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Enhancement of heat transfer in commercial buildings during night cooling - CFD study and reduced scale experimentation.

Miguel Lança[a)*], Pedro J. Coelho[a)] and João Viegas[b)]

[a)] Department of Mechanical Engineering, Instituto Superior Técnico,
Universidade de Lisboa
Av. Rovisco Pais, 1, 1049-001 Lisboa, Portugal
Email: miguel.lanca@tecnico.ulisboa.pt; p.coelho@tecnico.ulisboa.pt

[b)] Laboratório Nacional de Engenharia Civil
Av. do Brasil, 101, 1700-066 Lisboa, Portugal
Email: jviegas@lnec.pt

ABSTRACT

Most commercial office buildings is designed to be ventilated and cooled using mechanical systems. In a temperate climate, when the outdoor temperatures are favourable, e.g. at night, passive ventilation and cooling techniques can be used to reduce energy consumption. Buildings thermal mass represent a way to accomplish that goal due their ability to retain and dissipate heat. Furthermore, the portion of exposed elements in modern constructions is kept to a minimum. There are decorative components, like the suspended ceiling that represent an insulation between the outside air and the slab, and that is one of the most important construction elements that contributes to the building thermal inertia, avoiding the desired thermal exchange.

This work presents an innovative solution concerning the use of the plenum formed by the space between the slab and the suspended ceiling to mobilize the slab thermal inertia, which optimizes the night cooling phenomena.

Reduced scale experimentation based on dimensional analysis and similitude criteria was taken with several types of suspended ceilings in order to compare their performance on lowering ambient temperatures during the occupation period. The suspended ceilings used in the experiments allow the outside air to cool the slab, therefore promoting an increase of the heat exchanged between the structural elements of the building and the zone that needs to be cooled.

Computational fluid dynamics (CFD) is used to study different cases of suspended ceilling configurations used in the building construction. The indoor and slab temperatures are predicted and compared with the reduced scale results. The experimental results show good agreement with the simulations and indicate that the increased amount of exposed slab area contributes to lower the day peak indoor temperatures.