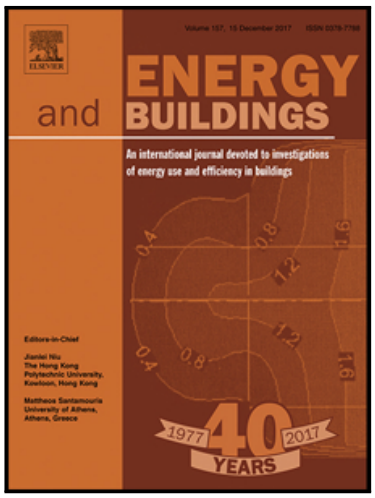

Effects of Different Operational Configurations on Interconnected Consequences of Room Air Stratification and Thermal Decay in UFAD System

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Effects of Different Operational Configurations on Interconnected Consequences of Room Air Stratification and Thermal Decay in UFAD System

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Abstract: The non-insulated underfloor supply plenum and the heat gain of the cool supply air into supply plenum results in significant magnitude of thermal decay defined as the supply air temperature rise. Eventually, these changes have influence on the room air stratification, causing negative effects throughout whole system. Therefore, for the optimization of UFAD system, it is important to understand these fundamentals and relevant effects on the overall system operation. In this study, comparative analysis was conducted during cooling period using validated EnergyPlus model, after employing different operational configurations related to room air stratification and thermal decay. The thermal behavior and cooling energy performance were analyzed by observing the convective heat transfer, thermal decay, airflow, stratification among different operational configurations. As a result, it was observed that the existence of non-insulated supply plenum have influences on the thermal behavior in occupied zone, and the corresponding heat transfer has load reduction effect of the space by about 40%. However, there were still significant amounts of cooling energy consumption in the form of thermal decay despite the reduced cooling load, indicating that unintended and additional energy consumption was occurred in supply plenum. In addition, return air temperature rise by the room air stratification increased the cooling coil load. Eventually, these effects canceled each other out. As a result, standard UFAD system consumed more electric energy by about 30%, and for fully-insulated UFAD system as able to reduce the energy consumption by about 6%.

Keywords: Underfloor Air Distribution; Thermal Decay; EnergyPlus; Room Air Stratification; Underfloor Supply Plenum; Energy Modeling