The Stylistic Evolution of Historic Cast Stone

Richard Pieper

How the use of this remarkably variable material responded to accommodate changing tastes in natural stone.

Fig. 1. Cleft Ridge Span, Prospect Park, Brooklyn, New York, built 1871–1772. This span is New York City's oldest extant cast-stone structure and was constructed of Coignet stone. The abutments have cast stone tinted to replicate brown and buff sandstones. All photographs by the author, 2021, unless otherwise noted.

Cast stone—precast concrete molded and finished to resemble cut natural stone—played a significant role in late nineteenth- and early twentieth-century architecture in the United States and Canada. Given its ubiquity and its often prominent use, it is surprising that not more has been written about it in preservation literature. The U.S. National Park Service's *Preservation Brief 42* focuses on its repair and replacement issues.[1] Adrienne Cowden and David Wessel's chapter in *Twentieth Century Building Materials* places cast stone within the context of modern materials and also deals with conservation issues.[2] In the *APT Bulletin: The Journal of Preservation Technology*, Theo Prudon's thorough survey piece reviews in detail the origins of the manufacture of cast stone and presents a summary of patented cementing systems used in the last quarter of the nineteenth century.[3] This article specifically examines the changes in the manufacture, surface treatment, and appearance of portland cement–based cast stone as it was adapted to architectural fashions for natural stone during the first and second quarters of the twentieth century.

Early Efforts at Fabricating "Artificial Stone"

As the popularity of concrete expanded at the end of the nineteenth century, a multitude of names was used to describe concrete products. "Artificial stone," one of the earliest terms, was used to refer to both cast-in-place and precast concrete. Beton Coignet or Coignet stone, Frear stone, Ransome stone, and Sorel stone were all patented systems using various cementing agents. “Artistic concrete” was a genre of decorative precast concrete, popular in residential construction, which used molded forms but made little effort to imitate the tooling and surface appearance of natural stone. “Concrete stone” was a popular catch-all term that was often used to refer to precast concrete in general. In the twentieth century, “cast stone” was the term that became most commonly used for precast concrete that imitated natural stone.

The proprietary cast-stone systems listed above, plus a few others, were reviewed and evaluated by Quincy Adams Gillmore, a consulting U.S. Army civil engineer, whose work, entitled *A Practical Treatise on Coignet-Béton and Other Artificial Stone*, was published by D. Van Nostrand in New York City in 1871.[4] As suggested by the title, Gillmore found Coignet-béton, which used a cementing matrix of portland cement imported from France or England and domestic Rosendale cement, to be a superior product. Gillmore became an officer of the New York and Long Island Coignet Stone Company, which had been founded in 1869 and was based in Gowanus, Brooklyn.[5]

Two structures produced by the company illustrate the range in appearance of their cast stone. The first, Cleft Ridge Span in Prospect Park, the earliest cast-stone structure in New York City, is a pedestrian tunnel designed by Calvert Vaux and Frederick Law Olmsted and constructed of Coignet stone in 1871–1872 (Fig. 1). Today, the colors of the weathered abutments of the tunnel are soiled and muted, but it is apparent that both a brown and a buff cast stone were used, in imitation of popular sandstones of the period. Weathering shows that a fine grade of natural sand was used as the aggregate (Fig. 2). The cast stone of the extraordinarily ornate paneled intrados of the tunnel has faded as well; the ornament within the panels has been overpainted, but it is surrounded by an uncoated brown Coignet stone framework. Portions of this frame adjacent to the abutments were replaced during a ca. 1980s restoration, but the inner portions of the intrados are in remarkably unweathered condition. A sample of this brown frame removed during the restoration shows that the color of the stone is provided by the tinted cementitious matrix, not a colored aggregate, and that the color runs through the entire piece (Fig. 3). The unweathered castings within the vault may have been washed or brushed after casting but display no evidence of tooling.

The second Coignet stone structure is the headquarters of the New York and Long Island Coignet Stone Company itself. Designed in 1872 and constructed soon thereafter, the structure is clad with a white/buff Coignet stone veneer with extensive ornamentation: rusticated ashlar and quoining and extensively ornamented window hoods

Fig. 2. Cleft Ridge Span, detail of a weathered bracket. Coignet stone used relatively fine-graded natural sand, not crushed stone, as the aggregate.

Fig. 3. Cleft Ridge Span, showing the frame of the intrados of the tunnel, which was constructed of Coignet brownstone. A small sample of a salvaged element shows that the original color was quite similar to that of brownstone from Portland, Connecticut, a popular building stone of the time. Algae growth has stained portions of the intrados green.

Fig. 4. New York and Long Island Coignet Stone Company headquarters, intersection of Third Street and Third Avenue in the Gowanus section of Brooklyn, New York, built 1872–1873, showing an unaltered portion of the base of the west facade of the building before restoration. The building was used to showcase the level of detail that could be achieved with the material. While this weathered surface is white; on broken surfaces, Coignet stone was a dark buff, similar to that of Canadian Maritimes sandstones, which saw wide use in New York City in the 1870s.

and surrounds. While areas of flat wall ashlar were later clad with a brick veneer, the lower part of the west facade had been covered by adjacent construction and remained relatively unaltered (Fig. 4). This Coignet stone, which may have been washed or coated, was quite white on the exposed surface. On freshly broken surfaces, however, the stone is darker and more like the Ohio, Nova Scotia, and New Brunswick sandstones that were popular in this era. An acid-washed sample prepared for a recent restoration of the building found that the original aggregate was a fine siliceous sand, similar to the aggregate of the buff and brown stones of the Cleft Ridge Span. The mix was uniform throughout the castings. There was no coarse aggregate.[6]

The initial success of the New York and Long Island Coignet Stone Company was impressive. The *Brookyln Eagle* reported in 1871 that "early commissions included four thousand feet of cast stone for a pavilion in Rockaway, as well as an unidentified church on Staten Island and a house faced with 'Coignet brown stone,' which was claimed to be superior to natural brownstone, Ohio sandstone, and similar materials."[7]

Despite a number of notable projects, such as the Cleft Ridge Span and the arches and clerestory windows of Saint Patrick's Cathedral in Manhattan, the company filed for bankruptcy in October 1873 and again in April 1876. Reorganized as the New York Stone Contracting Company in 1877, the company closed in 1882.[8] What happened? The rapid growth of the burgeoning terra-cotta industry in nearby Perth Amboy, New Jersey, undoubtedly hurt business, and the need to use expensive imported portland cement very likely played a role as well.[9]

Cast Stone Comes of Age

The growth of the domestic portland cement industry at the end of the nineteenth and beginning of the twentieth centuries is documented in *Portland Cement Materials and Industry in the United States* by Edwin C. Eckel and Ernest Francis Burchard.[10] The authors state that imported cement (primarily from England and France) exceeded domestic production until about 1897. They chart the falling price of portland cement as domestic production increased: A barrel that cost an average of $3.00 between 1870 and 1880 brought just $1.09 in 1900. In 1911 this price had fallen further to 84 cents. This brought precast products within the reach of a much broader clientele and led to a strong recovery of portland cement–based precast products. Starting in the 1890s, the production of precast concrete intended to imitate natural stone increased dramatically. "Artistic concrete" became more popular as well, and the two were used contemporaneously.

Cement Age, a monthly magazine first published in 1907, chronicled the developments in precast work, as well as cast-in-place, during its period of growing popularity. The editor of *Cement Age*, Harvey Whipple, issued a handbook in 1915 for fabricators entitled *Concrete Stone Manufacture*, which drew upon the articles in the magazine.[11] It is clear from reviewing the articles in *Cement Age* that precast manufacturers were emerging throughout the U.S. and that all concrete was local. Today, one generalizes about aggregates, pigments, and molds at their peril; Whipple's book attempts to draw themes and common methods from the disparate efforts of a nation of innovators.

Whipple devotes a long chapter to molds and patterns, detailing the use of cast-iron molds, wooden molds, and many types of plaster, gelatin, and glue molds, ending, most importantly, with sand molds. It was the introduction of the sand-molding process that would enable dramatic increases in cast-stone production and lead to advancements in surface finishing and appearance that would spur the adoption of cast stone on major buildings.[12]

One limitation in the production of precast concrete had always been the time required for the initial "set," after which the cast element could be removed from the mold. For elements for which numerous units were required (balusters, for instance) freeing molds for reuse was a major problem. Early fabricators responded by using rigid molds of wood or cast iron and a relatively dry and stiff concrete mix, to allow castings to be removed quickly. This "dry-tamp" method used pressure and tamping to assure that the mix filled the mold and allowed molds to be reused more frequently, but it necessitated the use of steam rooms for moist-curing and proper hydration of the cement. The use of a moist sand mixture for molds, similar to the "green sand" used to produce cast iron, allowed multiple molds to be made easily with one pattern and made quick removal of the castings unnecessary. The cast-stone units could also be "wet cast," with a more liquid mix. The added water in the mix and the moist sand form facilitated proper hydration.[13]

"Cut" Cast Stone

The Onondaga Litholite Company, a cast-stone manufacturer based in Syracuse, New York, was an early leader in the manufacture of sand-cast stone, although other companies, such as Emerson & Norris in Boston and the Benedict Stone Company in Chicago, became major producers as well. Onondaga called its product "cut cast stone," because the cement-mold skin at the surface was removed not just by brushing and washing but by tooling the surface after casting. Harvey Whipple noted that "in the production of a high quality of wet cast stone, the best results are obtained in treating the products just as natural stone is treated. This includes the use of chisels, bush-hammers, crandals [*sic*], abrasives, planers, polishers, and so on."[14] Other sources indicate that tooling typically removed a full quarter inch of the surface of the rough casting. In 1925 the Onondaga company published a booklet that illustrated all of these tooling techniques and included pictures of major buildings throughout New York State and in Philadel-

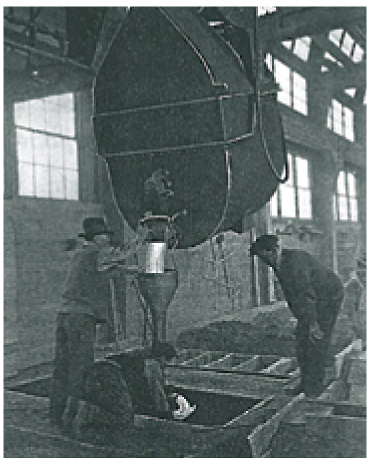


Fig. 5. Production of Onondaga cut cast stone at the Onondaga Litholite Company, ca. 1925. This image shows the method and scale of the facility for sand-casting cut cast stone. Courtesy of Avery Classics, Avery Architectural & Fine Arts Library, Columbia University.

Fig. 6. Production of Onondaga cut cast stone at the Onondaga Litholite Company, ca. 1925. This image shows the method of pouring into the mold without disrupting the sand and the method of supporting internal reinforcement for larger pieces. Courtesy of Avery Classics, Avery Architectural & Fine Arts Library, Columbia University.

phia, Baltimore, and Washington for which the company had provided cut cast stone.[15]

Charles Richardson's *Building Stones and Clays*, published in 1917 in Syracuse, includes a section entitled "Cut Cast Stone," in which he stated:

> This material has been coming very rapidly into use in the East during the last five years. The Onondaga Litholite Company of Syracuse, N.Y., has alone furnished this stone for over four hundred large and prominent structures during the past two years. This material is adapted for use in any place where natural stone can be used. It is reasonably low in price and it is particularly adapted for use where a large amount of ornamentation is desired. It has this past year been used in a large percentage of the public buildings erected by the State of New York, as well as very extensively for city and municipal work in New York City and throughout the state. It has been used largely in the construction of balustrade[s] and ornamental garden work, as well as bridge construction and in a number of high grade residences constructed in the east.[16]

Illustrations of the sand-casting and tooling process in the Onondaga booklet show how production of this magnitude was possible. Photographs show a football field–length building with multiple rows of sand molds filled from overhead tracks. Richardson stated that "a portable mixer, with which the liquid concrete is kept constantly agitated, [is] used to convey the material from the mixer to the molds. An electric crane is used for this purpose. This portable mixer handles two yards of material at one time" (Figs. 5 and 6).[17]

Tooled, wet sand-cast stones dominated the market for more than two decades. Due to falling prices for domestic portland cement and to the nature of the stones popular at this time, cut cast stone competed quite favorably with natural stone in this market. The key to its success was the high level of ornamentation used in public architecture of the period. Whipple noted that "cast stone, finished by the various methods mentioned, has reached a high plane of development in several factories, more especially in the East. . . . On straight work it is made for very little less than Indiana Limestone, but on work where natural stone would require a great deal of cutting, and where many like pieces are required, the concrete stone is much cheaper."[18]

While Coignet stone was intended to imitate the brown and buff sandstones popular at the end of the nineteenth century, the tooled cast stones commonly produced by Onondaga and others at this time were intended to imitate two building stones that were extremely popular in the early twentieth century: Indiana limestone and fine grained "white granite," like that quarried in Hallowell, Maine; Concord, New Hampshire; and Chelmsford, Massachusetts. The "limestone" type was produced by using a fine aggregate of crushed white marble or limestone (Onondaga used white marble from Gouverneur, New York); Onondaga's "granite" was produced with the same marble aggregate but with the addition of a smaller amount of jet-black crushed-copper smelting slag to replicate the dark "mafic" minerals in the genuine stone (Fig. 7). Onondaga called this stone "Onondaga Cut Cast Granite" and noted in its 1925 booklet that it had "been used in more than 500 bank buildings."[19] In later years, when more coarsely grained colored granites from Maine, Massachusetts, and New York became popular, this mix was sometimes adapted by adding a tinted cementing matrix and a slightly larger marble aggregate in order to suggest a pink granite (Fig. 8).

Figured and Highly Colored Natural Stones Become Popular

In the 1920s, tastes in natural stone changed again. Indiana limestone and fine-grained granites were still used, of course, but highly figured and colorful stones became much more common in prominent buildings. In New York City, the architectural firm of York and Sawyer popularized the use of a banded Ohio sandstone (often called "Briar Hill sandstone"), which they mixed with Indiana limestone on the facades of such distinguished buildings as the Bowery Savings Bank on 42nd Street (1923), the Federal Reserve Bank (1924), and the New York Academy of Medicine (1926) (Fig. 9). Cast-

Fig. 7. Detail of cut cast granite, 145 Hudson Street, New York City. At right, the stone's surface is as manufactured, with shallow tooling from a flat chisel still intact. At left, the surface of the stone has weathered; the tooling is gone; and the aggregate becomes more prominent.

Fig. 8. Detail of cut cast granite using a pink cementing matrix, 872 Madison Avenue, New York City. While cut cast stone imitating Indiana limestone and fine-grained white granites were most popular; in the second and third decades of the twentieth century, a pink-tinted cementing matrix was sometimes used (less successfully) to imitate colored granites.

stone manufacturers responded with a cement-paste, surface-ornamented cast stone (as opposed to a tooled aggregate-decorated cast stone), which was intended to imitate this figured stone. The Columbia University Irving Medical Center at 622 West 168th Street (1925–1928) is a prominent example of this material. More modest buildings, such as 425 Park Avenue South, used it for entries as well (Fig. 10).

At about the same time, Kasota limestone (also known as Mankato-Kasota stone) from Minnesota became popular in the East. This textured, porous, and colorful yellow, orange, and pink limestone famously saw prominent use for the exterior of the Philadelphia Museum of Art (1928). York and Sawyer, which had used the limestone for the lobby of the New York Academy of Medicine, clad the exterior of the lower four floors of One Park Avenue in New York City with it in 1929. Frederic Emerson, of the Boston cast-stone firm Emerson & Norris, submitted a patent application for surface-ornamented cast stone in 1927. Emerson's application derided the "uniform and monotonous surface" produced by the "ordinary sand-mold process" and proposed that with his new method, the "surface may be made to present not only a variegated texture, but to combine with this a variegated and clouded or blended color tone effect, so that there may be produced a wide range of cast stone surfaces resembling the natural and even weathered surfaces of [a] wide variety of natural stones which have heretofore been incapable of being reproduced by the casting or molding process."[20]

A surface-ornamented cast stone could obviously not be tooled, as cut cast stone was, to remove the hard cement layer that formed at the interface with the sand mold. Emerson's patent describes a method for preparing the surface of the sand mold with a sometimes chunky mix of paraffin and kerosene to prevent water loss into the sand and to add texture to the surface of the casting. After this preparation of the mold, Emerson noted: "a relatively small amount of a wet mixture containing coloring material and cement . . . may be applied in irregular patches or masses, or may be veined or blended into the stone-producing mixture as or before the latter is poured into the mold."[21]

Soon thereafter, lower facades of pink, orange, and yellow surface-ornamented cast stone sprang up, many of them on Manhattan's Upper West Side. These facades vary significantly in how literally they simulate Mankato-Kasota stone, and the differences in coloration and patterning suggest that they are the work of more than one fabricator. One of the most skillful and best-preserved examples is the lower facade of Sherman Square Studios at 160 West 73rd Street (1929) (Fig. 11).

Fig. 9. Detail of the nameplate engraved on banded Ohio sandstone adjacent to the main entry of the former Bowery Savings Bank, 110 East 42nd Street, New York City, built 1923. York and Sawyer popularized the use of this stone in several prominent buildings in New York City in the 1920s.

Fig. 10. Columbia University Irving Medical Center, 622 West 168th Street, New York City, built 1925–1928. Cast stone was used for the entries and trim. Some accounts of the period stated that cast-stone imitations of the banded sandstone were done by laying wet strings dipped in masonry pigments in the molds and removing them before the elements were cast.

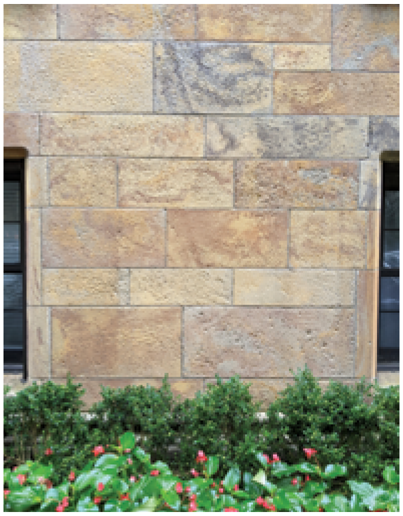
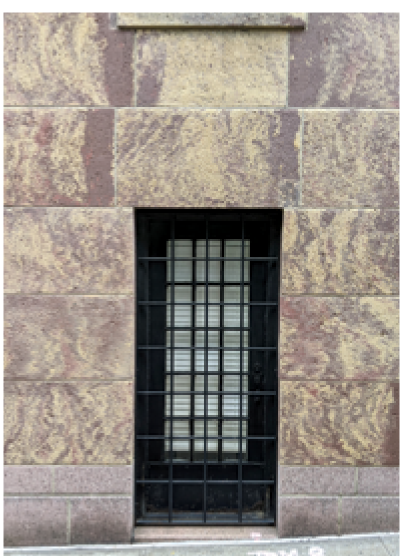


Fig. 11. Sherman Square Studios, 160 West 73rd Street, New York City, built 1929. When Mankato-Kasota stone became popular in the 1920s, cast-stone manufacturers responded with a cement-paste, surface-ornamented cast stone that approximated its appearance; this is one of most successful and best-preserved examples.

Fig. 12. 400 West End Avenue, New York City, built 1931, showing an example of surface-ornamented stone. Numerous versions of surface-ornamented stone can be found, varying in style and apparently produced by different manufacturers.



The El Dorado apartment building at 300 Central Park West (1931) uses a similar cast stone for the cladding of its lower three floors and for other trim. The base of the former George Washington Hotel (1930) on Lexington Avenue between 23rd and 24th Streets shows another reasonably well-preserved interpretation. Numerous others are to be found in New York City.

All cast stones weather through erosion of the cementing paste, but, as would be expected, this loss of paste has a more dramatic effect on surface-ornamented stone than on aggregate-decorated stone. A quick cast-stone walking tour will reinforce an understanding of the weathering limitations of surface-ornamented stone, as well as the importance of artistry in the fabrication of this material (Fig. 12). It may also give new appreciation for the "uniform and monotonous" appearance of earlier cut cast stones imitating granites and limestones.

Other, lesser known stones became popular in the Northeast in the 1920s and 1930s, and cast-stone manufacturers could be counted on to respond. The Baptist Tabernacle Warren Hall (1928) on Second Avenue between 10th and 11th Streets in Manhattan attempts to imitate a coquina—a porous, shelly limestone, like those quarried in Texas and Florida—that saw brief popularity in this period. A review of manufacturers' catalogues and technical literature of the period reveals just how varied and regional cast-stone offerings were. Aberthaw Construction Company of Boston offered stones matching the colors of Berea limestone [*sic*]; gray, red, and brown sandstones; and bluestone, as well as a "composite granite."[22] In 1927 the Arnold Stone, Brick & Tile Company of Jacksonville, Florida, offered "cut cast stone" in nine different shades, including "pink granite" and "blueish-gray granite."[23] A 1908 article in *Cement Age* about the National Stone Manufacturing Company of Minneapolis, Minnesota, noted that by using an aggregate of crushed dolomite, the company could produce a cast stone resembling marble and, with masonry pigments, brown and red sandstones that corresponded "closely" with the local Port Wing, Wisconsin, and Portage Entry, Michigan, stones. A cast stone made with an aggregate of the "native blue limestone," the article noted, "resembles blue Bedford stone so closely that it is frequently taken for Bedford by the expert stonecutter."[24] The expansive use of the term "artificial stone" in period literature can be misleading, however. An article in the January 1914 *Concrete-Cement Age* magazine (the successor to *Cement Age*), entitled "Artificial Travertine Stone Manufacture for Panama-Pacific Exposition," suggested another local interpretation of portland-cement cast-concrete stone, but a careful reading suggests that this was a gypsum plaster product.[25]

An Era Passes

Cast-stone manufacturers had been remarkably adept at modifying their production to adapt to changing tastes in building stone: They replicated buff and brown sandstones with graded natural sand and pigmented matrix beginning in the third quarter of the nineteenth century, limestones and granites with decorative aggregates and tooling in the beginning of the twentieth century, and highly figured and colorful sandstones and limestones in the 1920s and 1930s with surface-ornamented cast stone. There was something much more difficult to adapt to, however, and that was changing architectural design. The move to modernism and the international style sounded the death knell for an industry predicated upon the manufacture of inexpensive masonry ornament. In her article "Cast Stone's Trials of Authenticity: How Labor and Modernism Conspired to Kill a Nascent Industry," Jennifer Kearney argues that labor strikes initiated by unions affiliated with stone cutters, criticism of cast stone as a cheap artificial material, and the general slowdown of construction on the eve of World War II doomed the industry.[26] Undoubtedly, there were many nails in cast stone's coffin, but chief among them was the rapid adoption of the metal-and-glass curtain wall in the 1950s. The United Nations Secretariat Building and Lever House (both completed in 1952) are two prominent and early metal-and-glass curtain-wall buildings in New York City. The Onondaga Litholite Company filed for bankruptcy two years later, about the same time that construction started on Mies van der Rohe and Philip Johnson's international style Seagram Building on Park Avenue.

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Notes

1. Richard Pieper, *Preservation Brief 42*, "The Maintenance, Repair, and Replacement of Historic Cast Stone" (Washington, D.C.: U.S. National Park Service, 2001).

2. Thomas Jester, *Twentieth Century Building Materials: History and Conservation* (Los Angeles: Getty Conservation Institute, 2014), 87.

3. Theo Prudon, "Simulating Stone, 1860–1940: Artificial Marble, Artificial Stone, and Cast Stone," *APT Bulletin: The Journal of Preservation Technology* 21, nos. 3–4 (1989): 79–91; Prudon's article also includes information about Keene's, Martin's, and Parian cements; gypsum-based products; and scagliola, a technique that used tinted gypsum-plaster mixes to simulate polished marble for interior decoration.

4. Quincy Adams Gillmore, *A Practical Treatise on Coignet-Béton and Other Artificial Stone* (New York: D. Van Nostrand, 1871).

5. The terminology for this material can be confusing. The proper French term is Beton Coignet, with the modifier (Coignet) following the noun (Beton). In his 1871 book, Gillmore put the modifier first, as is typical in English. This was later anglicized further. New York Landmarks Preservation Commission 378, LP-22-2, New York and Long Island Coignet Stone Company Building, 360 Third Avenue, Brooklyn, N.Y., June 26, 2006, http://www.nyc.gov/html/records/pdf/govpub/2469ny_li_coignet_stone_co.pdf. Matt Postal's wonderfully detailed designation report is as much a history of Beton Coignet as it is a history of the building it reviews. Postal notes that the company was originally incorporated as the Coignet Agglomerate Company of the United States but operated as the New York and Long Island Coignet Stone Company.

6. I am indebted to John Walsh of Highbridge Materials Consulting and to Mary Jablonski of Jablonski Building Conservation for providing a sample of original stone and acid-washed aggregate from the New York and Long Island Coignet Stone Company. Stone from the Canadian Maritimes was popular in New York City in the 1860s and 1870s. Calvert Vaux used it for construction of the arcade, terrace, and fountain of the Bethesda Terrace in Central Park from 1861 to 1864.

7. New York Landmarks Preservation Commission 378, LP-22-2, 3. The claim that Coignet brownstone was superior to natural brownstone comes from "Artificial Building Stone," *Brooklyn Eagle*, March 9, 1871, 2, which reported on the construction of a large building of Coignet brownstone by a "well-known builder." The article also stated that "Mr. Harteau, who was for many years in the brownstone business in this city, endorses the new material as far superior to natural brownstone, Ohio sandstone, Nova Scotia stone, and similar material now in use, and predicts its general adoption in the United States."

8. New York Landmarks Preservation Commission 378, LP-22-2, 6.

9. Perth Amboy, New Jersey, and the surrounding areas were known for their abundant deposits of Cretaceous clays. The area became a center of production for architectural terra-cotta in the 1870s. There were several firms in the area, but the Atlantic Terra Cotta Company was the largest.

10. Edwin C. Eckel and Ernest Francis Burchard, *USGS Bulletin 522: Portland Cement Materials and Industry in the United States* (Washington, D.C.: U.S. Dept. of the Interior, 1913).

11. Harvey Whipple, *Concrete Stone Manufacture* (Detroit: Concrete-Cement Age Publishing Co., 1915).

12. Harvey Whipple began his section on sand molds with a caveat: "The use of sand molds in making concrete casts is covered by patent," adding that the sand mix employed was also protected by patent and suggesting that the reader "make inquiry" with the Patent Office to check particulars. Whipple did not specify which patent he was referring to. Edmund S. Parsons, Process of Molding Concrete, U.S. Patent 1,241,144A, granted Sept. 25, 1917; the patent describes a method of sand-casting. In his preface to the *Concrete Stone Manufacture*, Whipple thanked "Mr. Henry P. Warner, President and Manager of the Ononodaga Litholite Company, Syracuse, N.Y. . . for his suggestions on Sand Cast Stone manufacture."

13. Numerous sources describe the way that sand-casting improved the cast material. It allowed the use of a wetter mix, assuring good compaction without tamping. As the sand initially absorbed some of the water from the mix, it lowered the water:cement ratio, increasing the strength of the casting. Ultimately, the water held in the sand assured proper hydration and curing of the cement in the casting. The migration of water into the mold, however, left a cement skin on the surface of the casting, and this needed to be removed by washing, brushing, or tooling.

14. Whipple, *Concrete Stone Manufacture*, 150.

15. *Onondaga Cut Cast Stone* (Syracuse: Onondaga Litholite Co., 1925), 44–47, https://archive.org/details/onondagacutcasts00onon.

16. Charles Richardson, *Building Stones and Clays* (Syracuse: self-pub., 1917), 401.

17. Richardson, *Building Stones and Clays*, 397.

18. Whipple, *Concrete Stone Manufacture*, 152.

19. *Onondaga Cut Cast Stone*, 44.

20. Frederic Emerson, Artificial Cast Stone and the Process of Producing the Same, U.S. Patent 1,681,727, granted Aug. 21, 1928.

21. Frederic Emerson, Artificial Cast Stone and the Process of Producing the Same, U.S. Patent 1,681,727, granted Aug. 21, 1928.

22. *Aberthaw Cast Stone for Trimmings of Buildings and Other Uses* (Boston: Aberthaw Construction Co., 1903), 2, https://archive.org/details/aberthawcaststone00aber#.

23. *Tentative Standard Specifications for Cut Cast Stone* (Jacksonville: Arnold Stone, Brick & Tile Co., 1927), appendix, paragraph 3, https://archive.org/details/cut-cast-stone-1927-a/page/n1/mode/2up#.

24. C. A. P. Turner, "Concrete Building Stone," *Cement Age*, Jan. 1, 1908, 3.

25. H. M. Wright, "Artificial Travertine Stone Manufacture for Panama-Pacific Exposition," *Concrete-Cement Age*, Jan. 1, 1914.

26. Jennifer Kearney, "Cast Stone's Trials of Authenticity: How Labor and Modernism Conspired to Kill a Nascent Materials Industry," *Future Anterior: Journal of Historic Preservation, History, Theory, and Criticism* 1, no. 1 (2004): 83–89.

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