

Waterproofing materials used in buildings in the colonial period in Mexico: Case study Huichapan, Hidalgo

Materiales de impermeabilización empleados en edificios en la etapa colonial en México: Caso de Estudio Huichapan, Hidalgo

RODRÍGUEZ-URIBE, Juan Carlos^{†*}, TREJO-TORRES, Zaira Betzabeth and BENÍTEZ-ALONSO, Margarita

Tecnológico Nacional de México/Instituto Tecnológico Superior de Huichapan, Licenciatura en Arquitectura.El Saucillo, Huichapan Hgo, México. C.P. 42411.

ID 1st Author: Juan Carlos, Rodríguez-Urbe / CVU CONAHCYT ID: 166235

ID 1st Co-author: Zaira Betzabeth, Trejo-Torres / CVU CONAHCYT ID: 774137

ID 2nd Co-author: Margarita, Benítez-Alonso / CVU CONAHCYT ID: 1249989

DOI: 10.35429/JAD.2023.18.7.10.17

Received September 15, 2023; Accepted December 30, 2023

Abstract

Mexico, focusing specifically on the case of Huichapan, Hidalgo. The study examines various applied waterproofing techniques, considering factors such as available materials and type of building. The particularities and challenges associated with the implementation of these techniques in a historical context are highlighted, providing valuable actions for the effective conservation of ancient buildings in Mexico. The richness of cultural heritage is emphasized through architectural diversity, highlighting the various types of buildings that stood out during the colonial period in Mexico. This approach not only seeks to document physical characteristics but also to underscore the significant contribution of these buildings to the cultural identity and history of the region.

Conservation, Historical, Contexto

Resumen

El presente documento aborda la temática concerniente a los materiales de impermeabilización que se emplearon en las cubiertas de edificios en la etapa colonial en México, centrándose específicamente en el caso de Huichapan, Hidalgo. El estudio examina diversas técnicas de impermeabilización aplicadas, considerando factores como materiales disponibles y tipo de edificación. Se destacan las particularidades y desafíos asociados con la implementación de estas técnicas en un contexto histórico, proporcionando acciones valiosas para la conservación efectiva de edificios antiguos en México. Se resalta la riqueza de la herencia cultural a través de la diversidad arquitectónica, destacando los diversos tipos de edificaciones que se destacaron durante la época colonial en México. Este enfoque no solo busca documentar las características físicas, sino también resaltar la significativa contribución de estos edificios a la identidad cultural y la historia de la región.

Conservación, Histórico, Context

Citation: RODRÍGUEZ-URIBE, Juan Carlos, TREJO-TORRES, Zaira Betzabeth and BENÍTEZ-ALONSO, Margarita. Waterproofing materials used in buildings in the colonial period in Mexico: case study Huichapan, Hidalgo. Journal Architecture and Design. 2023. 7-18: 10-17

* Correspondence to Author (e-mail: jcrodriguez@iteshu.edu.mx)

† Researcher contributing as first author.

Introduction

Both current society and our ancestors seek to preserve their heritage, ensuring its longevity, as inheriting a property in which intangible memories and traces of family, community, and societal identity are ingrained is part of the customs in Mexico.

Despite technological advances, there are still areas for improvement in terms of waterproofing, as it is subjected to numerous abiotic and structural factors. It may require a specific formulation for a particular case or a standard that helps regionally identify these heritage sites within a sector with similar characteristics. These issues arise due to the vast complexity of construction systems, with a great mix in historical properties featuring different composite systems or increasing levels of complexity.

Waterproofing can take various forms, ranging from natural to synthetic, all aiming for the common goal of being durable, of high quality, with a good aesthetic finish, and a positive chemical reaction. In the case of historical buildings, it is crucial that the National Institute of Anthropology and History (INAH) is satisfied with the implementation in restoration interventions.

During the colonial era in Mexico, constructions faced specific challenges related to climate, geographical conditions, and available materials. While they did not use modern chemicals like the synthetic waterproofing we know today, colonial-era builders employed local techniques and materials to protect structures against moisture and rainfall.

It is essential to consider that construction techniques and materials used in the colonial era varied by region, local construction traditions, and resource availability. Additionally, colonial constructions often required regular maintenance to preserve their structural integrity and protect them against the elements, including moisture.

Current waterproofing products focus on a generic market without addressing the specific needs of properties with delicate details, such as historical ones.

The INAH is meticulous about restoration procedures, aiming to replicate the original system and materials in interventions. This involves tracing the origins of natural waterproofing throughout Mexico's history, rooted in pre-Hispanic times with lime and vernacular systems, to the present day, where scientific advancements reintroduce the beneficial properties of nopal mucilage. This is implemented not only in historical buildings but also in residential homes due to its affordable cost. The goal is to conserve a long tradition of caring for properties, contributing to a characterization that aids in both cases.

Historical framework

For Castillo M. *et al.* (2004), the roots of Huichapan date back to pre-Hispanic times, showing traces of Teotihuacan, Toltec, Mexica cultures, but above all, the Otomi culture. The name Huichapan, meaning "river of willows," comes from Nahuatl, but the Toltecs named it Hueychapan, meaning "abundance of water."

According to glottochronological studies, this diversification of the name's origin in different cultures is a common characteristic of this area, as it has been inhabited since the Late Preclassic period (600 – 150 B.C.) and belongs to the Bajío of Otopames Mesoamericans and Otomangue origin.

The emergence of the first agricultural remains in Mezquital and Bajío indicates an expansion of sedentary Otopames from the valleys of Mexico and Toluca towards the north, with a possibility of having joined or displaced the Pames. Wright D. C. (2005).

During the Protoclassic period in the Mezquital Valley, the absence of pottery is observed, suggesting the depopulation of a large area of this region. This is argued by the dispersed population concentration related to Teotihuacan in the southern part of the valley. Noteworthy architectural features include bases with slope and board, buttresses on the sides of staircases, lime-based coatings, and braziers. Brambila R. *et al.* (2013).

For the Classic period (200-600 A.D.), they were re-colonized by Teotihuacan rulers, living in multifamily residential complexes.

Teotihuacan sites in Mezquital show strong similarities to the metropolis in their architecture. Residential complexes were made of stone, lime, and wood, and it is very likely that Teotihuacan colonies in Mezquital produced lime for the metropolis, with wood probably extracted from the forested areas of the region. However, this architectural-commercial harmony declined by the 5th century.

During this new period, the "culture of the tables" or "Xajay culture" emerged. Together with Bajío, they used the "closed courtyard," with a rectangular perimeter platform, usually with a base on one of its sides. Wright D. C. (2005).

During this time, evidence of the use of lime within buildings as a coating and protection material was found. This was not only by the Teotihuacans in their city, but also the Mezquital area, responsible for providing tribute in this material. This provided knowledge in this area for its own use, although it was not intensive due to sending a fixed tribute, it was crucial to analyze how it behaved with the specific climate and vernacular systems of the region.

With the dissolution of Teotihuacan, lime was only used in the Mezquital Valley. Although the veins had been exploited and were no longer sought after, those that remained continued to be used until the resource was exhausted. In constructions, its implementation is noted in a measured manner without excess, reflecting the care they had with this raw material.

During the 16th century, there was a process in which the Otomis of Mezquital expanded into Pame territory in the Eastern Bajío, but never in a procession-like manner.

With the arrival of the Spaniards on the Mexican coasts in 1519, a period of conquest and evangelization began, creating a large network of processions and missions of different religious orders alongside military campaigns and settlements. The Franciscans prevailed during this time.

In 1531, Huichapan was subdued by the chief of Jilotepec, Don Nicolas Montaña, originally from Tula and a relative of Moctezuma II. Montaña was appointed Captain General of the places near Querétaro, a designation he received from Viceroy Velasco on behalf of Carlos V. With this, he managed to have contact with Fernando de Tapia (Conín), who had been present in Huichapan before the conquest as a merchant (being originally from Nopala, forming his family in the current capital of Queretaro in the Cañada area. Engaging in trade with the Mezquital - Kingdom of Jilotepec area, managing links and contacts between different ethnic groups), passing his title on to his son Diego de Tapia, who was also present in Huichapan, but now for the designation of encomiendas, having knowledge of routes and settlers from his father. Brambila R. *et al.* (2013).

Thus, in 1532, the Valley of San Mateo Huichapan was founded. Francisco de Alejos led the main family that settled the town. None of those who accompanied Montaña in his campaign stayed to populate Huichapan, so the "Alejos" arrived later with "Alejos de la Bárcena" to settle the place, requesting permission to found the town along with other families, including that of Don Diego de Tapia. In January 1557, the founding of "Valle de San Mateo Gúeychiapan" was officiated in Jilotepec. Castillo M. *et al.* (2004).

In the 17th century, Friar Felipe de Santiago contributed to the writing of the "Huichapan Codex," a document that narrates part of indigenous history and the colonial designation that would be known as the entire regional history. Santiago F. *et al.* (1632).

In present-day Huichapan, it is common to find constructions from the 16th to the 20th century where the roofs show significant wear or even total collapse and loss of slab. It is worth noting that there is a category of Religious Architecture, where buildings belong due to their massive and monumental character. Figures 1 and 2 show, through artistic representation, the main facade and architectural plans of a chapel as a representation of religious architecture.



Figure 1 Composition of the main facade of a chapel as a representation of religious architecture in Huichapan, Hidalgo

Source: Own Authorship

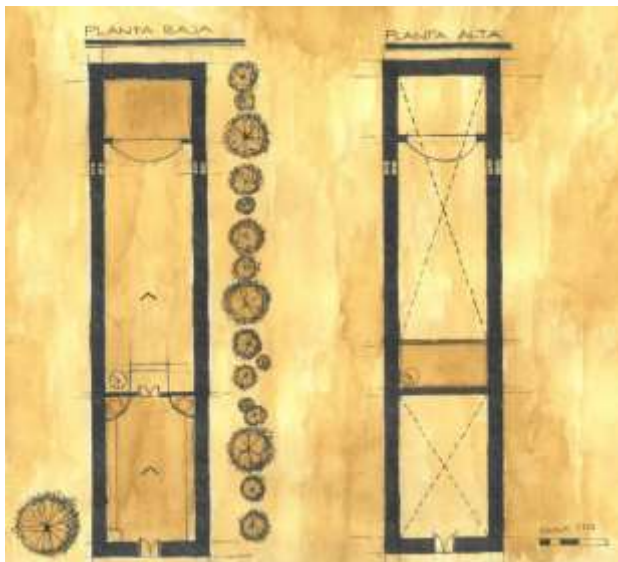


Figure 2 Architectural floor plans of a chapel as a representation of religious architecture in Huichapan, Hidalgo

Source: Own Authorship

Civil Architecture

There are two types; the first consists of constructions with architectural elements and religious precedents that play a significant role together. The second is on a smaller scale, involving residences that define and complement the urban landscape. As examples, in Figure 3, we identify a graphic model of an arcade-type building as a representation of civil architecture in Huichapan. Meanwhile, in Figure 4, we observe the architectural typology of a residence.



Figure 3 Graphic model of an arcade-type building as a representation of civil architecture in Huichapan, Hidalgo
Source: Own Authorship



Figure 4 Graphic model of an arcade-type building as a representation of civil architecture in Huichapan, Hidalgo
Source: Own Authorship

Materials

As mentioned by Cedeño (2019), the term "humidity" refers to the water that permeates a body. This moisture can come from the subsoil, the air, or the effects of rain. In the field of construction, water will always be the number one enemy of building materials. Therefore, to prevent water from impregnating these materials, it is necessary to consider waterproofing methods.

Thus, preventing water from passing through a porous body is called impermeability, and the material that performs this function is known as a waterproofing agent. In ancient times, materials such as straw, leaves, branches, and slate slabs were used. In Mexico, waterproofing with alum, soap, prickly pear cactus, and aguacal was widely employed.

Some of the methods and materials used to waterproof buildings in the colonial period in Mexico included:

Lime and plaster: Lime and plaster were common materials used in colonial construction. These materials had properties that helped repel water and prevent leaks in the walls. Lime was also used to create stuccos that could serve as waterproof coatings.

Clays and adobe: Local clays and sun-dried adobe bricks were basic components of many colonial constructions. These materials could be treated and mixed in a way that helped resist water penetration.

Clay tiles: Fired clay tiles were common on the roofs of colonial constructions. Properly arranged, these tiles formed an effective barrier against rain and provided a drainage system to prevent leaks.

Stone: In some constructions, especially those of historical significance, stone was used as a building material. Careful arrangement of stones and the use of mortars could help minimize water entry.

When analyzing the historical context of Huichapan, it is noted that they implemented a carpentry and cabinetmaking system widely used by Adalberto Jiménez, a local resident considered a great master craftsman who passed away in the seventies. He inherited the method of making "glue" (glue made from gelatinous parts of animals), which was sold in plates or pieces. These had to be soaked and then subjected to a "double boiler" for gradual dissolution since direct heat would burn it (Sánchez F., 2015).

By combining these facts and the composition of the "glue," it could be inferred that it is a triggering factor within colonial architecture in this municipality, as it was applied as a sealer and for curing wood. Specifically, it was the wooden beams that collapsed first, compromising the entire slab system. The wall system did not show the same exhaustion, standing without fractures, only exhibiting some gradual or significant dampness due to the failure of the main roof.

In Figures 5 and 6, we identify the wooden beams and their importance within the slab system, as well as their behavior in conjunction with the building as part of the construction and structural system.

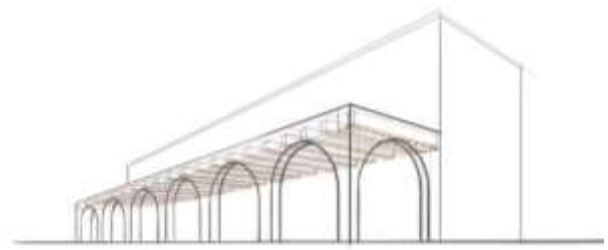


Figure 5 Composition of wooden beams in the archetypal arcade, represented in a two-point perspective on the section of wooden beams in colonial arcade porches, very common in New Spanish architecture
Source: Own Authorship



Figure 6 Composition of wooden beams in the archetypal colonnade, represented in a two-point perspective on the section of wooden beams in unadorned colonnade porches
Source: Own Authorship

Typology

The facades are characterized by a tendency towards horizontality with smooth alignments, simple parapets, and varying ornamentation, either with molding stripes or carvings that serve to protect against splashes and direct rain, especially in the corners where construction tends to be more critical, including openings.

The construction system presented in Huichapan ranges from a degree of simplicity to a certain degree of opulence, featuring materials such as stone, composite walls, wood, and an abundance of quarry.

As observed in Figure 7, when broken down, the structural relevance of a single clear span of the slab becomes apparent. It tends to be vulnerable to moisture from rain, exhibiting a tendency to flex in the slab and consequently sagging in the middle where the critical point is located.



Figure 7 Composition of wooden beams in the archetypal colonnade. Two-point perspective representation on the section of wooden beams in colonnade porches, where the structure is marked up to the midpoint of the entire porch section, highlighting the critical point

Source: Own Authorship

It is important to analyze these diagrams to diagnose how materials behave, where there is a tendency to flex in the slab and consequently sag in the middle where the critical point is located.

Considering the above, we can understand why there are so many failures in slabs of this type in the Huichapan region. The practice of "waterproofing" is seen as a construction method by covering the beams with traditional cabinetmaker's glue, neglecting the external waterproofing of the structure as a final finish and protective coating. This method becomes outdated due to its natural composition and lack of internal-external complementation.

Results

Architectural and material surveys were conducted on various buildings from the colonial period in Huichapan, encompassing structures of both religious and civil nature (residences). This allowed us to identify the different nature of materials used in construction, as well as the waterproofing agents incorporated into the buildings. Through this process, sketches of architectural representation (prototypes) were developed with the aim of assessing the current state of the work concerning its performance regarding the employed waterproofing.

In Figures 8 and 9, we observe the architectural and tectonic plans, as well as a schematic section of a religious building, respectively, as part of the comprehensive technical data sheet for construction systems and materials incorporated into religious buildings.

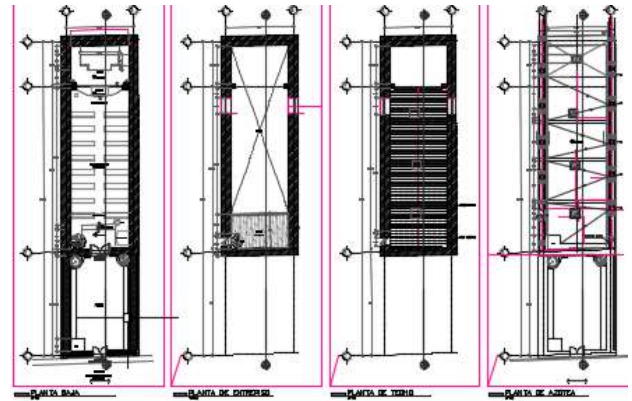


Figure 8 Architectural and typological plan of a religious building as part of the technical data sheet concentrating on construction systems and materials used in religious buildings

Source: Own Authorship

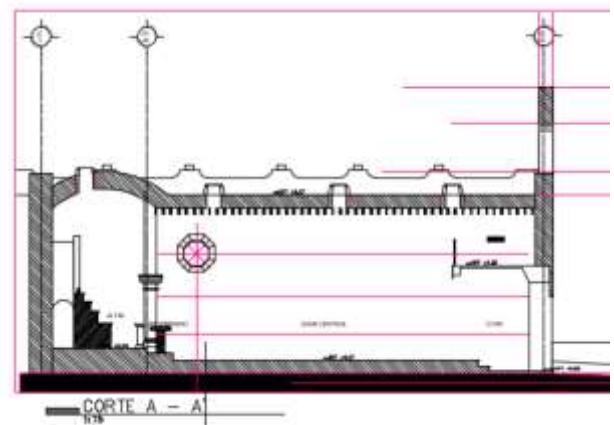


Figure 9 Typical schematic section of a religious building as part of the technical data sheet focusing on construction systems and materials used in religious buildings

Source: Own Authorship

In Figure 10, we observe respectively the typical architectural facade of a civil building as part of the technical data sheet focusing on construction systems and materials used in religious buildings.



Figure 10 Schematic facade of a civil building as part of the technical data sheet concentrating on construction systems and materials used in religious buildings

Source: Own Authorship

Gratitudes

The publication of this article would not have been possible without the interest and commitment of a group of colleagues and researchers who undertook the task of supporting the development of the case study presented through a practical methodology to solve problems related to the conservation of architectural heritage. I appreciate the collaboration of researchers: TREJO-TORRES, Zaira Betzabeth, MSc. BENÍTEZ-ALONSO, Margarita, BSc. for the development of this article. I appreciate the comments of RUFINO – MENDOZA, Mauricio Abraham, BSc. regarding the theme of architectural elements and components.

Likewise, the authors of the article express their gratitude to the Higher Education Institution (HEI) that supported them in the development of this work: Instituto Tecnológico Superior de Huichapan (ITESHU). Also, we thank TecNM for the support provided for the development of the publication. I also want to express my gratitude for the support provided by the students of ITESHU, C. VEGA-ZÚÑIGA, Raquel, C. CHÁVEZ-ARTEAGA, Valeria, SÁNCHEZ RIVERA Nayelly Monserrat, RAMÍREZ-HERNÁNDEZ, Jazmín, BOTELLO-GUAPILLA, Francisco Javier, AREVALO-ÁLVAREZ, Francisco Adrián, HERNÁNDEZ-RESÉNDIZ, Ariel, DE LA CRUZ-YERBAFRÍA, Rodrigo, C. ARANDA-TREJO, Diego & VEGA-ANGELES, Luis Manuel, for the development of this work.

Conclusions

As we managed to synthesize the wear factors and agents that cause deterioration in roofs of historical-colonial buildings, we could observe that the relationship between construction methods influences significantly, not just the abiotic factors alone over time. This implies that a harmony must be achieved between waterproofing and coating both internally and externally to balance the wear and failure of the structural system. In this case, noticing the presence of wooden framework, one might suggest replacing it with a more modern and less perishable material.

However, in compliance with INAH regulations to preserve the identity and maintenance of these buildings, the materials and execution methods must be respected for any intervention. Hence, the relevance of seeking a solution where the formulation of the waterproofing is composed of ingredients that have shown favorable precedents in their behavior over time in preserving these properties.

An example is the use of lime, which dates back to pre-Hispanic times. It behaves differently depending on the vein from which it is extracted, the method of exploitation, as well as the customs and uses for its application, the region's temperature, and the proportions. For instance, in the constructions of the Mezquital Valley during Teotihuacan's dominance, lime was used sparingly, in almost light layers, leaving traces. However, after the fall of Teotihuacan, its use increased, and thicker layers were applied. Similarly, the abundance of prickly pear cactus, with multiple variants, each with distinctive characteristics, went relatively unexplored or endemic.

This was not mere chance because while in the southern region of the country the Mayans also implemented lime-based waterproofing or sprayed seashells, a political-commercial relationship can be observed between Diego de Tapia and the active area from La Cañada to Jilotepec, a product of his father's contacts and even a factor in founding Huichapan itself. Although it is no longer a splendid reign or under the commercial yoke of a stronger civilization, mestizaje allowed these knowledge integrations and the creation of new, somewhat experimental, somewhat secure systems, leaving us a legacy where we can improve to preserve our identity and deconstruct ourselves for the benefit of modern society.

It was gratifying to see that the "glue" is considered good for carpentry and applied to architecture, making its presence a demonstration of the local identity. Hence, the importance of observing not only the current environment but also what causes it and since when. For example, vernacular architecture indicates the use of simpler, almost curved-linear joints, while the colonial era explores mixed systems with more marked archetypes.

However, one is not necessarily better than the other, and the best aspects of both should be preserved. In the case of the waterproofing based on the present research, the goal is to create a friendly, durable formula that the current population can apply to continuously contribute to the care not only of historical heritage but also of their own current heritage that they will pass on to their children.

References

Brambila R. *et al.* (2013). Códice de Jilotepec (2da ed.) Fondo Editorial Estado de México. Scribd
<https://es.scribd.com/document/374706462/Codice-de-Jilotepec-pdf>

Castillo M. *et al.* (2004). Huichapan, Hidalgo. Mediateca Departamento de Difusión. Centro INAH Hidalgo; Texto.

Valdiviezo, A. C. (2019). Protección contra la humedad en edificios históricos. *Diseño en Síntesis*, (61), 60-69.

INAH (2015). Expediente “Casa del Artesano”, Huichapan. Consultado en versión del 2020 INAH; Catalogo.

Sánchez F. (2015). Huichapan de mis recuerdos (1era ed.) Ediciones Mayahuel.

Santiago F. *et al.* (1632). Códice del Monasterio de San Mateo Huichapan; Códice de Ueychiapa; [Códice Otomí]. INAH; Texto (bajo Dr. Dávalos E.).

Wright D. C. (2005). Los otomíes: cultura, lengua y escritura [Tesis doctoral]. El Colegio de Michoacán, A.C.