soil or storing heat in soil. It is by providing piles for example with a heat collection piping of the geothermal heating system that the construction of a separate heat collection pipe system is avoided in projects that would require the use of piling anyway.

The tightness of heat transfer pipes is important from the standpoint of both a functional heat collection or storage system and environmental protection. A challenge in pile driving is posed by the tightness of joints between the piles. Pile driving involves the use of major forces which may easily damage the joints with resulting pipe leaks.

Brief summary of the invention

Embodiments of the invention to provide an improved reinforced concrete pile, which can be driven into the ground for supporting a building or the like structure, and by which problems of the prior art can be solved.

According to a first aspect of the present invention, the reinforced concrete pile includes at least one heat transfer pipe for circulating a heat transfer fluid within the pile, at least one of the ends of the reinforced concrete pile constituting a splicing end, by which splicing end the pile is connectible to another identical or similar pile for constructing a longer pile assembly, and whereby, at said splicing end, said at least one heat transfer pipe is adapted to be connected to a respective heat transfer pipe of the pile connectible to the discussed splicing end, wherein the pile has its splicing end fitted with a positioner sleeve which surrounds the heat transfer pipe's end in such a way that between the heat transfer pipe and the positioner sleeve develops an annular space for receiving a sealing sleeve, which is made at least partially from a plastically deformable material and which extends outward from the pile's splicing end, and the positioner sleeve has its end, which is further from said splicing end of the pile, designed to decrease in its inner diameter towards the discussed end in such a manner that, in the process of coupling two piles to each other, and when hammering the upper pile towards the lower pile, the sealing sleeve disposed in the annular space has its end within the positioner sleeve's decreasing inner diameter zone deforming plastically, thereby sealing against the heat transfer pipe's external surface.

It is by means of positioner and sealing sleeves that a tight and durable joint can be established between the heat transfer pipes of two piles.

According to one embodiment of the invention, the positioner sleeve is adapted to fix the position of the heat transfer pipe in the heat transfer pipe's radial direction. The positioner sleeve is thereby capable of keeping the heat transfer pipe stationary during a pile casting process.

According to one embodiment of the invention, inside the heat transfer pipe, at the pile's splicing end, is disposed a support sleeve, which is adapted to prevent the heat transfer pipe from collapsing as a result of the sealing sleeve being deformed as piles are being connected to each other. The support sleeve ensures the formation of a secure joint and enables a thinner wall thickness for the heat transfer pipe. However, the joint could also be constructed without a support sleeve.

According to one embodiment of the invention, the positioner sleeve comprises, at the end which is further away from the pile's splicing end, an attachment zone for securing the support sleeve immovably inside the heat transfer pipe by applying to the attachment zone a force for deforming the same plastically in such a way that the attachment zone presses the heat transfer pipe against the support sleeve. It is by means of the attachment zone that the immovability of a support sleeve can be ensured as piles are being connected to each other.

According to one embodiment of the invention, the positioner sleeve is made of a metal or metal alloy. This enables the attachment of a positioner sleeve to a pile's end plate or end enclosure by welding, a threaded joint, or a press joint. The positioner sleeve could nevertheless be also made from some other material.

According to one embodiment of the invention, the positioner sleeve is attached to an end plate present at the pile's splicing end. This ensures a precise placement of the positioner sleeve during the fabrication of a pile.

According to one embodiment of the invention, the end plate forms part of an end enclosure surrounding the pile's splicing end.

According to one embodiment of the invention, the heat transfer pipe is dimensioned in such a way that between the ends of the interconnectible piles' heat transfer pipes can be disposed a sealing element. The sealing element is an annular component

made of an elastic material, which compresses as piles are being connected to each other and creates a tight joint between the piles' ends. The sealing element functions as a backup feature for the sealing provided by the sealing sleeve.

According to one embodiment of the invention, the annular space is provided with a sealing sleeve.

According to one embodiment of the invention, the pile is adapted to engage with another pile by means of at least one locking sleeve–dowel pair, whereby the pile's splicing end is provided with at least one dowel or locking sleeve, which is adapted to function with a locking sleeve or a dowel disposed at the opposite pile's splicing end for securing the piles to each other, and the dowel and the locking sleeve are dimensioned in such a way that, in the process of joining the piles to each other, the dowel and the locking sleeve come into mutual contact before the sealing sleeve, disposed in said annular space, comes into contact with the opposite pile's respective annular space. Since the dowel and the locking sleeve are adapted to withstand even major forces, it is by bringing those into mutual contact and by restricting a lateral movement between the piles that damage to the sealing sleeve and the heat transfer pipe's end is prevented as piles are being connected to each other.

The pile assembly of the invention comprises a reinforced concrete pile as defined above disposed as a lower pile in such a way that the pile's top end is a splicing end, and a reinforced concrete pile as defined above disposed as an upper pile in such a way that the pile's bottom end is a splicing end, and a sealing sleeve disposed in the lower pile's and the upper pile's annular spaces so as to seal a joint between the lower pile's heat transfer pipe and the upper pile's heat transfer pipe.

According to one embodiment of the invention, the sealing sleeve is made entirely from one or more metals or metal alloys. The sealing sleeve can be made completely from a single material. Optionally, the sealing sleeve may comprise two or more materials. The sealing sleeve may include for example a body portion, which essentially retains its shape as piles are being connected to each other, and plastically deformable sealing zones provided at the ends of a sealing sleeve.

According to one embodiment of the invention, the sealing sleeve is at least partially made from copper or a copper-containing metal alloy. The sealing sleeve can be made entirely from copper or a copper-containing metal alloy. Optionally, the sealing sleeve may include a body portion of some other material and sealing zones of copper or a copper-containing metal alloy provided at the ends of a sealing sleeve.

According to one embodiment of the invention, between the ends of the lower pile's and the upper pile's heat transfer pipes is disposed a sealing element. The sealing element is an object made of a flexible material, which compresses as piles are being connected to each other and provides a tight joint between the ends of the piles. The sealing element functions as a safety backup for the sealing provided by the sealing sleeve. The joint could also include two sealing elements. Hence, the end of each pile could be provided with a sealing element in such a way that, in the process of joining piles together, the sealing elements press against each other.

According to a second aspect of the present invention, there is provided, a method of joining to each other the heat transfer pipes of a reinforced concrete pile as defined above , the method including the steps of

- disposing one of the piles in the ground as a lower pile in such a way that the pile's top end is a splicing end,
- disposing, in the annular space of one of the piles, a sealing sleeve made of a plastically deformable material in such a way that the sealing sleeve extends outward from the discussed pile's end,
- aligning the piles in such a way that the sealing sleeve is essentially concentric with a respective annular space of the other pile,
- lowering the-yet-to-be installed pile in such a way that the sealing sleeve penetrates into the annular space of the other of the piles,
- striking the upper pile in such a way that the piles' opposite ends come into mutual contact and the sealing sleeve deforms plastically in the annular spaces, producing a tight joint between the piles' heat transfer pipes.

According to one embodiment of the invention, prior to the lowering of a yet-to-be installed pile for installing a sealing sleeve, the end of at least the other pile's heat

transfer pipe is fitted with a sealing element. The sealing element can be fitted as early as during pile fabrication of, alternatively, during pile driving.

An embodiment of the method of the invention for the fabrication of a reinforced concrete pile as defined above includes the steps of

- providing at least one heat transfer pipe,
- disposing at least one end of said heat transfer pipe inside a positioner sleeve,
- casting concrete around said at least one heat transfer pipe in such a way that the positioner sleeve is left at least partially embedded in the cast concrete.

According to one embodiment of the invention, the method further comprises a step of disposing, inside the end of a heat transfer pipe, a support sleeve. The support sleeve can be disposed inside the end of a heat transfer pipe before or after the casting of concrete.

Description of the drawings

Embodiments of the invention will be described hereinafter in more detail with reference to the accompanying drawings, in which

Fig. 1 shows, in a simplified view, two interconnected reinforced concrete piles in cross-section,

Fig. 2 shows components of two interconnected reinforced concrete piles without actual concrete casting,

Fig. 3 shows the assembly of Fig. 2 in an overhead view,

Fig. 4 shows a cross-section of Fig. 3 along line A–A,

Fig. 5 shows, in an enlarged view, detail B of Fig. 4,

Fig. 6 shows a detail similar to Fig. 5 in another embodiment of the invention,