Abstract

Energy piles are considered as efficient solution for tapping geothermal energy. Despite vast applications, the current design of energy piles has very limited input from a geotechnical aspect. While some parts of industry accept the use of energy piles, others question the impact of thermal changes to the pile behavior. Unfortunately, apart from anecdotal evidence of successful long-term operation of such systems, there is no definite information supporting the safe use of energy piles. Hence, there is an urgent need for a more detailed study of the long-term performance and sustainability of energy pile systems. In this dissertation, five available field studies of full-scale energy piles were reviewed. Discussions are focused on issues such as pile head restraint conditions; thermal generated concrete stress; thermal induced physical deformation of the pile; and the thermal modification on the pile shaft resistance. The discussion also extends to consider the potential influence of cyclic thermal loadings on the pile bearing capacity. It emphasises that the thermal modification is more likely to affect the serviceability of the pile rather than its ultimate bearing capacity. Hence, the thermal induced settlement and thermal stress need to be assessed. However, the use of Factor of Safety (FoS) is not recommended to assess the influence of thermal load, as the thermal changes reflected by the change of FoS do not necessarily relate to the failure of the structure.

The design tool proposed in the current research is capable of providing an efficient preliminary estimation of the thermal settlement and stress to assist the design of the energy pile. This design tool has also been used to study several hypothetical piles and the results are summarised in four design charts, which can be used directly to make informed decisions on energy pile design.