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Measurement of the Thermal Environment in Temporary Settlements with High Building Density after 2008 Wenchuan Earthquake in China

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Abstract

After 2008 Wenchuan earthquake in China, a large amount of temporary settlements with high building density had appeared in the earthquake-stricken area. These temporary settlements all consisted of low-energy temporary buildings: prefab houses. In order to make clear the indoor and outdoor physical environments in the settlements, we measured the relevantly important parameters such as wind velocity, air temperature in Happy Homeland, a typical post-disaster temporary settlement. The field measurements' results showed as followed: (1) the indoor thermal environment of the prefab houses in summer was always worse than that in winter, (2) the wind velocity inside settlement was much lower than that outside, and indoor ventilation was very poor, (3) a micro-scale heat island effect further deteriorated both the summer outdoor and indoor thermal environment.

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1. Introduction

2008 Wenchuan earthquake was the severest large-scale earthquake disaster in the past sixty years in China. After the earthquake, the governments of China faced a very difficult mission to provide a large amount of temporary shelters for the five million homeless victims within only three and a half months. Because the constructions of the

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temporary houses must be completed quickly after the earthquake and these houses could have a service life of at least months, or even years before permanent reconstruction could be completed for the survivors, applying expandable polystyrene sandwich boards to construct prefab houses was better than pitching tents. Under the menace of the frequent aftershocks, single-story house was safer than multi-story one and was a better choice. Meanwhile, limited by the scanty construction lands, the spaces between the houses were very narrow, as shown in Fig.1. So in the earthquake-stricken areas, a large amount of post disaster temporary settlements had been constructed with high building density to accommodate so much affected population.

Because the prefab houses had cheap construction costs, short construction periods and transitory lifespan during the design and construction, the living quality of these prefab houses in Wenchuan earthquake-stricken area had not been taken as seriously as that of permanent ones and was very poor, for example humidity or mould, no adequate ventilation or daylighting, too hot in summer, and so on. It had been found that many post-disaster problems of the survivors were connected with the poor living environment. Therefore much attention had been drawn on the issues about how to improve the living environment of the post-disaster temporary settlements of Wenchuan earthquake, in terms of public physical and psychological health (Kun et al. 2009), sanitary and anti-epidemic (Chen 2009), fire safety (Song 2010), infrastructure construction (Wang 2008), location selection (Liu 2011), and so on. Additionally, the poor thermal environment in the prefab houses had been noticed in China long before (Zhang 2009 and Chen 2011), because such houses had also been widely used as temporary houses in the field or the constructions sites. But by far, it was only the indoor thermal environment of a single prefab room that had been paid attention to, and the outdoor thermal environments of a whole temporary settlement with high building density, such as that in Wenchuan earthquake-stricken area, had not been referred to yet.

As the natural catastrophes have become more and more frequent, the governments of China have been trying to improve the ability of disaster response to alleviate human suffering since Wenchuan earthquake, for instance, to provide enough temporary houses with sufficient quality in time after disasters. Thus it is a prototype of future relief work in Chinese densely populated areas that the design, construction and management of the temporary settlements after Wenchuan earthquake will become. Hence, it was very significant to make clear the thermal environments of the prefab houses in the temporary settlements.

Nomenclature

T_i	the mean indoor air temperature
θ_i	the mean internal surface temperature
T_e	the mean outdoor air temperature

2. Outline of Happy Homeland

Happy Homeland with an area of 10 hectares was one of the typical biggest temporary settlements in Dujiangyan, a severely afflicted area, which is in the hot summer and cold winter zone. This settlement consisted of three similar zones of A, B and C, had 2585 standard rooms in total, and could accommodate about 6,700 homeless. Hence, this settlement had a high building density, which was very common in the earthquake-stricken area. In this study, only zone-A whose layout plane was shown in Fig.2 was selected for measurement.

In order to save construction materials, lands and time, every prefab house had single-story and consisted of several standard rooms. Every standard room was made of 100mm thick EPS board and had two windows located 1m above floor in both front and back walls respectively, as shown in Fig.2. The layout of these prefab houses was very typical in the post-disaster area after Wenchuan earthquake. The spaces between rows were defined as streets and the spaces between lines were defined as passages. These different kinds of passages or streets were marked with different colors in Fig.2. The passage of P7 with 7m width, the street of S7 with 7m width and the two streets of S14 with 14m width formed the main roads and firebreaks of zone-A. The passages of P3.5 with 3.5m width formed the entrance passages, and the passages of P1.5 with 1.5m width formed the necessary spaces between the back windows of two adjacent houses.

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