

PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON RAMMED EARTH  
CONSERVATION, RESTAPIA 2012, VALENCIA, SPAIN, 21–23 JUNE 2012

# Rammed Earth Conservation

*Editors*

**C. Mileto, F. Vegas & V. Cristini**  
*Universitat Politècnica de València, Spain*

 **CRC Press**  
Taylor & Francis Group  
Boca Raton London New York Leiden

CRC Press is an imprint of the  
Taylor & Francis Group, an **informa** business

A BALKEMA BOOK

## Restoration of rammed earth architecture in the Iberian Peninsula: Ongoing research

C. Mileto, F. Vegas López-Manzanares, V. Cristini & L. García Soriano

*Instituto de Restauración del Patrimonio, Universitat Politècnica de València, Valencia, Spain*

**ABSTRACT:** The Iberian Peninsula represents the geographic area of Europe with the largest amount of architecture built out of rammed earth. For some time now, all the variants of this building method have been studied and yielded very important results. On the other hand, quite a few interventions have been carried out on historic rammed earth buildings. We can affirm that since the nineteen eighties, more and more interventions have been carried out on rammed earth constructions, both monumental and vernacular, all over the Peninsula. The interventions performed on this historic heritage have been different as regards reconstruction, conservation, repairs, substitution, structural consolidation, etc. The criteria, techniques, materials and actions put into practice have also been different. The research presented here strives to pool the experiences of restoring the monumental architectonic heritage in the Iberian Peninsula in order to learn from these interventions and draw conclusions and perspectives for the future.

### 1 FOREWORD

The research presented below is being carried out thanks to the project “La restauración de la arquitectura de tapia en la Península Ibérica. Criterios, técnicas, resultados y perspectivas” (The restoration of rammed earth architecture in the Iberian Peninsula. Criteria, techniques, results and perspectives, ref. BIA 2010-18921), granted by the Spanish Ministry of Science and Innovation under the National Grant Scheme for the year 2010. The research put into practice aims to analyze the restoration works carried out from the eighties until the present in order to evaluate the criteria and techniques used and the results obtained over the years, along with the evolution these criteria and techniques have undergone over the years. The initial date is in the eighties, since it coincides with the arrival of democracy in both Spain and Portugal and the political and administrative changes that came about and the different intervention policy on monuments that ensued regarding the criteria and the professionals involved. The analysis has been carried out from a multidisciplinary point of view, involving researchers and collaborators from different fields: architects, quantity surveyors, archaeologists, historians, art historians, restorers, engineers, petrologists, etc. The research team also relied on the important collaboration of scientists, whose mission was to oversee the project at all times.

### 2 GROUNDS AND REASONS FOR THE RESEARCH

In the last thirty years, many interventions have been carried out in the Iberian Peninsula on our monumental rammed earth architectonic heritage. Thirty years ago, when the first actions were carried out (Niebla City walls, 1979), there was a scant corpus of knowledge about building techniques, but still less was known about the sort of interventions to carry out. In time, the professionals and technicians who took part in this type of architecture experimented with criteria and techniques related with their knowledge and experience to achieve the best possible results.

The intervention criteria, the techniques used and the results obtained have been diverse, but in many cases it was not possible to consult the experience of other technicians because knowledge and experiences were fragmented by the geographic distance between professionals. At the present time, the conservation of rammed earth architecture from the point of view of the criteria and techniques used has hardly been studied at all from a general point of view (Viñuales 1981, Odul 1993, Warren 1999; Warren 2001, Pignal 2005, AA.VV. 2004, AA.VV. 2008, Boussalh 2005, Correia 2007, CRATerre 1993, Guillaud 2001, Graciani 2008), although there are many publications about the restoration of several concrete examples of intervention on certain monuments (Niebla City Walls, Toral de los Guzmanes, Granada City Walls,

Sevilla City Walls, Bétera Castle, Murcia City Wall, etc.), addressing the reasons for the intervention, the criteria followed and the techniques used (Guarner 1982, Guarner 1987, Jurado 1987, Guarner 1991, Jurado 1991, Algorri 1994, Gallego 1993, Gallego 1996, Cabeza 1996, López Martínez 1998, López Martínez 2001).

Therefore, the original hypothesis of this research consists in sharing experience to generate knowledge within reach of everybody, both regarding the specific criteria to follow in the restoration of rammed earth architecture and the techniques used and the difficulties involved in their use. The idea is to provide valuable information for the technicians who have to work on this sort of architecture based on the experience of others, where we can learn from both successes and errors.

### 3 AIMS OF THE PROJECT

Any sort of study, however in-depth and multidisciplinary, or any intervention methodology, however serious and rigorous it may seem, is no guarantee of a correct intervention in the architectonic restoration process. Preliminary studies of a building with an enormous amount of detail sometimes result in interventions that distort its essence or character. This occurs because the discipline of restoration is not an exact science and the restoration project belongs in another disciplinary sphere that lacks the credibility and impartiality of science. At this point, it is necessary to address the intervention criteria that must be based on the principles of the discipline of restoration and guide the actions of the project designer (Vegas 2011).

The definition of the basic principles of the discipline of restoration can be found in several authors (Carbonara 1997: 451–51, Jokilehto 1999: 295–304, Earl 1996: 80–118, Doglioni 2008: 85–103), who coincide on important issues. These general disciplinary principles make it possible to control the impact of the intervention regarding the conservation of the building, that is, to control the degree of change and therefore the relationship between the situation before and after the intervention (Doglioni 2008: 89). Among these general principles we can include: the conservation of the authenticity of the historic-cultural document; the minimal intervention; the reversibility of the intervention; the compatibility of the intervention in all its aspects (material, structural, functional, aesthetic, etc.); the durability of the intervention; current expressiveness and distinguishability. The relative importance attached to these principles involves

different kinds of intervention, leading to different criteria, regardless of the specific case study addressed. The criteria that lie at the basis of the reflection about the project also influence or should influence the choice of actions in the intervention (protection of the coping of a wall, underpinning, opening up of a new bay, etc.) and the execution modalities or techniques employed.

The general and principal aim of the proposed research is to define, based on general intervention principles, specific criteria for the restoration of rammed earth architecture and the analysis of the techniques used in order to obtain guidelines for future interventions.

Furthermore, this research aims to obtain a series of specific objectives that could be summarized in the following categories: (a) a comprehensive database of interventions performed in the Iberian Peninsula in the last thirty years on historic monumental buildings and sites built partially or entirely out of rammed earth; (b) a comprehensive compilation of unpublished information about the state prior to restoration, the project, the works and the state after the works of a selection of interventions carried out in the Iberian Peninsula in the last thirty years on historic monumental buildings and sites built partially or entirely out of rammed earth; (c) the drawing up of a methodology for the analysis of the intervention criteria and techniques useful for the study and analysis of the cases selected but that can also be used in any other geographic and architectonic context where intervention criteria are to be evaluated; (d) the drawing up of guidelines for intervention on monumental rammed earth architecture in the Iberian Peninsula through the knowledge gleaned during research and directly applicable in future interventions; (e) the transmission of the knowledge acquired and training of professionals and future professionals through the actions of the program and other actions arising from it (seminars in master's degrees, talks in professional associations and schools connected with the exhibition, lectures in courses, congresses, conferences, publication of articles and chapters of books, promotions of research work and doctoral theses, etc.).

When all is said and done, the ultimate objective consists in contributing by means of the knowledge learned and the reflections made to the conservation of the abundant monumental and other rammed earth architectonic heritage in the Iberian Peninsula. Thanks to the knowledge acquired by shared observation, new interventions can be planned on the basis of past experience, by perfect familiarity with the successes and failures and the durability of the possible options.

#### 4 METHODOLOGY USED IN THE RESEARCH AND THE FIRST RESULTS OBTAINED IN 2011

The methodology chosen for the research is founded on the analysis of case studies with a qualitative method on the basis of abundant information gleaned from different primary sources (interviews and information directly provided by the agents involved in the restoration of the buildings) and secondary sources (other possible sources of information), both direct (the restored buildings themselves) and indirect (bibliography, documentation in archives, project documentation, etc.).

From this point of view, the research is based on three fundamental stages, divided in turn into different tasks that define all the sections of the research in detail, each of which corresponds to the development over a one-year period approximately:

1. Compilation of information (preparation of a database with the most complete list possible of works carried out; a list of a selection of interesting cases; compilation of as much information as possible; visits to the buildings restored; physicochemical analyses; material characterization testing and treatment evaluation testing).
2. Case analysis, reflection and experience sharing (analysis and evaluation of cases with a multidisciplinary method; compilation of a detailed data sheet of each intervention; a comparative analysis of the interventions; organization and holding of meetings for reflection; publication of the minutes of the meetings).
3. Production and diffusion of the corpus of knowledge (drawing up of the general guidelines for the restoration of monumental rammed earth architecture in the Iberian Peninsula; publication of the results of the research; setting up of a website to permit the diffusion and implementation of the results of the project; organization and setting up of an exhibition). Below we shall address the stages of methodology and the first results found in 2011, based mainly on stage 1 of the research.

##### 4.1 *Compilation of information*

In the first place, at this stage of the research, a database has been created containing a file designed in a specific manner with fields in which to classify the works completely. The fields are divided into three sections: general data about the building (name of the building, address, autonomous community, GPS coordinates, ownership, type of building, description, building technique(s), photographs), general data about the intervention (author(s), title of the project, funding agency, estimated cost), intervention techniques used

(foundations, structure/walls, cladding, coping, other elements), current state of the intervention (presence of damp, presence of salts, loss of mass, cracks, etc.); intervention criteria. So far 230 buildings located all over the Iberian Peninsula have been recorded (Fig. 1). This number may increase during the course of the research. To compile the files in the database we have drawn from different types of sources, depending on the type of information sought. In the first place, the aim was to identify restored rammed earth buildings scattered all around the peninsula, and, in the second place, to compile a minimum amount of information in the database files so as to be collect the data necessary to catalogue them. All the researchers in the project and the group of scientific collaborators participated, as well as all possible contacts of researchers, professionals, administrations, associations, etc. that could be reached. Furthermore, the lists of the following archives were consulted: the Institute of the Cultural Heritage of Spain, the Ministry of Culture and the Ministry of Development (1% Cultural Plan and the so-called Plan E). At the following stage of the research planned for 2012, the databases of the autonomic administrations will be consulted (Generalitat Valenciana, Junta de Andalucía, Gobierno de Aragón, etc.).

On the other hand, using the database previously created, a first selection of interesting cases was drawn up, which may increase in the future depending on the interest that may be aroused by the new cases introduced in the database. The selection of the first approximately 50 cases was based on: the interest of the building, the interest and importance of the restoration works, the variety of building techniques used, the presence of different interventions carried out at different times, etc. For the buildings selected, a detailed file was drawn up to contain the information necessary to analyse the intervention criteria and techniques and the results of these. The files were drawn up by the architects,



Figure 1. Location of the buildings catalogued up to date and introduced in the data base.

architectural technicians, restorers, companies involved in the restoration process or researchers who had participated in the cases or studied them in detail. In order to compile information in a satisfactory fashion for both the database and for the cases selected, some of the buildings were visited.

#### 4.2 Analysis of the cases, reflection and experience sharing

As regards the second stage of the research, most of which will be carried out in 2012, analysis and evaluation of the cases are already under way. This task has been informed as a multidisciplinary analysis (history, archaeology of architecture, construction, chemistry and petrology, architectonic restoration and conservation, restoration and conservation of materials, etc.) aimed at identifying the intervention criteria and techniques used and evaluating the results. In this first year, a rough draught has been made of the analysis and evaluation methodology of the cases of intervention, based, after a general study of the case (intervention dates, budget, funding institution, architects and agents taking part in the intervention etc.), on the study of five main sections that define the study of the building and the intervention on it.

On the one hand, the plan is to study the parameters related with the building itself. In the first place, the architectonic and construction characteristics

of the building and especially the building technique (rammed earth, lime washed, with *brencas*-undulated reinforcement-, in Valencian style -brick- or stone-reinforced rammed earth-, with added stones, etc), since, depending on the basic building technique, a series of specific problems and pathologies arise and consequently specific intervention criteria and techniques are required (Fig. 2).

In the second place, it is necessary to identify the needs of the building itself (structural, material, functional, cultural, etc.) and especially the degradation phenomena that affect the buildings divided into structural pathologies (cracks, collapse, overloading, etc.), material pathologies (erosion, disintegration, salts, etc.), pathologies caused by vulnerability to atmospheric agents (missing coping, rising damp, etc.), anthropic pathologies (plundering, partial demolitions, etc.).

On the other hand, it is necessary to study the parameters that define the intervention on the building, which in turn can be divided into three sections. In the first place, identifying the use of a clear methodology for the intervention that makes it possible to establish a relationship between the building and its characteristics, the requirements involved in its physical, symbolic, cultural, etc. conservation and the criteria and techniques to be put into practice. In the second place, the intervention techniques used in the restoration (interventions on the foundations, walls/structure,

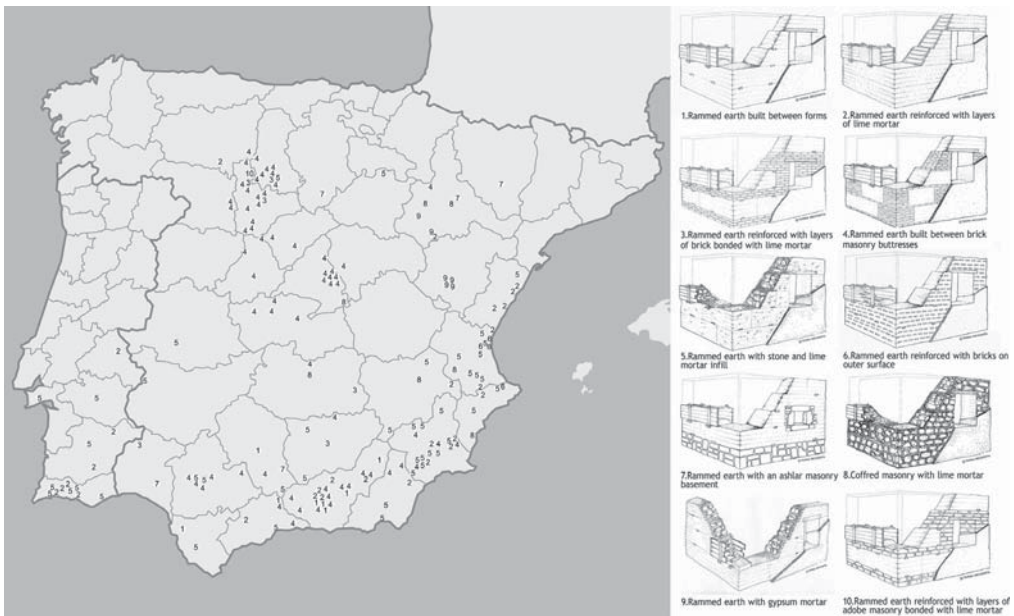


Figure 2. Variants of the rammed earth constructive techniques that appear in the case studies of the data base. (Drawings: García, Cristini, Tibor).

cladding, coping) analyzed according to the aim of the method used (structural consolidation, protection from atmospheric agents or damp, geometric or volumetric recuperation, typology, preparing the building for a new function, etc.), the materials used (traditional materials, new materials, a mixture of traditional and new materials, materials similar to the existing ones, etc.), the type of action (conservation, transformation, elimination, substitution, partial or total reproduction of the existing material, etc.), type of contact relationship (physical connection, mechanical connection, adherence or physicochemical adhesion, etc.). (Fig. 3).

In the third place, the intervention criteria, based on both the general principles of the restoration discipline (conservation of authenticity, minimum intervention, reversibility, compatibility, durability, current expressiveness and distinguishability, neutrality) and on specific criteria for intervention on rammed earth: volumetric recuperation (recuperation of the upper profile according to the original level or the erosion level, recuperation of missing volumes, etc.), substitution or recuperation of the surface, conservation of existing remains both at a volumetric and a material and surface level. These criteria are analyzed in the first place on the basis of the criteria mentioned in the primary sources (projects, interviews, files, etc.) and, in the second place, on the basis of the intervention works carried out and the techniques used. In this sense, in order to measure the criteria of reversibility, compatibility and durability respectively, the following

parameters are used: conservation of the existing material, addition of new elements without removing the existing ones, etc.; the use of materials similar to the existing ones, traditional materials; maintenance of the structural conception, etc.; lack of damage caused by the passage of time; behavior of the intervention over time), etc.

Finally, the organization of the International Conference on Rammed Earth Conservation—ResTAPIA 2012 belongs in this section, since it was created from the outset as an opportunity to meet and share experiences.

#### 4.3 Production and diffusion of the corpus of knowledge

As regards the third stage of the methodology, a website has been designed ([www.restapia.es](http://www.restapia.es)) as part of the production and diffusion stage of the corpus of knowledge. This website will facilitate the diffusion and implementation of the results of the project. It is a website that contains the aims of the project and the most relevant results but that also puts at the disposal of society (professionals, companies, researchers, etc.) not only the knowledge gleaned but also the possibility of consulting a forum of experts. The site was designed and structured with the following sections: introduction, objectives of the project and research team and team of collaborators; complete database of the monumental rammed earth architectures restored in the last thirty years in the Iberian Peninsula; an explanation of the building techniques for the variants of rammed earth constructions (drawings of details and explanations); intervention criteria and techniques (guide or protocol for intervention, details of the intervention techniques); virtual bibliography; specific bibliography with downloadable pdf texts; useful links; news blog related to the subject; an interactive space or forum for the exchange of information.

## 5 CONCLUSIONS AND PLANS FOR THE FUTURE

Now that the first year of this research has come to an end, we can conclude that all the interventions on monumental buildings in the Iberian Peninsula constructed in any possible variant of rammed earth building technique are being abundantly catalogued. Efforts are also being made to create a methodology for the analysis of the interventions based on objectivable and measurable parameters. Furthermore, we are attempting to keep the research open and participative so that any researcher or professional who so wishes can share his own experience to broaden the common knowledge. On the other hand, in the two remaining years, we intend to

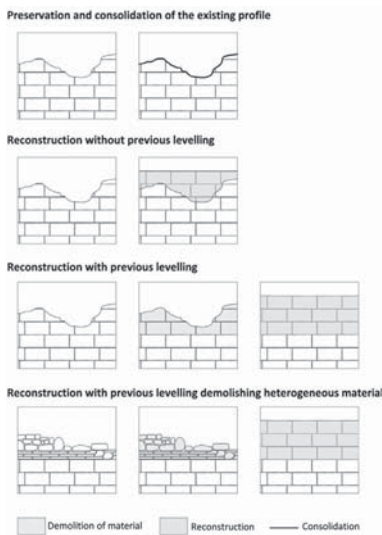


Figure 3. Example of the different constructive techniques found in the studied cases related to the different intervention criteria while building with rammed earth on top of the existing rammed earth wall.

increase the case studies and study in greater depth the cases that present characteristics of special interest in order to make a profound and concrete comparative analysis of the criteria and techniques used and results obtained over time. The final product of this broad study and analysis will allow us to draw up some guidelines for intervention on monumental rammed earth buildings as regards both criteria and intervention techniques.

## NOTE

The team of the project “La restauración de la arquitectura de tapia en la Península Ibérica. Criterios, técnicas, resultados y perspectivas” (The restoration of rammed earth architecture in the Iberian peninsula. Criteria, techniques, results and perspectives, ref. BIA 2010-18921), granted by the Spanish Ministry of Science and Innovation under the National Grant Scheme for the year 2010, is composed by: Camilla Mileto, Fernando Vegas (head researchers), Valentina Cristini, Maria Diodato, Paolo Privitera, Lidia García Soriano, all from Universitat Politècnica de València; Francisco Javier López Martínez, Universidad Católica de Murcia; Vincenzina La Spina, Universidad Politécnica de Cartagena; Francisco Javier Castilla Pascual, Universidad de Castilla La Mancha; José Manuel López Osorio, Universidad de Málaga; Amparo Graciani García, Universidad de Sevilla; José Antonio Martínez, Instituto de Historia Naval; Esther de Vega García, former member of the Instituto del Patrimonio Cultural de España; Mariana Correia, Escola Superior Gallaecia; Maria Fernandes, University of Coimbra; Hubert Guillaud, CRATerre—University of Grenoble.

## REFERENCES

- AA. VV. 2004. Los castillos. Reflexiones ante el reto de su conservación; Actas de las Jornadas, Alcalá la Real, Jaén, 26–28 may 2004.
- AA.VV. 2008. *Terra Incognita. Préserver un Europe des Architectures de terre*. Bruxelles: Culture Lab Editions & Lisboa: Argumentum.
- Algorri, E. 1994. Tres soluciones en la restauración del Palacio de Toral de los Guzmanes, Leon, España, *Informes de la construcción*, n. 434, pp. 27–38.
- Boussalh M., Mustapha J., Guillaud H., Moriset S. 2005. Manuel de conservation du patrimoine architectural en terre des vallées présahariennes du Maroc. CRATerre-EAG.
- Cabeza J.M. 1996. Restauración de las murallas islámicas de Sevilla, *BIA*, n. 185, pp. 42–50.
- Carbonara, G. 1997 *Avvicinamento al restauro*, Napoli: Liguori.
- Correia M. 2007. Teoría de la conservación y su aplicación al patrimonio en tierra, *Apuntes*, n. 20. Pontificia Universidad Javeriana.
- CRATerre-EAG and ICCROM 1993. *Bibliographie sur la préservation, la restauration et la réhabilitation des architectures de terre*, Roma: ICCROM.
- Dogliani, Francesco. 2008. *Nel restauro. Progetti per le architetture del passato*, Venezia: Marsilio.
- Earl, John. 1996. *Buildings Conservation Philosophy*, Donhead.
- Gallego F.J. 1996. La ciudad y sus murallas. Conservación y Restauración. Universidad de Granada.
- Gallego Roca F. J. & López Osorio, J. M. et alii 1993. The city Walls of Granada (Spain). Use, conservation and restoration, *7th international conference of the study and conservation of earthen architecture*. Silves, pp. 272–277.
- Graciani A., Canivel J. 2008. Técnicas de Intervención en Fábricas Históricas de Tapial, *Actas de las II Jornadas de Investigación en Construcción*, Madrid. Amiet, pp. 85–99.
- Guarner I. 1982. La restauración del recinto amurallado de Niebla, *Informes de la Construcción*, nº344–45.
- Guarner I. 1991. Muralla de Niebla, Huelva, *Jornadas sobre restauración y conservación de monumentos*, Dir. General de Bellas Artes y Archivos.
- Guillaud H. 2001. Conservation des architectures de terre. Revue de la littérature scientifique des 15 dernières années. Relatório provisório. S.l.: CRATerre-EAG, ICCROM, GCI.
- Jokilehto, Jukka. 1999. *A History of Architectural Conservation*, London-New York: Elseiver.
- Jurado F. 1987. Rehabilitación de la casa castillo de Bétera, Valencia, *Monografía* n. 385/386, Inst. Eduardo Torroja.
- Jurado F. 1991. Rehabilitación de la casa-castillo de Bétera, Valencia, *Jornadas sobre restauración y conservación de monumentos*, Dirección General de Bellas Artes y Archivos.
- López Martínez F.J., Martínez J.A. 1998. La muralla Islámica de Murcia, el tramo de las Verónicas: una obra de tapial. *Arquitectura de tierra*, Min. de Fomento.
- López Martínez F.J., Sánchez R. 2001. La muralla Islámica de Murcia, el tramo de las Verónicas: una obra de tapial, *Catálogos de Arquitectura*, n. 9. COAMU.
- Odul, P. 1993. *Bibliographie sur la preservation, la restauration et la réhabilitation des architectures de terre*, Rome: CRATerre.
- Pignat B. 2005. *Terre crue. Techniques de constructions et de restauration*. Paris: Eyrolles.
- Vegas F., Mileto C. 2011. *Aprendiendo a restaurar. Un manual de restauración de la arquitectura tradicional de la Comunidad Valenciana*. Valencia: Generalitat Valenciana. Colegio Oficial de Arquitectos de la Comunidad Valenciana.
- Viñuales, G. M. 1981. *Restauración de arquitectura de tierra*. Editorial del Instituto Argentino de Investigaciones de Historia de la Arquitectura del Urbanismo, Buenos Aires.
- Warren J. 2001. Forma, significado y propuesta: objetivos éticos y estéticos en la conservación de la arquitectura de tierra, *Loggia 12*, pp. 10–19.
- Warren, John. 1999. *Earthen Architecture: The conservation of brick and earth structures. A handbook*. ICOMOS International Committee on Earthen Architecture.