Editorial

Marco Barla PhD

Confirmed Assistant Professor, Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Turin, Italy

Alice Di Donna PhD

Postdoctoral Research Assistant, Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Turin, Italy

The demand of energy in the world is continuously growing and is still currently satisfied mainly by oil, natural gas and coal. At the same time, high levels of air pollution and lack of green spaces affect the major cities, leading to an increasing use of the underground for transportation and utilities. The need to develop local and low-environmental-impact energy resources becomes more and more necessary. In this context, shallow geothermal systems, used for domestic heating and cooling, may play an important role and their growth potential should be investigated. Currently, closed- or open-loop borehole systems are the most common applications. However, all geotechnical structures, such as piles, diaphragm walls, basement slabs or walls, or tunnel linings and anchors in tunnels or in retaining structures, can be instrumented to become energy geo-structures and exploit geothermal energy, with great economic and environmental benefit. The integration of ground heat exchangers (GHE) in such elements is particularly attractive due to the inherent cost saving involved in combining a required structural component with the harvesting of geothermal energy. However, while reasonable experience is now available on the behaviour of energy piles, limited examples exist related to retaining walls and tunnel linings.

Environmental Geotechnics has devoted attention to this advancing technology with an introductory paper in 2014 (Barla and Perino, 2014). This 2016 themed issue was conceived at that time, as the need emerged to build networks, make synergies among studies in this field, and disseminate the results across the world.

The same need is addressed by the COST (Cooperation of Science and Technology) Action TU1405 (European Network for Shallow Geothermal Energy Applications in Buildings and Infrastructures), a new European network of researchers and professional engineers, which has recently been launched to address the challenges of thermoactive geostructures in terms of thermal and mechanical design, based on a multidisciplinary approach.

The challenges that need to be faced to foster the development of thermoactive geostructures are still diverse. Demonstrating direct applicability and economic convenience is the key factor to promote the application of the technology to stakeholders and city planners. To this end, the ability to reliably quantify the heat that can be exchanged with the ground represents a key issue. This calls for the study of hydro-thermal interaction between the ground and the thermo-active structural elements by advanced numerical modelling as well as for large-scale site experiments. This is particularly relevant for those geostructures where limited experience is still available (almost all other than piles).

It is also expected that increasing application would stimulate designers towards the optimisation of the process. This could be obtained by seeking the use of new materials and techniques. As an example, the guest editors have recently deposited a patent for a new tunnel energy segment, which improves the energy efficiency thanks to geometrical optimisation of the pipe system.

In the scenario of an increasing use of such technology, interactions between close geothermal systems and their sustainability in the long term may become a major issue. This includes the mechanical behaviour of the structural elements subjected to cyclic thermal loads as well as the influence on the surroundings in terms of increase in the temperature in the ground and subsidence or deformations in the pre-existing buildings.

This themed issue was devoted to collect papers related to these studies, exploring advances and perspectives of thermoactive geostructures. The issue presents eight papers. Topics addressed go from theoretical aspects of the thermal behaviour of soils and rocks to the description of virtual or real demonstrators.

The role of geotechnical parameters is addressed by Yu *et al.* (2016) who provided recommendations for determining soil thermal conductivity to guide the design of energy geostructures. Wang *et al.* (2016) presented a physical model test of energy piles. Di Donna and Barla (2016) explored the role of ground conditions on the efficiency of energy tunnel segmental linings. The outcomes are practical design charts that can be used at a preliminary stage for the assessment of the heat that can be exchanged with the ground.

Virtual or real applications of GHEs are considered in the other papers. Bidarmaghz *et al.* (2016) show the potential of GHE in loess, while Abdelaziz and Ozudogr (2016) investigated the thermomechanical response of energy piles giving practical recommendations to designers. Mikhaylova *et al.* (2016) proposed a methodology for the estimation of GHE design length based on uncertainties in design parameters and Loveridge and Cecinato (2016) presented thermal activation of continuous flight auger piles, which is a common pile construction method for buildings in urban areas.

Finally, Ryżyński and Bogusz (2016) make a preliminary evaluation of the city-scale impact of thermoactive geostructures using the city of Warsaw (Poland) as a case study.

The guest editors wish to acknowledge the support of authors, reviewers and the Chair, without which the issue could not

come true. Most of them are also actively involved in the above-mentioned COST Action. Hopefully also the readers will appreciate their effort.

REFERENCES

- Abdelaziz S and Ozudogru TY (2016) Non-uniform thermal strains and stresses in energy piles. *Environmental Geotechnics* **3(4)**: 237–252, <http://dx.doi.org/10.1680/jenge.15.00032>.
- Barla M and Perino A (2014) Energy from geo-structures: a topic of growing interest. *Environmental Geotechnics* **2(1)**: 3–7, <http://dx.doi.org/10.1680/envgeo.13.00106>.
- Bidarmaghz A, Makasis N, Narsilio GA, Francisca FM and Carro Pérez ME (2016) Geothermal energy in loess. *Environmental Geotechnics* **3(4)**: 225–236, <http://dx.doi.org/10.1680/jenge.15.00025>.
- Di Donna A and Barla M (2016) The role of ground conditions on energy tunnels' heat exchange. *Environmental Geotechnics* **3(4)**: 214–224, <http://dx.doi.org/10.1680/jenge.15.00030>.
- Loveridge F and Cecinato F (2016) Thermal performance of thermoactive continuous flight auger piles. *Environmental Geotechnics* **3(4)**: 265–279, <http://dx.doi.org/10.1680/jenge.15.00023>.
- Mikhaylova O, Johnston IW and Narsilio GA (2016) Uncertainties in the design of ground heat exchangers. *Environmental Geotechnics* **3(4)**: 253–264, <http://dx.doi.org/10.1680/jenge.15.00033>.
- Ryżyński G and Bogusz W (2016) City-scale perspective for thermoactive structures in Warsaw. *Environmental Geotechnics* **3(4)**: 280–290, <http://dx.doi.org/10.1680/jenge.15.00031>.
- Wang C, Liu H, Kong G, Ng CWW and Wu D (2016) Model tests of energy piles with and without a vertical load. *Environmental Geotechnics* **3(4)**: 203–213, <http://dx.doi.org/10.1680/jenge.15.00020>.
- Yu X, Zhang N, Pradhan A and Puppala AJ (2016) Thermal conductivity of sand–kaolin clay mixtures. *Environmental Geotechnics* **3(4)**: 190–202, <http://dx.doi.org/jenge.15.00022>.