Structural health monitoring of historical adobe buildings Part I – Summary of the results of three years of continuous monitoring to enhance the knowledge of their structural and thermohygrometric behaviour

Giacomo Zonno[a], Rafael Aguilar[a], Rubén Boroschek[b] and Paulo B. Lourenço[c]

[a] Department of Engineering, Pontificia Universidad Católica del Perú - PUCP,
Av. Universitaria 1801, San Miguel, Lima 32, Peru
e-mail: g.zonno@pucp.edu.pe, raguilar@pucp.pe

[b] University of Chile, Department of Civil Engineering,
Av. Blanco Encalada 2002, Santiago, Región Metropolitana, Chile
e-mail: rborosch@ing.uchile.cl

[c] University of Minho, ISISE, Department of Civil Engineering,
Campus de Azurém 4800 - 058 Guimarães, Portugal
e-mail: pbl@civil.uminho.pt

ABSTRACT

Adobe has a very significant place in the field of civil construction materials. Different types of structures were made over the centuries and in various parts of the World with this material due to its attractive characteristics such as low cost, local availability, the possibility to be self/owner-made, good thermal insulation and acoustic properties [1]. In particular, adobe buildings are widely diffused in Latin America, and in Peru where cultural heritage and archaeological sites made of this material are a fundamental part of its intellectual richness and cultural diversity. Unfortunately, these structures require a special attention and investigation due to the high vulnerability of the adobe heritage buildings affected by anthropological factors (such as lack of maintenance, inappropriate use and traffic vibrations), natural factors (such as earthquakes, tsunami and environment conditions) and intrinsic factors (such as aging of the materials and the low tensile strength and brittle behaviour of the adobe) [2]. Modern tools were developed to assess existing buildings and reduce their vulnerability. Within the available tools, vibration-based structural health monitoring (vSHM) is finding an increasing use in the preservation and conservation of historical constructions due to the low invasiveness, increase of the level of knowledge of structural system, accuracy of the results and the possibility of check the health state of the structures [3]. For this purpose, the paper describes in detail the application of a vSHM system to the San Pedro Apostol Church of Andahuaylillas located in Cusco (Peru), a 16th century adobe church considered a representative example of South America baroque architecture. The results of three years of long-term vibration and environmental monitoring program are reported in detail in the paper, with a focus on the long-term and short-term correlations between natural frequencies and temperature and humidity parameters. The results demonstrate that an accurate estimation of the first eight frequencies in the range 2-6 Hz is possible in the case of complex adobe structure and the existence of an annual cyclical behaviour of the natural frequencies with a clear correspondence with the changes in environmental conditions due to seasonal influences. The performed correlations of ambient conditions and structural parameters confirmed the presence of different timescales and their not negligible influence in the case of a vSHM assessment of adobe systems with large thermal inertia.

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