

Conservation in Earthen Heritage

Conservation in Earthen Heritage:

*Assessment and Significance
of Failure, Criteria,
Conservation Theory,
and Strategies*

By

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By Mariana Correia

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Dedicated to Andreia, Sónia, Daniel, and Jacob

CONTENTS

List of Figures and Tables	xi
Preface	xii
Acknowledgments	xiv
List of Acronyms	xvi
Chapter One.....	1
Introduction	
1.1 Introduction	
1.2 The focus on earthen heritage	
1.3 Assessment of failure in earthen heritage	
1.4 The research purpose	
1.5 Research objectives of the investigation	
1.6 Research methods approach	
1.7 Thesis structure	
Chapter Two.....	17
Evaluation of Strategies and Planning Systems in Earthen Heritage Conservation	
2.1 Introduction	
2.2 Strategies in earthen heritage conservation	
2.3 Planning systems in earthen heritage conservation	
2.4 Conclusions	
Chapter Three	44
Evaluation of Methodology of Intervention and Conservation Practice in Earthen Heritage	
3.1 Introduction	
3.2 Methodology of intervention in earthen heritage conservation	
3.3 Intervention in conservation practice in earthen heritage	
3.4 Conclusions	

Chapter Four.....	73
State of Significance of Conservation Theory in Earthen Heritage	
4.1 Introduction	
4.2 The need to address a conservation theory framework	
4.3 Principles observed in charters of heritage and international guidelines	
4.4 Degrees of intervention	
4.5 Values and significance	
4.6 Conclusions	
Chapter Five.....	101
Research Methods	
5.1 Introduction	
5.2 Research aims	
5.3 Overall methodological design	
5.4 Sample selection	
5.5 Data collection methods	
5.6 Data analysis	
5.7 Reporting the findings	
5.8 Conclusions	
Chapter Six.....	126
Conservation in Earthen Sites - Chan Chan (Peru)	
6.1 Introduction to the case study	
6.2 Architectural and archaeological significance	
6.3 UNESCO World Heritage List	
6.4 Addressing the management plan	
6.5 Conservation state of the site	
6.6 Conservation practice at the site	
6.7 Methodology of intervention at the site	
6.8 Reasons for failure identified at the site	
6.9 To recognise criteria for intervention at the site	
6.10 Addressed significance of conservation theory at the site	
6.11 Addressed strategies at the site	
6.12 Site questionnaires analysis	
6.13 Comparative issues to address between the three sites	
6.14 Summary of key issues concerning Chan Chan site	

Chapter Seven.....	149
Conservation in Earthen Sites - Ait Ben Haddou (Morocco)	
7.1 Introduction to the case study	
7.2 Architectural significance	
7.3 UNESCO World Heritage List	
7.4 Addressing the management plan	
7.5 Conservation state of the site	
7.6 Conservation practice at the site	
7.7 Methodology of intervention at the site	
7.8 Reasons for failure identified at the site	
7.9 To recognise criteria for intervention at the site	
7.10 Addressed significance of conservation theory at the site	
7.11 Addressed strategies at the site	
7.12 Site Questionnaires analysis	
7.13 Comparative issues to address between the three sites	
7.14 Summary of key issues concerning Ait Ben Haddou site	
Chapter Eight.....	168
Conservation in Earthen Sites - Arg-E Bam (Iran)	
8.1 Introduction to the case study	
8.2 Architectural and archaeological significance	
8.3 UNESCO World Heritage List	
8.4 Addressing the management plan	
8.5 Conservation state of the site	
8.6 Conservation practice at the site	
8.7 Methodology of intervention at the site	
8.8 Reasons for failure identified at the site	
8.9 To recognise criteria for intervention at the site	
8.10 Addressed significance of conservation theory at the site	
8.11 Addressed strategies at the site	
8.12 Site questionnaires analysis	
8.13 Comparative issues to address between the three sites	
8.14 Summary of key issues concerning Arg-e Bam site	
8.15 Summary of key issues concerning the three sites	
Chapter Nine.....	189
Failure and Criteria in Earthen Heritage Conservation	
9.1 Introduction	
9.2 To identify reasons for failure in earthen heritage conservation	
9.3 To recognise criteria for intervention in earthen heritage conservation	
9.4 Conclusions	

Chapter Ten	221
Conservation Theory and Strategies in Earthen Heritage	
10.1 Introduction	
10.2 To give significance to conservation theory in the field of earthen heritage	
10.3 To provide strategies concerning earthen heritage conservation	
10.4 Conclusions	
Chapter Eleven	259
Conclusions	
11.1 Introduction	
11.2 Research Objective 1: Failure in earthen heritage conservation	
11.3 Research Objective 2: Criteria in earthen heritage conservation	
11.4 Research Objective 3: Significance of conservation theory in earthen heritage conservation	
11.5 Research Objective 4: Strategies in earthen heritage conservation	
11.6 Overall conclusions	
References	270
Appendix I Site survey questionnaire.....	298
Appendix II International key-experts survey questionnaire.....	304
Appendix III Participation information sheet	308
Appendix IV Contact summary forms.....	313
Appendix V Contact theme forms	321
Appendix VI Logic models	331
Appendix VII Example of responses to survey questionnaires	333
Appendix VIII International key-experts questionnaire responses.....	342
Appendix IX Selected photos of the visit to the 3 case studies	378
Appendix X Sheet Display Diagrams.....	382

LIST OF FIGURES AND TABLES

Figures

The authorship of the images presented in the thesis is credited to Mariana Correia, except when mentioned otherwise.

List of Tables

The author of the research developed all the tables.

- Table 1.1 Addressing research objectives in each chapter
- Table 5.1 Analysis progress and flows of action
- Table 5.2 Decision criteria contributing to the selection of the sites
- Table 5.3 Principal contributors for the assessment of the sites
- Table 5.4 Decision-criteria and contributors answering to the questionnaire
- Table 5.5 International key-expert questionnaire country representation
- Table 5.6 Methods and models followed within this research
- Table 5.7 Response to site survey questionnaire
- Table 5.8 Response to the international key-expert survey questionnaire
- Table 5.9 International key-expert questionnaire addressing research objectives
- Table 5.10 Research objectives addressed at the site survey questionnaire
- Table 5.11 Example of coding, and identification of where the code can be found
- Table 5.12 Categories, themes and codes identified within this coding method
- Table 9.1 Network diagram of research objective 1
- Table 9.2 Network diagram of research objective 2
- Table 10.1 Network diagram of research objective 3
- Table 10.2 Network diagram of research objective 4

PREFACE

Worldwide, there is a vast fragile earthen heritage that is barely surviving due to serious damage and decay of the fabric. In general, it is believed that natural agents are the overall cause for failure of earthen heritage. However, when thoroughly evaluating causes of decay, it is discerned that the interventions of conservators have a major impact. According to the literature, conservators' actions towards earthen heritage have not been consistently and systematically investigated. This leads to questions about the approach to conservation, reasons why intervention mistakes are repeated, and why successful conservation results are still scarce. This investigation aims to discover reasons for failure of earthen heritage conservation; to identify consistent criteria standards for conservation intervention across identifiable indicators; to give significance to conservation theory in the field of earthen heritage; and to provide a framework concerning intervention strategies in earthen heritage conservation.

The research methodology of this investigation is based in qualitative methods and a case study strategy analysing three World Heritage earthen sites: Chan Chan in Peru, Ait Ben Haddou in Morocco, and Arg-e Bam in Iran. A combination of sources was used following a multi-method approach: published literature, unpublished reports from international organisations, collection of local data, field analysis through site observation, two different types of questionnaires, and open interviews.

The findings show consistent evidence of shortcomings due to the making of inadequate choices, lack of follow-up and maintenance, lack of preparation and confusion of roles. Mixed interpretations and lack of knowledge are also recognised as important causes of failure in the conservation approach. These findings support the claim that unprofessional practices are frequent, such as the use of universal solutions and of incompatible materials often applied by professionals without enough knowledge or experience in earthen heritage conservation.

This research suggests standards for high quality intervention through the definition of criteria for decision-making, indicators of quality and indicators of best practice, as well as clarification concerning procedures in methodology of intervention. It also stresses the importance of conservation theory in earthen heritage conservation, combining theory

and practice, as well as defining specific principles. Finally, this investigation recommends an overall strategy in the conservation of earthen heritage, with particular emphasis on an approach that integrates education, awareness, and research; anthropological conservation; scientific conservation, and preventive conservation.

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LIST OF ACRONYMS

CERKAS:	<i>Centre de Conservation et de Réhabilitation du Patrimoine Architectural des zones Atlasiques et Subatlasiques</i> (Centre for the Conservation and Rehabilitation of Architectural Heritage of Atlas and Southern Atlas Regions) (France).
CRATerre-ENSAG:	CRATerre - International Centre for Earthen Construction - <i>Ecole Nationale Supérieure d'Architecture de Grenoble</i> (France).
EAI:	Earthen Architecture Initiative – GCI (USA).
EAP:	The World Heritage Program on Earthen Architecture (UNESCO).
ESGallaecia:	Escola Superior Gallaecia (Portugal).
GCI:	Getty Conservation Institute (USA).
ICCROM:	International Centre for the Study of the Preservation and Restoration of Cultural Property (Italy).
ICHHTO:	Iranian Cultural Heritage, Handicrafts and Tourist Organisation (Iran).
ICHO:	Iranian Cultural Heritage Organisation (Iran).
ICOMOS:	International Council on Monuments and Sites.
ICOMOS-CIAV:	ICOMOS-International Scientific Committee on Vernacular Architecture.
ICOMOS-ISCEAH:	ICOMOS-International Scientific Committee on Earthen Architectural Heritage.

INC:	National Cultural Institute of Peru <i>Instituto Nacional de Cultura del Peru</i> (Peru).
NSW:	National Trust of Australia.
RCCCR:	Research Center for Conservation of Cultural Relics (Iran).
RPBCH:	Recovery Project of Bam's Cultural Heritage (Iran).
PUCP:	Pontificia Universidad Católica del Peru (Peru).
UNDP:	United Nations Development Program.
UNESCO:	United Nations Educational, Scientific and Cultural Organization.
WHEAP:	World Heritage Earthen Architecture Program.
WTO:	World Tourism Organisation.

CHAPTER ONE

INTRODUCTION



Fig. 1.1 - Failure following conservation intervention at the earthen fortress of Alcácer do Sal, Portugal (credits: Mariana Correia).

1.1 Introduction

In the last thirty years, there has been a resurgence of interest in earthen architecture, evidence being the increased number of publications; the dissemination of information through numerous conferences, seminars and exhibitions being organised worldwide; the creation of international and regional organisations, associations and networks; the broadcast of documentaries and news-reports; etc. This is due to an increase in the

number of academics and professionals working in the area (Houben and Guillaud, 1989) (Doat et al., 1985) (Minke, 1994, 2001); a growing awareness of the public (Dethier, 1981); the interest in earthen heritage preservation (Jeannet et al., 1991) (Warren, 1993) (Warren, 1999); the continuity of Terra international conferences organisation (Terra 93) (Terra, 2000) (Terra 2003) (Terra 2008); to an increased interest for postgraduate training (Trappeniers, 1999) (Alva Balderrama and Albertini, 2004); the use of the earthen material for self construction (McHenry Jr., 1992); or in housing development projects (Swenarton, 2008), or in contemporary architecture (Terra 93) (Easton, 1996) (Fernandes and Correia, 2005) (Walker et al., 2005). Matero and Cancino confirmed that “interest in the conservation of earthen heritage has escalated at a rapid rate since 1990” (2000, p.21).

Earthen architecture has an ancient history reaching back to the first settlements of humankind. This is witnessed by remains found in Jericho of adobes dated from 8300 to 7600 B.C. (Aurenche, 1993, p.73, p.77) (Sauvage, 1998, p.41) and in Çatal Höyük, Anatolia, one of the first cities to be built in adobe (Bahn, 2005, p.274). Earthen architecture also constitutes a diverse living heritage existing in almost all the continents (Oliver, 1997) (Vellinga et al., 2007), using different techniques and architectural expressions (Houben and Guillaud, 1989) (Guillaud et al., 2008a, 2008b). This rich earthen heritage represents an important component of the World Heritage Listed sites. In 2006, the World Heritage Committee stated that 25 percent of the “cultural properties inscribed on the List of World Heritage in Danger” (World Heritage, 2007a, p.2) are earthen sites, which illustrates the vulnerability of this type of heritage. At first sight the cause for the earthen heritage being at risk is the impact of natural agents (such as water, wind, earthquakes), as earthen architecture is composed of a fragile material. However, when reviewing the body of literature, it can be perceived that several threats are increasingly related to man-made actions. If this is the case, then the human agent is to a certain degree a source of decay, and can potentially contribute to failure, not just through physical causes, such as war and vandalism, but also through inadequate intervention or lack of action. This brings the need to focus primarily on the understanding of the meaning of earthen heritage.

1.2 The focus on earthen heritage

Earthen architecture is the generally used term; though there are alternative terms also in use (e.g. mud architecture, unbaked earth

architecture). However, during the 4th International Symposium on Mudbrick (adobe) Preservation held in Ankara in 1980, it was recommended that the term “earthen architecture” should be used in the future, to represent this type of architecture (Terra 93, 1993b, p.143). Earthen architecture is considered as all the architecture built with raw earth, comprising different ways of building (monolithic group, masonry group and bearing structure group) (Houben and Guillaud, 1989, p.165) using different techniques such as rammed earth, adobe, wattle and daub, cob, etc. Earthen architecture is one of the most universal and diversified built heritages of humankind. It ranges from modest dwellings and mosques in Sub-Saharan Africa, to farms and urban dwellings in the United Kingdom, to churches, factories and «chateaux bourgeois» in France, to Islamic fortresses in Portugal and Spain, to missions and native American pueblos in the USA, village settlements in China, imperial cities in Peru, “skyscrapers” of more than eight floors in Yemen, etc. (Dethier, 1981) (Warren, 1993). Earthen architecture includes vernacular and monumental heritage, contemporary architecture, self-building construction, etc.

In 1985, Doat et al. mentioned that a third of the world’s population that inhabited rural areas lived in earthen structures (1985, p.8). In 1989, Houben and Guillaud stated: “At least 20% of urban and suburban populations live in earth homes” (1989, p.6). These numbers are no longer real, in a constant changing world. In 2007, the United Nations established that half of the population lived in cities. This probably means, that 15% to 17% of the world’s population live in earthen structures. The great number of dwellings worldwide that are made of earth embrace a large variety of earthen architecture and earthen construction techniques. In the past, the building methods used depended mainly on the available soil, the know-how of the master builders, local building culture, resource availability in the region, climate and environment conditions, etc. In terms of traditional construction, a humid to dry soil mixture was used in rammed earth (compressed mixture of earth and aggregates rammed between form boards). When the soil was softer, a semi-soft paste or mud combination with dry grass or straw was used; earth was applied in wattle and daub (structure of wood or bamboo with earthen fill-in), in cob (mixture of earth with straw piled to form walls) and in earthen mortars. A more plastic type of soil, with a high clay composition was used in adobe (sun-dried bricks) (Correia and Fernandes, 2006, p.234). However, this is no longer the case, as nowadays the availability of aggregates, additives, and stabilisers provides the possibility to improve any earthen building material according to the type of soil. Each technique incorporates an extensive

variety of typologies with intrinsic characteristics (see Correia, 2008a, 2008b). Considering that each earthen building material and technique in a specific context implies different conservation procedures, the difficulty is increased yet further with the broad diversity of local building cultures. This diversity of techniques and intrinsic earthen characteristics are part of the uniqueness of earthen architecture, but it also creates problems of how to address conservation intervention.

In the last years, the World Heritage Committee increased its interest in the preservation of this endangered heritage due to its long history and outstanding architectural diversity and value. During the 32nd Assembly, attention was dedicated to the serious threats that earthen sites are facing. It was stressed that:

“In 2006, 105 out of 644 cultural properties inscribed on the World Heritage List incorporated earthen structures, and a considerable number of sites currently inscribed on States Parties’ Tentative Lists are partially or wholly built of earth. However, many of these sites are seriously threatened both by natural disasters (e.g. floods and desertification in Timbuktu, Mali; earthquakes in Bam, Iran; rain in Chan Chan, Peru; tornadoes in Abomey, Benin) and by social and physical changes to the environment (e.g. degradation of the environment through industrialisation and inappropriate use of modern technology, adaptation to modern comfort, disappearance of traditional conservation practices).”

(World Heritage, 2007a, p.2)

This research focuses in particular on the diverse aspects of earthen heritage, such as tangible and intangible, material and immaterial, movable and immovable, vernacular and monumental architecture, cultural landscapes, etc. This investigation addresses earthen structures and sites included on the World Heritage List, and defined as archaeological or inhabited architectural heritage. Through the review of the body of literature there is evidence of the existence of damage and decay in earthen heritage (Warren, 1999) (Guillaud et al., 2008b) (Rainer, 2008), as well as recognition of the need to protect earthen structures and sites (Terra 93, 1993b) (Terra 2000, 2000b). The following section concentrates on reviewing conservation actions, or lack of them, undertaken in earthen heritage during the last decades, in order to identify causes for the frequent lack of success of conservation intervention.

1.3 Assessment of failure in earthen heritage

Reviewing the body of literature concerning the physical state of ancient earthen heritage, it was noticed that most earthen structures or sites

lack a conservation policy and preventive procedures. Some of the monumental earthen sites are barely 'surviving' and are without conservation measures, only limited conservation repairs. For instance, this is the case with the ancient city of Jiaohe, in the autonomous region of Xinjiang Uygur in China (UNESCO Beijing Office, 1999) and the fortresses of the Ayaz Kala site, in Uzbekistan (World Monuments Fund, 2008b). Their remote locations and difficulty of access protected them from the human factor, but the vast dimensions of these sites exposed to weather conditions for several centuries and without any protection contributed to the acceleration of decay. Abduraschidow et al. refer to the fact that in the Republic of Uzbekistan, the city walls of Afrasiyab (the predecessor of today's Samarkand) were built in earth (2005, p.248). Unfortunately, lack of maintenance has caused some areas to partially collapse. The same has happened to large parts of the Great Wall of China. Some of its sections were later faced with stone. The first walls constructed in rammed earth are dated to 656 B.C. (Scarre, 2000, p.215). In spite of the erosion, the survival of parts of the great wall certifies to the durability and resistance of this construction. In Egypt, the site of Shunet el-Zebib built in approximately 2750 B.C. is one of the oldest standing adobe monuments in the world, and one of the last remains of "monumental mortuary complexes built at Abydos by the early dynastic pharaohs" (World Monuments Fund, 2008b). If there is no urgent intervention "the walls of this highly important and very rare monument could collapse within a few years" (ibid., 2008b). In Bangladesh, the monastery of Paharpur, built from the 7th century A.D. onwards, is the biggest Buddhist monastery in the south of Asia. It is located 40km from the capital Mahasthan (Scarre, 2000, p.135). Due to the almost non-existence of stone in the region, the central part of the sanctuary is entirely built in adobe and is considered a wonder of engineering (ibid., p.135). The other parts of the monument are built in fired brick. Unfortunately, all the above-mentioned monuments are without consistent conservation actions and measures.

Can the lack of action from national heritage organisations be a cause for damage? Or is it more related to the lack of systematic intervention or adequate action from the conservators? Due to the rapid loss of the protective earth layer, degradation can affect the interior of the structure very fast. Being exposed to the environment is only one of the reasons for the rapid decay of this ancient heritage. Warren states that the great ancient city of Samarra still has city walls made of adobe (1999, p.15). In spite of major erosion, which created many degraded structures, the walls

are still standing 3,000 years after being built. If properly protected and conserved, these monuments would be in better physical condition.

Another possible source of damage is the human factor, which can be the cause of severe decay to the monument, especially through war. For instance, in Oman there are several historical earthen structures in this situation. This is the case of the fortress of Bahla (Michon and Guillaud, 2000), the fort of Bid-Bid and the palace of Birket Muz (Warren, 1999, p.xiv). During the fifties, British bombardment affected the palace of Birket Muz, which led to its abandonment. This was especially due to successive aerial attacks, which damaged the earthen walls (Warren, 1993, p.68).

Following archaeological excavations, the lack of conservation measures can have a negative impact on the heritage survival. Frequently, after being exposed by the archaeological diggings, the structures are neither protected from the weather nor subject to conservation procedures. This was the case in the ruins of the adobe village of Mehrgarh (7.000 B.C.) in Pakistan. According to Bahn, this is the village that gives the only clue concerning the origins of agriculture in the Indian subcontinent (2005, p.154). Its value is immense, but unfortunately, when exposed to natural agents, these earthen remains, which have been covered for centuries, are disappearing rapidly.

In Pakistan, in the Indus valley, the World Heritage archaeological ruins of the vast city of Moenjodaro listed in 1980, are also invaluable remains, as they are “built entirely of unbaked brick in the 3rd millennium B.C. (...) [and] provide evidence of an early system of town planning” (World Heritage, 2008e). In Turkmenistan, the earthen remains of Merv also present the same type of abandoned excavation. Cooke underlines the particular risk of the Archaeological Park of Merv, due to “the intensity of the earlier archaeological work” (2003, p.102). In Uzbekistan, the same has happened with the three adobe fortresses at Ayaz Kala. After 1,300 years of abandonment, the archaeologist Tolstov exposed them in the 1940s (World Monuments Fund, 2008a). Since then, they have been unprotected, hardly surviving because of natural decay. The fact that they were not reburied and did not receive any measure of protection exposes them to fast decay.

According to a comprehensive review of the literature, increasing reasons for failure are related to the lack of measurements, and especially the lack of conservation processes. Correia and Fernandes maintain that there are difficulties both in “the efforts to conserve structures and/or the efforts to prevent the structure from decay, in part, because of the lack of information concerned with the compatibility of the materials and

techniques” (2006, p.235). Some of the World Heritage earthen cities, like Marrakech in Morocco, had, according to Serra Desfilis, inadequate practices of restoration and rehabilitation applied to them (2006, p.120). This leads to inevitable questions about the best ways to conserve and restore earthen structures.

The fact is that through the years, there have been inconsistent approaches with regard to conservation intervention. A common solution was to face the earthen structure with stone masonry or to reinforce corners of earthen structures with stone facing (Pinto, 1992, p.37). This was a normal procedure, especially in monumental earthen heritage, as there was not enough experience and published literature about the conservation of earthen architecture. For instance, rammed earth walls faced by stone masonry can be observed in the south of Spain, at the Talamantes castle (Jaquin, 2008b, p.29). It can also be observed in the corners of the rammed earth tower, located in the archaeological museum of Silves, in Portugal (Fernandes and Correia, 2005, p.206). Another solution was to repair the damaged parts of the earthen walls with a cement plaster or a stabilised cement-earthen plaster. Such was the case during the sixties, of conservation intervention addressed at Larabanga mosque in Ghana (Ghana Museums and Monument Board, 2004), or the Wa Naa’s Palace, also in Ghana, coated with a sand-cement mixture in the seventies (World Monuments Fund, 2008c). During the sixties at Alcácer do Sal earthen fortress in Portugal, there was consolidation of the fortress walls with a cement capping. Results from this intervention can be observed on the left side of Fig.1.1. In the eighties, concrete was applied to the foundations, and a facing plaster was used that had a mixture to be rammed, which fundamentally consisted of hydraulic lime, yellow sand, and small pieces of brick as inert material (Trindade Chagas, 1992, p.90). Before the introduction of the earthen mixture, a metal net was placed inside the form boards, onto which was applied a uniform and homogeneous layer of cement glue and pebbles, followed by the earthen mixture that was then rammed (*ibid.*, p. 90). All of the above-mentioned cases suffered, as a result from decay of the earthen fabric caused by incompatibility of materials. This was mainly due to the lack of conservation knowledge of how to intervene when dealing with earthen heritage. Other reported cases are the use of earthen plasters stabilised with emulsified bitumen (Orazi, 2000, p.88) or with industrial products. Orazi also mentions the use of “sulphonate petroleum products (SPPs)” (*ibid.*, p.89). Presently, several of these solutions are being questioned, as there is more awareness of material compatibility and the results of their use have not been successful.

There is also reference to the use of a more sustainable approach to the conservation of earthen heritage. This approach in conservation intervention relates to the use of available material on site (e.g. pieces of broken bricks or tiles, small irregular stones). For instance, an earthen plaster and a stabilised earth-lime plaster mixed with recovered pieces were used to fill in existing gaps in rammed earth walls (Correia and Merten, 2000, p.229). With the advance of research, conservators realised that in earthen heritage conservation practice, not using the same material of the original fabric could create new causes for failure in the medium and long-term.

From another standpoint, if the same material is used, could failure be related to the earthen method applied to conserve the ancient fabric? There are presently different solutions that use earth as filler to repair gaps. One solution is to fill the gap with masonry, as is the case of adobe masonry. This was used in al-'Udhaibat, in Saudi Arabia (Warren, 1999, p.183), but it is also recommended by Palma Dias for general adobe repair (1993, p.212). A further possibility is the replacement of ancient adobes by new ones with the same dimensions (Pinto, 1993, p.615). Another option is to use cob blocks, as was the case in Bowhill, United Kingdom (Harrison, 1999). An alternative type of earthen filler used for repair is a mass of cob, which is a common procedure in Devon, United Kingdom, where there is an important cob heritage (Williams-Ellis, 1999). Following the same type of procedure, it is also currently the practice to use a mass of rammed earth, which means to compress earth mixture in the existing gaps. This technique was used, for instance, in Castillo de la Reina, in Spain (Rocha, 2006, p.117), and in Lagos fortress wall, in Portugal (Mendes Paula et al., 2005, p.131). It would be important to assess the medium-term results of these interventions in order to get a fair evaluation of these solutions. Rammed earth conservation attracts increasing interest, as it is one of the techniques presenting the highest complexity in conservation practice. It is a monolithic earthen construction method that requires deeper knowledge for its conservation. Currently, when addressing the filling of the gaps, there is a tendency to try to reproduce the mixture of the original fabric. Feilden even states that rammed earth is "more difficult to repair than mud brick, since the repair is wetter, it shrinks, making it difficult to obtain a bond between old and new work" (2003, p.76-77). In addition, the consistency in the rammed earth quality varies, depending on the local earth used, the mixture in the rammed earth composition, and the amount of lime (if added) and its slow conversion into carbonate, as well as the amount of compression applied at the moment of construction. Besides, local geographical settings and physical conditions can also contribute to the acceleration of deterioration if the structures are not properly

maintained. It is observable that the monolithic group requires a more complex approach towards conservation practice than the other two main earth groups of building (masonry and bearing structure). Notwithstanding, all earthen building methods are complex when dealing with conservation.

Other ways to fill gaps are through earth projection, a technique applied in Paderne castle in Portugal (Cóias e Silva and Costa, 2006). It is also becoming commonplace to repair gaps and cracks, when possible, with various types of mortars. Attention should also be paid to reinforcement of old and new materials with bonding emulsions (like lime water), linear elements (e.g. wooden elements), as well as other connectors. However, a consistent assessment of all the mentioned solutions is still missing. There have been reports of failure resulting from using different earthen methods, especially when subjected to major disturbance, such as earthquakes (Mokhtari et al., 2008, p.167) (Shahnoori, 2005, p.319).

The choice for the conservation material and the methodological procedure should be carefully analysed. A problem can develop if the old and new materials do not bond adequately and the conservation fails under continuous pathologies. Besides, if the conservator is driven by retention of the authenticity of the material, using earth as a repair material is not enough. Further attention and reflection should be directed to bonding between old and new materials, between distinct earthen techniques, procedures, etc. Additionally, it is rare to find papers that evaluate failure in intervention, and even rarer to identify papers that assess previously carried out conservation interventions. From the last four Terra conference's proceedings, very few papers evaluated previous intervention (Chiari et al., 2000) (Matero and Cancino, 2000) (Guillaud and Avrami, 2003). This also demonstrates the lack of awareness of conservators for the need to review and evaluate previous interventions.

Through a review of related literature, it can be observed that even if there is failure following the conservation intervention, this is not acknowledged by the conservator. When failure is recognised to exist, then it is justified due to the physical condition of the material or the structure or site, or due to continuous or dynamic natural agents. Failure is rarely attributed to the conservation procedure. However, it is important to accurately understand the concept of failure in order to encompass a comprehensive response to the cause of the failure. The Oxford English Dictionary defines failure as "lack of success" and "the process or fact of failing (...) giving way under pressure" (Brown, 1993, p. 907). Therefore, failure is considered to be a lack of achievement, and, in the scope of this investigation, will be considered as lack of success to accomplish the conservation process. As previously mentioned, there is a tendency to

justify bad conservation results caused by material fragility and fabric weakness, but also due to the fact that earthen structures and sites have a tendency to decay faster than any other type of heritage. However, analysing the body of literature and observing earthen heritage under conservation intervention, it is noticeable that there is a specific lack of information and clarity of how earthen heritage should be preserved, and why there is a lack of successful conservation cases in earthen heritage. Is this related to a lack of knowledge of dealing with the material and with intervention procedures in conservation of earthen heritage? This will be investigated and analysed throughout the research.

There has never been a thorough investigation of the impact of the actions of conservators. This explains the need to concentrate in the analysis of the actions carried out by conservators, as these are the professionals in charge of conserving and managing the earthen heritage. In this investigation, conservators are responsible for the conservation works that comprise the project, intervention, practice, and management of the earthen heritage. Conservators can include architects, engineers, archaeologists, material specialists, etc.; mainly professionals with recognised expertise in conservation that lead the conservation process.

1.4 The research purpose

A cursory review of the international publications concerning earthen architecture in the last 20 years reveals a strong attempt to present, in some detail, case study papers and results of research. The body of literature reveals that several areas have been widely researched, in particular the identification and characterisation of soils (Anger and Fontaine, 2005) (Anger et al., 2009); analytical methods and material improvement and performance (Baiche, 1992) (Dayre, 1993) (Kanan, 1995); structural performance (Varum et al., 2006); physical condition (Matero, 1999b) (Bruno, 2006) (Rainer, 2008); (Matero, 2003) (Guillaud et al., 2008b); conservation intervention case studies (Aguilar and Falck, 1993) (Rua et al., 1993) (Calarco, 2000); building materials and techniques (Campana, 2000) (Cooke, 2004) (Correia, 2007a) (Viñuales, 2007); plaster analysis and preservation (Matero, 1995, 1999a, 2000) (Faria Rodrigues, 2005); historical study of earthen construction structures (Pujal, 1993) (Jaquin, 2008a, 2008b); traditional methods and materials (Gupta, 2003) (Licciardi, 2007), architectural design and typologies (Guillaud et al., 2008a, 2008b); protection and management of sites and monuments (Crosby et al., 1992) (Castellanos, 1995, 2000, 2001) (Cooke, 2003); analysis of treatments and/or stabilizers (Chiari et al., 2000);

seismic retrofitting (Kimbrow, 1993) (Cancino and Matero, 2003) (Crocker, 2000) (Vargas et al., 2009); etc.

Through studying the literature, it is noticeable that there is a general tendency to consider each case study in isolation and not to relate it in comparative terms with other similar case studies. Besides, when analysing earthen architecture conservation procedures, there is a tendency to repeat mistakes. This can be due to a lack of concerted strategies dealing with the methodological approach; lack of a conservation program or plan and its implementation; lack of knowledge of local conditions, or lack of identification of roles and responsibilities in the process of conserving; but in general, there is a lack of thorough reflection on the problem of conservation framework in earthen architecture. The existing research is concentrated on physical and structural conditions, structural performance, material analyses, construction technology, history and archaeology, conservation materials and treatments. There is very little literature or research that deals with the conservation process, and even less with the theoretical approach to conservation. Internationally, there are very few papers or book chapters that provide some analysis concerning conservation theory in earthen architecture (Warren, 1993) (Warren, 1999) (Correia and Fernandes, 2006) (Correia, 2007b), and even this can be considered to be limited in scope. The literature is also restricted concerning the assessment of conservation frameworks. A lack of general procedures assessment and of cross evaluation between the distinct methodology components can be noticed. The few existing assessments covering earthen heritage conservation are generally addressed in the introductory chapters of the international conference proceedings (Terra 2000, 2000a), in their post-proceedings or recommendations (Terra 93, 1993b) (Terra 2000, 2000b), or in the few literature reviews covering the field (Guillaud and Avrami, 2003) (Avrami et al., 2008). In comparison with other materials, the literature concerning the conservation of earthen heritage is still insufficient, as confirmed by Taniguchi and Fardanesh:

“Conservation of earthen architecture has not been studied as much as that of other types of structures. Research on timber and stone structures has led to international consensus on how the authenticity is perceived and retained in a heritage asset, but studies on the preservation of the authenticity of earthen monuments in the comprehensive conservation process are relatively new.”

(2008, p.40)

This entails a need for a consistent assessment and review of the literature in earthen heritage conservation, but especially the response to a

prominent gap in conservation intervention, dealing with failure and lack of procedural approach. The purpose of this research is therefore to:

- Identify reasons for failure related to conservator's actions towards earthen heritage conservation
- Provide consistent criteria and principles of conservation intervention across identifiable indicators
- Give significance to conservation theory in the field of earthen heritage
- Provide a framework concerning intervention strategies in earthen architecture conservation.

The following sections explain the research objectives of this investigation.

1.5 Research objectives of the investigation

It is in general believed that natural agents are the overall cause of damage to earthen heritage. However, when evaluating the reasons for failure more thoroughly it is observed that conservator's intervention has a major impact on the earthen fabric. From reviewing the literature, it was also noticed that actions of conservators towards the heritage they are supposed to protect have not been consistently and systematically investigated. This poses questions concerning the conservation approach, and differences between conservation justifications and intervention results, but also reasons why mistakes are repeated and why there is a lack of best practice. This is why there is a need to identify and understand the causes of the damage, which can contribute to finding suitable methods of reducing earthen fabric damage. Therefore, the first research objective is:

- To identify reasons for failure in earthen heritage conservation.

Following the uncovering of causes for distress, it is fundamental to recognise criteria for intervention in order to provide standards for best practice in the conservation process. Consequently, the second research objective is:

- To recognise criteria for intervention in earthen heritage conservation.

During the literature review, when establishing a conceptual approach to earthen heritage, a common gap identified was the lack of a theoretical