RECLAIMING HERITAGE

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DEBRIS MATERIALS FOR RECONSTRUCTION IN THE CASE OF CHANCO, CHILE

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PREFACE

Reclaiming Heritage was born as a collaborative initiative to promote the reconstruction of the destroyed areas after the earthquake of February 2010 in southern Chile, with the aim of contributing to the recovery of heritage architecture and the protection of the cultural values embodied in them. The case for study and work was the protected area of Chanco, one of the most affected communities after the Earthquake. The project explores the potentials of reclamation of building materials for a sensitive post-disaster reconstruction by means of acombined traditional and contemporary builnding techniques, and by direct involvement in the technical decisions and in the construction.

The main problem addressed was be the relevance and possibilities for the use of reclamationmaterials in current contexts, underlining the economy of resources and the architectural values of these materials, as
opposed to reconstruction based on new, more expensive materials.

This volume is a documentation of the research, design and construction work conducted by a number of students during two academic semesters plus a 1 ½ month stay in Chile. It includes, in a synthetic way, the formulation of the problem to be studied and designed; the objectives, methodologies and the academic work both by students and faculty; and the field work experience and built results. Additionally, two Thesis works related to the project make a contribution in specific aspects.

An additional Semester of work was used to compile and articulate the results in the articles compiled here, written by some of the students who went to Chanco, who are recognized as the authors of the chapters. The work substantiating them, however, was performed by and belongs to all of those who took part in the project at different stages.

Herrle, Peter
D'Alençon Castrillon, Renato

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INTRODUCTION

Introduction

1. Reconstruction, an open question

Earthquakes occur in Chile with great magnitude, very often and however with relatively little human and material losses. Many earthquakes that would be disastrous elsewhere are perceived in Chile as a commonplace event. Public attention is drawn to the casualties and damages only when a huge earthquake -above 7,5° Richter- strikes a populated zone, roughly every 20 to 25 years, like it happened last February 27th in the southern regions of Maule and Bío-bío. The focus is then put on emergency responses: restoring infrastructure and communications, providing emergency shelter and recovering normality as soon as possible.

The process of reconstruction to be conducted after the emergency takes several years, if not decades, and is bound to be partial, with little support and burdened with a number of problems concealed in the process, many of which receive little or no attention.

One of these problematic edges is the loss of a valuable built heritage, which occurs widely, yet almost unnoticed behind the chaos of fast demolition during the first days and of practical reconstruction priorities of the months and years to come. Monuments such as historic buildings, churches and other built stock suffer severe damage, and even if some of the most notorious are repaired, many of them are lost with the earthquake and subsequent demolitions or are impossible to recover. Furthermore, the destruction of valuable domestic, non-monumental heritage is almost completely neglected. The most representative of these are the traditional architecture of small towns, which suffer extensive destruction and undergo little repair even if designated as "Typical Zones" and thus protected. At the same time, the importance of conservation of built heritage grows as a cultural reference and collective memory, especially in developing countries facing constant urban development and environmental pressures.

Face to face with the destruction of the earthquake and the need to rebuild, the question arises of how to recover the assets damaged or lost in the buildings and houses collapsed, the cultural heritage embodied in the built stock and the patrimonial construction techniques. It is then necessary to develop ad-hoc tools that allow the inclusion of some criteria or architectural heritage value in the conservation, restoration and / or reconstruction of small towns and villages with a heritage value.

After a disastrous event a large amount of building demolition debris needs to be disposed of before any reconstruction is possible. Because of the emergency management priorities, this is not done immediately, but instead demolition materials are first accumulated and taken to a landfill only after several months. In this period, an opportunity arises for working with these materials for reconstruction by selectively recycling them or reclaiming them before recycling. In the particular case of destroyed heritage constructions a potential arises for recovering also some of the cultural meaning embodied in the materials.

2. Built Heritage Protection in Chile

The idea of Heritage is understood today as a complex issue with a wide range of meanings, far exceeding the built heritage, extended to the more inclusive concept of cultural heritage. Under this idea are included as belonging to heritage things such as biodiversity, folklore, audiovisual heritage, etc., further expanded through a series of other agreements and international definitions. Since 1980 more than 50 charters and other agreements have been announced directed to the recognition and preservation of heritage in various specific fields, greatly expanding the scope of the original idea1.

To illustrate this development it will suffice to mention the most recent ones, such as the the European Landscape Convention (2000), and the Convention for the Safeguarding of Intangible Cultural Heritage (2003). UNESCO itself now recognizes a broader concept, which reflects mainly the above, the "cultural diversity", from the UNESCO Universal Declaration on Cultural Diversity (2001) which established a commitment to "the fruitful diversity of cultures, "taking into account the risks associated widening ethnic homogenization and universalization.2

In Chile, the Heritage Unit of the Ministry of Housing and Urbanism, in its "Manual metodológico de Identificación de Inmuebles y Zonas de Conservación Histórica", 2005, defines the built heritage as:

> *"(...)as part of the broader concept of cultural heritage, built heritage includes architectural and urban spaces whose shape is an expression of knowledge, rooted and transmitted, which individually or together, reveal cultural, environmental, anthropological characteristics or that express and promote social culture.*
>
> *"The built heritage, which is part of the collective wealth of the city, region or country, is composed of works from both past and present, with value in themselves, the appreciation and importance of which does not depend on constraints imposed by their ownership, use, age, or economic value, but have become heritage due to the cultural and social action they fullfil"*

Despite the importance of the widening perspective of heritage the definitions in many countries are focused on protection of built heritage by means of imposing restrictions to its intervention. The legal framework on the built heritage in Chile is given by the provisions of the General Building and Urbanization Code (Ordenanza General de Construcciones y Urbanización, O.G.U.C.), and the National Monuments Act (Ley de Monumentos Nacionales, Ley 17.228). The National Monuments Act defines historic monuments, archaeological monuments, public monuments, typical areas, historic sites, and sites of architectural and urban interest. The Code makes definitions that complement the previous at the local level, such as Historic Preservation Building (Inmueble de Conservación Histórica, I.C.H.), and Historic Preservation Zone (Zona de Conservación Histórica, Z.C.H.).

This legal framework offers no incentive mechanisms for effective conservation. Only the Ministry of Housing does provide some instruments within their subsidy programs, that has other constraints. Regulation instruments, financing mechanisms and incentives or supervision attributions in this area are clearly insufficient, and require the development of new tools that enable effective action and increased coverage of the conservation of Chilean built heritage.

3. Housing Provision in Chile

Given the precarious economic conditions of many communities, the alternatives available for reconstruction are largely restricted to those contained in programs providing affordable housing promoted by the state. They do not consider other elements that the most economical minimum final solutions (hand-made masonry, 25 to 35 sqm, about U.S. $ 10,000.-). However, at this date the emergency has been covered with over 70.000.- emergency units based on prefabricated panels of wood, known as "mediaguas" (3x3 or 3x6 meters, without windows or toilets, about U.S. $ 700-1400.-).

The process of providing housing has been undertaken during the last 20 years by a subsidized system claimed to be successful, at least in terms of quantity. Since 1985 the system has reduced the housing deficit at ratios of around 10 units per 1000 inhabitants, building some 800,000 units in the decade 1991–2000 (according to MINVU data).

The houses provided, however, are small and built to very poor standards. Most of the users need to build extensions in spite of the restrictive designs and of Code prescriptions. They do so in a spontaneous, self-constructed way in backyards, front gardens, or on community spaces, with poor or improvised techniques, often recycling their previous, temporary solutions, yet very persistently solving their

[1] Addis, Bill. Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling. (Earthscan Publications Ltd., London, 2006).

[2] Berge, Bjorn. The Ecology of Building Materials (2nd Edition, Architectural Press, 2009).
Chini, Abdol, Ed. Deconstruction and Materials Reuse: Technology, Economics and Policy. (CIB Publications, Wellington, New Zealand, 2001).

dwelling needs.

In 2001, the widely extended practice of building extensions, however informal or illegal it may be, was integrated in the system at large. The new "Fondo Solidario de Vivienda" (FSV) has since then become the prevailing Program, which paid in 2005 for 33,421 units out of the total 56,155 houses built in the country. It promotes privately provided houses based on US$ 280 of previous savings + US$ 7,840 of subsidy to complete US$ 8,120 of the entire cost per unit, thus sparing the users the need for a loan to complete the payments. The starter area was cut down to an average of 35 sqm, endorsing to the user's responsibility the enlargement up to at least some 50 sqm –and in many cases to complete some elements left unfinished in the starter unit- using the liberated financial resources.

4. Reclamation materials in building

The use of reclamation materials in building construction has usually two contrasting approaches: on the one hand, a traditional approach based on recycling of valuable pieces salvaged from demolitions because of a specific quality no longer available from the regular market, such as cast iron bathtubs, big sized doors and windows, bronze locks, etc. A material and a cultural value are attached to such elements, considered antiques, and they are used to convey a sense of tradition in a new context, or to complete a refurbishment of an old building with such qualities as a whole. On the other hand, based on sustainable development rationale applied to building, the re-use has gained ground, not only of building materials but all sorts of refuse, industry debris and the like, often testing extremes such as the use of materials considered garbage: used bottles or cans, old tires, used with or without further process as construction materials. In between these prevailing extremes, however, an array of alternatives remains to be explored consistently.

A major problem to be addressed is the user underestimation of reclamation materials by underlining the cultural (community history and identity) values and qualities in opposition to the reconstruction with new, cheaper materials. Such re-valorization needs to be achieved by developing a substantial community support in the form of direct involvement in the technical decisions and in the project management. The hypothesis implied is that a simultaneous social, cultural and technical approach should facilitate and promote the use of less conventional technologies that bear cultural qualities not considered in conventional construction methods that would otherwise be lost.

Massive re-use of building materials neither for luxury purposes nor based on garbage is a promising alternative, still unexplored for the most part. One of the few systematic approaches in this field has been articulated by Bill Addis in his book "Building with Reclaimed Components and Materials"[1], where the fundamental concepts are presented. The aim of Addis and other authors[2] (Berge 2009; Chini 2001) is to promote the spread of reclamation, reuse and recycling practices to other items in building construction. Their analysis are often based on the discussion of life cycle and flow of materials in the building stages by improving related practices in the design, building, use and demolition stages.

However these authors consider heritage conservation as an example of the extinguishing tradition of reuse and reclamation, they do not reconsider it as a potential strategy for promoting its use from a social – cultural perspective and remain bound to technical aspects. Even if it is in many cases implicit in cases of study and on-site reuse of materials, little consideration is given to the heritage values conveyed by the materials reused, and the rationale behind its use continues to be cost savings, reduction of environmental impacts, transport and time optimization, etc.

When discussing the "barriers" for broader use of reclaimed and reused materials in building construction, the implicit assumption in the field is that further development of technical

aspects could overcome such obstacles by using cheaper, less polluting, more accessible materials. We take a different stance here. Technical aspects, i.e. cost, environmental quality and availability -however they could be improved- are already clear enough as these authors themselves show, and should be have reached the turning point of a rational decision making. Instead, we ask if the resistance to further use is then not due only to technical aspects but may include an added cultural dimension, one that prevails in the users or in those making the decisions.

5. Reclaiming heritage: an hypothesis

In this work, reclamation is proposed and explored as an alternative to the existing practices of building social housing in a post-catastrophe context because it has the potential to retain architectural and cultural traditions while being economically attractive in existing social networks.

The modification and clarification of existing Chilean housing and heritage policies could enable a participatory process of reclaiming damaged building elements for use in reconstruction, and in doing so could prevent total destruction of heritage and culture embodied in the country's older architecture that is commonly obliterated.

6. This Volume

This volume is composed of 9 Chapters, that move from the more abstract to the more concrete of the building and its results.

Chapter 1, "Introduction", I have introduced the problem as a general argument for the architectural reflection and work.

In Part I : Chapter 2, "Situation of Chanco before and after the earthquake" conducts a brief urban description and analytic documentation of the town of Chanco; and documents five traditional adobe houses cases of study, considered of a heritage value by the team. Chapter 3, "Design Process and results" reviews the work conducted in the first Research Seminar SoSe 2010, which formulated the Research questions and studied preliminary the reclamation and its potentials in Germany; and the second Design Seminar WiSe 2010/2011 which designed architectural solutions for a group of houses based on the general principles formulated in the first Seminar .

In Part II : Chapter 4, "Materials flow in reclamation: Logistics and Systematics" follows in a parallel the process of deconstruction and simultaneous construction and the specific paths of materials from a house due for demolition to a new use in a reconstruction house. Chapter 5 "The construction process: Technical aspects and solutions" is a specific documentation of the particular building techniques employed to enable the use of reclamation material.

In Part III : Chapter 6 "Economical Analysis: Feasibility and Social Evaluation" an assessment is conducted on the affordability of the methods employed and their potentials in a commercial context. Chapter 7 "Management and heritage" discusses the managerial elements in the context of the current Chilean policies.

The final Chapter "Conclusion" summarizes the main findings and the experiences collected by the team, and outlines potential developments for the topic and this line of work. An extensive Bibliography, also available online through the webpage of the project www.reclaimingheritage.org completes the volume for those interested in our sources or in an in depth discussion of specific topics.

PART I: DESIGN

Documentation included in Part I:

- Urban plans and sections
- Analysis of 5 Heritage Cases
- Case of Study number 5 Detailed (within the subject “Restauración Arquitectónica, from Polytechnical University of Valencia)
- Photographic facades surveys

Fig. 1: Ground Plan of Chanco before the earthquake (based on Land Register plan from Municipalidad de Chanco. Modified by Luis Beltrán del Río. Santiago, 2010)

Urban Plans and Sections

Fig. 2: Ground Plan of Chanco after the earthquake (based on Land Register plan from Municipalidad de Chanco. Modified by Luis Beltrán del Río. Santiago, 2010)

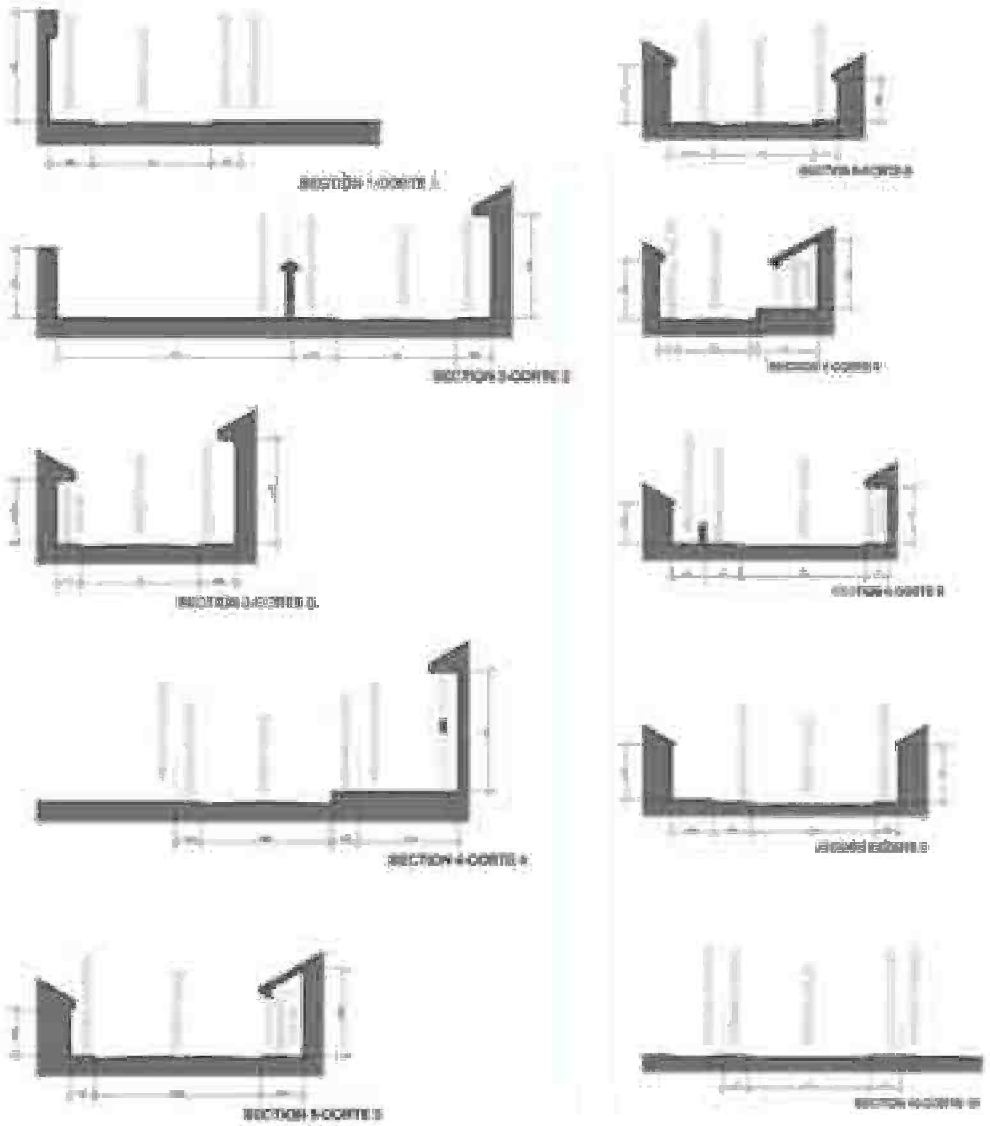


Fig. 5: Street Sections (based on Land Register Plan from Municipalidad de Chanco. Modified by Luis Beltrán del Río. Santiago, 2010)

Fig. 6: Five heritage cases inside the limits of the heritage area, configuring a corner. From north to south they have been numbered (based on Land Register plan from Municipalidad de Chanco. Modified by Óscar Natividad. Berlin, 2010)

Analysis of 5 Heritage Cases

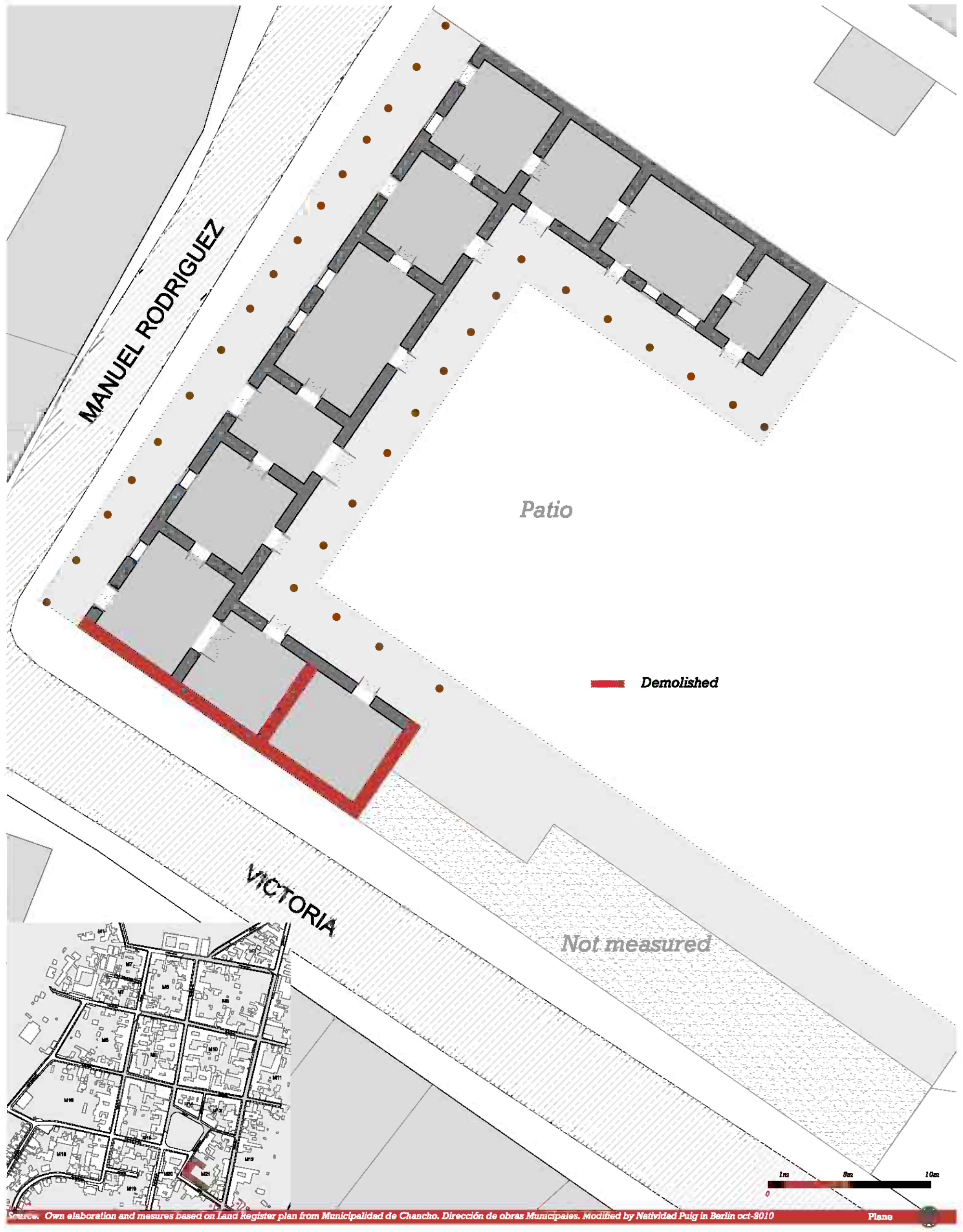
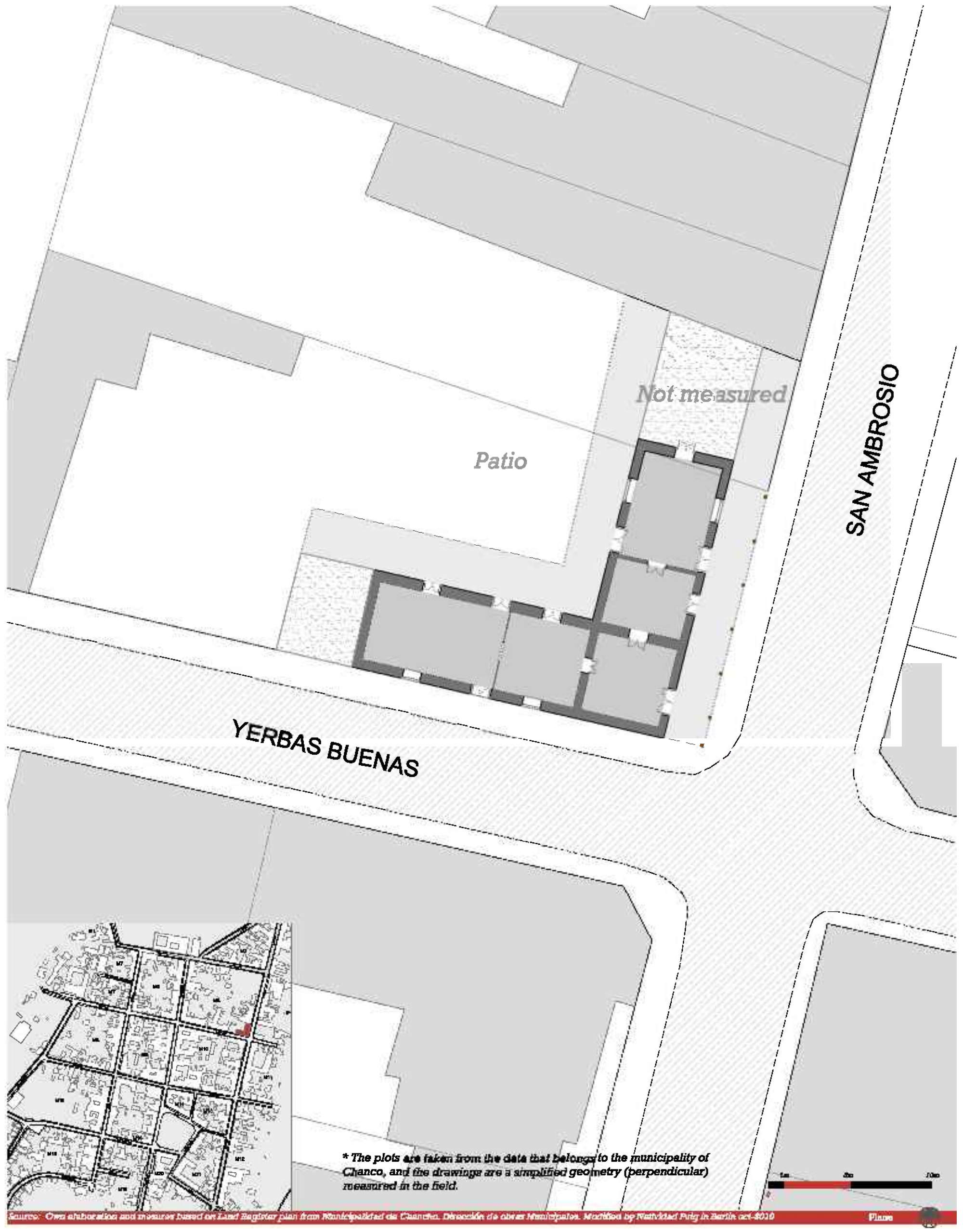


Fig. 7: Plan Case of Study number 5 (Drawing by Óscar Natividad. Berlin, 2010)

Fig. 8: Plan Case of Study number 4 (Drawing by Óscar Natividad. Berlin, 2010)

Analysis of 5 Heritage Cases



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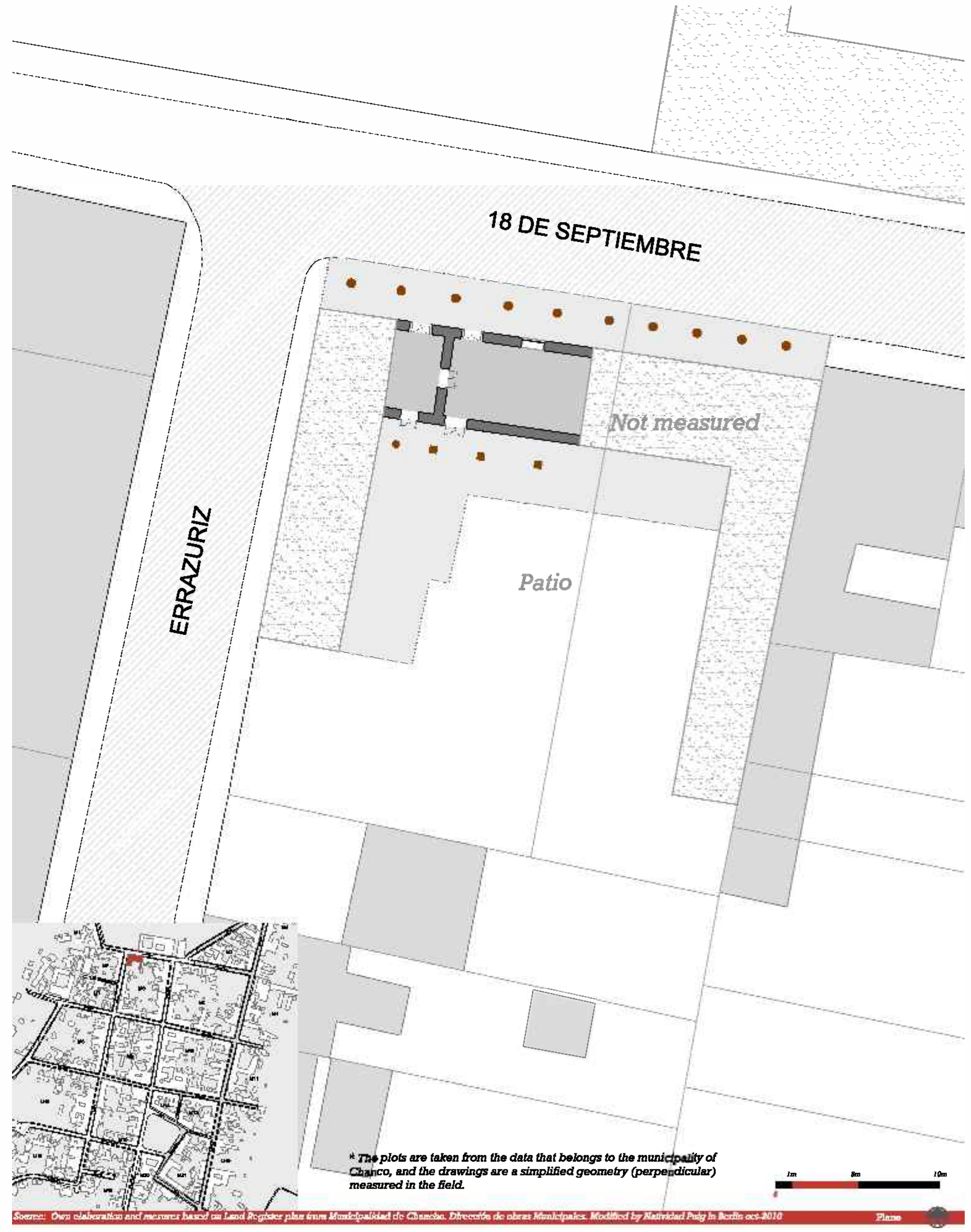


Fig. 10: Plan Case of Study number 2 (Drawing by Óscar Natividad. Berlin, 2010)

Analysis of 5 Heritage Cases

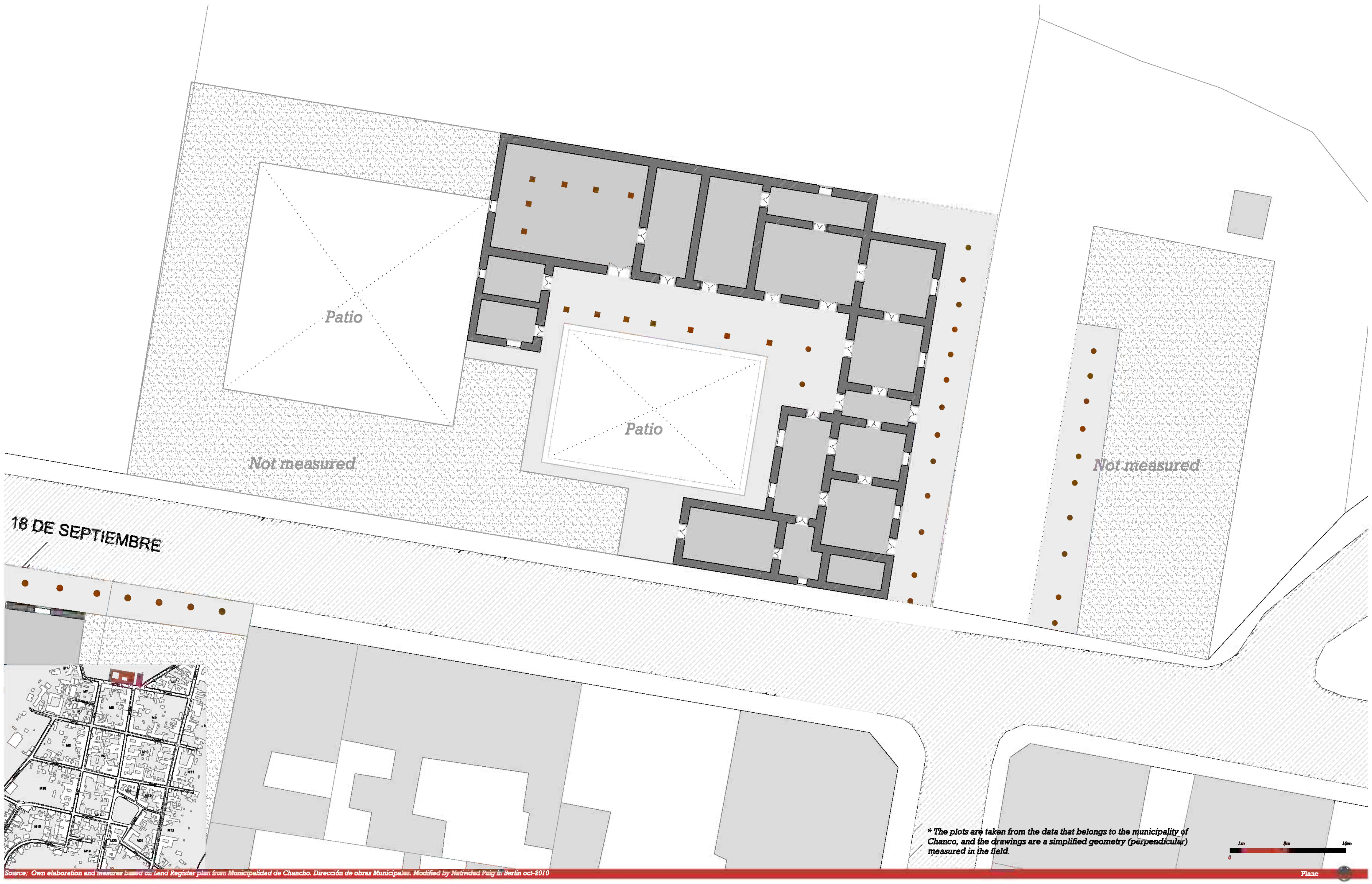
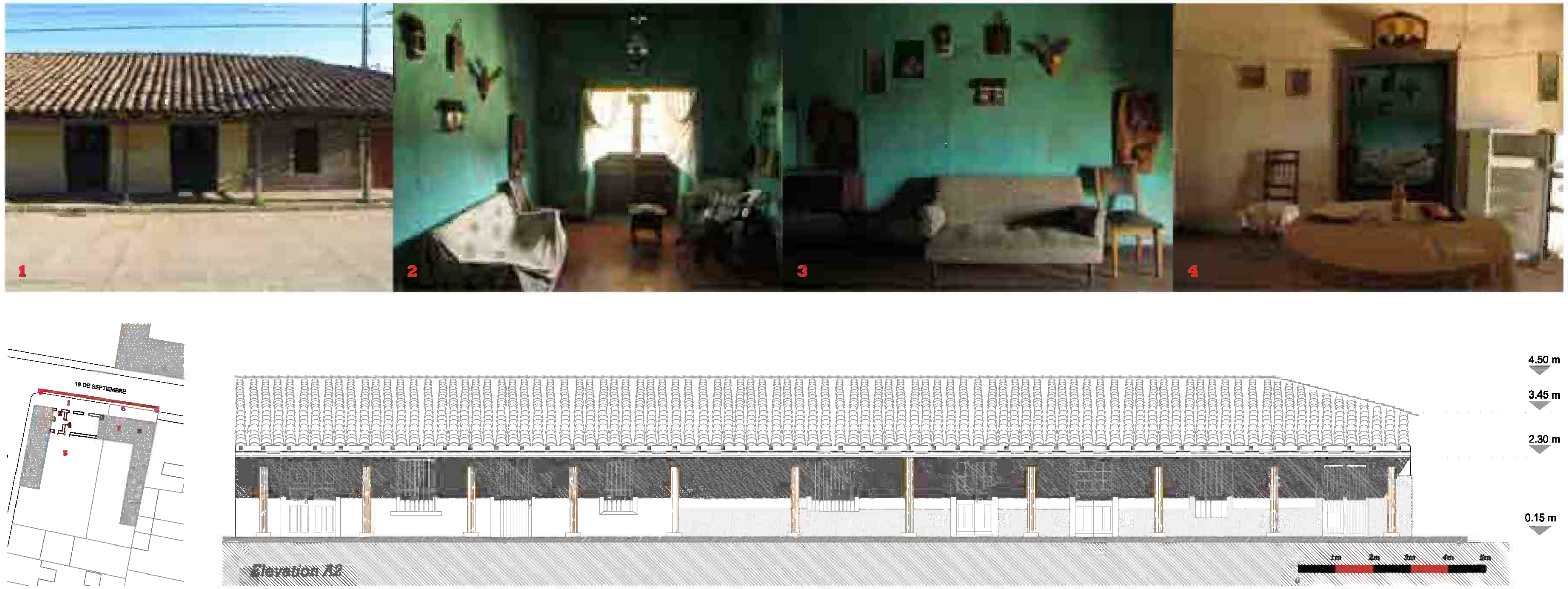


Fig. 11: Plan Case of Study number 1 (Drawing by Óscar Natividad. Berlin, 2010)

Fig. 15: Ideal elevation and relevant pictures Case of Study number 3 (Drawing by Óscar Natividad. Berlin, 2010)

Analysis of 5 Heritage Cases



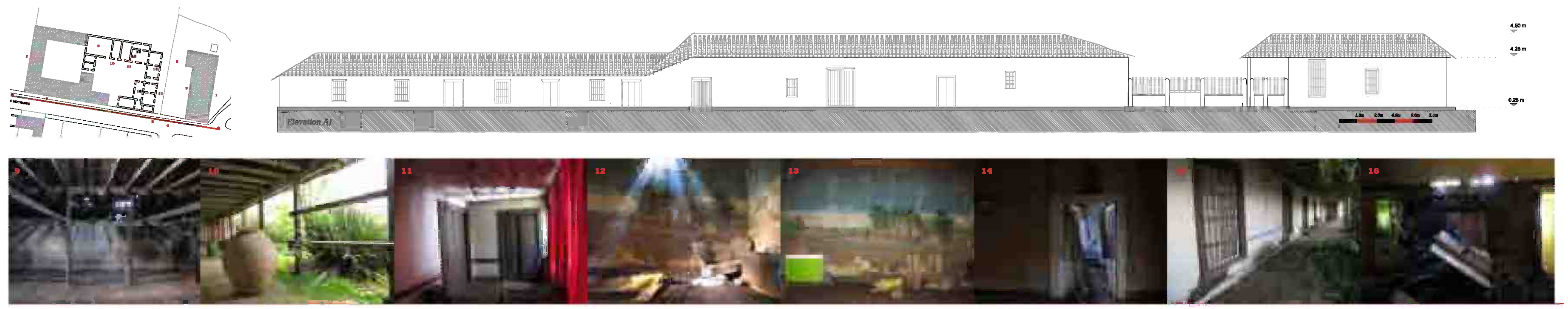
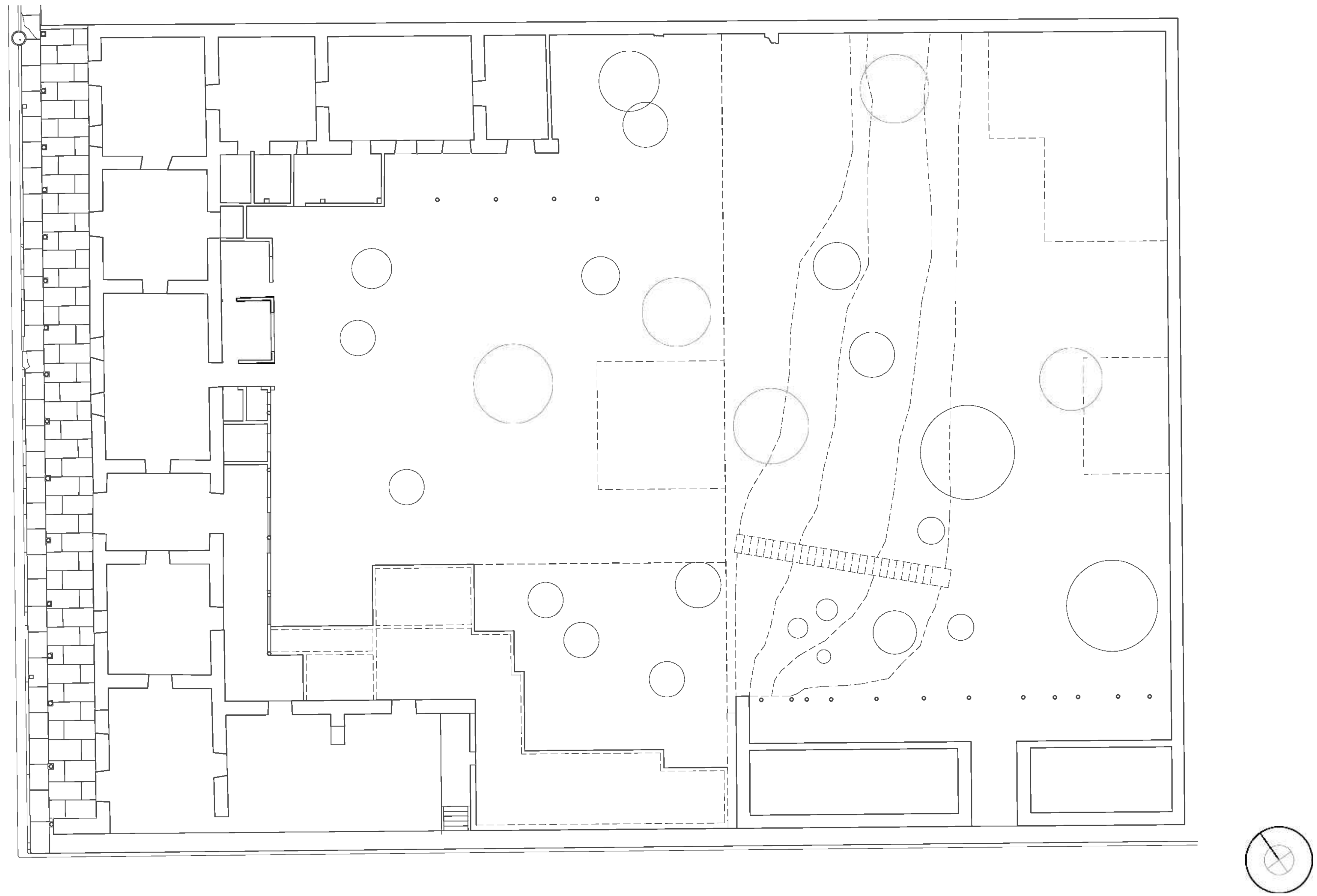


Fig. 16: Ideal elevation and relevant pictures Case of Study number 2 (Drawing by Óscar Natividad. Berlin, 2010)

Fig. 17: Ideal elevation and relevant pictures Case of Study number 1 (Drawing by Óscar Natividad. Berlin, 2010)

Case of Study number 5 Detailed



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Case of Study number 5 Detailed

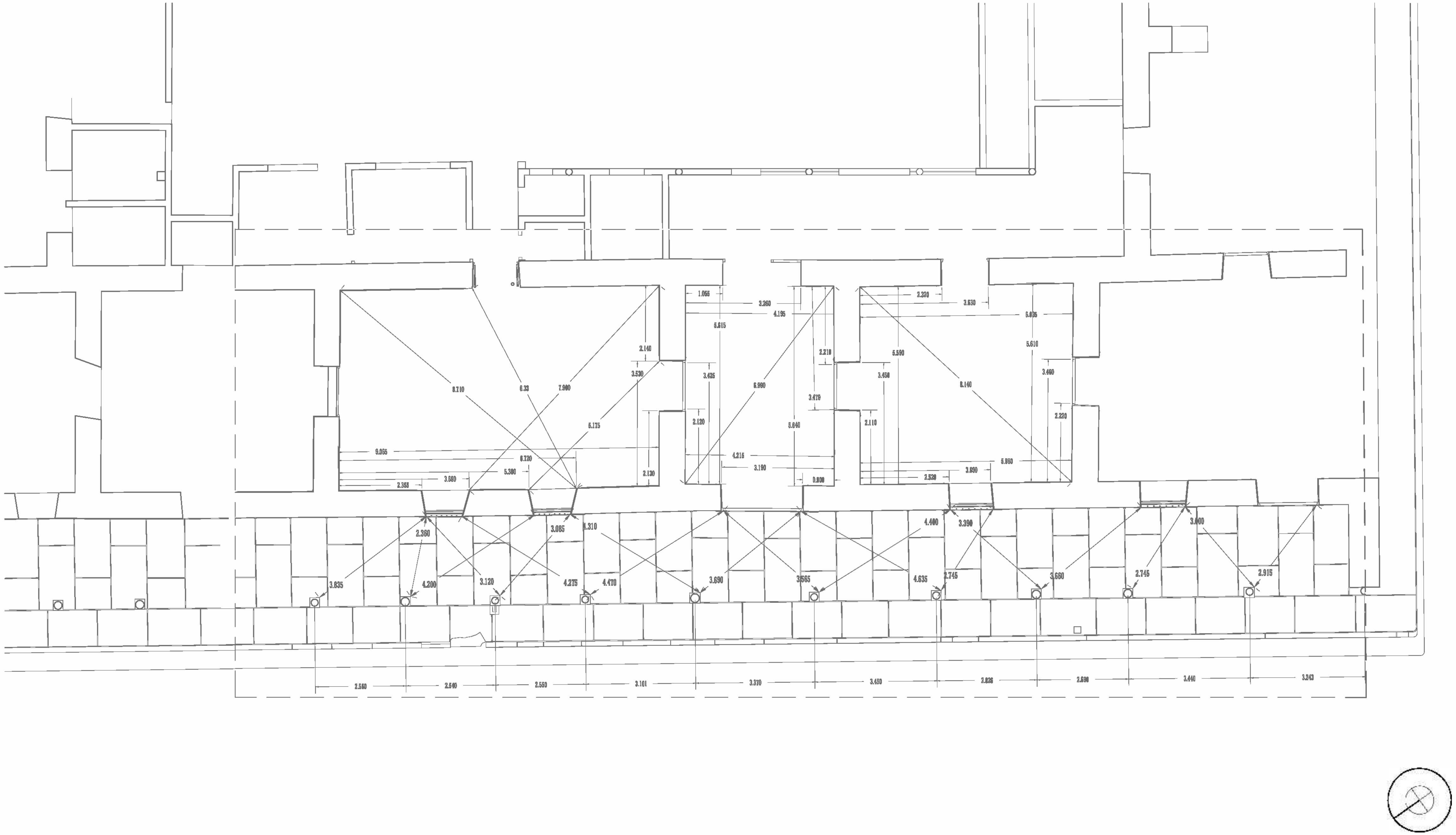
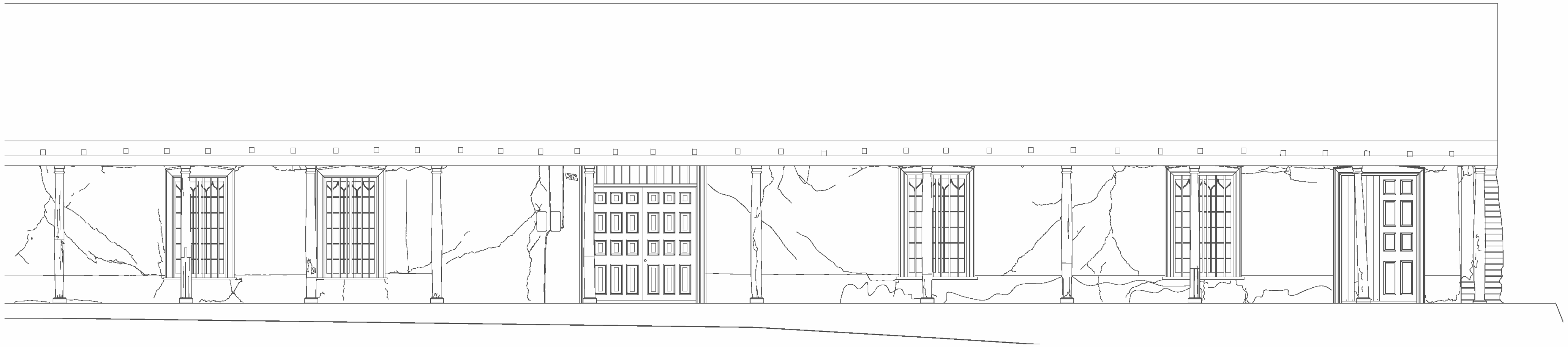


Fig. 13: Bounded Plan of an area from Case of Study number 5 (Drawing by Óscar Natividad. Valencia, 2011)

Case of Study number 5 Detailed

Fig. 14: Pavement Plan of a part from Case of Study number 5 (Drawing by Óscar Natividad. Valencia, 2011)

Case of Study number 5 Detailed



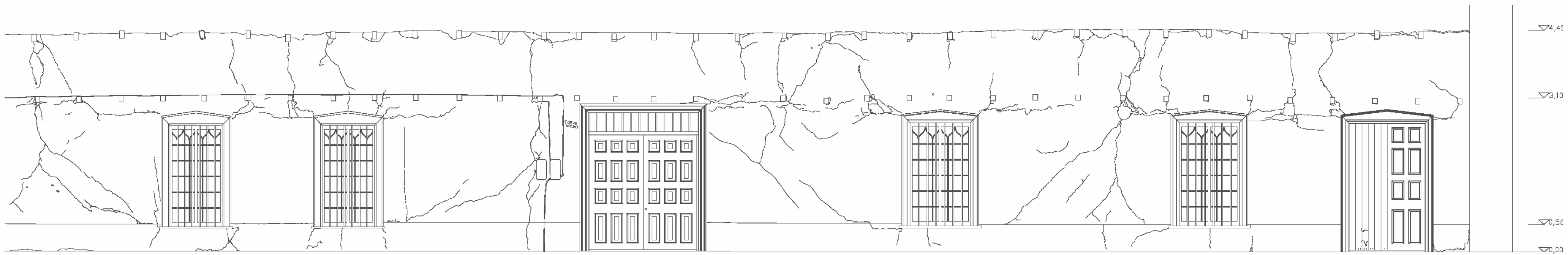


Fig. 18: Elevation Case of Study number 5 from outside the corridor (Drawing by Carmen Gómez. Berlin, 2011)

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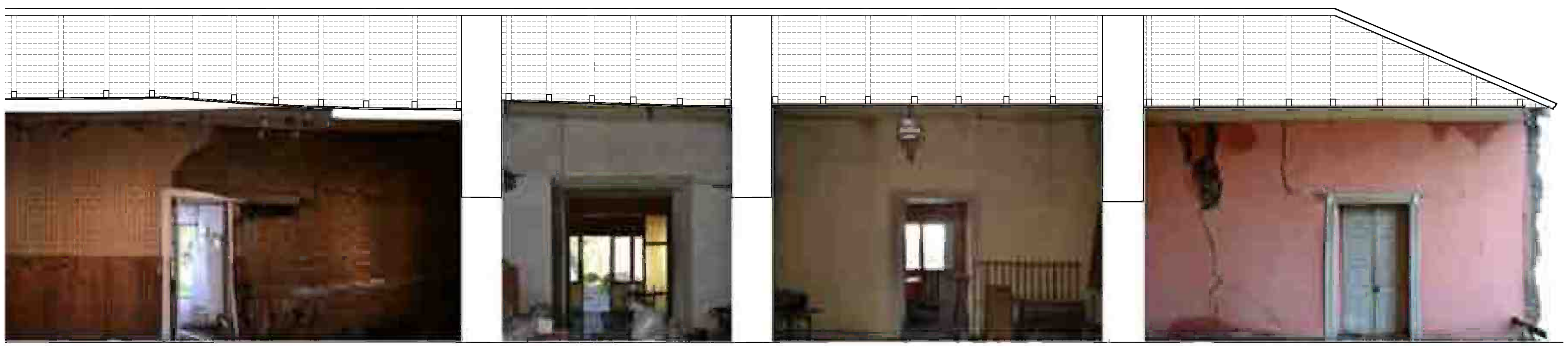
Case of Study number 5 Detailed



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Photographic Fasade Surveys

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Fig. 30: Abdon Fuentealba West 3 after the earthquake (Photos by Municipalidad de Chanco, before 2010)

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Fig. 32: Abdon Fuentealba East 1 after the earthquake (Photos by Municipalidad de Chanco, before 2010)

CHANCO:

BEFORE AND AFTER THE EARTHQUAKE

Gómez Maestro, Carmen
Natividad Puig, Óscar

The Town of Chanco, in the Region of Maules (Fig. 1) was declared to be a "Typical Zone" in 2000 (Fig. 2). This decision was based on a series of features of the village, which after the Earthquake of February 2010 were severely damaged. This status awarded to Chanco has greatly affected the conditions for reconstruction: in Chile, post-earthquake housing reconstruction is a responsability of the Government, but in Typical Zones, the Consejo de Monumentos Nacionales (CMN) is at the same time responsible for the preservation of Heritage.

This, along with the fact that there is a lack of solutions that serve both aims, create a conflict which greatly complicates reconstruction in these particular areas[1].

In the following chapter, a brief analysis of the previous situation and values will be made, as well as a statement as to what is the current state of the village, and the consequences of that policy after the earthquake.

2. Urban Lattice - Damero tradicional

Chanco was founded in 1849 originally next to the sea, where previously Promaucae indians were settled. This location was soon discovered as not the most ideal, as sand dunes advanced slowly from the seashore to the interior menacing the existing village and farmland. Thus, at the beginning of the 20th century, the Federico Albers natural reserve was designed and planted to consolidate the land, and the village was reconstructed at the east of it, settling this national park as a barrier between itself and the sea.
As mentioned in the document declaring Chanco as a typical and, therefore, protected zone, the urban structure of Chanco is that of "damero tradicional", a lattice of parallel and perpendicular streets which form rectangular built blocks, very typical in South and Central American cities.

[1] Beltrán del Río, L., Master Thesis (Technische Universität Berlin, Berlin, 2011)

Fig. 1: Map of Chanco before the Earthquake (from www.googlemaps.com)

Fig. 2: Ministry of Education Decree Nr 155 where Chanco is declared typical Zone (by Ministry of Housing and Urbanism from Chile : MINVU)

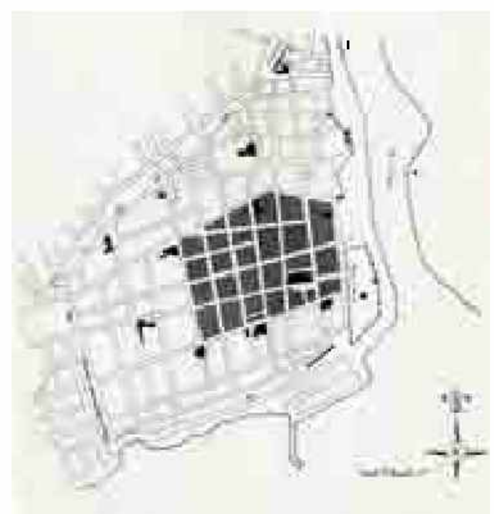
According to the attached document, Chanco was declared a Typical zone considering:
THAT, the village of Chanco, located over an old settlement of indigenous fishermen, is characterized by a street lattice in damero tradicional, with an architecture of colonial houses with continuous façades and corridors in one height that form strong image and urban continuity. Highlights on their façades are the variety of windows, doors and blinds of elaborated detail and proportions, […] exemplary framing and an interesting treatment for corners and roofs made out of rustic clay and wooden pillars […], all of it of a great architectonical value;
THAT, the sector where the village of Chanco is settled is an area of touristic development, characterized by coastal or lakeside spas, highliting the ones of Pelluhue, Iloca and Vichuquén;
THAT, west to this village is the Federico Albert National Reserve […], representing a sector of ecological interest. […]"

Previous state

The origins of the damero tradicional remain until nowadays unclear. Although most popular theories attribute the parallel structure to legislation issued during colonization (mostly to the Órdenes issued by Carlos V in 1523 and Felipe VII's Leyes de Indias of 1573) some cities founded before these were made and distributed already have this particular urban structure [2] (Fig. 3).

In any case, the origin of this regular lattice is based on the European influence that the Spanish brought to the newly discovered land and adapted to the circumstances of the territory and of the colony.

It is very easy to observe in Latinamerican cities a transposition of the humanistic ideas of order and hierarchy developed during the Renaissance, which was the main tendency in Europe at the time, but these are actually deprived of the high aspirations of the theoretical urban models developed in the old continent, probably due to the fact that the main need at that moment was to settle the city in the most quick and simple way [3], as almost every urban nuclei was used as the base to organize the new territory, as a way to settle down and unite the progress during the conquest.



Renaissance revisited ideas from the classical world, and was clearly based on the treaties elaborated by Vitruvius (I a.C.). These imposed a regularity to the urban form, and paid a very particular attention to environmental factors, such as wind circulation, which is a main criteria for the orientation of the city. Water evacuation will also be one of the conditioning factors when planing the colonial cities, affecting direclty the orientation in which streets are traced and built.

The colonial city is a constant element in the whole South America. It is so, that it forms great part of a particular identity. A proof of the trancendence of this urban structure beyond practical issues or legislation is the fact that cities founded much later than the one built up in the colonial times (and this is including Chanco and some other cities in the surrounding areas) were planed to meet this particular basis and structure.

It is a well established sociological phenomenon that an urban environment in a city relates intimately to the culture which inhabits it, creating a sense of identity and orientation [4], that may be lost when introduced in a foreign environment, where the usual references don´t exist or change their significance [5]. It is precisely here where the value of this kind of urban structures and urban developement remains, a much deeper meaning than just a historical evolution or origins. In the case of Chanco, designated a typical area precisely based on its value as a whole urban ensemble, this concept applies precisely. The destruction that the earthquake supposed in Chanco means not only a loss for particular houses or privates interests, but for the town as such and its cultural identity and values reflected in the urban configuration and in the architecture.

Post-earthquake situation

During the earthquake of February 2010, 204 houses out of the 407 that composed the Heritage Zone where damaged. 119 of these were destroyed.

[2] Martinez Lemoine, R., El modelo clásico de ciudad colonial hispanoamericana (Universidad de Chile, Santiago, 1977)

[3] Chueca Goitía, F., Breve historia del urbanismo (Alianza Editorial, Madrid, 2005)

[4] Lynch, K., The image of the city (Harvard University Press, Cambridge, 1960)

[5] Rojas Mix, M., La plaza mayor: el urbanismo, instrumento de dominio colonial (UniversidadNacional de la Plata, Buenos Aires, 2006)

Fig. 3: Santo Domingo, fouded 1502, is believed to be one of the inspirations for later cities founded according to the damero tradicional structure, even though if the lattice is clearly still not perfect. ("El modelo clásico de ciudad colonial hispanoamericana" R.Martinez Lemoine, reproduced from "The preservation of the Monasterio de San Francisco, Santo Domingo" H.M.Prudon.)

Having lost one third of its houses, Chanco lost the structure of its urban tissue, making it difficult in some points to recognize the preexisting grid. Nevertheless, not every building collapsed as a result of that earthquake, but many were demolished, partly due to the existing housing subsidy system, which favours economically the building of new houses rather than the preservation of the old ones. Therefore there was an upswing in demolitions, under the city's approval, due to structural damages, However, later professional advice recommended against 43% of the demolition projects existing in 2010. By the time when the demolitions put on hold, the damage was already done: the town had lost its collective form and character and many of the inhabitants where desolated.

> *"It is like living in the countryside – some of them said – when the wind blows, it runs through every plot, because there is no building continuity that creates a street.* [6].

When visiting Chanco in March 2011, it was very shocking to see that the previous state was more difficult to imagine than when looking at the photographs from the post-earthquake situation, even if the reconstruction had already slowly started.

Being in a rural context (most common situation in Chilean settlements, even in cities, due to the large size of the territory), the voids in the blocks allow much wider perspectives into the open land, making the whole village look more as houses placed randomly into the territory than as a conformed settlement with a coherence inside itself: the urban configuration has been lost.

3. Public Spaces

What usually determines the character of a city is the image of it and the impact it produces on the observer [7]. This image is determined in and by the public spaces, how they are bound and/or how they relate to each other. It is the configuration of this public space in opposition to private which mostly characterizes a city, and it is also where the civic culture is best observed.

Plaza, streets and continuous façade.

In the Latin-american city, the most important condenser of public life is the central square or plaza. (Fig. 4 and 5). Here is where most of the common activities take place, and it is around it where the main buildings of the city are concentrated. In colonial legislation it was established that the most prominent buildings should be located surrounding it and then, concentrically, housing should be allocated to citizens, those of "greater value" being nearer to the plaza.
Traditionally it was also the place where the market was held, and where people would go to see and be seen. It was the place where public executions would take place, as well as exhibi tions of any kind: the real essence of the city at the time. With the evolution of the city, some functions where lost or transformed, but it has remained through time the reference to the city. It usually occupies a central spot in towns, except in those that fall directly to the coastline.

[6] Interview to Chanco inhabitants

[7] Lynch, K., The image of the city (Harvard University Press, Cambridge, 1960)

Fig. 4: Lifestyle of the Plaza de Armas in Santiago (Drawing by Carmen Gómez, 2011)

Chanco: before and after the earthquake

The other main element of public space in the city are the streets (Fig. 7). In the case of those cities with a damero tradicional structure, the limit of them being determined by the location of the houses, or more specifically the façades. Even if the house is smaller than the length of street corresponding to its plot, the yard won't be left to be seen, but a wall will be built to close it to the view. This clear distinction is then blurred by other elements such as corridor, which will be spoken about further on in this chapter.

It is also worthwhile mentioning that the streets don't follow a range of hierarchy, as far as section is concerned. The different importance of the streets is determined by the connectivity they provide and by the use they are given. In the case of Chanco, the main street is Abdón Fuentealba, as it connects to the coastal road which links Chanco with other nearby settlements. The street Yerbas Buenas is also a remarkable spot in town, as it is here where the market occurs every Sunday (Fig. 8 and 9)

Fig. 6: View of the plaza in Chanco from one of the restaurants surrounding it (Drawing by Carmen Gómez, 2011)

Fig. 7: Pisco Elqui, as an example of how continuous façade works configurating a street in a small sized village. (Drawing by Carmen Gómez, 2011)

Fig. 8: Yerbas Buenas on a regular day: one man with his fish box is the only activity to be seen (Drawing by Carmen Gómez, 2011)

They are nevertheless approximately the same width as all others.

A remarkable fact is that the street is not intended to be a regular meeting point, though it does house special events as mentioned market, and also religious exhibitions. Usually, social life takes place more inside the houses themselves: for example, there are no street terraces or balconies as in European cities, but a big part of the city life and commerce occurs indoors, which is probably heritage of the Arabic influence in Spanish cities.

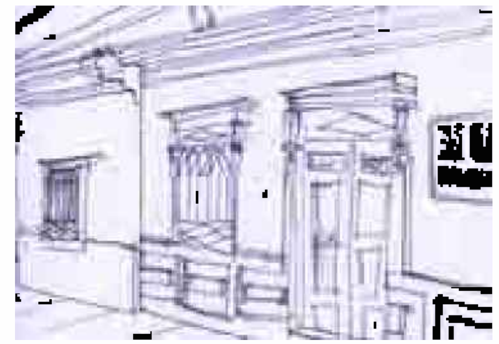
Post-earthquake situation

Due to the earthquake, the continuity of the façade was very much lost. This also occurred in the buildings surrounding the plaza: some of them fell down and many where left in a bad condition. Some reconstruction in this area had already began in March 2011, mainly due to the fact that the owners of the biggest damaged houses around the plaza are wealthy men. Still, less wealthy people were owners of other buildings which have just left voids, consequence of which the plaza has lost its characteristic magnificence along with its limits.

In the same way, the falling of the continuous façades has caused the continuity and, therefore, image of the streets to be lost. What is now perceived is not a line with an ending in open land, but a series of voids alternating with some constructed parts, which in themselves, when standing alone, have not got the value which awarded them the status of heritage goods when being declared Typical Zone.

The lack of façades also allows a view into the common inner patios, which have not changed their use to allow this sudden and unwanted lack of privacy. Little constructions intended for practical reasons are sometimes the only focus to be seen inside of a plot. Sometimes, the view from the street is just the trace of a former patio, some plants, and some left overs from the demolitions: the previously homogeneous city image has been substituted by a range of different situations, coming from the fortunately undamaged buildings, to the complete voids, the emergency housing built outside of street alignments, etc. being the determining factor to every particular case the economic situation of every plot owner (Fig. 10 and 11).

Fig. 9: Image of the Sunday market in the street Yerbas Buenas. (picture by Reclaiming heritage Team, 2011)



4. Architecture

Colonial typologies – A transition from public to private sphere.

City structures are usually bound to a particular kind of architecture. The typical architecture to be found in Chanco shares most of the common features of Latin-american colonial architecture:

1. Façade continuity (Fig. 12)
2. Covered corridors, both in the front and the back of the house;
3.Interior courtyards of big architectural quality;
4.Traditional constructive techniques and inhabitants' knowledge:
5.Particular proportions and materiality of walls, roofs, windows and doors.

The limits of the streets are defined by the continuous façade. Nevertheless, in the kind of colonial architecture that exists in Chanco, a new element appears: the corridor. This is a part of the street covered by an overhang coming from house roof, which origins from climatic needs of solar and rain protection, not only for pedestrians, but mostly for the adobe walls of the houses .

In this way, we can see a gradation of the publicity of the outside space : the plaza being the totally public space, and the streets being a prolongation of it, with a lower concentration of activity, mostly due to the fact that they are obviously not so spacious as the plaza is. Corridors in Latinamerican cities are somehow different to those existing in European cities: in the later, covered passageways can be

Fig. 10: Damaged house close to the plaza (picture by Parker Hoar, 2010)

Fig. 11: Image of a fallen house in Chanco, where only the patio can still be recognized (picture by Parker Hoar, 2010)

Fig. 12: Traditional Colonial House in Chanco (Drawing by Gómez, 2011)

found surrounding main squares, or following commercial streets, to serve as a protection for people shopping or executing some kind of consuming activity, whilst in the first, these exist also in regular houses with no particular commercial or public aim (Fig. 13).

Fig. 13: Corridors in Chanco (picture by Parker Hoar, 2010)

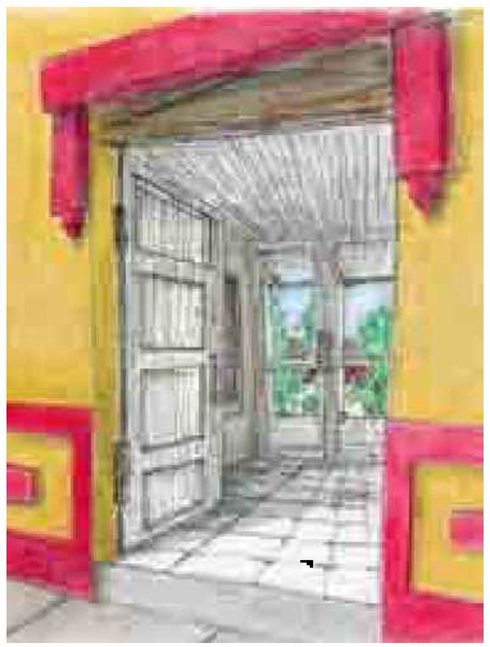


Fig. 14: View of the inner private patio from the street through the *zaguán* (Drawing by Carmen Gómez, 2011)

The most recurrent typology is that of houses around a patio, which can be frequently seen from the entrance through the zaguán (Fig. 14) This patio is a part of the privacy of the house, and even if there is some kind of commercial space inside it, the patio won´t be left to be seen from it. It is frequent that these patios have also a corridor surrounding them and are sometimes paved with ceramic tiles, something quite exceptional, bearing in mind that sometimes the flooring of the house itself is made simply out of compressed adobe. This general typology of house probably has it´s roots in the Roman Villa, which was also organized surrounding a patio [7]. Analogies can also be found with christian monasteries and their atriums, and with Arabic houses, which closed themselves to the street, concentrating their life in their interior patio.

[7] Guardia B., F. and R. Mercado B., D., Procesos históricos de conformación de la red urbana del valle alto de Cochabamba (Colegio de Arquitectos de Cochabamba, Cochabamba, 1995)

As for the houses themselves, they are typically built out of adobe brick walls, some of them with wood reinforcements, and wooden partitions inside them. The adobe bricks are made out of mud and straw usually, and are a carrying wall system. As such, walls have a considerable thickness (ca. 70cm) and therefore a big thermal inertia which, along with higrothermal qualities of adobe, helps to mantain inner spaces in confort conditions, in spite of the high ceilings. This constructive technique, as well as others using adobe such as quincha (infilling of a thin wooden frame with adobe) is very characteristic of the area, located in a wet part of the country, where the correct kind of clay for construction is easily found. Wood is also a very common material in the area, and therefore, the roof structures are made out of wooden trusses to which wooden planks are nailed to create a surface to place ceramic hand-made tiles.

Post-earthquake situation

Almost all of the houses in Chanco were affected by the earthquake. Those that didn´t suffer severe problems also had some cracks or a fallen wall, or problems in the roof. Houses that fell or were partially destroyed where also huge houses, whose dimensions won´t be covered by the available subsidies. This is a big problem when trying to reconstruct a house, as due to the CMN regulations, no design which does not guarantee a continous façade will be approved for construcion. In addition, CMN prioritizes the 5 mentioned points characteristic of colonial arquitecture as criteria to allow construction in the Heritage Zone. It is clear in any case that the most important heritage value lies on the houses together, working as a whole, although the architecture has a value in itself.

Interestingly enough, when asking inhabitants how they would like to see their town, some of them prefer another typology that goes against the heritage preservation to which the CMN aims: "we would like to see every house rebuilt, but with front gardens so that we can see flowers when we pass by"-they claimed.

Independently of these issues, it was very noticeable when visiting Chanco how owners salvaged any material possible for it´s further use, making obvious that there is still economic and heritage values embedded in them.

PROCESS AND RESULTS

Problem formulation SoSe 2010

Compiled by
Natividad Puig, Óscar

Because of how recent the earthquake was, the seminar defined as a first task to configure the problem, rather than solving it. That is, in a situation of wide uncertainty, where everything was being reconsidered starting from the public policies and the legal framework, we needed to shape a problem before solving it. Therefore, the work involved as specific objectives determining a specific place, community and size of the housing group to be designed; establishing and studying in depth the relevant factors for the design; and formulating a specific approach to the design in a synthesis that should be both comprehensive and assertive.

The Semester contents was organized around 4 Topics to be studied and discussed by the students. These were expected to reflect critical positions regarding the future design:
1. Housing in Chile, which involved a basic research in the housing provision system, its standards and current problematics;
2. Heritage and Culture, where we studied the cultural and architectural potentials of heritage conservation in the case of Chile;
3. Climate and Environment, an overview on the climate of the region, and its correspondance to traditional architecture; and
4. Appropriate Technologies, where we critically addressed the technical problems posed by the construction with traditional materials.

1. Configuring a problem to solve

Focusing further in heritage and technology the questions formulated in order to begin identifying the problematics of the work were:

"What can be a specific contribution that is not already in use?"
"What is the importance of heritage, climate and technologies in the field of housing?"
"How do heritage and technology relate to each other or correspond?"
"How is each aspect related to the everyday habits of a society and its culture?"

The work started with mapping all the aspects involved in the topic and its relevance and this were defined the problems related to reconstruction, restoration and recovery of heritage zones, not only about the physical aspects of the urban area, but also the social functions they used to have (Fig. 1).

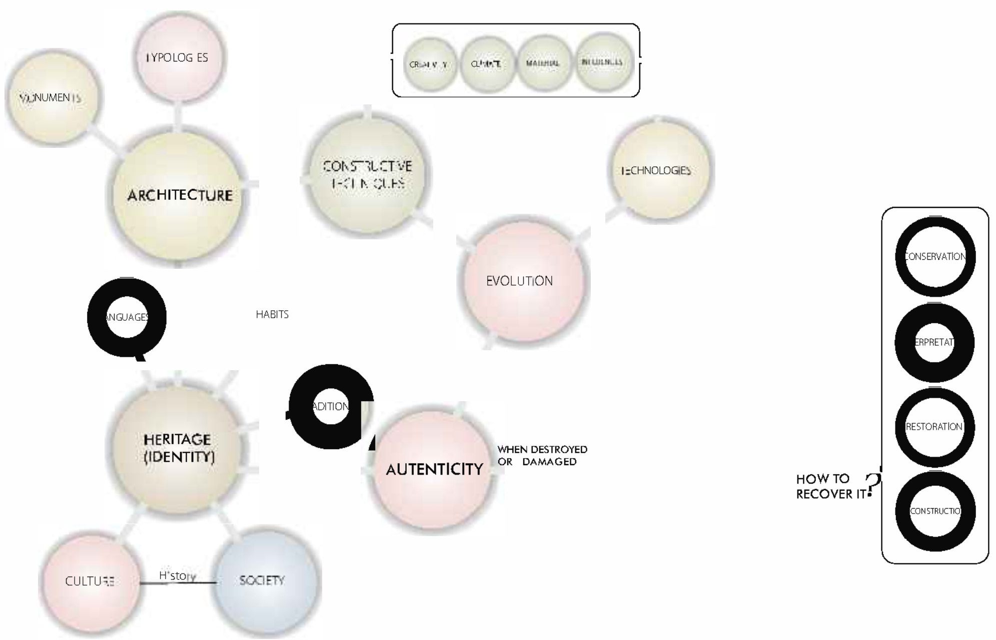


Fig. 1: Diagram (Miguel Cabezas, Marta López, Pedro Rodríguez)

The discussion enphasized the perception that during reconstruction the context and the social problems of the inhabitants -their will to stay, move to other places or come back to new constructions- are not taken enough into consideration. Influential factors in the physical organization are the existing buildings in the construction area; their permanence is really significant as a platform for the existent social contacts[2]. Yet one of the main problems remaining and that this project aims to address is the loss of heritage and inheritance culture after an earthquake. The simpliest meaning of identity, restricted to everyday terms: to belong to a place.

2. Recycling and Reclamation

After an understanding and analysis of the four topics proposed, the seminar group decided to focus on technlogy and its cultural articulation, without forgetting about the other ones. Always under the comprenhension of what they can bring as a real contribution to a field where all the chileans would already be working. Therefore a challenge for the seminar was formulated as:

Finding, understanding, developing and systematizing recycling processes for a new context.

Since the work was being conducted in Germany, the aim was to define an innovation by understanding existing procedures and techniques, in order to bring them to a different context. Several experiences were documented and discussed by the students:

Trümmerfrauen, women who recovered and cleaned bricks in order to be reused in the reconstruction of Germany after the second World War; the Reconciliation's Church (Berlin) a remarkable example of reuse the debris from the old building, in order to last and coexist with the new church.; the Recycled Paper Fiberboard House, made with recycled paper fiberboards, with the idea of producing it where it will stay, reducing the enviromental impact and generating local work; the reuse of concrete debris Reuse , collected out from a construction, a new mixture can be created in order to be used in roads or other any other kind of ingeneering projects; *"Plattenbau"* Reuse (Berlin) investigating on the possible reuse of old buildings made of concrete prefabricated panels, as some 350.000 uninhabited apartments are due for demolition.

3. Outcome

On the second part of the semester, with all the previous documentation as a basis, the students prepared proposals in different formats: papers, mapping or experimental techniques. These were menat to be speculative work, ellaborating on the problematic formulated preliminary to the design. The results are documented below as they illustrate the final outcome of the first stage of the work

3.1. Reclaiming Heritage

Parker Hoar's paper discusses the lack of conservation leading to a loss of many of the historical buildings after an earthquake. This demolition will remove the cultural heritage embodied in the physical composition of these architectural artifacts, and replace them with characterless constructions. Reclamation has the potential to retain architectural and cultural traditions while being economically attractive in existing social networks. In opposition, Hoar proposes the relevance of traditional techniques, the potentials of the existing reclamation practices and the community integration in the process of reconstruction.

Benefits of local buiding traditions in architectural design
Traditional carpentry practices, rough stonework helped inform opportunities and limitations of the design,reduced costs on transportation and misuse of expensive machinery unfamiliar to contractors. For these reasons of efficiency, and performance quality, it might appear that the economic advantages of using local building practices drove design decisions. But it was not always the distance from industrial centers that made local materials

[2] Kirschenmann, Jörg C. Diseño de barrios residenciales: Remodelación y cremiento de la ciudad (Ed. Gustavo Gili, Barcelona, 1980).

appealing- The resulting construction looks and feels like it is from that setting, physically fitting and socially appropriate. The idea is to retain instead of replacing something.

Cultural retention from reclamation

Reclamation, the process of carefully dismantling architectural materials or components and reconfiguring or reusing them into new or existing construction, is one way of preserving the physical artifact for future generations and the history and building practices that are associated with those objects. To properly reclaim architecural salvage, the dismantling process requires a working knowledge of older building systems and architetural elements. Adapting them into new construction demands that the architects and contractors understand not only the material qualities of the objects, but to archieve artful reuse and reintegration withnew construction benefits also from understanding their historical and social side.

Existing Reuse in Chile

Although the official system for reuse and recycling of all waste in Chile is less active than in Europe, a widespread system of independent and, in some instances, organized laborers have made a business out of recycling materials and objects that may be seen as damaged, obsolete, or just not wanted by the owner since the 1970s[3]. Several thousand recyclers - also know as "*cartoneros*" collect used goods (Fig. 2)

Fig. 2: Cartoneros (Photograph by Fortín M 2008)

Potentials for reclamation in the FSV participation process.

The reclamation process is labor intensive and that is where it draws ist economic and social benefits. The reclamation technique of dismantling, cleaning, organizing, and eventual reusing of older buildings for new construction can be a cost-competitive option when compared to constructing with new materials in Chile. Because energy costs are high, and new materials manufactured far from a building site require large amounts of energy to produce and transport, relcamation, which occurs locally through manual labor can be much less expensive if wages are low.

In addition to the savings that may benefit the owner, the way money flows from this kind of work creates a positive psychological effect around a reconstruction that uses a hand salvage process. Unlike most of the new constructions that bring materials to construction site for assembly, reclamation architecture draws more upon the work of those in the community, thus sending work to the place of the disaster instead of the place of manufacturing. The laborer who dismantles a historic building gets paid three times more.

When people have no control over, nor responsability for the decisions in the housing process, on the other hand, dwelling environments may instead become a barrier to personal fulfillment and a burden on the economy[4]. Reclamation requires a great deal of participation from local labor.

3.2. Harvest Map

In their mapping work, students Miguel Cabezas, and Marta López argue that the work of an architect requires the recognition and analysis of a wide range of factors, like geographic or climatic, material availability, prices, historical baggage or even political matters. It is not the first time that an architectural project deals with recycled or reused materials.

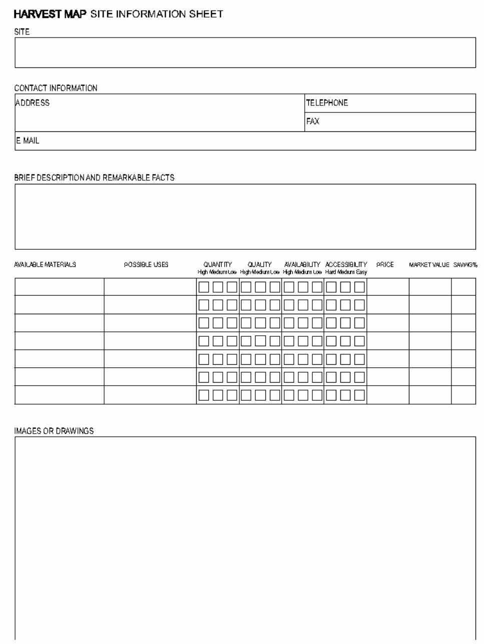
Cabezas and López document the experience of the Dutch Studio 2012 Architekten, which created a tool called *harvest map*, representing the building site and its surroundings in a basic plan and marked the spots where to find materials that could be used in the project, also showing the distance with concentric circles with the site as the center. A full method was developed by the students to deal with recycled materials: find, recognize, evaluate, prepare and build. It was tested to show a general path within a particular case in Berlin.

[3] Steubing, B., E-Waste generation in Chile: Situation analysis and an estimation of actual and future computer waste quantities using material flow analysis. (Swiss Federal Institute of Technology at Lausanne (EPFL), Lausanne, 2007)

[4] R. Fichter, J. T. a. P. G. The Meaning of Autonomy. Freedom to Build: Dweller control of the housing process. (Macmaillan, New York, 1972)

First step: Site Recognition

During a field research, a basic form is to be filled up, with relevant information that would help us when comparing different materials and taking decisions (contact information, distance, availability, price, conditions of the material, saving costs....). (Fig.3)



HARVEST MAP SITE INFORMATION SHEET

SITE

CONTACT INFORMATION

ADDRESS | TELEPHONE | FAX

E MAIL

BRIEF DESCRIPTION AND REMARKABLE FACTS

AVAILABLE MATERIALS	POSSIBLE USES	QUANTITY High Medium Low	QUALITY High Medium Low	AVAILABILITY High Medium Low	ACCESSIBILITY Hard Medium Easy	PRICE	MARKET VALUE	SAVING%
		☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
		☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
		☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
		☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
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IMAGES OR DRAWINGS

Fig 3: Site information sheet (Chart by Miguel Cabezas and Marta López)

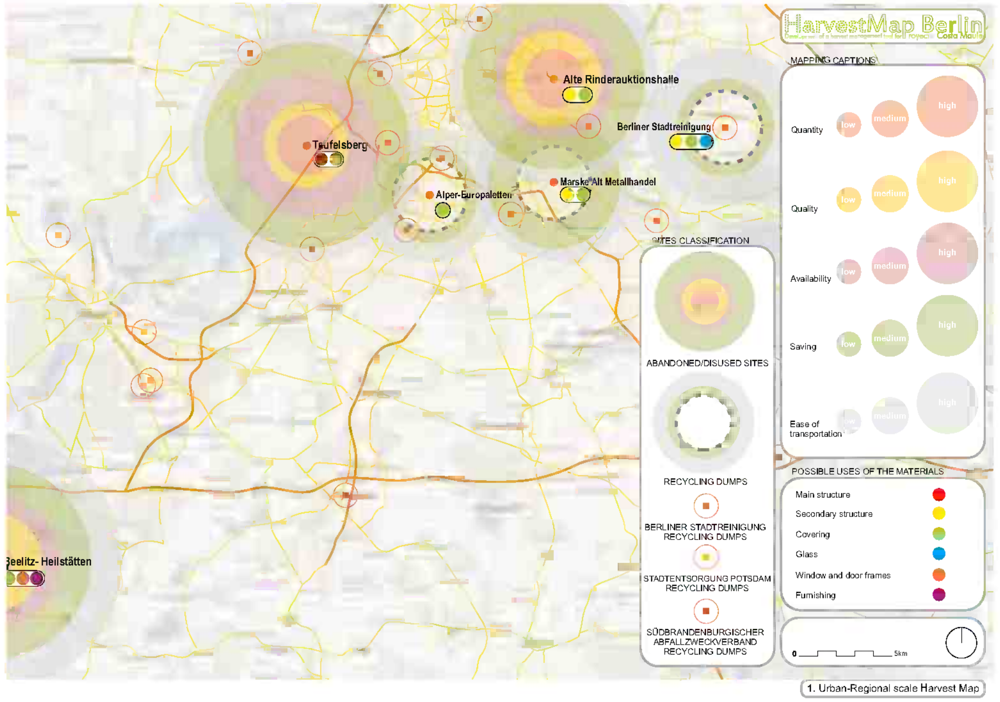
Second step: Compiling information

In an Urban-regional scale, transportation nets and systems seemed to us crucial when dealing with materials coming from different sites. The first map comes directly from those information sheets we filled up during the field research. Using a radial system which grades different factors we can easily test the feasability of each spot marked. At this point, we reached a way of placing the data in a geographic plan. We use this tool to discover connections and nexus that are not visible at first sight, but need to be represented in a graphic way to find them.

In a Local-plot scale a different map is used to include information about the materials that have been found and the process that each element has to follow from its original location to the building. With this tool we can estimate costs of manufacture and testing, as well as finding which are the best paths to get to the site. In the case shown, we see a local context, because of the size of the city, whereas in small villages we would be talking about plots.

In the Architectural scale, rather than mapping a diagram of how the materials and elements found fit in the project is built, in which part can they be used or which function would they develope. It is possible to use a rough drawing including all basic elements (structure, roof, partitions, basements...), just to place them

By documenting the whole harvesting process, it is possible to achieve several goals. First of all, it allows us to know which kind of materials we can use in our specific project, and optimize their use with distances and other information. Distribution systems can be organized with this information, as well as the design of the structure and building system. We can also decide wether we use recycled materials or new ones.



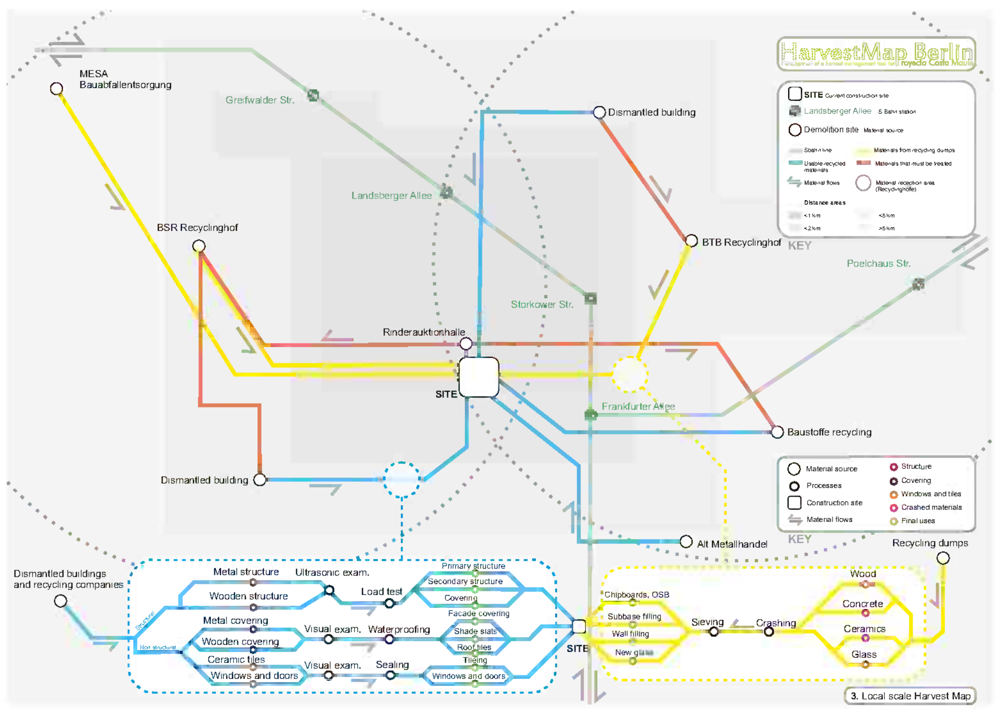
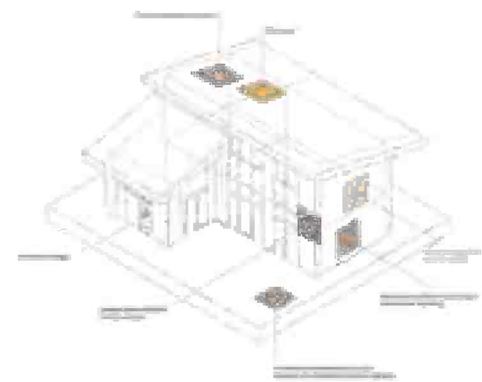


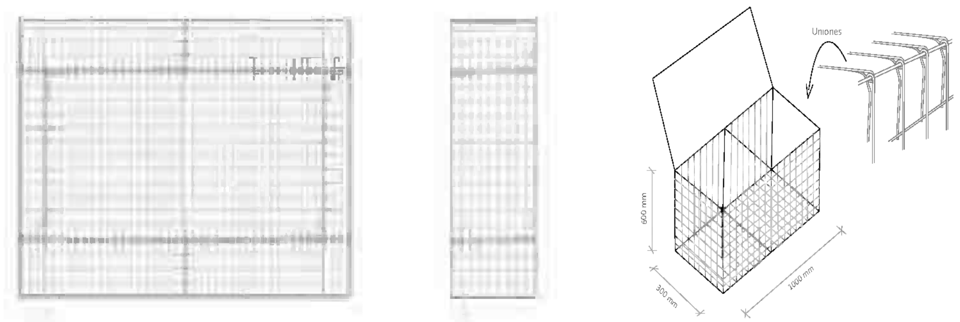
Fig 4: Havest Map Regional Scale (Drawing by Miguel Cabezas and Marta López)

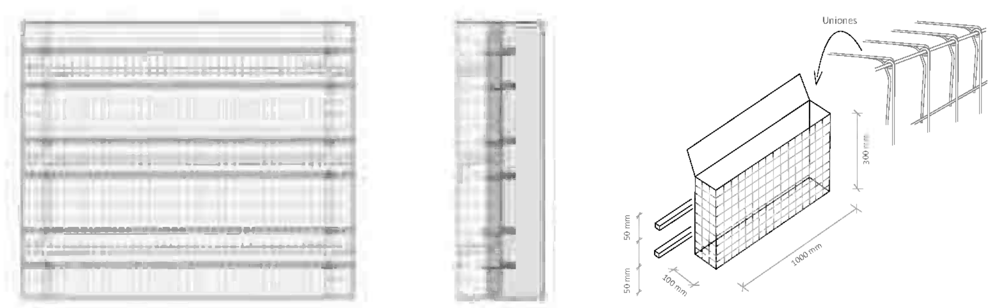
Fig 5: Havest Map Local Scale (Drawing by Miguel Cabezas and Marta López)

3.3 Brick and Gabion systems

Once the materials are classified and sorted, it is time to decide how and where they will be used. Different kinds of debris can be used for different functions. Students Elena Ramos Caballero, and Pedro, Rodrígues López, proposed to use big stones in gabions as an structural wall, smaller ones for some cladding inside a smaller gabion, or even a fassade composition out of bricks, concrete debris, grabble or other stones, placed as we wish to create different aspects.







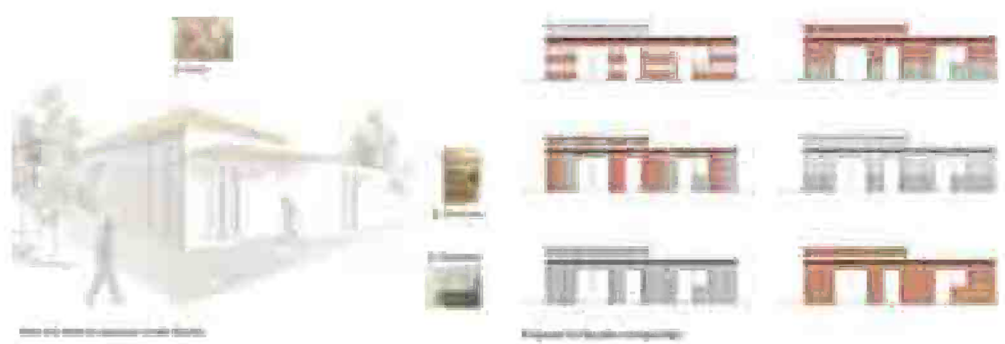
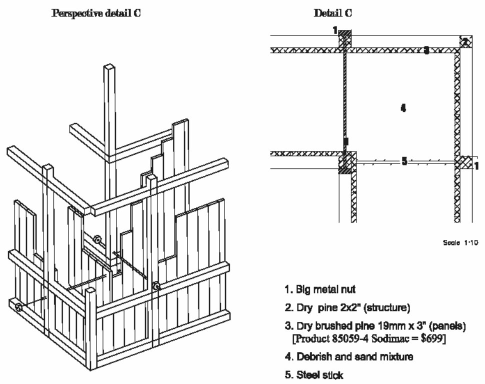


Fig 6: Havest Map Architectural Scale (Drawing by Miguel Cabezas and Marta López)

Fig. 7: Massive Structural Gabion (Drawing by Elena Ramos and Pedro Rodríguez)

Fig.8: Cladding Gabion (Drawing by Elena Ramos and Pedro Rodríguez)

Figure 9: Fassade compositions(Drawing by Elena Ramos and Pedro Rodríguez)



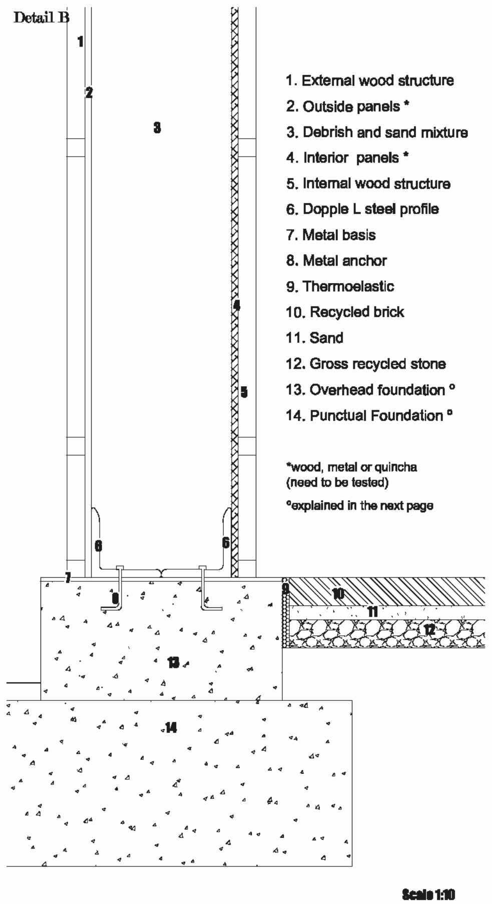


Fig. 10: Corner system (Drawing by Óscar Natividad)

Fig. 11: Section Detail (Drawiing by Óscar Natividad)

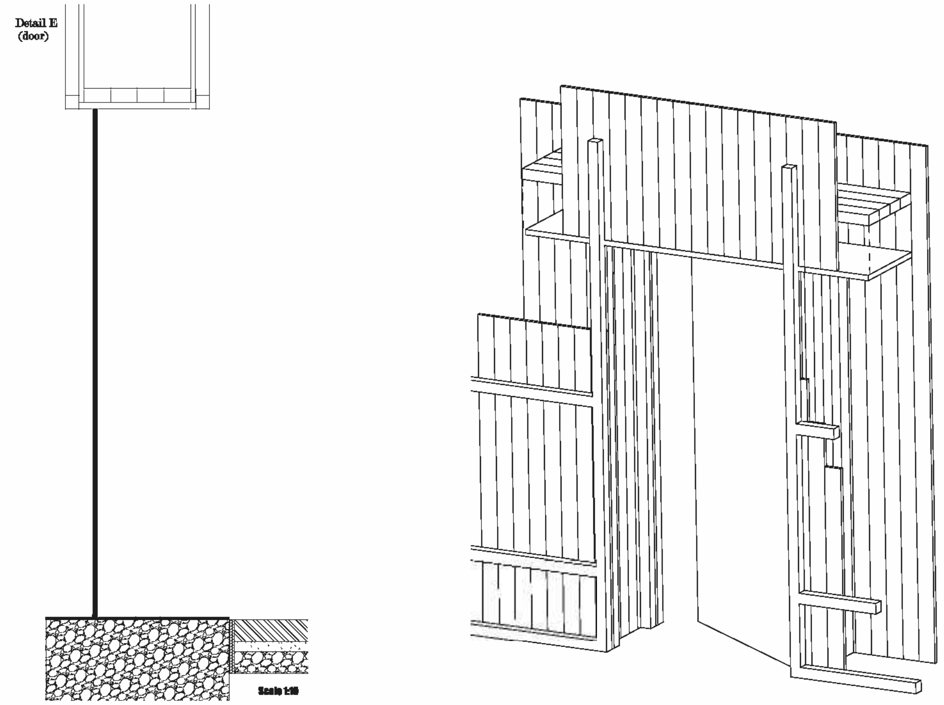
6.4. Construction System

Students Óscar Natividad and Marcelo Frías proposed this system based in the use of a mass recicled out of debris as a principal element. To this mass a wood panels superficial substructure is added. As seen in a remaining building (La Casona) after Tarapaca's earthquake, this kind of structure works without problems and its big thermal inercia keeps the house under confortable temperatures (it retains the heat during the day and emits it during the night, when the temperatures go down). The foundation consists on some punctual supports, on top of them a U steel profile is laying down (it will be the base of the recycled mass). In between the punctual supports it will be filled up with some debris, previously sorted and classified attending to resistance capacities. Finally, some smaller debris can be used to compose an exterior cladding. That way heritage aspects of the chilean house are respected and reinterpreted.

Window detail (next page)
Based on historical designs in chilean houses, where the thickness of the wall was a relevant point, we consider the incorporation of some benches to the windows. In that sense, what it could be considered as a residual space, is again an important aspect in the residential environment.

Door detail (next page)
As happened with the window, the door is placed in the most external part of the wall, creating a small interior space previous to the hall. The upper part is not fulfilled with debris and it could eventually be opened to ventilate in a more appropiate way. So does the window.

Synthesis
Through this innovative debris reuse from old buildings we see a potential that supposes a considerably economical and cultural saving. In other words, not only supplies materials without the need of buying them, but also means a heritage reinterpretation through its own elements. Therefore we think that could be specially atractive to social housing policies.



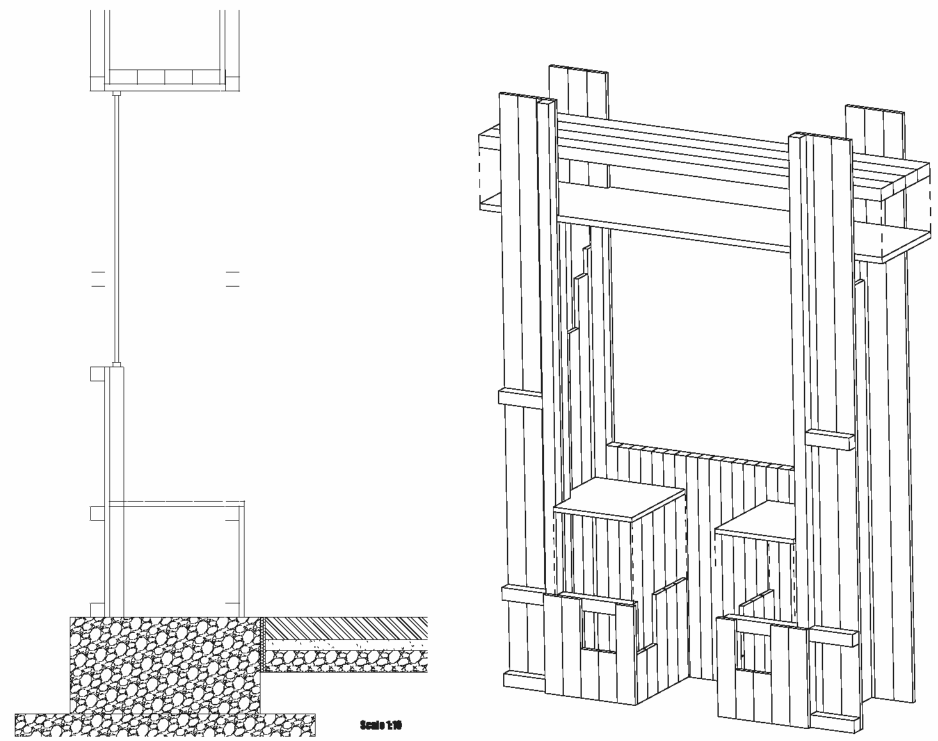


Fig. 12: Floor Deatil (Drawing by Óscar Natividad)

Fig. 13: Window Detail (Drawing by Óscar Natividad)

PROCESS AND RESULTS

Design Seminar WiSe 2010/11

Compiled by
Beltrán del Río García, Luis

The design seminar subject problematic was mainly based on the application of the reclaiming heritage hypothesis to the case study of Chanco. The information obtained from the Research Seminar and Field Trip helped to articulate the basis of the problem to be solved. Although the design process (developed within the seminar) represents one of the main parts of the project, as a whole it was understood that as another step towards the construction workshop and the developed designs were meant to be built from the beginning.

By means of bringing a real problematic into the academic world and in the minds of young students, the goal was to promote a responsible speculation on possible solutions that went beyond those currently available. The comprehensive approach then went from the academic speculation to full development of a prototype.

Even though the main focus of the projects developed in the seminar was to confront the problematic of a sensitive post disaster reconstruction, this had to be done by means of exploring the potentials of reclaimed material. The problem then, had to be understood and solved by the means obtained from previous researches. Therefore a more abstract comprehension of the main hypothesis had to be made. (Fig. 1 to 3).

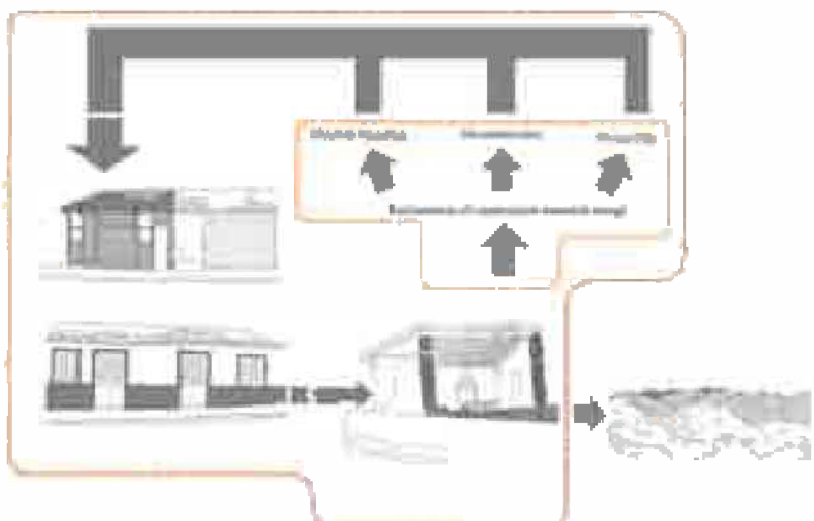


Fig. 1: Collapsed vernacular architecture and the materiality of the same in a waste landfill (Drawing by Luis Beltrán del Río)

Fig. 2: Most common solutions given by governments, where new housing is built in a industrialized way, regardless the loss of networks and vernacular elements (Drawing by Luis Beltrán del Río)

Fig. 3: By means of reclaiming construction materials, through material mapping, deconstruction and processing, we intend to recover the vernacular architecture while remaining in the previously existent netwrok (Drawing by Luis Beltrán del Río)

2. Methodology: Testing and Developing

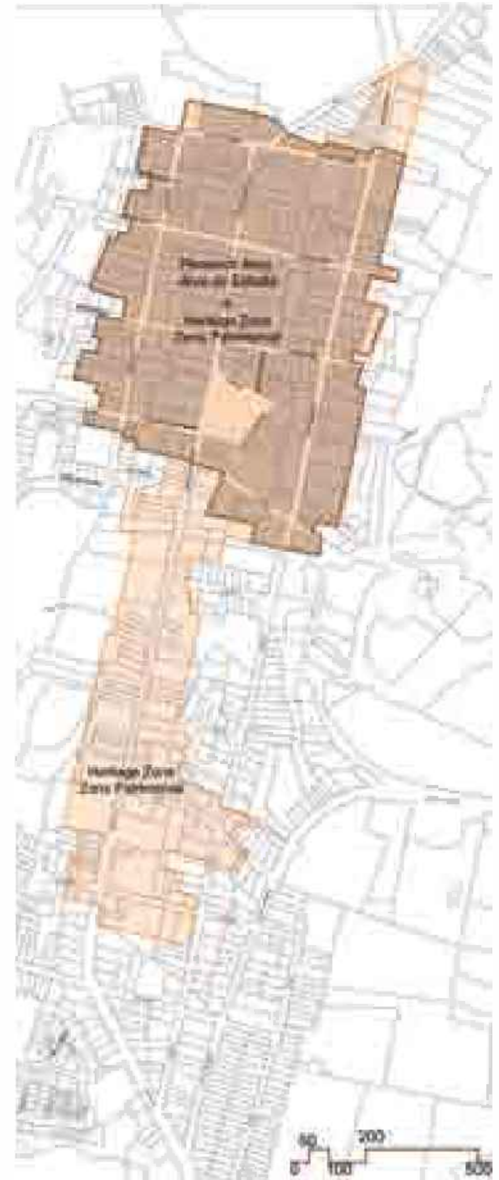
The specific objective was to develop a building system based on the existing debris and to test its applicability to the reconstruction of houses in a post-disaster context by architecture designs in the context of housing. The seminar took the form of an internal competition, where week by week progress of the different projects was discussed. At the end of the semester and after submitting two times, there was a chosen project that was to be further developed and adapted for construction.

The project general assumptions included the availability of demolition materials after the earthquake of February 2010 in Maule, Chile, and an implementation that was based on existing standard housing policies of a group of 20-30 houses that included the community organization considered in the policy in the town of Chanco, Maule.

The proposals were to be developed in the context of Chanco´s Heritage zone. Therefore the design needed to form part of an urban proposal. Then it could be said that the projects were addressed and evaluated in three different dimensions: the urban character of the town, the potentials for reclamation and heritage value of both.

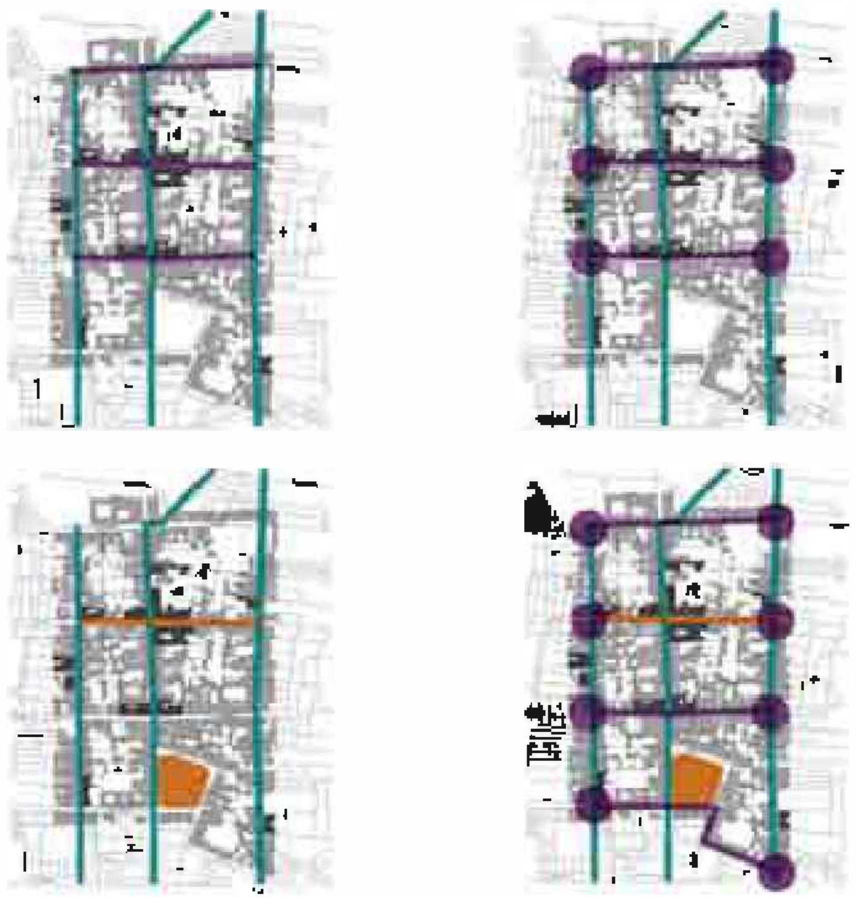
3. Urban characteristics and the "Typical Zone"

Chanco was designated in 2000 as a Typical or Picturesque Zone (Zona Típica o Pintoresca, Z.T). The considerations underlined in the study as a fundament in the designation are explained in the same document in the second chapter. Such characteristics were highly considered as part of the design requirements. The work area considered for the seminar was defined with the assistance of the Municipality of Chanco. It is the biggest and most central part of the Typical Zone (Fig. 4) . The lots for design were to be selected within these areas, preferably, and they should consider maintaining some existing buildings as part of the intervention, in particular those documented in the field work.



Considering that we had very detailed information concerning the plot distribution in Chanco, and that the scale of the HZ was not to big, the urban proposals were approached in two types, an overall scheme on where to concentrate the living spaces, and a more specific that depicts the distribution of twenty houses by joining different plots.

Fig. 4: The plan highlights the Typical Zone of Chanco and the research area for the design seminar it's shown darker. This area was fully scanned and analyzed during the first field trip in order to make an adequate diagnosis of the state of the typical zone (based on Land Register plan from Municipalidad de Chanco. Drawing modified by Luis Beltrán del Río, Santiago, 2010)



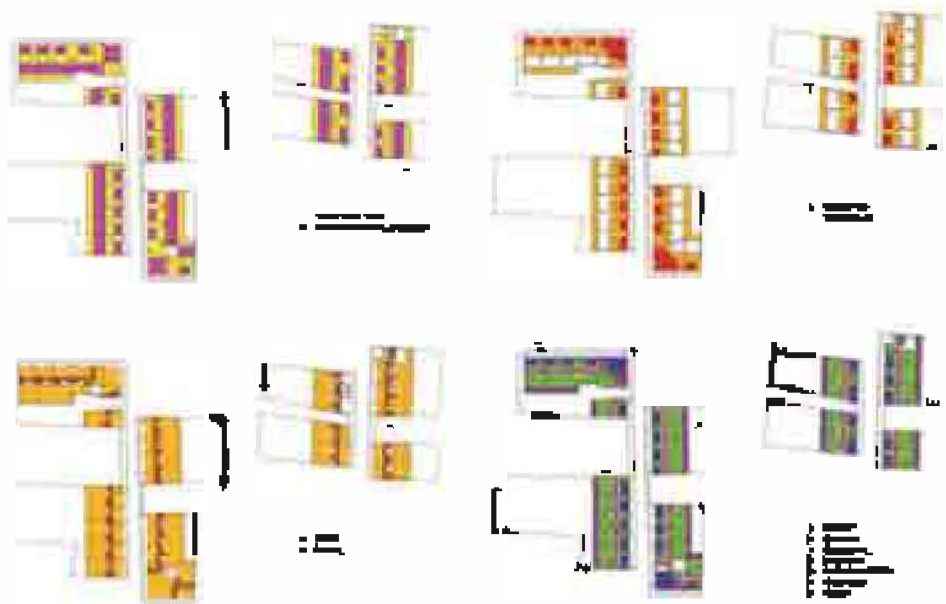


Fig. 5: Overall scheme, where the main axis's of the Typical Zone are highlighted. The proposal also suggested a series of relevant intersection points that could be intervened in order to achieve a more balanced approach (Drawings by Alejandro García and Eduardo Barros)

Fig. 6: Housing proposal in which the prototype is inserted in four different plots. The schemes not only consider the arrangement of the houses, but also their progressive growth and functions (Drawings by Alejandro García and Eduardo Barros)

4. Potentials for Recycling and Reuse in Post-earthquake Chanco

A visit to the town confirmed previous understanding of recycling practices in Chile. Reuse, and in the case of Chanco, the reclaiming of materials from demolished buildings is occurring consistently at an unorganized local level, but with limited use in new constructions. Almost every cleared building lot that once had an adobe and wood frame house has organized piles of the timber and the roof tiles that were once on the building lot.

Fig. 7: Roof tiles being wied for re-installation, covered in the corridor in the corner of San Ambrosio and Yerbas Buenas Street, Chanco (picture by Reclaiming Heritage)

Fig. 8: Timber is plentiful and consistent in sizes and quality. Most of them are old pieces, but nevertheless they still have good structural quality, and with adequate oil treatments, it could be easily reused. The lengths of these pieces were varied depending upon whether they were used as posts or beams (picture by Reclaiming Heritage)

Fig. 9: Dump yard perspective from the inside, a small creek separates this lot from others. Here, most of the adobe clay has been deposited, among with others, apparently useless materials, such as broken tiles, broken concrete blocks or timber (picture by Reclaiming Heritage)

During the seminar ideas on how to reclaim material were brought into discussion and then in some cases applied to the designs. The evaluation criteria for such proposals was strictly related to level of complexity of the solutions and the considerations towards the available material, taking into account that during the field trip there was an extensive mapping of the accessible materials.

Fig. 10: Earthbag construction technique which propose a direct application, in which the infills of the bag are done with reclaimed adobe material (taken from the student Schaedel's seminar research update)

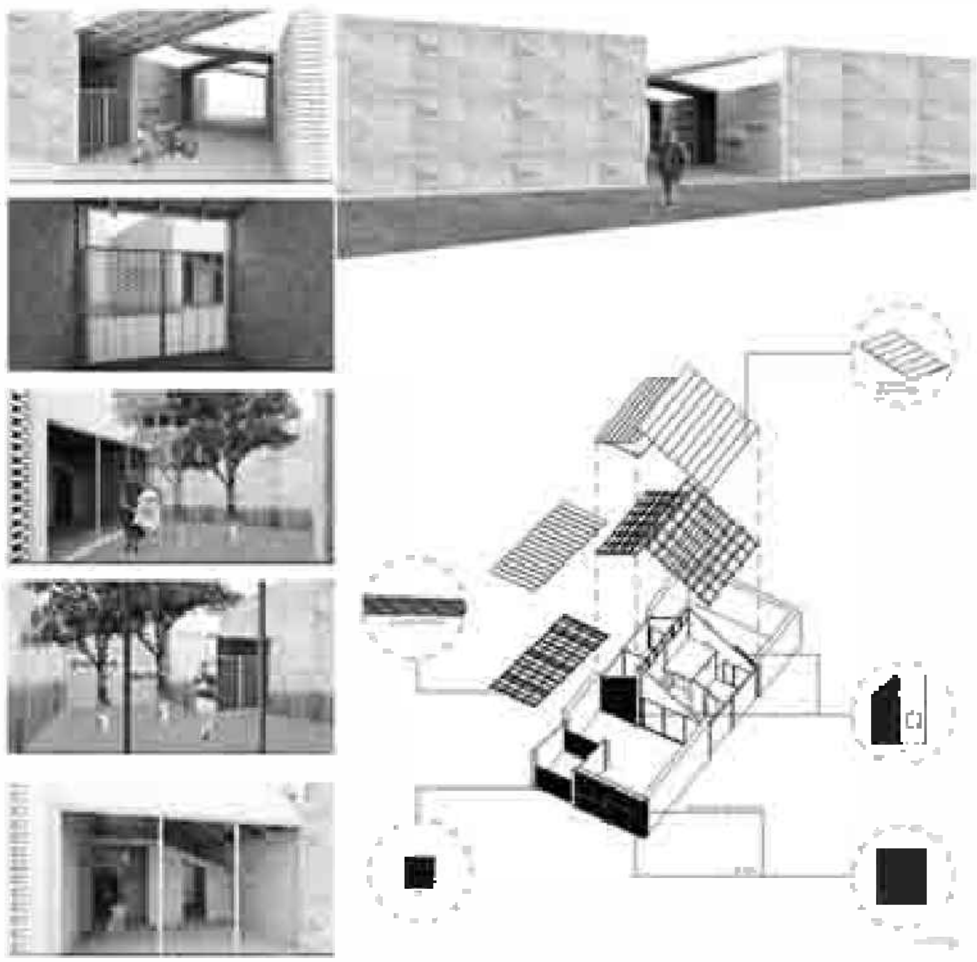


Fig. 11: Project proposal in which most of the reclaimed materials are embedded in the walls, in the form of screens or only pieces of broken tiles to give more cohesion to the mass of the wall (Drawings by Ella Nik Aminaldin and Safuraa Razak)

Similar solutions to a similar problem

An essential objective for the development of the seminar was to focus further and further into less projects, obtaining at the end only one product. The first stage consisted of twelve teams integrated each by two persons. For the second stage the teams were reduced two half by joining projects trough their similarities, flaws and weaknesses. At the end one project was chosen and further developed to the necessities and specific regulations of Chile. By joining the efforts more and more towards one project, not only most of the useful ideas were taken into account, but, the final product belonged in a certain way to most of the students. Therefore it could be said that the seminar-contest, ended up working as a participative design process, where discussions and suggestions about everybody´s projects were taken into account.

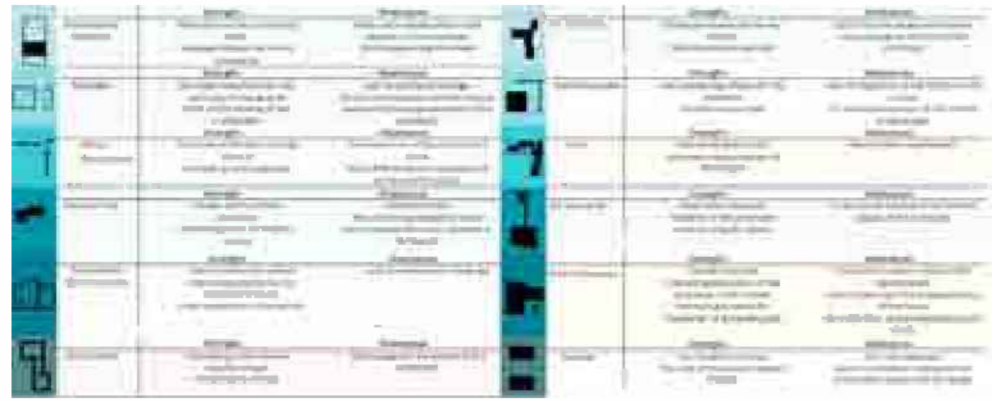


Fig. 12: An abstraction of the twelve proposals at the first part of this semester. These projects were joined together by considering their strengths , waknesses and similatrities.

5. The final design

The winning project by Federico Rota, Joao Moreira, Javier Hernani, and Albert Lavall, proposed simple solutions that recovered the functional traditions of vernacular houses by using a wide hallway that distributes spaces and can be, at the same time, used as a living space. The hallway brings together the internal circulations with the filter towards the internal patio, but even more it is an analogy of the porches in the vernacular architecture. By bringing this element the house recovers the livelihood activities of the old town in a contemporary language. The house is composed by a very simple construction system, two adobe baring walls and a wooden pillar structure. Most of the material reclamation in this case was done by having a mixed structure system that was modulated according to the size of the material found in Chanco. In the case of the load-bearing walls, the system was composed of recovered adobe bricks working in compression, combined with a series of timber horizontal sections in the corners to join better the walls and contain the loads of traction.

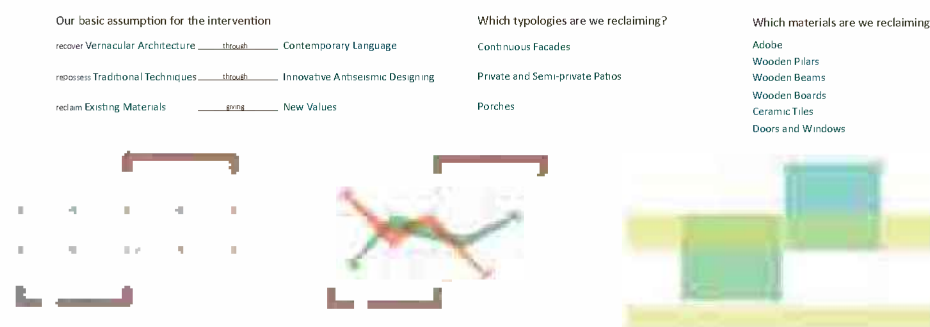


Fig. 13: Concept schemes of the winning project

PART II: CONSTRUCTION

Documentation included in Part II:

- Plans of the final project

Fig. 1: First page of the winning project. (Federico Rota, Joao Moreira, Javier Hernani, Albert Lavall)

Plans of the final project

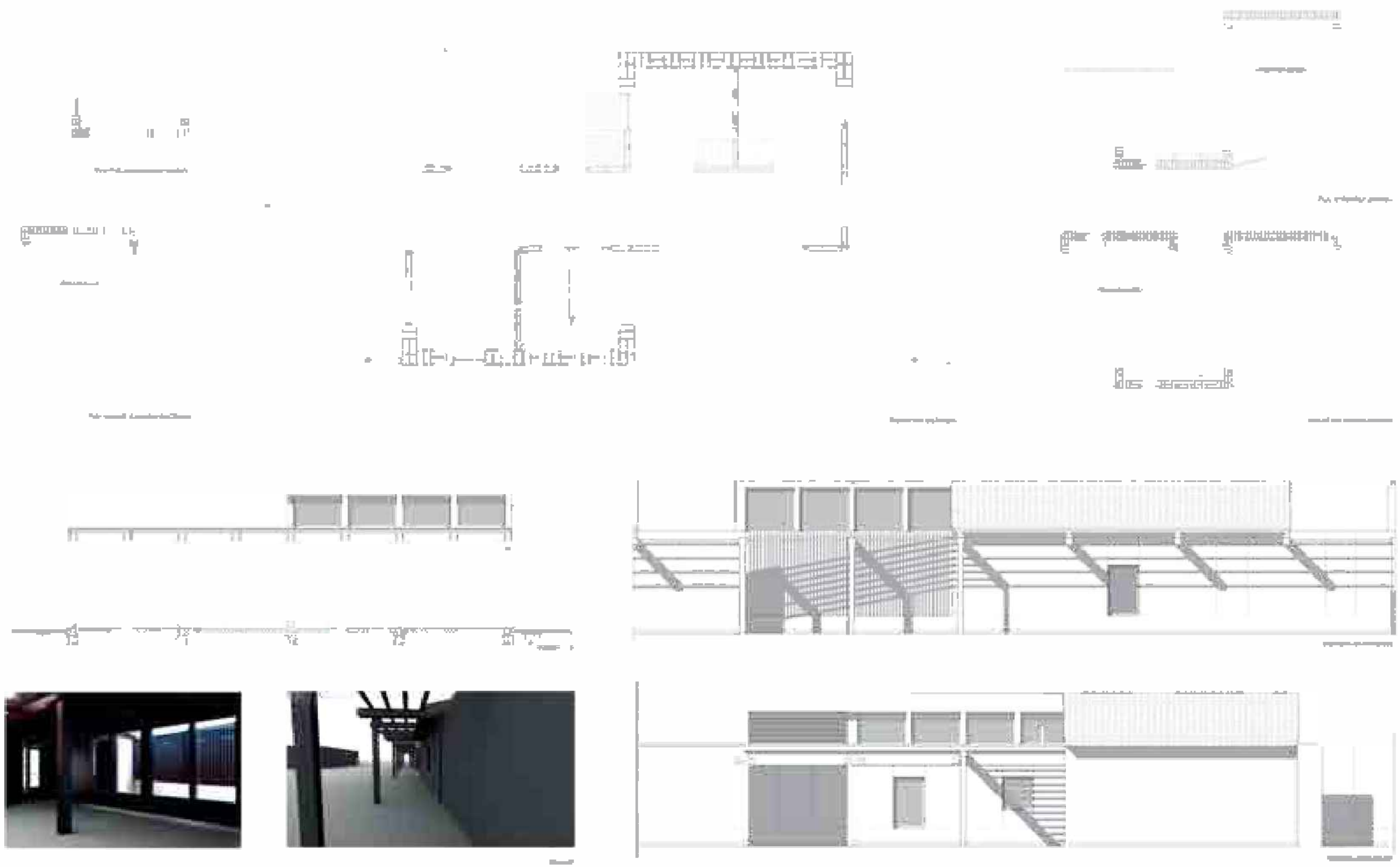


Fig. 2: Second page of the winning project. (Federico Rota, Joao Moreira, Javier Hernani, Albert Lavall)

Plans of the final project

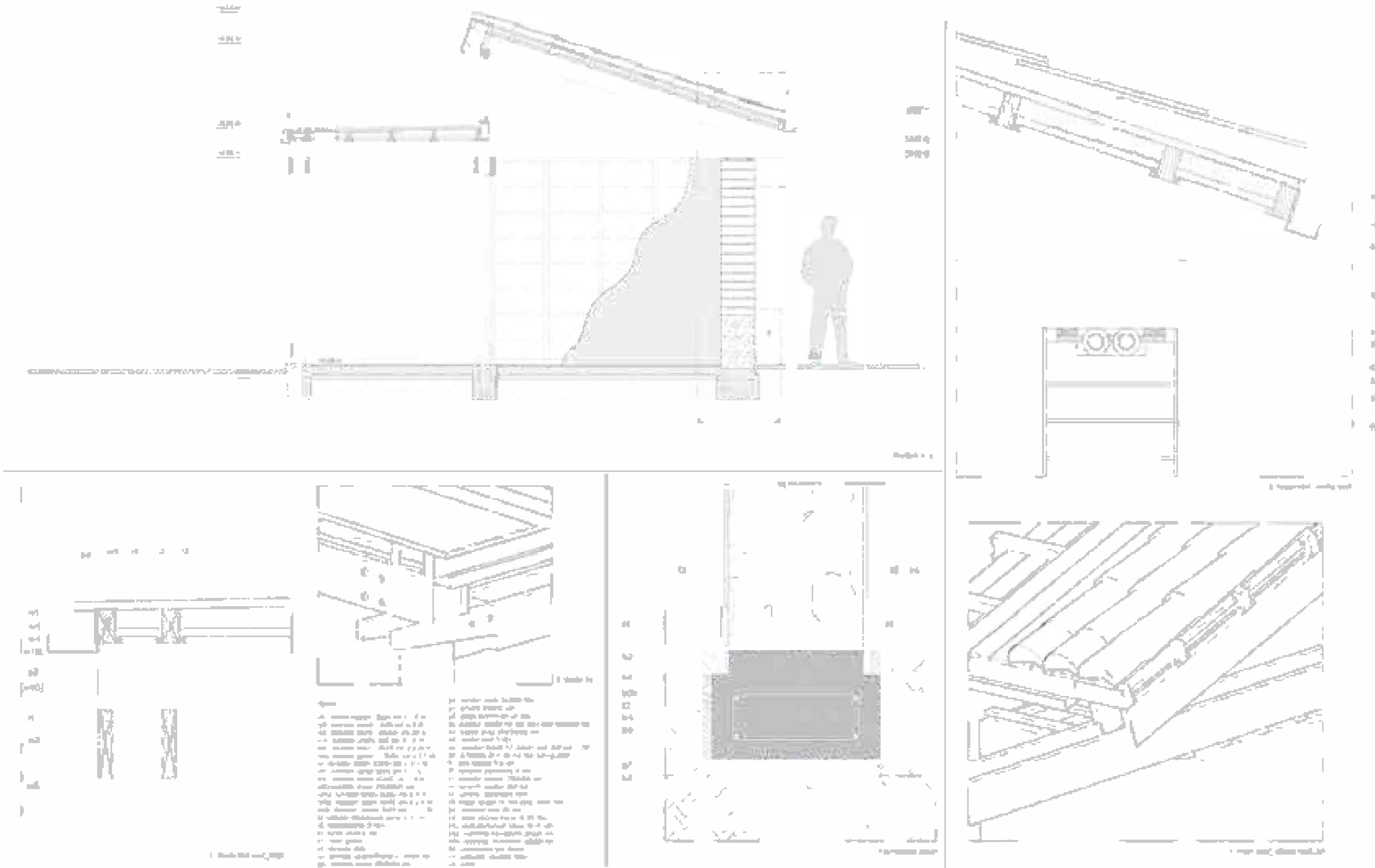


Fig. 3: Third page of the winning project. (Federico Rota, Joao Moreira, Javier Her-nani, Albert Lavall)

Plans of the final project

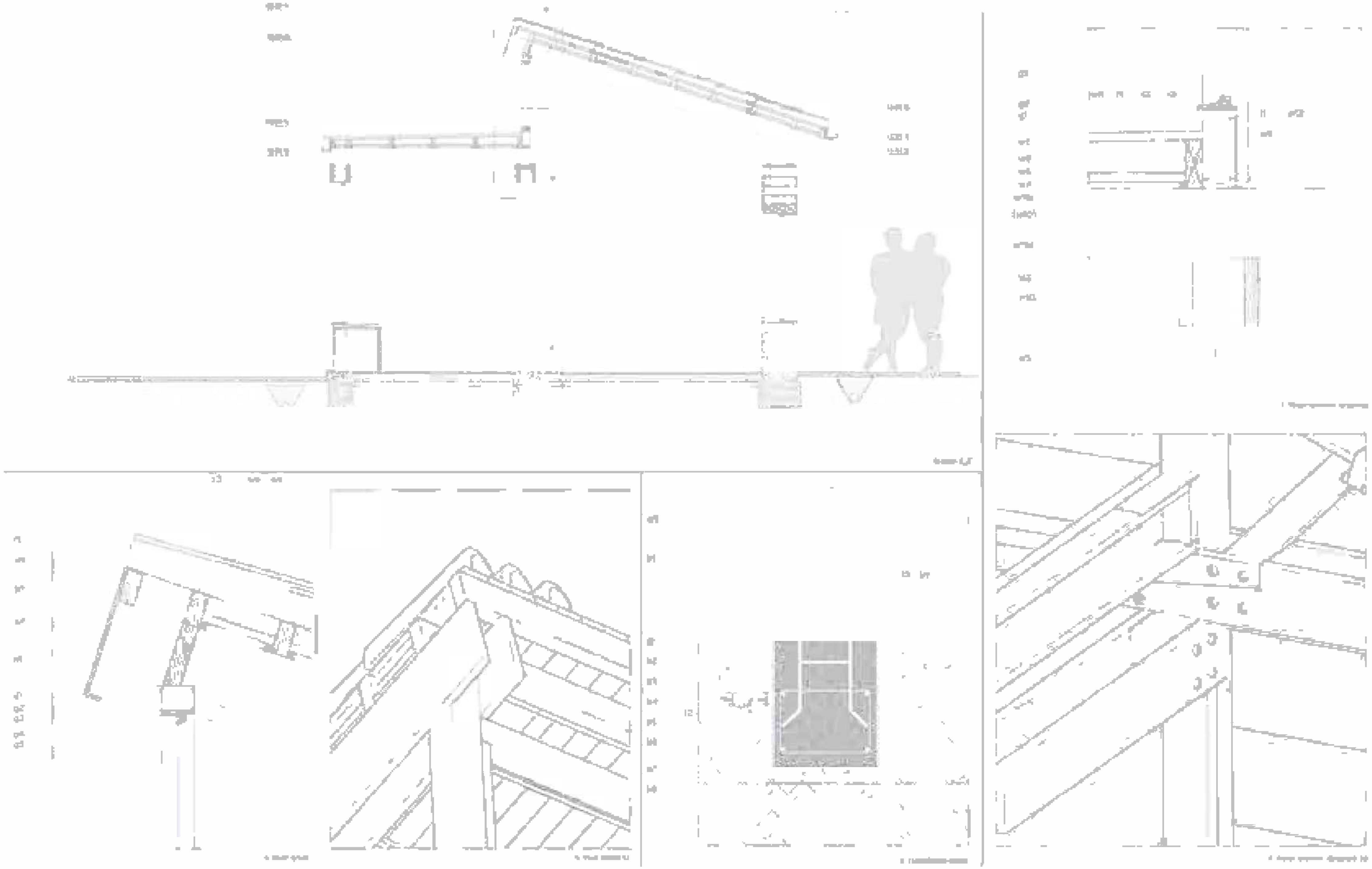


Fig. 4: Fourth page of the winning project. (Federico Rota, Joao Moreira, Javier Hernani, Albert Lavall)

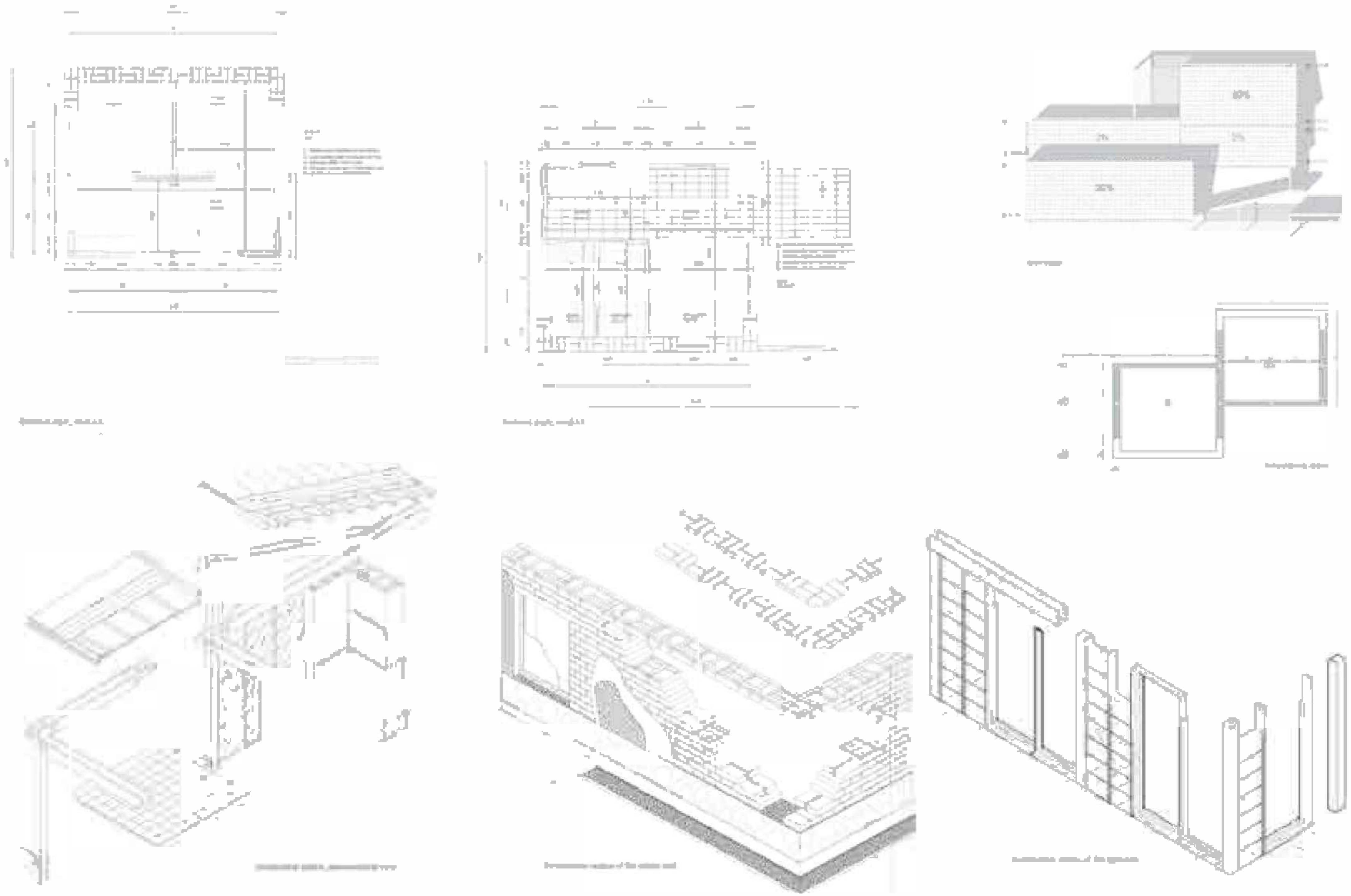


Fig. 5: Fifth page of the winning project. (Federico Rota, Joao Moreira, Javier Hernani, Albert Lavall)

MATERIALS FLOW IN RECLAMATION:

Logistics and systematics

Au, Holly
Barros, Eduardo

Fig. 1: Four pictures showing the old state of the materials and the new use given (Reclaiming Heritage Team, 2011)

The issue of material reclamation and re-use in the building industry has been growing in importance as people grow more concerned with sustainability issues such as unrenewable resources and reducing waste. It remains however, largely uncommon in standard building practice as it takes at least two and up to ten times as long to deconstruct than to demolish[1]. Currently, materials recovered are mostly limited to high-value objects by architectural salvage firms or alternatively sold to recycled product manufacturers [2]. Though it is possible to reclaim other materials, this is not widely done because of a lack of market these materials.

Re-use constituting significant proportions of building remain largely confined to showcase sustainability projects as we see in the case studies Addis provides in *Building using reclaimed components and materials* (2006). The current literature on making reclamation of significant proportions of buildings viable mostly focus on the design of new buildings, called Design for Deconstruction, making them easy to deconstruct for re-use and with the ideal of continuous recycling and re-use, eventually forming a closed-loop cycle thus having no need for the consumption of more resources [2 and 3]. This vision sees restoration the most optimal followed by re-use, then recycling as each step slowly degrades the value of the material [2].

However the problem of making reclamation of existing buildings viable remains. The lack of market is due to the eventual re-use not being considered in the deconstruction as the two remain separate industries. Books that give practical advice on reclamation also focus on one side or the other, such as Falk's *Unbuilding*, (2007), a guide to deconstruction and Addis's *Building using reclaimed components and materials* (2006), a guide to re-use and recycling. We propose to make reclamation viable by combining the deconstruction and re-use as a continuous process, thereby providing the immediate market required. This gives us the opportunity to coordinate the deconstruction and construction process using the same reclaimed materials in the most effective way. This hypothesis is tested by constructing a housing prototype using reclaimed materials in a post-disaster context where there is an abundance of materials waiting to be reclaimed and see whether it is possible to make reclamation viable for more everyday projects such as housing.

1. Case of Study

The earthquake in Chile in February 2010 caused widespread damage throughout the country rendering many houses uninhabitable. Many of these houses are awaiting demolition with materials ripe for reclamation and there remains a serious need for the reconstruction of housing for those whose houses were destroyed. The reconstruction process was especially slow in rural towns and the heritage typical zones due to the need to meet strict heritage guidelines meaning that many houses remain empty in their damaged state.

We proposed using the reclaimed materials as a way of preserving the heritage that is remaining in these heritage areas. Working in the rural town of Chanco, we developed a flexible design that could be adapted to the materials that we were able to get hold of. Two architects and nine students travelled to Chanco, to test this until now largely theoretical project. The plan was originally to test reclamation within the typical zone but were denied permission by the Council of National Monuments. Instead we were able to get permission from the local municipality for the deconstruction of an uninhabitable house just outside the typical zone and permission to build a prototype on council land near the football oval.

The aim of the prototype was to test the use of reclaimed materials and to discover how to optimize our processes and the logistics to make post-disaster reclamation viable for the reconstruction of houses. This also means that the whole process of reclamation, including deconstruction, processing and construction would need to be doable by

[1] Chini, Abdol and Bruening, Stuart, Deconstruction and material reuse in the United States, The future of sustainable construction, 2003

[2] Addis, Bill, Building using reclaimed components and materials: A Design handbook for reuse and recycling, (earthscan publications, 2006)

[3] Storey, John, Reconstructing deconstruction (CIB publication, 2002)

regular local workers and was done in our test by a largely inexperienced group with common construction tools. In the following, we show how deconstruction and construction can be implemented in continuity, then discuss its shortcoming, and potential based on our experience.

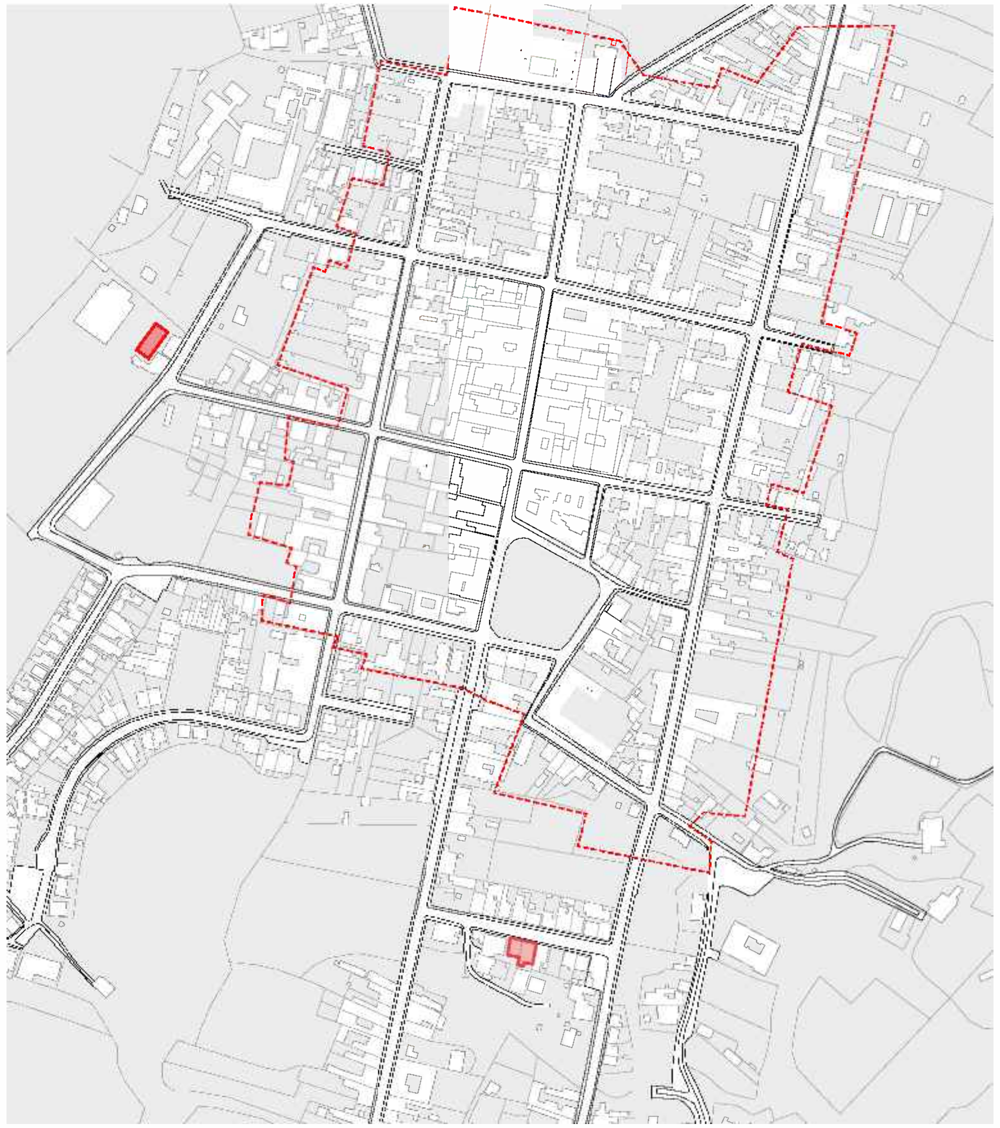


Fig. 2: Materials with heritage values attached, waiting for being decosntructed (picture by Luis Beltrán del Río, 2011)

Fig. 3: Construction and Deconstruction sites (based on Land Register (Plan from Municipalidad de Chanco. Modified by Holly Au, 2011)

2. Deconstruction

The first step in the reclamation process was to find a suitable house to deconstruct. Following the earthquake we did documentation regarding the town pre and post earthquake and had been in contact with the local municipality about using reclamation as part of the reconstructive efforts and as a way to retain some of the heritage of the area. Having shown them our design proposals for reconstructive housing using reclaimed materials, the municipality of Chanco gave us permission to deconstruct an earthquake-damaged house that would need eventual demolition, what allowed us to get reclaimed materials for free. The house lies just outside the heritage typical zone of Chanco, but uses the same traditional materials and forms (Fig. 4). Like many houses in Chanco, it had been marked with an X declaring it uninhabitable. It has remained unused for just over a year. However many materials appear intact and suitable for reclamation.

3.1. Assessment

Prior to our team's arrival to Chile, the student Frías, Marcelo from Santiago went to Chanco to do a preliminary survey of the materials which may be possible to reclaim, so that this could be taken into account in our proposals. Upon arrival we further assessed the condition of the house. The main structural concern was that the whole roof structure was leaning (Fig. 5)

The roof was reinforced it before work began with new timber pillars, thinking of reusing them later in the construction of the prototype. There were also many large cracks through the plaster and the adobe bricks forming the gable were in danger of collapse (Fig. 6)

There was also water damage from the leaking roof causing rotting and fungus in some parts of the house (Fig. 7)

Our assessment of what could be reclaimed was rather vague at this stage as we were unsure what was needed in the construction of the prototype and what materials it was actually possible to salvage without damage due to our lack of experience. It would be helpful next time to establish what can be reclaimed earlier as a lot of time was wasted carefully taking apart materials that could not be reused anyway due to their bad condition.

Fig. 4: Frontal picture of Departamento de Salud (picture by Marcelo Frías)

Fig. 5: Leaning roof structure of the roof on the west side of the deconstructed building (picture by Holly Au)

Fig. 6: Cracks through plaster on the adobe walls (picture by Holly Au)

Fig. 7: Reclaimable planks covering the outside corridor of the house to be deconstructed (picture by Holly Au)

2.2. Dismantlement

The dismantlement process itself may also cause further damage to the materials. It involves the careful examination of connections to disassemble materials with minimal damage, however some materials cannot be dismantled without rendering them useless.

In other cases, disassembling components may cause irreparable damage to another and a choice needs to be made on which is more important. For instance, the light timber walls, whose cladding would split as we tried to lever out the nails that connect it to the frame, regardless of how careful we were (Fig. 9).

Alternatively, we could have cut just below and above the nails and salvaging smaller but undamaged pieces. However, this could not be done without also cutting the timber frame behind which as a large undamaged component, was more important to us. Once we realized that the timber cladding could not be saved we could deconstruct much faster as were able to cut and hack away at the cladding instead of treating it carefully.

We also faced problems in the recovery of the adobe bricks, having to chip away at the mortar and lever the bricks out, just one brick at a time. However this operation was halted as the municipality asked us to stop dismantlement due to ownership issues between the owner and the municipality regarding the site. The adobe bricks were instead obtained from another house that was being demolished conventionally (with a crane), by collecting the most intact bricks off the ground (Fig. 11). In hindsight, we could have been rougher with the dismantlement of materials and were too hesitant to 'waste' the material by causing further damage.

Fig. 8: Departamento de Salud with the roof already deconstructed (picture by Javier Hernani)

Fig. 9: Timber frames(picture by Holly Au)

Fig. 10: Timber cladding of the walls (picture by Holly Au)

Fig. 11: Reclaimed adobe bricks storaged waiting to be prepared (picture by Federico Rota)

2.3. Sorting

Nevertheless not all the materials dismantled will be reused as they are simply not needed in the new construction. Of the dismantled materials, clearly broken or too small pieces were thrown into waste piles the other materials were sorted and stored in separate piles inside the other half of the house, under the patio, the side fenced walkway and in the backyard (Fig. 12 to 14)

From these piles, only the pieces in the best condition were chosen for use in the prototype. However it is necessary to establish a line of acceptability in the faults of the materials. The materials reclaimed were in varying conditions, for instance there were some whole tiles and some broken, some whole but old wooden planks and some with signs of rot and insect damage. While for the prototype we picked up only the best pieces, there is still much left that can be easily reused, especially given that some materials are quite more abundant than others.

3. Construction

With the reclaimed materials in hand we could test their reuse for the case of housing reconstruction. Our test depicts just a quarter of the proposed house, a module that will be repeated so that the whole can be built. The other aim was to show the community the benifits of using reclaimed materials in order to promote their use. We originally planned to build within the heritage zone with our test on heritage using reclaimed materials in order to complete the continuous façade that is so typical in Chanco. However, upon arrival in Chile we understood we would fail to obtain a permit to build in the heritage zone due to our underdeveloped plans, along with a lack of stablished rules, which led to no approval of any project presented during Frebruary 2010-April 2011). The detailed plans would only be able to be develop once we began deconstruction of the old house to know exactly what materials were available and CMN prescriptive views of heritage of which are currently being rewritten.

The Chanco municipality allowed us to build the prototype in a plot already conatining the gym, the football field, some office buildings and parking lot. Hence we were given a chance to test our ideas and expose the project in a well-frequented public site, but lacked the chance to test our prototype in a contextual heritage zone.

Fig. 12: Reclaimed roof tiles storaged in the other half of the Departamento de Salud (picture by Holly Au)

Fig. 13: Reclaimed timer planks storaged on the side fenced walkway (picture by Holly Au)

Fig. 14: Reclaimed timer frames (picture by Federico Rota)

3.1. Transportation

Standard reclamation materials are transported from the deconstruction site, to another site for storage and possible processing until a buyer is found and then finally to the site of its reuse[4]. In our approach, the market for reclaimed materials is already provided. Therefore the reclaimed materials can be moved from the deconstruction directly to the construction site without a need to store them on a third site. The new construction site was only 700m away from the site of deconstruction, which meant there was no need to organized special transportation. Our pick-up truck was adequate to bring each time a small amount of materials. It gave us flexibility in transportation, so that we could go back to the old site (as we said, just 700m far away) and bring only what we needed at a time. This was fortunate as we needed to go back a number of times to get more materials when we found out that some of the reclaimed materials were unsuitable for our designed test, such as the reclaimed timber ceiling joist being too bent to be reused as a pillar (Fig. 15 to 18)

3.2. Processing

Indeed most materials need to be processed in some way to make them suitable for reuse (Fig. 19 and 20). Using reclaimed materials post-disaster we need to show their intrinsic value by presenting them in their best conditions, so that we clarify that we are not simply reusing 'waste' in order not to buy new materials. We had many good quality materials, but not through its entirety, as a result we cut off the unacceptable parts. For instance we trimmed the 2m high wooden frames from the extension to 1.6m, as wood was rotten along the bottom of the frame because of being for long time in contact with the soil. The circular wooden joists of 5.5m also had many notches cut out for the connections in the deconstructed house rendering the ends unusable. Processing also took place in a more superficial manner, in order to reveal the beauty we saw these materials and present them as the planned aesthetic of the house rather than a mismatch of bits and pieces. This involved the cleaning of cobwebs and lichen off the ceramic tiles and the stripping of paint off timber.

[4] Addis, Bill, Building using reclaimed components and materials: A Design handbook for reuse and recycling (earthscan publications, 2006)

Fig. 15: Transportation of timber (picture by Holly Au)

Fig. 16: Transportation of adobe bricks (picture by Holly Au)

Fig. 17: Transportation of people (picture by Holly Au)

Fig. 18: Transportation of tiles (picture by Holly Au,)

Fig. 19: De-nailing the timber (picture by Reclaiming Heritage Team)

Materials flow in Reclamaiton: Logistics and Systematics

3.3. Reuse

The design had to be adapted to best incorporate the reclaimed materials. One way was by allowing for the use of smaller reclaimed components. For instance the timber basket frame was made by joining together reclaimed timber frames of 1.6m to 2m in height with new timber in order to reach the 2.5m height required for the prototype (Fig. 21 to 25)

Other materials instead were repurposed because they could no longer be trusted to perform a structural function. Locals were hesitant towards the use of adobe ,as far as many of the houses damaged by the earthquake were poorly maintained adobe homes, thus adobe was used in the prototype as an infill enclosed by a timber basket frame in order to provide mass and materiality instead.

Fig. 20: Sanding back the timber beams (picture by Federico Rota)

Fig. 21: Trimmed Timber Frame (picture by Holly Au)

Fig. 22: Reclaimed Timber pieces (picture by Federico Rota)

Fig. 23: Joined Timber pieces (picture by Federico Rota)

Fig. 24: First frame of the timber structure ready to be joined to the foundations (picture by Federico Rota)

Fig. 25: Complete timber frame for our main wall (picture by Federico Rota)

The roof planks could not be used structurally neither, suffering from some minor warpage and signs of insect damage. However they were also reused as a non-structural capacity in a timber screen that incorporated their varying lengths of the trimmed planks. (Fig. 26 to 29)

The planks could also be reused temporarily as formwork for the concrete slab and foundations as well as forming the surface stamp for the finish of the concrete floor (Fig. 30 and 31)

Our treatment of ceramic tiles best illustrates different uses depending on the condition of the material. The sheer quantity of tiles both whole and broken prompted experimentation. Unbroken ceramic tiles we cleaned and kept for their original purpose as roof tiles. The broken tiles however, were used to create different floor surfaces being both cut lengthwise into strips and set into the concrete slab and used by itself as a paving material (Fig. 32 to 36)

Fig. 26: Planks from the Departamento de Salud not usable for structural purposes (picture by Federico Rota)

Fig. 27: Reclaimed value of the planks through new uses (picture by Holly Au)

Fig. 28: New timber to sustain the reclaimed planks (picture by Holly Au)

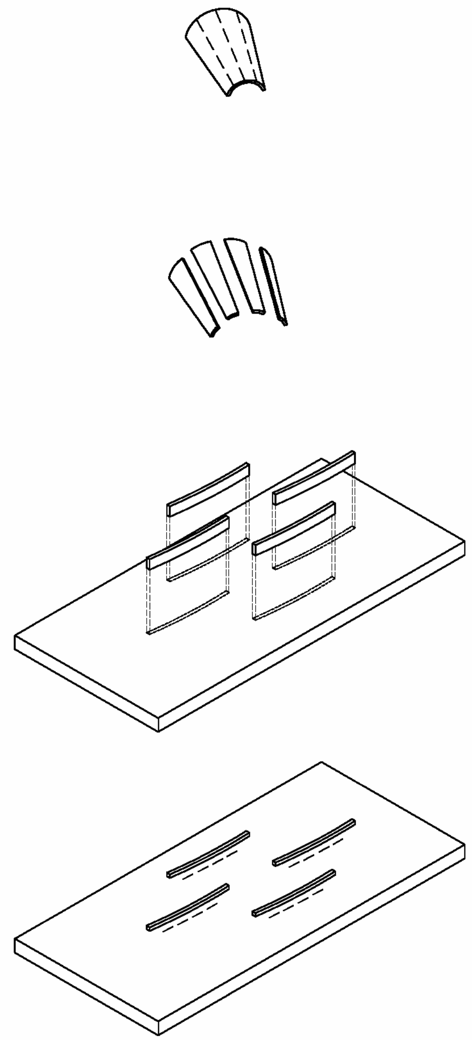
Fig. 29: Architectural screen for the corridor (picture by Carmen Gómez)

Fig. 30: Planks reused as foundation frames (picture by Federico Rota)

Fig. 31: Planks being stamped on the fresh concrete and the result (picture by Federico Rota)

Fig. 32: Tiles in its original condition and place (picture by Marcelo Frías)

Fig. 33: Unbroken tiles, cleaned and reused for the same purpose: roofing (picture by Óscar Natividad)



Though we managed to build a significant proportion of the prototype with reclaimed materials this needed to be supplemented with new materials, notably for the reinforced concrete foundations and for the new connections. We also may need to rethink our non-acceptance of certain materials such as the reclaimed timber boards. Though slightly warped and with some insect damage , they felt more solid and trustworthy than the new but cheap low quality timber boards that we ended up using.

The design was also developed to show off the materials we were able to reclaim wherever possible. While some materials were re-used for their original purpose, many materials were in a bad condition because of the earthquake and were adapted for our needs or experimented with to find a new use and prevent it from becoming waste. The diagram on the following page shows the materials from the old house, their found condition and how they were reused in the new prototype (Fig 37 and 38).

Fig. 34: Broken tiles as exterior pavement (picture by Holly Au)

Fig. 35: Roof tiles cut lengthwise to create a flooring pattern (diagram by Eduardo Barros)

Fig. 36: Roof tiles cut lengthwise, embeebed in fresh concrete and the final appeareance of both pavements with damaged tiles (pictures by Reclaiming Heritage Team)

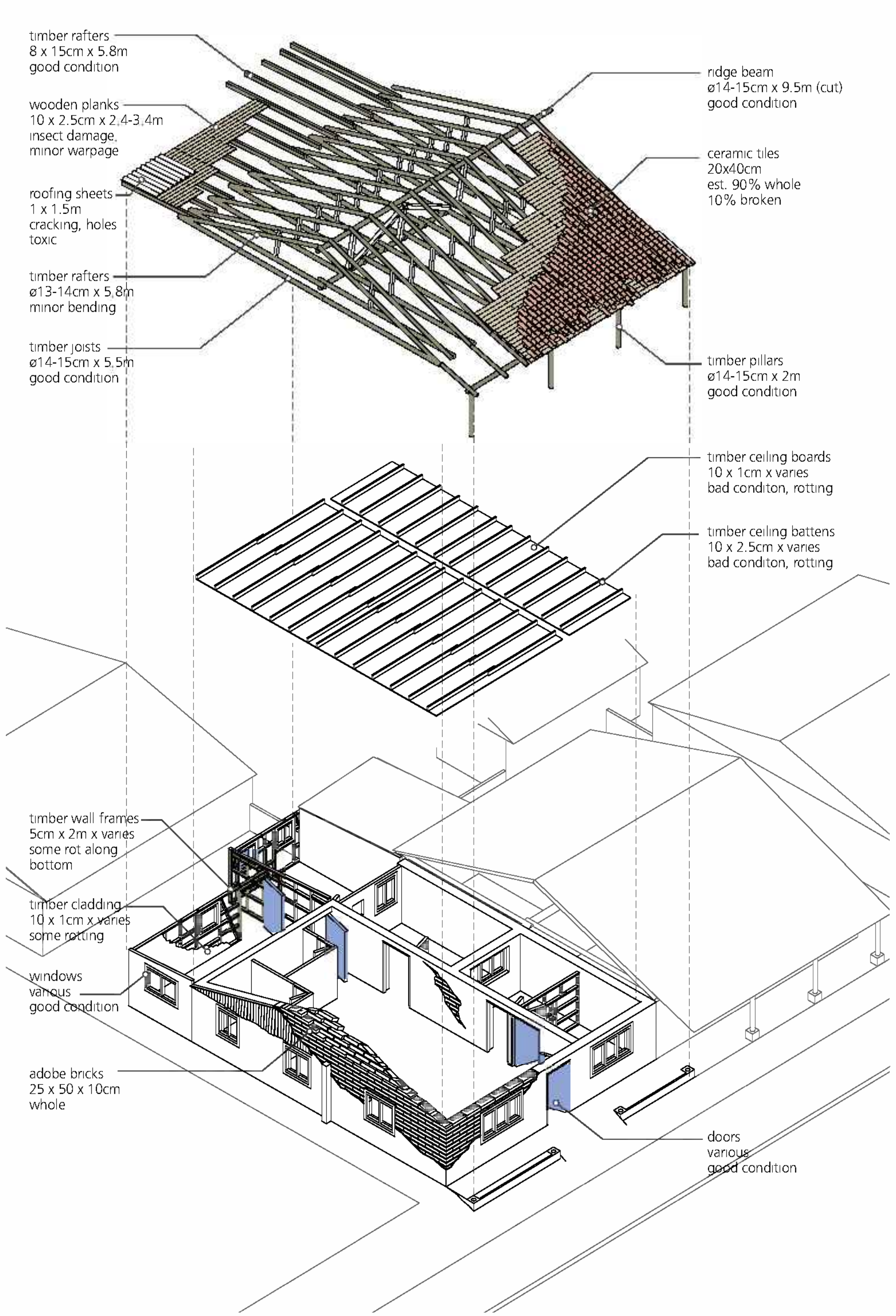


Fig. 37: Axonometric of the dismantled building. Coloured are the elements re-used (Drawing by Holly Au)

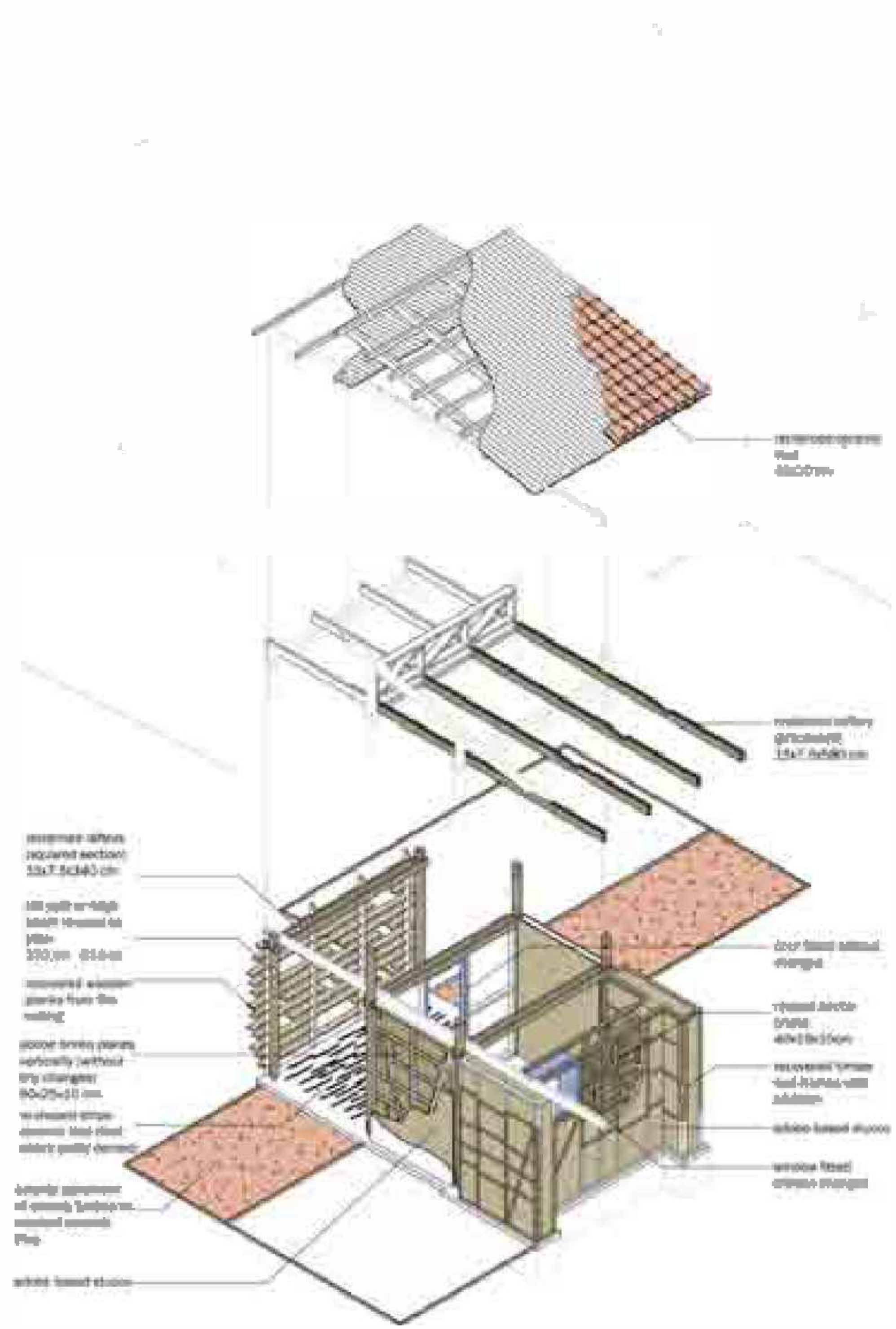


Fig. 38: Axonometric of the prototype built. Coloured are the elements reused (Drawing by Eduardo. Barros)

Fig. 39: Deconstruction sequence (pictures by Federico Rota,)

Fig. 40: Construction sequence (pictures by Holly Au,)

Materials flow in Reclamaiton: Logistics and Systematics

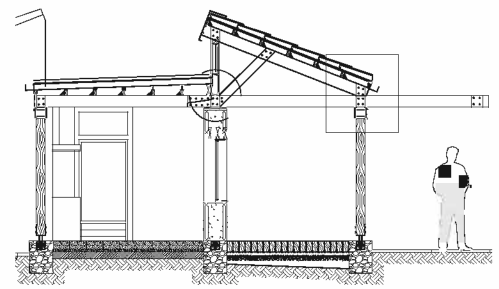
4. Integration of Construction and Deconstruction

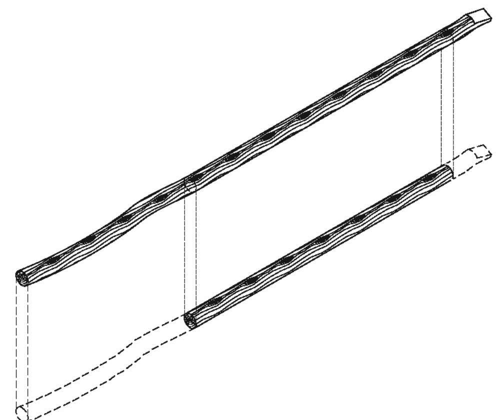
We started the project with the belief that using the same team to do both the deconstruction and construction not only makes reclamation possible by providing the market for the materials but also offers advantages in time and cost by allowing for better coordination between the old house and the new. The following discusses the integration we managed to achieve, counting on a short period of time, but being able to see the potential of integrating it for future use and explain what should be changed of the process.

4.1. Logistics

Originally we were envisioning deconstruction and construction to a great extent as a simultaneous process, a large overlap where we would be working on both sites at the same time. However, we only managed to get access to the construction site seven working days after deconstruction began, when we had already dismantled the majority of the roof and timber frames. We were then told the following day to stop the deconstruction due to an ownership dispute between the landowner and the municipality. This meant that apart from cleaning, sorting and finishing the dismantlement of components we had already started, there was no chance to test the two processes simultaneously. Nevertheless, this turned out not to be a big deal, because we could still do the sorting and processing of reclaimed materials during construction where we may otherwise have had to wait, for example while setting off the concrete foundations.

We also needed time to redevelop the initial design (Fig. 41). While a standard construction process involves first designing, then choosing materials and detailing to achieve the desired result, in reclamation a more basic design can only be developed in detail once materials have been reclaimed. Even once we had secured a house for deconstruction, the preliminary assessment of reclaimable materials was misleading, as it was difficult to judge the conditions of the materials before dismantlement. For example the 5.2m ceiling joists could theoretically make two pillars of 2.5m each, but in reality the notches cut out for connections in its previous use meant that each joist was good for only one pillar (Fig. 42). This means that we would not have been able to do the two processes simultaneously anyway, as only once deconstruction is nearing completion can we get a vast idea of which materials can actually be reused, and in what dimensions, in order to develop the design that will actually be constructed (Fig. 43).





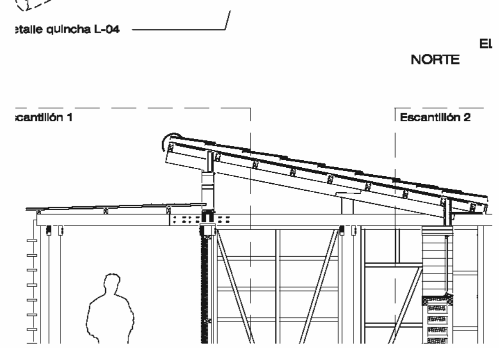


Fig. 41: Section of the prototype before obtaining the reclaimed materials (Drawing by Ioannis Charalampidis. Berlin, 2011)

Fig. 42: Usable part joist (Drawing by Eduardo Barros. Berlin, 2011)

Fig. 43: Section of the prototype. Documentation to get the building permit (Drawing by Óscar Natividad. Santiago, 2011)

4.2. Resources

Our team in Chanco (Fig. 45 to 47) consisted of 9 students who had little construction experience and 2 architects. We worked together in the preceding five months on designs that used reclaimed materials as a way of reclaiming heritage. This gave us basic theoretical knowledge of reclamation in varying degrees, with certain members having done more research into particular materials for use in their design, and thus broke up into corresponding teams for the construction.

Fig. 45: From left to right: Javier Hernani, Federico Rota, Renato D'Alençon, Simona Benedetti, Óscar Natividad, Holly Au, Carolin Rachel (picture by Holly Au)

Fig. 46: Reclaiming Heritage Team working on the roof (pictures by Marcelo Frías)

Fig. 47: From left to right: Eduardo Barros, Javier Hernani, Marcelo Frías, Holly Au, Óscar Natividad, Carmen Gómez-Maestro, Simona Benedetti, Renato D'Alençon (pictures by Federico Rota)

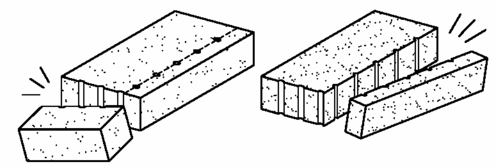
[5] Chini, Abdol and Bruening, Stuart, Deconstruction and material reuse in the United States, The future of sustainable construction (2003)

Fig. 48: Students getting skilled through deconstruction, working with basic tools (picture by Holly Au,)

However, we found that our theoretical knowledge was of little use sometimes, as for instance when preparing the adobe mortar. Following strictly instructions we had from manuals, the resulting mortar was unusable, likely because of variances in the local soil to that found in the manual. Luckily, the local construction laborers working nearby had experience in constructing with adobe and showed us the local way of making the mortar. Without their help we would have wasted a long time trying to figure out methods that have already been tried and tested for years by locals. Therefore it is essential to get someone experienced with the local materials involved.
That said we had some practical knowledge of the materials simply through doing the deconstruction. This let us understand the traditional way of how these materials work together in real life. Deconstruction can be used to create employment and training opportunities for low-skilled workers (Fig. 48), generating ten times more jobs than by just putting the new materials in landfill [5]. This is valuable, especially in a post-disaster situation where there is a high need for employment with the destruction of many businesses.

It is also worth mentioning that only standard and easily obtainable construction tools were used. We brought with us some tools from Santiago, but further tools and construction materials were purchased locally in Chanco and in Cauquenes, a larger town an hour and a half away. However, at deconstruction site we did not even have free access to electricity as it had been disconnected from the damaged house. Fortunately the ever-accommodating

neighbours allowed us to borrow power when we needed to use the power tools, but meant that we used them more sparingly. Our limited tools and lack of experience lead to some inappropriate uses, such as cutting adobe with saws, blunting them in just two days. Otherwise, different methods were tested, such as cutting the adobe bricks with a radial saw or drilling a some holes on it to create a break line using the concrete drill to split it. Having to do everything on-site meant that we did not have access to machines that may had beenn more suitable for the job. At a larger scale it may be more efficient to do certain steps such as the processing in a workshop environment (Fig.49 to 53)



4.3. Processes

One of the biggest opportunities to integrate deconstruction and construction, that would have saved a lot of time, was in the processing of the materials by designing the new prototype with dimensions compatible to the reclaimed materials. For example the adobe bricks reclaimed from other houses had a width of 30cm while the frame of the new prototype required 25cm bricks meaning every brick had to be trimmed by 5cm. These incompatible dimensions also create wastage by producing off-cuts, though we managed to rectify this by soaking and crushing these off-cuts to make adobe mortar and stucco (Fig. 54 to 56)

Fig. 49: Working the joists with a chisel (picture by Federico Rota)

Fig. 50: Cutting adobe bricks with a radial saw with a diamond disc (picture by Federico Rota)

Fig. 51: Concrete mixer elevated on a table to be able to pour the concrete inside (picture by Federico Rota)

Fig. 52: Collecting the concrete in a wheel barril to bring it closer to the pouring site (picture by Federico Rota)

Fig. 53: Adobe splitting technique (diagram by Eduardo Barros,

Fig. 54: Reclaimed adobe bricks being coverd with reused and renewed morter (picture by FedericoRota)

Fig. 54: Adobe bricks resized and prepared to be place in the construction (picture by Federico Rota)

Fig. 55: Adobe bricks covered by the morter when completing the wall, except where the glass is, in order to leave a window to the constructive detail and appreciate the building process (picture by Óscar Natividad)

Fig. 56: Foundations constructive process (picture by Federico Rota)

Fig. 57: Detail of the base conection of the pillar with the foundations (picture by Federico Rota,)

We also found that connections that have a bigger allowance for imprecision are needed, particularly in post-disaster reclamation due to the imperfect materials. For example the circular wooden pillars was to be bolted though a custom metal profile to secure it to the foundations. After drilling, the holes did not exactly line up and we had to enlarge the holes of the profile by essentially wearing away at the sides of the existing hole with a drill. In some cases it was easier to make the cuts in-situ for example for the diagonal cut at the top of pillar, which needed to both hold the diagonal rafters and sit flush with the top of them. Too much allowance however, results in gaps, such as with the back timber screen that had larger than necessary notches to accommodate the minor warpage of the timber boards slotting in. There were also other opportunities for reclamation that we did not take, such as the re-use of foundations. The construction of new foundations including excavation, formwork, reinforcement and pouring was the most time consuming task of construction taking seven working days with minimum four people working continuously on it for each day. It would interesting in the future to test the use of existing foundation in-situ as in a real housing project we envision the deconstructed house and constructed house on the same lot or at least the same bundle of lots. This would also save in transportation, as the deconstruction and construction site will be the same.

4.4. Further conclusions

Though we managed to achieve some integration between deconstruction and construction there were many opportunities missed, most notably the use of compatible dimensions that meant a much longer processing time. The reclaimed materials leftover also pose a problem as they were not used proportionately, meaning subsequent construction would have less reclaimed materials as these materials begin to be used up.

One point this project does however illustrate is that one way of making reclamation happen is to do both the deconstruction and construction, regardless of whether or not it is economically viable. Though we did not finish the prototype within the planned 4 weeks, the extra time cost of reclamation is possibly made up by the money not spent, if the damaged house can be obtained at no cost, or if in fact the new house is built out of the owner's own destroyed house. Regardless of our shortcomings, the prototype that has been built can now showcase the use of post-earthquake reclaimed materials to the local population and officials and hopefully help us transform the project from a one-off prototype to a real housing project.

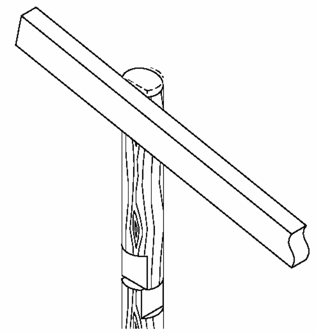


Fig. 58: Different connections to the pillar (diagram by Eduardo Barros)

Fig. 59: Solution of the different wood nodes (picture by Federico Rota)

Fig. 60: View of the prototype in April 2011 (picture by Óscar Natividad)

Fig. 61: Elevation of the prototype waiting for the last finishings (picture by Óscar Natividad)

Fig. 62: Continuity of pavements made out of "unusable" tiles. (picture by Federico Rota)

THE CONSTRUCTION PROCESS:

Technical aspects and solutions

More than just recovering materials, heritage and traditional architecture patterns, it is also important for us to integrate the typical construction techniques with earthquake resistant structure, innovating but at the same time respecting and learning the local knowledge.

Fig. 1: Adobe house partially collapsed (picture by Óscar Natividad)

The main aim of this project was to address the reconstruction with a strong focus on heritage: one of the ways that have been used to do this is reusing and reclaiming materials, including adobe (together with wood, one the main applied in building construction in those typical areas). While for the wood is easier to find new uses without huge intervention in the material itself, for the adobe the research faced more difficulties, especially in figuring out how to recover and shape the bricks without breaking them.

According to the current literature, a few possibilities have already been tested to reuse that kind (or similar) of material: adobe, being mainly not fired earth, can be smashed and used to do new bricks (maybe fired, smaller and lighter), as infill in the rammed earth technique[1] or for earth bags fulfil with it can be utilized as load-bearing walls [2]

However, reclaiming heritage means consider the value that a material has also in itself and the consistence it has in the situation it's found. During a first survey in the field in September 2010, the team realized how many bricks in good conditions were available from the fallen houses (Fig. 2). Chanco, as well as the whole Maule coast region, was a cemetery of half destroyed buildings, but with a big potentiality: adobe bricks available. How could these bricks be reused as they were found?

The aim of this chapter is to analyze how adobe has been reused, and which innovations have been applied to solve problems related to the materials, its safety and concerning its usage in earthquake prone area.

Fig. 2: Adobe dismantled bricks (picture by Federico Rota)

1. State of the Art

This first section contains a description of the material proprieties (qualities and limits), followed by some founding regarding adobe buildings made by the research team in a previous experience in the north of Chile.

1.1. Adobe: the material and its proprieties

Prof. Euclides Guzmán, teacher from the University of Chile, is one of the most known experts about traditional techniques and materials used for building construction in Chile; his manual "Curso Elemental de Edificacion" (1979), that has a depth chapter about adobe (Cap. IV, pg. 209-211), is still considered by most of chilean architects a valid tool; it has been fundamental for the research done and the technical data about the material used in which the following paragraphs are based on.

[1] Minke, Gernot: Building with Earth: design and technology of a sustainable architecture (Birkhäuser. Basel, 2009)

[2] California Institute of Earth Art and Architecture, Hesperia; Building Research Laboratory, University of Kassel, Germany; Standardized Lab Tests and Earth building Norms, Germany)

Fig. 3 Adobe wall in Chanco (picture by Luis Beltrán del Río)

Adobe (Fig. 3) is made by clay, sand and in some cases straw (but others components can be used, depending to the availability in the territory). The dimensions are considerable, even if variable case by case, from the standard one in Chile (60 x 30 x 10 cm, with common variations of 50 x 30 x 10), to those being researched in Chanco (70 x 30 x 10 cm). The density (relation between weight and volume) of adobe is approximately 1.6 - 1.7, with a consequent weight of 1600-1700 kg every cubic meter; this means that every brick oscillates in between 24 and 30,6 kg (for the standard Chilean cases) and in between 33,6 and 35,7 kg (for Chanco experience). The density is less than the one from the concrete, which is 2,2 - 2,45 kg/dm3 and similar to the standard construction fired brick (made of clay, silica, calcium carbonate, water and iron oxide) which oscilates in between 1.4 - 2.2 kg/dm3; the main difference is that these ceramic bricks are bought usually in measures of 5,5 x 12 x 25 (the full ones) with a consequent weight of 2,3 – 3,6 kg (completely different way of construction) and, as it's treated further on, they have very different structural proprieties.

The result is a very massive wall, able to load the weight coming from the roof, built with big and full section wooden beams (cylindrical or squared, of about 12-15 cm). Those bricks are linked using a quite poor mortar, made of clay and water (even here, relative by the local methods, other materials can be used) that has not special binding proprieties and with low resistance to friction; the deconstruction work has proved the facility, even if it's a slow process, to remove brick by brick from an existing wall, separating the mortar from the brick itself.

The built product of this technique is a heavy structure, statically simply resting to the ground and that, working like a whole block, does not allow any movements. Adobe compression strength is in between 11 – 16 kg/cm2, even if it must not be loaded more than 1 -1,6 kg/cm2 (permissible load). For masonery made with standard bricks (seen before), the values are about 35 – 50 kg/cm2, even if it has to be considered that they can be used for more than one floor and the walls are considerably thinner (depending on the kind used, a 20 cm thick wall can be structural).

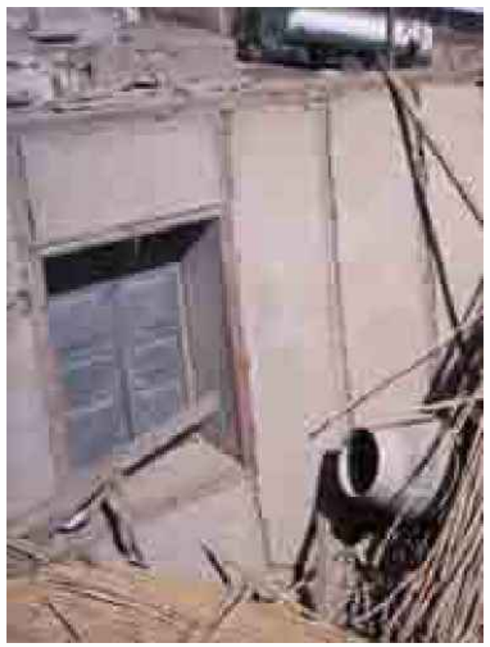
The adobe walls are discreet in compression (a wall 4 metres high plus the wooden heavy roof with ceramic tiles represents the 1 kg cm2 of compression load seen before), being massive, but very deficient in traction. In an area of high seismic risk, a safe structure has to work in both directions as well as allowing small oscillations, trying to follow the earthquake movements, instead of looking for a firm and rigid grip against seismic waves. Adobe provides a good insulation against cold, hot and noise, being better also compared on the cooked bricks, due to its great thermal capacity; it's main problem, over the traction, is that it's extremely sensible to humidity and water which alters its main agglomerate proprieties, the clay. This has to be considered in the design phase, in order to recognize and apply the right countermeasures.

Summarizing, the main aspects to be faced are two: a problem inherent in the material itself (its proprieties), and one regarding the way the bricks used to be linked among them. The research work then focused towards solving those conditions, trying to provide traction proprieties and a better binder in between bricks (increasing the friction and the quality).

1.2. Tarapaca Experience

Having set the target to use the dismantled bricks as they are, the only way to give traction properties to the walls was to work the structure as a whole, and not as single elements. During a preliminary survey in a research project after another terrible earthquake in the north of Chile, more precisely in the village of Tarapaca, the same Coordination Team that worked for this project [3], found out that on of the few adobe walls still standing in the area, without relevant damages, had externally a wooden frame structure (Fig. 4 to 6) .

This structural team (adobe plus wood) allowed the building to work well both in compression and in traction, giving to the whole the needs to resist properly a destructive and unpredictable waves movement power of an earthquake. The efforts of the project then were focused on figuring out how to propose and adapt that kind of frame in Chanco, considering the materials available on the ground and in the market.



[3] www.projectotarapaca.org 8th July 2011

Fig. 4: Standing wall from the "Casona" in Tarapaca after the earthquake on June 2005 (picture by proyectotarapaca)

Fig. 5: Adobe bricks inside the wooden frame (picture by proyectotarapaca)

Fig. 6: Vertical wooden posts with a short pitch (picture by proyectotarapaca)

1.3. Statement

Tests about how to dismantle brick by brick an adobe wall in order to build a new construction have never been done before. Consequentially, the will to reclaim values through reusing dismantled bricks and the interest to test something new, lead the focus of the research in this direction; however, as seen so far, adobe has several limitations that have to be considered.

Is reclaiming adobe bricks one by one technically feasible? How should the bricks be treated in order to be reused? How could the traction properties to face an earthquake be provided without being able to manipulate directly each of the component materials themselves? How can the mortar be improved in order to get higher binding strength?

Those are the main targets that the research project has faced both in the planning and construction phases once we were on the field; the following chapter shows and analyses, tests and results done for answering each of the questions above.

2. Innovations and improvements in reclaiming adobe

In this section, several relevant elements for the reclaiming process of adobe are discussed, in order to clarify the innovations applied in the new construction. Starting from the wooden frame designed following the analysis and results of the Frías Reyes, Marcelo and Natividad Puig, Óscar, from the Research Seminar, passing through a wider understanding on how to adapt and treat the old dismantled bricks and on how to increase the friction proprieties of the mortar, coming to a timing comparison with other construction materials.

2.1. Wooden frame: an alternative at the low traction strength

In this specific case, we found out that the light interior walls in the Departamento de Salud had a wooden internal frame (Fig. 7) reusable for our purposess (regarding the thickness of the profiles). These were in good conditions and quality (even if a few new wooden pieces have been used in some joins, so that we could reach the required high in our prototype).

Fig. 7: Wooden frame of the old light inner walls from the dismantled building (picture by Holly Au)

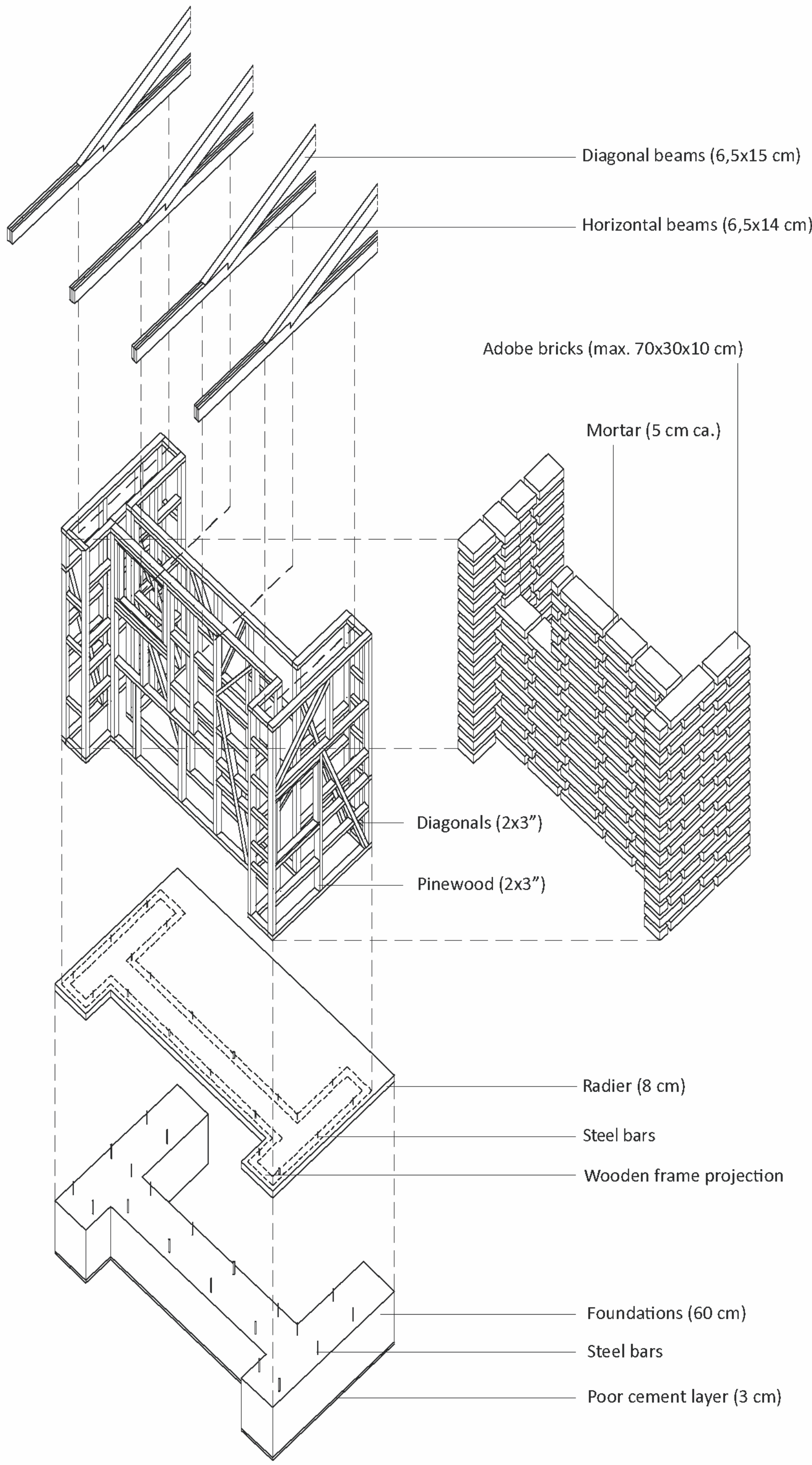


Fig. 8: Axonometric showing how the adobe wall works. The wooden frame is an autonomous structure, linked directly to the foundations; the adobe bricks are secondary put inside it and aslo the horizontal beams of the roof are connected to the basket (drawing by the author)

The frame designed for the project runs along the walls on each side, creating a basket in which the bricks are put in later on (Fig. 8); the peculiarity is that to build such a frame also little pieces of wood can be used, joined together through screws, little metal profiles or simply nailed. Usually after an earthquake (it also happens with every big natural disaster), it's not common to find remains with considerable dimension and good conditions along every single part of them. This kind of frame gives the correct answers to those problems, not only because small pieces can be used, but also the bigger ones can be cut and reassembled if they present rotten or broken parts that we want to get rid of.

Before going to the field, a standard wooden basket has been designed. When the construction team has realized that they were able to take the frame of the old light walls without disassembling every part and starting from zero, the basket has been redesigned (this shows the importance of having a flexible project in such circumstances).

The basket is made by dry pinewood, with a dimension of 2x3" (variable due to the availability); the space in between pieces is never longer than 60/70 cm (even if mainly less) and diagonals to stiffen the structure have been used whereas needed.

The first step of the construction consisted in moving the frames to the new site (Fig. 9); later on they were dismantled as less as possible and reassembled using new nails and wooden connection.The new structure is composed by four parts in U-form (Fig. 10), one for every long side (these will be the first ones to be placed and fixed on the foundations through rebars already embeebed in the concrete) and one for every lateral (put subsequently); once finished, they proceeded mounting it in place (Fig. 11).

Fig. 9: Wood frames stored in the new site (picture by Federico Rota)

Fig. 10: Reassembling the old frames to make the new structural basket (picture by Federico Rota)

Fig. 11: First U-form place waiting to be joined to the rebars in the foundations (picture by Federico Rota).

One of the main innovation of this frame is that is linked directly to the foundations, through steel bars coming from the reinforcement that has been embeebed into the concrete (Fig. 13). Those bars are 20, and the base of the wooden frame is drilled (only during the placing phase, in order to avoid errors) in the points in which the bars come up; this guarantees a firm anchor for the whole structure. It's not just linked to the foundations, but also to the horizontal beams, through long 6" nails (Fig. 12). It gives both to the wooden frame and to the roof structure better stability, because the whole is bounded. Otherwise they can still allow some movements in case of earthquake (not responding the waves with an immovable and completely rigid construction, but trying to contribute flexibility to absorb that shaking).

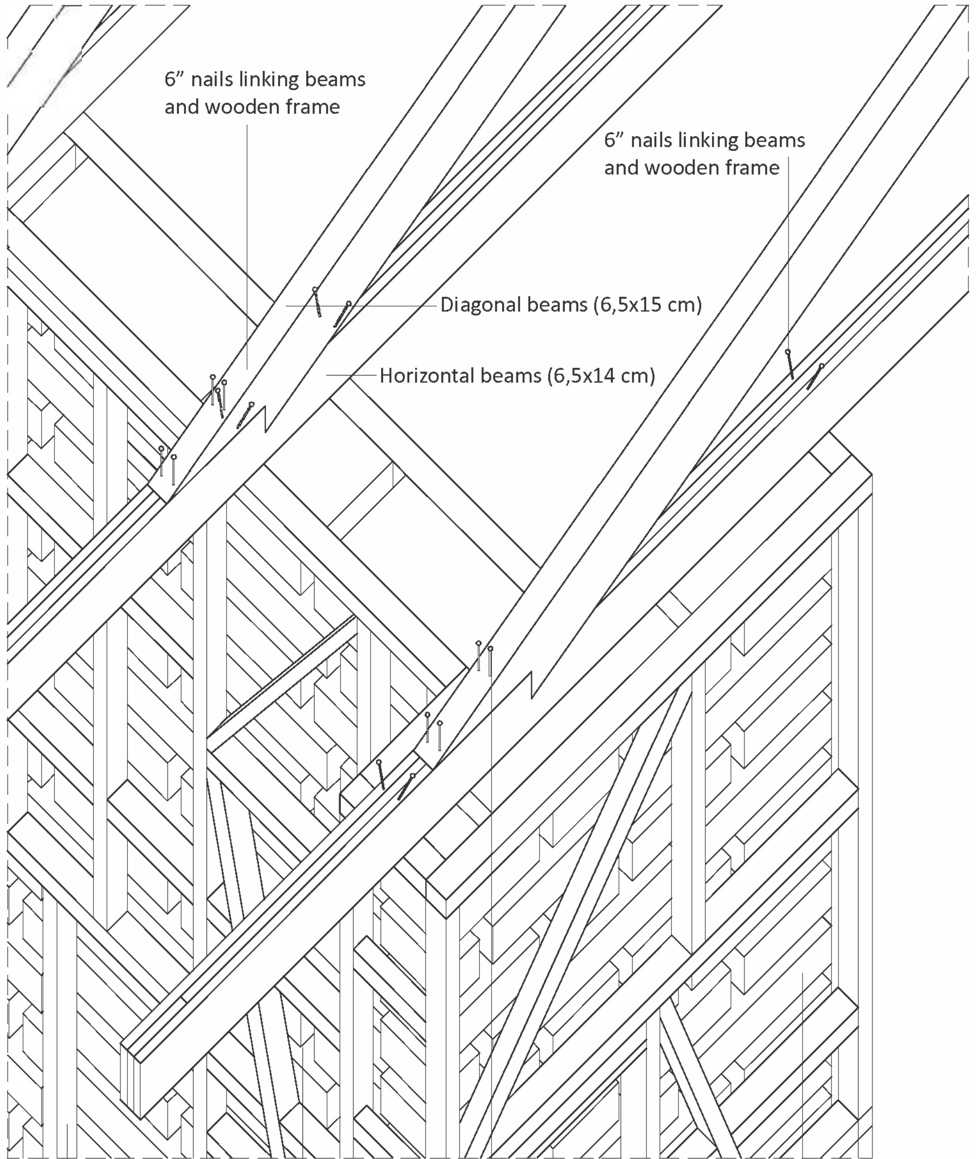


Fig. 12: Axonometric showing the connections (nails) in between the wooden frame of the adobe wall and the horizontal beams of the roof (Drawing by the author)

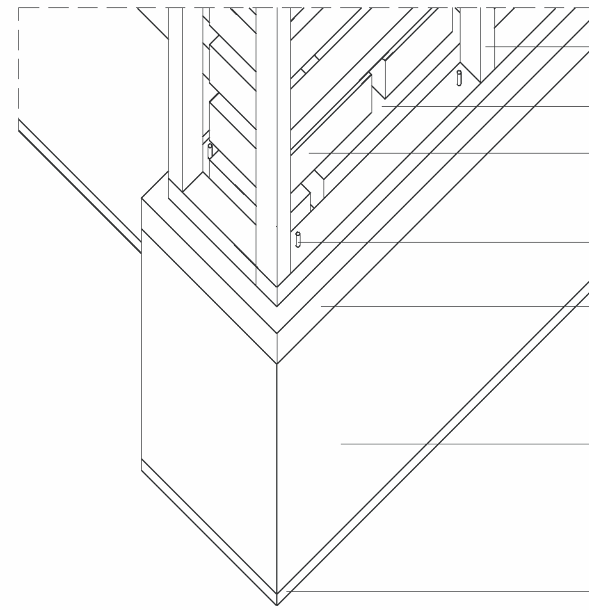


Fig. 13: Axonometric showing the steel bars linking the fram directly to the foundations (drawing by the author)

2.2. Adobe bricks: the reuse and treatment of the old dismantled ones

Originally, the frame was designed based on the thickness of the bricks that were supposed to be disassembled from the wall of the Departemento de Salud. They had to be sometimes cut in the length, but the test was thought to act on the bricks themselves as little as possible. Suddenly, while the team was dismantling, a legal problem didn't let them finish the work and acquire the quantity of adobe needed; after some failed tempts in other sites, they finally found the suitable masonry to take off the materials left (the other buildings had also the roof to be disassembled, and the time wasn't enough). Obviously, being hand-made, those bricks were different in measures compared with the ones the frame was planned for: the consequence is that every brick had to be cut both in the thickness and the length.

As for the other activities, several methods were tested: to start with, they mark directly on the bricks the correct dimension (Fig. 14); the fastest tool they had to cut them was the blade (Fig. 16), which unfortunately is not deep enough to reach the whole thickness, so it needed to be finished by hand-sawing (Fig. 15).

Fig. 14: Reclaimed adobe brick marked where to be cut (picture by the author)

Fig. 15: Second phase. Hand-sawing the brick (picutre by the author)

When they had already cut several adobe bricks (Fig. 17), they began placing them in the frame; the worktable where the bricks are cut is placed near by the construction (5 metres), because they are heavy and they tend to break while the team moves them.

At the beginning two persons are in charge of cutting the bricks, while other two are preparing the mortar and placing them in the corresponding place; when they have enough bricks to fullfil a whole row, all the adobe team together focus on placing them before the mortar becomes dry again (Fig. 18 to 22).

Fig. 16: First phase, cutting the adobes with the radial saw with diamond disc (picture by the author)

Fig. 17: Adobe bricks resized and ready to be reused (picture by the author)

Fig. 18: Putting the mortar in between rows (picture by the author)

Fig. 19: Moving the heavy adobe bricks to the place (picture by the author)

Fig. 20: Second row of adobe bricks already placed (picture by the author)

The Construction Process: Technical Aspects and Solutions

The mortar layer needed is about 5 cm in every line (Fig. 25), and it's also placed as a base layer, between the concrete foundations and the bricks (Fig. 26). Water is poured before the mortar, because the bricks are very dry and they tend to absorb all the water contained in the mortar, modifying the physical properties.

When some lines are completed, the following step is to cover the surface with the same mortar used in between the bricks, to give a first layer of protection at the bricks themselves and to make the whole structure more solid (Fig. 27). The second step is to put plaster on it; this is basically needed because adobe is, as said before, drastically sensible at the water and the humidity (Fig. 28); this second layer, together with the projection of the roof above, help to reduce the risk of degradation of the material, that can lead to structural failures; third and last barrier is obtained by a layer of waterproof painting.

Fig. 23: Covering the lateral sides with mortar to give continuity to the wall (picture by the author)

Fig. 24: Interlocking the bricks in order to give more stability to the corners (picture by the author)

Fig. 25: Detail of three rows and the mortar in between them (picture by author)

Fig. 26: Base adobe row with its necessary mortar (picture by the author)

Fig. 27: Adobe wall reaching the top, with the base already compacted with mortar (picture by Javiera Infante)

Fig. 28: Second step: covering every spot with adobe mortar (picture by Javiera Infante)

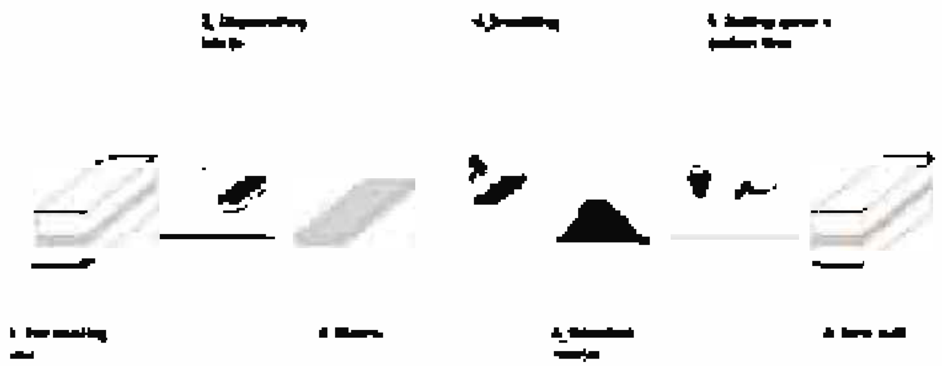
2.3. Mortar: tests and traction innovations

The first phase consisted in a research about the methods used for the mortar in traditional and earthen building construction, both studying publications and books and asking to the maestros in construction places, especially one close to the selected area. Having suggestions and advices from workers that do everyday those kinds of processing and are specialized had been fundamental in order to learn the basis of the knowledge and, applying changing and modifications that are proper of our research targets, to correct the mistakes and improving the mechanical proprieties.

On a second phase, several tests had been done directly in situ, in order to verify the validity of the options, planned in the first step, and choose the best one to apply in the construction; the first test (Fig. 29) has been done using the old smashed mortar (obtained dividing the bricks of the pre-existing walls), adding water and, in the second test, pieces of broken tiles, in two different ways:

- Some broken pieces (from 1 to 3 cm approximately) are added in the mortar to increase the friction.

- Other are smashed like sand and put directly



into the mixture because, having the tiles waterproofed qualities, it can help the mortar against the rainwater.

The attempt fails, as using this method the bricks are unconnected, so the decision is to abandon the idea of reclaim also the mortar.
This led to the second test (Fig. 30), done following precisely the literature studied before, making it with clay, water and sand (all new materials). The maestros assisting us are for the beginning very sceptics about adding the sand; it's not the way in which people do it, at least in these areas, in fact it also fails.The third test is composed by three options (Fig. 31),

Fig. 29: First test concept (diagram by author)

Fig. 30: Second test done adding sand to the mortar mixture (picture by author)

Fig. 31: Different probes with the third test of mortar (picture by author)

obtained trying different materials on the same basic mixture; this is made by two parts of water and one of clay. Concerning the differences:
a- Addition of oil: it was indicated in a construction book, but it does not work, because the bricks tend to slide on each other.
b- Addition of pieces of broken tiles (Fig. 32): it increases the friction, but they will be used in another way.

c- Addition of straw (Fig. 33): the basic idea will be maintained, but with different proportions.

The fourth test, which has been used for the construction (Fig. 34), is made with the same basic mixture (water and clay), adding just a few straws. The broken pieces of tiles are put not directly into the mixture, but after that the first layer of mortar is posed on the bricks. In some rows also the barbed wire is tried (Fig. 35), but the main problems are:

- The necessary tools (reinforced gloves and cutter) needed have not been provided for this type of manufacture, so the material is quite difficult to use.

- The question is also the relation between the benefits and the economical aspect. Is it appropriate, required and financially sustainable? Those elements must be studied further on before apply it in the whole construction.

Fig. 32: Third test, adding broken tiles to increase friction (picture by the author)

Fig. 33: Third test, adding straw to the mixture (picture by the author)

Fig. 34: Fourth test, the final mixture used as morter to link the bricks (picture by the author)

Fig. 35: Fourth test, barbed wire add in some morter rows to increase the friction. It has not been used anymore due to the lack of proper tools (picture by the author)

2.4. Timing: how much time is needed for the construction of the adobe wall?

The experience explained so far has shown that reclaiming adobe and is physically and technically possible and feasible, also introducing innovation to make the structure working well with earthquakes (wooden frame, improved mortar, reinforcement bars, etc.); it has even been proved that the materials used for those improvements are usually easily available after a natural disaster such the one researched on.

The following step is to consider if this way of reclaiming is really suitable; so far we have analyzed this like a prototype, but the further goal of the research is understand if this system can be applied as a reconstruction pattern. If a layout works on theory or little scale, it does not mean it will do it also for lager interventions. In order to figure it out, a good tool can be the construction timing.

The following (Table 1) shows how many days, people, hours and which kinds of activities have been necessary to complete 3,56 m3 of the adobe wall.

Day	People	Tasks	Hours
1	3	Transporting, Redesigning, Selecting, Testing	6
2	3	Dismantling	6
3	3	Dismantling, Making new pieces	9
4	3	Dismantling, Assembling, Cutting, Making new pieces	4
5	3	Assembling, Cutting, Making new pieces	5
6	3	Assembling, Cutting, Making new pieces	10
7	3	Assembling, Placing (frame, 1° line)	10
8	4	Placing (frame, 2°line, laterals), Cutting, Linking, Testing mortar, Putting bricks	12
9	4	Cutting bricks, Doing mortar, Putting bricks	12
10	1	Cutting bricks, Doing mortar, Putting bricks	8
11	4	Cutting bricks, Doing mortar, Putting bricks	7
12	5	Cutting bricks, Doing mortar, Putting bricks	8
13	4	Doing mortar, Putting bricks, Doing and putting stucco	9
14	3	Doing and putting stucco, Cleaning and placing window	8

Total hours per 1 person	382
Total hours per 1 m^3	107,3

Table 1 Days, people, tasks and hours needed to build 3,56 m3 of adobe wall (complete work) (chart by the author)

Mainly two aspects have to be considered reading the graph:

- People working there were unskilled students, which needed time to learn procedures, methods, ways to use tools and techniques (for instance, the third day of the adobe bricks placement, one person in 8 hours did more lines than 3 people in the previous two days for 15 hours, and it happened the same with the foundations).

- The tools provided have not always been appropriated for the kind of work and material needed. It means that often some jobs have been done anyway, but it took more time than with the right tools.

This lead to consider an approximate amount of 50% less, calculated based on the construction time of the final days compared to the firsts, of Table 1.

Total hours per 1 person	191
Total hours per 1 m^3	53,6

2.5. Comparison between adobe bricks and ceramic fired bricks

In order to understand if this method represents a real alternative for the reconstruction, it has to be compared with a new fired bricks wall. Let's start from the bricks themselves, without considering the finishing (stucco) and the wooden frame; the reference used is Guzman, 1979 (Cap. VIII, pg. 191).
The main aspects to consider are:

- Holes in the wall (windows, doors) are not subtracted at the surface if they are less than 3 m2 (as in the case considered); if they're more than that they have to counted, but with an amount of 3m2 each.

- All the materials (bricks, mortar, cement, sand, scaffolding, ect.) must be in the floor considered, and never farther than 20 metres (as in the case considered).

- It's included the montage and movement of the scaffolding till 1,5 metres high and a distance not more than 20 metres and the preparation of the mortar.

- The work is calculated with 2 maestros (high skilled) and an adjutant (middle-low skilled)

If we calculate that for just 1 person and for the surface we are interested in, we obtain:

People	Tasks	Surface	Minutes
3 (2 high-skilled maestros and 1 adjutant)	Using hand made bricks 11 cm high; wall 24 cm deep	1 m^2	32

Total minutes per 1 person per 1 m^2	96
Total hours per 14,732 m^2	23,52

Now the timing Table 2 regarding adobe construction has to be reconsidered, excluding the time needed for the frame, the stucco, the tests and for cutting the bricks, taking in account also the 50% of loosing time given by the factors discussed before Table 3:

Table 2, 3 Days, people, tasks and hours needed to build 3,56 m3 of adobe wall (complete work) (chart by the author)

Day	People	Tasks	Hours
1	2	Doing mortar, Putting bricks	3
2	2	Doing mortar, Putting bricks	10
3	1	Doing mortar, Putting bricks	5
4	3	Doing mortar, Putting bricks	7
5	3	Doing mortar, Putting bricks	8
6	2	Doing mortar, Putting bricks	7

Total hours per 1 person per 14,732 m^2	90
Reduction of 50%	45
Total minutes per 1 person per $1m^2$	183

Table 4, 5 Days, people, tasks and hours needed to build 3,56 m3 of adobe wall (complete work) (chart by the author)

Comparing the two data, in the Adobe case the construction time just for the wall itself takes 1.9 times more than a normal hand made bricks wall. This derives basically from two aspects:

- The bricks considered in the Curso Elemental de Edificacion have standard dimensions of 24x14x11 cm, while the Adobe bricks used were considerably bigger (till 70x30x10 cm). This means that they're heavier, more difficult to move even if for a few meters, but mainly really arduous to lift (especially after 1,5 metres high). Most of the time there were needed two persons to lift and place one brick, while new bricks are lighter and easily movable for one worker alone (so everyone can work for his own).

- The mortar needed is much more in the Adobe construction (approximately 5 cm in between every brick) than in the other solution (1,5 / 2cm); this means that more mortar has to be produced and placed.

3.6. Comparison between new wooden frame and traditional tabique

Regarding the wooden frame, the reference is still Guzman, 1979, from the chapter dedicated at the tabiques (Cap. XII, pg. 27-28). The frames for the tabiques (the light partition walls with wooden structure inside) are similar to what has been done for the Adobe wall; in fact for the new structure, as seen before, old frames coming from the light walls have been used. The main aspects to consider here are:

- The structure is in wood and made in situ; it includes post, beams and connections.

People	Tasks	Surface	Minutes
1 (high-skilled maestro)	Using wooden commercial profiles of 2/4" thickness	1 m^2	27

Total hours per 30,48 m^2	13,74

- The considered type of wood is a commercial one, with a thickness in between 2 and 4".

- The worker included is one, high skilled.

Even in this case, the construction Table 1 has to be reviewed: in order to be compared with the one above, it has to consider only the time to assemble the frame and for the cuts in the wood (already disassembled, as it was from the industry) and a reduction of the 50% (Table 4). Comparing the two data, the frame done with reclaimed wood takes 1.6 times more than the frame for the tabiques; this difference is due to the fact that the wooden frame done to contain the adobe is not only structural, but the pitch in between posts and beams is minor, the quantity of wood is much more (due to a considerable presence of diagonals) and probably the inexperience counted even more than for the Adobe bricks (the nails to link the diagonals are 5 or 6", difficult to put and hammer and often the students were wrong more than once before being able to manage it, taking even 10 minutes for one nail).

Day	People	Tasks	Hours
1	3	Assembling, Cutting	2
2	3	Assembling, Cutting	2
3	3	Assembling, Cutting	6
4	3	Assembling	5

Table 6 Days, people, tasks and hours needed to build 3,56 m3 of adobe wall (complete work) (chart by the author)

Conclusions

This research project has demonstrated how is possible to reclaim adobe, dismantling brick by brick and taking them as they are, to create a new stable structure, earthquake resistant and capable to integrate innovative solutions with old traditional techniques. Problems relative to the material and the ways to build with it have been analyzed and studied; consequentially new solutions have been designed and applied in a real construction experience.

However, even if the process is technically feasible, the analysis of timing, in comparison with other materials (fired bricks and wooden frames), has clearly showed that building an adobe wall with such a frame and reinforcement, takes more time than in the other cases. Though the main focus of the project was not toward economical feasibility, but more in reclaiming heritage, some considerations has to be done; in the analysis done in chapter d, the time needed to dismantle the pre-existing walls has not been considered; this means more workers, and consequentially more economical investment.

It's also true that in order to do a wall made by fired bricks or other materials it's necessary to buy the material itself, while in the reclaiming practises materials are for free most of the time. If there is the will to understand if this kind of reclamation processes have the chance to be applied in a whole region or country like a pattern for the reconstruction after such natural disasters, a serious economical analysis has to be done, comparing with other situations in which those layouts have been already applied. From the experience and the considerations done, a small-scale intervention is probably not economically worth for a few families and little local construction enterprises; if it was recognized like a valid reconstruction way, with behind an appropriate market and a system of companies (like in Great Britain [4])Building with Reclaimed Components and Materials, B.Addis, 2006) it might be more feasible and proposable for a larger-scale operation.

[4] Addis, Bill: Building with Reclaimed Components and Materials: A design Handbook for Reuse and Recycling, London, Earthscan, 2006)

PART III: EVALUATION

Documentation included in Part III:

- Graphic Documentation for the Building Permit

Graphic Documentation fo the Building Permit

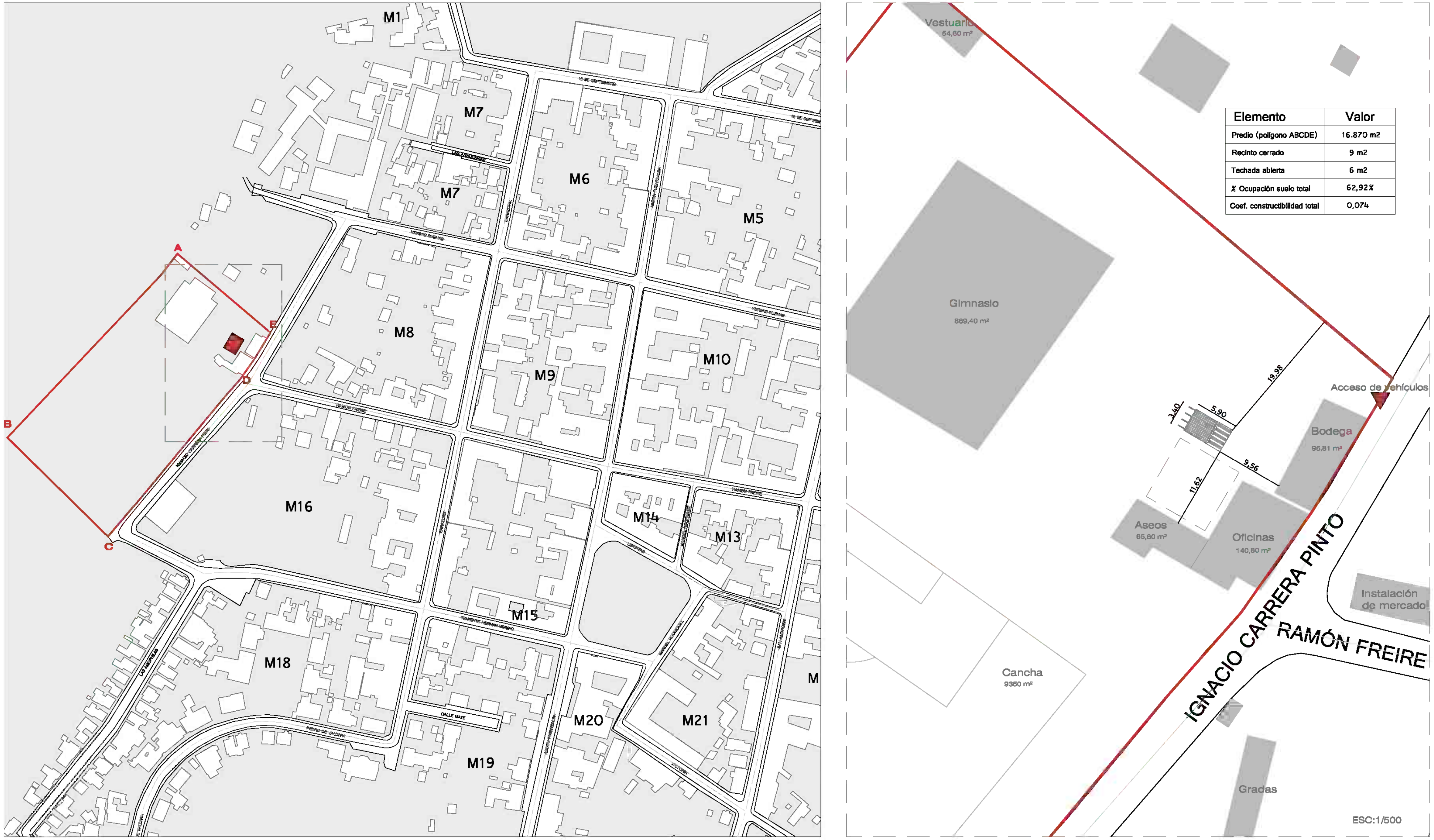


Fig. 1: Situation Plan (drawing by Óscar Natividad)

Graphic Documentation fo the Building Permit

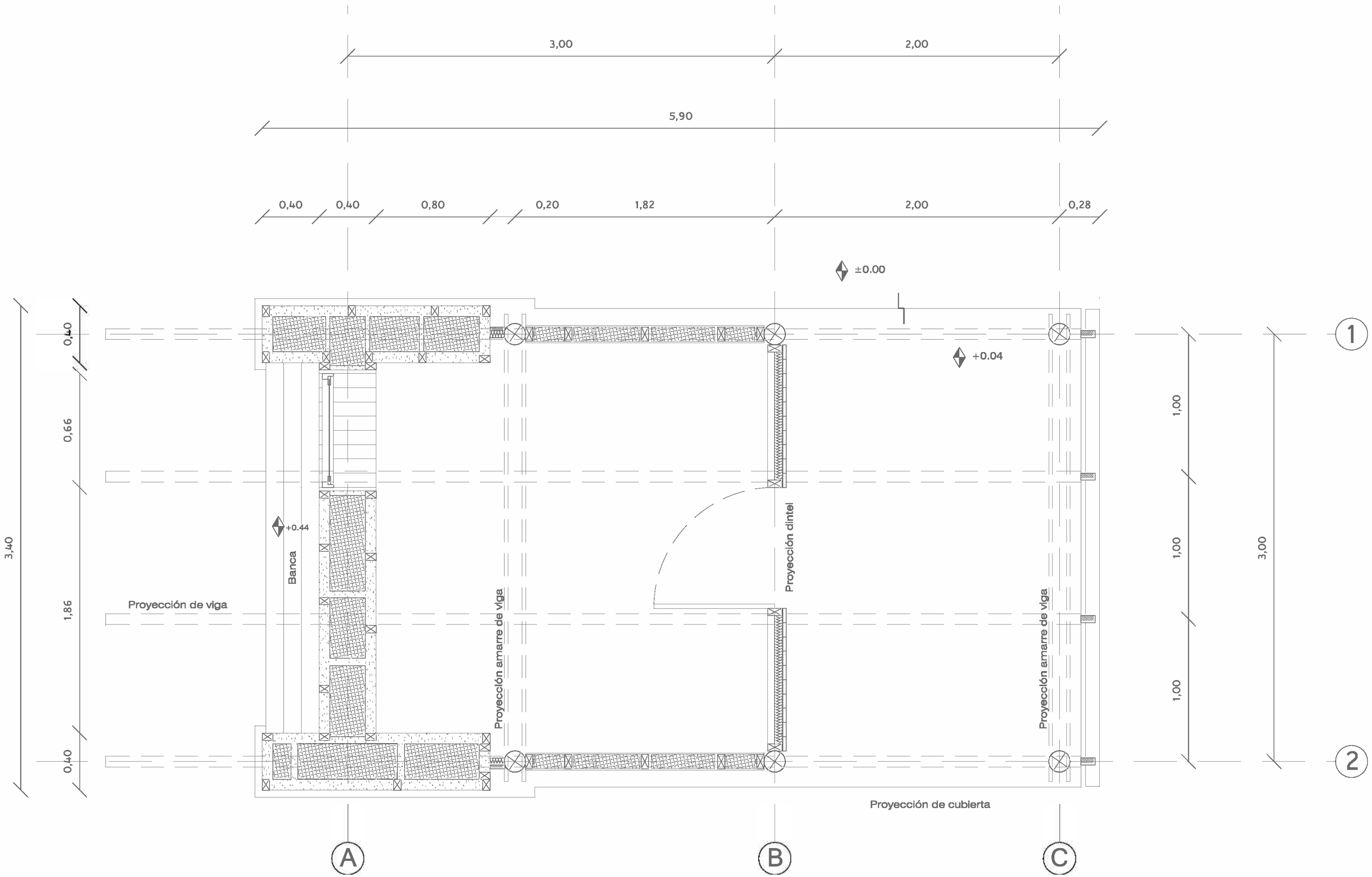
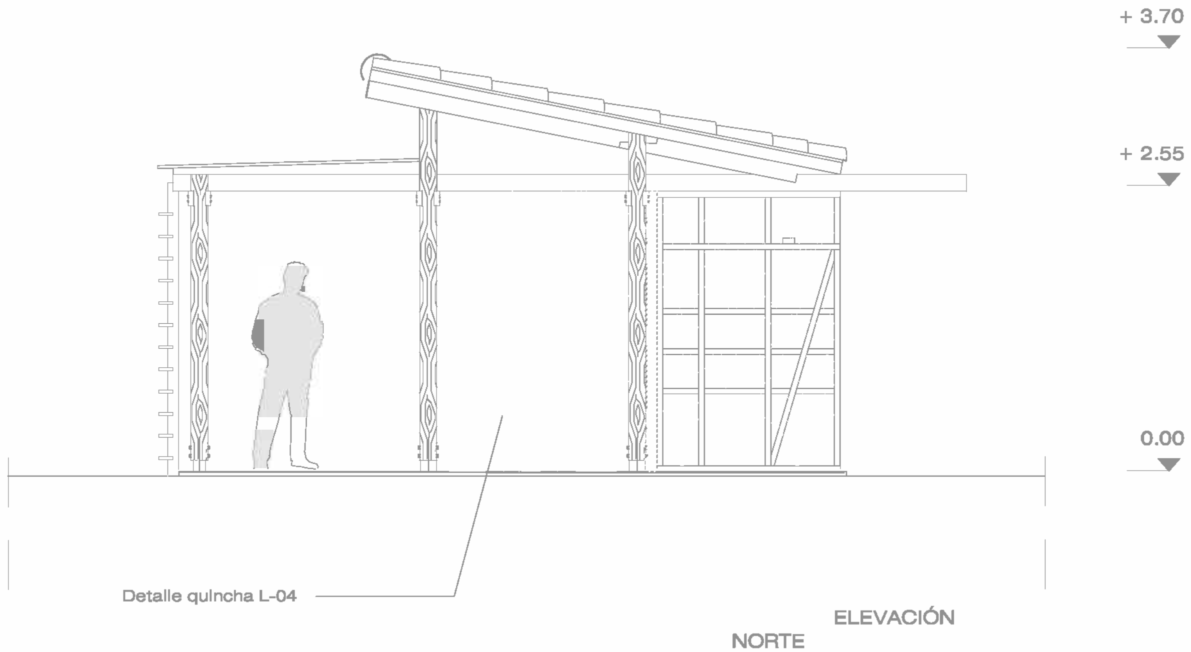
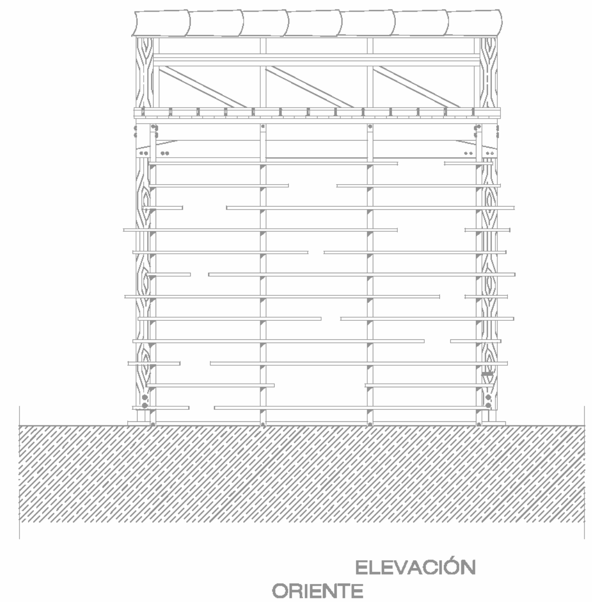
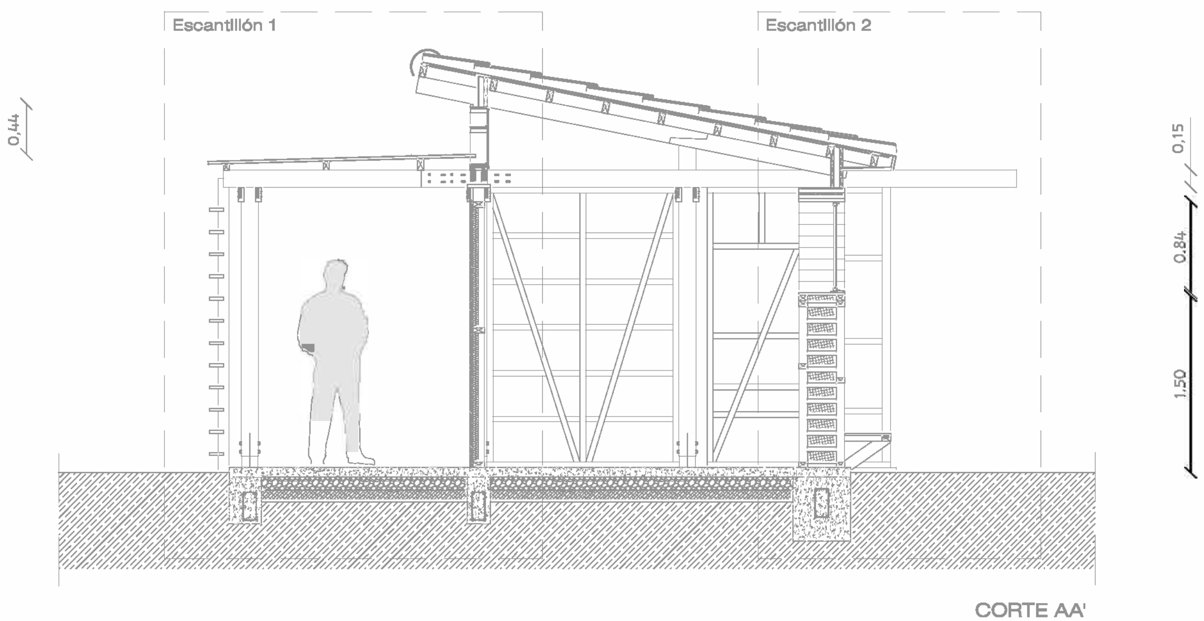


Fig. 2: Built Prototype Plan (drawing by Óscar Natividad)

Graphic Documentation fo the Building Permit







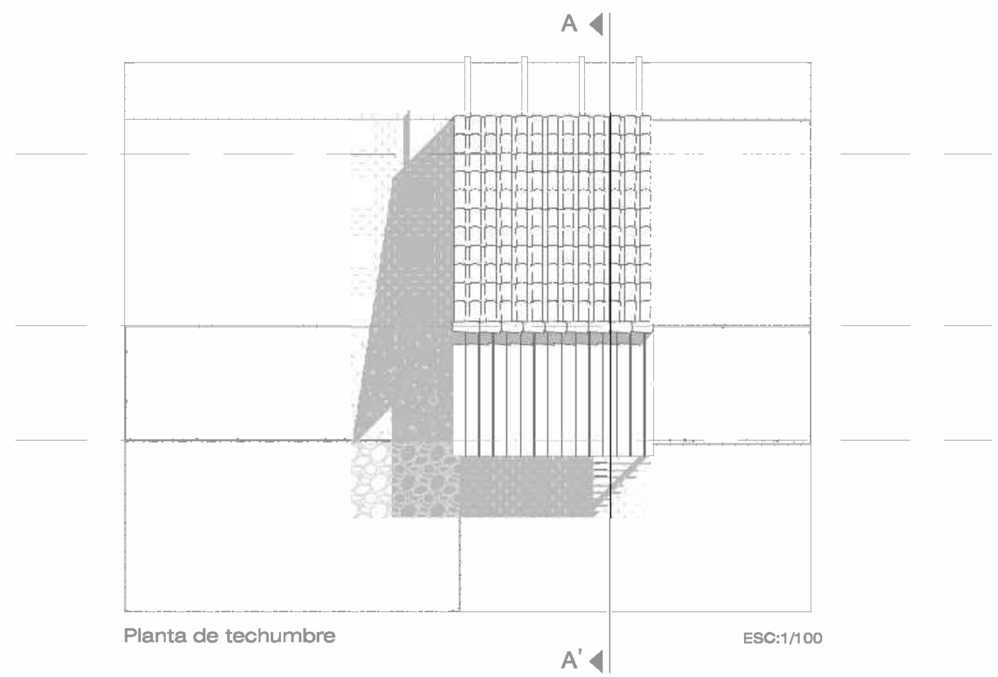


Fig. 3: Built Prototype Sections, Elevations and roofing Plan (drawing by Óscar Natividad)

Graphic Documentation fo the Building Permit

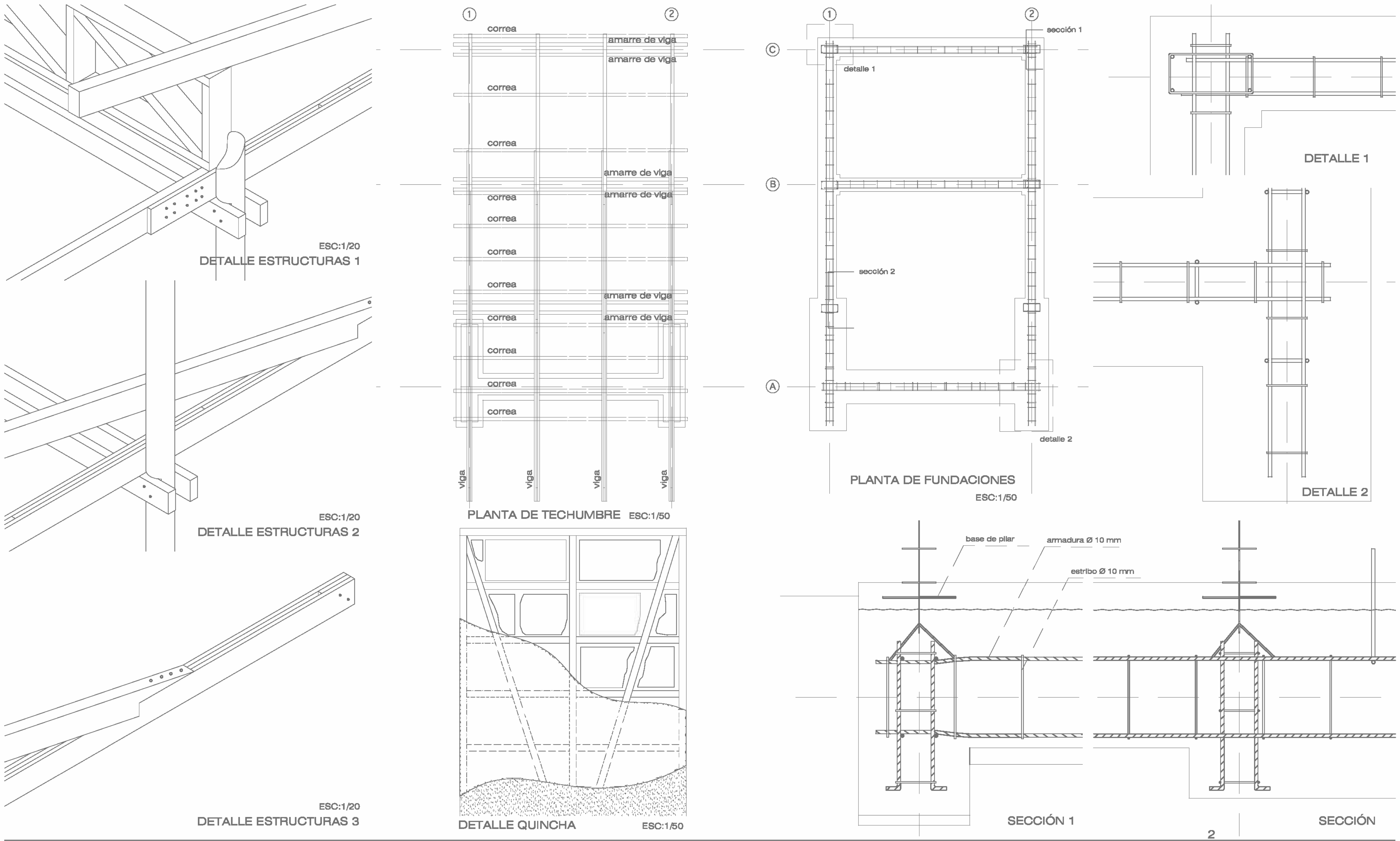


Fig. 4: Constructive Details (drawing by Óscar Natividad)

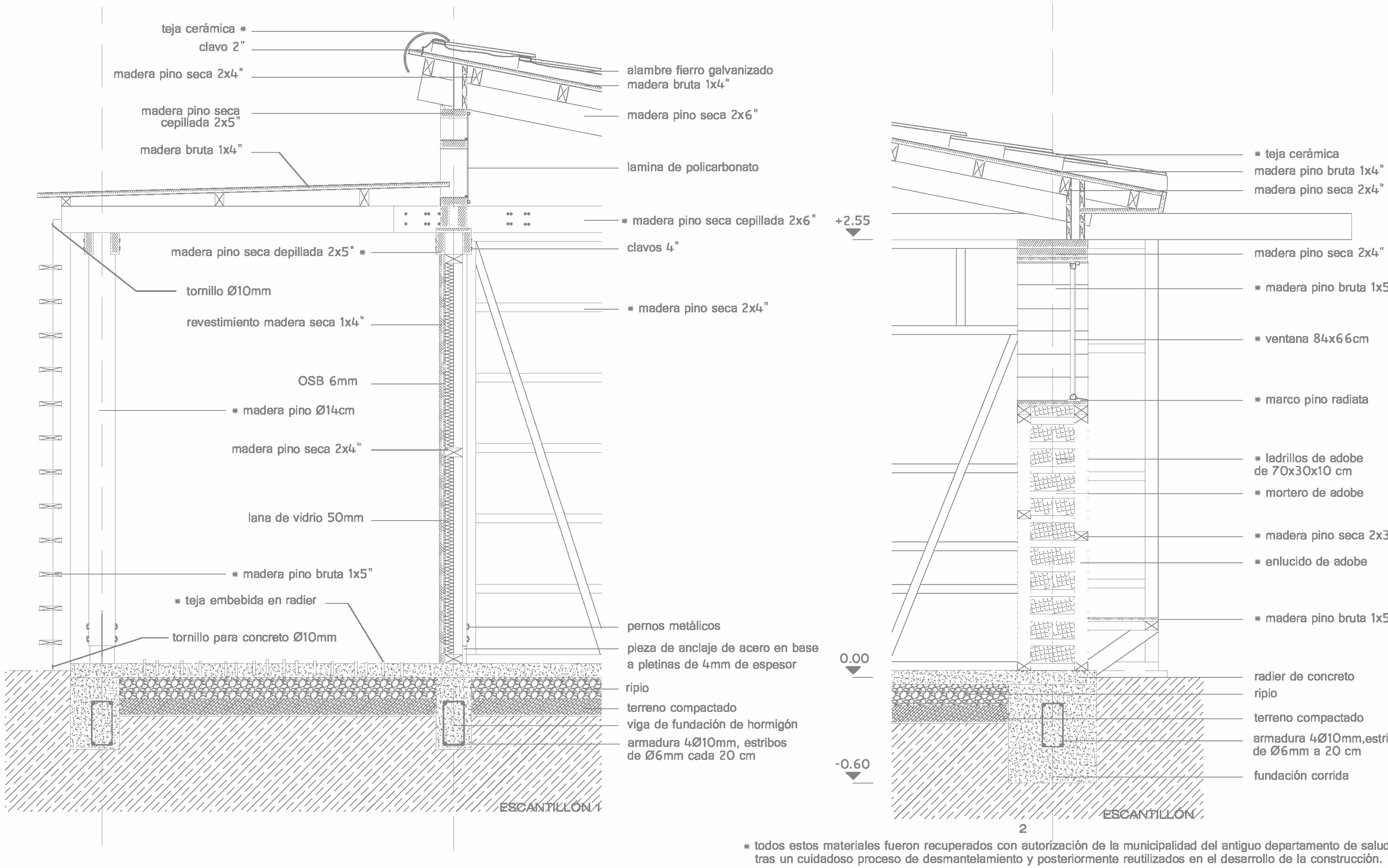


Fig. 5: Constructive Sections (drawing by Óscar Natividad)

COMPARATIVE ECONOMIC ANALYSIS:
OF DECONSTRUCTION AND DEMOLITION

Frías Reyes, Marcelo

1. Assumptions and Economical Factors of the Analysis

1.1. Assumptions

The assumptions in this section are intended to create a comparative framework in order not to step into propositions that produce doubt in the economic projections and comparisons made in the case study.

Thus, elements such as the general expenses of any company are neglected, as they would be necessary regardless of the technical development the construction work follows. Another assumption is that the company providing the deconstruction or demolition services is located in Talca, therefore travel costs and labor are considered for companies located in that region.

On the other hand, the projection of the working days in the case of deconstruction is made based on the direct experience of the project. In the case of demolition a destructive demolition is considered, even if today, after investigation, I have found that most demolition companies also deliver the service of dismantling (at least 30 in part). To simulate a total deconstruction of the home, including walls that were actually not dismantled, the team work performance experience is considered, including a second visit to Chanco in April 2011, when he had to recover adobe bricks. At that time , the bricks recovered were obtained from another house by me and a second student, Oscar Natividad. The result was about 1 meter of wall per person every 4 to 5 hours. This means 2 meters per person per day, or 10 meters per day with 5 persons. With a total of 35 linear meter of wall to dismantle (not including lot partition walls) and the disposition of 5 workers per day, 3.5 days are needed to dismantle as required and gives full 11 days worked, plus a final closing day .

A particular case is considered for of skilled or qualified labor, and that for purposes of calculation a "deal price" ("a trato") is used, less usual for most professionals , but is not an isolated case in the field of building construction. This sets a value for the professional labor per day, not considering social security, which are paid by the worker . As of the worker team, five men (three from Talca and two from Chanco) are considered in the deconstruction analysis and two for the demolition analysis. In both cases a professional supervisor of the project is considered.

Despite that the experience was carried out with a Chevrolet Luv 1998 pick-up truck, the cost of vehicle depreciation for terms of use shall be the value of a Nissan Terrano truck. This vehicle is one of the best sellers in the Chilean market and has a value of depreciation of $ 1,250,000 per year (Munoz, Ignacio). Also within the assumptions, deconstruction does not require a backhoe and the cost of a truck to move the debris is considered a third (third) of the output generated by the walls of the building. This is considered even if not absolutely necessary.

Finally, note that the boxes that show the level of interference in the total cost of each method. In the case of deconstruction, it is considered 50% of the market value of recovered materials.

1.2. Economical Factors

The economic analysis was performed by comparing the work of dismantling systems (deconstruction) on one side, and demolition on the other. I considered three cases:

1. A professional deconstruction simulation for the same property,
2. Simulated professional housing demolition,
3. The real deconstruction held by the academic group

Considering these three case studies, mainly based on our experience, I defined economic factors affecting the comparison analysis:

- Materials, tools and safety equipment,
- Transportation and local mobility,
- Stay costs and daily allowances,
- Labor,
- Waste generation and management,
- Recovered materials

These factors were established mostly based on the impact they have on the final cost of the work, either deconstruction or demolition. But there are other factors which did not gravitated heavily on the experience we conducted and still could make an impact in other circumstances, such as the cost of power tools, although they were involved, were not used and were left out of the expenses. In the following, I will review and explain the factors one by one, discussing how each affects the costs in the analyzed scenario to conduct towards a result with the sum of the factors.

2 Relevance of the Economical Factors

2.1 Labor Costs

The labor costs were obtained in informal conversations with workers in the area of Chanco and then corroborated by e-mail with companies and individuals in contact with the services and the reality of the area and the region.

Thus, the costs of labor for a construction worker, day laborer ("jornalero") or assistant ranges between CLP $ 6,000 - $ 8,000 a day if from Chanco (ROJAS, Francisco) and $ 10,000 if from Talca (VERGARA, Ciro) . For a professional or skilled worker, the labor cost is estimated around $ 25,000 per day (VERGARA, Ciro).
In this item, labor may be the same and what makes the difference in cost is the amount of people and the time it takes one or the other , this being highly influential in deconstruction. Below is the detail in Table 1:

In the last part of the table we notice that the labor cost of deconstruction has a 215.56% increase over the demolition and the relevance of this item in each case, is also notoriously different. In deconstruction, it reaches 57% of the total cost of the demolition, close to one third of the total.

Also, if for example, the work is more complex (with two levels for example), the time for the work of deconstruction would increase (for example, add four days); not necessarily for the demolition, the gap increases in this item to 305.7% .

Deconstruction Expenses (Estimated)

E. Workforces Expenses

Item	Description	Amount #	Amount CLP	Amount Days	Total CLP	Comments
9.	**Manpower**					
9.1	Worker	3	10000	12	**$ 360.000**	
	Local Worker	2	8000	12	**$ 192.000**	
9.2	Professional Worker	1	25000	12	**$ 300.000**	
	Worker Demand	5		12	**540**	Hours-Person (9 hours*day)
	Professional Demand	1		12	**108**	Hours-Person (9 hours*day)
	Sub-Total				**$ 852.000**	

Costos demolición (Estimados)

E. Workforces expenses

Item	Descripción	Amount #	Amount CLP	Amount Days	Total CLP	Comments
9.	**Manpower**					
9.1	Worker	2	10000	6	**$ 120.000**	
	Local Worker	0	8000	6	**$ 0**	
9.2	Professional	1	25000	6	**$ 150.000**	
	Worker Demand	2		6	**108**	Hours-person (9 hours*day)
	Professional Demand	1		6	**54**	Hours-Person (9 hours*day)
	Sub-Total				**$ 270.000**	

Table 1: Costs associated to workforcesn-for deconstruction and demolition (by the author)

E. Workforces Expenses				
Item	Description	#	Total CLP	Relevance in the case
	Deconstrucción		$ 852.000	53,63%
	Demolición		$ 270.000	27,00%
	Deconstruction > Demolition		215,56%	Deconstruction expenses 216% higher

2.2 Transport Costs

The transportation costs are referenced primarily to the experience that took place in March 2011, using a Chevrolet pick-up truck Luv (1998), but the estimated depreciation costs were performed with the vehicle referred to in section Assumptions. Thus, the following expenses were considered for this item:

- Gasoline used by the vehicle on the way Talca to Chanco and Chanco to Talca,
- The toll fees for using the highways,
- One week worth of Gasoline,
- Bus Tickets Talca to Chanco and Chanco to Talca,
- Depreciation of the vehicle by the number of days on site (Muñoz, 2011).

With this, the following table shows the summaries of costs on transportation, which show that transport expenses are not significant in the final cost:

The table below (Table 3) shows that the local transport is 100% more expensive to deconstruction because it is twice as long, with weekly petrol costs $ 20,000 plus daily depreciation is the vehicle used. In the case of interregional transport, the difference occurs specifically on the tickets of buses should pay workers to come to the place. At a cost of $ 2,000 pesos a ticket from Chanco to Talca, three workers for deconstruction and two for the demolition, the difference is $ 4,000.

B. Local transport expenses				
Item	Description	#	Total CLP	Relevance in the case
	Deconstrucción		$ 87.945	5,54%
	Demolición		$ 43.973	4,40%
	Deconstruction > Demolition		100,00%	Deconstruction expenses 100% higher

C. Interregional transport expenses (Santiago-Chanco/Chanco-Santiago)				
Item	Description	#	Total CLP	Relevance in the case
	Deconstrucción		$ 43.200	2,72%
	Demolición		$ 39.200	3,92%
	Deconstruction > Demolition		10,20%	Deconstruction expenses 10,20% higher

Table 2: Relevance in the total cost for deconstruction and demolition in workforces expenses (by the author)

Table 3: Relevance in the total cost for deconstruction and demolition in transportation (by the author)

2.3 Waste Generation and Management Costs

In this item, the relevant difference is that deconstruction can be conducted without the use of machinery, in cases up to 100%. However in this analysis a truck for debris removal is used in both models. Also, a lower waste production can be observed in the case of deconstruction (1/3 approximately) , because the project involved the reuse of adobe bricks and tiles for the pavement.

The machinery -truck and backhoe- was considered as leased, with costs of $ 1,500 m3 of debris on the truck and $ 18,000 per hour with operator and fuel on the backhoe (Vergara, 2011). In the previous page is Table 4 below shows the details of projected expenses:

The detail shows that the cost of demolition is significantly higher than deconstruction. As previously discussed, the possibility of not using the truck to transport debris in the deconstruction and using a pick-up truck, however more cumbersome and slow, it is feasible. Indeed it was done so during the experience of March 2011.

It is also possible to consider the added expense of a hydraulic jack for the removal of debris in the deconstruction and save time, but this was not planned and should be compared with the man-hours to be spent in retirement versus the cost of machine-hours.

Deconstruction Expenses (Estimated)						
F. Debris production and managment						
Item	Description	Amount #	CLP	Unidad	Total	Comments
10.	Debris transport			m3		Debris or depreciation!
	Truck 8m3	1	1500	11,99	$ 17.979	1/3 from the total walls 35,9 m3
		1	1500	5,00	$ 7.500	5 m3 painted wood
	Total debris m3			17,0		
11.	Demolition machines			horas		
11.1	Backhoe	0	13759	8,0	$ 0	8 hours a day
	Machine demanded	0		8,0	0	Hours-Machine (8hours*day)
	Sub-Total				$ 26.000	
	TOTAL				$ 1.588.760	Not counting on the value of the materials
			+IVA	$ 452.797	$ 2.835.937	at 50% benefit in relation to the costs

Costos demolición (Estimados)						
F. Debris production and managment						
Item	Description	Amount #	CLP	Unidad	Total	Comments
10.	Debris transport			m3		Debris or depreciation!
10.1	Truck 8m3	1	1500	35,96	$ 53.936	1/3 from the total walls 35,9 m3
		1	1500	10,00	$ 15.000	trusses wood
		1	1500	5,00	$ 7.500	5 m3 painted wood
		1	1500	3,00	$ 4.500	tiles
	Total debris m3			54,0		
11.	Demolition machines			horas		
11.1	Backhoe	2	18000	8,0	$ 288.000	8 hours a day
	Machine demanded	2		8,0	16	Hours-Machine (8hours*day)
	Sub-Total				$ 369.000	

Table 4: Costs associated to debris production and managment in deconstruction and demolition (by the author)

F. Debris production and managment				
Item	Description		Total	Relevance in the case
		#	CLP	
	Deconstrucción		$ 26.000	1,64%
	Demolición		$ 369.000	36,89%
	Demolition > Deconstruction		1319,23%	Demolition expenses 1319% higher

Table 5: Relevance in the total cost for deconstruction and demolition in debris production and managment (by the author)

2.4 Materials, tools and safety equipment Costs

The expenses detail regarding construction materials is based entirely on the team experience in Chanco. an initial stock of materials was available at the beginning of the deconstruction and this should be replaced completely by the end of the intervention . The team created a full account of the materials, then the money spent on the experience counted and with this data I calculated a percentage of loss in materials and supplies for deconstruction.

The following table shows the summary of expenses and the cost associated. It is important to note that as no data on the demolition is available –as it was not performed as such, for the projection of this item the same data is used but with some discounts.

This tables (number 6 and 7) shows the difference between the two methods when it comes to expenses on materials and supplies. In the case of deconstruction, these costs are comparable to those in a construction, since, as mentioned earlier chapters, it can be seen as construction in reverse. In the case of the demolition safety equipment is necessary anyway, but in this case they are given to fewer people.

In terms of percentage of material loss, deconstruction is around 48% while demolition up to 70% because of posts that were used to secure the roof pitch, and also because less spending is done in building materials .

Around the relative importance of this item in the total cost of each case , this is very similar and close to 8%, since although it is higher spending on deconstruction, the total cost is also higher and this compensates the previous.

Deconstruction Expenses (Estimated)						
A. Tools & Safety materials expenses						
Item	Description	Amount			Total	Comments
		#	CLP	Unidad	CLP	
1.	Tool expenses					
1.1	Picota 5,5 Lb con mang	1	7490	-	$ 7.490	
1.2	Shovel	2	4190	-	$ 8.380	
1.3	Lever	2	2400	-	$ 4.800	
1.4	Lever	1	4800	-	$ 4.800	
1.5	Hammer	2	1890	-	$ 3.780	
1.6	Hammer	2	2669	-	$ 5.338	
1.7	Brush	1	8000	-	$ 8.000	
1.8	Pike	1	12990	-	$ 12.990	
1.9	Meter	3	2990	-	$ 8.970	
1.10	Saw	2	12150	-	$ 24.300	
1.11	Wheelbarril	2	22290	-	$ 44.580	
1.12	Mallet (2lb)	1	3990	-	$ 3.990	
1.13	Folding working table	2	8990	-	$ 17.980	
1.14	Prensa tipo Sargento 1(	2	5490	-	$ 10.980	
1.15	Extension cable	1	16990	-	$ 16.990	
1.16	Tool box	1	21890	-	$ 21.890	
2.	Value of Safety Materials					
2.1	Safety googles	10	915	-	$ 9.150	
2.2	Protection Mask	4	610	-	$ 2.440	
2.3	Gloves	10	1290	-	$ 12.900	
2.4	Ear plugs	10	1390	-	$ 13.900	
2.5	Safety Helmet	10	2190	-	$ 21.900	
2.6	Safety box	1	4990	-	$ 4.990	
	Sub-Total				$ 270.538	

Table 6: Costs associated to materials, tools and safety equipement, and relevance in the total cost for deconstruction and demolition (by the author)

Costos demolición (Estimados)						
A. Tools & Safety materials expenses						
Item	Description	Amount			Total	Comments
		#	CLP	Unit	CLP	
1.	Tool expenses					
1.1	Shovel	2	4190	-	$ 8.380	
1.3	Lever	1	2400	-	$ 2.400	
1.5	Hammer	2	1890	-	$ 3.780	
1.8	Chuzo	1	12990	-	$ 12.990	
1.9	Meter	1	2990	-	$ 2.990	
1.10	Saw (Stanley)	1	12150	-	$ 12.150	
1.11	Wheelbarril	1	22290	-	$ 22.290	
1.15	Extension cable	1	16990	-	$ 16.990	
1.16	Tool box	1	21890	-	$ 21.890	
2.	Value of Safety Materials					
2.1	Safety googles	3	915	-	$ 2.745	
2.2	Protection Mask	2	610	-	$ 1.220	
2.3	Gloves	3	1290	-	$ 3.870	
2.4	Ear plugs	3	1390	-	$ 4.170	
2.5	Safety Helmet	3	2190	-	$ 6.570	
2.6	Safety box	1	4990	-	$ 4.990	
	Sub-Total				$ 127.425	
3.	Material Expenses					
3.1	Safety Googles	1	915	-	$ 915	
3.2	Safety Box	1	4990	-	$ 4.990	
3.3	Protection Mask	1	610	-	$ 610	
3.4	Ear plugs	3	1390	-	$ 4.170	

A. Tools & Safety materials Expenses				
Item	Description		Total	Relevance in the case
		#	CLP	
	Deconstruction		$ 131.615	8,28%
	Demolición		$ 88.980	8,90%
	Deconstruction > Demolition		47,92%	En herramientas y equipo de seguridad: Deconstruction expenses 47,92% higher

Table 7 Costs associated to materials, tools and safety equipement, and relevance in the total cost for deconstruction and demolition (by the author)

2.5 Stay and daily allowances Costs

Stay and daily allowances costs, just as labor costs, are closely linked to the amount of time in which to do the work and the number of workers who are designated to work. Although in this case, the town of Chanco offers enough economic opportunities for accommodation and food services. A summary of these costs is presented in the following Table 8:

This shows that the cost for deconstruction is more than double (137% more) than for demolition. This occurs simply because it is twice as long and it took one more person to work needing accommodation and food.

In terms of relative relevance, one can see that for deconstruction it is more important than for demolition, so one might assume that in the case of a project in a bigger town this extra expense would not apply and the final cost of both alternatives would tend to equate, at least in regard of this factor.

In the case of an extension in the work of deconstruction, which was the case in Chanco , this difference becomes 205%, ie, more than triple.

Deconstruction Expenses (Estimated)						
D. Hosting and ADS expenses						
Item	**Description**	**Amount**			**Total**	**Comments**
		#	**CLP**	**Days**	**CLP**	
8.	**Hosting**					
8.1	Chanco Cabins	1	12000	14	**$ 168.000**	Low season (December-March)
	Hostel (room)	4	10000	14	**$ 560.000**	
8.2	ADS (cabins)	4	5000	14	**$ 280.000**	
	ADS (hostel)	4	2000	14	**$ 112.000**	
						Option not requested:
	Sub-Total (cabaña)				**$ 448.000**	672000

Costos demolición (Estimados)						
D. Hosting and ADS expenses						
Item	**Description**	**Amount**			**Total**	**Comments**
		#	**CLP**	**Days**	**CLP**	
8.	**Hosting**					
8.1	Chanco Cabins	1	12000	7	**$ 84.000**	Low season (December-March)
	Hostel (room)	3	10000	7	**$ 210.000**	
8.2	ADS (cabins)	3	5000	7	**$ 105.000**	
	ADS (hostel)	3	2000	7	**$ 42.000**	
						Option not requested:
	Sub-Total (cabins)				**$ 189.000**	252000

D. Hosting and ADS expenses				
Item	**Description**		**Total**	**Relevance in the case**
		#	**CLP**	
	Deconstrucción		$ 448.000	28,20%
	Demolición		**$ 189.000**	18,90%
	Deconstruction > Demolition		**137,04%**	Deconstruction expenses 137% higher

Table 8: Costs associated to hosting, and relevance in the total cost for deconstruction and demolition (by the author)

2.6 Material recovery value

The analysis of this factor requires a special care. It will consider the material recovery for a deconstruction and a destructive demolition intervention. This is mainly because as the springs out of the earthquake event, the interventions that were conducted in Chanco after the earthquake were also destructive demolitions and did not consider or encouraged the recovery of building materials. Materials recovery was attempted on rare occasions, based on individual initiatives and in many cases led to the sale of demolition elements outside Chanco .

Below is the recovery of materials and associated values built for this analysis and how it affects the cost of deconstruction versus demolition:

This table has several edges to be discussed. To begin with, the costs were obtained mostly by local contributions, the people of Chanco. Especially for items such as doors and windows, which were valued by craftsmen who produce these items with wood from the area. On the other hand, the elements of eucalyptus (beams of 6 meters long, 4-5" diameter) was not possible to value as in the area this wood is no longer used and is intended primarily to cellulose pulp. These were not the only materials recovered, the list is longer but in terms of value the analysis focused on these.

Nevertheless, the salvage value of the materials, a market value of 100%, is considerable. If the case is 50%, this value is lower and creates competition conditions for deconstruction. This finding is detailed in the next section.

Deconstruction Expenses (Estimated)						
G. Recovered Materials						
Item	**Desciption**	**Amount**			**Total**	**Comments**
		#	**CLP**	**Unidad**		
11.	**Reclaimed Material**					
11.1	Tile	3000	200	-	**$ 600.000**	Value in Cauquenes
11.2	Plank	400	250	1x4" x 2,44m	**$ 100.000**	Local value
11.3	Eucaliptos Pilar (6m)	32		4-5" x 6m	**$ 0**	
11.4	Eucaliptos pilar (8m)	1		4-5" x 8m	**$ 0**	
11.5	Brushed Pine Wood	4	3190	2x5" x 3,20m	**$ 12.760**	Sodimac
11.6	Joined up Beam	3	7944	6x14x540cm	**$ 23.832**	4 x Wood 1x6" joined up
11.7	Interior door with glass	2	30000	-	**$ 60.000**	Local value
11.8	Small door (1,80 mt)	1	25000	-	**$ 25.000**	Local value
11.9	Small window	1	8000	-	**$ 8.000**	Local value
11.10	Simple window	1	12000	-	**$ 12.000**	Local value
11.11	Doble window	2	16000	-	**$ 32.000**	Local value
11.12	Panel (masisa)	2	15845	240x150x15cm	**$ 31.690**	sodimac
11.13	Posts 5-6" x 6m	2	25000	-	**$ 50.000**	Local supplier
11.14	Cement Slaty	15	3590	150x90cm	**$ 53.850**	Price each piece 120x90cm
	Sub-total				**$ 1.009.132**	Value new market
	Sub-total				**$ 504.566**	Value 50%, used
	TOTAL				**$ 1.084.194**	**at 50% of market value**
	TOTAL	+IVA		$ 308.995	$ 1.935.287	at 50% benefit related to costs
	TOTAL				**$ 579.628**	**at 100% of market value**
	TOTAL	+IVA		$ 110.129	$ 979.572	at 50% benefit related to costs

Table 9: Costs associated to recovered materiales in the deconstruction (by the author)

3 Final Costs for Deconstruction and Demolition, case comparison

Having discussed the most relevant factors in the costs structure of deconstruction and demolition and their relative relevance, it is necessary to show these differences to be compared and to finally able to draw conclusions.

Therefore, the following is the detail of each case end-state and their comparison:
This summary information shows the differences of implementing a deconstruction system in terms of costs. Thus, without considering the economic value rescued from recovered material the difference is almost 66% excluding profit and VAT. Thinking about this case is not unreasonable, but the value which should be observed would be the first box (page above), with profits and taxes included, as it would apply, for example, as a service to an individual who wants to recover some of his heritage.

A second alternative case would include assessing the material at 50% and with this the costs of interventions and are somewhat matched and entering at competitive prices. Of course, those are without VAT and the price increases but not the ratio . Basically, this value would be a market price to offer the deconstruction and corroborates the market price of the demolition, which was requested prior to conducting the analysis several companies and was obtained “Empresa de Demoliciones Ciro Vergara” at $ 1,450,000 + VAT.

Finally, there is the case in which the salvage value is 100%. This is where deconstruction concepts beyond economic feasibility of demolition and not narrowly. The value of demolition is 45% more expensive than the deconstruction and the process could be developed in two ways:

- A natural person with the appropriate resources want to implement deconstruction to the own property, or
- For a company to meet the margin money has to recoup some of the salvaged materials such as doors, windows and beams with pests . There may be other scenarios that also favor

TOTAL			
Item	Description	Total	Relevance in the case
	#	CLP	
	Deconstrucción	$ 1.588.760	146,54%
	Demolición	$ 1.000.153	100,00%
			Without recovering materials:
	Deconstruction > Demolition	58,85%	Deconstruction expenses 59% higher
	Deconstrucción	$ 1.084.194	100,00%
	Demolición	$ 1.000.153	100,00%
			Recovering material, value 50%:
	Deconstruction > Demolition	8,40%	Deconstruction expenses 8% higher
	Deconstrucción	$ 579.628	53,46%
	Demolición	$ 1.000.153	100,00%
			Recovering material, value 100%:
	Demolition > Deconstruction	72,55%	Demolition expenses 73% higher

Table 10: Summary of the relevance in the total cost for deconstruction and demolition (by the author)

this, suffice it by now the above as it is not the intention of this study identify and define.

6.4 Costs of the Case Study developed in Chanco

In the following, we want to show the costs achieved in the intervention in March and thus expose the future feasibility of this for further studies in the area, and thus establish a single point of view to compare with the future costs in similar projects cases based on this first experience. Below is a summary of expenses:

Deconstruction Expenses (Costa Maule Project)					
A. Assessment Tools & Safety Materials					
Item	Description	Total		Date	Exchange rate
		CLP	EUR		
1.	Tools Value				
2.	Safety Materials Value				
	Sub-Total	$ 270.538	€ 408,81		
3.	Material Costs				
4.	One use Materials				
	Sub-Total	$ 131.615	€ 181,94		
	Lost in Materials percentage	48,65 %			
B. Local Transport Expenses					
Item	Description	Total		Date	Exchange rate
		CLP	EUR		
5.	Pick-up Truck				
	Sub-Total	$ 123.000	€ 185,92		
C. Interregional Transport Expenses (Santiago-Chanco/Chanco-Santiago).					
Item	Description	Total		Date	Exchange rate
		CLP	EUR		
6.	Pick-up Truck				
7.	Bus Tickets				
	Sub-Total	$ 194.100	€ 291,86		
D. Hosting and ADS expenses					
Item	Description	Total		Date	Exchange rate
		CLP	EUR		
8.	Hosting				
	Sub-Total	$ 233.333	€ 349,92		
E. Workforces Expenses					
Item	Description	Total		Date	Exchange rate
		CLP	EUR		
9.	Manpower				
	Sub-Total	$ 0,00	€ -		
	TOTAL	**$ 682.048**	**€ 1.237**		

Table 11: Summary of costs in deconstruction in Costa Maule Project (by the author)

INSTRUMENTS AND ACTORS

FACING THE RECOVERY OF HERITAGE

Beltrán del Río García, Luis

1. Instruments and problems in the reconstruction of Heritage Zones in Chile

In terms of basic housing provision, Chile is well-known for having one of the most successful housing systems, which is why the Chilean model is being copied throughout many Latin-American countries. Chile has a completely Government subsidized housing system that has almost completely eradicated housing deficit. However, within this system informal constructions may be more a quantitative success than a qualitative one[1]. Now that many of the deficit problems have been solved in terms of quantity, there is an ongoing discussion about the lack of quality in new housing developments[2]. It is important to observe the fact that the same model that is being used for housing is being used for reconstruction after natural disasters, which create sudden and widespread housing deficits. The case of reconstruction in Heritage Zone (HZ) is not different, even though a successful solution to heritage preservation requires a unique approach with very specific problem-solving tactics. Thus conflict arises when the standard subsidy system is applied indiscriminately to all areas, including HZ. The Governmental subsidy plan is one that places general emergency response over specific heritage preservation; an example of the other side of the conflict is clear in the case of the regulations from the Council for National Monuments Consejo de Monumentos Nacionales (CNM), in which the problem of preservation is addressed without taking in account the urgent necessities for a shelter[3]

In Chanco, reconstruction and demolition are being done informally inside the Heritage Zone because of slow government response and the lack of flexibility from the CNM[4]. Informal housing endeavors and heritage protection have become a critical problem, making this scenario one of the worst cases of the aforementioned conflict after the Chilean earthquake of February 27, 2010[5]. One third of the houses collapsed or were demolished. Reconstruction is stunted due to lack authorization from the CMN; these problems are reflected in the mood of the community; even though being a HZ represents some economical benefits, the inhabitants are starting to reject it. They do not want the status of HZ anymore because the difficulties of regulation outweigh the benefits of the designation[6]. In Chanco the situation is problematic on both sides of the conflict between existing regulations and the actors involved; inhabitants of the HZ are not receiving a shelter and the heritage is being demolished in an informal manner.

2. Particularities of Reconstruction of Heritage Zones in Chile

Heritage Zone (HZ) reconstruction after natural disasters has three main components: instruments, heritage and actors. The instruments are displayed inside the regulations and these can be used by the actors whether to protect the heritage or to provide housing. The case of HZ reconstruction in Chile is a very special one; it has peculiarities at each of these three levels. At the Instruments level, Chile has a very unique subsidized social housing system. Provision of houses is a responsibility of the Government. The same Governmental authority also oversees reconstruction, and has many inherent virtues and flaws worthy of examination. Second, Chile has a peculiar situation for HZ; it seems that the construction techniques used in these areas, which are mainly different systems to build with adobe, have a cultural relevance. However, they have also very low structural resistance when it comes to torsion efforts, such as the ones caused by earthquakes. In this case there is a clash in between cultural relevance and structural qualities. This conflict is especially important given Chile's vulnerability to frequent earthquakes.

3. Housing Policies in Chile

Chile presents unique housing reconstruction strategies. It has a special housing policy system. In Chile, the reconstruction of houses works through the same system as social housing supply; it is a subsidized system in which the Government takes the responsibility

[1] Hidalgo, M. J. (2007). Cien años de política habitacional en Chile. In M. J. Hidalgo, 1906-2006 Cien años de política de vivienda en Chile (page 19-24). Santiago: UNAB Universidad Andres Bello

[2] Ducci, M. (2007). La Política Habitacional como Instrumento de Desintegración Social. Efectos de una Plítica de Vivienda Exitosa. En M. J. Hidalgo, 1906-2006 Cien anos de política habitacional en Chile (págs. 107-123). Santiago: Universidad Andres Bello.

[3] CMN. (2001). Instructivo Especial de Intervención "Zona Típica Pueblo de Chanco" VII Región del Maule. Santiago: Municipalidad de Chanco.

[4, 5 and 6] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio .

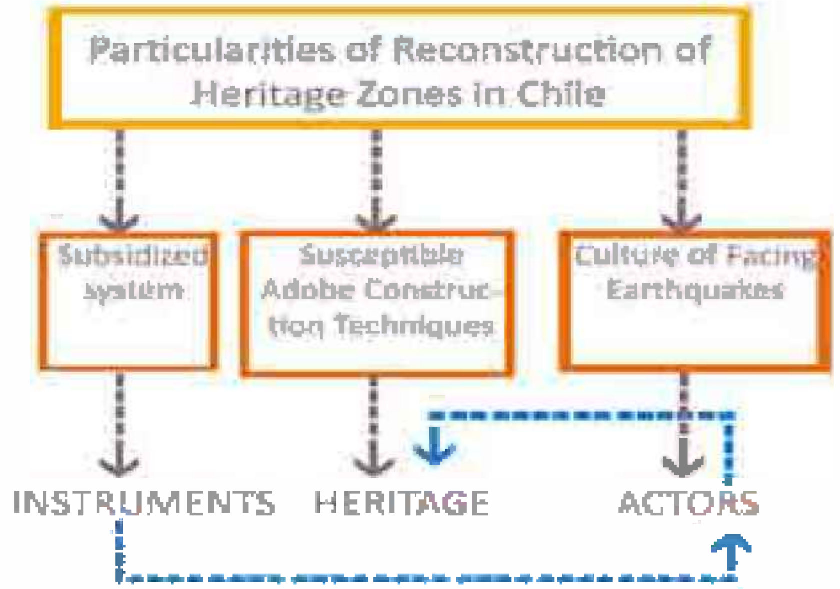


Fig. 1: The particular aspects of reconstruction in Heritage Zones in Chile (diagram by the author)

to provide shelter to the Chilean people. The system arose as the government attempted offset widespread informal housing. During the years of the military coup there was a strict control of everything. This control continued into the times of reconstruction, rendering informal developments impossible. At the end of the dictatorship the new democratic Government had the difficult task of combining continuity with governmental control by using other methods. A great concern of the Ministerio de Vivienda y Urbanismo (MINVU) was that the people would try to go back to informality. One way to stop this was to provide a house for everyone; consequently the State took the responsibility trough a subsidized system[7]. Nowadays the model for housing provision in Chile is well known for being a very successful one. The model is well known for tackling in a very successful way housing deficit and informality. The problem lay in the fact that when undertaking large-scale construction projects, quality was sacrificed for the sake of efficiency. After the year 2000 a series of programs to upgrade the quality of Government-built houses were adapted, solving the problem for existing developments. However, today the main objective has changed; after the massive destruction caused by the February 27th earthquake, the continuous success of Chilean housing rates ended, and the entire housing system in Chile began confronting problems that had been solved up to that point.

The current model is mainly based on a series of combinations between subsidies given by the State (a savings of about 10%) and a financing plan that provides for a loan enabling people to buy or build a house. In the 90´s the part of the loan became something optional, so that people wouldn't acquire a debt. However, the result of doing this caused that the quality of the houses to go lower[8]. This model had a series of advantages; one of the most important advantages is that by using even a small portion of their savings, people could obtain a sense of ownership of their new house.

This system proved to be efficient from the outset. Even in the first years of reconstruction housing deficit reduced in a considerable way. In the period from 1990 to 2003, there was a production of 1,609,305 houses. This is an average of 115,938 per year. Out of these,

[7 and 8] Greene, M. (2009). Winter Semester Seminar. Case Study. Housing Policies in Chile . Berlin: TU Berlin .

75% were financed by the program of the MINVU. Between 1990 and 2002 the coverage increased significantly from 252 houses for every 1000 persons, to 291 for every 1000[9]. The main intention was to avoid informal construction. While in most of the South American countries informal settlements were made up about 30% or 40% of total settlements, in Chile it was only 15%. Out of this 15%, only 2% were actual informal constructions; the rest were allegados, a term referring to families with very low income that do not own a house and live in the house of another person or family member, either through sharing or renting[10].

This scenario seemed promising; according to MINVU[11] in the year 2002 the deficit in housing was only around 543,542. However, the quality issue was still a big problem. By the mid-90´s, many of the new houses started to have problems during rainy seasons; it was during these times that the low quality of these projects was revealed. This costed MINVU a lot of money and signaled that changes to the policies were needed. To solve these policy problems, a new program within the subsidy system was implemented in the year 2000. The Fondo Solidario de Vivienda (FSV) was organized to develop progressive solutions. One of these solutions was a plan wherein the government provided enough for families to build 50m^2, allowing the rest of the house to be built over time and with better quality[12].

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Quality issues are something that can be detected by inhabitants in a very short period of time. Broader issues, however, would become visible only with time. The efficient solutions that provided government subsidized houses put the people at risk of social exclusion. When so much new housing is done at one time, it requires that land be allocated in large extensions. Land in core areas was too expensive. Therefore, most of the developments that were successful from the quantitative point of view were located in the outskirts of the cities, leaving aside many relevant dimensions of housing, such as social network and urban infrastructure. Greene[13] (2009) explains that in this sense the next step would be to bring public infrastructure to these developments. Ducci[14] argues that it is more a problem of social exclusion. As a response to this, in the year 2000, the Government of Chile installed the Programa de Integración Social (P.I.S.) program, this one is an instrument created by MINVU in order to combine different social strata in the same housing space[15].

After the earthquake all the strategies changed. The organization responsible for developing the strategies to reconstruct is MINVU. As a consequence, the reconstruction system was based on the previous housing model, with the added initial stage of evaluating the earthquake damage to existing affected houses. However, the subsidies remain exactly the same[16]. As mentioned before, the earthquake left a housing deficit of 370,051 damaged houses, out of which 217,469 required demolition. One must add the previous deficit to the deficit created by the earthquake damage. Because of the dimensions and urgency of the problem, the Chilean model for housing now faces a bigger challenge. Both quality and quantity need to be addressed in an urgent way. In addition, attention must be given to the social aspect of the housing scheme for the reconstruction plan. A final component further complicates plans in Chile: the reconstruction in the heritage zone. Most of the risk management handbooks expect heritage conservation and housing allowance to work together. However, there are a series of characteristics that oppose to this collaboration. These are mainly related to the prioritization of fast shelter provision over heritage preservation. Something similar happens to the housing policy model from Chile and the natural opposition in between quality and quantity.

4. Base Conflicts for Heritage Reconstruction in Chile

To understand the process of reconstruction of HZ in Chile it is necessary to first identify the two main affected parties and the problems that shape them. The main objective of the reconstruction after the February 27 earthquake was to provide shelter for the affected

[9] and [10] Ducci, M. (2007). La Política Habitacional como Instrumento de Desintegración Social. Efectos de una Plítica de Vivienda Exitosa. En M. J. Hidalgo, 1906-2006 Cien anos de política habitacional en Chile (págs. 107-123). Santiago: Universidad Andres Bello.

[11] MINVU². (2004). Un Siglo de políticas en vivienda y barrio. Santiago: Pehuén Editores.

[12] Hidalgo, M. J. (2007). Cien años de política habitacional en Chile. In M. J. Hidalgo, 1906-2006 Cien años de política de vivienda en Chile (pp. 19-24). Santiago: UNAB Universidad Andres Bello.

[13] Greene, M. (2009). Winter Semester Seminar. Case Study. Housing Policies in Chile . Berlin: TU Berlin .

[14] Ducci, M. (2007). La Política Habitacional como Instrumento de Desintegración Social. Efectos de una Plítica de Vivienda Exitosa. En M. J. Hidalgo, 1906-2006 Cien anos de política habitacional en Chile (págs. 107-123). Santiago: Universidad Andres Bello.

[15] Siclari, P. (2009). Intrumentos de Integración Social en la Nueva Política Habitacional y Urbana de Chile. Revista de la Organización Latinoamericana y del Caribe de Centros Históricos , 63-75.

[16] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

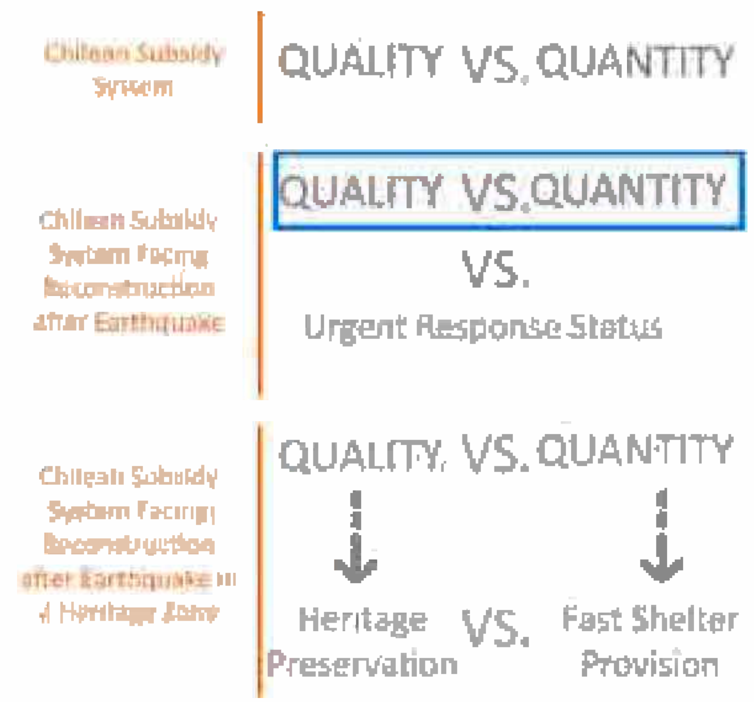


Fig. 2: Changes in the problematic of Chilean subsidy system when faceing reconstruction in Heritage Zones (diagram by the author)

communities without sacrificing the existing social and economical networks that survived the disaster. Protecting heritage in HZ provides an extreme example of this problem, as the need to maintain existing communities and structures extends beyond resource preservation to include heritage preservation. The solutions implemented to solve such problems must respect the preservation of the HZ while addressing housing provision for the community. As discussed in Chapter Two, some elements of these coexisting goals bring out natural conflict. There is a conflict between housing provision and HZ conservation. While heritage conservation requires a very precise, detail-oriented approach[17], fast housing allocation requires a much more aggressive procedure. Divergence occurs where proposed solutions are designed either to preserve the heritage or to bring fast and efficient shelter to the community. Despite the fact that idealized guidelines recognize the importance of both goals, few real life action plans consider both heritage preservation and emergency shelter together. The essential question of the problem of reconstruction in HZ is: What are the characteristics that disrupt collaboration between heritage conservation and timely emergency response?

In the case of post-earthquake reconstruction, creating and providing shelter is a responsibility of the Government. As outlined above, this is done through the MINVU. Though the PRCH developed by MINVU considers heritage preservation relevant, the real responsibility for implementing action related to heritage lies in the hands of the CMN. MINVU and CMN are both under the control of the Government; however, they are very different organizations with different (and often conflicting) agendas and interests. One problem caused by the combination of Governmental authority and semi-autonomist groups comes in the usage of Instruments (see point one of this chapter for a full discussion of Instruments as related

[17] The World Bank. (2010). Cultural Heritage Conservation. In J. Abhas, Safer Homes, Stronger Communities. A Handbook for Reconstructing after Natural Distasters (pp. 173-180). Washington DC: The International Bank for Reconstruction and Development / The World Bank.

to the guidelines for reconstruction). Heritage preservation is threatened because though the Instruments for solving specific problems are developed under a single centralized authority, the delegation of responsibility and division of power between MINVU and CMN results in the Instruments being implemented in a decentralized manner, while MINVU does have instances to work in a decentralized way the small infrastructures from CMN does not allow them that, therefore solutions are brought from two entities that have different approaches and priorities (see figure No. 8). Though all Instruments are technically developed by the central authority, MINVU works mainly at the local or municipal levels, increasing decentralization[18].

The enforcement of these Instruments is carried out by several actors, with ultimate success frequently depending on efficient cooperation. The central actor—the Government—dictates the general plan in the form of the PRCH. However, regulations, not incentives, for the protection of heritage come from the CMN. The PRCH can only be executed properly if the agencies that carry out distinct elements of the plan agree on interpretation and action—an agreement made difficult by the discord of idealized guidelines and real-life implementation.

5. Government approach for the Reconstruction Program

The PRCH opens with the slogan ¨reconstruyendo al país¨, or "reconstructing the country"[19]. This slogan underscores the fact that the Government sees the problem of recovery from

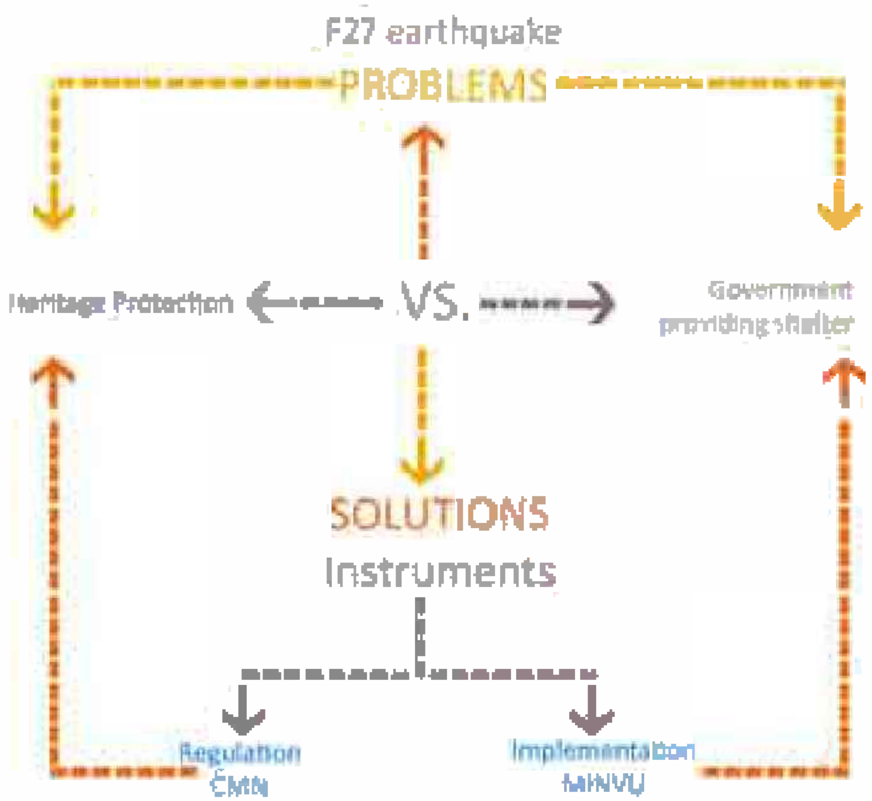


Fig. 3: Relations in the conflict in Heritage Zones (diagram by the author based on MINVU, 2010)

[18 and 19] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

Instruments and Actors: Facing the Recovery of Heritage

disaster with a broad view: despite the horrible human and material losses, the massive destruction of the earthquake also has as a positive aspect in that it provides opportunity to rebuild large parts of Chile. As detailed in the third version of the PRCH from MINVU[20], there are three lines of action along which MINVU is addressing the problem of reconstruction:

1. The Program for Housing Reconstruction
2. Program for Attending the Villages and Camps
3. Territorial, Urban and Heritage program for reconstruction

These three facets of reconstruction are designed to be complementary, taking into account that the reconstruction processes not only entails the production of buildings, but also involves many other dimensions including but not limited to infrastructure and social networks. The approach divides itself into three different scales that are solved by three different work teams: The scale of housing that is mainly solved by the Fondo Solidario para la Vivienda (FSV) subsidy program from MINVU, the scale of district whose objective is to reduce the housing deficit in a sustainable way, and the scale of city and territory in which the priority is to link and actualize the Statutory Plans at a urban scale. Like the threefold courses of action that developed them, these three scales are meant to be complementary.

MINVU has the responsibility for the reconstruction of affected zones. However, because the Government is aware of the complexity of the reconstruction a task, the PRCH proposes a decentralized approach in which most of the actual implementation occurs at the community level. Local governments have organizational freedom supported by the Servicio de Vivienda y Urbanisación (SERVIU) at a regional level and by MINVU at the national level (MINVU, 2010). This decentralization through the freedom of local governments creates certain problems. The power of local governments complicates enforcement of guidelines set forth by the national Government. Also, local autonomy in this sense represents a risk for unequal development, as occurred in Chanco where over-demolition policies decimated HZs[21].

In addition to unequal development, the problems of community decisions that go against national plans have emerged in many ways. The voice of the communities if often one of frustration; at the local level some question or undermine the authority and priorities of national organizations involved in designating HZ. In frustration and desperation, the community is turning its back on heritage. One community leader sums up the mindset of those he represents, saying, "Nobody asked us if we wanted to be a heritage zone, we'd rather not"[22]. The Chanco case is one of several examples that elucidates the problem of local preference versus national planning. In Chanco the policy of the mayor and the people was to over demolish and start again without regard for HZ. In the case of Vichuquen the people defended their heritage.

In the reconstruction model, the communities are owners who share responsibility for their plans. In theory, the model makes reconstruction a unifying group effort through a certain amount of decentralization:

"The sense of unity proposed in the plan named "Chile builds better" makes a general call upon in order to understand that the reconstruction that will be done is in the hands of everyone. It would be a mistake for the State to try to reconstruct in a centralized way, the more than one thousand cities and destroyed towns. That is why the plan suggests an exercise of decentralization and cooperation among the Government and the civil societies without precedents in the history of Chile" (MINVU/Matte; 2010; p.108).

Responsibilities shift between national and local authorities depending on the stage of response. Every timeline of reconstruction begins with the design of a model and ends with the implementation of the goals described by that model. The idea is to start with a design of housing and head towards construction. The closer a plan gets to the implementation stage, the more the responsibility lies with the local government; as the project advances the local

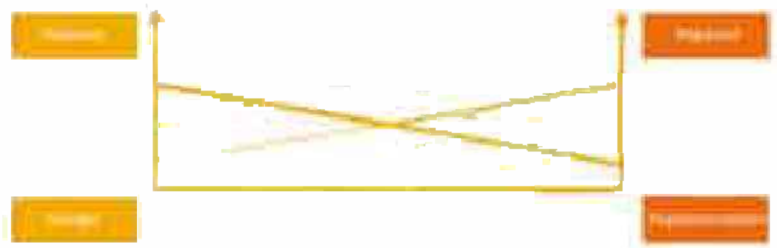
[20] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

[21] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio .

[22] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio . (page 2)

responsibilities become greater. Despite these aspects of planning involving local authorities, certain aspects of the PRCH speak to the inclusion of a centralized structure. For example, in the case of HZ the relevant documentation to build needs to be evaluated by the local Dirección de Obras Municipales (DOM), but is ultimately sent to CMN—a central authority in Santiago de Chile—for a final evaluation[23]. Because the local municipalities do not usually deal with such great problems, it seems like they do not have the infrastructure to approve so many projects in the level of detail that CMN asks from them. The local DOMs are overwhelmed with work. At the same time the State has been constantly delayed when supplying technical support.

To explain the issues such as enforcement difficulties rising from the vying aspects of centralized planning and decentralized implementation, especially that of timeline efficiency, it is



necessary to seek where the system fails. Some points include:

1. The local government`s incapacity to solve so many problems of such magnitude in an acceptable period of time.
2. The processes that go from local to national level and vice versa which require extra steps in communication, implementation, and enforcement, translating into a slower and less efficient allocation of response efforts.

The PRCH´s approach is completely logical; nevertheless the most critical point is this unusual switch from centralized to decentralized. The Local authorities are empowered to implement reconstruction, yet the resources are not enough[24]. For that matter local entities should have stronger representatives from the side of CMN and more resources from the governmental side. But an analysis of the conflict in the Chilean system could extend to more general examples, providing beneficial suggestions for future recovery efforts that present a need for special treatment of HZ. Perhaps a decentralized approach should be part of the plan from the prevention stage, during which implementation strategies mainly consider the local level of action. The decentralized approach is similar in many aspects to the ones of the Armenia reconstruction in Colombia; the main difference is the simultaneous problems of heritage preservation and large-scale destruction in Chile.

The plan´s approach towards heritage conservation considers that many of the fallen houses in the 27F earthquake were built out of adobe[25]. This illustrates the deep relationship between heritage preservation problems and the damage caused by the disaster. When it comes to the most relevant problems that the government addresses in the PRCH, PRCH differs from CMN as CMN focuses on all aspects of heritage recovery, including rebuilding, whereas PRCH focuses on preserving existing structures.

The national plan's dedication to heritage represents one of the most basic conflicts between centralized and decentralized decision making. The national authorities put an emphasis on heritage preservations and offer tools for the task. The plan first and foremost assumes that communities will be interested in heritage preservation, stating:

"In this plan we make the commitment of promoting and recovering the heritage, creating with this, incentives and ways so that the own communities are the ones who decide how to reconstruct their urban image. We will not impose or forbid any constructive expression, as long as it guaranties the safety of their inhabitants"[26].

[23] Ministerio de Educación Pública. (2009). Ley N° 17,288 de Monumentos Nacionales. Recuperado el 05 de september de 2010, de UTA: http://www.uta.cl/masma/patri_edu/PDF/LeyMonumentos.PDF

Fig. 4: How responsability for the regional level increases through time (diagram by the author based on Plan de Reconstrucción MINVU, 2010))

[24] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio .

[25] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

The statement combines the idea of reconstructing urban image with heritage preservation, only to imply that no specific guidelines will be enforced. This raises several questions concerning the efficiency and intent of the Government: Is it effective to organize resources at a national level that may or may not be relevant at the local level? Also, given the Government's strong dedication to heritage, what actually happens on the local level when a community is not interested in preserving their heritage? In these cases, does the CMN, the national organization that specifically formed to regulate and oversee heritage protection, have any power? If the CMN has no power over local decisions, how do they operate or manifest any authority?

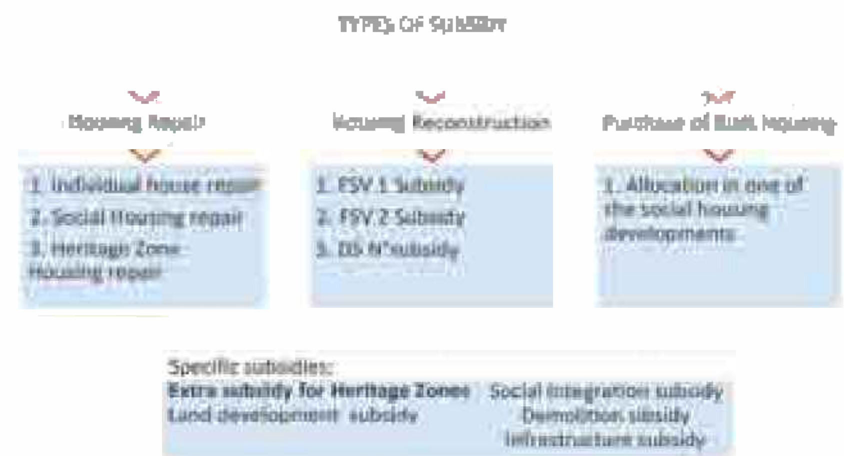
To complicate matters, despite strong national support of heritage preservation, Magdalena Mate—head of the national organization MINVU—takes a stand for the view that building faster and better is one of the most important points of the PRCH. This is the same position of the "build back better" strategy shown in the international guidelines from UN-HABITAT[27]. This response, which stresses the necessity fast, permanent housing, is not in and of itself a weak approach to reconstruction. However, though these structures aim for quality in a way that temporary housing ignores, the emphasis on construction speed brings similar problems in terms of issues such as HZ preservation on both physical and social levels.

This paper reflects on the three most relevant elements in Chile's reconstruction process:

- A decentralized approach.
- Considerations for the pre-existing heritage.
- Fast reconstruction.

As noted in the first point of this chapter, the reconstruction program is heavily based on the subsidized system used for housing in Chile. In this system, the Government takes on most of the expenses for the reconstruction through programs such as FSV 1 and 2, and the DS N°40; and for repair the Programa de Protección al Patrimonio Familiar (PPPF)[28]. In individual cases of housing reconstruction, the first stage is to evaluate whether or not a house can be repaired. Afterwards, there is a postulation procedure and then reconstruction.

In HZ this procedure also goes through the approval of CMN. Special subsidies may be obtained on a case-by-case basis. Among these is the subsidy for reconstruction in zones classified as HZ. In absence of local cultural interest, this is the only direct incentive at the local level for the protection and recovery of these zones.



[26] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

[27] UN-Habitat. (2007). Enhancing Urban Safety and Security. Global Report on Human Settlements. London: Earth Scan.

[28] MINVU. (2010). Plan de Reconstrucción MINVU "Chile Unido Reconstruye Mejor". Santiago de Chile: Gobierno de Chile.

Fig. 5: Different possibilities for subsidy in the PRCH (diagram by the author based on Plan de Reconstrucción de MINVU, 2010)

6. *Influence of the third parties: NGO´s, Universities and Private Sector*

Though the Government technically arranges and implements the subsidized system, it would be a gross oversight to jump to the conclusion that civilian parties are not involved in Chile's planning process. Parties such as NGOs and Universities are very influential, especially at the implementation stage.

There is the case of the international NGO Un Techo para mi Pais (A Roof for my Country), whose involvement in the emergency shelter allocation process is essential. The main objectives of this organization founded 1997 continue to be the eradication of poverty and the construction of emergency settlements by providing shelter. Their strategies began by using University student enthusiasm for solving Chilean social problems as a resource for their work. Now, Un Techo para mi Pais is one of the most successful housing NGOs in the world. During the reconstruction after the earthquake they have played an essential part in supplying medias aguas as temporary shelters [29]. In this case funding for most of the projects was provided by the Government; however the expenses in the infrastructure and organization of the NGO are provided by other sources. At the local level the methodology is that of free labor construction trough the organization of communities and student groups [30].

At another level there are organizations that link the work of the Universities with the needs of society trough the Government. For example, the Pontificia Universidad Católica's (Ponifical University of Chile) has a Public Policy office that works as a consultant for the Government. This office is constantly making proposals for and evaluating the success of various plans and programs. The office also draws on the work of professionals and academics; the office has a budget for its own infrastructure provided by both the Government and the University. At the level of project they have an specific budget for venture [31]

There are many other organizations committed with the reconstruction of Chile. However very few organizations focus exclusively on protecting heritage. The foundation Patrimonio Nuestro has as main objective the rescue, promotion and conservation of the Chilean heritage. Most of their work is done through an organization of conferences and publications, such as the Manual de daños post Terremoto (Handbook for damages after the Earthquake). It is worth mentioning that this organization has contention with the CMN; they accuse the CMN of criminalizing dissenting civilians rather than considering their opinions. CMN does not consider the opinion of the civilians by criminalizing them instead of helping them recover their houses [32].

Another large and influential force is the PS. This element of society takes a completely different approach than do NGOs and University-sponsored initiatives. In most cases PS involvement is through investment. Several Government policies offer an incentive for Private Sector investment; for example, the Law 20,444 for private investment that offers a free-tax policy that allows the investor to skip a percentage depending on the invested amount. The other method of PS involvement is the offering of services, as in the case of the construction companies that offer prefabricated housing trough MINVU.

Considering the scale of the problems, the local infrastructure issues, and the decentralized approach from the Government, it is essential to engage other parties in the reconstruction process, by allocating the needed instruments an adequate involvement can be fulfilled. In the level of heritage protection it is a more complicated task, especially for the case of the PS involvement [33].

7. *Role of the Actors in the Reconstructions Process*

In the reconstruction effort, several groups of actors related to the process handle the instruments, implement the instruments, and are affected by said process and implementa-

[29 and 30] Un Techo Para Chile. (2010). Un Techo Para Chile 2010 Sin Campamentos. Recuperado el 2 de nov de 2010, de Official Web Page og Un Techo Para Chile : http://www.untechoparachile.cl/?page_id=14

[31] (Centro de Politicas Publicas UC. (2008). Centro de Politicas Publicas UC. Recuperado el 13 de 12 de 2010, de Quienes somos : http://politicaspublicas.uc.cl/proyectos/

[32] Fundación Patrimonio Nuestro. (2008). Official Web Site Fundación Patrimonio Nuestro. Recuperado el 10 de January de 2011, de Consejo de Monumentos Nacionales falta a la verdad y criminaliza a la ciudadanía: http://www.patrimonionuestro.cl/index.php

[33] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio .

Instruments and Actors: Facing the Recovery of Heritage

Fig. 6: Type of actors involved and affected by the reconstruction process (diagram by the author based on PRCH, 2010 & Law No. 17.288 of Monumentos Nacionales, 2009)

tion. These groups could initially be classified into providers and affected; the affected are the inhabitants of the destroyed communities, and the providers come from the Government and other sectors (NGO´s, Universities, Foundations, Private Sector); the Governmental ones are mainly the MINVU and the CMN, and each focuses on different priorities (fast shelter allowance and heritage protection).

Residents of HZ are caught in a conflict between permanent housing needs and heritage preservation. A decentralized approach can cause many different reactions that depend on the way the people and the local governments have confronted the problems caused by disasters. In section 3.2, two cases—the case of Vichuquén and the case of Chanco—were presented as exemplary of their respective decisions to support or overlook heritage preservation. These cases illustrate how all three types of actors—Government, NGO, and Private Sector—come together through planning and funding to the stage of implementation. Vichuquén, cognizant of the fact that adobe structures were a part of heritage, signed an agreement with the architect organization Sencico a NGO Peruvian construction that specializes in adobe techniques. Sencico will conduct a series of workshops to educate laborers on how to develop high resistance adobe. This action plan was promoted by the mayor and financed by the private enterprise Barrick (López, 2010). Chanco is one of the most dramatic ones, where according to the maps of the municipality, 61% of the demolitions were done in an informal way and 43% of the demolished property had professional recommendations for not being demolished. For the case, the main difference among this two are the postures of the inhabitants and the majors towards the preservation on the heritage (See figure No. 12). While in Vichuquén the major made an effort to bring professionals in the field of adobe construction, in Chanco the major promoted the demolition[34]. There are differences in treatment, strategy, and success between parties who ask for a subsidy for reconstruction in a HZ and a

Fig. 7: The banner in the entrace says "Our ancestors live in these walls" (picture from Beltrán del Río, Luis, 2010)

[34] Luco, V. (2010, August 15). La difícil reconstrucción de las zonas típicas: el caso de Chanco. El Mercurio .

party that wants to build outside the HZ with a pre-approved design. The differences in the complexity of each party's proposal become evident in measuring time requirements and expenses, (see Fig. 8). It is from this conflict in between the interests of the community and the protection of the HZ that the main problem appears. Every proposal must be checked on two standards, because every proposal needs to obtain an approval on local at centralized and decentralized (national and local) levels. The CMN, MINVU, and local organizations such as the DOM and the Municipality are all involved in approval. When these processes extend the timeline, there arise desperate responses from the community, such as informal constructions or neglect of HZ status. The general problem of this contradiction is simplified and illustrated in Fig: 9.

Fig. 8: Analysis of different stages, illustrating the amount of involvement of actors in two different processes, one in HZ and one outside the HS (diagram by the author based on MINVU 2010)

8. *Problems and Given Solutions: Considerations for the Community and the Heritage.*

For further classification, some of the most relevant problems and their ostensible solutions—instruments provided by the Government—could be classified as below:

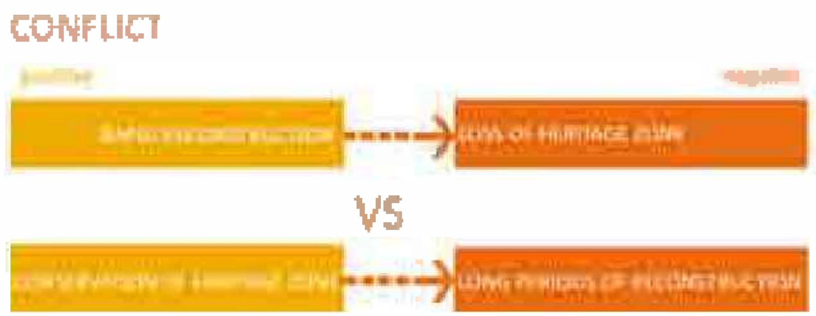


Fig. 9: Main conflict in the reconstruction of heritage zones (diagram by the author)

The next table summarizes the discussions presented above, visually representing the most relevant problems and the solutions designed to solve them. It is notable that among these plans there is only one whose main objective is to preserve the Heritage—the 200 UF extra subsidies for the continuous façade. The efficiency of these instruments has to do with the level of involvement of other actors such as the PS. The extent to which each actor is involved is often related the availability of and demand for financial resources. The complexity of planning and construction projects inside the HZ often calls for larger budgets

PROBLEMS	ACTORS	INSTRUMENTS	RELATED PROBLEMS
1- Land Tenure Documentation	-Community - Local Government - MINVU - MVN	- Reducing the time - Doing a parallel process	2. Informal Construction and Demolition 5. Neglect of the HZ
2- Informal Construction and Demolition	-Community - DOM - Municipality	- Regulations imposed by the CMN - Pre-approved housing designs - Land tenures regularization process	1. Land Tenure Documentation 3. No Incentives from CMN 5. Neglect of the HZ 7. No Incentive for Middle Income Subsidy
3- Lack of Flexibility from CMN	-Community - CMN - MINVU	- Considerations from MINVU towards HZ - Subsidy for continuous façade - No instruments or incentives from CMN for the inhabitants	2. Informal Construction & Demolition 5. Neglect of the HZ
4- Scale of the Problems	-Community - DOM - Municipality - EGIS & PSAT - SERVIU - MINVU - Government of Chile	- Government supporting the payment of the EGIS & PSAT - External aid from NGO´s and Universities to the DOM - No specific instrument for this, because it is the approach of the Government	2. Informal Construction & Demolition 5. Neglect of the HZ
5- Migration from HZ	-Community, specifically the *allegados* and *arrendadores*	- FSV subsidy for reconstruction in group - PIS subsidy	1. Land Tenure Documentation 3. No Incentives from CMN 6. No prototype for HZ
6. No Pre-approved house project for HZ	-Community - DOM - MINVU - CMN	- Group Subsidy - Subsidy for construction of predesigned house - PIS subsidy	5. Neglect of the HZ 7. No Incentive for Middle Income Subsidy
7- The D.S. N°40 Subsidy does not have Special Subsidy for HZ	-Community - Middle Income - CMN - MINVU	- PIS subsidy	5. Neglect of the HZ
8- Loss of the Pre-existent Economical System	-Community - PS - Municipality	- Law for Donations N° 20,444 - PRBC plan	5. Neglect of the HZ

Table 1: Summary of the problems and instruments (diagram by the author)

that cannot be covered by the existing subsidy system. Scenarios tend to be more or less effective depending on how the Local Governments and inhabitants react towards their heritage. Reactions vary drastically; there are very successful heritage preservation efforts in cases like Vichuquén and Cobquecura, and extremely difficult cases that involve heritage loss, as seen in the example of Chanco. There is a necessity to bring into the field more comprehensive solutions that involve heritage preservation and fast housing reconstruction. These solutions can come from a managerial point of view, yet they can also be that of good design and a smart technical approach. The behavior of the actors is something that remains out of the range of the controllable; however incentives and involvement can direct this behavior.

CONCLUSIONS

For over a year beginning March 2010, our team has worked in the study and implementation of alternative strategies for the reconstruction in heritage areas. Chanco has been our selected location, yet it represents a general problem affecting many other towns all over Chile, and probably beyond. The issues at stake are those of cultural values, community involvement, technical appropriateness and local management, all of them in the context of an emergency. Fortunately, because of our discipline and training we can go way beyond volunteer work alleviating the direct consequences of the catastrophe. Instead, we engaged with the questions around reconstruction, a process that can be said to start after the emergency is dealt with and certainly takes a longer time span and scope. It is exactly the scope of the reconstruction that we address: How can we recover the lost heritage? What elements of the destroyed can be taken? How do we adapt heritage values to current requirements, resources and building methods?

We have explored the problematic of these general questions with an academic approach retrieving the experiences in Germany and studying their relevance in Chile, studied the urban and architectural values of Chanco itself and finally designed several architectural alternatives for the reconstruction. But probably the most relevant in these Seminars, we took the previous to a "hands-on" experience, only possible due to the support of our local partner Programa de Políticas Públicas UC and our main sponsor Deutscher Akademischer Austausch Dienst, DAAD. This approach has of course a variety of methodological and logistic implications, the main of which is probably the students' engagement and learning experience. The gap from the classroom to reality disappears for a month or two, and there we are in the end of the world giving our vision a chance to exist for a first time. From time to time we are exhausted, dirty, hungry, but we are always excited, motivated and eager to work.

Conclusions should be approached in three different levels the design and build seminar, application of the hypothesis and repercussions in the commune of Chanco: learning process; hypothesis testing and local relevance.

1. Design and Building Workshop: a learning process

The process covered by the Seminars goes from design speculation to testing through construction, and it intends to exemplify (given the scale) the dynamics and complexity of the architects' work. The discipline of architecture is bound to many, often diverging requirements and restrictions during the process that goes from conception to completion. To achieve a built result takes often several years, and most of the times it is not accomplished. Therefore, there is an intrinsic value of a design studio that includes completion through construction. This is –of course- reflected on the commitment and enthusiasm of the students and is a most valuable "extra" for any learning experience.

In the case of the Reclaiming Heritage Project, there are also social components that make the whole more complex, yet these components -if well managed- can also bring resources to the whole project.

The process of actual building brings a new layer of achievement in learning. While the mental process of design consists of doing and reflecting on the drawn or modeled, when this is confronted with reality in the day to day problems in the construction site, it is inevitable to have further reflections about the previous work. Probably in these cases the reflections and the learning is even more valuable than the product itself. Not only did students manage to materialize a design idea, but they also got to do the craftsmanship, having then a full comprehension of the nature and complexities of the building process.

Conclusions

Fig. 1: Carolin Rachel, student of the design seminar at the TU, testing ways of adapting old adobe bricks into new ones by sawing them (picture from Reclaiming Heritage Team)

2 Heritage reclamation: testing our Hypothesis in the field

The Hypothesis of the Reclaiming Heritage, in principle, can be approached in several ways, depending on the scale and focus. It could be said that there is a symbolic approach, craftsmanship (given a small scale) and an Industrial (given a large production scale). Independently of these, the main idea remains; recovery of a previously existent set of cultural or social values, by using the preceding materiality, underlining the advantages and improving the technique. The case of Chanco, in a first stage, was approached with a craftsmanship type of intervention. The material mapping and recovery process was done with care and in parallel to the design, meaning that the materials that were recovered were evaluated and carefully adapted to the material necessities of the project. Although the process proved to be cost-effective when it comes to saving in construction material, the delicacy of the craftsmanship and the ongoing adaptation to a design, in situ, required long time and turned to be similar to a restoration procedure. Although there were some symbolic elements to the built work (like in the case of the stamped concrete floor, see chapter 5), the project remained to be a pavilion that tested construction techniques. Most of the reclaimed materials were used in a very functional way, where the essence of the elements was not changed and the material was barely processed or adapted.

Even though the adaptation of the theory had a richer diversity during the seminar (given the freedom of speculation), the outcome of the workshop had to be limited by shortage of resources. Yet it was because of the nature of our hypothesis, that we were able to pull the project off, with little resources, there was almost no need for material budget.

Fig. 2: Symbolic adaptation of the Reclaiming Heritage theory, by stamping the concrete floor with old wooden planks obtained from the fallen houses. (picture from Reclaiming Heritage Team))

3. The commune of Chanco: local relevance.

According to the Special Handbook for the HZ of Chanco (CMN[2], 2001), the most relevant feature of the area as a whole is the relation and continuity of the facades of the building that as a hole dictate the livelihood of Chanco. Facades regulate the transitions between public, semi-public and private spaces. Also, the internal economical system of the town was based façade orientation, with commercial spots facing the streets. By doing so, urban security and urban activity was incentivized. Fig 4 shows the physical existent vs. the voids. The figure of the old Colonial houses shows the clear containment of the orthogonal streets. In this traditional scheme, the houses functioned as a border between the core of the blocks and the street.

The image of Chanco is now diffuse. The visible continuity of the streets is interrupted by the emptiness. Fig 5 shows the contrast between structural loss after the destruction of the earthquake and after the demolitions. To reveal the disruption of continuity in another way, the view of a street that previously had houses and porches and now has empty plots.

A thorough analysis of Chanco's current morphological state and predictions based on this should be developed based on the amount of physical heritage lost and the assumption that the HZ is relevant to the urban harmony and the street livelihood.

It can be said that this is the result of trying to reconstruct the old large houses with an insufficient subsidy amount for the new ones. To recover the facades and the core of the blocks of Chanco's Heritage Zone, a much larger subsidy should be allocated. This insufficient subsidy is partly the result of the reconstruction processes guided by a Government-subsidized system that cannot cover all the expenses for the houses as they existed before the earthquake.

The production of a housing prototype that tests certain techniques is only another step in order to achieve a more sensitive post disaster reconstruction. For the moment there is already an academic achievement, the problem of Chanco is understood, yet the repercussions of a test prototype are still uncertain. For the moment several links have been made with the local Government and other Organizations from Chile, there is an effort to obtain funding for the development of a series of houses, however if this was to be made considerations and changes (based on the previous experiences) on how to apply the Reclaiming Heritage concept remain to be explored.

Fig. 3: Adapted frames, columns and beams in the material test prototype (picture from Reclaiming Heritage Team)

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