

Impacts of Subsurface Urban Heat Islands on Civil Infrastructure

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The ground beneath many urban areas worldwide is warming up due to so-called subsurface urban heat islands. Resulting from localized and large-scale drivers of heat in the underground, subsurface heat islands cause thermally induced deformations of key materials constituting civil infrastructure: soils, rocks, concrete, and systems thereof. Currently, the effects of thermally induced deformations driven by subsurface heat islands on the performance and durability of civil infrastructure remain poorly understood. This paper presents the results of a numerical and experimental study to shed light on the impacts of subsurface urban heat islands on civil infrastructure. The study is based on the first 3-D model of the subsurface characterizing the central business district of Chicago, called the Loop, which is affected by an underground climate change. This numerical model is used in combination with temperature data gathered through a sensing network deployed across the Loop district to run thermo-hydro-mechanical simulations of the current subsurface conditions, highlighting satisfactory capabilities to model reality. Based on the analysis of the current subsurface conditions, numerical predictions are run over fifty years to reproduce the influence of heat flows on the deformation of the subsurface. The obtained results indicate that subsurface urban heat islands can involve noteworthy and potentially detrimental effects for the performance and durability of civil infrastructure, requiring consideration in the design of such structures or mitigation through appropriate strategies. An analysis of such strategies is proposed and perspectives to hamper this silent hazard for urban areas are provided.