THE GCI Project
Bibliographies SERIES

Terra

Sorted by General Category

The Getty Conservation Institute

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The Getty Conservation Institute

The Getty Conservation Institute works internationally to advance conservation and to enhance and encourage the preservation and understanding of the visual arts in all of their dimensions—objects, collections, architecture, and sites.

The Institute serves the conservation community through scientific research; education and training; field projects, and the dissemination of the results of both its work and the work of others in the field.

In all its endeavors, the Institute is committed to addressing unanswered questions and to promoting the highest possible standards of conservation practice.

GCI Project Bibliographies

Project bibliographies represent a distillation of many years of research by Getty Conservation Institute staff in support of a given project. The unique bibliographic resources available at the Getty Center and in the Los Angeles area make it possible for GCI staff to access and review literature that is not easily obtainable by many conservation practitioners. With this unique opportunity comes a unique responsibility to share the results of this research with the conservation community and other interested parties.

The TERRA bibliography is an effort to provide information to the conservation community regarding this important area of the world's cultural heritage. Earthen architecture exists globally and continues to provide housing for many people. These buildings represent a contemporary manifestation of an ancient tradition. Examples of this tradition in archaeological sites all over the world present challenges for those entrusted with their preservation. It is hoped that this bibliography will be helpful to them.

TERRA Project Overview

In academia, earthen architecture and materials are largely absent from courses on history, design, and construction technology. With earthen structures constituting only a fraction of new construction in the industrialized world, there is no industry to support continued investigation of earthen materials and their applications. As such, the scientific and technological research base for earthen architecture and its conservation is very limited compared to that of stone, brick, and timber. Procedures and information are frequently borrowed from other fields, such as agriculture and road building, but significant differences in application often preclude a direct transfer of technology. The result is a fragmented body of knowledge.
The past two decades have witnessed considerable advancement of the earthen architecture conservation field through a series of international conferences, training initiatives, and the formation of national and international committees devoted to the cause; a network of practitioners, scientists, and academics has been established through these opportunities for exchange. Institutional commitment has lagged behind, however, along with support for larger scale initiatives and collaboration. Institutional involvement and cooperation is key in developing the broad-based support needed for the conservation of earthen architecture.

In November 1997, following their collaboration on PAT96 (the first Pan–American Course on the Conservation and Management of Earthen Architectural and Archaeological Heritage), the International Centre for Earth Construction—School of Architecture of Grenoble (CRATerre–EAG), the Getty Conservation Institute (GCI), and the International Centre for the Study of the Preservation and the Restoration of Cultural Property (ICCROM) initiated discussions to establish a joint program in the study and conservation of earthen architecture.

These organizations recognized—through their independent and collective activities in earthen architecture conservation—that the most successful means of leveraging resources and developing the field was through partnership. Having a long history of involvement in the field, these institutions created a cooperative framework—Project Terra—to promote the study and conservation of earthen architecture heritage. Within this framework for international collaboration, previous institutional activities such as ICCROM/CRATerre–EAG’s Gaia Project and the GCI’s research in the field, are evolving into Project Terra.

The GCI Bibliography of the TERRA Project

Literature in this bibliography was compiled over the past decade at the Getty Conservation Institute as a part of the TERRA project.

The research component of this project involved the review of a very large body of literature. The prevalence of earthen architecture worldwide both past and present means that a great deal has been published on the subject in many languages and disciplinary fields. To address the conservation of earthen architecture has also meant that a thorough understanding of the nature of the materials involved is essential; this has necessitated a review of mineralogy, clay and soil science, chemistry, and the analytical techniques used in these fields. The deterioration mechanisms affecting earthen architecture also needed to be well understood. For that reason, the literature on biodeterioration, and wind and water erosion, as well as damage caused by salts and seismic activity, had to be reviewed in light of their effect on earthen structures.
A number of dedicated individuals have been involved in this effort over the years and this bibliography gives us an opportunity to share with the conservation profession their expertise and the fruit of their bibliographic research. They are listed below.

**Project Team Members**

**GCI**
Mary Hardy, Project Manager  
Erica Avrami (past Project Manager)  
Gaetano Palumbo (past team member)  
Evin Erder (past team member)  
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**CRATerre–EAG**
Hugo Houben  
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**ICCROM**
Alejandro Alva

**Methodology and Arrangement**

The bibliography has been arranged in thematic sections that were settled upon after considerable discussion and thought. This topical arrangement is followed by a reiteration of the entire bibliography alphabetically by author. Users may simply view sections of interest or scan by author. Some citations will appear in multiple sections because they address more than one of the subjects defined in this bibliography.

Particular credit goes to Urs Mueller who devoted many hours to refining this bibliography, bringing to the task great professional rigor and the highest professional standards. Eric Bruehl assisted Urs in this process. Prior to Urs's arrival at the GCI, Gaetano Palumbo and Evin Erder applied a great deal of their time and expertise to the formation of the bibliography. Thanks also goes to the reviewers who took the time to examine the bibliography in light of their professional experience and to make suggestions which have been adopted whenever possible.
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Identification and Characterization

Citations in this section deal with the identification and characterization of the discrete components of earthen structures, as well as the analytical methods involved in doing so. This section is divided into four subsections.

Mineralogy

Mineralogy lists literature addressing the mineral components of earthen materials and their influence on the behavior of earthen structures.


Clay Science

The Clay Science section examines the behavior of clays and their role in earthen materials as an important component in understanding earthen structures.


Kenney, T. C., Shear strength of soft clay. *Contributions to the geotechnical conference on shear strength properties of natural soils and rocks*. Oslo, Norway, 1967 (1968)


**Soil Science**

The Soil Science section addresses the behavior, properties, and characteristics of various soils.


de Vos, A. Mud as a perfectly viable building material. (1977) 7p.


Kenney, T. C., Shear strength of soft clay. *Contributions to the geotechnical conference on shear strength properties of natural soils and rocks*. Oslo, Norway, 1967 (1968)


Mendonça de Oliveira, M. and Santiago, C. C., Comportamento de alguns solos tropicais estabilizados com cal. *7a conferencia internacional sobre estudo e conservação da arquitectura de terra = 7th international conference*


Analytical Methods

Analytical Methods reviews literature describing analytical techniques and methods for characterizing earthen materials.


Deterioration and Pathology

Citations in this section deal with the deterioration of earthen structures and the mechanisms involved.

Water, Wind, Salt, Biology and Environment

This section cites literature that describes problems caused by Water, Wind, Salt, Biology, and Environment as agents causing deterioration.

Effects of frost heaving on objects in soils and its archaeological implications. In *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN I-6–1–8.

Ice wedge erosion at Fort Hall historic trading post, Idaho. *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN I–1–1–6.


Arnold, A., Soluble salts and stone weathering. *The conservation of stone I: proceedings of the international*


Liegay, A. Les problemes de conservation de l'architecture de brique crue au Proche–Orient = Conservation problems


Rautureau, M.; Cooke, R. U.; and Boyde, A. The application of confocal microscopy to the study of stone weathering. Earth surface processes and landforms, 18, no. 9 (1993), pp. 769-775.


Scharff, W. Umweltschaden: bedrohung fuer archaologische bodenfunde = Damage by the environment: archaeological artifacts at risk. Archaeologie in Deutschland, no. 2 (1992), pp. 4-5.


**Structural**

Literature regarding the Structural behavior of earthen structures, structural failures and the amelioration of structural problems is listed in this section.


Trotman, P. M.  Mud slinging at the building research establishment: 80 years of research and information dissemination. *Terra 2000: papers of oral presentations not included in pre-prints* (unpublished)


**Seismic**

The influence of Seismic activity on earthen structures and seismic amelioration is the subject of the literature in this section.


Diagnosis and Conservation

This overall heading deals with diagnosing and assessing the state of earthen structures, appropriate documentation and planning, subsequent interventions, and the maintenance of structures.

Assessment

Citations in the Assessment section are concerned with recording and condition surveys and evaluations of earthen structures. Structural, environmental, and moisture monitoring are also addressed.


de Vos, A. Mud as a perfectly viable building material. (1977) 7p.


Matero, F. G.; del Bono, E.; Fong, K. L.; Johansen, R.; and Barrow, J., Condition and treatment history as prologue to


**Intervention and Maintenance**

The Intervention and Maintenance section addresses interventions and maintenance by examining issues such as structural interventions, the installation of drainage, seismic mitigation, dealing with decorated and undecorated surfaces and stabilization of archaeological features. Site management, repair materials and biological control are also addressed.

*The archaeological sites protection and preservation notebook.* In Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), ix + 304p.


The McCutchan–McLaughlin in Mound stabilization project, Oklahoma. *The archaeological sites protection and preservation notebook.* Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–2–1–6.

Site burial and results of soil tests at the Mangrum Site Craighead County, Northeastern Arkansas. *The archaeological sites protection and preservation notebook.* Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN II–1–1–8.


Site preservation at Roods Creek Mounds, Georgia. *The archaeological sites protection and preservation notebook.* Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–3–1–5.

Streambank protection of the Chapel of Santa Rosa de Lima de Abiquiu, New Mexico. *The archaeological sites protection and preservation notebook.* Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–4–1–10.


Agnew, N.; Preusser, F.; and Druzik, J. R., Strategies for adobe preservation – The Getty Conservation Institute research program. *5th international meeting of experts on the conservation of earthen architecture = 5ième


Crosby, A. Evaluation of potential stabilization mortars for Salinas National Monument and recommendation for long-term field evaluations. Southwest Cultural Resources Center (1986)


Friedman, O. Architectural and archaeological monuments and the problems of their preservation. 4p.


Skibinski, S. *Problemas de conservacion de monumentos arqueologicos de piedra en el Peru y Ecuador..* Instytut Zabytkoznawstwa i Konserwatorstwa UMK, Torún, Poland (1991), 95p.


Construction and Architecture

History of Earthen Architecture and Traditional Methods

The history of earthen architecture and the occurrence of traditional cultural methods and practices are examined in this area. The section is divided by topic and by geographic area.


Moldovan, M.–S. and Graur, T., Earth architecture in Romania. *7ª conferencia internacional sobre e estudio e conservação da arquitectura de terra = 7th international conference of the study and conservation of earthen...*


Risom, S. Lerhuse stampede og soltorrede = Houses made of clay pressed and dried in the sun. S. l. (1952), 95p.


Materials, Construction Techniques and Architectural Design

This section is concerned primarily with contemporary earthen construction, materials, construction technique, and architectural design using earthen materials.


Cointeraux, F., Ecole d’architecture rurale, ou leçons par lesquelles on apprendra soi-même à bâtir solidement les maisons de plusieurs étages avec la terre seule. Cointeraux, François, Paris (1790), 82p.


Hartzler, R. *Acrylic-modified earthen mortar: a program of investigation and laboratory research into acrylic-modified earthen mortar used at the prehistoric Pueblo sites*.. In Professional Paper, 61. Intermountain Cultural Resource Center, Santa Fe (1996), 139p.


Earthen Architecture Worldwide: America

This section consists of works describing earthen architecture by region. It describes the history, issues, conservation efforts, regional characteristics, and case studies for each area.

Ice wedge erosion at Fort Hall historic trading post, Idaho. *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN I–1–1–6.


Site burial and results of soil tests at the Mangrum Site Craighead County, Northeastern Arkansas. *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN II–1–1–8.


Site preservation at Roods Creek Mounds, Georgia. *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–3–1–5.

Streambank protection of the Chapel of Santa Rosa de Lima de Abiquiu, New Mexico. *The archaeological sites protection and preservation notebook*. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–4–1–10.


Barrow, J. Against the odds – Hottai Ki. Cultural resource management: conserving earthen architecture, 22, no. 6 (1999), pp. 52–54.


Compton, E. B., Ancestral techniques and materials used in the architecture and mural paintings of the pre–plateau sierra of the Chilean Andes. *7a conferência internacional sobre e estudo e conservação da arquitectura de terra = 7th international conference of the study and conservation of earthen architecture*. Silves, Portugal,


del Pino, I.; de Sutter, P.; and Moran P. M., La arquitectura de Quito frente a los sismos. 6th international conference on the conservation of earthen architecture: Adobe 90 preprints. Las Cruces, New Mexico, 14–19 October 1990 (1990), pp. 316–321.


Grigg, Milton L. A study for the preservation of the Old Mud Meeting House, Mercer County, Kentucky. (1975) 2 + 16p.


Skibinski, S. *Problemas de conservacion de monumentos arqueologicos de piedra en el Peru y Ecuador.* Instytut Zabytkoznawstwa i Konserwatorstwa UMK, Torun, Poland (1991), 95p.


Skibinski, S. and Jagodzinski, L. *Zastosowanie komputerowej analizy obrazów wizyjnych standardu VHS do badan przyczyn niszczenia budowli centrum ceremonialnego kultury Nasca (stanowisko Cahuachi, k/Nasca, Peru) = The application of computer analysis of VHS standard visual images for the examination of the devastation of buildings belonging to the ceremonial center of the Nasca culture (the Cahuachi site, near Nasca, Peru).* *Ochrona zabytków,* 45, no. 1–2 (1992), pp. 42–48.


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**Earthen Architecture Worldwide: Europe**

This section consists of works describing earthen architecture by region. It describes the history, issues, conservation efforts, regional characteristics, and case studies for each area.


Nardi, R., Conservation of medieval structures of mudbrick and of fired brick laid in clay. *5th international meeting of


Risom, S. Lerhuse stampede og soltorrede = Houses made of clay pressed and dried in the sun. S. l. (1952), 95p.


Sanna, R., The town environment of earth architecture in Oristano and in the villages around it, in relation to the building increase that is happening from 1950. 7a conferencia internacional sobre e estudo e conservação da arquitectura de terra = 7th international conference of the study and conservation of earthen architecture. Silves, Portugal, 24–29 October 1993 (1993), pp. 645–647.


**Earthen Architecture Worldwide: Africa**

This section consists of works describing earthen architecture by region. It describes the history, issues, conservation efforts, regional characteristics, and case studies for each area.


**Earthen Architecture Worldwide: Asia**

This section consists of works describing earthen architecture by region. It describes the history, issues, conservation efforts, regional characteristics, and case studies for each area.


de Marco, G.; Caneva, G.; and Dinelli, A. Geobotanical foundations for a protection project in the Moenjodaro archaeological area. *Prospezioni archeologiche*, Quaderni 1, (1990), pp. 115–120.


Earthen Architecture Worldwide: Australia and New Zealand

This section consists of works describing earthen architecture by region. It describes the history, issues, conservation efforts, regional characteristics, and case studies for each area.


Site Management and Site Preservation

Citations in this section feature literature concerning different approaches to the management and preservation of earthen structures. This includes archaeological contexts as well as discrete monuments and buildings and earthen cities.

The archaeological sites protection and preservation notebook. In Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), ix + 304p.


Site preservation at Roods Creek Mounds, Georgia. The archaeological sites protection and preservation notebook. Field preservation of cultural sites. United States Army Engineer Waterways Experiment Station. Environmental Laboratory, Vicksburg (1989), pp. ASPPN III–3–1–5.


Arnon, N. and Baca, S., Churches, symbols of community: the preservation of New Mexico’s adobe churches. 6th international conference on the conservation of earthen architecture: Adobe 90 preprints. Las Cruces, New Mexico, 14–19 October 1990 (1990), pp. 143–148.


Pinto, F., Arquitectura de terra – que futuro? 7a conferencia internacional sobre e estudio e conservação da


Stevens, A. Architecture de terre: monuments et sites de l’oasis de Turfan (Xinjiang) sur la Route de la Soie = Earthen architecture: monuments and sites of the oasis of Turfan (Xinjiang) on the Silk Road. Monumentum, 26, no. 1 (1983), pp. 45–69.


Descriptions of Sites and Monuments

This literature features accounts of earthen sites and monuments in various areas worldwide.


Proceedings and Bibliography on Earthen Architecture

This section lists conference proceedings and bibliographies important for the literature of earthen architecture.


Miscellaneous

This category includes useful literature that does not fit the subject subsections but has been defined as valuable and useful.


