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Heat Transfer Enhancement of Structural Concretes Made of Macro-Encapsulated Phase Change Materials

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Abstract : Low thermal conductivity of phase change materials (PCMs) affects the thermal performance and energy storage efficiency of latent heat thermal energy storage systems. In the current research, a structural lightweight concrete with function of indoor temperature control was developed using thermal energy storage aggregates (TESA) and nano-titanium (NT). The macro-encapsulated technique was served to incorporate the PCM into the lightweight aggregate through vacuum impregnation. The compressive strength was measured, and the thermal performance of concrete panel was evaluated by using a self-designed environmental chamber. The impact of NT on microstructure was also assessed via scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) tests. The test results indicated that NT was able to increase the compressive strength by filling the micro pores and making the microstructure denser and more homogeneous. In addition, the environmental chamber experiment showed that introduction of NT into TESA improved the heat transfer of composites noticeably. The changes were illustrated by the reduction in peak temperatures in the centre, outside and inside surfaces of concrete panels by the inclusion of NT. It can be concluded that NT particles had the capability to decrease the energy consumption and obtain higher energy storage efficiency by the reduction of indoor temperature.

Keywords : heat transfer, macro-encapsulation, microstructure properties, nanoparticles, phase change material
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