Interactions between energy geostructures in the same aquifer

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Energy geostructures are a very cost-effective geothermal solution to produce renewable energy for the heating and cooling needs of the buildings. Their principle is to attach heat exchange pipes to the reinforcing cages of geotechnical structures (foundations, retaining walls, ...). Mechanical and thermal roles are assigned to the same structures in order to reduce the economic and ecological costs.

Perturbations of the temperature field induced in the soil by this technology are propagated through conduction, diffusion and advection along the water-flow, leading to thermo-hydro-mechanical interactions between neighbouring structures. The behaviour of downstream energy geostructures is affected by the presence of upstream ones. In order to achieve a smart management of the shallow geothermal development at the city scale, it is crucial to characterize these interactions and their influence on the thermal efficiency.

For this purpose, a group of nine energy piles has been studied in Sense-City, a mini city where a specific climate can be imposed and the underground water-flow can be controlled. The piles can be thermally activated separately and are equipped with optic fibre to monitor their temperature evolution through time. Different groundwater conditions were imposed and different combinations of activated piles were studied.

To extrapolate and upscale the results, a numerical model was developed with CESAR-LCPC, a FEM software. Challenged by the experimental observations, the numerical model allowed simulating more complex boundary conditions and thermal infrastructure configurations. Furthermore, numerical modelling are able to simulate a long term experiment and to predict potential multi-year thermal shift.

Using combination of experimental and numerical experiments, observations can be made on the positive or negative consequence of energy geostructures interactions.