Thermal characterization of energy pile dynamics

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Abstract

The heat transfer process in energy piles is strongly affected by the heat ca-pacity of such foundation elements. This phenomenon is more pronounced for energy piles compared to borehole heat exchangers, because of the lower slen-derness of the former compared to the latter, and involves axial thermal gra-dients. In literature, capacity effects of energy piles and their transient ther-mal performance have not been analysed in depth. Looking at such challenge, this paper investigates the dynamic thermal performance of energy piles at short-to-medium time scales. The work analyses the results of almost thirty 3D finite element simulations of an energy pile equipped with 3-U ducts by vary-ing: (i) the velocity of the fluid circulating in the ducts, (ii) the slenderness ratio of the pile, (iii) the radial position of the ducts, and (iv) the boundary condition characterizing the uppermost surface of the model. Simulation results are ana-lysed to identify for which times, geometries, and operative conditions the en-ergy pile can be modelled with a 2D geometry, instead of a full 3D geometry. Our analysis highlights a limited relevance of the axial effects during the tran-sient period in any tested configuration. These results are functional to the ap-plication of simplified analytical models and design criteria for energy piles.