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Comparative investigation on building energy performance of double skin façade (DSF) with interior or exterior slat blinds

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ABSTRACT

Advanced passive control technologies attract a great deal of attention by architects and engineers as a way of achieving both high indoor environmental quality and energy efficient buildings. This study investigates the thermal and daylighting effects of a double skin façade (DSF) system with interior and exterior blinds. A buffer type DSF and slat type blinds are used for this comparative study. To investigate thermal and daylighting effects of three passive control models, evaluation of annual heating, cooling, and lighting loads is conducted using a widely-accepted whole building energy modeling program, EnergyPlus. A simulated DSF model is developed using the air-flow network (AFN) model in EnergyPlus and calibrated against measured data from an experimental DSF facility installed to an office building in Daejeon, South Korea. After a proper calibration of the simulated DSF model, the impact of blinds in the cavity of the DSF is also evaluated by adopting a slat blind model in EnergyPlus. For exterior and interior blind models, the simulated DSF model is modified by removing a DSF box and adding slat blinds at inner and outer surfaces of the windows. A Radiance-based daylighting simulation program, Daysim, is used to evaluate daylighting aspects of blinds and lighting controls within an office building with simulated DSF, interior blind, and exterior blind models. Generated lighting and blind raise/lower control schedules from Daysim are used as input values in EnergyPlus for annual thermal and lighting load calculations. In addition, the impact of natural ventilation to reduce trapped hot air within the cavity of the DSF box is considered in this study during a cooling period only for the DSF model. Results indicate that the simulated DSF model can save up to 40%, 2%, and 5% for heating, cooling, and total loads, respectively, when compared to the baseline (i.e., No passive technologies) without any blinds or controls. With the combination of the daylight-based dimming control based on the indoor illuminance levels and the blind raise/lower control, the simulated DSF and the exterior blind models could potentially reduce the building thermal loads and lighting energy consumption, ranging around 27% to 52%.

KEYWORDS: double skin façade; blind raise/lower control; daylight-based dimming control; building energy performance; interior and exterior blinds.

1. INTRODUCTION

Residential and commercial buildings represent around 40% of the energy consumption around the world [1]. Recent building constructions have been influenced by considering energy efficiency and indoor environmental quality of buildings, as well as the aesthetic of the building façades. Passive