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Earth block houses of historic centers. A sustainable upgrading with compatible repair materials

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Abstract

Earth structures have been continuously used in construction from prehistory until nowadays (33% of worldwide houses), due to their low cost and easy production, without high energy embodied materials. They were constructed with various techniques and materials which depicted apart from the regional traditions in building, the construction philosophy of the past, inspired from the respect to environment and saving of materials and energy resources. In many towns of the South East Europe there is a stock of earth block houses of vernacular architecture. Most of them have been abandoned and destroyed or reconstructed with concrete or cement based materials, altering completely their original characteristics. Nowadays, there is not a unified policy for the preservation of this significant part of the common European Cultural Heritage due to:
- The tradition of manufacturing earth masonry has been vanished
- The lack of scientific knowledge regarding the restoration and repair materials of earth structures by using adequate and mild interventions.
- The lack of regulations regarding the proper compatible materials and techniques.
However, the consolidation, upgrading and reuse of these earth masonry houses in the urban plan of modern cities, is of great importance for the cultural identity and development of them. In the paper the main characteristics of these houses have bee recorded, as well as the main damages and problems they confront. Then a series of techniques and materials compatible to the existing ones is proposed and commented properly from the aspect of performance and cost effectiveness.

Keywords: Earth block houses, repair materials, constructional techniques

1. Introduction

Earth structures have been continuously used in construction from prehistory until nowadays (33% of worldwide houses are still built with earth), due to their low cost and easy production, without high energy embodied materials.

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They constitute a great part of European Monumental Heritage and are closely related to the wider historic, socioeconomic and environmental aspects of each region. They are constructed with local clayish materials by using techniques which depict the regional constructional traditions. Many techniques of building with earth have been developed, such as cob in UK and taipa in Portugal.

In SE Europe they are usually located in lowland villages and mountainous settlements. Some of them are still inhabited, others have been abandoned. They are considered as cultural heritage of vernacular architecture, since they are constructed with earth blocks and mud-mortars of local raw materials and by using traditional techniques (Figs.1-2).

Figs. 1-2 Earth-block houses of N Greece (town of Goumenissa)

Up to date there is no policy for their retrofitting, maintenance and upgrading, since the tradition of manufacturing earth masonry has vanished and there is lack of relevant regulations. As a result, earth-block houses have been abandoned and destroyed due to damages from earthquakes, ageing or unsuitable interventions (use of concrete members, cement based mortars), while many settlements with earth houses have been marginalized and abandoned. Meanwhile, modern engineers are not accustomed to this type of buildings and there is lack of scientific knowledge and experience in repairing and upgrading them.

Under the light of sustainability in constructions, alternative ways of building are pursued, for low energy consumption and environment protection. According to literature [1] [2] [3] [4], about 50% of raw materials taken from nature are for buildings and modern cement based construction is responsible for the 40% of worldwide energy consumption and 50% of the total waste burden of the planet. To this direction, building with earth has been reconsidered and there is a revival of the interest all over the world and in many European countries such as France and Germany.

During the last two decades, a research on the development of effective materials and techniques for repairing old earth block masonries has initiated at the Laboratory of Building materials of Aristotle University, aiming at using compatible and locally available raw materials. In this paper, the holistic study of analyzing the existing earth buildings and the design of compatible repair materials for their upgrading are presented.

2. Research Analysis of Earth Block Structures

Traditional earth-block houses can be of 1 or 2 storey's (Figs. 1-2). Masonries are usually 50-100cm thick and are constructed with earth-blocks and mud mortars (structural mortars, renders, plasters) based on locally available clay. Wooden beams and conjunctions reinforce the structure by connecting the structural members and increasing bearing capacity (Fig. 3). Foundations, as well as basements are usually of stone masonry in order to be stable and resistant to humidity.