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Comparison of the performance of single energy piles and group energy piles in summer mode

Fatma Dülger Canoğulları [*1], **Özgür Lütfi Ertuğrul** [2]

[1] *Toros University, Civil Engineering Department, Türkiye, fatma.dulger@toros.edu.tr*
[2] *Mersin University, Civil Engineering Department, Türkiye, ertugrul@mersin.edu.tr*

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Abstract

Nowadays, the exploration for new energy sources has accelerated because of the increase in the world population and the decrease in current fossil fuel-based energy sources. Interest in geothermal energy is increasing day by day in terms of being both environmentally friendly and economical. Another application that has become common in recent years, especially in European countries, is thermal energy recovery systems that take advantage of the heat energy potential that is already included in shallow soils. As a multi-purpose engineering solution, energy piles can be applied as a variation of the mentioned heat exchanger systems. In this study, comparison of the performance of single energy pile and group energy piles in summer season mode (heat storage mode) was investigated using GeoStudio TEMP/W and SEEP/W Finite Element Method Software.

Introduction

Solar and wind energy have considered as the primary renewable energy sources in the current decades. However, the geothermal heat potential of the earth is also another important renewable energy source. Generally, the temperature of shallow soils from a certain depth is stable during the year and is not submitted to seasonal effects. This advantage allows the heat potential available to be used for both heating and cooling purposes in buildings [1]. To take advantage of this stable thermal medium, shallow ground heat recovery systems have been developed. These systems aim to use the heat potential with energy transfer pipes placed on the ground horizontally or vertically. The heat systems called energy piles have emerged as a variation of the mentioned heat recovery systems [2]. A conceptual sketch showing the geothermal pile system is depicted in Figure 1.

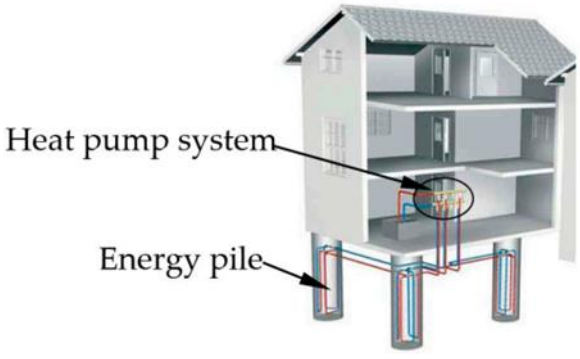

Figure 1. Schematic drawing of geothermal piles system [3]

Material and Method

In recent years, studies on energy piles have been increasing rapidly. Most of the studies are focused on numerical modeling because the experimental investigation of energy piles is both demanding and economically disadvantageous [4]. In this study, it is aimed to evaluate the energy performance and efficiency of energy piles produced in single and group styles for the summer period, based on the numerical method. Single energy pile and energy piles group's model geometries designed in TEMP/W and SEEP/W [5-6] are shown in Figs. 3 and 4.

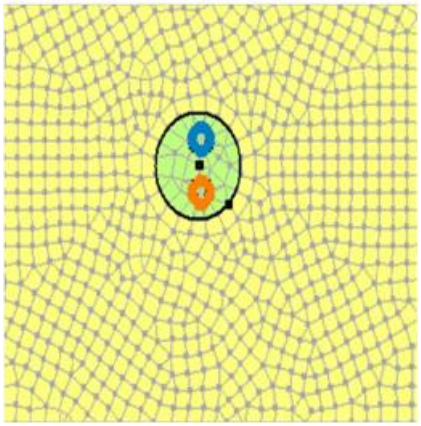

Figure 2. Single energy pile [6]

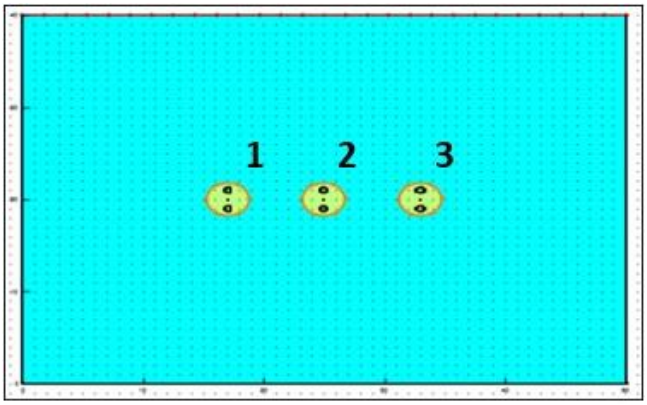

Figure 3. Energy piles group [6]

Results and Discussion

Within the scope of this study, the efficiency obtained from single energy piles and group energy piles were analyzed in summer mode (heat storage mode) using TEMP/W and SEEP/W software. It is seen in Figure 5 that the temperature contours move in the flow direction depending on the flow direction in the aquifer for plan analysis. The percentages of energy efficiency of single energy pile depending on time in summer mode are shown in Table 2.

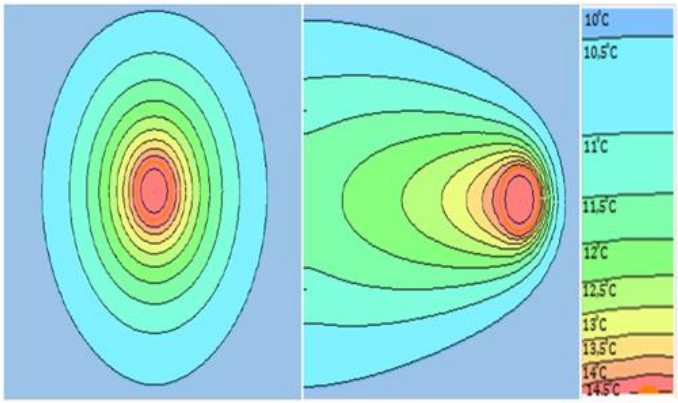

Figure 4. Single energy pile in summer mode (heat storage mode) a) Temperature profile after 360 days (no groundwater flow) b) Temperature profile after 360 days (ground water flow)

Table 2. Percentages of energy efficiency of single energy pile depending on time in summer mode (heat storage mode)

	Energy Efficiency (%)	
Time (day)	**no groundwater available**	**ground water available**
0	100	100
30	52,886	58,551
60	42,726	51,658
360	27,399	47,969

Temperature profile of group energy piles is shown in Figure 6 and percentages of energy efficiency of group energy piles depending on time are given in Table 3.

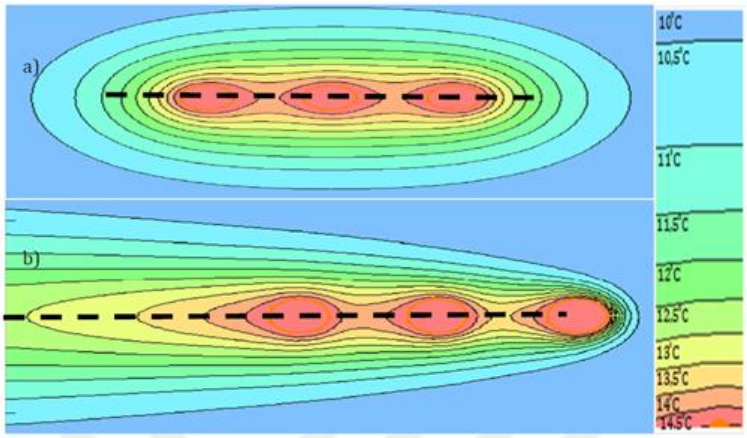

Figure 5. Group energy piles working in summer mode (heat storage mode) a) Temperature profile after 360 days (no groundwater flow) b) Temperature profile after 360 days (ground water flow)

Table 3. Percentages of energy efficiency of group energy piles depending on time in summer mode

	Energy Efficiency (%)					
Time (day)	**no groundwater available**			**ground water available**		
	First Pile	**Second Pile**	**Third Pile**	**First Pile**	**Second Pile**	**Third Pile**
0	100	100	100	100	100	100
30	50,528	48,158	50,541	63,376	49,305	48,914
60	38,940	35,120	38,956	58,396	37,091	35,599
360	20,698	14,411	20,703	56,776	28,656	22,503

Conclusion

Energy piles have attracted a lot of attention in the recent decades due to their multi-purpose use in civil engineering. In this study, the thermal capacities for single and group energy piles working in summer mode (heat storage mode) were compared. Analyses results indicated that in the absence of groundwater, higher energy efficiency was achieved from the single energy pile compared to the energy piles in the group at all periods.

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