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Earthen Architecture in Costa Rica: Building Typologies in the Historic Centers of Cartago and Santo Domingo de Heredia

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Abstract

Earthen architecture in Costa Rica experienced two significant stages of development. The first corresponds to the pre-Columbian period, during which local inhabitants constructed their dwellings using logs, thatch, plant fibers, and mud as infill material. The second began with the Spanish conquest, which introduced adobe construction — a technique previously unknown in the region. Cities such as Cartago, which served as the national capital until 1835, were primarily built using adobe. Over time, the influence of this construction technique spread throughout Costa Rica. Urban centers like Santo Domingo de Heredia still retain numerous adobe buildings integral to their historic urban landscape. Due to the region's geographical and climatic conditions, Costa Rican domestic architecture from the 17th century onward generally followed two principal typologies: urban and rural. Both share similar characteristics, such as thick masonry walls, small openings for doors and windows, steeply sloped roofs, and wide eaves in response to climatic factors. Despite these similarities, cities evolved in terms of density and land use, resulting in a broader and more complex range of building typologies today. This study forms part of the research project "Seismic Earth: Physical and Mechanical Analysis and Characterization of Adobe and Bahareque Construction Systems in the Historic Centers of Cartago and Santo Domingo de Heredia as a Basis for Seismic Adaptation". The project seeks to deepen understanding of the adobe and bahareque construction systems, including their pathologies and specific features. Preliminary findings reveal the distinctive characteristics of various building typologies in the two case study areas and their relationship with the urban development of these historic centers.

Keywords: *adobe; bahareque; historic urban landscape; seismic earth; construction systems*

1. Introduction

Located in Central America, Costa Rica was under Spanish colonial rule from approximately 1519 until independence in 1821. Unlike some neighboring countries, Costa Rican architecture did not stand out for its scale or degree of sophistication. Although there is evidence of significant pre-Columbian architectural complexes, such as the Guayabo National Monument and the stone sphere settlements in the Diquís area, most buildings were vernacular in nature and constructed with perishable materials. As a result, only a few structural elements—such as stone foundations, roads, or aqueducts—have survived to the present day.

The limited presence of pre-Hispanic architecture and even of structures from later periods can be attributed to the convergence of several factors. During the pre-Columbian era, Costa Rica was a meeting point for cultures such as the Maya and the Chibcha, whose influence is evident in local crafts, cuisine, and customs. However, the region was primarily a zone of transit and exchange rather than a permanent settlement for these cultures.

During the colonial conquest, proximity to administrative centers established by the Spanish was crucial for developing new settlements. In this context, Costa Rica's geographic conditions and the dispersion of its indigenous populations kept it relatively isolated from key colonial cities in Guatemala, Nicaragua, and Panama. This isolation contributed to a scarcity of skilled labor familiar with the construction techniques introduced from other parts of the world.

Another key factor that affected the country's architectural heritage preservation was the region's persistent seismic activity. Historical records document significant earthquakes as early as the 17th century, which repeatedly necessitated the rebuilding of homes, municipal buildings, churches, and other structures (González, 1994).

The pre-Columbian period was characterized by vernacular construction using local raw materials. "Elliptical and rectangular huts were common in the North Pacific, while circular ones dominated in the Central Valley; in contrast, the Caribbean and South Pacific regions typically featured palenques" (Molina & Parmer, 2017, p. 15). These buildings employed wood for the primary structure and palm leaves for the cladding. The steep roof pitch often extended to the ground, functioning as walls. A clay pot was suspended from the highest point of the roof to collect rainwater and prevent flooding inside the dwelling. The walls were made waterproof using a mixture of earth and water. In drier regions such as the Greater Nicoya area, roofs were less steep, and the gaps in wooden or cane walls were filled with earth. This technique closely resembles bahareque, a method found in other parts of the region.

The colonial period brought a notable rise in using earth as a building material in Costa Rica. With the founding of Garci Muñoz by Juan de Cavallón in 1561 and Cartago by Juan Vázquez de Coronado in 1563 (Mata, 1999), the adobe construction technique was introduced to the country. This system became characteristic of the new colonial settlements, which contrasted with indigenous ones not only in materials but also in urban layout. Settlements followed the grid pattern mandated by the Royal Ordinances of Philip II in 1573 (Woodbridge, 2007).

Adobe construction became popular in the country's former capital and spread to other cities such as San José and Heredia, including towns like Escazú, Pacacua, Barva, and Santo Domingo. These towns replicated the colonial grid layout, with the church and main square as central elements around which buildings were organized. Despite the expansion of adobe construction across various regions, only a few urban centers retain a significant number of earthen buildings within their historic fabric. The loss of this architectural heritage can be attributed to frequent earthquakes, flooding, and increasing pressures from land value. The research project "Seismic Earth: Physical and Mechanical Analysis and Characterization of Adobe and Bahareque Construction Systems in the Historic Centers of Cartago and Santo Domingo de Heredia as a Starting Point for Seismic Adaptation," conducted by the Costa Rica Institute of Technology, aims to inventory these buildings to enhance the understanding of their construction techniques and highlight their cultural value.

This paper presents some initial findings from identifying these structures based on the research activities carried out during the project's first year.

2. Materials and methods

In 2024, both study areas were delineated to determine the zones for identifying earthen buildings. This task was carried out through the consultation of historical maps at the National Archive and a bibliographic review conducted at the Center for Cultural Heritage Conservation (CICPC) or the Heritage Directorate. In the case of Cartago, the delineation proposed by Fallas-Pastor (n.d.) and Mata-Gamboa (1999) was considered, along with its correspondence with the map by Figueroa-Oreamuno (1801–1821). This information was further contrasted with the notes of Tristán-Fernández (1910). For Santo Domingo, the delineation by Ruiz-Briceño (n.d.), the map by Riggioni and González (1920), and the study by Zamora and Vives (2005) served as key references. The comparison of historical cartography and bibliographic sources led to the determination of the historic center boundaries in both cities.

Subsequently, a documentary review was conducted to understand better the characteristics of Costa Rica's earthen constructions and their associated building typologies. Key references included the works of Gutiérrez-Rojas (2018), Fonseca & Garnier (1998), and Woodbridge-París (2003).

Building on this foundation, a preliminary inventory of adobe and bahareque constructions was developed through archival research involving architectural thesis projects, historical records, and registries of protected buildings. This stage relied on prior studies such as the work by Guevara and Navarro (2014) in the historic center of Santo Domingo, the study by Morera-Cortés (2015) in the city of Cartago, and the inventory compiled by Sancho-Víquez (1985).

A standardized survey form was designed to guide field data collection from this preliminary inventory. The form was created in Excel format and implemented in print and digitally through the Plumsail application. Field visits were conducted to validate existing records and to identify additional undocumented buildings. In the case of Cartago, three site visits were conducted, while six sessions were required for Santo Domingo.

Finally, the research team analyzed the collected data to define the building typologies in each historic center and compare their current configuration with those described in the consulted literature.

3. Results

3.1. Delimitation of Historic Centers

3.1.1. The Historic Center of Cartago

Cartago served as the capital of Costa Rica from 1563 until 1823, when the seat of government was relocated to San José. The city was laid out following a grid pattern (*damero),* with the Plaza Mayor at its center, organizing the parcels allocated to various buildings: the Santiago Apóstol parish to the east, the Cabildo (municipal council) to the north, as well as other governmental institutions and the residences of local authorities in the surrounding blocks. Around 1635, the discovery of the image of the Virgin of Los Ángeles in the area known as Puebla de los Pardos led to the construction of a chapel on the site. It altered the city's morphology by expanding its historic center eastward (Mata, 1999). According to historical records, by 1719, the city had approximately 70 adobe and tile-roofed houses (Zamora & González, 2009), and by the early 19th century, the urban core comprised 40 city blocks.

According to the map by Figueroa-Oreamuno (1801–1821), prior to the 1910 earthquake, the city perimeter was clearly defined: to the north along 14th Street behind the military barracks up to Cinco Esquinas in the San Nicolás neighborhood, to the west along the eastern edge of the general cemetery; to the south, bounded by the municipal slaughterhouse; and to the east,

extending to Calle de La Soledad. In total, 189 blocks were recorded, with dimensions ranging between 77 and 130 meters and sidewalks approximately 1.10 meters wide (Mata, 1999).

Cartago's history has been shaped by a series of natural disasters that progressively transformed its urban image and influenced the evolution of construction systems. Earthquakes in 1715, 1722, and 1841, along with the 1891 flood, caused significant loss of life and damage to the built fabric of the historic center. However, the most devastating event occurred in 1910 with the Santa Mónica earthquake, which remains the worst disaster in the city's history. According to the provincial governor of Cartago, José María Peralta, the event resulted in 233 deaths and the destruction of approximately 85% of the city's buildings (González-Víquez, 1994).

Despite repeated natural disasters, Cartago was rebuilt, maintaining its original urban layout while introducing new reconstruction regulations. These included a ban on adobe construction, a reevaluation of bahareque as a building method, and an incorporation of stylistic influences favoring timber construction, such as Victorian architecture.

3.1.2. The Historic Center of Santo Domingo de Heredia

Before the colonial period, the indigenous Toyopán group inhabited the area. Following the Spanish conquest, the territory came under colonial control, and in 1829 the first chapel dedicated to Saint Dominic of Guzmán was constructed. This religious dedication gave the settlement its current name. The building, originally made of adobe and clay tile, was later demolished to make way for the construction of the Church of El Rosario in 1838 (Zamora & Vives, 2005). Located facing the plaza and oriented east-west, the church and the cabildo (town council) constituted the urban core of the settlement. The layout of the historic center was formalized by the decree of then-president Braulio Carrillo, who mandated the grid plan (damero) for all new urban centers. By 1840, Santo Domingo had 296 houses, according to records from the military administration under Carrillo (Ruiz-Briceño, n.d.).

During the 19th century, the town consolidated as a key settlement due to the cultivation and processing of tobacco, followed by coffee. The rise of the coffee economy led to the appearance of hacienda-style houses built in adobe and bahareque, typically located on large plots of land.

These dwellings evolved. Mid-18th-century constructions, built during the tobacco boom, were situated outside the urban centers. By the early 19th century, houses increased in scale, integrated within the blocks of the historic center, and reflected the transition from colonial peasantry to small-scale coffee producers (Ruiz-Briceño, n.d.). Eventually, corner houses appeared on the city grid, usually owned by large-scale coffee growers.

According to the map by Riggioni & González (1920), the historic center of Santo Domingo was bounded to the north by Calle de Tures, to the east by Calle Iglesia Nueva—located behind the basilica and running along its perimeter up to Calle la Real or Quintana—to the south between Calle Ronda. What is now 12th Avenue, and to the west by Calle 8. 71 blocks were documented, with dimensions ranging from 87 to 105 meters, except for the lots adjacent to the basilica, which measured between 50.5 and 58 meters. This urban layout remains largely intact today, along with many earthen constructions dating from the late 19th century.

3.2. Early building typologies

3.2.1. Urban housing

The building was constructed from the corner of the block, directly on the property line, following an "L"-shaped configuration on the site. The main entrance was oriented toward the most

important street, while the secondary entrance served complementary functions such as carrying firewood or allowing access to animals. The house's layout created an interior yard or patio, enclosed on two sides by the two wings of the building (Gutiérrez, 2018). It was connected to the interior by a lateral corridor. Though lacking walls, this space was sheltered by the roof, which rested on a structure of wooden beams and columns.

The various rooms were interconnected and linked to the corridor, with their use determined by each owner according to their needs. However, the house generally featured a room or vestibule adjacent to the main entrance, bedrooms, and, in some cases, a dining room connected to the kitchen area (Gutiérrez, 2018). The oven and the bathroom were separated from the dwelling but connected by a tangential path, isolated from the main structure for safety and hygiene purposes. At the end of the property, the troja area was located, where firewood, grains, and washing spaces were stored, and occasionally, it also served as a shelter for domestic animals.

The roof was generally gabled with a four-pitched configuration that followed the plan's layout, featuring wide eaves and steep slopes. On some occasions, the eaves of the more exposed facades had decorative details. "To extend the eaves without risking structural integrity, corbels were embedded in the wall, which, in some cases, were made of perforated wood for aesthetic purposes" (Gutiérrez, 2018, p. 38).

3.2.2. Rural housing

The house was perpendicular to the street, with one of the narrower facades facing the public space. This characteristic allowed for the creation of a front yard, providing greater privacy and contributing to the adaptation to climatic variables: vegetation was used to mitigate sunlight, and cross-ventilation was achieved through the surrounding corridor.

The rectangular-shaped house extended inward on the plot, with the first room functioning as the living area, followed by the bedrooms. The dining room was omitted, as this function was integrated into the kitchen space, typically located at the rear of the house (Gutiérrez, 2018).

Separated from the house, there was a small area for the oven, a washing space, and a small volume housing the sanitary service farther from the main structure. There was no dedicated bathroom area, as the inhabitants used nearby streams for bathing.

The roof was typically gabled with a two-pitched design, featuring a change in slope over the corridor area, where the roof extension helped protect the space.

To complement the housing functions, a troja was located apart from the house in a square-plan structure made of wood and clay tile.

Rural housing was more common in areas with larger plots, whereas urban housing, although larger in dimensions, had less available land due to the restrictions of the city block grid.

In both types of construction, the walls ranged from sixty centimeters to one meter in thickness, with foundations consisting of compacted trenches for rural homes and stone-filled trenches for urban homes. Both types featured small openings for windows, shutters, and wooden doors.

A notable characteristic of earthen dwellings is the purity of the volumes, typically of a uniform scale, usually one-story, and with minimal ornamentation.

3.3. Evolution of building typologies

The inventory work carried out in the historic centers of Cartago and Santo Domingo de Heredia, as well as the comparison with the urban and rural housing typologies studied in the bibliographic references, identified the following variants.

3.3.1. Corner unit

This type is located at one of the corners of the block. Its floor plan is rectangular, without an "L" shape. It features a gable roof, with one slope facing the front and the other facing the rear (Fig.1).

3.3.2. Corner unit with courtyard

Located at one block's corners, this unit extends on both sides of the property in an "L" shape. The roof follows the floor plan's form. It includes an open space or courtyard on both sides of the building, sometimes open to the street or enclosed by a low wall. An internal corridor may connect to the courtyard (Fig. 1).

3.3.3. Attached corner unit

Like the previous types, this unit is located at a corner of the block but maintains a continuous relationship with the adjacent building. This condition may result from urban expansion in the years following the original construction (Fig.1).

Fig. 1 – *a) Corner Unit, b) Corner Unit with Courtyard, c) Attached Corner* Unit (Chavarría-Villagra, 2025).

3.3.4. Attached unit

Located centrally within the block, this type has a rectangular floor plan and shares lateral boundaries with neighboring properties. It generally has a gable roof, one slope facing the front and the other facing the rear (Fig. 2).

3.3.5. Semi-attached unit

This unit is positioned centrally within the block, sharing one lateral boundary with the adjacent property. On the opposite side, it typically has an open space, such as a courtyard or uncovered passage, bordered by a small wall. The roof is hipped, with slopes toward the front, back, and courtyard or passage (Fig. 2).

3.3.6. Detached unit

Situated centrally within the block, this unit retains setbacks on both sides. It is typically used as a patio or lateral passage enclosed by a small wall. It can have a gable or hipped roof, with slopes facing the front and rear (Fig. 3).

3.3.7. Semi-detached unit

This unit is centrally located within the block. It has a rectangular floor plan and shares a lateral boundary with an adjacent property. On the opposite side, there is a setback for the patio. The most notable feature is the roof shape, usually with three slopes (Fig. 2).

Fig. 2 – *a)* Attached Unit*, b)* Semi-attached Unit, *c) Semi-detached Unit* (Chavarría-Villagra, 2025).

3.3.8. Paired units

A group of housing units sharing a boundary. The roof structure is continuous, typically with two slopes—one facing the front and the other facing the rear. In some cases, these units may be located at the corners of the block. This configuration reflects the evolution of the inhabitants' needs over time (Fig. 3).

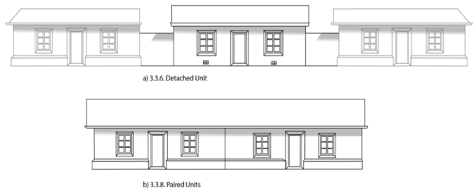

Fig. 3 – *a) Detached Unit, b) Paired Units* (Chavarría-Villagra, 2025).

3.3.9. Rural unit

This type is distinguished from the others by its perpendicular alignment to the street or road. It features a garden and courtyard on at least two sides of the building, enclosed by a small wall. These units are situated on larger plots of land and generally have a lateral corridor, usually only one segment long.

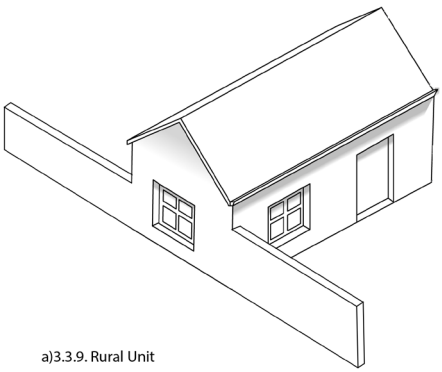

Fig. 4 – *a) Rural Unit* (Chavarría-Villagra, 2025).

In the historic center of Cartago, 24 earthen buildings were recorded. Of these, 21 correspond to the bahareque construction system, and 2 are adobe buildings and 1 in mixed construction system. Regarding typologies, the distribution is as represented in Table 1.

The historic center of Santo Domingo de Heredia records a total of 102 earth buildings. In the area, there are 92 adobe constructions, 5 bahareque constructions and 5 in mixed construction system. The distribution by construction typology is represented in Table 2.

4. Discussion

Earthen buildings in Costa Rica correspond to specific geographic locations, either within or outside the city centers. However, their constructive evolution is related to the original urban grid layout and the social and economic background of their inhabitants at the time of construction, particularly during the 19th century.

Table 1 – *Distribution in historic center of Cartago.*

Typology	Amount	%
3.3.1	1	4.16
3.3.2	2	8.33
3.3.3	5	20.83
3.3.4	6	25
3.3.5	3	12.5
3.3.6	0	0
3.3.7	2	8.33
3.3.8	1	4.16
3.3.9	4	16.66

Table 2 – *Distribution in historic center of Santo Domingo de Heredia.*

Typology	Amount	%
3.3.1	5	4.90
3.3.2	16	15.68
3.3.3	23	22.54
3.3.4	20	19.60
3.3.5	12	11.76
3.3.6	4	3.92
3.3.7	1	0.98
3.3.8	21	20.58
3.3.9	0	0

Variations in the urban and rural housing typologies were identified in both historic centers. These differences reflect adaptations to the owners' needs, the cities' spatial growth, and the increasing population density.

Regarding the construction materials, in Santo Domingo, only 1.98% of the recorded buildings correspond to bahareque constructions. In contrast, in Cartago, the opposite trend is evident, with 93.1% of the earthen buildings made of bahareque. This stark contrast in building systems can be attributed to the historical prohibition on adobe construction in the former capital.

As previously mentioned, following the 1910 Santa Mónica earthquake, adobe was legally restricted, which promoted the use of alternative systems such as bahareque and timber framing.

Cartago's predominant typology corresponds to attached buildings, while in Santo Domingo, most registered buildings follow the attached corner typology. In both cases, the growing urban density may have contributed to this configuration, as some property owners subdivided their lots and sold portions of land, encouraging the construction of new adjacent dwellings.

Notably, in Santo Domingo, most buildings are located on corner lots, and no rural typologies were identified in the sample. In contrast, 13.79% of the recorded buildings in Cartago are rural. This discrepancy deserves further investigation. Although Cartago—being the former capital and one of Costa Rica's earliest colonial cities—would be expected to present a more urban character, Santo Domingo underwent significant development in the mid-19th century due to the rise of tobacco and coffee production. This may have led to a stronger trend toward reproducing urban housing models.

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References

González Víquez, C. (1994). *Temblores, terremotos, inundaciones y erupciones volcánicas en Costa Rica 1608-1910.* Editorial Tecnológica de Costa Rica.

Molina Jiménez, I., & Palmer, S. (2007). *Historia de Costa Rica: breve, actualizada y con ilustraciones* (2th ed.). Editorial de la Universidad de Costa Rica.

Woodbridge-Paris, R. (2003). *Historia de la arquitectura en Costa Rica*. Editorial Tecnológica de Costa Rica.

Mata-Gamboa, J. (1999). *Monografía de Cartago.* Editorial Tecnológica de Costa Rica.

Zamora-Hernández, C., & Vives Luque, I. (2005). *La Basílica de Santo Domingo de Heredia*. *Revista Patrimonio 5*(5). Centro de Investigación y Conservación del Patrimonio Cultural.

Gutiérrez Rojas, M. E. (2007). *La casa de adobes costarricense* (2th ed.). Editorial de la Universidad de Costa Rica.

Fonseca, E., & Garnier, J. E. (1998). *Historia de la arquitectura en Costa Rica*. Fundación Museos del Banco Central de Costa Rica.

Sancho Víquez, J. (1985). *Estudio del proceso de deterioro de las estructuras arquitectónicas: caso centro histórico Santo Domingo de Heredia.* [Dissertation, Universidad de Costa Rica].

Fallas Pastor, C. (n.d). *Reseña histórica del casco antiguo de la ciudad de Cartago*. Centro de Investigación y Conservación del Patrimonio Cultural. https://patrimonio.go.cr/biblioteca_digital/inventario/2003_ia_de_cartago.aspx

Ruiz Briceño, Z. (n.d). *Reseña histórica de Santo Domingo*. Centro de Investigación y Conservación del Patrimonio Cultural. https://patrimonio.go.cr/biblioteca_digital/inventario/2004_ia_de_santo_domingo_heredia.aspxps://www.rastreator.com/hipotecas/consejos/pedir-una-hipoteca.aspx

Morera-Cortés, M.F. (2015). *Plan especial de protección: centro histórico de Cartago.* [Dissertation, Instituto Tecnológico de Costa Rica].

Guevara-Murillo, M. & Navarro-Morera, E. (2014). *Santo Domingo: Centro de interés histórico patrimonial, propuesta de conservación del patrimonio urbano arquitectónico.* [Dissertation, Instituto Tecnológico de Costa Rica].

Figueroa Oreamuno. (1821). Mapa de la ciudad de Cartago [Map]. Archivo Nacional de Costa Rica.

Riggioni & González (1920). Mapa de la ciudad de Santo Domingo de Heredia [Map]. Archivo Nacional de Costa Rica.