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SOSTierra Project. Initial results

C. Mileto, F. Vegas López-Manzanares, L. García-Soriano & V. Cristini
Instituto de Restauración del Patrimonio, Universitat Politècnica de València, Spain

ABSTRACT: The aim of the SOSTierra Project (Restoration and Rehabilitation of Traditional Earthen Architecture in the Iberian Peninsula. Guidelines and tools for sustainable intervention) is to investigate the possibilities of compatible, respectful, and sustainable conservation and re-use of non monumental earthen architecture in the Iberian Peninsula, shunning standard foreign solutions and prioritizing options which respect technical and cultural diversity and the lessons in future sustainability. Traditional architecture, and especially earthen architecture, can provide important lessons for a broad concept of sustainability in the modern world. Expert analysis and evaluation of the interventions in the different fields uses a multidisciplinary methodology to draw up guidelines and a list of tools (manual, website, exhibition, symposiums, etc.) to guarantee the actual transfer of the project results to the specialists and society in general through the relevant administrations and official bodies.

1 INTRODUCTION

Earthen architecture is a major part of the monumental and non monumental architectural heritage of the Iberian Peninsula. The rich geography, geology, climate and language of the Iberian Peninsula is reflected in the wide range of techniques used in this architecture (rammed earth, adobe, framework, cob, cut earthen blocks, reeds, *launa* clay, etc.) and in the different local variants (Maldonado & Vela 1999) which are developed depending on available materials and integration with environmental and cultural surroundings (Sanz 1996). For some time earthen architecture in the Iberian Peninsula has been studied in both monuments and dwellings. However, these studies are often carried out at a one-off localized level and are rarely shared at peninsular level.

In addition, the restoration of earthen architecture has focused mostly on the restoration of monuments. In most cases, these have been localized and isolated experiences. Efforts have recently been made to combine these experiences (Mileto & Vegas 2014), within the project "Restoration of rammed earth architecture in the Iberian Peninsula. Criteria, techniques, results, and perspectives" (ref. BIA 2010–18921), funded by the Spanish Ministry of Science and Innovation (2010–13), and directed by the authors of this text. This research has provided the first opportunity to share the criteria, techniques and results of restorations carried out on rammed earth monuments, and has become a national point of reference. However, there are fewer examples of interventions carried out in the field of restoration and rehabilitation of non monumental earthen architecture in the Iberian Peninsula. These tend to be private undertakings, rarely coordinated with others, and carried out spontaneously by local specialists and companies.

Despite all the above, no systematic studies have been carried out on vernacular earthen architecture in the Iberian Peninsula to provide an overall assessment of its actual possibilities for conservation, restoration, and functional rehabilitation, or to propose compatible solutions for the recovery of constructions. It should also be noted that the restoration of traditional non monumental architecture is now subject to special attention from the Spanish Ministry for Culture which through the Spanish Cultural Heritage Institute (IPCE) and a panel of experts, has developed the Spanish National Plan for Traditional Architecture.

With this in mind, the four-year project "SOSTierra. Restoration and rehabilitation of traditional earthen architecture in the Iberian Peninsula. Guidelines and tools for a sustainable intervention" was funded by the Spanish Ministry of Economy and Competitiveness (BIA2014-55924-R) and initiated under head researchers Camilla Mileto and Fernando Vegas in January 2015. The overall aim of this research is the investigation of the possibilities of sustainable restoration and rehabilitation compatible and respectful with the existing non monumental traditional earthen architecture in the Iberian Peninsula. This should avoid standard alien solutions, while favoring options that respect technical and cultural diversity and its lessons in future sustainability.

2 AIMS OF THE PROJECT

This project aims to study the current situation and restoration and rehabilitation interventions carried out to date in earthen traditional architecture in order to propose real solutions and tools for the efficient recovery of this architecture. These should take into account the needs for habitability and structural and energy efficiency, while ensuring compatibility with heritage, constructive, environmental, and sociocultural values.

2.1 *General objectives*

The three main objectives of this research project are:

1. To contribute to the valorization of traditional earthen architecture in the Iberian Peninsula as an architecture suited to the modern world, while rich in cultural, technical, bioclimatic, and environmental values. In order to achieve this general objective it is essential to research and promote this architecture on a national and international level and not be limited to localized research.
2. The main objective of the project is to encourage the sustainable conservation and restoration of traditional earthen architecture in the Iberian Peninsula. There is currently little awareness among all the agents (administrations, specialists, owners, companies, etc.) of the criteria and techniques to be used in restoration or of rehabilitation interventions that are compatible with the traditional building but also meet the current required standards.
3. To contribute to the valorization of traditional materials and techniques and their use in the restoration of traditional heritage. Traditional earthen architecture uses local materials and the traditional techniques best suited to environmental conditions and using local labor.

2.2 *Specific objectives*

The three general objectives specifically cover five further objectives:

2.2.1 *Data collection on traditional non monumental earthen architecture in the Iberian Peninsula*

The information currently available for this type of architecture in this context is currently scattered or found in general atlases of architecture. It is necessary to collect all available information, drawing up a detailed map of the techniques and materials used in this heritage and defining constructive families that are of use in the analysis and proposal of compatible interventions.

2.2.2 *Exhaustive data collection and creation of a database for interventions carried out in the traditional non monumental earthen architecture in the Iberian Peninsula*

Data will be clearly organized in a database according to constructive families and type of intervention with a view to identifying the most common problems requiring intervention guidelines.

2.2.3 *Fine-tuning and application to case studies of a methodology of analysis and assessment of the interventions*

This multidisciplinary methodology will cover the different aspects involved in the restoration and rehabilitation of traditional earthen architecture. The methodology will be applied to the selected case studies, but will also be exportable to any other geographic and architectural contexts to evaluate interventions on traditional architecture.

2.2.4 *Drafting guidelines for the restoration and rehabilitation of traditional earthen architecture*

These guidelines will be based on the results of the research carried out. The aim is to create a specific body of knowledge on criteria and techniques for intervention applicable to interventions in non monumental traditional earthen architecture in the Iberian Peninsula. This knowledge will also be partly transferable to vernacular architecture in other materials and in other geographical settings (rest of Europe, Maghreb, Middle East, America, etc.)

2.2.5 *Transmission of acquired knowledge and training professionals and students*

This knowledge will be transmitted through the different actions proposed: holding round tables and dissemination seminars, publishing proceedings and websites, books, an exhibition and any actions derived from it (seminars in masters', talks in professional colleges and schools linked to the exhibition, lectures in courses, conferences, publication of articles and book chapters, promotion of research work and doctoral theses, practical workshops, etc.).

3 PROJECT METHODOLOGY

The analysis and assessment of interventions uses a multidisciplinary analysis based on a qualitative analysis of cases studied, backed by poly-methodological data collections combining the review of all publications, the study of archives from administrations, fieldwork, compilation of catalog fiches, visits to restoration work, interviews with specialists, and experimental research in specific scientific-technical fields. Case studies were confirmed using a three-level methodology: a first level

of general study on a broad database which aims to cover as many cases of non monumental earthen architecture as possible throughout the Peninsula; a second level of case studies, only covering cases in which interventions have been carried out in recent decades; a third level exploring the different disciplines within a small sample of cases.

The first level consisted in the compilation of information from different sources (bibliography, web pages, networks, consultation with experts, etc.) and the creation of an extensive database on non monumental earthen architecture in the Iberian Peninsula. This database gathered information in the peninsular territory using a specific fiche (see point 4 of this text).

The second level focused on the analysis of intervention criteria and techniques in the intervened cases. For this, all the fiches collected to date were analyzed to ascertain the dynamics, types, criteria, materials, and techniques for intervention, as well as any problems following intervention.

Finally, the third level is a detailed study of the interventions carried out in a selection of case studies chosen from the interventions cataloged and analyzed in the first phase. These cases are analyzed from different perspectives: geographical, cultural, and architectural contexts; materials and techniques used in the construction of the building; intervention carried out according to the criteria, materials, and techniques used; structural behavior before and after intervention; climate and energy efficiency; regulations, etc.

After this analysis with successive zooms, all the data will be analyzed in detail to assess the advantages and drawbacks of each potential intervention. The conclusions will assess the suitability of each type of intervention, identifying the best types of intervention to meet the criteria for conservation, compatibility, sustainability, efficiency, etc.

The project is being carried out in parallel with other European and non-European research in countries where there is currently active policy on the restoration and rehabilitation of traditional earthen architecture, including France, Italy, United States, Morocco and Peru. The study of these situations and the results reached can be of great help in establishing the best possible approach for the problem and desirable guidelines.

Finally, the project is being intensely promoted through publications and participation in international conferences and forums, organization of seminars, webpages, etc. (see paragraph 6 of this article).

4 DATABASE FICHE

The first phase of the methodology is the collection of information through different sources, putting together a database on non monumental earthen architecture in the Iberian Peninsula. The subsequent phases are analyzed on the basis of this extensive compilation of cases throughout the peninsular territory.

The fiches used to catalog the cases in this database have been structured into six distinct blocks: a first block with general data on the building, its architecture, constructive morphology, and integration into the landscape; a second block on the environment surrounding the building; a third block analyzing the constructive techniques and variants used in the construction of the building; the fourth block is dedicated to the assessment of current pathologies in the buildings and the reasons for intervention; the fifth block, the main body of the fiches, analyzes the restoration, type of intervention and constructive techniques used in the building depending on the area intervened; while the sixth and final block features photographic documentation of the building.

5 INITIAL RESULTS OF THE PROJECT

To date over 675 fiches have been collected from forty-one provinces and fourteen communities and this data collection will continue throughout the project. The extensive database has allowed further research on constructive techniques in the Iberian Peninsula. In addition restoration actions in progress were analyzed to determine their eventual suitability and efficiency and assess what aspects could be modified to ensure better conservation and valorization of the earthen vernacular heritage.

5.1 *Constructive materials and techniques*

The initial compilation of all the information relating to materials, constructive techniques, and variants used in earthen architecture in the Iberian Peninsula was carried out to obtain geographical distribution mappings of the different constructive variants, which have been grouped by family: rammed earth, cob, excavated architecture, adobe, sod, cut earthen blocks, framework, renderings, roofs) (Figs. 1–3).

This synthesizing approach makes it possible to further examine the authors' previous mapping of the land (AA.VV. 2005, Mileto et al. 2011, Mileto et al. 2012, AA.VV. 2015), establishing correlations between techniques and variants and territorial, geographical, historical, and cultural factors.

5.2 *Intervention dynamics*

The analysis and assessment of the interventions carried out was based on a selection of interventions

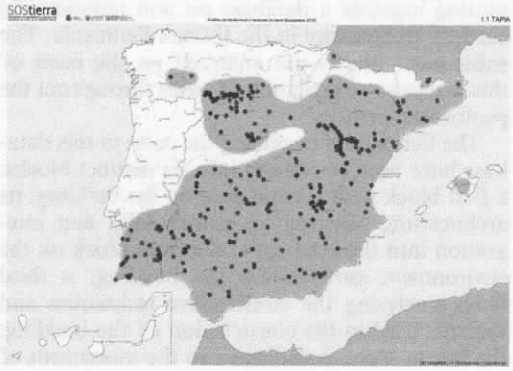

Figure 1. General geographical distribution of the constructive technique of rammed earth (data updated in May 2017).

Figure 2. General geographical distribution of the constructive technique of adobe (data updated in May 2017).

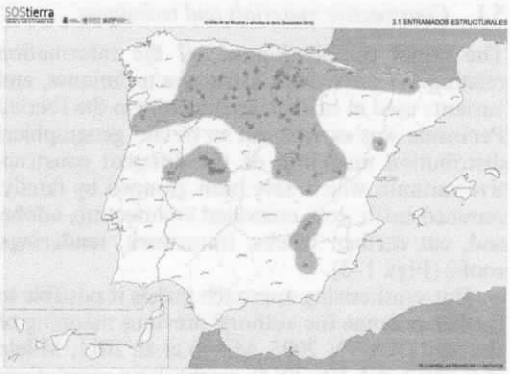

Figure 3. General geographical distribution of the constructive technique of framework (data updated in May 2017).

carried out in the 1970s and 1980s. These took the database as a starting point, at a time when there was already a break with constructive tradition. To date 125 cases have been examined. In this sample, data were cross-referenced to identify the general intervention dynamics in traditional earthen architectural heritage. The first chart of the current situation was based on this study.

The fiches produced to analyze interventions incorporate seven different types of intervention (maintenance, repair, restoration, partial rehabilitation, complete rehabilitation, expansion, demolition), as well as recording whether the intervention was premeditated or spontaneous. The interventions cataloged were analyzed in an attempt to identify the reasons for the different types of intervention in relation to the different materials and techniques. This provided an initial framework of the intervention dynamics and their motivations.

Maintenance (which accounts for 34.8% of cases) linked to buildings in use as a main residence or second home, is usually a continuum of the materials found in the dwelling, and does not involve major transformations. In general these are small interventions to repair damage, patch up the roof, paint or fix the facade, check exterior joinery, adapt bathrooms and kitchens, etc.

Repair (which accounts for 21.8% of cases) is not necessarily linked to buildings in use but is generally connected with one-off interventions on specific structural problems (cracks, collapses, deterioration of the roof) which in time would bring the building to a state of ruin. These urgent repair interventions show that the building has an owner, even if it is not used continuously or regularly.

The actions for partial rehabilitation (21%) are generally linked to chance interventions. These are mostly cases of recovery of a part of the building to be used as a store or restaurant, or as housing units on the upper stories. In addition, numerous interventions for complete rehabilitation have also been found (14.6%). In most cases these were linked to subsidies for the recovery of dwellings or rural houses or in some case to the creation of a community center.

Given their spontaneous nature, interventions for expansion or heightening (4.9%) resort to new materials without paying attention to the finishes. These interventions generally answer to functional needs such as the construction of a garage or the construction of an additional floor to extend a very small residence.

Interventions for restoration, which are very few (1.4%), correspond to exceptional situations linked to the recognition of the heritage value of the building or construction. This is the case of vernacular buildings recognized as representative elements of a past culture (Corral del Puente in Soria) or buildings which are virtually monuments such as some Andalusian *cortijos* or large country houses (Hacienda de los Maestre in Seville). There are also some cases of entire groups of buildings undergoing major

conservation and restoration action. One example of this is the village of Calatañazor in Soria, protected as historical and artistic heritage from 1962.

Finally, the cases of demolition of these buildings are almost always connected to replacement intervention (1.5%), often with neo-rural buildings which are a pastiche of traditional forms and materials using new materials.

5.3 *Detailed selection of case studies*

This first general overview has provided examples for identification and further study using a multidisciplinary methodology. As these are not monuments, there tends to be no detailed documentation for plans or construction work, which makes it extremely difficult to record the process of intervention. Studies are often based mainly on the results of the interventions themselves. Three types of examples have been selected: specific geographical regions or areas, detailed case studies of interest for the type of intervention executed, and buildings connected with specific scientific-technical studies.

To date eleven examples have been found based on the type of restoration or maintenance carried out: historic nuclei (Molezuelas de la Carballeda and Calatañazor in Castilla y León), housing that has been maintained and is in use (Béjar in Castilla y León, Serpas in Alentejo, Argamasilla de Alba in Castilla La Mancha, Feria in Extremadura), buildings restored for tourism use (Hacienda del Maestre in Seville, Corral Cañada Real de Palencia, a hostel in Avís, a restaurant in Alcobaça in central Portugal, the Casa da Rua Nova in Guimaraens in northern Portugal). These cases are being studied in detail to establish the factors which have contributed to an exemplary intervention.

5.4 *Scientific-technical studies*

Finally, numerous specialist studies have been carried out to further explore specific scientific and technical aspects in some selected cases. This final approach examines studies in structural behavior (Alonso et al. 2017), energy efficiency and bioclimatic behavior (Barbeta et al. 2017), and eventual adaptation of the intervention to regulations on accessibility and acoustics, as well as general compliance with the technical code (González et al. 2017).

This project has the necessary technology for this analysis (thermographic camera, hygrometer and dataloggers) and the cases have been selected taking into account the characteristics suitable for study (use, facade orientation, number of stories, insertion in the city) (Serrano et al. 2017).

Special attention was paid to facade orientation, which is closely linked to the use of thermal inertia in earthen walls, in the analysis of thermal behavior of the earthen buildings selected. Thus, preference has been given to cases where the main rammed earth facade faces south, receiving solar radiation for more hours of the day and so accumulating more heat, which is progressively transferred to the inside. The dataloggers were placed in areas with average shade in the facade to ensure maximum reliability of results. Thermographic cameras were also used to study the lesions visible in the earthen walls of the buildings selected, as well as latent decay phenomena in order to obtain additional information on the behavior of the building and to confirm the results of the energy simulations.

Following cross-referencing of the results, restoration proposals will be established for the earthen buildings studied, bearing in mind the consumption goals of the Horizon 2020 program, respecting vernacular heritage and showing compatibility with traditional techniques in terms of material, construction, structure, and energy efficiency.

6 PROMOTION OF THE RESULTS OF THE PROJECT

6.1 *Seminars*

To date two round tables, "Seminarios SOStierra", have been held. Project researchers, members of the work group and many collaborators in the project took part as guest speakers. The first seminar was held at Universidad Politécnica de Valencia on 12, 13 and 14 November 2015. The second was organized at Universidad Politécnica de Madrid on 20, 21 and 22 April 2016 (Fig. 4).

These seminars have also included reflections and comparisons between the current situation in

Figure 4. Posters advertising the seminars.

Figure 5. Project webpage.

the Iberian Peninsula and other countries, crucial to the internationalization of the research.

6.2 *Webpage of the project*

The webpage for the research project (sostierra.blogs.upv.es) has been designed and set up with a description of the project and objectives, group researchers, seminars carried out, etc. (Fig. 5). The website also provides downloadable fiches in the set database format so that anybody wishing to collaborate and provide information can fill these out and send them.

7 CONCLUSIONS. RESULTS FORECAST FROM THE RESEARCH

The results of the project will constitute a scientific advance in several fields. Firstly, they will take a major step forward in terms of global knowledge of earthen traditional architecture all over the Iberian Peninsula. In addition, the analysis methodology for this traditional architecture will be improved including parameters for sociocultural, constructive, bioclimatic analysis, etc.

Secondly, major progress will be recorded in the collection of results of the interventions carried out in these buildings to date, as well as in the implications of the application of regulations in different fields. The multidisciplinary methodology for the analysis and assessment of these interventions will be a major scientific contribution.

Thirdly, the detailed analysis of the interventions will lead to progress in each of the disciplines involved (human sciences, structures, construction, conservation, bioclimate, energy, etc.), which are developing analysis and assessment protocols adapted to research in traditional architecture. Moreover, the results of this research will have major technical impact, providing tools for the administrations and specialists involved in the restoration and rehabilitation process for covering interventions in traditional earthen architectural heritage. The results—guidelines as well as a future book and exhibition—will provide basic knowledge for carrying out sustainable actions compatible with this type of heritage.

NOTE

This work is part of the research project "Restoration and rehabilitation of traditional earthen architecture in the Iberian Peninsula. Guidelines and tools for a sustainable intervention", funded by the Spanish Ministry of Science and Innovation (Ref.: BIA2014-55924-R; main researchers: Camilla Mileto and Fernando Vegas López-Manzanares).

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