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 exchangersof 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 exchangewithout 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 recommendedto 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. 1. Introduction

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.

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.

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

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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 ...

Shallow geothermal is a renewable and clean energy source [1,2,3], and shallow geothermal storage is one of the technologies used to store and extract stored geothermal energy when needed [].At present, there are two ...

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 ...

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.

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].

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 ...

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 ...

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.

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 ...

This study presents a novel heat exchanger configuration, called a deeply penetrating U-shaped configuration, for energy piles. The outlet water temperature, temperature variation along the tube, and heat transfer rate are ...

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 × 2 energy pile group ...

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 ...

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 spi-ral 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.

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 ...

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 ...

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

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 ...

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 ...

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 ...

For the single energy pile, the temperature was approximately uniformly distributed along the pile body except for the locations near the top and end of the pile. The maximum pile temperature was 35.1 °C, which increased by 15.1 °C from the initial value. The maximum temperature of the soil was 32.7 °C, which occurred close to the lateral ...

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 ...

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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 ...

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

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 ...

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.

An energy pile with U-tubes is a special type of ground heat exchanger (GHE) formed by setting U-tubes into a concrete pile during the construction of building foundations. The parallel U-tubes increase heat transfer area, thereby improving energy pile performance.The analytical and numerical heat transfer models of U-tube energy piles are established in this ...

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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 ...

single spiral energy pile is discrete within the depth of 0-7.5 m, which does not occur in the double spiral energy pile. The maximum pile temperature difference of the single spiral pile at the ...

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