# Calibration of a Geothermal Energy Pile Model

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## Abstract

In this study, a model of in-situ geothermal energy piles was constructed using COMSOL Multiphysics® software. Geothermal energy piles serve two purposes, first to transfer building load into the subsurface, but also to extract thermal heat from surrounding soils. This is achieved using a heat pump coupled with embedded heat exchangers. As a result, a multiphysics problem is introduced - heat transfer coupled with fluid flow.

This paper outlines the COMSOL model description and discusses results obtained during calibration. The configuration outlined by Murphy et al. (2014) was used to construct geometry, define boundary conditions, and calibrate the model. Calibration was accomplished using a Thermal Response Test (TRT) performed on four energy piles during the summer of 2013 in a full-scale field experiment. The test lasted for 1800 hours total; 500 hours of active heat rejection into the soil surrounding the energy piles and 1300 hours of non-operational observation. Accordingly, a numerical analysis of the TRT was performed in three dimensions using both the Heat Transfer Module and Pipe Flow Module. Heat transfer in solids and porous media was imposed on the energy pile and surrounding soils. Non-isothermal pipe flow was imposed on the heat exchange tubes embedded in the energy piles. Additionally, several field data were incorporated into the model including variables for atmospheric temperature, inlet pipe temperature/flow, and subsurface temperature gradients.

The model was successfully calibrated using in-situ TRT data. Good agreement was observed within Foundation 4 and at Borehole 4 (Figures 1 & 2). Existing discrepancies in model predictions can be attributed to unknown soil condition/stratification at depths greater than 12m, coarse meshing within the model, and simplifications within heat transfer and pipe flow physics.

## Reference

1. Kyle Murphey et al., Evaluation of Thermo-Mechanical and Thermal Behavior of Full-Scale Energy Foundations, Acta Geotechnica (2014).

# Figures used in the abstract

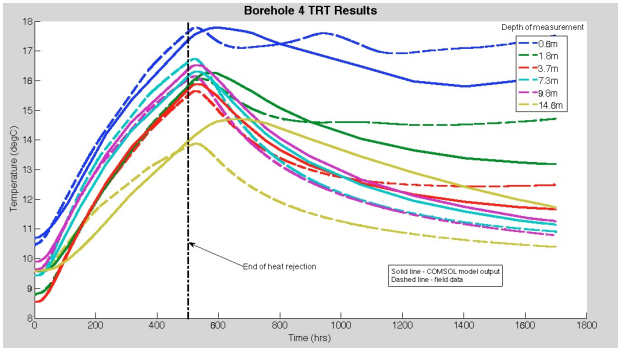


**Figure 1**: Model output vs field data comparison for Borehole 4.

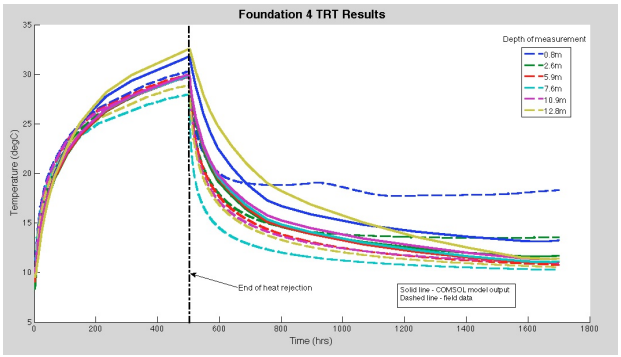


**Figure 2**: Model output vs field data comparison for Foundation 4.