



A PROJECT OF SEISMIC IMPORTANCE

Earth, a humble and common building material, has given form to an amazing array of structures throughout history, many of great beauty and sophistication. From ancient archaeological sites to modern buildings, in urban complexes and historic centers, earthen buildings have provided human shelter for millennia. Today, more than half the world's population either lives or works in buildings constructed of earth, a sustainable, locally sourced, and renewable material.

For nearly two decades, the Getty Conservation Institute (GCI) has been a recognized leader in developing methodologies and setting standards for the conservation of earthen heritage worldwide. Seismic events in particular pose a risk to historic earthen buildings, most of which are classified as unreinforced masonry structures. The risk is especially high if a building lacks proper and regular maintenance.

In the 1990s, the GCI led a major research and laboratory testing program, the Getty Seismic Adobe Project (GSAP), which analyzed the seismic performance of historic adobe structures in California and developed cost-effective retrofitting techniques that substantially preserved the authenticity of these buildings. In 2011, the GCI joined forces with the Ministerio de Cultura del Perú, the Civil, Environmental and Geomatic Engineering School at University College London, and the Escuela de Ciencias e Ingeniería of the Pontificia Universidad Católica del Perú to adapt the GSAP retrofitting techniques and design new ones to be used in countries where high-tech equipment and materials, and advanced structural skills are not easily available. This partnership launched the Seismic Retrofitting Project (SRP), which aims to provide low-tech, easy-to-implement retrofitting techniques to improve a building's structural performance during an earthquake while also preserving its historic fabric.

The SRP is based in Peru, which has a long and rich tradition of building with earth, from the ancient cities of Caral and Chan Chan to the vernacular and monumental structures of the colonial and republican eras. Four prototype structures were selected to be studied as part of SRP—the Hotel Comercio, the Cathedral of Ica, the Church of Kuño Tambo, and Casa Arones (see next page). These prototypes represent principal historic building types in need of sensitive retrofitting techniques that have the potential for the most widespread application not only in Peru but also in other seismic regions in Latin America.

The project involves scientific research, analysis, testing and design, capacity building, and implementation of the designed techniques on model projects. "One of the most important contributions of this project is that we are providing suitable



Above: Shear strength tests via lateral displacement of mock up of a quinchá panels, a vernacular building technique, at the Pontificia Universidad Católica del Perú. Photo: Scott S. Warren

Left: View of the central nave of Ica Cathedral after the 2007 Pisco earthquake. Photo: Scott S. Warren, 2011

retrofitting techniques and scientific data that calculates how the building will improve its seismic performance, once these are implemented," said Claudia Cancino, senior project specialist at the GCI and manager of the SRP. "This will be very useful for architects and engineers."

The SRP will also provide guidance for those responsible for implementation (e.g., architects, engineers, and conservators), and work with authorities to gain acceptance and to facilitate the implementation of the designed techniques.

"The importance of this project for Peruvians is that the designed techniques could be then adapted and implemented to other buildings in seismic regions, safeguarding a great deal of earthen heritage for generations to come," said Daniel Torrealva, structural engineer and principal investigator at Pontificia Universidad Católica del Perú.

As a result of this work, the SRP building prototypes will become model case studies, illustrating how retrofitting techniques can be implemented as part of a larger conservation project. It will demonstrate technically feasible solutions to seismic retrofitting in countries where access to high-tech construction materials and professional expertise is limited.

Through wide dissemination of the designed retrofitting techniques, the project will reduce earthquake damage while advancing the conservation of similar earthen structures in Latin America, and other parts of the world.

The SRP is generously supported by the GCI Council.

SRP BUILDING PROTOTYPES

Hotel Comercio:

The Hotel Comercio is located in the historic center of Lima. The site was first developed in the sixteenth century; however, the current structure dates to the middle of the nineteenth century. Hotel Comercio is representative of a typical courtyard or "patio" building, known as a casona. The three-story building consists of 131 rooms arranged around two interior patios.

Hotel Comercio is constructed with rubble stone foundations, a fired brick masonry base course, mud brick masonry walls at the first floor, and quincha panels at the second and third floors.



Photo: Amila Ferron, GCI

Kuño Tambo Church:

The Church of Santiago Apóstol of Kuño Tambo, located in a remote Andean village, has been in continuous use as a place of worship since its construction in the seventeenth century. Remarkably, it still retains much of its original configuration and materials.

Constructed with thick adobe walls and buttresses over a rubble stone masonry base course and a wood-framed gable roof "par y nudillo," the church exhibits many of the design features and materials typical of churches in small villages established by the Spanish across Latin America. The church, including the beautiful wall paintings that decorate the interior, are being conserved with support of Friends of Heritage Preservation.



Photo: Wilfredo Carazas, GCI



Photo: Sara Lardinois, GCI

Ica Cathedral:

Located on the coast of Peru, the Cathedral of Ica was originally built in 1759 by the Society of Jesus and was used as a place of worship until it was damaged in the 2007 Pisco earthquake.

The thick lateral walls are constructed with mud brick masonry over a fired brick base course and stone foundations. The side aisles are separated from the central nave by a series of hollow quincha (wattle and daub) pillars and arches covered with painted plaster. The barrel vault and domes are also constructed with wood arches or ribs and quincha.



Photo: Scott S. Warren, GCI

Casa Arones:

Casa Arones, a sixteenth-century building in the historic center of Cusco, Peru, is a typical residential structure of Andean historic centers. Originally constructed as a single-family dwelling with ground floor commercial spaces, the building was later divided into multiple residential units.

The two-story building exhibits many of the design features and materials typical of residences from the Spanish Viceroyalty period, including moderately thick mud brick walls over a rubble stone masonry foundation, wood-framed gable roofs, and galleries with fired brick and stone masonry arcades surrounding a central patio.