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Effects of Free-Hanging Horizontal Sound Absorbers on the Cooling Performance of Thermally Activated Building Systems

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Abstract : Thermally Activated Building Systems (TABS) have proven to be an energy-efficient solution to provide buildings with an optimal indoor thermal environment. This solution uses the structure of the building to store heat, reduce the peak loads, and decrease the primary energy demand. TABS require the heated or cooled surfaces to be as exposed as possible to the indoor space, but exposing the bare concrete surfaces has a diminishing effect on the acoustic qualities of the spaces in a building. Acoustic solutions capable of providing optimal acoustic comfort and allowing the heat exchange between the TABS and the room are desirable. In this study, the effects of free-hanging units on the cooling performance of TABS and the occupants’ thermal comfort was measured in a full-scale TABS laboratory. Investigations demonstrate that the use of free-hanging sound absorbers are compatible with the performance of TABS and the occupant’s thermal comfort, but an appropriate acoustic design is needed to find the most suitable solution for each case. The results show a reduction of 11% of the cooling performance of the TABS when 43% of the ceiling area is covered with free-hanging horizontal sound absorbers, of 23% for 60% ceiling coverage ratio and of 36% for 80% coverage. Measurements in actual buildings showed an increase of the room operative temperature of 0.3 K when 50% of the ceiling surface is covered with horizontal panels and of 0.8 to 1 K for a 70% coverage ratio. According to numerical simulations using a new TRNSYS Type, the use of comfort ventilation has a considerable influence on the thermal conditions in the room; if the ventilation is removed, then the operative temperature increases by 1.8 K for a 60%-covered ceiling.

Keywords : acoustic comfort, concrete core activation, full-scale measurements, thermally activated building systems, TRNSys
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