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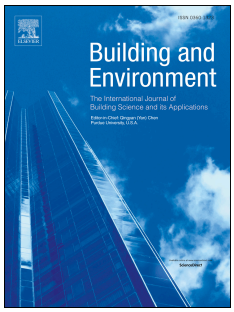

A longitudinal study of summertime occupant behaviour and thermal comfort in office buildings in northern China

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A longitudinal study of summertime occupant behaviour and thermal comfort in office buildings in northern China

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Abstract

The adaptive behaviour and thermal responses of building occupants can be responsible for significant uncertainties when comparing monitored and modelled building energy performance. A better understanding of the interaction of occupants and their buildings is necessary for managing this uncertainty and reducing discrepancies between predicted and actual energy use (commonly known as 'the performance gap'). This paper presents the results from a longitudinal study during a summer season of ten mixed-mode offices located in Harbin, a city in northern China, which experiences severe winters and warm summers. The study collected data from on-line daily surveys, field measurements of the local environment, occupants' experiences and adaptive control behaviours. Occupant-building interactions were analysed through observing adaptive behaviour, perceived thermal sensations in the physical environment, architectural geometric variables and personnel characteristics. The driving mechanisms for behaviours and feelings were also studied. The results showed a high probability of window opening for both day and night, and a high frequency of the use of a mix of cooling options, including fans and air conditioning, accompanied by natural ventilation in the summer season. The active interaction of the offices' internal environments with the outdoor environment motivated more connections of occupant thermal feelings with the outdoor physical variables. Relative humidity levels were potential key predictors for window opening, and the geometric parameters of offices, occupants' fan use and perceived thermal feelings also showed a level of predictive ability. Evaluating the nature of occupant feelings and behaviours interactions may inform and improve results from building performance-based design.

Keywords: occupants' behaviour, thermal comfort, longitudinal survey, mixed-mode office, severe cold area

1. Introduction

Economic development and the expansion of urbanization mean that the energy consumption of human activities continues to grow in different fields. Energy consumption associated with buildings accounts for around 30% of the total amount worldwide, indicating the great potential of energy efficiency that could be achieved via more rational architectural design (IEA, 2012). Due to urbanization, building energy consumption in China is growing rapidly. According to statistics (Tsinghua University Building Energy Conservation Research Centre, 2009, 2013), the total building energy consumption in China accounts for 21% of the total national energy consumption. From 1996