CERIS : Civil Engineering Research and Innovation for Sustainability

Sustainability and optimization guidelines of efficient solutions in shallow geothermal systems. Case study of Aveiro University

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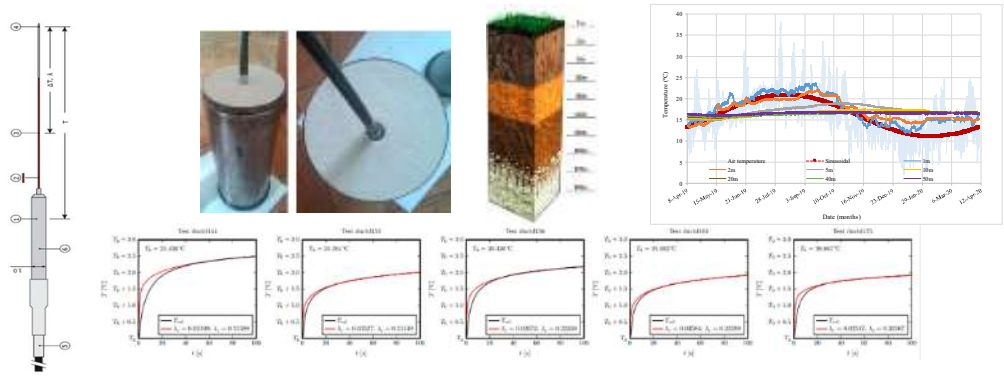
Summary

The increasing energy demand using conventional conditioning systems has contributed to the growth in greenhouse gas emissions and the scarcity of the limited natural resources. This fact reinforces the global need to develop more sustainable and resilient environments to control climate changes. Sustainable environments could be achieved throughout the use of renewable energy sources. Replacing the traditional heating/cooling systems with more renewable ones, such as geothermal energy systems which can significantly contribute to reducing the electric energy demands, greenhouse emissions and the dependence on the fossil fuels. This research aims to study the efficiency of a shallow geothermal system implemented in a building in Aveiro University, mainly concerning its primary circuit (part of the system which is embedded in the ground). The overall system (soil-building) will be comprehensively studied both experimentally and numerically aiming to optimize the system efficiency. Its sustainability will be analysed by means of Life-Cycle-Assessment methodology and its economic viability will be analysed using Life Cycle Cost method. The principal purpose of this research is to contribute to the advance knowledge on the performance of GSHP systems under Portuguese soils and climate conditions, namely, to organize study solutions of these systems to potentially improve its efficiency and sustainability. Taking advantage of having a case study (prototype) of a Scholar building (CCCI) in Aveiro University (UA) which is equipped with a shallow geothermal energy system. A comprehensive study of the primary circuit (soil and geo-energy structures) will be performed, as well as its integration with the secondary system (building). The following goals are to be achieved:

- Soil thermal characterization: create a database with data form new tests regarding soil thermal characterization; evaluate the reliability of different test procedures (laboratory and/or in-situ) and identity the main parameters which control soil thermal behaviour having significantly impact the thermal efficiency of the system;
- Characterize the GSHP system on the long-term: support different tasks of the installation of the monitoring system which will be settled up soon in the ground close the geostructures and collect, process and analyse its response in the long term (a large volume of data will result);
- Carry out further studies with the Building Energy Model (BEM) via dynamic simulations using EnergyPlus and integrating the shallow geothermal system SGE in this model in order to optimize the efficiency of the geothermal system;
- Finally, studding the different solutions suggested optimizing the performance of the geothermal system by means of Life-Cycle-Assessment analysis and Life Cycle Cost.

Keywords

Soil thermal properties, soil thermal conductivity, soil thermal contact conductance, shallow geothermal energy system monitoring, building energy model, SGE system integration with BEM, optimization, LCA, NPVLCC, economic viability methods.



Examples of work development from several tasks and objectives of this work.