PROCEEDINGS: International Seminar Theory and Practice in Conservation. A Tribute to Cesare Brandi

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"The conservation of earth architecture: The contribution of Brandi's theory"

Mariana Correia
Architect, ESG/Escola Superior Gallaecia, Vila Nova de Cerveira, Portugal
marianacorreia@esg.pt

Maria Fernandes
Architect, Universidade de Coimbra, Portugal
arqmariafernandes@gmail.com

SUMMARY: Earth architecture, in spite of its antiquity and its endangered and highly diffused world wide heritage, just recently became scientifically accepted as an area of conservation investigation. Consequently, there hasn't been enough research concerning earth architecture. The use of inadequate criteria and measures applied on conservation interventions has not allowed the research effort to be developed. In balance, this paper aims to contribute for the discussion and awareness of the need for preservation of earthen cultural heritage.

KEY-WORDS: Earth architecture; Conservation; Management plan;

INTRODUCTION

Earth as a building material is present in five continents (HOUBEN) (1), as a third of humanity still lives in earthen shelters (DOAT) (2). These earthen constructions range from modest dwellings to churches and palaces, as in France, and settlements of small villages, as in the United Kingdom, to imperial cities, like Chan Chan, in Peru, or to "skyscrapers" with more than ten floors, as in the case of Shibam, Yemen.

Ten percent of the sites from the UNESCO World Heritage List are earthen sites and many are threatened. Alejandro Alva states that sixteen out of the hundred most endangered sites listed in World Monuments Watch 2000 report – as well as fifty seven percent of the sites of the World Heritage List in Danger – are of earthen construction (ALVA) (3). This reality, gives the idea of damage and degradation of earth cultural heritage and the difficulties on the conservation.

Fig. 01 - Tschudi Palacio, Chan Chan, Peru. Repair of the lacunas with reconstruction of architectonic surfaces.

The development of the conservation of earthen architecture has been to a great extent influenced, in the last 35 years by two series of events. The first was succession of international conferences on earthen architecture conservation and second, the international earthen architectural heritage courses. Each conference made a mark on the earthen architecture landscape by articulating the needs of the field through courses, hosting initiatives, workshops, seminars, and other educational initiative. These activities resulted in the establishment of a network of some two hundred professionals whose expertise was tapped for the purpose of advancing the scientific research and knowledge indispensable in the area of study (3).

EARTH CONSTRUCTION TECHNIQUES

Numerous earth building methods with distinctive variations are recognized worldwide. At least twelve main ways of building using earth as a construction material are identified. They can be basically divided in three groups: monolithic, brickwork and structure.

The monolithic group is identified by at least five earth construction techniques: Dug-out, poured earth, stacked earth, direct shaping and rammed earth. The second group can be recognized by earth construction techniques associated with brickwork: tamped blocks, pressed blocks, cut blocks, sod, extruded earth, machine moulded adobe, hand moulded adobe and hand shaped adobe. In the third group are the techniques that compose the structure group: daubed earth, cob on posts, straw clay, fill-in and earth sheltered space (HOUBEN) (1).

What composes the basic soil difference in the three groups is the state of soil hydration, which is different for each case. Monolithic construction requires a dry to moist soil. Brickwork construction requires a semi-solid paste or plastic soil. And, finally, the structure group requires a semi-soft paste and mud combination. Thus, it is this variation of soils that allow different types of applications of the raw earth, consequently different techniques of earth construction. However, it is just possible to use earth, if there is good cohesion, which is achievable by the balance between the different components and their grain fraction: clay, lime, sand, gravel, pebble – plus water and other aggregates.

It is also important to have balanced conditions in terms of humidity, as it has a major effect on the material. If the exposition to weather is too dry, the material can be transformed into powder, but if the structure has too much humidity, the material can be saturate with water and consequently transformed into liquid fluid and without cohesion.

Nowadays, the most widespread techniques are rammed earth, C.E.B., adobe, cob and wattle and daub. The most common to find worldwide is adobe. In general, dwellings located in desert climates are often built in **rammed earth** (compressed mixture of earth and aggregates rammed between form boards), or **C.E.B.** (compressed earth blocks). For these techniques, a more humid to dry soil is needed. Construction in **adobe** (sun-dried bricks) takes place in areas with a more plastic soil. Besides, when the soil is softer, earth is used as **cob** (mixture of earth with straw piled up to form walls) or as **wattle and daub** (structure of wood or bamboo with earthen fill-in).

REPAIR APPROACH

Regrettably, 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. This leads to inevitable questions concerning the best ways to restore earthen structures. The same problems arise with protected heritage. For example, most of the surviving earthen fortresses in Portugal are abandoned (AAVV) (4) and have never undergone a wide conservation programme; only some small conservation repairs. The lack of expertise and research in the area has gained the attention of people who deal with heritage and the university researchers who share the some interest (AAVV) (5).

Unfortunately, for lack of knowledge, some of the most common methods followed on the conservation of earth architecture, have been based on conservation procedures applied to stone masonry structures, in spite of there very different requirements. For a long time, some of the most common options to apply into the earthen structure were the use of stone masonry; or the consolidation of the fragile parts of the earth wall with cement plaster. This last method of repair was one of the worse methods of conservation, as it did not allow the wall to breath. The cement layer stopped the humidity to pass through; as a consequence the humidity holds to the plaster and creates holes between cement and the earth structure. With time, the cement plaster detaches and falls dragging part of the wall.

There are different conservation approaches that can be implemented for earth construction, depending on the building techniques presented on site. Repairs to **wattle and daub** can be done using the traditional methods of conservation of wood structures, a section at a time. With **adobe** construction, some of the unrecoverable adobes can be replaced by new ones of the same type and size, but using for example, different earth pigmentation. The technique of **cob** is, to some extent, a difficult technique to conserve. However, attempts at better practices have been tried in the United Kingdom, in the French region of Brittany, and, even in Yemen. **Rammed earth** attracts rising interest as it is one of the techniques presenting the highest complexity in conservation. Unlike adobes or C.E.B., rammed earth is not transportable. It is a monolithic earth construction technique that requires deeper knowledge for its conservation. Feilden states (6) that rammed earth is more difficult to repair than mud brick, since the repair is wetter than the original. It shrinks, making it difficult to obtain a bond between old and new work. In addition, the lack of consistency in the rammed earth quality varies, depending on the local earth used, the mixture in the rammed earth composition, the amount of lime and its slow conversion into carbonate, and compression applied at the moment of construction. Besides this, local geographical conditions and pathologies of the structures can also contribute to the acceleration of deterioration if they are not properly maintained. Warren even bemoans (7) the limited literature available on the repair and conservation of rammed earth structures, due to its being a recent field of study.

The preservation of architectural ruins and earthen archaeological sites presents a complex problem for conservation, interpretation and management, mainly because of the tremendous difficulties and limitations in stabilizing such fragmented and exposed structures. The remaining original earth fabric must be given maximum protection, as it is highly susceptible to deterioration from exposure and weathering (MATERO) (8). Those with fragile materials, such as deteriorated earthen walls and plasters, are better understood in context, but are more difficult to safeguard, in particular, if the site is open to the public.

Careful examination of earth structures, all over the world, reveals the skills of their conservators in solving the serious problems involved in preserving the durability of structures exposed to water risks, as those built with earth soil are particularly vulnerable to water action. When water stands close to a building or penetrates it, the building runs the risk of rapid deterioration. Earth techniques require regular maintenance, which is ignored nowadays, being even regarded as unacceptable in a modern context (1)

Other usual problems are chronic damp and structural defects. The stress on the material, the presence of chronic damp on the walls, a poor design and construction of the building, as related causes due to climatic influences; but also the action of living organisms can be the responsible for the lose of original material and deformation of the original form. It is important to refer that the repair of these pathologies, are much more difficult on the group of monolithic method of construction, than the brickwork or structure group of construction.

Some isolated cases were identified, where earth was used to restore vernacular earthen dwellings, but a general lack of scientific research into the subject limited the projects (9).

SCIENTIFIC RESEARCH

Internationally, there are just a few published materials specifically about conservation of earth buildings. Existing scientific research studies financed to look into this topic almost always refer to the historical heritage of that earthen architecture which is protected by heritage charts. These protected structures can command a large allocation of finance for their conservation or restoration and for the expensive laboratory analyses associated with the process. Examples of these protected structures include the Missions buildings in the Southwest of the United States, the Latin American pueblos, some of the monumental earth heritage of the African continent and the Middle-East, and also the earth fortresses of the ex-Soviet Union Republics. Some were financed by the Getty Conservation Institute, with the scientific support of CRATerre and ICCROM, within the scope of the GAIA and Terra Projects. One should also refer to the patronage of UNESCO, ICOMOS - Earth Conservation Committee and some Japanese and German foundations for the protection of earthen archaeological structures in the Middle East. Nevertheless, for restoration of earthen dwellings, the reality is a general lack of scientific investigation to improve structures built of earth, and of finance for its conservation. Thus, the present emphasis by international agencies is particularly on the endangered earth monumental world heritage, while insufficient attention has been given to the preservation of earthen vernacular architecture.

The first international expressions regarding the need to preserve the world's earthen architectural heritage were voiced in the early 1970s (TRAPPENIERS) (10) Since then, there has been an increased development of scientific standards observable from the *1st International Conference on the Study and Conservation of Earthen Architecture* in 1972 to the *9th* international conference held in Iran in December 2003. Over the last 15 years, in several research centres, interest in this topic has grown, but one can say, there is still insufficient research undertaken, concerning earth conservation.

The first and the second international conferences, in Yazd, Iran in 1972 and 1976, may be seen as the first systematic attempts to characterise earthen architectural heritage and to outline preliminary recommendations for their preservation. Earth archaeological sites were the priority, on those conferences. The meeting in Santa Fé, New Mexico in 1977 clearly identified the urgent need to conduct research on specific areas. Although a subsequent conference in Ankara, Turkey, in 1980, did not record further development of the previous recommendations, but this forum did encourage a broader view of the field by introducing for the first time, the expression "earthen architecture". In Lima, Peru in 1983, discussion about specific concerns of earthquake-resistant structures led to the recommendations to establish networks and intensive training opportunities in established centres. Finally, in Rome, Italy in 1987, commitments were made by the ICCROM and CRATerre/EAG to carry out training activities with formulation of the Gaia Project. The agreement grew out of the critical evaluation of the implementation of international recommendations. The result of the network between the three institutions focused on a plan of cooperation, which included a broad array of activities. Notables among these activities were the gradual exchange of training experience, a pilot course in 1989, followed by three international courses in 1990, 1992, 1994, the shared responsibility for the organization of scientific events, and the development of joint publications (10).

The lasts four conferences: Adobe 90, in Santa Fe USA; Terra 93, in Silves Portugal; Terra 2000, in Torquay, UK; and Terra 2003, in Yazd, Iran provided a opportunity for a wider exchange of ideas, methods, techniques, and research findings. The immediate consequences of this meeting were the appearance of different networks, all around the world. For example, the Italian experience is characterized by academic and scientific rigor, the integration of methodologies for planning the conservation of historical centres built out of earth, and the opportunity for defining a national policy for the study and conservation of earth architecture (3).

Since its creation the GAIA Project has stressed the importance of organizing regional activities within an institutional framework. In 1996 and 1999, the Pan-American courses in Chan Chan, Peru, provided the opportunity for training *in situ*. Chan Chan, an earth archaeological site, classified world heritage by the UNESCO since 1986, was the place where international professionals learn how to conserve earth structures, and at the same time, participated on the elaboration of the management plan for the site.

Fig. 02 – Tschudi Palacio, Chan Chan, Peru. Know-how of the adobe constructive technique.

CONTRIBUTION OF BRANDI'S THEORY

It becomes increasingly apparent that there has not been enough research concerning earth architecture. The study and research associated, in spite of this "new" area of conservation investigation has been sporadic, at best, and is characterized by the use of inadequate criteria and measures to guide its effort. Perhaps, it is time to consider some of Brandi's contribution to guide us in a systematic approach to our efforts. Thus, some of the principles are:

The object under investigation must be assessed as a **unity**. It is important to consider it, as a whole according to the original concept how it was constructed. That does not mean that the restoration should be faced, following an external model, as often happened during the nineteenth century. The restoration should be considered in a unified scientific basis, which means based on what is suggested by the potential unity of the object, taking into account not just its parts, but also the demands of its historical and aesthetic aspects (JOKILEHTO) (11). Like all guiding principles, there are some exceptions to the application of these principles in and under all circumstances. The unity principle may be compromised when cohesion of material is affected and structural appearance is deformed. In some archaeological sites, aggregates are used to protect the earth surfaces. A case in point is ethylic silicate which creates no chemical reaction with the earth material and therefore does not leave a residue in the original material, thus it protects the object, its authenticity, and its unity. Also important is to refer that the presence of lacunas in earthen structures are very difficult to repair. Many times the only option is to protect the structure as a ruin, because the original unity does not exist anymore.

Another aspect to consider is how a work of art becomes a ruin, as it is difficult to identify the turning point of unrecoverable damage. The only way, is to look for the maintenance of its potential unity. In Chan Chan from the original 9 palaces built in 20.000km2, it is just identified nowadays, 14.000m2. Human action (agriculture, vandalism, aggressive tourism, etc.), but also nature (wind, salts, etc.) destroyed the unity of the original place. Today, Chan Chan is at risk to loose its authenticity, if the management plan is not applied soon enough.

Fig. 03 - Tschudi Palacio, Chan Chan, Peru. Top protection.

The investigation and intervention must be based on the rigorous evaluation both of aesthetic and historical values. Its historicity is independent from the aesthetic values and the way these may vary over time (11). Thus, it is essential to refer that in earthen architecture, there are more values that should be taken into account. Sometimes, some earth buildings walls have apparently no value. Their unique character and reason for restoration can be a social, religious or even political value, but also the unique construction technique that built it or the fact it can be one of the unique buildings made of earth. A reality still authentic in many places of the world, like it was 2000 years ago, so the maintenance of the knowledge and know-how is still an important value for earthen architecture: it is the guarantee of an identity and continuity of the cultural tradition. Important to refer is the symbolic value, which is fundamental in African cultures, that is the case of Abomey, in Ghana (RAINIER) (12). In spite of the damage, the architectonic surfaces were saved and restored later on. The importance for safeguarding historical earthen surfaces justified the intervention, especially because these bas-reliefs represented the history of the people from the community, which had no written documents. Earth is also a very ephemerous material, so many of the protected surfaces need to be constantly renewed. The value is to maintain this traditional repair and not to maintain the material itself.

To try to restore authenticity to the unity requires a deeper focus on the material. Brandi defended that the material in relation to the aesthetic aspect of an object could be understood as having two functions: one related to providing the structure, the other concerning the aspect of the object (11). So, priority should not just be given with the only purpose of reintegrating losses. Brandi maintained that intervention should be limited to consolidation or reinforcement, to the part of material that forms the structure rather than interfering in the aspect (13). In this case, it can be referred the importance that acquired the historical buildings in the citadel of Ag-a-Bam that survived the 2003 earthquake,. These structures become a real document with archaeological data, thus more important than what a new appearance or restoration could provide.

The minimum intervention principle is mostly used on archaeological sites (13). The interventions based in protecting earth structures on the top (capping) and surfaces, with compatible materials are common used in earth structures. It is indispensable, when following the principle of minimum intervention to research and acquire a good knowledge concerning the object, material and its techniques, so adequate interventions are applied. This principle also helps to keep the unity, but especially the authenticity of the original object.

Final aspect of the object after the intervention is important, in particular in the case of earth architecture. This is just possible, if there is a balance between aesthetic and historical aspects. This balance principle has been applied in a visible sense in many conservation efforts. It has been used in different earth construction techniques to repair monolithic earth structures when, at the end of the effort, the entire structure is protected with earth mortar, looking like the original structure. In a seismic area this option is dangerous, if not controlled, as evidenced by what happened at Bam. In this case study, the tourist value was more important. Effort was made to give unity and an attractive final aspect to draw tourism into the region. Unfortunately, the 26th December 2003 earthquake destroyed the citadel and revealed a too thick layer of earth plaster used during the restoration of the previous decade, besides the application of different earth construction techniques on the same structure which made the buildings work as whole. The protected walls built during the conservation project were destroyed, as were the original walls. Buildings that had not been repaired survived the seism better.

Finally, in what concerns the **context and the impact principle** of the intervention, this has extremely importance for earthen conservation. Earth construction in many places of the world is still a reality, but in many of these areas it has no lasting effect. For instance, in Africa some of the establishments are rebuilt after the rain season. In these cases the value is focused on the maintenance of the knowledge of the construction technique and not on the material protection of the village. In the instances of the Mali Mosques, they are well conserved as they are protected by the people of the local communities, who keep the technique knowledge and "know-how".

To conclude, it can be said that the case study of the archaeological site of Chan Chan, in Peru, is of particular interest as it reveals the importance of the principles referred by Brandi. The special role on the training of earth techniques underscores the importance of having a good knowledge about the material and the techniques of construction, the conditions and agents of failure that can lead to degradation, the methodological approach in terms of levels of intervention, the importance of the environmental context, etc.

Fig. 04 - Tsudi Palace, Chan Chan, Peru. Protection layer on the top of the walls.

CONCLUSIONS

It is essential to stimulate the discussion of the importance of value-based criteria. As the objects of analyses are different, it follows that methods of intervention are different, too. However, it is vital to note one consistent factor; that is, over a long period of time the action recommended is linked to the value attributed to the object.

Finally, it is important to give consideration to the possibilities and the limits of application of conceptual bases of conservation, taking into account the knowledge for the specificity of the material, its characteristics and the historical and traditional constructive systems present on the earth structures.

There is a need for thorough research concerning: different types of earth architecture, best ways to conserve it, reinforcements for this type of construction, and structure and behaviour of earthen material. Decisions have to be taken on the embodied value of earthen dwellings versus the protected monumental earth heritage. A coherent and methodological programme of action to prevent deterioration and improve living conditions in the earthen dwellings should be undertaken, if the structure is worth preserving. If that is so, well-planned strategies to properly restore earth buildings, involving scientific, technical, managerial, social, legal and financial measures should be applied. Consequently, the implementation programme should analyse different aspects, such as existing pathologies of the buildings before restoration, their criteria and resolution, laboratory analysis of the composition of earth and its stabilisation, study and documentation of the buildings, different degrees of intervention during the restoration process, financial management of the site, and finally, social involvement of the community in the conservation and restoration project (e.g. by maintenance of the site). Measures to be implemented should consider practical intervention to conserve or restore the buildings, and a combination of tradition and modernity in the restoration of earthen structures.

In conclusion, the conservation of earth architecture requires an integration of different actions: cooperation, synergy of interdisciplinary works and initiatives, institutional and professional networks, promotion of study, and a rigorous consideration of cultural diversity. The conservation of earth cultural heritage and the promotion of its values are essential for this heritage to be universally recognized as an area of study and professional practice (3).

Still, it would be an illusion to treat such matter as indicative of overall success. While in some regions it is now more feasible to improve policies regarding this heritage, the majority of the world has yet to implement significant measures promoting earthen architecture and its conservation.

BIBLIOGRAPHY

1 HOUBEN, H; GUILLAUD, Hubert - *Earth Construction, A Comprehensive Guide.* 1st ed. Intermediate Technology Publications, Earth Construction Series, CRATerre -EAG, London, 1994, ISBN 1 85339 193

2 CRATerre, DOAT, P. [et al.] – *Construire en terre.* 3rd ed. Ed. Alternatives, Col. an Architecture, Paris, 1985, ISBN 2 88227 031 8

3 ALVA, Alejandro - *The conservation of earthen architecture.* Conservation newsletter, vol 16, nº 1, Getty Conservation Institute, USA, 2001 pp. 4-11, [http//www.getty.edu/conservation/resources/newsletter/16_1] access in 2006/03/01

4 AAVV – *Terra 93, Actas da 7" Conferência Internacional sobre o Estudo e Conservação da Arquitectura de Terra* (Silves – Portugal, Outubro de 1993). 1ª ed. Direcção Geral dos Edifícios e Monumentos Nacionais, Lisboa, 1993, D.L. 72181/93

5 AAVV – *Arquitectura de Terra em Portugal.* Argumentum, Lisboa, 2005, ISBN 972 8479 360 0

6 FEILDEN, Bernard M. - *Conservation of Historic Buildings.* 3rd ed. Architectural Press, Oxford, 2003, ISBN 0 7506 1739

7 WARREN, John - *Conservation of Earth Structures*. Butterworth-Heinemann, Series in Conservation and Museology, Oxford, 1999,
ISBN 0 7506 4191 6

8 MATERO, Frank G. - *The conservation of plasters in earthen archeological sites.* Cultural Resource Management, vol 22, nº 6, National Park Service, USA, 1999, pp. 59-62. [http//www.crm.cr.nps.gov/issue.cfm?volume-22&number=6] access in 2006/03/01

9 AAVV – *Terra 2000, Preprints – 8th International Conference on the Study and Conservation of Earthen Architecture* (Torquay – UK May 2000). English Heritage and James & James, London, 2000, ISBN 1 902916 05 0

10 TRAPPENIERS, Marina – *Training in the conservation of earthen architectural heritage.* Cultural Resource Management, vol. 22, nº 6, National Park Service, USA, 1999, pp. 7-13. [http//www.crm.cr.nps.gov/issue.cfm?volume-22&number=6] access in 2006/03/01

11 JOKILEHTO, JUKKA – *A History of Architectural Conservation*. Butterworth-Heinemann 1St Ed. Series in Conservation and Museology, Oxford, 1999, ISBN 0 7506 5511 9

12 RAINER, Leslie; PIQUÉ, Francesca – *Les Bas-reliefs d'Aboney, l'histoire racontée sur les murs*. Societé Nouvelle Adam Biro, Paris, 1999,
ISBN 2 87660 276 8

13 BRANDI, Cesare – *Teoria del restauro*. Giulio Einaudi Ed., Torino, 2000, ISBN 88 06 15565 2

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