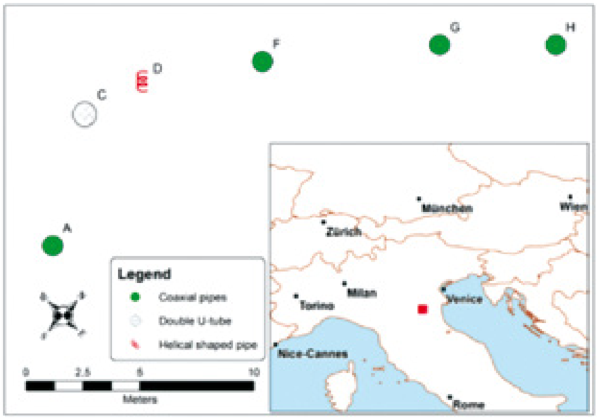
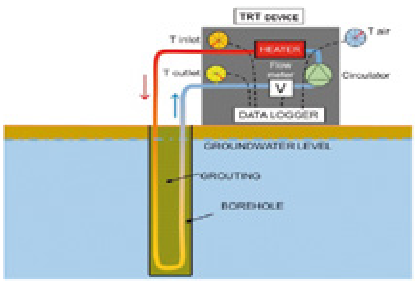
Ground Source Heat Pump systems: Interpretation Methods of Thermal Response Testing Measurements

The design phase of Ground Source Heat Pumps (GSHPs) is an extremely important one as many of the decisions made at that time can affect the system's energy performance as well as installation and operating costs. The current research examined the interpretation of thermal response testing measurements used to evaluate the equivalent ground thermal conductivity and thus to design the system. All the measurements were taken at the same geological site located in Molinella, Bologna (Italy) where a variety of borehole heat exchangers (BHEs) had been installed and investigated within the project Cheap-GSHPs (Cheap and efficient application of reliable Ground Source Heat exchangers and Pumps) of the European Union's Horizon 2020 research and innovation program.
The measurements were initially analyzed in accordance with the common interpretation based on the first-order approximation of the solution for the infinite line source model (S-ILSM) and then by utilizing the complete solutions of both the infinite line and cylinder source models (ILSM, ICSM). An inverse numerical approach based on a detailed model (CaRM) that considers the current geometry of the BHE and the axial heat transfer as well as the effect of weather on the ground surface was also used. Thermal Response Tests (TRTs) were carried out on coaxial pipe, double U-tube and helical shaped pipe BHEs. The equivalent thermal conductivity provided by literature data depending on the ground type was about 20% higher than that found using the common interpretation of the TRT measurements conducted on the 96 m long BHE. In addition, the thermal response testing interpretation showed that in that same area the equivalent thermal conductivity ranged from approximately 1.35 to 1.60 W/(m K) for the same BHE depth. The minimum misfit between the experimental and calculated values of the mean fluid temperature was found using the inverse numerical procedure by means of the CaRM simulation tool which considers important phenomena that affect the thermal behavior of the borehole heat exchanger, e.g. the weather conditions at the ground surface, axial heat transfer and borehole thermal capacity.





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BETA_Lab: Building Energy Technology Assessment


Angelo Zarrella
angelo.zarrella@unipd.it
Phone: +39 049 8276871


Michele De Carli
michele.decarli@unipd.it
Phone: +39 049 8276870

Assisted by:
Giuseppe Emmi,
Research fellow
Samantha Graci,
Research fellow

www.dii.unipd.it

The research activity is ongoing and carried out in collaboration with:

Antonio Galgaro, Geoscience Department of Padua University;

Partners of Cheap-GSHPs project (http://cheap-gshp.eu/)

Main research topics:

- Modeling and Field Measurements of Radiant Systems
- Ground Source Heat Pumps
- Solar Systems Design for Heating and Cooling
- Double Skin Facades
- Energy Analysis and Temperature Distributions in Large Spaces
- Simulations and Measurements in Buildings
- Energy Efficiency of Building Plant System
- Nearly Zero Energy Buildings (nZEB)
- Low Exergy Systems in Buildings
- Thermally Activated Building Systems
- District Heating and Cooling Networks
- Thermal Comfort
- Modelling and Development