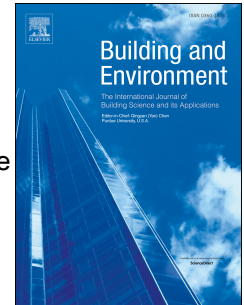


Accepted Manuscript

Comparing the indoor environmental quality of a displacement ventilation and passive chilled beam application to conventional air-conditioning in the Tropics

Jovan Pantelic, Adam Rysanek, Clayton Miller, Yuzhen Peng, Eric Teitelbaum, Forrest Meggers, Arno Schlüter



PII: S0360-1323(17)30533-4

DOI: [10.1016/j.buildenv.2017.11.026](https://doi.org/10.1016/j.buildenv.2017.11.026)

Reference: BAE 5179

To appear in: *Building and Environment*

Received Date: 17 June 2017

Revised Date: 16 November 2017

Accepted Date: 16 November 2017

Please cite this article as: Pantelic J, Rysanek A, Miller C, Peng Y, Teitelbaum E, Meggers F, Schlüter A, Comparing the indoor environmental quality of a displacement ventilation and passive chilled beam application to conventional air-conditioning in the Tropics, *Building and Environment* (2018), doi: 10.1016/j.buildenv.2017.11.026.

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Comparing the indoor environmental quality of a displacement ventilation and passive chilled beam application to conventional air-conditioning in the Tropics

Abstract

The satisfaction of occupants with an indoor environment supplied by a conventional central VAV air-conditioning system was compared to a novel system represented by decentralized ventilation units and a network of passive chilled beams. In parallel with occupant survey measurement of indoor air quality (IAQ) parameters was conducted with the developed wireless IAQ sensing kits. The same occupant cohort was surveyed for both systems, as occupants of the conventionally-conditioning office, known as the 'Previous Office' later moved into the office conditioned by the novel system, known as the '3for2 Office'. We observed that the perceived thermal comfort and air quality satisfaction of the occupants were markedly higher in the 3for2 Office than in the Previous Office. While occupants of the 3for2 Office could raise or lower indoor air temperatures, they appeared to be consistently satisfied with higher indoor air temperatures than that set by the building management of the Previous Office. The primarily Singaporean occupants of the 3for2 Office also felt thermally comfortable even when indoor air velocities in the office were measured to be below 0.1 m/s recommended by Singaporean Standards. The 3for2 Office's ventilation system was designed to supply outdoor air beyond minimal required ventilation rates, which lead to relatively low levels of CO_2 and PM2.5 concentrations in the 3for2 office. We believe that higher ventilation rates resulting in lower pollutant concentrations are responsible for a higher-than-average survey score on air quality satisfaction. We also believe that enabling occupants to set air temperature in the space resulted in higher-than-average thermal comfort satisfaction.

Keywords: indoor environmental quality, decentralized ventilation, passive chilled beams, displacement ventilation, cohort study, tropically acclimatized occupants

1. Introduction

Anthropogenic climate change and population migration to cities are resulting in extensive global urbanization and increasing demand for built environments that operate energy-efficiently and use sustainable sources of energy. While this is a global problem, a portfolio of solutions are required that can address the individual concerns of specific sectors, specific climatic regions, and specific economies. The global commercial building stock, for instance, is driven largely by the productivity of its office-based workforce. For this sector, the requirement of the built environment is first and foremost to provide comfortable indoor environments that facilitate productive workplaces. Hence, the built environment

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