

# Single pile and double pile energy storage

Can energy piles be used as ground heat exchangers?

Energy piles offer a promising and eco-friendly technique to heat or cool buildings. Energy piles can be exploited as ground heat exchangers of a ground source heat pump system. In such application, the energy pile and its surrounding soil are subjected to temperature changes that could significantly affect the pile-soil interaction behaviour.

What is an energy pile?

Energy piles, also called thermo-active piles, are an alternative solution for heating and/or cooling needs. Energy piles are double purpose structures that allow transferring the loads from the superstructure to the soil and that integrate pipe circuits allowing heat exchange between the pile and the surrounding ground.

Why do buildings need a group of energy piles?

Adjacent energy piles The heat transfer capacity of a single pile is usually insufficient to cover the heating and cooling loads of a building. Thus, buildings require the activation of a group of piles to meet the thermal loads.

Can energy piles be used for underground energy exchange?

Energy piles, which are combinations of BHEs with pile foundations, could be used for underground energy exchange without the need for drilling holes [,,]. Energy piles have been combined with ground source heat pump (GSHP) systems for building heating or cooling for years [33 ].

Can a multi-objective optimization improve the dual performance of energy pile systems?

It is concluded that a multi-objective optimization is highly recommended to enhance the dual performance of an energy pile system coupled with a heat pump using the 4E evaluation criteria (energy, exergy, economy, and environment) while ensuring the safety of the foundation under thermal cyclic loads.

Do energy piles need seasonal thermal storage?

Unbalanced operation of energy piles, where more heat is being extracted than rejected, in some cases may lead to a significant decrease in long-term energy performance. Therefore, to maintain stable operation of energy piles in a long-term perspective, consideration of seasonal thermal storage may become feasible.

Pile-structure-pile interactions were investigated as the heated pile pulled on the adjacent piles, from pile heads (expansive strains) to pile ...

Energy pile technology has garnered significant interest in utilizing shallow geothermal energy and has been utilized in numerous practical projects (Sani et al., 2019; Xie and Qin, 2021). As a unique hybrid foundation pile, the energy pile serves as both a heat exchange element for ground source heat pumps and a stabilizing force for the superstructure (Fadejev ...

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The precast quadratic concrete energy pile can be constructed using a single precast segment when the total length of the pile is shorter than 15 m; otherwise, it is required to build them in several precast segments due to the length limits during the transportation. ... Concrete Pile for Pile-Driving to Form a Thermal Soil Storage (2002) WO03 ...

This conclusion is supported by experimental energy piles results [7]. The relatively low values of additional stress, expressed as a function of temperature compared to values mentioned in the available literature, will be explained in the next section, but they are also the reason why using thermo-piles for energy storage is possible.

The flat-plate solar collector with a single-layer glass cover measures by length 2000 mm  $\times$  width 1000 mm. The collector has seven parallel tubes with an outside diameter of 10 mm and a thickness of 1 mm. ... The daily average rate of energy storage per unit pile length increases from about 50 W/m to 200 W/m as the soil degree of saturation ...

The results shows the heat transfer efficiency of the double U connected tubes is suitable used in drilled pile, and the heat transfer capacity of the energy piles does not decrease significantly ...

The paper established a variable heat flow segmental superposition heat transfer model of energy pile groups, which can consider the heat transfer between circulating water ...

pile strain, axial force and shaft friction of two spiral energy piles were studied. The major findings of the experimental studies were: First, when the double spiral energy pile was heated, the temperature distribution was more uniform; the total heat transfer and the heat transfer rate were higher than those of the single spiral energy pile.

By injecting thermal energy in summer and extracting it in winter, the ground in the area of a building's piles can be used for seasonal energy storage, as long as the underground water flow in ...

Geothermal energy piles or ground heat exchange (GHE) systems embrace a sustainable source of energy that utilizes the geothermal energy naturally found inside the ground in order to heat and/or cool buildings. GHE is ...

Additionally, piles with larger diameter greatly influence the heat transfer and storage capabilities of the GEP due to the enhanced pile contact surface area with the ground, thereby, resulting in higher thermal performance [39], and allowing a higher number of energy loops to be incorporated within the foundation [33].

Although GCHP systems provide renewable energy to buildings, long-term financial benefit and space requirements prevent their widespread. One possible method for reducing their cost is to place tubes of heat

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exchangers in foundation piles, which are connected through the larger pipes to the heat pump, as Fig. 1 a illustrates. Foundation heat exchangers ...

It is due to the preferable heat conduction properties of concrete and larger heat exchange surface of foundation structure that the energy pile has the better heat exchange efficiency than the traditional geothermal heat exchanger. Research results showed that the energy pile system could save more than 30% energy than air conditioning system.

Abstract: In order to study the working characteristics of energy pile groups, based on the Abaqus finite element simulation, assigns the average temperature of the heat transfer stable stage to the pile body for steady-state ...

Reported investigations on the thermal and thermo-mechanical performance of the whole energy pile-based GSHP system are relatively limited [29]. The case study reported by Wood et al. [30] had a total of 21 energy piles equipped with single U-tube pipes serving as heat exchangers. The measured coefficient of performance (CoP) of the heat pump unit was about 3.6.

In this review different fundamental schemes of heat pump plants with energy piles, and various energy pile configuration types and their performance are studied. The study ...

sustainable and cost effective energy sources. Energy piles, also called thermo-active piles, are an alternative solution for heating and/or cooling needs. Energy piles are ...

Energy pile groups provide superior thermal energy storage performance over boreholes. Both energy pile geometry and number of internal heat exchangers are important. ...

It can be used to heat or cool the buildings by utilizing the stable heat storage characteristics of soil. ... U-shaped) and concluded that W-shaped pipes were more efficient than single, double, and triple U-shaped pipes [6,7]. ... The tests include three distinct pile configurations, namely, a single energy pile, a 2 &#215; 2 energy pile group ...

The results showed that 84% of the injected thermal energy could be transferred to the surrounding soil by the energy pile, and the total amount of the thermal energy stored by a ...

In recent years, energy piles have been attracting attention from the academic field and getting more installations in engineering practice [7], [8], [9]. The energy piles combine the foundation piles with the heat exchange pipes, the latter being attached to the steel cage and embedded in the pile body, as illustrated in Fig. 1 this way, the energy piles sustain the ...

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Design of energy pile is to account for thermal stress and thermal energy storage when using numerical and analytical methods. In the thermal design simulation models of GHEs (ground heat exchangers) are necessary for sizing and energy calculations [24]. ... when solving transient problem for a field of GHEs or a single pile [25]. To account ...

For predicting energy pile responses to the external loads, numerical models have been established with load transfer method considering the deformation and force in the longitudinal direction of the pile. ... L. Korkiala-Tanttu, and C. P. Cervera. 2015. "Numerical analysis of seasonal heat storage systems of alternative geothermal energy ...

As the offshore wind energy production units move to deeper waters the design of their foundations demand more creative and complex approaches especially for large turbines (i.e. ~5-7 MW) this article, a novel piled foundation alternative with closely spaced double piles at the edges of the jacket is studied for various pile spacing and lengths.

The single energy pile is simulated based on the finite element theory, which then is extended to energy pile groups. ... the finite element solution of energy piles in double-layered elastic media, and the field pile test results to validate the theory and ... Numerical analysis of seasonal heat storage in an energy pile foundation. Comput ...

This paper investigates the behavior of a single energy pile with three different mechanical head loads (65, 115, and 185 N) and also the effect of pile temperature on its ...

A pile is a row of rooms: a single-pile house is therefore one with a single row of rooms; a double-pile house is two rooms deep, sometimes, but not always, with a corridor between the two rows. According to some authorities, one of the earliest double-pile houses to survive is Whitehall, Shrewsbury, Salop. (1578-82), although Inigo Jones's Queen's House, ...

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In this paper, two energy piles, single and double spiral-shaped pipes, were tested under the combined effects of temperature and loading. At a constant heating

Boreholes and energy piles coupled with ground source heat pump plants utilize renewable geothermal energy for buildings heating and cooling purposes and need proper design and sizing in order to end up with high plant efficiency. This paper conducted a review of available scientific literature, design standards and guidelines on energy piles performance within the ...

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The use of alternative sustainable ways to climatize residential structures or industrial/agricultural venues has thus double advantages, as reducing environmental impacts as well as saving primary energy. ... to lead to larger movements and lower stress changes compared to a single pile, depending on constraints and no. of piles in the group ...

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