LTES with PCMs in radiant floor

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3 authors:

Eleonora Baccega
University of Ferrara

Silvia Cesari
University of Ferrara

Michele Bottarelli
University of Ferrara

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Eleonora Baccega, Silvia Cesari, Michele Bottarelli

Department of Architecture, University of Ferrara, Italy

The ever-increasing demand for space heating and cooling is forcing man to constantly find new strategies to provide indoor comfort with lower energy consumption and emissions. During recent decades, radiant floors have spread widely particularly to provide heating both for new constructions and in the refurbishment of existing ones, thanks to the lower source temperature required when compared to more conventional systems.

H2020 European project IDEAS - Novel Building Integration Designs for increased Efficiencies in Advanced Climatically Tunable Renewable Energy Systems (call H2020-LC-SC3-2018-RES-TwoStages, grant agreement No. 815271) - works in this direction, focusing on the development of a low-cost RES to generate heat, cooling and electricity, optimized according to the climatic conditions. After initial numerical studies with COMSOL Multiphysics V5.5© and TRNSYS, and some experimental investigations carried out in the lab, a real scale radiant floor was realized in a set up building at TekneHub laboratory at the University of Ferrara, as part of WP3 of the above-mentioned project.

Considering that summer as well as winter performance of the radiant floor were subjects of the research, two PCMs with different melting temperatures were chosen: 21°C for the PCM employed during summer and 27°C for the one used in winter. Both the PCMs were hydrated salts encased in HDPE containers, named ThinICE, provided by PCM Products Ltd – partner of IDEAS project. The different containers were arranged above the mortar alternately in order to avoid any located inhomogeneity of the floor temperature, and embedded in wet sand, so that the floor could be fully inspected (Figures 1 and 2).

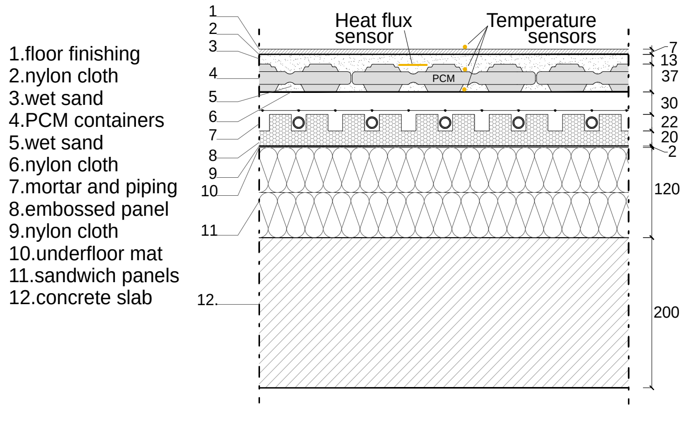

Figure 1: Floor configuration and sensors position

The performance of the floor was monitored during late summer. The monitoring activity was carried out continuously with heat flux meters and temperature sensors (T-type thermocouples), and often with a thermal imaging camera. As soon as the system was

Figure 2: Floor installation, positioning of the heat flux meter

switched on, slight inhomogeneities of the floor temperatures were visible in correspondence of the two PCMs. Later, however, these were no longer perceived (Figure 3).

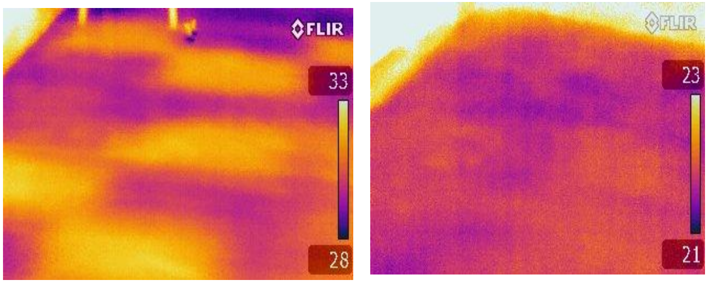

Figure 3: Pictures taken with a thermal imaging camera

The behaviour under the floor finishing on a typical day is represented in Figure 4. When the system was turned off, there was no difference between the two PCMs in terms of temperature and downward heat flux. On the contrary, while the system was turned on, a difference of less than 1°C and 5W/m^2 on top of the two containers was visible due to the phase change of the PCM with a melting point of 21°C that was occurring.

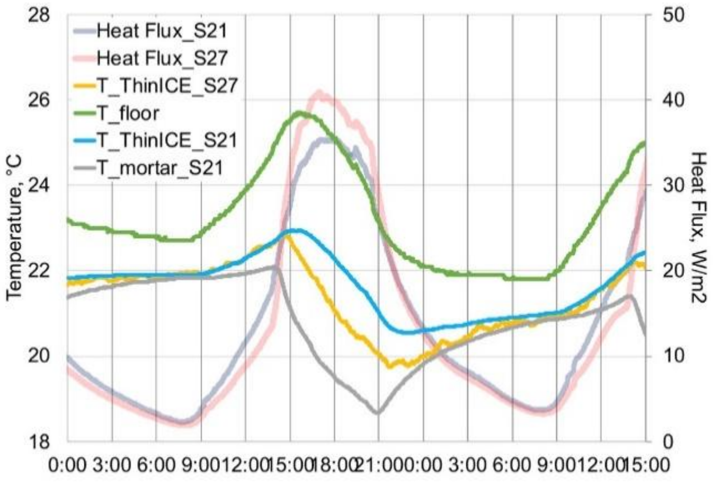

Figure 4: typical day functioning

The initial monitored activity was related only to a daytime functioning of the heat pump as the switching was regulated just by an ambient thermostat, unable to manage the solidification during night time. The next scheduled activities in IDEAS project include the artificial intelligence regulation of the system, which would allow even night functioning when the heat pump can work with a lower external temperature, thus having a higher COP.