Renewable and Sustainable Energy Reviews 28 (2013) 130–165

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

A guideline for assessing of critical parameters on Earth architecture and Earth buildings as a sustainable architecture in various countries

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ARTICLE INFO

Article history:
Received 2 March 2013
Received in revised form
9 July 2013
Accepted 14 July 2013
Available online 15 August 2013

Keywords:
Earth architecture
Earth building
Sustainable architecture
Questionnaire
Vernacular architecture

ABSTRACT

For thousands of years, Earth itself has been the most tried and tested natural construction material that can also be used to construct modern sustainable buildings in combination with modern methods. For centuries, humanity has understood very little of the technical and material properties of natural resources, often creating buildings and structures with serious failures in durability, strength and corrosion resistance. Many engineering properties have been understood in the past, and now more fully in highly developed societies, but with this increased knowledge, many other factors seem to have been lost. There has been no modern attempt to connect Earth's architecture and Earth's buildings, and this topic creates the foundation of this study. This study considers seven parameters including the role of national codes and the International Council on Monuments and Sites (ICOMOS), triggers, drivers, obstacles and reasons in the development of the architecture of Earth and Earth's buildings. Other parameters stem from online questionnaires conducted in six countries that evaluated the importance of architectural styles, construction methods, materials, structural and economic aspects, climate conditions, and new technologies like nanotechnology. The online questionnaires were completed based on various aspects of the existing research, literature review and discussion with several senior architects and researchers at ICOMOS. The questionnaires were conducted in between 14 August and 14 November 2012, and the responses came from ICOMOS members from USA, UK, Australia, Iran, India and Malaysia. Upon completion the 763 survey responses were compared, which approximated a confidence interval of 95% and a margin of error of $\pm 5\%$. The responses were investigated using regression analysis for producing related equations on parameters and their relationship in each country. An average of 71% of the respondents found a lack of national codes and guidelines in all countries. Thirty-four percent of the respondents voted for acceptable ICOMOS influence in a shift toward more Earth architecture development. Around 32% of the respondents feel that a single factor, an integrated process where responsibility is shared, could be responsible for driving the Earth architecture in all countries. The main environmental reasons cited for Earth architecture by an average of 58% of the respondents included protection of the environment, minimizing the ecological impact of buildings, and waste reduction. The main social cause noted for Earth buildings by 34% of respondents was a moral imperative of being sustainable. An average of 58% of respondents voted that the main obstacles for the Earth architecture were lack of awareness, perceived higher upfront costs, and lack of education. Therefore, the survey results indicate that appropriate parameter choices and proper decisions in the design and construction stage could lead to developing Earth architecture and Earth buildings. These assessments of various parameters presented in this survey could be applied for the development of Earth architecture and Earth buildings in six countries.

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http://dx.doi.org/10.1016/j.rser.2013.07.020

1. Introduction

Sustainable architecture is an architecture based on localized requirements and building materials and reflecting local traditions. The behavior of sustainable architecture evolves over time to reflect the environmental, cultural, technological and historical contexts in which it exists. It has often been dismissed as crude and unrefined, but has proponents which highlight its importance in the current design. The Earth architecture is a type of sustainable architecture. For thoUSAnds of years, Earth has been the most tried and tested natural construction materials, which in combination with modern methods can be used to construct modern sustainable and eco-friendly buildings. From many years to now, Earth-building techniques have been growing in Iran, USA and all over Europe and Middle East. The reason for this increase is the interest in eco-friendly construction. At the same time, there is also an increase in new building products and technical developments in the production of sustainable building materials. The Earth is one of the most widely used construction materials for different architectural applications such as building, hills, shaped hills, Earth sheltered, terraces, garden, landscape sites. In most instances the use of Earth in the western developed countries is confined to Earth walls only; however, Earth walls can sometimes constitute quite a small percentage of the structure of a building. In many developing countries where the properties of Earth construction are more widely appreciated, Earth is utilized in the construction of floors and roofs in addition to walls. Buildings made with Earth are economical, energy-saving, eco-friendly and sustainable. Earth buildings include adobe, cob, straw and rammed Earth blocks and walls. Worldwide, traditional Earth-construction techniques are known by various names such as cob, rammed Earth, pise de terre, adobe, clay lump and mud. The Earth used in various construction techniques may be stabilized with cement, lime or bitumen. The type of stabilizer depends on the type of clay present in the Earth and the desired modification of built properties. Appropriate stabilizers normally tend to increase the strength and, therefore, improve the durability of the fine product. This is particularly important in areas that experience particular inclement wheatear and often allow the Earth construction to acquire a greater strength more quickly. In case of using inappropriate or incorrect stabilizers, however, the stabilisers can have negative effects upon the properties of an Earth building. All these methods have been used successfully according to the local conditions, customs and materials. In this study, the impact assessment of critical parameters on Earth architecture and Earth buildings as a sustainable architecture is investigated.

Unlike other living organisms that seek a balance with nature to ensure their survival, human beings are concerned with only the immediate satisfaction of their “needs”, which may in turn cause the exhaustion and the collapse of the ecosystem part of which they are an integral part. And this happens despite the fact that scientific communities have been alerting all of us on the drastic effects of our activities that have on the ecosystem [1–4]. The construction industry is one of the largest and most active sectors throughout Europe representing 28.1% and 7.5% of the employment in the construction industry and the European economy, respectively. With an annual turnover of 1200 billion Euros, this sector represents 25% of all European industrial productions, being the largest exporter with 52% market share. In the global scenario, the construction industry is growing at a fast pace. For instance China will need 40 billion square meter of combined residential and commercial floor spaces over the next