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Experimental Study of Hydrothermal Properties of Cool Pavements to Mitigate Urban Heat Islands

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Abstract : Urban heat islands designate a local phenomenon that appears in high density cities. This results in a rise ofambient temperature in the urban area compared to the neighboring rural area. Solar radiation plays an important role in this phenomenon since it is partially absorbed by the materials, especially roads and parking lots. Cool pavements constitute an innovative and promising technique to mitigate urban heat islands. The cool pavements studied in this work allow to limit the increase of the surface temperature, thanks to evaporation of the water conducted through capillary pores, from the humidified base to the surface exposed to solar radiation. However, the performance or the cooling capacity of a pavement sometimes remained difficult to characterize. In this work, a new definition of the cooling capacity of a pavement is presented, and a correlation between the latter and the hydrothermal properties of cool pavements is revealed. Firstly, several porous concrete pavements were characterized through their hydrothermal properties, which can be related to the cooling effect, such as albedo, thermal conductivity, water absorption, etc. Secondly, these pavements initially saturated and continuously supplied with water through their bases, were exposed to external solar radiation during three sunny summer days, and their surface temperatures were measured. For draining pavements, a strong second-degreepolynomial correlation(R^2 = 0.945) was found between the cooling capacity and the term, which reflects the interconnection of capillary water to the surface. Moreover, it was noticed that the cooling capacity reaches its maximum for an optimal range of capillary pores for which the capillary rise is stronger than gravity. For non-draining pavements, a good negative linear correlation (R^2 = 0.828) was obtained between the cooling capacity and the term, which expresses the ability to heat the capillary water by the energystored far from the surface, and, therefore, the dominance of the evaporation process by diffusion. The latest tests showed that this process is, however, likely to be disturbed by the material resistance to the water vapor diffusion.

Keywords : urban heat islands, cool pavement, cooling capacity, hydrothermal properties, evaporation
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