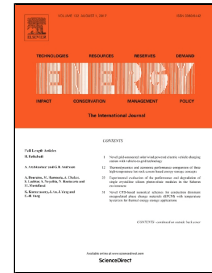


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# THE EFFECT OF FLOOR INSULATION ON INDOOR AIR TEMPERATURE AND ENERGY CONSUMPTION OF RESIDENTIAL BUILDINGS IN MODERATE CLIMATES

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## Abstract

This paper proposes a novel passive cooling method utilizing the heat capacity of the ground under an uninsulated floor slab in the summer to cool the inside air. The calculation results and measurements of the indoor air temperature inside two full-scale laboratory rooms located in western Poland were validated with simultaneous statistical analysis. The similar, terraced rooms differed from each other only in the presence or absence of thermal insulation over the whole floor slab area. Experimental research fully confirmed the simulation results. Omitting the ground floor thermal insulation decreased the indoor air temperature in the room during a 2 week heat wave by almost 4 K; thus, the cooling potential of the uninsulated floor is approximately 0.2 MJ/m<sup>2</sup>day. Moreover, the cooling effect remained stable independent of the heat wave duration. The differences in the average floor surface temperature did not exceed 0.5 K; therefore, the “cold floor” effect was negligible. The energy demand for the two rooms was significantly different but can be easily offset by alternative energy sources, e.g., solar energy.

**Key words:** passive cooling, floor thermal capacity, ground heat storage, energy consumption, transient 3D calculations, time series.

## 1. INTRODUCTION

Global warming significantly affects weather on both global and local scales. Specifically, some weather phenomena have become increasingly frequent and intense. For example, extreme heat waves have become more frequent, more severe, longer lasting, which affects the climate in buildings.

The most recent heat waves in Europe occurred in 2003, 2006, 2010, and 2015. In summer 2003, the area of western and central Europe was affected by record-breaking heat waves [1]. The 2003 heat wave in Europe showed a 20–30% increase in the average July temperature. In many European countries, extremely hot temperatures lasted for more than 20 consecutive days. The number of people in Europe who died because of heat stress in 2003 is estimated at over 30 000. High temperatures centred over south-eastern France and extended from northern Spain to the Czech Republic and from Germany to Italy [2]. Similar events are

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