Computational Investigation of Dwellings' Foundations as a GHE in Mediterranean Climate

Lazaros Aresti, Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus
Email: lg.aresti@edu.cut.ac.cy
Paul Christodoulides, Faculty of Engineering and Technology, Cyprus University of Technology, Limassol, Cyprus
Email: paul.christodoulides@cut.ac.cy
Christos Makarounas, Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus
Email: christos.makarounas@cut.ac.cy
Lazaros Lazaris, Department of Mechanical Engineering and Materials Science and Engineering, Cyprus University of Technology, Limassol, Cyprus
Email: lazaros.lazaris@cut.ac.cy
Georgios Florides, Faculty of Engineering and Technology, Cyprus University of Technology, Limassol, Cyprus
Email: georgios.florides@cut.ac.cy

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Geothermal energy finds application through Ground Source Heat Pumps (GSHPs) for space heating and cooling. GSHP systems extract or reject heat into the ground through a network of pipes, namely Ground Heat Exchangers (GHEs). GHEs can either be horizontal of vertical with various configurations such as U-tube, spiral/helical pipe and others. Although GSHPs provide higher performance than Air Source Heat Pumps, the longer payback periods and higher initial investment has made the systems unattractive as an investment. One solution to reduce the initial investment is the use of GHEs in the buildings' foundations. These systems are named Thermo-Active Structure systems or Energy Geo-Structures. The study here is concerned with Thermo-Active Geo-Structures systems for dwellings in Cyprus. Thermo-Active Geo-Structures coupled with GSHPs could provide an alternative solution to minimize the initial costs and make the GHSP system viable and economically encouraged. Such systems have yet to be applied in Cyprus, therefore, an initial computational investigation is considered using the COMSOL Multiphysics software and available weather and ground temperature data from the island of Cyprus. A typical dwelling in Cyprus is considered, namely a three-bedroom two-storey house of 190m2 total floor area, for which the heating and cooling loads are presented. Typical foundations are modeled at full scale in COMSOL Multiphysics to examine the rejected/absorbed energy to/from the ground. The convection-diffusion equation for heat transfer is used with the three-dimensional conservation of heat transfer for an incompressible fluid. The related parameters are adjusted to present actual parameters taken from experimental data. Preliminary results indicate that the use of a building's foundation as a GHE (Thermo-Active Geo-Structures) could be an alternative to borehole GHEs, where a detailed study on the buildings' loads is required.