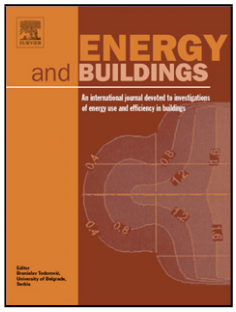

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Development and Validation of a Time-series Model for Real-time Thermal Load Estimation

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ABSTRACT

Dynamic cooling load changes caused by weather, occupants and equipment use are prevailing challenges for heating, ventilating and air conditioning (HVAC) system design, operation and controls. The thermal capacity of a building envelope delays conduction heat gains while the thermal capacity of the whole structure delays radiative cooling loads. These delays make cooling load calculations inherently complicated. It has been challenging to accurately estimate cooling load in a building in real-time. In this paper, a time-series cooling load model is deduced from a simplified Resistance-Capacitance (RC) model to provide an efficient solution with manageable computational requirements. In addition, the time-series model is also tested on a thermal zone in an office building, defined in EnergyPlus as a single zone with an ideal HVAC system. RC parameters of building envelope and internal mass are obtained using theoretical characteristics of the building construction in frequency domain and EnergyPlus data, respectively. These are used in formulation of a time-series representation of the cooling load for three scenarios of light, medium, and heavy construction of a thermal zone in an office building. For all scenarios, cooling load with the simplified time series model is estimated within 7% mean absolute percentage error relative to EnergyPlus.

Keywords: Cooling Load; Time Series; RC model; Building Envelope; Internal Mass; EnergyPlus; Robustness/Uncertainty Analysis