Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 104 (2016) 431 – 436

Energy Procedia

CUE2016-Applied Energy Symposium and Forum 2016: Low carbon cities & urban energy systems

Design of an Energy-saving Environmental Control System for Relics Preservation in Archaeology Museum

Xilian Luo[a,*] Penglong Song[a],Yike Wang[a], Wei Tian[b], Zhaolin Gu[a]

[a]*School of Human Settlements and Civil Engineering, Xi'an Jiaotong University, No.28, Xianning West Road, Xi'an 710049,China*
[b]*China United Northwest Institute for Engineering Design & Research Co., Ltd, No.81 Laodong Road, Xi'an,710082, China*

Abstract

An energy efficient displacement ventilation (DV) system was proposed to independently control the local preservation environment of funerary pit from the large-space exhibition hall an archaeology museum. A series of experimental tests were conducted to investigate the performance and validate the feasibility of the DV system for preservation of historical terracotta figurines in their semi-exposed pits in the exhibition hall. The experimental results showed that the DV system provides a feasible and energy-saving strategy for controlling the preservation environment independently.

Peer-review under responsibility of the scientific committee of the Applied Energy Symposium and Forum, CUE2016: Low carbon cities and urban energy systems.

Keywords: Displacement ventilation system; Relics preservation; Energy saving; Archaeology museum; Local environment control

1. Introduction

Over one-third of China's total energy use can be attributed to building [1], of which one-fifth is consumed within public buildings [2]. The progressive depletion of fossil fuels, the growing energy demand and government policies for reducing environmental pollution emissions have increased the urgency of finding technology solutions to reduce energy consumption and to use energy more efficiently, particularly for those high energy consumption public buildings, including office buildings, schools, hotels, museums and others. For an ancient civilized country, there are more than 3000 museums in China, and a large proportion of the existing museums are archaeology museums. Archaeology museum hold the advantages in accommodating the panorama of unmovable ancient sites in a single space and preventing

* Corresponding author. Tel. +86-29-83395100; fax: +86-29-83395100.
E-mail address: xlluo@mail.xjtu.edu.cn.

Peer-review under responsibility of the scientific committee of the Applied Energy Symposium and Forum, CUE2016: Low carbon cities and urban energy systems.
doi:10.1016/j.egypro.2016.12.073

natural weathering of relics caused by the sun, wind and rain. Yet now, the in situ relics in archaeology museum are far from being preserved well since the lack of understanding of site conservation and the impact of indoor micro-climatic conditions. Many of them are suffering deteriorations or even ruins due to improper environment adopted for maintenance of relics [3-4]. Energy consumption for museum buildings is usually of less significance relative to the demands of maintaining proper indoor climate for the collections. However, if possible, energy consumption should be as low as possible since the exhibition hall of archaeology museum usually has a large space layout, which is characterized by a high floor height, large volumes and the proportion of the area occupied by relics is quite small in terms of the total exhibition space, such that most of the energy load by the A/C system is wasted in the non-occupied area [5-7].

In this research, an alternative way that employ a displacement ventilation system in providing a local environment for the in situ unearthed relics in the funerary pit independently was investigated. The DV system is one of the ventilation systems that is known for its effectiveness in controlling environment of the visitor occupied area at a lower energy cost and is widely used in public buildings with large space layout [8-9]. Furthermore, the displacement ventilation systems improve indoor air quality in the low level by separating contaminated air from clean air through stratification. Energy saving as well as high indoor air quality can be implemented efficiently. Therefore, the DV system should have the potential to improve the environment for the preservation of the artifacts in archaeology museums.

2. Experimental setup

2.1. The DV system

A DV system was designed and set up in the laboratory room. The schematic diagram of the system is shown in Fig.1. The air was supplied through a pit ground level plenum chamber with dimensions of 2.5 ×0.7m in the length and height direction of the funerary pits. One façade of the chamber is composited of a perforated panel with dimensions with 2.0mm diameter circular holes. The porosity of the perforated panel is 25%. The returned air was purified and cooled in the air handling unit and then was supplied to the plenum chamber by a centrifugal fan. The pressure of supplied air was equalized in the plenum chamber to ensure the air can be supplied uniformly from the perforated panels. An air source water chiller, with the rated cooling capacity of 7100W, was used as the cold source for the air handling unit.