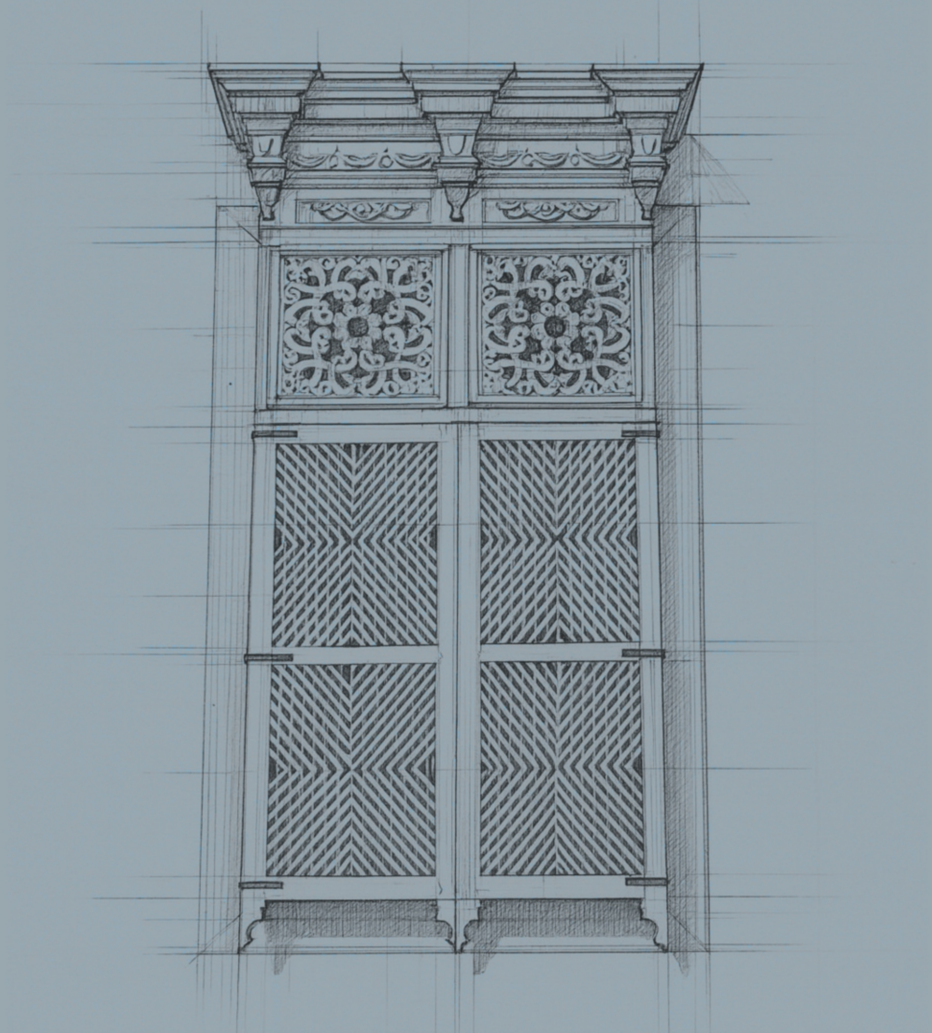
VERNACULAR RESIDENTIAL ARCHITECTURE FROM THE GOLDEN CYCLE IN THE BRAZILIAN MIDWEST

BEST PRACTICES FOR THE RESTORATION



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VERNACULAR RESIDENTIAL ARCHITECTURE FROM THE GOLDEN CYCLE IN THE BRAZILIAN MIDWEST. BEST PRACTICES FOR THE RESTORATION.

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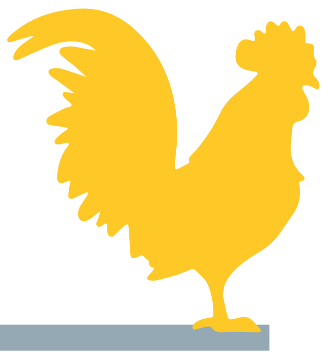


I dedicate this thesis to all the *caipiras*, whose essence forms the foundation of my origin and culture. May the authenticity, wisdom, *brazilian spirit*, and resilience of our traditions shine through every page, celebrating the vernacular heritage that defines us. This work is a tribute to the reddish lands of my *cerrado*, the birthplace of the unique architecture I proudly call my own.

Débora Carneiro Ávila

ABSTRACT

UNESCO recognized the Historic Centre of the Town of Goiás as a World Heritage Site on December 16, 2001. According to ICOMOS, the place stands out as a European-style town that was well adapted to the climate, geography and cultural life of South America. The harmony of the houses, the proportions and the building types show a clear evolution in local design through time. The urban layout also makes it possible to see its stylistic changes, from colonial houses to the 19th century eclectic style, creating a mix of historic periods in the same city.

For UNESCO, the Historic Centre of Goiás, and also the 18th-century vernacular houses of Brazil´s Midwest, are important proof of colonial urbanization and also part of world architectural heritage. The use of local materials, simple proportions and clear style gives this heritage a special and global value, which explains why it received the World Heritage title. Because of that, this heritage must be studied, restored with best practices and preserved to protect its integrity for the future.

This research aims to study vernacular houses in the time of the Gold Cycle in the Brazilian Midwest and make stronger their recognition as true expressions of local culture and traditional knowledge of the *caipira* people. The study uses bibliographic review to explain the history, the city growth, the house types, the traditional materials and the building techniques. Through three examples: Otilia House, Setecentista House and Enxaimel House, it will check restoration works and suggest best practices of preservation, following international rules but also adapting to today´s use.

Keeping this architectural heritage is very important to guarantee cultural and historical continuity, showing how nature, traditional building skills and society of that time worked together. More than simple houses, these homes keep both the physical and symbolic memory of the region´s identity, while also facing the challenges and social changes of today.

Keywords: Vernacular architecture; Gold Cycle in Brazil; Heritage preservation.

INDEX


Brazil
N
Mato Grosso
DF
Goiás
Mato Grosso do Sul
Brazilian Midwest

Geographic Scope of the Study

1

ARCHITECTURE IN THE BRAZILIAN MIDWEST: A HISTORICAL OVERVIEW

Figure 1 – Map by the Italian Giovanni Battista Ramusio, featuring an illustration of brazilwood trade, published in 1556 in Delle Navigationi et Viaggi. [Source: DIGITAL LIBRARY OF HISTORICAL CARTOGRAPHY – UNIVERSITY OF SÃO PAULO]

1.1.Colonial Brazil [1]

The Colonial Brazil period began in 1500 when Pedro Álvares Cabral reached the land. It lasted until 1822, when Brazil became independent. During the so-called pre-colonial period, from 1500 to 1530 the Portuguese Crown did not establish systematic colonization. Limiting itself to extracting *pau-brasil,* a tropical tree. This exploitation was carried out with the assistance of indigenous peoples, in a barter system. Initially, the Portuguese provided manufactured goods and tools to the natives as payment rather than relying on slave labor. It´s documented that during these years the Portuguese presence was almost nonexistent. With small constructions called *feitorias*.

The *feitorias* (trading posts) were built near the coast (Figure 1), in strategic locations to facilitate maritime transportation. They were made of wood and thatch and had simple constructions. Their primary purpose was to serve as storage sites and points of exchange with the indigenous peoples. In addition to being centers for territorial control and surveillance. They were designed to be easily dismantled and reconstructed in a new location when the brazilwood was depleted in a given area.

Due to the threat of invasions by other countries, especially the

[1] *All the information in this paragraph has been drawn from:* FAUSTO (2006); FONSECA (2011)

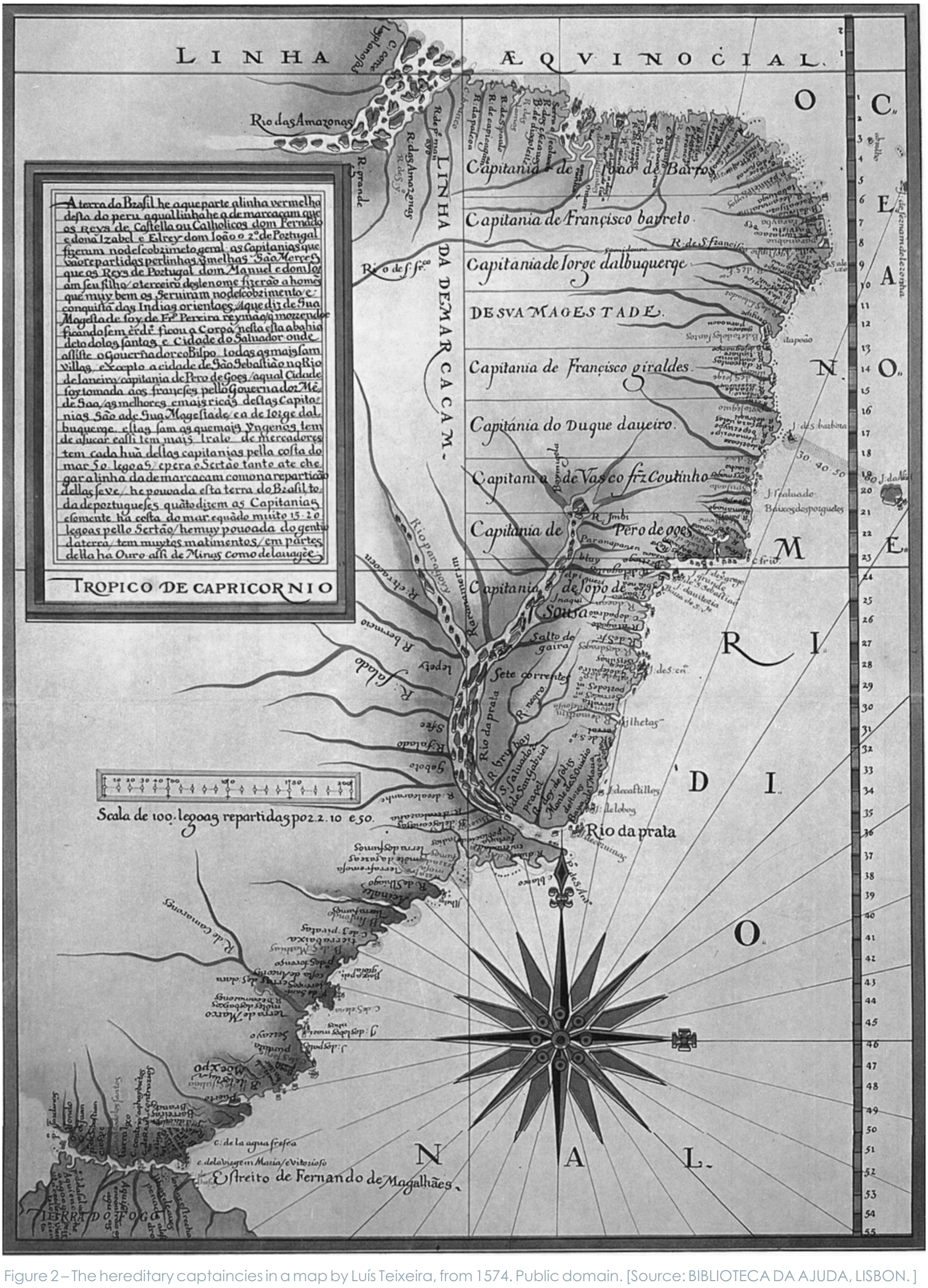


Figure 2 – The hereditary captaincies in a map by Luís Teixeira, from 1574. Public domain. [Source: BIBLIOTECA DA AJUDA, LISBON.]

French, between 1530 and 1533 Portugal began to colonize the territory effectively. In 1534 Dom João III implemented the system of hereditary captaincies (Figure 2), outsourcing and dividing the territory into different captaincies. Each captaincy was granted to a donee, who administered it and exploited it economically.

However, only the regions of Pernambuco and São Vicente would prosper. Consequently, in 1548 the Crown created the General Government to replace and complement the hereditary captaincies. Which had failed to achieve the expected economic and settlement results. During this same period Salvador was founded as the first capital of Brazil, and Tomé de Sousa became the first governor-general. His arrival in the colony marked the beginning of a period of greater organization, and defense.

It was during this period that the construction of two important types of architecture began: military fortifications and sugarcane mills. The first represents typical 16th-century military architecture, which had the clear function of defending the colony from maritime attacks and protecting Portugal's economic interests. These initial fortifications were designed to strengthen control over the coast, and ensure the safety of ships arriving at Brazilian ports.

Adjusted for the tropical environment, the architecture of the first forts was inspired by European models. The buildings typically had a polygonal or rectangular shape with towers or bastions, which are angular projections of a fortification. Typically located at the corners of the walls, used to allow defenders to target enemies from different angles and provide greater defensive capability. The forts were not very tall but had thick walls to withstand artillery attacks (Figure 3). Despite being simple constructions these forts were quite functional, and adapted to local conditions and the available technology at the time. They were primarily built with materials such as wood and earth. In some regions, where stone was more abundant, it was used to ensure greater resistance.

The second building type was the sugarcane mill. These mills reached their apex between the 16th and 17th centuries, marking the so-called Sugar Cycle period. Which refers to the production of sugarcane, concentrated in northeastern Brazil, especially in the then Captaincy of Pernambuco. It became the main economic activity, characterized by the use of monoculture systems, the use of African enslaved labor, and the large landowners. Despite sugar, the byproduct of sugarcane, which integrated Brazil into the transatlantic trade and being a source of great prosperity for the colonial elite, there was no significant advancement in the quality and technology developed in architecture.

The sugar plantations and the sugar mills were the centers of production where sugarcane was

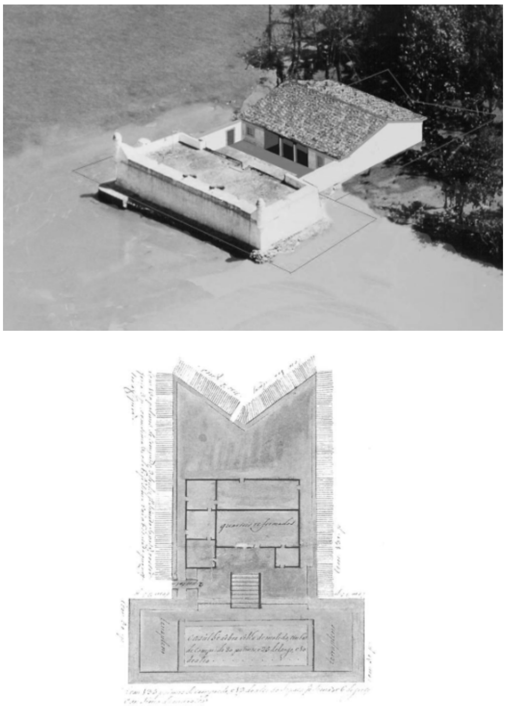


Figure 3 – Composite of two images of the São João Fort in Bertioga.Top: Illustration published in 2018 in the book Arquitetura Militar: um panorama histórico a partir do Porto de Santos, by Victor Hugo Mori, Carlos A. Cerqueira Lemos, and Adler H. Fonseca de Castro.Bottom: Plan by Luís Antônio de Sá Queiroga, 1751 – Arquivo Ultramarino. [Source: MORI, V. H.; LEMOS, C. A. C.; CASTRO, A. H. F. (2018); HISTÓRIA DE BERTIOGA.]

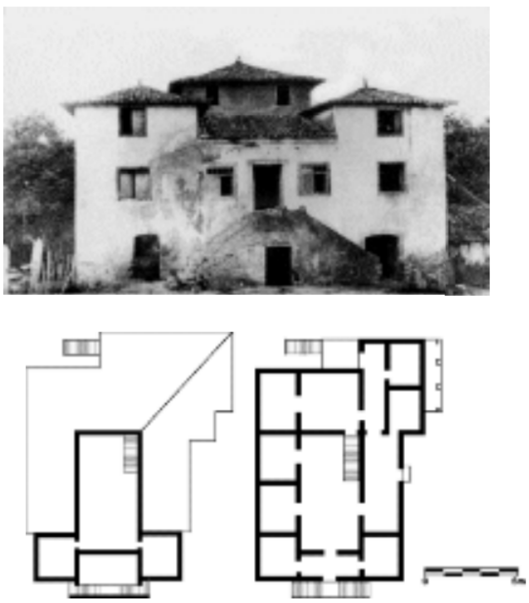


Figure 4 – Illustration from the book Arquitetura do açúcar by Geraldo Gomes, featured in Arquitetura na formação do Brasil, organized by Briane Elisabeth Panitz Bicca and Paulo Renato Silveira Bicca. [Source: UNESCO, 2006.]

cultivated, processed, and turned into sugar. These structures were rural properties that included both the facilities for processing the cane and the residential areas for the landowners, workers, and enslaved people.

The sugar mills or the machinery of the mills were divided into two types: royal mills, using hydraulic force, and *trapiche* mills. The term *trapiche* originates from Spanish, where it refers to a type of mill or press used to crush sugarcane. The word itself is derived from the Latin *trappa*, which means mill or press, and it uses animals as a force. The central part of the mill was called the mill house, where the sugarcane was pressed to extract its juice. The juice was then taken to the boiler house or purging house, where it was boiled and processed until it formed crystallized sugar. The entire process required a significant amount of labor and was very labor-intensive. With enslaved people playing a fundamental role in every stage, from planting to processing.

In addition to the production facilities, the mills included the residence of the mill owner and his family (Figure 4). These houses were spacious buildings, generally made of clay, wood, and stone, using construction techniques brought by the Portuguese. It served not only as a residence but also as the administrative center of the estate. From where the mill owner supervised the operations and management of the farm. The architecture of the residence was simple and robust but

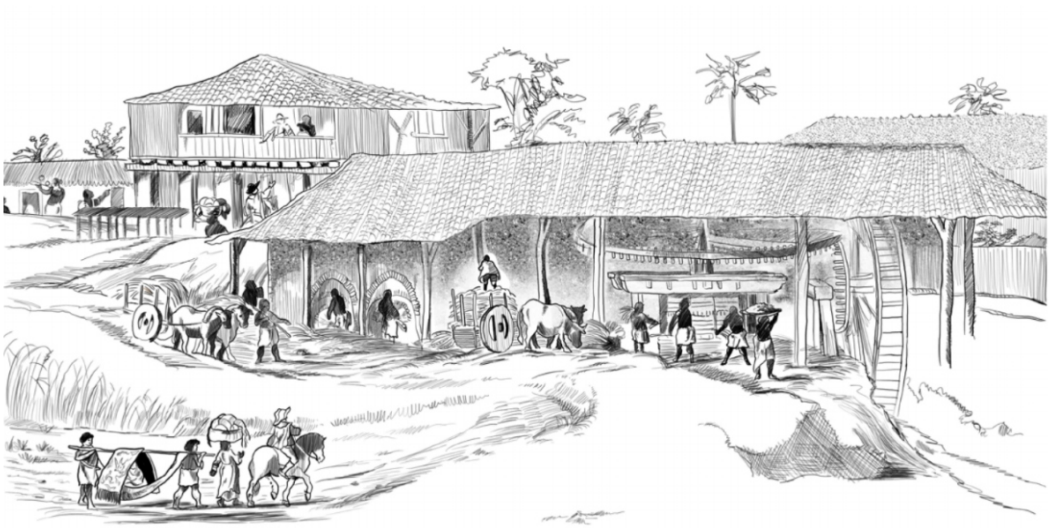


Figure 5 – Sugar mill in Itamaracá. Illustration attributed to Frans Post (1612–1680), depicting a 17th-century sugar mill during the Dutch occupation of northeastern Brazil. [Source: https://ensinarhistoria.com.br/para_colorir_engenho_frans_post/.]

offered some comfort and ostentation. As seen in the tiles, floors, and other ornaments imported from the Metropole, reflecting the social and economic importance of the owner.

The enslaved people, on the other hand, lived in dwellings called *senzala*. A Portuguese term used to describe the collective quarters for enslaved people during the colonial and imperial periods in Brazil. They were rudimentary and collective constructions, often made of wood and covered with thatched roof. The *senzala* could be dark and damp, and offered poor conditions of hygiene and comfort. This stark contrast between the owner's house and the *senzala* reflected the hierarchical social structure of the sugar mill. Where the master and his family occupied a privileged position, followed by the rural workers, with the enslaved people at the bottom.

The sugar mills were true social and economic microcosms (Figure 5), also including small chapels, grocery stores, and food gardens. The chapel was an important component, highlighting the influence of the Catholic Church and the religiosity of the time. These spaces contributed to the organization of communal life, and ensured its smooth functioning.

In the 17th century, between 1624 and 1625, and again from 1630 to 1654, the Dutch invaded and occupied parts of the Pernambuco captaincy. Seeking to control the lucrative sugar production. In addition to the military conquest, the invaders brought to the capital of Pernambuco, Recife, several urban and architectural innovations. Which were implemented under the governance of John Maurice of Nassau, who was appointed gover-

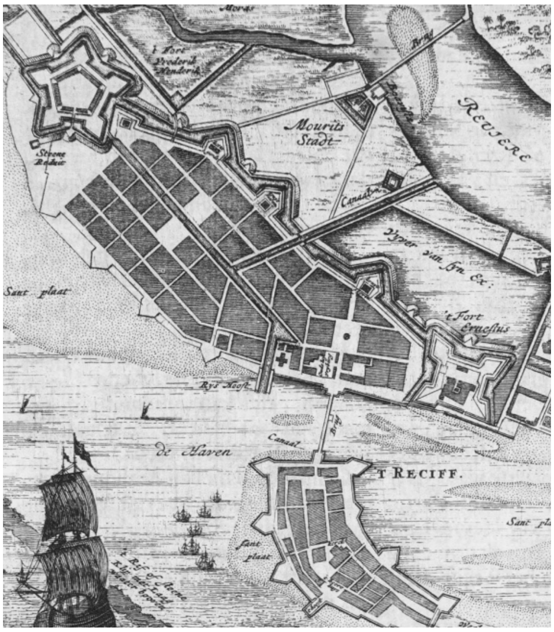


Figure 6 – Map of Mauritsstad, Recife and environs. [Source: Engraving from the book Rerum per octennium in Brasilia et alibi nuper gestarum by Caspar van Baerle, published in 1647 in Amsterdam by Joannis Blaeu. Attributed to Georg Marcgraf (cartographer), Joan Blaeu Sr. (publisher), and Frans Post (artist).]

nor-general of the Dutch colony in Brazil by the authorities of the Dutch West India Company.

One of the main changes was the improvement of the drainage system. With the construction of canals and other hydraulic infrastructure works to control water and prevent flooding. The city's urban planning became more organized (Figure 6), with a more logical arrangement of streets and a clear separation between the port area and the residential neighborhoods. This contributed to a more efficient circulation of people and goods. The construction of bridges was also an important innovation, with the highlight being the Maurício de Nassau Bridge. Which facilitated the connection between the different islands of Recife. Nassau also encouraged the creation of new public spaces, such as the Customs House. It became a commercial and administrative center, as well as promoting the construction of ceramic brick buildings, replacing simpler materials like earth used in Portuguese construction techniques. The Dutch strengthened the city's defense by building fortifications. Essential for protection against potential attacks.

These urban and architectural changes had a significant impact on the development of Recife. Reflecting the urban planning ideas, and the cultural and artistic investments made by the Dutch in their colonies. However, the Portuguese-Brazilian resistance managed to expel the Dutch in 1654, and Portuguese culture regained dominance in the region.

With the departure of the Dutch from Brazil, the Portuguese colony not only lost cultural and architectural enrichment, but the former invaders, now armed with the knowledge and techniques to cultivate sugarcane, established new sugar colonies. Directly competing with Brazilian producers. This led to the loss of markets for Brazil and, consequently, a decrease in profits for the Metropolis. And the end of the Sugar Cycle.

When studying the Brazilian colonial period, it´s very important to talk about the Jesuits. It was during this period that the Jesuits began the so-called *missões*, which were Jesuit missions intending to catechize and evangelize the

Figure 7 – Ruins of São Miguel das Missões, Rio Grande do Sul, Brazil. [Source: Photograph taken on June 9, 2005, by Goldemberg Fonseca de Almeida from Dourados, MS, Brazil.]

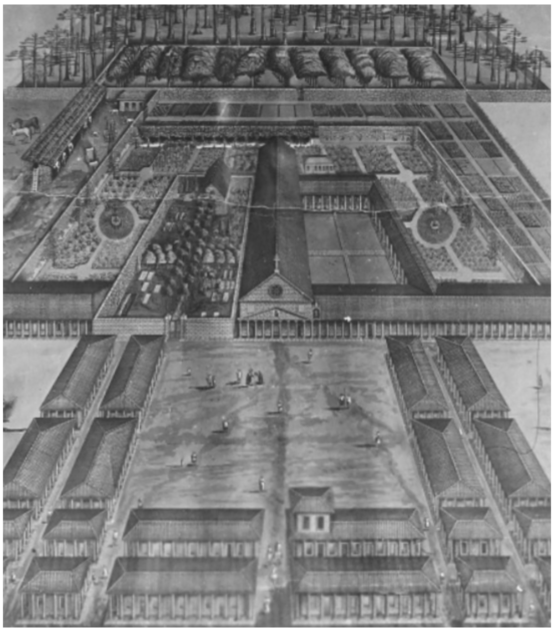


Figure 8 – Plan of the Jesuit mission of Salto del Guairá, attacked by São Paulo bandeirantes in late January 1629. The mission was located at the confluence of the Piquiri and Paraná rivers, in present-day Terra Roxa, Paraná. [Source: José Wille Collection (Curitiba, Brazil).]

Indigenous peoples. Helping the Portuguese Crown to "*Europeanize*" the natives. The Jesuit missions in Brazil were characterized by an architectural style that embodied the religious and civilizing aims of the Society of Jesus. These structures were generally simple but functional, strongly influenced by Portuguese Baroque (Figure 7). And adapted to local materials and construction techniques. Mission complexes typically featured a centrally located church, around which were arranged residences, a school, workshops, and agricultural areas. The spatial organization was deliberately planned to facilitate the control and catechization of Indigenous populations. Fostering a communal structure that integrated spirituality, labor, and education (Figure 8).

Another important point to be studied in this period is the captaincy of São Vicente, which was located in what is now the state of São Paulo in the south. The planting and cultivation of land in this region, unlike the northern captaincy, was subsistence-based. Mostly restricted to the region and consumed by the colonists themselves. As there was no trade or exportation with other countries, the people from the south watched the arrival of the first African slaves to work on the sugar and other plantations in the north. However, for them the more viable labor force was the enslavement of Indigenous people.

From the beginning of colonization, one of the most well-known

Figure 9 – Map of Brazil depicting the routes and objectives of the main expeditions and bandeiras conducted between the 17th and 18th centuries. [Source: ARRUDA, José Jobson de A.; PILETTI, Nelson. Toda a História: História Geral e História do Brasil. 3rd ed. São Paulo: Ática, 1995. p. 35.]

figures was the group that specialized in capturing Indigenous people. Whose role was to rescue runaway Indigenous individuals or capture new ones for enslavement. This group of men would venture into the Brazilian hinterland in search of expanding this trade (Figure 9). In the southern region they would become known as *bandeirantes*. Which comes from the term *bandeiras* or "flags" in English, which were called this way because of the flags that led these expeditions, serving as symbols of authority and organization.

After the pre-colonial period and the first exchanges with Indigenous groups, the Portuguese started to enslave them. But because it was hard to capture, control, and keep them alive, the Jesuits began to speak out against this practice. For them Indigenous people were not workers to be used, but souls to be saved. They believed these groups could be converted to Christianity, and become part of the Catholic faith. Slavery made that harder.

Even though the Catholic Church had banned it, there are many records of fights between the Jesuits and the *bandeirantes*. That is because, for the *bandeirantes*, capturing Indigenous people who had already been influenced by European culture was more profitable.

One of the main examples of rural housing from early colonial Brazil is the *bandeirante* house in São Paulo (Figure 10). These rural residential structures played a key role in the occupation and use of the land during that period. Which were characterized by simplicity and functionality, reflecting the conditions of the time and the need to adapt to the newly occupied envi-

Figure 10 – Bandeirista House at Sítio Santo Antônio, São Roque, São Paulo, Brazil. [Source: Photograph taken on November 20, 2012, by José Augusto Bianchini.]

ronment. Predominantly built with earth, these homes had a rectangular plan and hip roofs crowning the rectangular structure. With minimal ornamentation. These houses were usually isolated, organized around internal courtyards, and designed to meet the basic needs of rural life, and territorial defense.

The *bandeirantes* entered Brazilian territory through the rivers, and it was through the use of river navigation that these mercenaries discovered that, in addition to gravel and clay, the Brazilian rivers also held precious stones. Such as gold, diamonds, and emeralds. It was the *bandeirantes* and their expeditions into the Brazilian interior. Initially in search of Indigenous people and later gold, that established new settlements and cities. Which would later form a new economic system in Brazil, the so-called Gold Cycle, which would last from the late 17th century to the 18th century.

With the brief unification of Portugal and Spain and the end of the *Treaty of Tordesillas* in 1750, Brazil began establishing the borders as we know them today. States such as Minas Gerais in the southwest and Goiás and Mato Grosso in the Midwest region (Figure 11) became new economic centers, due to the discovery of gold. Leading to an urbanization boom and population growth in these areas.

Brazilian society became more diversified, new economic systems were established in the country, and the culture in the small towns of the Midwest began to develop. The primitive urbanization of the gold mining cities started with the division of the land. With this presence, small settlements were established along the riverbanks. This moment in Brazilian history was a

Figure 11 – Map of Brazil highlighting 18th-century mining regions.

great social, cultural, architectural, and economic development.

Churches, palaces, and administrative buildings were constructed following European styles. Portugal brought techniques from the Metropolis, such as wood carving for Catholic altars covered in gold. And using stonework for ornamentation. The Gold Cycle also brought significant political transformations to colonial Brazil. Such as the transfer of the capital from Salvador to Rio de Janeiro in 1763. Reflecting a shift in the country's economic and political axis.

During the rule of the Marquês de Pombal, who was a statesman and Prime Minister of Portugal during the reign of Dom José I, between 1750 and 1777, the colonial administration underwent profound reforms. Pombal promoted the renewal and centralization of the Crown, expelled the Jesuits from Portuguese colonies, and reorganized Brazilian regions to strengthen control over the colony. He also encouraged the development of trading companies to revitalize the economy.

At the end of the 18th century, the so-called End of the Gold Cycle occurred as a result of a combination of economic, social, and political factors. The main reason for the decline in mining was the progressive exhaustion of the gold mines, with most deposits being depleted, and the techniques used at the time being limited. Such as alluvial gold extraction, which led to a diminishing supply. In response, the Portuguese government created strict tax rules, raising mining taxes like the "*quinto*" (a 20% tax on all gold) and the capitation tax. This heavy taxation caused strong dissatisfaction among miners, and eventually led to major revolts.

With the progressive exhaustion of gold, many nobles and landowners migrated to other economic activities. By the early 19th century there was an agricultural renaissance, with large plantations and monocultures focusing on products like cotton and coffee. The Brazilian Coffee Cycle began to gain prominence in the economy in the following decades. Transforming the new economic centers like São Paulo. The lack of a substitute product, and the increase in the financial remuneration from gold resulted in a crisis. That lasted until the mid-19th century. During this period Brazil's economy faced significant stagnation and regression.

In architecture, the end of the Gold Cycle had profound consequences for Brazil's Midwestern region. As many people who had once relied on commerce in the cities turned to agriculture, returning to the countryside or migrating to cities like São Paulo and Rio de Janeiro in search of new opportunities. As a result the mining cities, which had experienced rapid urbanization during the 17th and 18th centuries, suffered a significant decline and stagnation. In both population and construction technologies.

The beginning of the 19th century was marked by decisive changes that led to independence. With the arrival of the Portuguese royal family in Brazil in 1808, fleeing Napoleon's troops, Rio de Janeiro became the new capital of the Portuguese Empire. The opening of ports to other nations and new policies contributed to a new socio-economic development. With the growing discontent with colonial exploitation, the path to independence became inevitable. In 1822 Brazil proclaimed its independence, officially ending the colonial period. And beginning a new chapter in its history.

This period was marked by the strong influence of neoclassical and eclectic architecture. But the ideals of independence and republicanism did not reach the central regions of Brazil, which remained under the influence of the local landowners called *coroneis*. They were large landowners and local political leaders during the 19th and early 20th centuries. Exercising significant economic and social influence, they controlled the population through *clientelism* and coercive power. Often dominating regional and national politics, with their height of influence occurring between 1889 and 1930. Economic and social development in the region would only be restored in 1930. With the so-called *"March to the West"* under President Getúlio Vargas. Because of that, it´s evident that even into the mid-20th century the Midwestern region of Brazil still used construction techniques from the colonial period. Preserving 18th-century architecture as the dominant architectural style.

1.2. Architecture that Comes from Portugal[2]

To better understand how Brazil transitioned from indigenous vernacular architecture, using wood and local techniques, to more elaborate constructions using earth and stone, it´s necessary to examine the Metropolis that colonized the country. Portugal is composed of a mainland located at the western tip of the Iberian Peninsula. The mainland is elongated, almost like a rectangle stretching in a north-south direction. This long and narrow configuration contributes to the country's climatic, geographical and also social diversity. The southern part has a Mediterranean climate, with few elevations and more arid soils. While the north features mountainous areas, cooler temperatures, frequent rain, and lush vegetation.

Influenced by climatic and geographical factors, the Portuguese territory exhibits a distinct cultural and architectural character between the north and south. In the north the "*stone civilization*" predominates, while in the south the "*clay civilization*" prevails.

The choice of clay was partly due to its practicality and low cost. The technique was also influenced by the proximity to Spanish regions rich in clay. The use of this material reflects not only the availability of local raw materials. But also the culture and history of the communities.

The use of clay in Portugal dates back to prehistoric periods, with archaeological evidence dating to the 4th century BC. Such as the walls found in Castro Verde. Between the 8th and 13th centuries the Islamic occupation of the Iberian Peninsula, which occurred between 711 and 1492 , was a period during which much of the Peninsula was governed by the Moors. Establishing al-Andalus, a region known for its cultural, scientific, and architectural richness. The Islamic occupation ended with the reconquest, a gradual process in which the Christian kingdoms reclaimed the Peninsula. Culminating in the capture of Granada in 1492.

The Moors introduced and spread knowledge and construction practices. Including traditional techniques of building with raw earth. The Arabs have a long tradition of using clay as a building material, dating back to around 1000 BC. With the three main techniques: wattle and daub, adobe, and rammed earth, adapted to the arid climate and extreme desert conditions. Wattle and daub is a very old method where builders make a wall using wooden sticks (wattle), and then cover with a mix of clay, soil, straw and sometimes dung (daub). This technique is cheap and use local materials. But it need constant repair, because it´s not very resist to rain.

The invaders contributed to adapting constructions to local climatic conditions. Raw earth used in construction has excellent ther-

[2] *All the information in this paragraph has been drawn from:* CIMINO (2012); BICCA (2006); SMITH (2016)

mal performance, helping to keep the interior cool in the summer heat, and moderately warm in the winter. This was particularly relevant in southern Portugal, where the Mediterranean climate is characterized by hot dry summers. Additionally, raw earth was abundant and inexpensive in the region.

The Moors also influenced the ornamentation and aesthetics of southern Portuguese architecture. Elements such as arches, inner courtyards, tiles, stucco, white lime, geometric designs, and mashrabiyais. A traditional wooden structure commonly found in Islamic buildings, especially in Arab regions and North Africa. It provides ventilation, privacy, and protection from intense sunlight. Primarily used in windows and balconies, it allows light and air to enter while maintaining privacy. It´s a characteristic feature in hot and arid climates. These features not only served practical needs, but also reflected Islamic taste and culture. Leaving marks that endured even after the Christian reconquest (Figure 12).

The Castle of Paderne, located in Albufeira, is one of the finest examples of Islamic military architecture in Portugal (Figure 13). Built by the Moors in the 12th century, it stands out for its use of rammed earth. A traditional Islamic building technique that involved compacted raw earth, well-suited to the region's hot and dry climate.

With these architectural influences and construction techniques, the Portuguese reached the

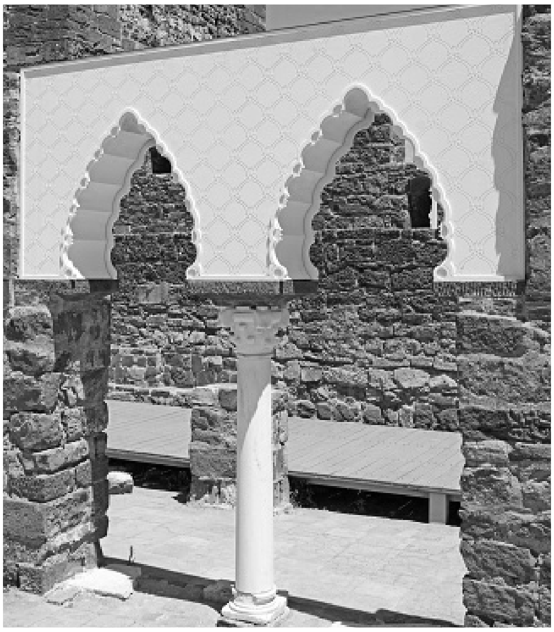


Figure 12 – Palácio das Varandas, Silves Castle, Portugal. Photograph by CaronB, uploaded on May 9, 2018. [Source: iStockphoto.]

Figure 13 – Paderne Castle, Albufeira, Portugal. Photograph featured in the article by Jorge Eusebio, published on April 16, 2024. [Source: Algarve Marafado.]

Figure 14 – "Urbs Salvador" (Salvador da Bahia, Brazil), 1671. Engraving by Arnoldus Montanus, published in De Nieuwe en Onbekende Weereld (The New and Unknown World), Amsterdam: Jacob van Meurs, 1671. [Source: CIDEHUS – University of Évora.]

Brazilian coast. With the construction of the first rudimentary towns of São Vicente and Santo André, founded by Martim Afonso de Souza under orders from Dom João III of Portugal in 1532, an important event began. Despite the simplicity and poverty of the architecture, these first clay buildings contained the genesis of a profound transformation. That would impact all of Brazil. Through historical accounts and letters from Pero Vaz de Caminha, who was a Portuguese nobleman and the official scribe of the 1500 expedition to Brazil, to the Portuguese Crown, the indigenous peoples encountered were very different from the civilizations found by the Spanish in other parts of the Americas. The Brazilian native tribes had an essentially different structure. Simple, nomadic, and with little intervention in the physical space of their constructions. It´s certain that in pre-colonial Brazilian indigenous societies, there were no political-administrative functions or buildings similar to the European model. The tribes were organized according to the dictates of their culture and ethnicity.

This reality changed with the advance of colonization as Colonial Brazil began to take shape. In a society that was becoming a political extension of Portugal, the construction of buildings and structures began as an integral and necessary part of the formation of villages and cities. This process had significant economic, social, political, religious, and cultural relevance. As a result the creation of a new physical and human geography began. Essential for political-military control, and the economic exploitation of the territory conquered by the Portuguese Crown.

This marked the beginning of the effective occupation and ownership of the land on which the

Figure 15 – "San Salvador, Bahia", 1839. Lithograph by Thomas Abiel Prior (1809–1886), based on an original drawing by Augustus Earle (1793–1838), published in Narrative of the Surveying Voyages of His Majesty's Ships Adventure and Beagle by Robert FitzRoy, Volume 2, page 62, London: Henry Colburn, 1839. [Source: ResearchGate.]

foundations of what is now called Brazilian Colonial Architecture would be built. The Portuguese were able to replicate their cities and architectural styles with great similarity when colonizing Brazil. A notable example is the city of Salvador, which for approximately 215 years, from 1549 to 1763, was the first Portuguese Metropolis in South America (Figure 14). During this period Salvador became a faithful replica of Lisbon and Porto. Portugal's two largest cities. This similarity extended beyond the buildings to their location and urban development. Just like Lisbon and Porto, following Portuguese customs, Salvador was built on various levels, overlooking a vast body of water. For its protection the city was surrounded by walls with towers, gates, and forts interspersed.

In its urban organization, the highest points on the hills, following the Portuguese tradition, were reserved for churches, convents, public buildings, and mansions. While commercial activities were concentrated in the lower area, near the dock (Figure 15). Given that, there were two cities in one: the upper and lower parts, connected by narrow winding paths that were so steep they made the transport of goods difficult. The orthogonal urban system was not definitively adopted by the Portuguese. The main streets, called *direita* or right, influenced by the *decumanus* of ancient Roman cities, served as the primary route for trade and circulation. Connecting important points of the city, such as squares, churches, and markets. Ironically they were winding and uneven, and the squares tended to have irregular shapes.

Houses aligned along the slopes, forming a mesh of narrow paths, stairways and passages. With the terraces of upper floors projecting outward, just as in European cities. So, in 1763, when Salvador ceased to be the capital of Brazil, it retained a medieval appearance similar to that of Lisbon. This pattern was repeated in other cities that were established. And throughout the colonial period, Brazilian cities were all somewhat similar to each other.

Figure 16 – Image of Our Lady of the Conception. Photograph by Ane Souz, featured in the news article "Church in Ouro Preto housing Aleijadinho's remains is restored; see photos," published by G1 Minas on August 1, 2022. [Source: G1 Minas.]

1.3. Architecture During the Gold Cycle and Brazilian Baroque[3]

At the end of the 17th century, the discovery of gold in the interior of Brazil marked the beginning of one of the most significant periods of colonial history (Figure 16). Affecting the territories of the present-day states of Minas Gerais, Goiás, and Mato Grosso. In 1693, Antônio Rodrigues Arzão discovered gold deposits in the region of Minas Gerais, initiating intense gold extraction. Quickly the region attracted thousands of migrants from Brazil and Portugal. Founding the first golden towns such as Mariana, Ouro Preto, and Sabará. By 1709 over 30,000 people had already settled in these areas. The *bandeirantes* soon opposed the arrival of new explorers, leading to conflicts over the ownership of mineral lands. This confrontation resulted in administrative measures by the Portuguese Crown, creating the Captaincy of São Paulo and Minas do Ouro in 1709. Later, in 1720, the Captaincy of Minas Gerais was established with its main city in Vila Rica (now Ouro Preto), marking the political and economic centralization of the region.

The *bandeirantes*, who sought more territories from which they could extract minerals, organized new expeditions into the

[3] *All the information in this paragraph has been drawn from:* OLIVEIRA *in* BICCA (2006); SMITH (2016); BOAVENTURA(2001); VAZ(2003)

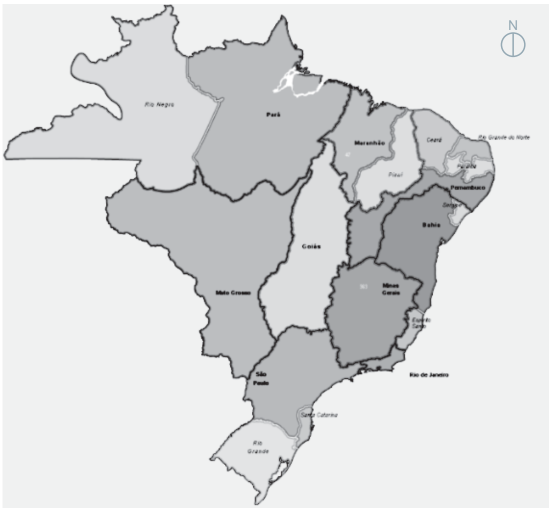


Figure 17 – Administrative Division of Colonial Brazil at the End of the 18th Century.[Source: Atlas Histórico do Brasil – Fundação Getulio Vargas (FGV).]

interior of Brazil. And the Gold Cycle expanded beyond Minas Gerais. In the Goiás territory, in 1718, gold deposits were discovered in the Cuiabá and Vermelho rivers. Leading to the foundation of important settlements such as Vila Boa de Goiás (now Goiás city), Pirenópolis, Pilar de Goiás, and Cuiabá in Mato Grosso. The *bandeirantes* expanded territorial occupation along mining routes. Marking the occupation and colonization of Brazilian Midwest region (Figure 17).

Alluvial mining, carried out in Brazilian rivers, spurred the emergence of urban centers evolving from simple camps. These small settlements grew spontaneously with irregular streets following the riverbeds and spreading along the hillsides. Where buildings traced the street lines. This winding layout became a hallmark of the period, influenced by Portuguese urbanism and architecture. These cities maintain an intimate atmosphere, with simple whitewashed houses, colorful doors and windows, and strong integration with the surrounding natural landscape.

The gold society was highly hierarchical. At the top were mine owners, merchants, and civil and ecclesiastical authorities. In the middle were free workers and artisans, who performed trades such as carpentry, tailoring, and sculpture. At the base of this structure were enslaved Africans, who performed the hard labor of mining. And contributed, directly or indirectly, to the construction of churches, houses, and public spaces.

The city became the center of this society, and new needs arose. Including the need for a building that symbolized political power. The Portuguese built *Casas de Câmara e Cadeia* (Town Hall and Jail), combining administrative and prison functions. Following the Portuguese tradition where the *Câmara* (Town Hall) occupied the upper floor, while the ground floor housed the cells. Such functional overlap was a common practice in colonial towns, evidencing the centralization of civil and penal power within a single building. In accordance with the model adopted by the Portuguese Crown. An example of this is the *Casa de Câmara e Cadeia* of Mariana, in Minas Gerais (Figure 18). From a formal standpoint, the building presents characteristics of late Baroque architecture. Especially in the strict symmetry of the façade and the organization of the openings.

Figure 18 – Casa de Câmara e Cadeia of Mariana (Minas Gerais, Brazil). Photograph by Ane Souz, featured in the article "Casa de Câmara e Cadeia de Mariana" by Arnaldo Silva, published on the website Conheça Minas on March 1, 2020. [Source: Conheça Minas.]

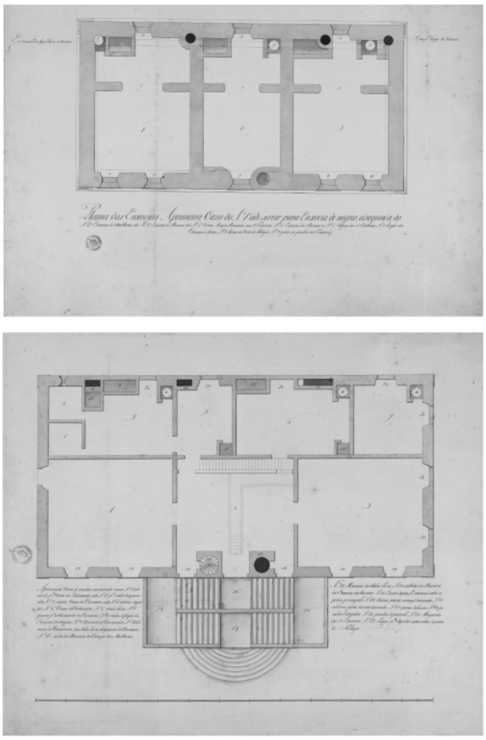


Figure 19 – Floor Plan of the Casa de Câmara e Cadeia of Mariana (1762). Manuscript map depicting the ground floor of the Casa de Câmara e Cadeia of Mariana, designed by José Pereira dos Santos in 1762. Provenance: Pirajá da Silva Collection. [Source: Google Arts & Culture.]

The architectural composition reveals balance and rationality. With full arch windows and stone-framed moldings that reinforce the solidity of the structure. The most striking feature is the front staircase, composed of two symmetrical flights, which leads to the upper noble floor. And lends monumentality to the main entrance. This treatment of access reinforces the spatial hierarchy and highlights the symbolic importance of the building's administrative function (Figure 19).

The materiality of the structure reflects traditional construction techniques adapted to the climate and local resources. The building's elevated position and orientation toward a public square follow the principles of Portuguese colonial urbanism. In which government buildings were placed in prominent visual and symbolic positions within the urban fabric.

Another important building type of the period was the mint house. Where extracted gold was refined and stamped. *The Intendancy of Ouro Preto* (Figure 20), now known as *the Casa dos Contos,* is a prominent example from this golden period. This building combined functionality with refinement. Evident in details like soapstone staircases and elaborate balconies. In *the Intendancy of Ouro Preto,* the monumental chimney remains as a vestige of its role in gold refinement.

Between 1730 and 1760 the wealth from gold led to many public and private projects that helped shape the cities of that time.

The Catholic Church, Portugal's official religion and, consequently, that of Brazil, played a predominant role in commissioning architectural works and artworks. Surpassing civil constructions. This power is evident in richly adorned interiors with gilded carvings. Reflecting the wealth generated by gold. It´s important to note that in the same period, more remote areas such as the Brazilian Midwest maintained simpler building practices. Revealing architectural diversity across the colonial territory. The gold cities from Minas Gerais, with their blend of opulence and spontaneity, represented the interaction between economic wealth, artistic creativity, and social challenges. Which was particularly revealed in sacred architecture. In general Catholic architecture was restricted to three main types of buildings: primitive chapels, parish churches, and churches of brotherhoods or third orders.

The primitive chapels (Figure 21) featured simple layouts, with a nave for the congregation and a small chancel accompanied by a lateral sacristy. They were characteristic of the earliest settlements and were named primitive because they were the first churches to be built. Representing the presence of Catholicism. The scarcity of skilled labor and resulting improvisation led to peculiar formal solutions. Such as the placement of bells. Many bell towers were built independently out

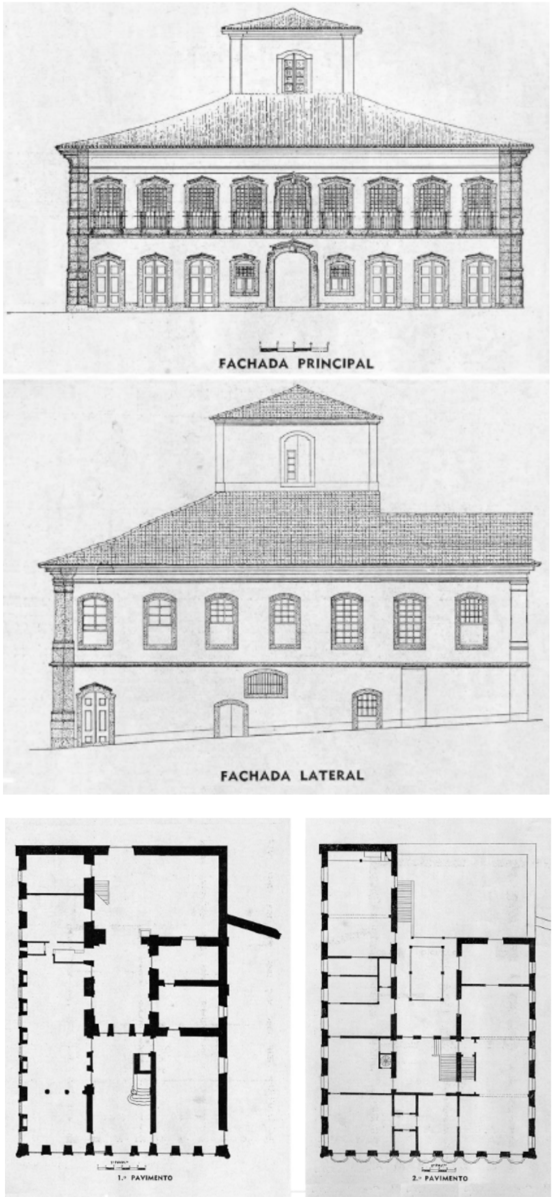


Figure 20 – Casa dos Contos. [Source: Revista do Arquivo Público Mineiro, year XIX – 1921, p. 267–344; Casas de Fundição in Minas Gerais, Jan 11, 1934.]

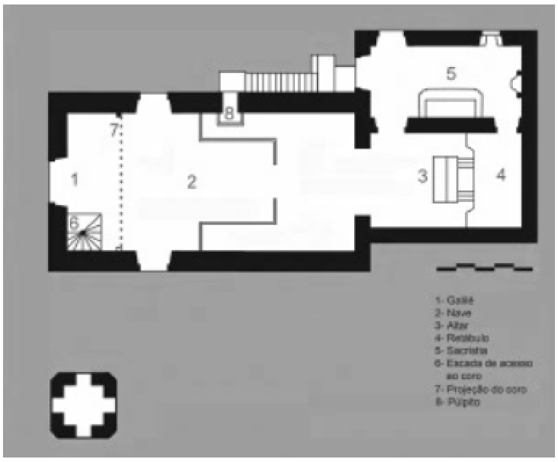


Figure 21 – Capela de Padre Faria, Ouro Preto (Minas Gerais, Brazil). (1) Floor Plan of the Capela de Padre Faria. Published in the article "Morfologia das Igrejas Barrocas II" on May 9, 2012. [Source: Coisas da Arquitetura.Photograph: "Ouro Preto a Capela de Padre Faria com a sua Linda Cruz de Pedra." Anonymous artist, December 1923. Photograph/postcard from the Museu Paulista da USP collection. Source: Wikimedia Commons.]

of wood and covered with tiles. These were temporary solutions that became permanent in many areas. Particularly in Goiás. This method of tower construction prevented structural collapse caused by the bells' movement. Later, these bell towers evolved into freestanding structures.

From 1720 onwards, as populations consolidated in the gold cities, parish churches emerged as the ultimate symbols of the Catholic Church's religious power and opulence. These buildings were initially constructed with wood and clay. Featuring rectangular floor plans, lateral aisles, and frontispieces flanked by square towers. Internally they predominantly had a single nave, a chancel, a transverse sacristy, and a choir loft. The interior decoration harmonized continuous spaces separated by the triumphal arch. With altarpieces located in the nave and chancel. In Goiás, the parish church of Pirenópolis (Figure 22) is an excellent example of this construction technique.

The use of masonry, starting in 1740, was limited only to the state of Minas Gerais. It was led by Portuguese master builders such as Manuel Francisco Lisboa. Who oversaw the construction of the Antônio Dias parish church and the Church of Santa Efigênia in Ouro Preto. And José Pereira dos Santos, responsible for churches in Mariana and Ouro Preto. This allowed for curvilinear facades and elevations, elaborate pediments, and decorative crowning of towers. All this grandeur reinforced the economic power centralized in a few Brazilian cities.

In churches built in the Midwest throughout the 18th and early 19th centuries, the simplicity of rectangular floor plans is a common characteristic. The contrast between the dimly lit interiors and the intense external light reveals intricate details such as the golden reflections of the carvings and the warm colors of the paintings. The interior environment converges toward the chancel and its monumental *retable*. A decorative structure behind an altar, featuring carvings, paintings, or sculptures. It highlights the sacred space and often depicts religious themes or scenes, framed by lateral altarpieces.

During the first six decades of the 18th century, two primary styles of Baroque altarpieces were prominent (Figure 23). The first, the Portuguese National *Retable*, prevailed until around 1730. This style, exclusive to the Lusitanian repertoire, featured *Solomonic* columns and rich ornamentation with grapevine leaves, grape clusters, and motifs like the phoenix. Complemented by coffered ceilings with iconographic paintings. The second, introduced after 1730, was the Dom João V style, influenced by Italian design. Characterized by a greater presence of human figures and theatrical crowning elements in the form of draped canopies. Churches from this period stand out for their extensive gilded decoration and the use

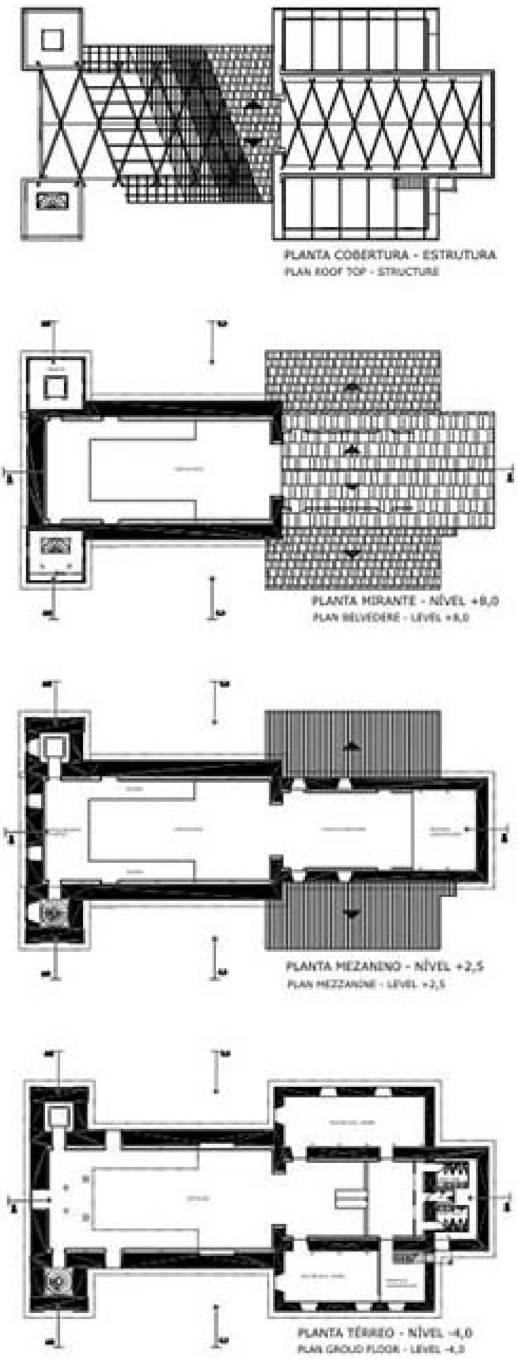
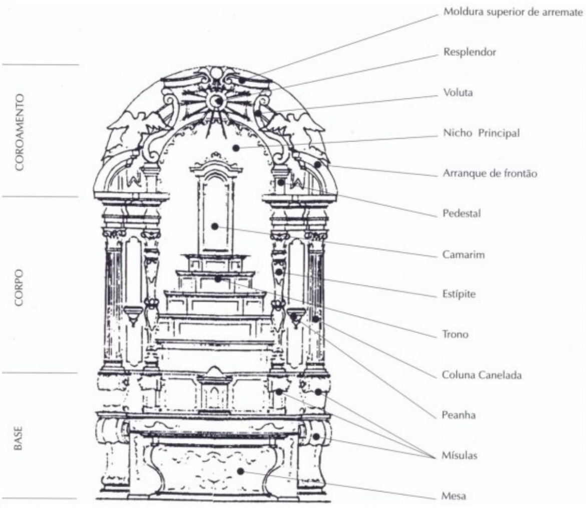
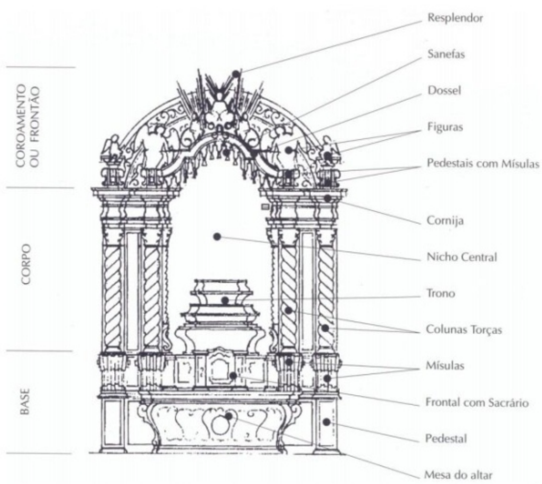


Figure 22 – Plan of the Igreja Matriz de Nossa Senhora do Rosário, Pirenópolis (Goiás, Brazil). Architectural plans featured in the article "Igreja Matriz – Pólo de Artesanato – Largo da Matriz, Pirenópolis GO,"[Source: published in the Vitruvius journal, issue 047.01, December 2004. Authors: Daniel de Castro Lacerda, Filipe Berutti Monte Serrat, and Iara Moderozo dos Santos.]



Portuguese National Retable



Dom João V style

Figure 23 – Structural Analyses of Baroque Altarpieces. (1) Structural analysis of the Rococo altarpiece of the Church of Nossa Senhora da Saúde. Image extracted from the book Arquitetura Religiosa Colonial no Rio de Janeiro by Sandra Alvim, page 84, Drawing 38. (2) Structural analysis of the altarpiece of the Church of São Francisco da Penitência. Image extracted from the book Arquitetura Religiosa Colonial no Rio de Janeiro by Sandra Alvim, page 74, Drawing 26. [Source: SOARES, Lenin Campos. História da Arte Potiguar: Escultura Barroca. Natal das Antigas, November 28, 2020.]

of *trompe-l'œil* paintings covering wooden vaulted ceilings.

The chancel of the Matriz do Pilar in Ouro Preto is a masterpiece of this period. Crafted between 1741 and 1751 by Francisco Xavier de Brito, who was born in Portugal in 1687 and was one of Brazil's leading architects of Baroque architecture. Focusing on the construction of churches and religious buildings. Among his most important works are the Church of São Francisco de Assis in Ouro Preto and the Church of Nossa Senhora do Carmo, also in Ouro Preto. Landmarks of colonial architecture in Minas Gerais. Its impressive structure integrates *Solomonic* columns and voluted pilasters. With a vast canopy serving as the base for sculptures of the Holy Trinity and a variety of angels and cherubs. In the Minas Gerais region, the perspective paintings are exemplified with works by José Soares de Araújo, illustrating the artistic mastery of the period. Goiás offers another fine example of perspective painting, with illusory architecture and somber tones.

From 1760 onwards, churches of brotherhoods and third orders multiplied, particularly in Minas Gerais. Unlike parish churches, these were dedicated to the activities of a single brotherhood and were smaller in scale. However their interior decorations were distinguished by the extensive use of gilded carvings and paintings on vaulted ceilings. Ornamental carvings on doorways, crafted in soapstone or fine woods, often displayed the brotherhoods' coats of arms. The architectural experience of the time was limited to a small number of religious buildings. With decorative opulence dominating the interiors. Notable examples include the Church of Rosário in Ouro Preto and São Pedro dos Clérigos in Mariana.

One of the protagonists of Brazilian Baroque and religious constructions was Aleijadinho, or Antônio Francisco Lisboa. Renowned for works such as the Church of São Francisco de Assis in Ouro Preto and the Prophets and the Via Sacra ensemble at the Sanctuary of Bom Jesus de Matosinhos in Congonhas (Figure 24). These sculptures, crafted in wood and steatite, portray the nuances of human suffering and compose a grand open-air scenography. Aleijadinho immortalized this Catholic Baroque heritage. Elevating Brazilian sacred art to a uniquely expressive level within the colonial context.

Figure 24 – The Twelve Prophets at the Sanctuary of Bom Jesus de Matosinhos, Congonhas, Minas Gerais, Brazil. Photograph by Glauco Umbelino, taken on July 3, 2007. Originally published on Flickr. [Source: UMBELINO, Glauco. 12 Profetas no Santuário do Bom Jesus de Matozinhos, em Congonhas/MG.]

The religious architecture vividly reflected the economic wealth derived from gold. The sacred constructions of this period not only showcase the artistic grandeur fueled by the patronage of the Catholic Church. But also highlight regional disparities and adaptations to local conditions. While Minas Gerais developed a rich and elaborate Baroque style, featuring gilded *retables,* curvilinear façades, and sophisticated artistic techniques such as perspective painting and *trompe-l'œil*. On the other hand, the Midwest was marked by simplicity and constructive ingenuity due to the scarcity of skilled labor. The colonial churches, in their various forms, primitive chapels, parish churches, and brotherhood or third-order churches, reflect the central role of religion in the social and cultural life of the time. Serving as material testimonies to the interplay between faith, art, and economic power.

Another type of architecture of this time was the colonial residential. The intense economic flow of the gold mining cities drove the construction of houses in urban areas. In Minas Gerais, these buildings had two to three floors with symmetrical facades, vertically aligned windows, and stone doorways, often made of steatite. The two-story houses followed a functional organization: the ground floor was designated for commerce or storage, and often a slave quarters. The first floor contained bedrooms and social spaces, and the attic was frequently used for storage. Features such as wrought-iron balconies, overhanging eaves, and handmade tiles highlighted the sophistication of these residences. Internally, decorated ceilings with painted coffered panels, noble wood staircases, and floors covered with Portuguese ceramic tiles were marks of the economic power and refined taste of the elite.

In the Midwest, mining also developed new urban centers. However, unlike Minas Gerais, the housing followed simpler and more functional patterns. Reflecting the conditions of limited access to specialized labor. In these regions, single-story houses constructed with vernacular techniques predominated. The modest facades featured wooden windows in vibrant colors that contrasted with the whitewashed walls. The roofs with simple cornices protected the houses from heavy rainfall. Internally, there were simple ceilings that sometimes could also expose the wooden structures. And the floors were made of wooden boards and handmade clay tiles. The practical nature of these buildings addressed the climatic needs and the reality of the peripheral villages.

These colonial residential constructions, whether imposing or modest single-story houses, reveal an architecture that maintained functionality, socio-cultural expression, and adaptation to the environment. Indeed, it´s what architect Lúcio Costa would call *"the beginning of Brazilian architecture."* [4]

[4]Lúcio Costa (1902-1998) was a Brazilian architect who, in his work ''*Razões da Nova Arquitetura*'' (1957). He regarded colonial architecture as a fundamental milestone, stating that, despite its limitations, it represented the "beginning of Brazilian architecture" by adapting to the environment and local culture.

1.4.Timeline

Period	World	Brazil	BrazilianArchitecture
1500–1530	Age of Exploration; European maritime expansion	Cabral arrived (1500); pre-colonial period; brazilwood extraction	Coastal feitorias (trading posts) made of wood and thatch for trade with Indigenous peoples
1530–1549	Early colonization of the Americas	Effective colonization begins; Hereditary Captaincies; Martim Afonso expedition	Start of sugar mills using Portuguese techniques
1549–1600	Reformation and Counter-Reformation; imperial expansion	General Government created (1549); Salvador founded; Sugar Cycle intensifies	Coastal fortifications
1600–1654	Religious wars; Protestant expansion	Dutch Invasions (1624–1654); urban development of Recife under Nassau	Dutch influence in urban planning
1654–1700	Enlightenment begins; rise of absolutist monarchies	Bandeirantes expand inland; active Jesuit Missions	Bandeirante houses, Jesuit churches, and villages in Indigenous areas
1700–1760	Scientific Revolution; Enlightenment ideals spread	Gold Cycle begins (Minas, Goias, Mato Grosso); mining cities are founded	Rich Baroque architecture: gilded churches
1760–1800	American Independence (1776); French Revolution begins (1789)	Peak of gold cities in the Midwest (Goias, Cuiaba); Pombaline reforms	Simpler, functional architecture in the Midwest
1808–1822	Napoleonic Wars; Congress of Vienna (1815)	Portuguese Royal Court arrives (1808); ports opened; growing movement for independence	Neoclassical architecture begins to spread

2

VERNACULAR RESIDENTIAL ARCHITECTURE IN THE BRAZILIAN MIDWEST

Figure 25 – "Largo do Rosário" in Goiás Velho, Brazil. Sand painting by Goiandira do Couto, featured in the article "Goiandira do Couto e a pintura/colagem com as areias multicoloridas da serra dourada," published on August 24, 2011. [Source: Carlos Sena Passos Blog.]

2.1. Urban Contexts of Gold Cycle Cities in the Midwest [5]

In Chapter 2 of Book I of Politics, Aristotle describes the human being as a "*political animal*" and understands the city (*polis*) as a natural extension of human relationships. Social organization develops in three stages: the family (*oikos*), focused on survival; the village (*kōmē*), which expands forms of coexistence; and finally, the city, where communal life aims at collective well-being (*eudaimonia*). The nomadic life of early humans, though communal, was shaped by environmental demands. Sedentarism, in turn, allowed the transformation of territory and enabled the emergence of cities. For Aristotle, the *polis* represents the full realization of human life, as it´s within the political sphere that reason is exercised, justice is pursued, and virtues are cultivated.

In architectural theory, this relationship between humanity and construction is represented by the idea of the "*primitive hut*", formulated by Marc-Antoine Laugier in 1753. More than a shelter, it symbolizes the ancestral impulse to create a space of belonging and mediation with nature. Marking the origin of architecture. Given that, the house and the city have always reflected the social, political, and cultural transformations of civilizations. From the earliest settlements

[8] *All the information in this paragraph has been drawn from:* ARISTÓTELES, *in* RAMOS(2014); LAUGIER (1753); REIS FILHO (2000); TEIXEIRA (2009); MARX(1990)

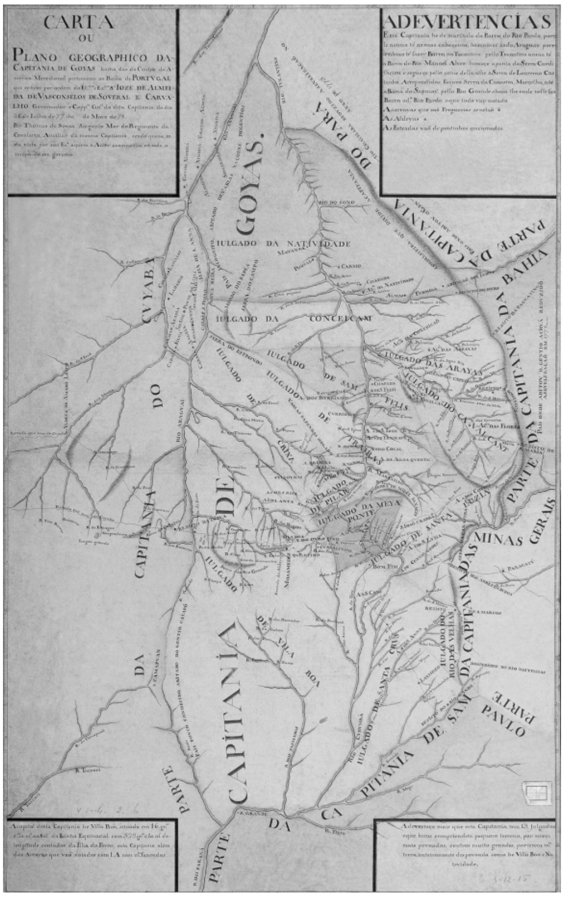


Figure 26– Geographical Map of the Captaincy of Goiás, 1778. [Source: Arquivo Histórico do Exército Brasileiro.]

along fertile riverbanks to today's technological metropolises.

And it was precisely the urbanization process that occurred in Brazil between the 17th and 18th centuries, during the so-called Gold Cycle, that led to the development of the vernacular residential architecture of Brazil's Midwest region. Understanding how these cities emerged is crucial for comprehending the construction processes and technologies employed during that period.

The official colonization of the Brazilian Midwest began with the creation of the Captaincies of Goiás (Figure 26) and Cuiabá in the 18th century. Driven primarily by the discovery of gold. The region that would later become the state of Goiás started to be explored in the late 17th century by *bandeirantes* from São Paulo. With the growth of mining activities and the consequent increase in population, the Portuguese Crown decided in 1748 to create the Captaincy of Goiás. Administratively separating it from São Paulo to facilitate fiscal control. Its capital was established in the city of Goiás, ensuring greater efficiency in territorial management. That same year, the Captaincy of Cuiabá was also created through a similar process. The occupation of the region began with the discovery of gold in the Coxipó River in 1719 by Pascoal Moreira Cabral. Which attracted a large number of settlers. Initially linked to the Captaincy of São Paulo, Cuiabá gained its administration in 1748, with its capital in the city of the same name. This way, they ensured control over mineral wealth. The creation of these captaincies also had a strategic purpose, reinforcing Portuguese occupation in regions near the borders with Spanish territories.

The discovery of gold in the regions of Goiás and Mato Grosso attracted a large portion of the population to the cities. The urbanization promoted by the Gold Cycle also had a major impact on social dynamics. With intensified inequalities, reflecting an urban structure deeply marked by labor relations, religiosity, slavery, and the exhaustive exploitation of mineral

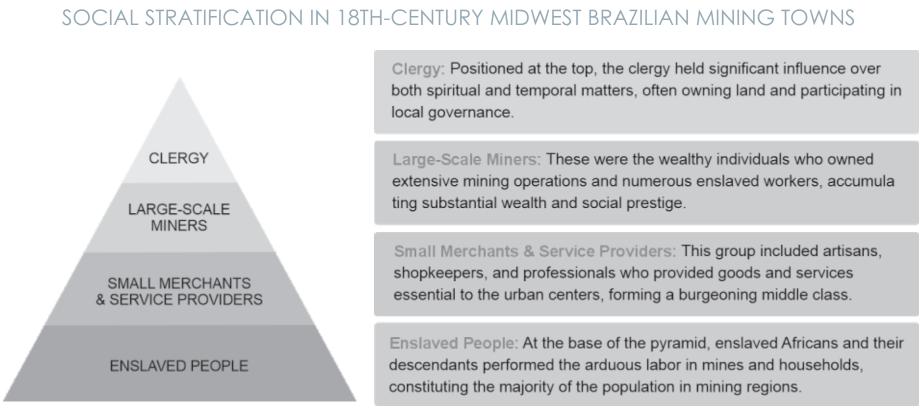


Figure 27 - Social stratification in 18th-century Midwest Brazilian mining towns.

resources. This led to the formation of vertically structured urban centers (Figure 27), with the architecture and cities serving as both the peak and the reflection of the social relations of that time. Since they were linked to a raw material, it´s possible to say that the availability of the product would define the pace of development and transformation of space. And its decline would coincide with the depletion of that resource.

At the beginning of gold exploration, the main motivation was rapid enrichment. Resulting in a complete lack of organizational principles among miners. These gold cities were, for the most part, rudimentary settlements that arose precariously, as resource exploitation was more important to Portugal than social and urban development. With population growth and the emergence of new needs, these small settlements would become cities of great economic, religious, and cultural significance. Becoming urban reference centers in the vast territory of Brazil's Midwest region. Mining cities also stood out due to the diversification of their activities. Including trade in goods and services, residences, churches and chapels, public buildings, squares, and open spaces. All this was accompanied by the development of Baroque and vernacular architecture, which became the symbolic historical legacy of that era. As gold transformed the colonial economy, Brazil ceased to be merely a rural colony. And began developing regions marked by intense urbanization, bringing new challenges to the Metropolis.

In early colonial Brazil, the Portuguese government's method of colonizing the territory was to grant large parcels of land. These were called *sesmarias* and were meant to be used for agriculture and exploration, measured in square leagues. During the Gold Cycle, the urgency to regulate mining activities led the Portuguese to divide the land into smaller parcels. Known as *lavras minerais* or *datas*, which were measured in square fathoms, equivalent to only 66 m². This extremely reduced measure reflected the intensive nature of mining, conducted in

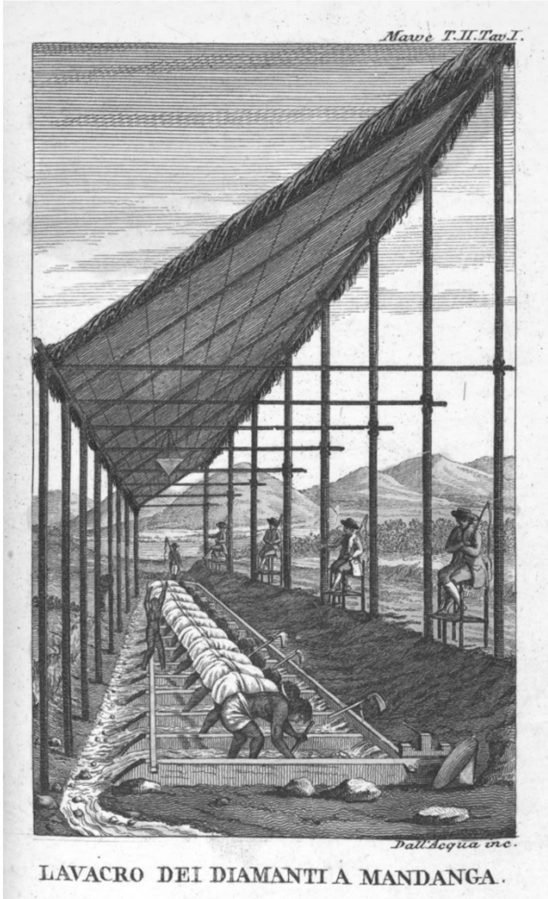


Figure 28 – Diamond mining at the Mandanga mine, Jequitinhonha Valley [Source: MAWE, John. Viaggio nell'interno del Brasile. Milan: Dalla Tip. Sonzogro e Comp., 1817.]

smaller, more specific spaces. Additionally, the number of *lavras* granted to a miner was directly related to the number of enslaved people they possessed. As labor was essential to the activity. These areas were located along rivers, streams, and caves.

The distribution of *lavras* was strategically controlled by the Portuguese government. Which granted land only to those who committed to regulated gold extraction. It was necessary to register the area, follow a bureaucratic process, and pay taxes like "*the quinto*", which corresponded to 20% of everything extracted. Additionally, there were licensing fees and several other charges. This entire system served not only to control mining but also to ensure that a large portion of the wealth generated was sent to the royal treasury in Portugal.

As gold was found in various places, streams, rivers, and caves , settlements emerged in a dispersed manner, often separated by geographic obstacles. The growth of these small mining hubs depended directly on the presence of gold: if plentiful, the area would grow; if depleted, it was abandoned in search of new zones. Over time, exploration advanced to hillsides, giving rise to areas known as *grupiaras*. Lands invaded or occupied without legal authorization, usually by small miners seeking survival in regions beyond the direct control of the Crown. These irregular occupations did not generate property titles, leading to conflicts with legal landowners or the Portuguese government itself.

This scenario led to the need to better organize mining spaces. Making them more productive and structured (Figure 28). That´s when *lavras* became even more important, associated with the earliest settlements and mining towns. Unlike the beginning, when individual miners worked in the *lavras*, these operations became more sophisticated, typically controlled by large landowners. They required heavy investment in infrastructure and, above all, in enslaved labor. In these *lavras*, mining was conducted using more advanced techniques such as drainage channels, dams, and gold smelting furnaces. The work was highly specialized, and the intense demand for labor brought thousands of enslaved people to these regions. Increasing the population flow and shaping the territorial occupation.

To regulate all this activity and prevent misuse, the Portuguese government created, on April 19, 1702, the "*Royal Regulation for the Superintendent, Chief Wardens, and Other Appointed Officials Responsible for the Gold Mines*". This regulation established clear rules for the distribution of *lavras* and created specific authorities to oversee mineral exploitation and ensure tax collection. As a result, asserting Crown control over the wealth of the colonial subsoil.

The application of the Royal Ordinances, which were the legal codes used for law enforcement and public administration, functioning as the Constitution and Penal Code of the time, was valid for Portugal and its colonies. Given that, Brazil was subjected to a legal and regulatory system designed for the European context. However, these laws did not detail specific urban planning issues. Things like street layouts or building volumes. Consequently, in the absence of clear metropolitan legislation on these matters, ecclesiastical norms played a fundamental role in the spatial organization of settlements. Determining guidelines not only for religious buildings, but also for their surroundings. And in this way shaping the cities of the colonial period.

During the Gold Cycle, the Church's involvement became relevant with the popular devotion that drove the construction of temporary chapels. Built to house saints venerated by miners, they were later replaced by permanent structures. The proximity between homes and religious buildings demonstrated the Church's fundamental role in the territorial and urban structuring of these early mining settlements. As the population grew due to new gold discoveries, two or more settlements would merge. Resulting in the formation of the first cities of the Gold Cycle. These cities maintained the centrality of Catholic temples. Ecclesiastical norms filled the absence of urban planning.

In 1719, the Constitutions of the Archbishopric of Bahia, based on the guidelines of the Council of Trent, established urbanistic and religious norms for cities and towns in colonial Brazil. These constitutions reflected the Portuguese Crown's delegation of urban spatial organization to the Catholic Church. Among the main guidelines were instructions for constructing religious temples. Requiring that parish churches be built on elevated sites, free from humidity and away from unhealthy areas. Additionally, it was recommended to leave open space around churches for processions. Although this was not always possible in already densely occupied towns. These recommendations led to squares and open areas around churches. Influencing street and building layouts.

Already established mining settlements would seek formalization by donating the church estate for official recognition. The imposition of a minimum annual income for the cities to the maintenance of Catholic buildings reinforced the connection between urban space and religious property.

The Constitutions also required chapels to have churchyards and cemeteries suitable for burials. This model led to the Church's dominance over urban land through a donation system. Portuguese religious fervor defined the chapel as the initial center of settlements, around which houses were built. The land assigned to the saint was called "*the Church Estate*", and residents who wished to build their houses within this area had also to pay an annual fee. This system allowed the Church to secure more resources for maintaining the chapels. And solidify its central role in urban organization.

The Church also influenced house design in urban areas. Since the fee was proportional to the width of the facade, homes had narrow frontages and greater depth. Contributing to the linear character of the Gold Cycle settlements.

Residential architecture was deeply conditioned by lot characteristics. These lots usually had irregular layouts. With narrow frontages,

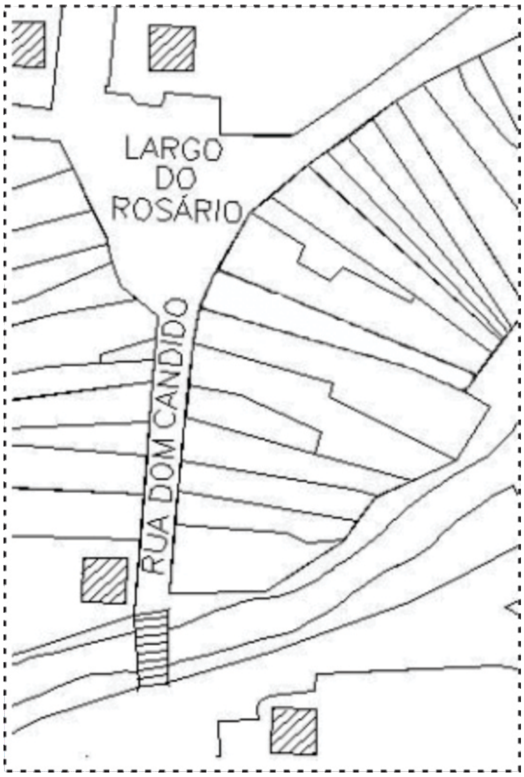


Figure 29 – Lot Division in Goiás, Brazil. Image extracted from the lecture material "A Arquitetura Civil Residencial Colonial Brasileira," part of the course "Teoria, História e Crítica da Arquitetura e do Urbanismo II – TH 2" at Pontifícia Universidade Católica de Goiás (PUC Goiás). [Source: PUC Goiás.]

typically ranging from 5 to 8 meters (Figure 29), and significant depth. Resulting in no setbacks between buildings. Because of this layout, streets were defined by the continuous alignment of buildings. With sidewalls marking the property lines and creating a unified and defining urban fabric.

During the colonial period, urban lots had well-established characteristics. Streets were uniform, unpaved, and lacked sidewalks. And buildings were constructed in alignment with the street, as per ecclesiastical norms. This standardization implied the absence of setbacks in urban housing.

It can also be observed that

residential models repeated themselves internally. Reflecting a highly homogeneous society. Urban housing followed a single pattern, determined both by lot configuration and environmental factors. This parcel system, with narrow and deep lots, supported the very idea of public roads. Which, at that time, were defined by the continuity of buildings.

The uniformity and architectural solutions, both in facades and internal space organization, characterized the residential pattern. Showing the strong relationship between lot shape and urban environment configuration. Disorganized growth led to the formation of irregular urban centers. Where streets were narrow and winding, often adapted to rugged terrain. Houses made of clay and wood were lined up to create a unique urbanization style for each city of that period.

To understand this form of urbanization in the Midwest, four cities will be compared (Figure 30): (1) Goiás, (2) Pirenópolis, and (3) Pilar de Goiás, in the state of Goiás, and (4) Cuiabá, in the state of Mato Grosso.

These cities share the same 18th-century Luso-Brazilian origin and were fundamentally centers for the extraction and transportation of gold. In the first map, which shows the satellite view, it can be observed a key characteristic of the gold-mining cities in the Midwest region: large areas of green space, as seen in the cities of Goiás, Pirenópolis, and Pilar de Goiás. Cuiabá, however, due to its contemporary urbanization, has lost many of these features.

When observing their street layouts, it can be noticed the absence of geometric patterns in the cities of Goiás, Pirenópolis, and Cuiabá. Pilar de Goiás, on the other hand, being smaller in scale than the others, has a more compact and organized urban grid. It´s important to note that this pattern of occupation reflects a way of city-building that responded directly to the terrain, the mining routes, and the immediate needs of those who lived there.

In the final map, the influence of the Catholic Church, which was fundamental in shaping these spaces, becomes evident. In the cities of Goiás, Pirenópolis, and Pilar de Goiás, the main religious building is always accompanied by a square or open space in front of it. Around which streets and homes were organized. This centrality of faith in daily life became materialized in the urban landscape.

Although these cities may appear disorganized, especially when compared to more recent or planned urban centers, they share a coherence of their own. It´s a form of organization born from practice, terrain, and religiosity. The city, in that period, was also the result of lived and empirical experience. One that carries the memory of an occupation deeply rooted in the reality of the land.

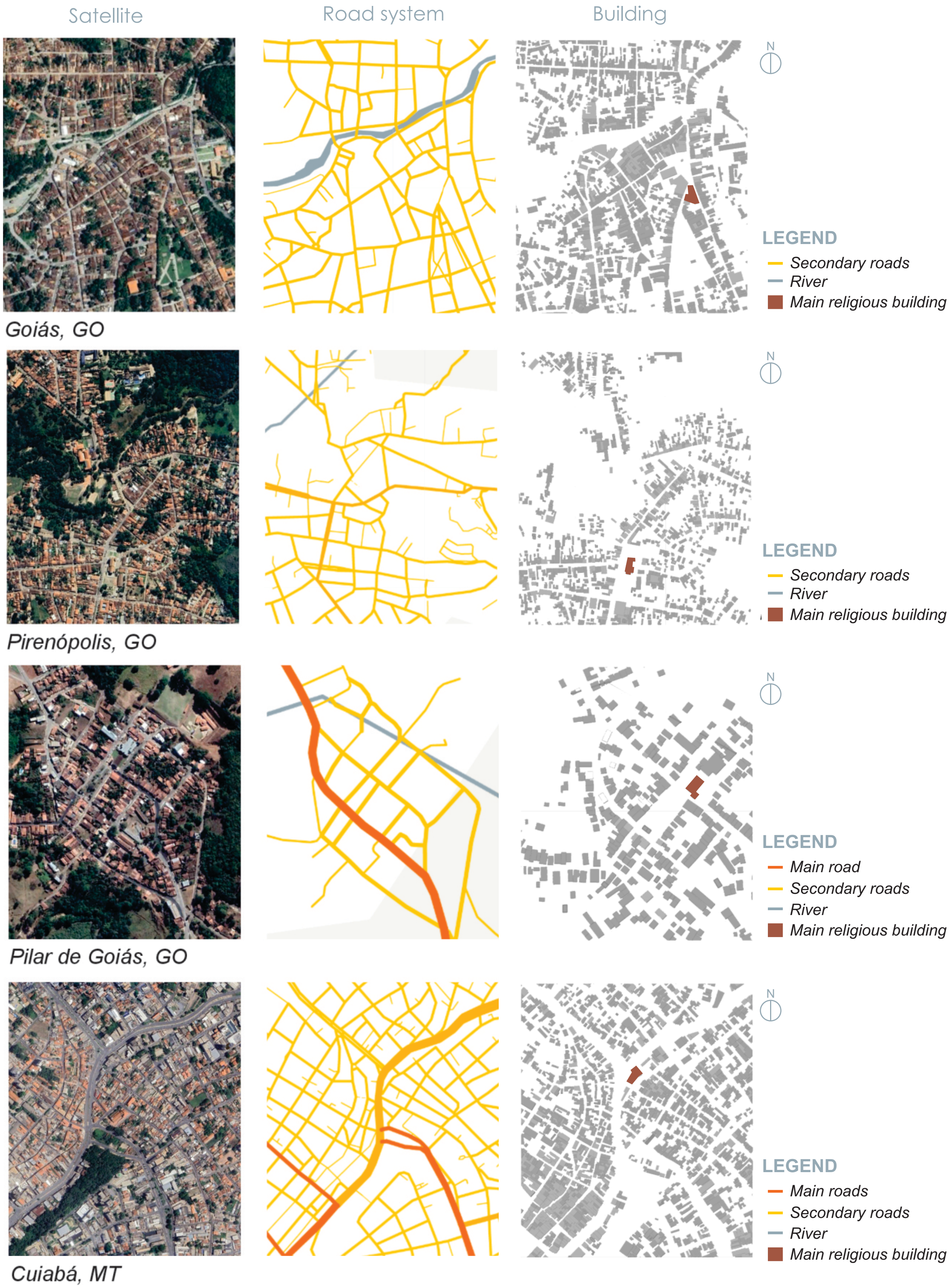


Figure 30 – Urban Stratification of Mining Towns in the Brazilian Midwest. Maps created by the author using Google Earth imagery, accessed on May 10, 2025. [Source: Google Earth.]

Figure 31 – "Caipira Picando Fumo" (1893). Oil on canvas by José Ferraz de Almeida Júnior. Collection of the Pinacoteca do Estado de São Paulo, Brazil.[Source: Wikimedia Commons.]

2.2.Types of Houses [6]

The vernacular architecture of the 18th century in the Brazilian Midwest is closely linked to the figure known as the *caipira* (Figure 31). The term *caipira* originates from the Tupi word *ka'apir* or *kaa-pira*, meaning *"bush cutter"*. Initially, it was used by the Guaianases Indigenous people to refer to the *bandeirantes*, and later came to denote people living in Brazil's interior. The ethnic and cultural formation of the *caipira* is complex, but it can be described as the result of a process of *interethnic relations (racial and cultural mixing)*. In addition to the blend of Indigenous peoples and Catholic Portuguese settlers, forming the so-called *caboclos* established in the São Paulo region, there are significant records of descendants of *Sephardic Jews* who emigrated from Spain and Portugal due to the Inquisition. These groups settled in the Midwest region, contributing to the cultural and ethnic diversity of the *caipira* population. This figure was shaped by the persistence of simple practices, a strong connection to the land, and a deep appreciation of traditional ways of life. This cultural continuity was so profound that this group developed its dialect, architecture, music, and cultural expressions.

When discussing a residence, it´s important to study the society that made it their home, in this way understanding the houses they built. The Midwest of Brazil in the 18th century reveals a complex interaction between economic, social, and cultural factors, in which *patriarchy* plays a central role in the family

[6] *All the information in this paragraph has been drawn from:* RIBEIRO(1995); LEMOS (1999); BOAVENTURA (2001); FREYRE(1933); VAZ (2003); COUTO (1997)

Figure 32 – Casa do Sítio do Padre Inácio. Photograph by Victor Hugo Mori. Source: PETINI, Andrea; RODRIGUES, Bianca Yinli Wu Candido; BERLATO, Elisabeth. "A Casa Bandeirista: Proposta de uma ambiência bandeirista para uma galeria de artes." Arquiteturismo, São Paulo, year 10, no. 115.03, Oct. 2016.

nucleus and, consequently, becomes the rule that determines the arrangement of spaces.

During this period, intense mining activity not only drove economic transformations but also consolidated hierarchical social structures, which were reflected both in family relationships and in the organization of residential spaces.

Between the 16th and 19th centuries in Brazil, the house symbolized the power of the landowner and, consequently, male authority in both private and public spheres. This configuration reflected a logic of domination that extended to all aspects of life, including the architecture of residences, where the division of spaces was designed to reinforce family and social hierarchy. During the 17th century, in the Southwestern region of Brazil, there was a predominance of rural residences known as *bandeirista houses* (Figure 32).

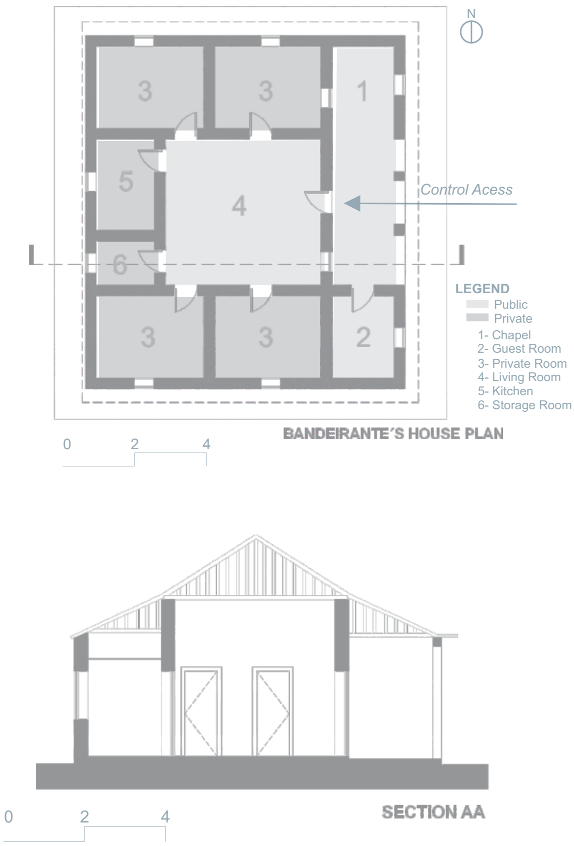


Figure 33 - House of Padre Inácio Plan and section

The consolidation of a social system where power relations were defined vertically meant that *patriarchy* manifested not only in family organization but also in the way rural residential environments were conceived and structured to meet a plan of needs that prioritized circulation and control of flows within the house. The *bandeirista houses* were planned to concentrate essential functions for maintaining the home and affirming social status. This planning implied a division of spaces into public and private areas, where the living room, the chapel, the private rooms, and spaces for servants formed a set that symbolized and reinforced family hierarchy. In the floor plan (Figure 33), it´s possible to see that the social areas are arranged at the front, ensuring family privacy and control by the father figure over the movement and circulation of children and spouse. Service areas were located outside the house or at the back, as the presence of enslaved people inside residences and in intimate spaces was meant to be minimal. Slave quarters, when located in the main building, were placed on the ground floor or in the basement, as a result, consolidating the vertical hierarchy between the owner and the enslaved individuals.

The Caipira House can be classified as transitional architecture, this is the type of architecture developed within the urban context of the 18th century in the Brazilian Midwest will be an evolution of the *banderista house*. The transition was a direct reflection of the urbanization process triggered by mining activities.

Before the so-called Gold Cycle, residences in central Brazil were mostly rural. The properties were large and essential for subsistence, agricultural practices, and animal domestication. With the emergence of settlements and later the consolidation of mining towns, this housing model began to change, and houses started to cluster together.

It´s possible to say that the preservation of rural practices within urban settings was a strategic form of adaptation: being far from major centers, residents needed to grow and produce their food. This necessity enabled the continuation of traditional customs from the countryside, even when these were being developed within urban spaces. The physical structure of these houses, with open spaces and areas for cultivation, reflected this cultural heritage, reinforcing the notion that people from rural backgrounds, even when living in urban clusters, retained aspects of their original way of life. This gives rise to the term transitional architecture, which also defines the vernacular architecture of the colonial period.

The *Caipira House* (Figure 34) in the urban context of Brazilian Midwest in the 18th century is a clear expression of adaptation and cultural continuity. In addition to the construction techniques and materials used, the layout of the houses, allowing for backyards and small

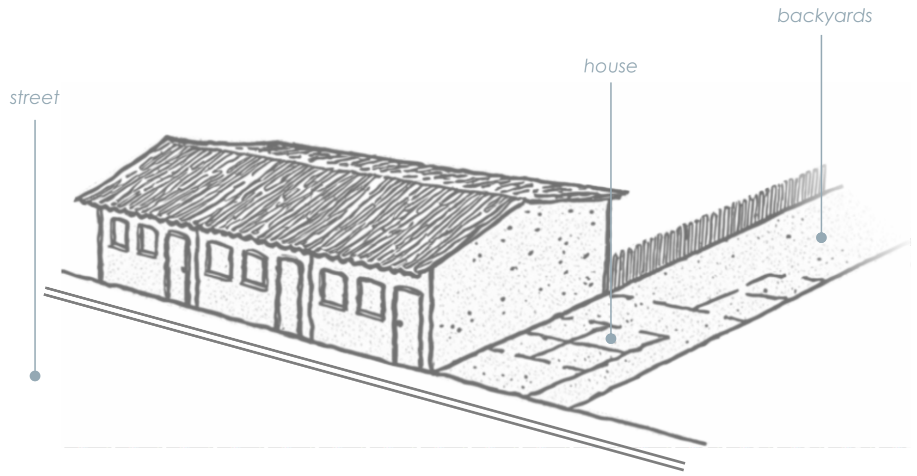


Figure 34 – Composition and volume of The Caipira House..

spaces dedicated to farming and raising animals, was a defining element that maintained ties to the rural environment.

The houses were aligned along the front boundary of the plots and attached at the sides, forming continuous sets known as "*corridor street houses*". This urban configuration was related both to technical aspects and to the structural limitations of construction at the time.

The precariousness of building methods presented high vulnerability to humidity and rain, which made it necessary to protect the buildings. One solution found to minimize climate damage was the construction of adjoining houses with shared side walls, gable to gable, reducing the direct exposure of external surfaces.

In the Midwest region, houses were predominantly single-story. When the family had wealth, it was possible to build a two-story house. Sometimes, when there was a slight slope in the terrain, a basement was often built and used for storing grain, housing animals, or, in some cases, functioning as a *senzala*. When the slope was more pronounced and toward the front, it was possible to build a *''Two-story house on a slope''*, with the ground floor often used for commercial purposes and the upper floor for residential use.

The volumes of the buildings were defined by prisms, with a predominance of both horizontality and, in some cases, verticality, varying according to the width of the lot. The continuous roofs and simple, aligned façades reflect the influence of Portuguese architecture. The gable roof is the most common form, while hip roofs can also be used depending on the building's projections or its isolated placement.The roof was the element that crowned the overall volume.

In the composition of the facades, the openings are essential to create rhythms and of the filled or empty spaces, accompanied by decorative elements such as lintels, shutters, and rosettes, all made of wood. Additionally, eaves, cornices, parapets, columns, and frames with

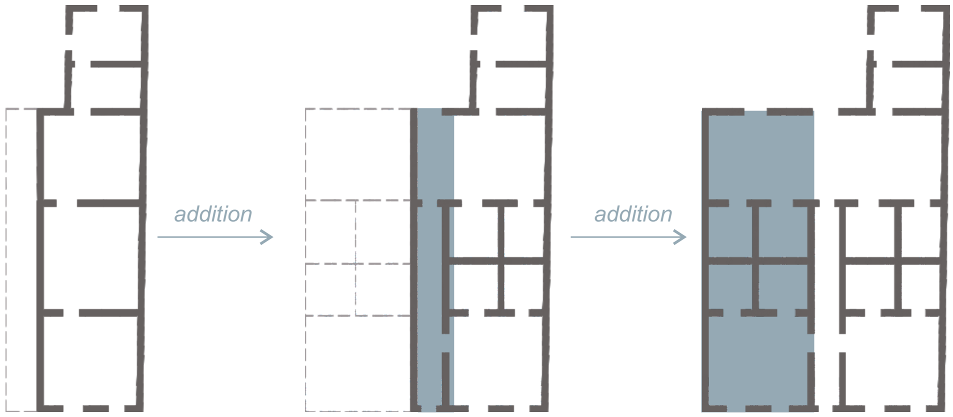


Figure 35 - Expansion of the Caipira House

various designs made up the main ornamental resources.

Although there is currently little detailed documentation about these spaces, it´s known that, in the vast majority, the divisions were very similar in these types of residences. The division of the urban house varied according to the owner's resources and the functional program, based always on traditional values, *patriarchy*, rurality, and always aligned with the privacy standards of the time.

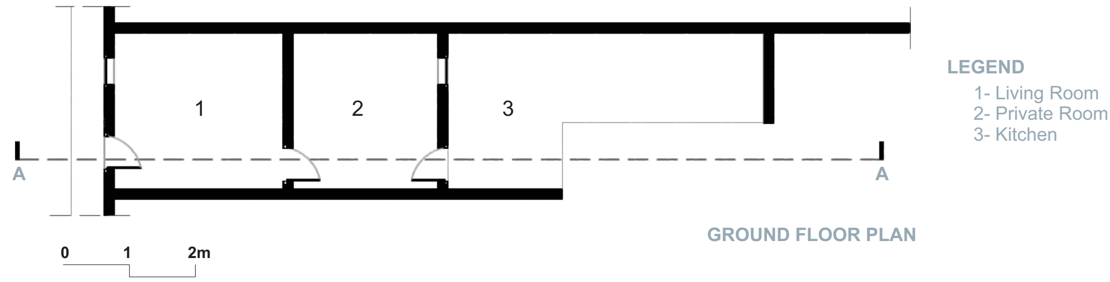
These houses, as seen (Figure 35), share the same 'L'-shaped base, but may feature additions or mirrored layouts in their architectural plans, reflecting a progressive adaptation to the urban setting and the distinctions between social classes.

In this way, based on the book *''A casa goiana: documentação arquitetônica.''* by Maria Diva Araújo Coelho Vaz from 2003, it´s possible to classify 5 different types of houses in this context:

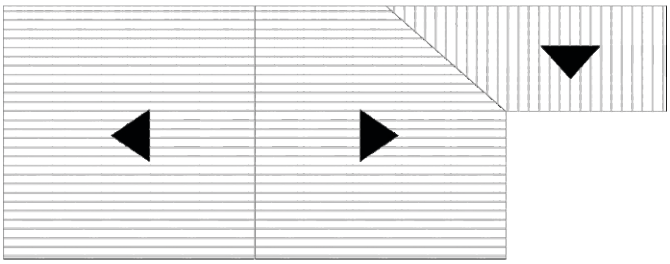
Type 1- Door and window house

Figure 36 - Type 1

The simplest configuration of colonial residences, characterized by a reduced and functional space, composed of a living room, private room, and a kitchen. The internal organization was quite rigid, reflecting the customs and social norms of the time. This layout reinforced the separation between social areas and more intimate spaces through the use of a wall. It was common for only family members to be allowed access to the private room or to pass through it to reach the kitchen.



GROUND FLOOR PLAN



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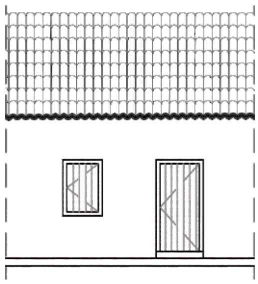
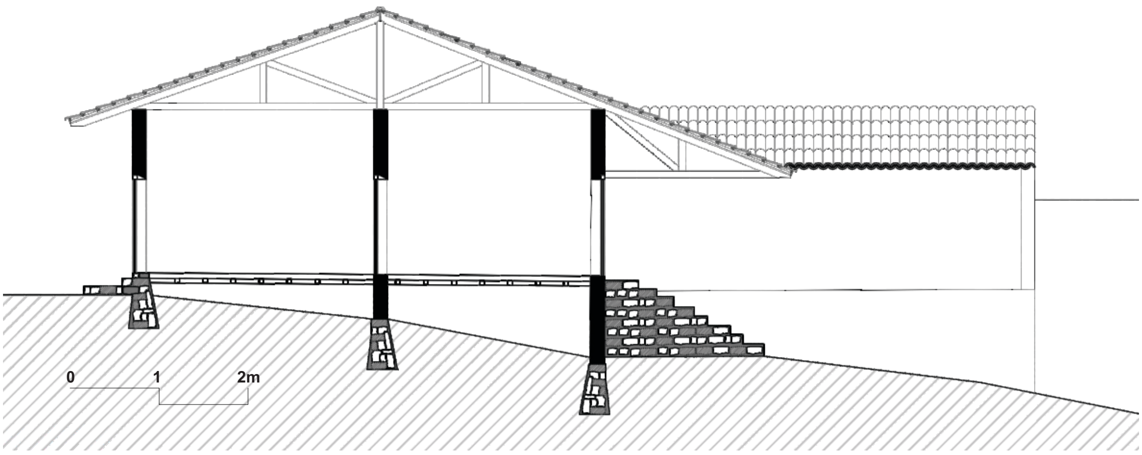


ELEVATION

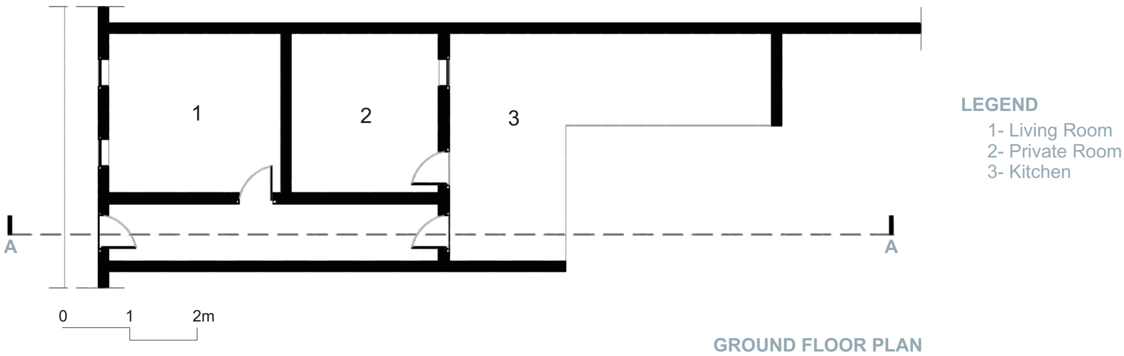


SECTION AA

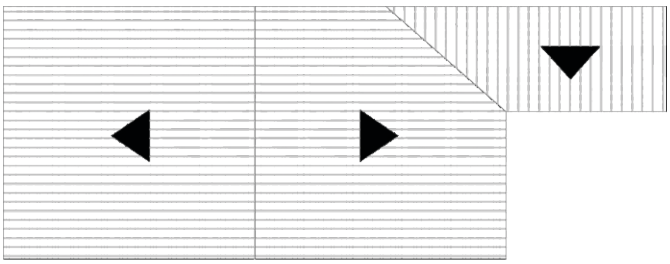
Type 2 - Half single-story house

Figure 37 - Type 2

An evolution of the door and window house, incorporating a corridor into the layout. This addition allowed for improved internal circulation while maintaining the same rigid organization that reflected the social conventions of the time. The access to the private room of the house remained restricted, and the living room continued to function as the main space for reception and controlled interaction with the street. The corridor served as an internal axis, without requiring passage through the rooms.



GROUND FLOOR PLAN



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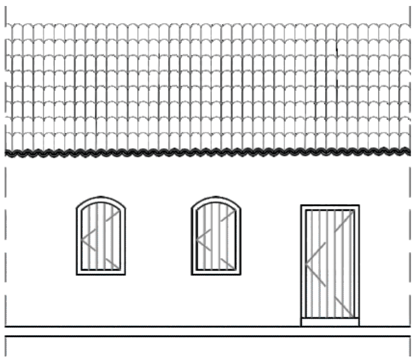

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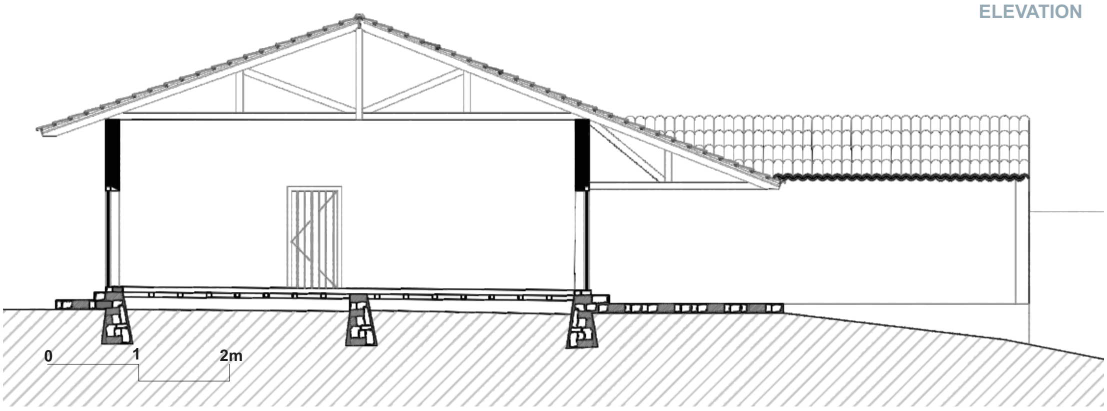
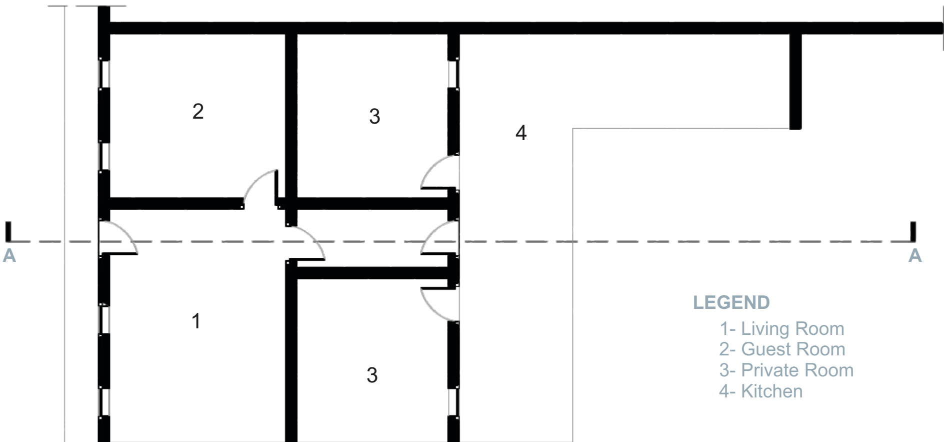


SECTION AA

Type 3 - Full-scale single-story house

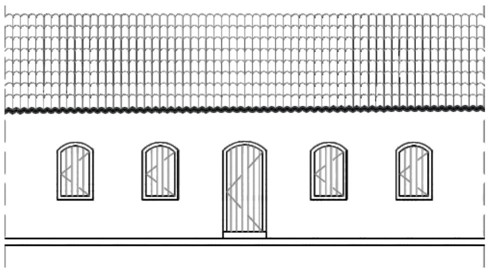
Figure 38 - Type 3

Represented the mirrored version of the Half single-story house, reaching its most complete form. This configuration replicated the corridor layout on both sides of the central axis, creating a balanced and expanded floor plan. While maintaining the traditional separation between public and private spaces, this house type offered more room and flexibility, often indicating a family with greater financial means. It´s also possible to have a guest room and a *senzala*. In this type of house, in addition to the traditional gable roof , it´s also common to see hipped roofs .

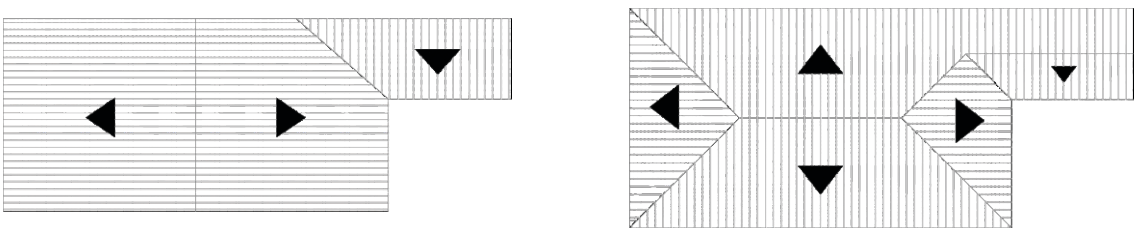


LEGEND
1- Living Room
2- Guest Room
3- Private Room
4- Kitchen

GROUND FLOOR PLAN



ELEVATION



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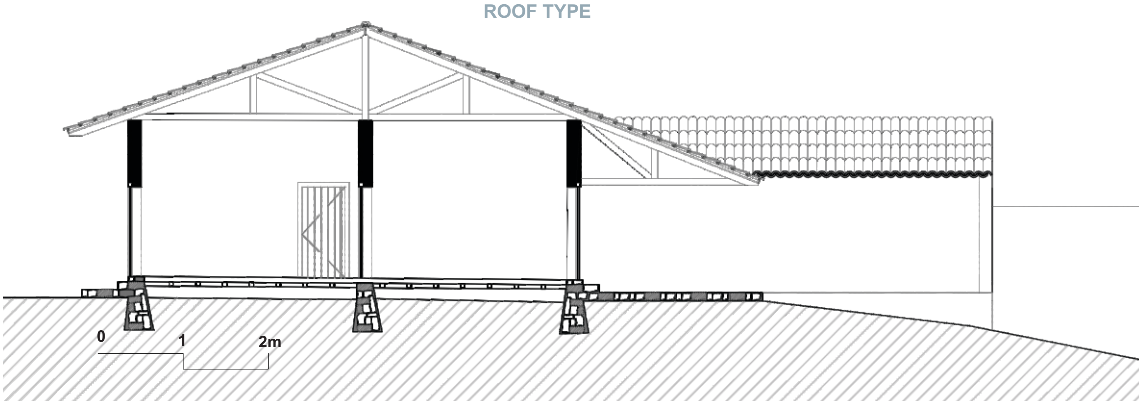
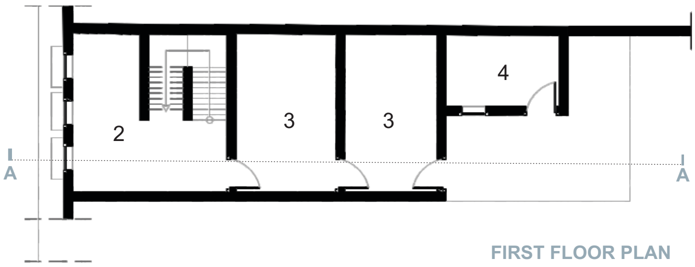


SECTION AA

Type 4 - Two-story house on a slope

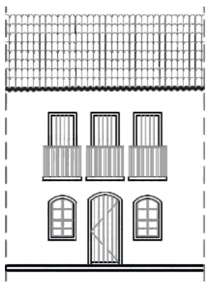
Figure 39- Type 4

It maintained the same basic layout as its single-story, but was adapted to sloped terrain through simple construction solutions. Wooden pillars and a wooden floor were used to level the structure and create a floor aligned with the street. Internal wooden staircases provided access to the main level. The main floor was established on an upper level, which also served as the family living space, the overall organization continued to follow the same social logic of spatial separation and functional hierarchy, but with the distinction that the ground floor could be used for commercial purposes.



LEGEND
1- Store
2-Living Room
3- Private Room
4- Kitchen

FIRST FLOOR PLAN



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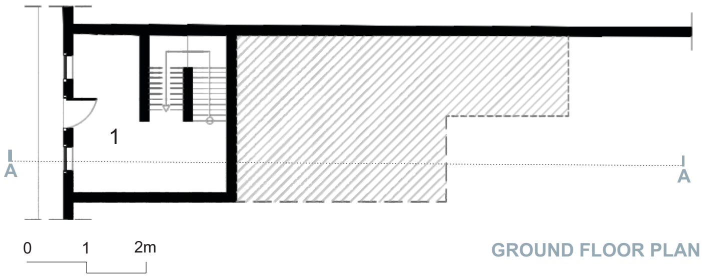
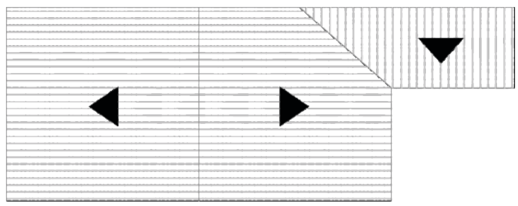


GROUND FLOOR PLAN



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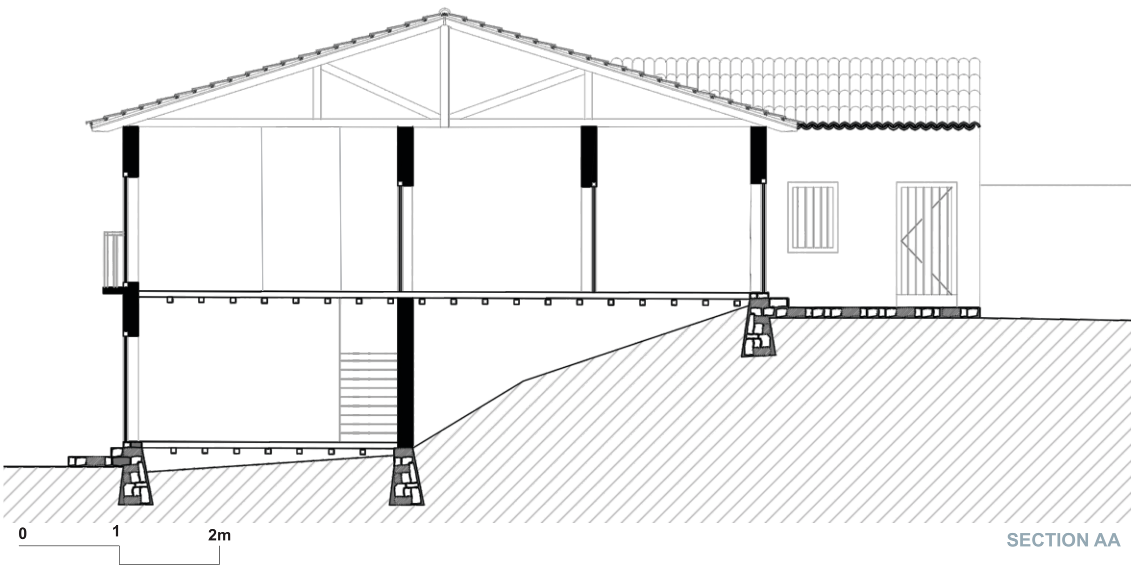
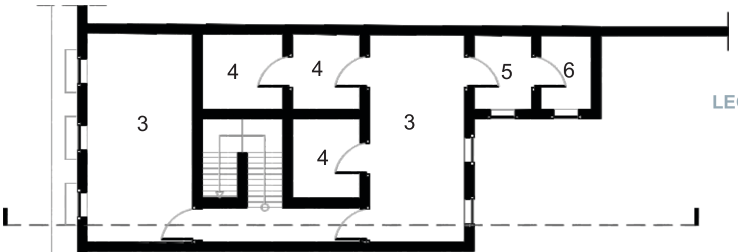


SECTION AA

Type 5 - Full-scale two-story house

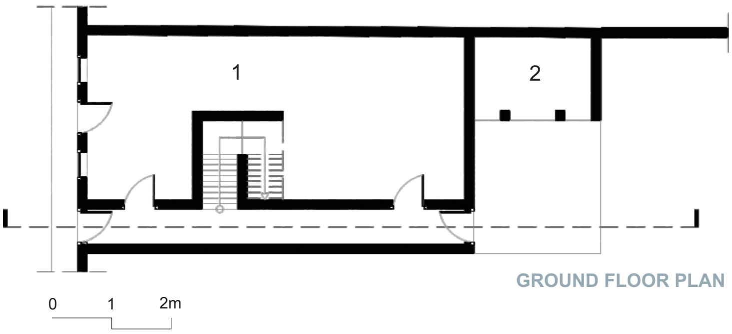
Figure 40 - Type 5

It´s the most complex type of house. Different types can emerge based on the economic condition of the family, while still adhering to the principles of hierarchy and privacy that defined domestic architecture in the colonial period. In the house's internal distribution, the ground floor commonly serve as utilitarian or commercial purposes, and the upper floor reserved for family life. In wealthier households, construction techniques allowed for more elaborate architectural elements, such as refined staircases, distinct facades, and larger private rooms. In this type of house, in addition to the traditional gable roof , it´s also common to see hipped roofs.

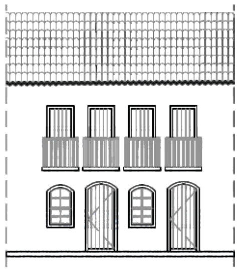


LEGEND
1- Store
2- Senzala
3- Living Room
4- Private Room
5- Kitchen
6- Deposit

FIRST FLOOR PLAN



GROUND FLOOR PLAN



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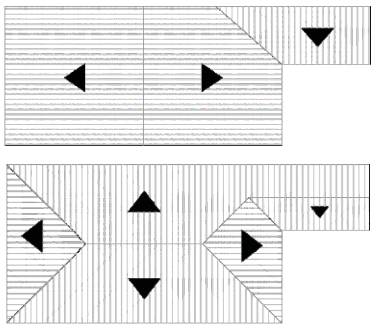

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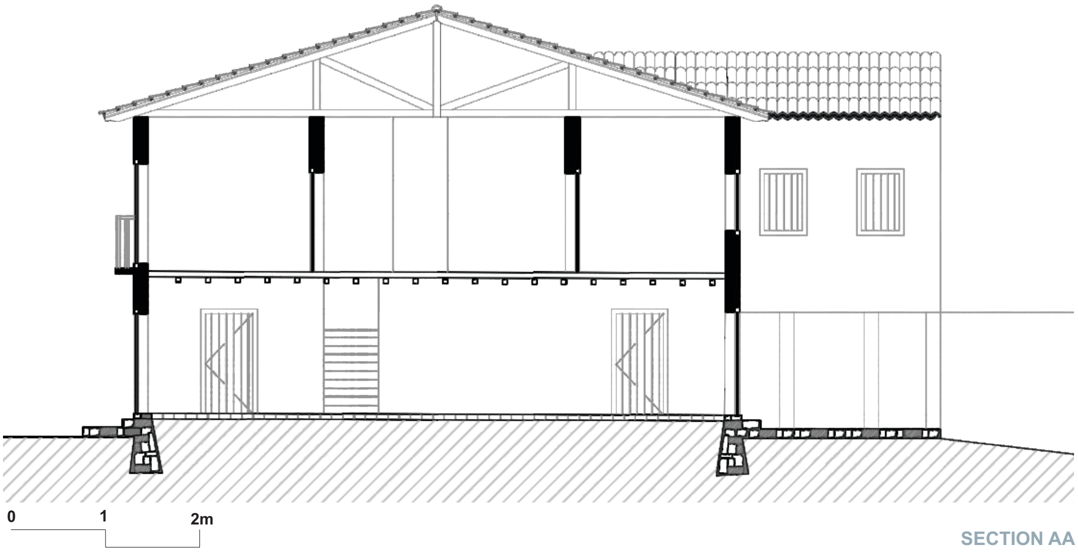

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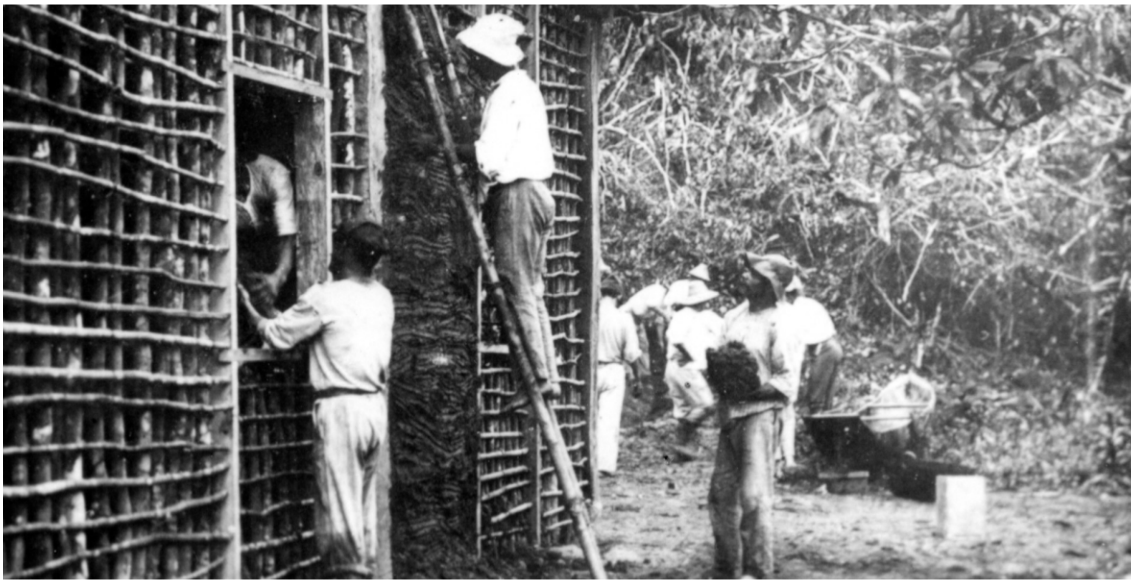


Figure 41 – Construction of a Wattle and Daub House. [Source: Photograph by Agnello Ribeiro dos Santos, from the Historical Archive of São Sebastião. Image sourced from the article "HISTÓRIA – Casas de mãos e barro" by Clayton Galdino, published on June 12, 2019.]

2.3. Building Materials [7]

House building was considered a collective event in the *caipira´s society*, involving not just the family unit but the entire community (Figure 41). This collective knowledge formed the foundation for decisions and practices which, although not formally systematized, revealed a profound understanding of local realities. These houses in the Brazilian Midwest were shaped by several factors. Even though their construction techniques came from Portugal and other regions, the style is considered vernacular.

Vernacular architecture develops from construction techniques and practices transmitted orally and empirically, knowledge acquired through hands-on experience, without relying on formal scientific methods. This type of knowledge evolves through repetition, experimentation, and horizontal transmission, allowing individuals to adapt their actions to the specific realities of the environments in which they live.

For the *caipiras*, empirical knowledge was essential to house construction, given the challenges of mobility and the high cost of transportation between the Brazilian interior and the coast, where manufactured goods from the Metropolis arrived. The use of locally available materials became essential and the norm in these gold towns. The *caipiras* used the empirical knowledge about the properties, functions, and identification of natural materials for assertive resource selection, such as which type of soil, wood, and stones to use.

Material selection varied depending on its application within the building (Figure 42). The raw earth was the predominant material

[7] *All the information in this paragraph has been drawn from:* NEVES (2011) ; ARAÚJO (2007); CHIODI FILHO (2009); MENEZES (2015)

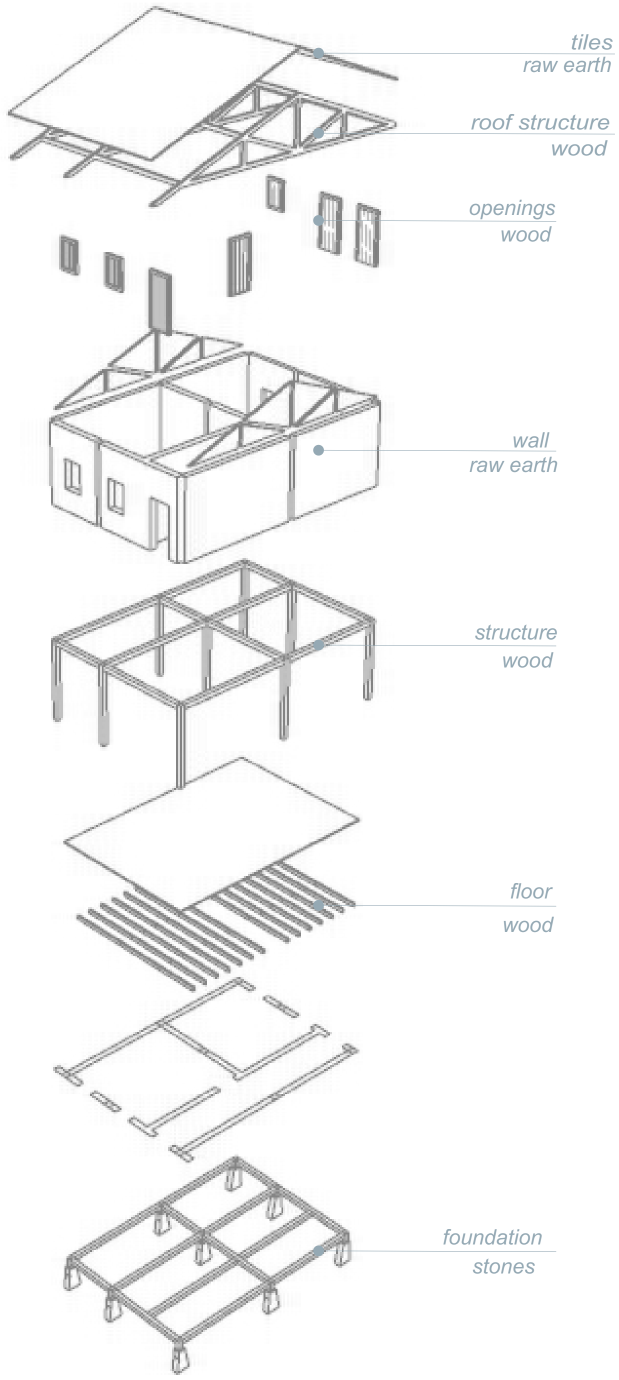


Figure 42 - The vernacular residence of the 18th century in Brazil's Midwest stratification

used for wall construction. The types of soil used were Latossolo, Argissolo, and Neossolo. However, when clay did not stabilize properly, other elements had to be added, like vegetal fibers, and sometimes stabilized with animal-based additives. These compositions enhanced the mechanical performance of the walls, reducing cracking and improving moisture resistance.

Stone was frequently used in foundations or simply to protect the walls from moisture, elevating them to avoid direct contact with the ground. The foundations were typically built using Basalt, Sandstone, or Limestone, materials chosen for their durability and availability. Also, the external pavement, as the sidewalks, could be made of stone.

A fundamental material was wood, extensively used in structures, roofs, floors, doors, and windows. Joinery techniques without the use of nails or screws were common in colonial carpentry, allowing greater flexibility and better load distribution across the roofs and floors. Different types of wood were chosen according to their resistance and flexibility. Wood species as Aroeira, Ipê, Angico, and Peroba were widely employed due to their high resistance to pests and moisture. In the wattle and daub frameworks, materials such as Taquara bamboo and Cipó-titica liana were used, reflecting an integration of local, flexible natural resources that allowed good tensile strength and bonding for earthen walls.

Table 1 - Construction Components and Their Applicable Materials[1]

Nº	Structure	Main Material	Specification
1	Roof Tile	Raw Earth	Argissolo or Latossolo
2	Roof Structure (trusses, purlins)	Wood	Aroeira, Ipê, Angico, Peroba
3	Ceiling	Wood	Peroba
4	Pillars and Beams	Wood	Aroeira, Ipê, Angico, Peroba
5	Wall (infill)	Raw earth + fibers	Argissolo, Neossolo; Vegetal Fibers; Animal-based Stabilizers
6	Wall (structure)	Wood	Taquara, Cipó-titica
7	Wall whitewash	Lime	Limestone
8	Lintels (above openings)	Wood or Stone	Aroeira, Peroba; Basalt, Sandstone
9	Frames (doors and windows)	Wood	Peroba, Aroeira
10	Baseboard (internal finishing)	Wood	Aroeira, Peroba
11	Floor	Wood	Ipê, Peroba
12	Foundation	Stone	Basalt, Sandstone, Limestone
13	Foundation binding (mortar)	Raw earth + Lime	Latossolo, Argissolo; Limestone

(1) NEVES (2011) , ARAÚJO (2007), CHIODI FILHO (2009), MENEZES (2015)

Another widely used material was lime, produced by burning limestone in rudimentary kilns. Lime was essential for producing mortars and coating walls. When hydrated lime was mixed with sand and water, it created a highly workable mortar used for laying stones and adobe bricks, as well as for wall coatings that protected earthen surfaces from moisture and weathering. Additionally, limewash and white-washing, made entirely from lime-stone and water, gave buildings a more uniform appearance and contributed to hygiene, as it has bactericidal properties. Also, some nature-based pigments can be add. Over time, the application of multiple lime layers reinforced the buildings' durability and helped maintain façade colors despite sun and rain exposure.

Table 1 reflected a deep empirical knowledge of available materials and their properties. It maps out the materials used in different parts of a building, from the roof tiles and wooden beams to the walls made of raw earth and fibers, the stone foundations, and the lime used for whitewashing and mortar. Each item listed connects directly to traditional methods that relied on empirical knowledge, experience, and observation from the *caipira* people. In Chapter 2 Appendix, a detailed list of each building materi-als can be found, the physical and chemical composition of the mate-rial that the buildings were con-structed from, and the use behind each choice.

The detail section (Figure 43) was based on Table 1, showing in the design, the location of each mate-rial in the project.

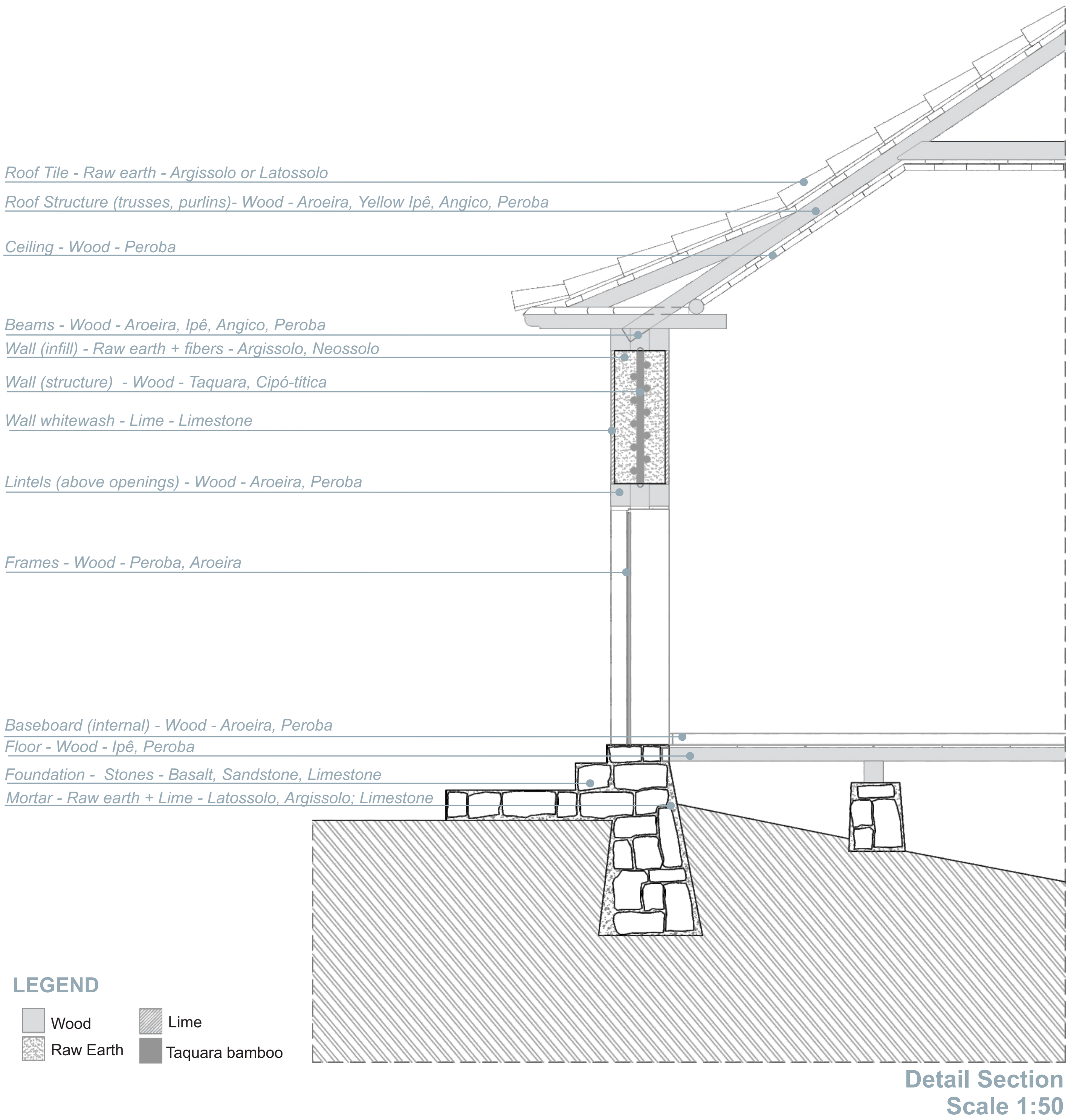


Figure 43– Section of a typical 18th-century colonial house in the Midwest

Figure 44 – External wattle and daub wall on stone foundation, Cachoeira do Brumado District, Mariana, MG, 2014. [Source: Image sourced from the website Vitruvius.]

2.4. Traditional Construction Techniques [8]

Earthen construction is an ancient practice, developed and adapted by different civilizations over time and in various cultural and geographic contexts, having been brought to Brazil by the colonizers. This diversity of uses resulted in a wide range of building techniques, each shaped by the characteristics of the soil, climate, and local traditions. These techniques can be grouped into three main categories: monolithic constructions (such as rammed earth), load-bearing masonry (such as adobe), and structural infill systems (such as wattle and daub).

One of the most widespread techniques is adobe, which use manually shaped or wood-molded blocks of earth, usually sun-dried before application. Adobe bricks are used in the construction of load-bearing walls and around window and door frames, and in many buildings, they appear specially in internal partitions. However, in the Brazilian Midwest, adobe was also widely used in external walls. The advantages of adobe are its simplicity and versatility, as well as good thermal performance and easy of repair. The material can be stabilize by adding straw, lime, or other additives, which increase its resistance to moisture and shrinkage.

Rammed earth involves compacting layers of earth between wooden molds, forming thick and homogenous walls. It´s particularly valued for its thermal

[8] *All the information in this paragraph has been drawn from:* VASCONCELLOS(1979); BRITO(1999); MARQUES(2019); OLENDER(2006); CASTRIOTA(2012); ICOMOS(2017)

and acoustic properties, which come from the high thermal inertia and mass of the walls. Rammed earth construction follow specific stages: selection and preparation of the earth, excavation of foundations, assembly of the molds, filling in layers, and compaction. The final strength of the walls depends of factors such as the correct proportion of clay to sand, the occasional use of stabilizers like lime or straw, and attention to the laying of joints and corners.

Wattle and daub, in turn, is an infill technique in which wooden rods are interwoven with thinner sticks and filled with a mixture of earth, plant fibers, and occasionally manure. It´s a lighter building solution, often used solely as a partition wall and not for a structural support.

In 18th-century Brazil, especially the Midwest where the dry climate favor these methods, the three construction techniques were widely used. These vernacular solutions, adapted to environment and local resources. Based on that, the most common structural system in the region was the mixed wood–earth model, also called "*cage and enclosure*." The wooden frame, vertical pillars and horizontal beams, were the main load-bearing part. It´s supporting the first floor (when there was one) and the roof, and the loads go down vertically to the foundation. The earth walls were secondary: they close the spaces and give lateral stability.

This system was especially prevalent in the Midwest due to the greater availability of suitable timber, reflecting that how locally sourced wood was commonly used in vernacular architecture in colonial Brazil. The structural logic relied on vertical wooden posts (typically 20–30cm in diameter) with high compressive strength (f_{c0}:50–90 MPa), easy capable of bearing the loads. Beams such as purlins, wall plates, and grade beams was robust and proportionally thick, even if not formally calculated. Spans were generally modest (3–5m), and the sizing of structural members followed by empirical knowledge and builder experience.

In this model, horizontal stability were ensured by the inherent stiffness of the earth walls themselves, with reinforcement by occasional internal wooden bracing, such as slats or cross-ties. The enclosure walls closed the spans between pillars but were not responsible for vertical load-bearing. To summarize, the primary structure of the *caipira* house supported and transmitted to the ground the weight of the roof, any intermediate floors, and the partition and enclosure walls, while the secondary structure served to stabilize the building and close the spans, ensuring horizontal rigidity and enclosing the spaces.

In the Midwest region of Brazil, seismicity is low, but theoretically, colonial mixed wood–earth buildings, using the typical "*cage and enclosure*" system, is structurally vulnerable to earthquakes. Earthen walls offer strong compressive resistance but perform poorly under shear and tensile stress. As a result, moderate earthquakes often generate diagonal cracks and partial collapses, since earthen materials fail in a brittle manner on lateral loads. While the wooden framework adds some flexibility compared to pure earth structures, without metal reinforcement the deformation exceeds material strength, rising the risk of catastrophic failure.

Wind is also a hazard. Although gable roofs with deep eaves help protect walls from rain, strong crosswinds can produce tensile stresses at joints and dislodgement in lighter roofing elements. Since earthen walls provide good inertia against lateral forces, their stability critically depend on solid wooden connections.

Rainfall poses a major threat to earth-built structures. Without protective plaster or mineral finishes, splash-back and rising damp rapidly erodes wall surfaces and undermine foundations. Traditional designs lifted wooden pillars on stone bases and anchored grade beams to stone foundations to prevent capillary moisture.

Across all the traditional construction techniques types, the durability of these systems depend on the material integrity, absence of cracks in earth walls, and rotting in wood. When well maintained, the empirical use of wood and earth produced long-lasting, stable buildings consistent with vernacular construction knowledge.

2.4.1. Adobe construction technique

Adobe is a building component made from earth in a plastic state, molded with the aid of forms, without the need for compression. After drying, it´s used in the construction of self-supporting or load-bearing masonry, among other forms. It can be applied both in orthogonal and curved shapes, as long as its main characteristic: compressive strength, is respected. Traditionally, before the use of molds, clay was shaped by hand into forms such as spheres, cylinders, cones, and parallelepipeds.

The most common technique used in 18th-century Brazil involves the use of wooden molds to produce one or two rectangular units at a time. These molds are filled with a mixture of soil, water, and often additives such as chopped plant fibers or animal-based stabilizers that help control cracking during drying and improve the cohesion of the mass. In more recent methods, walls are made with square adobes reinforced with bamboo, avoiding the use of additives.

Regarding soil selection, it´s essential to use material below the surface and arable layer, which is usually richer in organic matter. The ideal earth for adobe production should contain between 54% and 75% sand, 10% to 25% silt, and 15% to 18% clay. According to various authors in Table 2 the ideal composition are:

Table 2 – Granulometric Composition of Soil Suitable for Adobe Production

Authors[1]	Clay (%)	Silt (%)	Sand (%)
Barrios et al. (1987)	35–45	—	55–65
Houben & Guillaud (1994)	5–29	—	—
Graham McHenry (1996)	15–25	—	—
Carazas Aedo (2002)	1 part clayey soil : 2 parts sandy soil	—	—
HB 195 (2002)	10–40	10–30	30–75 (sand and gravel)
Proyecto Hornero (2007)	50% clayey soil : 50% sandy soil	—	—

(1) BARRIOS(1987), HOUBEN(1994), MCHENRY(1996), CARAZAS AEDO(2002), Hb195 (2002), HORNERO(2007)

Soils with too much clay tend to cause cracks during drying; while soils with excessive sand or silt may exhibit low cohesion and reduced compressive strength. Therefore, the mixture can be adjusted with additions such as sand when the soil is very clayey, or plant fibers when more control over cracking is necessary. In some cases, additives such as lime are used to improve compressive strength and the stability of the adobe against moisture, being incorporated beforehand into the mixture due to its slow hardening.

Soil Preparation

The process begins by removing impurities such as stones and roots using sieves with a mesh of about 5 mm, followed by breaking up clumps with hand tools. The soil is then mixed with water to create a homogeneous, moldable paste.

Tools

Manual molding can be done with various types of wooden molds, which vary in size and number of units formed at a time. The most common molds produce between 1 and 2 adobe bricks at once and may be used on a flat surface or a table, with or without a base, depending on tradition. The tools used in the production and construction with adobe are: wide shovel, water drum to moisten the molds, ruler, plumb line, bucket, and mason's trowel.

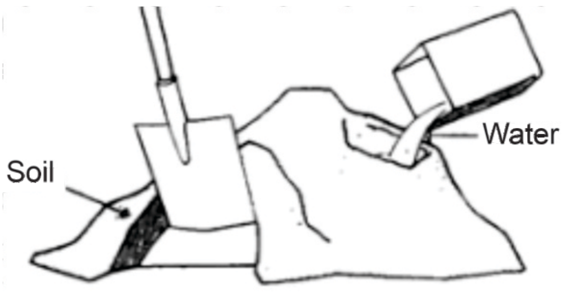


Figure 45 – Soil preparation [Source: Image from "25 manuales de autoconstrucción, diseño y arquitectura participativa en México, parte 1." Courtesy of INBA.]

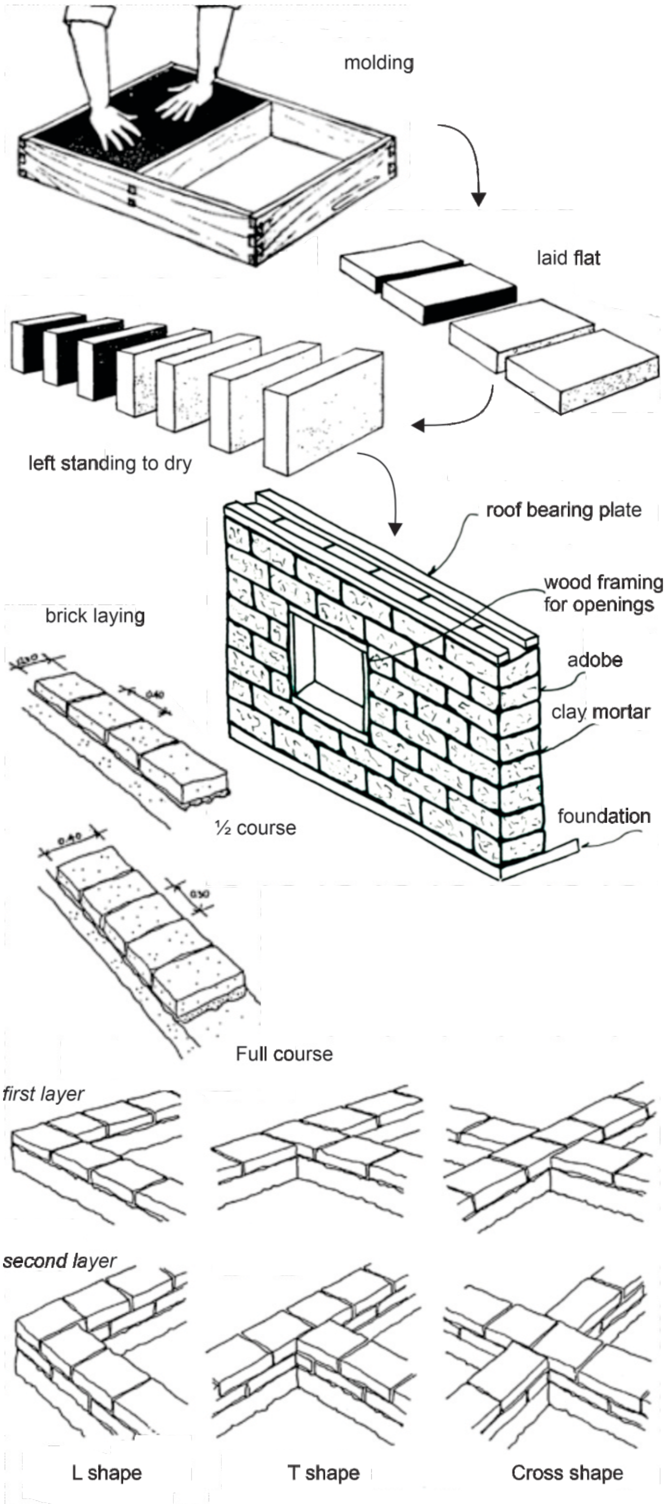


Figure 46 – Adobe construction process. [Source: Image from "25 manuales de autoconstrucción, diseño y arquitectura participativa en México, parte 1." Courtesy of INBA.]

Construction Stages

Brick molding: The prepared mixture is placed in molds (without a bottom) positioned on flat surfaces. The exposed surface is smoothed and moistened to prevent sticking. The adobe is then removed from the mold, which is cleaned for reuse.

Drying: Initially, the bricks are dried in the shade, a crucial step to avoid cracking caused by shrinkage. Then they are exposed to the sun, being turned periodically to ensure uniformity. This process can last from 3 weeks to 45 days, depending on the climate. After drying, the blocks should be stacked with enough spacing for ventilation.

Foundation and wall raising: Adobe walls must be built on foundations of local stones and lime mortar, elevated 30 to 50 cm above ground level. Masonry is laid in continuous courses, avoiding vertical alignment of joints. In structurally critical areas such as corners or wall tops, reinforcements in wood or stone may be used.

Joints: Joints between blocks vary from 1.5 to 2.5 cm and are filled with mortar similar in composition to the adobe blocks. In some cases, stones are inserted to improve surface adhesion.

Openings for doors and windows: Areas around doors and windows can be reinforced with wooden elements, molded adobe, or structural arches, ensuring greater stability at these vulnerable points.

Table 3 – Quality control for adobe and masonry mortar

Parameter	Adobe	Masonry Mortar
Soil component	Dry strength test (presence of clay)	Control of cracking and proportion of soil to coarse sand (1:0 to 1:3) (²)
Mold	Check for voids at the edges	—
Shrinkage	The base should not expand more than 5% (³)	Check for cracks deeper than 5 cm (³)
Compressive strength	≥ 1.2 MPa – 6 cube test samples (cross-sectional area) (⁴)	≥ 2 MPa – prism test (min. 5 samples) (⁵)
Shear strength	—	≥ 0.25 MPa – diagonal compression test on prism (min. 3 samples) (³)
Adobe/mortar ratio	Length-to-height ratio 2:1 (⁴)	—

(1) 1 MPa ≈ 10 kgf/cm2; (2) VARGAS NEUMANN ET AL (1984); (3) CARAZAS AEDO (2002); (4) SENCICO (2000); (5) HABITERRA (1995)

The ideal time to build with adobe is outside the rainy season and while the earth remains moist. Wall finishes are usually done with lime and sand plaster, which can be followed by whitewashing with waterproof additives. The roof structure is anchored with boards or logs fixed to the upper courses of bricks. On top of these, rafters, battens, and tiles are assembled. In some cases, large anchoring stones are used to lock the walls.

Like any construction technique, adobe has advantages and disadvantages. Among the advantages are ease of fabrication, drying, and stacking; good thermal insulation provided by the material's porosity; the possibility of forming elements of various shapes and sizes; complete recyclability of the material; no requirement for specialized labor and the use of simple and inexpensive artisanal equipment; application in various construction elements such as walls, arches, and domes; and abundance of raw material. On the other hand, its main disadvantages include low tensile and flexural strength compared to ceramic bricks or concrete blocks; physical effort required for artisanal production; need for large, airy drying areas; intensive water use during preparation; difficulty in obtaining standardized dimensions; dependence on mixture quality and mass hydration ("*rest*") time; unsuitability of heavy vaults in seismic zones, requiring additional structural reinforcement; and high water absorption due to material porosity.

Mechanical Strength and Quality Control of Adobe

The mechanical strength of adobe blocks must be strictly considered in structural design (Table 3). The allowable vertical compressive load should not exceed 4 kgf/cm², and construction elements must be sized based on technical quality control tests performed from material selection to the manufacturing and use of adobes in masonry.

It´s recommended to carry out tests that assess the presence of clay (dry strength test), block shape (checking for voids at edges), and shrinkage during drying (the base should not increase more than 5%). Cracks deeper than 5 cm in the blocks should also be monitored, as well as cracking control in the mortar, which should respect the soil:

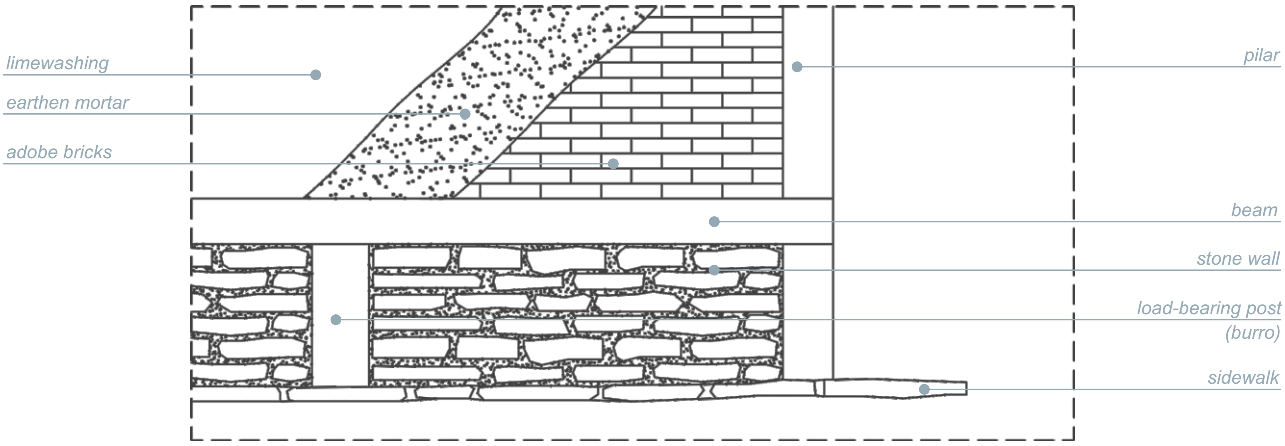


Figure 47 - Adobe layers wall

coarse sand ratio between 1:0 and 1:3.

Minimum required strength values are: ≥ 1.2 MPa for compression of adobe blocks (test with 6 cubes); ≥ 2 MPa for masonry compression (prism test, with at least 5 samples); and ≥ 0.25 MPa for shear strength (diagonal compression test in prism, with at least 3 samples). Flexural strength can be evaluated by a simple empirical test: an adobe block is supported at both ends on other units (with 2 cm support) and must hold for two minutes the weight of a 70 kg person.

To ensure the safety and durability of adobe constructions, it´s important to follow complementary structural guidelines: Avoid long walls without lateral support or bracing elements; Distribute doors and windows symmetrically, away from wall corners; Use tie beams at the top of walls for containment and stability; Adopt floor plans with rectangular, regular, and symmetrical geometries, which favor load uniformity.

Two additional strategies can be applied to improve structural performance: Structural reinforcement with ties, anchors, or more rigid complementary materials; Soil stabilization with additives such as lime, which increase particle cohesion and reduce material porosity.

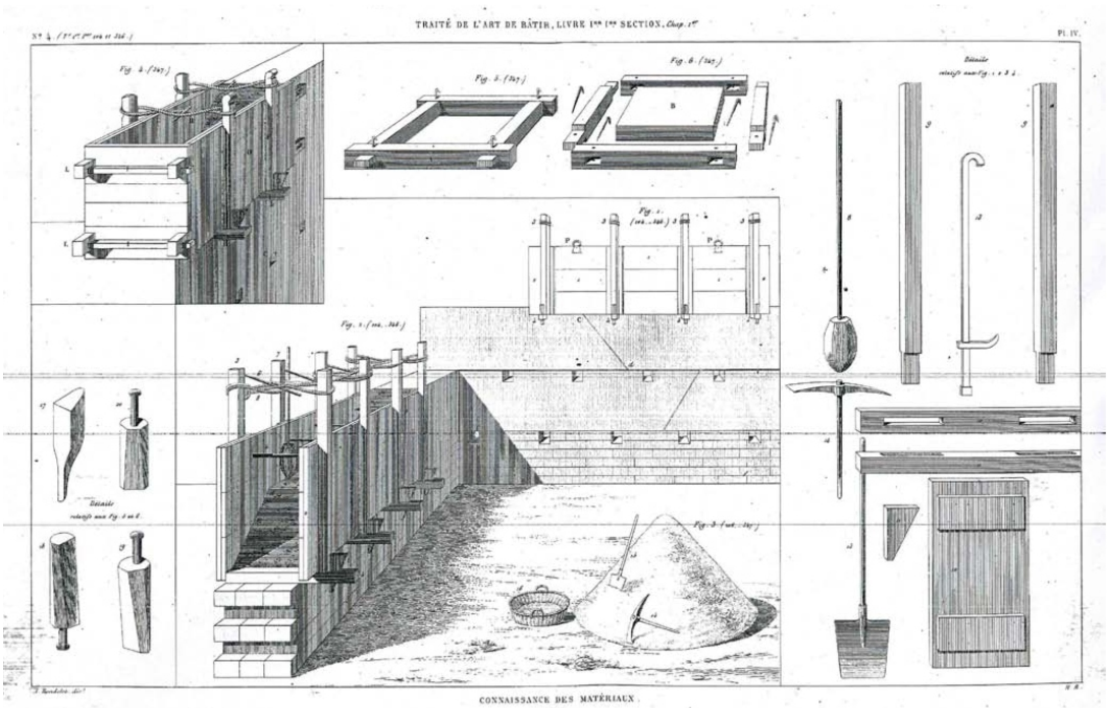


Figure 48 – Rammed Earth Tools.[Source: Rondelet, 1802. Connaissance des Matériaux. Pisé.]

2.4.2. Construction technique using rammed earth

Due to its thickness, rammed earth is primarily used for exterior walls that serve three simultaneous functions: *Structural,* supporting the building's weight and resisting environmental forces; *Thermal,* its thermal mass reduces heat exchange, keeping the interior more comfortable; *Acoustic,* the density of the material dampens external sounds.

Soil Preparation

The soil used in this technique is very important, as not all earth is suitable for rammed earth construction. Highly clayey soils tend to crack as they dry, while overly sandy soils lack cohesion. The ideal mix contains between 15% and 30% clay (or 10% to 20%, depending on the source). To balance out unsuitable soil, for clayey soils add sand, fine gravel, and occasionally vegetable fibers such as straw. For the sandy soils, add clay or binders such as lime. The soil must be thoroughly broken down and homogenized, manually and using shredders.

Tools

The main tools for rammed earth construction includes the form and the compactor. A soil breaker can also be used to break up clumps of earth. The forms need to be sturdy yet lightweight and easy to assemble and disassemble to speed up the work. There are box-type forms and forms with fixed or movable side panels, which determine the method for building the wall. The material of the form affects the surface finish, with wood producing a rougher texture. Forms are made from standardized boards, secured with wooden pieces, and tied with liana or leather straps. The manual compactor should be firm but lightweight since compaction depends on the frequency of strikes rather than the weight.

Construction Stages

Excavation of Foundations: The soil removed from the foundation trenches can be reused in construction. The base is filled with local stone masonry, laid using lime and sand mortar, clay, or even dry stone, forming a base between 0.5 and 1 meter high, and wider than the wall itself. A waterproof layer is placed between the base and the rammed earth to prevent rising damp and improve structural durability.
Assembly and Filling of Molds: Wooden molds form an open box at the top and bottom. These are set on the stone base, held in place by wood pieces and braced with wedges, ropes, or bars. Earth is then inserted in layers about 10 cm thick, forming wall sections between 1 and 3 meters in length.
Compaction of Earth: Each layer is vigorously compacted using mallets or rammers, adding water as needed until a dense, homogeneous, void-free mass is achieved.
Laying of Wall Courses: After the initial drying of a compacted layer, the molds are moved to continue with the next section. Courses should be staggered for greater overall stability, especially at corners. Sometimes stones are inserted to improve the adherence of the finish.
Joint Construction: Vertical and horizontal joints can be filled with bricks, stones, or ceramic fragments bound with mortar. These joints enhance the structure's stability and are made with materials stronger than the rammed earth. In angled joints, the courses are laid in opposing directions for better locking.
Corner Reinforcement: The corners of the building require additional reinforcement. This can be done with overlapping blocks in a crossed pattern, embedded long stones, wooden posts, or solid bricks.
Opening of Voids: Door and window openings may either be left out during construction or carved out afterward, being framed with bricks or wood. The soil around these openings should be stabilized to prevent cracking.

Rammed earth construction is ideally started in spring, when the earth still retains sufficient moisture for molding and compaction. In the following months, especially during summer, the intense heat acts as a natural “dryer” for the walls, promoting the gradual hardening of the material. The plastering, done with lime and sand mortar, should only occur in the following spring, along with limewashing, after the walls have undergone a full drying and

Construction Stages

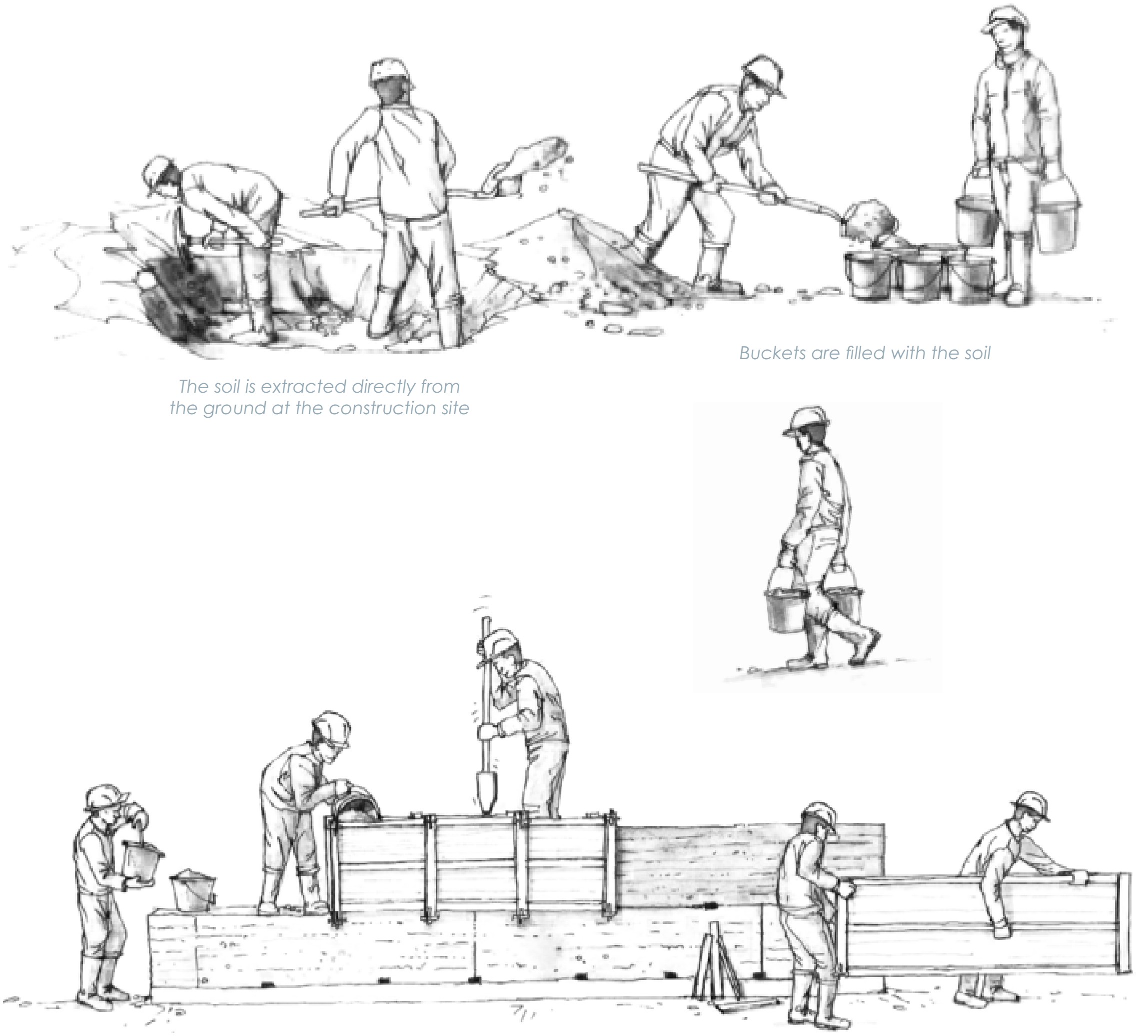


Figure 49 – Stages of Rammed Earth Construction. [Source: A. Misse, Il processo della costruzione in pisé. In: R. Anger, L. Fontane. Bâtir en terre. Du grain de sable à l'architecture. Paris: Belin Editions, 2009, pp. 28–29.]

stabilization cycle. The process begins from the interior, ensuring the exterior finish is only applied after the inner parts have completely dried to avoid moisture being trapped inside the walls.

Mechanical Strength and Quality Control of Rammed Earth

In some thicker rammed earth structures, walls can resist water even without limewashing, due to the use of natural additives that increase their water resistance. The dimensions of rammed earth walls vary according to the building's height, ranging from 40 to 50 centimeters for single-story structures and from 70 to 90 centimeters for the ground floor of two-story buildings.

Beyond the thermal and acoustic benefits associated with the mass and thickness of the walls, structural safety is a key aspect of this construction system. The mechanical strength of rammed earth walls depends on factors such as the continuity and symmetry of the architectural design, balanced load distribution, the absence of critical stress points, material homogeneity, and sufficient rigidity. A conservative estimate for vertical compressive strength is about 3 kgf/cm².

When it comes to horizontal forces, especially in regions like the interior of Brazil where seismic activity is absent, the main concerns are structural thrusts caused by pitched roofs or vaulted ceilings (Figure 50), which may lead to cracking, bulging, or even wall collapse. To improve lateral stability, builders apply reinforcement solutions such as strategically placed anchoring stones or tensioned wooden ties embedded into the structure.

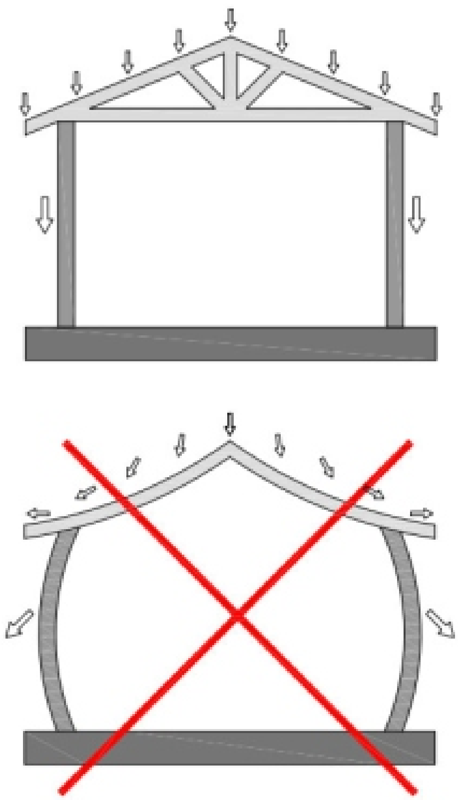


Figure 50 – Load transmission in earthen structures [Source: Image from the book "Técnicas de construção com terra," edited by Célia Neves and Obede Borges Faria. Bauru: FEB-UNESP / PROTERRA, 2011.]

Architectural design must always respond to the properties of the building material and the construction system used. A structure built from raw stone, for example, naturally demands a different design than one using stretched fabric membranes. In rammed earth construction, the use of earth as the primary material and the monolithic nature of the system must guide the design process.

Rammed earth is defined by

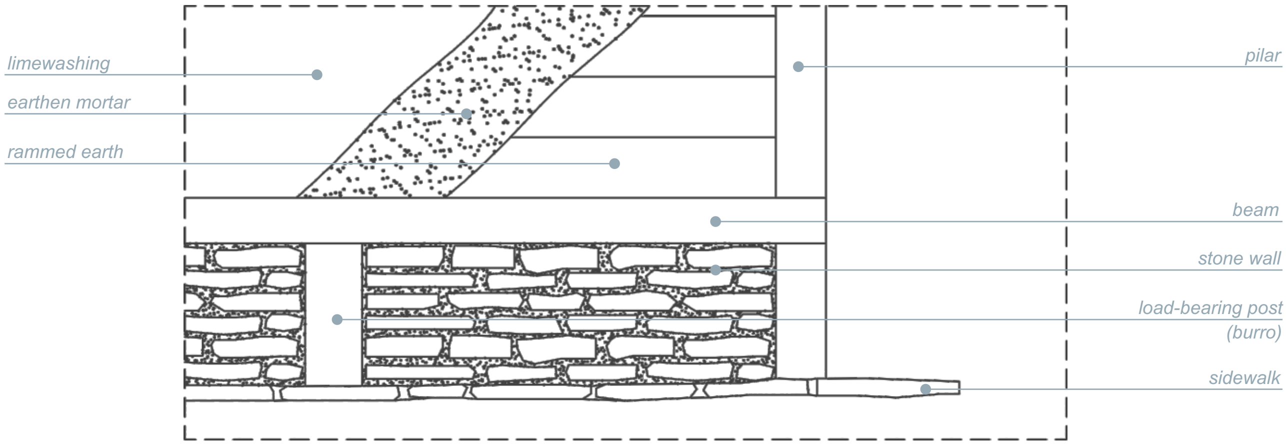


Figure 51- Rammed earth layers wall

its *in loco* molded structure, with high compressive strength but low tensile strength. As such, design solutions must address how forces flow through the structure to avoid bending, twisting, or shearing stresses on the walls. Loads should act perpendicularly to the wall surface to maintain stability, and horizontal forces should be avoided.

Protective architectural features are essential to preserve the integrity of rammed earth walls, including wide eaves, proper drainage systems, impermeable foundations, and preventing direct contact between the wall base and the ground. In areas with high rainfall, surface waterproofing treatments may also be necessary.

Additional infrastructure such as sidewalks and drains helps keep water away from the walls.An important design consideration involves the formwork used in rammed earth construction. The dimensions of the forms must correspond with the modulation of the building, and flexibility in form design can improve construction efficiency. Since formwork represents a significant cost and is repeatedly assembled and disassembled, optimizing its design is crucial for productivity. Architectural planning and formwork design must be approached together.

Rammed earth presents both advantages and challenges. From a sustainability perspective, it addresses many issues in modern construction. The building sector is responsible for a significant share of environmental impact, through high energy use, natural resource extraction, and the generation of solid waste. Rammed earth responds positively to these concerns by requiring low energy for production, often eliminating the need for raw material transport, and offering recyclability, once demolished, the material can return almost entirely to its original soil state. It also provides excellent thermal inertia and humidity regulation, reducing or eliminating the need for artificial climate control.

In earthquake-prone areas,

however, appropriate seismic-resistant design is required, as rammed earth walls have low resistance to tension and bending. Stability in these cases is ensured by designing suitable wall dimensions, incorporating reinforcements like buttresses, or combining with other structural systems. In the fields of preservation and restoration, water remains a major threat to earthen buildings. Despite the apparent simplicity of this building system, restoration of earthen structures is technically challenging. Due to the diverse physical and chemical behavior of its clay minerals, demands careful study and methodical approaches for interventions in architectural heritage built with earth.

2.4.3. Wattle and daub construction technique

Wattle and daub is a vernacular construction technique widely used as a wall infill system, that is, for closing wall sections without a direct structural function. Nevertheless, in many cases, especially in rural areas or in simple buildings, these infill walls ended up performing semi-structural roles, contributing partial stability to the structure.In the Brazilian Midwest, this construction method was adopted due to its simplicity and speed, offering an efficient solution for a region with limited building techniques.

Soil Preparation

The clay used in wattle and daub must be carefully selected. Ideally, a clay-sandy soil should be used, that is, a balanced mix of clay (responsible for cohesion) and sand (which reduces shrinkage and prevents cracking). The proper ratio varies, but it's common to use soil with about 20% to 30% clay, complemented by coarse sand. To this mixture, chopped plant fibers, such as rice or wheat straw, or fibers from Babaçu and Buriti, are added. These fibers help reduce shrinkage during drying and increase tensile strength. The earth is mixed with water until it reaches a plastic and sticky consistency, firm enough to adhere to the wooden lattice but malleable enough to be shaped by hand.

Construction Stages

Building the Framework: The technique begins with creating a vertical and horizontal wooden framework that will support the clay to be applied later. The process starts with the installation of vertical poles, usually round, with or without bark, placed between the base beams and the upper beams of the structure. These vertical posts typically range from 1 to 1.5 cm in diameter, depending on the desired thickness of the wall, usually between 15 and 20 cm. Between these vertical elements, thinner horizontal slats are attached. These vertical and horizontal elements are made of Taquara or other flexible and durable materials. The binding of the framework elements is carried

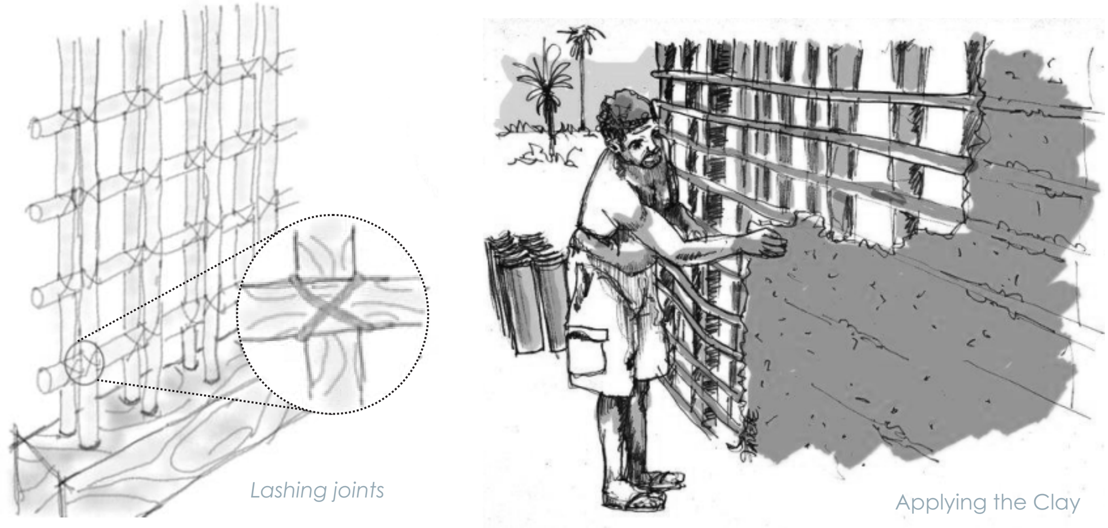


Figure 52 – Wattle and daub construction process [Source: Images from the lecture "Arquitetura Colonial Brasileira – Técnicas Construtivas," course: Theory, History and Criticism of Architecture and Urbanism II – TH2, PUC Goiás.]

out using local natural materials, commonly known as natural fibers, the most common being Cipó-titica, as well as leather, or even nails, depending on available resources. The horizontal slats may be arranged in an alternating pattern or paired on both sides of the wall, creating a three-dimensional framework that allows the clay to adhere effectively. The spacing between the vertical posts is roughly one handspan (about 20 cm), and the spacing between the horizontal slats is typically even smaller, forming a tight mesh.

Applying the Clay: With the framework assembled and the clay mixture prepared, the "Slap" Technique started by applying the material manually onto the wooden structure. This process is done without tools, only with the hands, which slap or pound the clay forcefully against the framework, filling the spaces and ensuring strong adhesion. This is why the method is sometimes called "slap" or "pounding." The application is done on both sides of the wall, layer by layer, ensuring complete filling of the framework. It´s important to allow some drying time between thicker layers to prevent cracking or detachment.

Drying: After the clay is applied, the walls are left to dry naturally, protected from rain and excessive direct sunlight. Drying time can vary depending on the climate, taking anywhere from a few weeks to a month. Slow and even drying is critical to maintaining the structural integrity of the wall.

Once the wall is dry, a plaster coat, usually made of lime and sand, is applied to provide waterproofing and a smoother finish. Afterward, the wall is whitewashed, a process that involves applying a mixture of hydrated lime and water, which helps protect the wall from moisture, insects, and enhances its

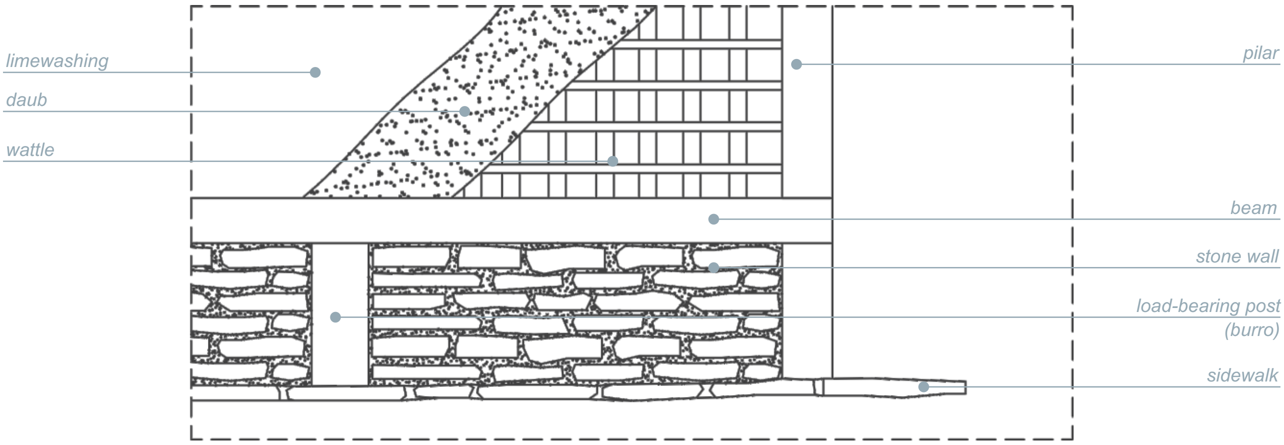


Figure 53 - Wattle and Daub layers wall

aesthetic appearance. For greater durability, the whitewash may be enriched with natural additives such as fish oil, animal fat, or beeswax, which improve the impermeability of the plaster.

Wattle and Daub represents a wall infill technique deeply embedded in Brazilian construction traditions, especially during the colonial period and in rural regions. Its effectiveness depends on careful material selection, the proper construction of the framework, and correct application of the clay. Despite its simplicity, this system provides excellent thermal and acoustic comfort. In the context of 18th-century Midwest Brazil, techniques such as wattle and daub were widely used in the construction of residences in both rural and urban areas. In some cases, it´s even possible to find two or more construction techniques combined within the same house.

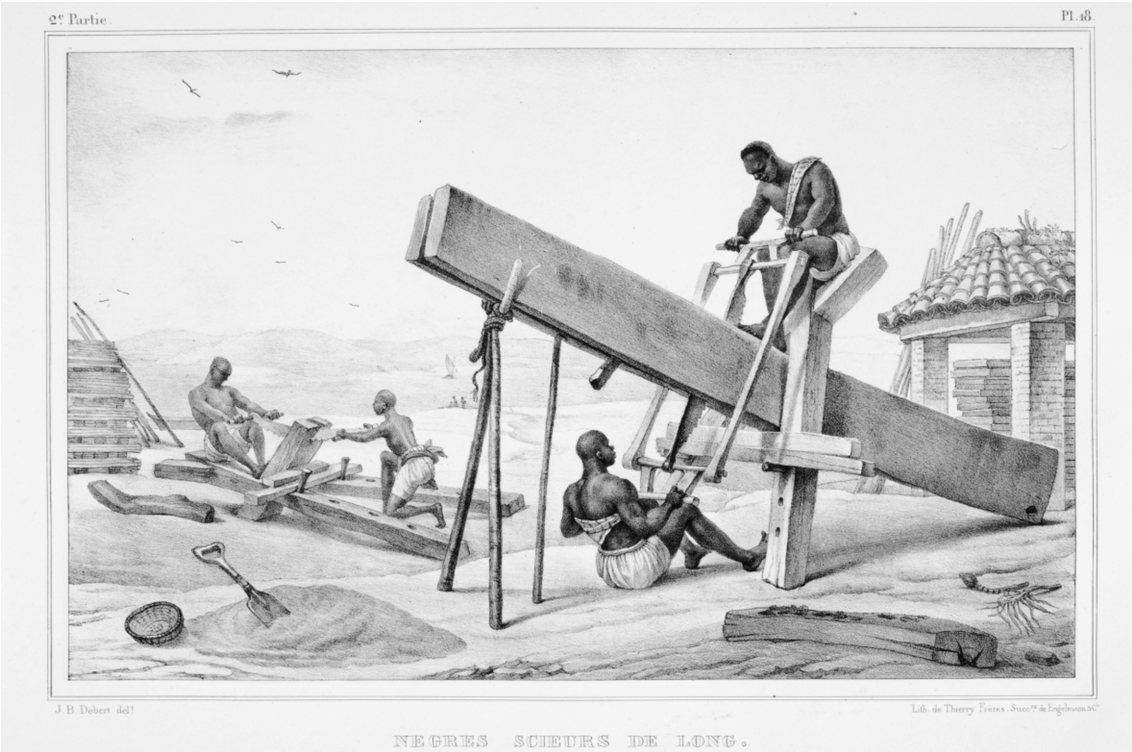


Figure 54 – Carpentry work in 18th-century Brazil. [Source: DEBRET, Jean Baptiste, 1768-1848 . Paris: Firmin Didot Frères, 1835.]

2.4.4. Wooden structure and other wooden elements

In colonial Brazilian residences during the 18th century, the structural stability of buildings was ensured by an integrated wooden framework composed of a system of posts and beams that continuously supported the roof structure and "tied" the walls together. This "cage" was one of the fundamental structural bases of colonial construction, consisting of timber posts and beams that, together with the load-bearing walls, divided and stabilized the buildings.

In the context of the roof, which was also wooden, outriggers and eaves worked together as part of a reticulated (lattice-like) structure that ensured stability and cohesion between the roof and the rest of the building, while protecting the walls and ensuring proper drainage of rainwater. In traditional roof carpentry, joinery techniques are large used in structural timber framing, an example is the half-lap splice, or simple splice, where portions of each timber are removed so that they overlap with interlocking surfaces. These joints may be reinforced with wooden pegs or mechanical fasteners, increasing the strength of the connection without relying on glue. Another example is when long rafters need to be joined end-to-end, for instance, to extend a rafter beyond available timber length, the joint most commonly used is the scarf joint. This method is especially prevalent in practical and vernacular carpentry.

These structural elements were crafted from carefully selected wood species native to the Midwest of Brazil. The choice of woods such as angico, peroba, aroeira, and ipê-amarelo was crucial, as these species presented high densities and mechanical resistance, aligning with strict technical standards, and offered robust performance in compression and flexion, making them ideal for beams and rafters in demanding structural systems. After wood selection, each piece was meticulously crafted with precise tools to joinery and tight-fitting surfaces.

Tools

Carpenters worked exclusively with manual tools, which required skill, strength, and care. Among the most important were hand saws for cutting timber into planks, and planes used to smooth surfaces. Chisels and gouges allowed them to carve and shape wood, especially for complex joints and decorative work. Hammers and wooden mallets were essential for driving parts together or guiding tools. Measurement and alignment were ensured by tools like the square, marking gauge, compass, plumb line, and water level. These instruments, though simple, were precise and vital for achieving both structural soundness and aesthetic harmony.

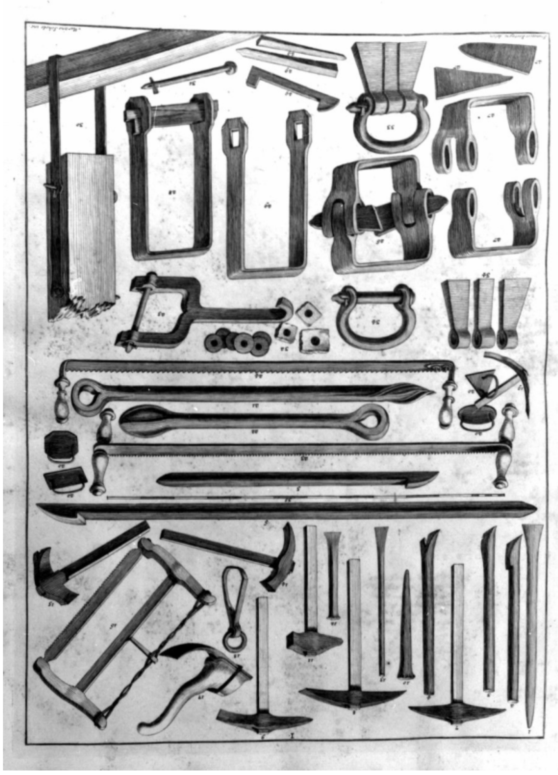


Figure 55 – Carpenter's tools in early 18th-century [Source: UNKNOWN ARTIST. Bridgeman Images.]

Construction Stages

Selection and preparation of the wood: The carpentry process began with the selection and preparation of the wood. Carpenters choose species that are durable and easy to work. After cut the logs, usually the bark is taken away before the drying phase. Then the logs were left to dry naturally, many times for some months, to reduce moisture and to avoid warping or cracking during construction.
Sawing of the wood: After drying, the wood underwent the stage of transformation. This involved manually sawing the logs into boards, beams, and planks suitable for structural or decorative use. This was a physically demanding phase,

Figure 56 – Restoration of the Roof of the Matriz Church in Pirenópolis in 2002. [Source: CAVALCANTE, Silvio; CAVALCANTE, Neusa. Barro, madeira e pedra: patrimônios de Pirenópolis. 2nd ed. Brasília: IPHAN, 2019.]

often carried out in teams to manage the labor-intensive work.

Marking and measuring: Once the timber was processed, carpenters moved to measuring and marking. Using compasses, squares, and gauges, they laid out the dimensions and alignment of each piece with extreme care. Accuracy in this step was critical, especially for complex joints that required a perfect fit without the use of nails or glue.

Cutting and carving: The next stage involved cutting and joinery. Here, the carpenter shaped the wood using chisels, gouges, and saws to create joints such as mortise and tenon, dovetails. These traditional joinery methods were remarkably strong and allowed for the assembly of large wooden structures without metal fasteners.

Assembly: With the parts prepared, the structure could then be assembled. Roofs, floors, stairs, doors, and windows were fitted together with precision. In more elaborate buildings,the carpenter's role extended to crafting ornamental pieces, often integrating with other artisans like sculptors and painters.

Finishing and detailing: the finishing stage brought refinement to the work. Surfaces were smoothed, edges detailed, and elements sometimes polished, painted, or varnished. In sacred or elite architecture, wood was often intricately carved with baroque motifs, showcasing the artistic dimension of the craft.

Carpenters employed highly sophisticated techniques to join the wooden frame elements. One such method was the mortise and tenon joint, which involved carving a cavity (mortise) in one timber and shaping a projection (tenon) on

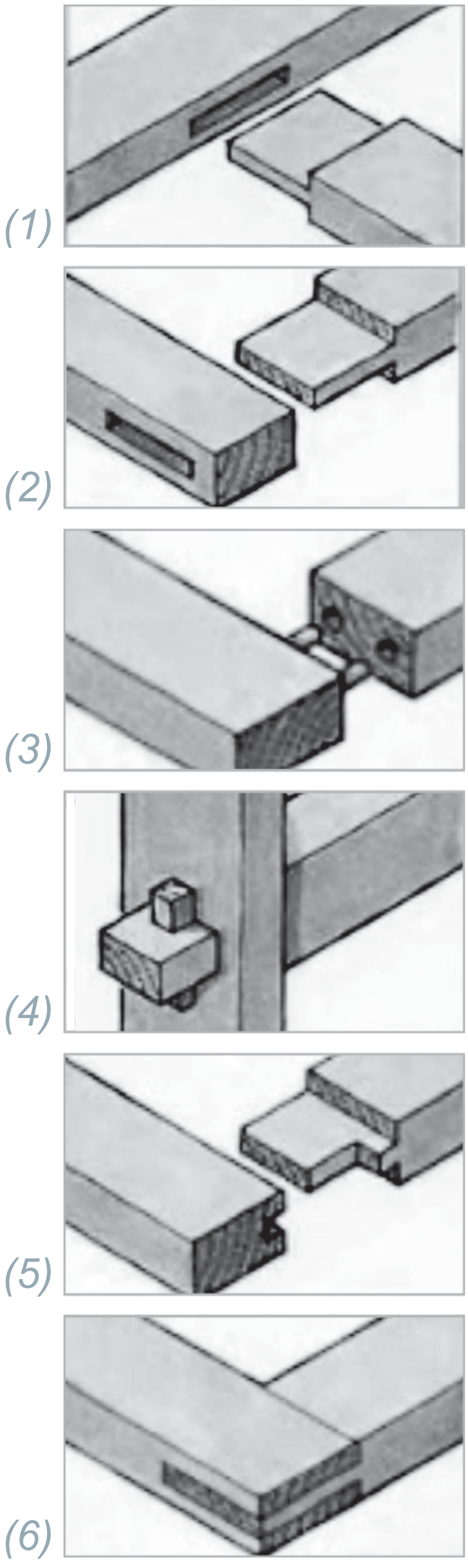


Figure 57 – Types of mortise and tenon joints [Source: Image available at: https://1.bp.blogspot.com]

another to fit snugly into it. This joint could be reinforced with wooden pegs inserted into pre-drilled holes. Several types of mortises and tenon joints were widely used in colonial Brazil:

1. *Blind mortise and tenon*
2. *Through mortise and tenon*
3. *Pegged mortise and tenon*
4. *Wedged through mortise and tenon*
5. *Haunched mortise and tenon*
6. *Open mortise and tenon*

The precise cutting of joints, performed with chisels, fine-toothed saws, and other manual tools, was essential to ensure firm, gap-free fittings. This allowed for even load distribution and increased resistance to both compression and flexion. These techniques were used to assemble structural systems that integrated, in a continuous way, the base of posts and beams with the roof framework, including trusses, battens, rafters and eaves.

Figure 58 – Roofs in a colonial city in Brazil [Source: Photo available at Freeimages.com]

2.4.5. Roof tiles

In colonial Brazil in the 18th century, roof tiles were produced in pottery workshops, small ceramic workshops located near clay deposits and wood sources, where teams of potters, mostly enslaved individuals of African descent, carried out a standardized artisanal process. The clay was extracted, broken down, and prepared with water (sometimes enriched with plant fibers) until it reached the desired plasticity. Then, the mass was molded into wooden forms to create the cover and channel type tiles. After sun drying, the pieces were fired in wood-fired kilns, which gave them resistance and the characteristic reddish hue.

The main raw material was clay, extracted from deposits near the pottery workshops and stored in tanks or pits, where it was softened with water until it reached the ideal plasticity for molding. In colonial pottery workshops, the potter's craft was carried out by male teams, often composed of enslaved individuals, highlighting the division of ceramic labor during the period. Although indigenous techniques for firing clay were already known, the Portuguese colonizers, with the help of the Jesuits, introduced the use of wheels and potter's wheels, systematizing the process into mass production.

Molding: The clay was placed into wooden molds with the concave shape typical of the cover and channel, also called colonial tiles. Records and illustrations from the time clearly show the use of wooden molds to shape the pieces.
Drying: After molding, the tiles were

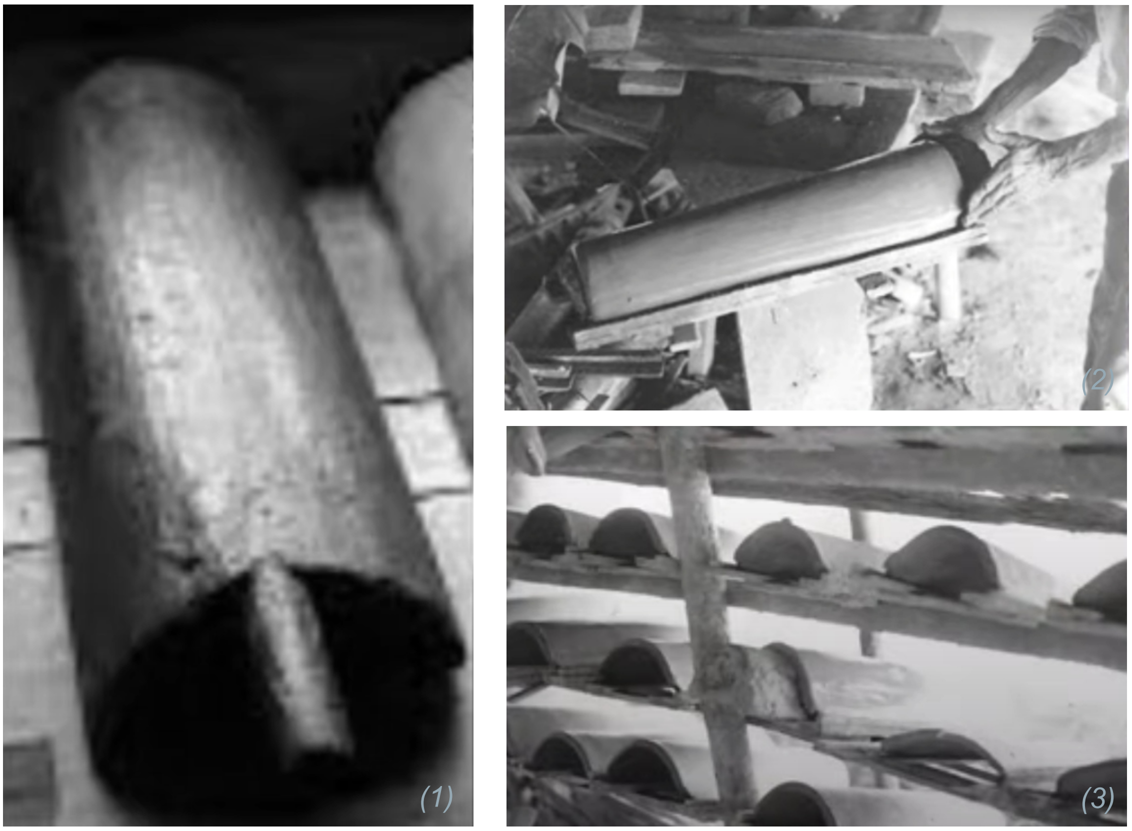


Figure 59 – (1) Wooden mold, (2) Manual shaping process, (3) Tile drying [Source: Images from the video "MITO ou VERDADE: As Telhas Antigas Eram Feitas na Coxa?" Research and script by João Marcos Moisés. YouTube channel: @conceitorural.]

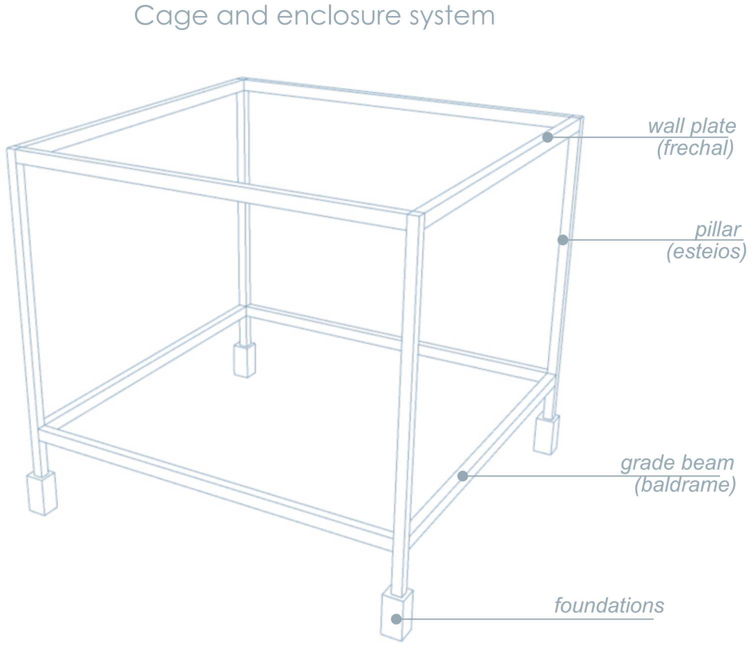
placed in drying yards or drying sheds, where they were left to dry under the sun and wind for several days. This ensured the gradual removal of water and prevented cracks during firing.

Firing: The dried pieces were loaded into chapel kilns, which were masonry kilns shaped like chapels and mainly fueled by wood. The firing process would last for days until the ceramics were fully hardened. In larger pottery workshops, there were kilns with the capacity to fire thousands of units at once.

The process of producing tiles in 18th-century colonial Brazil reflects a knowledge of European techniques, resulting in a highly specialized artisanal method. The use of earth, the work of teams of potters, and the introduction of new tools and methods by Portuguese colonizers were fundamental to producing high-quality tiles, characteristic of colonial architecture. The standardization of production and the evolution of molding, drying, and firing techniques not only ensured the strength and durability of the tiles. This artisanal process reflects the importance of the beginning of ceramics in colonial Brazil and the skill of the workers who, despite the adversities, played an essential role in the development of the infrastructure of the time.

2.5. The Structure of the House and its Elements[9]

2.5.1. Structural components



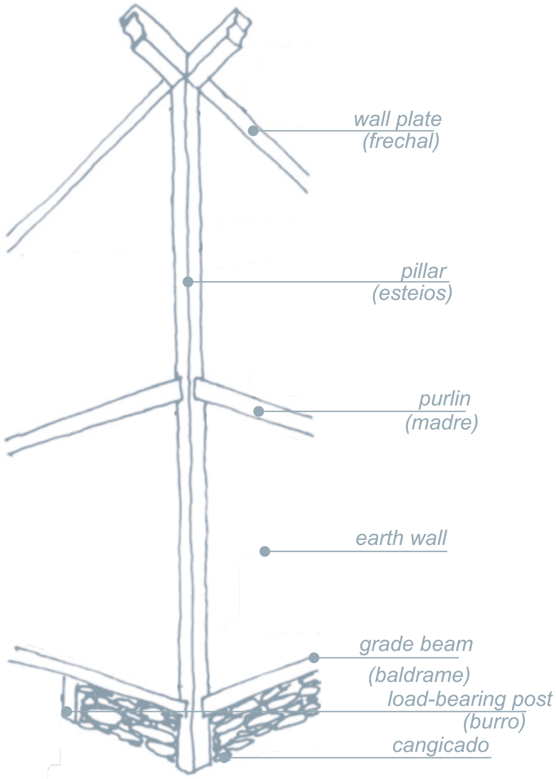


Figure 60 – Structure volume. [Source: OLENDER (2006).]

The main structures in colonial buildings were made in wood, using the typical *"cage and enclosure"* system. It´s formed by vertical elements called *esteios* (pillars), which connect to horizontal pieces known as *baldrames, madres, and frechais* (beams), depending of the position they have in the building. The walls are part of the secondary structure and are supported on the beam. To prevent infiltration problems, the baldrames were usually set on a small masonry base in stone (*cangicado*), which stops the rising moisture from the soil reaching the wood. Underground, has the foundations located at the ends of the pillars.

[9] *All the information in this paragraph has been drawn from:* VASCONCELLOS(1979); OLENDER (2006); CALHEIRO BAURU(2017)

Foundation

During the colonial period in Brazil, particularly in the Midwest region, architectural practices were deeply influenced by the need to adapt to local materials, climatic conditions, and available labor. This led to the development of unique foundation techniques that reflect the ingenuity and resourcefulness of colonial builders.

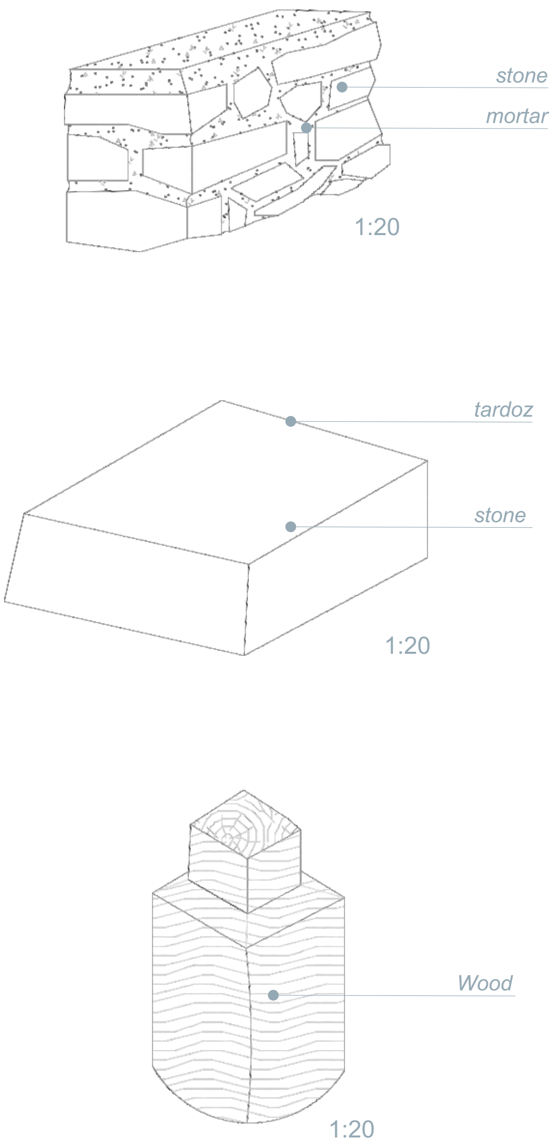


Figure 61– Types of foundation.

Cangicado

The *cangicado* is also a type of foundation technique characterized by the use of stone walls made from stones of varying sizes, bound together with a mortar of clay and lime. The resulting foundation are typically thick and robust, providing stability to the structures built upon them. The *cangicado* was particularly prevalent in the Midwest, where the availability of stone resources facilitated its use in constructing durable foundations.

Ensilharia

The *ensilharia* involves the use of large, hewn stones arranged with precision and bound together with lime-based mortar. This method was more labor-intensive and required skilled craftsmanship. The *tardoz* side of these stones faced the interior of the building, while the exterior side, often more polished, was visible.

Nabo

The *nabo* foundation in this context refers to the buried portion of the wooden posts used in the Wattle and Daub construction method. These posts, typically made from durable hardwoods like aroeira, were treated with fire to prevent decay and insect infestation. The *nabo* was buried to a depth of 2 to 4 meters, providing a stable base for the structure. This technique was widely used in the Midwest, where timber resources were abundant, allowing for the construction of elevated houses that were well-suited to the region's humid climate

In colonial Brazilian residential architecture, the connection between foundations and pillars is essential for stability and durability of constructions. This integration between them is crucial for resistance and adaptation to local weather conditions, characteristics of colonial architecture.

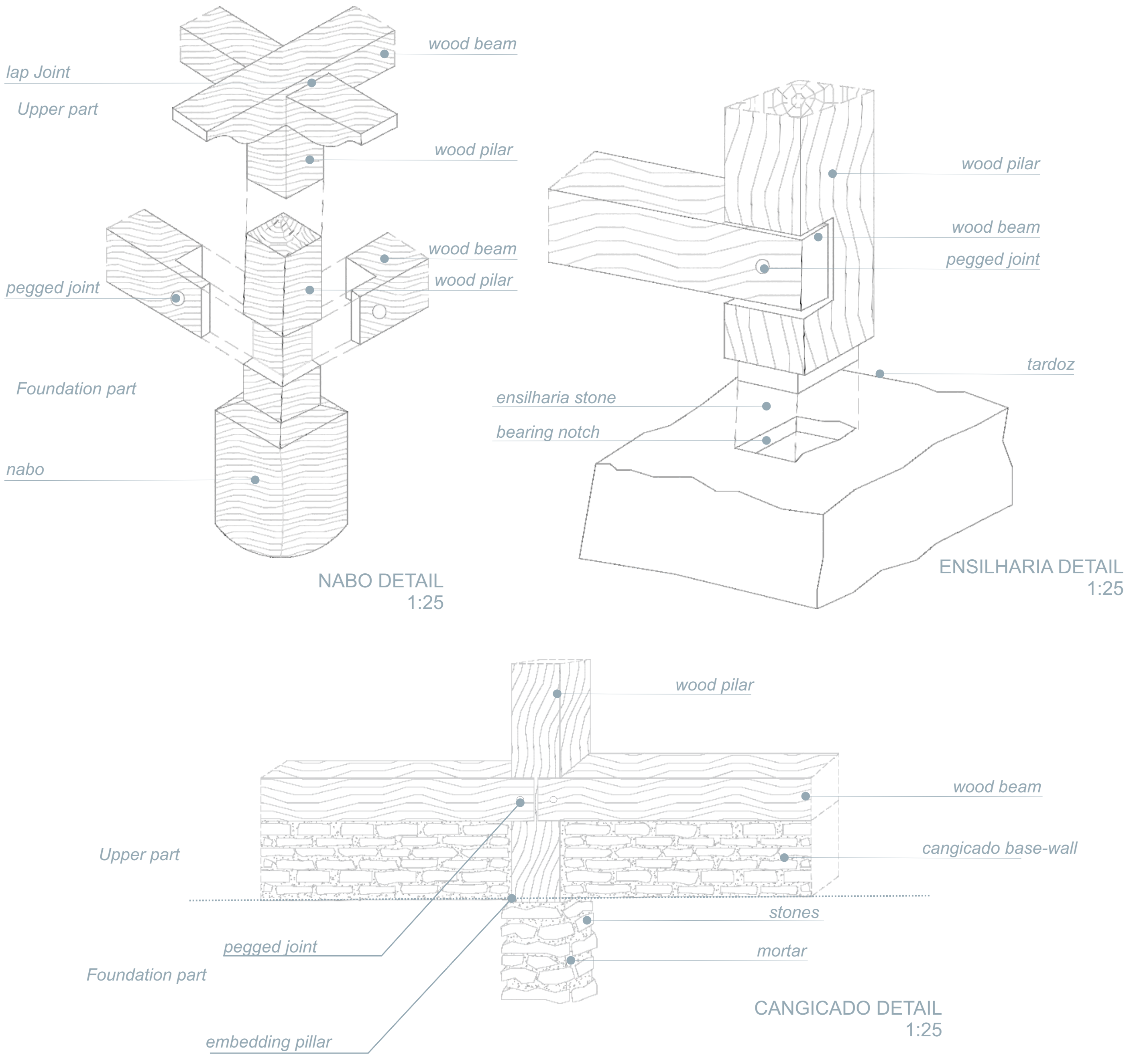


Figure 62 – Different types of connection between foundation and structure.

Wattle and daub wall

The Wattle and daub wall structure, comprises a framework of vertical wooden posts fixed into a wooden beam known as grade beam or *baldrames*, this prevent the direct contact with moisture. These vertical elements, known as *esteios*, are interlaced with horizontal and vertical wattles, typically made of bamboo and tied with liana, forming a perforated panel. This lattice provides stability to the structure.

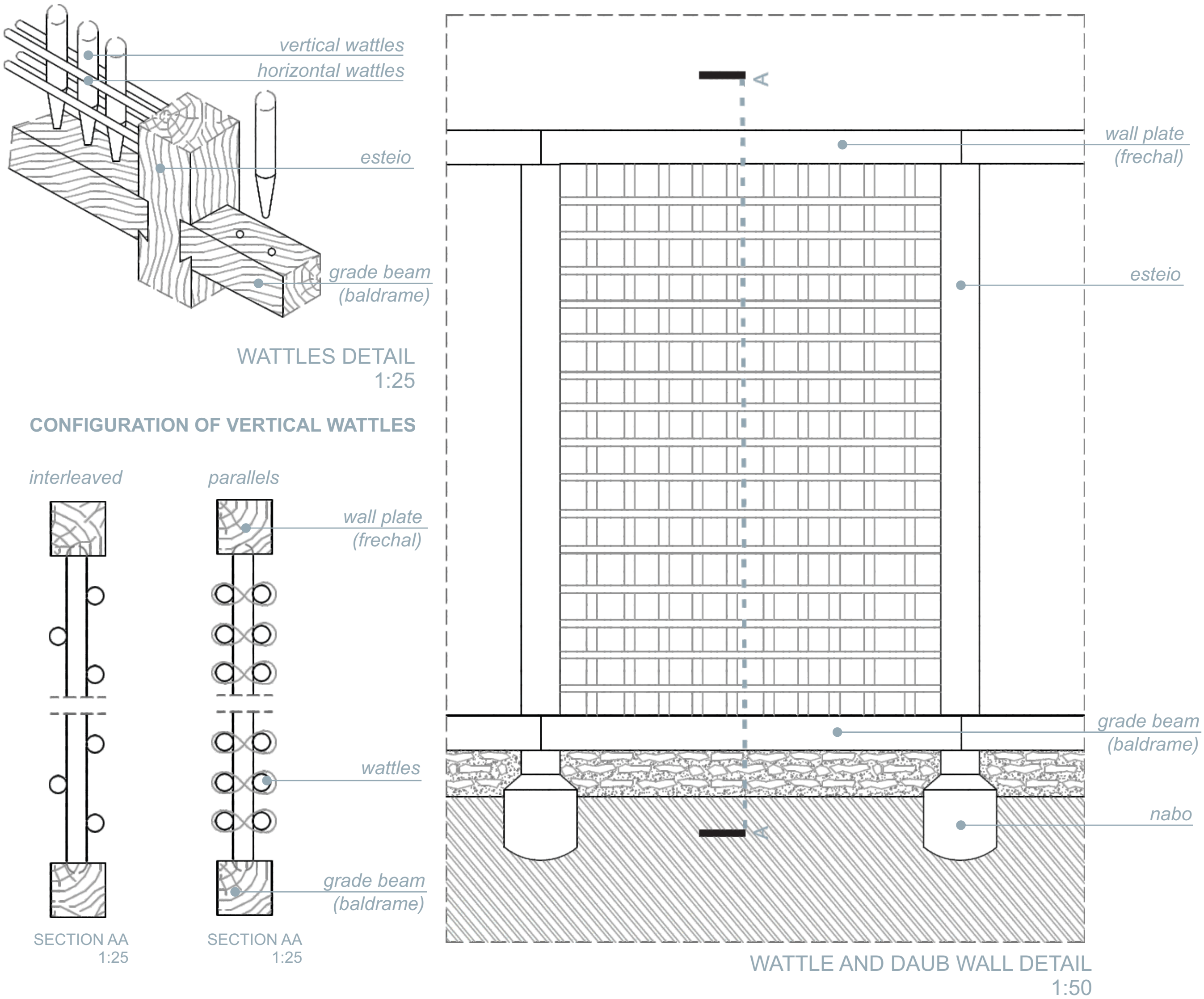
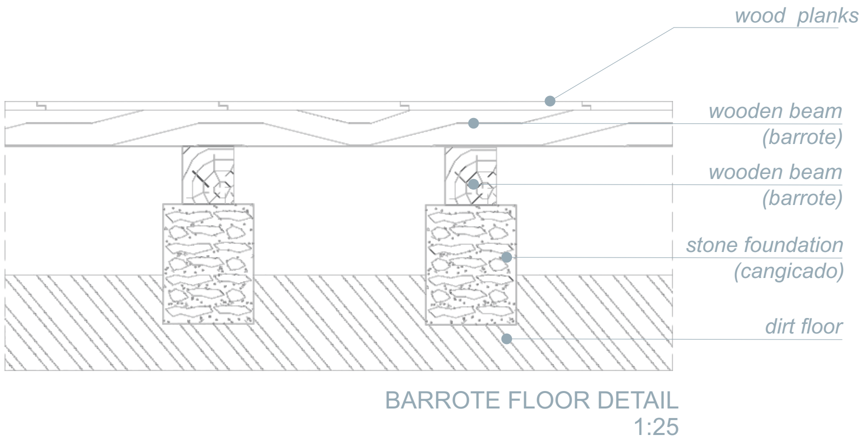


Figure 63 – Wattle and daub wall details

2.5.2. Floor

In colonial Brazilian architecture particularly in Midwest, floors played crucial role in adapting homes to regions climatic, social, and cultural conditions. Elevated wooden floors such as those made with wooden beams (*barrotes*), provided thermal and acoustic insulation, protecting inhabitants from soil moisture, and insects. In kitchen external areas, and backyards, earth floors (*mezanela*) was common offering durability, and easy maintenance. The floors not only meet practical needs but also reflected social status of residents. As dirt floors were common, especially in rural house.



Barrote

The *barrote* is a wooden piece with a square cross-section, typically measuring 15 to 30 cm on each side, serving as a supporting beam for elevated flooring. The term *barrote* also refers to the type of flooring used. Above these beams, wide wooden planks were laid to form the floor, secured by joints. This system, allowed ventilation of the space beneath the floor, preventing moisture buildup and the proliferation of insects, while also providing thermal and acoustic comfort.

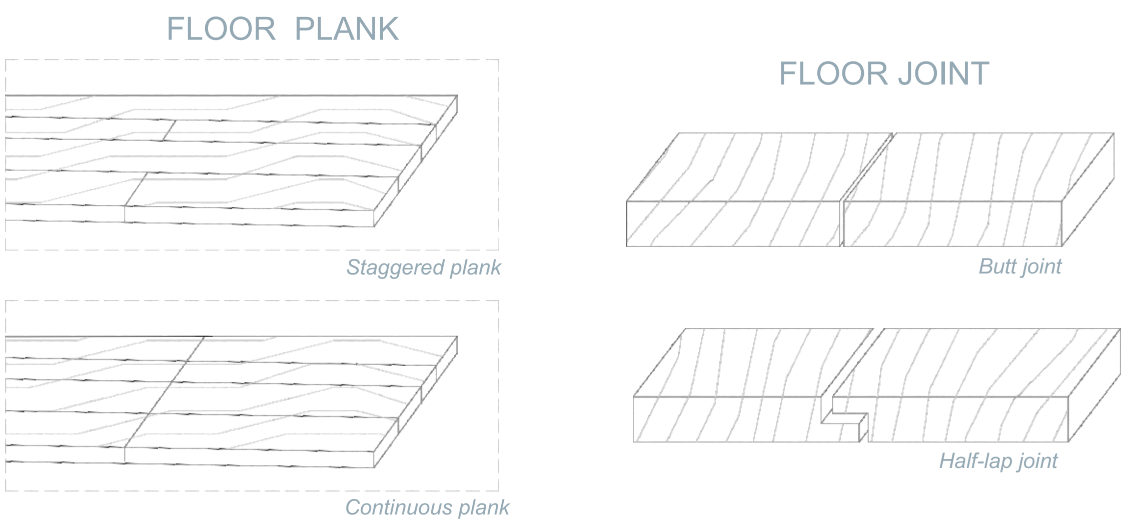


Figure 64 – Floor specification

2.5.3. Openings

The openings represent connection between interior and exterior, doors and windows were fundamental elements in Brazil's Midwest both functionally and aesthetically. Reflecting the simple construction techniques of the period, and the use of local materials especially wood. Openings are divided into doors and windows, can be classified according to category shape and finish. The openings it's composed of four elements: lintels (*vergas*) at top, jambs (*ombreiras*) on sides and the sills (*peitoris or soleiras*) in the bottom.

The three most common lintel formats during this period was, the straight lintel consisting of a simple horizontal wooden piece supported directly on pillars or side walls of opening, it was the most common type, due to simplicity and easy execution. The full arch lintel, had a perfect semicircular curvature forming a 180-degree arch used for aesthetic and structural reasons, allowing better distribution of loads over opening. And segmental arch lintel was characterized by a gentler curvature than full arch with center of arch situated below line of straight lintel, combining structural and aesthetic advantages, being common in larger or important buildings.

Windows can be considered in the following types. Sill windows (*janela de peitoril*) the most common, where the open span in wall plane has full sill. They appear in wattle and daub, adobe walls and more rarely in rammed earth walls. And cut-through windows (*janela rasgada*) which are windows opened in massive walls of great thickness, so that joinery it's placed on external face of walls, their frames thinner than walls. Doors also can be placed in solid or cut-through walls. The joinery of upper floors facing street, can also be balconied. That is have floor-to-ceiling opening, divided between with inset parapet (*entalado*) and with projecting parapet (*sacado*).

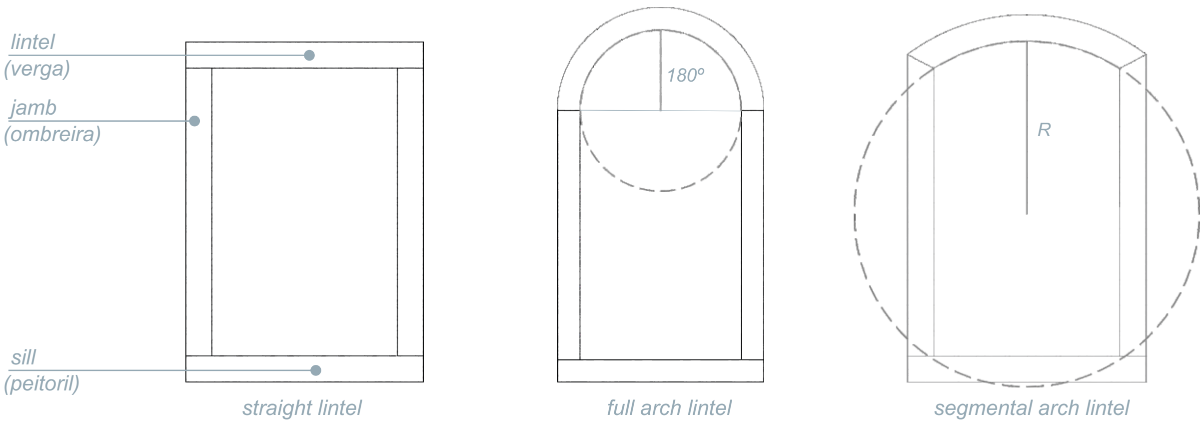


Figure 65 – Types of windows

Another division is made by type of opening, and number of leaves. The most common are single-leaf hinged joinery, double-leaf hinged joinery in French style (with shutters) and double-leaf hinged joinery in French style gelosia. The Italian word "*gelosia*" means jealousy, it refers to lattice element that allowed women observe street movements, without being seen and while being protected at the home.The joinery it's predominantly made of solid wood without incorporation of glass, which was rare and expensive material at time.

They could have smooth, or paneled leaves depending on desired level of elaboration. The hardware was made of iron and could feature simple or complex mechanism depending on owners financial availability. The designs also vary but always in arabesques.

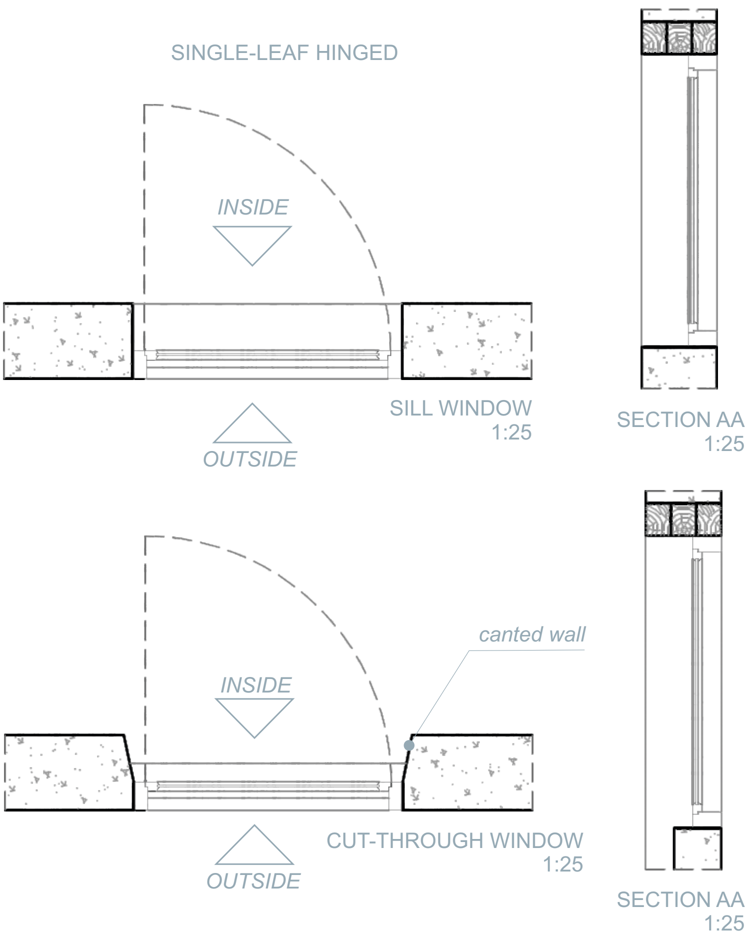


Figure 66 – Detail of single-leaf hinged

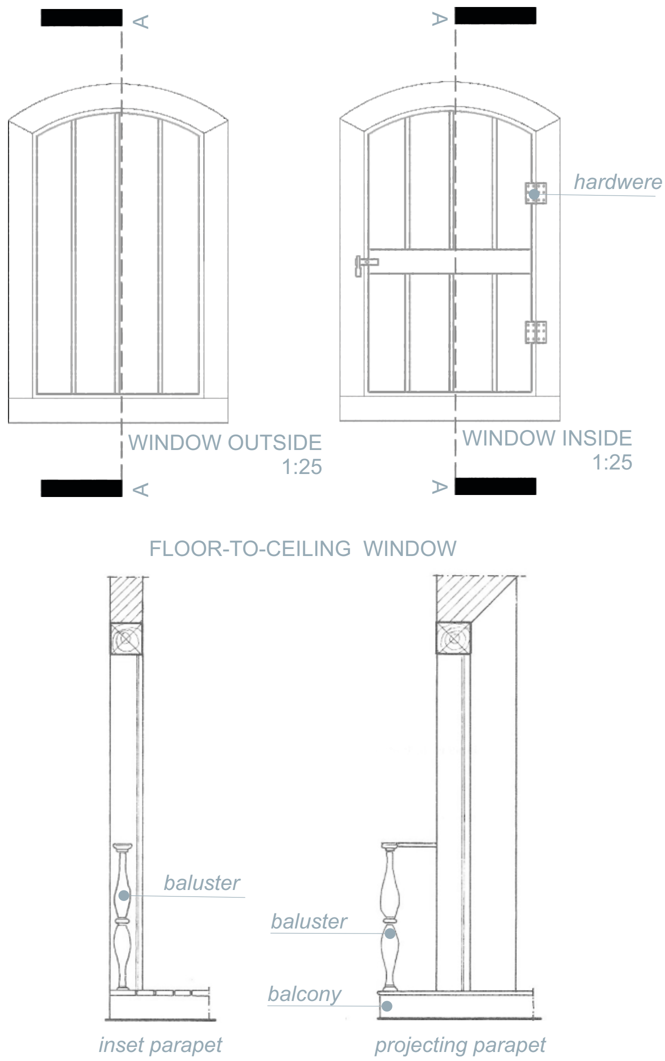
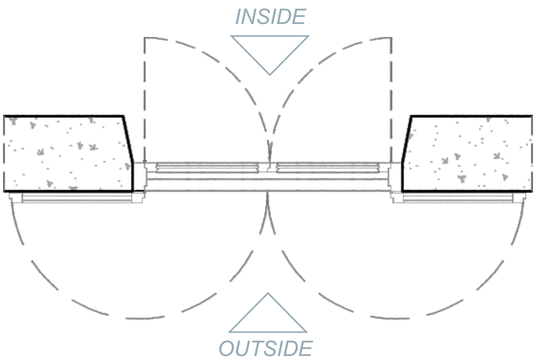
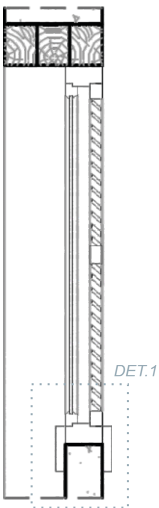


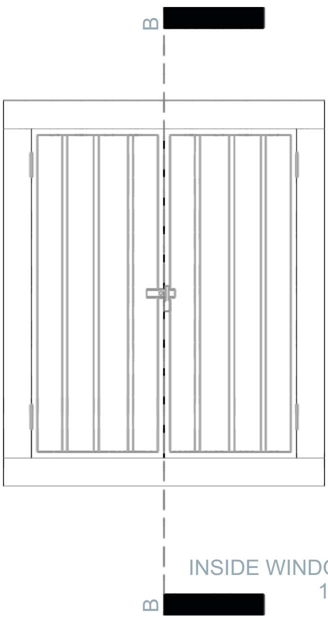
Figure 67– Detail of floor-to-ceiling window
[Source: VASCONCELLOS (1979).]



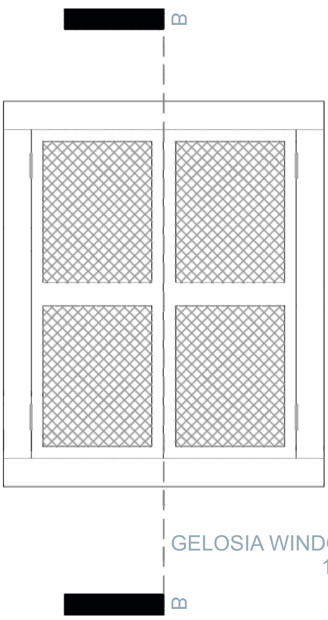
DOUBLE-LEAF HINGED WINDOW
1:25



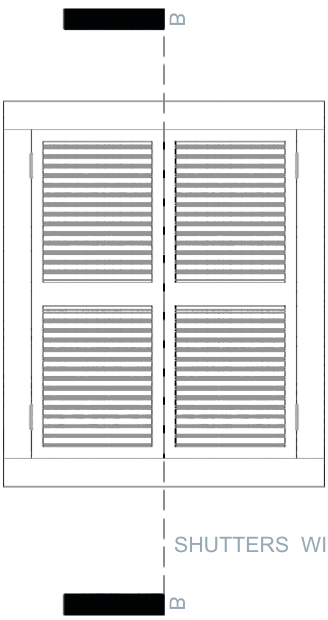
SECTION BB
1:25



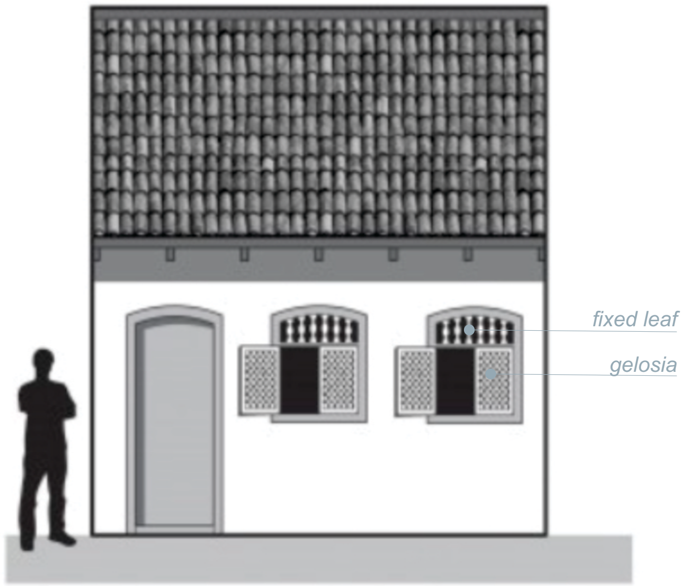
INSIDE WINDOW
1:25



GELOSIA WINDOW
1:25

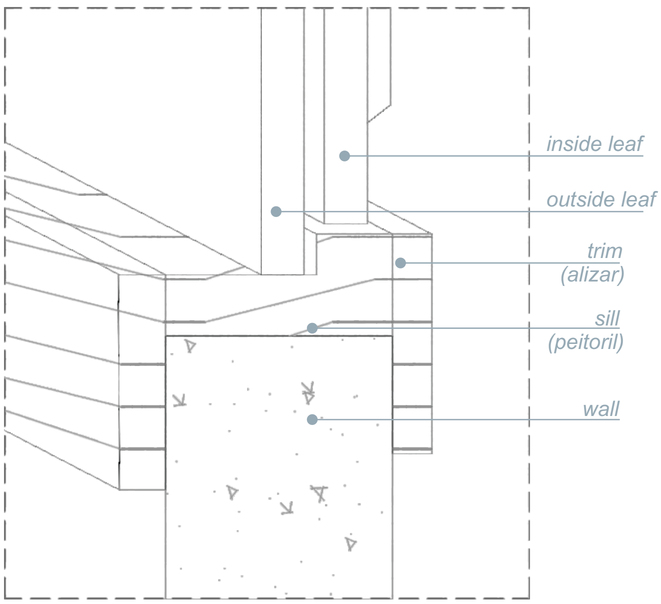


SHUTTERS WINDOW
1:25



GELOSIA WITH FIXED LEAF

Figure 68 – Detail of window with fixed gelosia. [Source: VETTORAZZI (2022)]



DET.1 FRENCH WINDOW
1:10

Figure 69 – Detail of double-leaf hinged window.

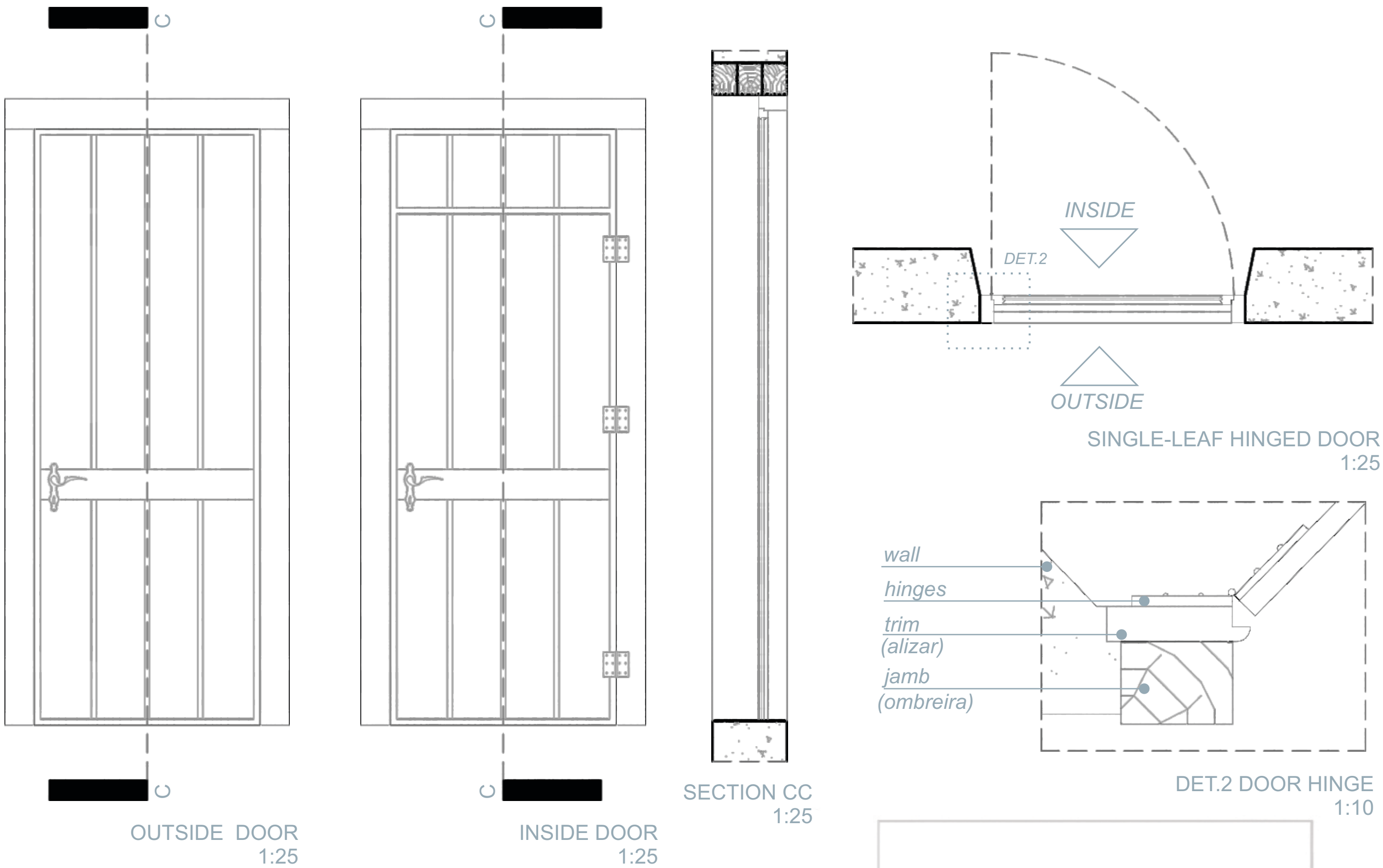


Figure 70 – Detail of single-leaf hinged door

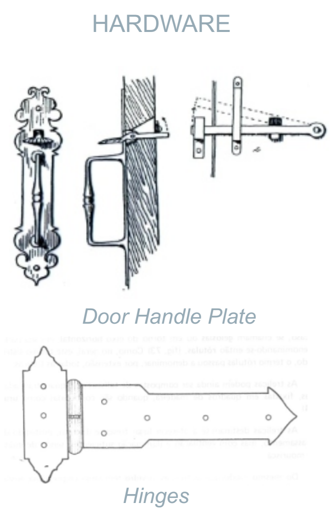


Figure 71 – Detail of hardware. [Source: VASCONCELLOS (1979).]

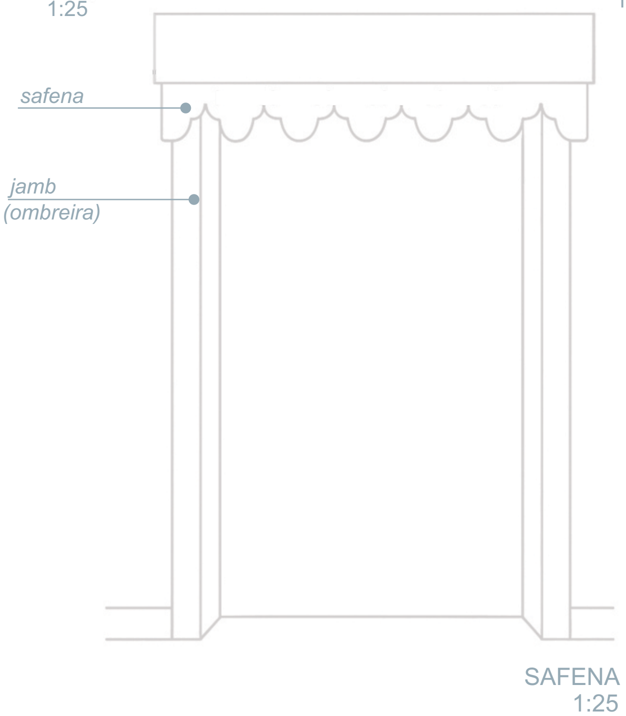


Figure 72– Detail of Safena.

Mashrabiya

The mashrabiya is architectural element of Arab origin that played significant role in Brazilian colonial architecture. It consists of a projecting balcony extending outward from façade and encompassing one or more windows. The primary function of mashrabiya is to provide solar protection, natural ventilation, and privacy to interiors of buildings. Because of Its lattice structure allowed entry of air, and diffused light while preventing direct visibility, from outside to inside. Enabling residents observe the street without being seen. Beyond its practical functions mashrabiya also possessed strong aesthetic appeal, featuring elaborate geometric design, that enriched composition of façades.

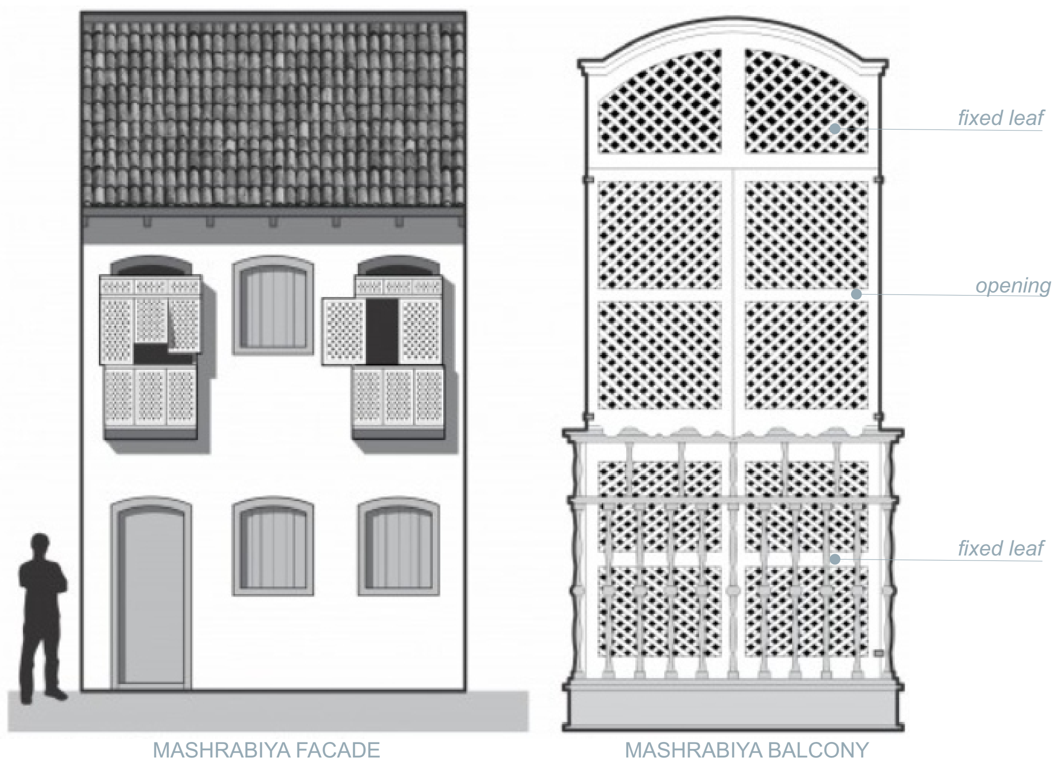


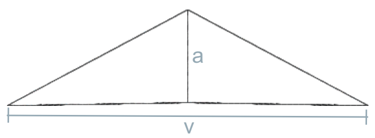
Figure 73 – Detail of mashrabiya window Source: VETTORAZZI (2022)

2.5.4. Roof

The roofs are hallmark of colonial residential architecture in Brazil, they represent both the crowning element and the dominant volume of building. The structure it's always made of wood, a true masterpiece of carpentry requiring sophisticated knowledge of joints, and timber angles. All work was handcrafted and typically carried out by enslaved people, under supervision of the carpenters. The most commonly used trusses (*tesouras*) in Midwest region were the suspended tie truss (*linha suspensa*), French truss and Roman truss. The rafter framing (*encaibramento*) was executed in various ways with reinforced rafter (*caibro armado*) technique, being very common. Timber sections for trusses were larger than those used today, and measured in palmos (a traditional unit equivalent to 22 cm): one square palmo (22 x 22 cm), one palmo and a half, 22 x 33 cm and so on. To better distribute loads on rammed earth walls, wooden reinforcement was added, to support rafters or truss legs. Each *tarufo*, short wooden beam that connects wall plate (*frechal*) with roof structure is joined the wall plate using dovetail joints (*sambladuras*).

Structure analysis

These Tables 4 and 5 provides a essential data for the structural analysis of colonial roofs, helping to understand the dimensions and strengths required to ensure safety, and proper performance of the roofing.



slope=a/v=1/4

Table 4 – Load Data (applies to all spans)[1]

Item	Value / Description	Notes
Permanent distributed load	0.85 kN/m²	Includes tiles, battens, rafters, and safety margin
Wind load (external)	±1.0 kN/m² (suction or pressure)	Estimated for lightweight roofs in Brazil's Midwest region
Estimated axial effort (8 m span)	±6.8 kN/m	Based on roof surface area ≈ 4.47 m² × 0.85 kN/m²

(1)CALHEIRO BAURU(2017)

Table 5 – Roof Structure Dimensions and Loads[1]

Span (m)	Height (m)	Slope (a/v)	Rafter Length (m)	Roof Area (m²)	Total Load per Meter (kN/m)
4	1.00	1/4	2.24	2.24	1.90
5	1.25	1/4	2.80	2.80	2.38
6	1.50	1/4	3.35	3.35	2.85
7	1.75	1/4	3.91	3.91	3.33
8	2.00	1/4	4.47	4.47	3.80

(1)CALHEIRO BAURU(2017)

From 7–8 meters onward, the increase in load, deflections (deformations), and stresses at the joints would require precise calculations and reinforcements such as buttresses or composite trusses.

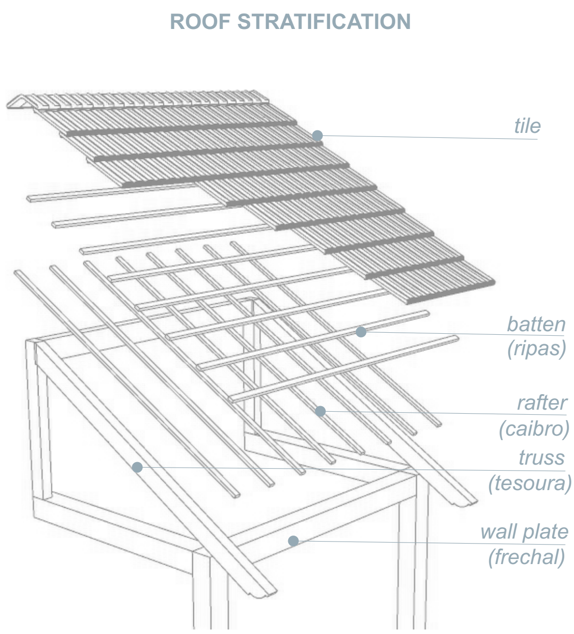


Figure 74 – Roof stratification.

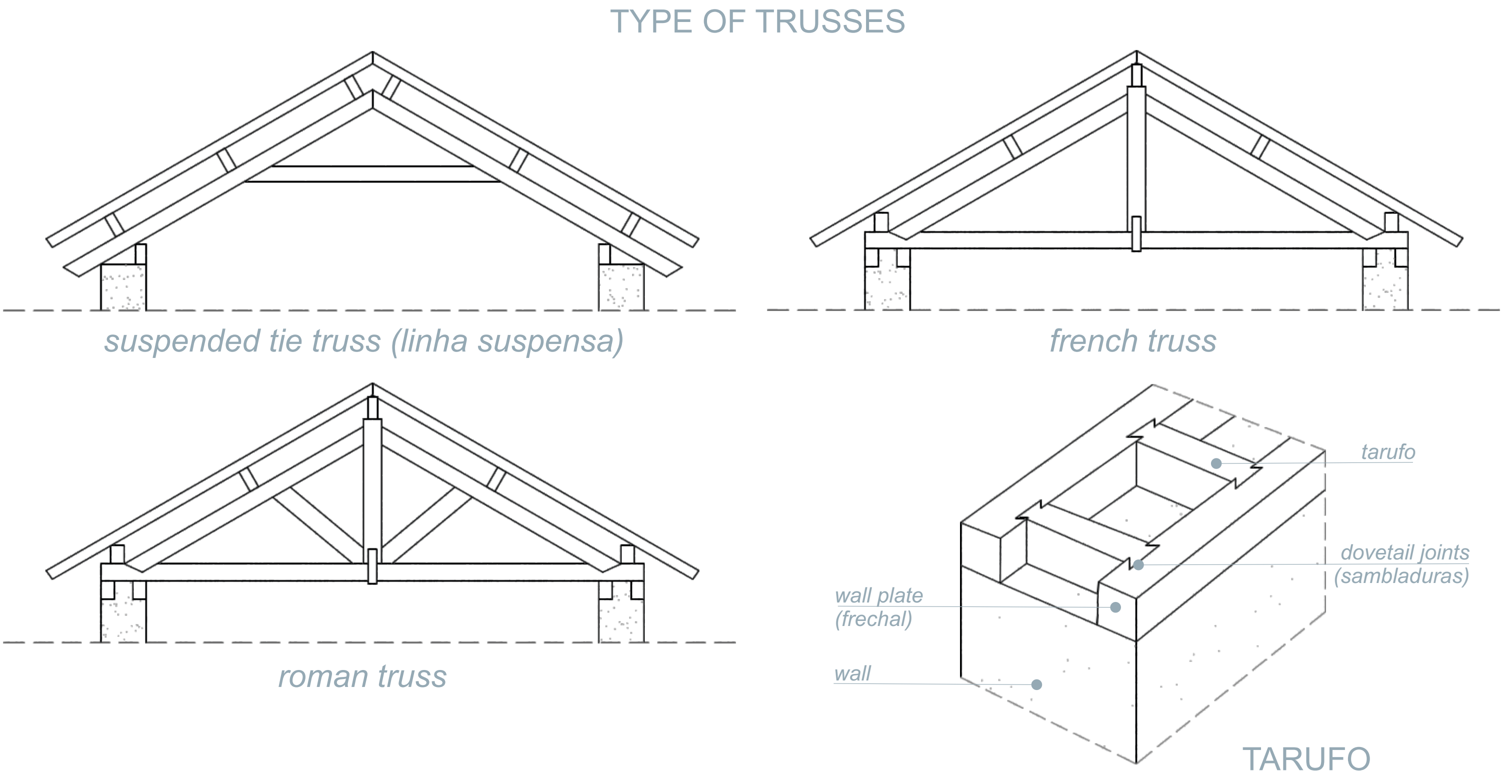


Figure 75– Types of trusses

Verandas and Porches

A veranda is a space created by the extension of the main roof slope, supported directly on the ground, can be enclosed with a guardrail, balustrade, or iron grille, and it´s supported by a wooden pilar. A porch (*alpendre*) is a covered area, generally on the ground floor, with an independent roof structure with no pilars. This distinction is crucial for understanding their architectural function.

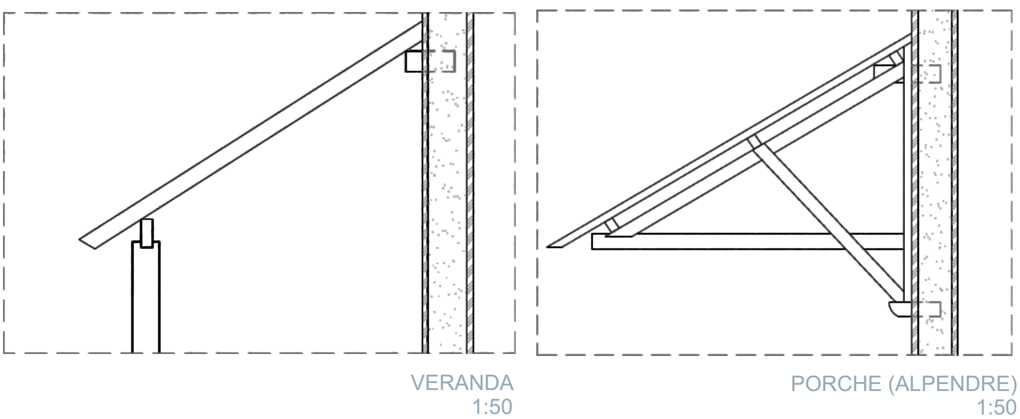
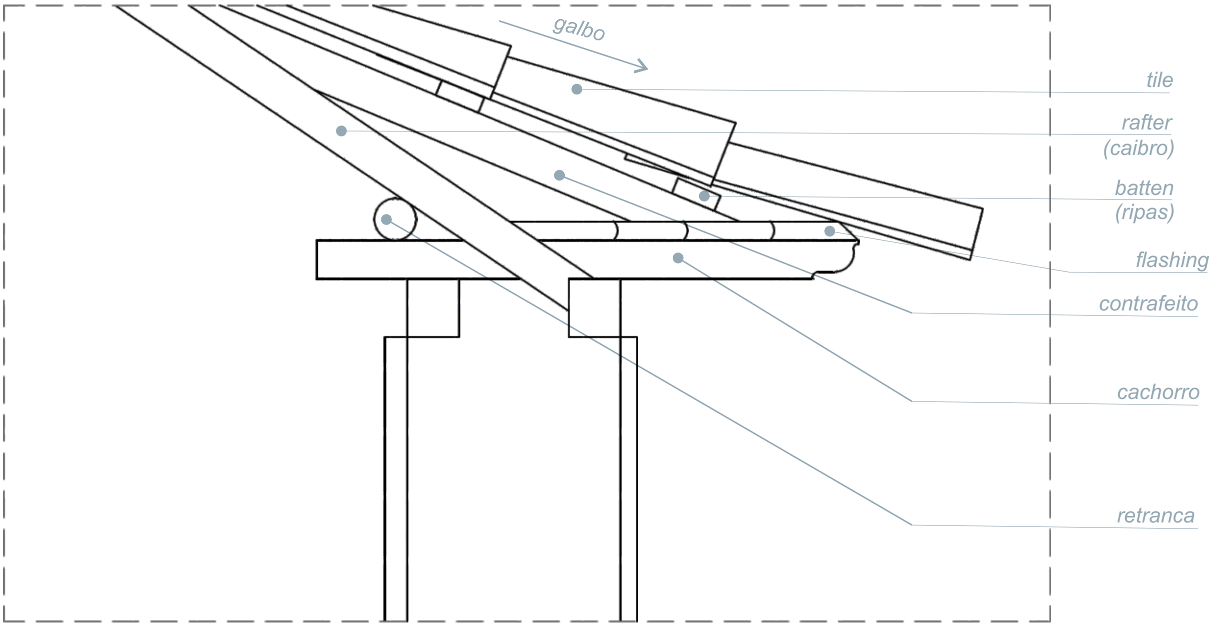


Figure 76– Types of veranda and porch

Eaves

Due to their importance in protecting walls, directing rainwater, and contributing to the aesthetic language, eaves are one of the defining features of Brazilian colonial buildings, they shielded the earthen walls from rain. The distinctive slope change of the water runoff, called the *galbo*, was designed to project water further from the building. The wooden piece enabling this slope change is known as the *contrafeito*. At the end of the rafters forming the *contrafeitos*, and parallel to the ground, were pieces called *cachorros* (*dogs*), which held a symbolic protective role over the house. The entire set of projecting rafters in the eaves was known as the cachorrada (*a pack of dogs*). *Beiras*, in contrast, are shallow ornamental moldings in the masonry at the junction with the roof. These could be made from the same material as the wall finish, molded clay tiles, or wood, serving both aesthetic and functional purposes, particularly as a barrier against birds, insects and bats.



EAVES DETAIL
1:50

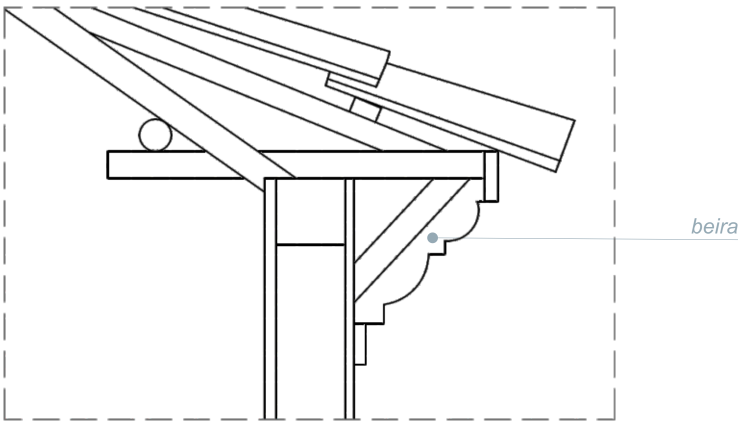


Figure 77– Detail of eaves

BEIRA DETAIL
1:50

Ceilings

The most common ceilings were made of wooden boards, flat, and either attached directly to the roof structure or to a secondary beam system (*barrote*). The joints between the boards could vary in form. In addition to flat ceilings (similar in construction to flooring), there were vaulted ceilings (abobadados) and trough-shaped ceilings (*gamela*).

Vaulted and gamela ceiling required auxiliary beams (*cambotas*) shaped to match the ceiling. In the case of trough-shaped ceilings, it was common to reuse structural elements from the roof, often from suspended tie trusses. In more luxurious homes, ceilings could include paneled moldings. These ceilings were usually painted, sometimes with abstract or figurative designs. A popular technique was *faiscada* painting, which imitated the appearance of wood or stone.

TYPE OF CEILINGS

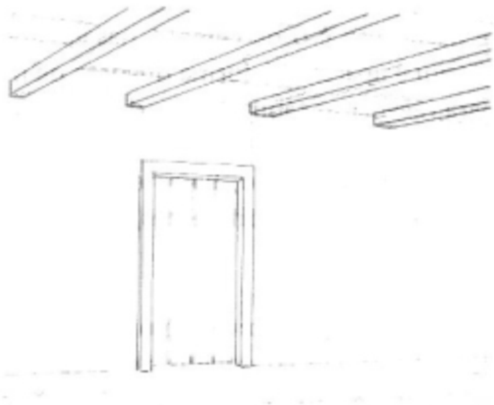
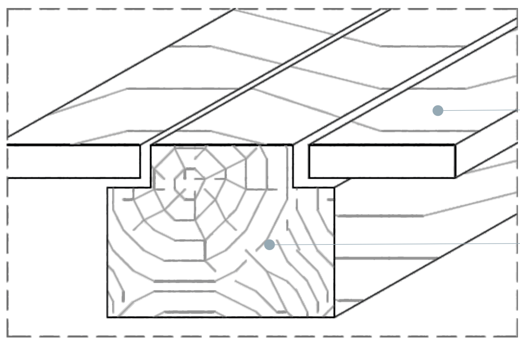
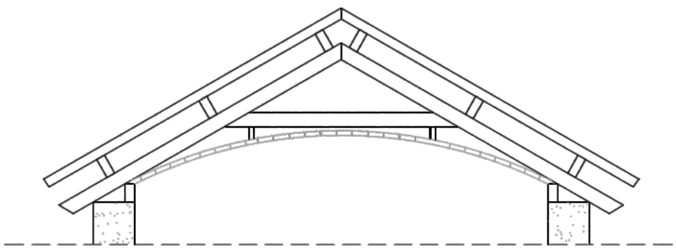


Figure 78 – Barrote ceiling [Source: VASCONCELLOS (1979)]





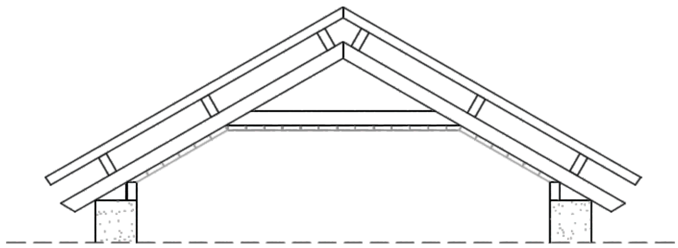


Figure 79 – Types of ceiling

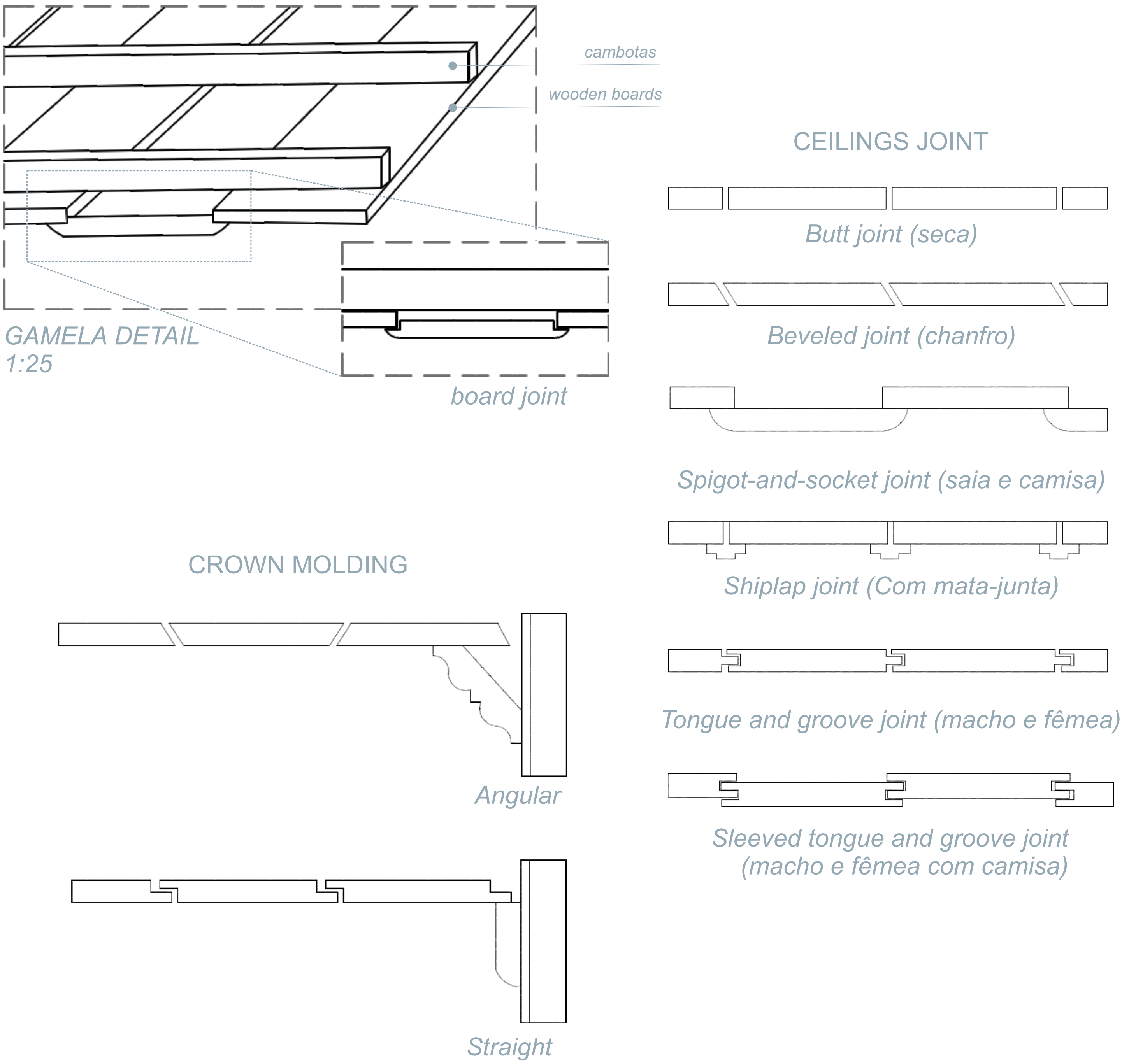


Figure 80– Ceiling details

Chapter 2
Appendix

BUILDING MATERIALS LIST[10]

1.Raw Earth

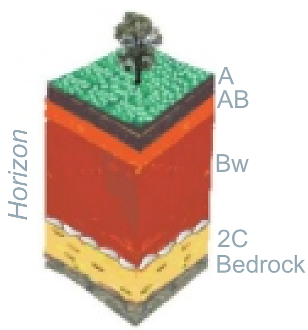
Colonial architecture in the Midwest demonstrated great efficiency in adapting to the environment. To understand the soil used during this period, it's important to understand the region where it´s located.

Brazil, with its continental dimensions, holds one of the richest biodiversities in the world. This natural wealth is expressed in six major biomes: Amazônia, Cerrado, Mata Atlântica, Caatinga, Pantanal, and Pampa. Each biome has unique ecological characteristics shaped by climate, soil, relief, and biological interactions. The Midwest region is situated within the Cerrado, considered the most biodiverse savanna in the world, covering approximately 2 million km² and accounting for around 24% of Brazil's national territory.

The Cerrado is a unique biome, shaped over millions of years by climatic, geological, and edaphic factors that contributed to its distinctive landscape.

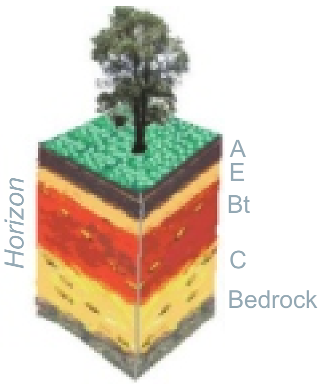
Mostly situated at altitudes between 300 and 1,600 meters, it features deep, well-drained, and highly weathered soils, resulting from prolonged chemical weathering and erosion processes. The climate is tropical seasonal, with a rainy season from October to March and a dry season from April to September, during which air humidity drops sharply. The vegetation has adapted with mechanisms such as leaf drop, small leathery leaves, and trichomes to reduce evapo-transpiration.

Regarding the soil, most types are acidic and nutrient-poor, though they retain water well, crucial for sustaining springs and aquifers. The main soil types in the Cerrado include:



Latossolos (Oxisols)
Chemical composition: Predominantly aluminum and iron silicates (containing Fe_2O_3 and Al_2O_3), with iron oxides that give the soil its reddish color; low in organic matter.
Physical properties:
Density 1,400–1,800 kg/m³
Good compressive strength (1.5–3 MPa)
High permeability, requiring moisture protection
Construction use: Used for walls, requiring stabilization to improve moisture resistance.

[10] *All the information in this paragraph has been drawn from:* NEVES (2011) ; ARAÚJO (2007); CHIODI FILHO (2009); MENEZES (2015)



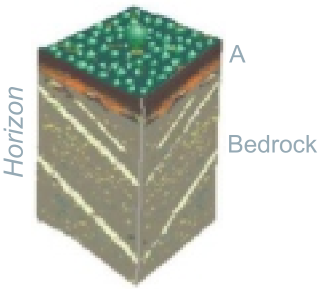


Figure 81 – Soil Horizons. Illustration depicting the distinct layers (horizons) within a soil profile. [Source: "Horizonte dos Solos"]

Argissolos (Ultisols)

Chemical composition: Composed of clay minerals (such as kaolinite and montmorillonite), silica (SiO_2), and iron/aluminum oxides.

Physical properties:

Density 1,400–1,900 kg/m³

High plasticity, allowing easy shaping

Greater shrinkage during drying, which can lead to cracking

Construction use: Used in walls, roofing tiles, and general finishes.

Neossolos (Entisols)

Chemical composition: Poorly developed soils with varied chemical composition depending on parent material. May include weatherable primary minerals such as feldspar and mica, as well as iron and aluminum oxides. Naturally low fertility, requiring proper management for agricultural use.

Physical properties:

Density varies depending on composition and degree of weathering

Can be sandy, clayey, or a mix, affecting water/nutrient retention

Generally weak structure and low particle cohesion, making them prone to erosion

Construction use: Despite their limitations, Neossolos were used in housing construction, especially in wattle and daub techniques, where soil was mixed with plant fibers to form walls. However, additional care was needed to ensure structural durability.

2. Wood

The vegetation of the Cerrado is extremely diverse, with the typical vegetation presenting medium-sized trees, irregular canopies, and deep roots. Dicotyledons, known as hardwoods, stand out for their high mechanical strength, high density, and good adaptation to hot climates, characteristics that make them ideal for various applications in engineering and construction. These types of wood are composed of vessels, fibers, and medullary rays, anatomical elements that provide rigidity, durability, and efficient sap conduction. The trunks often have thick bark impregnated with tannins and silica, characteristics that provide resistance to fire and herbivory.

Figure 82 – Angico Tree. [Source: from the article "Angico – Mudas Nativas para Reflorestamento" on the Odair Plantas website.]

Figure 83 – Trunk of the Angico Tree. [Source: Photograph by Paulo Fernando dos Santos Machado. Santa Maria, Rio Grande do Sul, Brazil. Image included on: October 27, 2018.]

Angico

Scientific name: Anadenanthera macrocarpa
Popular names: angico-vermelho, angico, angico-da-mata, angico-verdadeiro, angico-amarelo, angico-cedro, angico-rosa.
Occurrence: Brazil´s Midwest, Southeast, and South regions.
Wood: Density of approximately 0,84–1,10 g/cm³; compact, very hard, with low elasticity, but extremely resistant and highly durable under natural conditions.
Characteristics: Trunk diameter ranges from 30 to 50 cm, covered with dark bark and scaly rhytidome.
Strength
Compression: 58–118 Mpa;
Bending: 80–100 Mpa.
Use in construction: Employed in roof structures, beams, posts, and other structural elements.

Peroba

Scientific name: Aspidosperma polyneuron
Popular names: amargoso, guatambu-amarelo, pau-caboclo, peroba-verdadeira, pereiro, peroba-comum, peroba, peroba-açu, peroba-mirim, perobeira, peroba-amarela, peroba-amargosa, peroba-branca, peroba-miúda, peroba-osso, peroba-paulista, peroba-rajada, peroba-de-são-paulo, peroba-do-rio, perobinha, perova
Occurrence: Brazil´s Midwest, Northeast, Southeast, and South regions.
Wood: Medium to high density (0.75–0.90 g/cm³), with fine texture and high hardness. It has low elasticity but high mechanical strength; highly durable and resistant to termites and fungi.
Characteristics: Evergreen tree, 15 to 25 meters tall, with a diameter at breast height between 50 and 100 cm, though it can reach up to 50 meters in height and 390 cm in diameter in mature specimens. The trunk is cylindrical, straight or slightly twisted; bole generally measures between 12 to 20 meters, sometimes up to 30 meters.
Strength
Compression: 40–60 Mpa;
Bending: 88–104 Mpa.
Use in construction: Used for beams, rafters, ceilings, door and window frames, shutters, gates, baseboards, moldings, boards, floors, and furniture.

Figure 84– Trunk of the Peroba-Rosa Tree. [Source: Photograph sourced from the article "Madeira Peroba-rosa: preço, detalhes e características" on the Chalé de Madeira website.]

Figure 85 – General Characteristics of Peroba-Rosa Wood. [Source: From the article "Madeira Peroba-rosa: preço, detalhes e características" on the Chalé de Madeira website.]

Figure 86 – Peroba Tree. [Source: Photograph titled "PALO ROSA," created on December 27, 2015.]

Figure 87– Trunk of the Aroeira Tree. [Source: Photograph sourced from a sales listing on the MFRural platform, titled "Aroeiras," added on February 3, 2015.]

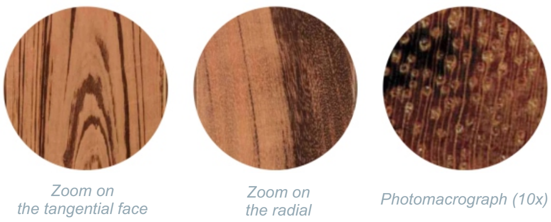


Figure 88 – General Characteristics of Aroeira Wood. [Source: Photograph sourced from the article "Madeira Aroeira: preço, detalhes e características" on the Chalé de Madeira website.]

Figure 89 – Aroeira Tree. [Source: Photograph by mbre cursos ambientais. Image included on: March 2 2008]

Aroeira

Scientific name: Myracrodruon urundeuva
Popular names: aroeira preta, aroeira-do-sertão, urundeúva
Occurrence: Predominantly in Brazil´s Northeast, Southeast, and Midwest regions, in biomes such as the Caatinga and the Cerrado.
Wood: High density (approximately 0.95–1.10 g/cm³), fine texture, and high durability; low to moderate elasticity and high mechanical strength, with strong resistance to termites and fungi.
Characteristics: Medium-sized tree, typically 10 to 20 meters tall with a diameter at breast height of 40 to 80 cm, but may reach up to 30 meters in height and 200 cm in diameter in exceptional cases; trunk is generally straight and cylindrical.
Strength
Compression: 45–65 Mpa;
Bending: approximately 145 Mpa.
Use in construction: Used for beams, poles, rafters, ceilings, moldings, boards, flooring, and furniture.

Ipê-amarelo

Scientific name: Handroanthus serratifolius (synonym: *Tabebuia serratifolia*)
Popular names: ipê-amarelo, ipê
Occurrence: Common in Brazil´s Southeast and Midwest regions, found in areas of the Mata Atlântica, Cerrado, and other tropical forests.
Wood: High density (approximately 0.95–1.15 g/cm³), with fine to medium texture and very high hardness; known for excellent durability and high resistance to weather, termites, and fungi.
Characteristics: Large tree, usually 20 to 30 meters tall with a diameter at breast height of 60 to 100 cm, potentially exceeding these dimensions; robust, straight trunk with a broad canopy.
Strength
Compression: 50–70 Mpa;
Bending: 148–161 Mpa.
Use in construction: Widely used in high-performance structures such as beams, flooring, bridges, outdoor decks, as well as in furniture and finishings.

Figure 90 – Trunk of the Ipê Tree. [Source: Photograph sourced from the article "Madeira de Ipê: Características e Usos," published on July 23, 2019, on the Leo Madeiras blog.]

Figure 91 – General Characteristics of Ipê Wood. [Source: Photograph sourced from the article "Madeira Ipê: preço, detalhes e características," published on May 27, 2021, on the Chalé de Madeira website.]

Figure 92 – Ipê Tree. [Source: Photograph by G. Nichols, taken on September 8, 2010, in Brasília, Federal District, Brazil.]

3. Bamboo

Bamboo is a plant from the grass family *Poaceae*, same family of rice, corn and wheat. It´s known for growing very fast and for its hollow stem with segments, called culm. Depending on the species, it can grow only a few centimeters or more than 30 meters high. Brazil has one of the biggest natural diversity of bamboo in the world, with around 250 native species, including the *taquara*.

Figure 93 – Cross-section of Taquara Bamboo. [Source: Photograph by MikeNZ, uploaded on November 10, 2004.]

Figure 94 – Taquara Bamboo. [Source: Photograph sourced from the article "Bambu Taquara," published on September 20, 2019, on the Usual Design website.]

Taquara

Scientific name: Guadua weberbaueri
Popular names: taquara, bambu, taboca
Occurrence: Common in various regions of Brazil, especially in the Cerrado, Mata Atlântica, and Amazon Rainforest, growing in humid areas and along riverbanks, forming dense bamboo groves.
Material: Low to medium density (0.40–0.70 g/cm³), with smooth, fibrous texture; offers good mechanical resistance, although it´s prone to rotting when in direct contact with soil, treatment can improve durability.
Characteristics: Can grow 10 to 20 meters tall, with a base diameter ranging from 2 to 10 cm; lightweight, flexible, and strong due to its longitudinal fibers and hollow internodes; rapid growth and harvest cycles of 3 to 6 years make it a sustainable alternative to timber.
Strength
Compression: 40–55 Mpa;
Bending: 100–140 Mpa.
Use in construction: Used as the structural base in the wattle and daub and rammed earth system, and also for building lightweight roofs and beams.

4. Liana

The liana is a plant typical from tropical forests in Brazil, mainly in the Amazon. It has a long, flexible, and strong stem, and belongs to the genus *Heteropsis*, in the family *Araceae*. Using the trees for support, the liana climbs up to reach the sunlight, making natural ropes in the forest. Its fiber is durable, and easy to bend, so it´s very used by traditional communities for many different purposes.

Cipó-titica

Scientific name: Heteropsis flexuosa
Popular names: cipó-titica, titica
Occurrence: Common in the Amazon region and the Mata Atlântica, and can also be found in transitional zones with the Cerrado.
Material: Unlike dense woods, cipó-titica stands out for its high flexibility and tensile strength, thanks to its natural fibers.
Characteristics: Possesses long, thin, highly resistant fibers that extend over great lengths and allow for effective weaving and binding without compromising integrity.
Strength: High tensile strength, essential for ensuring stability in construction techniques using natural lashings.
Use in construction: Employed in techniques wattle and daub for binding structures.

Figure 95 – Use of Titica Vine in Construction. [Source: Photograph by Marcos Amend, dated March 2019.]

Figure 96 – Titica Vine on a Tree. [Source: Photograph sourced from the article "Amapá: Cipó-titica é matéria-prima para móveis luxuosos no Sul do País," published on May 16, 2007.]

5. Stone

The Cerrado presents a diversity of rock formations that directly influence its landscape and ecosystems. Sedimentary rocks predominate, such as dolomitic limestones and finely laminated microcrystalline limestones, which are gray. Additionally, outcrops of quartzites and sandstones are common, contributing to the formation of hills and plateaus. These geological structures, associated with deep, well-drained soils, shape the characteristic relief of the biome, with plateaus, valleys, and depressions. The interaction between these rocks and erosive processes over time has resulted in varied topography, which harbors a rich biodiversity adapted to the specific conditions of each formation. In 18th-century construction, the following were used:

Limestone

Extraction location: Quarries in marine and lacustrine sedimentary basins of the region.
Chemical composition:
Predominantly calcium carbonate ($CaCO_3$), with impurities of clay, silica (SiO_2), and iron oxides (Fe_2O_3).
Density: Approximately 1.5 to 2.7 g/cm³.
Compressive strength: From 30 to 250 MPa, depending on homogeneity and degree of cementation.
Use in construction: Used in masonry and as a coating material, primarily in foundations.

Sandstone

Extraction location: From continental sedimentary deposits in local basins.
Chemical composition: Composed mainly of silicon dioxide (SiO_2) – between 85% and 95% – with smaller quantities of aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3).
Density: Between 2.1 and 2.6 g/cm³.
Compressive strength: Ranges from 40 to 80 MPa, depending on the degree of consolidation and cementation of the grains.
Use in construction: Used in walls, fences, and coatings.

Basalt

Extraction location: Extracted from ancient volcanic flows in the region.
Chemical composition: Rich in mafic minerals (such as pyroxenes, olivine,

and plagioclase) with silica (SiO_2) content ranging from 45% to 55%.
Density: Around 2.65 and 2.80 g/cm³.
Compressive strength: High, typically between 100 and 300 Mpa.
Use in construction: Applied in pavements, structural blocks, and foundation elements due to its high strength and durability.

Fluvial Sandstones or Conglomerates

Extraction location: Extracted from riverbeds in the Midwest Plateau, where natural abrasion processes deposited the pebbles.
Chemical composition: Classified as sandstones or conglomerates, they have a high content of silicon dioxide (SiO_2) – usually between 85% and 95% – with a matrix made of clay and silicates, and traces of aluminum oxide (Al_2O_3), iron oxide (Fe_2O_3), and, in some cases, traces of calcium oxide (CaO).
Density: Generally between 2.0 and 2.4 g/cm³.
Compressive strength: Moderate, ranging from 30 to 70 MPa, depending on natural cementation and the grain size of the components.
Use in construction: Used in paving, masonry, and wall coatings, taking advantage of its high availability and low cost.

6. Lime

In the 18th century, during the Gold Cycle in the Midwest, residential construction widely used lime as an essential material. The region, rich in limestone, allowed the local extraction of this sedimentary rock, which was then calcined in rustic furnaces to produce quicklime. The abundance of limestone in the Cerrado region facilitated the production and use of lime, making it a fundamental component of colonial architecture.

In other regions of Brazil along the coast, particularly in areas where *sambaquis* were found, builders made use of the shells accumulated in these ancient mounds. *Sambaquis* are archaeological sites formed by the long-term accumulation of mollusk shells, fish bones, and other organic and cultural materials built up over thousands of years by Brazilian Indigenous peoples. These mounds, rich in calcium carbonate from the shells, became a valuable resource for producing lime. By calcining the shells from *sambaquis* in kilns, early settlers could produce quicklime.

It can be said that these two techniques used in colonial Brazil can be referenced as sources of lime used both in the Midwest region and in other parts of the country. The extraction location could be in areas with abundant limestone and shells from *sambaquis*. Lime was produced from the extraction and burning of this sedimentary rock and mollusk shells. The process involved mining the limestone, followed by calcination in specific furnaces, resulting in the production of quicklime. In the case of mollusk shells, it was separated from the other organic elements, found in the *sambaquis*, and calcinated in specific furnaces.

Quicklime (Calcium Oxide - CaO): The calcination process results in the formation of quicklime, predominantly composed of calcium oxide.

Hydrated Lime (Calcium Hydroxide - $Ca(OH)_2$): The controlled addition of water to quicklime produces hydrated lime, used in mortars and coatings.

Carbonation: Over time, hydrated lime reacts with carbon dioxide (CO_2) in the air, forming calcium carbonate ($CaCO_3$), a process that provides strength and durability to constructions.

Use in construction: Preparation of mortars, which were used in stone setting and coatings, providing greater adhesion and durability to buildings. It was used in the production of decorative finishes, such as stuccoes and frescoes, adding aesthetics and protection to surfaces. The technique of lime-washing (*caiação* in Portuguese), which is a traditional wall painting method, was widely used in colonial Brazil.

7.Pigments

Red Ochre

Predominantly composed of hematite (Fe_2O), which gives it a deep red tone. Obtained from manual extraction of soils and clays from natural deposits.

Yellow Ochre

Generally contains goethite ($FeO(OH)$) combined with clay impurities, resulting in a color that ranges from yellow to orange. Obtained from manual extraction of soils and clays from natural deposits.

Brown

Generally composed of a mixture of iron oxides (such as hematite) with clay components and silicates, with variation in the proportion of these constituents determining the final tone. It was extracted from regional soil and clay deposits, particularly in areas where geological activity concentrated these minerals.

Use in construction: In woodwork, they were used to paint the surfaces of doors, windows, frames, and other architectural elements. This application served two purposes, aesthetic, providing a harmonious and natural color palette that highlighted the nuances of the wood and adapted to tropical lighting and climate, and conservation, as the paint helped protect the wood from weathering, acting as a physical barrier that minimized the effects of humidity and atmospheric agents, preserving the integrity and durability of the woodwork.

8. Other materials

With empirical knowledge, the caipira began mixing other elements with traditional techniques to enhance the use of materials. These are:

Tabatinga

Chemical composition: Tabatinga is a mixture of clay rich in aluminum silicate, mainly composed of the minerals kaolinite ($Al_2Si_2O_5(OH)_4$) and illite ($K_{0,3}Al_{2,33}Mg_{0,67}Si_4O_{10}(OH)_2$), in addition to organic matter.
Use in construction: Due to its plasticity, tabatinga was used in the preparation of mortars and plasters, facilitating application and ensuring adhesion to surfaces.

Fine Sand

Composition: Fine sand is composed of silica (SiO_2) particles with a diameter smaller than 0.6 mm, ensuring greater plasticity to mortars.
Use in construction: Fine sand was used in the preparation of mortars for plasters and internal finishes, providing smoother surfaces suitable for painting or other coatings.

Vegetal Fibers

Materials used: Rice and wheat straw; fibers from babaçu and buriti.
Use in construction: Used in preparing earthen materials, as they increase tensile strength, reduce cracks during drying, and improve the structural flexibility of walls.

Animal-based Stabilizers

Materials used: Cow dung – better cohesion and lower shrinkage; Fish oil or animal fat – provides waterproofing to materials; Beeswax – preservation and waterproofing of materials.
Use in construction: Increase cohesion and strength of the clay, reduce moisture absorption.

3

RESTORATION OF VERNACULAR ARCHITECTURE IN BRAZIL

Figure 97 – Restoration of the Main Church of Pirenópolis in 1996. [Source: CAVALCANTE, Silvio; CAVALCANTE, Neusa. Barro, madeira e pedra: patrimônios de Pirenópolis. 2nd ed. Brasília: IPHAN, 2019.]

3.1. Restoration in Brazil [11]

The institution responsible for the preservation and protection of historical buildings in Brazil it´s the National Institute of Historical and Artistic Heritage (Instituto do Patrimônio Histórico e Artístico Nacional - IPHAN). Its responsibilities include inspection, regulation and preservation of assets with historical, artistic or cultural value. In the concept of heritage, to preserve a historic building means to protect the culture that it´s a right guaranteed by Article 215 of the Federal Constitution. This means to recognize that each human being carry a unique history that defines them, and architecture it´s a part of this collective memory and sense of belonging. Protecting this architecture is important because it keeps the history of society, both in buildings and in space.

UNESCO and IPHAN work together, and this is very important for keeping and promoting Brazilian cultural heritage in the world. UNESCO created global rules to identify and protect cultural and natural places of great value in the 1972 Convention, which Brazil accepted in 1977. Today, Brazil has 24 sites on the UNESCO World Heritage List (15 cultural, 7 natural, and 2 mixed). There are also 22 more places waiting on the tentative list. In comparison, Italy has 60 sites, the highest number in the world, which shows that Brazil still needs to make more effort in this area.

When a building becomes historical heritage, IPHAN uses special tools for preservation, like restoration projects. Restoration means actions to conserve old buildings, trying to keep their unity, in the original form or with the changes made over time. It must be based on clear study and documents, so people can see what is original and

[11] *All the information in this paragraph has been drawn from:* ALOISE(2015); KÜHL (2007); IPHAN(2005)

what was changed. Among the many tasks of architects, restoration needs more specialization, making it unique.

The idea of restoration today comes from a long history of events and theories, changing with the concept of heritage. When the idea of heritage changes, restoration and conservation methods also change. If a building gets a new meaning, the way of restoring it also evolves. The modern practice of restoration started during the French Revolution, when many religious and royal buildings became public property. At this moment, the idea of public heritage and the need to protect it appeared. Since then, the debate about restoration has moved between more scientific positions, which try to rebuild with technical criteria, and more romantic visions, which give value to time, landscape and symbolic dimension of architecture.

In the 20th century, especially after Second World War destructions, restoration was understood as a critical act: not only recover lost material, but also to recognize aesthetic, historical, social and symbolic values. Principles like minimal intervention, reversibility, distinction between original and new, and respect for time marks were consolidated. The central idea it´s that restoration must preserve the unity of the work without creating historical or artistic falsification, and guarantee its transmission to future generations.

In Brazil, the institucionalization of preservation started in 1930´s, but the systematic incorporation of these ideas came only in 1980´s, with the creation of research centers and courses of conservation and restoration. Since then, restoration it´s understood as a creative and planned process that must consider not only the materiality, but also uses, symbolic and social meanings, management and future potential of the cultural good. Heritage, material or immaterial, it´s always in reinterpretation, demanding continuous appropriation by each generation.

The big challenge in the country it´s the very heterogeneous diversity of heritage, a result of continental dimension and cultural plurality of its people. This makes restoration very different in each region.

With this variety, Brazilian heritage policy expanded: not only looking to “monuments”, but also including immaterial heritage with Decree nº 3.551, from 2000, in dialogue with local cultural references. This movement tries to legitimize preservation practices that recognize diversity as part of national identity. In practice, it means valorization of local techniques (like material substitution in vernacular buildings, when constructive processes are preserved), recognition of regional identities (baroque, modernism, popular architecture, religious yards, etc.), participation of communities in the definition of what its heritage and how to preserve it, and a balance between national unity and cultural diversity.

To keep authenticity in this context means respecting regional specificities: not imposing homogenous criteria, but accepting that originality of a culture, a popular knowledge, a constructive technique or an urban set depends of the living relation with the community. So authenticity it´s not only material integrity, but continuity of uses, memories and knowledge that gives sense to the good.

In practice, this idea of authenticity became real with the "*Política Nacional do Patrimônio Cultural*", implemented by IPHAN in 2010. Instead of only conserving monuments, the policy also recognizes as heritage the knowledge, practices, celebrations, religious rituals and ways of life of different communities. This makes new instruments, including new social actors in preservation and considers that authenticity is in continuity of practices and living relation with groups. Heritage stopped being only objects to protect and became a collective right, connected to citizenship and cultural diversity. In management, this means safeguard actions with community participation, transmission of traditional knowledge, education projects and initiatives that connect preservation with sustainable development and social inclusion, reinforcing the plurality of Brazilian society.

Brazil tries to build laws and actions for heritage protection that are aligned with global debates, but also adapted to Brazilian context. This alignment shows that preservation it´s not only about abstract ideas, but something that must be applied in real life situations. Each heritage it´s unique and needs its own interpretation, so architects and technicians must do a critical reading in all project stages. Restoration theories give guidance, but also give space for decision and creativity. The balance between them it´s very important to avoid interpretations that can damage the integrity of heritage.

To guarantee this, it´s essential to have clear legislation to guide practice and ensure the protection of heritage. In Brazil, this legal base was created since Decree-Law nº 25, of 1937, which created the heritage listing as an instrument of safeguard and the heritage books to classify goods of historical, cultural, archeological or anthropological value.

Article 215 of the Federal Constitution of 1988 expands the concept of cultural heritage, including tangible and intangible, recognizing Brazilian cultural diversity and giving responsibility of preservation to society and the State. IPHAN, as a federal institute, it´s responsible for creating and executing preservation policies. Its Internal Regulations were updated by Ordinance nº 141, of 2023, defining competences like the National Archaeology Center, which makes national guidelines for heritage management.

IPHAN also developed technical documents to help professionals in intervention projects. These guides guarantee quality and coherence. According to the technical manual for project development, restoration follows methodological principles divided into stages, that make in coherence with international practices, laws and theories. The project starts with data collection and diagnosis, with historical, graphic and technical research. Documentary analysis and pathology mapping are essential to understand changes and identify problems. Decree-Law nº 25/1937 and IPHAN guides are legal tools in this stage. Careful analysis shows the importance of interdisciplinary work and precision, because mistakes here can compromise authenticity.

From the collected data, start the preliminary research and intervention plan. In this stage, restoration alternatives are studied, considering historical, artistic and cultural values. The "*Manual de elaboração de projetos de preservação do patrimônio cultural*" by IPHAN of 2005 says the proposal must follow minimal intervention, reversibility and distinction between old and new. It´s essential to adopt a critical perspective and harmonize preservation with current needs. Material substitution is accepted only when necessary, and must respect traditional constructive processes. What must be preserved it´s not only the physical substance, but constructive logic and the knowledge in it. Interventions must use compatible materials and methods, protecting technical know-how and make new parts clear from the original. Manuals say authenticity it´s in preservation of matter and in continuity of constructive practices.

The executive project put technical decisions in drawings, specifications, schedules and execution strategies. It must follow ABNT, Law nº 10.098/2000 about accessibility, and IPHAN approvals. Precision it´s essential, because design or material mistakes can destroy the heritage.

At the same time, budget and planning show costs, schedule, logistics and resources. It´s necessary to align design and execution for financial viability. Law nº 5.194/1966 regulates professional responsibilities and need registration of Technical Responsibility. If there is no alignment, works delay or fails, and no completion it´s the "death of heritage". The execution phase needs specialized monitoring to follow guidelines. Traceability is guaranteed with photos, reports and diaries. Article 17 of Decree-Law nº 25/1937 allows adjustments if IPHAN approves. Restoration needs more care and technique than normal work, and mistakes can make irreversible damage.

After the end, a final report documents actions, changes, methods, materials and results. A preventive conservation plan must be implemented with the National Culture Plan (Law nº 12.343/2010). But analysis shows post-restoration monitoring is still rare, making interventions fragile. Lack of preventive conservation culture it´s one of big

Figure 98 – Restoration of floor from the Main Church of Pirenópolis in 2002. [Source: CAVALCANTE, Silvio; CAVALCANTE, Neusa. Barro, madeira e pedra: patrimônios de Pirenópolis. 2nd ed. Brasília: IPHAN, 2019.]

problems in Brazil.

In vernacular buildings, the "*Manual de técnicas de Construção com Terra*" from IPHAN of 2005, says that conservation must respect traditional techniques and value the knowledge of this heritage. Substitution of degraded parts must be with compatible materials and equivalent constructive processes, to guarantee physical integrity and transmission of technical knowledge. But it also says that in this kind of intervention, it´s not always possible to make a clear distinction between new and old, because the repair follows the same constructive logic. This makes even more delicate the limit between preservation and reintegration.

It´s important to understand that from diagnosis to monitoring, successful restoration needs a balance between technical knowledge, legal framework and cultural sensitivity. Procedures must be in line with professional training, institutional articulation and long-term vision. Brazilian conservation still needs improvement and legal adjustments to ensure that interventions respect and preserve the symbolic and material values that define heritage.

Figure 99 – Setecentista House in 1970. [Source: IPHAN. Descriptive Report – Museu Casa da Princesa: executive project design and execution of the first restoration stage, in Pilar de Goiás/GO. Goiania: IPHAN, 2011.]

3.2. Vernacular Architecture in Brazil[12]

Knowledge is how people understand the world, and it can present itself in different forms. Empirical knowledge comes from everyday life and experience, such as knowing that a mud house is cool without explaining why. Scientific knowledge is more organized, using methodology, tests, and data, for example, when architects calculate structures. Philosophical knowledge doesn't provide technical answers, but reflects on the meaning and questions of life. Religious knowledge is based on faith, dogma, and cult and doesn't require proof, like the sacredness of churches or temples. Finally, intuitive knowledge is a quick feeling, without much logic, an insight.

In universities, in general, scientific knowledge has always prevailed, since they are, by excellence, the spaces where this type of knowledge is produced, organized, transmitted, and constantly questioned and updated. They are environments that not only pass on already established knowledge, but also investigate, research, and propose new ways of understanding the world. Always based on rigorous methods, experimentation, and logical reasoning. In a metalinguistic sense, this academic work is scientific knowledge because it uses a research methodology to justify itself.

In architecture schools, especially in the more traditional ones, its common to observe a certain lack of appreciation for empirical knowledge, and by prioritizing this type of approach. Practical knowledge, which is born from direct experience

[12] *All the information in this paragraph has been drawn from:* TOFANI (2020); ICOMOS (1999)

with architectural making, is often placed in the background or even ignored. This loss of value appears mainly in vernacular construction solutions.

Vernacular architecture is the oldest way of building in the world, originating back in Prehistory, when the first human groups began to build fixed shelters with stone, wood, and clay available in nature. The vernacular does not follow universal canons, it´s deeply contextual and plural, varying according to climate, geography, natural resources, and the culture of each region. In short, it´s the native science of construction, charged with local dialects and traits.

Because of this dynamism, there is no single way to characterize it. This type of architecture is predominantly the result of empirical knowledge passed down orally over generations and built by residents or artisans, without the guidance of a figure like the architect, but with knowledge of the community's daily needs and locally available materials.

One of the great challenges currently in the field of heritage protection is precisely the preservation of vernacular architecture, which is disappearing in many places. Several things make communities think these building methods are old-fashioned or a step backward. Many of these traditional houses have been replaced by buildings made with factory-produced materials like concrete, ceramic bricks, and fiber-cement tiles, because these are seen as more modern or respected by society. There is still a lot of prejudice against houses made of earth, which are often linked to poverty or poor living conditions.

The concept began to receive institutional attention worldwide at the end of the 20th century with the *Charter on the Built Vernacular Heritage*, issued by ICOMOS in 1999, which reinforces the importance of recognizing and conserving these constructions as authentic cultural expressions, born from popular tradition and not from formal architecture. The Charter emphasizes that these constructions have symbolic, aesthetic, functional, and environmental value, even when they lack monumentality or formal sophistication. They are the result of a collective evolution that responds to the needs of daily life and represents a way of inhabiting deeply connected to the cultural identity of communities. Given that, their conservation must take into account social values and the involvement of local populations.

Among the main points defended by the Charter are:

1. The need to recognize vernacular heritage as an essential part of the world's cultural diversity;
2. The importance of preserving not only the physical buildings but also the knowledge, practices, and construction techniques associated with them;
3. The emphasis on community participation in conservation pro-

cesses, avoiding interventions that distort or replace traditional systems;

4. The appreciation of continuity of use, that is, the maintenance of the original function of the constructions whenever possible;

5. The encouragement of legal protection strategies, documentation, training, and education, which ensure the transmission of this knowledge to future generations.

As a result, the Charter warns that, in the face of accelerated urbanization, globalization, and market pressures, vernacular heritage is increasingly threatened with destruction or distortion, advocating that its conservation be integrated into public policies for sustainable development, territorial planning, and the appreciation of cultural diversity.

In Brazil, this challenge takes on a continental scale, since the country's spatial and cultural diversity is enormous. One example is that currently in the country, there is the possible extinction of indigenous peoples, which is a real and serious concern, linked to the loss of territories, the advance of deforestation, violence, the pressure of economic projects (such as mining and agribusiness), and the denial of their constitutional rights.

When a group disappears, not only is a community lost, but also a language, a culture, a worldview, and a way of building and inhabiting the world that existed in the territory before the arrival of Europeans. One of the greatest losses, for example, is the traditional indigenous constructions, such as *ocas, malocas,* and *tapiris,* which are direct expressions of their ways of life, collective values, relationship with nature, and social organization. They are made with materials found in the forests and designed to respond to the climate and community use. These constructions do not follow Western architectural standards: there are no foundations, nor industrialized materials, but they effectively fulfill the functions of housing, get-together, and ritual.

There are also other examples of vernacular architecture in the country, such as earth constructions influenced by Portuguese colonization and timber buildings in the *enxaimel* style, brought by German immigration in the 19th century, all strongly linked to the local environment, cultural identity, and the way of life of the communities.

In cities of the Midwest, the vernacular architecture built during the Gold Cycle reflected a sense of transition, all marked by the scarcity of resources coming from the coast. These structures used materials extracted directly from nature, with earth walls, tiles, wooden floors, and roofs, following local and subsistence-based artisanal production. The homeowner himself was responsible for its construction, relying on knowledge passed down orally through generations, a collective and empirical tradition that reinforces the vernacular character of these buildings.

Even the Baroque churches

built between 1761 and 1764 in the Midwest are considered vernacular, such as the Parish Church of Pirenópolis, which features a simple external façade without exuberant ornamentation, with walls made of rammed earth and adobe and *barrote* floor.

These buildings were produced by the *caipira* population, resulting in a form of Baroque adapted to local conditions. The so-called "*Midwestern colonial Baroque*" is functional, modest, and symbolic, in harmony with the economic and social reality of the region, even during the Gold Cycle.

Figure 100 – Caipira´s House, Pilar de Goiás, 1956. [Source: Arquivo Central do IPHAN.]

3.3. Decay Processes [13]

Buildings constructed with earth, stone, and wood are generally subject to various degradation processes: natural or anthropogenic. Continuous exposure to moisture, seasonal rainfall, and sharp thermal variations causes surface wear, cracks, structural deformations, and loss of cohesion between materials. In these contexts, moisture is a frequent issue, especially in foundations and roofs, resulting in basal erosion and granular disintegration of surface coatings.

Human factors aggravate the deterioration: the lack of preventive maintenance, the functional obsolescence of buildings, and, often, abandonment, combined with the use of improvised repairs and incompatible materials (such as cement-based mortars over original earth or lime structures), compromise both the stability and the historical authenticity of the buildings.

Faced with this scenario, the 2002 IPHAN manual "*Elaboração de Projetos de Preservação do Patrimônio Cultural*" recommends the use of degradation mapping as a fundamental diagnostic tool in conservation. This technical procedure involves:

1. on-site inspection with systematic photographic documentation;
2. identification and classification of pathologies;
3. detailed graphic representation in plans and technical sections, using standardized symbols.

In this context, each damage in the building is located in space and connected with its possible causes. Using the same graphic and conceptual system makes communication easier between architects,

[13] *All the information in this paragraph has been drawn from:* IPHAN (2002); ICOMOS (2019); ICOMOS (2008); WEYER (2015)

engineers, conservators and heritage managers, so everyone has the same understanding of the conservation state. The mapping also gives technical and contextual information for making restoration proposals, helping to explain the choices, give technical reasons, plan the budget, and maintain transparency with heritage authorities.

The right evaluation of colonial buildings made with earth and wood needs a careful and detailed approach. It´s recommended to do systematic monitoring, with visual inspections, photos, and simple descriptive forms, to understand changes and strange behavior in the original materials and to find the real cause of the damage.

In parallel with on-site analyses, specific laboratory tests may be necessary, which may include physical, chemical, and biological tests on representative samples, aiming to establish relationships between the behavior of materials and the environmental, constructive, or biological factors involved. This makes it possible to establish a more precise diagnosis of the origin of the pathologies, avoiding inadequate or generalized interventions that could compromise the historical value of the heritage. In addition to the analysis of the materials used, such as the composition of the earth, mortars, and pigments, and the characterization of the applied woods.

Another important point is to always pay attention to xylophagous insects, which usually stay in wooden structures. Looking for outside signs together with non-destructive detection methods is very important to follow the integrity of the building parts and to protect the structural system.

The mapping of damages must always be done with help from specialized professionals, who see not only the physical performance of the components but also their historical and cultural value, respecting traditional techniques and materials in future works.

Joining the mapping of degradation with the use of special glossaries helps to keep technical precision and also cultural sensibility in the interventions. This way, Brazilian practice stays closer to international rules for conservation of vernacular heritage, making interventions that respect both the physical heritage and the intangible values.

To ensure that decay detection is accurate, effective, and respectful, it´s possible to identify all the types of decay found in 18th-century vernacular residential architecture in the Brazilian Midwest, as listed in the Appendix of Chapter 3.

Figure 101 – Setecentista House during the restoration work in 1978. [Source: IPHAN-GO Collection.]

3.4. Restorative Interventions [14]

A restorative intervention, like the name already says, is a process that tries to restore a cultural or architectural heritage through some projects and rules. In theory, it´s about keeping and recovering the building, respecting its original materials, its history and its symbolic values.

In Brazil, every intervention in built heritage must start with a deep understanding of the object to be restored, both in its physical side and its symbolic meaning. This understanding needs careful historical research, using books, pictures, oral stories and documents, together with a detailed physical survey that includes floor plans, sections, facades, materials and the problems already there.

Artistic elements inside the architecture, like paintings, sculptures and ornaments, also need to be identified and studied with care, because they help to understand the changes that happened through time and to check the authenticity of each detail.

With this information collected, it´s possible to go to the technical diagnosis step. This diagnosis helps to prepare a proposal that respects both the physical characteristics and the actual or future use of the building, always keeping coherence with its original logic and materials.

The proposal is divided into three main steps: the preliminary

[14] *All the information in this paragraph has been drawn from:* IPHAN (2002); IPHAN (2005); IPHAN (2005); IPHAN(2007); IPHAN(2007)

study, which defines the general idea of the intervention; the basic project, where materials, methods and spaces are explained; and finally, the executive project, which sets the schedule, budget and final specifications, including other projects like structural, electrical and accessibility ones. In Brazil, the whole process must be approved by the right authorities, like IPHAN, and followed by a specialized technical team. Complete documentation of each step is very important to make decisions clear and to keep the technical memory of the intervention.

The preservation of historical, cultural and structural values needs strong technical planning, but also sensibility and ethical compromise. In this logic, restorative intervention can be organized in Project Units, which divide the work into connected steps, from the first diagnosis until later monitoring. Each step has clear objectives and uses proper methods. This organization makes it possible to repeat good practices and adapt solutions to different heritage contexts.

Good conservation practices guide that every intervention in heritage must preserve its authenticity and integrity, based on detailed analysis of the form, structure, materials and cultural context. Actions should be punctual, reversible and use compatible materials, avoiding falsifications or wrong modifications. It´s also important to recognize that transformations over time are part of the history of the asset, giving value to the historical layers and to the continuous use as part of its cultural story. So restoration should not freeze the building, but show its vitality, adapting in a sensitive way to contemporary needs and always respect symbolic, spatial and social values.

In the case of vernacular heritage, preservation it´s even more delicate, because it involves traditional ways of life and a strong relation with the landscape and the community. Compatibility goes beyond the material and includes the transmission of constructive knowledge to new generations, guaranteeing cultural continuity. More than conserving physical structures, restoration means to recognize the social and identity value of heritage and to ensure its permanence through careful planning, continuous evaluation, sustainability and active participation of society, promoting inclusive management that pays attention to diversity of contexts.

In the restoration field, to say that compatibility goes beyond materiality means that it´s not enough to replace one material with another of a similar look; it´s necessary to respect original construction methods and processes. This involves use traditional techniques, keeping proportions, textures and forms, and understanding that constructive knowledge is part of the value of the asset. So, when one component needs to be replaced, the goal it´s not only to guarantee the physical stability, but also to preserve and

reactivate cultural practices reflected in the way of building.
The transmission of this knowledge happens through workshops, training courses, work with master builders and a detailed record of the techniques used. In this way, restoration it´s not only a punctual action of conservation, but a process of cultural continuity, where knowledge it´s shared and updated in the present. Restoration works as a bridge between past and future, keeping heritage alive not only in its material, but also in its immaterial dimension, connected to human work and collective memory.

More than just conserving physical structures, restoration means recognizing the social and cultural value of the goods and the role they play in the identity of communities. Because of this, it´s essential to use an approach that includes careful planning, continuous evaluation and social participation, promoting inclusive management that respects the diversity of contexts. The dialogue between technical guides, international norms, and local knowledges it´s a necessary part of this process, because it helps to organize the procedures without erasing the uniqueness of each heritage.

3.4.1. Interventions on earthen walls

The conservation of buildings constructed with earth requires specific technical knowledge, as this type of material responds very sensitively to human and environmental actions. IPHAN advises that all interventions must begin with an accurate diagnosis of the construction technique used, the soil composition, and the state of conservation. Pathologies such as erosion, cracks, excessive moisture, or biological attacks must be identified. Laboratory tests help verify the compatibility between old and new materials.

Actions must follow the principle of material compatibility. Modern and impermeable materials, such as cement mortars, should be avoided, as they cause internal tensions, hinder the evaporation of moisture, and accelerate deterioration. Repairs must be carried out with earth of similar composition to the original, molded and applied using traditional techniques. The replacement of compromised parts should only occur when truly necessary and must be thoroughly documented.

Moisture control is essential to ensure the durability of these constructions. Measures such as correcting gutters, restoring eaves, installing drainage systems, and using floors that allow the soil to breathe must be adopted. Coatings must follow traditional logic, using earthen renders and limewash. Synthetic or waterproofing products should be avoided, as they prevent the evaporation of internal moisture.

All interventions must be carried out by professionals knowledgeable in vernacular techniques and must be accompanied by complete documentation, including photographic records, technical reports, and detailed descriptions. The original constructive logic must be preserved, and the introduction of contemporary materials should only be considered in very specific and justified situations.

3.4.2.Interventions in wooden structures and roofs

Wooden structures and roofing systems are fundamental components of historic buildings and demand specialized technical attention. According to IPHAN, the first step is to identify the wood species used, their physical properties, and how they were employed in construction. This stage involves visual analyses, microscopic examinations, and resistance tests when necessary.

The diagnosis of the wood's condition seeks to identify problems such as rot, insect attacks, cracks, deformations, and joint failures. Whenever possible, conservative techniques are prioritized, such as cleaning, treatment with natural insecticides, and structural corrections. In cases of localized damage, the use of grafting is recommended, replacing only the compromised part with wood of equivalent characteristics. Joints must be made using traditional techniques or systems that can be undone, avoiding rigid glues or permanent metal pieces.

In roofs, it´s essential to care for the water drainage system, the geometry of the roof, and the ventilation between the tiles and the ceiling. This ventilation prevents the accumulation of moisture that can compromise the structure. In cases of dismantling, the pieces must be numbered and recorded to ensure faithful reassembly. The introduction of metal structures should only occur with clear technical justification and with respect for the asset's characteristics.

All interventions must be rigorously documented, with photographs, drawings, technical sheets, and precise descriptions, ensuring traceability and respect for the material's authenticity.

3.4.3. Interventions in stone foundations and floors

Foundations and stone floors play a significant structural and symbolic role in historic constructions. The recommendation is that their restoration follow the principles of minimal intervention, compatibility, and reversibility. The first step is to carry out a detailed diagnosis of the type of rock, its state of conservation, resistance, and interaction with moisture. Pathologies must also be identified.

Cleaning should be done with non-abrasive tools, such as vegetable fiber brushes and wooden spatulas. When necessary, neutral soap and water can be used. The use of chemical products must be cautious and always preceded by tests. In cases of stone reassembly, the blocks must be dismantled, numbered, cleaned, and reassembled on a compatible base. The use of pure cement is not recommended. Lime mortar mixed with sand or local earth is preferred, as these materials allow masonry to breathe and adapt.

When replacing a stone is unavoidable, the new piece must have a similar geological origin and compatible finish. It´s acceptable to discreetly mark the difference between the original and the new stone without compromising the overall harmony. Efficient drainage and moisture control of the soil are crucial for the preservation of foundations. In the end, every intervention must be recorded with updated plans, images, and complete descriptions.

3.4.4. Challenges in restorative interventions

Despite the technical guidelines available, interventions in Brazil's vernacular heritage face numerous challenges. Among the most common are the lack of proper technical diagnosis, the shortage of qualified professionals, and the use of materials and methods incompatible with the original construction techniques. Cement plasters, aluminum frames, industrial tiles, and synthetic paints are frequently used, compromising wall breathability and disfiguring the ensemble.

Many interventions are limited to isolated buildings, without considering the urban and landscape context. Elements such as fences, backyards, dirt roads, and old pavements are often discarded, harming the ambiance and integrity of the cultural ensemble. Community participation is also often limited, weakening the symbolic relationship with the heritage.

Comparing this reality with the guidelines of the Charter on the Built Vernacular Heritage, issued by ICOMOS in 1999, a significant gap is observed.

The Charter advises that every intervention be preceded by complete and accessible documentation, that the landscape surroundings and the continuity of constructive practices be respected, and that contemporary adaptations preserve the formal and material coherence of the asset. It also states that the marks of time must be understood as part of the history and not erased in the name of an idealized aesthetic. The Charter says that training restorers and supporting local communities are essential. Although the public universities develop relevant initiatives, structured public policies aimed at vernacular heritage are still lacking.

If these challenges are not faced in a clear and organized way, and without strong public policies, the risk of damaging or losing the historical and traditional heritage of the Midwest will keep increasing. Restoration, in this context, must be understood as a collective responsibility and an ethical commitment to memory, ways of life, and Brazilian material culture.

Chapter 3
Appendix

DECAY LIST[15]

1. Cracks and Deformations

Crack in Mortar: A visible crack has formed in the mortar layer, likely due to shrinkage during drying or thermal expansion and contraction. This type of crack can also result from poor adhesion to the substrate, inconsistent mortar mix, or structural movement. While often superficial, it may allow moisture ingress and should be monitored or repaired to prevent further deterioration.

Structural cracks: This type of damage is very common in walls made of earth and also in those that use stone. They are cracks with a width > 0.1 mm that traverse structural elements, common in constructions that lack protection against the elements, have inadequate drainage, and can also be caused by various factors, including differential soil settlement, which generates uneven movements in the foundations and walls. The absence of upper bracing, such as that of a well-structured roof, also contributes to instability, especially in adobe walls, favoring the emergence of cracks. Moreover, walls built with earth are not always properly connected, allowing independent movements between the segments of the building. Diagonal or shear fractures, usually caused by seismic shocks, which completely cross the walls and exhibit considerable variations in width, are also common, but this is not the case in Brazil since there are no earthquakes.

Fracture: Complete rupture that crosses through a component. In masonry or wood, the fracture completely breaks the piece under tension. This often occurs in stone (monolithic fracture) and wood (cracks along the fibers); earthen walls tend to fissure before completely fracturing.

Star-shaped crack: Cracks that radiate from a point (usually due to impact). Common in stone and also in earthen walls, when localized stresses occur, they are rarely seen in wood, but they can happen.

Hair crack / Capillary fissure: A fine fissure (width < 0.1 mm) visible on the surface. Common in both stone and adobe or rammed earth, resulting from shrinkage or surface tensions; less common in wood, which tends to exhibit larger cracks.

Craquelé: A network of fine cracks on the surface. Frequently observed in dry earth plaster or old wood finishes.

Splitting (cleavage): Fracture along preexisting planes of weakness (such as stratification planes in stone or growth rings in wood). In columns or stone blocks, it occurs along the layers; in wood, it follows the grain. In rammed earth or adobe walls, vertical division can occur in weak layers due to overloading (an analogous phenomenon).

Wood-cracks: Wood, being a hygroscopic material, constantly absorbs

[15] *All the information in this paragraph has been drawn from:* ICOMOS (2019); ICOMOS (2008); WEYER (2015)

and releases moisture, which causes it to expand and contract. When exposed to very dry environments, the wood loses moisture and shrinks, generating internal stresses that can lead to visible cracks (width = 0,5 mm a 2 mm). These type of crack follow the grain direction, as this is the path of least resistance to tension. Although they do not compromise the structural integrity of the piece, they can alter its appearance, expose the material to deterioration agents such as moisture, fungi, or insects, and indicate inadequate environmental control.

Exfoliation: Shedding of thin layers parallel to the surface. Characteristic of laminated stones. Rare in earthen walls; in wood, it corresponds to the delamination of layers or lamination defects.

Bending/bowing/warping: Change in shape without loss of material integrity. For example, a bowing or tilting earthen wall, or a warped wooden beam or plank (twisting, curvature). Deformation is common in thick earthen walls (bulging) and in wooden elements (bending under moisture/load).

Basal erosion: This condition arises from the combination of wind erosion with the rise of soluble salts from the soil, weakening the base of the earth wall. The result is often significant erosion at the base of the wall, visible on both sides, creating a typical "wine glass" profile. The absence of eaves or coverings accelerates the process, and the displaced soil tends to accumulate near the baseboard. If left untreated, it can lead to partial or total wall collapse.

2. Detachment

Blistering: Localized formation of "blisters" filled with air on the surface, caused by the detachment of a thin outer layer. It occurs on stone facades (for example, worn crusts that detach due to the action of salts) and also on earthen plasters (in the form of peeled blisters).

Bursting: Localized loss of material in the form of a crater due to internal pressure. In stone, it´s caused by inclusions that expand (such as rusted nails or clays that swell). In earthen walls, similar explosions can occur if expansive materials are retained by moisture.

Delamination (layer separation): Separation along sedimentary or laminated layers. It mainly affects stratified stones (such as sandstone or slate). In earth or wooden constructions, the analogous effect is the delamination between layers (such as overlapping boards or plywood sheets).

3. Features Induced by Material Loss

Alveolization: Formation of interconnected cavities ("alveoli") of various sizes on the surface. It´s a form of differential erosion in which the weaker points wear away, forming holes. It´s common in heterogeneous stones and also in blocks of weaker soil or clay.

Differential erosion: Irregular erosion where different areas wear away at different rates due to the heterogeneity of the materials. For example, inclusions of softer clay in an adobe wall or joints of weak mortar erode faster, leaving cavities or protrusions. It affects earthen structures, stone foundations, and even wood surfaces (like wood knots that resist more than the grain).

Rounding: Preferential loss of originally sharp edges, resulting in a smooth and rounded profile. Typical of processes dominated by granular disintegration. It´s observed in the corners of worn stones, the edges of eroded clay bricks, and even in wood (such as worn handrails).

Roughening: Loss of fine particles from a smooth surface, leaving it uniformly rough. It occurs in stones or plaster under repeated abrasion or long-term granular wear. In wood, roughness appears where the fibers have been worn down (floorboards or wooden walkways).

Impact damage: Loss of material due to a sudden blow (projectile, stone chip), resulting in a crater. It applies to stones (bullet holes, chisel marks) and hardwoods (stump holes). In earthen walls, strong blows can chip off pieces.
Incision: Removal of material by cutting tools, creating a groove or notch. This is observed in carved stones (tool marks) and wood carvings with an axe or chisel. In earth elements, it´s rare, except in intentional cuts. In wood, this process can also involve removing a damaged section and replacing it with a new piece of wood. This repair technique alters the original continuity of the material and may affect the mechanical or aesthetic integrity of the element if not properly executed.

Scratch: Linear superficial loss caused by a sharp object. Example: graphite-like scratches on stone or marks on wood. Rare in solid ground, except if made in plaster.

Abrasion: Gradual wear due to friction or loose particles. Present in stones (steps worn by traffic) and wood (boards or stairs smoothed). Earthen plasters or cob panels also wear out with repeated contact.
Keying (bouchage): Perforation of the surface with a pointed tool to create roughness that improves adhesion. Common in stone masonry (scoring to receive plaster). In wood, a similar practice can be done in structural joints.

4. Discoloration and Deposits

Rising damp: Moisture spots that can develop at the base of an earthen wall or stone foundation (caused by moisture rising through capillarity) or isolated damp spots at higher levels. When moisture appears above the level of the landing, the source must be carefully identified. This moisture can also result in stains or deterioration of the surface finish or wall materials.

Soiling: Accumulation of dirt, soot, or particulate debris on surfaces. (black dust on stone or earth walls, deteriorated paint film on wood). Dark dirt is common on all materials.

Stains: Discoloration of limited extent (rust stains, green stains from copper carbonate). Caused by metal corrosion, biological pigments, or tannins. They affect stone (rust from iron anchors, darkening from fireplace soot), earthen plaster (iron oxidation, algae stains), and wood (water stains, tannin bleeding).

Bleaching (fading): Surface bleaching due to chemical weathering or leaching. For example, marble that becomes pale as iron and manganese oxides are removed. Observed in stone or plaster exposed to the sun, and in wood (graying or "silvering" due to UV exposure).

Moisture darkening: Dark areas caused by moisture (wet earth walls show darker zones; stone or wood near leaks also darken).

Black crust: Dark and adherent crust (usually soot bound to plaster) on protected stone surfaces. Rare on earthen walls (but smoke-darkened plasters can mimic this effect).

Salt efflorescences: White or colored mineral crusts formed by soluble salts. The saline crust (external) forms on the surface; subflorescence (internal crystallization) occurs beneath the surface. Very common in earthen walls (rising moisture causing salt deposits) and in porous stones (halite or gypsum crusts).

Iron-rich patina: Thin black/brown coating of iron minerals and clay. It develops uniformly on exposed surfaces of stone that contain iron (and often on clay-rich earth plasters).

Oxalate patina: Brownish-red film of calcium oxalate on limestone. Formed by biological/metabolic processes. It can occur in lime-rich earth plasters.

5. Biological Colonization

Algae: Greenish-black, slimy or powdery films that thrive in damp areas exposed to light. They do not adhere permanently and can be washed away. Found on stone and earthen walls where there is water flow or splashes; mosses can grow on them.

Lichen: Fungi and algae in symbiosis that form crusty or leafy patches on surfaces. Common in stone and earth masonry, especially in protected areas; lichens can appear as crusts or shrubs. Painted wood or old beams exposed to the open air sometimes show lichens.
Moss: Small green bryophytes that

form tufts or carpets in shaded and humid areas of stone or soil. Indicators of prolonged moisture (bases of walls or roof joints). Moss can also grow on wooden beams.

Mold: Fungal growth that produces discoloration (often brown, black, or orange) and softening of the surface. On soil or wood, mold (Aspergillus, Penicillium) proliferates in damp and shaded areas. Stone can harbor mold in cracks.

Higher plants: Roots or seedlings (weeds, climbers, trees) that penetrate the masonry. In earthen walls and mortar joints, they cause cracks and detachment as the roots grow. Stone foundations often show vines or seedlings in cracks. Wood is compromised by root fungi, not by vascular colonization.

Wood-decaying fungi: Fungal colonization (brown or white rot) in wood. It causes weakening, cracks in cubes (brown rot) or frayed fibers (white rot). This is a serious type of deterioration in wooden elements.

Wood-boring insects (termites/bore damage): Holes, tunnels, and wood loss are caused by insects. In the Brazilian Midwest the most frequent are termites, especially subterranean and drywood termites. Cerambycid beetles (longhorn beetles) also make big damage in wood. Other borers like scolytidae and bostrichidae attack furniture and structural parts. Caruncho (small beetles) eat fine wood. Wood-wasp, like Sirex noctilio, is also present in pine woods. All of them can result in material loss and even collapse of wooden parts.

4

RESTORATION PROJECTS: THREE CASE STUDIES

4.1.The Case Studies Methodology[16]

Among the methodological strategies in architecture and urbanism, the use of case studies it´s very important to understand in a critical way the restoration process. This approach allows to identify good technical solutions, recognize limitations of older methods and evaluate the impacts of interventions both in the buildings and also in the urban context. It offers support for future practices more balanced between material conservation and the preservation of cultural authenticity.

In this work, three houses from the 18th century were selected in Pilar de Goiás, in the state of Goiás, the Midwest region of Brazil. The choice it´s justified because they still keep a big part of their physical characteristics, original materials and construction techniques, and also have technical documentation available from IPHAN. They are: Otília House (Figure 102), Setecentista House (Figure 103) and Enxaimel House (Figure 104).

The historic center of Pilar de Goiás was protected by IPHAN in 1954 like an Architectural and Landscape Group, and it means that all the urban area, with the streets, squares and colonial houses, are now protected by the institute and by the law. This protection makes sure that changes in the city respect its original shape, avoiding loss of identity and keeping the cultural memory and the historic value of the place. So, the urban heritage it's safe from modifications that can destroy its authenticity, and the architectural and landscape heritage stays alive for future generations.

The Setecentista House was completely restored by IPHAN between 2011 and 2012, and the Enxaimel House between 2013 and 2015. All the descriptive reports were made available by the Institute for this research. The Otília House, in 2011, had a technical report prepared by Hollus Engenharia, which evaluated the condition of the property according to heritage conservation criteria. This report was not followed by a restoration, but it was also provided by IPHAN as study material.

In each case study was examined the history of the building with iconographic sources, the architectural survey with formal characteristics, the damages identified in materials and constructive systems, and the restoration interventions made (when realized). And in the end, an assessment was made of the last intervention realized.

The architectural survey drawings are a re-elaboration from the descriptive manuals and technical information provided by IPHAN, to make more clear the formal characteristics of each building.

[16] *All the information in this paragraph has been drawn from:* MANZIONE(2009); ICOMOS(1999)

Figure 102 – Otilia Houses. [Source: IPHAN/GO Collection.]

Figure 103 – Setecentista House. [Source: GALVÃO, Marco Antônio. Pilar de Goiás, from the 18th to the 21st century. Vitruvius, year 2, no. 020.05, Oct. 2002.]

Figure 104 – Enxaimel House. [Source: GALVÃO, Marco Antônio. Pilar de Goiás, from the 18th to the 21st century. Vitruvius, year 2, no. 020.05, Oct. 2002.]

4.1.1. Methodology of assessment

The assessment of the last architectural interventions in the case studies follows the guidelines of the Charter on the Built Vernacular Heritage, published by ICOMOS in 1999. This document talks about preservation using traditional techniques, compatible materials and respect of cultural identity. It´s important because it considers not only the physical aspects, but also the social, cultural and symbolic values of the heritage. Based on these principles, each intervention is assessed in relation to the Charter.

For this, it´s used a score from 1 to 6. The value "1" means low alignment or no conformity, and the value "6" means a full and exemplary respect to the guideline. The assessment scores help to see the strong points and also the limits of each intervention in relation to the preservation of vernacular heritage values. It´s a way to discuss in a critical form the restoration practices and to see how theory and practice meet in the 18th-century Midwest vernacular houses.

In the specific case of the Otilia House, the building didn´t arrive in the intervention phase. So, the assessment it´s made from the Technical Report, considering how much the analysis proposed in the report is in line with the ICOMOS Charter.

Figure 105– City of Pilar [Source: IPHAN/GO Collection.]

4.2. Pilar de Goiás [17]

4.2.1. Historical overview

Pilar de Goiás emerged in the context of the expansion of gold mining in the interior of Brazil during the 18th century. It was officially founded in 1741 by João Godoy Pinto da Silveira, a *bandeirante* known for discovering new gold mines. The region, previously inhabited by indigenous groups such as the Curuxás, Canoeiros, and Kirixás, was occupied by the *Quilombo* de Papuã, considered the original nucleus of the settlement, where gold extraction was carried out clandestinely a *grupiara*. A *quilombo* was a form of collective resistance organized by enslaved people of African origin who escaped from farms, sugar mills, mines, or other forced labor regimes during the Brazilian colonial period. These communities were established in remote and hard-to-reach areas, such as dense forests, mountains, or regions far from urban centers, forming autonomous societies where the formerly enslaved sought to reconstruct ways of life based on freedom, solidarity, and African ancestry. Many *quilombos* also welcomed Indigenous people and other marginalized groups. In these spaces, agricultural practices, crafts, religious expressions of African origin, and autonomous forms of political and defense organization flourished.

After the capture and dissolution of the quilombo, the new settlement founded by Godoy was named "Pilar," in honor of his devotion to Our Lady of Pilar. It quickly became a prosperous center with a strong flow of gold, attracting a

[17] *All the information in this paragraph has been drawn from:* DUBUGRAS (1965)

Figure 106 – Old city of Pilar. [Source: GALVÃO, Marco Antônio. Pilar de Goiás, from the 18th to the 21st century. Vitruvius, year 2, no. 020.05, Oct. 2002.]

large influx of population. This resulted in the construction of four churches and the presence of around nine thousand enslaved people, making it one of the main mining centers of the Captaincy of Goiás. In 1751, it was elevated to the status of a parish, an ecclesiastical recognition that marked the consolidation of urban settlement. The scarcity of new gold deposits and the technical difficulties of extraction led to the decline of mining in the 19th century, reflecting a broader decline in the gold regions of Brazil. This caused a drastic population decline and a process of urban abandonment, plunging the settlement into decay.

During the 18th century, Pilar de Goiás was part of a network of colonial settlements that developed around mining. At the end of the colonial period, even amidst economic decline, it had already established itself as an urban center with notable Baroque architecture, including a town hall and jail (*Casa de Câmera e Cadeia*), residential houses, and churches. A large part of the architectural heritage built between 1741 and 1800 was preserved, leading to the recognition of the settlement as a national historical heritage site by IPHAN in 1954, with its architectural and landscape ensemble registered in the Historical and Fine Arts Heritage Books, under numbers 302 and 414, respectively.

Pilar de Goiás constitutes a representative example of the social, economic, and environmental transformations triggered by the Gold Cycle in colonial Brazil. It was shaped, elevated, and then weakened by the extractive logic that defined much of the occupation process of the Brazilian Midwest in the 18th century.

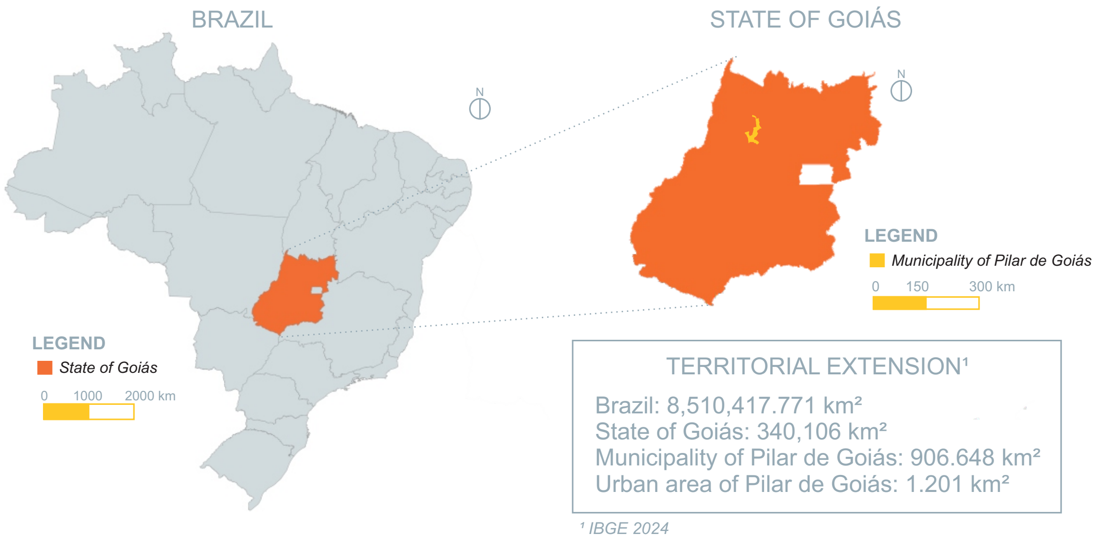


Figure 107 – Geo-demographic data demonstration.

4.2.2. Geo-demographic data

One of the great challenges of analyzing Brazil is due to its diverse geography and the complexity of analyzing its social and cultural aspects. The country has a total area of 8,510,417.771 km², making it the sixth largest in the world in terms of land area. Goiás occupies a central physical and strategic position within Brazilian territory. It´s the seventh largest state in the country, with 340,242.860 km², located in the Midwest region.

Pilar de Goiás is a municipality in Goiás with an area of 906.048 km², consisting of both an urban core and vast rural areas. These areas are fundamental to the local economy, especially in agricultural and metal mining activities. The urban center of the municipality is small compared to its total area, concentrating most of the population and economic activities. The current urban area is approximately 1.201 km². This population concentration imposes challenges to urban planning, especially in the search for solutions that reconcile the preservation of historical and environmental value with population growth.

The analysis of the population data of Brazil, Goiás, and Pilar de Goiás over time reveals significant transformations caused by historical, economic, and social factors. In 1800, Brazil had approximately 3.25 million inhabitants living in urban and rural areas, with an economy based on subsistence agriculture and gold mining. Goiás was still in the process of being settled, with about 70,000 inhabitants. Pilar de Goiás was a small rural settlement with about 15,000 people. The society of the time was marked by slavery, and the cities were beginning to develop.

In 1954, the year Pilar de Goiás was designated as a Brazilian histori-

Population of Brazil, Goiás,
and Pilar de Goiás at various dates

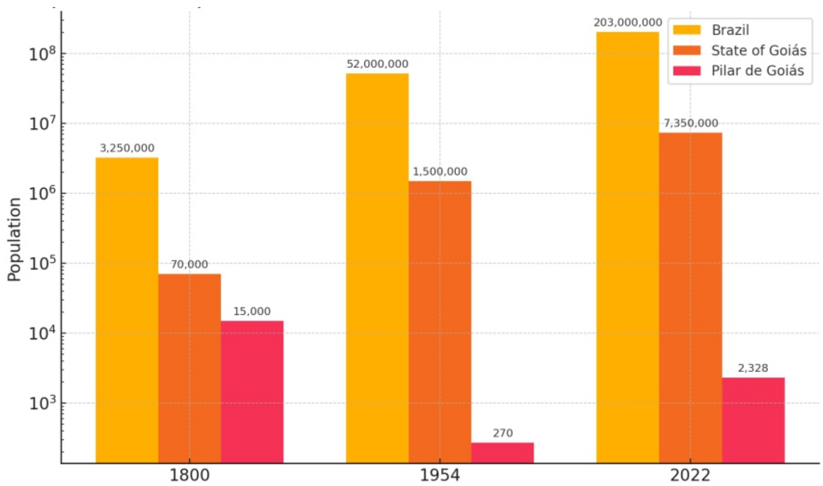


Figure 108 – Geo-demographic data demonstration. [Source: Prepared by the author based on IBGE data.]

cal monument, the country's population had grown significantly, reaching around 52 million people. This growth was driven by the expansion of coffee, European immigration, and industrialization processes in some regions. Goiás had approximately 1.5 million inhabitants, growing due to the construction of the new capital, Goiânia, and the expansion of the agricultural frontier. Pilar de Goiás, on the other hand, maintained a modest population of around 270 people, highlighting the transformations in the state after the decline of the Gold Cycle.

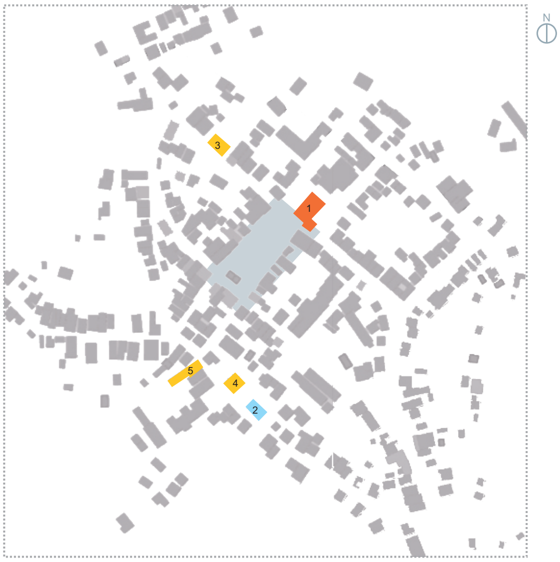
According to the 2022 census, the Brazilian population reached around 203 million. Goiás continues to develop, with around 7.35 million inhabitants. Goiânia has undergone significant urban growth in recent decades. Pilar de Goiás, on the other hand, has grown slowly, currently housing around 2,328 inhabitants. This highlights the difficulties faced by small rural municipalities in accessing infrastructure and services.

This demographic trend (Figure 108) illustrates the transformations of society: from a rural and slave-based foundation to cities centered around gold, marked by periods of peak and decline in the early 19th century, until the formation of an urban-industrial culture. It also reveals the persistence of difficulties in allocating resources to small towns that have historical and heritage significance. Regional inequalities and local specificities, such as those of Pilar de Goiás, highlight the importance of public policies based on the particularities of each region, promoting balanced and inclusive growth while preserving the history, memory, and culture of the cities from the Gold Cycle in the Brazilian Midwest.

The Matriz Church of Our Lady of the Pillar (1)

The town hall and jail (2)

Figure 109 – Different buildings in Pilar [Source: Google Earth. Accessed on: July 8, 2025.]



LEGEND

Main religious building
Casa de camera e cadeia
Study cases
Area of religious influence

Otília House (3)

Setecentista House (4)

Enxaimel House (5)

4.2.3. Locations of the case studies

In the 18th century, Pilar was one of the main economic centers of the Captaincy of Goiás, driven by gold mining at Morro da Pedreira, which stood out as the only *lavra* with regular operations, described in historical documents as a gold-rich area. The town had a diversified economy and a strategic location, connecting to important colonial centers. It featured a planned urban structure, with refined houses and stone-paved streets. In the 19th century, with the decline of mining, the town faced abandonment and subsequent urban deterioration.

The flowing map shows buildings and locations established by agencies or institutions:

(1)The Matriz Church of Our Lady of the Pillar, whose construction began in 1747, is the main religious temple and is located in the city center, facing the public square (in light gray). This arrangement reflects the typical pattern of Brazilian colonial cities, in which religion structured urban organization and its guidelines.

(2)The town hall and jail (Casa de Câmara e Cadeia) is not located in the main square, which differs from the usual Luso-Brazilian standard, where civil, religious, and penal powers were concentrated in the same space.

And the three case studies:

(3)Otília House

(4)Setecentista House

(5) Enxaimel House

These three houses, built in the 18th century, continue to be significant examples of the architecture of the time, even though they now serve purposes different from their original ones.

4.3. Otília House[18]

The Otília House is located on Rua da Matriz, in the historic center of Pilar de Goiás, and was built in the 18th century, although there is no exact date recorded. It's now owned by the Diocese of Uruaçu and it's working today as a parish house and in 2025, it's interdicted because of the bad conditions of the building. The property doesn't have a maintenance plan registered in IPHAN. It's part of the Architectural and Landscape Complex of Pilar de Goiás, listed by IPHAN in 1954, and it's protected by federal law Decree-Law nº 25/1937. This is a problem because all maintenance and restoration must pass by IPHAN control, and without an official plan it's not possible to guarantee regular care. So the risk of damage and loss of authenticity of the heritage it's more high.

Its structure is made by an independent wooden frame on stone masonry and foundations (*cangicado*). The original walls were made of adobe, but in 1980, due to the collapse of the east facade, this part was replaced with solid brick masonry. Inside the floor it's made of wood (*barrote* type), and the house doesn't have ceilings. The hipped roof is showing different supports and fittings, reflecting the many interventions over time, but it still has a french wooden truss and colonial tiles. On the south and west facades, it's possible to see the eaves with wooden brackets (*cachorros*). It stands out for its layout and strong architectural elements, like the carved latticework (*gelosia*) and the mashrabiya, typical of colonial architecture.

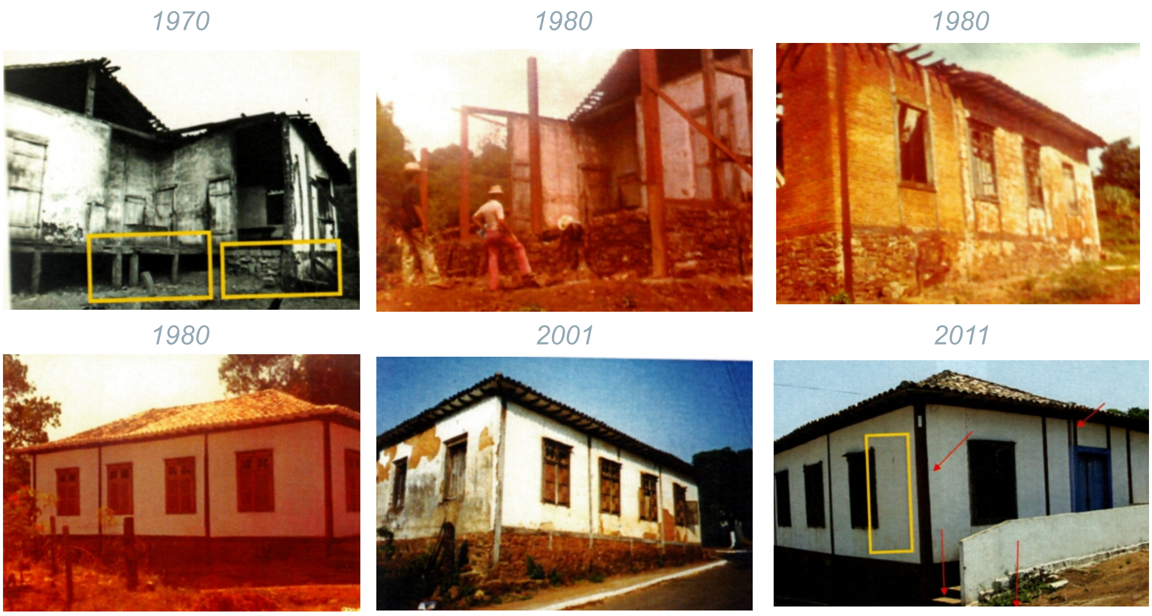
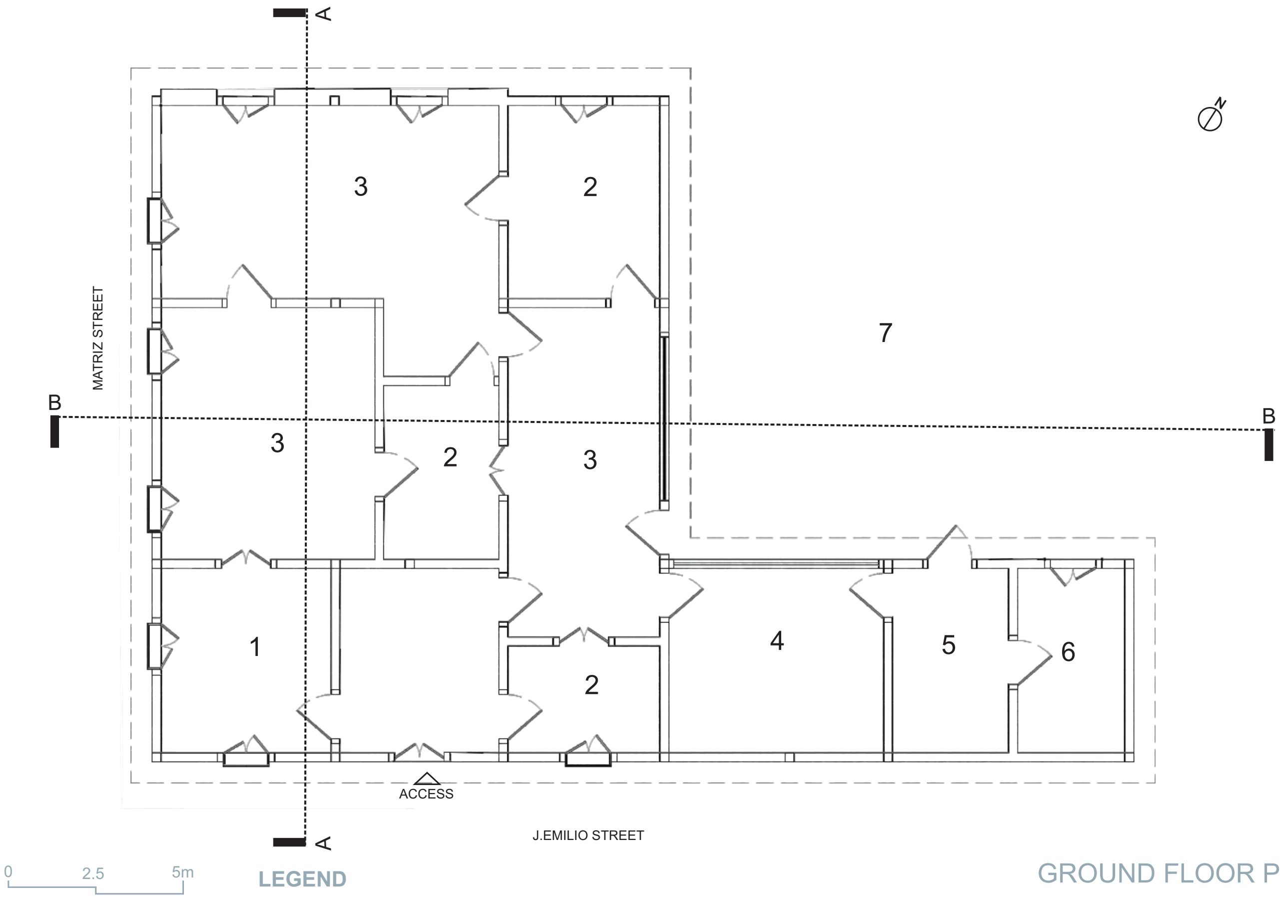


Figure 110 – Illustrated timeline of the Otilia House. [Source: IPHAN. Descriptive report prepared by Hollus Engenharia. Goiânia: IPHAN, 2011.]

[18] *All the information in this paragraph has been drawn from:* IPHAN (2011)

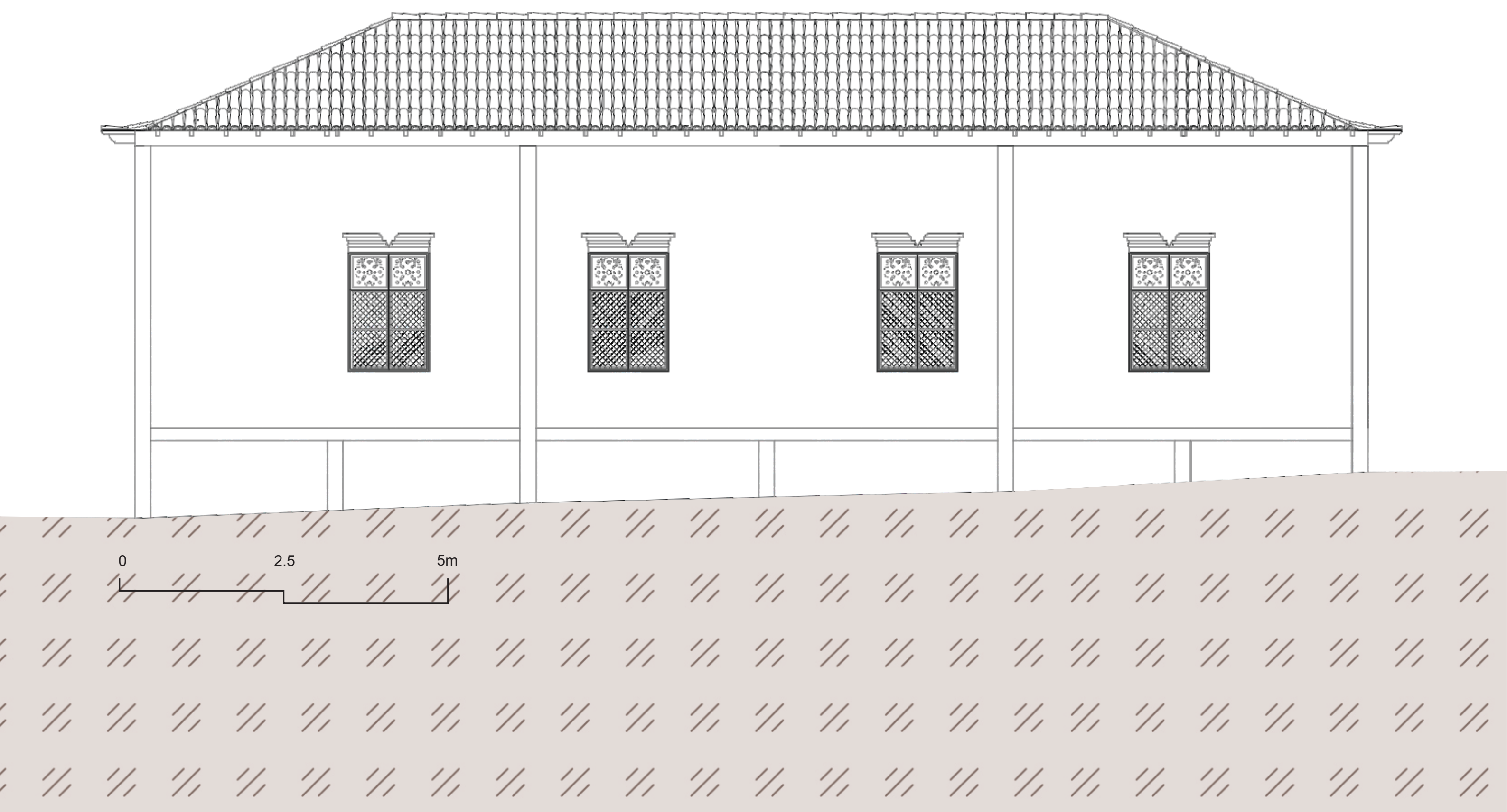


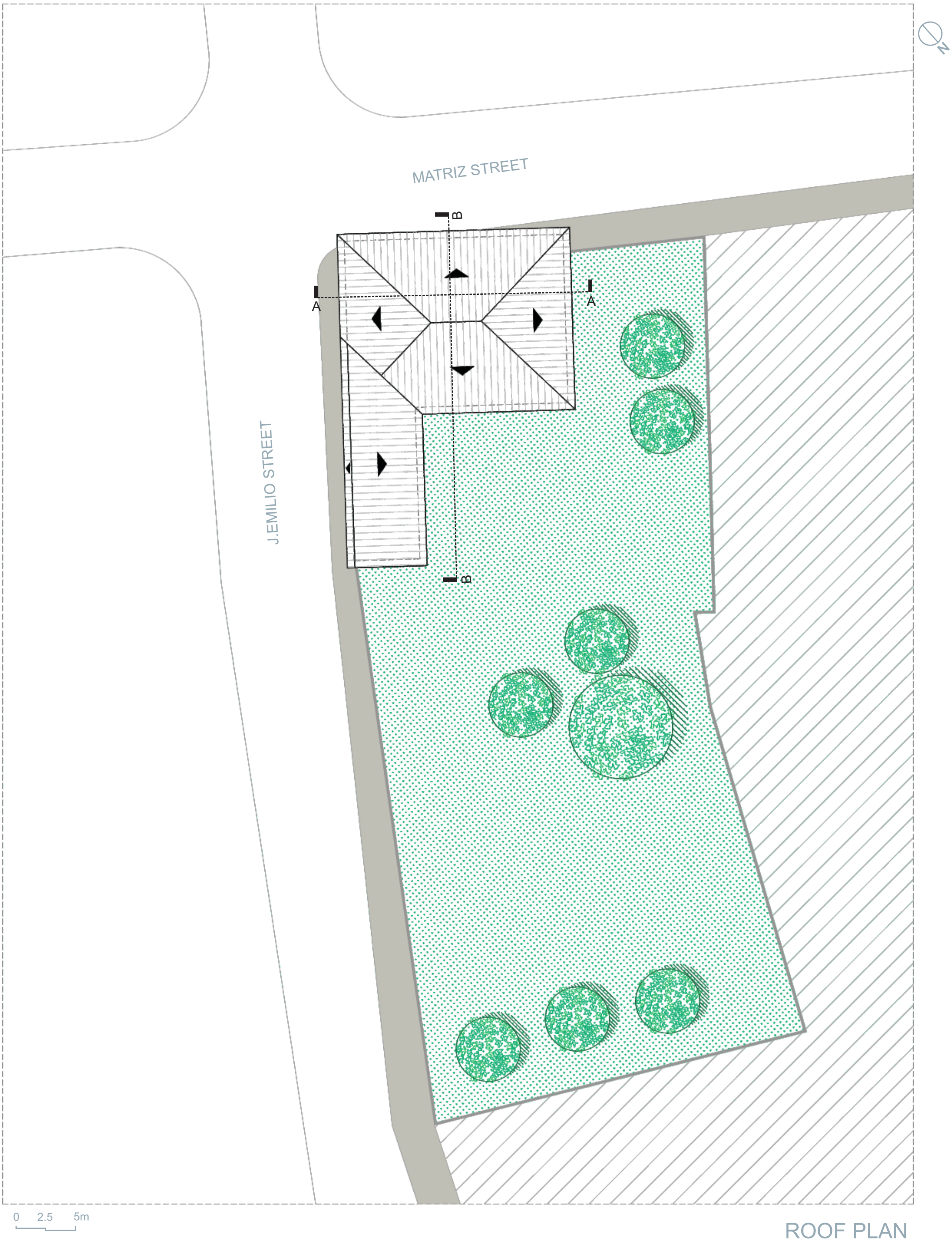
LEGEND

1- Guest Room
2- Private Room
3- Living Room
4- Kitchen
5- Deposit
6- Senzala
7- Backyard

GROUND FLOOR PLAN

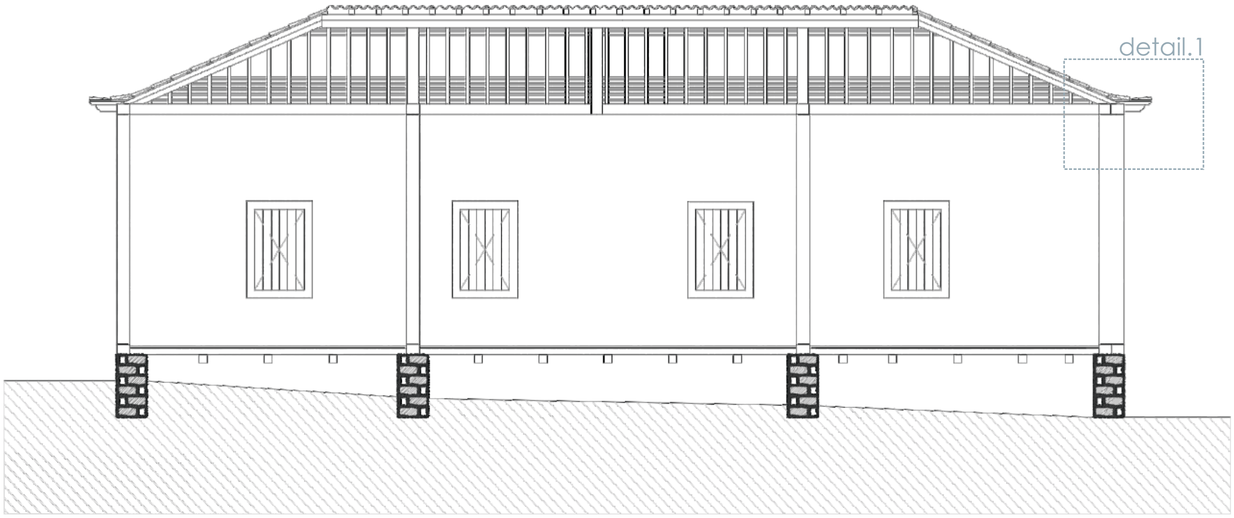
The Otília House is a typical 18th-century residential home in Goiás, built in an L-shape as a full-scale single-store house. Unlike the other case studies, this residence is a detached house not designed to be semi-detached, featuring four independent façades, with its entrance located on the side of the building.





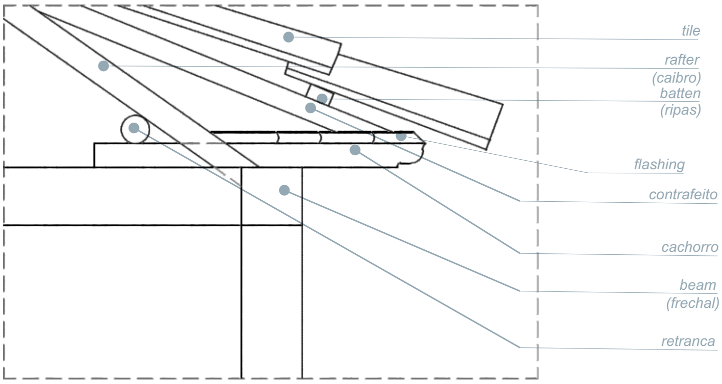
ROOF PLAN

Sections

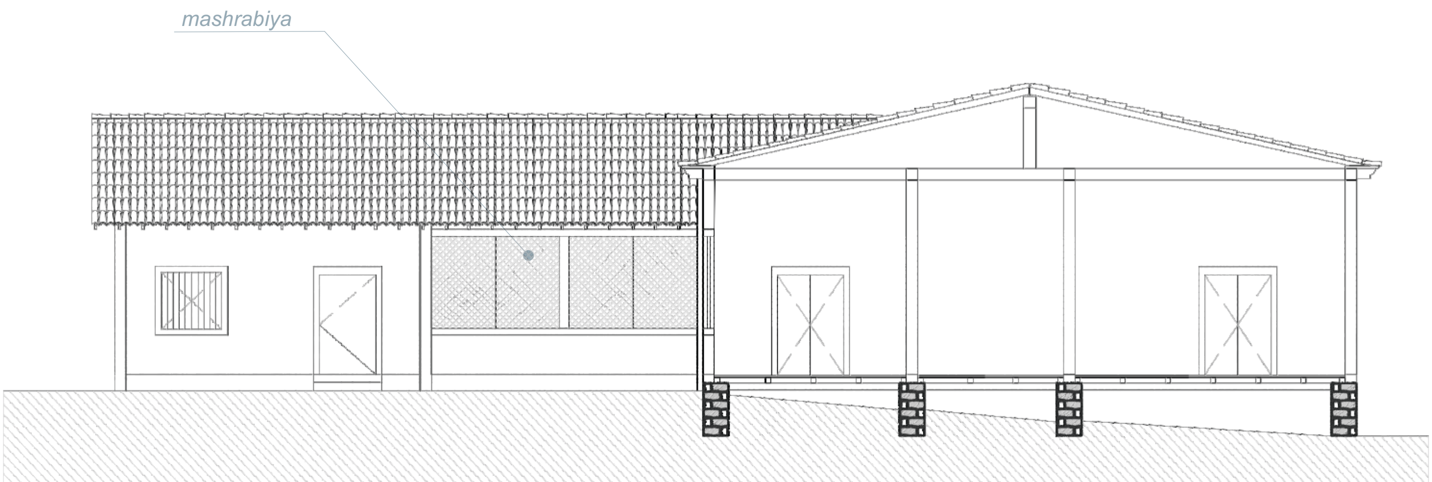


0 2.5 5m

SECTION AA

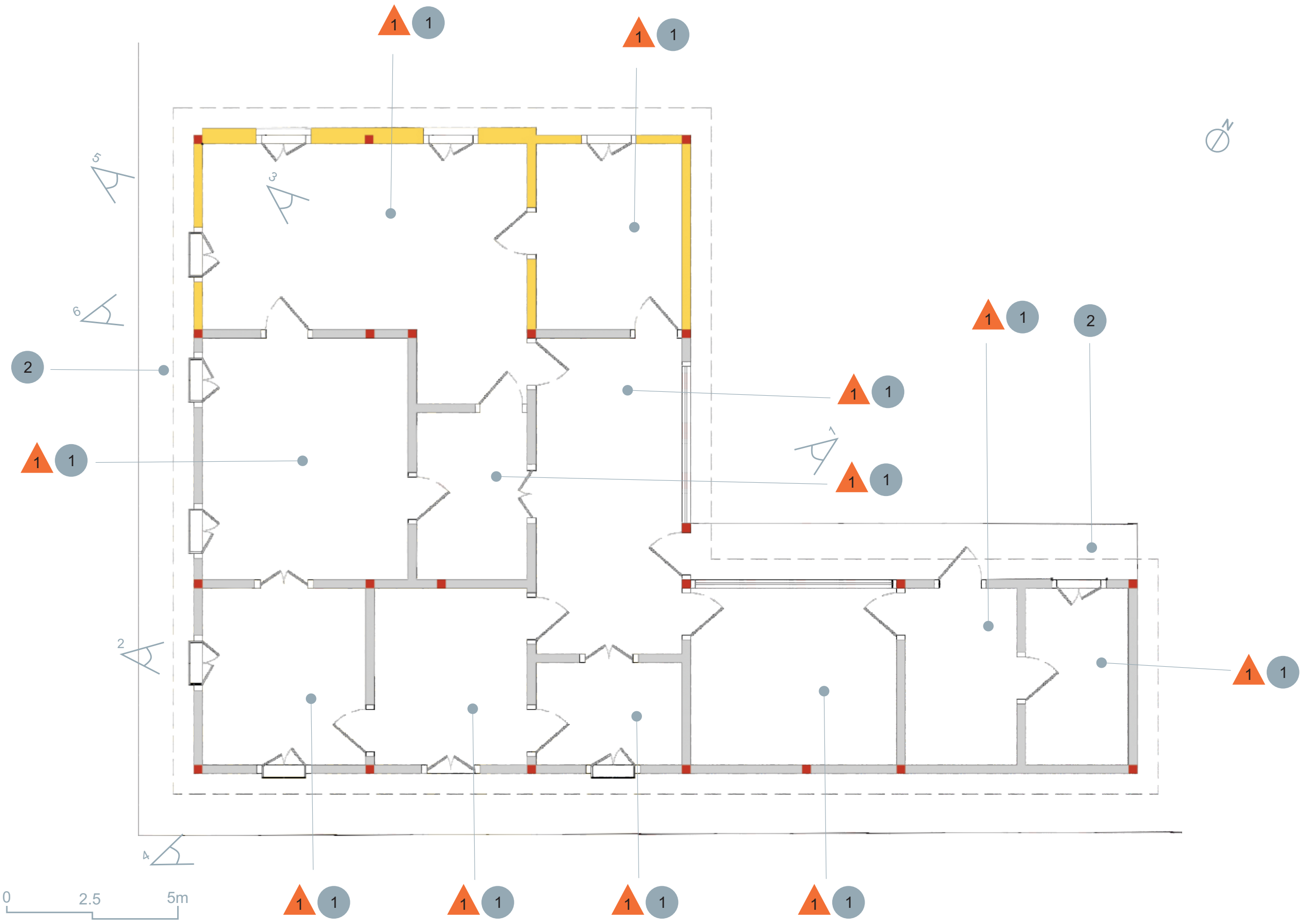


DETAIL.1



0 2.5 5m

SECTION BB



LEGEND

- Adobe wall
- Solid brick wall
- Wood pillar

Ceiling
1- Tiles

Floor
1- Barrote
2- Stone

CONSTRUCTION SYSTEMS

Photo details


1- Mashrabiya


3- French truss


5- 1980-Solid Brick wall


2- Gelosia


4- Adobe wall


6- Cangicado

Figure 111 – Otilia House. [Source: IPHAN. Descriptive report prepared by Hollus Engenharia. Goiânia: IPHAN, 2011.]

4.3.1.Decay

According to the photos from the a technical report prepared by *Hollus Engenharia* and carried out by IPHAN in 2011, the following decays were observed in the Otília House:

Decay: Wood splitting
Possible Causes: Nail penetration causing localized stress and splitting along the wood grain.
Location: Pillar

Decay: Delamination
Possible Causes: Excess moisture; Incompatible materials; Rapid drying; Poor adhesion between the wall plaster layers; Structural movement; Incorrect mix composition
Location: plaster applied under the roof

Decay: Moisture darkening
Possible Causes: Water infiltration from rain or leaks; Rising damp from the ground; Lack of protective overhangs or drainage; Use of non-breathable surface coatings; Hair cracks allowing moisture ingress
Location: exterior wall painting

Decay: Black crust
Possible Causes: Air pollution (sulfur dioxide and other pollutants); Accumulation of soot and dust particles; Repeated wet-dry cycles and moisture retention; Poor drainage around the foundation; Persistent humidity; Chemical reactions between pollutants and stone minerals
Location: Stone Foundation (Cangicado)

Decay: Stains
Possible Causes: metal corrosion, biological pigments, or tannins from the window
Location: exterior wall painting

Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration; Water trapped between paint layers and wood; Failure of protective coatings.
Location: Gelosia window

Decay: Wood-boring insects
Possible Causes: Use of untreated or unprotected wood; Lack of preventive chemical treatment; Wood in direct contact with soil or damp masonry; High wood moisture content; Cracks or openings allowing insect entry; Warm and humid environments favorable to insect activity
Location: Wood pilar

4.3.2. Interventions

Late 1970s – A partial collapse of the walls in the east façade. The main cause was the long abandonment, together with the lack of maintenance of the roof, that leave the adobe walls exposed. This situation was worse with the action of the strong rains, causing heavy degradation of the material, displacement of the wooden support structure and finally the collapse.

1979–1980 – Emergency and recovery works in 1979, were carried out on the roof. In 1980, the restoration was conducted by IPHAN with contracted technicians and included: replacement of the roof structure, new roofing, restoration of the wooden structure, reconstruction of damaged walls with solid bricks, subdivision of the lateral annex with internal masonry, removal of external plaster to expose the original adobe walls, leveling of the floors without altering the original unevenness, and reconstruction of the windows with modifications to the dimensions and details of the latticework.

1980–2001 – Abandonment Period: Phase marked by abandonment, progressive degradation, and new damage.

2011 – A technical report prepared by Hollus Engenharia evaluated the condition of the property according to heritage conservation criteria, but it was not followed by a restoration project.

4.3.3. Assessment

Table 6 - Assessment of the technical report from 2011

ICOMOS guideline	Justification	Score[1]
1. Research and documentation	A chronological study was built using photos from 1980–2001 and a technical report in 2011. However, no evidence indicates community access to this documentation, nor continuous record-keeping between interventions. The period of abandonment reflects a lack of consistent research-based stewardship.	**4**
2. Siting, landscape and groups of buildings	The spatial configuration and relation to the surrounding architectural context were respected. However, the addition of masonry walls altered part of the volumetric perception and its vernacular openness. External paving was appropriate but not critically integrated.	**4**
3. Traditional building systems	The original mixed construction (wooden cage, adobe, stone) was only partially maintained. The use of solid bricks in the wall reconstruction significantly compromised traditional systems, because this material changed the structural behavior and physical properties of the walls, reducing permeability and flexibility typical of adobe and wood, and breaking the original constructive logic.	**3**
4. Replacement of materials and parts	Wooden elements and gelosias were rebuilt with noticeable dimensional and typological changes, deviating from the originals. While materials were compatible, there is no clear documentation that differentiates old from new.	**3**
5. Adaptation	New partitions, window openings, and spatial reorganizations, though practical, these shifts altered the internal logic of the vernacular typology. Adaptations were more programmatic than culturally embedded.	**3**
6. Changes and period restoration	The 1980 intervention emphasized exposure of raw materials (wood, adobe), replacing prior plastered finishes. This aesthetic reinterpretation ignores the cumulative history and promotes a new “crafted” identity not aligned with the original finish. Partial restoration of collapsed elements lacked historic layering.	**2**
7. Training	No training programs, skill transmission, or heritage education were linked to the restoration. During the abandonment period (1980–2001), no community-based conservation efforts were reported, showing a gap in vernacular knowledge continuity.	**2**

[1]*(1 does not comply with the guideline, and 6 fully complies with the guideline)*

The assessment made by the author in Table 6 shows that the technical report presents only a partial level of conformity with the ICOMOS 1999 guidelines about vernacular heritage, being the sum of points 21 of a maximum possible of 42 – 50% of conformity (average 3/6). The stronger points are in the chronological documentation and in the description of the implantation of the complex in its landscape context, which was approached in a relatively satisfactory way. These dimensions receive higher notes, because it's demonstrate there was an effort to register the temporal evolution and to place the heritage within its spatial configuration.

On the other hand, the report shows important weaknesses in central areas for the conservation of vernacular heritage. The sections that talk about traditional constructive systems and replacement of materials don't describe in enough way the original logic of the techniques used, and also don't establish clear criteria to distinguish the historical elements from the new ones. In the same way, the observations about spatial adaptations stay limited, without a deep discussion about their typological and cultural impacts.

Another critical point it's the approach of period restoration, that don't contemplate in an adequate way the historical stratigraphy, and also the almost total absence of references to initiatives of training, transmission of knowledge or community participation, factors that are fundamental in the field of vernacular heritage.

In this way, the evaluation concludes that the technical report analysed is only partially aligned with the ICOMOS recommendations. Even if it brings valid contributions in the field of documentation and spatial contextualization, it presents relevant gaps in the treatment of material authenticity, in the valorization of traditional technics, and in the integration of social and educational aspects. These lacks limit its capacity to answer in full to the international principles of conservation of vernacular heritage.

4.4. Setecentista House[19]

The Setecentista House is located on Rua da Cadeia, in the historic center of Pilar de Goiás. It was built between 1741 and 1760, in the time of the gold mining peak in the region. It was donated to the Federal Government by Vicente Gomes Tição and Antônia Emerenciano de Andrade in 1951, and since this time, it's been under IPHAN care, working as a museum. The house it's listed by IPHAN since 1954, registered in the Book of Fine Arts under number 413, and it's part of the Architectural and Landscape Complex of Pilar de Goiás. Because of this, today by the Decree-Law nº 25/1937, it's protected by federal law, and all restoration projects must be authorized by the Institute. The property has a maintenance plan registered in IPHAN, because of the obligation of its actual function, and in 2025, it's in a good conservation state.

The house it's a representative example of 18th-century residential architecture in the Midwest, important because of the traditional construction techniques and the good conservation of original decorative elements. The structure uses wooden frames on a stone foundation (*cangicado*), and the walls are adobe. The house keeps important architectural elements, like the carved latticework (*gelosia*) on the main facade, and the gable roof

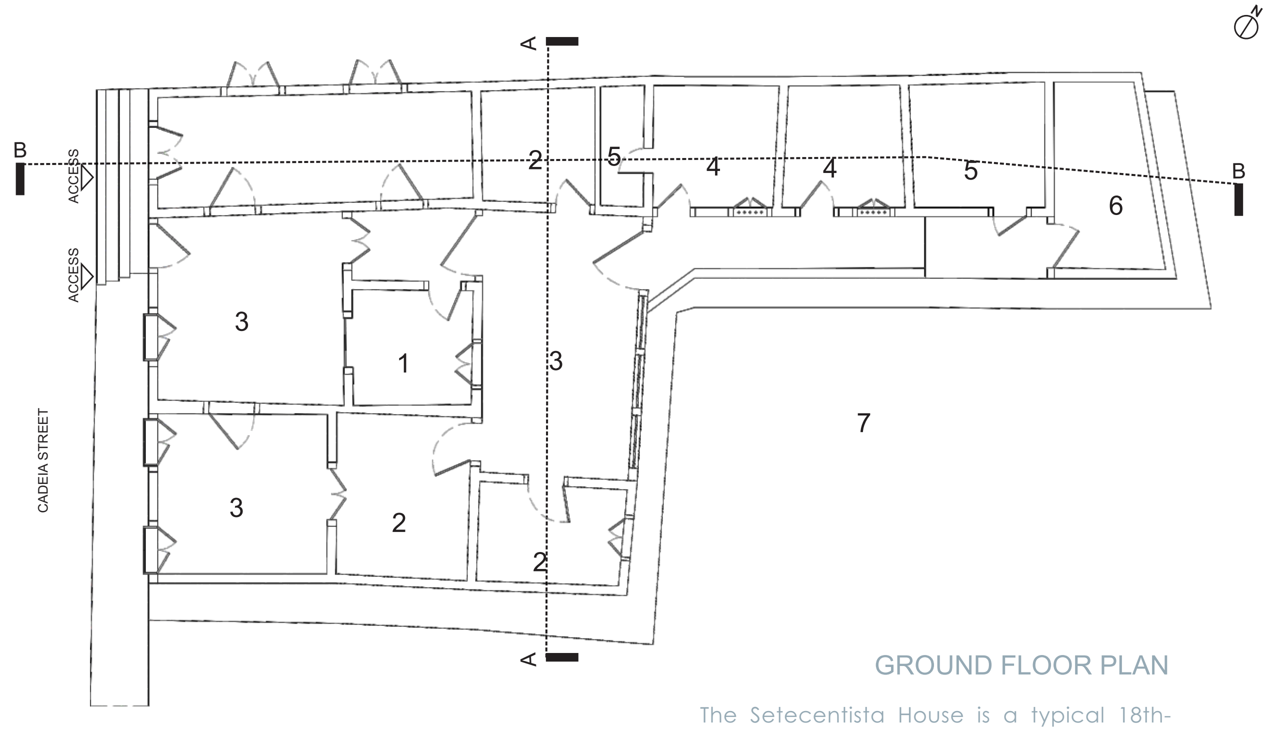
The roof structure it's made of wood, and presents the french truss. The front facade of the building show the eaves with wooden brackets (*cachorros*) typical of the period.

One of the most remarkable aspects of the house it's the decorative elements set: two painted ceilings and five painted doors, three of them with carved and *safenas*, some with openwork carving and visible unfinished preparation layers. The ceilings, made of wood and structured with rough-shaped ceilings (*gamela*), show floral garlands with frames of daily life scenes, like hunting and music, with main colors ochre, pink, green, and red.

1950 *1980* *2009*

Figure 112 – Illustrated timeline of the Setecentista House [Source: IPHAN. Descriptive Report – Museu Casa da Princesa: executive project design and execution of the first restoration stage, in Pilar de Goiás/GO. Goiania: IPHAN, 2011.]

[19] *All the information in this paragraph has been drawn from:* IPHAN (2011)

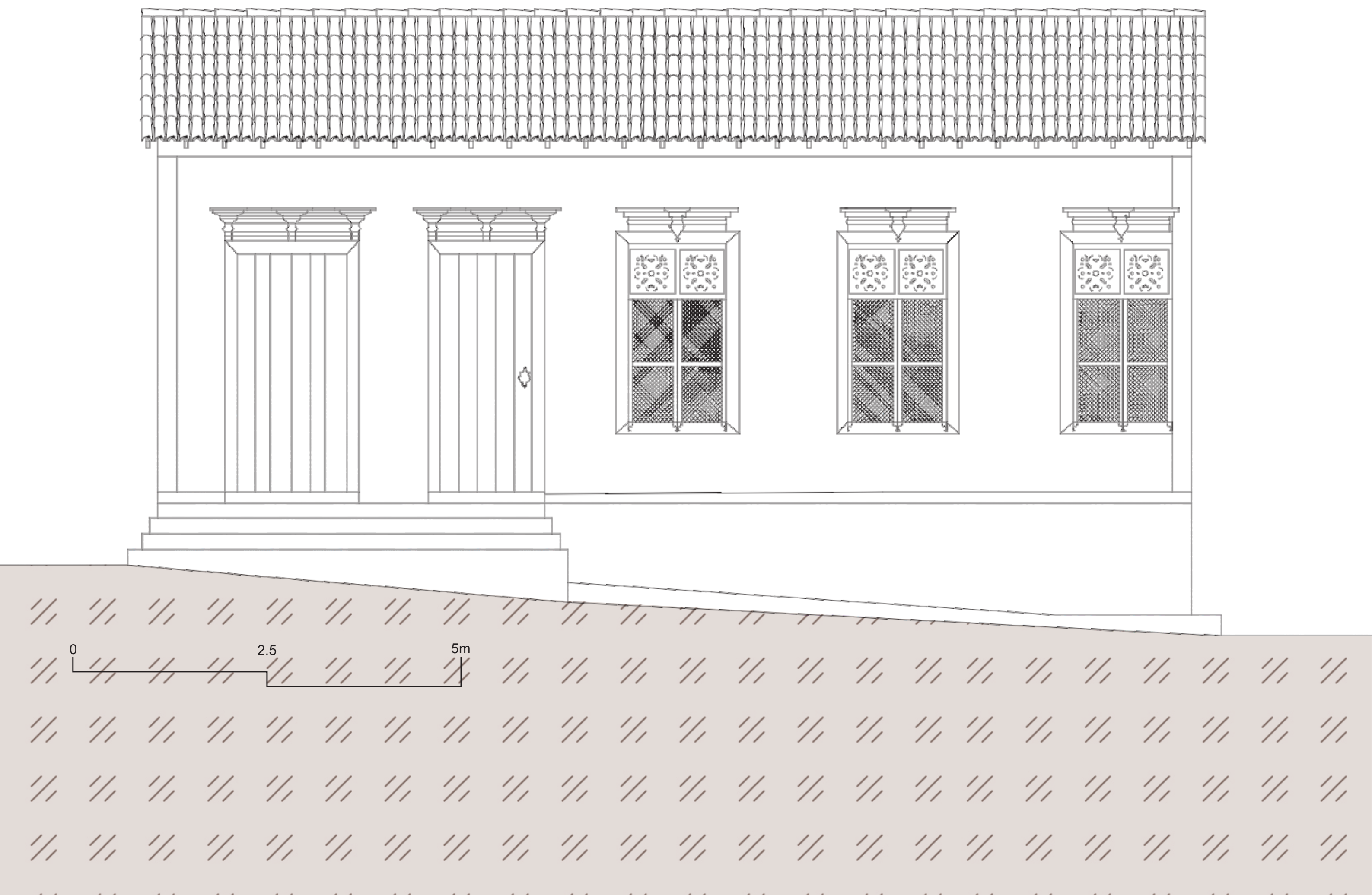


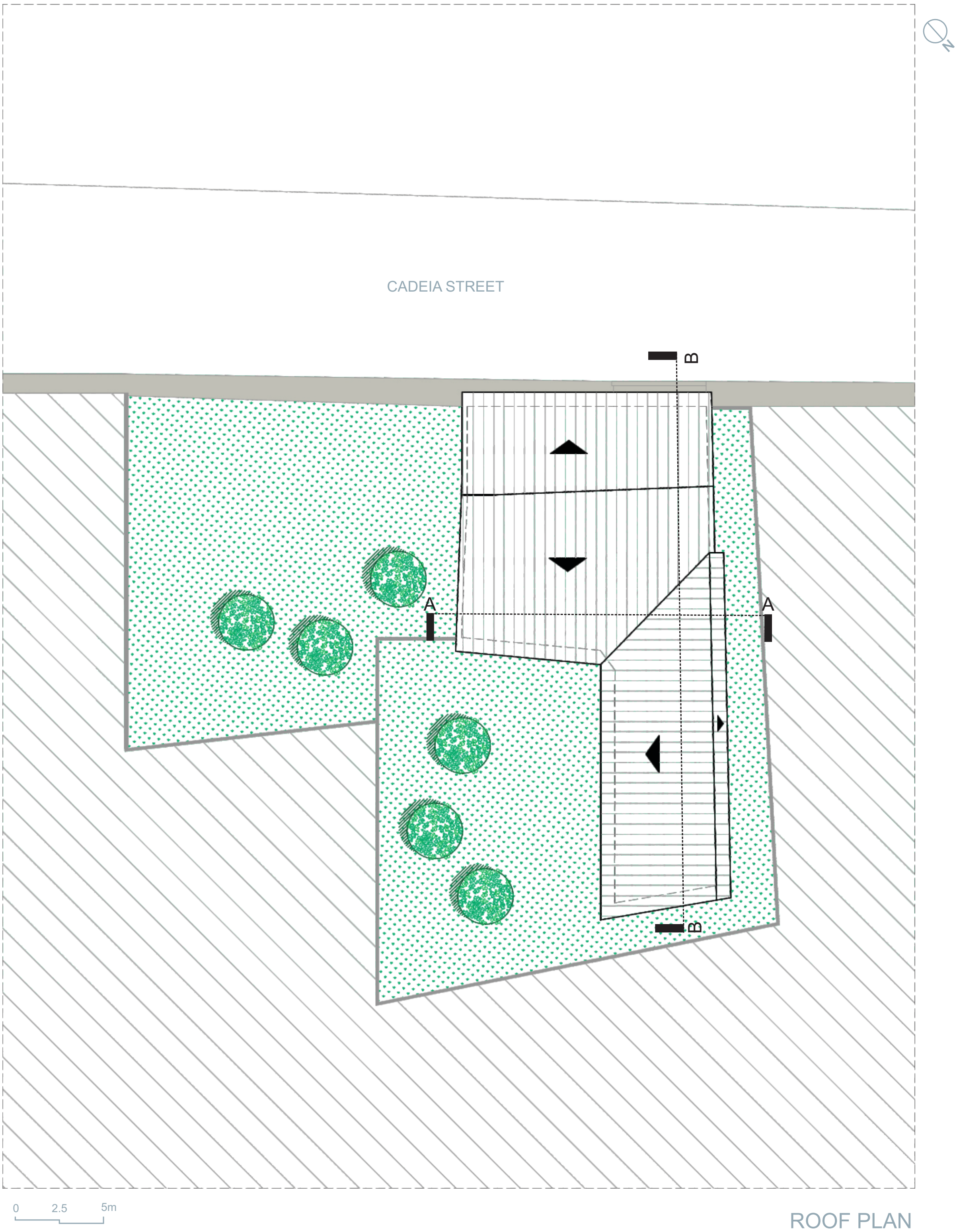
GROUND FLOOR PLAN

The Setecentista House is a typical 18th-century residential home in Goiás, built in an L-shape as a half single-store house. The private area is located at the back and within the interior of the building, while the section facing the street serves public functions. It ´s possible to see a large compartmentalization of the house, as well as the presence of a senzala.

LEGEND

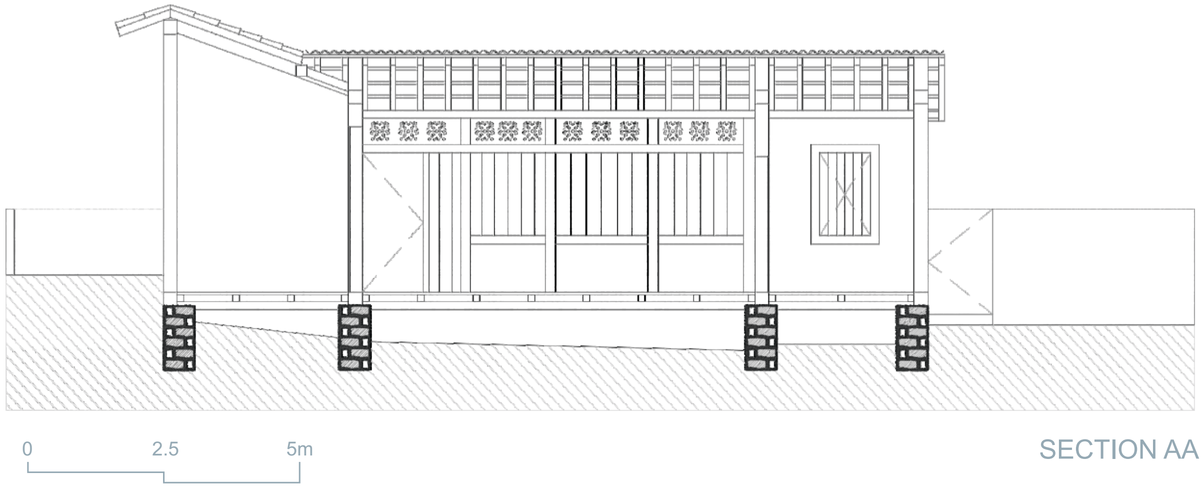
1- Guest Room
2- Private Room
3- Living Room
4- Kitchen
5- Deposit
6- Senzala
7- Backyard

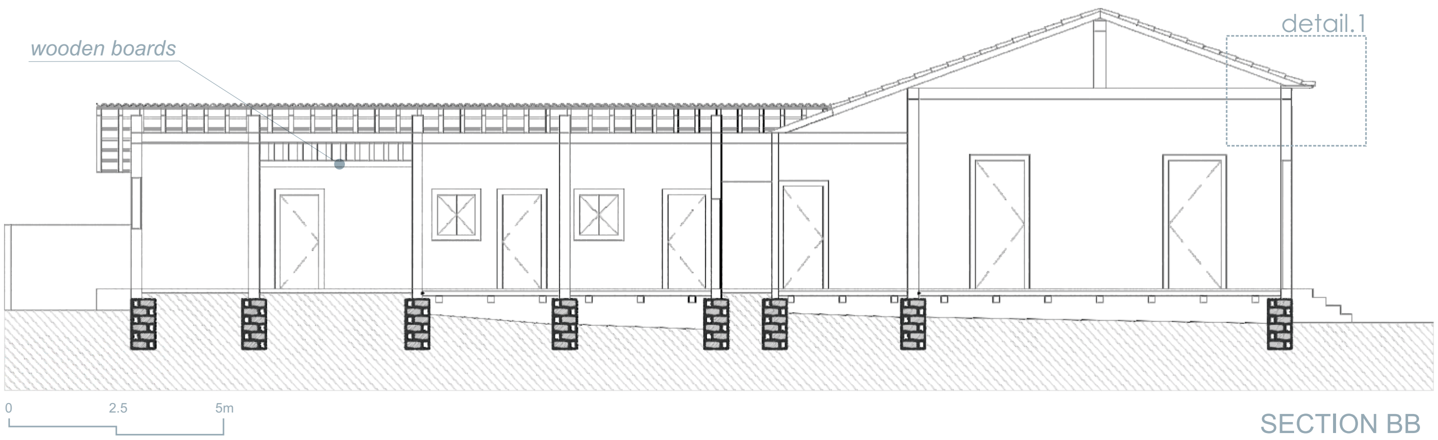




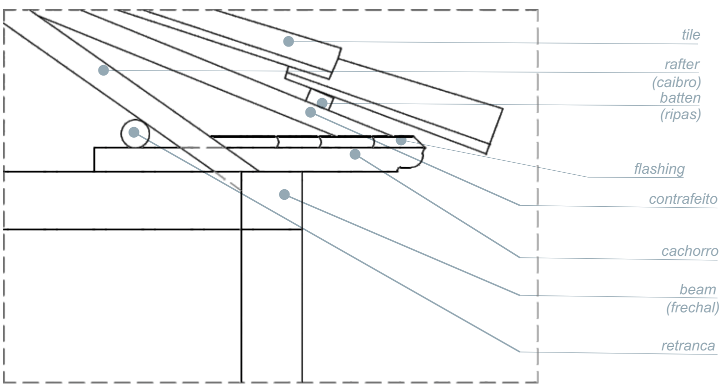
ROOF PLAN

Sections



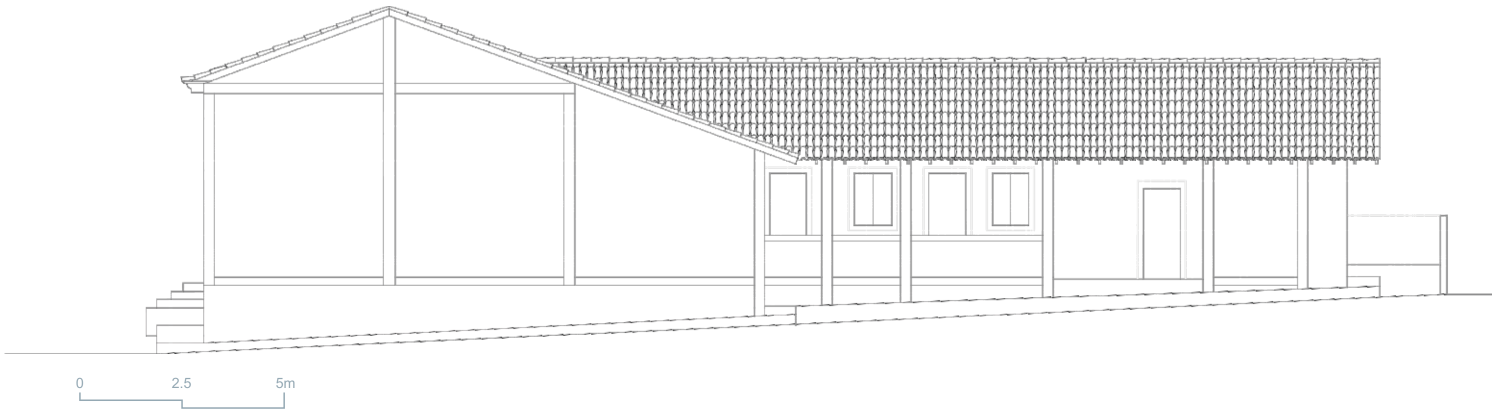


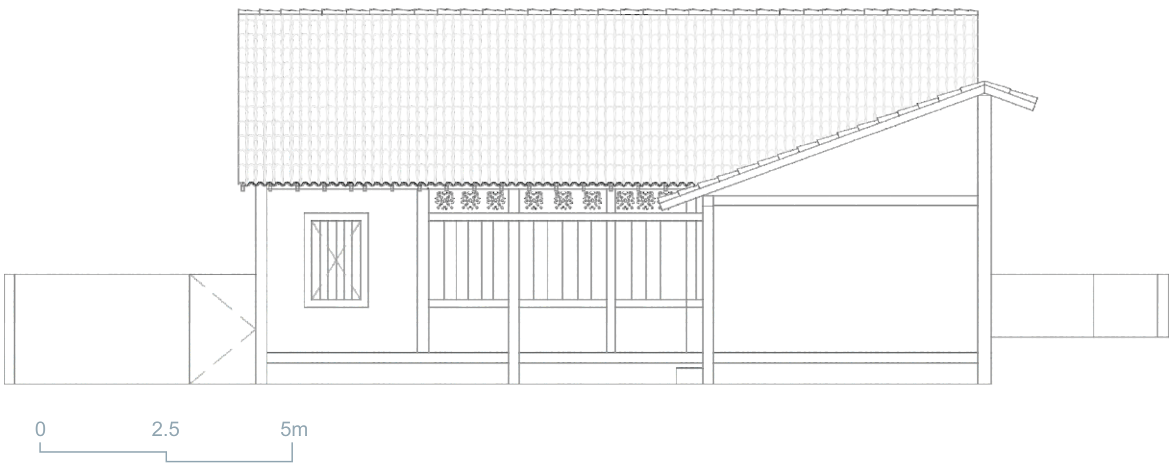
SECTION BB

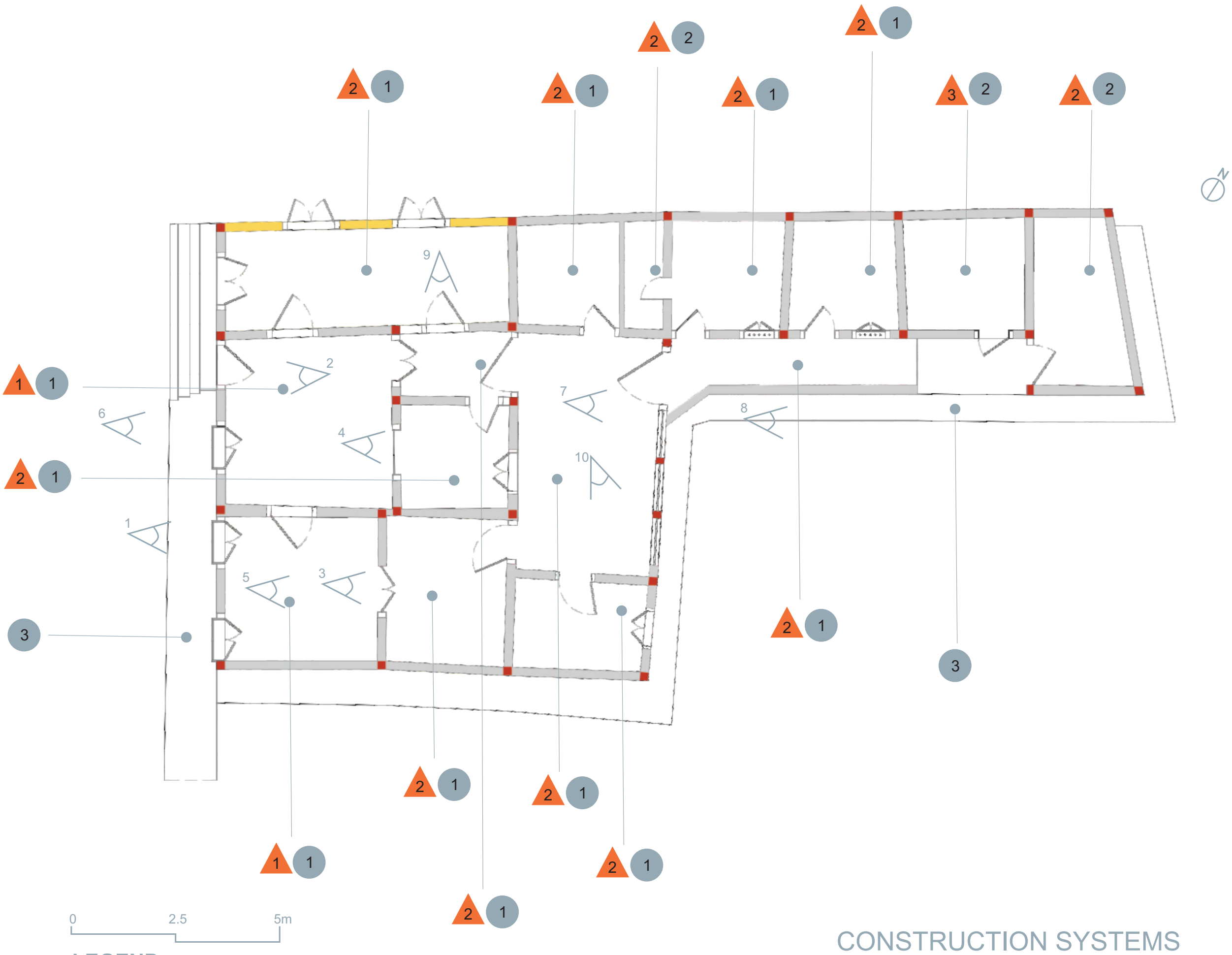


DETAIL.1

Elevations







CONSTRUCTION SYSTEMS

LEGEND

- *Adobe wall*
- *Solid brick wall*
- *Wood pillar*

Ceiling

1- Gamela
2- Tiles
3- Wooden board

Floor

1- Barrote
2- Mezanela
3- Stone

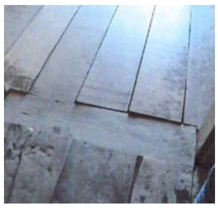
Photo details


1- Gelosia


3- Safena


5- Gamela


7- Double-leaf hinged window


9- Barrote


2- Single-leaf hinged door


4- Safena


6- Cachorro

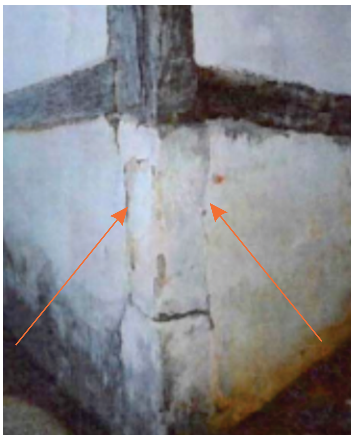

8- Stone floor


10- Tiles

Figure 113 – Setecentista House [Source: IPHAN. Descriptive Report – Museu Casa da Princesa: executive project design and execution of the first restoration stage, in Pilar de Goiás/GO. Goiania: IPHAN, 2011.]

4.4.1.Decay

According to the photos from the descriptive report "*Museu Casa da Princesa: projeto executivo e execução da primeira etapa da restauração,*" carried out by IPHAN in 2011, the following decays were observed in the Setecentista House:



Decay: Crack in mortar
Possible Causes: Differential movement between materials; Shrinkage of the earthen material during drying; Lack of proper bonding connection at the joint; Moisture variation affecting one material more than the other; Wood swelling or shrinking due to humidity changes; Foundation settlement or structural movement; Thermal expansion and contraction cycles; Improper construction detailing or lack of flexibility at the junction
Location: exterior wall painting

Decay: Wood bending
Possible Causes: Excessive moisture absorption (from below or above the floor); Improper acclimatization of the wood before installation; Uneven subfloor or structural movement; Use of green or insufficiently dried wood; Thermal expansion due to temperature changes; Improper fastening or installation techniques; Incompatible adhesives or finishes trapping moisture
Location: Barrote floor

Decay: Blistering
Possible Causes: Trapped moisture beneath the surface layer; Application of plaster over a wet or non-cured substrate; Use of non-breathable finishes (acrylic or cement-based coatings); Poor adhesion between layers; Condensation behind the wall due to lack of insulation or ventilation
Location: internal wall painting

Decay: Abrasion
Possible Causes: Frequent foot traffic or friction from furniture; Use of a weak or overly sandy earthen mix Moisture fluctuations weakening the surface; No regular maintenance or reapplication of protective layers; Vibration or structural movement
Location: Kitchen Mezalena floor

Decay: Stone abrasion
Possible Causes: Frequent foot traffic;Moisture fluctuations weakening the surface; Vibration or structural movement
Location: Outside stone floor

Decay: Impact demage
Possible Causes: Dropping of heavy or sharp objects; Accidental hits from tools or equipment; Moving furniture without proper padding; Falling debris during construction or renovation; Localized structural stress beneath the impact point; Poor wood quality or low-density species
Location: Barrote floor

Decay: Moisture darkening
Possible Causes: Water infiltration from rain or leaks; Rising damp from the ground; Lack of protective overhangs or drainage; Use of non-breathable surface coatings; Hair cracks allowing moisture ingress
Location: exterior wall painting

Decay: Rising damp
Possible Causes: Degraded or failed damp-proof barrier;
Capillary action drawing moisture from the soil into the masonry;
Soil in direct contact with stone walls without protection;
Use of impermeable plasters or coatings trapping moisture inside;
Water accumulation around the foundation due drainage failures
Location: exterior wall

Decay: Soiling
Possible Causes: Airflow patterns carrying dust and pollutants toward the top of the door; Poor indoor air quality or ventilation; Smoke from candles, cooking, or heaters; Condensation attracting dust in humid areas; Previous water infiltration leaving dirty marks;
Improper or infrequent cleaning in hard-to-reach areas
Location: Safena

Decay: Soiling
Possible Causes: Dirt from the ground or wall surfaces; Air pollution and vehicle emissions; Condensation attracting airborne particles; Bird droppings or insect activity; Accumulation in textured or rough window frames
Location: Gelosia window

Decay: Mold
Possible Causes: High indoor humidity levels; Poor ventilation in the room; Roof leaks allowing moisture to reach the wood; Condensation forming on the wood surface; Lack of protective coating or sealant on the wood; Thermal bridges causing localized dampness; Organic dust accumulation serving as a food source for mold; Inadequate insulation leading to temperature differences and moisture buildup
Location: gamela celling

Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration;
Water trapped between tiles and wood;
Failure of protective coatings.
Location: Roof eaves

Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration;
Water trapped between paint layers and wood; High wood moisture content; Failure of protective coatings.
Location: Door

Decay: Wood-boring insects

Possible Causes: Use of untreated or unprotected wood;
Lack of preventive chemical treatment; Wood in direct contact with soil or damp masonry; High wood moisture content;
Cracks or openings allowing insect entry;
Warm and humid environments favorable to insect activity
Location: Door jamb

4.4.2. Interventions

1978 to 1981 – First major intervention made by IPHAN, given the advanced state of deterioration, structural repairs were carried out on the wooden elements, with partial roof replacement (around 50%), reconstruction of beams and the porch floor, and rebuilding of the east façade walls using solid bricks. Side windows were installed, and new electrical and hydraulic systems were added. The ceiling was protected with zinc sheets, and a stone walkway was built around the house. The porch windows were restored based on historical photographs.Inauguration as a museum: The building was reopened to the public as the "Setecentista House Museum", featuring a collection donated by the local community.

1986 and 1995 – Maintenance of the roof repair, replacement of rafters and battens, maintenance of plaster, and painting.

2001 – Artistic restoration of integrated elements made by IPHAN: leaning, fixing, and pictorial reintegration of ceilings, doors, and safenas. It included the consolidation of cracks, retouching with watercolor on the ceilings, securing the painting and filling gaps on the doors, and the removal of base paint from the safenas for wood treatment with wax and resin.

2011 to 2012 – A complete restoration project was carried out by IPHAN, representing the most recent intervention. It can be described through the following Project Units (UP):

UP.1 – Preliminary Survey and Documentation

UP.1.a – Foundation and initial explorations

The surveys in stone and clay foundations identified cracks and settlements, allowing for the planning of future insertion of stone wedges in lime mortar, without compromising the original structure. The methodology included visual inspections, the use of rubber hammers for percussion, and spot excavations. The main concern was to preserve the integrity of the original foundations, avoiding damage or instability during excavations and inspections.

UP.1. b – Survey of materials and diagnosis

As described, this stage involved surveying the conditions of the constituent materials, such as wood, masonry, and coatings, through detailed visual inspections and sample collection for laboratory tests to confirm composition and degradation. The methodology was based on meticulous inspection, photographic documentation, and laboratory analysis. The fundamental care was not to compromise the samples and to faithfully document the characteristics to support the restoration stages.

UP.1. c – Photographic and documentary record

Detailed enlargements of photographic records, drawings, and notes were made to document all pathologies, fissures, deformations, and general structural conditions. The methodology included the use of high-resolution digital cameras and recording software. The main concern was to ensure the accuracy and comprehensiveness of the record to support all subsequent technical decisions.

UP.1. d – Preliminary stability monitoring

In the case of the Setecentista House, crack and structural movement monitoring was installed using instruments such as millimeter scales, levels, and fixed reference points, periodically monitored to assess the evolution of pathologies before any intervention. The methodology focused on systematic and periodic monitoring. The care was to avoid any intervention that could modify the structural dynamics before the consolidated data analysis.

UP.2 – Cleaning

UP.2. a – Removal of dust, loose particles, and surface residues

This process included controlled removal of organic residues, such as mosses and lichens, that adhered to external surfaces.

UP.2. b – Controlled cleaning with localized application of water and neutral detergent for the removal of stains and deposits

Tests were conducted to determine the contact time of the solution, ensuring that the original layers of plaster and masonry were not softened or dissolved. The removal of the solution was done with dry cloths to avoid moisture retention that could damage the structure.

UP.2. c – Controlled removal of damaged plaster for inspection and masonry repair

In specific areas, it was necessary to remove sections of deteriorated plaster for a detailed assessment of the underlying masonry conditions. The methodology included manual removal with delicate tools to avoid structural damage, followed by cleaning the exposed masonry surfaces, allowing for the identification of cracks, moisture, and areas needing intervention.

UP.3 – Structural Consolidation

UP.3.a – Reinforcement and stabilization of the foundations

The existing foundations showed signs of differential settlement and cracking, compromising the structural stability of the building. An intervention for reinforcement and stabilization was carried out, aiming to correct these pathologies and ensure long-term structural safety. After a thorough technical diagnosis, it was decided to inject a suspension based on natural hydraulic lime (NHL) into the cracks and voids, promoting the filling and re-compaction of the soil adjacent to the foundations, given its physical-chemical compatibility with the historical materials. At critical points, micro-piles and additional footings were executed, sized based on geotechnical surveys, and carried out using low-impact techniques to avoid unwanted vibrations.

The execution was accompanied by continuous monitoring to control settlements and prevent additional damage. The techniques used were technical inspection with photographic documentation, controlled injection of hydraulic lime suspension, manual soil re-compaction, and installation of localized structural reinforcements with reversible anchors. The products used were natural hydraulic lime (NHL) prepared on-site, lime mortar with sand for stabilization, selected natural aggregates for re-compaction, and metallic elements treated with corrosion inhibitors, prioritizing reversibility and compatibility with the original materials.

UP.3.b – Consolidation of stone and clay masonry

The mixed masonry of stone and clay showed degradations such as disaggregation, cracks, and loss of cohesion between the components, jeopardizing the structural integrity. The consolidation was carried out using techniques compatible with the original construction materials, respecting their hygroscopic and permeability properties. Interventions were applied, such as surface reinforcement with manually applied lime plaster, injection of fluid suspension of hydrated air lime with fine aggregates to fill internal voids, and joint reconstruction with air lime mortar and washed sand, without the addition of cement, preserving the flexibility of the assembly. Products used included aerial lime mortar with controlled grain size sand, fluid suspension of hydrated aerial lime for injection, plant fibers, and natural additives (such as casein or linseed oil) to optimize adhesion and elasticity.

UP.3.c – Reinforcement and recovery of wooden structures

Structural elements in wood showed biological and mechanical degradation, mainly caused by wood-boring insects and moisture. After a detailed assessment, the consolidation of compromised pieces was carried out, and the localised replacement of those that were irrecoverable, ensuring the stability and durability of the system.

The cracks and losses were treated with epoxy or polyurethane resins compatible with wood, promoting internal filling and restoration of structural strength. The replaced pieces followed strict criteria for morphological and material compatibility, using reforested wood with physical properties equivalent to the originals. Preventive antifungal and insecticide treatment was applied. The products used were epoxy or polyurethane resins for consolidation, biocidal products based on natural solvents for preventive protection, and reforested treated wood with the original profile (the report does not specify which was used).

UP.4 – Restoration of integrated elements

UP.4.a – Restoration of frames

The wooden frames showed degradation due to prolonged exposure to the weathering agents, including localized rotting, warping, cracks, corrosion of the hardware, and fitting issues. The intervention aimed at functional and aesthetic restoration, preserving the historical value. The pieces were carefully removed and sent for treatment in a specialized workshop. The techniques applied were specific cleaning, mechanical and chemical, for the removal of dirt, fungi, and deteriorated paint layers; volumetric recomposition with natural fillers in gaps and cracks; punctual replacement of irrecoverable components with compatible wood; reframing and alignment of the sheets; recovery or replacement of original hardware when necessary; sanding and finishing with natural products. The products used were plant-based fillers for fillings, natural oils and varnishes for finishing, lime-based paints with mineral pigments, hardware compatible with the original models, and natural adhesives for structural bonding.

UP.4.b – Restoration of Coatings and Finishes

The internal and external coatings exhibited superficial and structural degradations, such as delaminations, efflorescences, cracks, loss of cohesion, and color changes. The pathological survey guided the restoration of the affected areas using techniques compatible with the original construction system. The techniques employed were the manual removal of loose coatings, reapplication in successive layers of lime mortar (plaster and render), leveling with wooden trowels, and finishing with mineral paint or natural pigments. The surfaces with cohesive substrate were preserved and integrated with the new layers, respecting the historical stratigraphy. The materials used were aerial lime mortar with selected sand of controlled granulometry, natural mineral pigments, plant additives for plasticity, and mineral paints for finishing.

UP.4.c – Recovery of Floors

The original floors, made of wood type *Barrote*, *mezanela,* and natural stones, showed superficial wear, rot, unevenness, and partial losses. The intervention included a detailed inspection, photographic documentation, and an assessment of the compromised areas. The loose pieces were removed and stored for reuse. Reinforcement and replacement of the structural supports of the beams were carried out with compatible materials. Deteriorated boards were replaced with equivalent pieces of treated wood, applied over beams with antifungal treatment. For earth and stone floors, the installation of the new pieces used lime mortar, with compatible grouting. The products used were compatible treated wood (the memorial does not specify which was used) from reforestation with preservative treatment, supports in stone or compatible mortar, *mezanelas* and stones similar to the originals, lime mortar for setting, and natural resins for fixation and protection.

UP.5 – Additional facilities

UP.5.a – Review and Update of Electrical and Hydraulic Installations

The electrical and hydraulic networks were removed due to their state of obsolescence and non-compliance with current standards. The update prioritized safety, functionality, and compatibility with the heritage value. The techniques used were the selective removal of old installations, the implementation of new pathways in hidden areas (ceilings, baseboards, shafts) to minimize visual impact. Installation of modern electrical panels with differential protection and independent circuits. The hydraulic network was replaced with lightweight, durable materials that are easy to maintain. Detailed documentation for future maintenance. The materials used were copper wiring with thermoplastic insulation, modern circuit breakers and distribution panels, PVC pipes and easy-to-assemble hydraulic connections, faucets, valves, and safety devices following the Brazilian standard (NBR 5410).

UP.5.b – Integration of Security and Monitoring Systems

A modern asset security system was installed, including sensors, cameras, and alarms, with minimal visual interference on the facades and volume. The techniques used included routing cables through conduits hidden in cornices, baseboards, and ceilings; non-invasive installation of compact cameras at strategic points; and centralization of management and automation via control panels. The materials used were presence and motion sensors, high-resolution cameras, acoustic and visual alarms, low-voltage cables, and equipment for remote recording and transmission.

UP.5.c – Suitability for Accessibility and Environmental Comfort

Adaptations to comply with accessibility standards and improve thermal and acoustic comfort, respecting original construction characteristics. The techniques used included the installation of ramps with an incline and non-slip flooring, support bars in restrooms, thermal and acoustic insulation with natural materials in roofs and ceilings, and optimization of cross ventilation with minimal structural impact. Materials used included cork or fiberglass insulation panels, non-slip flooring, discreet metal bars, shutters, and perforated elements for natural ventilation.

UP.6 – Painting and Protection

UP.6.a – Surface Preparation for Painting

Before the application of the paint, all internal surfaces (walls, ceilings, frames) and external surfaces (facades, moldings, decorative elements) were prepared according to their specific characteristics. The process included mechanical and chemical cleaning to remove dirt, fungi, efflorescence, and loose layers, as well as sanding with natural abrasives to uniform the texture. Stratigraphic surveys were conducted in the internal and external areas to identify and document the historical pictorial layers, enabling the faithful reconstruction of the original colors and patterns. Any irregularities were corrected with natural base compounds, respecting the original texture and permeability of the substrate. The products used were natural abrasives (vegetable and mineral), sealers based on lime or silicate, and leveling compounds formulated with lime and natural aggregates.

UP.6.b – Application of Lime-Based Paints and Natural Pigments

The painting was carried out on the internal and external walls, ceilings, and wooden frames of the building, using mineral paints based on hydrated lime. Traditional techniques were used to ensure the permeability and breathability of the surfaces. The application was done in multiple thin layers with broad brushstrokes, ensuring uniformity and adherence. The colors were reproduced from natural mineral pigments, extracted from inorganic sources compatible with the historical color palette, according to surveys conducted on the internal and external surfaces. The products used were high-purity hydrated lime, natural mineral pigments (ochre, sienna earth, charcoal, colored clays), and potable water for dilution.

UP.6.c – Application of Surface Protection

To increase the durability of the paint and protect the external surfaces exposed to the elements, especially the facade walls, frames, ornaments, and external decorative architectural elements of the historical building, a protective layer composed of natural products compatible with the mineral base was applied in thin and homogeneous coats, ensuring absorption without the formation of an impermeable film. The products used provide water repellency, maintaining the breathability and hygrothermal balance of the building, essential to avoid moisture-related pathologies. The products used were emulsions of vegetable resins (such as casein and emulsified linseed oil), potassium silicate-based water repellents, and natural waxes.

UP.7 – Final review and delivery of the work

UP.7. a – Final inspection and adjustments of the intervention

After the completion of the restoration and protection phases, thorough inspections were carried out in all intervening areas, checking the structural integrity, effectiveness of the treatments, and quality of the finishes. Measurement instruments were used to detect possible settlements or residual cracks, as well as moisture and resistance tests at critical points. Spot adjustments, such as additional reinforcements, finishing touches, and reapplication of protective products, were carried out as needed.

UP.7. b – Final documentation and intervention records

Detailed documentation of all project phases was prepared, including intervention maps, technical reports, and descriptive memoranda, but without photos. This documentation serves technical and historical purposes, for future reference and conservation monitoring.

UP.7. c – Heritage education and future monitoring

Heritage education was carried out as a final step to raise awareness among the local community and users about the importance of preservation and continuous care for the heritage.

4.4.3. Assessment

Table 7 - Assessment of the restoration project from 2012

ICOMOS guideline	Justification	Score[1]
1. Research and documentation	Documentation was thorough and methodologically sound, with clear diagnoses and surveys.	6
2. Siting, landscape and groups of buildings	The site was respected and modern additions (accessibility, utilities) were discreet. However, the document lacks critical discussion on visual integration of infrastructure like ramps and security systems with the historical language of the house.	4
3. Traditional building systems	Traditional systems were generally preserved and reinforced, but some treatments (use of micro-piles) introduce modern materials without full reversibility or clarity on long-term behavior with traditional components.	5
4. Replacement of materials and parts	There was commendable effort in using compatible materials, but the introduction of certain new composite materials (resins, synthetic protectors) raises questions about long-term aging and reversibility in a vernacular context.	4
5. Adaptation	Accessibility and climate control interventions were modest and reversible, though there is minimal evidence of a deeper participatory design process or local code of ethics guiding the adaptive reuse.	4
6. Changes and period restoration	Restoration avoided fictional unity, but certain aesthetic decisions (surface standardization, painting tones) appear to prioritize formal regularity over acceptance of patina and irregularity inherent to the vernacular.	4
7. Training	A basic heritage education component was included, but there's no indication of training craftspeople, capacity-building, or skill transmission key for the continuity of vernacular traditions.	3

[1]*(1 does not comply with the guideline, and 6 fully complies with the guideline)*

The assessment made by the author in Table 7 shows that the restoration project presents a medium level of conformity with the ICOMOS 1999 guidelines about vernacular heritage, being a sum of points of 30 points out of a maximum possible of 42, or around 71% of conformity (average 4,3/6). The strongest point it's in the research and documentation, which was very complete, with clear diagnoses and surveys, giving the highest score. Also, the traditional building systems were, in general, preserved and reinforced, showing an effort to respect the original constructive logic.

In other aspects, like the siting and the relation with the landscape, the project keeps a discreet approach, but doesn't discuss in deep the visual integration of new infrastructures like ramps or security systems. The replacement of materials also shows a good intention of compatibility, but the use of resins and synthetic protectors creates doubts about long-term behavior and reversibility. Adaptations for accessibility and climate control stay modest and reversible, but the document don't show evidence of participatory design or local ethical codes that could guide the restoration

The part about changes and period restoration avoided fictional unity, but the aesthetic decisions prefer more standardization and regularity, not so much the patina and irregularity that are important in vernacular heritage. Finally, the training component was weak, because even if a basic heritage education was included, there was no clear program for capacity-building or for transmission of skills to local craftspeople, which are essential for the continuity of traditions.

In this way, the evaluation concludes that the restoration project analysed is in partial but significant alignment with the ICOMOS recommendations. It brings strong contributions in the field of documentation and in the respect of traditional building systems, but presents limitations in the critical integration of modern additions, in the use of new materials, and especially in the social dimension of training and transmission of knowledge. This means the project it's technically consistent, but not yet complete in relation to the international principles of conservation of vernacular heritage.

4.5. Enxaimel House [20]

The Enxaimel House is located on Rua da Cadeia in Pilar de Goiás, and it was built in the middle of the 18th century, maybe in the time of the wedding of Francisco Gomes Tissão, a Portuguese immigrant, with Eufrásia Maria Xavier Pissarro in 1752. The house passed to the family, and the last owner got it like a gift from her grandfather, Vicente Gomes Tição. Now it belongs to the State of Goiás and it works like a museum, under the Museum of Bandeiras in the city of Goiás. The building it's part of the Architectural and Landscape Complex of Pilar de Goiás, which was listed by IPHAN in 1954. Because of this, today it's protected by federal law (Decree-Law nº 25/1937), and all restoration projects must be authorized by the Institute. The house has a maintenance plan in IPHAN, because of the obligation of its use, but in 2025 it's closed for visits, and the conservation state it's moderate, with some decays in the main facade.

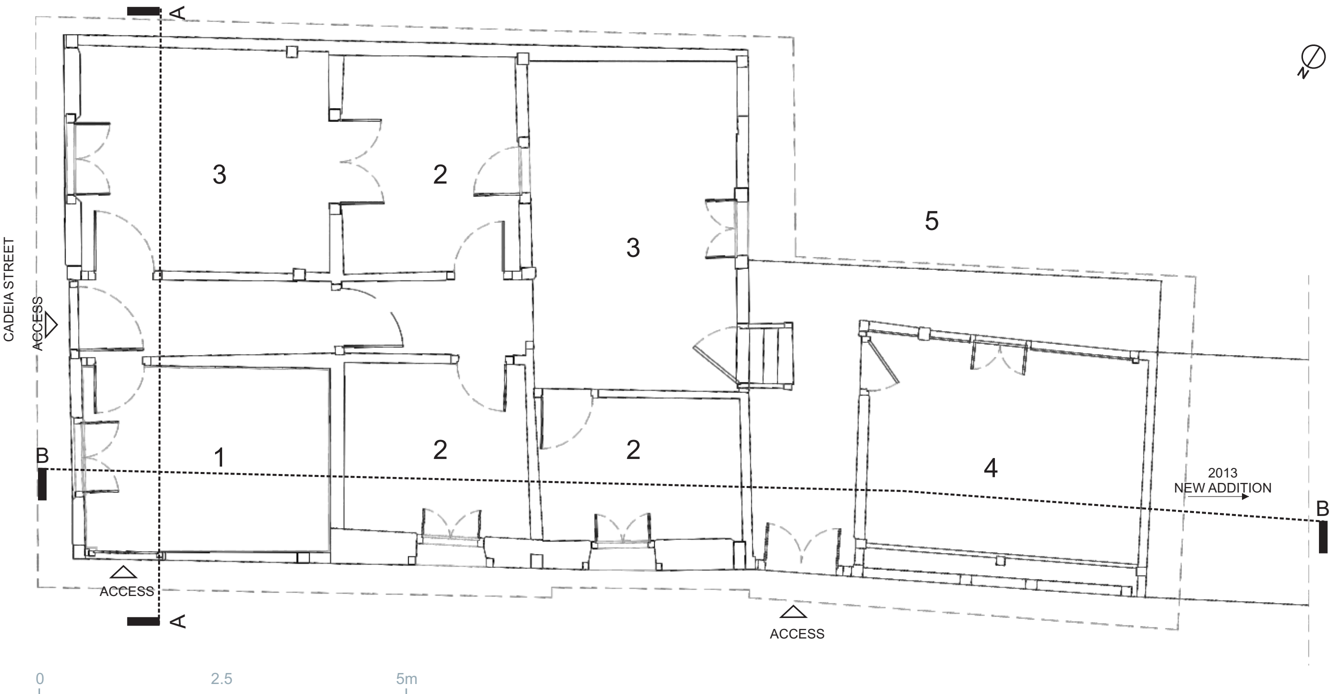
The building uses the half-timbering technique in the north and east facades. This system, from Europe, it's a wood frame visible outside. The structure uses diagonal bracing for stability, and the infill between beams it's normally clay, stone, raw brick, or fired bricks. But the Enxaimel House uses Portuguese half-timbering with horizontal bracing. It's a rare example in the region and shows adaptations of the system, with local knowledge and local materials.

The half-timbering walls' infill was made with adobe and stones, and inside, it used the wattle and daub technique. The structure it's wood, with the foundations type *ensilharia* and *cangicado*. The floor it's *barrote* type in the private and living rooms, and in the kitchen it's *mezanela* type. The roof has French truss in wood, and it's covered with colonial tiles. On the border of the main facades, it's possible to see the wooden brackets (*cachorros*), very common in the colonial architecture. The house also presents ornamental woodwork, including *safanas* on the doors and *gelosias* on the windows.

1954 *1982* *1995*

Figure 114 – Illustrated timeline of the Enxaimel House. [Source: IPHAN. Descriptive report on restoration/requalification: CASA ENXAIMEL 2013/2015. Goiânia: IPHAN, 2015.]

[20] *All the information in this paragraph has been drawn from:* IPHAN (2015); FEIBER(2014)

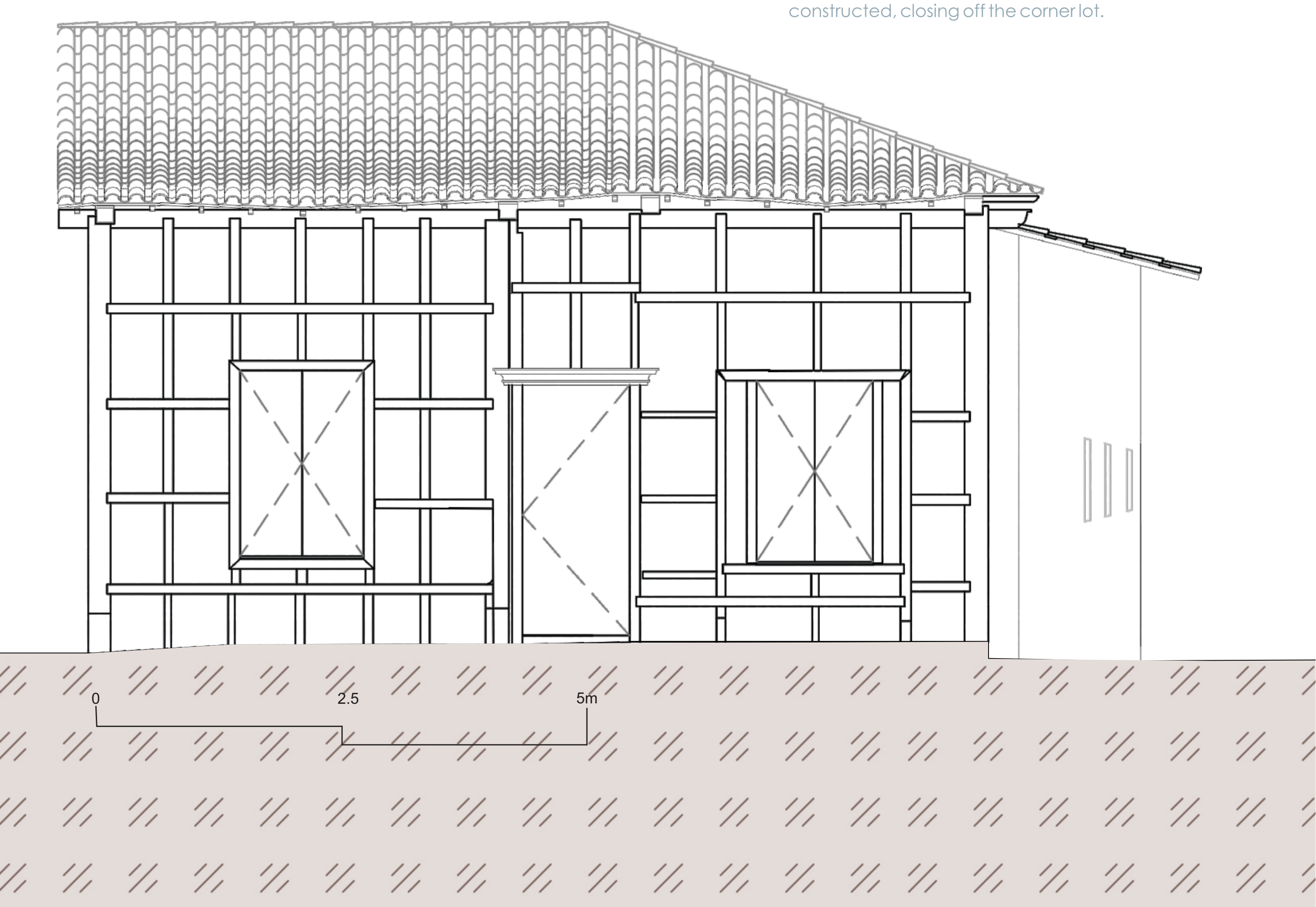


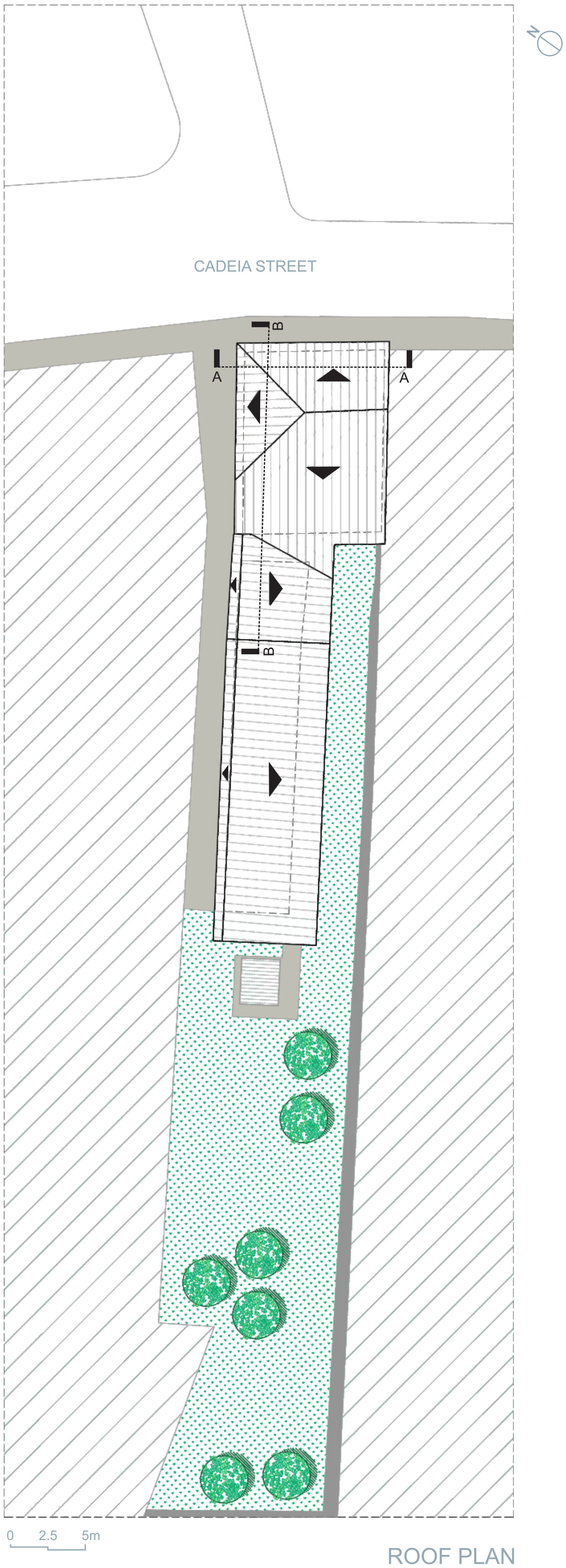
LEGEND

- 1- Guest Room
- 2- Private Room
- 3- Living Room
- 4- Kitchen
- 5- Backyard

GROUND FLOOR PLAN

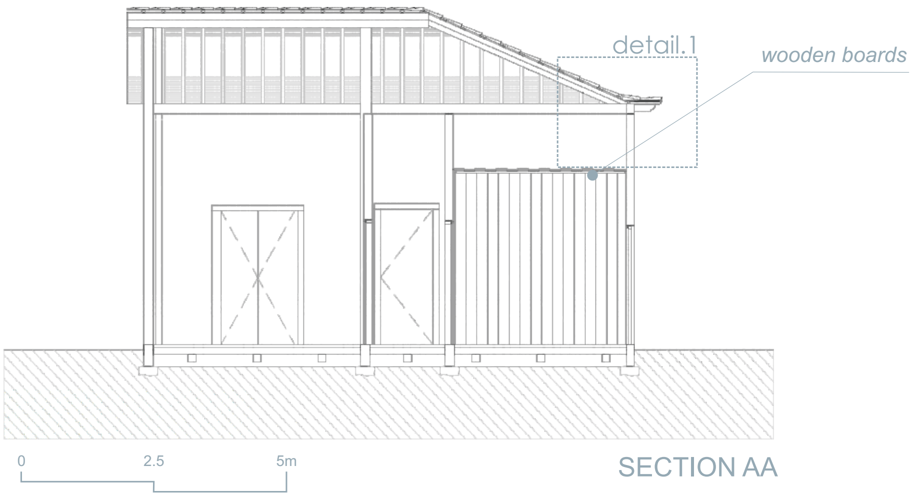
The Enxaimel House is a typical 18th-century residential home in Goiás, built in an L-shape as a full-scale single-store house. The private area is located at the back and within the interior of the building, while the section facing the street serves public functions. In 2013, as part of the rehabilitation project, an annex was constructed, closing off the corner lot.



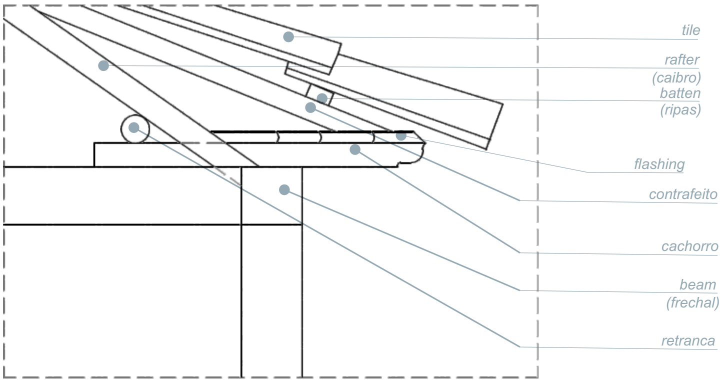


ROOF PLAN

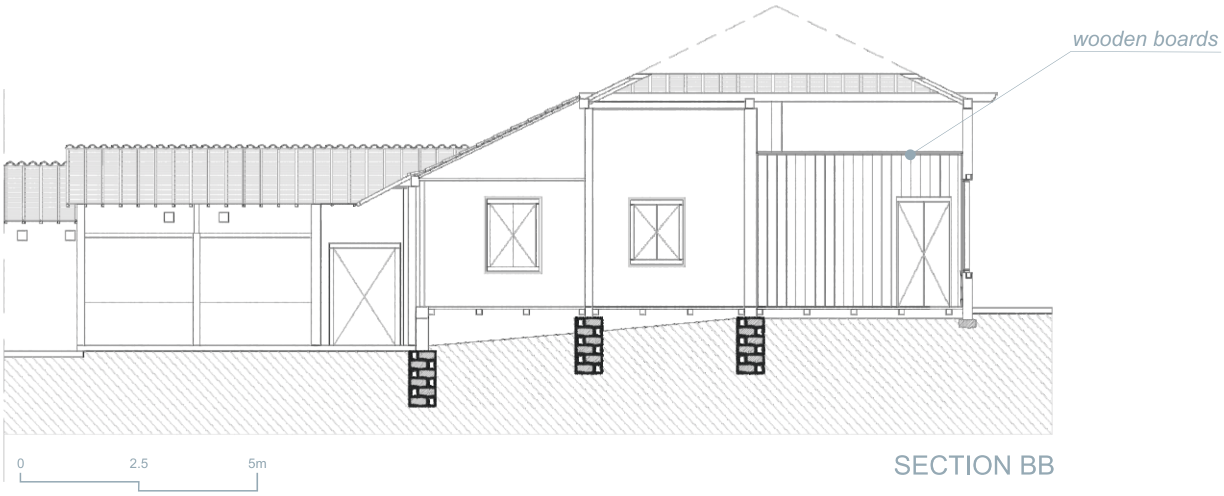
Sections



SECTION AA

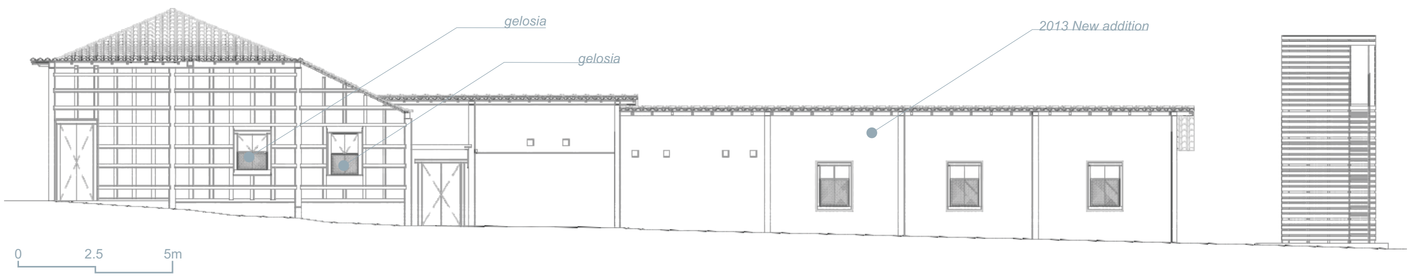


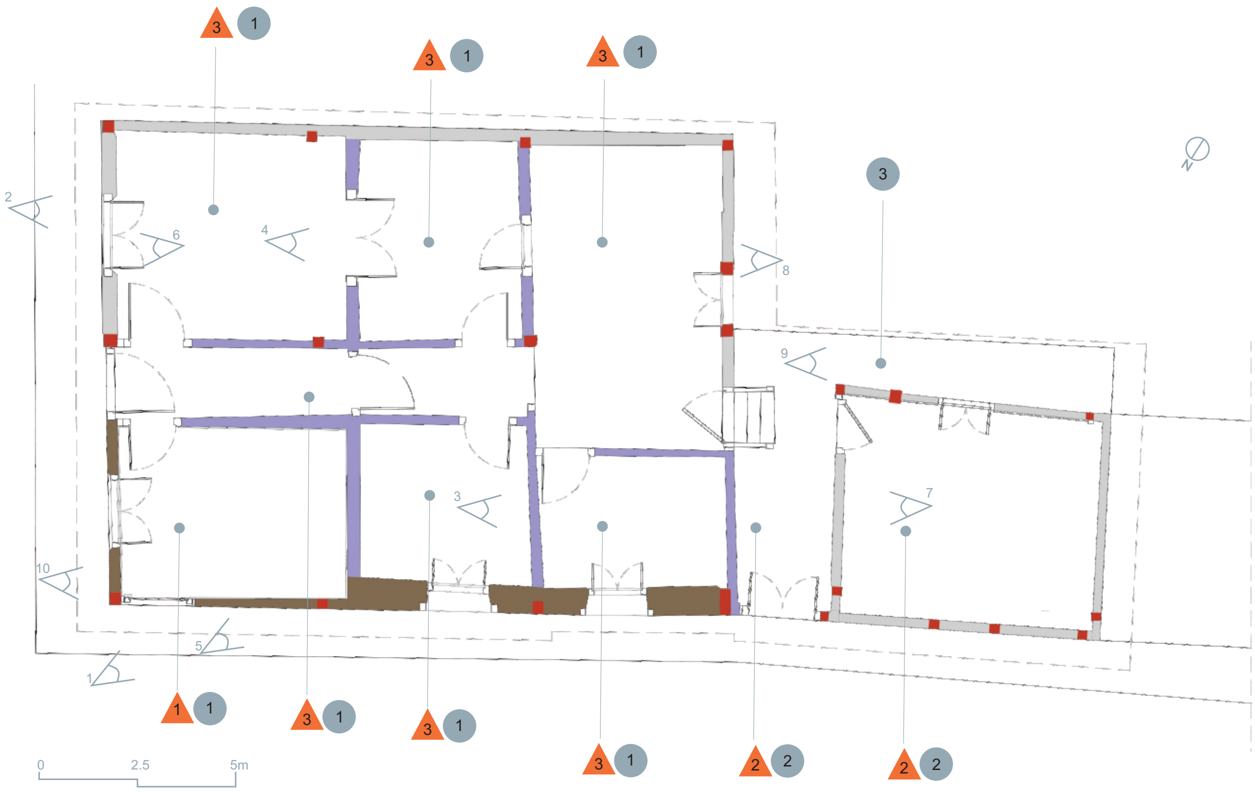
DETAIL.1



SECTION BB

Elevation





LEGEND

- Adobe wall
- Wattle and daub wall
- Stone and lime wall
- Wood pillar

Ceiling

1- Barrote
2- Tiles
3- Wooden boards

Floor

1- Barrote
2- Mezanela
3- Stone

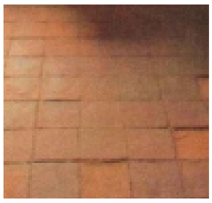
CONSTRUCTION SYSTEMS

PHOTO DETAILS


1- Stone and lime


3- Wattle and daub


5- Pegged joint


7-Mezanela


9- Stone floor


2- Adobe


4 -Safena


6- Double-leaf hinged window

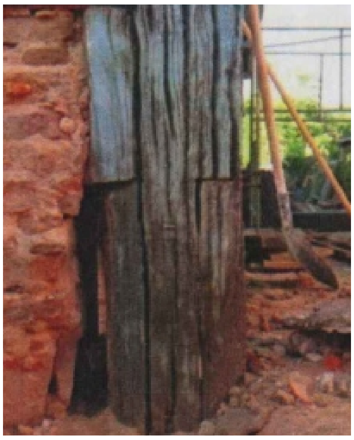

8- Cangicado


10- Ensilharia

Figure 115 – Enxaimel House. [Source: IPHAN. Descriptive report on restoration/requalification: CASA ENXAIMEL 2013/2015. Goiânia: IPHAN, 2015.]

4.5.1.Decay

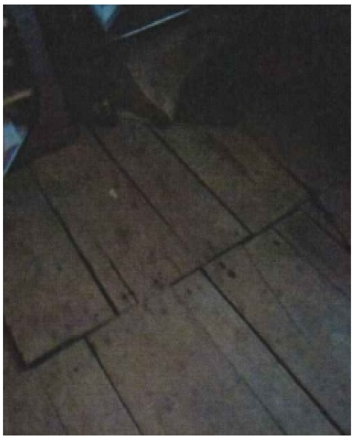
According to the photos from the descriptive report ''*Restoration/requalification: CASA ENXAIMEL 2013/2015*''. carried out by IPHAN in 2015, the following decay were observed in the Enxaimel House:



Decay: Wood-cracks
Possible Causes: Loss of moisture causing contraction;
Rapid or uneven drying; Internal stresses in the wood grain;
Natural wood defects; Expansion and contraction cycles;
Use of green wood; Mechanical stress or overloading;
Aging and long-term weathering
Location: Pillar

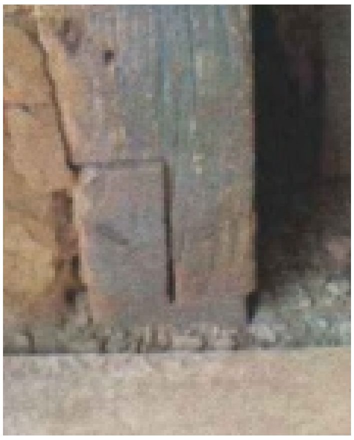
Decay: Wood-cracks
Possible Causes: Loss of moisture causing contraction;
Rapid or uneven drying; Internal stresses in the wood grain;
Natural wood defects; Expansion and contraction cycles;
Use of green wood; Mechanical stress or overloading;
Aging and long-term weathering
Location: Jamb

Decay: Craquelé in Paint
Possible Causes: Wood movement due to humidity changes ;
Application of paint over an unstable or dirty surface; Incompatible paint layers; Aged or degraded wood under the paint; Painting over a surface with residual moisture; Excessive paint thickness or poor layering; Sun and weather exposure causing thermal stress;
Use of low-quality or expired paint
Location: Jamb



Decay: Wood bending
Possible Causes: Excessive moisture absorption (from below or above the floor); Improper acclimatization of the wood before installation; Uneven subfloor or structural movement; Use of green or insufficiently dried wood; Thermal expansion due to temperature changes; Improper fastening or installation techniques; Incompatible adhesives or finishes trapping moisture
Location: Barrote floor

Decay: Delamination
Possible Causes: Excess moisture; Incompatible materials; Rapid drying; Poor adhesion between layers; Structural movement; Incorrect mix composition
Location: plaster applied in the façade



Decay: Incision
Possible Causes: Intentional cutting; Previous repair or adjustment attempts; Improper fitting of the door requiring trimming
Location: Jamb

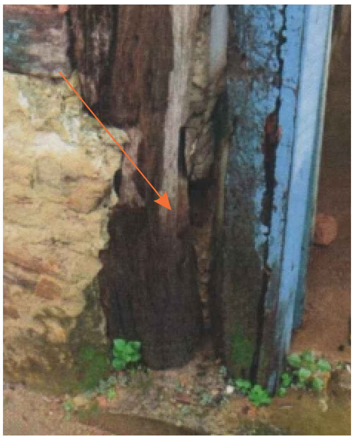
Decay: Abrasion
Possible Causes: Frequent foot traffic or friction from furniture; Use of a weak or overly sandy earthen mix
Moisture fluctuations weakening the surface; No regular maintenance or reapplication of protective layers; Vibration or structural movement
Location: Kitchen Mezalena floor

Decay: Rising damp
Possible Causes: Degraded or failed damp-proof barrier;
Capillary action drawing moisture from the soil into the masonry;
Soil in direct contact with stone walls without protection;
Use of impermeable plasters or coatings trapping moisture inside;
Water accumulation around the foundation due drainage failures
Location: exterior wall

Decay: Stains
Possible Causes: High humidity; Condensation forming near the door area;
Metal corrosion (e.g., screws, nails) causing rust stains;
Cleaning products or chemicals reacting with the finish;
Aging or breakdown of the protective coating or varnish
Location: door and jamb

Decay: Bleaching
Possible Causes: Prolonged exposure to sunlight (UV radiation);
Use of low-quality paint; Chemical reactions with cleaning agents
or air pollutants; Natural aging of the paint film
Location: Safena

Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration;
Water trapped between paint layers and wood;
Failure of protective coatings.
Location: Cachorro from eaves



Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration; Water trapped between paint layers and wood; Failure of protective coatings.
Location: Pillar

Decay: Wood-decaying fungi
Possible Causes: Persistent moisture infiltration; Water trapped between paint layers and wood; Failure of protective coatings.
Location: Door

Decay: Wood-boring insects
Possible Causes: Use of untreated or unprotected wood; Lack of preventive chemical treatment; Wood in direct contact with soil or damp masonry; High wood moisture content; Cracks or openings allowing insect entry; Warm and humid environments favorable to insect activity
Location: Pillar

Decay: Wood-boring insects
Possible Causes: Use of untreated or unprotected wood; Lack of preventive chemical treatment; Wood in direct contact with soil or damp masonry; Cracks or openings allowing insect entry; Warm and humid environments favorable to insect activity
Location: Jamb

4.5.2. Interventions

1965 – Technical survey made by IPHAN with the first cadastral and photographic survey. It identified significant changes and recorded the loss of the painted ceiling.

1982 – First documented intervention, made by IPHAN in the roof and plaster repairs, exposure of the timber framing on the main facade. The interior floor in some parts was replaced with different floor, altering the original level.

1995 – First restoration project was carried out by *Construtora Aliança*, it included: reconstruction of the lateral wall in half-timbering; rebuilding of internal partitions in wattle and daub; replacement of the old ceilings with canvas; sealing of windows on the facade and in the internal rooms.

2013 to 2015 – A complete restoration project was carried out by IPHAN, representing the most recent intervention. It can be described through the following Project Units (UP):

UP.1 – Preliminary Survey and Documentation

UP.1.a – Foundation and initial explorations

A survey was conducted on the house's foundations, revealing the absence of adequate foundations under the masonry of the main façade. This necessitated excavations to expose and shore up the

A survey was conducted on the house's foundations

Foundations that had been replaced

beams and columns, which were then pre-consolidated to maintain the physical integrity of the building. In this same survey, it was found that the other foundations had been replaced, probably in 1995, with reinforced concrete. It was verified that there was no incompatibility, so the material was retained to avoid further damage to the masonry.

UP.1. b – Survey of materials and diagnosis

This stage involved surveying the conditions of the constituent materials, such as wood, masonry, and coatings, through detailed visual inspections and sample collection for laboratory tests to confirm composition and degradation, and made the Damage Identification Sheets (DIS). The methodology was based on meticulous inspection, photographic documentation, and laboratory analysis. The primary concern was to preserve the samples and accurately document their characteristics to support the restoration stages.

Controlled removal of damaged plaster for inspection and masonry repair

UP.1. c – Photographic and documentary record

Detailed enlargements of photographic records, drawings, and notes were made to document all pathologies, fissures, deformations, and general structural conditions. The methodology included the use of high-resolution digital cameras and recording software. The main concern was to ensure the accuracy and comprehensiveness of the record to support all subsequent technical decisions.

Controlled removal of damaged plaster for inspection and masonry repair

UP.2 – Cleaning

UP.2. a – Removal of dust, loose particles, and surface residues

The first stage of cleaning consisted of the careful removal of dust, loose particles, and superficial residues accumulated over time. The methodology applied involved brushing with soft brushes, using low-suction vacuum cleaners, and light manual brushing, aiming not to damage original surfaces in plaster, wood, and masonry. This dry cleaning is essential to prevent dirt from penetrating the historical materials, preparing the substrate for subsequent interventions.

Controlled removal of damaged plaster for inspection and masonry repair

UP.2. b – Controlled cleaning with localized application of water and neutral detergent for the removal of stains and deposits

After the removal of surface dirt, some areas showed difficult stains and encrustations that required deeper cleaning. The methodology consisted of the localized and controlled application of small amounts of water combined with low alkalinity neutral detergent, using brushes and soft sponges to avoid saturating the materials. The solution acted on the removal of soot, organic stains, and pollution, being applied carefully to avoid compromising the original substrate.

UP.2. c – Controlled removal of damaged plaster for inspection and masonry repair

The complete removal of plaster and mud from the wattle and daub, adobe, and stone walls was carried out, allowing for the diagnosis of hidden pathologies in the wooden structures and assisting in the planning of the restoration.

UP.3 – Structural Consolidation
UP.3.a – Reinforcement and stabilization of the foundations

During the excavations on the front facade, the absence of a foundation under a section of the wall was observed, which rested directly on the ground. Initially, the execution of a reinforced concrete beam was planned, following the alignment of the half-timbered wall.

Repair and adding the stone foundation (type *Ensilharia*)

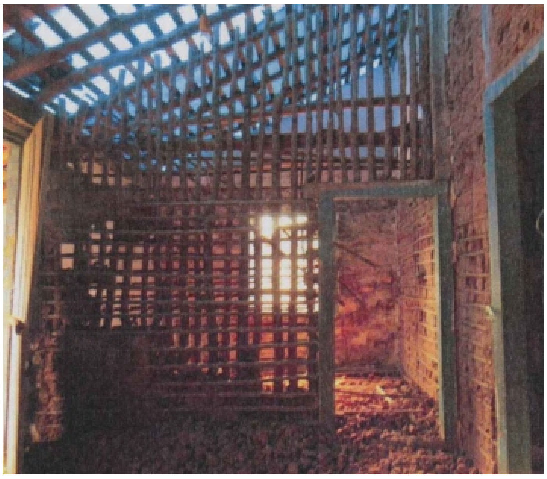
Adding the stone foundation (type *Cangicado*)

Repair the cement foundation (made in 1995)

However, during the execution, the excavation revealed a stone foundation possibly dated to 1835 (type *Ensilharia*), which allowed for the reconstruction of the foundation in a manner compatible with the original construction technique. In the other foundations, possibly redone in 1995 with reinforced concrete, the existing elements were reinforced and, due to their compatibility, the supports were maintained and expanded according to the structural needs identified in the field. The technique used was reconstruction with the use of stone similar to the original; localized execution of a concrete base to support the wooden structure; and leveling and alignment of the foundations to receive the restored masonry. The products used were structural concrete with zero gravel, cement, and sand, and locally quarried stone, compatible with the original (the report does not specify which was used).


Clay filling in the adobe walls


Total or partial reconstruction of the panels in the stone walls


Total or partial reconstruction of wood locking and clay filling were used in the wattle and daub walls

UP.3.b – Consolidation of stone and clay masonry

With the removal of the superficial plaster, it was found that the half-timbered facade walls were partially made of stone and adobe. Due to the observed damage, a total or partial reconstruction of the panels was chosen. The wooden structures of the wattle and daub were restored or replaced, respecting the traditional dimensions and joints. In the case of the wattle and daub panels, traditional techniques of wood locking and clay filling were

wood-borers and moisture were
completely eliminated through the anchoring
of the walls.

used. In the stone sections, the grouting was done with a mixed mortar, respecting the original materials and aesthetics. The techniques used were controlled dismantling of panels with prior photographic mapping; reconstruction in sections with new wooden structure; mixed mortar (lime, sandy soil, cement) for stone; and liquefied clay mortar for filling and grouting the adobe and wattle and daub. The products used were wood (the report does not specify which type was used), mixed mortar (cement, lime, sandy soil), and clay mortar with plant fiber.

UP.3.c – Reinforcement and recovery of wooden structures

A visual assessment of the condition of the posts (pillars) and other wooden structural elements was carried out. Elements compromised by wood-borers and moisture were completely replaced, while the preservable pieces were treated and reintegrated into the structure. The roof was also revised: the rafters were completely replaced (the report does not mention if the intervention followed any standard or international principles), and the purlins were reinforced with durable wood, in addition to the installation of new braces. The techniques used included the replacement with new pieces compatible in size and type (the report does not specify the wood species), intervention in the roof with structural reinforcement. The products used were wood for rafters and purlins, and an aluminized sheet for the overlay.

UP.4 – Restoration of integrated elements

UP.4.a – Restoration of frames

The original frames were subjected to a rigorous technical evaluation through Damage Identification Sheets (DIS), allowing for the diagnosis of the conservation status of each set. Pieces in irrecoverable condition, initially intended for preservation, were replaced based on criteria of materiality, typology, and aesthetic compatibility. Internal door and window leaves required only small patches, mainly at the points of installation of new hardware. The final color choices respected stratigraphic surveys conducted at the building's cornice, which revealed two historical layers of paint: a blood-red tone and Prussian blue. In the exhibition room, the wainscoting was dismantled, with individual cataloging of the pieces. The support structure was reinforced, the boards were reused whenever possible, and the cornice was faithfully replicated based on

Removing the compromised elements

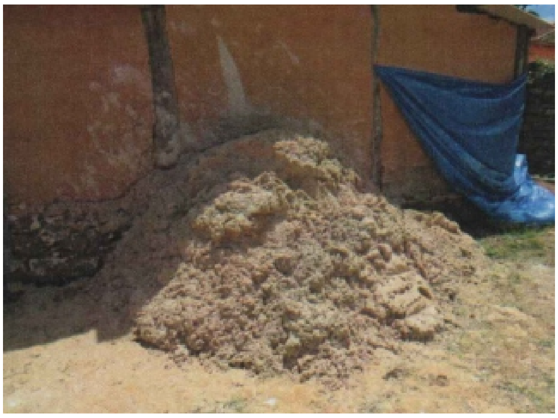
Wood replaced through the anchoring of the window.

Adding the new wood elements

original models identified in the property itself. The techniques used included cadastral survey and diagnosis with DIS's; targeted replacement of frames with structural compromise; localized grafts in areas of hardware fixation; application of satin enamel according to colors obtained through historical prospecting; disassembly and reassembly of the wainscoting with structural reinforcement; and partial replacement of boards and artisanal replication of the cornice. The products used were satin finish paint in blue for half-timbered structures and portals; satin finish paint for door and window frames also in blue; wood compatible with the original for grafts, wainscoting, and cornices (the report does not specify which type was used).

UP.4.b – Restoration of Coatings and Finishes

The wall coverings in wattle and daub were redone using lime and sand mortar, with a mix ratio of 1:8. The mixture was hydrated on-site in the form of dry powder and left to rest for about three months, ensuring better integration and workability of the mortar. On the stone walls, the reassembly and plastering of the frames were carried out with a mixed mortar (cement, sandy soil, and lime), due to the low adhesion and resistance observed in pure lime mortars in previous tests. The exhibition room received complete plastering on both walls (wattle and daub and stone) to protect the structural materials and provide a



Lime and sand mortar

Appling the mortar on the walls

homogeneous aesthetic finish. The ceramic roof tiles were cleaned and reused whenever possible, with broken ones being replaced. An aluminized underlayment was also added for thermal protection and additional insulation. The techniques used included the application of traditional hydrated lime and sand mortar (1:8 mix) on wattle and daub walls; dry powder hydration with prolonged resting (3 months) for better maturation; adhesion and resistance tests on different mortar mixes; the use of mixed mortar for stone walls (cement, sandy soil, and lime); full plastering in the exhibition room; and washing and sorting of old tiles for reuse. The products used were hydrated lime of type CH III, sieved medium-grained sand, sandy soil for better performance in mixed mortar, CP II-Z-32 cement for mixed mortar, and colonial tiles.

UP.4.c – Recovery of Floors

The wooden floors (*barrote* type) showed a high degree of deterioration, with the presence of rot, extensive cracks, and loss of structural stability. The complete replacement was recommended by the inspection after a technical survey and documentation of the conditions in the Damage Identification Sheets (DIS). The support beams were also evaluated, with the replacement of compromised pieces and structural reinforcement through the installation of new supports in stone and cement mortar directly on the subfloor. The new floor was installed with wooden boards of the same type, respecting the language and standard of the original. The techniques used were inspection and technical recording of the conditions using DIS's; careful removal of the old floors and separation of potentially reusable pieces; complete replacement of the boards with installation on revised joists; and inclusion of new stone supports to ensure leveling and stability. The products used were wooden boards for the new floor (the report does not specify which were used), treated wooden beams (same dimensional profile), and stone supports for anchoring the beams and cementitious mortar for the bases of the beams.

Careful removal of floor components
(type *Barrote*)

The complete replacement

UP.5 – Additional facilities

UP.5.a – Review and Update of Electrical and Hydraulic Installations

The existing electrical and plumbing installations were removed due to their obsolescence and non-compliance with current standards. New networks were designed and executed based on the intended uses for each environment, aiming for maximum efficiency, safety, and minimal visual impact, especially in historical areas. The techniques used were the complete dismantling of the old installations. The installation of embedded or concealed conduits, respecting the constructive logic of the property. Replacement of the hydraulic network with a rationalized layout and revised points. Connections are made with cold welding or compression devices to reduce vibrations. The products used were flame-retardant cables following Brazilian standards (NBR 5410). Rigid and flexible PVC conduits. Hydraulic pipes in PPR or CPVC. Fixtures and fittings with water-saving features (valves with aerators).

UP.5.b – Integration of Security and Monitoring Systems

The building received passive and active security infrastructure, including an alarm system, camera monitoring (CCTV), and emergency lighting. The equipment was discreetly integrated into the property's architecture. The techniques used were the installation of cameras and motion sensors at strategic points. Hidden wiring using shared conduits. And the positioning of sirens and emergency lights without affecting heritage elements. The materials used were high-resolution IP cameras. Alarm control panel and infrared sensors. Emergency lighting with rechargeable batteries.

UP.5.c – Suitability for Accessibility and Environmental Comfort

The interventions aimed to meet the criteria of universal accessibility and environmental comfort, respecting the historical value of the building. Discreet and reversible solutions were included for access and ease of use for all audiences.

The techniques used were leveling floors and ramps with appropriate slope (max. 8%). Installation of tactile signage and elements of visual contrast. For environmental comfort, natural ventilation points and optimized light entries. The materials used were metal handrails painted with epoxy. High-strength PVC tactile strips. LED luminaires with a diffuser for glare reduction.

The artisanal preparation of lime paint

UP.6 – Painting and Protection

UP.6.a – Surface Preparation for Painting

The surfaces were carefully prepared to ensure the adhesion and durability of the finishing layers. The cleaning was carried out manually and non-abrasively to preserve the historical substrates. The techniques used were cleaning with natural bristle brushes and dry cloths for the removal of dust, grease, and efflorescence. Spot corrections of cracks with a mass compatible with the substrate. Light sanding and surface homogenization. The products used were cleaning solutions based on alcohol and neutral soap. And lime putty with fine sand and pigment for corrections.

UP.6.b – Application of Lime-Based Paints and Natural Pigments

The painting used mineral paints based on lime, prepared with natural pigments compatible with the historical tones identified during the survey. The application respected the original layers and favored the permeability of the construction systems. The techniques used were the artisanal preparation of lime paint on site. Application with brushes and rollers in thin, overlapping layers. Respect for the curing time between coats. The products used were hydrated lime, CH III. Mineral pigments (iron oxides, natural earths, etc.). Drinking water for preparing the mixture.

Application of lime paint

UP.6.c – Application of Surface Protection

Certain surfaces of exposed wood and masonry received additional protection against weather and biological agents, maintaining the original appearance. The techniques used were manual application with brushes in thin layers. Preliminary testing for compatibility with the substrate. And targeted interventions to avoid excessive overlap. The products used were polymerized linseed oil for wood. And silane/siloxane-based water repellents for masonry.

UP.7 – Final review and delivery of the work

UP.7. a – Final inspection and adjustments of the intervention

After the completion of the restoration and protection phases, thorough inspections were carried out in all intervening areas, checking the structural integrity, effectiveness of the treatments, and quality of the finishes. Measurement instruments were used to detect possible settlements or residual cracks, as well as moisture and resistance tests at critical points. Spot adjustments, such as additional reinforcements, finishing touches, and reapplication of protective products, were carried out as needed.

UP.7. b – Final documentation and intervention records

Detailed documentation of all project phases was prepared, including photographs, intervention maps, technical reports, and descriptive memoranda. This documentation serves technical and historical purposes, for future reference and conservation monitoring.

UP.7. c – Heritage education and future monitoring

Heritage education was carried out as a final step to raise awareness among the local community and users about the importance of preservation and continuous care for the heritage.

4.5.3.Assessment

Table 8 - Assessment of the restoration project from 2015

ICOMOS guideline	Justification	Score [1]
1. Research and documentation	Research was extensive, with DIS forms, lab analysis, and mapping of damage. There's no mention of publicly accessible records or participatory research involving the local community.	5
2. Siting, landscape and groups of buildings	The work respected the building's context and siting, but the documentation is vague about how modern infrastructure integrates visually and spatially. Potential visual disruptions are not critically assessed.	4
3. Traditional building systems	Traditional systems (half-timber, wattle and daub) were reinterpreted. Yet, compromises included the acceptance of earlier concrete foundations and the use of cement-based mortar in parts reducing authenticity and potentially harming breathability.	4
4. Replacement of materials and parts	Despite efforts to use compatible materials and techniques, the project allowed full replacement of structural elements like floors and frames without clear differentiation or documentation of original components versus new.	4
5. Adaptation	Modern systems were inserted carefully, and accessibility measures respected the building's structure. Still, there's no indication of a local code of ethics or vernacular-based decision-making being involved.	4
6. Changes and period restoration	The project aimed to preserve historical layering but replaced various features (entire floors, frames), and stratigraphic color studies were followed selectively. Some interventions risk visual homogenization and the use of satin paint.	4
7. Training	Although heritage education is mentioned, there's no evidence of training programs for local artisans or craftspeople, a major omission considering the technical complexity of the building's systems.	3

[1]*(1 does not comply with the guideline, and 6 fully complies with the guideline)*

The assessment made by the author in Table 8 shows that the restoration project presents a good but still partial conformity with the ICOMOS 1999 guidelines about vernacular heritage, being a total of 28 points out of a maximum possible of 42, around 66% of conformity (average 4/6). The research and documentation were extensive, with lab analysis, mapping of damage and technical forms, giving one of the highest scores. This shows that there was a strong effort to understand the building's condition.

In the part of siting and landscape, the work respected the context, but the documentation stays vague about how the new infrastructures integrate in a visual and spatial way. The traditional building systems were reinterpreted and mostly respected, but the use of concrete foundations and cement mortars reduces authenticity and may create problems for breathability. In the replacement of materials and parts, compatible techniques were tried, but the project allows total replacement of important structural elements, like floors and frames, without a clear differentiation between old and new, which limits the historical reading.

The adaptation interventions, like modern systems and accessibility, were made with care and reversibility, but again, there is no indication of participation in the local code of ethics or vernacular decision-making. In the changes and period restoration, the project follows stratigraphic color studies only in a partial way, and some decisions, like the use of satin paint or standardization of features, risk of homogenizing the visual aspect of the building, not respecting the irregularity and patina of vernacular tradition. Finally, the training aspect was the weakest point, because even if heritage education was mentioned, there is no real evidence of training for artisans or craftspeople, which is a problem considering the technical complexity of the constructive systems.

In this way, the evaluation concludes that the restoration project analysed it's partially aligned with the ICOMOS recommendations. It's strong in research and documentation, and it's careful in some constructive aspects, but it presents fragilities in the authenticity of materials, in critical analysis of new additions, and in the social dimension of training and participation. These gaps limit the project from being in full accordance with the international principles of vernacular heritage conservation.

5

CRITICAL REMARKS: BEST PRACTICES FOR THE RESTORATION OF VERNACULAR ARCHITECTURE

5.1. A Critical Comment on the Case Studies[21]

This chapter presents an expanded critical commentary based on the case studies of Enxaimel House, Setecentista House, and Otília House. The latter, despite not involving a restorative intervention, was particularly useful for the analysis and study phase. The goal is to identify strengths and weaknesses and, from there, select what we can call best practices.

In the restoration of Brazilian colonial houses and 18th-century vernacular houses, IPHAN says that methods must be preventive, compatible and, when possible, reversible, always with documentation. It's also important that restoration has low toxicity, little replacement, and offers accessibility and safety, managing risks such as humidity, fire, insects, and climate events. It's necessary to keep the materials breathing well and in good conservation. The use of the building and its cultural meanings must continue, with preventive planned maintenance at the center, like plans, routines, and most importantly, the authenticity of the building.

Authenticity is not only in the materials, but also in the context, in daily use, and in community meanings. It's necessary that restoration is transparent, inclusive, and brings benefits to people, especially in vernacular architecture that depends on local knowledge and regional materials. Because of this, best practices mean careful decisions that keep material integrity and cultural character. They are not a *"recipe"*, but a set of principles such as reversibility of interventions, minimum necessary changes, and sustainable solutions that are durable, with low environmental impact and social responsibility. In this way, heritage can stay safe and meaningful for the next generations.

In the case studies, historical review, surveys, and degradation analysis were made to understand the buildings. After that, the last interventions were checked, in light of the 1999 ICOMOS Charter on the Built Vernacular Heritage. From this, it was possible to make a critical review of the practices that can be called "best".

The chapter gives a continuous critical comment, organized in thematic paragraphs. Each section develops an argument that connects the author's critical reflection with the case studies and with lessons from fieldwork and bibliography review. Through the text, theory and practice are connected: the analysis shows strong points and weaknesses in the cases and explains why some choices meet or don´t meet the criteria of best practices. In the Appendix of Chapter 5, there is a list that connects common pathologies with the recommended solutions of best practices.

[21] *All the information in this paragraph has been drawn from:* BARBOSA(2021); DIAZ-BASTERIS (2022); UNESCO (1994); VASCONCELLOS(1979); BRITO(1999); MARQUES(2019); OLENDER(2006); CASTRIOTA(2012); ICOMOS(2017); ICOMOS (1999); BOAVENTURA(2001)

5.1.1. Preliminary survey

a) A key starting point is a solid diagnosis of ground and moisture behavior.

Do systematic surveys to map infiltrations and pathologies (capillarity, settlement, rainwater collection). Best practice is to install underground moisture measuring points and do permeability checks (penetrometry, capillary absorption tests), with strict records on plans and site logs.

In Setecentista, the inspections with percussion, visual checks and spot excavations were a good conservative start, and the crack watching before intervening was correct; however there were no underground moisture points or permeability tests, so the control of water paths was partial and decisions can become reactive later. Temporary shoring and strict moisture logs should be added when excavating near earthen or mixed walls, and it´s better to add hygrometers and thermo-hygrographs linked to a simple digital model from day one. In Enxaimel, the team exposed the foundation and did pre-consolidation on beams and columns. This was good for stability. But the moisture check was weak and the notes were poor. It needs to install ground probes, run capillary absorption tests, and keep site logs with plan maps to prevent new water damage.

Poor records at this stage create a serious gap. This is when the causes of repeated damp problems are found. Before any excavation, add temporary shoring to earthen walls with wooden braces and ties. Using hygrometers and thermo-hygrographs connected to a digital twin helps to map critical zones early.

b) Material knowledge should come before any intervention.

Do the stratigraphic sampling (micro-cuts) for plasters and mortars, but it can also be done in other materials like paints, renders, some kind of stone surfaces and also in wood to identify the species. It needs geo-referenced positions on plans, and each sample is analyzed by microscopy, X-ray diffraction, pH and granulometry. Best practice is to avoid intervention without full knowledge of the original materials. Sample mapping is very important for future traceability, every sample must keep the location in the drawings. Multi-planar photogrammetry (terrestrial and aerial) is recommended to create high-resolution orthophotos and to support the mapping of soluble salts with ionic kits.

In Setecentista there were lab samples and also color stratigraphy, which aligns with best practice, still, samples were not clearly geo-referenced on plans and some tests (microscopy/DRX/pH/ granulometry) are not fully reported, so traceability is weaker. It´s recommended to tie each sample to a code on drawings and archive slides and photos. In Enxaimel, the use of DIS improved control of pieces and decisions, which is a strong point, however, micro-analysis and mapped sampling per panel were not complete, and an archive of retained material samples should exist for future study, together with orthophotos supporting soluble salts mapping.

c) Documentation must be rigorous and complete.

Macro/micro photography, orthophotos, and 3D surface modeling are the basic layer, drones or 3D laser scanning should register the building in volume before any work. Where documentation was fragmentary, later decisions became weaker and sometimes not verifiable.

Setecentista had photos, drawings and notes during the work, but the final dossier came without photos, so verification and future comparison are difficult, adding orthophotos and a simple photogrammetry or laser scan would raise quality and make later audits possible. Enxaimel kept photos and DIS and this is a positive practice for evidence and learning, even so, a pre-work 3D scan or drone survey would give a full volumetric baseline and help to measure deformations and settlements with more confidence.

d) Preliminary structural monitoring and climate monitoring are not optional.

Best practice is to install digital hygrometers (±2%) and thermo-hygrographs with continuous recording, integrated to the digital model.

In Setecentista the crack monitoring with millimetric scales, level and fixed points before intervening was correct and careful, respecting the idea to not change structural dynamics until data are consolidated, however, climate monitoring was not installed, so risks related to humidity remain hidden. In Enxaimel there was also no continuous UR/temperature recording, even if cameras and security were installed, it´s necessary to place sensors in critical rooms, set automatic logs and export CSV to the project model, because it guides maintenance and reduces reactive actions.

Best practices: The effectiveness of the process depends on starting with moisture and soil diagnosis, georeferencing every sample, building a complete visual and 3D record, and starting continuous monitoring from the earliest stages. Missing one of these parts reduces control and usually brings reactive, not preventive, decisions.

5.1.2. Cleaning

a) Cleaning should preserve the surface without harming porosity or finish.

A safe sequence starts with HEPA vacuum cleaners and natural-bristle brushes when relative humidity stays below 60%. Work in stages: dry cleaning, controlled dampening, and careful drying. For very sensitive surfaces, dry CO_2 micro-jets avoid abrasiveness. This staged method reduces dust spread and infiltration of harmful agents.

In Setecentista the team did controlled dry removal of dust, moss and lichens and also localized cleaning, which is aligned with the staged method and it´s a good conservative choice, however ambient RH and temperature were not clearly logged and HEPA use was not specified, so the control of risk to porosity and finishes was only partial. It´s better to fix a threshold (RH < 60%), use HEPA and soft natural brushes as standard, and record a simple climate sheet per room during cleaning days. In Enxaimel the sequence dry-damp was applied and saturation was avoided, which is positive for sensitive substrates like earthen plaster and wood, but the absence of a climate log and of a decision record about CO_2 micro-jets (for very delicate areas) limits repeatability, adding these small procedures will reduce abrasion risk and give more traceability for future audits.

b) Where localized wet cleaning is necessary, tests guide the method.

Preliminary pH, conductivity and absorption tests should guide. A deionized water solution with neutral detergent up to 0.5% is applied with a soft brush and immediately suctioned. The key are strict moisture control and constant watching of material reactions. Local cleaning avoids leaching of soluble components from original mortar. Pilot tests must be documented with photos and result sheets.

In Setecentista localized wet cleaning with neutral detergent was done in a careful way and immediate removal was reported, which matches best practice, even so, it´s not clear if water was deionized, if pH/conductivity/absorption tests were done before, and there are no photo sheets of pilot grids, so verification later becomes hard. It´s recommended to run small pilot squares (10×10 cm), record pH and conductivity before/after, and attach photos and a result sheet to the dossier. In Enxaimel the damp cleaning also followed a cautious approach but again tests were not documented, the method should include deionized water, detergent ≤0.5%, immediate suction with low-suction vacuum, and a simple "test card" with date, operator, tools, dwell time and reaction notes, so the team can repeat the successful recipe without guessing.

c) Removing damaged plaster is not a default.

Priority is conservation of original plaster, using consolidation like nanolime injections in cracks and re-making with compatible lime mortars. Full removal only when the coating is modern and incompatible.

In Setecentista the removal was only in specific deteriorated areas to allow inspection and repairs, which respects minimal intervention and it´s a strong point, still, it would be better to register where consolidation (nanolime) was tested or applied before deciding to remove, and to archive any detached fragments with labels (location, date, layer description). In the Enxaimel House, complete removal was chosen because documents showed the coating was not original, this can be acceptable, but best practice is to keep material samples for archives and future study. The documentation should include: bagged samples per room/wall with codes on plans, step-by-step photo sequence, and short sketches indicating thickness and layering, without this, future research loses valuable evidence about previous phases and the risk of over-smoothing historic textures increases.

Best practices: Do cleaning in staged, dry-first phases, test before any use of water, keep strict moisture control, prefer consolidation over removal, and document all pilot tests and removals with high precision to ensure traceability, repeatability, and minimal intervention.

5.1.3. Structural consolidation

a) Do compatible injections and fillings in low-pressure in the foundations.

For foundation reinforcement, best practice is aerial lime injections (CL90) with local washed sand (1:3), at low pressure (<2 bar) in points diagnosed by resistance and penetration tests. Cement should be avoided, only in very deep and isolated foundations one may consider it, and even then, NHL 3.5 is usually more compatible.

In Setecentista, injections with NHL, manual recompaction and local reinforcements were a good choice because they keep compatibility and permeability, micro-piles and extra footings done with low-impact methods were also correct. But it's not clear if the team mapped each hole and logged pressure and volume, so traceability was weak, it's better to keep a plan with points, pressures < 2 bar, volumes by phase, and samples of the grout for archive. In the Enxaimel House, cement was used in the foundation because it was already present and showed no incompatibility, this may be acceptable, but it required explicit justification and preliminary tests, all recorded with volumes, pressures, injection points, and materials in site logs, without interface design, the stiffness jump lime×cement can create cracks and moisture traps. It's recommended to add lime-rich transition joints, flexible sealing in cold joints, and continuous settlement monitoring to reduce risk. In extreme cases, treated-wood micropiles or stainless-steel options keep the foundation profile invisible and historically coherent.

b) Do stitching, inserts and discreet bracing that are compatible with the masonry.

In stone and earth masonry, consolidation should use CL90 or NHL 3.5 mortars with local washed sand, ratios 1:2 to 1:3, after adhesion, shrinkage and permeability tests. Portland cement must be avoided in earthen walls, because it blocks permeability and creates incompatibilities. All replacements need technical sheets and formal approval by the team and heritage authority. Localized fluid-lime injections in joints, stitching with reused historic bricks, and discreet internal stitching with wood or stainless rods are suitable when necessary.

In Setecentista, the team consolidated mixed masonry with lime mortars and fluid lime injections, and re-made joints without cement, which is coherent with best practice and keeps the wall flexible and breathable, even so, it's important to record small tests of adhesion and shrinkage and to draw any hidden stitching with wood or stainless rods when used. In Enxaimel, the reconstruction of wattle and daub panels with traditional joints and clay infill was positive, but the mixed mortar (cement+lime+sandy soil) used on stone parts must be limited and proven by tests, on earthen areas, cement should be avoided. It's needed to set maximum cement content, use transition layers more permeable near-earth walls and write technical sheets for each replacement approved by the heritage authority.

c) Keep, disinfect and consolidate the wood with reversible methods.

Priority it's *in situ* conservation. Disinfection by microwaves or 5% borax injection is recommended, and in delicate areas, natural tannins or propolis can be used. Replacement it's only when the wood has a big structural loss, and always with the same species, dry and treated, using traditional joints. For discreet reinforcement, thin wooden laminations can be inserted inside the original piece, making a step joint between old and new, so the structure gets stronger but the historic look it's not changed.

In Setecentista, the team keeps the maximum original wood and only changes the pieces that are too weak. Some cracks were filled with epoxy and PU, but this it's not the best because they are too rigid. It's better to use reversible resin for the fissures, and borax or microwave treatment. The new wood came from reforestation and was treated, but the species and humidity were not written, so the future behavior it's not certain. In Enxaimel, the inspection shows many posts and beams with insect and humidity damage. Some pieces were treated and reintegrated, but many were replaced with new wood. The structure became safe, but again the species and class of wood are missing in the report. For best practice, each new piece must be identified, treated on the ends, and the information registered for the future.

It´s important to point out that best practices concerning wood conservation should also follow the ICOMOS Principles for the Conservation of Wooden Built Heritage from 2017. Which emphasizes the minimal intervention, reversibility, and proper documentation.

d) For colonial roofs, it's important to check the roof slope to be sure the water can drain correctly.

For colonial roofs is important to keep the maximum original material. The colonial tiles must be reused, replacing only the broken ones with handmade tiles of the same type. During the work, the roof is structured with temporary wooden shoring to support the purlins, rafters and ridge beam. The removal of tiles is done one by one, starting from the ridge to the eaves, storing them vertically to avoid breaking.

The wooden structure must be checked piece by piece, primarily through careful visual inspection, complemented when needed by non-destructive testing, such as moisture meters, resistographs, or ultrasonic devices, to verify internal conditions.

Rafters, laths, purlins, ridge beam, *frechal* (wall plate) and posts are preserved when possible and replaced only when the loss is too big. Old nails, wires, clamps or other oxidized metal objects that are not characteristic of traditional carpentry replaced whenever possible with wooden pegs more compatible with the system. The use of modern fixings (stainless fixings) must happen only when necessary for structural safety or for discreet reinforcement. It's important to preserve the eaves and *cachorros* (wooden brackets), because they are typical elements of 18th-century houses in Goiás. If necessary, they must be reinforced with wood of the same species and profile. The soffits under the eaves are also conserved, cleaned and, when damaged, replaced with similar boards fixed in a reversible way.

Gutters are not used in colonial roofs, water is drained naturally by the slope and projection of the eaves. It's important to check if the roof slope has any damage or deformation. Because this can change the way the water flows and create infiltration. It's essential to keep ventilation between tiles and the wooden structure, avoiding modern roofing underlayment that can trap humidity. The ridge tiles and hip tiles are set with lime mortar, never pure cement, to allow permeability and avoid cracks.

In Setecentista, the roof was conserved with minimal change. The tiles were reused, and only the damaged ones were replaced. This is coherent with best practice, because the historic material stayed in place and the roof kept breathability. But the report does not explain in detail the control of ventilation or the record of replaced tiles, and the wood species was not indicated in the memorials. This omission creates problems of compatibility and makes future repairs more uncertain. In Enxaimel, the intervention was heavier. The rafters were all replaced, the purlins reinforced, and an aluminum roofing underlayment was put under the tiles. Many old tiles were reused, but broken ones were replaced. This action gives safety and thermal protection fast, but the risk is that the roofing underlayment traps humidity if no ventilation exists. Also, the type of new wood was not indicated in the memorials, creating compatibility problems for future conservation or best practice. The roof needs clear ventilation, a list of wood species and class, and all changes must be written for future teams.

Best practices: Prefer lime-based solutions, test and document everything, keep permeability and reversibility, avoid cement and rigid polymers on earthen substrates and historic wood, and use discreet, compatible reinforcement to protect authenticity, durability, and future maintainability.

5.1.4. Restoration of integrated elements

a)Stratigraphic survey and micro-samples to define colors.

Before any action, stratigraphic surveys help to define the original color scheme. Micro-samples should be analyzed by optical microscopy and spectroscopy, and the position of each sample kept on plans. Best practice is to reuse as many original parts as possible, when a replica is needed, it must be hand-crafted with traditional tools, same wood species, and respect for historical joints. Interventions should follow reversibility and minimal intervention.

In Setecentista, the workshop treatment of frames and recovery of hardware was coherent and kept authenticity, but the lack of DIS per frame means traceability was broken, samples and micro-cuts should be geo-referenced on plans, with photos and codes, so future checks are possible. It´s positive that the frames were protected with polymerized linseed oil, pure beeswax, or shellac is compatible and sustainable. Casein-based sealants are good for joints, but sanding must be minimal to not erase historic tool marks. In Enxaimel, using DIS and doing color prospecting was a strong point that respects history, still, every micro-sample should stay linked to the plan with exact position, and replicas must use the same wood species and traditional joints to avoid visual noise. A small risk is over-cleaning before sampling, which can hide layers, it´s better to sample first, then clean.

b) Test adhesion, permeability and compatibility.

Adhesion, permeability and compatibility tests with the substrate should come first. Manual application in thin layers (max 3 mm per layer) with aerial lime (CL90) and well-graded local sand (3 parts by volume) is recommended, natural mineral pigment up to 5% is optional, water adjusted to reach a paste-like consistency considering sand humidity. Agar-agar solution may improve surface adhesion before the coating. The layer sequence needs photos and specific sheets. Stratigraphic probing helps to avoid changing historical textures and decorative patterns.

In Setecentista, using lime layers applied by hand fits best practice because it keeps permeability and texture, however, adhesion/shrinkage tests and the real layer thickness were not clearly logged, so repeatability is low. It´s recommended to record a small grid of tests, note water content and waiting times, and take photos of each layer sequence. In Enxaimel, the lime mortar on earthen walls was correct, but the mixed mortar with cement on stone needs strict limits and justification, without data, the interface can become too rigid and block vapor. It´s better to define cement content, create a lime-rich transition near earthen parts, try agar-agar priming when dusting, and keep photo sheets of each coat. Both cases should avoid overtroweling which makes a dense skin and changes the historic texture.

c) Respect the floor materiality with draining base/adequate ventilation.

Recovery must respect original materiality. Earthen floors should sit over a bed of fine sand and lime, with a draining layer of gravel or clay below. Wooden floors need subfloor ventilation to avoid moisture damage. Floor stabilization should use lime-based microcement (without Portland cement), keeping reversibility and elasticity. Adjust pieces with treated wood shims and fix with dry joints or natural organic glue (animal glue or cassava starch-based).

In Setecentista, reusing pieces and bedding with lime was compatible and low impact, but there were no DIS for floor panels and no optical leveling report, it´s important to map each bay, record deflections and keep a ventilation path under boards to limit moisture. In Enxaimel, the full replacement restored stability fast, yet the cementitious bases under supports can pull moisture into wood, a capillary break (felt or lime-rich layer), subfloor vents and ventilated skirting are needed to reduce risk. For future repairs, lime-based microcement should replace Portland mixes to keep elasticity and reversibility, and fixing should prefer dry joints or natural glues, so the system can be dismantled without damage. Best long-term performance comes when drainage below earthen floors is clean and when air can circulate freely under timber.

Best practices: Document each piece (DIS), prefer reversible and compatible materials, hand-craft replicas using original species and joints, keep coatings thin, tested, and lime-based, and stabilize floors with breathable, lime-rich solutions supported by good ventilation to keep authenticity, performance, and future reversibility.

5.1.5. Additional facilities

a) Install electrical/hydraulic in reversible and accessible ducts.

Best practice is to use conduits and flexible tubing (PEX, multilayer, or ventilated copper) in accessible and reversible channels, avoiding interference with historic masonry, wall-frame systems are a good option. Protection devices (circuit breakers, RCDs, SPDs) should be sectorized. It´s important to keep removable wooden channels under floors or behind false panels for inspection. Digital manuals with diagrams and network maps help future work. Quick-connect, modular systems with QR codes only at technical access points improve maintenance.

In Setecentista, the new electrical and hydraulic lines were discreet and sectorized according to NBR 5410, which is a strong point for safety and heritage compatibility, however, as-built drawings of routes, materials and inspection points were not delivered, so maintenance becomes harder and sometimes invasive. It´s better to add reversible ducts (removable skirtings, service shafts), label circuits and put QR codes at technical panels with diagrams and parts list. In Enxaimel, the choice of PPR/CPVC, flame-retardant cables and embedded conduits was correct and robust, but fully embedded routes reduce reversibility, inspection hatches and wall-frame cavities should be added in non-heritage partitions, with a simple digital manual showing maps of paths, valves, shut-offs and maintenance intervals.

b) Implement continuous environmental monitoring.

Install environmental sensors (humidity, temperature) and mini HD cameras integrated in a building management system with remote access. Rechargeable batteries and solar backup are positive. Integrate sensors with a BIM/digital twin. Place hygrometers and thermo-hygrographs in critical areas, target relative humidity of 40–60%, and set automatic recording with CSV export. Keep an independent circuit and full documentation with electrical diagrams and maintenance protocols.

In Setecentista, the security system was integrated with minimal visual impact, which is good, but there was no continuous RH/T logging, it´s needed to install dataloggers in risky rooms (near foundations, wet zones, wood beams), define alerts (UR > 60% for more than 7 days), and export CSV monthly to the project model. In Enxaimel, emergency lighting and CCTV were well implemented, but again there´s no climate monitoring to detect early moisture or condensation, a small independent circuit with UPS for sensors, plus a simple dashboard tied to a digital twin, will move management from reactive to preventive and support decisions with graphs and benchmarks.

c) Adopt removable and discreet solutions for accessibility and comfort, prioritizing passive strategies.

Solutions should be removable and discreet: certified wood ramps (FSC/PEFC), metal handrails with mineral paint, tactile signage on ceramic tiles. Thermal comfort should first use cross or mechanical ventilation, the projects didn't have a systematic plan for passive strategies. All proposals must comply with NBR 9050 and be compatible with heritage values. If needed, use split-type air conditioning with remote condensers and concealed evaporators in wall-frame systems. Combine passive strategies like solar control with vegetation or movable panels, and use warm-spectrum lighting to support the historical atmosphere.

In Setecentista, ramps, handrails and natural insulation were introduced with low visual impact, which is positive and aligned with NBR 9050, still, a formal passive strategy was not documented, so it´s recommended to map cross-ventilation paths, add shading devices where possible, and define a seasonal opening protocol to stabilize indoor RH/T before thinking about mechanical systems. In Enxaimel, ramps ≤ 8% and tactile signage improved accessibility clearly, but comfort design can go further with passive means (night purge, controlled ventilation, solar control on façades) and only then add discreet splits with remote condensers, luminaires should use warm spectrum and low glare to keep historical atmosphere. Both cases should keep all new elements removable, with fixation points in reversible substrates and a commissioning checklist to verify acoustics, glare, airflow and vibration before handover.

Best practices: Design interventions for reversibility and low visual impact, document all routes and components, monitor climate continuously via a digital twin, comply with NBR 9050, and prefer passive comfort strategies before discreet mechanical systems to ensure compatibility, maintainability, and user well-being.

5.1.6. Surfaces painting & protection

a) Prepare the surface and paint only in dry weather.

Painting should happen in dry weather (humidity < 60%) and controlled temperature. Use breathable membrane (non-woven polyethyleneto) to protect integrated areas. Ensure mortar is fully cured (at least 30 days) before painting. Light scraping with a manual spatula removes debris without harming the original surface. It´s always recommended to identify the original color palette and keep aesthetic accuracy.

In Setecentista, the team prepared surfaces with natural abrasives and lime/silicate sealers and also did color stratigraphy, which is very good because it respects the historic layers and keeps breathability, however, climate data (UR/temperature) and curing times per room were not reported, so control was partial. It´s better to keep a simple climate log and to write the exact curing days before painting, room by room. In Enxaimel, the non-abrasive cleaning protected the substrate, but there was no stratigraphic probing before painting, so color accuracy can be weaker, it´s recommended to do small probes first, to confirm palette and texture, and to use breathable tarps during work to avoid dust and accidental wetting

b) Apply mineral paints that are thin and breathable.

On earthen walls, hydrated aerial lime aged for at least 24 h mixed with natural mineral pigments (up to 5%) is advised. Apply by hand with vegetable brushes, two thin coats up to 0.5 mm each, respecting curing intervals. For historic wood, the most suitable paint is traditional casein-lime paint: a mix of casein (milk protein) activated with hydrated lime and mineral pigments (~3–5%), using ~4% casein solution diluted in water and pigment, applied in 2–3 thin coats with 12–24 h drying between coats. It's breathable, adherent and reversible, with no synthetic film or VOC issues. For earthen walls, stabilized mineral paints are recommended, using aged marble lime (at least three years), fine mineral grains of high purity, natural pigments up to 3–5% by volume, and low organic content (~3%) to support carbonation and coverage. The high pH (~11) gives a natural fungicidal effect and reversibility, with high breathability and good pigment compatibility. Maintenance is necessary: repaint normally every 8–10 years, or earlier if weathering and fading are visible.

In Setecentista, lime-based paints were applied on walls, ceilings and also on wooden frames in thin layers with mineral pigments, which keeps breathability and authenticity, still, for wood it´s safer to use casein-lime or oil with mineral pigment because pure lime paint on timber can chalk faster and needs more maintenance. A small adhesion test and a record of coat thickness (≤0.5 mm) would improve repeatability. In Enxaimel, limewash on walls was a right choice, but the satin enamel on frames is not suitable for historic wood because it forms a film and can trap moisture, and often has high VOC content. The corrective path is to test a gentle removal (solvent-free gels or controlled scraping), then repaint with casein-lime or polymerized linseed oil with mineral pigment in 2–3 very thin coats, with 12–24 h intervals and good ventilation. Both cases should keep simple cards for each room with pigment %, number of coats, and drying interval.

c) When necessary, protect with low-toxicity mineral varnishes.

When protection is necessary on wooden surfaces, prefer low-toxicity products like varnishes based on stabilized lime with casein or gum arabic, without synthetic solvents. For earthen or stone walls, breathable mineral coatings are recommended instead. Avoid plastic waterproof coatings that block vapor. Record product composition, batch, date and exact location of application on technical sheets to support future maintenance.

In Setecentista, the use of vegetable resins, potassium silicate water repellents and natural waxes in thin, homogeneous coats was coherent and keeps vapor diffusion, even so, it´s important to measure absorption before/after (simple drop test), avoid glossy film, and register batch, area and date to plan reapplication. In Enxaimel, linseed oil on wood and silane/siloxane on masonry can work if dosage is low and substrate is dry, the risk is over-application causing darkening or reducing breathability. It´s better to run small trials, check that the protection does not block future lime repaint, map every treated area on drawings, and set a review after one wet season to see if reapplication is very important.

Best practices: Probe first and paint later, keep paints mineral, thin and breathable, avoid synthetic films on wood, and document every batch and location to guide future care and ensure reversibility.

5.1.7. Final review, documentation & future monitoring

a) Do a final multidisciplinary inspection, check interfaces and systems on site, test comfort and functioning before handover, and record adjustments in a formal technical report.

A closing inspection should be done with a multidisciplinary team (civil engineer, restoration architect, conservator, and also other specialists according to the specificities of the architectural heritage (experts in wood technology, dendrochronology). All junctions between systems, finishes, material transitions, and hidden systems must be checked on site with detail. Any adjustments should go into a technical report and be formally filed.

In Setecentista, inspections and small adjustments happened, which is good because the team looked at stability and finishes, but the test plan was not complete, so performance is not fully proven. It´s necessary to run a formal checklist: leak test of rainwater lines (hose test), GFCI/RCD trip test, emergency lighting autonomy, security system trigger, door clearances and accessibility slope check, airflow and cross-ventilation path, and moisture readings at foundations after 24–48 h. Each test should have photos, pass/fail and a punch list item with deadline. In Enxaimel, the closing visit also happened and corrections were made, but it´s better to add integrated tests for the new exhibition room (glare, noise, thermal comfort), verify tactile signage continuity, check handrail fixations in reversible points, and measure settlement baselines at the façade after the new stone footing, so future movement can be compared.

b) Deliver a complete and interoperable dossier.

Complete records in print and digital forms are needed: site diaries, annotated plans, DIS, material inventories, chemical survey results, sensor climate reports, 3D/BIM models, and a clear before-and-after photo set. Final files should be interoperable and exportable, following semantic standards like Heritage Digital Twin Ontology and HBIM, to ensure traceability and future reuse. All interventions should be fully documented. This includes materials used, reasons for their choice, methodologies, characteristic samples of replaced elements, and information on traditional skills applied. Documentation must be securely stored and remain accessible, both to guide future maintenance and to serve as a historical record.

In Setecentista, the absence of photos in the final dossier makes verification hard and reduces learning, a retroactive package should be built: select "before–during–after" images, create orthophotos of façades, add a simple photogrammetry or point cloud, and link every sample and intervention to plan coordinates. It´s also important to deliver as-built of MEP with routes, shut-off points and QR labels, and to export data in open formats (IFC for HBIM, CSV for logs, PDF/A for reports) with a clear file naming and version control. In Enxaimel, the dossier has photos, DIS and intervention maps, which are strong, but it´s still missing a chemical inventory per material, a consolidated table of mortar mixes actually used on site, and a 3D baseline (scan/drone) to compare deformations in future. Both cases should include a metadata sheet (who/when/where, coordinates, units) and persistent IDs for elements, so the next teams can reuse the data without confusion.

c) Implement heritage education and a maintenance plan with scheduled inspections and continuous monitoring.

Heritage education with the community and the technical team support long-term care: workshops on preventive maintenance, presentation of results and use guidelines. A periodic planned maintenance must include sceduled technical visits and continuous climate monitoring. It's important to adopt

IoT sensors integrated in a digital twin, with automatic data collection and programmable alerts. BIM/Digital Twin frameworks allow dynamic reading of actual conditions and prediction of pathologies using historical + real-time data. It's also important to record, preserve and recover the traditional knowledge and skills used in the construction and maintenance of Brazilian vernacular architecture, so this can continue to guide future conservation practices.

In Setecentista, the educational action was a good start, but there´s no routine after delivery, the plan should schedule quarterly readings of crack gauges in year 1, semiannual roof/gutter cleaning, annual review of protections (silicate/wax), and monthly export of RH/T logs from new sensors, with alerts when UR > 60% for 7 days. It´s also useful to train the local caretaker to do simple checks (salt blooms, wood EMC, leaks) and to register everything in a shared log. In Enxaimel, the same gap exists: a practical program with passive comfort actions (opening protocol morning/evening), filter cleaning, verification of tactile paths and ramp friction, and a yearly community workshop will keep the building healthy. Both houses should fix KPIs (crack change $\leq \pm 0.2$ mm/year, wood EMC 12–18%, no detachment > 2 cm^2/m^2) and review costs each year, so maintenance becomes planned and not reactive.

Best practices: Close with a rigorous, multidisciplinary inspection, deliver interoperable documentation, educate users and plan maintenance, and install continuous monitoring linked to a digital twin to drive prevention rather than reaction.

5.2 The Addition of New Buildings[22]

The best practice to add new buildings or annexes on historic heritage start from the idea that to revitalize it´s not *''make-up''*: it´s to give a contemporary use without erase artistic, historic, and symbolic values. Conservation should be continue; new uses are welcome only when they keep the character of the building, keep the memory alive, and answer in balance the technical demands of today (safety, energy, accessibility). Ecological and social benefits only happen if the historic identity stay readable, avoiding pastiche and empty *''museumification''*.

About the design of the new part, the rule is compatibility without falsification: clearly shows what is old and what is contemporary, respecting materials, proportions, colors, rhythms, and the traditional relation with the surroundings.The 1994 *Nara Document on Authenticity*, written by UNESCO, says the "*genuine link*" of a heritage asset includes material and stylistic continuity. In Brazil, current norms also include IPHAN guidelines and good practice charters, like the 2023 Ouro Preto Charter for cultural heritage, published by IDPC BRASIL, together with technical sectoral directives, and it's important to follow them.

Together, these guidelines emphasizes that any intervention must preserve the integrity and authenticity of the cultural asset, ensuring architectural, material, and semantic compatibility between historic and the contemporary, following heritage protection legislation. This means that modern annexes must conforms to the proportions, colors, and rhythms of the existing structure, without falsifying the original. In other words, new structures can be visibly contemporary, as long as they harmonize and does not compromise the historical integrity of the site.

In the Enxaimel House case study, an annex was also add. However, contrary to the recommendations of heritage charters, the building constructed, although using materials like perforated bricks and cement mortar, create a simulacrum of an 18th-century building.

In colonial residential buildings made of earth, such as rammed earth, adobe, or wattle and daub from the 18th century in the Brazilian Midwest, introducing a new annex demand strict care regarding compatibility and differentiation between the old and the new. Any contemporary addition to a historic building must respects both the asset's integrity and its formal and material authenticity.

This means one must not to attempt to imitate or falsify the colonial style or use materials that artificially recreate the language of the period. The intervention should be legibles as contemporary, without competing volumetrically or formally with the existing building. This was not the case at the Enxaimel House(Figure 116), where elements like mashrabiyas closely

[22] *All the information in this paragraph has been drawn from:* CHOAY(2001); UNESCO (1994); ICOMOS(2017); ICOMOS (1999)

SC.EH. - Construction of the annex foundation in stone (Cangicado)

SC.EH. - Walls made of hollow bricks and cement

SC.EH. -Annex roof: simulating colonial tiles

SC.EH. - Annex mashrabiyas

SC.EH. - Interior façade of the annex

SC.EH. - Mashrabiyas seen from the outside

Figure 116 – Photos taken from IPHAN. Memorial descritivo restauração/requalificação: CASA ENXAIMEL 2013/2015. Goiânia: IPHAN, 2015 [Source: IPHAN]

replicates those of the 18th century, as seen in the Otília House, in addition to the *cangicado* type foundation, roof tiles similar to those used in the colonial period, whitewashed walls, doors, and windows.

Best practices suggest that annexes should thus adopt an current architectural language, preferably simple, neutral, and discreet lines that reveals their time of construction without disrupting the preexisting ensemble. This formal distinction must be balance with physical and material compatibility to ensure the original structures remain undamaged, especially in the case of earth buildings, which are highly sensitive to humidity, structural overload, and abrupt thermal changes. The new volume must respect the original building's scale, preserving the rhythm of openings, volume setbacks, and spatial hierarchy. The connection between the annex and the historic structure should be subtly, using technical joints or slight separations to avoid direct interference with the earthen walls, which was not designed to withstand modern mechanical stresses. Additionally, the annex should ideally be reversible, that is, removable without causing damage or compromising the historic asset.

Materially, the use of lightweight and technically compatible construction solutions are recommended, such as metal structures, treated wood panels, ceramic tile roofs similar to traditional ones, glass enclosures, or perforated elements that support natural ventilation and lighting. These choices align with the constructive logic of earth, whose durability depends on proper humidity control, thermal exchanges, and avoidance of overloading. The new construction must also clear express its distinction, whether through volumetric articulation, material textures, constructive modulation, or a absence of colonial ornamentation, allowing observers to easily identify what belongs to the original building and what was added later.

In earth-based historic buildings, the use of recessed contemporary volumes, integrated through internal courtyards or lightweight connectors, have made it possible to expand the functionality of the properties without compromising their original morphology. These annexes serve technical or operational functions and are visually set back, preserving the primary volume's reading. Such interventions must also be thoroughly documented, including photographic records, damage assessments, and structural diagnostics to ensure the intervention's integrity and reversibility. The inclusion of an annex should not be seen as a disruptive element, but rather as an opportunity to exercise a critical and sensitive architecture that understands the place's history and the materiality of earth construction as central elements of a project committed to permanence, historical clarity, and the preservation of cultural identity.

Figure 117 – Façade of the Goiás City Hall with the annex building in the background. 2014. [Source: Manuel Sá.]

In the historic centers of cities such as Goiás several restoration projects has followed these principles. One example is the Goiás City Hall project (Figure 117), carried out by IPHAN and A+P Architects and completed in 2014. The restoration and expansion of the city hall, located in the city's Historic Center, involved the restoration of two historic houses and the addition of a contemporary annex. Situated in a transitional zone between the traditional urban core and rural areas, the site has an unusual shape: a wide frontage and proportional depth, unlike the surrounding compact lots.

The 19th-century neoclassical building stand as the main highlight, while the adjacent 18th-century structure, once a residence, complements the setting through its scale. After assessing the programmatic demands in dialogue with the City Hall, a set of strategies were defined: in the main house, structural and aesthetic restoration was carried out, maximizing the original spatial limits. The 18th-century building was also restored, preserving historically compatible structural components for its new functions, while incongruent elements from later additions were removed. Additions necessary for contemporary use were implemented with moderation, using a formal language that are modern but respectful of the existing structures.

To connect the two buildings, previously inadequate annexes was demolished, and a single new contemporary volume was erected at the rear of the site. Positioned transversely, this new building facilitate internal circulation between the lots and houses most of the administrative activities.

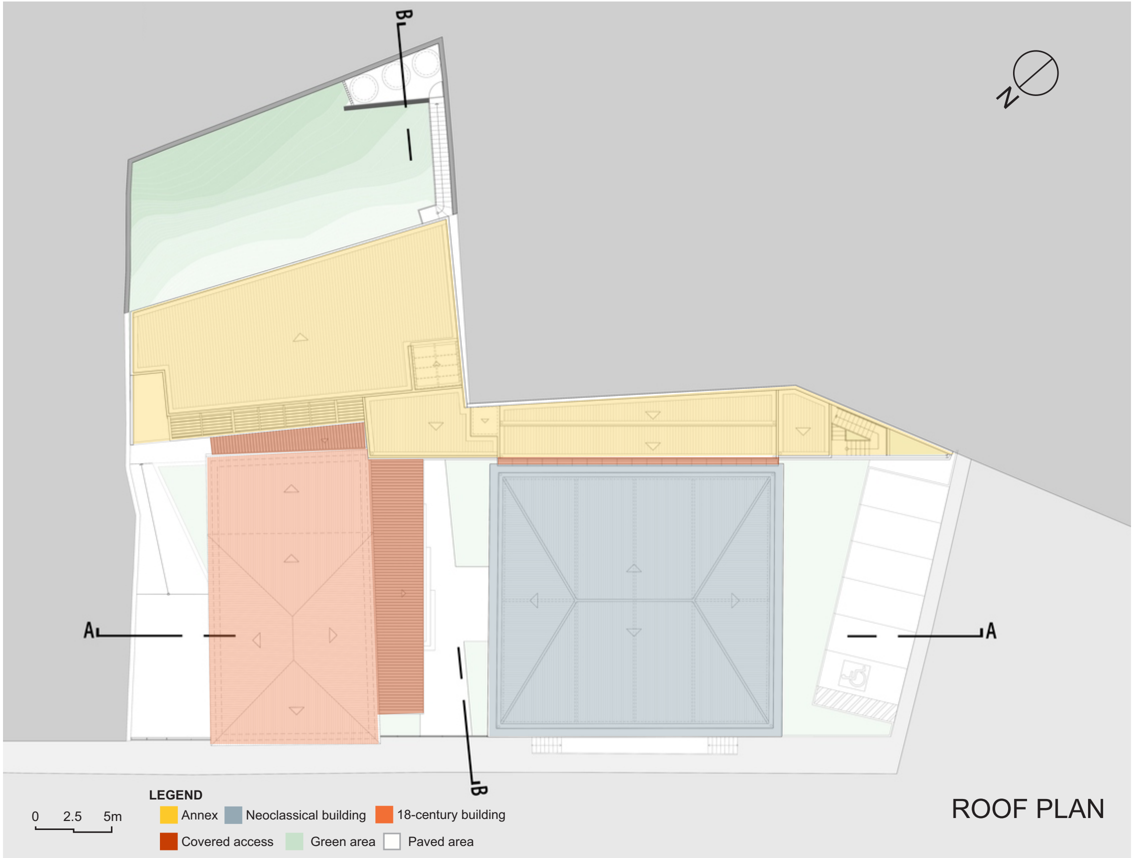


Figure 118– Roof plan by A+P Arquitetos Associados [Source: ArchDaily.]

The site layout preserved original setback areas, keeping them clear. On the sides, parking was created surrounded by gardens, while a covered access with a canopy visually and functionally connects the historic buildings to the new annex, resembling a pergola enclosed by green spaces.

The project of 810 m², finished in 2014, shows how restoration can be combine with new structures, using steel and stone but without covering the historic buildings. It's an example of keeping heritage in use and well cared.

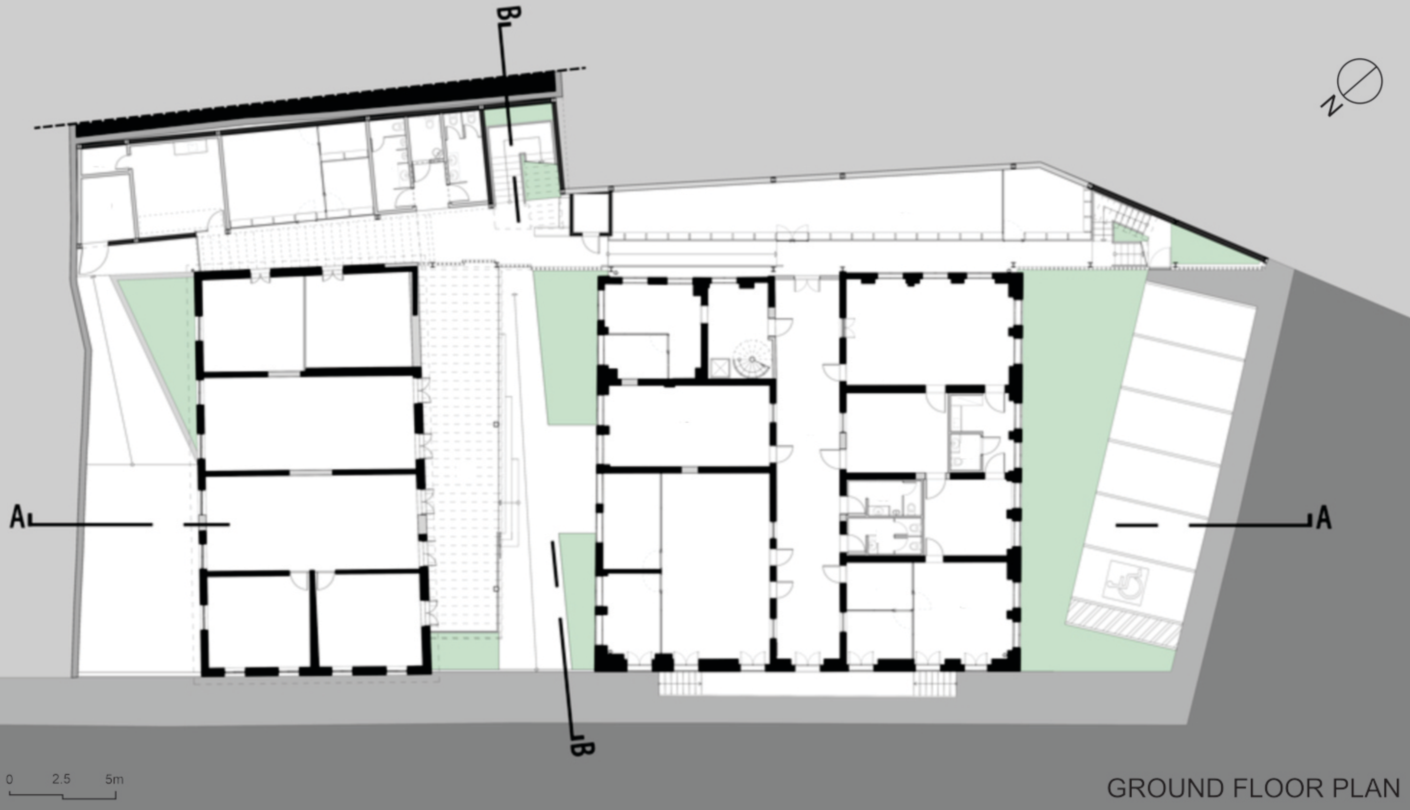


Figure 119 – Ground floor plan by A+P Arquitetos Associados [Source: ArchDaily.]

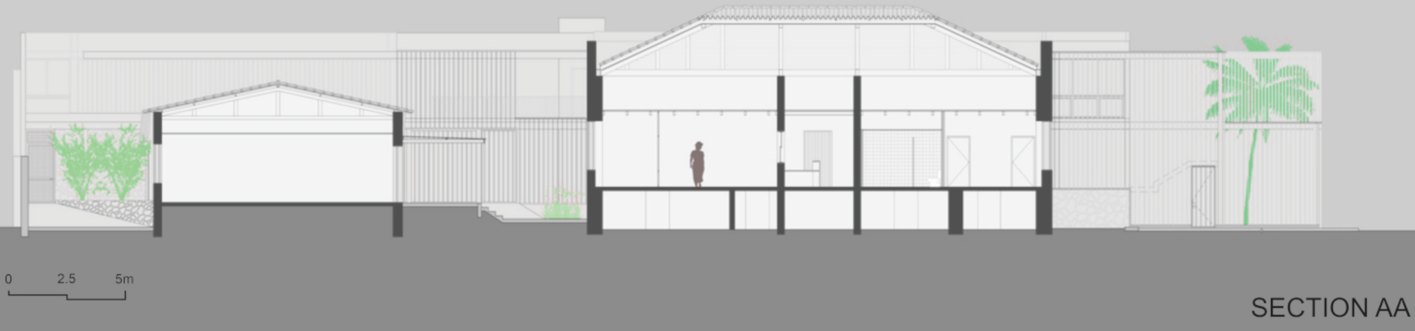


Figure 120 – Section AA by A+P Arquitetos Associados [Source: ArchDaily.]

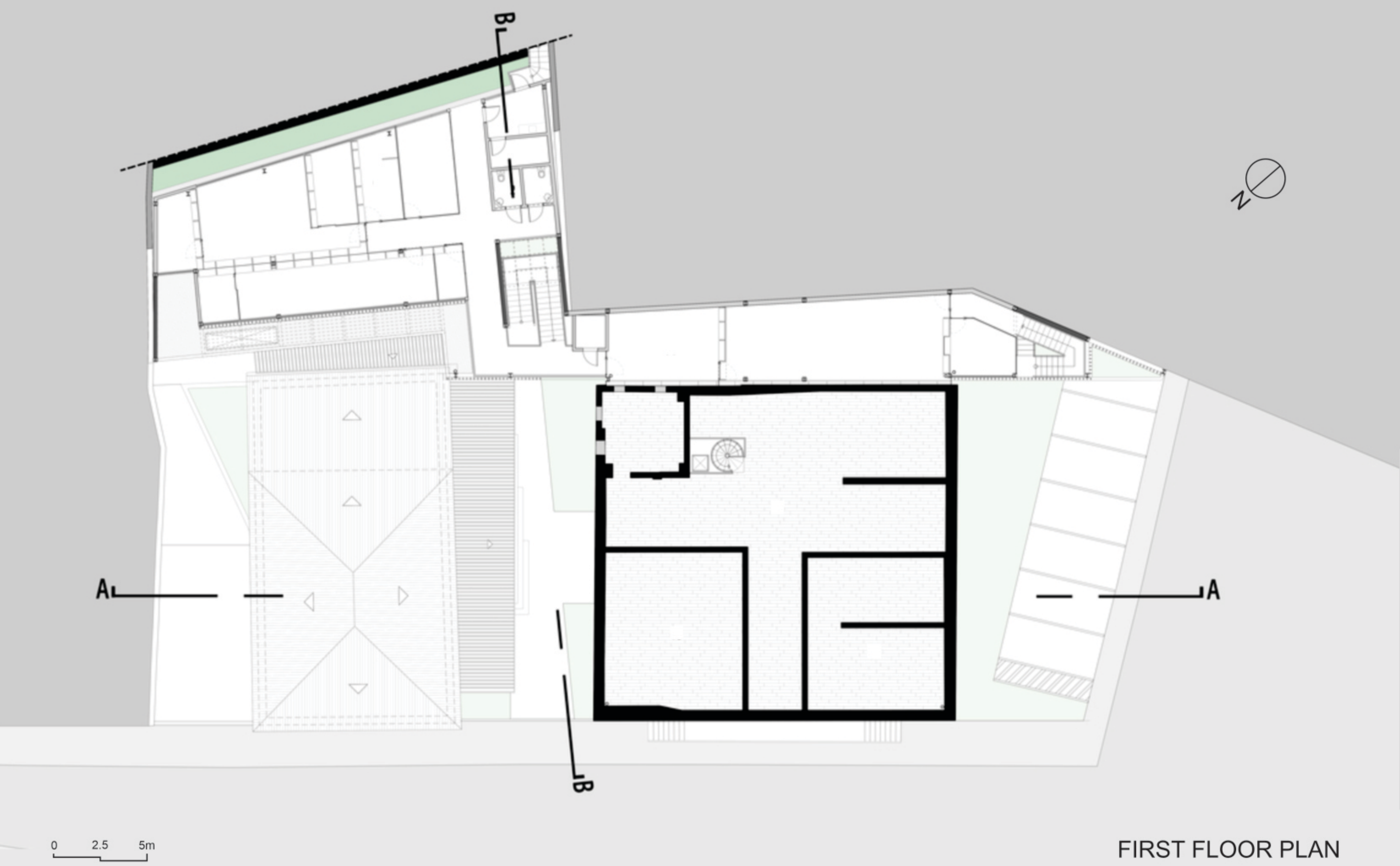


Figure 121 – First floor plan by A+P Arquitetos Associados [Source: ArchDaily.]

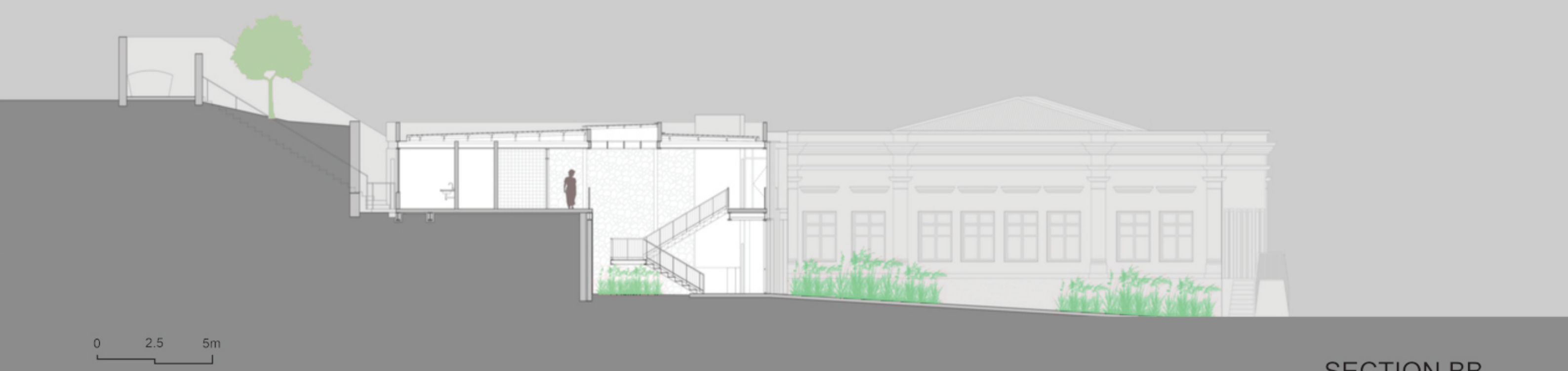


Figure 122– Section BB by A+P Arquitetos Associados [Source: ArchDaily.]

1- Parking

2- Glass connection with the 18th-century building

3 - Wooden pergola

4- Annex corridor

5- Glass partitions (annex)

6- Ribbon window in the annex

Figure 123 – Pictures from the Goiás City Hall. 2014. [Source: Manuel Sá.]

7- Annex staircase

8- Stone wall

9- Stair access opening

10- Glass partitions in the neoclassical building

11- Rooms in the annex

12- Corridor in the neoclassical building

Figure 124 – Pictures from the Goiás City Hall. 2014. [Source: Manuel Sá.]

Chapter 5
Appendix

BEST PRACTICE LIST[23]

Foundations and Cracks

Pathology	*Best Practice Category*	**Recommended Practice**
Absence or failure of foundation	Structural Intervention / Consolidation	Initial diagnosis including geotechnical and hydrological investigation. Perform excavation and underpinning with stone compatible with the original masonry typology. Avoid rigid concrete unless necessary and compatible. Prefer micro-piling and ensure reversibility and vapor permeability. Fully document the process with sketches and photos.
Differential settlement and cracks	Structural Intervention / Consolidation	Perform mapping, soil testing, and crack monitoring. Inject Natural Hydraulic Lime (NHL) grouts into voids. Stabilize foundations with low-impact micro-piling and manual soil re-compaction. Use reversible stainless steel tie rods if necessary. Ensure all techniques are minimally invasive and compatible with the structure.
Diagonal or shear cracks	Preventive Conservation / Diagnosis	Use plaster crack gauges and inclinometers to monitor. If instability is detected, apply concealed internal reinforcement. Prioritize reversibility. Document all steps.
Superficial cracks	Preventive Conservation / Diagnosis	Cracks may signal structural stress or aesthetic issues. Map cracks and perform resistance tests. Use compatible lime-based filler for localized plastering. Preserve continuity with original finishes. Use only mineral pigments. Ensure reversibility and full documentation.

[23] *All the information in this paragraph has been drawn from:* BARBOSA(2021); DIAZ-BASTERIS (2022); UNESCO (1994); VASCONCELLOS(1979); BRITO(1999); MARQUES(2019); OLENDER(2006); CASTRIOTA(2012); ICOMOS(2017); ICOMOS (1999); BOAVENTURA(2001)

Stone Masonry

Pathology	*Best Practice Category*	**Recommended Practice**
Disaggregation of stone masonry	Structural Intervention / Consolidation	Use lime-earth-sand mortars. Add hydrated lime for cohesion. Avoid cement. Prepare surfaces gently. Monitor moisture. Ensure compatibility and minimal intervention.
Exfoliation or flaking (stone)	Preventive Conservation / Diagnosis	Avoid mechanical cleaning. Use nanolime for limestone and siloxane/silane for sandstone. Monitor condition. Consult a specialist for basalt. Ensure reversibility. Document condition and treatment.
Alveolization / differential erosion	Preventive Conservation / Material Compatibility	Inspect porous stones with ultrasound/thermography. Control humidity. Fill cavities with lime-based mortar. Document and monitor long term.
Black crusts (soot, pollution)	Preventive Conservation / Diagnosis	Diagnose emission sources. Clean with dry compresses or soft mist. Avoid abrasives. Improve site drainage. Document thoroughly.

Earthen Masonry and Moisture

Pathology	*Best Practice Category*	**Recommended Practice**
Disaggregation of earth masonry	Structural Intervention / Consolidation	Reconstruct using earth mortar with local subsoil, sand, clay, and 5–10% hydrated lime if needed. Add natural fibers to prevent cracking. Avoid Portland cement. Preserve layering and original techniques. All procedures must ensure permeability, reversibility, and full documentation.
Basal erosion in earthen walls	Preventive Conservation / Material Compatibility	Apply breathable lime or earthen plasters to bases. Improve drainage and slope. Extend eaves. Install splash guards. Monitor and document regularly.
Unprotected earthen wall surfaces	Preventive Conservation / Material Compatibility	Apply breathable coatings such as earthen or lime render enhanced with beeswax, casein, or oils. Use sacrificial layers. Add physical protections like plinths or overhangs. Schedule reapplications. Document formula and application.
Salt efflorescence	Preventive Conservation / Diagnosis	Identify moisture ingress. Improve drainage and grading. Remove salts by dry brushing or vacuuming (no water). Apply breathable finishes. Avoid cement. Monitor and document.
Lichens and moss on walls	Preventive Conservation / Diagnosis	Identify species. Remove with dry brushing (soft plastic/nylon). Avoid high pressure or chemicals unless necessary. Promote sun and air exposure. Document and monitor.

Wood Elements

Pathology	*Best Practice Category*	Recommended Practice
Wood floor degradation	Material Compatibility / Preventive Conservation	Retain and repair using traditional joinery. Replace only irreparable boards with same-species, compatible wood, marking replacements. Inspect and stabilize. Control RH (45–60%). Check wood moisture content (in Brazil, the fibre saturation point – FSP typically ranges between 21% and 25%). Treat with borate, apply linseed or tung oil and beeswax. Reinforce supports if needed. Document everything.
Unprotected wood surfaces	Preventive Conservation / Material Compatibility	Protect exposed wood with cold-pressed linseed oil. Apply silane or siloxane to adjacent masonry to repel water while preserving permeability. Ensure reversibility. Document product data, date, and application method.
Structural wood degradation	Structural Intervention / Consolidation	It´s important make a diagnostic phase to see what elements need be changed. Only change the parts that are not possible to repair, and write all the informations. Use same type of wood, that is already dry and treated. Use traditional joinery. For consolidation you can use acrylic, silicate or natural polymers. Put antifungal and insecticide treatment. Make sure the wood can still breath moisture. Always make full documentation.
Degraded window/door frames	Material Compatibility / Preventive Conservation	Retain and repair original elements using traditional joinery. Replace only irreparable parts with timber compatible in species, grain, moisture, and density. Discreetly mark replacement pieces. Patch or reinforce with compatible materials. Finish with lime-based mineral paint.
Mold and mildew on wood	Preventive Conservation / Diagnosis	Monitor RH and temperature. Improve ventilation. Remove moisture-retentive materials. Clean with HEPA vacuum or mild borax solution. Avoid impermeable coatings. Document thoroughly.
Termite or borer infestation	Preventive Conservation / Diagnosis	Apply borate-based preservatives (DOT). Inspect annually. Use physical barriers (mesh, shields). Ensure compatibility and reversibility. Document treatments.

Roof System

Pathology	*Best Practice Category*	Recommended Practice
Broken or missing clay tiles	Material Compatibility / Preventive Conservation	Reuse original tiles whenever possible. Replace only broken ones with handmade clay tiles of identical type. Remove tiles one by one (from ridge to eaves), store vertically to avoid breaking. Discreetly mark replacements. Document all changes.
Deformation of roof slope / sagging structure	Structural Intervention / Consolidation	Support roof temporarily with wooden shoring. Inspect rafters, purlins, ridge beam, laths, and *frechal* piece by piece. Replace only irreparably damaged members with same-species seasoned timber. Maintain original slope (≥30–35°). Document interventions.
Use of incompatible fixings (nails, wires, clamps, oxidized metals)	Material Compatibility / Structural Adjustment	Remove inappropriate or corroded metallic fixings. Re-secure with wooden pegs or traditional carpentry methods. Stainless steel fixings allowed only when strictly necessary for safety, applied discreetly. Document materials used.
Missing eaves elements (*cachorros*, soffits)	Structural Intervention / Reconstruction	Preserve original cachorros and soffits whenever possible. Reinforce only when necessary, with same-species wood and matching profile. Replace missing soffit boards with similar timber, fixed using removable wooden pegs or screws (not glue), ensuring reversibility. Document shape, wood species, and replacements.
Deficient roof drainage	Preventive Conservation / Technical Improvement	Preserve traditional wide eaves (no gutters). Ensure correct projection of tiles (≥50–70 cm) to shed water. Adjust slope if deformation alters flow. Improve ground drainage around foundations. Document all corrective measures.
Inadequate ventilation between tiles and wood structure	Preventive Conservation / Diagnosis	Maintain natural air circulation under tiles. Avoid impermeable underlayments (like aluminum or asphalt membranes) that trap humidity. Ensure ridge and hip tiles are set with lime mortar (not pure cement), allowing permeability. Record ventilation solutions adopted.

Coatings and Paint

Pathology	*Best Practice Category*	**Recommended Practice**
Loss of lime or earthen plasters	Material Compatibility / Preventive Conservation	Carefully remove damaged layers. Prepare substrate and reapply lime mortar (1:8) or lime-soil-sand blends. Add hydraulic lime in exposed areas. Apply manually in ~10 mm layers with a wooden trowel. Cure slowly (3–10 days, at 5–30°C). Avoid PVA or synthetic additives. Document and monitor.
Inappropriate paint use	Material Compatibility / Preventive Conservation	Carefully remove modern synthetic/enamel paints with manual scraping. Apply lime-based paints with natural pigments (~3–5%), respecting curing time and permeability (SD ≈ 0.01). Avoid VOCs. Document composition and application.
Lack of painting	Preventive Conservation / Material Compatibility	Clean surfaces gently with brushes and dry cloths. Fill cracks with lime-sand filler. Sand lightly. Ensure smooth breathable base. Use lime-based/mineral paints. Avoid destructive or abrasive methods. Document all prep work.
Degraded window/door frames	Material Compatibility / Preventive Conservation	Retain and repair with traditional joinery. Replace only irreparable components with compatible timber. Mark replacements discreetly. Finish with breathable lime-based paint. Ensure minimal intervention and full documentation.
Craquelé in painted walls	Preventive Conservation / Material Compatibility	Avoid wet cleaning. Consolidate with diluted lime if detachment is imminent. Maintain dry, ventilated environments. Avoid unapproved commercial products. Document thoroughly.

Systems, Comfort and Environmental Performance

Pathology	***Best Practice Category***	**Recommended Practice**
Obsolete electrical and plumbing systems	System Upgrade / Infrastructure Integration	Fully remove hazardous wiring/pipes. Use reversible conduits in voids or behind moldings. Install compliant flame-retardant cables. Use cold/compression fittings. Retain visible historical fixtures when possible. Discreetly mark new ones. Document with photos, plans, and notes.
Lack of security and monitoring	System Upgrade / Infrastructure Integration	Install discreet cameras and sensors. Run cables through cornices or baseboards. Use battery-powered emergency lights. Integrate data into independent circuits. Document installations with technical records.
Inadequate accessibility and comfort	Preventive Conservation / Diagnosis	Install ≤8% ramps with certified wood, tactile signs, mineral-painted handrails. Use cork or vegetal wool insulation. Enhance ventilation. Use passive strategies before active ones. Comply with heritage compatibility and NBR 9050.
Fire safety deficiencies (lack of exits, alarms, extinguishers)	Retrofitting / Safety Compliance	Install smoke detectors, alarms, extinguishers, and sprinklers where required by law. Place emergency exit signs discreetly, ensuring reversibility and minimal visual impact. Document installation points and maintenance schedule.
Energy inefficiency (lighting, HVAC, insulation)	Retrofitting / Energy Saving & Sustainability	Upgrade to LED lighting and high-efficiency HVAC systems, using reversible cabling and ducts. Improve insulation with breathable natural materials (cork, hemp, vegetal wool). Introduce solar energy systems when possible, ensuring visual compatibility. Monitor performance and document interventions.
Water and resource sustainability gaps	Retrofitting / Sustainability	Implement rainwater harvesting and greywater reuse with discreet storage and piping. Use low-flow fixtures. Apply sustainable maintenance practices. Document system design and operation.
Inadequate thermal comfort	Preventive Conservation / Material Compatibility	Use passive strategies (shading, cross-ventilation, thermal mass). Apply breathable insulation (cork/hemp) only if needed. Avoid synthetic barriers. Monitor seasonally. Document interventions.

Systems, Comfort and Environmental Performance

Pathology	***Best Practice Category***	**Recommended Practice**
Poor ventilation / excess humidity indoors	Preventive Conservation / Diagnosis	Maintain cross-ventilation using original openings. Avoid sealing with impermeable paints or modern underlayments. Introduce discreet ventilation gaps if necessary. Monitor RH and temperature. Document changes.
Insufficient natural lighting	Preventive Conservation / Material Compatibility	Clean and maintain window frames to maximize daylight. Use limewash or mineral paints to enhance reflectance. Avoid enlarging openings. Add reversible reflective devices if needed. Document interventions.
Acoustic discomfort (echo, noise infiltration)	Preventive Conservation / Material Compatibility	Retain thick earthen walls for natural sound absorption. Introduce reversible interior panels of cork or wood fiber when necessary. Avoid synthetic foams. Document placement and material properties.

CONCLUSIONS

Today in Brazil, restoring a historic building is still a big challenge. Even if institutions like IPHAN are working hard, there is still a big gap between what theory and best practices say and what really happens in real projects. The main problems are that there is not enough technical knowledge, many times people don´t really value the old materials, and also there are not clear laws or rules about what should be kept as historic.

It´s always important to try make restoration work better, to follow some clear rules, and also to use international standards when possible. Good practices, like regular monitoring, heritage education, and using modern tools, help restoration to be more responsible and last longer.

To understand the vernacular residential architecture from the Gold Cycle in the Brazilian Midwest, it´s necessary to make a list of clear rules and principles to guide the work. By studying history, materials, building systems, house types, decay processes, and also the restorative intervantion. With special goals and methods, it was possible to define the best practices for restoring this kind of house.

The case studies of the Enxaimel House, the Setecentista House, and the Otília House give useful ideas on how restoration methods are used. They show real effort to use good techniques and materials, but some problems stay. For example, in the Enxaimel House, the use of cement-based materials makes doubts about compatibility and long-term results. In the Setecentista House, the use of wrong products, like in the paint, shows a common problem in restorations in Brazil.

Sadly, in earthen architecture restoration, invasive and no reversible methods are still common. These methods often destroy the original materials. This shows why it´s so important to use less invasive techniques that can repair damage but keep the building´s authenticity. Today, thanks to new technologies and better planning of maintenance, is a positive move to simpler and more respectful restorations, close to international conservation rules.

This study finish by opening the way for future research, specially in improving the best pratices list and the analysis of decay. It also shows the big importance of saving all types of heritage, even the simple or humble ones, because they all tell the real story of the people and keep cultural memory alive.

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Figure 19 – Floor Plan of the Casa de Câmara e Cadeia of Mariana (1762). Manuscript map depicting the ground floor of the Casa de Câmara e Cadeia of Mariana, designed by José Pereira dos Santos in 1762. Provenance: Pirajá da Silva Collection Source: Google Arts & Culture. Available at: https://artsandculture.google.com/asset/planta-a-da-casa-de-câmara-e-cadeia-de-mariana-josé-pereira-dos-santos/1wHHwNfwzxf4gA?hl=en. Accessed on: May 7, 2025.

Figure 20 – Casa dos Contos.
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Figure 21 – Capela de Padre Faria, Ouro Preto (Minas Gerais, Brazil). (1) Floor Plan of the Capela de Padre Faria. Published in the article "Morfologia das Igrejas Barrocas II" on May 9, 2012. Source: Coisas da Arquitetura.(2) Photograph: "Ouro Preto a Capela de Padre Faria com a sua Linda Cruz de Pedra." Anonymous artist, December 1923. Photograph/postcard from the Museu Paulista da USP collection. Source: Wikimedia Commons.
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