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Field study on acceptable indoor temperature in temporary shelters built in Nepal after massive earthquake 2015



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ABSTRACT

Natural disasters and wars are the two main reasons that force populations to leave their homes; there emerges an urgent need to be provided the victims with temporary shelters. After massive earthquake in 2015, thousands of Nepalese who lost their home were doomed to live in temporary shelters, which can hardly provide sufficient thermal comfort. The indoor environments within these shelters are very much affected by local climate. In order to know the seasonal changes of indoor thermal environment and find the acceptable temperature range experienced by people living in various temporary shelters mostly self-built after the massive earthquake, a series of survey on indoor thermal environment and thermal comfort was conducted in four main earthquake affected districts. The survey was conducted for three seasons: autumn, winter and summer with 1407 samples. The mean indoor globe temperature varied between 12.1 and 18.5 °C in winter and between 26.9 and 33.2 °C in summer; thus, the seasonal difference is 20.1 °C. According to the respondents' preference, making it warmer in winter and cooler in summer was dominant. The lowest value of mean comfort temperature among the four districts was 15.0 °C and the highest was 28.6 °C; that is, the seasonal difference is 13.6 °C. The range of indoor globe temperature, within which 80% of the respondents would accept, was found from 11 °C to 30 °C. The acceptable range could be referred to in a development of thermally acceptable shelters to be prepared for a future disaster.

1. Introduction

The landlocked country, Nepal, is the 11th most earthquake prone countries in the world [1]. Nepal has a history of being highly vulnerable to a range of natural hazards such as earthquakes, droughts, floods and landslides. On 25th April 2015, an earthquake of 7.8 magnitude struck Nepal and another of 7.3 magnitude hit again on 12th May, sooner than three weeks from the 1st hit. The death toll reached nearly 9,000, more than 25,000 people were injured and 900,000 houses got destroyed across many districts of the country [1]. Continued aftershocks occurred throughout Nepal at the intervals of 15–20 min. This was the largest earthquake in Nepal's history after Bihar-Nepal earthquake (8.1 magnitude) occurred in 1934 [2]. According to National Society for Earthquake Technology (NSET) [2], Nepal had experienced many devastating large earthquake at the interval of 70–80 years.

Those who lost their permanent houses by these hardest hits were forced to live in temporary shelters without basic facilities, and have been struggling to return in normal life. The Nepalese government had announced, for initial relief, that they provide NRs. 15,000 (USD 150) in cash to each family to buy corrugated zinc sheets and other materials

to build temporary shelters [3]. But due to the geographic circumstance of Nepal, the real victims were far from these kinds of relief. Most of the victims make their own makeshift shelters themselves by using their traditional method and available materials. Due to the insufficient thermal properties of the materials used, they have hardly been able to relieve from heavy rain, scorching sun or biting cold. Sick or injured people, pregnant women, children, and elderly people have been forced to be under very severe conditions in particular.

Temporary shelters are places where families can stay for a short time until they move to a new permanent house. In the case of developing countries like Nepal, the shelters built for temporary living tend to be used for a longer period of time. They have been forced to live in temporary shelters due to various reasons such as the lack of social infrastructure, poor materials, availability of lands, manpower and so on. Another reason may be, at that time, an unofficial blockade announced by the neighboring country, India, that has badly affected the supplies of essential commodities including construction materials and raw materials needed to build shelters. Due to these reasons the construction process went late.

The people living in temporary shelters must not be aware of how the indoor environment can be improved in spite of the fact that they

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Fig. 1. Map of Nepal with four investigated districts.

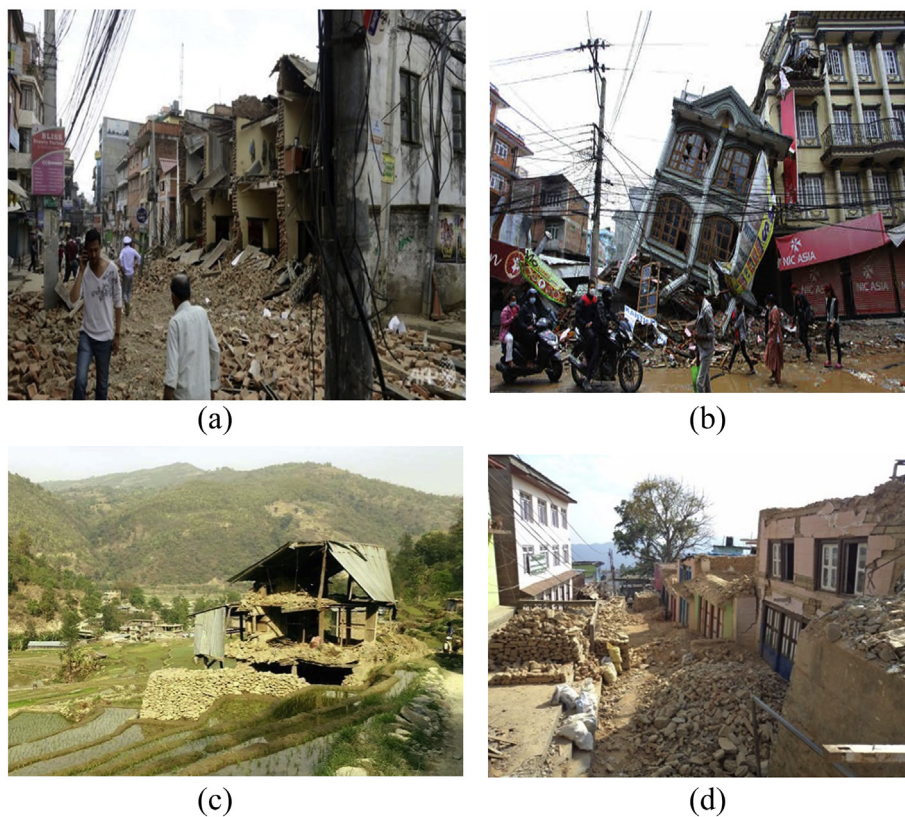


Fig. 2. Earthquake affected areas in investigated districts. (a) Lalitpur, (b) Kathmandu, (c) Shindhupalchowk and (d) Gorkha.

made their temporary shelters themselves. They are facing extreme hotness in summer and coldness in winter in temporary shelters. The adverse effects on their health must be immense. The indoor temperature should not be too high or too low, since it is related very much to human health [4].

Eighty-three years have passed, since the last big earthquake, and there were no such historical records of victims and their living conditions. Therefore, this study focuses on the present conditions of

temporary shelters built after the earthquake in 2015, and tries to identify the problems and possible solution. Indoor environment and living condition under different temporary shelters are an important area of concern and need an urgent attention in the context of disasters, though they tend to have been put aside. It should be useful to make some required improvements in the indoor thermal environment of temporary shelters.

Some researchers have conducted surveys on various issues related

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