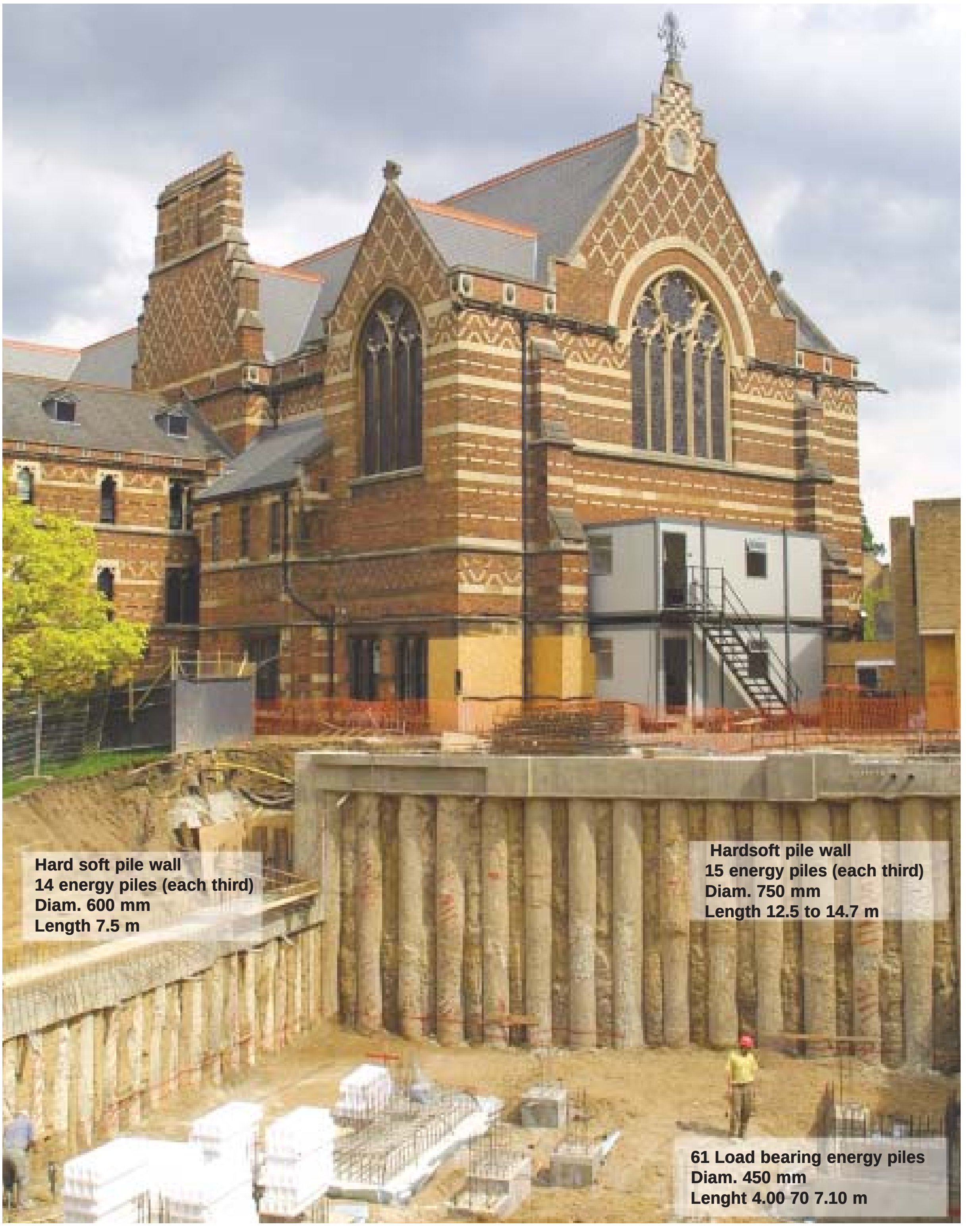
Geothermal Piling

Keble College Oxford

Cooling and heating with Geothermal energy using enercret thermo–ative foundations (energy piles)



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Energy concept and basic data

enercret technology

Concrete structures such as piles, diaphragm walls, retaining walls, foundation slabs etc. are used to absorb thermal energy from the ground and ground water (ground temperature is approx 12 °C in Europe). The energy is absorbed and transported to the building services center by means of fluid-filled pipe systems incorporated inside the foundations elements which are needed for structural reasons. A building can be cooled for next to nothing by using the cooling fluid. In the case of heating the same system can be used to extract energy by means of a heat pump. The ground provides an intermediate storage facility for excess energy - the warmth disposed during cooling period can be absorbed for heating and vice versa. For the new building Residence II of Keble College Oxford, investigated in this study, enercret provides energy savings of 80 % and a reduction of CO2 emissions of about the same value.

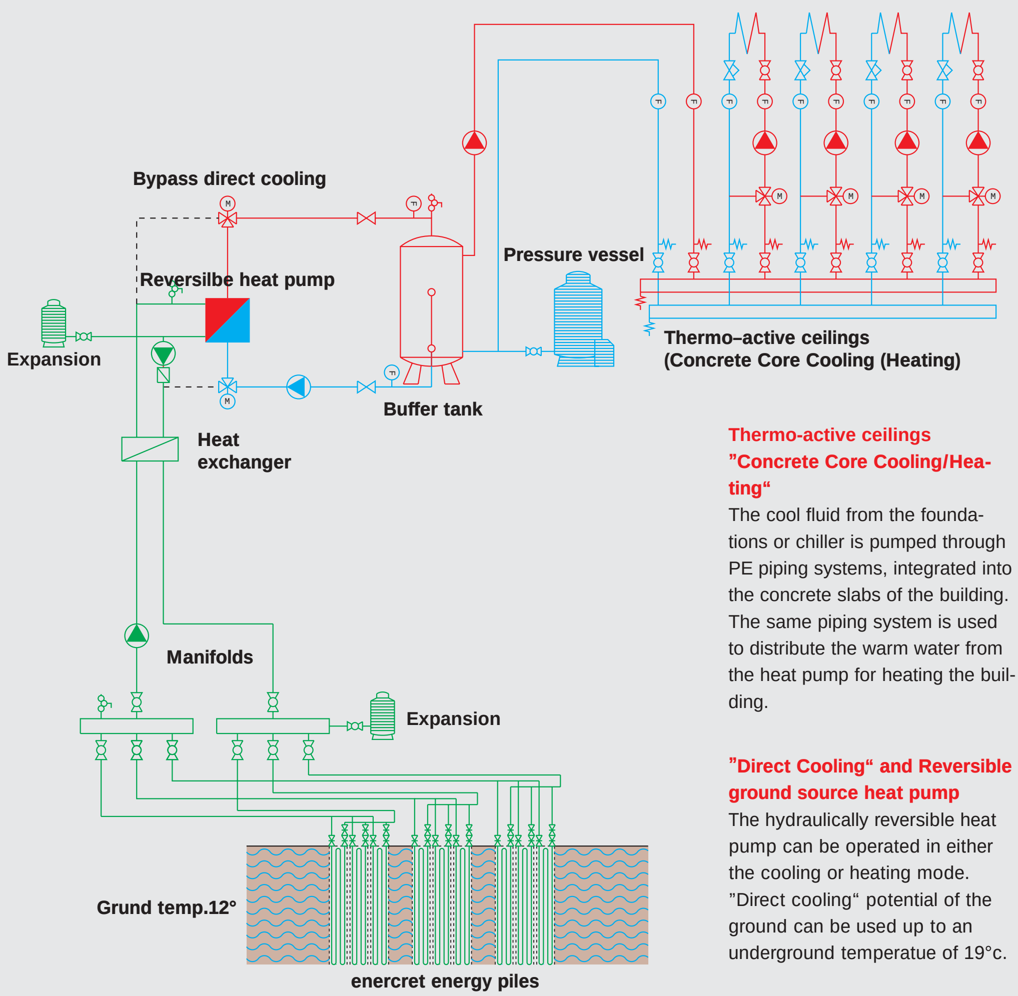
Relevant project data

	Heating energy requirement annual spread (kWh/month)	Coolig energy requirement annual spread (kWh/month)
January	16,235	
February	15,045	
March	10,285	98
April	6,545	851
May	1,870	3,925
June		10,566
July		20,902
August		15,505
September		2,747
October	2,550	589
November	8,585	
December	13,600	
SUM:	**74,725**	**55,183**

Absorber piles:
15 piles, diam. 750 mm, length 12.5 m
14 piles, diam. 600 mm, length 7.5 m
61 piles, diam. 450 mm, length 5 m
Absorber piping:
PE-HD, diam. 20/2.0 mm

Total length of piping installation:
41 loops, each approx 150 m long, amounts to 6.150 m.
Soil conditions:
sandy silty clay, moist

Scheme of the heating and cooling system



Thermo-active ceilings ”Concrete Core Cooling/Heating“

The cool fluid from the foundations or chiller is pumped through PE piping systems, integrated into the concrete slabs of the building. The same piping system is used to distribute the warm water from the heat pump for heating the building.

”Direct Cooling“ and Reversible ground source heat pump

The hydraulically reversible heat pump can be operated in either the cooling or heating mode. ”Direct cooling“ potential of the ground can be used up to an underground temperatue of 19°c.

Results of simulation with software Trnspile

Diagram Simulation Results:
100% of heating and cooling load of building can be absorbed from ground through absorber pile system, using a reversible heat pump. About 80% of cooling load are supplied by „direct cooling“ (max. ground temperature 19 °C). Temperature variation of fluid (average inflow/outflow): max. summer 27 degree centigrade, min. winter 1.0 degree centigrade.

Diagram System Temperatures and Heat Flows:
Calculation of pile system was performed for 40 piles out of 88 piles. Diagram shows temperature and heat flows over the year in hourly steps.

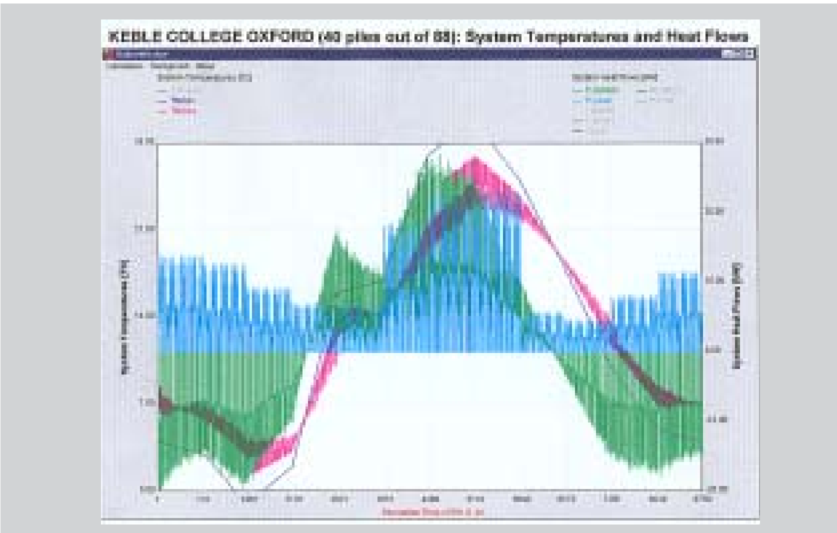
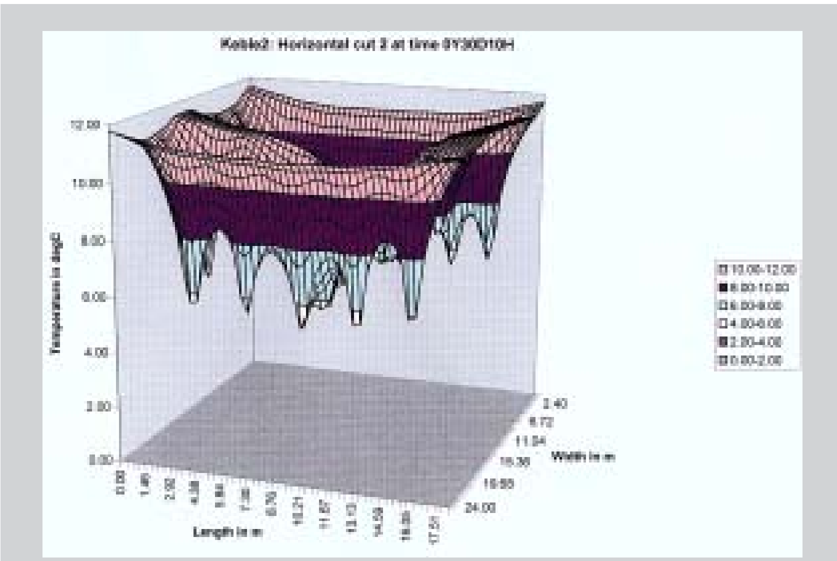


Diagram Min. Ground Temperature Winter:
This diagram is showing the temperature distribution in the ground at heating load–end of January.



Piling Works

The piling work involved forming a 100 m long hard/soft secant pile wall around the site perimeter for a two-level basement, as well as constructing bearing piles for the main structure. For the heating system more than 6 kilometers of 20 mm PE-HD piping were installed within the foundation system, included in 25 % of the secant wall piles and in all of the bearing piles.
The piping was fitted to the insides of the reinforcing cages for the piles on site. A ball-cock valve and a pressure gauge were fitted to the pipe ends and the loops were pressurized with an air pressure of 7 bar.

During the course of this work it was important to ensure that the pipes were properly spaced and secured to the inside of the cages.

The construction of the reinforcing cages was sufficiently sturdy to allow them to be handled without damaging the absorber units. The cage positioning and concrete pouring operation for the bored piles had to be performed with the utmost care and attention in order to prevent damage to the piping circiuts.

Before pouring the concrete a pressure testing was performed and a test report issued. The cages had to be installed at the required level.

A tremmie pipe was used in the rotary piles to control the concrete pour at the bottom an avoid the risk of the concrete impacting down onto the piping and damaging it.

The ends of the flow and return lines were secured at the pile heads by means of a PVC overtube to protect the pipe during cutting and excavation work and to ensure that they could be joined up to the connecting pipes.

The bearing piles, which only had a nominal diamenter of 500 mm had to be cut off at basement level, which varied up to 7 m below ground level. For these piles a special flexible rubber tremmie extension was fabricated to transport concrete down inside the narrow cage without damaging the pipes.

Once the pile heads were cut away to specified level, the protection pipe was removed and the absorber units joned to the connecting lines using thermofusion connectors. During this work it was imperative to ensure that no dirt particles got into the pipes. The pipe ends were protected with covers during breaks in the pipe-laying operations. The connecting lines of the load bearing piles were installed in the sub-case as the concrete pouring operations progressed and covered with a protective layer of concrete.

The connecting lines from the secant pile walls to the manifold were tied to plastic rails on the pile wall and ceeling. The ends of the connecting lines again were fitted with ball-cock valve and the pressure gauge and the circuit tested and recorded.

Reinforcement cage with absorber piping and protection tube

Thermofusion connectors

Manifold

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