DOCUMENTATION AND REGULATIONS OF HISTORIC STRUCTURES

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Abstract

In order to promote adequate preservation of our construction heritage, the documentation of the historic structures is essential. The historic data can be directly related to the preserved structures. Where data is not available studies must be made based on construction techniques and materials used at the times of construction. The protection, preservation and continued viable use of historic resources demands of us the application of today's technology to yesterday's construction materials and methodology, recognizing and utilizing the strengths inherent in archaic materials and methodologies which have permitted them to withstand the test of time.

1. Historic Preservation: Engineering or Art?

Engineering training promotes the systematic study of a problem in order to solve it. Basic science guides the engineer through the understanding of the effects of the surrounding universe in his life. In modern times building codes and lawyers equally affect the potential solution to a problem.

In terms of preserving historic structures, engineers must unlearn the rigidity that modern codes and lawyers impose, and travel through time in order to really understand the context where the building was conceived, designed and constructed and maintained.

Modern education has shortfalls:

1. Code based and regulated
2. Safety issues
3. Lawyers driven
4. High level of specialization
5. Lost of Basic engineering science
6. Obsession with computers

In order to considered Rehabilitation and Restoration as an ART, it needs to acknowledge the need to strength, to alter or to add to a historic building to meet continuing or changing uses while retaining the building historic character and heritage.

Unfortunately sometimes safety regulations are not used by professionals involved in restoration claiming to protect the structure. It is rationally indefensible to misuse the Codes in order to
fund, at a lower level than its non-historic peers, the earthquake repair of a structure identified as an historic resource. And it is a misreading of the Codes to interpret it as a license to merely "paint the cracks" of historic buildings.

The true Art is the commitment to preservation of these resources, by implementing, on a case-by-case basis, the solution which best fulfills the unquestionably long term goal that word implies.

2.0 Evaluation

First step toward a preservation of a structure is to assess available Documentation:

1. State or local record, survey or inventory,
2. Historical documents,
3. sketches and plans,
4. specifications,
5. architectural drawings,
6. paintings; and
7. Photographs.

Most of the Institutional buildings were developed through careful planning, either by the State (empires, kingdoms or democratic governments) or by rich and powerful citizens; therefore the existence of documentation can be found.

Civil buildings (houses, commercial purpose) may not have a record or a very limited one; therefore the professional must rely on reference of other existing or documented structures, as well as construction standards for the original construction date.

In essence Historical Buildings are physical records of the past. History will help to understand the circumstances of the construction. The character defining aspects of the building that need to be identified and evaluated may include the form and detailing of interior materials (lime and rubble mix, masonry, tapia, wood, metals...), exterior and interior features such as types of roofs, windows, finishes, moldings, cornices, room configurations, spatial relationships, and structural and mechanical systems.

![Figure 1 Assessment of historic wall](image)

Things to observe:
1. Additions such as wings, stories
2. Changes to surface finishes, finish coat, painting, tiles
3. Blocking of wall openings (doors, windows)
4. Changes to grade
5. Changes to cornices, stairs
6. False facades
7. Changes to basic plan

2.1 Asses Architectural Integrity

Integrity means the intactness of the buildings as whole, its features, materials, finishes and function ability of the structural systems. The integrity must be evaluated in terms of the original construction methods and not the modern materials and systems. Observe deficiencies due to settlements, deflection of beams, cracked arches, vaults, lintels and walls.

Observe materials failure due to:
1. Poor original material
2. Poor design
3. Changes of environmental conditions
4. Moisture and water seepage problems
5. Observe human inflicted damage
6. Removed or lost ornamentation
7. Inappropriate coatings
8. Bad repointing or cleaning
9. Insensitive and out of context additions
2.2 Plan for the rehabilitation work

It is of utmost importance to begin with the end in mind. In most cases the final use of the rehabilitated structure influences and controls the development of the rehabilitation work plan. It should include:

1. Photograph thoroughly the interior and exterior of the building.
2. Prepare As-Built detailed drawings
3. Determine need of testing of materials and systems
4. Plan for special fabrications of replacement materials
5. Need for specialized crafts.
6. Write unique specifications
7. As-Built drawings
8. Impact of proposed uses
9. Develop protecting measures
10. Need for disability access to public areas
11. Develop plan to preserve or restore the historic characters (both interior and exterior).
12. Develop requirements for construction advise and supervision
13. Prepare training for special interventions.

Figure 2 Different construction materials

2.3 Check Codes and other Legal Requirements

Different Countries, Cities and owners dictate rules for the preservation project. The rules are described through codes and legal constraints:

1. State or local ordinances
2. Historic zones requirements
3. Review requirements of Historic Commissions or Agencies
4. Application of Modern Codes

The key to successful application of codes and laws is to understand the construction practices (materials, structural systems, architectural trends and finishes) of the original building and integrate them with modern regulations without altering the PRESERVATION goal.

3. Historic Regulations

Great civilizations developed rules and guidelines for ordaining the cities and preserving human life. The oldest written record dates back...
2,200 B.C. by King Hammurabi. The following discussion gives an overview of regulations.

### 3.1 Code of Hammurabi

A portion of the famous Hammurabi code is dedicated to construction regulations. It was a performance specification with strict, simple and deadly consequences of non performance:

- If a builder build a house for a man and do not make its construction firm, and the house which he has built collapse and cause the death of the owner of the house, that builder shall be put to death.
- If it cause the death of a son of the owner of the house, they shall put to death a son of that builder.
- If it destroy property, he shall restore whatever it destroyed, and because he did not make the house which he built firm and it collapsed, he shall rebuild the house which collapsed at his own expense.

### 3.2 Roman Empire

For over 2,000 years Roman construction techniques dominated the development of Europe, North Africa, the Middle East and America (only after the XV Century). Romans were experts in developing systematic techniques and standardization for all types of construction. They particularly successful on:

1. The development of the use of lime mortars
2. The development of the use of the Arch
3. The development and evolution of the Arch as a dome
4. Development of infrastructure:
   a. Roads
   b. Bridges
   c. Water systems
   d. Sewage water systems
   e. Entertainment facilities

![Figure 4 Code of Hammurabi](image1.png)

![Figure 5 Roman Bridge Construction](image2.png)

**Figure 4** Code of Hammurabi

**Figure 5** Roman Bridge Construction

### 3.2.1 Vitruvius

Marcus Vitruvius Pollio (born ca. 80/70 BC?; died ca. 25 BC) was a Roman writer, architect and engineer, active in the 1st century BC. Vitruvius is most famous for asserting in his book *De architectura* that a structure must exhibit the three qualities of *firmitas, utilitas, venustas* - that is, it must be strong or durable, useful, and beautiful. The ten books included dissertations on a wide variety of subjects relating to architecture, engineering, sanitation, practical hydraulics, acoustic vases and the like.

England, Spain, Portugal and France were the driving force into the colonization of America. All of these countries were part of the Roman...
Empire, thus their technology came to America through them. Therefore Vitruvius description of materials and techniques are a great source in order to understand the construction of our historic buildings.

Because of modern engineers in America are use to ASTM standards, it is somewhat difficult to understand the quality controls established 2,000 years ago. For illustration purposes Vitruvius quotes are presented about Bricks and Lime.

3.2.1.1 Vitruvius on Bricks

The following description for bricks is a prescriptive specification by modern standards. It covers materials, fabrication method, storage and available models.

“I shall first treat of bricks, and the earth of which they ought to be made. Gravelly, pebbly, and sandy clay are unfit for that purpose; for if made of either of these sorts of earth, they are not only too ponderous, but walls built of them, when exposed to the rain, moulder away, and are soon decomposed, and the straw, also, with which they are mixed, will not sufficiently bind the earth together, because of its rough quality. They should be made of earth of a red or white chalky, or a strong sandy nature. These sorts of earth are ductile and cohesive, and not being heavy, bricks made of them are more easily handled in carrying up the work.

The proper seasons for brick-making are the spring and autumn, because they then dry more equably. Those made in the summer solstice are defective, because the heat of the sun soon imparts to their external surfaces an appearance of sufficient dryness, whilst the internal parts of them are in a very different state; hence, when thoroughly dry, they shrink and break those parts which were dry in the first instance; and thus broken, their strength is gone. Those are best that have been made at least two years; for in a period less than that they will not dry thoroughly.

There are three sorts of bricks; the first is that which the Greeks call Didoron (didw=ron), being the sort we use; that is, one foot long, and half a foot wide. The two other sorts are used in Grecian buildings; one is called Pentadoron, the other Tetradoron. By the word Doron the Greeks mean a palm, because the word dw=ron signifies a gift which can be borne in the palm of the hand. That sort, therefore, which is five palms each way is called Pentadoron; that of four palms, Tetradoron. The former of these two sorts is used in public buildings, the latter in private.”

3.2.1.2 Vitruvius on Lime

The following description is a prescriptive specification by modern standards for the use of lime. Lime became the most important discovery for speeding up construction. It became an almost magical process, to be able to transform stone into a paste that after drying it became stone again. It helped to protect less noble materials for wall, floors and roofs in order to withstand time.

“Having treated of the different sorts of sand, we proceed to an explanation of the nature of lime, which is burnt either from white stone or flint. That which is of a close and hard texture is better for building walls; as that which is more porous is better for plastering. When slaked for making mortar, if pit sand be used, three parts of sand are mixed with one of lime. If river or sea sand be made use of, two parts of sand are given to one of lime, which will be found a proper proportion. If to river or sea sand, potsherds ground and passed through a sieve, in the proportion of one third part, be added, the mortar will be better for use.

The cause of the mass becoming solid when sand and water are added to the
lime, appears to be, that stones, like other bodies, are a compound of elements: those which contain large quantities of air being soft, those which have a great proportion of water being tough, of earth, hard, of fire, brittle. For stones which, when burnt, would make excellent lime, if pounded and mixed with sand, without burning, would neither bind the work together, nor set hard; but having passed through the kiln, and having lost the property of their former tenacity by the action of intense heat, their adhesiveness being exhausted, the heat being partially retained, when the substance is immersed in water before the heat can be dissipated, it acquires strength by the water rushing into all its pores, effervesces, and at last the heat is excluded.

Hence, limestone, previous to its burning, is much heavier than it is after having passed through the kiln: for, though equal in bulk, it is known, by the abstraction of the moisture it previously contained, to lose one-third of its weight by the process. The pores of limestone, being thus opened, it more easily takes up the sand mixed with it, and adheres thereto; and hence, in drying, binds the stones together, by which sound work is obtained.”

3.3 Napoleonic Code (1804)

The Napoleonic Code, or Code Napoléon (originally called the Code civil des Français) was the French civil code, established under Napoléon I. It was drafted rapidly by a commission of four eminent jurists and entered into force on March 21, 1804. It is relevant to construction practices in countries were the Civil Code has latin heritages because it establishes a 10 year term of responsibility to professionals involve in the construction process. The code expressed:

“If there is a loss in serviceability in a constructed project within 10 years of its completion because of a foundation failure or from poor workmanship, the contractor and architect will be sent to prison.”

3.4 Arte de Albañileria, 1827

Although Arte de Albañileria was not written as a code, it represents the state of practice in Spain in early XIX Century. Don Juan de Villanueva was a well know architect whose work included interventions in the Royal Palace and the El Prado Museum in Madrid. This book is the culmination of the outstanding career of a great Architect; all the construction techniques of the late XVIII and early XIX Centuries are collected as a guide.

Figure 6  Masonry Wall Construction

The advisory committee on Technology of Galicia decided to start a collection of reproductions of basic Construction Books in order to make available the true foundation blocks of the construction of our patrimony. The reprinting was published in 2001.
The book covers all the different aspects of masonry construction. It covers materials, techniques and methods. It has a beautiful collection of ink drawings demonstrating tools, forms, techniques and methods. Figures 3 through 5 show some of them.

Because of his prestige as an architect the book was printed under de name of Pedro de Zengotita due to the mundane topics of construction. After the book became an instant success, Don Juan revealed the true author of the book.

As the book demonstrates, all material is based in Roman techniques that has basically not modified for almost two thousand years.

3.5 National Park Service, USA

In Puerto Rico, the Capital City of San Juan, was built as a fortified city during the Spanish empire. It development as stronghold of defense evolved though four centuries. The last mayor intervention was in late XVIII century to close the city based on recommendations by Alexander O’Rilley. He was commissioned by the Spanish Crown to built up the cities of Habana Cuba), Santo Domingo (Hispaniola) and San Juan.

Figure 9 shows the master plan developed by Don Juan Mestre, the military engineer that carry out the project. Due to the closing of the city, one of the main features of San Juan, and one that gives it a sense of identity, is the 3 miles of walls, las murallas, virtually enclosing the historic city and integrating the two other components of this study: el Castillo de San Felipe del Morro and el Fuerte de San Cristóbal. The walls are massive, varying in height from 15 to 60 feet, and in width up to 25 feet.

After Puerto Rico became part of the United States in 1898, the walls and fort in the old city became part of the National Park System in the USA. In the 1980’s NPS became more aware of the importance of Historic preservations for the system an commissioned an extraordinary study of San Juan.

The preparation of this Historic Structure Report for the San Juan National Historic Site took place over a five year period: from 1986 through 1990. The structures included in this report are; San Cristobal Castle and its outworks, el Morro Castle and his outworks, and the City Walls. The content is:

- Vol. I: Summaries of the historical and structural development of San Cristóbal, el Morro, and the City Walls.
- Vol. II: San Cristóbal
- Vol. IV: Compilation of all drawings executed by HABS

It has proven to be an extraordinary source of information for restoration and rehabilitation for maintaining the restoration projects in wall system. But in addition it is a great source of information about materials, methods and development the Old City through four centuries. As an example of the quality of the report the following quote is included:
The smoothness and sheen of the stucco’s surface are the result of floating. The Real Maestranza de Ingenieros report (ca. 1832) describes the scarped walls of el Morro that were stuccoed and burnished (presumed to be floated): revocado y brunitodo. Surfaces treated in this way resist water (by allowing for run off), thereby resisting many of the detrimental effects of water. In fact, it is where the surface has lost this outer layer that the deterioration visible today has set in. A description of polishing is given in this same report: embonado, repellado y sacado á plana refers to stuccoing and floating; á plana is a float that is described as being six fingers wide by a palm long.

Another great contribution of the report is a Glossary of construction terms in Spanish and English. As an example:

NPS - Glossary
- Cal: Lime. (6)
- Cal y canto: Cut stone and mortar construction.
- Cantera: Stone quarry. (6)
- Cantería: Quarried stone, cut stone; the art of cutting stone; building mad of squared stone, unit of squared stone. (6)
- Caponier: Sheltered passage across the ditch leading to outworks and sometimes providing additional flanking fire for the ditch. (4)
- Capuchinos: A term used occasionally for hinges with a conical socket and pintle arrangement. So named for its resemblance to the hoods worn by Capuchine monks. (JJ)

4. Modern USA Standards

4.1 Chapter 34 of the IBC (2000)

The United States of America is making an effort to unify its code system. The result is what is called the International Building Code. In terms of Historic Buildings we quote:

Historic Buildings. The provisions of this code relating to the construction, repair, alteration, addition, restoration, and movement of structures, and changes of occupancy shall not be mandatory for historic buildings where such buildings are judged by the building official to not constitute a distinct life safety hazard.

As it can be interpreted the Code is vague and relies on engineering judgment and knowledge to application of modern standards.

4.2 2001 California Historic Regulation Code, by the International Conference of Building Officials

In section 8-101.2 it states:

- “The purpose of this code is to provide regulations for the preservation, restoration, rehabilitation, relocation or reconstruction of buildings or structures designated as qualified historical buildings or properties (as defined in Section 8-218).
- Such regulations are intended to provide alternative solutions for the preservation of qualified historical buildings or properties, to provide access for persons with disabilities, to provide a cost-effective approach to preservation, and to provide for the reasonable safety of the occupants or users.
- These regulations require enforcing agencies to accept reasonably equivalent alternatives to the regular code (as defined in Section 8-219) when dealing with qualified historical buildings or properties.”

It is the most comprehensive code in the USA and it addresses all modern aspects of construction (fire protection, safety, durability, etc.) in relation to the Historic Structures. It should become a standard in the whole country.
4.3 ADA and Historic Buildings

Historical buildings shall be accessible to the public as defined by ADA (American with Disability Act) and Title 24. H&S Code, S. 18954 demands that the code be applied on a case by case, item by item basis. The CHBC, Chapter 8-6, S-602.1 requires that a project shall meet the standards of Title 24, or CBC Chapter 11, etc. unless, "strict compliance with the regular code will threaten or destroy the historical significance or character defining features of the building or property". If historic fabric is threatened the SHBC allows for alternates, equivalent facilitation and exceptions to the regular access code."

Figure 10 is an example of a 400 year old church whose intervention for rehabilitation was exempted from compliance of ADA regulations. The alternatives of ramps or elevators would have destroyed the historic character of the Church.

Figure 10 Porta Coelli Church in Puerto Rico

5. Building Codes and our Goals

For historic buildings, achieving code compliance is often perceived as one of the most formidable challenges to any rehabilitation project. It doesn't have to be. Innovative treatments and technologies, and the increasing adoption of rehabilitation codes present fresh opportunities for building owners, architects, consultants and local officials. New codes, materials and other planning and technical resources can facilitate life safety goals, while accommodating treatments that preserve the character of historic buildings.

Keys to Finding Code Solutions for Historic Buildings:

1. Understand the intent of the various codes.
2. Understand how the applicable codes treat historic buildings.
3. Understand the constraints of the local code official.
4. Utilize variance and appeal boards.
5. Determine the preservation priorities and explain them to the local code official.

6. Conclusion

The protection, preservation and continued viable use of historic resources demands of us the application of today's technology to yesterday's construction materials and methodology, recognizing and utilizing the strengths inherent in archaic materials and methodologies which have permitted them to withstand the test of time.

Building on this foundation, and supplementing it with the best in seismic resistance technology, we must be committed to incorporate a reasonable level of seismic resistance, life safety compliance and modern uses in the least intrusive manner.