

## Vernacular heritage seismic risk management—ongoing educational project

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**ABSTRACT:** This paper presents a seismic risk management research project. Activities were developed in Cusco, where four villages were chosen containing 95% earthen constructions and vernacular values. The aim is to achieve a strategy research for the existing diverse stakeholder groups. The strategy created a technical course for earthen construction (PUCP, 2011) for architectural and engineering students. Simultaneously, in the chosen Cusco's villages, were spread seismic constructive practices and create awareness within the rural population about vernacular value and its preservation. A Management Committee was also created with the Mayors of these three districts, and the support of the religious authorities, private enterprises and young associations to organize the zoning, and issue municipal declarations and rules in order to preserve its vernacular value. Finally, a seismic reinforcement workshop was addressed to earthen workers and builders, with an important number of participants, repeated in year 2013, as requested by worker

### 1 INTRODUCTION

Peru is a country with severe seismic activity, located on the Pacific Ocean belt where around the 85% of the world seismic energy is dissipated. The earthquakes are recurrent natural disasters producing cumulative damage to structures, which will collapse if they do not receive any maintenance.

Since 1983, earthen construction researchers from PUCP (Vargas Neumann 1983) (Vargas Neumann et al. 1986) (Vargas Neumann et al. 2007) have been studying a way to intervene in heritage and in housing with design criteria based on performance, and applying reinforcements.

Conservation principles for earthen heritage in seismic areas have been developed by Peruvians and presented to ICOMOS. Additionally, in December 2010, the Declaration of Lima was signed as conclusions from the International Symposium 2010 Disaster Management of Cultural Heritage (International Symposium 2010, Lima), and as of these days are part of the ICOMOS doctrinal texts.

The Lima Declaration, emphasizes that “the world is divided into seismic and non-seismic areas. Following international conservation charters and conservation policies, we now address the cumulative damage to cultural heritage associated with severe earthquakes in seismic prone areas”.

Professional interdisciplinary training must be needed to:

- Undertake and integrated risk assessment to analyse vulnerability of cultural heritage.
- Create an integrated risk management of cultural heritage, incorporating disaster preparedness.
- Formulate risk management plans for cultural heritage (International Symposium 2010).

### 2 ACTUAL CHALLENGES

It can be considered that natural disasters have three phases: 1. emergency, 2. recovery, and 3. mitigation. The last one corresponds to medium and long term actions: education, study, research, and the development of management risk plans.

#### 2.1 *General research approach*

The project's goal is the protection of vernacular value in many of the villages spread in the Peruvian territory. Originally, the case study concentrated in Cuzco southern area, in the Vilcanota Valley. The region characteristics revealed a huge potential for tourism (Fig. 1).

In order to concrete a management plan for the vernacular areas, it is understood that there is a need to address in advance an educational task group, including university teachers, future professional protagonists, authorities and the rural-urban population from the study area (Rodríguez-Larraín 2013).



Figure 1. Cusco Earthquake damage, 1950. (Credits: LIFE historic file).



Figure 2. Vulnerable houses in Huaró. (Credits: Centro Tierra).

### 3 VERNACULAR HERITAGE SEISMIC RISK MANAGEMENT PROJECT

The program began in the year 2011 with the creation of the course “Seminar I, Earthen Construction” at the PUCP, by Architecture Faculty, which was addressed to architectural and engineering students that wished to develop, design, and construct using their capabilities with earthen materials. It covers the modernity, social housing, and the heritage conservation, specifically emphasising the vernacular value of the villages already mentioned (Figs 2–3).

#### 3.1 *The selected vernacular zone at the south of Cusco, and its values*

In the Quispicanchi province, at Vilcanota Valley’s south river, we found the three selected adjacent districts, Andahuaylillas, Huaró, and Urcos, all having similar vernacular characteristics, such as the principal colonial squares, with valuable churches surrounded by the countryside with earthen housing generating vernacular valuable landscapes. The mentioned churches from *Compañía de Jesús* Order, conform to what is called *Ruta del Barroco Andino* (Andean Baroque route). In the year 2010, the Culture Ministry nominated the Andahuaylillas main square the Church and the surrounding houses as National Heritage. The technique used in the area is adobe masonry, for housing and two of the churches, and rammed earth with external stones for dividing fences of the lands.

#### 3.2 *Call for authorities management committee*

The more influential authorities in these districts are the mayors. Therefore, the first actions were



Figure 3. Rural houses in Huaró. (Credits: Centro Tierra).

addressed to present them the project, and to explain the importance of their involvement in it.

Several of the Mayors become part of the Management Committee, for the defence of heritage and the vernacular values within their districts. In this Committee, representatives from the Ministry of Culture, youth associations in defence of their heritage, like the *Qoriorqo Patrimonial Youngsters Group* and some private enterprises also participate.

The committee is focused in accomplishing the vernacular heritage maintenance. The mayors compromise to convene studies in the proposed zoning rules, in order to distinguish the heritage zones, the buffering zones, and the generic, where other type of construction with modern materials can be developed. These regulations will allow the local ordinances to constitute the vernacular value as the legal principle for the defence. Later it will carry out the monitoring task of their accomplishments.

The regulations will be created by the Regional Department of Ministry of Culture and infractions will be penalized by the town council.

### 3.3 *Interchange and integration experience with chosen village*

The first project phase was oriented to strengthen the local identity and generate the awareness to develop a common vision for specific initiatives, and for the development of local capabilities related to the vernacular heritage protection. The contacts with the parishes and their decision to support the project were crucial.

Construction workers' seminars were given to improve adobe masonry constructions using reinforced walls for earthquakes resistance. Existing possibilities and some historic building examples of earthen building were shown.

Additionally, technical activities were done at the Curial House, an adobe masonry building that is part of the church complex, located in Huaru Square and represents an opportunity for research and training on reinforced earthen construction techniques. This work consisted of the drafting of plans (floors, elevations and sections), meetings with specialists, secondary data compilation (leaflets, standards), and photographic records. All of this was possible thanks to a voluntary group of ex-students from the Earthen Construction Seminar.

### 3.4 *Heritage and local development forum*

During the year an interdisciplinary forum was prepared with the specialist involved in the following subjects: Cultural Heritage and local development, territory and cultural landscape, heritage and economy, heritage and tourism, risk management plans.

The idea was to promote interest in the heritage subject within the population from the Vilcanota South Valley, Cusco, and to promote the Cultural Heritage recognition for tourist and economic development.

The forum focused to reach four objective groups:

1. Mayors, local governors, communal leaders, and local decision makers, were invited to the presentation of ideas about the importance of vernacular value, with its preservation and relation with their towns' development.
2. Local young people, PUCP students, the Qoriorqo Heritage Association, and youngsters from the surrounding villages attended the workshop and forum, sharing common ideas and worries. As a result, a common statement with local



Figure 4. Field test of shicras foundation system to avoid use of clay and to stop water raising into the walls (capillarity). (Credits: Centro Tierra).

authorities at the workshop's closing event was made.

3. Children, with the collaboration of artists Silvia Westphalen and Rohny Alhalel, created a mural for the Andahuaylillas Parish play centre with their view about their heritage. Girls and boys expressed their perception and feelings evoked over their heritage and at the same time is an art work decorating their daily space.
4. Earthen housing builders and workers were invited to a technical workshop, a theoretical talk, and field practice on the application of geogrips technology, as a seismic reinforcement for earthen houses. Forty seven housing builders and workers of the region participated in the workshops. Due to the generated interest, a larger and more complete construction seminar was requested by the attendees. With this new requirement, a new request for financing will be requested to DARS during 2013. This new seminar/ workshop will take place in Huaru, with the participation of local authorities and some members of Management Committee Cusco South Valley.

### 3.5 *Production and diffusion of the corpus of knowledge*

Teachers from the Lima course, students, ex-students, and volunteers, worked together on some constructive innovations, inspired in seismic resistant knowledge coming from the ancient cultures of Caral and Chavin. Both cultures were the creators of the concepts for some modern techniques for applicable solutions to rural areas, are now presented in workshops to rural builders. (Figure 4).

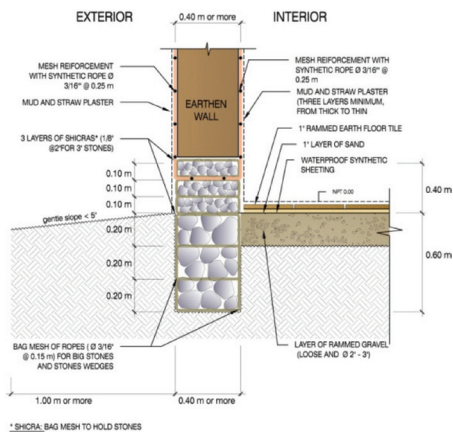


Figure 5. Innovative Foundation System and Wall Reinforcement for Earthen Buildings. Seismic isolation and drainage function. Synthetic mesh to avoid partial collapse. (Credits: Authors).

The main structural themes were:

1. The foundation (foundation and over foundation) the three main objectives related to security and durability are: (1) Transmit the wall load towards firm soil with security and without settlements; (2) Prevent humidity in the earthen walls coming from surface and subterranean waters (capillarity); (3) Dissipate seismic energy via isolation, dumping and friction. It can be done by loose stones packed in mesh bags of synthetic rope instead of mud in the foundation and three flat mesh bags in the over foundation (Kachi T. et al 2011) (Fukuyama 2012). Figure 1 shows an example of solution for earthen constructions, with the three mentioned objectives and one more, which is the drainage of subterranean waters.
2. The earthen walls with rope mesh reinforcement, which are the main seismic resistant elements of a building, and on which depends the resistance, the stability, and the dynamic overall performance. The walls should be reinforced by mesh of tensile resistant material, in both faces and with connections between them every so often, as well as packaged material to avoid partial collapses of the cracked walls by earthquakes.
3. The wooden roofs, should be lightweight in order to avoid lateral seismic forces. To obtain this result, cane layers are recommended instead of wood, and mixtures of straw-mud are used as thermal material. The weight of straw-mud is half the weight of the using only mud itself. The final coverage could be of traditional straw, as it is used now in zones of high altitude above sea level.

#### 4 CONCLUSIONS AND PLANS FOR THE FUTURE

The task is to raise the awareness of seismic risk in rural houses and the appreciation of the vernacular heritage value as an agent for development.

An effective solution could be to invite local authorities and young organizations to participate in the awareness and education of the population. It is important to promote their role as transfer agents to the rest of the population. This strategy should be considered in medium term and in long term, at least to be measured in years.

The overall process cannot be realized without the coordinated participation of the State and the expert agents on seismic risk management and earthquake resistant technologies.

The vernacular heritage risk management should be integrated into the overall risk planning of society.

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