

Research Status of Thermal Environment of Tents

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Abstract. As a special form of architecture, the internal thermal environment of tents is very poor because of the simple envelop. This paper summarized the research status of thermal environment of tents based on the foreign and domestic research results in this field and pointed out the research direction. This work can provide the reference and instruction for further study on improving thermal environment of tents.

Introduction

As the camping equipment, the tents are commonly used in site construction tourism, and other aspects. Compare to the conventional building and board room, the tent has an advantage of convenient transportation and installation. Because of the special structure, the thermal resistance and thermal inertia of the building envelope are small. As a result, the hot-humid environment in tent is bad. Summer is hot and winter is cold. In order to create a comfortable, healthy environment, it is essential to study the thermal environment in tent. In this paper, it will give a comprehensive description to the current situation of the thermal environment and better understanding about improving the thermal environment.

The Current Research Status of Traditional Building Thermal Environment

Tent has a special architectural form. Because of the simple structure, it is rarely used in daily life. Many producers focus only on the structure and appearance of the tent rather than the inner hot-humid environment. Therefore, the reference about this aspect is few. But as an architectural form, it has the general character of the architectural form. Now, it has mature technology to improve the thermal comfort, hot-humid environment, and energy saving of the conventional building. So in this paper, it firstly introduces the current status of the thermal environment evaluation and improvement about the conventional building.

Research Status of Thermal Environment of Conventional Construction in Foreign Countries. The research about indoor thermal environment in foreign countries is carried out earlier. At the beginning of the 20th century, some foreign scholars were started to study the indoor thermal environment.

In 2011, L. Susanti and other people [1]. Discussed the impact of natural ventilation of a roof cavity on improvement of the thermal environment and reduction of cooling load of a factory building. Results showed that a naturally ventilated cavity roof has excellent potential for improving the indoor thermal environment and energy savings of factory buildings without complicated cooling installations and life time power consumption.

In 2012, Jos é A. Orosa in Universidade da Coruña and other people studied the thermal inertia [2]. The paper describes a field case study of school buildings with different types of wall construction, aimed at demonstrating real thermal inertia effects on indoor conditions. Results showed a good agreement between simulated and experimental air temperature results, and that other building construction parameters, such as the use of permeable coverings, may have a large impact on indoor thermal conditions and energy consumption.

Research Status of Thermal Environment of Conventional Construction in China. Because of the low economy and living standard, the research about indoor thermal environment in foreign countries is carried out later. With the development of the society and appearance of environment

problems, many scholars had conducted a lot of research. And they had got significant achievement.

In 2003, professor Yang, Xi'an University of Architecture and Technology, studied the residents who live in cave located in the loess plateau region. They proposed to improve the indoor thermal environment for the design idea of "kiln Solar Housing". According to analysis the thermal environment of the new solar house, they proved that the project was feasible [3].

In 2008, J.Y. Zhang, Tongji university, X.P. Wu, Shanghai Maritime University, they used the RNG $k-\epsilon$ model to study the natural ventilation [4]. They considered the different directions of the sun and combined with the construction mechanism of natural ventilation. The results showed that it would improve the subjective assessment of the thermal environment if open the exterior window.

In 2009, Nan Li, B.Z. Li, Chongqing University, analysis the effect of natural ventilation on improving thermal environment, the field measured data showed that natural ventilation can improve the indoor thermal environment especially the cloudy and rainy weather in summer and the over season [5].

In 2013, C.Q. Xu, J.L. Zhao, Dalian University of Technology, studied the hot-humid environment in rural in the Northeast Cold Area, according to the investigation, they found fuel cell heating technology can improve the indoor heat and humid environment [6]. Meanwhile they put forward the improvement measures of the fuel cell heating technology

Research Status of Thermal Environment of Tents

The investigation of thermal environment in tent mainly aims at the high temperature and humid in summer and keeping warm in winter cold weather. Because of the special structure of tent, the heat and humidity environment is greatly influenced by the outdoor environment. In daily life, people make great change. Besides, the energy saving and environment measurement for the general building research is suitable for changing the hot and humid environment in tent.

Research Status of Thermal Environment of Tents in Foreign Country. In foreign country, people mainly focus on the optimization of fabric performance and the improvement of tent structure, etc. There is little research on the hot and humid environment.

In 2005, Salom, Jaume studied 16000 square meters tent. The tent is connected by a lot of tents, and communicated with the external environment through large openings. The purpose of this study is to analysis the thermal comfort of the tent using TRNSYS software to obtain the internal field simulation. And put forward some reasonable methods to improve internal thermal environment [7].

Research Status of Thermal Environment of Tents in China. In 2004, H.J. Wei Shi and Q.T. Mei, University of Logistics, overcame the shortcomings of the existing tent heating method. After numerous experiments, they developed a new type of heating device with the heating mechanism of conductive coating [8]. And the device was carried out in the low temperature experiment. The results show that the radiation mode of the tent is a comfortable and efficient heating method.

In 2006, Q.L. Meng, S.H. Hu, South China University of Technology, carried out a series of studies and experiments on the thermal environment of the tent [9]. They found that aluminum foil inside the tent can lower the temperature inside the tent. Globe temperature reduced 1degree to 2 degrees. They also found that it would improve the thermal environment in tent when the aluminum foil was poured water.

In 2009, Professor Wang Tao Y. Qi and E.S. Long, Chongqing University, conducted an investigation in disaster area in summer. Experimental results showed that tents looked like "greenhouse" [10]. Internal air temperature and average inner surface temperature could reach 40°C in open tent. They also carried out some experimental researches on some simple improvements for tents. And the main conclusion followed: compared with single tent, tents of three-tier envelope could greatly improved heat preservation performance, and insulation would have certain improvement.

In 2014, College of Architecture and Environment, Sichuan University, Y.F. Bai and X. Long, raised an idea of combining natural temperature control materials energy saver and natural ventilation in night to improve the tent thermal environment, for the low calorific capacity, low

thermal inertia and the thermal storage capabilities of the tents always lead to the temperature fluctuating hard which makes the temperature higher than outside in summer and lower than outside in winter [11]. The contrast experiment research turns out that the tents using the natural temperature control materials energy saver is effective to control the fluctuation of the IAQ (Indoor Air Quality) and the temperature rises in the hot summer condition, which would reduce 6.4°C indoor at most.

Expectation

According to the research status, in order to change the thermal environment, the author suggests that we should strengthen the research of the following aspects:

1) Strengthen the comprehensive application of natural ventilation in the tent. Combined with the climate characteristics, study the effects on the thermal environment of the tents of natural ventilation under different combinations of collocation.

2) Study on the control strategy of natural ventilation in different climatic regions of the tent in order to control the natural ventilation effective

3) Developing a software to simulation the natural ventilation of the tent is good for the studying the natural ventilation.

4) Strengthening the research on the influence on the thermal environment of the sunshade tent to study the effect that the sunshade tents have on the thermal environment.

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