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ScienceDirect

Procedia Engineering 146 (2016) 473 – 480

Procedia Engineering

www.elsevier.com/locate/procedia

8th International Cold Climate HVAC 2015 Conference, CCHVAC 2015

Theoretical Analyses and Predictions of Indoor Thermal Environment for Cave Dwelling in Northwest of China

Xinying Fan, Bin Chen *

Dalian University of Technology, Dalian, China

Abstract

The population living in loess plateau is about 108 million, but so far there are about 27.8% of them still living in cave dwelling, which is a represented traditional residence in northwest China. Whether traditional cave dwelling should be inherited or replaced is gradually received extensive attention at home and abroad which has different characteristics, for example, adjusting measures to local conditions, low-cost, warm in winter and cool in summer with the rapid development of China's urbanization. Just as other vernacular architectures in China, the traditional cave dwellings are renovated in recent years. To compare the indoor thermal environment performance of cave dwellings and other local typical inhabitancy style, the cave-dwelling, courtyard, new cave-dwelling, general residence was selected as the research object being carried out indoor thermal environment of survey and questionnaires during July 4 ~14, 2014, which is four typical architectural forms in Qingyang of Gansu province in loess plateau zones. The calculated value of prediction evaluation index PMV is generally higher than heat Sensation Vote value TSV through measuring. It turned out that the cave dwelling have a better thermal environment, but this test only based on one point temperature. However, in order to know about temperature field distribution, cliff soil cave dwelling, strengthening soil cave dwelling and new cave dwelling is regarded as objects through establishing physical model and heat transfer model at the same time. This article being based on different building structures deduces indoor temperature distribution. The result show that the temperature exponential decay along the cave dwelling depth direction. In addition, the airflow distribution inside cave dwelling are analyzed in theory using the application of plume model under the effect of hot-pressing ventilation. The article also get cave dwelling air velocity distribution of different interface.

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Peer-review under responsibility of the organizing committee of CCHVAC 2015

* Corresponding author. Tel.: 0411-84706371.
E-mail address: chenbin@dlut.edu.cn

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Peer-review under responsibility of the organizing committee of CCHVAC 2015
doi:10.1016/j.proeng.2016.06.373

Keywords: Traditional residential buildings, Cave dwelling, Thermal environment, Natural ventilation, Theoretical prediction;

1. SUMMARY

Just as other vernacular architectures in China, the traditional cave dwellings are renovated in recent years. Therefore, four different traditional residential buildings was selected as research object to analysis thermal performance and predict cave dwelling indoor temperature distribution in Qingyang of Gansu province in loess plateau zones. Through establishing physical model and heat transfer model at the same time, this paper being based on different building structures deduces indoor temperature distribution. The result show that the temperature exponential decay along the cave dwelling depth direction. In addition, the airflow distribution inside cave dwelling are analyzed in theory using the application of plume model under the effect of hot-pressing ventilation. The article also get cave dwelling air velocity distribution of different interface.

2. INTRODUCTION

From ancient to modern times, human solve accommodation through two paths of air to ground and underground to ground (Yoon 1990). Finally, traditional building was composed of wall, roof, foundation. Vernacular architecture is sourced from human wisdom. The study have shown that 90 percent of residential building is cave dwelling in Shanxi of China (Liu Jiaping 1999). Cave dwelling has different classification changing with times and distribution as shown in Figure 1 and Figure 2. Among the many types of cave dwelling, the cliff cave dwelling is mostly widely used building. Cave dwelling has received much attention in recent years due to its thermal properties, which is warm in the winter and cool in the summer. However, it has been found to too difficult to meet thermal comfort under severe cold and cold zones. Finally, some researcher proposed passive building ideas, which is using attached sunspace into cave dwelling (Liu, Wang, Yoshino, & Liu 2011; ZhuangLi & Chen 2009). There has been extensive research regarding the design method of the zero energy cave-dwelling solar house is given. For example, Liu Jiaping et al. showed that cave dwelling could be simulated indoor one point Instantaneous temperature using D.G.Stephenson methods and more recently,

Yan Zengfeng established model about dynamic thermal and moisture adjusting effect by interior materials of adobe building by MATLAB (Zengfeng 2003). Periodic heat transfer process was introduced into evaluating traditional dwelling thermal stability by Jiliang Zhang (Zhang 2008). However, although the effect of the building thermal process on indoor thermal environment was demonstrated over two years ago, little attention has been paid to production of indoor temperature distribution based on different points. The present paper presents a set of production methods for different cave dwelling.

Unfortunately, indoor thermal distribution and pollution distribution do always affect indoor thermal comfort and health. Previous work has focused only on indoor one point to analysis thermal stability. There remains a need for an efficient method that can solve this problems. The purpose of this study is to describe and examine indoor thermal distribution and pollution distribution.

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