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An innovative energy pile technology to expand the viability of geothermal bridge deck snow melting for different United States regions: computational assisted feasibility analyses

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ABSTRACT

Energy pile provides a sustainable way for snow removal of transportation infrastructure while fulfilling its role in supporting the structural and service loads. In a previous study, the authors have analyzed the potential of conventional energy pile to remove snow on a highway bridge deck, and found that the application is only technically feasible for geographic regions with high underground thermal resources. To further expand its applications, this paper proposes an innovative energy pile technology where the concrete pile is modified with phase change material (PCM) to improve thermal energy extraction. A computational model is constructed to evaluate the performance of this new energy pile technology. The results show that geothermal energy extraction is significantly enhanced by incorporating PCM into concrete pile. Sensitivity analyses are conducted on the use of energy pile modified with different mass fraction PCM for snow melting of a prototype highway bridge deck in 10 different U.S. cities located in different climate regions. The results indicate that the new energy pile technology can potentially significantly expand the geographic regions where energy pile is viable for bridge deck snow removal. Aspects to further improve the economic viability of the new PCM modified energy pile technology are discussed.

Keywords: Geothermal heat exchanger pile, Snow Melting, Phase Change Material, Finite Element Modeling
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