
Bibliography

Earthen Architecture Initiative Seismic Retrofitting Project

A Bibliography

Edited by

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The Getty Conservation Institute

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THE GETTY CONSERVATION INSTITUTE
LOS ANGELES

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The Getty Conservation Institute works to advance conservation practice in the visual arts, broadly interpreted to include objects, collections, architecture, and sites. It serves the conservation community through scientific research, education and training, model field projects, and the broad dissemination of the results of both its own work and the work of others in the field. And in all its endeavors, it focuses on the creation and dissemination of knowledge that will benefit professionals and organizations responsible for the conservation of the world's cultural heritage.

Cover:

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CHAPTER 1

Introduction to the Bibliography

This project bibliography is part of the Getty Conservation Institute's Seismic Retrofitting Project (SRP). The SRP combines traditional construction techniques and materials with advanced methodologies to design and test easy-to-implement seismic retrofitting techniques and maintenance programs to improve the structural performance of earthen historic buildings in Peru, as well as in other countries in Latin America.

The purpose of this bibliography is to provide a concise guide to publications that help conservation professionals better understand built earthen heritage sites and how they respond to earthquakes, with an emphasis on how to design and implement interventions that promote the preservation of historic earthen buildings and protect the people who use them.

Structure of the Bibliography

The SRP bibliography is organized as follows:

Categories:

The selected texts have been classified into the following categories:

Historic Structures in Seismic Areas

- Earthen Structures in Seismic Areas
- Earthen Building Cultures
- Conference Proceedings

Structural Analysis

- Acquisition and Interpretation of Data
- Existing Performance, Vulnerability Studies and Risk Analysis
- Testing and Numerical Investigation
- Timber Joints

Interventions

- Traditional
- New and Emerging

Case Studies

Policies, Standards, and Guidelines

The contents of these categories are elaborated upon in later sections of this introduction.

Arrangement:

Each category is divided into topics or thematic sections. Under each category, the texts are typically arranged in alphabetical order, by the author's last name; however, in the case of conference proceedings, the texts are arranged in chronological order for each specific conference.

Limitations of Research

There is a vast amount of literature related to the conservation of earthen sites. This bibliography is limited to publications addressing earthen buildings in seismic areas, seismic performance, structural analysis, methods of intervention, and conservation efforts in those regions. The bibliography includes articles related to numerical modeling, static and dynamic testing, and remedial interventions of other unreinforced masonry historic buildings in earthquake-prone zones, where the methodology may also be applicable to earthen sites. It also includes series of relevant international conference proceedings on earthen building conservation, building cultures, structural analysis, interventions in historic buildings, and construction histories.

The bibliography is generally limited to English language texts; however, it does include several Spanish language texts. The bibliography is meant to be global, without a particular geographic focus, except in that the geography is limited to seismically active areas and then by the language of the available texts for a particular geographic region. Entries include both printed texts, as well as those published in an electronic format.

Content by Category**Historic Structures in Seismic Areas:**

This category includes articles arranged by building type, seismic region, or building period. It is subdivided by the following themes:

1. Earthen Structures in Seismic Areas:

This category covers a broad range of topics. It consists of publications on historical and vernacular earthen buildings in seismic areas around the world. The purpose of this grouping is to identify different earthen construction techniques commonly used in seismic areas.

2. Earthen Building Cultures:

Earthen buildings in seismic areas, similar to any other building type, have evolved over time. The structural failure of earthen buildings has often led to a better understanding of their performance and improvements in their design. Over time, this has created an earthen building culture. The articles in this section focus on the evolution of that culture towards a better resistance to earthquakes.

3. Conference Proceedings:

This category is specific to conference proceedings such as the international conferences on the study and conservation of earthen heritage (Terra), Seminario

Ibero-Americano de Arquitectura y Construcción con Tierra (Pro-Terra), the Structural Analysis of Historical Constructions conference (SAHC), the International Conference on Studies, Repairs and Maintenance of Heritage Architecture (STREMAH) and the International Conference on the History of Construction, among others.

Structural Analysis:

This category includes publications addressing the different activities involved in the development of a building's structural analysis, particularly those targeted to seismic performance and behavior. It is subdivided into the following subcategories:

1. Acquisition and Interpretation of Data:

Publications in this subcategory are related to data acquisition methods for seismic studies, including site histories, construction techniques, building mechanics and behavior, classification of damage, and structural studies. This section of the bibliography also includes texts on post-earthquake data collection.

2. Existing Performance, Vulnerability Studies and Risk Analysis:

The publications under this subcategory include studies of the existing performance, site vulnerability to earthquakes, and risk assessments of historic buildings. The texts analyze the structural performance (capabilities and limitations) of a building during a seismic event, define its vulnerabilities, and identify potential structural damage.

3. Testing and Numerical Investigation:

This category includes publications on the topics of dynamic and static testing for material characterization, structural stiffness, and strength and load impact to better understand a building's seismic performance. Texts also include numerical and analytical models of connections, modes of failure, and seismic assessment.

4. Timber Joints:

A preliminary bibliography on the structural behavior and modeling of timber joints is included here. It includes resources that the SRP project partners consider applicable to this project, although it may not be representative of the full scope of research in the field.

Interventions:

In architectural conservation, different approaches are undertaken for the treatment of historic buildings, including preservation, rehabilitation, restoration and reconstruction. The final objective of any intervention is to increase and maintain the life span of a building for the future with minimum impact on its historic fabric. In many cases, the designed intervention is simple, traditional or has already been practiced for several decades and has been proven to be successful. In other circumstances new materials and techniques are used to improve the structural performance of the buildings. This category includes both types of remedial interventions.

1. Traditional:

The citations in this subcategory include traditional interventions carried out in buildings in seismic areas.

These methods have been carried out over decades and are known to be effective—in other words they are field-tested techniques.

2. New and Emerging:

These citations address the considerable amount of research that has been undertaken in the areas of new materials for seismic retrofitting or improvement of seismic performance of historic sites. These new materials help dissipate energy during seismic occurrences without damaging the buildings and their historic fabric.

Case Studies:

This category includes texts involving specific unreinforced masonry sites in seismic areas, including structural analysis, vulnerability and risks assessments, measures taken for their retrofitting, and other lessons learned. The texts in this category sometimes cover various buildings from different countries or, in other cases, only one particular building. Most of the time, the cited publication describes all the steps taken in a project from methodology development, data acquisition, structural analysis, testing and modeling to implementation of structural interventions.

Policies, Standards, and Guidelines:

The articles, publications, and reports in this category provide guidance and regulation for seismically upgrading historic buildings and implementing safety measures and maintenance programs for earthen sites in different parts of the world. This guidance not only addresses structural and safety concerns but also addresses the preservation of a site's significance.

Future Steps

The GCI will update this bibliography periodically.

CHAPTER 2

Historic Structures in Seismic Areas

2.1. Earthen Structures in Seismic Areas

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Carbajal, F., G. Ruiz, and C. J. Schexnayder. 2005. Quincha construction in Perú. *Practice Periodical on Structural Design and Construction* 10 (1): 56-62.

Carrillo Rosell, Pablo Américo. 1982. *Consolidacion de estructuras de adobe tecnica tradicional*. ICCROM Report.

Gutiérrez, Ramón. 1981. *La Casa cusqueña*. [Corrientes?, República Argentina]: Departamento de Historia de la Arquitectura, Universidad Nacional del Nordeste.

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- Jaquin, Paul. 2008. Study of historic rammed earth structures in Spain and India. *Structural Engineer* 86 (2): 26-32.
- Jaquin, Paul, and Charles Auteur. 2012. *Earth Building History, Science and Conservation*. Bracknell: IHS BRE Press.
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- López, J.E., H.A. Bellido, Y.Q. Villavicencio, A. Carrasco, G.S. Capelli, and E.B. García, ed. 2008. *Manual de técnicas constructivas tradicionales del poblado histórico de Vilcashuamán*. Lima: Instituto Nacional de Cultura.
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- Vissilia, Anna - Maria, and Maria Villi. 2010. Adobe and timber ties as main construction material for an historic Greek dwelling. *International Journal of Architectural Heritage* 4: 295-319.

2.2. Earthen Building Cultures

Chaire UNESCO Réseau en architecture de terre Cultures constructives et développement durable (Grenoble). 2011. *Aléas naturels, catastrophes et développement local: Stratégies intégrées de gestion des risques par le renforcement des dynamiques locales: De la reconstruction vers la prévention*. Villefontaine: CRATerre éd.

De la Torre Rangel, O., R.L. Vázquez, A.S. Hernández, and J.C.R. Cabrera. 2004. Evaluación estructural y comportamiento de las reparaciones efectuadas a edificaciones históricas. *Revista de Ingeniería Sísmica* (070): 1-26.

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Samanez Argumendo, R.S. 1980. Los monumentos de adobe en el Peru y los casos de restoracion efectuados en la zona de Cusco. In *Third International Symposium on Mudbrick (Adobe) Preservation: 29 September-4 October, 1980, Ankara = Üçüncü Uluslararası Kerpiç Koruma Sempozyumu: 29 Eylül-4 Ekim, 1980, Ankara*. 201-240 [Ankara?]: ICOM : ICOMOS. <http://www.international.icomos.org/publications/ankara18.pdf>

Seiner Lizárraga, Lizardo. 2009. *Historia de los sismos en el Perú: Catálogo: Siglos XV-XVII*. Colección Investigaciones (Universidad de Lima). Lima: Universidad de Lima Fondo Editorial.

Seiner Lizárraga, Lizardo. 2011. *Historia de los sismos en el Perú: Catálogo: Siglos XVIII-XIX*. 1st ed. Colección Investigaciones (Universidad de Lima). Lima: Universidad de Lima, Fondo Editorial.

Walker, Charles F. 2008. *Shaky Colonialism: The 1746 Earthquake-Tsunami in Lima, Peru, and Its Long Aftermath*. Durham: Duke University Press.

Yamin, L.E., C.A. Phillips, J.C. Reyes, and D.M. Ruiz. 2004. Seismic behavior and rehabilitation alternatives for adobe and rammed earth buildings. In *13th World Conference on Earthquake Engineering Conference Proceedings, Vancouver, British Columbia, Canada, August 1-6, 2004*. Paper 2942. [Vancouver, B.C.: 13 WCEE Secretariat?].

2.3. Conference Proceedings

The following series of conferences proceedings are listed individually and organized by date.

GSAP

Tolles, E. Leroy, Frederick A. Webster, Anthony Crosby, and Edna E. Kimbro. 1996. *Survey of Damage to Historic Adobe Buildings after the January 1994 Northridge Earthquake*. GCI Scientific Program report. Los Angeles: The Getty Conservation Institute. http://www.getty.edu/conservation/publications_resources/pdf_publications/damage_adobe_structures.html

Tolles, E. Leroy, Edna E. Kimbro, Frederick A. Webster, and William S. Ginell. 2000. *Seismic Stabilization of Historic Adobe Structures: Final Report of the Getty Seismic Adobe Project*. Los Angeles: Getty Conservation Institute. http://www.getty.edu/conservation/publications_resources/pdf_publications/seismic_stabilization.html

Tolles, E. Leroy, Edna E. Kimbro, and William S. Ginell. 2002. *Planning and Engineering Guidelines for the Seismic Retrofitting of Historic Adobe Structures*. GCI Scientific Program Reports. Los Angeles: Getty Conservation Institute. http://www.getty.edu/conservation/publications_resources/pdf_publications/seismic_retrofitting.html

Tolles, E. Leroy, Edna E. Kimbro, and William S. Ginell. 2005. *Guías de planeamiento e ingeniería para la estabilización sismorresistente de estructuras históricas de adobe*. Los Angeles Getty Conservation Institute. http://www.getty.edu/conservation/publications_resources/pdf_publications/seismic_retrofitting.html

Hardy, Mary, Claudia Cancino, and Gail Ostergren, ed. 2009. *Proceedings of the Getty Seismic Adobe Project 2006 Colloquium: Getty Center, Los Angeles, April 11-13, 2006*. Los Angeles, CA: Getty Conservation Institute. http://www.getty.edu/conservation/publications_resources/pdf_publications/gsap.html

History of Construction:

Huerta Fernández, Santiago, ed. 2003. *Proceedings of the First International Congress on Construction History, Madrid 20th-24th, January 2003*, Textos sobre teoría e historia de las construcciones = Texts on the Theory and History of Constructions. Madrid: Instituto Juan de Herrera, Escuela Técnica Superior de Arquitectura.

Dunkeld, Malcolm, ed. 2006. *Proceedings of the Second International Congress on Construction History Queen's College, Cambridge University 29th March-2nd April 2006*. [Ascot, England]: Construction History Society. <http://www.arct.cam.ac.uk/research/researchgroups/sustainablebuilding/traditional-building-construction-research/ICCH>

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SAHC

Roca, P., J.L. González, A.R. Mari, and E. Oñate, ed. 1997. *Structural Analysis of Historical Constructions: Possibilities of Numerical and Experimental Techniques*. 1st ed, Theory and Engineering Applications of Computational Methods. Barcelona: International Center for Numerical Methods in Engineering (CIMNE).

Roca, P., J.L. González, E. Oñate, and P.B. Lourenço, ed. 1998. *Structural Analysis of Historical Constructions II: Possibilities of Numerical and Experimental Techniques*. 1st ed, Theory and Engineering Applications of Computational Methods. Barcelona: International Center for Numerical Methods in Engineering (CIMNE).

Modena, Claudio, Paulo B. Lourenço, and Pere Roca, ed. 2005. *Structural Analysis of Historical Constructions: Possibilities of Numerical and Experimental Techniques*. 1st ed. Leiden and London: A. A. Balkema Publishers; Taylor & Francis Group.

Lourenço, Paulo B., Pere Roca, and S Agrawal, ed. 2007. *Proceedings of the 5th International Conference [on] Structural Analysis of Historical Constructions: Possibilities of Numerical and Experimental Techniques, 6-8 November 2006*, Macmillan Advanced Research Series. New Delhi: Macmillan.

D'Ayala, Dina, and Enrico Fodde, ed. 2008. *Structural Analysis of Historical Constructions: Proceedings of the VI International Conference on Structural Analysis of Historical Constructions, SAHC08, 2-4 July 2008, Bath, United Kingdom*. London: Taylor & Francis.

7th International Conference on Structural Analysis of Historic Constructions: Strengthening and Retrofitting: Selected, Peer Reviewed Papers from the 7th International Conference on Structural Analysis of Historic Constructions, October 6-8, 2010, Shanghai, People's Republic of China. 2010. Stafa-Zuerich, Switzerland and Enfield, NH: Trans Tech Publications.

STREMAH

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Brebbia, C. A., and B. Leftheris, ed. 1995. *Structural Studies of Historical Buildings IV*. Southampton and Boston: Computational Mechanics Publications.

Sánchez-Beitia, S., and C. A. Brebbia, ed. 1997. *Structural Studies, Repairs, and Maintenance of Historical Buildings V*, International Series on Advances in Architecture. Southampton, UK and Boston: Computational Mechanics Publications.

Brebbia, C. A., and W. Jäger, ed. 1999. *Structural Studies, Repairs, and Maintenance of Historical Buildings VI*, International Series on Advances in Architecture. Southampton, UK and Boston: WIT Press.

Brebbia, C. A., ed. 2001. *Structural Studies, Repairs and Maintenance of Historical Buildings VII*, Advances in Architecture. Southampton: WIT Press.

Brebbia, C. A., ed. 2003. *Structural Studies, Repairs and Maintenance of Heritage Architecture VIII*, Advances in Architecture. Southampton and Boston: WIT.

Brebbia, C. A., and A. Torpiano, ed. 2005. *Structural Studies, Repairs, and Maintenance of Heritage Architecture IX*, WIT Transactions on the Built Environment. Southampton and Boston: WIT.

Brebbia, C. A., ed. 2007. *Structural Studies, Repairs and Maintenance of Heritage Architecture X*, WIT Transactions on the Built Environment. Southampton and Boston: WIT.

Brebbia, C. A., ed. 2009. *Structural Studies, Repairs and Maintenance of Heritage Architecture XI*, WIT Transactions on the Built Environment. Southampton: WIT.

Brebbia, C. A., and Luigia Binda, ed. 2011. *Structural Studies, Repairs and Maintenance of Heritage Architecture XII*, WIT Transactions on the Built Environment. Southampton and Boston: WIT Press.

TERRA

Premier colloque international sur la conservation des monuments en brique crue: Yazd, Iran, 25-30. XI. 1972 = First International Conference on the Conservation of Mud-Brick Monuments. 1976. [Teheran], Iran: Ministry of Culture and Arts. <http://www.icomos.org/en/what-we-do/disseminating-knowledge/publicationall/other-publications/116-english-categories/resources/publications/389-premier-colloque-international-sur-la-conservation-des-monuments-en-brique--first-international-conference-on-the-conservation-of-mud-brick-monuments>

Deuxieme colloque international pour la conservation des monuments en brique crue = Second International Symposium on the Conservation of Mud-Brick Monuments, Yazd, 6-11 March 1976. 1976. Paris: ICOMOS. 1976. Paris: ICOMOS.

Third International Symposium on Mudbrick (Adobe) Preservation: 29 September-4 October, 1980, Ankara = Üçüncü Uluslararası Kerpiç Koruma Sempozyumu: 29 Eylül-4 Ekim, 1980, Ankara. 1980. [Ankara?]: ICOM and ICOMOS. <http://www.icomos.org/en/what-we-do/disseminating-knowledge/publicationall/other-publications/116-english-categories/resources/publications/388-third-international-symposium-on-mudbrick-adobe-preservation>

Adobe 84: Simposio Internacional y Curso-Taller sobre Conservación del Adobe: Informe y seguimiento = International Symposium and Training Workshop on the Conservation of Adobe: Progress Report. 1984. Lima: Proyecto Regional de Patrimonio Cultural y Desarrollo PNUD/UNESCO.

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Preprints of Papers: 9th International Conference on the Study and Conservation of Earthen Architecture: Terra 2003. 2003. Tehran, Iran: Deputy of Presentation, Iranian Cultural Heritage Organization.

Rainer, Leslie H., Angelyn Bass Rivera, and David Gandreau, ed. 2011. *Terra 2008: Proceedings of the 10th International Conference on the Study and Conservation of Earthen Architectural Heritage, Bamako, Mali, February 1-5, 2008*. Los Angeles: Getty Conservation Institute/Getty Publication. http://www.getty.edu/conservation/publications_resources/pdf_publications/terra_2008.html

OTHER

Proyecto Regional de Patrimonio Cultural PNUD/UNESCO, and Centro Nacional para la Protección de La Antigua Guatemala. 1983. *La protección de monumentos históricos en áreas sísmicas: Documentos y conclusiones: Seminario Internacional, La Antigua, Guatemala 4 al 11 de noviembre 1979*. [Lima, Peru]: Proyecto Regional de Patrimonio Cultural PNUD-UNESCO.

May, Gerald W., ed. 1981. *Proceedings of International Workshop held at the University of New Mexico, Albuquerque, New Mexico, May 24-28, 1981*. Albuquerque: University of New Mexico.

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CHAPTER 3

Structural Analysis

3.1. Acquisition and Interpretation of Data

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CHAPTER 4

Interventions

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CHAPTER 5

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CHAPTER 6

Policies, Standards, and Guidelines

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