enercret
thermo-active Foundations

Energy piles   Energy diaphragm walls   Energy foundations

Installation Description

Based on the example of Norddeutsche Landesbank, Hannover, Germany

1. The Project

This project was commenced in 1998 and is due for completion in 2002. The building encompasses a surface area of 14,000m² and has a total floor space of 72,000m².

The ground is used as a source and a storage medium for cooling/heating energy which is tapped by circulating water through pipe circuits embedded in the foundation piles.

The water absorbs the cool ground temperatures through the concrete and transports them to the central cooling/heating system. When cooling is required, this temperature (13 °C in central Europe) is used directly. During the heating period, heat is extracted with the aid of a heat pump.

122 cast-in-situ concrete piles, each measuring 90cm in diameter and approx. 20m in length, and rigged with 4 loops of 25mm x 2.3mm PE-HD piping, were used for the absorber pile installation. The 122 circuits were then connected up to the manifold via connecting lines. The system consists of some 37 km of piping.

Heating capacity 150 kW, annual heating output 80 MWh
Cooling capacity 350 kW, annual cooling output 80 MWh

The eight floor slabs house 505 pipe loop units comprising 77 km of piping.

2. Installation Work

2.1. Rigging the Absorber Piles

PE-HD piping 25mm x 2.3mm, PN 10 was fitted to the insides of the reinforcing cages for the piles on the general contractor's premises. A ball-cock valve and a pressure gauge were fitted to the pipe ends and the loops were pressurized with an air pressure of 7-8 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 to prevent them from being dislodged during transportation and the subsequent concrete pouring operations.

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 operations for the bored piles had to be performed with the utmost care and attention in order to prevent damage to the piping circuits.

The loops of the absorber units were fixed to the crown at a safety distance of 60cm from the top edge of the pile head (cut level).

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

In addition to performing the pressure testing and issuing the test report, the cages had to be carefully installed at the required level in the construction pit and due care and attention exercised when lowering and retrieving the concrete feeder pipe as well as when placing the concrete in order to avoid the necessity for repairs and to ensure that all the absorber units function properly.

2.2. Laying the Connecting Pipes

Once the pile heads or diaphragm wall crowns were cut away to the specified level, the pipe fastenings and insulating material were removed, and the absorber units joined 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.

During concrete cutting and excavation work, care had to be taken to ensure that the absorber unit connections were not damaged. Work performed near the actual absorber units themselves had to be done by hand.

The connecting lines for the absorber circuits were installed in the sub-base as the concrete pouring operations progressed and covered with a protective layer of concrete.

In order to ensure that they were laid correctly and retained their position during concreting work, the pipes were tied to plastic rails and the ends again fitted with ball-cock valve and pressure gauge.

Prior to the concrete pouring operation, the pressure in the circuits had to be tested and recorded. Once the outer wall of the sub-levels was completed, the absorber unit connecting lines were laid 9m along the outer wall and into the accessible distributor room for the manifold block, then fastened to the wall. A ball-cock valve and pressure gauge were again fitted to the pipe ends for checking and recording the test pressure of the complete absorber unit with connecting lines. The pipes were then permanently marked with the circuit number.

A 30m long PE manifold, DN 315 x 38.7mm/PN 10, was then installed in the distributor room and the flow and return lines comprised of DN 225 x 20.5mm/PN 10 were run into the building.

2.3 Additional Work for the Building Contractors

The contractors employed on site were faced with the following additional measures and duty of care requirements which were minimized by ensuring that all operations to be performed by the contractors were planned well in advance.

The reinforcing cages had be placed in a suitable storage area where the installation crews could work unhindered when laying the absorber circuits, making the pile head connections and securing the pipe ends.

The building contractor ensured that the cages were transported and stored in such a way that the piping circuits were protected against damage and retained their positions.

The cage positioning and concrete pouring operations were performed with the utmost care and attention in order to prevent damage to the piping circuits and to ensure that they retained their positions. Connecting points had to be positioned at the correct height.

All absorber piping, which projected in the area of the pile head, plus the pressure gauges and ball cock valves fitted to it were protected against any damage during excavation and cutting work.

Excavation work performed near the piping was carried out manually and/or in conjunction with equipment, and due care had to be exercised during cutting work.

Particular care was also taken when connecting the pipe circuits in the piles to the manifold and when installing the manifold itself.

The installations had to be protected during backfilling work in the area of the operation rooms.

Piping can also be damaged by sharp objects, weld splashes, flying sparks and cigarette ends. Specialist personnel involved in the construction work therefore had to be instructed accordingly.

The work was planned and co-ordinated by means of detailed construction schedules. A suitable storage area had to be provided by the customer. Crane equipment, electricity, water and toilet facilities plus a location for the erection of a construction sign were provided and billed by the customer.

2.4 Laying Absorber Circuits in Ceilings for Concrete Core Heating and Cooling

20mm x 2mm pipe loops made of cross-linked polyethylene (PE-Xa) were laid in cages at 15cm intervals in the centre of the ceiling cross section. Shortly after laying the pipes the specially manufactured cages then had to be covered with the top ceiling reinforcement layer to protect the piping.

Prefabricated absorber circuits were out of the question for this project as there were too many “taboo zones”.

The specialist engineer prepared pipe layout drawings for the absorber circuits which took these taboo zones into account. As no subsequent cutting or core drilling work is permitted in the area of the absorber circuits, recesses for piping had to be planned in addition to the structural taboo zones. It was essential to define these positions precisely in conjunction with all the specialist engineers, the structural engineer and the architect in order to avoid any problems at a later date.

When considering scheduling arrangements, management of all the installation work had to be properly coordinated in order to enable the individual subcontractors to proceed without mutual hindrance or time loss, and to prevent the need for any subsequent pipe or cable laying.

3. Consequences for Design Calculations and Tender Specifications

3.1 Designing enercret Installations

Heat exchangers in ground-contact concrete structures such as absorber piles are frequently designed on the basis of static energy outputs. However, this is inadequate as the various parameters in three-dimensional volumes of ground behave dynamically when heating or cooling.

In addition, the differences in the length of heating/cooling periods per day/year affect the regenerative behaviour of the energy potential, or heating and cooling can significantly increase the potential and utilize the storage function of the ground. Groundwater flow has an incalculable influence. These few examples show that a reliable design calculation for an enercret installation and economic optimization by adapting the available potential to the energy requirements profile of the building is only possible with the aid of special software.

Designing the absorber units and their hydraulic specifications is also a job for experienced engineers in order to ensure the cost-effectiveness and efficiency of the enercret installation. Another challenge for the design engineer is the optimal integration of the geothermal potential of the enercret installation into the HVAC concept for the building.

Once again it should be emphasized that, right from the early design phase for a building which is to be equipped with an enercret installation, the geotechnical engineer (additional information on groundwater temperature, flow direction and velocity), the structural engineer (pile type, design details) and the energy consultant must work together to ensure that the design work and the work phases are precisely coordinated.

3.2 Drawing up the Tender Specifications and Selecting the Contractor

The complexity of the installation work for absorber pile installations has certain implications for the tender specifications and for the contractor to be selected for a project of this type.

For reasons of responsibility and warranty, enercret installations or concrete core heating/cooling systems should always be awarded to one contractor. The ideal interface is the manifold/header installed ready for operation.

It should be contractually agreed that the building contractor is responsible for ensuring cooperation on site during the installation and for safeguarding the installation during interruptions due to construction progress.

The installations must either be part of the contract or the contractor must be held entirely liable in the contract, while adverse conditions, items to be supplied and hindrances to work operations must be stated in the specifications so that these can be provided for.

The local site management must also be held responsible. On no account can the design engineer accept the responsibility for and guarantee the proper functioning of the installation.

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