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Cover: During the late nineteenth century, many original wood or brick floors were replaced with imported or locally manufactured hydraulic mosaics, as shown in this rare interior photograph of a nineteenth-century house in Cuba. Photograph by Alfonso López. Private collection.

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Hydraulic Mosaics and Concrete Blocks in the Spanish Caribbean

Beatriz del Cueto

Fig. 1. During the late nineteenth century, many original wooden or brick floors were replaced with imported or locally manufactured hydraulic mosaics, as shown in this rare interior photograph of a nineteenth-century house in Cuba. Photograph by Alfonso López. Private collection.

Portland-cement molded and pre-fabricated architectural elements transformed the buildings of the Spanish Caribbean between the 1880s and the 1920s.

Architectural conservation in the Spanish Caribbean has focused primarily on traditional lime-based rubble and ashlar masonry buildings that incorporated lime mortars and renders as well. However, this geographical area was a melding pot of international interests from the 1880s through the second decade of the twentieth century. As a result, the advent of portland cement and some of its building products resulted in unique and impressive structures that must be incorporated into the professional dialogue of the region.[1] Many preservationists, the author included, have long considered portland cement an "enemy," detrimental to traditional building fabric. The study discussed in this article has resulted in an understanding of the virtues of cement, which, between the late-nineteenth and early-twentieth centuries, facilitated the production of a

new architectural vocabulary and the use of countless other innovative materials.

The Greater Antilles and the three islands that constitute the Spanish Caribbean—Cuba, the Dominican Republic (eastern Hispaniola), and Puerto Rico—are the focus of these investigations. Common denominators include their cultural and linguistic backgrounds as former Spanish colonies, their geography and geological events (earthquakes, tsunamis), climate (hot and humid, hurricanes), and flora and fauna (fungi, wood-eating insects), all contributing factors that influenced building design.

This paper focuses on only two of the multitude of molded and prefabricated portland-cement building materials used and produced in the tropics: the hydraulic mosaic cement tile and the concrete block. Some of these elements had first been imported into the territory and later locally produced. It is hoped that research into these understudied materials will promote a better understanding of their significant role in changing the face of tropical architecture, particularly that of the Spanish Caribbean, and will serve to generate awareness of the need for the appropriate preservation of significant extant examples (Fig. 1).

As a rule, port cities usually benefit from innovative design ideas at a faster pace than inland settlements and have thus served as important testing grounds and laboratories for technical construction feats. This was certainly the case for portland-cement building technologies in the Spanish Caribbean. The urban fabric and buildings of cities facing the Caribbean Sea and the Atlantic Ocean were important examples of technological evolution and revolution from the mid-nineteenth to the early-twentieth centuries, when the Industrial Revolution and wars defined the period.

The use of lime-based hydraulic mortars evolved into the use of portland cements of the nineteenth century as new and progressive building materials. In most large cities, these changes had meant urban expansion and housing models accessible to all social classes. Standardization and the ease of manufacturing portland-cement

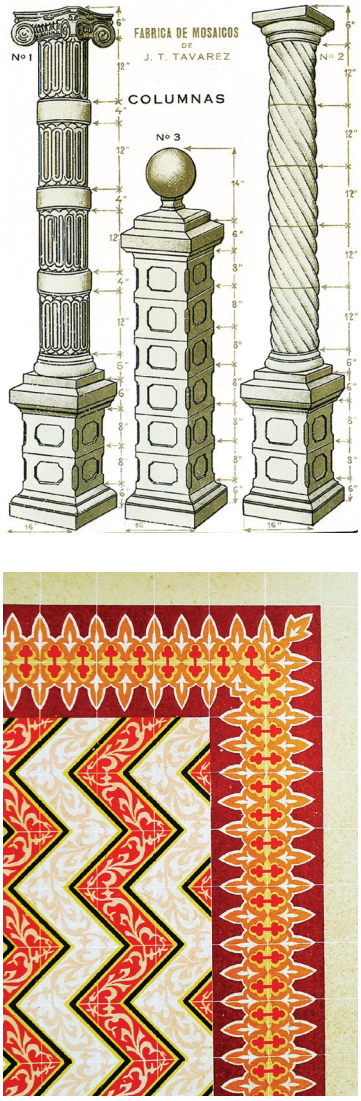

Fig. 2. The availability of molds and portland cement mixes allowed many shapes and forms of innovative and elaborate architectural elements to be manufactured in the Spanish Caribbean. J. T. Tavares, *Fábrica de Mosaicos de J. T. Tavares, Catálogo No. 2* (Santo Domingo: Litografía Ferrua, 1931).

building components made the dream attainable. The stage was set for the evolution of design concepts and a bolder architectural expression.

Portland-cement products gained popularity through European exhibitions and were brought to America by the late 1800s. These building materials were advertised as being permanent, waterproof, and fireproof in the trade catalogs of large enterprises, important characteristics that more than met nineteenth-century building ordinances of the region. As a consequence, hydraulic mosaics (also known as hydraulic cement floor tiles) and hollow-core concrete block would become the design vocabulary for residential, religious, and institutional architecture in the tropics during this era.

The innate characteristic of portland cement—of setting especially well in an extreme wet and humid climate, as well as in hot weather—made it the perfect material in tropical regions. The design of structural components, building facades, and interiors was immensely impacted by new architectural elements made possible by using a mold and a portland-cement mix, allowing many shapes and forms (Fig. 2). Prefabrication facilitated installation and provided price competitiveness. Thus, the relative simplicity of the manufacture of the first hydraulic mosaic floor tiles and concrete blocks, which required no ovens, no artificial heat, nor large manufacturing areas, facilitated their local production. The rather small metal molds and presses needed for both tiles and blocks could be imported easily and set up almost anywhere.

During the last decade of the nineteenth century, many European businessmen and craftsmen emigrated to the Spanish Caribbean due to war or economic problems in their homelands. Portland cement and its products were initially imported from the Old World into the West Indies until the first cement plants were established and the local industries prospered. Leading the list of cement exporters to the region was Germany, followed by Denmark, Belgium, England, France, and later the United States. After the Spanish-American War, during a period of increased economic wealth and growth, construction projects on the Spanish Caribbean islands benefitted from the fast-setting properties of portland cement.

The first portland-cement factory in the Spanish Caribbean was established in Havana in 1895 and known as the Cuba factory. In the Dominican Republic the Fábrica Dominicana de Cemento was inaugurated in 1947. In Puerto Rico the government-owned Puerto Rico Reconstruction Administration factory was built in 1936.[2]

Hydraulic Mosaic Pavements as Metaphors for the Textile Carpet

At the end of the twentieth century Catalonian Modernism, Art Nouveau, and the Eclectic movements heavily influenced design trends in the Spanish Caribbean. It was then that hydraulic mosaics, as a metaphor for the textile carpet and as an architectural element, became common paving material for interiors.[3] Oftentimes called *mosaicos hidráulicos, baldosas de cemento,* or *losa criolla o isleña*, hydraulic mosaics refer to a cement tile measuring 20 centimeters square by 2.5 centimeters thick with highly colorful surfaces. The tiles were composed of three layers of materials compressed in a mold by a press: a thin, decorated top surface (fine sand, marble dust, cement, and pigments that serve both as a durable and artistic layer); a middle joining layer (equal parts of sand and cement that bind the other two layers and absorb the moisture); and a support or bottom layer with the manufacturer's seal (sand and portland cement, in a ratio of approximately 4:1).[4]

Before the incursion of hydraulic mosaics into the Americas, the composition of the earliest tiles was the result of master recipes and experimentation using local lime, as well as cement from France and pigments from Italy. The origin of the hydraulic mosaic pavement has been attributed to Catalonian as well as French inventors, even though the raw materials and equipment to produce it were manufactured and brought from southern France, including the portland cement itself.[5] The tiles would not be fully accepted until ten or fifteen years later as Catalonian Modernism and the Eclectic movements took root. Immigrants from Barcelona to the Spanish Caribbean between the 1880s and early 1900s not only brought the taste for these pavements but also their knowledge of technical production.

It should be noted that the hydraulic nomenclature of the *mosaico hidráulico* is not necessarily derived from the use of hydraulic mortar or portland cement as a primary raw material in the manufacturing process. The term is more directly associated with the hydraulic press, the indispensable equipment used in the tile-manufacturing process; the hydraulic press was a considerable improvement over the original hand-press method and contributed to a better-quality end product.[6]

Installation specifications, which were included in catalogs of hydraulic mosaics, recommended contracting with an experienced mason. The tiles were placed starting from the center of each room and then working outwards. The most common pavement arrangement consisted of a minimum of three different designs. The most elaborate and colorful would form the central pattern, which would be framed by a quadrilateral border and completed by a transitional edge of unicolor tiles (simulating an elaborate rug on a plain floor). The mosaics were commonly laid by tapping with the handle of a mallet, and installed perfectly level from the start, since the finished decorated surface could not be abraded.

During the 1890s many companies established manufacturing plants in Spain, France, and Italy, indicating that the demand for the hydraulic mosaics had grown and was profitable. The fame and acceptance of these paving materials in Europe, and particularly in Barcelona, would be brought to the Spanish Caribbean as early as the 1880s, through catalogs, the mosaics themselves, and experienced Catalonian manufacturers and laborers.

Documentation suggests that as early as 1886, Cuba took a leading role in the establishment of the first hydraulic mosaic or cement-tile factory in the Spanish Caribbean in Havana. By 1894 *La Balear* factory, also in Havana, manufactured an excellent product, and by 1909 its production had increased from 1,000 to 40,000 tiles per month. *La Cubana*, established in 1903, employed 200 workers and had a weekly output of 100,000 tiles.[7]

These molded and prefabricated architectural elements were marketed at trade and industrial expositions in Cuba. Two significant instances were the Palatino Exposition (1909) and the National Exhibition (1911). Public sanitation and hygiene also played an important role in promoting the hydraulic mosaic cement-tile industry, since concerns about the Bubonic plague, present in port cities at the time, led to strict regulations regarding merchandise-storage spaces, which required reinforced concrete slabs or hydraulic mosaics to facilitate cleaning and disinfecting floors.[8]

By the first decade of the twentieth century, the hydraulic-mosaic industry had become a competitive market, which quickly spread throughout the major cities of Cuba (Fig. 3). The weight and weak edges of the tiles contributed to the decentralization of

Fig. 3. Interior of a nineteenth-century house in Trinidad, Cuba. The manufacture and use of hydraulic mosaic tiles spread rapidly throughout the Spanish Caribbean from the 1880s through the 1920s. Photograph by the author, 2015.

Fig. 4. Architectural elements advertised in the *Fábrica de Mosaicos de J. T. Tavares* trade catalog from 1931, produced in Santo Domingo using artificial stone or portland cement and imported pigments. J. T. Tavares, *Fábrica de Mosaicos de J. T. Tavares, Catálogo No. 2* (Santo Domingo: Litografía Ferrua, 1931), 58, 60.

Fig. 5. The Ponce Mosaic Company in Puerto Rico became one of the largest producers of hydraulic mosaics in the region; the firm also exported architectural components to the Dominican Republic. Advertisement, *Puerto Rico Ilustrado* (February 14, 1914).

the industry, since oftentimes it was more practical to take the small, semi-portable presses and materials nearer to the project site than to transport the tiles over the country's uneven and mostly unpaved roads. By 1926 there were 32 hydraulic mosaic-tile factories in Havana alone.

As in Cuba, imported Catalonian hydraulic mosaics made their debut into the Dominican Republic during the 1890s, where they were adopted as part of the general architectural vocabulary. The tiles brought controversy when "Sanitation inspectors blamed their cold temperature for the appearance of yellow fever…Because of this, the tiles were accused of being harmful to health…very cold to the feet, harmful to the eyes."[9] Government officials insisted that the tiles not be used in public buildings due to continued protests, yet their use prevailed, since one of their virtues is that they stay cool and help mitigate the warm temperatures of the Caribbean interiors.

As a consequence of the Spanish-American War, Catalonian immigrants who had been established in Cuba moved to the Dominican Republic in search of new business opportunities. José Turull-Vilanova is credited with having established the first hydraulic mosaic factory called *La Primera* in 1896 in the capital of Santo Domingo. By 1920 local Dominican industrialists began to control hydraulic mosaic-tile production. This was the case with Juan Tavares-Juliá, who established a factory to produce hydraulic mosaics and other artificial stone or cement architectural components in 1921. Tavares bought out his competitors in order to consolidate the Dominican hydraulic mosaic-tile production under one name, *Fábrica de Mosaicos J. T. Tavares* (Fig. 4). By 1925 he was the only mosaics manufacturer in Santo Domingo, advertising molded portland-cement elements such as hydraulic mosaics, columns, capitals, blocks, and balusters.[10]

Even though imported hydraulic mosaics from Barcelona had made their way into Puerto Rican buildings by the 1890s, the first local factories were not established until c. 1904. During this period of economic growth, grand residences, as well as important institutional buildings, exhibited *losa criolla* or *losa isleña* pavements, as these were known locally. New tastes had entered the local market, aided by the dissemination of the Catalonian companies' catalogs, a new upper class influenced by the latest styles and fashion, and a new generation of architects who had studied abroad and been enticed by innovative building materials.

Porto Rico Mosaics in Yauco, founded in 1904, was one of the first manufacturers established on the island. They also produced prefabricated and molded portland-cement architectural columns and moldings.[11] Other manufacturers were established during the first decade of the 1900s, including Jimenez, Ribot & Co. and the Ponce Mosaic Co. (Fig. 5). The factory in Ponce, Puerto Rico, became one of the biggest manufacturing enterprises for hydraulic mosaics, as well as other architectural elements made using portland cement; it exported products to the Dominican Republic as well.[12]

In addition to serving as pavement for new construction, hydraulic mosaics were used for reconstruction work in Puerto Rico following several major natural disasters between 1899 and 1928 (hurricanes, major fires, and a significant earthquake). New regulations promoted cement products, materials, and building technologies that would be appropriate and safe for local structures.

Many more manufacturers appeared in the Spanish Caribbean during the 1920s

Fig. 6. Concrete blocks, in many different designs, were promoted by Sears, Roebuck & Co. of Chicago as being more economical than wood, brick, or stone. Sears, Roebuck & Company, *Catalog of Cement Block Machines: Cement Brick Machines, Concrete Mixers, Etc.* (Chicago: 1907).

and the 1930s, when portland-cement building products reached their highest popularity and the industry reached its greatest wealth. However, the industry lost steam by the 1940s, when much simpler-patterned tiles, mostly simulating marble, were used to pave large housing projects.

Concrete Blocks as True Artificial Stone

Speed, economy, and effectiveness marked other early portland-cement products such as the concrete block.[13] Its use spread throughout the United States and the world quickly, when thousands of businesses and individuals manufactured them, even though the industry had a difficult start and detractors at all levels.[14] Regardless of the heated criticism of the face plate (sides or ends of the block mold that provided its particular finish or design) that imitated natural rock or stone, "artificial stone" blocks were accepted as a quickly produced, economical, and reliable building material.[15] In the United States the period from 1900 to 1905 was marked by experimentation, testing, and the race for patents.

According to advertisements of the time, these new building components could be quickly hand-made on-site by inexperienced workers. They required no ovens or large equipment, were easily stored, and were ready for installation within a month. By 1907 large companies like Sears, Roebuck & Co. boasted several concrete-block machine and face-plate models (Fig. 6). These ads and mail catalogs converted the term "concrete block" into a household word in the United States; the blocks were advertised as fireproof and more economical than wood, brick, or stone construction.

The initial triumph of concrete block in the U.S. helped to promote it throughout the country, as well as in the Spanish Caribbean, where there is evidence that American concrete-block machines arrived as early as 1901. The new building material was adopted, modified, developed, and used together with other innovative construction technologies in the region, such as steel framing and reinforced concrete.

Based on the present research, Cuba seems to be the first country in the Spanish Caribbean to have used concrete block as a building material. A branch of Purdy & Henderson, an important New York design and construction firm, was established in Havana.[16] The firm's earliest projects, dating from 1901, consisted of several steel-frame and concrete-block buildings in Havana; they included residences, the Miramar Hotel, the first Cuban branches of the Royal Bank of Canada, and the National Bank of Cuba.[17] The firm invented an innovative concrete block that included a central waterproof barrier, which they used for their projects in Cuba.[18]

The four-story residence of Horatio Rubens in Mariel, Cuba was completed around 1905, an early date even for concrete-block counterparts in the United States. Impressive due to its monumental height and volume, its blocks diminish in size as the building rises (Fig. 7). The block walls were reinforced vertically with steel rods to provide lateral stability. The architectural ornaments, also molded and prefabricated with portland cement, provided exuberance.

Other early concrete-block structures in Cuba were directly associated with Evangelical religious groups that came from the United States after the Spanish-American War. These buildings

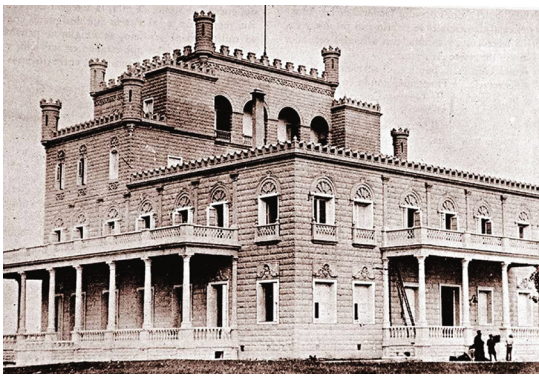

Fig. 7. The Rubens Palace, built in 1906 in Mariel, Cuba, is likely the tallest and largest of the earliest structures built entirely of concrete blocks in the Spanish Caribbean. "El Palacio de Mr. Horacio Rubens en el Mariel," *El Fígaro, Revista Universal Ilustrada* (September 9, 1906), 461.

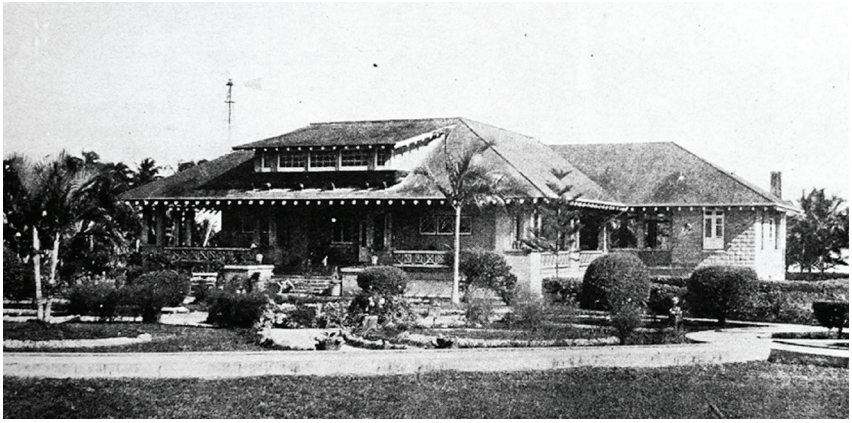

Fig. 8. The Michelena-Belvé residence in Santo Domingo, built in 1912, is believed to have been the first concrete-block building in the Dominican Republic. *El Libro Azul de Santo Domingo, The Dominican Blue Book* (New York: Compañía Biográfica, 1920), 41.

Fig. 9. The Santiago Palmer School, built in 1907, was the first school built in Puerto Rico using concrete block. *El Gráfico, Revista Ilustrada* (March 28, 1914).

included the Presbyterian Church in Havana (1906) and the Methodist Church in Cienfuegos (1908). An article published in 1908 referred to the Cuban practice of using wood molds for concrete-block manufacture instead of the U.S. metal molds, with a mixture of one part cement and four parts sand, tamped by hand.

There is no certainty about when the first concrete-block machines arrived in the Dominican Republic, but that industry may have been directly tied to hydraulic mosaic-tile manufacture and other cement-molded components. The upper industrialist and merchant classes, attuned to progressive and fashionable building materials utilized elsewhere, would have been interested in incorporating the architectural expressions and technologies promoted abroad.

The original rock-faced concrete-block residence of prominent banker Santiago Michelena-Belvé, built in 1912, may be the first concrete-block structure built in the Dominican Republic (Fig. 8). Although it still exists, it was completely transformed during the 1930s, when any evidence of the original concrete-block building technology was destroyed or concealed. Various other rock-faced concrete-block residences followed during the 1920s in the suburban area of Gazcue. This was probably due to the establishment in Santo Domingo of a factory owned by Tavares-Juliá that made portland-cement architectural elements. It produced a rusticated or "wart-type" concrete block, as it was called locally.[19] In the company's second catalog, printed in 1931, a section of the introduction is dedicated to concrete blocks as important building products made by the factory.

In 1930 a major hurricane destroyed nearly all building types in Santo Domingo, the capital city of the Dominican Republic, except for those structures built with concrete blocks, an outcome that further promoted their use. Reconstruction housing incorporated concrete-block walls, reinforced-concrete slabs for floors and roofs, and hydraulic-mosaic pavements.

A complete cement or concrete-block kit could have been imported to the Dominican Republic at more or less the same time that they arrived in Cuba and Puerto Rico, between 1905 and 1910, through the main seaports of Santo Domingo and San Pedro de Macorís.

As a result of the Spanish-American War, North Americans from all walks of life went to Puerto Rico. The United States' civil administration undertook an ambitious island-wide construction program of roads, bridges, and schools in their new possession. Most institutional and housing projects were built using imported portland cement and/or reinforced concrete following models introduced by the U.S. government, Evangelical religious groups, and the military.

Around 1905 metal molds for hollow-core concrete blocks were most likely brought to Puerto Rico by Evangelical missionaries to expedite the construction of their churches, schools, universities, and hospitals. The Robinson Orphanage for Girls in Santurce and the Collins Memorial Methodist Episcopal Church in Aibonito were the first two concrete-block structures built in Puerto Rico, both in 1906, followed by the Salinas Graded School in 1907 (Fig. 9).[20] The most commonly selected concrete-block face plate for these three buildings simulated ashlar masonry, with some areas of plain-faced blocks, which when combined, granted the institutional character most desired for religious and school buildings of the period. Not only were these building materials new to the Puerto Ricans, so were the building types.

The public schools of Puerto Rico were designed by architects under the direction of the island's Department of the Interior. By 1906 the department's general directive had been to abandon wood as a building material for school buildings and to replace it with concrete block, due to a shortage of seasoned timber.[21] This situation in itself was an incentive to use the innovative concrete-block technology in school buildings and would provide "permanent" masonry structures in a tropical region plagued by wood-eating

Fig. 10. The González-Cuyar residence in Santurce, Puerto Rico, originally built in 1913 with concrete block walls and hydraulic mosaic floors, was rehabilitated for the headquarters of the Architects and Landscape Architects Association of Puerto Rico. Historic hydraulic mosaics throughout the building were recycled and supplemented with new monochromatic mosaics manufactured for the project in Santo Domingo. Restoration project and photographs by the author, 1994.

insects, hurricanes, and earthquakes. An advertisement found in the folder for the 1907 Vieques Public School project included the following statement: "Hercules Stone is used exclusively by the Porto Rico Board of Education."[22] Imported from Rochester, New York, and manufactured by the Century Cement Machine Company, the Hercules Cement Stone Machine advertised that it could produce "every shape and kind of stone."

The Presbyterian Mission at the Polytechnic Institute of Porto Rico in San Germán, established in 1910, required hand-manufactured cement blocks and the construction of campus buildings by young men as part of their student training.[23] The founder, the Rev. J. Will Harris, had used the technology since 1907, when, with the aid of members of his mission, he had erected two rock-faced concrete-block buildings in town, the Presbyterian Church and the manse.[24] Harris may have imported the molds and machines to the western part of the island when the Presbyterian communities were establishing themselves.

The use of concrete blocks had their heyday in Puerto Rico during the first decade of the twentieth century. The equipment needed for block fabrication must have quickly spread throughout the island, since from 1906 to 1910 a significant number of different types of buildings were constructed with blocks. As was the case in the United States, the preferred face-plate design was that which simulated natural rock or stone masonry, but historic photographs indicate that usually more than one face-plate design was used in order to create highly ornamental facades. The Ponce Mosaic Company is the only Puerto Rican industry identified to date that would have manufactured molded ornamental materials made with portland cement other than hydraulic mosaics.

Passion for the use of concrete block in the Spanish Caribbean quickly died down after 1915, due to the preferred use of reinforced concrete, which was readily adopted by the local building industries of each country, long accustomed to building masonry structures using formwork for traditional Spanish rubble-masonry.

Conclusion

Two prefabricated portland-cement-based building materials, hydraulic mosaics and concrete blocks, played a fundamental role in the architecture of the three islands of the Spanish Caribbean—Cuba, the Dominican Republic, and Puerto Rico—between the end of the nineteenth and beginning of the twentieth centuries. Their use not only marked technological advances in building processes but also defined a style of a time and a place: the tropical Caribbean.

Their material properties being fire, water, and vermin-proof—together with the prefabrication processes, standardization, and speed of manufacturing and installation—revolutionized construction means and methods (Fig. 10). The history of these materials exhibits a common genesis in the three islands: a Catalonian origin at the end of the nineteenth century, amplified by an increasing American influence starting with the Spanish-American War and the subsequent economic boom, a product of sugarcane exploitation.

The two building materials would intersect in a tropical region that was a crossroad between worlds, concurrently accepting all influences. These imported building technologies, from Catalonia and the United States, blended in the Spanish Caribbean, where they were used together and independently. The resulting architecture showcased new ways to use imitation, molded, and prefabricated portland-cement-based building components that would survive indefinitely.

The additional study and documentation of these building materials and technologies will serve as an important tool for the preservation and conservation of structures of this period in the Spanish Caribbean.[25] Lastly, it is important to note that the original early-twentieth-century specifications and recommendations for the preservation and maintenance of these materials are of equal relevance today.[26] Largely, herein lies the key to their survival and durability in the future.

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Notes

1. A renewed interest in hydraulic materials began in England and France during the late eighteenth century. John Smeaton, an English engineer, discovered that the best mortar came from limestone that contained the greatest percentages of clay. More significant were Joseph Aspdin's investigations that resulted in a patent in 1824 for portland cement (so called because the mix was similar in color and texture to the limestone from Portland, England). The need to build canals, roads, bridges, and other works of civil engineering demanded high-performance materials such as hydraulic mortars or artificial stone. The new product set rapidly, hardened underwater, attained early strength, and helped waterproof and fireproof buildings. See Beatriz del Cueto, "The Development of Hydraulic Mortars, Cement, and Concrete in Puerto Rico," *APT Bulletin* 42:1 (2011): 46. Del Cueto, "Historia en Concreto: la evolución de los morteros hidráulicos y el uso del cemento en Puerto Rico," *AAA—Archivos de Arquitectura Antillana, Revista Internacional de Arquitectura y Cultura en el Gran Caribe 50* (March 2014): 8-11.

2. Juan de las Cuevas-Toraya, *500 Años de Construcciones en Cuba* (Havana: Chavín, Servicios Gráficos y Editoriales, S.I., 2001), 116-117. Enrique Penson, *Arquitectura Dominicana 1906-1950* (Santo Domingo: Mediabyte, S.A., 2005), 68. Del Cueto, "The Development," 49.

3. Maribel Roselló i Nicolau, *La Casa Escofet—Mosaics per als Interiors: 1886-1900-1916* (Barcelona: Escofet, 2009), 2, http://upcommons.upc.edu/e-prints. Translation from Catalan by the author.

4. Jaume Rosell and Joan Ramón Rosell, "La Técnica del Mosaic Hidráulic i el Modernisme," *Ciencia* 51:5 (Nov. 1986): 25. Translation from Catalan by the author.

5. The first public presentation of the *Mosaic Hidráulic* was at the Paris Universal Exposition of 1867, when it was introduced by Barcelona merchants Garret Rivet i Cia as a building product. The tiles generated heated discussions as an "imitation" paving material. They were not considered a "true" floor decoration as were original textile carpets, or a natural floor surface made of ceramic, brick, or stone.

6. Jaume Rosell and Joan Ramón Rosell, *El Mosaic Hidráulic* (Barcelona: Colegio Oficial de Aparejadores y Arquitectos Técnicos de Barcelona, 1985). Rosell, "La Técnica," 27. Translation from Catalan by the author.

7. "Tile and Shoe Factories," *The Cuba Review and Bulletin* 5:11 (Oct. 1907): 15. *El Libro de Cuba—Obra de Propaganda Nacional* (Havana, 1925), 790-792. Translation from Spanish by the author.

8. "To Investigate Cuba," *The Cuba Review and Bulletin,* 10:9 (Aug. 1912): 9.

9. Carmen Ortega and Ana Mitila-Lora, *El Mosaico Hidráulico: Arte en Evolución—Cement Tile: Evolution of an Art Form* (Santo Domingo: Industrias Aguayo de Construcción, C. x A., 2008), 95.

10. Luis O. Peynado, ed., *Directorio Industrial y Comercial de la República Dominicana—Industrial and Commercial Directory of the Dominican Republic* (Santo Domingo, 1925), 78, 121.

11. Jerry Torres Santiago, "Une folie bourgeoise: arquitectura y valores sociales en Yauco y Ponce a principios del siglo XX," in *Ilusión de Francia: arquitectura y afrancesamiento en Puerto Rico* (San Juan: Archivo de Arquitectura y Construcción Universidad de Puerto Rico, 1999), 133-35, 143.

12. The Ponce Mosaic Co. patent was granted on March 15, 1915, to Felipe Salazar Palau. Archivo Histórico Municipio de Ponce, Tesorería Municipal, Fondo: Ayuntamiento, Sub-sección: Tesorería, Serie: Patentes 1915, Caja: F-471, Legajo: 12.

13. The terms "cement block" or "concrete block" were found by the author in the earliest twentieth-century construction documents cited in this article. In theory, since cement was the manufactured binder in the mix, and had been a new product in the building industry since the mid-nineteenth century, both terms (cement block and concrete block) were used interchangeably. According to Thomas Jester, "Concrete block is produced from a mixture of Portland cement and aggregates." Thomas C. Jester, ed., *Twentieth Century Building Materials—History and Conservation* (New York: McGraw Hill, 1995), 80-85. According to Cyril M. Harris, "Concrete is a composite material consisting of a binding medium [cement], aggregates [gravel and sand] and water." Cyril M. Harris, ed., *Dictionary of Architecture and Construction* (New York: McGraw Hill, 1975), 121. Del Cueto, "The Development," 47, 51-52.

14. William M. Torrance, *The Manufacture of Concrete Blocks and Their Use in Building Construction, Second Prize in Engineering News Competition of 1905* (New York: Engineering News Publishing Company, 1906), 52.

15. "This imitative quality turned the architectural elite against the material…In 1907, a special committee of the American Institute of Architects had concluded that while reinforced concrete had much to recommend it, concrete block did not and should be avoided…because the imitations of rock face masonry so frequently seen were so depressing and distasteful"; cited in Pamela H. Simpson, *Cheap, Quick & Easy—Imitative Architectural Materials, 1870-1930* (Knoxville: Univ. of Tennessee Press, 1999), 24.

16. Jeffrey W. Cody, *Exporting American Architecture 1870-2000* (London and New York: Routledge, Taylor & Francis Group, 2003), 94-95.

17. Purdy and Henderson's original (early-twentieth century) project drawings on microfilm, Office for Metropolitan History, New York City.

18. Torrance, 39-40, 54, 56.

19. Penson, 72.

20. See the *Mission Albums* and the *Annual Reports of Porto Rico* at the General Commission on Archives and History of the United Methodist Church, Drew University, Madison, N.J. See also the Presbyterian Board of Home Missions' *Annual Reports for Porto Rico* at the Presbyterian Historical Society Archives, Philadelphia, Pa.

21. Government of Puerto Rico, *Annual Reports of the Department of the Interior* (Fiscal Year ended June 30, 1906), 461.

22. *Vieques Public School—Construction Specifications,* 1907, Archivo General de Puerto Rico: Fondo: Obras Públicas, Serie: Edificios Escolares, Caja: 074.

23. Del Cueto, "The Development," 45.

24. Rev. J. Will Harris, *A Concrete Case—A New Industry and the Kingdom of God in a Porto Rican Town. Stories of the Field No. 1. San Germán, Puerto Rico* (New York: Board of Home Missions of the Presbyterian Church in the U.S.A., May 1910), 1-2.

25. For conservation and maintenance specifications of hydraulic mosaics and/or concrete block see: Industrias Aguayo de Construcción, "Aguayo Tiles—Guidelines for installation, care, and maintenance," San Cristóbal, República Dominicana: http://www.aguayo.com.do/index.php. See also Thomas C. Jester, 84-85. See also Paul Gaudette and Deborah Slaton, "Preservation of Historic Concrete," Preservation Brief No. 15, U.S. Dept. of the Interior, National Park Service, Preservation Assistance Division, Technical Preservation Services, 2007.

26. *El Mosaico Hidráulico* (Castellón, Spain: Institut de Promoció Cerámica), 18, http://www.ipc.org.es/pav-hidraulico. Ladislao Díaz y Hno and Planiol y Cagiga, Fábrica de Mosaicos La Cubana Tile Catalog. (La Habana, n.d.), 5. *Salinas Graded School Repairs Memoir (1907),* Archivo General de Puerto Rico: Fondo: Obras Públicas, Serie: Edificios Escolares, Caja: 1047.

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