enercret
thermo-active Foundations

Energy piles Energy diaphragm walls Energy foundations

System Description

1. Introduction

In Central Europe the ground temperature at a depth of around 10-20 metres averages roughly 13 °C. In the soil layers above this, the temperature will depend on weather conditions. Every square metre of soil is irradiated by approximately 1100 kW of solar energy on an annual basis.

In the lower layers of the ground, geothermal influences predominate, causing the temperature of the ground mass to increase by around 1 °C for every 33 m of depth.

The basic idea is to extract heat from the ground (geothermal energy) and to utilize it by means of suitable systems integrated into the building.

Conversely, this principle can be used for cooling purposes. In this case, excess heat is dissipated in the ground. In areas with suitable soil conditions, it is also possible to store cooling and heating energy in the ground from one season to the next.

The enercret technology was first introduced in 1980. At that time, it went under the name of “solid absorber technology” and later on became known as “concrete absorber technology”. It is still sometimes referred to as a “groundsource heat exchanger” or “geothermal foundations”.

While this technology was initially used essentially for detached or multiple-unit residential properties, nowadays the main applications are large buildings, such as public buildings, office blocks, cultural centres, industrial and manufacturing premises.

2. enercret-concrete members

The choice of energy system will normally depend on soil conditions and the structural engineering requirements of the building.

In cases where bore piles or diaphragm walls are needed for the foundations, these also provide the structures needed to make effective use of geothermal energy as they usually go down to groundwater level and offer a large area of surface contact with the soil for heat exchange. Other options include the use of construction pit shoring, floor slabs and other ground-contact concrete members.

In case of piles or other foundation structures, PE piping forming closed circuits is incorporated in the concrete. This is used to circulate the heat transfer medium and transport the thermal energy to the central building services control system. Providing that the conditions are right, the fluid used can be water or mixture of water and antifreeze.

The piping units are either attached to the reinforcing cages at the factory or on site.

The right cages are then places in the locations determined by the structural engineer and cast in concrete. The pipe spacing is derived from the calculation of energy use; the dimension and length of the piping systems from the hydraulic calculations. As a rule, a pipe circuit (water circuit) will have a length of 150 m – 300 m from manifold to header block.

The individual circuits are subsequently joined up via connecting lines to the manifold and header blocks. Pipes are laid primarily below the floor slab and along the exterior face of the outer wall of the building which is in contact with the soil. The work is usually carried out in phases as the walls of the basement must be completed before the connecting lines can be installed.

The shaft to house the distributor blocks should be located above groundwater level and, if possible, in the building services room. The distribution systems consists of a manifold and header block to which the flow and return lines of the piping circuits are connected.

The circuits are kept under a pressure of 6 bar throughout the complete construction phase so that they can constantly be checked for possible leaks. The pressures are tested and recorded in test reports prior to and after pouring the concrete.

Precast absorber piles from Naegelebau are used in many cases, particularly for friction piles and small buildings.

Cost benefit and time scale considerations are usually the reasons for choosing this type of piling. In this case the absorber system consisting of PE-HD piping is placed in the concrete at the factory.

Once the piles have been driven, the polystyrene packing is removed and the pile can be joined up to the connecting line. Absorber piles of this type have cross sections of between 30/30 cm and 40/40 cm and can be up to 14 m in length.

A newly developed rapid connector for use on site means that precast absorber piles can be executed in lengths of up to 28 m.

3. Heating, cooling / direct cooling

Although originally conceived merely to heat buildings with the aid of a heat pump, the technology was later further developed to include cooling.

The heat pump can be used to extract thermal energy from the ground via the foundation structures, which is then raised to a higher temperature suitable for heating purposes.

While the average temperature to be found in the concrete foundations is in the region of 13° C, the heat pump produces temperatures between 25 °C and 35 °C in the heat transfer medium, which is quite adequate for radiant heating systems such as floor heating, ceiling or concrete core heating.

As a result of the ever increasing use of technology in offices, greater use of glass surfaces in building façades as well as improved building insulation, we can expect to see a further increase in building cooling requirements in the future. And as cooling requirements increase, so too will the relevance of earth connections for buildings because the average cooling capacity available in the ground over the year provides an ideal temperature.

Here, a radiant heating/cooling system is used, with cool fluid circulating through the foundation structures. The running costs are extremely low in comparison with conventional systems. In applications where the heat extraction and utilization system can be used both for heating and cooling the building, the investment costs for installation are particularly economical.

If the capacity of the soil is inadequate, a refrigerator unit or a reversible heat pump can be integrated into the system.

Systems which are designed to operate with low temperature differences between the heat transfer medium and the space, such as wall, floor and ceiling heating and chilled ceilings, are predestined for the use of geothermal energy. The heat transfer medium which circulates through the integrated piping system is cooled by the ground in the summer and heated in the winter. The preheating or cooling stages of air-conditioning systems are also ideal applications for combination with heating or cooling energy from the ground.

Another technical development which forms an ideal complement for enercret is the concrete core cooling/heating system, also known as thermo-active ceilings. In this case networks of polyethylene piping are laid in the concrete ceiling. These are then used to circulate cooled or heated water which automatically regulates room temperature. The storage capacity of the concrete is used to buffer the heat loads which occur during the daily cycle.

4. Energy storage in ground

The sun provides us with an inexhaustible source of thermal energy which can be put to direct use with the aid of solar collectors. In combination with enercret, solar collectors present an interesting possibility for storing thermal energy in one season for use in the next.

The soil can be used as a vast energy store to retain the excess heat from production processes over long periods. This stored thermal energy can later be used for heating purposes. This saves on primary energy from fossil fuels both in summer and winter.

5. Design

In view of the complexity of the planning and engineering processes, the geologist (construction site investigation), the structural engineer and the energy consultant must be included right from the beginning, in addition to the architect.

As these new technologies affect the design of the building, the foundations and the air-conditioning concept, and part of the installation has to be incorporated in the foundations, it is essential to involve the relevant consulting engineers at a very early stage.

The parameters, which are required for the detailed engineering calculations, are contained in Questionnaire 1. This also includes questions to basic layout details such as foundations, basement levels and location of the control room for building services.

Questionnaire 2 is for the energy consultant. This information is used to match the energy potential present in the ground with the annual heating and cooling load profiles and peak requirements for the building.

6. Pay-back time, benefits

In most cases, the additional investment costs are paid for by the savings in running costs within a short period of time. Major factors influencing pay-back time include energy prices, cooling requirements and the technical energy concept for the building.

Generally speaking, it can be said that most buildings requiring deep foundations due to poor soil conditions satisfy the requirements for an alternative cooling and heating system which is both very economical and environmentally friendly.

This is borne out by numerous projects in Austria, Switzerland and Germany. One of the most widely publicised buildings was the "Kunsthaus" (art gallery) in Bregenz, Austria. Here, the building services were switched during the planning stage from a conventional air conditioning system to a concrete core cooling system using geothermal energy. The foundations (diaphragm walls) were based on the enercret system while the walls and ceilings were of thermo-active design.

As a result, the investment costs were reduced by 1.3 million EURO and the bill for annual running costs has been cut by some 22,650 EURO.

The ecological benefits of the installation should also be borne in mind.
The avoidance of fossil fuels such as oil or natural gas means that CO_2, SO_2 and NO_X emissions are drastically reduced and,

under favourable conditions, even eliminated altogether.

Other benefits include:

- self-regenerating energy source
- low dependence on conventional power
- closed circuits preventing any risk to groundwater
- reliable system with low space requirements
- most of the piping is laid in concrete structures
- long service life

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