool deck tiles, allowed chlorinated water to penetrate the concrete and degrade the existing concrete encasement of the structural steel members below. It was also believed that airborne chlorine particles from the chlorine room in the cellar, along with excessive humidity levels, were the cause of concrete encasement delamination and spalls exposing the structural steel to these caustic conditions. These findings led to the following recommendations:

LLW No. 083703 - Pool Structural Damage

- Provide crack injection and concrete spall repairs at concrete bleachers in Natatorium
- Remove and replace displaced concrete at bleacher upper landing as shown in the drawings
- Provide concrete repairs at locations of mechanical mushroom diffusers at bleacher area in conjunction with mechanical work
- Provide floor drains at the base of the concrete bleacher area; refer to plumbing scope
- Remove and replace existing glazed-brick knee wall between pool and spectator area; provide stainless steel railings
- Provide fluid applied waterproofing at extent of concrete bleachers and up knee wall
- Remove all floor tiles at pool deck down to existing concrete deck
- Provide concrete repairs to deck
- Install a continuous waterproofing membrane at extent of pool deck and up surrounding walls
- Provide new finishes and sealant at all joints between floor and wall finishes throughout Natatorium
- Provide spot replacement of ceramic wall tiles at locations of mechanical removals
- Provide fire-rated enclosure at location in Natatorium for routing of vent piping up to roof

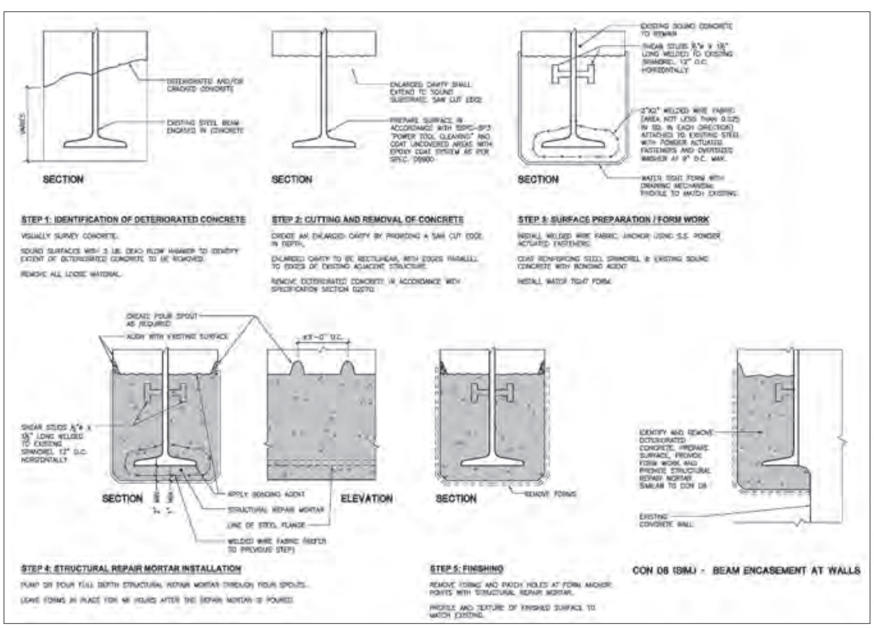


Fig. 6.13.29

Fig. 6.13.27
Deterioration of concrete and steel at mechanical room below the Natatorium. Courtesy: SuperStructures Engineers + Architects

Fig 6.13.28
Rebar from within the pool's foundation enclosure exposed after continued deterioration from excessive chlorine air particles and high humidity. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.29 (left)
Concrete restoration detailing removal and new concrete encasement installation of existing structural steel beams within the cellar mechanical room below the Natatorium. Courtesy: SuperStructures Engineers + Architects

BAYSIDE HIGH SCHOOL

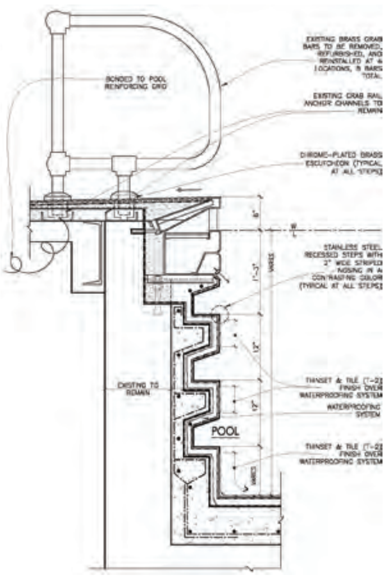


Fig. 6.13.30
Detail of pool ladder. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.31 & 6.13.32 (above - below)
Before and after of bleachers in Natatorium. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.33 (right)
Plan of Natatorium work. Courtesy: SuperStructures Engineers + Architects

- Provide repairs to reinforcing at underside of concrete deck within equipment room below Natatorium
- Sound all existing concrete encasement at beams within equipment room below Natatorium, to identify extent of deteriorated concrete to be removed
- Provide steel repairs and reinforcement to beams at underside of concrete deck within equipment room below Natatorium
- Prepare, prime, paint with epoxy coat paint system, and provide new concrete encasement to exposed steel beams within equipment room below Natatorium
- Remove all existing paint finishes at extent of pool's concrete foundation walls
- Sound and chop out areas of delaminated concrete at extent of pool's concrete foundation walls
- Provide rebar splicing, spall repairs, corrosion inhibitor and breathable coating at extents of walls
- Remove terracotta enclosure at existing chlorine room and provide new CMU wall enclosure with new door and frame
- Remove existing and install new pool filtration system.
- Remove existing and install new pool and mechanical room dehumidification system

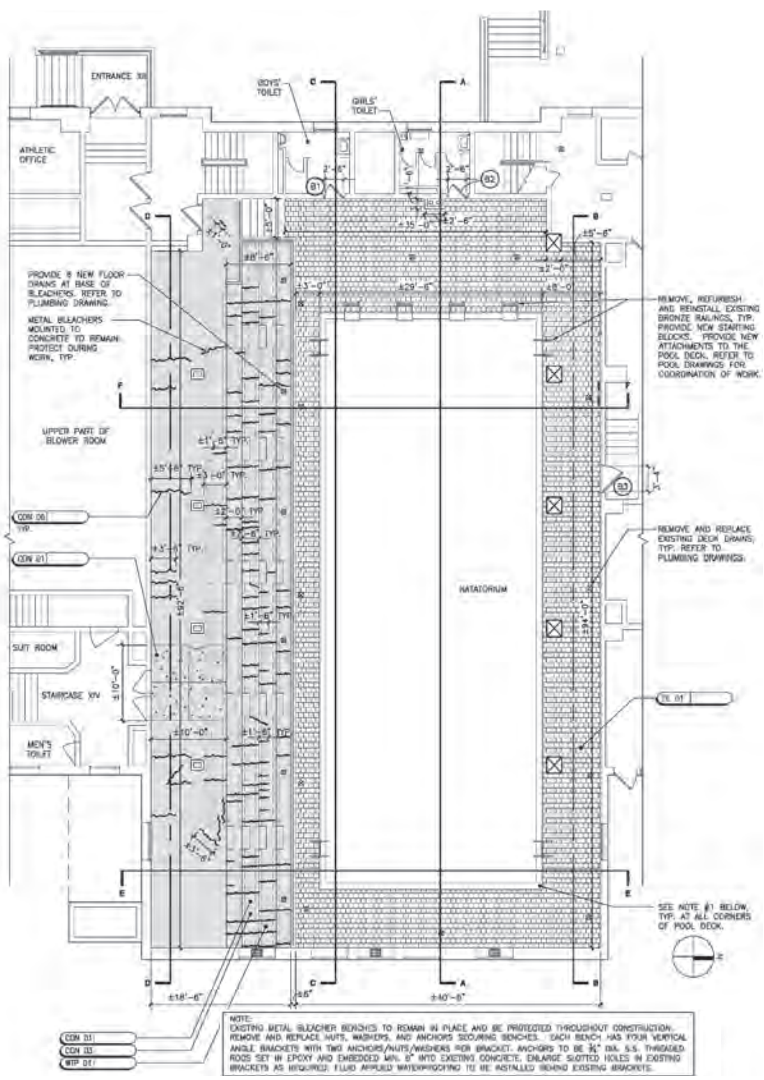


Fig. 6.13.33

Findings through visual inspections revealed the existing site sloped towards the rear of the building. In addition to this, low basement level window sills and foundation wall damages accompanied by broken drain piping beneath the handball courts was causing water ingress into the basement levels of the building. Geotechnical investigation confirmed that groundwater was not the culprit as the static groundwater level was determined to be greater than 50 feet below grade. These findings prompted the following recommendations:

LLW No. 083704 - Paved Areas Concrete

- Remove existing asphalt and concrete paving at extent of handball & tennis courts and provide asphaltic paving appropriately pitched to yard drains
- Provide concrete repairs/rebar splicing to existing handball court walls.
- Provide masonry infill to window opening adjacent to handball court, stitched into existing surrounding masonry
- Remove and discard existing door saddles at locations shown in drawings, seal all exposed foundation joints and provide new saddles
- Provide marble replacement to match existing in color, size, texture and profile at entry door locations as shown in the drawings
- Remove glazed-brick masonry at interior chases, prepare, prime, and paint with epoxy coat system all exposed steel and provide new glazed-brick masonry to match existing size, color, and texture of adjacent
- Hand-cut out existing joint materials and provide new sealant joints at all locations of mechanical ductwork and brick masonry junctions
- Excavate down to bottom of footing at the north elevation to provide waterproofing membrane at extent of foundation wall
- Provide re-grading and re-seeding of landscape
- Provide injection waterproofing at wall around pipe penetrations
- Remove and replace existing utility trenches properly pitched away from building
- Provide perimeter building sealant at joints between exterior building wall and paved areas
- Provide new interior plaster finishes, acoustic wall tiles, brick and CMU replacement, repointing and concrete spall repairs at interior walls and ceilings damaged by water-infiltration throughout cellar locations
- Provide efflorescence cleaning, painting and finishes as shown
- Excavate at handball court to expose subsurface drain piping, remove and discard.
- Provide new exterior underground yard drains and piping.

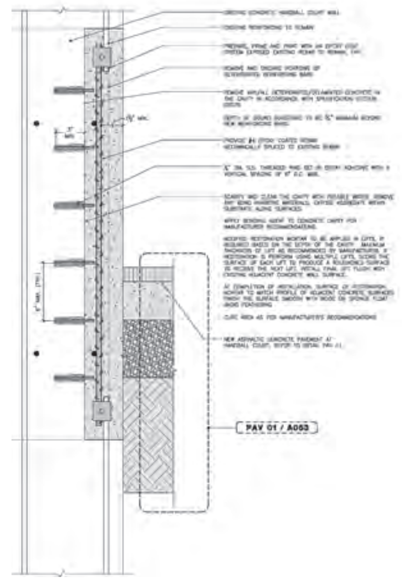


Fig. 6.13.34
Construction detail for reconstruction of the existing handball court walls. Courtesy: SuperStructures Engineers + Architects

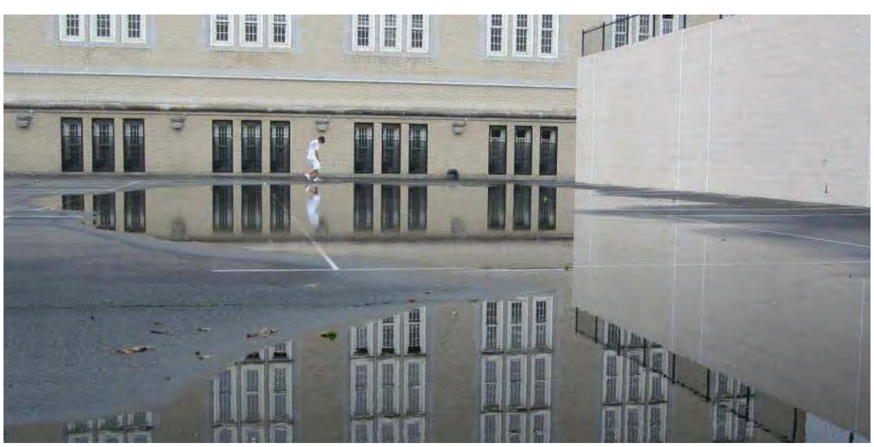


Fig. 6.13.35

Fig. 6.13.35 (left)
Existing condition of handball courts at the rear elevated yard. Negative sloping along with clogged and broken drain piping is the cause of this excess water. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.36
Step cracking of the face-brick masonry from existing corner, continuing up through the ornamental terracotta dentil units. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.37
Horizontal cracking and spalling of existing ornamental terracotta units. Courtesy: SuperStructures Engineers + Architects

Findings through visual inspections, those confirmed during the course of non-destructive testing, and exploratory probes proved the foremost causes of water infiltration at the exterior masonry was through failed sealant, failed mortar joints and cracked/failed brickwork. Cracked, spalled and displaced bricks at heads of window, louver and door openings were caused by deteriorated, delaminated and bowed steel lintels. Deficiencies were also observed throughout the existing ornamental terracotta units, more of which were discovered during construction after completion of sounding at 100% of the existing units. These findings led to the following recommendations:

LLW No. 083742 - Exterior Masonry

- Provide face-brick masonry replacements to match existing color, size, texture and coursing patterns
- Provide brick masonry pointing
- Provide perimeter joint sealant installations at all windows and louvers
- Remove existing and provide new terracotta sills with stainless steel pan flashing and drip-edge at boys and girls gymnasiums to match existing color, size and texture
- Provide brick masonry replacement at window and door heads in conjunction with lintel repairs
- Provide new sealant and backer rod at all existing corner control joints
- Temporarily remove existing window at east elevation, provide brick masonry replacement and new terracotta sill installation; reinstall window with perimeter sealant
- Hand-cut out joints at existing glass block windows and repoint with silicone sealant
- Provide first and third floor terracotta string course unit replacement, crack repair and spall repair as shown in the drawings
- Provide terracotta sill unit replacement and crack repair as shown in the drawings
- Provide raking and repointing of all terracotta units to remain
- Provide terracotta glazing as shown in the drawings
- Provide terracotta window surround unit replacement, crack repair, and spall repair as shown in the drawings
- Provide terracotta decorative panel replacement as shown in the drawings
- Hand-cut out and repoint existing joints between terracotta units and between terracotta and brick masonry walls at window surrounds
- Provide terracotta decorative finials as shown in the drawings
- Hand-cut out and repoint existing joints between terracotta and brick masonry at decorative finials
- Provide terracotta units at existing masonry piers as shown in the drawings
- Hand-cut out and repoint existing joints between terracotta and brick masonry at masonry piers
- Provide backer rod and sealant at open joints of the third floor limestone string course; existing sky joint weather caps to remain
- Provide cleaning of all biological growth on the third floor limestone string course
- Remove existing flashing and concealed metal clips from decorative first floor limestone string course; provide crack repairs to top surface of stone and provide new flashing
- Hand-cut out and repoint the decorative first floor limestone string course
- Provide spall and crack repair and stone cleaning to the decorative limestone areas adjacent to main entries
- Hand-cut out and repoint existing granite base units throughout

Fig. 6.13.38 (below)
Failing brick masonry face-brick units at window head locations directly associated with deteriorated and delaminating steel lintels. Courtesy: SuperStructures Engineers + Architects

- Provide cleaning of all biological growth on all existing granite base units
- Hand-cut out existing perimeter joints throughout and provide new silicone sealant with compressible neoprene filler.
- Clean faces of all copper louvers throughout with a non-caustic solvent cleaner
- Provide flashing at chimneys in conjunction with parapet work at selected roofs
- Provide epoxy coat paints systems at existing areaway gratings
- Provide stainless steel mesh at underside of existing areaway gratings
- Provide limestone replacement and crack repair at main entry stairs
- Hand-cut out and repoint all joints at the main entry steps, landing, knee walls, etc.
- Temporarily remove and reinstall metal railings in order to provide replacement of granite units at main entry
- Prepare, prime and paint with epoxy coat system existing railing and brackets prior to reinstallation
- Remove and replace cracked and spalled glazed brick within gymnasiums
- Provide soft joints at all beam locations on the exterior walls
- Provide masonry cleaning to remove all efflorescence
- Temporarily remove and reinstall existing window guards to facilitate the relocation of existing air conditioning units
- Prepare, prime and coat with epoxy paint system - all the existing window guards, including the exterior metal lock enclosures.

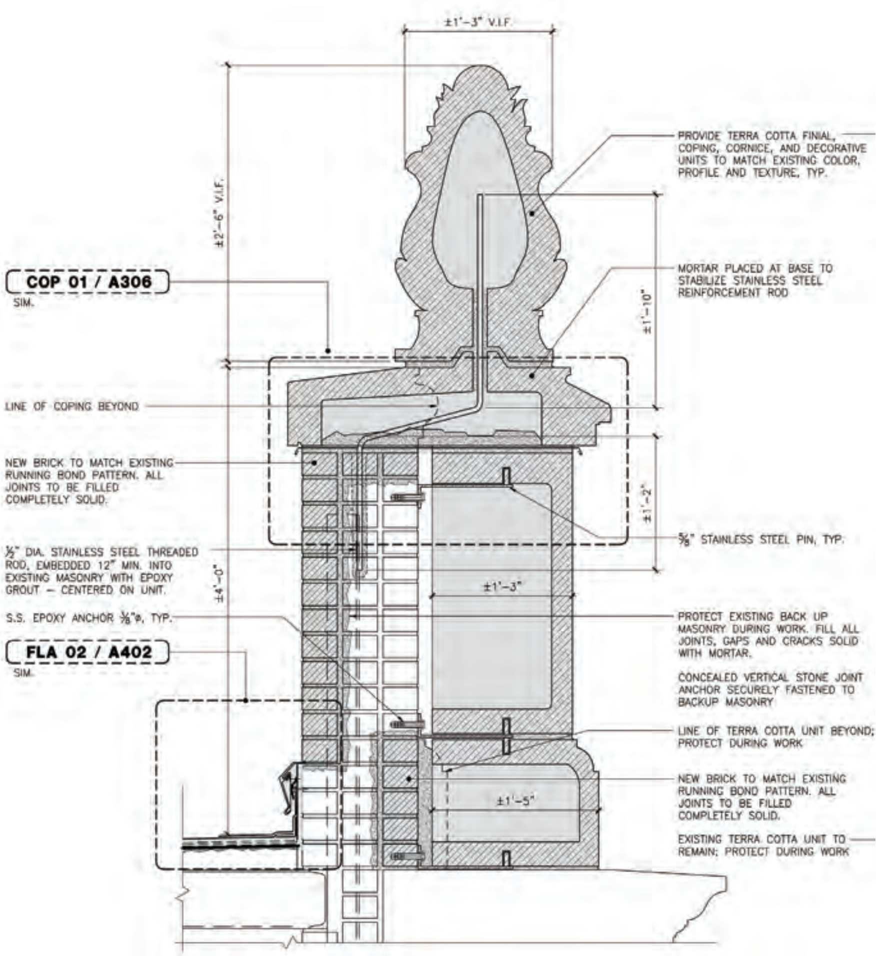


Fig. 6.13.41

Fig. 6.13.39
Biological growth at pilaster. Courtesy: SuperStructures Engineers + Architects

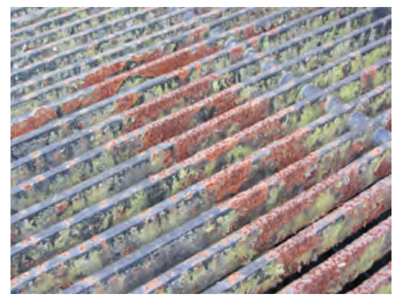


Fig. 6.13.40 (above)
Deteriorated areaways. Courtesy: SuperStructures Engineers + Architects

Fig. 6.13.41 (left)
Detail of parapet and final reconstruction. Courtesy: Nelligan White Architects

Fig. 6.13.42 (below)
Damage and staining observed at terracotta panels and sills. Courtesy: SuperStructures Engineers + Architects

SECTION 6.14

CASE STUDIES:
FASHION INDUSTRIES HIGH SCHOOL

FASHION INDUSTRIES HIGH SCHOOL

Introduction

Building ID	M600
School Level	HS
Address	225 West 24th Street Manhattan, NY 10001
Cross Streets	7th & 8th Avenues
NYC DOE District	2
SHPO Status	Eligible
SHPO ID	
Flood Zone	
FEMA Map	3604970201F
Architect	Walter C. Martin
Year Built	1938-1940
Plan Form	
Style	Art Deco
Internal Sq Ft	228,000
Classrooms	54
Stories	12
Structural System	Concrete encased frame
Columns	Concrete encased steel
Beams	Concrete encased steel
Floors	Reinforced concrete slab
Roof	BUR, PMR
Cladding	Brick, Limestone
Backup	Brick

Fashion Industries Vocational High School is a twelve-story building, designed by Walter C. Martin and constructed in 1938. The building is a rectangular shape in plan for the first three stories, with small courtyards on east and west sides, and large setback terraces at the midpoint of the north and south elevations. Above the third story, the building has an I-shaped plan. There are two street elevations; West 25th Street to the north and West 24th Street to the south. The building's main entrance is located on West 24th Street. Additionally, there are setback elevations at street elevations.

First opened as Central Needle Trades High School in a garment loft on West 26th Street in 1926, its original purpose was to provide a trained work force for the many disciplines in fashion related industries. As part of a Works Projects Administration (WPA) project, construction of a new school began in 1938. It was designed to be the ultimate vocational school. Its visitor's guide referred to the new school as *"The Fulfillment of an Ideal in the Field of Vocational Education."*

Principal Mortimer Ritter wrote, *"It is only fourteen years since the school was founded – a few classes held in a third floor loft. Today a skyscraper school proudly demonstrates the achievement of an important phase in modern vocational education, planned and fulfilled by people of vision".* The school that opened its doors in 1940, was also a prime example of the Art Deco movement, as best illustrated in the landmark status murals in the auditorium and exquisite mosaic over the main entrance to the building.

Fig. 6.14.1 (below)
Front elevation on 24th Street, before renovation.
Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.1

The building's structural frame is steel encased in concrete, and exterior walls consist of three wythes of brick. The inner two wythes are supported on the structural slab at each level, while the outermost wythe runs continuously across the face of the building, except where supported by steel lintels over window and door openings. Floor and roof slabs are poured-in-place reinforced concrete. The facade is a yellow face-brick and glazed red iron spot-brick at spandrel. The building has a limestone base at the first and second floor with incised ornamentation and a granite water table at street level.

Parapets are of brick construction, which are three wythes thick. Copings atop the parapets are limestone. At the third floor roof terrace, the parapet features bronze railing. Other roof terraces have wrought iron railings.

The existing windows consist of steel double-hung construction. At the first and second floor the frames, sash and grilles are bronze. Most of the windows are original with few new windows replaced during a 1999 campaign. Exterior doors are typically bronze clad doors over metal frame. They appeared to be original to the building, featuring Art Deco ornamentation.

Roofs consist of a main roof at eleventh floor and various roof terraces with setbacks and bulkhead roofs. Terraces consist of protected membrane roofing system with quarry tiles while other roofs consist of a built-up membrane with gravel.

Project scoping began in 2005 and identified various areas of deficiencies, primarily with the exterior masonry, roofs and windows. Past projects in 1998 and 1999 had addressed some minor deficiencies with the exterior masonry and refurbished the windows. However, the window replacement project resulted in window sashes not being reinstalled in the original frames leaving some windows inoperable. Additionally, during scope the windows were observed to have rusted frames and sashes, cracked glazing and deteriorated putty. Due to its historic style, close attention was to be paid to all the exterior materials as to not adversely impact the period architectural qualities of the building.

Fig. 6.14.4

Fig. 6.14.2
Front elevation detail prior to rehabilitation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.3
Rear elevations before renovation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.4 (left)
Overhead view of set back roofs and rear facades toward 25th **Street.** Courtesy: SuperStructures Engineers + Architects

FASHION INDUSTRIES HIGH SCHOOL

Methodology

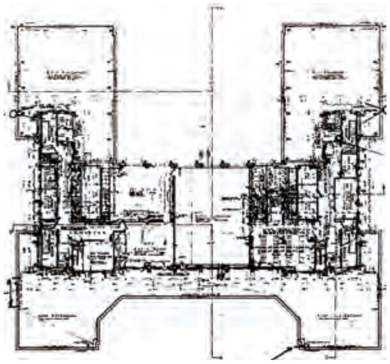


Fig. 6.14.5
Plan of tenth floor from original drawings. Courtesy: SCA Alchemy

Fig. 6.14.6 (below)
Front elevation on 24th Street from the original drawings. Courtesy: SCA Alchemy

Research

To define the scope of masonry, window, door and roof replacement at Fashion Industries High School, information was obtained from the SCA's Alchemy Database. This yielded some original design drawings from 1938, as well as some drawings pertaining to modernization projects carried out in 1998 and 1999.

The quality of the drawings varies depending on the age and method of reproduction, however, careful analysis yielded valuable information regarding the original design and subsequent renovations which guided the scoping of the project. For example, the drawings associated with the window refurbishment project of 1998 explained that the existing windows had been removed and refinished, glazing had been replaced, sash weights replaced and the windows reinstalled from the third floor up.

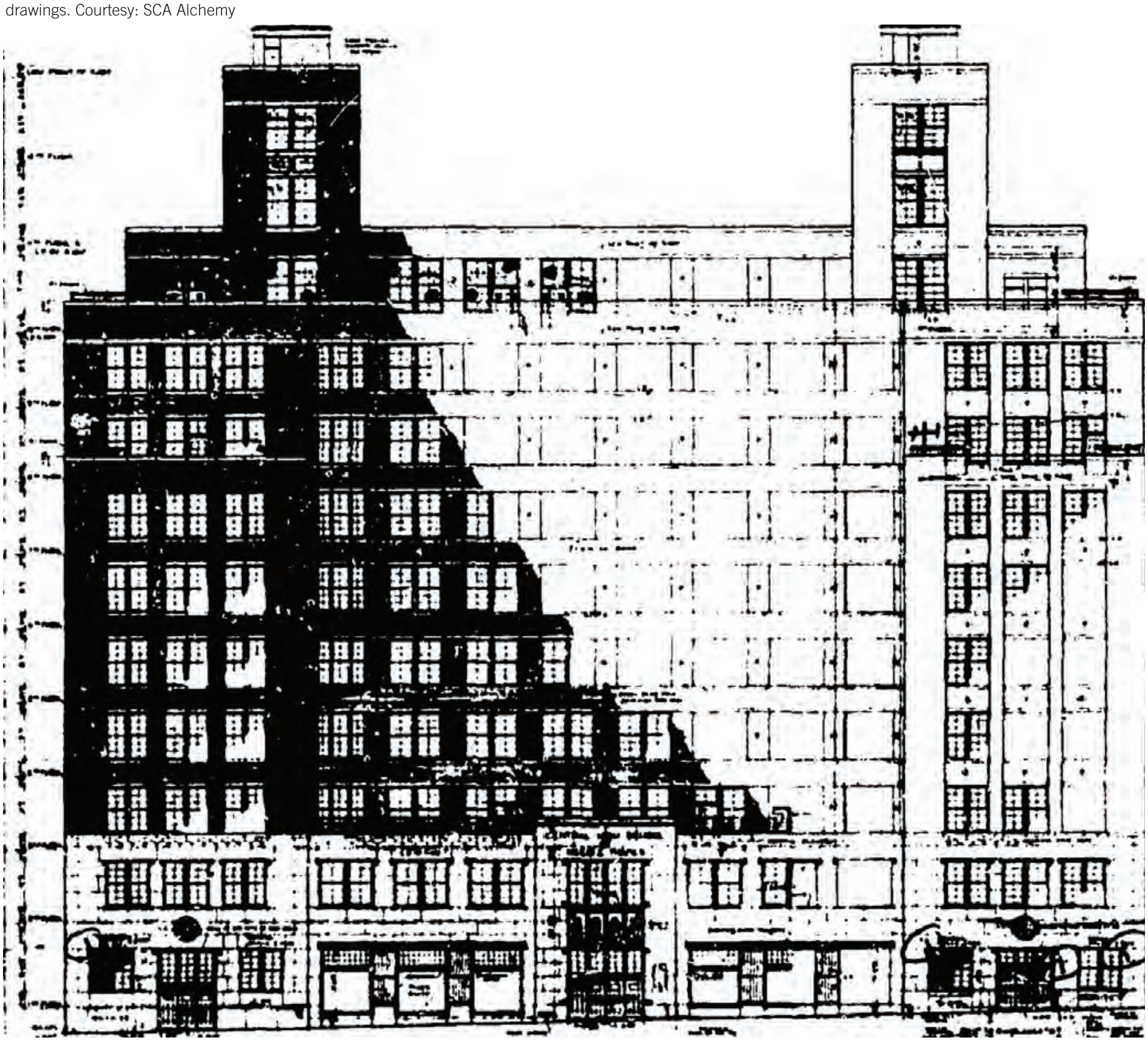


Fig. 6.14.6

Observation & Mapping

In addition to the Building Condition Assessment Survey (BCAS), visual and photographic surveys of the interior and exterior were conducted at Fashion Industries VOC High School in 2005. Photographic surveys are typically accompanied by a corresponding elevation drawing that pins the locations of photographs taken in order to determine if deterioration is a singular condition or the failure of an entire system.

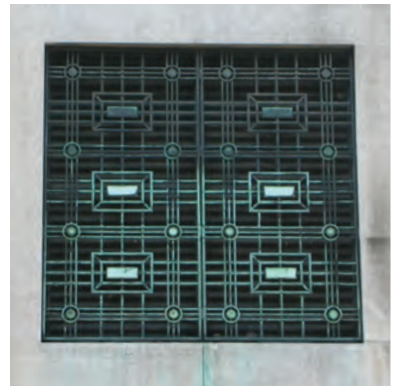


Fig. 6.14.7 (above)
Louvers behind ornamental bronze grille. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.8 (above)
Spalled and cracked limestone. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.9

Fig. 6.14.10

Fig. 6.14.9 (above left)
Deteriorated steel lintel and masonry. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.10 (left)
Terrace drain before renovation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.11 (below)
Interior water damage. Courtesy: SuperStructures Engineers + Architects

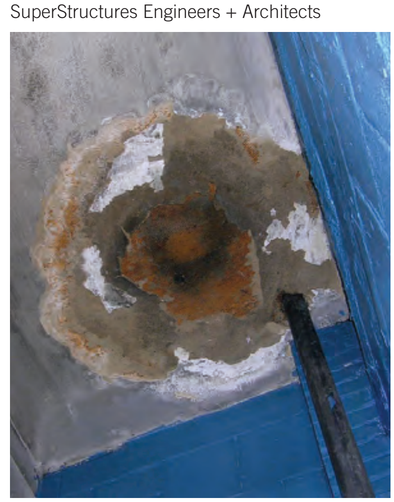


Fig. 6.14.11 (above) & 6.14.12 (right)
Masonry probe at stone ledge on parapet. Courtesy: SuperStructures Engineers + Architects

Exploratory Probes

Probes were requested during the Scope Phase of the project and were provided by the contractor during the Design Phase. The six requested masonry probes were observed in November 2006 through accessible roofs and setbacks. They revealed that the parapet stone watertable was attached to the backup masonry with corroded steel anchors. They also revealed that the copper roof-flashing was adequately installed turned up between the outer wythe of brick and the interior wythe. The masonry was also found to be mostly in fair condition.

Fig. 6.14.12

Fig. 6.14.13

Fig. 6.14.13 (left)
Masonry probe at column. Courtesy: SuperStructures Engineers + Architects

Recommendations & Design

LLW No. 043220 - Paved Area Concrete

1. Concrete Retaining Walls

- Concrete cracks shall be repaired with high modulus injection epoxy in to injection ports, starting from lower ports
- Remove injection ports and patch with surface sealer; apply finish coating at conclusion
- For large spalls, clean and prepare exposed reinforcing bars
- Repair spalls with modified repair mortar and coat wall with breathable concrete coating
- Remove exisitng backer rod and sealant at expansion joints and prepare surface; install new backer rod and sealant
- Restore railing posts by removing and reinstalling railing posts with new galvanized steel sleeves and setting posts in non-shrink grout

Fig. 6.14.14
Before the repair of retaining wall. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.15
After the repair of retaining wall. Courtesy: SuperStructures Engineers + Architects

LLW No. 043222 - School Safety

1. Exterior Doors

- Replace existing doors with new in kind Bronze clad doors as required, including saddle, hardware and frame components
- Restore main entrance bronze doors and replace glazing.

Fig. 6.14.16 (below)
Existing bronze doors before restoration. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.16

Fig. 6.14.17
Before the repair of masonry crack. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.18
After the repair of masonry crack.
Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.19
Deteriorated bulkhead louvers. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.20
Deteriorated bulkhead louvers. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.21 & 6.14.22 (right - far right)
Cracked parapet brick masonry. Deteriorated limestone coping at the fifth floor terrace. Courtesy: SuperStructures Engineers + Architects

LLW No. 043222- Exterior Masonry

1. Louvers

- Replace two 9’x9’ lead-coated copper louvers, located behind ornamental bronze grilles; remove and protect grilles during work and reinstall at completion
- Replace other deteriorated louvers on bulkheads and two on courtyard elevations in-kind.

2. Masonry Face Brick

- Replace cracked face-brick masonry found at spot locations around the facades
- Replace brick masonry at areas of displacement observed at spot locations on the parapet at the eighth floor and tenth floor terraces at south and north street elevations
- At spandrels, remove masonry on each side of the vertical crack at a width and depth sufficient to fully expose the underlying steel column or beam
- After steel repair, install new masonry, including waterproofing, flashing, weeps, and anchorage to underlying steel

3. Lintels

- Remove four courses of brick masonry to replace lintels and support straps or clip angles as required
- Apply rust-inhibiting coating to the steel, install new masonry, including membrane flashing and weep holes
- Where spandrel repairs and lintel repairs occur in the same location, the repair detail will provide for the restoration of both the spandrel and the hung lintel in combination
- Prepare and coat all exposed portions of all lintels to remain.

4. Limestone Masonry

- Repair cracks and spalls in limestone with a specially formulated repair mortar

5. Parapet and Coping

- Remove existing limestone coping and reset entire copings on fifth floor roof terrace with new anchors; install copper flashing underneath copings

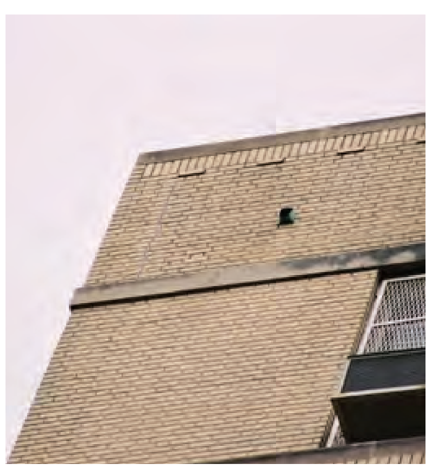


Fig. 6.14.21

Fig. 6.14.22

Additional Recommended Items

1. BUR Roofs at 11th & 12th Floor Roofs

- Remove existing roof and install built-up roof membrane system (4 ply) with gravel embedded in asphalt flood coat
- Remove and replace all drains with new including lead and other associated flashings
- Install new two-piece copper in-wall counter flashing including the removal and replacement of two courses of brick above the flashing level; install weeps above the counter-flashing to assist in draining the wall of any entrapped moisture

2. PMR roofs on 3rd, 5th, 8th and 10th floor terraces

- Remove existing construction down to structural slab and install new PMR roofing system consisting of vapor barrier, tapered insulation, plaza deck roofing membrane, filter fabric and quarry tile/pre-cast paver overburden
- Install perimeter membrane flashing and copper counter-flashing.
- Install new terrace drains at existing locations
- Replace door saddle with new, at three locations on 10th floor

Fig. 6.14.23 & 6.14.24 (below - far below)
Typical terrace roof condition prior to renovation. Terrace after renovation. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.23

Fig. 6.14.24

Constructability & Lessons Learned

Exterior Doors

The exterior bronze doors were meticulously restored as part of the project. Years of grime accumulation and regular wear and tear had taken a toll on these exquisite doors. Restoration of the doors proved to be financially feasible instead of full replacements. The doors were removed from the frames and moved to the restoration contractor's shop. They were cleaned and stripped of their patina. They were then refinished with a toner to match the original statuary bronze finish.

On site, the frames were left in place and also stripped and refinished; glazing on the transoms was replaced. The original sill was in poor condition and was to be fully replaced, however, it was installed under the frames and mullions. It could not be fully removed without affecting the jambs. Therefore, it was decided that the existing sill would be cut at the jambs and that mullions with an infill bronze sill would be installed. This solution allowed for the preservation of an original portion of the sill that was designed to intricately follow the form of the jambs and mullions.

Fig. 6.14.25
Bronze doors prior to refinish. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.26 (above)
New bronze saddles and restored doors. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.27 (right)
Bronze doors during restoration. Courtesy: SuperStructures Engineers + Architects

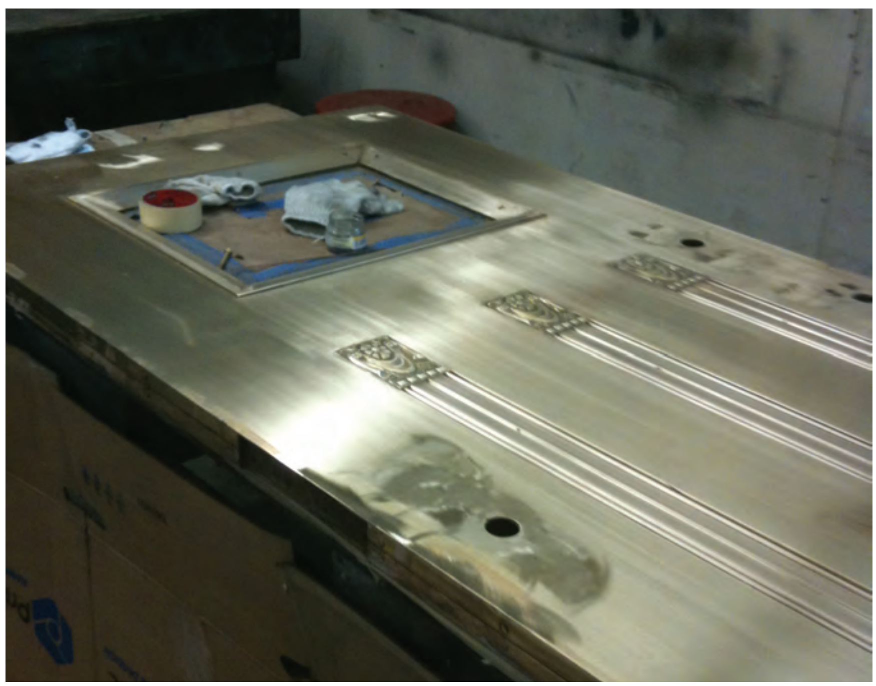


Fig. 6.14.27

Fig. 6.14.28
Terrace roof pavers replacement. Courtesy: SuperStructures Engineers + Architects

Roofing Membrane

All sixteen building roofs were recommended to be replaced with hot-applied roofing membranes. During the course of construction, when approximately 20% of the roofs had already been replaced or were in the course of replacement, strong opposition from the neighborhood caused by the hot-applied roofing odor resulted in a reevaluation of the roofing replacement work.

The design teamed together with the roofing manufacturer and contractor devised a strategy to change the roofing membrane application from hot to cold-applied. While a few roofs had already received a hot-applied base ply, the subsequent plies had to be adapted to the new *"hybrid"* installation.

Parapet Guardrails

Due to roof-level changes, some parapets required the addition of fall prevention guardrails. There were existing guardrails at some parapet locations around the building, and new guardrails were designed in wrought iron to replicate the original, existing style. During construction, a mold was taken of the original guardrail to replicate the shape in the shop drawings. Where installed, the new guardrails blend seamlessly with the originals.

Fig. 6.14.28

Fig. 6.14.29

Fig. 6.14.28 & 6.14.29 (far left - left)
Original guardrail at parapet. New guardrail matches style of replaced guardrail but conforms with code requirements. Courtesy: SuperStructures Engineers + Architects

Fig. 6.14.30 (below)
Design drawing for replacement of guardrail. Courtesy: SuperStructures Engineers + Architects

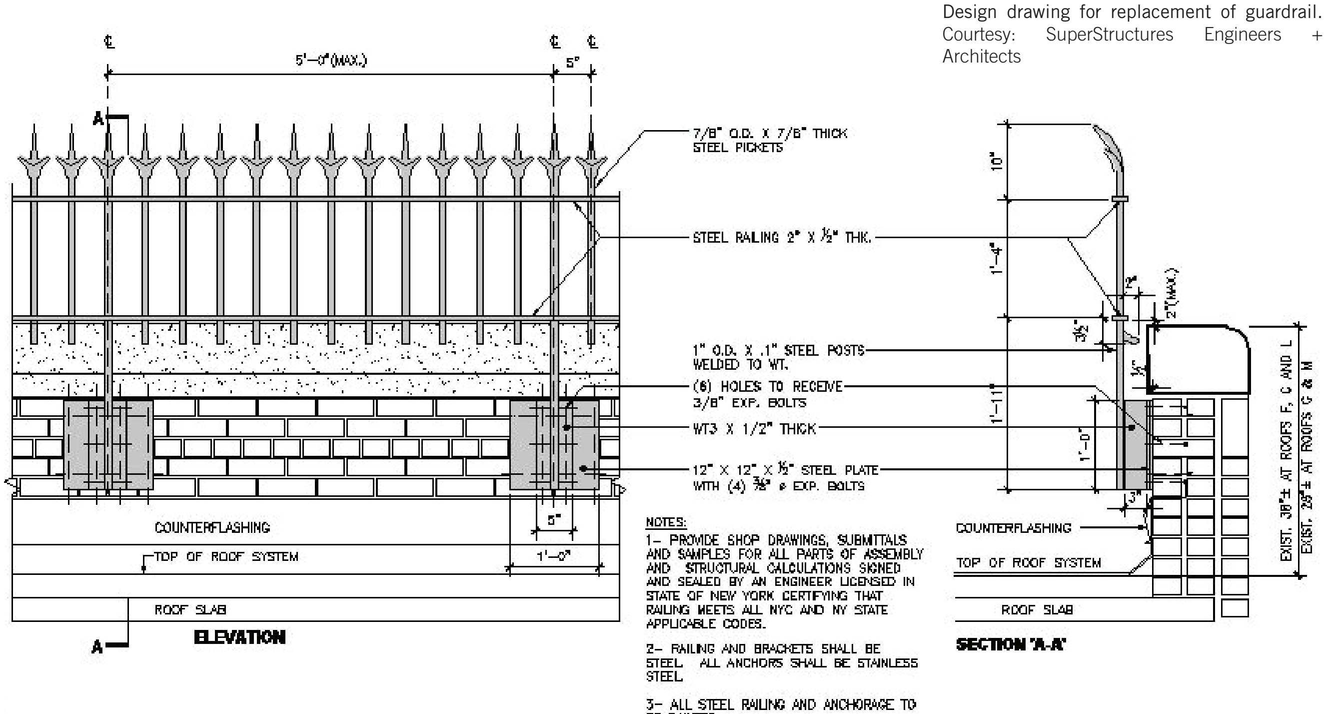


Fig. 6.14.30

SECTION 6.15

CASE STUDIES:
PS 200 Q

CASE STUDIES:
PS 200 Q

Introduction

Building ID	Q200
School Level	PS
Address	70-10 164th Street Fresh Meadow, NY 11365
Cross Streets	71st Ave, Jewel Ave
NYC DOE District	25
SHPO Status	Eligible
SHPO ID	D011508
Flood Zone	Outside Flood Zone
FEMA Map	3604970231F
Architect	Eric Kebbon
Year Built	1952-1953
Plan Form	L-Form
Style	Mid-Century Modern
Internal Sq Ft	68,000
Classrooms	33
Stories	3 + Basement
Structural System	Reinforced Concrete
Columns	Concrete
Beams	Concrete
Floors	Concrete Slab
Roof	BUR
Cladding	Face Brick, Extruded Aluminum Curtain Wall
Backup	CMU

Fig. 6.15.1 & 6.15.2 (above - right)
New curtain wall at the main entrances, painted to match the original color. Courtesy: Sylvia Hardy

Fig. 6.15.3 (below)
Detailing at the main entrance. Courtesy: Sylvia Hardy

Fig. 6.15.2

Fig. 6.15.5

Until the late 1930s, the majority of schools were designed in one of several historical styles, often on a monumental scale. In 1937, the Board of Education commissioned the AIA to perform a survey of schools and provide a set of recommendations to improve the design of new schools. Following a moratorium on construction during World War II, these recommendations were quickly implemented.

Nearly coinciding with the 1937 AIA report, Eric Kebbon would succeed Walter C. Martin as the Superintendent of School Buildings in 1938. Following the pause in construction and design, Kebbon would be able to start to fully implement the AIA report. The most notable of these recommendations - that schools should be built no higher than three stories, especially in outlying districts.

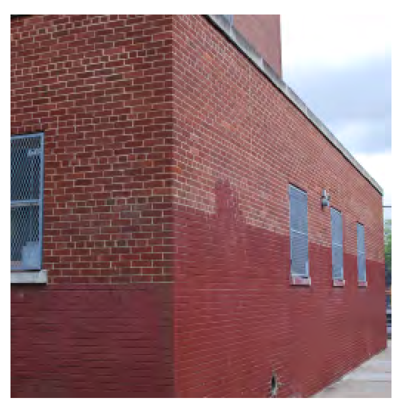
PS 200 Q's styling is the outcome of a 1937 report by the AIA, which pushed for more modern approaches to public school design. Constructed between 1951 and 1953, the school is located on 164th Street and 71st Avenue in Queens. It is characteristic of schools built in the post-war era, classified by its continuous vertical bays at entrances and fire stairs, with limestone surrounds (Fig 6.15.2 & 6.15.5) and brick walls, stripped of ornament. Much of the styling makes references to Art Deco. The building is a reinforced concrete structure with solid brick masonry infill and facade. It has three floors, a basement and multiple-level flat roofs, including those for the main building, gymnasium, utility rooms and bulkheads. PS 200 Q also incorporates curtain wall systems at the building's main entrances, constructed from brake-formed aluminum components. These aluminum windows were especially common in schools of 1950s, perhaps attributed to the number of skilled metal workers employed at the Brooklyn Navy Yard, in need of jobs at the end of World War II.

Fig. 6.15.4 (above)
The main entrance on Jewel Avenue after rehabilitation. Courtesy: Nelligan White Architects

Fig. 6.15.5 (left)
The main entrance on Jewel Avenue before rehabilitation. The curtain wall was deteriorating, and had been painted over several times. Mismatched brick was visible on all facades. Courtesy: Nelligan White Architects

Fig. 6.15.6
Mismatched bricks and noncontinuous expansion joints from a previous parapet repair. Courtesy: Sylvia Hardy

Fig. 6.15.7 (below)
Some facades had protective coatings which exacerbated spalling of mortar. Courtesy: Nelligan White Architects



CASE STUDIES:

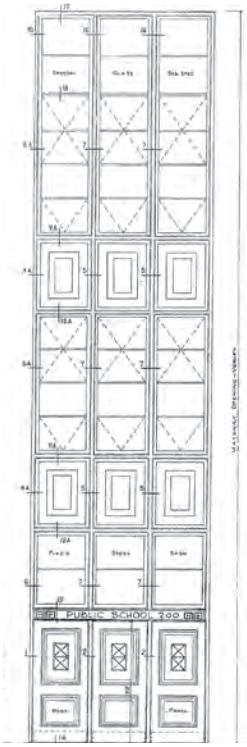
PS 200 Q

Methodology

Fig. 6.15.8
1953 cornerstone. Courtesy: Nelligan White Architects

Research

To aid in the scope of design, information regarding the school's original design, construction, its history of remediation, and any alterations or additions were obtained. The SCA's Alchemy Database yielded a full set of original design drawings from 1951, which includes architectural and structural plans, sections, elevations and mechanical/electrical drawings (Fig. 6.15.9 - 6.15.11). Original construction sketches were also available, as well as drawings from two minor modernization projects conducted by the SCA between 1994 and 2000.



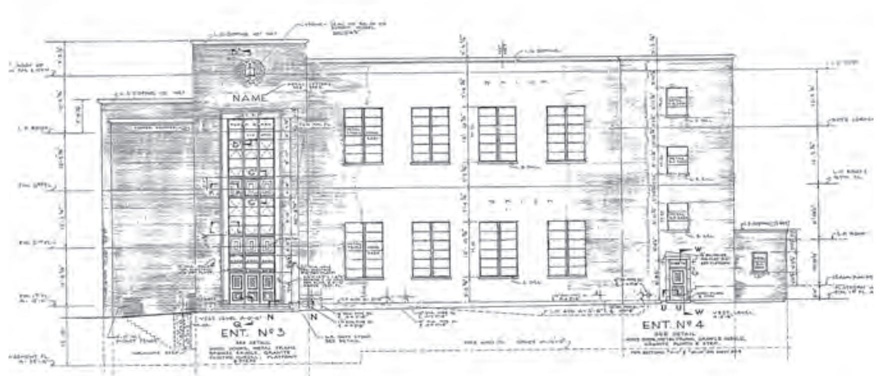


Fig. 6.15.10

Fig. 6.15.9 (above)
Entry detail from the original 1951 drawings. Courtesy: SCA Alchemy

Fig. 6.15.10 & 6.15.11 (above right - right)
Plans and Elevations from the original 1951 design drawings. Courtesy: SCA Alchemy

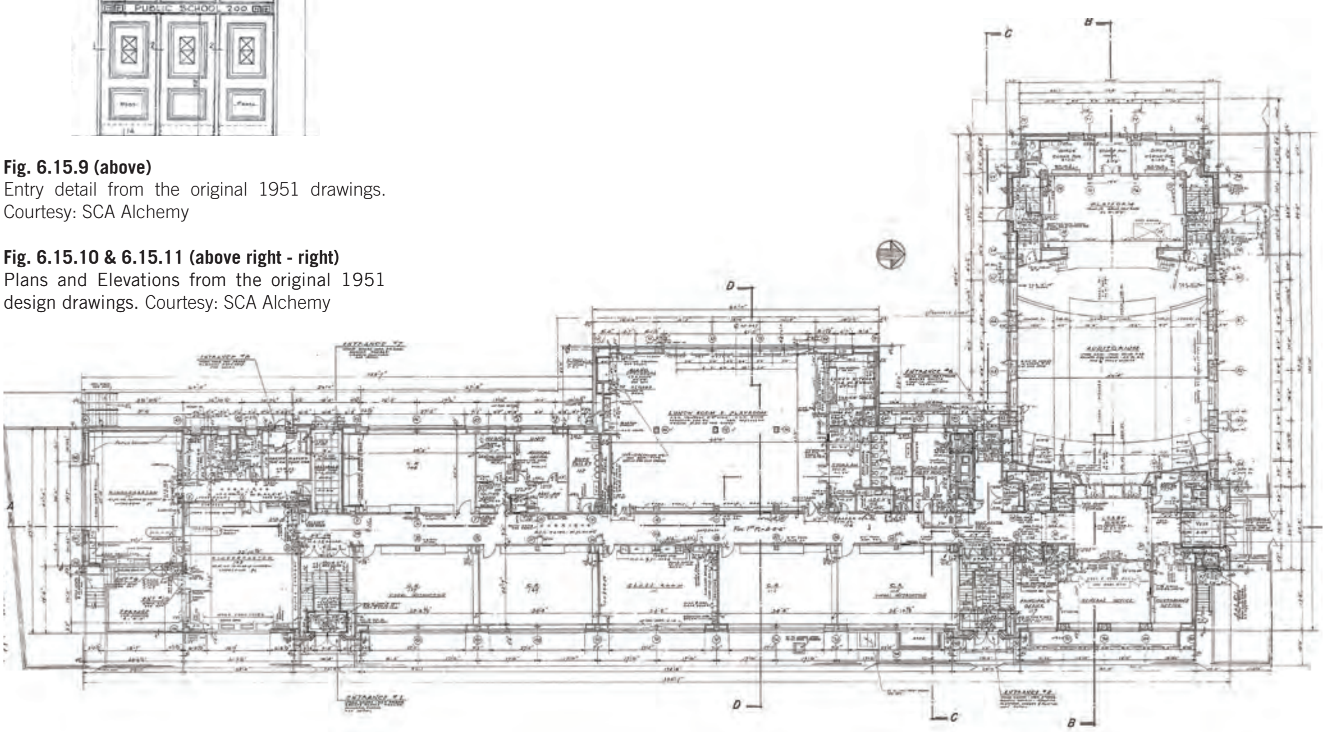


Fig. 6.15.11

Observation & Mapping

In addition to Building Condition Assessment (BCAS) Reports, visual and photographic surveys of the interior and exterior were conducted at PS 200 Q in 2007. Cracks, mismatched repairs, and weep holes clogged with mortar were observed at the face brick (Fig. 6.15.15). During a previous campaign, expansion joints were installed at the parapet, stopping just above the window line. Sidewalks and areaways were cracking, spalling and did not pitch to drains. Window lintels and the surrounding masonry showed rust stains and spalling. At the interior, water damage included peeling paint, rust, and spalling plaster at windows and openings (Fig. 6.15.12). Many windows were inoperable or broken, while those that were operable had been painted over multiple times, making them difficult to open and close. Sealant around windows was failing in most locations (Fig. 6.15.13 & 6.15.14). At the roof organic growth was noted in the ballast, and cap-flashing was damaged around the entire interior of the parapet. Damage was also noted at roof penetrations.

Fig. 6.15.12
Water damage at the head of a window opening. Courtesy: Nelligan White Architects

Fig. 6.15.14

Fig. 6.15.13 (above) & 6.15.14 (left)
The windows at PS 200 Q were in a very deteriorated condition. Most were difficult to operate or inoperable due to rusting and broken counterbalances. Additionally, failed sealants allowed for water infiltration. Courtesy: Nelligan White Architects

Fig. 6.15.15

Fig. 6.15.15 (left)
The curtain walls were rusted through their face, and paint was peeling at several locations. Courtesy: Nelligan White Architects

Fig. 6.15.15 (below)
Voids and cracking at the mortar. Courtesy: Nelligan White Architects

Non-Destructive Testing

After assessment of damage, it was recommended that a thermal scan report be prepared to determine the water-tightness of the existing roof and the building enclosure in late 2007. Water Testing was carried out in 6 survey areas (Fig. 6.15.18**)**, where the defects identified were related to inadequate, low level flashing details which were not designed to discharge water, and also ineffective joints between the main parapet wall (inner face) and a low level beam which extends around the perimeter of the roof.

In addition, many of the windows were found to be in poor condition, especially at the entry curtain wall systems where the surface had rusted through leaving holes open to the elements. Moisture meters were used at interior plaster finishes to confirm the data collected by thermal imaging. Of the 17 tests performed at the 6 survey areas, 6 tests yielded positive results.

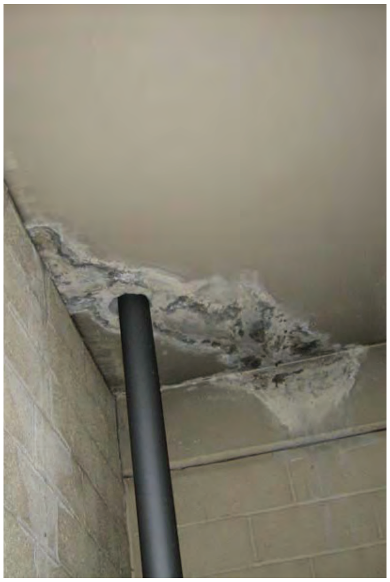


Fig. 6.15.16
Water damage visible at the interior during the moisture meter survey at machine room. Courtesy: Nelligan White Architects

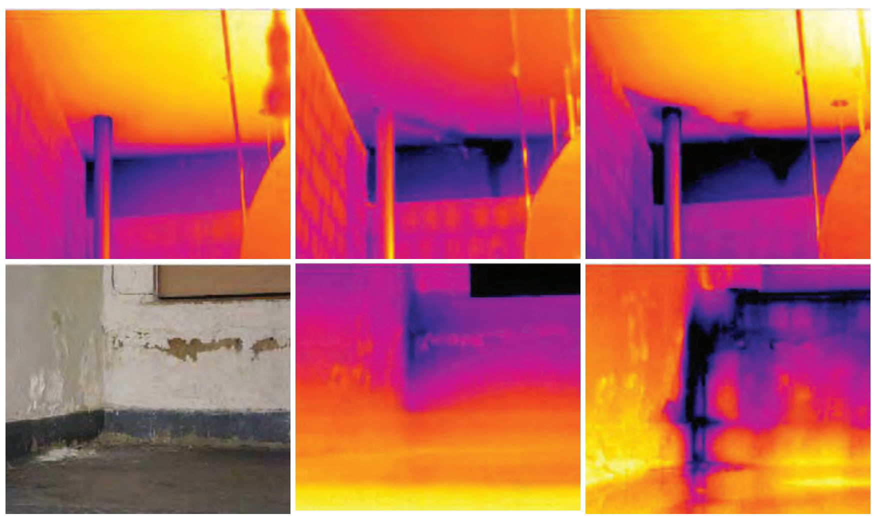


Fig. 6.15.17

Fig. 6.15.17 (right)
Through spray tests and infrared images, it was discovered where water was infiltrating the building. The top row of images show the machine room and the bottom row show results at the south-west bulkhead. Courtesy: GBG USA Inc

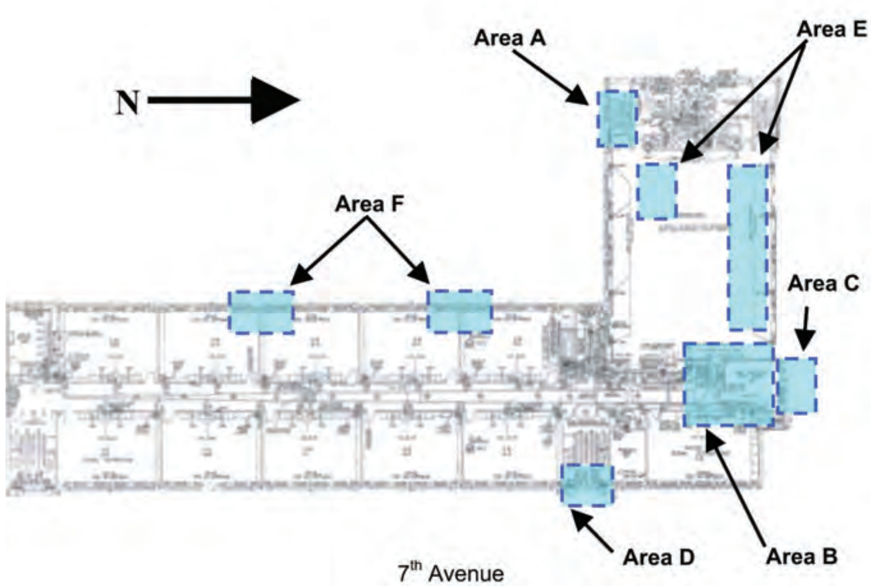


Fig. 6.15.18

Fig. 6.15.18 (right)
The areas where spray tests were conducted. Machine room images were taken from area A and the south-west bulkhead was taken from area B. Courtesy: GBG USA Inc

Exploratory Probes

Probes were conducted to determine the condition of face-brick and backup. Findings confirmed that the existing masonry was mostly in good condition, likely due to the relatively young age of the building. However, several deficiencies were noted which most likely contributed to moisture infiltration or were determined to be problematic in the near future. Original mortar was in fair condition, though it crumbled when disturbed in some locations. Other areas of mortar did not crumble, but were not bonded to the adjacent brick, as evinced by cracks between the two materials. There were many voids in the pointing, and most joints were not concave, as is standard.

Fig. 6.15.18 & 6.15.19 (above - below)
Exploratory Probe No.1, face-brick and backup was observed to be in good to fair condition. Courtesy: Nelligan White Architects

Fig 6.15.20

Fig. 6.15.21

Fig. 6.15.20 (above left)
Were face-brick had been coated mortar was observed to be in poor condition. Non-breathable coatings may exacerbate damage associated with moisture infiltration. Courtesy: Nelligan White Architects

Fig. 6.15.21(left)
Exploratory ProbeNo.2, face-brick and backup was observed to be in good to fair condition. Courtesy: Nelligan White Architects

Fig. 6.15.22 - 6.15.25 (below right)
Cross sections of the samples magnified in a laboratory show the history of the building's colors. The paint layer directly beneath the orange primer is the original color that was used in 1953. Courtesy: Nelligan White Architects

Fig. 6.15.26 - 6.15.29 (below)
Paint sample locations at door frames and window jambs. Courtesy: Nelligan White Architects

Materials Testing

In addition to testing for lead based paint and asbestos containing materials, a paint analysis was conducted to determine the original color of the existing brake formed steel window systems. Samples of paint were removed from the exterior and interior of window casements and the main entrance door frame (Fig. 6.15.26 - 6.15.29). The magnified cross section of these samples were analyzed in natural daylight (Fig. 6.15.20 - 6.15.23). Paint layers were first matched to the Munsell Color Chart, then to a commercial paint chart provided by Benjamin Moore.

Fig. 6.15.26

Fig. 6.15.27

Fig. 6.15.28

Fig. 6.15.29

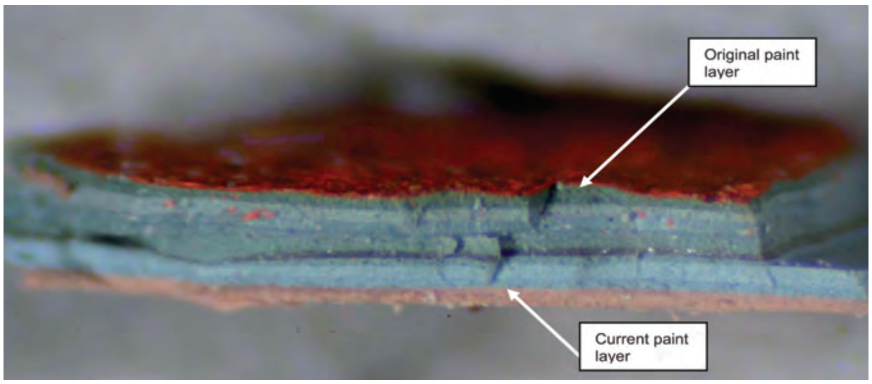


Fig. 6.15.20

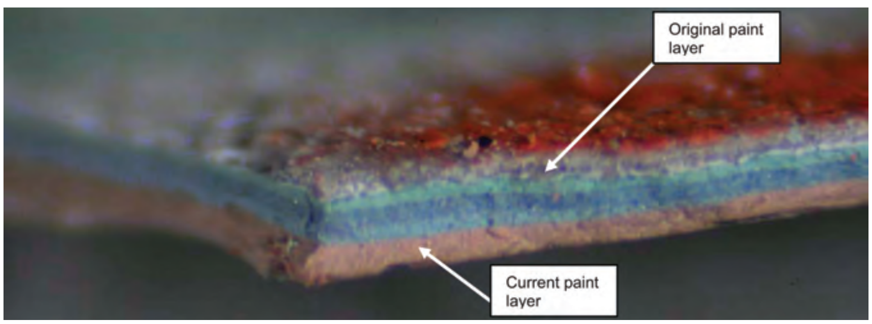


Fig. 6.15.21

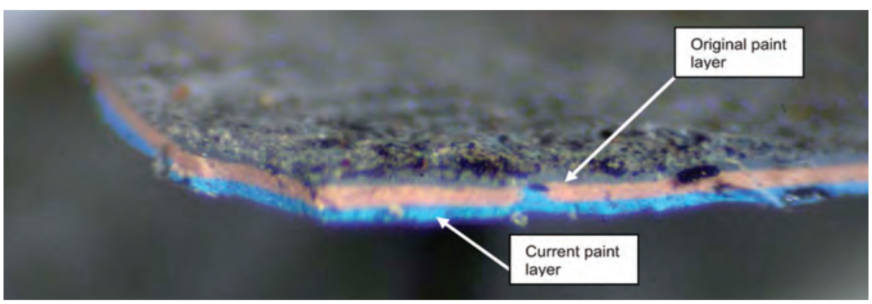


Fig. 6.15.22

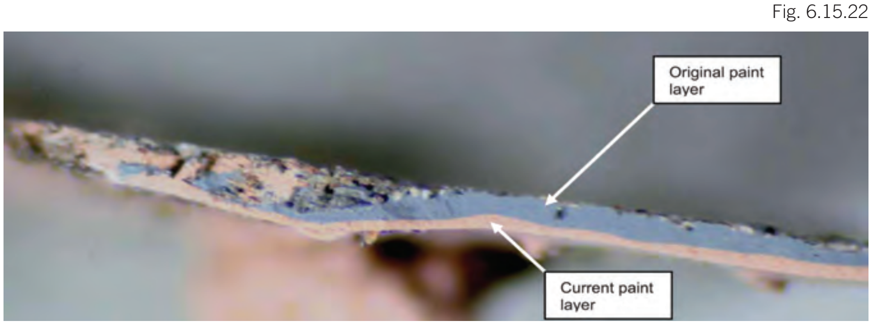


Fig. 6.15.23

Recommendations & Design

LLW No. 049012 – Windows

The original 1952 single-glazed, brake formed steel windows were rusted and leaking. Many were inoperable, and those that were able to open had broken, irreplaceable counterbalances. Rusting in the jamb tracks also added to operational difficulty. The seals between the glazing and steel frame had failed, and paint on the exterior of the windows was chipping and peeling allowing rust to bleed through. The existing metal doors, frames and lintels at exterior entrances were in fair to good condition with exception of the stage doors. In some areas the paint was deteriorated, chipped, and faded. There was rusting along the bottom edges of the doors and wherever holes were drilled or fasteners placed and at the bases of the frames. These findings prompted the following scope items:

1. **Windows at Masonry and Entrances** (Fig. 6.15.31 & 6.15.32)
   - Replace all windows were with historically accurate aluminum windows
   - Provide double-glazed windows to comply with contemporary energy standards, results in a thicker frame
   - Coated new windows to match their original color

2. **Window Guards** (Fig. 6.15.30)
   - Remove and refinish all window guards
   - Shotblast paint any rusty decorative window guards
   - Coat galvanized window guards with a Kynar finish and reinstall directly to the brick masonry using stainless steel epoxy anchors

Fig. 6.15.30
To avoid damaging the windows and voiding their warranty, window guards were attached directly to the brick. Courtesy: Nelligan White Architects

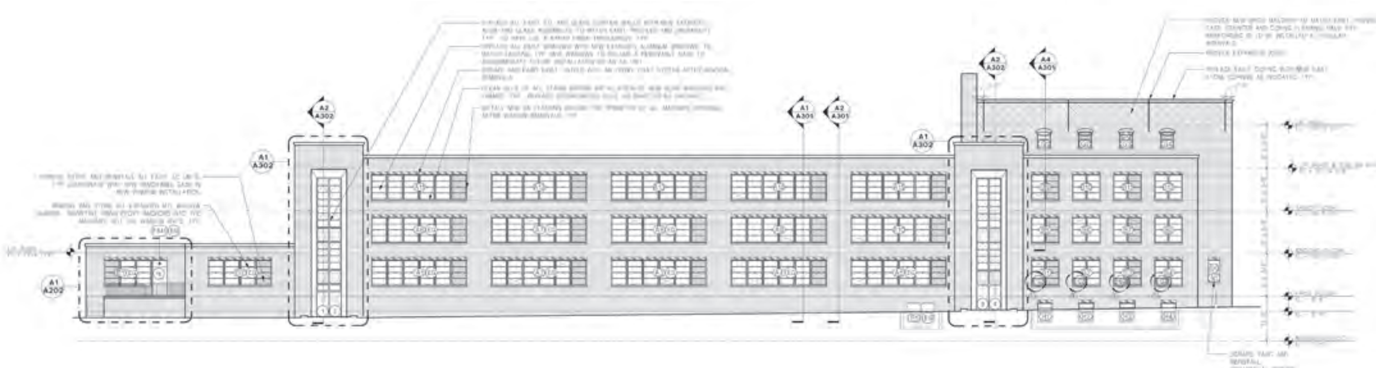


Fig. 6.15.31
Construction documents detailing the scope of work at building elevations. Courtesy: Nelligan White Architects

Fig. 6.15.31

Fig. 6.15.32 (left)
Both window systems were replaced, and painted to match the original color as specified in 1953. Courtesy: Nelligan White Architects

Fig. 6.15.33
Newly weather sealed air conditioner unit. Courtesy: Nelligan White Architects

Fig. 6.15.34
Resurfaced guard around air conditioner unit on the exterior. Courtesy: Nelligan White Architects

3. Air Conditioners (Fig. 6.15.33)

- Remove, store, and reinstall Air conditioners using extensive thermal and weather sealant

4. Doors (Fig. 6.1535 & 6.15.36)

- Remove doors, frames, hardware and supports at main entrances
- Provide heavy duty insulated hollow metal aluminum door leaves and frames, finish with the same Kynar coating as the windows
- Provide new institutional grade hardware, thresholds, weatherstripping and seals
- Protect, scrape, and paint existing door lintels
- Replace existing doors with vision lites with insulated hollow metal aluminum and matching lites

Fig. 6.15.35 - Before

Fig. 6.15.36 - After

Fig. 6.15.35 & 6.15.36 (right - far right)
Before and after images of the curtain wall at the 164th street entrance. Courtesy: Nelligan White Architects

LLW No. 048701 – Exterior

The exterior masonry of PS 200 Q was red brick and in fair-to-good condition, with localized areas of greater damage. Voids in the pointing existed, joints exhibited poor craftsmanship, and many weeps were filled with mortar. The parapets apparently had work done at some point, as the brick and mortar were of a different color than that the rest of the building, and expansion joints were installed at the parapets, but not elsewhere. One large crack described in the BCAS report was observed at the fan room wall adjacent to the stair bulkhead. The crack is at least 20 brick courses high (Fig. 6.15.37). The chimney's mortar joints were washed out or crumbling and existing steel coping was deteriorated.

There were several defects at the south-eastern entrance, including worn masonry steps, missing mortar from brick joints, signs of efflorescence, and loose bricks and cracks in the masonry (Fig. 6.15.38). One concrete entry slab had a long crack, and the slab was pitched to an area with no drain causing a crack to develop at that corner. In addition, the fences were rusting and in need of replacement. At the interior, leaking and plaster-damage was observed at the windows and adjacent ceilings at all floors and classrooms. There were also signs of water-infiltration at the fan room walls and ceiling. Additional water-damage occurred at the cafeteria and gymnasium ceiling, damaging the acoustic ceiling tiles. These findings prompted the following scope items:

Fig. 6.15.37
The crack in the masonry discovered at the fan room wall. Courtesy: Nelligan White Architects

Fig. 6.15.38 (below)
Missing mortar from face brick joints at the south-east entrance. Courtesy: Nelligan White Architects

Fig. 6.15.38

Fig. 6.15.39
Seismic masonry anchors installed at the new parapet. Courtesy: Nelligan White Architects

1. Exterior Walls

- Repoint all exterior building facades
- Remove and replace all face-wythe brick at the fan/utility room and stair bulkheads
- Dill out all weep holes filled with mortar; replace in-kind
- Install new flashing around all window openings
- Clean any paint/stains from stone window sills

2. Chimney

- Repoint all brick masonry on chimney
- Install new stainless steel copings with new cast-stone cap secured with metal anchors set in epoxy, copper cap-flashing, and spark arrestor

3. Exterior Entryways and Stairs (Fig. 6.15.40 & 6.15.41)

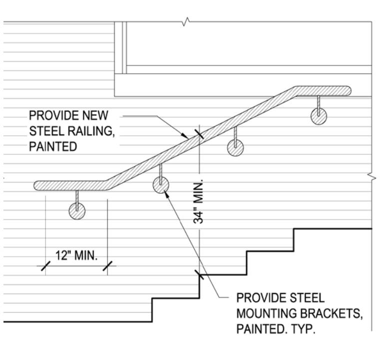
- Replace, in-kind, all exterior masonry steps, platform slabs, wall surrounds, stone curbs, steel fencing and railings at the south-eastern building entrance
- Replace, in-kind, all entry platforms to provide positive drainage, and include a membrane underlayment
- Remove sealant from all control joints on north, south, and east sides of platform and replace with new sealant.

4. Interior

- Provide repair plaster to all interior, window related, water-damaged areas of wall and ceiling finishes, including areas at the top floor
- In all areas where repairs occurred, entire wall and ceiling to nearest corner is to be painted to match the existing finish
- Replace acoustic tile at cafeteria ceiling

Fig. 6.15.40 & 6.15.41 (right - below)
Photograph and construction documents of new steel fence and railing at southeast entrance.

Fig. 6.15.40



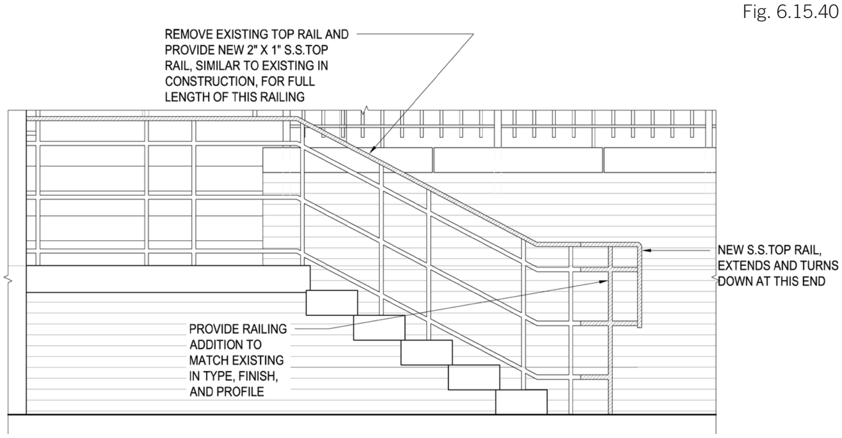


Fig. 6.15.41

Additional Recommendations:

1. Roofs (Fig. 6.15.42)

- Remove all roofs and the associated 4 courses of parapet
- At the existing walk-through opening between the fan/utility room roof and the gymnasium roof, remove two existing scuppers; install four new soldered, lead-coated copper scuppers
- Alter the pitch of the roof to flow toward the four new scuppers
- Install new base, counter, cap flashing and face-brick at the wall between the two roofs
- Repair gymnasium roof to accommodate new conditions at the fan/utility room and new scuppers

2. Parapets (Fig. 6.15.43 & 6.15.45)

- Remove and replace all parapets with expansion joints, cast-stone coping, stainless steel flashing, galvanized bar reinforcement, and through-wall flashing
- Replace a 36" swath of roofing running parallel to the parapet to facilitate the work.

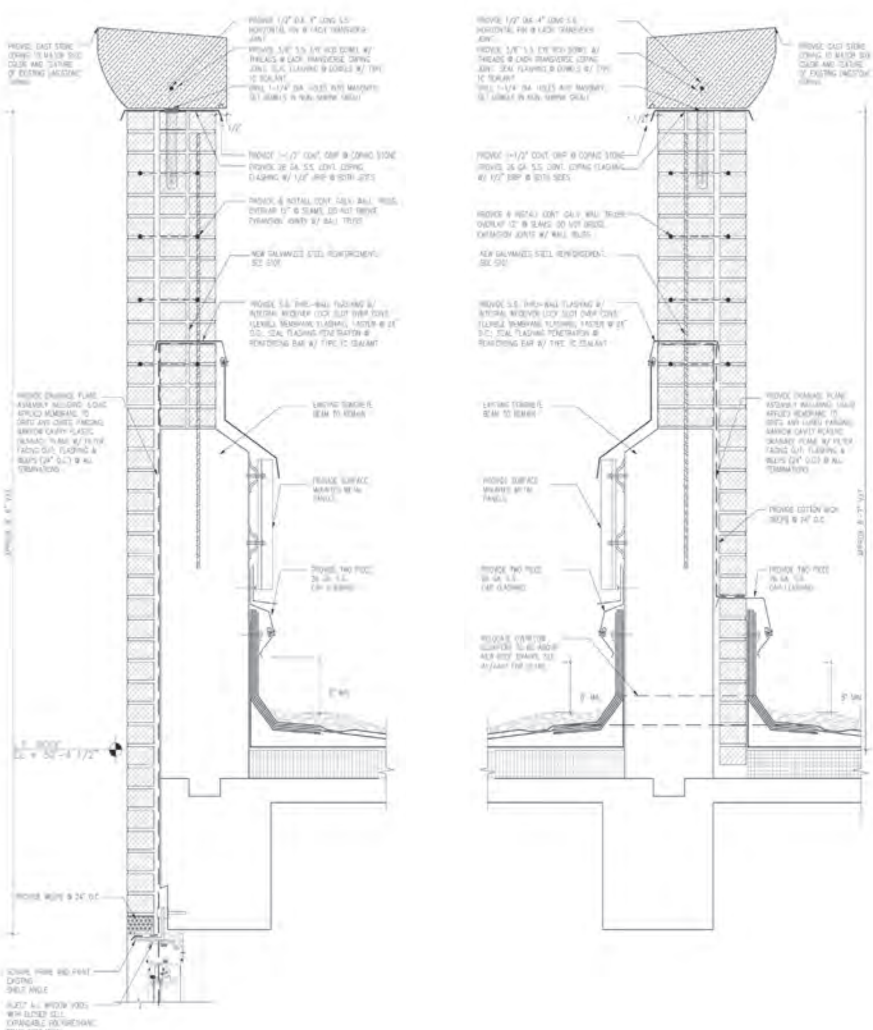


Fig. 6.15.45

Fig. 6.15.42
Roof bulkhead with newly replaced door, face brick and base flashing. Courtesy: Nelligan White Architects

Fig. 6.15.43 (above)
New cap flashing at the parapet. Courtesy: Nelligan White Architects

Fig. 6.15.44 (above)
A low wall separated the main roof from the fan areas at the gymnasium. No drains were present inside this area, only a few scuppers were present to drain water to the main roof area. Drains were provided inside this area as part of the remediation. Courtesy: Nelligan White Architects

Fig. 6.15.45 (left)
Construction documents detailing the scope of work at the parapets and low wall at the gymansium roof. Courtesy: Nelligan White Architects

CASE STUDIES:

PS 200 Q

Constructability & Lessons Learned

Fig. 6.15.46
Relieving angle and straps at the slab behind the curtain wall. Courtesy: Nelligan White Architects

Fig. 6.15.47
New curtain wall mullions at the slab which has been chipped back for clearance of the curtain wall assemblies. Courtesy: Nelligan White Architects

Windows

All existing windows were single-glazed, brake formed steel original to the building. All windows suffered from varying degrees of deterioration; many were inoperable, and those did work had broken counterbalances which were not able to be salvaged. Remaining operable windows were difficult to open and close, exacerbated by rusted jambs. The three main entries utilize a curtain wall system which was also deteriorated and leaking. It was recommended that all the windows and main entries be replaced.

The original windows were replicated to be as historically accurate as possible. Formed from extruded aluminum, these windows were thicker that the original to house double-glazed units rather than the original single-glazed. Paint samples were taken and the cross section examined under magnification to find an original color match.

Where the second floor slab meets the curtain wall, a relieving angle was found supported by metal straps directly into the slab (Fig. 6.15.46). This discovered condition was in conflict with the clearance requirements of the replacement curtain wall. Additionally, the edge of the floor slab was not parallel with the proposed curtain wall, but deviated by about ½" over its length.

The contract documents specified that the new curtain wall was to be ½" inboard of the exterior window reveal (Fig. 6.15.49). Because the new window system was thicker to accommodate double-glazing, there was no clearance for the mullions at the interior. When placed inside the opening, the new system projected out rather than being ½" inboard of the reveal. This was not a feasible option due to the susceptibility of moisture infiltration, as well as historical inaccuracy.

This site condition should have been present during the shop drawing phase and the surveys which proceeded it, and thus, a design should have reflected them. It was decided that the concrete floor slab should be chipped back where in conflict with the window mullions (Fig. 6.15.47). Prior to this demolition, a shop drawing was to be submitted showing the locations where concrete was to be removed.

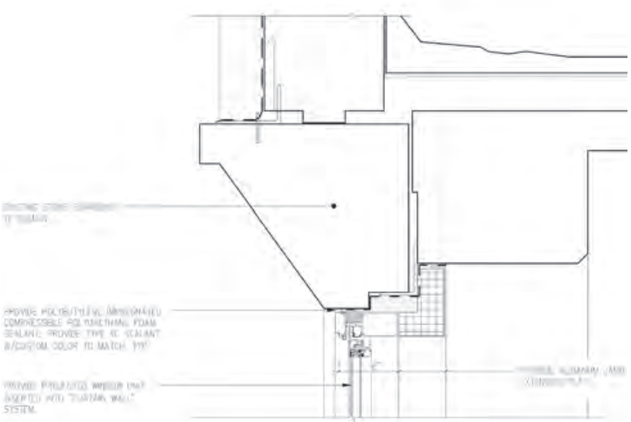


Fig. 6.15.48

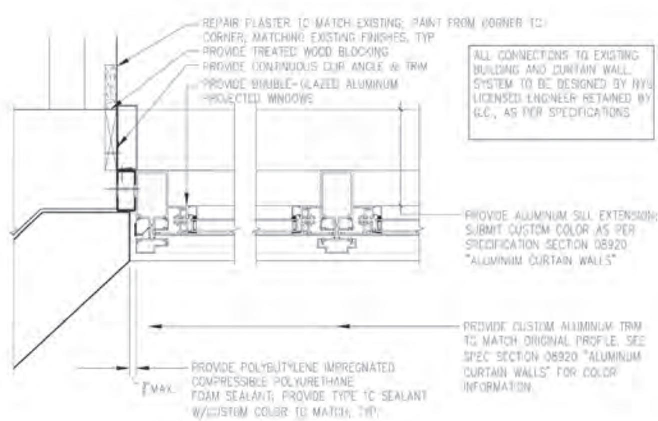


Fig. 6.15.49

Fig. 6.15.48 & 6.15.49 (above - above right)
Section at the head and plan section of the new curtain wall, both showing the cast stone surround, and the curtain wall ½" inboard of the reveal edge. Courtesy: Nelligan White Architects

Concrete Slab

The concrete slab at the kindergarten entry assumed to be on grade was to be replaced in kind. During demolition, it was discovered that there was no soil beneath this slab (Fig. 6.15.49). Original drawings were consulted, showing a crawl space rather than a slab on grade. It was determined that the existing slab was not structurally adequate to support the live loads which would be imposed on it, therefore could not be replaced-in-kind as specified in the contract documents. A new reinforced concrete slab as designed in consultation with the engineer. This new slab included metal decking below the reinforced slab supported by relieving angles at its edges, and a new reinforced beam at the center of the span.

Fig. 6.15.49
The existing concrete slab was found to have a crawlspace below, and was not adequate to support the new live loads. Courtesy: Nelligan White Architects

Bulkhead

Face-brick was to be removed from a roof bulkhead for replacement, but during demolition, it was discovered that no cavity existed, that the wall was solid masonry (Fig. 6.15.50). The contractor thought there would be no space for waterproofing or a drainage plane, and proposed that the wall be replaced in-kind.

The contract documents did not call for a standard cavity wall, but a narrow drainage plane designed to fit within a 3/8" collar joint. The narrow drainage plane included a liquid applied membrane over a parge coat, a narrow cavity drainage plane, and flashing/weeps at all terminations. This was to be stabilized by seismic anchors at 16" O.C. and installed in line with the roof cap flashing, so that any moisture would drain directly off the flashing and onto the roof.

Fig. 6.15.50
During demolition of the bulkhead, the wall was found be solid masonry with no cavity. Courtesy: Nelligan White Architects

Cast-Stone Seal

The contract documents called for the existing cast stone Board of Education seal above the school's main entry be removed, cleaned and replaced after providing a continuous waterproof membrane over the backup. During demolition, the General Contractor and Cast Stone Manufacturer advised that the seal should remain in place, as it would most likely break during removal due to age (Fig. 6.15.51). A detail was proposed which installed waterproofing around the entire seal, though this was denied as any weak points in water resistance is one more location where moisture may infiltrate.

As a resolution, the Contractor was directed to take an impression of the existing seal as a precaution. The Contractor was then directed to either safely remove the seal and install per contract documents after submitting a removal/re-installation rigging plan to the Architect prior to removal, or to provide a new cast-stone seal identical to the existing.

Fig. 6.15.51
The contract documents called for the removal and re-installation of the seal; as a precaution an impression was made in case of breakage. Courtesy: Nelligan White Architects

SECTION 6.16

CASE STUDIES: PS 111 M

PS 111 M

Introduction

Building ID	M111
School Level	PS
Address	440 West 53rd Street Manhattan, NY 10019
Cross Streets	9th Avenue & 10th Avenue
NYC DOE District	02
SHPO Status	Eligible
SHPO ID	06PR01002
Flood Zone	Outside Flood Zone
FEMA Map	3604970088F
Architect	Michael L. Radoslovich
Year Built	1958
Style	Mid-Century Modern
Internal Sq Ft	90,000
Classrooms	40
Stories	4 + Basement
Structural System	Concrete Encased Steel
Columns	Steel
Beams	Steel
Floors	Reinforced Concrete Slab
Roof	BUR (2006)
Cladding	Brick,Terracotta, Glass/Steel Panel
Backup	Brick, Concrete

By the late 1950s, schools were incorporating materials and technologies in new construction that had come into use for commercial and industrial architecture following World War II. These schools were exemplified by irregular massing of geometric shapes, emphasis on the horizontal, and exterior metal window wall and panel systems which can be found at PS 111 M.

Under the direction of Michael L. Radoslovich, succeeding Eric Kebbon in 1963, PS 111 M was designed in 1956 for a Midtown West lot on 53rd street, between 9th and 10th avenues. Completed in 1958, the school is a prime example of postwar architecture in New York City Public Schools.

PS 111 M is comprised of three primary masses. A four-story tower, containing the bulk of classroom space, is composed of a cast-in-place concrete frame with masonry infill and buff-brick cavity wall. Flanked on either end of the main tower are two single story wings containing a gymnasium, auditorium, lunchroom and administrative offices. These wings are also composed primarily of a cast in place concrete frame with masonry infill and buff-brick cavity wall.

Fig. 6.16.1

Three typical window enclosure systems are used:

1. Window Wall

There is a one-story window wall system at the exterior wall of the gymnasium and lunch room, originally of blue painted steel framing, yellow steel enamel panels, and blue painted aluminum awning type window units. Structurally, this window wall is similar to a curtain wall, though it is not entirely self-supporting.

2. Window Infill System

The east and west facades of the four story tower, which contain the bulk of classroom space, are enclosed by a window infill system. Windows fill the bays created by projecting vertical brick piers, spaced approximately 12' apart, averaging two bays per classroom. This system is comprised of two elements; blue painted double-hung steel windows and blue architectural terracotta veneer at the spandrel.

3. Punched Windows

Windows units installed at punched openings in brick masonry are found primarily on the west facade along the large playground. These windows are blue painted double-hung steel units. As scoping began for PS 111 M in 2005, over a half century of wear and exposure had degraded these systems. Many windows were inoperable, drafty, or broken. Rust was present, paint was faded or chipped, mechanical components were worn, and the existing single glazed windows did not perform to contemporary thermal standards. Though it was apparent that the window systems would require replacement, close consideration on the part of the designer was needed to avoid adverse impacts to the character defining historical qualities of PS 111 M, as a product of postwar American architecture.

Fig. 6.16.1 (overleaf)
The entrance at PS 111 M after rehabilitation. Replaced architectural terracotta at the window infill system is nearly indistinguishable from the original. Courtesy: Sylvia Hardy

Fig. 6.16.2 & 6.16.3 (bottom left - below)
PS 111 M before and after rehabilitation. Courtesy: Nelligan White Architects, Sylvia Hardy

Fig. 6.16.2 - Before Rehabilitation

Fig. 6.16.3 - After Rehabilitation

Methodology

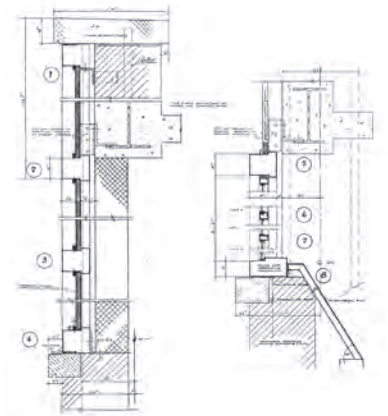


Fig. 6.16.4 (above)
Window details from the original design documents. Courtesy: SCA Alchemy

Research

To define the scope of window replacement at PS 111 M, information was obtained regarding the school's original construction, its history of remediation, and any alterations or additions. The SCA's Alchemy Database yielded original design drawings from 1956, as well as drawings from 11 other projects carried out at the school between 1956 and 2006.

While some drawings are not entirely legible due to poor reproduction or age, they are, nonetheless, invaluable to the designer. Original design drawings give foundational insight to observed design and construction flaws while conducting surveys, and simultaneously guide the rehabilitation and replacement of elements which have 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.

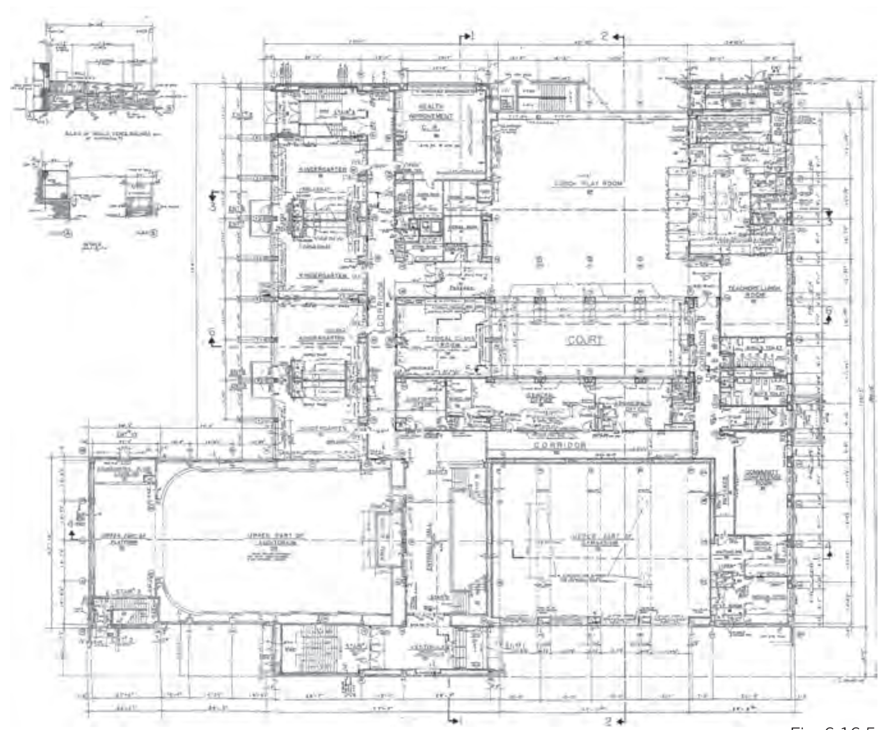


Fig. 6.16.5

Fig. 6.16.5 (right)
Original ground floor plan. Courtesy: SCA Alchemy

Fig. 6.16.6 (below)
Original elevation showing the window wall system to the right and the main classroom block in the center. Courtesy: SCA Alchemy

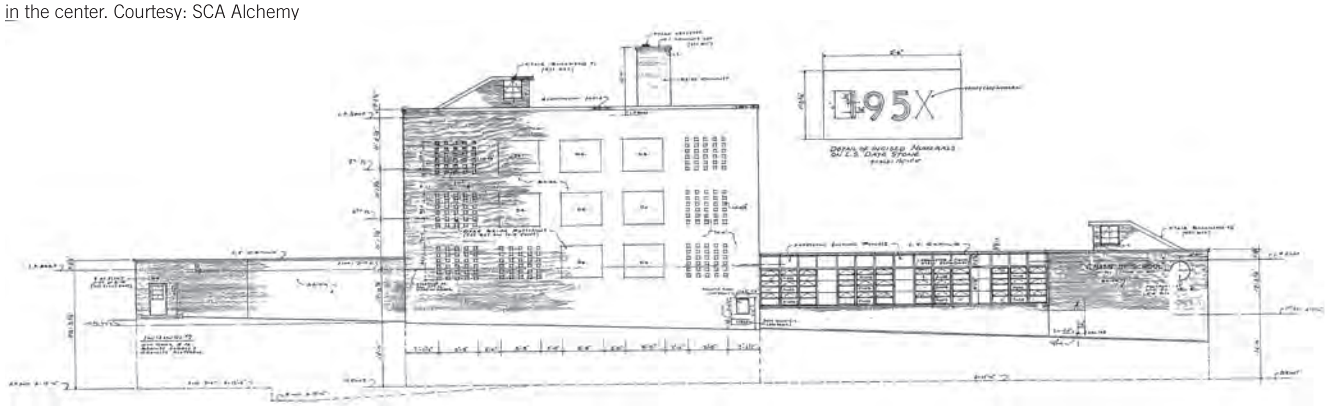


Fig. 6.16.6

Observation & Mapping

In addition to review of the Building Condition Assessment (BCAS) Reports (which can be found at each school's Department of Education website), visual and photographic surveys of interior and exterior damage were performed at PS 111 M in late 2005 and early 2006.

BCAS reports deficiencies noted by school administration, and a consultant's experience guide the process of carefully documenting the condition of each building component. Photographic surveys should be accompanied by a corresponding plan, showing the locations of photographs taken in order to determine if deterioration is a singular condition or the failure of an entire system.

Fig. 6.16.7 - 6.16.10 (below)
Visual observation of damages notes during survey. While moisture damage was noted at ceilings in specific locations, the primary cause of moisture infiltration and environmental discomfort was associated with the rusted windows. Courtesy: Nelligan White Architects

Fig. 6.16.7

Fig. 6.16.8

Fig. 6.16.9

Fig. 6.16.10

Fig. 6.16.11
The window wall system at the one-story cafeteria and playroom wing before rehabilitation. Metal panels were rusting through the enamel, and windows did not operate properly. Courtesy: Nelligan White Architects

Fig. 6.16.12 (below)
The window wall system and the window infill system at the main classroom block during photographic survey. Courtesy: Nelligan White Architects

Non-Destructive Testing

With the exception of testing for lead-based paint and asbestos-containing materials, few tests were carried out at PS 111 M, as the deficiencies were evident in visual surveys. Water-damage at the interior was observed inside the building, away from any exterior walls, and was, thus, was assumed to be a plumbing deficiency. As plumbing deficiencies fall outside the requested scope of window replacement, or any collateral work required for window replacement, it was not included within the final scope of work. Extensive water-damage was not observed at the building envelope, and only minor deficiencies were noted at the roofs (flashing, sealants), thus, an extensive spray testing regimen was deemed unnecessary for this project.

Exploratory Probes

As with non-destructive testing, no exploratory probes were performed at PS 111 M. Deficiencies evident in visual surveys, pointed to a clear scope of work early in the project, thus, an extensive probe regimen was deemed unnecessary for this project.

Materials Testing

Additionally, with the exception of testing for lead-based paint and asbestos-containing materials, testing of material properties was deemed unnecessary for this project.

Fig. 6.16.12

Fig. 6.16.13 (left)
View from 53rd Street looking south. Courtesy: Nelligan White Architects

Fig. 6.16.14 (below)
Interior of classroom before rehabilitation. Courtesy: Nelligan White Architects

Fig. 6.16.14

CASE STUDIES:
PS 111 M

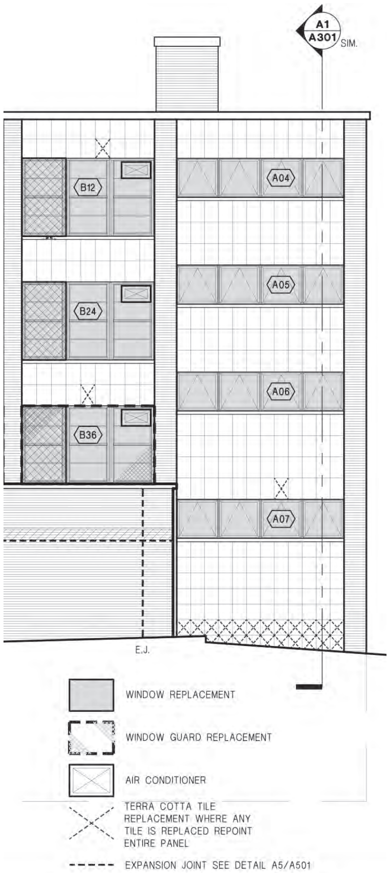


Fig. 6.16.15 above)
Partial elevation showing extent of work. Courtesy: Nelligan White Architects

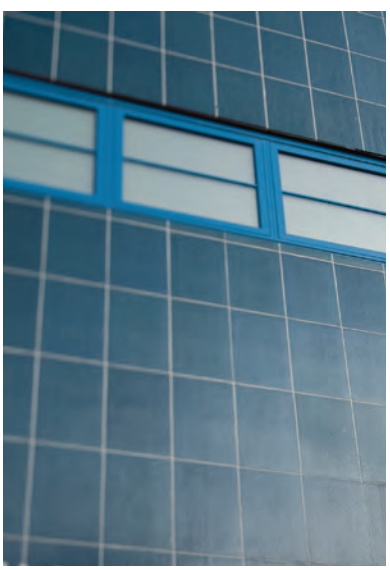


Fig. 6.16.16 (above)
Window infill system after rehabilitation. Courtesy: Nelligan White Architects

Fig. 6.16.17 (right)
Section through replacement window at window infill system. Courtesy: Nelligan White Architects

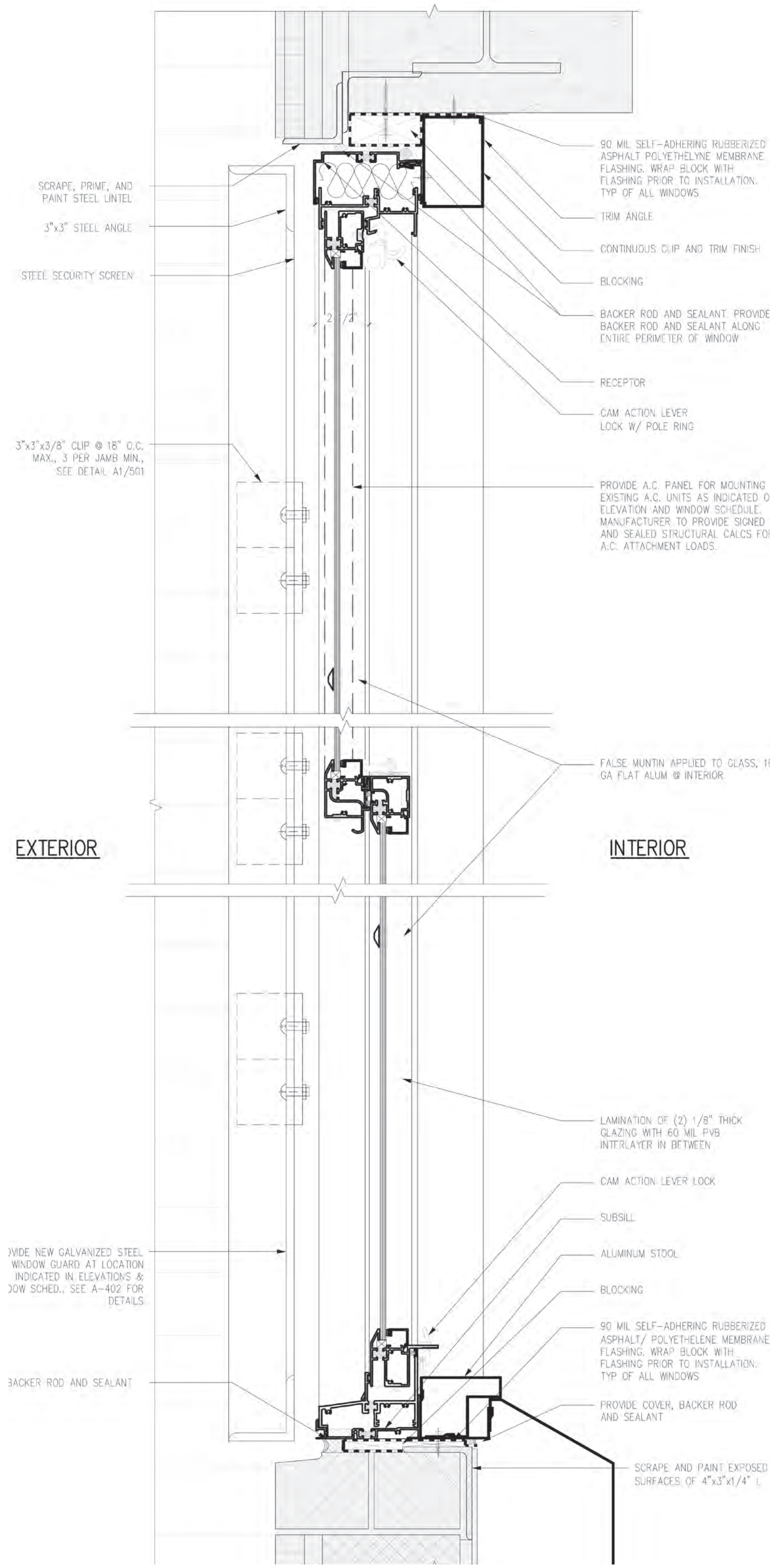


Fig 6.16.17

Recommendations & Design

LLW No. 04547 - Window Replacement

Findings of visual inspections pointed to a clear scope of work early in the window replacement of PS 111 M; with the exception of isolated deficiencies which are addressed in the form of additional recommendations, issues present were related to the dated windows. The following represent a complete list of findings and recommendations by component, based on findings complied during the scope phase of work:

1. Window Wall System

The framing, steel enamel panels and window units which comprise the window wall system exhibit deterioration throughout. Steel framing was rusted, had holes, and was further compromised by the inset aluminum windows, causing galvanic action between the dissimilar metals. None of the components of the window wall system were thermally broken or insulated. Steel enamel panels were rusting, spalling and blowing out the enamel on their face. The window units themselves were in fair condition, though they were only single glazed. These findings prompted the following recommendations:

- Replace existing curtain wall framing with new extruded aluminum framing, coordinate finish with all components of system.
- Replace all steel panels with insulated aluminum panels, coordinate finish with all components of system.
- Replace windows with new double glazed, thermally broken extruded aluminum window units, coordinate finish with all components of system.

2. Window Infill System

It was observed that the steel frames and hardware of the infill window system had been painted over several times leaving many windows inoperable. Some were rusty and dysfunctional leaving windows drafty. At the spandrels, architectural terracotta panels were chipped and spalling in many places. Deterioration was frequent near ground level, where physical impact and abuse combined with freeze-thaw cycles had aggravated spalling. Many panels had been replaced with ceramic tiles of a differing size and color, standing out as obvious repairs. These findings prompted the following recommendations:

- Replace all infill windows with new double glazed, thermally broken extruded aluminum window units, coordinate finish with all components of system.
- Patch damaged glazed masonry units with color-matched epoxy material.
- Remove all glazed units at ground level, replace with cast stone units.

Fig. 6.16.18 (above)
Steel enamel panels were deteriorated; previously replaced panels did not match original. Courtesy: Nelligan White Architects

Fig. 6.16.19 (above)
Years of rust and layers of paint had made many windows inoperable. Courtesy: Nelligan White Architects

Fig. 6.16.20 (below)
Fully replaced window. Courtesy: Nelligan White Architects

PS 111 M

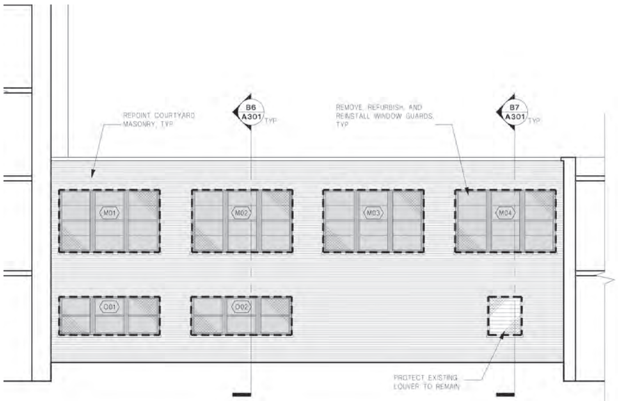


Fig. 6.16.21

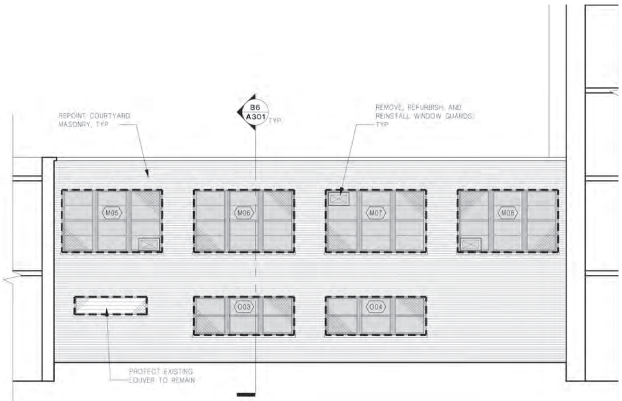


Fig. 6.16.22

Fig. 6.16.23

Fig. 6.16.24

3. Punched Window System

Painted windows at punched openings throughout the school were observed to be chipped and peeling. In several locations, rust was present and some window panes were broken. All windows were single glazed, and glazing putty was either falling out or missing at some units. These findings prompted the following recommendation:

- Replace all windows at punched openings with new double glazed, thermally broken extruded aluminum window units, coordinate finish with all components of system.

4. Window Lintels

Loose lintels were visible above all windows at punched openings, along the western facade near the large playground. Steel angles were not galvanized and showed signs of corrosion including rusting, flaking and expansion. Carrier angles are shown to be fully flashed in the original drawings, and because they are not directly exposed to the elements they were expected to be in fair condition, however, this could not be visually confirmed. These findings prompted the following recommendations:

- Replace all loose lintels at the west facade with galvanized lintels.
- Install composite copper flashing, cotton wick weeps, and provide brick masonry removal and replacement as required.
- Visually examine all carrier angles at spandrels as windows are removed; scrape and paint all exposed surfaces with epoxy coat system.

5. Steel Window Guards

Operable window guards existing at the first and second floor windows were observed to be in fair condition. In some locations guards were painted to match the surrounding building while others were galvanized. Window guards were installed directly into the face of window frames with metal screws, forming a path for water to leak into the window frame. These findings prompted the following recommendations:

- Remove, store, scrape and epoxy paint all existing window guards.
- Reinstall using epoxy anchors directly into masonry so that attachment does not compromise waterproofing of the building shell, avoid galvanic action between dissimilar metals.

6. Window Treatments

Roughly 20% of windows had been completely stripped of their shades leaving only hardware behind, and 30% of existing shades were not functional. Aluminum tie-offs for the original shade draw-strings remain at most windows. These findings prompted the following recommendations:

- Remove and replace all window shades with semi-transparent light-filtering roller shades for improved light quality.
- Provide an opaque over-shade integrated for complete blackout.
- Remove all aluminum tie-offs.

Fig. 6.16.221 & 6.16.22 (overleaf - top)
Partial elevation showing extent of work at punched window system. Courtesy: Nelligan White Architects

Fig. 6.16.23 & 6.16.24 (left page - below - far below)
Before and after rehabilitation. Courtesy: Nelligan White Architects

Fig. 6.16.25 (above)
Window lintels suffered from degrees of rust, flaking, and corrosion. The steel window guards, while in fair condition, were fastened directly to the windows creating a path for water to infiltrate. Courtesy: Nelligan White Architects

Fig. 6.16.26 (below)
Of the remaining window treatments, many were not functional. Courtesy: Nelligan White Architects

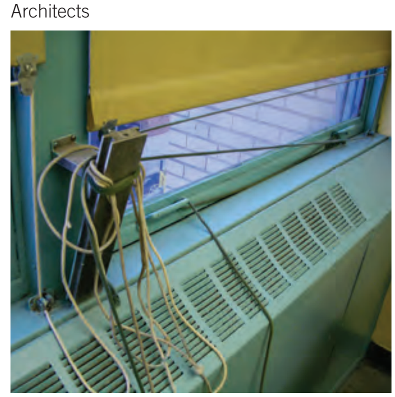


Fig. 6.16.27
Window screens at the lunch room were a retrofit that exhibited minor tears. Courtesy: Nelligan White Architects

7. Window Screens

Windows at the southern end of the lunch room were previously retrofitted with window screens which remain in fair condition, though some screens showed minor tears. The robustness of their installation however, seems to be insufficient for the amount of traffic exposed to them. These findings prompted the following recommendations:

- Remove and protect all window screens, refurbish as necessary.
- Reinstall with brackets as required for increased resilience.

8. Air Conditioners

Window air conditioners and receptacles were installed in the existing window units at many rooms in PS 111 M. Several rooms have no air conditioners or receptacles in place for future installation. These findings prompted the following recommendations:

- Remove, store and reinstall existing air conditioning units with thermal and weather stripping.
- All rooms shall be provided a window with one removable sash for the re-installation of units, or for future installation.

Fig. 6.16.28 (right)
Partial view of the window infill system after rehabilitation. Courtesy: Nelligan White Architects

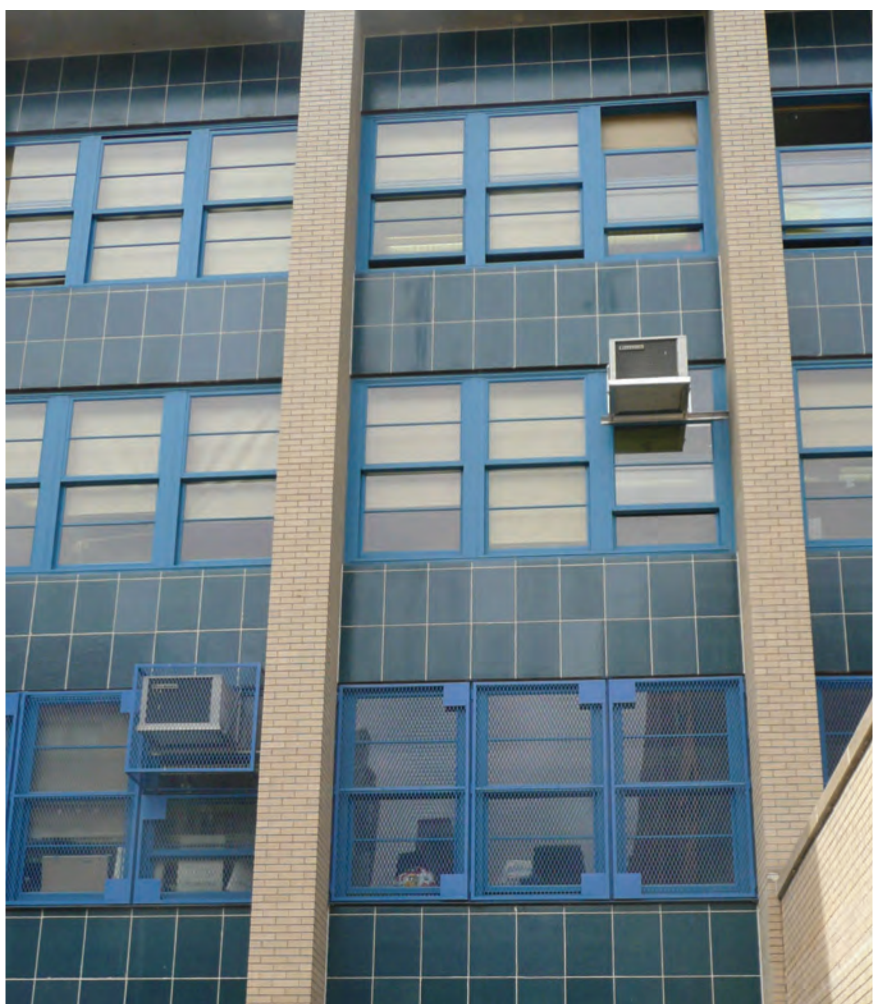


Fig. 6.16.28

9. Painting and Plaster

Water staining was observed at several locations below grade and in the entrance hall, thought no water damage was visible in classrooms. It is expected that window replacement will necessitate plaster removal and will cause damage to plaster finishes. These findings prompted the following recommendations:

- Allow for plaster repair and painting around new windows.
- Allow for plaster repair and painting in localized discovered conditions.

10. Additional Recommendations - Hollow Metal Doors

Existing doors and frames show signs of corrosion, rust and wear due to near constant use. Having been painted over several times, existing paint was cracked and faded. Holes and screws have been drilled into doors, aiding rust and corrosive action. Lintels bearing on brick masonry were used in several locations. These lintels were observed to be in fair condition, though they are not galvanized and therefore prone to future corrosion. These findings prompted the following recommendations:

- Replace heavily used doors and frames with heavy duty insulated hollow metal aluminum doors and extruded aluminum frames, provide institutional grade hardware, new thresholds, weather stripping, seals, and finish to match window wall system.
- Remove all remaining doors, scrape, clean, and reinstall doors with new weather stripping and seals, scrape and clean frames.
- Protect existing door lintels during door replacement, scrape and paint with epoxy mastic paint, isolate dissimilar metals with polyethylene tape.

Fig. 6.16.29
The near constant use of exterior doors had degraded them significantly. Heavily used doors were replaced while the remaining were repaired. Courtesy: Nelligan White Architects

Constructability & Lessons Learned

Fig. 6.16.30
Color verification of ceramic panels. Courtesy: Nelligan White Architects

As with most schools built during this era, the years of wear and tear had left many of the windows inoperable, damaged, and inefficient. While water damage was found at ceilings at certain locations the primary cause of that water damage was determined to be associated with plumbing deficiencies and outside the current scope of work. Overall the investigation was kept to visual inspections as the deficiencies were highly evident making the need for probing and sprays tests unnecessary.

Windows

At PS 111 M, three categories of windows were quantified; curtain wall, window infill system, and punched windows. For the curtain walls rust and punctures had compromised the system along with the galvanic reaction between the inset aluminum windows and steel frames. Additionally the system was not energy efficient due to the lack of thermally broken or insulated components. The entire system was replaced with new extruded aluminum framing and double glazed energy efficient windows. As a part of the replacements no steel components were used to prevent any future reactions between the two metals.

At the window infill system, many were inoperable due to rusting and multiple layers paint. The terracotta panels at the spandrels were chipped and spalling while previously replaced panels were a different size and color. All infill windows were replaced with double glazed energy efficient windows. Damaged masonry panels were patched to match existing while the inaccurate panels were replaced to match existing.

The punched windows system suffered from deteriorated paint, rust, and in some locations broken panes. Like the other window systems, they were single glazed and not energy efficient. All of the windows were replaced with aluminum double glazed units.

Fig. 6.16.31

Fig. 6.16.31 (right)
Construction progress of the replacement of punched windows and associated lintels. Courtesy: Nelligan White Architects

Hollow Metal Doors

The existing doors and frames to the exterior were in near constant use. They suffered from corrosion, rust, and general wear and tear. Doors and frames found to be the most used were replaced with heavy duty insulated aluminum doors and frames. Other doors were removed and refinished then reinstalled.

Masonry

As a part of the repairs associated with the windows any masonry removed was replaced to match existing. During the construction process paint removal at the west facade was added to the scope of work. Repointing of the architectural terracotta was also added to the scope of work during the construction process.

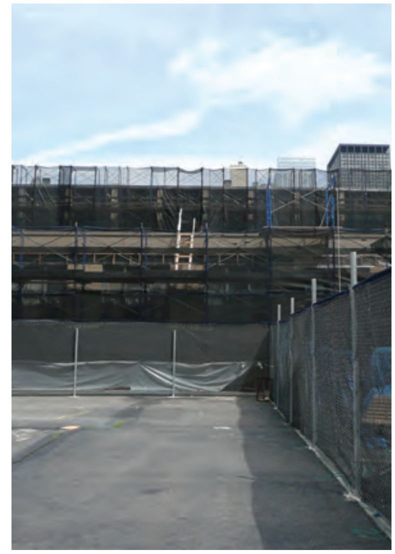


Fig. 6.16.32
View of scaffolding during the construction phase. Courtesy: Nelligan White Architects

Fig. 6.16.33 (above)
Finished doors at entry. Courtesy: Nelligan White Architects

Fig. 6.16.34 & 6.16.35 (far left - left)
Section through replacement door.
Section through replacement curtain wall.
Courtesy: Nelligan White Architects

Fig. 6.3.36 (below)
Paint removal on west facade in progress. Courtesy: Nelligan White Architects

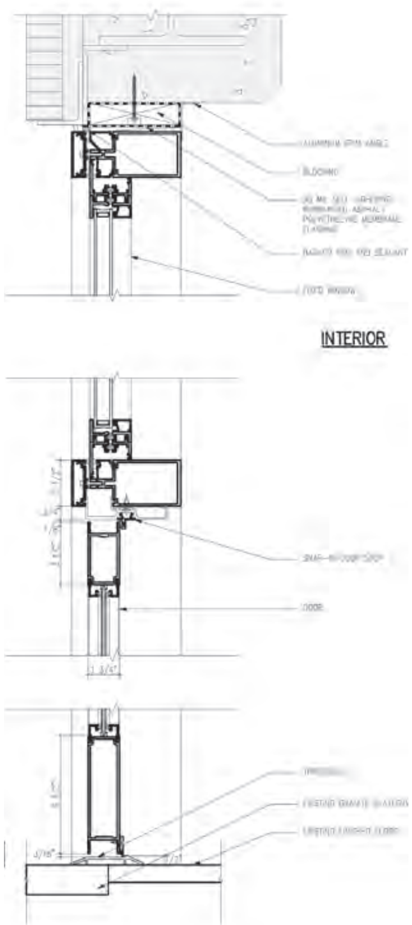


Fig. 6.16.34

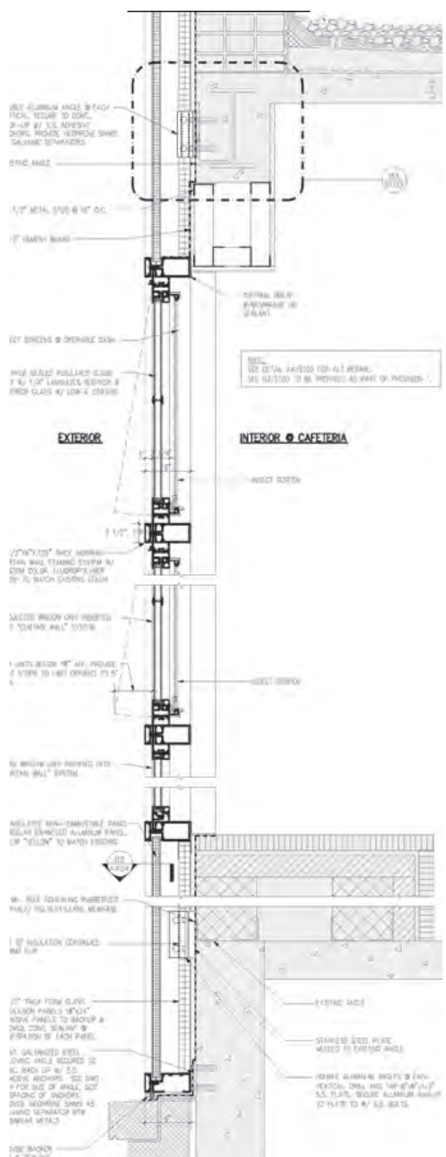


Fig. 6.16.35

SECTION 6.17

CASE STUDIES:
PS 36 M

Introduction

Building ID	M036
School Level	PS
Address	123 Morningside Dr Manhattan, NY 10027
Cross Streets	W 123 St & Amsterdam Ave
NYC DOE District	05
SHPO Status	Not Elligible
SHPO ID	N/A
Flood Zone	Outside Flood-zone
FEMA Map	3604970087F
Architect	F. Frost Jr. & Associates
Year Built	1967
Plan Form	Irregular
Style	Mid-Century Modern
Internal Sq Ft	95,000
Classrooms	65
Stories	4 + Cellar
Structural System	Reinforced Concrete Frame
Columns	Reinforced Concrete
Beams	Reinforced Concrete
Floors	Reinforced Concrete Slab
Roof	BUR (2010)
Cladding	Concrete, Brick, Stone
Backup	Concrete

PS 36 M, also known as the Margaret Douglas School and the Morningside School, is an early childhood center with approximately 500 students, grades K-3, located at the edge of Morningside Park in upper Manhattan. Completed in 1967, the building was an award winning design by the firm Frederic Frost Jr. & Associates and is a unique expression of Mid-Century Modern Brutalist architecture in New York City Public Schools.

The building is composed of four connected units which meet in plazas at different levels, constructed primarily of reinforced, poured-in-place concrete construction, with the exception of certain stair towers, bulkheads, and infill panels between columns, which have a brick masonry veneer over reinforced concrete or cinder concrete block wall.

The building uniquely incorporates an exposed outcropping of Manhattan Schist as foundation and site walls, with portions of construction which bear directly onto it and cantilever over it. There are also a series of sub-grade crawl space tunnels that connect the units. A paved plaza surrounding Unit 4 connects all units at the second level of the building. Due to the contours of the site, the paved plaza is accessed primarily at grade along the south side of the site and by a series of steps and landings, starting at the north-west corner of the site.

By 2007, water-damage had become an ongoing issue at PS 36 M. Degraded interior finishes were beginning to pose safety hazards, and the concrete structure throughout was cracked and spalling.

Fig. 6.17.1 (below)
PS 36 M's unique site features a steep grade-change as well as an exposed outcropping of Manhattan Schist, which is incorporated into the design. In some locations the actual rock is used as a foundation wall, while in others, the building cantilevers over the outcropping. Courtesy: Sylvia Hardy

Fig. 6.17.1

Fig. 6.17.2

Fig. 6.17.3

Fig. 6.17.2 (above)
Parapet on south facade after rehabilitation. Once active concrete deterioration had been mediated the entire concrete structure had to be restored to a consistent color and texture. Since the original cover was insufficient, up to three inches of new cover had to be added to the structure. Courtesy: Nelligan White Architects

Fig. 6.17.3 (left)
Parapet before rehabilitation. The rapid decay of the concrete due to design flaws and poor material choice had led to a host of issues, including cracked walls and extensive water-damage throughout the interior of the building. Courtesy: Nelligan White Architects

CASE STUDIES:

PS 36 M

Methodology

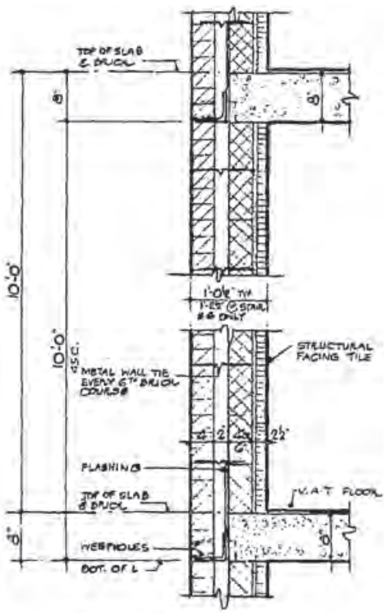


Fig. 6.17.4
Original wall sections specify weeps at masonry cavity walls, however, no weeps were present at the building as of 2007. Courtesy: SCA Alchemy

Research

Initial research was carried out to obtain information regarding the school's original construction and its history of remediation, alterations, and any additions. The SCA's Alchemy Database yielded a full set of original design drawings from 1965, as well as drawings for change orders during construction and documents from a 1998 exterior modernization. The original drawings were in excellent condition, and their digital reproductions were of a high quality, giving a comprehensive view of the buildings history, and a direction to start scoping from observed design and construction flaws and repair induced flaws.

These drawings also guided the rehabilitation and replacement of elements which had fallen into disrepair. Much of the cast-in-place concrete structure, and the brick cavity walls had not been built as drawn, and were found, in some cases to be missing all together. The drawings serve as evidence of deficient craftsmanship which had been observed, and confirmed opinions regarding the sources of moisture intrusion.

Original drawings also aid in the basic understanding of a buildings structure. When no original drawings exist, defining the materials and structural systems of a building used can be a challenge and consumes time which may be better used on the detailed scoping of a project. They also aided in the production of base drawings to begin recoding damage and producing construction documents as seen under 'Damage Mapping'.

Fig. 6.17.5 (below)
Elevations from the original 1964 design drawings. Courtesy: SCA Alchemy

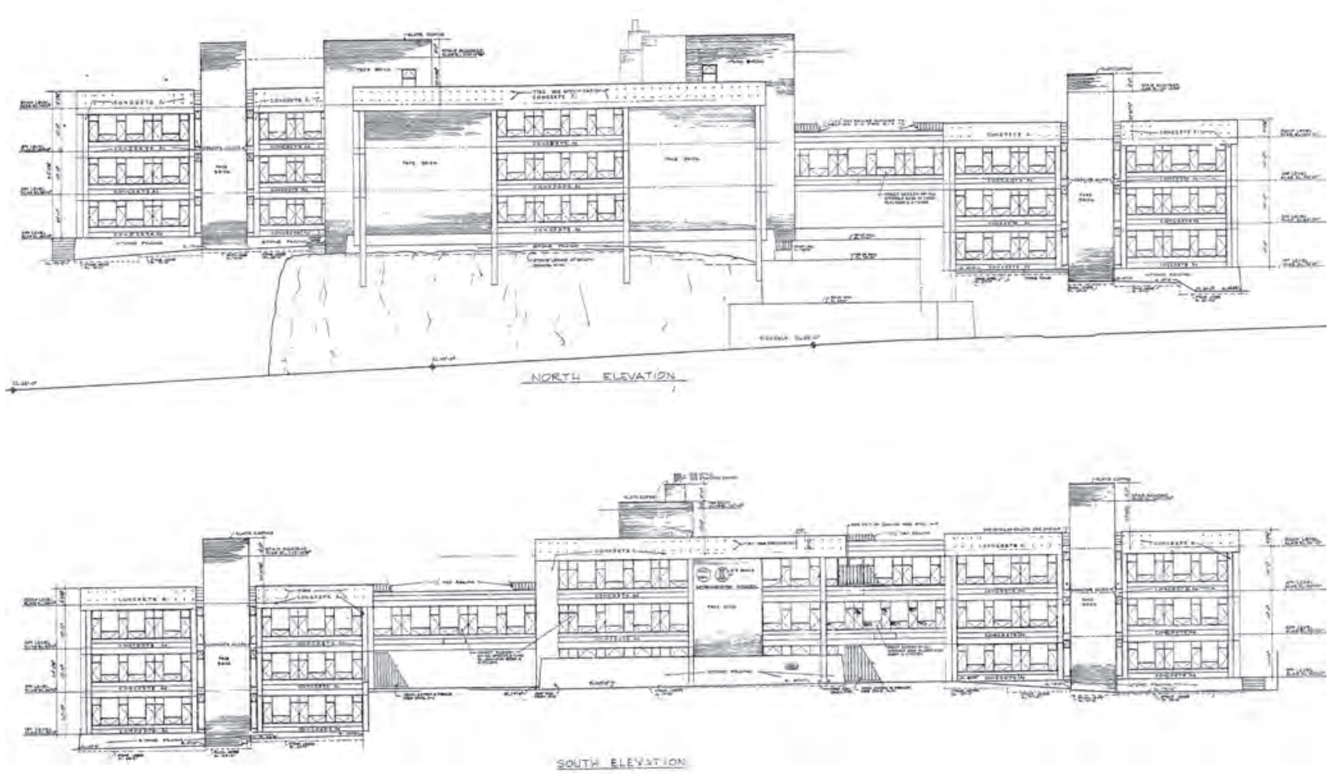


Fig. 6.17.5

Observation & Mapping

Initial observation reports from July 2007, confirmed and detailed the effects of water infiltration present at PS 36 M as described in the BCAS (Building Condition Survey) Reports. Concrete throughout the building was observed to be in poor condition. Cracking and spalling was present throughout, as were exposed and rusted reinforcing bars due to insufficient concrete cover. Brick masonry was observed to be in fair condition, cracks and patches were noted where water damage was present at the interior, and no weeps were observed.

Though roofs at all units were replaced in 1998, they were observed to be in poor condition at most locations, with moisture visibly present beneath the membrane and organic growth at the ballast.

Damage mapping drawings were created based on the results of several surveys. These damage maps facilitate the quantification of deficiencies, aiding in the determination of scope and the production of estimates.

Fig. 6.17.6 (below)
The damage mapping exercise is superimposed over the existing drawings, resulting in a diagram which quickly expresses the observed deficiencies. Damage mapping at the interior plans can be compared to damage mapping at the elevations, and may reveal location for potential investigation. Courtesy: Nelligan White Architects

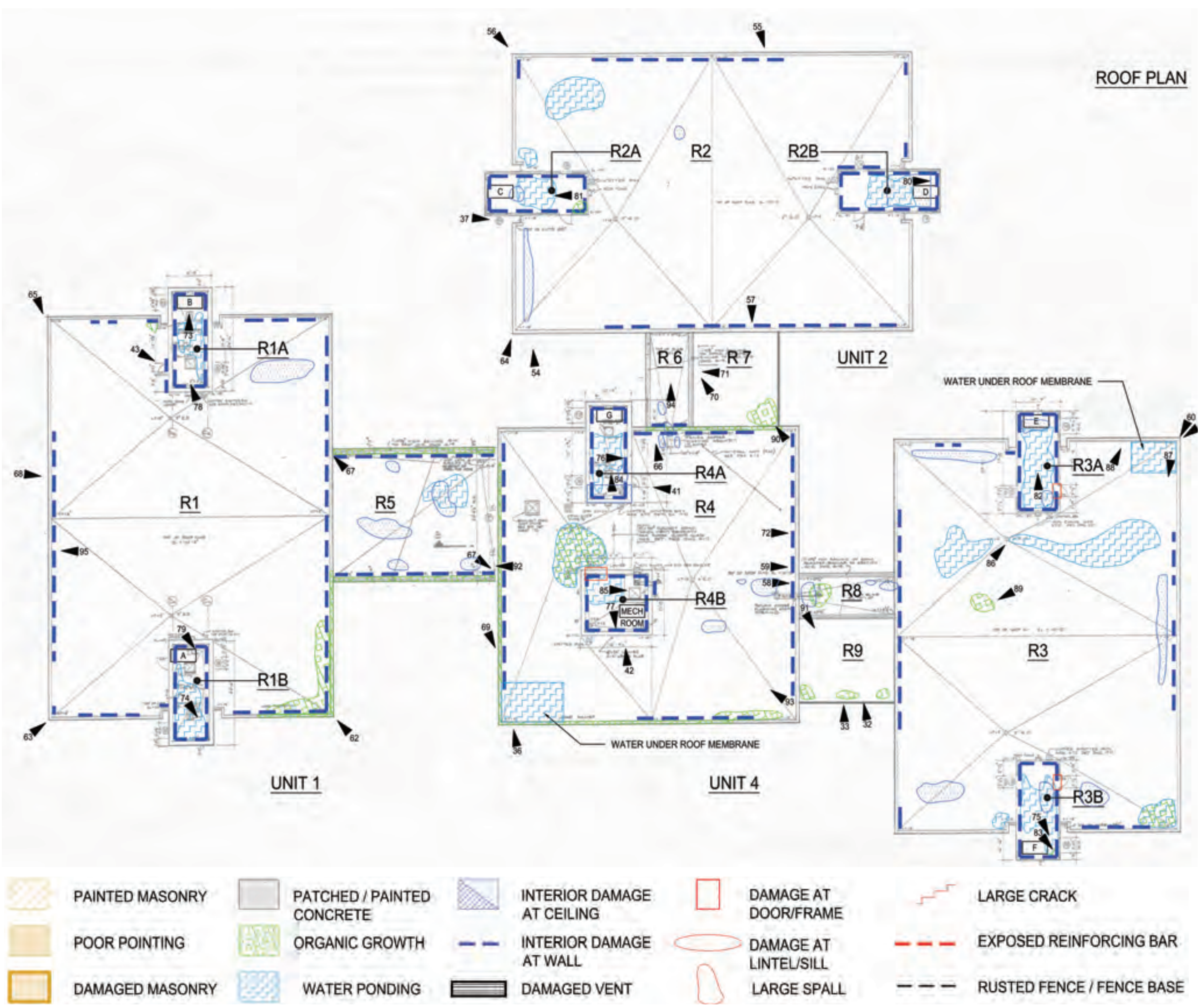


Fig. 6.17.6

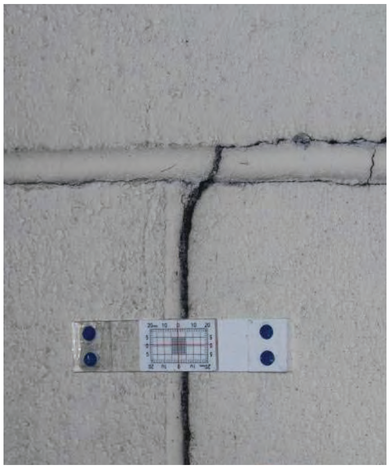


Fig. 6.17.7
Crack meters were installed at several locations throughout the school. After a three-month trial, no movement of the cracks was noted. Courtesy: WSNY Engineering Design P.C.

Fig. 6.17.8 (below)
Infrared images of the facades proved relatively inconclusive. Courtesy: Nelligan White Architects

Non-Destructive Testing

A series of non-destructive tests were carried out at PS 36 M, to determine the location of moisture and the condition of building elements and materials. A thermal imaging regimen was conducted at the roof and facades. This photographic method uses infrared imaging to detect the temperature differences across the surface of a PS 36 M. Where moisture was present, the infrared images showed a different temperature difference compared with the surrounding area. This strong indication of moisture can assist in determining the exact locations of moisture infiltration.

Additionally, monitors were installed at the parapet where cracks were observed. Some of the cracks, which were observed from the ground during the damage mapping exercise, turned out to be spalls along a joint upon close inspection. Other cracks were monitored, but no changes were noted during the three-month test period.

Overall, the results of non-destructive tests were inconclusive, and pointed to the need of more invasive testing methods to determine all causes of moisture infiltration and material degradation.

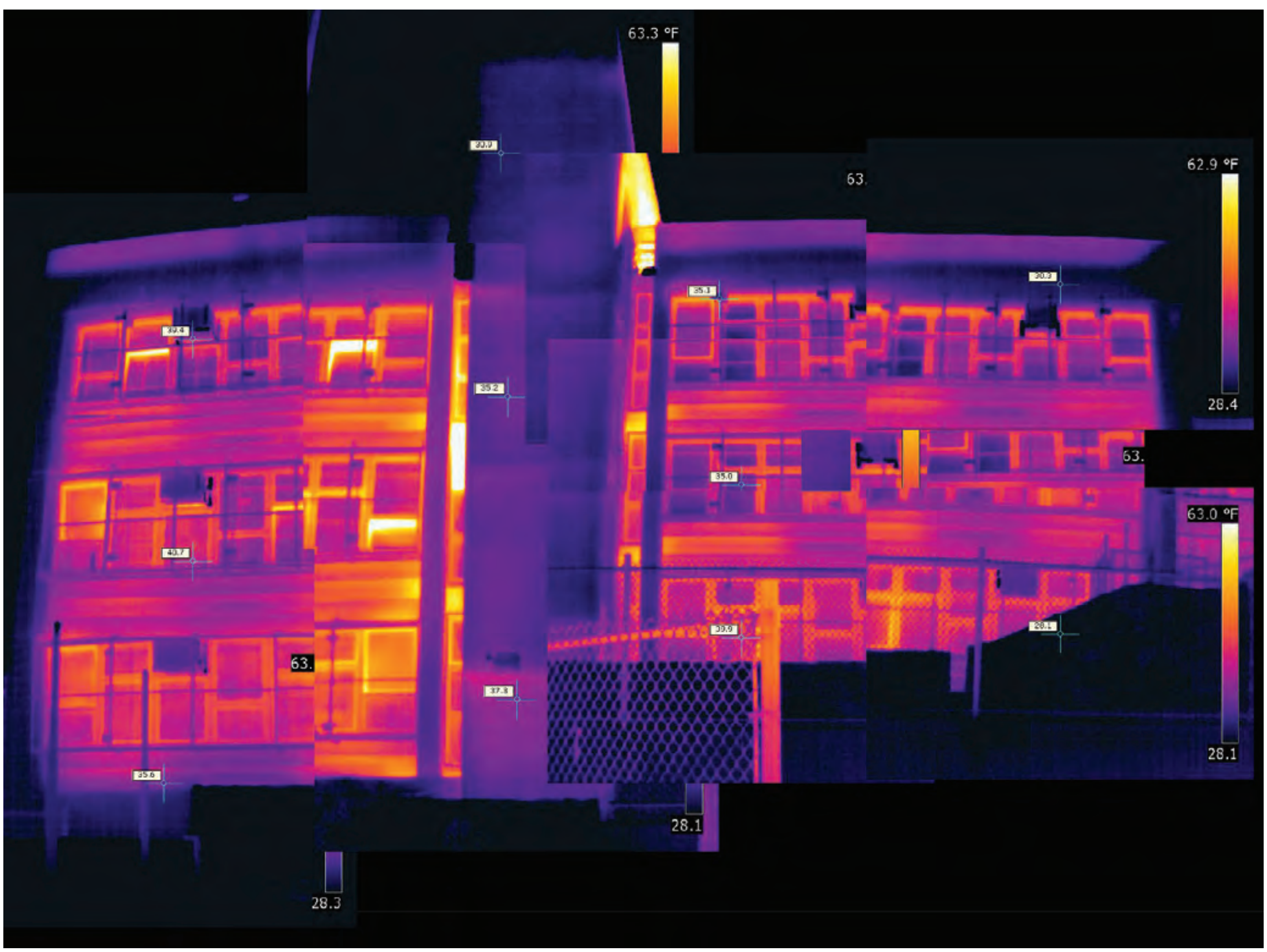


Fig. 6.17.8

Exploratory Probes

A total of six exploratory probes were performed at PS 36 M in October of 2009, during which, existing materials were inspected, and cores of concrete and steel samples were extracted for testing. Results confirmed what was noted in the initial visual surveys. Reinforcing bars were not consistently placed throughout the concrete, often with a cover of less than ½". The bars with the least cover showed the most corrosion and loss of section.

Probes at the stone veneer near the building's base revealed that the stone itself was extremely unstable. When removal was attempted the surrounding stone crumbled and loose stone peeled away in layers. The steel dovetail channel and stone anchors were completely corroded and able to be broken with the hand. Immediately following the probe, it was recommended that the area be netted due to the high level of deterioration.

Masonry cavity walls were opened and noted to be in fair condition, although the condition of anchors could not be assessed as they were covered with mortar. There were no weeps observed at the cavity wall, which may have contributed to any masonry deterioration which was present.

Fig. 6.17.9
Masonry was noted to be in fair condition, although the absence of weep holes was considered problematic. Additionally, masonry anchors could not be inspected, as they were covered with mortar, and some were observed to not reach out to the wall for a proper connection. Courtesy: Nelligan White Architects

Fig. 6.17.10
Probes taken at the stone veneer walls revealed the stone and anchors is be in very poor condition. Anchors suffered from advanced corrosion, and were able to be broken with the hand. Stone was spalled, could be crunched in the hands, and disintegrated as it was removed for the probe. Courtesy: WSNY Engineering Design P.C.

Fig. 6.17.11

Fig. 6.17.12

Fig. 6.17.11 & 6.17.12 (above left - left)
Insufficient cover, sometimes as little as half an inch, contributed to the corrosion of reinforcing bars at concrete over the entire exterior of the building. Courtesy: Nelligan White Architects

Fig. 6.17.13
The Windsor Pin apparatus is a spring-loaded device which drives a steel pin into the surface of the concrete or mortar using a controlled amount of energy, and the depth of the penetration is measured. The depth of the penetration is inversely proportional to the material surface hardness. Courtesy: Atkinson-Noland & Associates, Inc.

Materials Testing

A series of tests intended to evaluate the roof, concrete and reinforcing conditions at PS 36 M were conducted, relating to roof moisture intrusion, concrete compressive strength and composition testing, and reinforcing location and composition. These tests at the roof included infrared thermography and capacitance moisture detection at the roof. Tests analyzing the concrete and reinforcing included cover-meter testing, half-cell potential and corrosion section loss measurements, Windsor Pin, core compression testing and crack monitors.

Results of testing at the roof indicated that it is generally in poor condition, especially where moisture beneath the roofing had created bulges in the roofing.

Results of testing at the concrete and reinforcing revealed significant problems related to the reinforcing, where there was often insufficient cover. In these locations loss of steel section was significant. Further petrographic analysis revealed the concrete to be non-air-entrained, which is not durable under severe exposure conditions. Cyclical freezing and thawing in the presence of abundant moisture had resulted in sub-parallel cracking throughout the core sample examined.

The concrete at most locations was found to be acceptable in its composition, but the concrete found at the plaza slab was found to contain unacceptably high levels of chloride, associated with the application of de-icing salts.

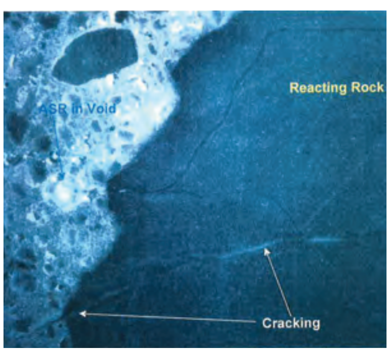


Fig. 6.17.14
A Photomichrograph showing the non-air entrained concrete analyzed. This concrete is experiencing alkali-silica reactivity cracking, a form of deterioration caused by reactive aggregates. Courtesy: Future Tech Consultants of New York, Inc.

Fig. 6.17.15 (right)
The non-uniform distribution of the course aggregate is readily apparent. The arrow indicates an entrapped air void, however concrete is non-air entrained, and thus extremely susceptible to scaling as a result of freeze thaw cycles. Courtesy: WJE Engineers, Architects, Materials Scientists

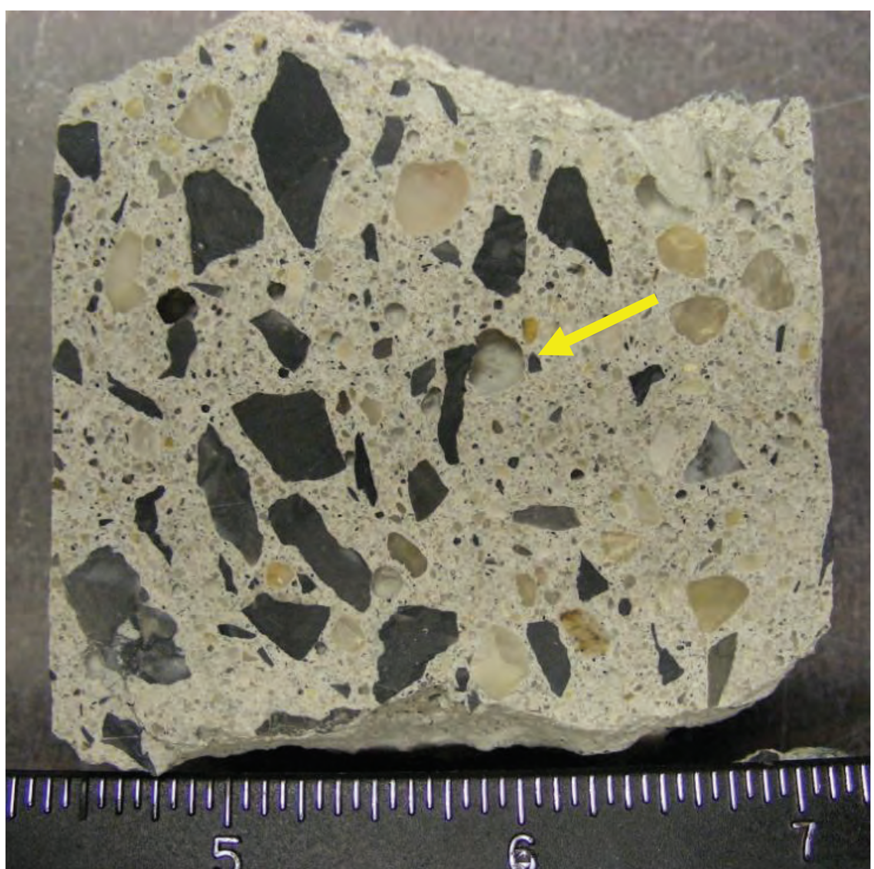


Fig. 6.17.15

Recommendations & Design

LLW No. 060111 – Reinforcing Support Elements

1. Underside of Plaza Slab at Loading Dock

- Remove all existing pavers above the main plaza slab that are directly over inhabitable space
- Remove all contaminated concrete, provide new concrete slab with steel reinforcing
- Provide new waterproofing membrane
- Provide 2” mortar screed, pitch deck to drain properly
- Provide new asphalt block paving stones
- Replace all light fixtures and damaged electrical conduit in loading dock
- Replace plaza drain and pipe drain in loading dock
- Provide new concrete retaining wall and new concrete landing slab with new reinforcing

2. Unit 2, North Side

- Install continuous drip edge on the underside of each wall

3. Columns, Spandrel Beams and Roof Slab soffits

- Remove all existing paint that has been applied to the concrete
- Repair existing cracks found throughout the structural elements using micro injection grout to repair hairline cracks and injection grout for larger cracks
- Repair spalled concrete and exposed rebar
- Provide additional concrete cover
- Apply a migrating corrosion inhibitor for all exterior concrete
- Remove, scrape, paint and reinstall all window guards to facilitate concrete repair work

4. Interior

In order to provide of sufficient movement between the structural beams and the non-structural infill wall below them, the following was recommended:

- Remove plaster at joint between CMU and concrete beams
- Cut the joint between CMU and concrete beams
- Provide horizontal expansion joint between CMU and the concrete beam, including backer rod, filler and sealant
- Replace all cracked and damaged Glazed CMU to match existing
- Replace all cracked and damaged CMU
- Provide L-bead and repair plaster
- Provide paint from corner to corner where plaster is repaired

Fig. 6.17.16
The loading dock before rehabilitation: showed rusted and exposed reinforcing bars, concurrent with spalling concrete. Concrete cover was so minimal in some areas that rusting bars and stirrups could be seen without any significant spalling. Long cracks were visible as well. Courtesy: Nelligan White Architects

Fig. 6.17.17
Exposed steel bars were hydro-blasted, using a high pressure water jet, to expose and clean the bar. Where reinforcing had deteriorated beyond repair, new bars were spliced in and a migrating corrosion inhibitor was applied to surfaces, helping to protect embedded reinforcement from future corrosion. Courtesy: Nelligan White Architects

Fig. 6.17.18
Epoxy injection grout was used to repair cracks in structural elements. Courtesy: Nelligan White Architects

Fig. 6.17.20
Brick cavity wall installation with seismic anchors and spray applied waterproofing membrane. Courtesy: Nelligan White Architects

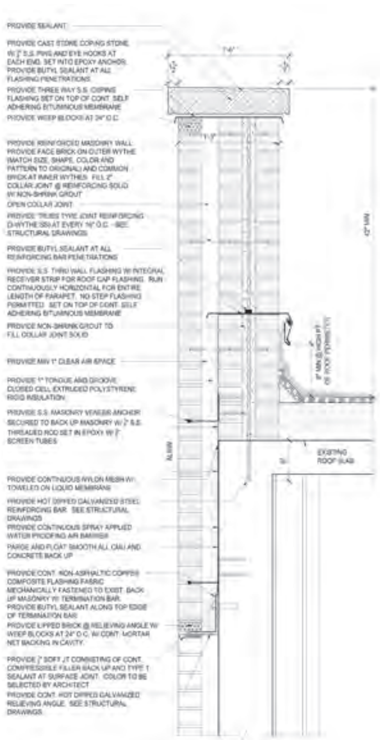


Fig. 6.17.21
Brick cavity wall construction document. Courtesy: Nelligan White Architects

Fig. 6.17.22 (right)
Stainless steel ties installed at new stone masonry walls, which included the installation of a narrow cavity drainage plane and waterproofing membrane. Courtesy: Nelligan White Architects

LLW No. 060116 – Exterior Masonry

1. Exterior Brick Masonry

- Remove 5 courses of brick at each relieving angle
- Remove existing flashing and provide new copper composite flashing
- Provide new SCA standard honeycomb weep vents at 24" O.C. at every relieving angle and at the base of each masonry wall to properly drain the cavity walls
- Provide new brick to match original
- Tie new face-brick to backup masonry
- Provide brick replacement for crack repair and damaged face-brick
- Provide paint removal
- Provide raking and pointing at areas of paint removal
- Provide roof access doors, frames and hardware
- Scrape, prime and paint steel lintels at roof access doors
- Provide anti-graffiti coating for lower portion of brick masonry
- Remove and replace all face-brick at all stair and mechanical bulkheads, provide a drainage plane assembly over all back up masonry including the following: parge all CMU backup masonry, apply liquid applied waterproofing membrane, and provide drainage plane with weeps

2. Exterior Stone Masonry

- Remove all unsound/cracked stone veneer and replace in kind
- Provide stainless steel masonry ties

3. Louvers

- Replace broken louvers

4. Interior

- Provide interior wall and ceiling repair, including plaster repair and painting.

Fig. 6.17.22

LLW No. 060208 – Flood Elimination

1. Underside of Plaza Slab at Unit 4 Cellar Corridor

- Repair damaged ceiling plaster
- Paint wall/ceiling from corner to corner

2. Room B15 at Unit 4 Cellar

- Provide chemical grout injection waterproofing for the foundation wall
- Replace damaged conduit
- Replace damaged ceiling and wall plaster, and paint

3. South Stair Tower, Unit 1

- Remove damaged exterior brick masonry
- Provide new brick to match original
- Provide weep holes at base of wall at 24" O.C to drain excess water building up in wall cavity
- Replace damaged glazed CMU at interior
- Replace deteriorated concrete paving stones at base of wall

4. Site Paving

- Remove and replace all asphalt pavers
- Patch substrate with concrete repair mortar to level surface
- Snake all site drains
- Repair cracking and spalling concrete curbs.
- Provide architectural biocide wash to pavement to inhibit organic growth
- Remove paint from concrete sculpture platform
- Provide concrete repair for sculpture platform

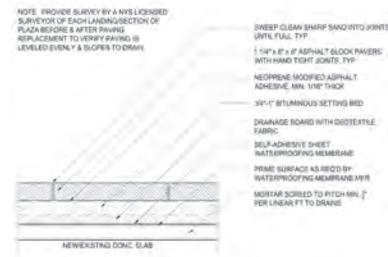


Fig. 6.17.23
Brick cavity wall installation with seismic anchors and spray applied waterproofing membrane. Courtesy: Nelligan White Architects

Fig. 6.17.23
Brick cavity wall installation with seismic anchors and spray applied waterproofing membrane. Courtesy: Nelligan White Architects

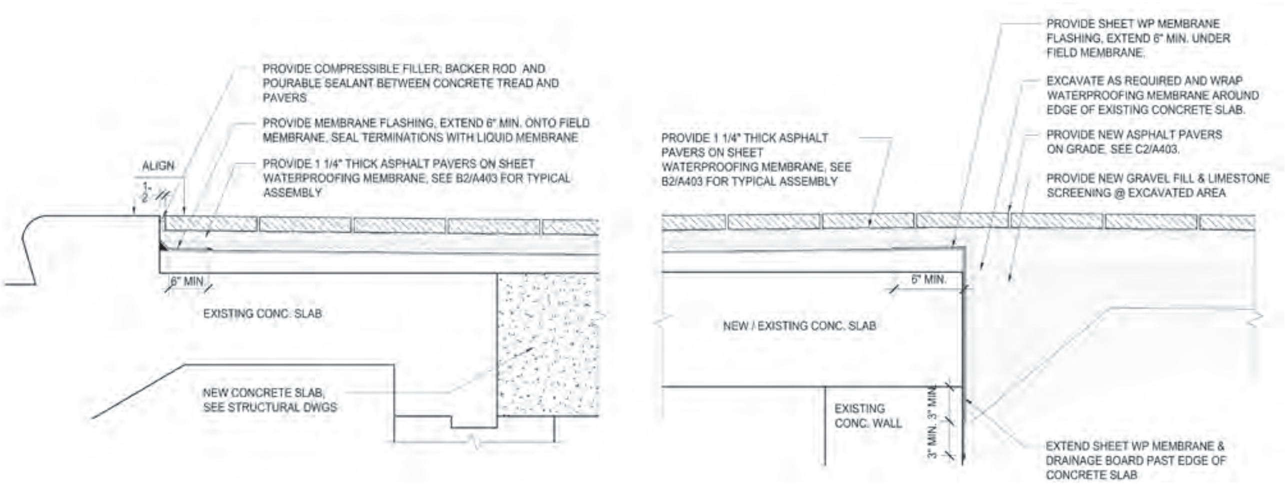


Fig. 6.17.23
Brick cavity wall installation with seismic anchors and spray applied waterproofing membrane. Courtesy: Nelligan White Architects

Fig. 6.17.21
Parapets were hydro-blasted, using a high pressure water jet to exposed and clean reinforcing bars, and the concrete surface. Courtesy: Nelligan White Architects

LLW No. 060224 – Parapets

1. Concrete Parapets

- Remove all existing paint that has been applied to the concrete
- Repair existing cracks found throughout the structural concrete elements of the building, including the columns, spandrel beams, roof slab soffits and parapets
- Remove and repair all spalled concrete, apply anti corrosion coating to rebar, or replace if beyond repair
- Provide a migrating corrosion inhibitor to all exterior concrete to help protect embedded reinforcing steel from future corrosion
- Provide vapor permeable protective coating to restore all surfaces to consistent color and texture
- Provide new railings to be secured to the existing concrete parapets to meet the code required height of 42”
- Provide new custom profile railings to match existing, install at 42” high off the roof

2. Brick Bulkhead Parapets

- Replace all existing brick bulkhead parapets
- Provide new coping stone with drip edge and SS through wall flashing

Fig. 6.17.22
A series of custom fiberglass form liners were manufactured to serve as form work for the new parapet face. Courtesy: Nelligan White Architects

Fig. 6.17.23 (right)
At the parapet, individual pours had to be staggered to prevent further cracking due to initial expansion of concrete. Courtesy: Nelligan White Architects

Fig. 6.17.23

LLW No. 060289 – Roofs

1. Roofs

- Provide full built-up-roof replacement for roofs R1-R9
- Provide new Kemper roof for all bulkhead roofs
- Provide 2" screed coat to all slabs to pitch to drain
- Snake all existing drains
- Provide new reglet mounted base flashing a minimum of 8" above new roof
- Provide new gutters, leaders and splash blocks at roof R6 & R8

Fig. 6.17.24 (below)
A finished section of the new parapet. Courtesy: Nelligan White Architects

Fig. 6.17.24

Constructability & Lessons Learned

Fig. 6.17.25
Concrete deterioration by hydro-scrubbing. Courtesy: Nelligan White Architects

Fig. 6.17.26 (below)
Bugholes observed in the concrete after the formwork was removed and the required coating applied. Courtesy: Nelligan White Architects

Parapet Formwork

Once active concrete deterioration had been mediated by hydro-scrubbing, replacement of corroded reinforcement, and application of a migrating corrosion inhibitor, the entire concrete structure had to be restored to a consistent texture and color. Since the original cover was insufficient to prevent corrosion, up to three inches of new cover were poured over the entire building. In order to maintain the original wood pattern at parapets, an original feature resulting from the wood used in the original formwork, a series of custom fiberglass form liners were manufactured for the new parapet face. Individual pours were staggered to prevent further cracking due to initial expansion of the concrete, resulting in a clean, safe, code compliant parapet, which maintains the structures original textural features.

Cast-in-Place Concrete

While the pouring of the additional 3" of cover over the entire building, was both an aesthetic and structural success, *'bugholes'* were observed in the concrete after the formwork was removed and the required coating applied. These bugholes are small pockets that allow water to collect and freeze within them, exposing the surface to a freeze/thaw dynamic. Despite these deficiencies, it was determined that since the coating had already been applied, patching would cause even greater problems during freeze thaw cycles, and this work was eventually accepted.

Fig. 6.17.26

Coping Stones

It was observed on-site that the cast-stone copings at the top of the brick parapets had been damaged and chipped during installation. These chips ranged from 2” – 8” wide and up to 1” deep. The contractor was directed to remove and replace the damaged coping stones, as patching was not acceptable per the specification. Additionally, based on the way the stones were damaged, it was assumed that the materials did not meet the standards of the specification.

The stones were tested, and failed the specification requirement of less than 5% mass loss after 300 freeze-thaw cycles, with results of 13% mass loss. It was determined that the coping stones were not left to cure for the required amount of time, thus, they did not reach their maximum strength. Hence, all coping stones were replaced.

Fig. 6.17.27
Damaged cast stone copings at the parapet. It was determined that the cast stone was not allowed to cure for the required amount of time, significantly reducing its strength. Courtesy: Nelligan White Architects

Fig. 6.17.28 (below)
Materials testing of the coping stones simulated 300 freeze-thaw cycles. The specification mandated less than 5% mass loss, these coping stones lost an average of 13%. Courtesy: Future Tech Consultants of New York, Inc.

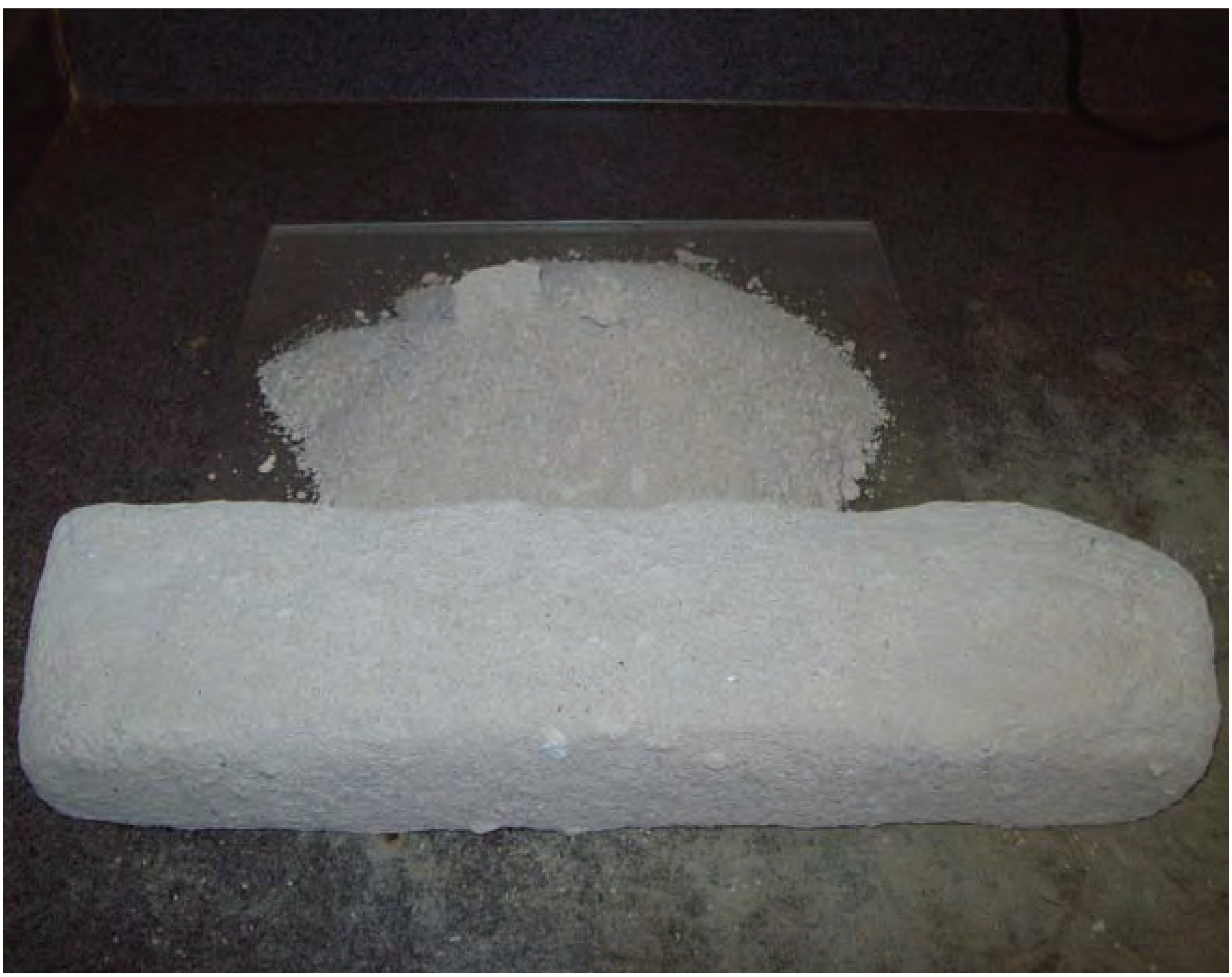


Fig. 6.17.28

Fig. 6.17.29 & 6.17.30 (above - below)
Scratched and uneven coating at the window guards after their first installation. Courtesy: Nelligan White Architects

Window Guards

Existing window guards were directed to be removed, hot-dipped galvanized, and reinstalled, however, the specification was updated and the contractor was later directed to shop-apply an epoxy coat paint system.

Following refurbishment, window guards were first reinstalled on the building, though their finish did not meet the standard of the approved mockup. The finished painted surface was uneven and bumpy, indicating that the surface preparation was not adequate before the primer and paint was applied. Additionally, paint and primer was scratched and chipped in many locations both at the guards that had been installed, and the guards being stored at ground level.

Once the refinished guards were installed it was found that they were in the wrong locations, thus, inhibiting Fire Department access. Window guards must be installed with Fire Department access panels in locations with removable window panes. These guards had to be removed, and reinstalled in their correct locations.

Fig. 6.17.31

Fig. 6.17.32

Fig. 6.17.31 & 6.17.32 (above right - right)
Final images of the completed window guards in their correct, Fire Department compliant locations. Courtesy: Nelligan White Architects

Roof Installation

During construction, it was noted that the SBS modified Bituminous Roofing System had failed. At several locations, the cap sheet had buckled, creating creases across the roof. In these locations, the cap sheet was not adhered to the layer below. Additional layers of ply were used to patch these locations; this did not remedy the problem. Upon inspection areas of shiny asphalt were present underneath the cap sheet, thus, demonstrating sites of no-adhesion between layers. A bulletin was issued mandating that areas where blistering was present and where Infrared Analysis showed moisture was present should be cut out, and patched with dry materials. The final roofs were to have an entirely new cap sheet installed, though it was eventually agreed that a method of cutting out the deficient sections and patching with new material was sufficient.

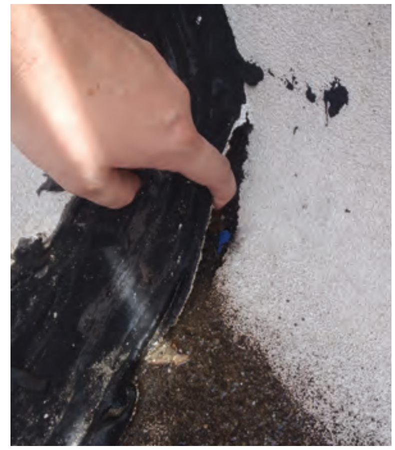


Fig. 6.17.33 (above)
The roof cap sheet was observed to be unadhered in multiple locations. Courtesy: Nelligan White Architects

Fig. 6.17.34

Fig. 6.17.34 (left)
Ridges and buckles were found across the cap sheets, indicating that they were improperly installed and unadhered at the bottom. Courtesy: Nelligan White Architects

Fig. 6.17.35 (below)
The finished roof after patching.
Courtesy: Nelligan White Architects

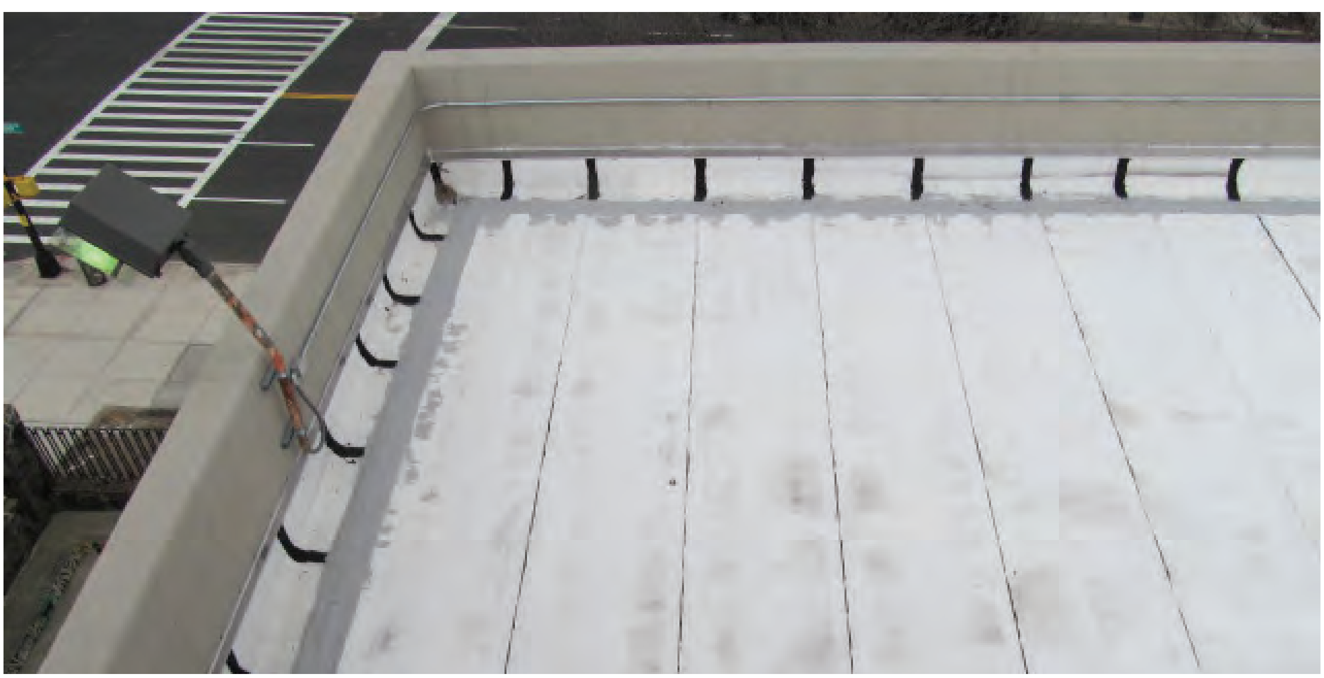


Fig. 6.17.35

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These buildings must be preserved not only as architectural, historic, and cultural assets, but also as facilities essential to the success of their original mission – the education of New York's children.

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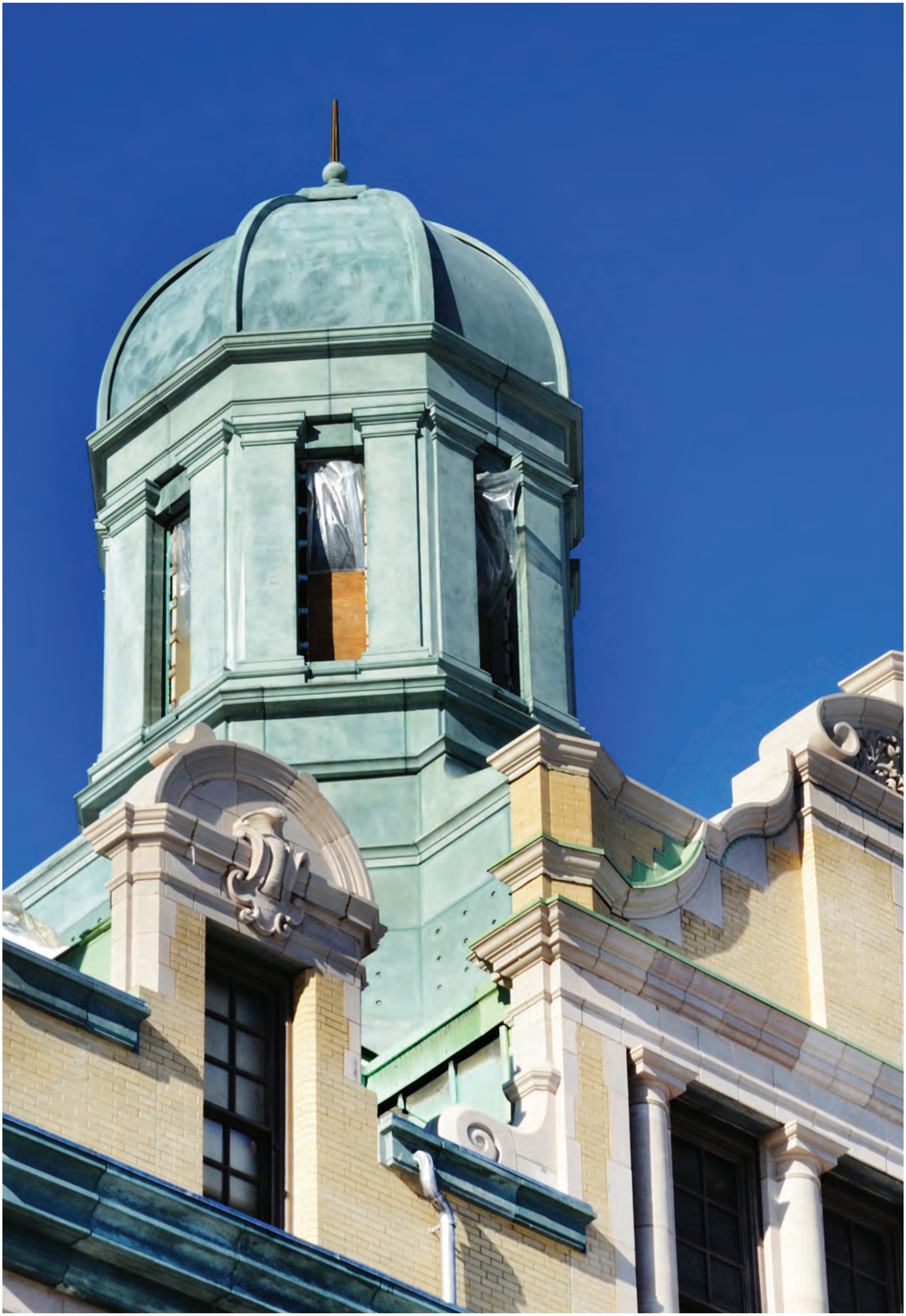

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