Rafael Guastavino and the Boston Public Library

by

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ABSTRACT

This thesis looks at the role of Spanish architect Rafael Guastavino in the design and construction of the Boston Public Library through an examination of correspondence, construction documents and meeting minutes from the Archives of the Trustees of the Boston Public Library, the Guastavino/Collins Archive at Columbia and articles in Boston newspapers.

This examination explains how and why Guastavino received the contract for tile vaulting at the library, the method of construction, his relationship with architect Charles F. McKim and the effect the library had on Guastavino's reputation and career as a builder.

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Acknowledgements

I would like to acknowledge the pioneering work of George Collins, who is responsible for much of our current knowledge of Guastavino's career. Without his efforts, it is unlikely that Guastavino construction would be known today and this thesis would not have been possible.

I would also like to acknowledge the following people for helping to make this thesis possible: Professor John Ochsendorf, thesis advisor at MIT, John Dorsey of the Boston Public Library's Research Services Office, Eric Frazier, librarian in the Boston Public Library's Rare Books Room, Janet Parks, Curator of Drawings and Archives at Columbia University's Avery Library and William Barry, architect with Shepley, Bulfinch, Richardson, and Abbott.

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Chapter 1: Introduction

1.1 Objectives

This thesis is a first attempt to understand the role of Spanish architect Rafael Guastavino in the design and construction of the Boston Public Library. It investigates how and why Guastavino received the contract for tile vaulting at the library, the method of construction, his relationship with architect Charles F. McKim and the effect the library had on Guastavino's reputation and career as a builder. This investigation is important because it will look at the specific details of the building that launched Guastavino's career in the United States, instead of providing a broad survey of his work. It will start to explain how Guastavino became such an accomplished builder in America and will also present the details of a construction process that has not yet been fully explored. The relationship between architect and builder during the construction of the Boston Public Library will also be examined and may lead to an understanding of Guastavino's role in the construction of other buildings.

1.2 Literature Review

There are many resources on the work of Rafael Guastavino. The late art history Professor George R. Collins at Columbia University pioneered the study of Guastavino in his article titled, "The Transfer of Thin Masonry Vaulting from Spain to America," published in the *Journal of the Society of Architectural Historians* in 1968 and in various

other publications.[1] He has also contributed significantly to the cataloguing of documents pertaining to Guastavino construction in the Guastavino Fireproof Construction Company/George R. Collins Archive at Columbia University's Avery Library. In addition to these resources, several catalogues of Guastavino's work have been published recently. Namely, Las bóvedas de Guastavino en América, edited by Santiago Huerta Fernández, which also contains a comprehensive bibliography, The Old World builds the New: the Guastavino Company and the technology of the Catalan vault, 1885-1962 by Janet Parks and Alan G. Neumann and Guastavino Co. (1885-1962), Catalogue of Works in Catalonia and America, edited by Salvador Tarragó. In 1999, an entire issue of the *APT Bulletin* was dedicated to the Guastavino Company with articles that examine the beginnings and history of the company, the preservation and restoration of Guastavino vaults, sources and suggestions for research as well as reproducing all the patents held by Guastavino. There have also been several theses completed that examine some aspect of Guastavino's construction: "Guastavino Construction: the predecessor of thin shell concrete," a M.S. Thesis in the Department of Civil Engineering at University of Houston in December 1971 by Carl Etheredge, "Putting Guastavino in context: A scientific and historic analysis of his materials, methods and technology," a M.A. Thesis in the Graduate School of Architecture, Planning and Preservation at the University of Columbia in 2000 by Daniel R. Lane and

[1] See George R. Collins, "The Transfer of Thin Masonry Vaulting from Spain to America," Journal of the Society of Architectural Historians 27 (1968): 176-201; Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America, ed. Salvador Tarragó (Barcelona: Col·gei d'Arquitectes de Catalunya, 2002), p. 17-43; and Las bóvedas de Guastavino en América, ed. Santiago Huerta (Madrid: Instituto Juan de Herrera, 1999), p. 19-45.

"Guastavino tile construction: An analysis of a modern cohesive construction technique," a M.S. Thesis at the University of Pennsylvania in 1992 by Ann K. Milkovich. Academic interest in Guastavino's work has been growing in recent years and scholars are beginning to explore more detailed aspects of the company's history. While there are many general studies of Guastavino's work, this thesis investigates Guastavino in the specific context of the Boston Public Library. The study of individual projects will allow researchers to move beyond a general discussion and to develop a more sophisticated appreciation for Guastavino's role in the history of construction in the United States.

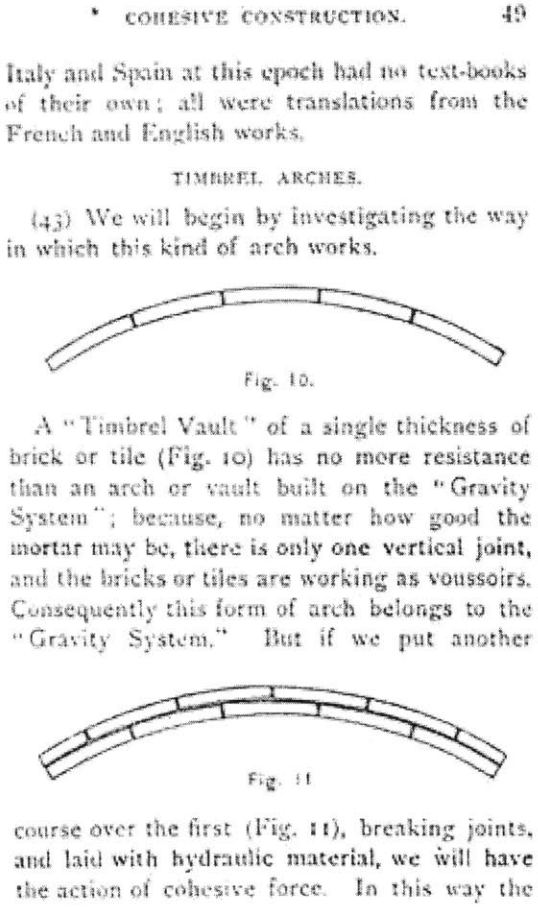
1.3 Organization and sources

This thesis focuses specifically on the role of Rafael Guastavino in the construction of the Boston Public Library, beginning in 1885, and the impact this had on his career as an architect and builder. Chapter One gives a background of the events leading up to construction and discusses the possibilities that may have led to Guastavino's involvement. Chapter Two presents details of construction pertaining to the tile vaulting and significant events relating to them. Chapter Three examines the relationships between Guastavino, the architects, and the Trustees, as well as the effect of this project on the future of the Guastavino Company. The sources for this thesis are primarily documents such as correspondence, construction documents and meeting minutes from the Archives of the Trustees of the Boston Public Library, the

Guastavino/Collins Archive at Columbia, articles in Boston newspapers of the time and the various publications mentioned previously.

1.4 Rafael Guastavino: Background

Spanish architect Rafael Guastavino was born in Valencia on March 1, 1842. After studying at the *Escuela de Maestros de Obras de Barcelona*, he began designing and constructing major buildings in Spain with a system he called "cohesive construction."[2] This system was described by Guastavino in a paper titled, "Cohesive Construction. Its Past, Its Present, Its Future" and was presented to the Congress of Architects in connection with the Columbian Exposition in Chicago on August 5, 1893 and later published in *American Architect and Building* News. In this paper, Guastavino describes cohesive construction as a method of building that relies



* COHESIVE CONSTRUCTION. 49

Italy and Spain at this epoch had no text-books of their own; all were translations from the French and English works.

TIMBREL ARCHES.

(43) We will begin by investigating the way in which this kind of arch works.

Fig. 10.

A "Timbrel Vault" of a single thickness of brick or tile (Fig. 10) has no more resistance than an arch or vault built on the "Gravity System"; because, no matter how good the mortar may be, there is only one vertical joint, and the bricks or tiles are working as voussoirs. Consequently this form of arch belongs to the "Gravity System." But if we put another

Fig. 11

course over the first (Fig. 11), breaking joints, and laid with hydraulic material, we will have the action of cohesive force. In this way the

Figure 1.1, Timbrel arches, from Essay on the Theory and History of Cohesive Construction, Applied Especially to the Timbrel Vault,

[2]Joan Bassegoda Nonell, "La obra arquitectónica de Rafael Guastavino en Cataluña (1866-1881)," in Las bóvedas de Guastavino en América, ed. Santiago Huerta (Madrid: Instituto Juan de Herrera, 1999), p. 3.

on the adhesion of materials as opposed to the friction of the more commonly used gravity system.[3]

Vaults of cohesive construction are composed of several layers of tile and mortar and can be characterized by their thinness, strength, double curvature and non-combustible properties. Guastavino further clarifies the differences between the two systems in his Essay on the History and Theory of Cohesive Construction, Applied Especially to the Timbrel Vault.[4] His illustrations clearly show that in a vault of single thickness with only one vertical joint, it is gravity alone that keeps the elements in place. According to Guastavino, adding a second layer with breaking joints and mortar significantly decreases the weight of a similar vault and provides greater load capacity due to the cohesion of the materials (Fig. 1.1). Cohesive construction, in its most common form, the timbrel vault, uses little or no steel. It can usually be constructed using little or no centering as the masonry is self-supporting.[5] This, combined with the use of quick-setting mortar, greatly reduces the time and cost of construction compared to conventional masonry vaulting. The tiles and mortar form a homogeneous structure, infallible even to accidental penetrations.

Although Guastavino's theories, calculations, and explanations portray his vaults as unique for lacking the thrust of typical masonry vaults, he built them as if they did provide thrust on the supporting walls. The Spanish historian of construction Santiago

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[3]See Rafael Guastavino, Lecture Written for the Congress of Architects in Connection with the Columbian Exposition, on Cohesive Construction: It's Past, It's Present, It's Future, (Chicago: August 5, 1893) and The American Architect and Building News. (August 26, 1893): 125-129.
[4] Rafael Guastavino, Essay on the Theory and History of Cohesive Construction, (Boston: Ticknor and Company, 1893): 49.
[5] Collins, "The Transfer of Thin Masonry Vaulting from Spain to America," p. 177.

Huerta has described this condition as a "schizophrenia" that existed for Guastavino and other builders of this time period. As with all unreinforced masonry vaults, it is their geometry, not their cohesive characteristics that provide for their safety since masonry does not have appreciable tensile strength.[6]

1.5 Rafael Guastavino: Early Work

Two of the many structures built by Guastavino in Spain utilizing this system were the Batlló Brothers Factory in 1868-1869 and the Centre Vilassanès theatre in 1880.[7] Guastavino's work was first introduced to the United States during the Centennial Exhibition of 1876 in Philadelphia for which he received a medal.[8] During a visit to the United States he also observed that there was a greater supply of Portland cement, one of his major improvements on traditional timbrel vault construction that had been unavailable to him during the time he was building in Spain. He decided in 1881 that these two factors, at least, were enough of a reason to move the United States with his son, Rafael Guastavino, Jr. and continue the tradition of building with tile. Guastavino's first job in the United States was the Progress Club building in New York City in 1883 followed by fireproof tenements.[9] At about the same time he also completed a synagogue on Madison Ave and 65th Street, and the floors of the Arion Club, all in New York.

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[6] Santiago Huerta, "La mecánica de las bóvedas tabicadas," in Las bóvedas de Guastavino en América, ed. Santiago Huerta (Madrid: Instituto Juan de Herrera, 1999), p. 98-99. 108-109.
[7] Salvador Tarragó, "Considerations on Guastavino's Work in Catalonia," Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America, ed. Salvador Tarragó (Barcelona: Col·legi d'Arquitectes de Catalunya, 2002): 10-11.
[8] Peter B. Wight, "The Life and Work of Rafael Guastavino. Part II. What is cohesive construction?" The Brickbuilder, 10 (May 1901): 101.
[9] George R. Collins, "The Transfer of Thin Masonry Vaulting from Spain to America," p. 192-193.

Guastavino's career as an architect never really thrived in the United States despite his awards and extensive experience in Spain. For that reason, Guastavino worked primarily as a building contractor, collaborating closely with leading architects to create vaulted ceilings in tile. Cohesive construction was a fairly new concept for American architects and builders of the time even though it had been used in Europe for nearly one thousand years. The first documented use of this type of construction is from the 14th and 15th centuries in Spain. By the 16th century it was a well-known method throughout the Mediterranean region and was used in France by the early 18th century.[10]

Guastavino's career took off with his involvement in the construction of the Boston Public Library in 1888 and later when the Guastavino Fireproof Construction Company was officially incorporated in 1889.[11] Several letterheads encountered during this research show that during the time of the library's construction Lindley M. Hoffman was President, Guastavino was Vice-President and Wuffredo Uffreduzi was Secretary. It is not known at this time how and why Guastavino became involved with these men and what role they played in the construction of the library building or in the beginnings of the company. The letterheads also indicate an address for a Boston office but it is also not known if this office was established in order to facilitate this project or if it existed beforehand.

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[10] Santiago Huerta, " La mecánica de las bóvedas tabicadas en su contexto histórico: la aportación de los Guastavino," in Las bóvedas de Guastavino en América, ed. Santiago Huerta (Madrid: Instituto Juan de Herrera, 1999), p.88.

[11] George R. Collins, "The Transfer of Thin Masonry Vaulting from Spain to America," p. 194.

Chapter 2: Planning of the Boston Public Library, 1871-1887

2.1 Art, culture, education

The Boston Public Library in Copley Square was built between 1888 and 1895. It was the third structure built by the City of Boston to house their growing collections and to facilitate a growing urban population. The increased interest in art, education and culture is reflected in the new building of the time. In the second half of the 19th century Boston began to establish itself as a cultural center with the creation and construction of several universities and cultural institutions such as the Massachusetts Institute of Technology, Tufts University, Boston University, the Museum of Fine Arts, the Isabella Stewart Gardner Museum, and the Boston Symphony Orchestra.[12]

2.2 The Trustees' Competition and the Entry of Charles F. McKim

The City of Boston granted the Trustees the power to contract with an architect and to oversee all aspects of design and construction of the new library.[13] There was little precedent for public libraries in the United States at this time and thus presented a challenging problem.[14] In 1885 the Trustees solicited designs in the form of a competition. Guastavino entered this competition along with 20 other architects, none of whom provided plans satisfactory to the Trustees, so the design competition ended

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[12] Douglass Shand-Tucci, Built in Boston: City and Suburb, 1800-1950, (Amherst: University of Massachusetts Press, 1988), p. 133

[13] Horace G. Wadlin, The Public Library of the City of Boston: A History, (Boston: Trustees of the Boston Public Library, 1911), p. 92-93.

[14] Leeland Roth, McKim, Mead & White, Architects, (New York: Harper and Row Publishers, 1983), p. 118-119.

with no clear architect chosen for the new building.[15] The details of Guastavino's design entry are not yet known. Future research in this area might clarify Guastavino's initial connection to the Boston Public Library.

The Trustees eventually contracted with the well-known and established New York architects McKim, Mead and White, who went on to design one of Boston's most impressive monuments. Preceding their work at the Boston Public Library, McKim, Mead and White were involved in several residential projects and a few larger projects such as the Newport Casino in Rhode Island, St. Paul's Episcopal Church in Stockbridge, Massachusetts, as well as the New York Life Insurance Company Building and Madison Square Garden, both in New York city.[16] Charles Follen McKim set up a temporary office in a Beacon Street residence in order to facilitate the design and construction of the new library building.[17]

2.3 Fireproof design

The City of Boston, the Trustees and McKim were definitely aware of the fires that plagued many major cities during the 19th century and they must have been concerned about the fire resistance of the new library building. The Great Chicago Fire in 1871 destroyed a large part of the city and left approximately 100,000 people homeless. One of the worst fires in history struck Peshtigo, Wisconsin around the same

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[15] Wadlin, The Public Library of the City of Boston: A History, p. 91.
[16] Samuel G. White and Elizabeth White, "McKim, Mead & White: *The Masterworks*," (New York: Rizzoli International Publications, Inc., 2003), p.23-66.
[17] Douglass Shand-Tucci, Built in Boston: City and Suburb, 1800-1950, p. 136.

time, killing over 1000 people.[18] In New York, both the Singer Sewing Machine Company Building and the Fulton Bank Building burned completely to the ground increasing public awareness of this crucial problem.[19] Closer to home, Boston suffered a major fire in 1872 when over 300 buildings were burned, one of which was the Trinity Church in Copley Square.[20] This apprehension about fires was compounded by the fact that the library was to house a vast collection of rare and irreplaceable books and manuscripts, which were highly flammable. These factors most likely led its builders to seek out a practical and effective method of fireproof construction.

2.4 Guastavino's initial involvement

It is not clear how Guastavino initially became involved in the construction of the Boston Public Library, but two theories will be presented here. The first is that Guastavino's involvement with the library was a result of his entry in the competition held by the Trustees.[21] The Trustees may have been impressed by his unique fireproof structural system, although not taken with his architectural design. Even if they did like his plans, they may have chosen McKim as their architect for his reputation and to call greater attention to their new building. In this case, the Trustees would have introduced Guastavino and his system to McKim.

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[18] Sara E. Wermiel, The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City, (Baltimore: The Johns Hopkins University Press, 2000), p. 81.
[19] Peter B. Wight, "Fireproof Construction and the Practice of American Architects," American Architect and Building News (August 19, 1893): 113.
[20] Roth, McKim, Mead & White, Architects, p. 388.
[21] "Views of a Spanish Architect on the New Building," Boston Herald, 27 September 1890.

The second theory is that Guastavino and McKim started their relationship in New York, where they both maintained offices. This relationship may have developed after McKim read an advertisement for Guastavino Fireproof Construction in a publication such as *American Architect and Building News*, where the Guastavino Company advertised extensively during this time period. Another possibility, because Guastavino may not have necessarily been well established as either an architect or builder at the time of construction of the Boston Public Library, is that McKim became aware of the many patents Guastavino held related to fireproof construction. Guastavino held four patents for the construction of fireproof buildings by 1888. He filed and was granted another nine patents during the time the library was being constructed for tile arches, staircases, fireproofing and building tile.[22] In this case, McKim would have recognized the need for fireproof construction in the library and then as a result, introduced the Guastavino system to the Trustees for possible use.

[22]Diana Waite and Patricia Gioia, "United States Patents held by the Rafael Guastavinos, father and son." APT Bulletin v.30 no. 4, (1999): 59-156.

Chapter 3: Construction of the Boston Public Library, 1888-1895

3.1 Guastavino secures a place for his work

Based on the records available at the Boston Public Library, it seems that Guastavino's involvement began late in the project, well after McKim's design was completed and construction had begun. Guastavino met with McKim in New York on March 27, 1889, about a year after the construction first began. The next day he made his first documented appearance at the library lot. By this time the foundations had been completed and the plans drawn.[23] Guastavino's reaction to the ongoing construction is documented in a letter from Edward R. Benton, the project superintendent, to McKim regarding his visit. (See Appendix A for a copy of this letter.) Benton relays Guastavino's admiration for the foundations but writes, "it is a great pity that the whole ground floor could not have been put in by his system, with no beams whatever- only a few girders." Benton goes on to say that if they would give Guastavino "all the iron beams for the ground floor (already on the ground) he [Guastavino] would sell the iron, and build the whole ground floor for nothing." This offer would make room for his work in the ongoing construction and secure the use of his system throughout much of the library.

During this same visit, Guastavino explained his system further to Benton and showed on the section drawings how it would be used. Benton was highly impressed with the Guastavino system and discussed plans for the building of a sample arch on

[23] Letter from Edward R. Benton to Charles F. McKim (March 28, 1889) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

the library lot. Also in this letter, Benton informs McKim that the President of the Trustees, Samuel Abbott, was in favor of getting rid of all iron beams below and above Bates Hall floor.

3.2 The first arches are tested

The earliest documentation of Guastavino vaulting in the Boston Public Library is in a construction photograph from the Trustees Archives dated April 5, 1889 (Fig 3.1). This photograph shows an arch under construction in the sidewalk area of the library. A similar photograph dated April 8, 1889 shows Guastavino himself standing on one of the arches overseeing construction, only a few days after construction began (Fig. 3.2). This shows how quickly the system can be built and then used. A photograph of the same location on April 20, 1889 shows the arches being tested (Fig. 3.3). This may have been the sample arch that Guastavino and Benton discussed in their March 1889 meeting. Only about two weeks after the construction of the arch began, it was loaded with 12,200 pounds concentrated on a 4'x5'6' block. The results of this particular test have not yet been located.

Figure 3.1 Tile arches, April 5, 1889
(No. 54 Archives of the Trustees of the BPL)

Figure 3.2 Tile Arches, April 8, 1889
(No. 55 Archives of the Trustees of the BPL)

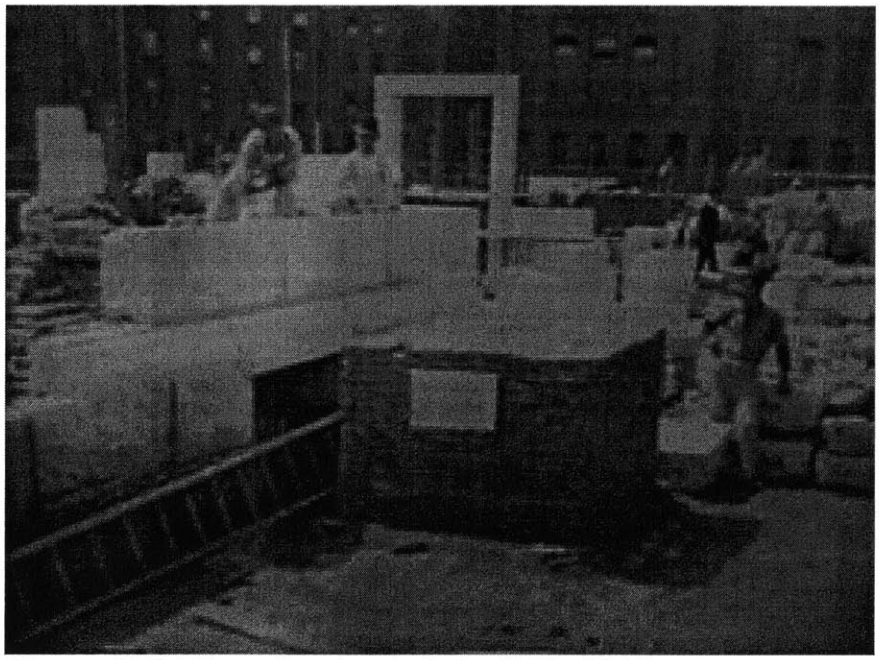

Figure 3.3 Tile arches loaded, April 20, 1889
(No. 60, Archives of the Trustees of the BPL)

3.3 A proposal for tile work

Since cohesive construction had hardly been used in this country, there was no competitive pricing available. This made the Trustees uneasy about whether or not they were receiving a fair price for the work. As a result, they put a provision in the specifications that if another contractor emerged that was doing similar work in any of the New England states at a lower price, that the prices for the library would be adjusted accordingly. The proposal submitted by Guastavino included the furnishing and setting of rough tile arches and domes, the setting and pointing of glazed tile ceilings, the cutting of skewbacks in the masonry, the cutting, fitting and setting of iron beams, brick partitions for leveling on top of arches and domes, tile floors and covering

beams with tile arch material, as well as constructing rough tile stairs.[24] The prices proposed by Guastavino for this work can be seen in Appendix B.

3.4 The Trustees finalize Guastavino's contract

Guastavino returned to the library to meet with Benton again on April 26, 1889. At this time Benton wrote him a long letter explaining the work to be done below Bates Hall floor. On May 9, 1889, the drawings and specifications were altered to officially include the use of the Guastavino Tile Arch System. On May 14, 1889, the Trustees authorized Abbott, "to contract for the substitution of tile arches in place of iron beams in the construction of the new Public Library building."[25] Benton wrote to McKim on May 18, 1889 to inform him that an agreement with Guastavino was being drawn up and that his material would be ready to go in one week.

About mid-June, the Trustees began advertising for proposals for tile arch work according to the Guastavino system of fireproof construction. It was not unexpected that on June 21, 1889 the Trustees received only one bid since Guastavino's patents prohibited others from using his system. On June 25, 1889, the contract for tile work in the Boston Public Library was awarded to Guastavino. The total amount of the contract made with the Guastavino Company was $85,554.04, or about 4 per cent of the total

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[24] In Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. I, Archives of the Trustees of the Boston Public Library, p. 39.
[25]Minutes of the Trustees of the Boston Public Library, May 14, 1889.

cost of the library, which in the end was $2,203,178, excluding artwork and furnishings.[26]

3.5 Method of construction

The specifications for tile arch work in the Boston Public Library describe the construction method. The tile arches and domes were constructed with well-burned clay tile and the first course had vertical joints laid in plaster of Paris. Plaster of Paris was used because it set quickly, allowing the vaulting to be built with minimal formwork. By building the first layer in plaster of Paris, each individual tile could be held in place by the adhesion of the mortar and would not have to be supported by centering. After the initial layer was built with plaster of Paris, the subsequent layers were laid in English Portland cement. The arches were set in skewbacks cut into the masonry walls. On top of the completed arches, partitions were built about every two feet. These partitions were built of hollow brick, held a floor of tile arch material two courses thick and were at the appropriate height to receive a finished floor (Fig. 3.4). In some areas, the tile arches were reinforced by filling the spaces in between with tiles and cement, as described and illustrated in an August 6, 1889 letter from Edward Stevens, Clerk of the Works, to McKim.[27]

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[26] Minutes of the Trustees of the Boston Public Library, April 1, 1895; and Leeland Roth, The Architecture of McKim, Mead and White 1870-1920 A building list, (New York: Garland Publishing, Inc, 1978), p. 32.
[27] Letter from Edward F. Stevens to Charles. F. McKim (August 6, 1889) (Archives of the Trustees of the Boston Public Library). For an excerpt of this letter showing the Stevens sketch see Appendix C.

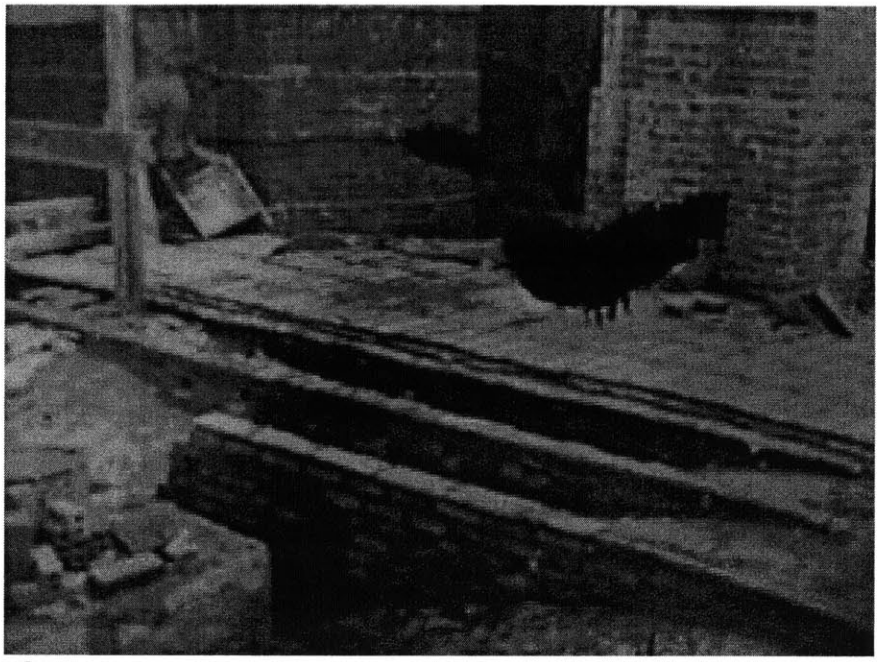

Figure 3.4 Partition of tile arches in Section J, July 13, 1889 (No. 83 Archives of the Trustees of the BPL)

The floor of tile was designed to sustain a load of five hundred pounds per square foot, and all domes and arches were designed to hold a superimposed load of one thousand pounds per square foot. This exceptional load capacity is well in excess of today's library floor loadings of 150 psf.[28] In all rooms where rough tile was to form the finished ceiling, the exposed iron beams and girders were to be covered with tile arch material.[29] One exception to this is visible in the Lecture Hall, or what is currently General Reference. In this space there is the unique combination of timbrel arches and exposed iron beams and ties. It is possible that these beams were covered with curtains during the time it was used as a lecture hall.[30] The specifications also state that Guastavino was responsible for the fitting and setting of all iron beams or ties necessary

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[28] Daniel L. Schodek, Structures, 4th Edition, (New Jersey: Prentice Hall, 2001), p. 101.
[29] Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. I., p. 39, Archives of the Trustees of the Boston Public Library.
[30] Discussion with Architect Bill Barry of Shepley, Bullfinch, Richardson and Abbott, March 12, 2004.

for his work. It was also requested that he lay not less than four thousand square feet of floor, including partitions and tile floor per week, if requested to do so by the Trustees.

As discussed earlier, this method of construction required little or no centering. An 1889 article from the *Boston Herald* presents details of the process and the "secret" behind the flat tile arches and domes. The minimal centering used in the library's construction is described by this article as follows,

> A 'centre' is made of two pieces of board in the form of a segment of a circle. These two pieces are placed on a level, parallel to each other, their curved edges up, and these are connected with lath laid across and nailed to both pieces of board. The length of the 'centre' so formed is such that its tips will just rest on the ledges on the pillars when it is placed between them.[31]

After the first layer of tiles laid in plaster of Paris and the following layer in Portland cement have set, the center can be removed. A similar center is used when constructing the domes in between the arches,

> To build this we take one of the flat boards of which our 'centre' was made and rest its tips on the ledges left on the two arches, so that it stands parallel to one of the other arches, and about eight inches from it. We now take tiles, and place them side by side, their ends resting on the ledge of the arch parallel with our 'centre' board...By the time this now is done this plaster is set, we can take out our 'centre' board and advance it up the side a dozen inches and put in another row of tiles... [32]

Two different types of centers used during the library's construction can be seen in Figures 3.1 and 3.7. Another type of center was used in the construction of the tile arches in the entrance hall shown in Figure 3.5. Reserve Space No. 1 is the only space

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[31] "Flat Tile Arches," Boston Herald, 12 July 1889.
[32] Ibid.

shown in the construction photographs that required more extensive centering. This is shown in Figure 3.6.

Figure 3.5 Tile Arches Entrance Hall, March 26 1890
(No. 159, Archives of the Trustees of the BPL)

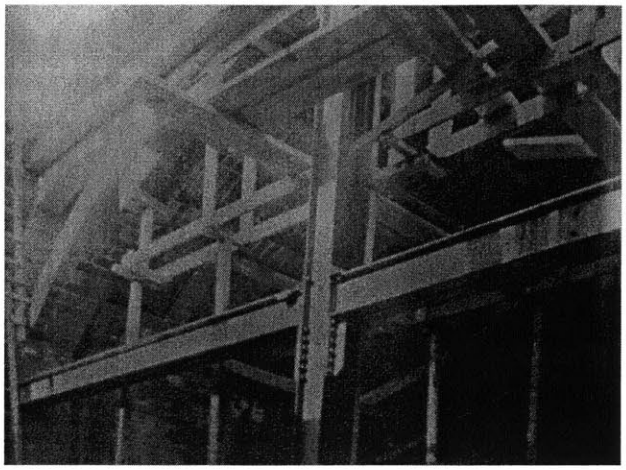

Figure 3.6 Tile Arch in Reserve Space No. 1, February 3, 1890
(No. 150, Archives of the Trustees of the BPL)

3.6 A potential strike

A significant amount of work had already been completed by the time Guastavino's contract was finalized on June 25, 1889. At least enough work had been done and sufficient time had passed that Guastavino's crew had become discontent. Around June 28, 1889 Edward Stevens, Clerk of the Works, wrote to McKim informing him of what he thought to be, "every appearance of a 'strike' with Guastavino's men all but two masons have stopped work but he promises to have there [sic] places filled in a few days."[33] The exact reason for this possible strike is not known, but Guastavino did not let it slow his progress. By this time, Guastavino completed the domes in L (Fig. 3.7) and M (Fig. 3.8) and was in the process of working on section J (Fig. 3.4). In

[33]Letter from Edward F. Stevens to Charles F. McKim (June 28 1889) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

about a two week period, from June 15 to July 1, 1889 approximately 4711 square feet of tile arch had been laid and several areas had been completed.[34]

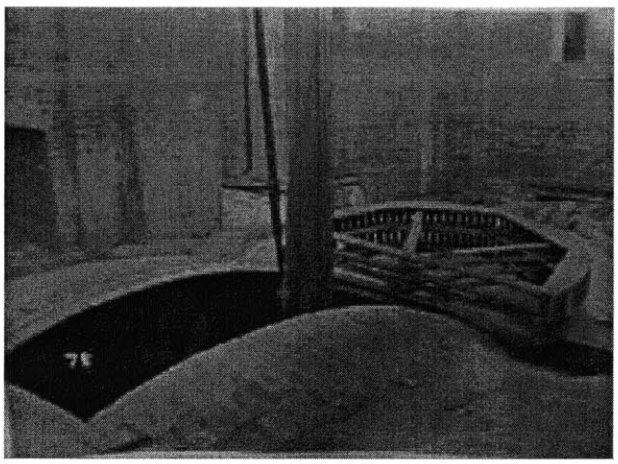

Figure 3.7 Tile Arches in L, July 10, 1889
(No, 78, Archives of the Trustees of the BPL)

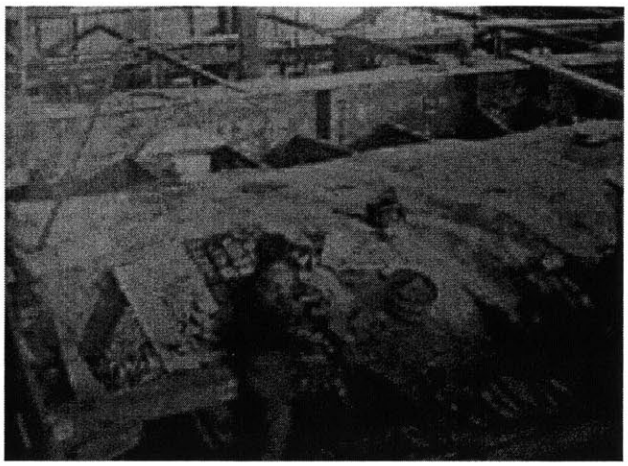

Figure 3.8 Tile Arches in M, January 3, 1890
(No. 142 Archives of the Trustees of the BPL)

3.7 A lack of tile and its consequences

In early August of 1889, Guastavino's rapid progress was halted due to a lack of tile, causing his men to only be able work about half the time. Although an August 8 letter from Benton to McKim describes Guastavino's work as progressing rapidly with two-thirds of the first floor done, only five days later on August 13, they had run out of tile again. Part of the reason for this lack of tiles is, as the letters indicate, the poor quality of tile in some of the shipments received. This made it necessary for Guastavino and Stevens to shift through the shipments to find the best tiles.

The tiles continued to be a problem throughout the entire construction process. It became a major concern for McKim in June of 1890. In an effort to express his

[34]Letter from Edward F. Stevens to Charles F. McKim (July 1, 1889) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

concern to Guastavino, McKim sent a letter alerting him to the "grave condition of affairs" that arose from the lack of material and was preventing the completion of Bates Hall floor and consequently delaying the granite work in the Dartmouth and Blagden Street areas. McKim notes that this delay is causing his own reputation to be called into question and is a significant loss to the contractor and the progress of the building as a whole. He does take the time though, to praise the quality of work Guastavino's men had completed so far, despite what he calls the mismanagement of material and the superintendence of its construction.[35] A day later, as a possible attempt to solve the tile crisis, the Trustees authorize Abbott to purchase tile for Guastavino.[36]

3.8 Sources and cost of tile

The tiles for the Boston Public Library most likely came from several sources. Much to the Trustees' disapproval, Guastavino proposed using flat glazed tiles from Spain. He assured the Trustees that it was exactly the qualities they were troubled by, the thinness, lightness and quality of clay, that make them well adapted to their use. In an attempt to convince them further, he went ahead and drew exactly how these tiles would be used in domes, ribs and sides of ribs. He noted that any other tiles may have a "good effect," and only in the future they may, "compete in combinations of color, and facility with these Spanish tiles, to make drawings in the ceiling and give

[35] Letter from McKim, Mead & White, Architects to Guastavino Fireproof Construction Co. (June 2, 1890) (Archives of the Trustees of the Boston Public Library)
[36] Minutes of the Trustees of the Boston Public Library, June 3, 1890.

richness of lines..."[37] Guastavino closes this letter to the Trustees by telling them that he thinks under the current situation, using any tiles but these would be a great loss of time and money. Whether or not the Trustees ultimately approved Guastavino's Spanish glazed tiles remains unclear from this letter.

The Spanish glazed tiles may never have been used because as the Contract and Specifications state, "The Contractor is not to furnish glazed tiles for ceilings, but he shall receive, take charge of, and be responsible for the good safety of such tiles when delivered at the building." Special orders issued by the Trustees and by E. R. Benton on behalf of McKim, Mead & White indicate that the Low Art Tile Company of Chelsea, Massachusetts glazed at least 2756 6" by 12" tiles at 30 cents per square foot and furnished and glazed an additional 2551 tiles at 50 cents per square foot.[38] The Low Art Tile Company of Chelsea, Massachusetts was founded by J.F. and John Gardner Low. They were most well-known for their decorative art tiles with hand-molded relief work and pressed pieces of grasses and leaves.[39] The Menlo Park Ceramic Works were also called upon to glaze 2000 6" by 12" tiles at a price of 50 cents per square foot.[40] Other Special Orders indicate that Guastavino was responsible for furnishing many of the tiles that were eventually glazed. In December 1889, Guastavino was asked to furnish 5200 flange tiles for glazing at a price of $236.90, a price that is less than five

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[37] Letter from Rafael Guastavino to Charles F. McKim (December 20, 1889) (Archives of the Trustees of the Boston Public Library) See Appendix D for the entire letter.
[38] Special Order No. 58, April 29, 1890, Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. II, Archives of the Trustees of the Boston Public Library.
[39] Paul Evans, Art Pottery of the United States, (New York: Feingold & Lewis Publishing Corp., 1987), p. 151-153.
[40] Special Order No. 56, Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. II, Archives of the Trustees of the Boston Public Library.

cents per tile. He was asked again to furnish an additional twenty flange tiles for glazing at the cost of $8.00, or about 40 cents per tile.[41]

3.9 Varieties and patterns of tiles

Guastavino also provided flange tiles in addition to his contract for rough tile work, but he does not identify the exact source of these tiles.[42] In January 1890, the Trustees and McKim, Mead and White issued a special order for the laying of flange tiles with breaking joints and pointing. In areas of small span, such as in the stacks, there was the additional cost for laying flange tile of five cents per square foot. The cost of laying flange tiles with breaking joints in areas with large spans, such as in Periodical Room (Map Room), was more than triple that of small spans, at sixteen cents per square foot. Also, for flange tiles laid in concentric rings, as in the Catalogue Room, there was an additional cost of twenty cents per square foot.[43]

In a January 1890 letter to the Trustees, McKim recommended the use of glazed tiles for certain ceilings in the first story of the new building, totaling approximately 15,000 square feet. The first bids for glazed tile were received in October 1889 from "an unnamed firm in good standing."[44] This company would provide the desired glazed tiles at 65 cents per square foot but McKim insisted competition would reduce that price. This letter also stated that cost of all glazed tiles would not exceed the cost of

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[41] Special Order No. 55, April 29, 1890, Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. II, Archives of the Trustees of the Boston Public Library.
[42] Special Order No. 54 and No. 55, April 29, 1890, Contracts, Specifications, Proposals, Etc. Regarding the New Library Building, Archives of the Trustees of the Boston Public Library.
[43] Special Order No. 51, January 21, 1890, Contracts, Specifications, Proposals, Etc. Relating to the New Library Building, vol. II, Archives of the Trustees of the Boston Public Library.
[44] Letter from Charles F. McKim to the Trustees of the Boston Public Library (October 22, 1889) (Archives of the Trustees of the Boston Public Library)

ordinary finish by more than 7000 dollars. The Trustees approve the use of glazed tile at McKim's recommendation as long as it did not exceed 55 cents a square foot.[45] From this information it appears that McKim pushed for the use of more expensive glazed tile, while the Trustees were more concerned about keeping the cost low.

The cost of laying tiles varied depending on the patterns in which they were laid. Guastavino provided the Trustees with ten different options for laying tile. He included individual sketches of each in a January 1890 letter to Samuel Abbott. These patterns are reproduced Appendix E. They range from a simple alternating brick pattern to his signature herringbone pattern. The prices for these patterns are in addition to contract prices and range from 26 to 34 cents more per square foot. Guastavino promised to reduce these prices by five cents per square foot if they were laid in flange tiles as opposed to rough tile[46]

[45]Minutes of the Trustees of the Boston Public Library, October 22, 1889.
[46] Letter from Rafael Guastavino to S.A.B. Abbott (January 8, 1890) (Archives of the Trustees of the Boston Public Library)

Chapter 4: Relationships developed and the significance of the Boston Public Library

4.1 Benefits and risks of a new system

Even though Guastavino was a well established builder in Spain and his structures there and in New York stood as proof of the safety and quality of cohesive construction and the timbrel arch, McKim and the Trustees understandably proceeded with some caution when choosing this system for their new library building. To further prove that the system worked, sample arches and testing were carried out before a contract was finalized. Guastavino made it beneficial for the Trustees and McKim to allow him to construct his arches in the first floor by taking the iron beams and putting in the first floor for free. Guastavino's work in these spaces must have made such an impression on the Trustees or McKim that they decided to continue using his system for a large portion of the building. As Leeland Roth discusses in his book titled McKim, Mead & White, Architects (Harper & Row Publishers, 1983), Guastavino's, "technique was 'new' but produced 'traditional' solid floors that required bookcases in the 'stack' storage area whereas the newest innovation in the 1880s were self-supporting cast-iron metal stacks that provided a greater density for storage."[47] Roth describes the many benefits of this choice, citing its strength and flexibility since the functions in the library spaces have continued to change over time. If the cast-iron metal stacks had been used, they would have not allowed this flexibility.

[47] Roth, McKim, Mead & White, Architects, p. 124-125.

4.2 Testing and lecturing at MIT

Since cohesive construction had rarely been used in America, the testing of Guastavino arches was an important part of validating the system and proving its merits to a larger audience. Many of this early testing took place on library grounds during construction and the results were calculated by Professor Gaetano Lanza of the Massachusetts Institute of Technology. The success of these tests became a selling point in the company's sales manual, where they state,

> In 1890, the first breaking load test ever made on 'Timbrel Vault' Construction were successfully conducted at the Boston Public Library, on full size models of Guastavino arches, by the late Professor Lanza of the Massachusetts Institute of Technology. Other tests for both fire and load have since been passed by the New York Building Department, and Compressions, Shear and Tension Tests made at MIT.[48]

The results from Lanza's tests were also discussed and published in Cohesive Construction, Applied Especially to the Timbrel Vault and the table is reproduced in Appendix F.

During the library's construction, Guastavino was invited to speak at the Society of Arts at the Massachusetts Institute of Technology. Professor Lanza was a member of this society, though it is unclear whether or not he was responsible for inviting Guastavino. In fact, it is not clear at this time how Guastavino and Lanza were introduced. Guastavino spoke at MIT's Society of Arts on two separate occasions, first on October 24, 1889 and then again on November 26, 1889, both times reading from his essay, "The History of Cohesive Construction as applied especially to the Timbrel Vault." This essay was published later in 1892 and 1893. After the first lecture at MIT,

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[48]"Timbrel Arch Construction", in the Akoustalith Sales Manual of the R. Guastavino Co., Guastavino/Collins Archive, Avery Library, Columbia University.

Guastavino constructed two arches to demonstrate his construction method. The demonstration was recounted in the minutes of the Society,

> Mr. Guastavino then had two arches of about 4 ½ feet span constructed before the audience in the same way they are being made in the new Public Library on Copley Square. The centers are ordinary boards cut to the proper curve, on which is laid a course of bricks or tiles about 12" x 6" x 1", the joints being of plaster of Paris. On the completion of the first course the centers are removed. The second course is laid in Portland cement, breaking joints with the first course, as is also the third course. The whole, after it is thoroughly set, forming a solid arch.[49]

It was also noted that after the building of the arches, the audience was very interested and asked many questions about the practical points of their construction. After Guastavino finished reading his essay at the second lecture, he proceeded to describe and provide evidence of testing completed in May of 1887 in the Department of Tests and Experiments, also at MIT, with the engineer V.A. Abbott. These results are also reproduced Appendix G. At the end of these results he explains how they were obtained,

> We use the first formula to get the thickness necessary at the center of the arch with a single load and independent of the weight of the arch itself. After that, we find the line of extrados of the arch in a graphical manner, derived from the formula given by Desjardin, for tracing the equilibrium profile of the extrados for the vaults, giving the section of the arch in the skewbacks or base of the arch on each side.[50]

It seems that these tests were used to validate the construction method mostly to academics and clients, because Guastavino appears to have designed largely from his intuition and experience.

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[49] Massachusetts Institute of Technology, Abstract of the Proceedings of the Society of Arts, (Boston: W.J. Schofield, Printer, 1889-1890): p 23.
[50]Ibid., p 33.

4.3 Vaulting showcase

The Boston Public Library was the first major building in the United States to make use of Guastavino vaulting throughout. Guastavino took this opportunity to showcase the various types of vaulting that could be achieved with his system and its flexibility. In the Boston Public Library alone there are approximately eight different types of vaulting. Several of these types will be discussed here. The Entrance Hall is a barrel vault with intersecting arches from the side bays and is covered in a mosaic (Fig. 4.1 and 4.2). Vaulting similar to this type can be seen in future construction by Guastavino, such as Ashdown House on MIT's campus, originally the Riverbank Hotel, built in 1900.[51]

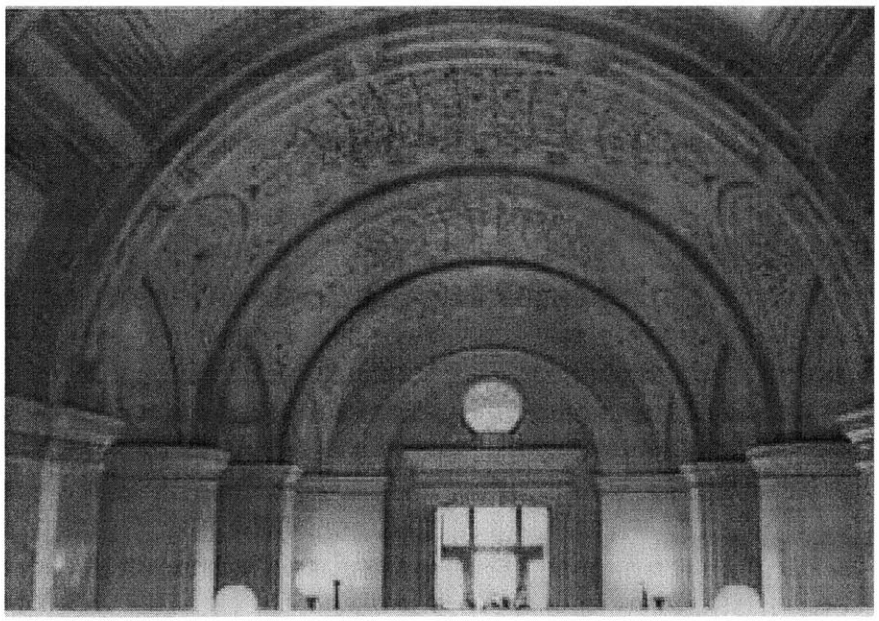

Figure 4.1 Entrance Hall

[51]Cambridge Historical Commission, Survey of Architectural History in Cambridge, Report Three: Cambridgeport, (Cambridge: MIT Press, 1971), p. 44.

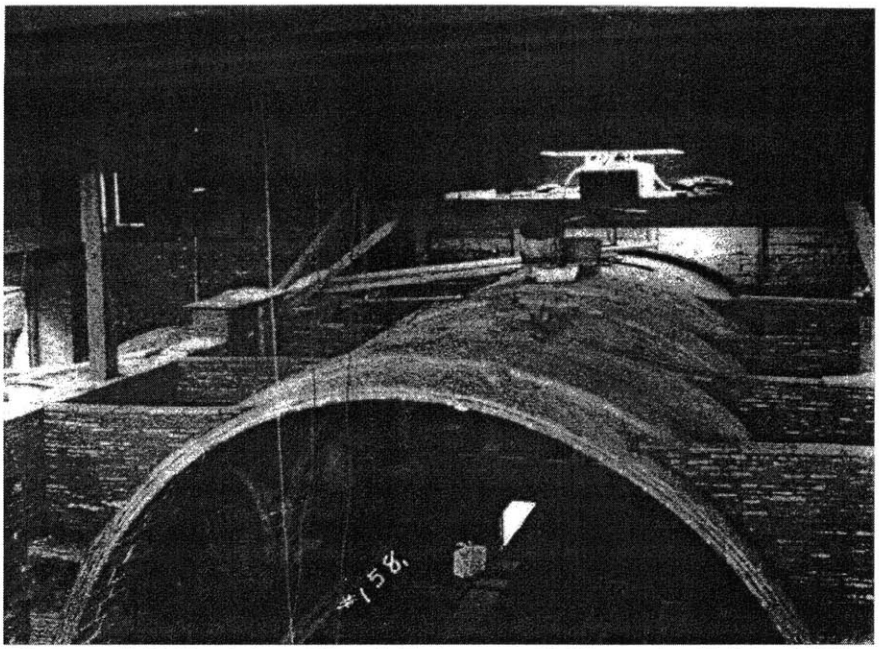

Figure 4.2 Boylston Street Entrance Ceiling, April 14, 1890 (No. 175, Archives of the Trustees of the BPL)

The Map Room in the Boston Public Library, formerly the Periodical Room, is built with shallow domes supported on tile arches and columns (Fig. 4.3). This type of vaulting can be seen in several of Guastavino's later projects, such as the Williamsburg Bridge in 1904 and the Vanderbilt Hotel in 1910.[52] The Catalogue Room has the same general dimensions and appearance as the Map Room with shallow dome vaults supported on a central row of columns. The vaults in the Map Room are constructed with elliptical courses of tile whereas the Map Room uses a herringbone pattern. The herringbone pattern is used in the pendentives in the Map Room vaults and the slope may or may not change at their intersection with the dome vaults (Fig. 4.4). This type of vaulting can be seen in many other buildings by Guastavino, such as the Library of

[52] Salvador Tarragó, Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America (Barcelona: Col·legi d'Arquitectes de Catalunya, 2002).

the New York State Education Building in Albany 1908-1911 and St. Bartholomew's Church in New York 1917-1921.[53]

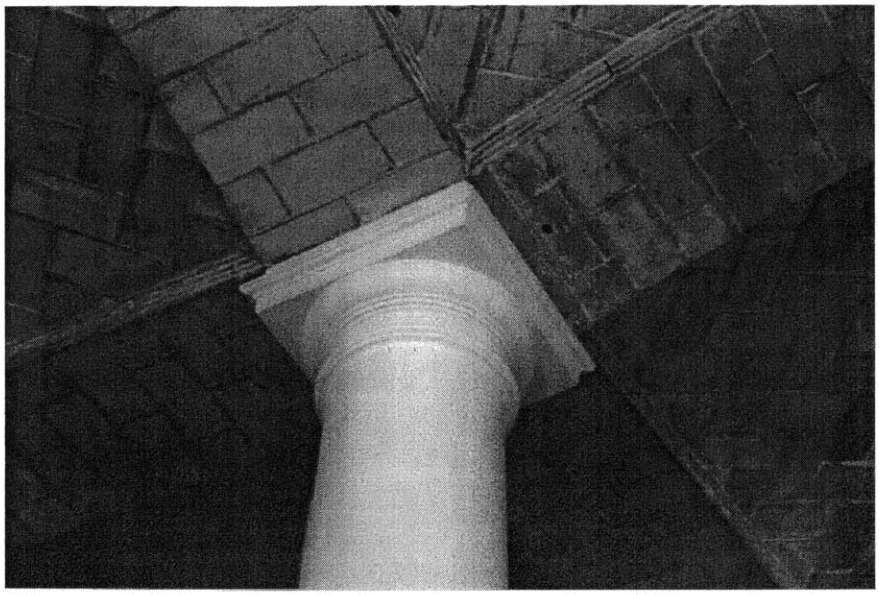

Figure 4.3 Detail of shallow dome vault and tile arches in Map Room (Periodical Room)

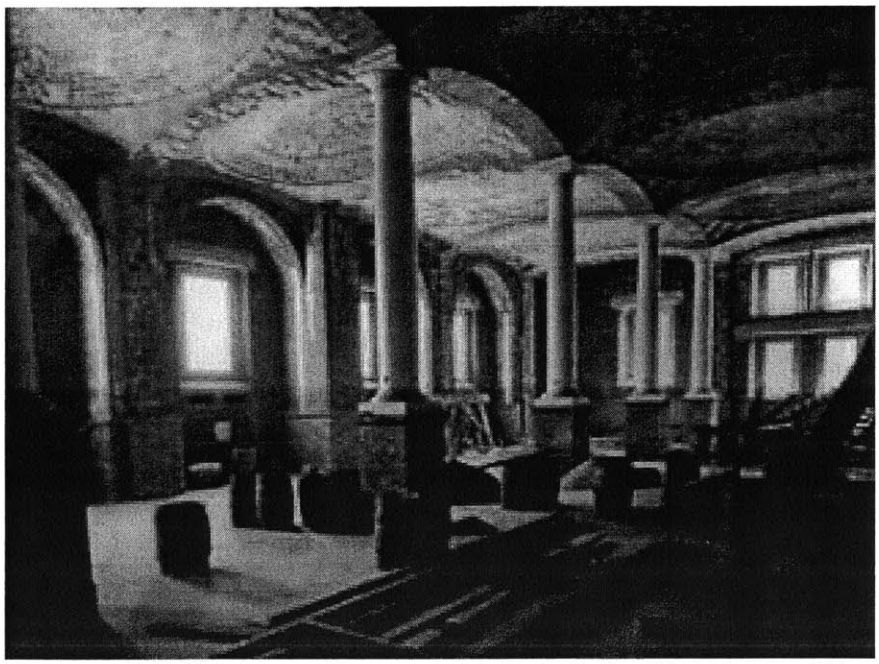

Figure 4.4 Catalogue Room, undated photo (Archives of the Trustees of the BPL)

[53] Huerta, Las bóvedas de Guastavino en América, p. 300-310.

The shallow barrel vaults in glazed tile in the hallways leading from the main Entrance Hall to the lower level were once the location of a public lavatory and coatroom. A similar shallow barrel vault in glazed tile can be seen in the Boston University Chapel Cloister constructed in 1950.[54] Only one of these shallow barrel vaults, on the public lavatory side, ended in small groin vault. During the recent restoration by architects Shepley, Bulfinch, Richardson and Abbott, a fake Guastavino vault in plaster to make both hallways identical.[55] Atop of the grand staircase in the Chavannes Gallery the ceiling is a series of groin vaults. This type was also used in the arcade of the interior court. Groin vaults were also used by Guastavino in buildings such as Grand Central Station in 1911-1913 and the U.S. Army War College in 1903-1906.[56]

Reserve Space No. 1, or the present day café, is a barrel vault with panels laid in relief with tiles in a variety of patterns (Fig.4.5 and Fig. 4.6). This is the same space that Guastavino requested extra payment for additional thicknesses required for such work. A similar use of tile can be seen in the dome of the First Church of Christ Scientist in Cambridge, MA built in 1924.[57] The Driveway Entrance on the Boylston Street side, now a restaurant, is a combination of several different types of vaulting with tile ribs (Fig. 4.7 and 4.8). The vault has a cylindrical curve from the springing up to the ceiling which is an elliptical shallow dome. There are cylindrical penetrations at the windows which allow more light into space.

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[54] George R. Collins, "First record of Guastavino's work in America," in Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America, ed. Salvador Tarragó (Barcelona: Col·.gei d'Arquitectes de Catalunya, 2002), p. 67.
[55] Discussion with Architect Bill Barry of Shepley, Bullfinch, Richardson and Abbott, March 12, 2004.
[56] Huerta, Las bóvedas de Guastavino en América, p. 299-300.
[57]George R. Collins, "First record of Guastavino's work in America," in Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America, ed. Salvador Tarragó (Barcelona: Col·.gei d'Arquitectes de Catalunya, 2002), p. 67.

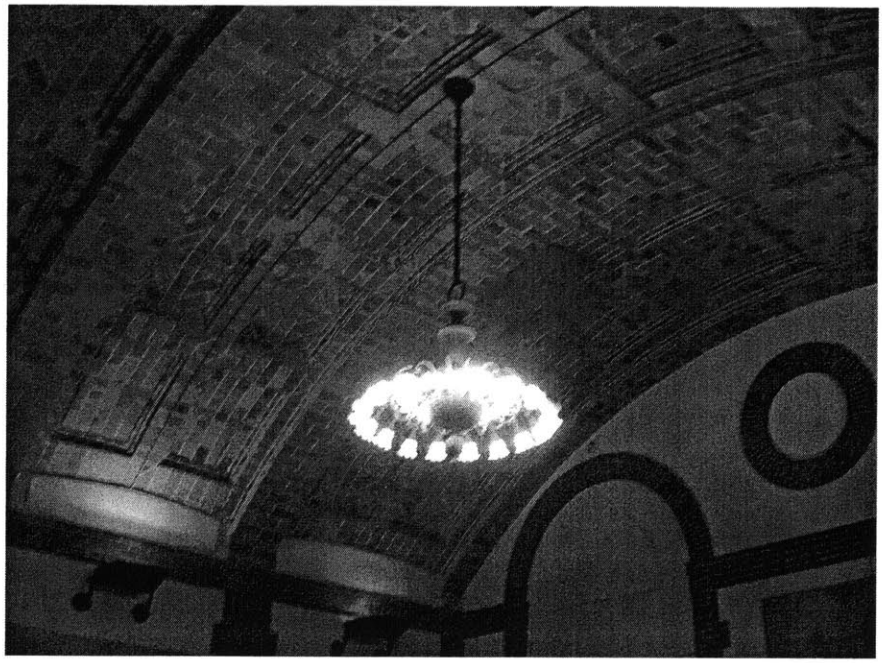

Figure 4.5 Reserve Space No. 1 (café)

Figure 4.6 Reserve Space No. 1 (café) detail

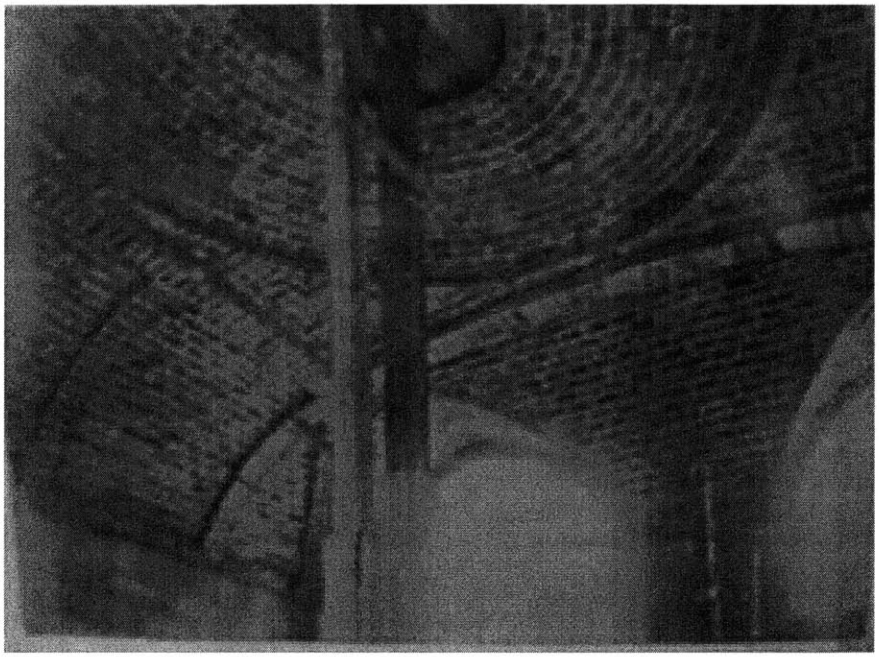

Figure 4.7 Boylston Street Entrance Ceiling, April 14, 1890 (No. 175, Archives of the Trustees of the BPL)

Figure 4.8 Restaurant Ceiling (Boylston Street Entrance)

The General Reference area, once a lecture hall, is a combination of tile arches and iron beams and ties (Fig. 4.9). This system allows long spans without the horizontal thrust, which is especially important on the upper floors, and is the only one

of its type known to exist with Guastavino vaulting. It appears that a prefabricated iron beam system was employed, and Guastavino provided shallow tile domes to serve as the floor system between the beams. It is not clear if Guastavino was responsible for the design of the iron beams and the origin of the beams is unknown. It would be interesting to investigate this unique example in more detail.

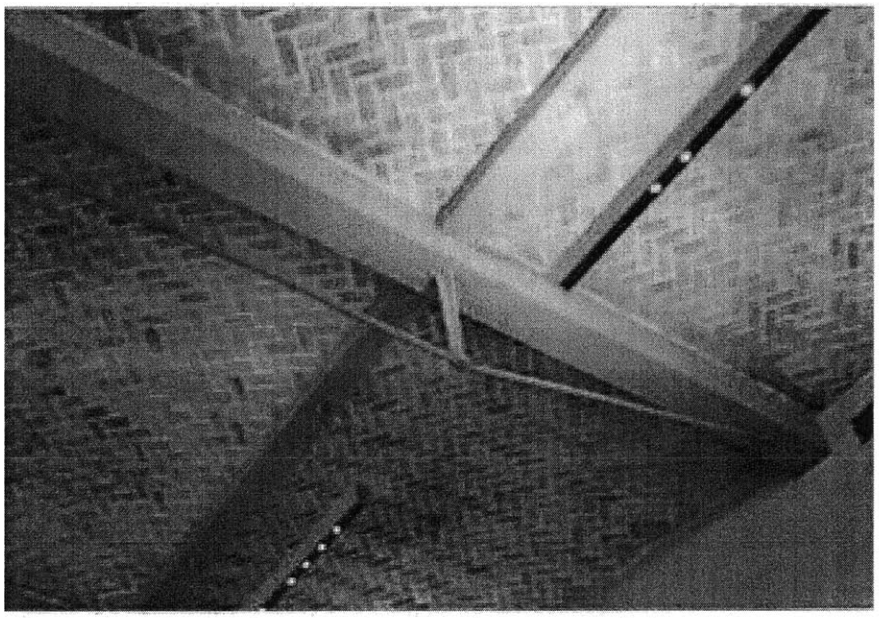

Figure 4.9 Tile domes with iron beams and ties

4.4 Design decisions

One area of the library that was altered by Guastavino was the Driveway Entrance (Fig. 4.7, Fig. 4.8 and Appendix H). Benton and Guastavino worked over the proposed design in December of 1889 and then Benton wrote to McKim, "the scheme is kept the same but there are several points in which I think he has improved it...I think it is now worked in a shape which is really good..."[58] The Trustees then approved the

[58] Letter from Edward R. Benton to Charles F. McKim (December 3, 1889) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

use of tile arch material in this same space.[59] In June of 1892, the Driveway Entrance was still under discussion. Guastavino proposed to finish the ceiling with a corrugated tile that would match the granite already in place and suggested that they change, "the curve from the spring to the first member of the ceiling, say about six or seven feet in height from the spring so the curve will be cylindrical instead of spherical and in consequence the intersection of all penetration will be regular instead of the irregular ones that we now have."[60] Guastavino also added that the ceiling could be finished in corrugated tile which would be less expensive than one finished in a cement mortar, appealing to the Trustees' concern about cost.

Reserve Space No. 1, or the present day café, is a dome with panels in relief with tile laid in a variety of patterns. The first indication of construction in this space is a February 3, 1890 photograph (Fig. 4.5 and Fig. 4.6). This vault has greater thicknesses than any other space in the library, thus requiring a special price. Guastavino proposes in a January 1889 letter that he get paid an additional 27 cents per square foot in addition to the regular contract prices for work in this space.[61] A special order issued on June 18, 1890 of the same year indicates that Guastavino was only paid an additional 13 cents per square foot for this same work, suggesting that others had negotiated him down to this lower price.[62] The development of this space implies that Guastavino took liberties with the tile work and was willing to take a lower price in

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[59] Minutes of the Trustees of the Boston Public Library, January 21, 1890

[60] Letter from Rafael Guastavino to S.A.B. Abbott (June 14, 1892) (Archives of the Trustees of the Boston Public Library)

[61] Letter from Rafael Guastavino to S.A.B. Abbott (January 7, 1889) (Archives of the Trustees of the Boston Public Library)

[62] Special Order No. 83, June 18, 1890, Contracts, Specifications, Proposals, Etc. Regarding the New Library Building, Archives of the Trustees of the Boston Public Library.

order to get it constructed. Having done this, there would be one more type he could exhibit to future clients.

Both McKim and the Trustees are the ones making the decisions about what type of tiles are to be used, in what spaces and the type of finish they are to have. Guastavino's role was to provide the Trustees with a range of options to choose from in type, finish and pattern.[63] Beginning in the fall of 1889, the different types of tiles start to be discussed among Guastavino, McKim and the Trustees. On September 4, 1889 Guastavino receives some of his new "liped" tiles and proceeds to build a sample arch with them in one of the stacks.[64] He presents McKim with the option of using either the "common tiles" or "special tiles" in the stack rooms as well as offering the Trustees several patterns to choose from.

From the research to date, it is not clear exactly how all the different vault types came to exist in the Boston Public Library. One possibility presented by Roth is that McKim, "decided first on the spatial volumes and then designed the roof support system."[65] He may or may not have had input from Guastavino in doing so. It would seem likely though, that since Guastavino was more familiar with the structural possibilities of the chosen method of construction, and he would have expressed these possibilities to McKim. To showcase different types of vaulting in his system would have been to his advantage in such a large scale public building. The development of at least two spaces in the library suggests that Guastavino had some influence on their

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[63] Letter from Rafael Guastavino to S.A.B. Abbott (January 8, 1890) (Archives of the Trustees of the Boston Public Library)
[64] Letter from Edward F. Stevens to Charles F. McKim (September19, 1889) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)
[65] Roth, McKim, Mead & White, Architects, p. 128-129.

design. The Periodical Room (Map Room) and the Catalogue Room are similar spaces symmetrically arranged around the Entrance Hall, but both have very different types of vaulting. This suggests that Guastavino was using this opportunity to display his construction abilities. Also, Reserve Space No. 1, with the tile laid in relief, work that was covered in the original contract but incurred an additional price, suggests that Guastavino went above and beyond what was originally planned for that space.

4.5 Publications and advertisements

The Boston Public Library became an important source of publicity for Guastavino and his company. In November 1890, Guastavino requested negatives and photographs that show their work in the library from Samuel Abbott.[66] As early as 1891 these images were being used by the Guastavino Fireproof Construction to advertise in *American Architect & Building News* (see Appendix I). An advertisement from a May 2, 1891 issue shows a sample of tile vaulting from the Boston Public Library and describes it as, "Domed Construction of fire clay corrugated flange finishing tile, requiring no plastering." This advertisement then goes on to describe the available tile options: plain and corrugated, color- white, yellow and buff, as well as glazed in different colors. The facing page of this advertisement listed all buildings completed or in the process of construction for which the Guastavino Fireproof Construction Company had obtained contracts. In 1891, in addition to the library, this list contained 43 other buildings, the

[66] Letter from Rafael Guastavino to S.A.B. Abbott (November 10, 1890) (Archives of the Trustees of the Trustees of the Boston Public Library)

majority of which were located in Massachusetts and New York, but also a few in Colorado, New Hampshire, Pennsylvania, Rhode Island and New Jersey.

Despite the praise bestowed upon the library in recent years, many were critical during its construction. An April 1895 article in *American Architect and Building News* describes this criticism as "jibes and sneers" and said that "there is hardly a single feature of the building concerning which we have not heard someone speak disparagingly."[67] One of these features was the Guastavino arches about which some said would never hold up. Regardless, Bostonians looked to Guastavino for his opinion of the building when McKim's design came under attack by Dr. William Frederick Poole, a Chicago librarian. Guastavino's positive remarks about the building are published in a September 27, 1890 article in the *Boston Herald* titled "Views of a Spanish Architect the New Building." His remarks about the building could be an attempt to ease the fears of the citizens of Boston about financing a poorly designed building. In this article, Guastavino asserts that the criticism surrounding the library, as expressed by Poole, had no basis and that it would be foolish for a building such as the library to be only functional. He emphasized the importance of having some artistic content that expressed the nature of the materials found within and the education that occurs there.[68]

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[67] "The Boston Public Library," American Architect and Building News (April 6, 1895): 3.
[68] "Views of a Spanish Architect on the New Building," Boston Herald, 27 September 1890.

4.7 Collaborations

The Boston Public Library was the first in a series of projects completed jointly by McKim and Guastavino. McKim was one of the first architects to use the Guastavino system in a number of his buildings. The partnership between the two led to at least fifteen large scale projects for Guastavino from the completion of the library up until 1917. A few of these buildings include the Low Library at Columbia University in 1896, the Library of the University of Virginia in 1897 and the Army War College in Washington, D.C. in 1903 to 1906.[69] A more comprehensive list of collaborations is included in Appendix J.

Guastavino and McKim appear to have maintained a supportive and professional relationship. When the architects Purly & Philips questioned McKim in 1892 about the use of the Guastavino arch system, McKim's response emphasizes his positive experience with the system in the Boston Public Library and suggested that these architects examine Guastavino's work in this building. McKim went on to add, he would not hesitate to place his entire confidence in the Guastavino system.[70] He does this despite a few situations that were cause for conflict during the construction of library, such as the lack of tiles. Clearly, McKim's initial experience with the Guastavino system was overwhelmingly positive and this project was the beginning of much collaboration between the two.

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[69] Huerta, Las bóvedas de Guastavino en América, p. 300.

[70] Letter from McKim, Mead & White, Architects to Purly & Philips, Architects (January 22, 1892) (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

Chapter 5: Conclusions and future work

As the first major building to utilize cohesive construction extensively throughout, the construction of the Boston Public Library had a major positive impact on Guastavino's career. In the next 60 years, the company he founded built over one thousand projects in North America and around the world.[71] This thesis presents several theories of how Guastavino might have obtained the contract for tile work in the Boston Public Library. These theories stem from his entry into the Trustees 1885 competition, the need for fireproof construction and his patents on such a system as well as a possible encounter between McKim and Guastavino in New York. Also presented here is the manner in which the tile arches and vaults were constructed and their cost. The Specifications detail the laying of tile and joints, types of material and method of construction. As various letters show, the tiles caused many problems throughout the construction. Guastavino was unable to find a reliable source for tiles and often had to sort through shipments of tiles to pull out only the best ones. Guastavino's crew was on several occasions unable to work because there were no tiles and this delayed construction to the point of drawing the attention of McKim.

More importantly, the relationships developed with McKim and MIT, and the overall importance of the Boston Public Library on the future of Guastavino's building has begun to be examined here. The results of testing carried out on arches at the library were calculated by professors at MIT and then used in a lecture to the Society of

[71] George R. Collins, "First record of Guastavino's work in America," in Guastavino Co. (1885-1962) Catalogue of Works in Catalonia and America, ed. Salvador Tarragó (Barcelona: Col·legi d'Arquitectes de Catalunya, 2002): 61.

Arts and in later publications. This became a way of validating his work, which was done mostly by experience and intuition, to a more skeptical American audience. It is hard at this point to discern the depth of the relationship between McKim and Guastavino, but it can be seen that Guastavino had some impact on the design of the library, even if only in minor changes to the Driveway Entrance. With such a variety of vaulting it is possible that his impact was greater and he may have influenced the design and construction of the ceilings in several other spaces. After the construction of the Boston Public Library, Guastavino and McKim maintained a relationship and went on to build many buildings together.

The Boston Public Library is used by Guastavino continuously throughout his career in advertisements and publications such as in *American Architect and Building News*, his Essay on the Theory and History of Cohesive Construction and in his Lecture Written for the Congress of Architects in Connection with the Columbian Exposition, on Cohesive Construction: Its Past, Its Present, Its Future, in which he does not hesitate to proclaim the significance of the Boston Public Library when he says it will form, "a page in the American history of constructive art."[72]

This is only the first step in examining the role of Guastavino in the construction of the Boston Public Library. Suggestions for future work in this area would be to further examine how Guastavino got involved in the library project in the first place. One way to do this may be to look at the early leadership of the company and what connections they may have had to Boston or McKim. Another avenue for this research

[72]Rafael Guastavino, Lecture Written for the Congress of Architects in Connection with the Columbia Exposition (Chicago: August 5, 1893): 12.

would be to locate the entries to the 1885 design competition held by the Trustees for the library. Another area of future study should be the source of tile before Guastavino established his own factory. Presented here are only the companies supplying glazed tile, which is used only minimally throughout the building. The design process and Guastavino's relationship with McKim is only briefly covered here. This is an area that may be developed in the future by looking at McKim's correspondence in reply to that presented here. The McKim Archives at the New York Historical Society may be a helpful source for additional correspondence and documents. There is also the opportunity to look at Guastavino's role and similar relationships in other significant buildings.

Without a doubt, the Boston Public Library was one of the most important buildings in Rafael Guastavino's career. With just a few minor buildings in the United States before 1888, his work increased greatly in the years following the construction of the Boston library and continued to do so up until the middle part of the 20th century. Guastavino's work at the library has not only stood as a testament to its quality and his ability as a builder, but as a constant physical advertisement for the Guastavino system.

Appendix A: Letter from Edward R. Benton to Charles F. McKim, March 28, 1889 (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

McK., Mead & White

Boston Office: 53 Beacon Street.

New York

Mar. 28, 1889

My Dear Mr McKim

Your letter of Mar. 27 was handed me this morning by Mr. Guastavino, at the Library lot.

I showed him the plans of the building and the foundations already built, which he admired very much. He thinks it is a great pity that the whole Ground floor could not have been put in by his system, with no beams whatever, - only a few girders.

He says if we would give him all the iron beams for the Ground floor (already on the ground) he would sell the iron, and build the whole ground floor for nothing.

He has been here all day, and has explained his system thoroughly, and shown us or our sections how to use it. We understand perfectly, I think, the scheme which you sent us on the blue prints. I talked with him at the lot, about

McKim, Mead & White.
ARCHITECTS.
57 Broadway, New York.

2

Boston Office: 53 Beacon Street.

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the sample arch, and we shall probably be able to have it built on the lot.

We are quite favorably impressed with the system, and have quite a little of it drawn in in our sections. Perhaps it will be decided at once that we are going to use it.

One question we feel that we must have answered at once by this work, namely:—

Shall we on each set of contract drawings which we are now making, (and which must be bid upon in public competition), show our construction according to the new system or according to the old system?

You say in your letter that Mr. Guastavino "will estimate in competition for the fireproofing against this present method."

We do not see here how he can do that unless there is a set of drawings

McKim, Mead & White,
ARCHITECTS.
57 Broadway, New York.

3

Boston Office: 53 Beacon Street,

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according to the present method for getting estimates upon. If two different methods of construction are to be estimated upon, how can we avoid having two sets of drawings? Perhaps you have come the way to propose. I hope so, as it would be bad to have to do so much more work in order to get ready for bids.

You will see by the letter which I enclose relating to Mr. Philbrick's bill, that the Executors say they are unable to divide the bill, and expect McKim, Mead & White to pay it all. I think the best way to arrange it would be for you to see Mr Abbott about it in New York as he is to be there Saturday. Hee says the Trustees will pay part of it. I told him I would send the correspondence on to you, and he will expect you to bring the matter up.

McKim, Mead & White,

57 Broadway, New York.

Boston Office: 53 Beacon Street.

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At the building, they are now ~~laying~~ setting cut stone all along Boylston St. They are also ~~laying~~ setting iron beams in Stack, on St. Jas. Avenue. They are also building the block granite foundation in the S.E. quarter of the building.

I have to go to the quarry tomorrow, and will hurry up those stones for carving. They are probably about ready by this time.

Mr. Abbot today talked as if he was in favor of getting rid of <u>all</u> iron beams <u>below</u> Bates Hall floor as well as above. Will you please discuss the matter with him Saturday, and decide at once whether anything is to be done in this direction, since work is now going on which should be immediately stopped, if anything of that sort is to take place. It would be fun to do it, but we ought to know at once.

Very truly yours, Edward R. Burton.

Appendix B: Proposal for Tile Work by the Guastavino Fireproof Construction Company in the New Public Library Building from "Contracts, Specifications, Proposals, Etc. Relating to the New Library Building," Library of the Trustees of the Boston Public Library.

Furnishing and setting rough tile arches:	
Two courses thick	30 cents per square foot
Three	38
Four	47
Five	50
Six	65
Furnishing and setting rough tile domes:	
Two courses thick	38 cents per square foot
Three	48
Four	57
Five	66
Setting and pointing glazed tile ceilings:	
Plain glazed tiles	5 cents per square foot
Glazed tile of more than one color	8
Tiles with ornaments in relief	10
Pointing rough tile ceilings	2
Cutting skewbacks:	
In granite	50 cents per linear foot
In brickwork	20
Rough stairs:	
For arch or dome	50 cent per linear foot of step
For rough step	30
For rough platform	50 per square foot
For slate tread and riser (1 inch thick, to 5 feet long)	70 cents per linear foot of step
For marble tread and riser (1 inch thick, 3 to 5 feet long)	95
For slate platform (1 inch thick, 3 to 5 feet long)	50
For marble platform (1 inch thick, 3 to 5 feet long)	75

Cutting, fitting and setting iron beams:
1 ½ cents per pound of beam set

Furnishing and setting all minor iron work:
1 ½ cents per pound

Brick partitions for leveling up on top, on tile arches and domes:

Two inches thick	18 cents per square foot, face measurement
Four inches thick	24

Tile floors of two courses, on brick partition:
20 cents per square foot

Covering beams with tile arch material:
17 cents per linear foot

Appendix C: Letter from Edward F. Stevens to Charles F. McKim, August 6, 1889 (Papers 1838-1930 1866-1909, Charles Follen McKim, Boston Public Library)

OFFICE OF
CLERK OF WORKS,
NEW PUBLIC LIBRARY BUILDING,
COPLEY SQUARE,
BOSTON.

having a grille instead of a door?

Evans & Lambs are carving all three Stones for the balcony there are five men on them.

Guastavinos men have been working but about half the time for lack of tiles. but he has a plenty now.

Guastavino has started to build the lower floor of Stock (C) with 4 courses but it seems to me that if it is built of 3 courses with a rib every section or under every book case 12 ft wide which would be 4 courses that it would be all that was needed. they are working now in Stock (A) they have reinforced the small central arch by filling the space between the beams full of tiles & cement them

which prevents any danger of the thrust of the large arches overcoming the strength of the smaller one

Appendix D: Letter from Rafael Guastavino to Charles F. McKim, December 20, 1889 (Archives of the Trustees of the BPL)

S. A. B. A.
28 State St. Boston.
C. F. McK.
57 B'way, N.Y.

Boston, Dec. 20th. 1889.

Chas. F. McKim Esq.

#53 Beacon St. Boston, Mass.

Dear Sir:

I was very sorry that the flat glazed tiles from Spain did not meet with your approval, but think that it was owing to some error of conception, on my part that I was not able to answer you satisfactorily.

In order to show the way of utilizing this thin and special quality of tile that are adapted to be used in any form, I am now drawing Reserved Space #3, domes , ribs, and side of ribs with this kind of tile which I will submit to you personally.

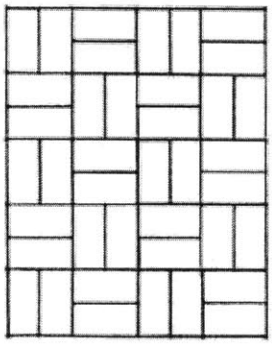
I will remark that just these conditions of lightness, thinness and quality of clay, is adapted to be utilized without the necessity for any other form save in the case of regular mouldings.

This does not mean that the other tiles have not good effect, and that in the future they will not compete in combinations of color, and facility with these Spanish tiles, to make drawings in the ceiling and give richness of lines, but in the condition of affairs here I do

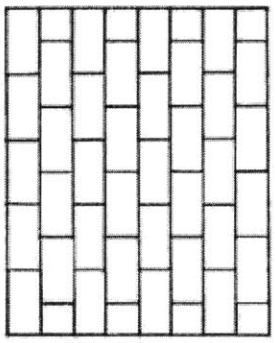
not believe that without great loss of time and money, we can attain as good results.

Yours Truly.

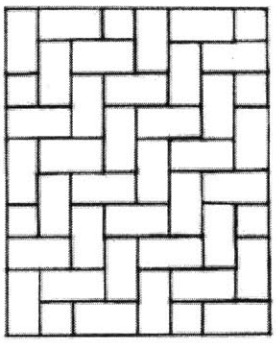
Appendix E: Tile Patterns and Prices
Sketches made from a January 8, 1890 letter from Rafael Guastavino to S.A.B. Abbott (Archives of the Trustees of the Boston Public Library)



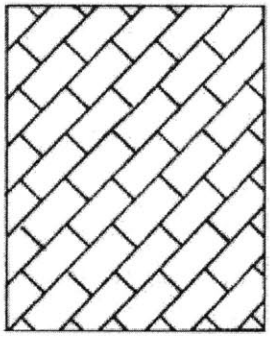
#1 26¢, 29¢ on the diagonal



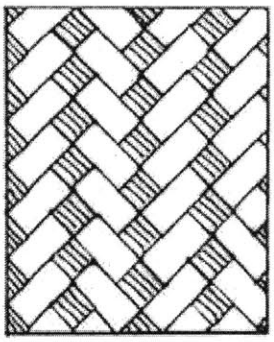
#2 27¢, 29¢ on the diagonal



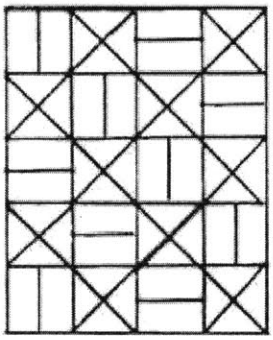
#3 28¢, 30¢ on the diagonal



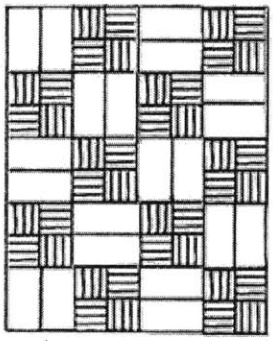
#4 29¢



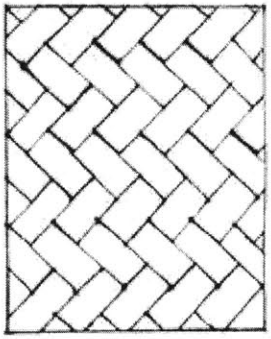
#5 32¢



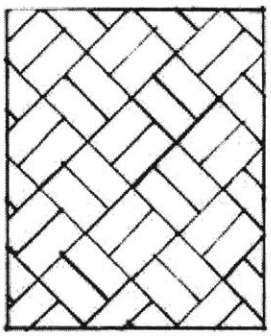
#6 34¢



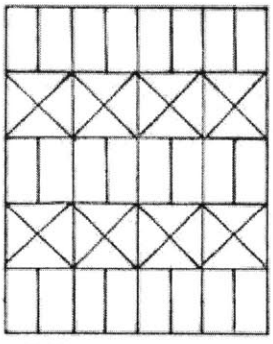
#7 30¢



#8 30¢



#9 29¢



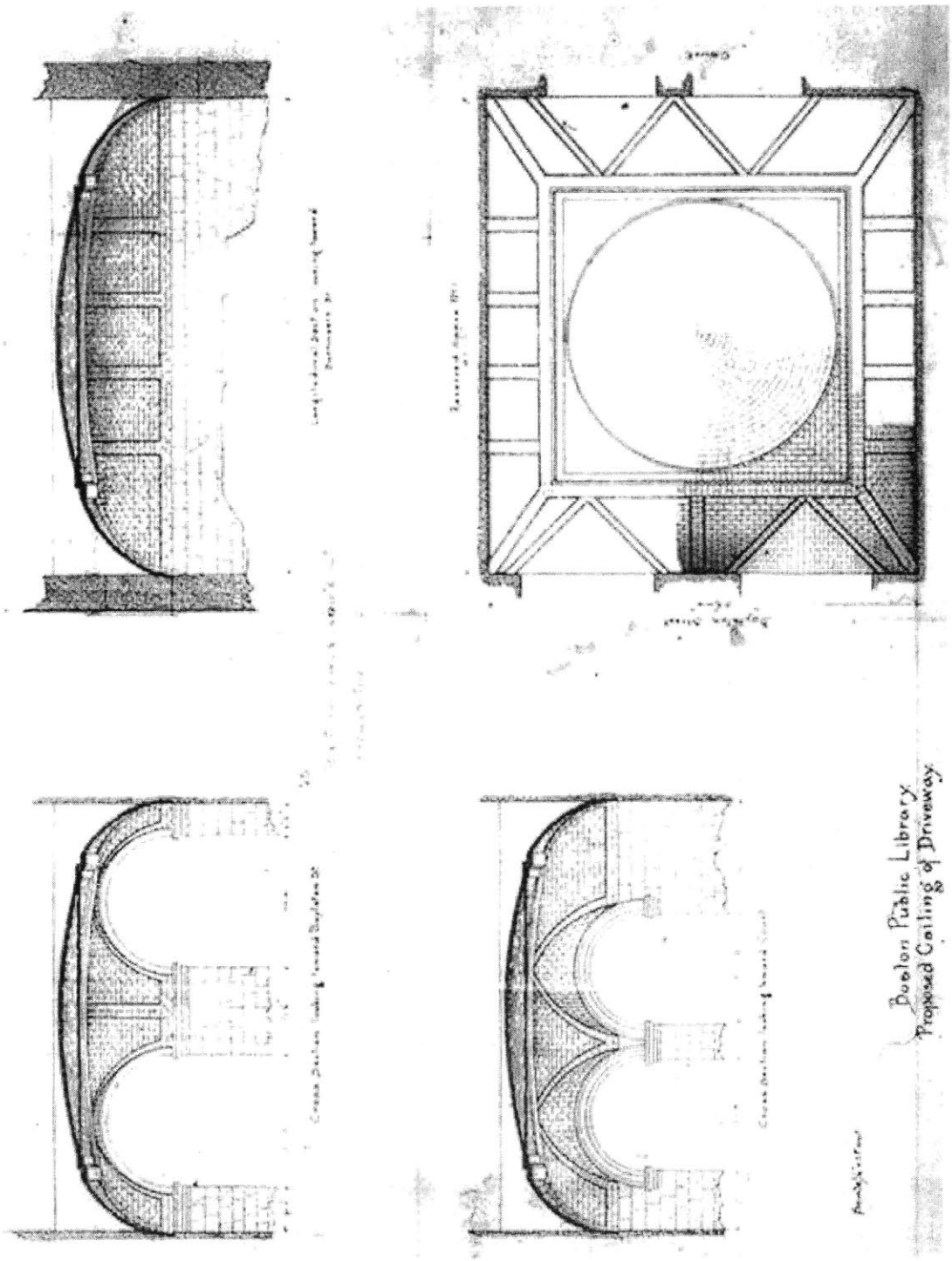
#10 32¢

Appendix F: Table of Theoretical Stresses for Arches 10% Rise with Uniform Load (W) Per Sq. Ft., from Rafael Guastavino, Essay on the Theory and History of Cohesive Construction, Applied Especially to the Timbrel Vault. (Boston: Ticknor and Company, 1893).

Span in feet	Rise in inches	Thickness in inches	Area of Sec., 12 in. wide	I of Section, 12 in. wide	Bending Moment at Crown. Inch pounds =WX	Stress due to bending moment	Thrust at Crown =WX	Stress due to thrust at Crown	Stress due to thrust at springing	Maximum stress at crown =WX
5	6	2	24	8	.540	.0675	6.16	6.673	.278	.32417
5	6	3	36	27	.540	.03	6.16	6.673	.18536	.20111
6	7.2	3	36	27	.7776	.0432	7.392	8.008	.2227	.24853
7	8.4	3	36	27	1.0854	.0588	8.624	9.3425	.2595	.29836
8	9.6	3	36	27	1.3824	.0768	9.856	10.677	.2966	.34458
9	10.8	3	36	27	1.7496	.09719	11.088	12.013	.3372	.40518
10	12.0	3	36	27	2.16	.12	12.320	13.346	.3707	.46222
11	13.2	3	36	27	2.6136	.1452	13.552	14.598	.4055	.52164
12	14.4	3	36	27	3.1104	.1728	14.784	16.016	.4449	.58347
12	14.4	4	48	64	3.1104	.0972	14.784	16.016	.3337	.4052
13	15.6	4	48	64	3.6504	.1140	16.016	17.351	.3615	.44767
14	16.8	4	48	64	4.2336	.1323	17.248	18.685	.3768	.49163
15	18.0	4	48	64	4.860	.15187	18.480	20.02	.4171	.53687
16	19.2	4	48	64	5.5296	.1728	19.712	21.355	.4449	.58347
16	19.2	5	60	125	5.5296	.1106	19.712	21.355	.3559	.43913
17	20.4	5	60	125	6.424	.1285	20.944	22.689	.3781	.47757
18	21.6	5	60	125	6.9884	.13977	22.170	24.024	.4004	.50937
19	22.8	5	60	125	7.7976	.15595	23.408	25.359	.4225	.54608
20	24.0	5	60	125	8.64	.1728	24.64	26.693	.4449	.58347
20	24.0	6	72	216	8.64	.12	24.64	26.693	.3707	.466222
21	25.2	6	72	216	9.5256	.1323	25.872	28.028	.3893	.49163
22	26.4	6	72	216	10.4544	.1452	27.104	29.363	.4079	.52164
23	27.6	6	72	216	11.4264	.1587	28.336	30.697	.4263	.55225
24	28.8	6	72	216	12.4416	.1728	29.568	32.932	.4449	.58347

Appendix G: Coefficients obtained in the Department of Tests and Experiments with the Engineer V.A. Abbott from Massachusetts Institute of Technology, Abstract of the Proceedings of the Society of Arts, (Boston: W.J. Schofield, Printer, 1889-1890), p.33.			
Compression Test			
No. 4817	May 3	5 days	2277 lbs. per square inch
No. 4818	May 3	5 days	1624
No. 4869	June 6	5 days	1430
No. 4870	June 6	5 days	2911
An average of 2060 lbs. per square inch.			
No. 4873, Oct. 21, 1889, 1 year 3290 lbs. per square inch			
Transverse			
No. 4871	June 6		90 lbs. per square inch
Tension			
No. 4875	June 7		287 lbs. per square inch
Shearing Stress			
No. 4873	June 6	in Portland Cement	124 lbs. per square inch
No. 4872	June 6	in Plaster of Paris	287 lbs. per square inch
The formula I am using is TC = LS/4r for concentrated load, and TC = LS/8 for distributed load where T= thickness of arch in middle, or area of cross section, C= coefficient = 2060 lbs. per square inch breaking load. S= span, r = rise of arch.			

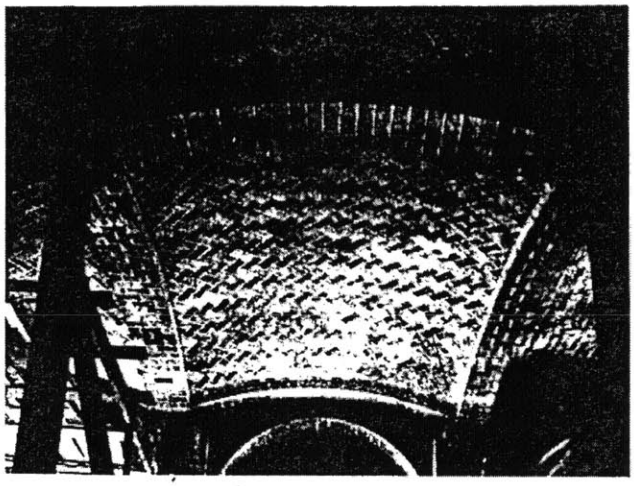
Appendix H: Proposed Ceiling of Driveway Reproduced from Santiago Huerta, Las bóvedas de Guastavino en América, (Madrid: Instituto Juan de Herrera, 1999). Original located in Guastavino/Collins Archive, Avery Library, Columbia University.



Appendix I: Advertisement from *American Architect and Building News*, May 2, 1891

DOME CONSTRUCTION OF FIRE CLAY CORRUGATED FLANGE FINISHING TILE, REQUIRING NO PLASTERING.

IN THIS BUILDING WE HAVE THIS CONSTRUCTION IN PLAIN & CORRUGATED TILE, WHITE, YELLOW AND BUFF, ALSO IN GLAZED TILE, DIFFERENT COLORS.



A SAMPLE OF TILE VAULTING IN THE NEW PUBLIC LIBRARY, BOSTON.
McKIM, MEAD & WHITE, ARCH'TS.

THE GUASTAVINO FIRE-PROOF CONSTRUCTION CO

MAIN OFFICE: 57th ST. & NORTH RIVER, NEW YORK, N.Y.

Appendix J: A Partial List of Collaborations between McKim and Guastavino after the Boston Public Library, compiled from Las bóvedas de Guastavino en América, ed. Santiago Huerta (Madrid: Instituto Juan de Herrera, 1999).

1896	Low Library, University of Columbia New York
1897	Library of the University of Virginia Charlottesville, Virginia
1900	Cabel Hall, University of Virginia Charlottesville, Virginia
1901	Students Hall, University of Columbia New York
1903	Public Library No.6 New York
1903-1904	Bank of Montreal Hamilton, Ontario, Canada
1903-1905	House for Clarence Mackay Roslyn, New York
1903-1905	Tiffany Building New York
1903-1906	Army War College Fort McNair, Washington, D.C.
1904	Madison Square Presbyterian Church New York
1905-1907	Girard Trust Company Philadelphia, Pennsylvania (also with Allen Evans)
1905-1909	Pennsylvania Station (demolished 1963) New York
1908-1910	Municipal Building New York
1911	Residence for Payne Whitney New York
1913	Stair in Redmond Houses New York

Bibliography

Primary Sources

Archives of the Trustees of the Boston Public Library.

"Contracts, Specifications, Proposals, Etc. Relating to the New Library Building," vol. I and II., Library of the Trustees of the Boston Public Library.

Guastavino/Collins Archive, Avery Library, Columbia University.

Massachusetts Institute of Technology, Abstract of the Proceedings of the Society of Arts, (Boston: W.J. Schofield, Printer, 1889-1890).

Minutes of the Trustees of the Boston Public Library.

"Papers 1838-1930 1866-1909," Charles Follen McKim, Boston Public Library.

"Timbrel Arch Construction", in the Akoustalith Sales Manual of the R. Guastavino Co., Guastavino/Collins Archive, Avery Library, Columbia University.

Secondary Sources

APT Bulletin 1999, v.30, no. 4.

"Flat Tile Arches." Boston Herald. 12 July 1889.

"The Boston Public Library." American Architect and Building News. 6 April 1895.

"Views of a Spanish Architect on the New Building." Boston Herald. 27 September 1890.

Cambridge Historical Commission. Survey of Architectural History in Cambridge, Report Three: Cambridgeport. (Cambridge: MIT Press, 1971), p. 44.

Collins, George R. "The Transfer of Thin Masonry Vaulting from Spain to America." Journal of the Society of Architectural Historians, 27 (1968): 176-201.

Guastavino, Rafael. Lecture Written for the Congress of Architects in Connection with the Columbian Exposition, on Cohesive Construction, It's Past, It's Present; It's Future. Chicago: August 5, 1893.

Guastavino, Rafael. Essay on the Theory and History of Cohesive Construction, Applied Especially to the Timbrel Vault. Boston: Ticknor and Company, 1893.

Guastavino, Rafael. The Function of Masonry in Modern Architectural Structures. Boston: America Printing Co., 1904.

Huerta, Santiago, ed., Las bóvedas de Guastavino en América. Madrid: Instituto Juan de Herrera, 1999.

Evans, Paul. Art Pottery of the United States New York: Feingold & Lewis Publishing Corp., 1987.

Roth, Leeland M. McKim, Mead & White, Architects. New York: Harper and Row Publishers, 1983.

Roth, Leeland, M. The Architecture of McKim, Mead and White, 1870-1920: A building list. New York: Garland Publishing, Inc., 1978.

Schodek, Daniel L. Structures, 4th Edition. New Jersey: Prentice Hall, 2001.

Shand-Tucci, Douglass. Built in Boston: City and Suburb, 1800-1950. Amherst: The University of Massachusetts Press, 1978.

Small, Herbert. Handbook of the New Public Library in Boston. Boston: Curtis & Cameron, 1908.

Tarragó, Salvador, ed., Guastavino Co. (Catalogue of Works in Catalonia and American. Barcelona: Col·legi d'Arquitectes de Catalunya, 2002.

Wadlin, Horace G. The Public Library of the City of Boston: A History. Boston: The Trustees of the Boston Public Library, 1911.

Wermiel, Sara E. The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City. Baltimore: The Johns Hopkins University Press, 2000.

White, Samuel G. and Elizabeth White. McKim, Mead & White: *The Masterworks*. New York: Rizzoli International Publications, Inc., 2003.

Whitehill, Walter Muir. Boston Public Library: A Centennial History. Cambridge: Harvard University Press, 1956.

Wick, Peter A. A handbook to the art and architecture of the Boston Public Library. Boston: The Associates of the Boston Public Library, 1977.

Wight, Peter B. "Fireproof Construction and the Practice of American Architects." American Architect and Building News (August 19, 1893): 113.

Wight, Peter B. "The Life and Work of Rafael Guastavino. Part I-V." The Brickbuilder 10 (April, May, September, October 1901).

Wilson, Richard Guy. McKim, Mead & White, Architects. New York: Rizzoli International Publications, Inc., 1983.