

# CONSERVATION OF EARTHEN ARCHITECTURE IN THE HUMAHUACA QUEBRADA OF JUJUY, ARGENTINA.

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Abstract

This paper presents the results of a project, whose main purpose is to develop a Manual of Architecture and Earthen Construction for the inhabitants of the Humahuaca Quebrada (Ravine), located in the Jujuy Province of Argentina. This manual is intended to be the guidelines for earthen-heritage conservation, and to impart recommendations for new earthen construction. The Quebrada is a territory where earthen architecture is found. This is one of the reasons why it was designated a World Heritage Site by UNESCO in 2003. The project also aims to identify vernacular technologies, in order to properly guide their recovery and insertion into legislation, taking into account that it is a territory affected by earthquakes and geological risks. The methodology considers the collection of bibliographic data, field surveys, interviews and workshops with local people and organizations, and the design of the manual, including recommendations for recovery and development of earthen architecture in the Quebrada.

Places and structures were selected, taking into account popular, state and NGO buildings, to identify the changes in autochthonous patterns and their characteristics. The main features, the architectural and construction facets of some of the studied construction, is described, as well as the features corresponding to their cultural value. Significant aspects of the impact of industrial technologies on local traditions are described, and proposals for conservation and development of earthen architectures in the Quebrada are submitted.

## 1. INTRODUCTION

The area under study comprises a part of the Argentine territory, known as Humahuaca Quebrada, in the Province of Jujuy, in northern Argentina. The Humahuaca Quebrada was declared Cultural Landscape of Humanity in 2003 (Nicolini, 1981; Reboratti, 2003; Boschi and Nielsen, 2004) for the values of the natural and cultural environment, which frame an exceptional occurrence of settlements, archaeological sites, Indian villages (today civilian villages in development accelerated by the impact of tourism), railroad populations, as well as villages and rural houses, farms and pens for agricultural livestock. It encompasses a 150 km long Andean valley that goes from Barcena and Volcan up to Tres Cruces, including the established gorges and valleys or mountainsides that define the natural landscape of the Quebrada.

This area is designated as a Level 2 and Level 3 seismic hazard area, according to the national zoning of the National Institute of Seismic Prevention (INPRES-CIRSOC 103, 1991). The natural environment of the Quebrada is known for its dry and cold semiarid climate, with significant conditions that are reflected in the architecture. There are sloping territories that determined

the location of settlements, the landscape and the orientation; an almost daily presence of cold southern winds, though dry and warm in August; low rainfall, but sometimes violent storms, along with high sunlight exposure all throughout the year; extreme variations between day and night temperatures; natural phenomena responsible for disasters, such as extraordinary swelling of rivers with flooding, mud and rock slides, and earthquakes. The same causes influenced the uniqueness of settlements; they defined the architecture and partly characterized the use of traditional materials and construction techniques.

As for the architectural and technological forms (Nicolini, 1981, SCA-IAIHAU UNT, 1982; Rotondaro, 2001, 2006; Paterlini, Villavicencio and Rega, 2006), the inhabitants of the Quebrada developed criteria, throughout centuries, that denote a deep knowledge of building their habitat, such as the careful selection of a site for a settlement, of the construction emplacement, the organization of houses without breaching the natural topography, or the use of the urban plot, setting aside a third of it to farm, as a productive unit. In particular, the dweller has retained techniques and procedures related to construction and the architecture using



Fig.1 Self-construction of a domestic housing using adobe, and terracotta tiles on hollow reed in El Perchel, Argentina (credits: Rodolfo Rotondaro, 2009)

natural materials, predominantly raw earth, stone and plants. It was accomplished through the natural transmission of knowledge and techniques among construction craftsmen over generations.

However, recent decades have witnessed profound economic, cultural and productive changes that are affecting and impacting on traditions with centuries of history. The local know-how of strong cultural significance is being modified and, in some cases, lost or supplanted by other forms of architecture. Nonetheless, in recent years, a process for recovery of traditional technologies is being generated based on the demand for current construction (mainly adobe).

The objectives of the project are the following:

- Identify construction techniques and materials in the vernacular and popular architecture of the Humahuaca Quebrada, by surveying built structures throughout, accompanied by interviews with construction artisans.
- Identify advances in construction procedures carried out in the architecture of the last 10 years, through on-site surveys and interviews of architects, engineers and technicians working in the region.
- Be acquainted with the progress of the construction industry in the matter.
- Propose new guidelines for buildings, by optimizing the use of materials and construction techniques.
- Develop an Earthen Architecture Construction Manual devoted to the inhabitants of Humahuaca Quebrada, through which guidance and instruction on how to build in the region is bestowed.

Within this territory, rural and urban human settlements are considered, as well as buildings in the territory that act as support for productive, tourist and religious activities. The project was led by one of the authors and funded by the Ministry of Science, Technology and Productive Innovation of Argentina. The counterpart is the Ministry of Tourism and Culture of Jujuy, through the Management Unit of Humahuaca Quebrada.



Fig.2 Quincha depot in an agricultural sugar plantation near Route 9, close to Maimará, Argentina (credits: Rodolfo Rotondaro, 2009)

## 2. NATIVE ARCHITECTURE FROM HUMAHUACA QUEBRADA

The autochthonous architecture and construction technology in force represents one of the enduring cultural traits, and characterizes the identity of Quebrada local populations. Their patterns are part of the system of people's knowledge, which, despite the impacts generated by the emergence of urban industrial models, are maintained and still orally transmitted at a family level, while continuously adapting it to the changes that occur from the 'globalized urban culture'. Autochthonous technology is also an important practice from the perspective of cultural sustainability, based on several factors: the use of natural resources that can be recycled without generating pollution, and produced with much less energy than industrialized materials. In bioclimatic terms, these are a better response to the quebradeño arid environment; and are kept alive as customs, ethnicity and knowledge transfer mechanisms with cultural meanings at the household and community levels.

### 2.1 Housing

The self-constructed housing is one of the clearest manifestations of the architecture of the Quebrada native lands, which continues and is mainly built of adobe and covered with hollow reed and terracotta tiles. The houses are compact clusters of rooms, L - and U - shaped, sometimes in a row, with patios facing east, northeast and north. The courtyard has multiple functions and connects the interior with the 'outside' of the house. The population of the area performs almost all activities outside the house, which is evidenced by the varied equipment installed around the housing and in the territory. The kitchen is usually a smaller room, with smoke vents or a fireplace at one end. It is common to also use the bedrooms for storing utensils, objects, wool blankets, materials and other household goods.





Fig.3 House fence of stone and clay over an irrigation ditch outside Iturbe, Argentina (credits: Rofolfo Rotondaro, 2009)

The growth of housing is solved by aggregating modules, following the shape of the settlement, or by adding new ones.

2.2 Domestic and productive equipment

Quebrada housing is a series of auxiliary buildings that comprise the peri-domicile: fences, stables, chicken coops, basins, reservoirs, ovens, stoves, orchards, water well, irrigation ditches, ritual tables, and pillars. Fig. 2 shows a structure of *quincha* (Quebrada hollow reed and earthen plaster), a depot for *quebradeño* farmers in the Maimará area consisting of two rooms with walls and roofs of the same construction type, used as storage space for seasonal agricultural products, which are marketed in the Quebrada. The supporting structure is made of *poplar* wood, a species abundant in areas with water.

The use of local materials and autochthonous techniques is also observed, in a clear and effective way, in the boundaries of domestic, agricultural or grazing areas. The fences are built with stacked stones; blocks cut from the floor or *champas* (grass); stones and earthen mortar; adobe masonry; rammed-earth; stone, clay and adobe; and different variants according to the practices of the self-builder.

2.3 Small hamlets and adobe churches

The configurations of small settlements and rural villages are adapted to the topography and are mostly built with local materials – mainly adobe, terracotta tiles, clay, stone and wood from the area. Almost all settlements include small chapels and churches, also predominantly built with local materials. In regards to churches, the influence of shapes, patterns and spatial organization of building elements are notably of colonial origin, imitating the most important churches in the urban centers of the Quebrada.



Fig.4 Hamlet and small church in La Cueva, Argentina, constructed of adobe, stone and clay, earthen plasters, and terracotta tiles roof (credits: Rodolfo Rotondaro, 2009)

3. RECENT EARTHEN ARCHITECTURE

Recent earthen architecture includes all state and private buildings over the past century: service infrastructure, urban and rural health, education, public works and housing facilities. These employ raw earth with timber, stone and vegetation, and embody various forms.

3.1 Religious architectural heritage

There is, in the Quebrada, a very rich and official historical and architectural religious heritage (CNMLH, 2000) from colonial inheritance. Some buildings are over three centuries old, and endured various conservation interventions (which also includes other earthen buildings, such as mansions and historical centers). Most of these were built with stone, adobe, wood and straw or terracotta tiles on the roofing, taking into account local self-builders and building systems. They have also incorporated innovations to improve problems and detected pathologies, such as impermeable layers, multiple layers on the roofs and plastering; reinforcements and beams; chinking and stone plinth with reinforced lime mortar, among others. The main churches are the Volcán, Tumbaya, Purmamarca, Maimará, Tilcara, Huacalera, and Humahuaca Uquía (Nicolini, 2000).

3.2 Adobe railway housing

The railway that joined the provincial capital, S. S. Jujuy, with the city of La Quiaca was built between 1906 and 1908, and was characterized by more than 20 houses built entirely or partially of adobe walls. Regarding the latter, and according to up-to-date railway plans, these were built of stone at the foundation, and adobe-masonry walls, such as the ones at the Yala railway station; or adobe and fired brick, as is the case at



Fig.5 Housing for railway staff of Tres Cruces railway station, in Argentina (credits: Mónica Ferrari, 2009)

the locomotive depot of Humahuaca. Generally, these houses have been characterized by the use of typologies that are often repeated, in which the juxtaposition of modules either in L- or U-shaped alignment prevailed. Of these, the most widespread, totaling 10 examples along the railway, consists of a six-module row, with a prominent volume of two modules on its axis (kitchen and bathroom), and galleries at their front and back. These refer to railroad staff housing, or traffic staff housing of the railway stations of Senator Pérez, Humahuaca, Iturbe, and Tres Cruces, taking into consideration the Quebrada.

3.3 New earthen architectural housing

An increase in private housing is seen that proposes new architectural models and reflects a clear attempt to generate new versions of earthen architecture in Quebrada. In many cases, these incorporate field implementations and adaptations that mimic popular architecture. The production from professional studies accompanies this construction in permanent and of temporary housing, incorporating innovations, such as plastering and surface treatments, roof materials and the appropriate design for seismic prone areas. New design in housing is also witnessed in state buildings in different areas of the Quebrada, which have been developed by government agencies, such as municipalities, Institute for Housing and Urban Development of Jujuy, Ministry of Public Works of Jujuy, National Institute of Industrial Technology (INTA), and Presidency of the Nation.

3.4 Schools and buildings with community and cultural functions

Some earthen built structures are produced by multi-disciplined management methods and shared efforts among governmental agencies (municipalities, departments and ministries) and community organizations. This applies to some isolated rural schools, in places where their maintenance and



Fig.6 Cultural Community Center with plastered adobe walls in Iturbe in the northeast of the Quebrada, Argentina (credits: Rodolfo Rotondaro, 2009)

additions depend on local efforts (e.g. Huachichocana); micro-regional and effective community halls; and cultural centers of regional relevance (such as the child cultural center of Tantanakuy in Humahuaca). The technology used varies from the local native use of adobe walls with earthen plaster and lime paint, and terracotta tiles on woven reed or timber; up to other innovations, such as the use of soil-cement and soil-lime, Trombe wall, square adobe, interior reinforcement with reeds; and stabilized earthen plasters; etc.

3.5 Construction of the tourist industry

In the last two decades, particularly in the last one, departing from the growing interest generated by the Quebrada after being declared a Cultural Landscape, new hostels and hotels have been built. These used construction technologies of stone, wood and raw earth, generating a great visual impact in some cases. In addition, there are several structures of small size and scale in urban centers and subsidiary ravines. In some situations, these were due to local family initiatives, and in others, they are an important business investment. The resulting structures are changing the hotel architecture that characterized the Quebrada for many decades: colonial-style buildings, some with whitewashed adobe walls, or with conventional urban architecture, of stone, concrete and terracotta tile.

3.6 Buildings with 'alternative' architecture: between the autochthonous and the 'modern'

There are other varieties of construction and interventions in the Quebrada that refer to the possibility of alternative architectural and technological proposals, in-between the intrinsic architecture and the newer one, which seeks to convey the image of 'regional', but is at the same time modern. These are produced in different areas and with different aims, either by community-based organizations, NGOs located in the

Quebrada but external to it, or entities that develop scientific and technological research (such as national universities, CONICET and the National Agency for Scientific and Technological Promotion). Though a minority, these models occasionally generate significant impacts that are replicated in popular areas by technicians and professionals involved in this region. They disturb the interchanges between traditions and the impression that Quebrada presents.

Within this pattern are included construction prototypes of modified autochthonous techniques, such as mixed roofs with layers of stabilized earth, passive-solar energy and adobe walls, coatings with stabilized earth, compressed earth blocks, prototypes of suitable housing for Quebrada, multipurpose halls using mixed construction technologies, and others.

4. CONCLUSIONS

4.1 Coexistence of different architecture and technologies

The autochthonous constructive methodologies and architecture remain predominant in rural areas and more isolated areas of the Quebrada and transverse valleys, where building types identified with local natural resources and the transfer of knowledge from parents to children are still valid. Thus, in hilly areas more stone is observed; where there is grass, cut blocks are used as flooring; where there is wood or cane, more quinchá and half-timbered houses are found. As a rule, in all areas of the Quebrada, adobe and stone walls, terracotta tiles and straw roofs are the most used and disseminated building type. There are also the local variations in shape, size and finishes. In urban and semi-urban areas, there is additionally the presence of autochthonous patterns, but adapted to the urban fabric (in grid or not), with changes in formal types, implementation and orientation. Here, the definition of the construction system and the selection of materials are characterized by the coexistence of different patterns, and thus, ethnic typologies incorporate non-ethnic elements and materials. Even in central areas, there are houses and other buildings using stone, adobe and wood; reed and terracotta tiles on rooftops, although with tile edges; cornices; arches; colonial fences; industrial doors and windows; stone, brick, and ceramic veneers, and other elements.

There are two other approaches to the architecture and technology present in the Quebrada: (a) the urban industrial design found in houses, schools, hospitals, public transportation stations and services, hotels, shops and government buildings, which use reinforced concrete, fired brick, concrete block, plastered adobe, steel sheet, metal structures, Styrofoam, paints and industrial carpentry; and (b) the alternative, also present in different types of uses (public and private, state, NGOs, migrant, scientific projects) with different levels of development according to their origin and roots. These structures have increased in the last decade

and are characterized by the search for an architecture and construction technology with local features, combined with urban industrial design and materials, that is more ‘harmonious’ to the environment and legacy of each place.

4.2 Pressures of urban industrial architectural and technological models

The non-native patterns, particularly those of urban industrial origin, generate pressure on the local communities. There are statutory and imaginary changes oriented towards consumption architecture, rather than to seek genuine expressions suitable for each place. The impact of urban industrial architecture in local popular strategies results in a conscious selection and use of materials and urban elements in architecture, looking for greater social status and local prestige, to live in houses like those of the cities, and of wealthy families (summer villas, residences). This also results in the devaluation of earthen architecture as a material of poor quality and durability, being considered the cause of regional poverty. The changes are also engendered by some privately funded architecture, business-funded architecture, and tenant or tourist dweller, who intentionally implement other models of architecture and other technologies, regardless of their impact on identity.

4.3 Changes in popular housing architecture

Changes were observed when comparing the popular earthen housing in rural areas with the housing typologies found in urban and semi-urban sectors:

- The existence of defined physical spatial limits (three or four limits of the plot, narrow dimensions of the plot) that determine the design and organization of the housing; and the presence of a street façade, which endows it with other formal connotations, and requires different statutory reactions.
- Regarding the natural environment, the orientation of the settlement is changed according to its location on the site. This causes changes in the insulation of the housing and patios, which in turn generates changes in the use of spaces, forms and people’s activities. The grids, though irregular and distorted at the edges of each settlement, do not impede creating planned situations that compose spaces, forms and techniques: division walls, frontage, linear forms, and incorporated toilets, no construction of domestic equipment, space and use limits, and different privacy and community spaces. In turn, the organization of the spaces in local rural housing has also begun to incorporate changes, such as the idea of “being” (as a space for actual use, but also as an image of its owners); the incorporation of bathrooms and kitchens inside the building; and the idea of the image projected to the street, associated with the existence of the city skyline, along with better treatment and materials of greater social prestige.

4.4 Technological Changes

The construction technology in the Quebrada conveys the capacity of popular experimentation, evident in the combination of local materials and techniques with industrial materials and techniques. The causes are probably related to statutory aims, but also utilitarian ones (such as less maintenance). As in other areas of the region, autochthonous constructions finely built have a superior construction quality and durability than those hybrids, combining traditional and urban industrial technologies. For example, the use of lintels, sills, horizontal and vertical reinforced concrete reinforcements without continuity or bond to the resistant structure of the building. However, other situations are observed evidencing an adequate use of combined techniques, such as soil-cement with a selection of local earth, reinforced edges, and outer surface treatment to improve the adhesion of plasters, drains and pipes, prepared with local building elements.

4.5. Recommendations

According to the results obtained through research, recommendations were suggested aiming at implementing actions to enhance and preserve earthen architecture in Humahuaca Quebrada, considering the management of this area as a World Heritage Site by:

- Documenting and analyzing autochthonous architectures and building techniques, as well as their variants and innovations, for future use as a design database.
- Re-evaluating and disseminating the formalized historical



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