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WINTER THERMAL IMPROVEMENT OF A TRADITIONAL HOUSE IN NEPAL

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ABSTRACT

An indoor thermal simulation was conducted in a traditional house in a mountain area of Nepal for the purpose of thermal improvement in winter and saving firewood. The results are as follows:

1) The simulation method used in the present research can be used to predict the indoor environment of various traditional houses and to determine optimal thermal improvements.

2) When firewood consumption is reduced by 60% in the "Integrated improved" model, nighttime indoor air temperature was 1.0 to 4.0K higher than with the "Base model". This shows that closing openings (doors, windows) to make the building airtight, and insulation of the roof are highly effective for thermal improvement and saving firewood.

INTRODUCTION

The aim of the present research is to investigate the effect of structural improvements on the thermal performance of traditional housing in a mountain area of Nepal. Prior to the present study, the thermal environment and the consumption of firewood in summer and winter were evaluated (Rijal et al., 2001, 2002, 2003). From this research, the following problems can be seen to occur in winter:

1) A large rise in the kitchen temperature from burning firewood in the open-hearth;

2) The nighttime air temperature of the attic room is below the outdoor air temperature, due to heat loss through radiation from the slate roof. Residents sleep in temperatures close to outdoor temperatures, which can have a negative effect on residents' health (see note 1). Therefore an increase in nighttime air temperature is desirable (see note 2);

3) Residents experience discomfort on the earthen floor, where the surface temperature is very low;

4) The forest area is decreasing due to unplanned/unmanaged firewood harvesting. The demand for firewood must be reduced by improving the design and thermal performance of houses.

Research into traditional housing using thermal simulation has been carried out in Japan (Urano et al., 1987), China (Wang et al., 2002), Thailand (Tantasavasdi et al., 2001) and Sri Lanka (Ratnaweera et al., 1996). However, research into the effects of housing improvements on firewood consumption has not been seen. In Nepal, 76% of the energy supply comes from firewood (H.M.G. of Nepal, 2002), and the amount of firewood consumption is directly related to the thermal environment in houses.

In this research, a traditional house in the mountain area of Nepal (Rijal et al., 2001) in winter was simulated before and after structural improvements for the following purposes:

1) To verify the accuracy of the "Base model" using measured indoor air temperature to analyze the effect of the improvements.
2) To determine the effect of the thermal improvements such as roof, floor, and wall insulation, and the air tightness of openings and gaps.
3) To evaluate the reduction of firewood consumption due to the thermal improvements.

OUTLINE OF SIMULATION

The simulation code was developed by modifying HASP/ACLD (Matsuo et al., 1980), a Japanese heating/cooling load calculation program where the algorithm is based on the internationally-used response factor method, adding two major parts: 1) calculation of the natural ventilation rates for a building with multiple compartments; and, 2) calculation of heating and cooling loads, considering simultaneous heat and moisture flow in the building and the existing materials in components (Yoshida et al., 2002). The time-step of the simulation is one hour. The initial influence of the earth floor and the thick walls was excluded by running the simulation over a period of 3 weeks.