THERMOMECHANICAL BEHAVIOUR OF THERMOACTIVE PILES

[1]Kenzo Jorge Hosokawa

[1]Alfonso Cobo

[1]María Isabel Prieto

[1]Inmaculada Martinez Pérez

[1] Tecnología de la Edificación. Escuela Técnica Superior de Edificación. (Universidad Politécnica de Madrid)

Keywords: *Thermoactive piles, energy geostructures, energy pile*

Thermoactive piles are a recent technology for the heating and cooling system of a building that integrates the structural bases of buildings with closed circuits of tubes that form vertical heat exchangers. Compared to conventional deep geothermal exchanger systems, thermoactive piles are more economical than boreholes, since the depth is lower and the existing structure is used to avoid drilling more holes in the ground. In addition, the thermal conductivity of concrete piles is twice that of the benthonic mortar used in the boreholes. Thermoactive piles exchange heat with the ground by using the ground as a heat source in winter or a heat sink in summer. The soil has a relatively constant temperature of approximately 10 to 15 °C at a depth of 10 to 20 m in most European countries (i.e. surface geothermal energy) [1].

The investigations that have been carried out so far, related to the topic of thermoactive piles, can be classified into three main categories, such as experimental studies [2, 3, 4, 5, 6], numerical models that try to predict the real behavior [7, 8, 9] and finally laboratory tests implemented to investigate the behavior of soils around geothermal piles [10, 11].

Despite the great variety of works related to thermoactive structures, the design of these structures is not incorporated in any European or national regulations, making it very difficult for quality control companies to validate them. Up to now, in the structural dimensioning process, the thermomechanical behaviour has been neglected as there are no pathologies that can be observed at present.

The aim of this work is to study the influence of different parameters on the thermomechanical behaviour of thermoactive piles. For this purpose, the modified transfer load model developed by Poudyal [6] will be reproduced, and once calibrated with its own experimental field study on a real scale, different parameters such as the diameter of the pile, the variation of the differential temperature and the increase in load will be modified, thus verifying the interrelation of these parameters with the thermomechanical behaviour.

The results obtained show that the cooling and heating cycles of the piles modify the interaction between the pile and the ground, even obtaining differential seats, although it is true that the maximum deformation values observed are within the safety parameters. However, it is suggested that the thermal load be incorporated into the pile dimensioning.

REFERENCES

[1] Brandl, H. (2006). Energy foundations and other thermo-active ground structures. *Geotechnique, 56*(2), 81-122.

[2] Laloui, L., Nuth, M., & Vulliet, L. (2006). Experimental and numerical investigations of the behaviour of a heat exchanger pile. *International Journal for Numerical and Analytical Methods in Geomechanics, 30*(8), 763-781. doi:10.1002/nag.499

[3] Bourne-Webb, P. J., Amatya, B., Soga, K., Amis, T., Davidson, C., & Payne, P. (2009). Energy pile test at lambeth college, london: Geotechnical and thermodynamic aspects of pile response to heat cycles. *Geotechnique, 59*(3), 237-248. doi:10.1680/geot.2009.59.3.237

[4] Amatya, B., Soga, K., Bourne-Webb, P. J., Amis, T., & Laloui, L. (2012). Thermo-mechanical behaviour of energy piles. *Geotechnique, 62*(6), 503-519. doi:10.1680/geot.10.P.116

[5] McCartney, J. S., & Rosenberg, J. E. (2011). Impact of heat exchange on side shear in thermo-active foundations. *Geo-frontiers 2011: Advances in geotechnical engineering* (pp. 488-498)

[6] Poudyal, R. (2014). The Thermal-Mechanical Behavior of a Multiple-Loop Geothermal Heat Exchanger Pile

[7] Knellwolf, C., Peron, H., & Laloui, L. (2011). Geotechnical analysis of heat exchanger piles. *Journal of Geotechnical and Geoenvironmental Engineering, 137*(10), 890-902. doi:10.1061/(ASCE)GT.1943-5606.0000513

[8] Ouyang, Y., Soga, K., & Leung, Y. F. (2011). Numerical back-analysis of energy pile test at lambeth college, london. *Geo-frontiers 2011: Advances in geotechnical engineering* (pp. 440-449)

[9] Pasten, C., & Santamarina, J. C. (2014). Thermally induced long-term displacement of thermoactive piles. *Journal of Geotechnical and Geoenvironmental Engineering, 140*(5), 06014003.

[10] McCartney, J. S., & Rosenberg, J. E. (2011). Impact of heat exchange on side shear in thermo-active foundations. *Geo-frontiers 2011: Advances in geotechnical engineering* (pp. 488-498)

[11] Stewart, M. A., & McCartney, J. S. (2013). Centrifuge modeling of soil-structure interaction in energy foundations. *Journal of Geotechnical and Geoenvironmental Engineering, 140*(4), 04013044.