

Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
Family name	MROUEH
First name	HUSSEIN
Email	Hussein.Mroueh@polytech-lille.fr
Web reference	Cliquez ou appuyez ici pour entrer du texte.
Lab name	LGCGE
Lab web site	www.lgcge.fr
Polytech name	Polytech Lille
University name	University of Lille
Country	France

PhD information	
Title	Numerical modelling of heat exchange between an energy geostructure and the surrounding ground
Main topics regards to CSC list (3 topics at maximum)	Geothermal structures, geotechnical engineering, Numerical modeling
Required skills in science and	Analysis of fully coupled thermo-mechanical

engineering	problems, development of specific numerical tools and methods of calculation
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Subject description (two pages maximum)

Energy geostructures, as well as ground heat exchangers and groundwater pumping, are among the applications of low geothermal energy and belong to renewable energy technologies. These technologies emerged slowly in Europe, since 1980 in Austria first, until 2005, and then faster with the construction of important works, for instance in France, with three metro stations in Paris with metro lines L12 and L14 and also in Europe, Switzerland, Germany and the UK. Nowadays, piles, diaphragm walls and the tunnel linings can be equipped with heat exchanger tubes. The main interest is to remove the drilling costs since heat exchanger tubes for energy geostructure are directly embedded to the cage reinforcement.

For subway stations, an original method of calculation based on the use of the heat linear finite dimension sources, directly embedded into the diaphragm wall has been recently developed. Analysis of the results permits a better estimation of the thermal power exchanged between the station and the surrounding soil. It is also possible to assess the contribution of each side of the station and to separate the advective and conductive part of exchanges.

The first objective of the PhD work is to improve this method of calculation by taking better into account the heat exchange between the diaphragm wall and the heat exchange fluid circulating into tubes. Calculation based on two pairs of the heat linear finite dimension sources should be developed. Within a pair, one line would be used to simulate the behaviour of the inlet fluid and the other one to simulate the behaviour of the outlet fluid. Considering only the conduction in a first step, the second objective is to provide design charts from parametric studies of the geometry of the structure, the position of the heat exchanger tubes, etc. These charts can also be obtained from analytical tools that still need to be developed. Such charts are eagerly awaited by the profession.

In practice, the thesis includes the following tasks:

- State of the art on energy geo-structures;
- Development of numerical tools and methods for innovative calculations;
- Application to three-dimensional coupled calculations;
- Development of design charts for geo-structures.

This work requires competencies in soil mechanics, thermal and mechanical analyses. Good command of specific calculation softwares (eg. FLAC3D) and quantitative skills are also required.

This work will be co-supervised by Dr. Hanbing BIAN (Associate Professor, University of Lille, Polytech Lille, LGCgE) and Dr. Yvon DELERABLEE (ANTEA Group, www.anteagroup.fr)