Heritage earth construction and hygrothermal comfort: The challenge of rebuilding in Central Chile

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Abstract. According to the latest official census of 2002, earth construction represented 5.5% of the Chilean building stock. These buildings of traditional construction techniques of unfired earth and straw blocks (adobe), rammed earth (tapial) or wattle and daub (quincha) form a large proportion of Chile’s National Monuments and heritage buildings. In addition to their heritage value, these buildings with their high thermal mass, respond well to the climate conditions of both the altiplano of northern Chile and the Central Valley, zones with high diurnal temperature oscillations, with typical daily temperature differences of up to 20°C. However following the 2005 earthquake in Tarapacá, northern Chile and that of the 27th February 2010 in Central Chile a serious rethink has been required as to the retention and restoration of adobe buildings. Public opinion has labelled earth construction as unsafe and most reconstruction to date has taken place with prefabricated timber solutions which lack the necessary thermal mass to respond well to the climatic conditions. At the same time research into the structural integrity, seismic resistance, maintenance and the living conditions provided by earth construction has been undertaken. In this wider context this paper presents the compilation of international and Chilean research into the hygrothermal properties of adobe construction, in addition to the authors in situ measurements of the temperature and relative humidity in two surviving adobe dwellings in the earthquake hit village of Chépica located in Chile’s Central valley. These measurements are compared with those of a dwelling rebuilt with straw bales and earth render in the same location. Based on this information the paper studies the challenge of rebuilding and restoring heritage buildings whilst providing occupants with the necessary levels of environmental comfort.

Introduction

History of Earth Building in Chile. Since pre-Columbian times earth construction has played an important role in the vernacular architecture of Northern and Central Chile. The ruins of the town of Tulor Aldea located near San Pedro de Atacama in the North of Chile date from 400BC and show signs of continual habitation until 300AD. The town consists of 26 circular structures, constructed using a technique of earth mixed with water and modelled insitu [1] similar to British cob construction. Other examples of pre-Columbian earth construction in Chile include Quincha a type of wattle and daub with a timber structure supporting a cane membrane to which an earth-gypsum render is applied; and Tapial rammed earth.

With the arrival of the Spanish in 1537 came the introduction of the unfired earth brick or Adobe. This building technique consists of earth to which natural fibres are added. In Chile the most commonly used natural fibre is straw. The earth-straw mix is formed into bricks or adobes in wooden moulds. The adobes are then left to dry in the sun. Adobes are used as both load-bearing solid masonry construction, bedded with an earth mortar, with walls typically between 600mm and 1200mm thick; and as an infill between timber structure forming thinner walls and partitions. Both systems are traditionally finished with an earthen render.

In time adobe became the predominant construction technique in Chile’s Central Valley and remained so until the beginning of the 20th Century. According to the latest national census of 2002