

Method and device for extracting a pile element from a ground

The invention relates to a method for extracting a pile element from a ground according to claim 1, and a device for extracting a pile element from a ground according to claim 8.

When producing, for instance, drill holes, diaphragm walls or excavation pits in a ground that was opened up for construction measures before, it is necessary to remove old elements such as in the ground inserted beams, piles or the like, i.e. generally pile elements, from the ground before using the ground again. These elements could be for example foundation elements of a previously torn down building or parts of a scaffolding structure. These elements could in particular be located several metres under the ground, which makes it difficult to determine their position from the surface.

Such pile element is usually removed by making a borehole using an appropriate tool, whereby a plurality of extraction drillings might be necessary in order to determine the exact position of the pile element in the ground, respectively to reach the pile element with the extraction tool.

Another known variant for extracting a pile element is to remove soil material over a planar area, e.g. for excavating a foundation, whereby the at least one pile element is laid open. However, this is perceived to be disadvantageous, as the tools for digging the ground could be damaged when getting into contact with the pile element. It is moreover necessary to discontinue the foundation work in order to remove the pile element, which can result in a delay in the already commenced construction project.

The **o b j e c t** of the invention is to specify a method as well as an arrangement for extracting a buried pile element from the ground, by means of which the pile element can be reliably removed.

According to the invention, this object is solved on the one hand by a method comprising the features of claim 1, and on the other hand by an arrangement comprising the features of claim 8.

Advantageous embodiments are described in the dependent claims, the description and the figures.

The method according to the invention for extracting a pile element from a ground is characterized in that a position and/or location of the pile element in the ground is determined by means of a detection unit, a first bore with a first drilling tool is made until reaching an upper end of the pile element depending on the determined position and/or location, whereby the first bore is executed as cased bore with an outer guide tube; when extracting the first drilling tool the guide tube remains in the ground, a second drilling tool with a hollow drill shank is brought to the pile element through the guide tube, the pile element is at least partially overdrilled by the second drilling tool, and the pile element is taken up in the drill shank and the overdrilled pile element is extracted from the ground.

A basic idea of the present invention is to determine the position and/or location of a pile element in a ground before extracting it, and, based on the determined position and/or location, to make a bore for extracting the pile element from the ground. The pile element can here particularly be covered by soil and preferably be located at a depth of several metres.

Another basic idea of the invention is to introduce a guide tube in the ground at least above the pile element for extracting a pile element from the ground, through which guide tube a tool is brought to the pile element, by means of which the pile element is extracted from the ground.

The invention solves a constant need to free a building ground from beamers, piles or the like that could be present partially in substantial depths of up to 10 or more metres already before foundation or drilling works are commenced.

The position of the pile element can principally describe a place or an area, in which the pile element can be found in the ground from a top view onto the ground. The location

of the pile element can particularly describe the orientation in which the pile element is positioned in the ground, but also a depth in which the pile element is located. The position or location of the pile element in the ground can be determined particularly relative to the provided sensor(s).

The pile element may be arranged in the ground both vertically as well as with an inclination, i.e. at an angle deviating from the perpendicular. The angle is preferably less than a right angle relative to the perpendicular. Particularly preferred is the angle of inclination of the pile element in the ground of up to 10° against a vertical orientation corresponds to an inclination of 0° .

The guide tube is preferably introduced in the ground together with the first drilling tool in an area above the pile element, whereby the guide tube is approximately aligned in parallel to the pile element. Preferably, ground material is removed and discharged out of the drill hole. It is particularly preferred that the guide tube is aligned in such a way that the pile element lies within the circumference of the guide tube when looking through the guide tube from a top view. The pile element may be located below the lower end of the guide tube, but may as well project into the guide tube. Preferably, at least one sensor is introduced in the ground in the area surrounding the pile element, and the at least one sensor sends the determined position data of the pile element to the detection unit.

In a preferred further development of the invention it is foreseen that for determining the position and/or location of the pile element in the ground at least one sounding drill hole is provided in the area surrounding the pile element, in which at least one sensor is introduced, which is connected to the detection unit and submits position and/or location data of the pile element to said detection unit, whereby the detection unit determines a position and/or location of the pile element based on the submitted data.

Principally, the determination of the position of the pile element in the ground can be enabled by means of at least one discretionary, yet suitable sensor in connection with the detection unit. The at least one sensor may, for instance, be designed to carry out a ferromagnetic measurement, such as in the form of a magnetic field measurement, and determine the position of the pile element on the basis of a share of ferromagnetic ma-

terial of the pile element, in particular an iron content of the pile element. It is also imaginable to determine the position of the pile element in the ground with an accordingly adjusted sensor by way of a seismic method or by way of radar technology, X-ray measurement or ultrasound. The sensor may be designed both as sender as well as receiver for the corresponding measurement method for determining the location and/or position of the pile element in the ground.

Along with the position of the pile element, a location of the pile element in the ground may also be determined by means of the detection unit with the at least one sensor provided. For this purpose, several measurements, particularly two measurements, preferably at least three measurements, can be performed with the sensor at different ground depths, whereby the location of the pile element can be determined by means of the majority of the measurements. It is advantageous if at least two sensors are provided, which can be introduced in the ground at different positions in the area surrounding the pile element. The sensors can be provided at the same depths in the ground relative to one another as well as at different depths for measurements and thus contribute to a particularly accurate determination of the position and/or location of the pile element in the ground.

It is especially preferred according to the invention that at least three sensors are introduced in the ground and that by means of triangulation or combination of the measuring signals of the introduced sensors, in particular by the detection unit, the location and/or the position of the pile element in the ground can be determined particularly accurately. It may be advantageous here that in each case several measurements are performed with the three sensors, whereby the at least three sensors will be provided at an at least similar ground depth relative to one another in the individual measurements, however, whereby they can together be brought to the pile element in the ground at different positions, i.e. at different depths. This can be good for a particularly accurate determination of both the position as well as the location of the pile element. Advantageously, the pile element can be surrounded by at least three of these sensors during a measurement, in particular uniformly, whereby at least three of the at least three sensors can be provided in one separate sounding drill hole each. Sensors can also be provided one above the other, whereby a distance from the pile element to the respective sensor can be deter-

mined, for instance. By difference calculation of the distances between the pile elements and the sensors each located vertically one above the other particularly can be determined an inclination of the pile element in a simple manner by means of one single collective measurement with the provided sensors. The same is principally also imaginable with one single sensor in each sounding hole, however, at least two measurements with at least one of the sensors at different depths might be necessary in order to enable the determination of an inclination.

According to a further development of the invention it is particularly advantageous that the at least three sensors are provided in order to determine the position as well as the location of at least two pile elements in the ground. The sensors may be arranged in the ground in such a manner that they build the corners of a geometrical shape in a top view from above onto the ground, for instance those of a triangle, rectangle or polygon, whereby the pile elements are preferably arranged within the geometrical shape, i.e. surrounded by the sensors. The signals of the sensors can be analysed by means of the detection unit in order to determine the location/position of the pile elements.

The sensors can be formed to measure the at least two pile elements which are arranged in the ground and are at least within the area of the geometrical shape, one after the other or contemporaneously. The position of the at least three sensors relative to one another can remain unchanged for determining in each one of the position data point, i.e. the position of a pile element section of each of the plurality of pile elements in the ground at a specific depth. The sensors may be displaced in height, i.e. approximately vertically, along the pile elements, whereby the sensors can each measure one position data point of all pile elements within the area of the geometrical shape at the respective height or respectively depth. Preferably, the sensors thereby remain horizontally aligned relative to one another.

An appropriate further development of the present invention exists in that the pile element is extracted from the ground through the guide tube in the drill shank together with the second drilling tool. The pile element can be taken up in the hollow drill shank of the second drilling tool at least partially. At this, soil material surrounding the pile element can be at least partially included in the cavity of the drill shank as well. In such a manner, a form-fit filling of the hollow drill shank with the pile element and the included soil

can be reached, which may enable a particularly reliable adhesion of the pile element in the drill shank.

A particularly efficient further development of the present invention provides that the second drilling tool is pulled out from the ground with the pile element by twisting, whereby the emerging hole in the ground is filled with soil material at least to some extent. A pulling out of the drilling tool from the ground by twisting may particularly take place in a direction of rotation opposite to the direction of rotation of the drilling. In this manner, the soil material that was transported upwards when overdrilling the pile element can be supplied to the drill hole emerging during the extraction. In such a manner, a collapsing of the drill hole emerging when the pile element is extracted can be prevented, for instance.

According to a further development of the invention, it is advantageous that the second drilling tool is pulled out from the ground with the pile element without involving a rotation. Such rotation-free pulling out of the drilling tool might be provided by a crane, for example, to which the drilling tool can be affixed.

The device for extracting a pile element from a ground according to the invention is characterized by providing a drilling rig at which a mast is arranged, a guide tube that is disposed to be rotatably drivable at the mast and that is insertable in the ground for forming a output opening for the pile element, a first drilling tool that is arranged to remove soil material at least in the guide tube above the pile element, a second drilling tool comprising a hollow drill shank that is formed to at least partially receive the pile element, whereby the second drilling tool can be brought to the pile element through the guide tube approximately coaxially, and at least one detection unit, which is designed to determine a position and/or location of the pile element in the ground.

An expedient further development of the device according to the invention foresees that the first drilling tool and/or the second drilling tool comprises a drill flight, whereby at least the second drilling tool is formed to loosen soil material surrounding the pile element before extracting said pile element. The first drilling tool and the second drilling tool can be executed in any shape, which enables the drilling in a guide tube, or the extraction of a pile element from the ground through a guide tube, respectively. For a par-

ticularly energy-efficient extraction or extraction by rotation, respectively, of the pile element out of the ground, it might be expedient to loosen the soil surrounding the pile element before extraction by means of at least the second drilling tool. A drill flight can be particularly suitable for this purpose. In this way, a static friction, for instance, between the pile element and the surrounding ground can be reduced.

According to a further development of the device according to the invention, it is preferred that an extraction arrangement is provided, which is designed in a manner to extract the pile element from the ground together with the second drilling tool. In particular, after reducing the static friction of the soil surrounding the pile element it is possible to extract said pile element from the ground with particularly small effort.

According to a further development of the invention, it is particularly preferred that the extraction device is designed to pull out the second drilling tool with the pile element from the ground without involving a rotation. For this purpose, the drilling tool may be affixed to a crane or any other lifting device and be pulled out by means of such device.

According to a further development of the invention, it is particularly expedient that the extraction arrangement is designed to pull out the second drilling tool with the pile element from the ground by twisting, particularly in a direction of rotation opposite to the direction of rotation of the drilling. A possible extraction arrangement is, for instance, a rotary actuator that is preferably arranged in a manner to introduce the first and/or the second drilling tools in the ground, and pulling the second drilling tool together with the pile element out from the ground by twisting.

According to a further development of the invention, it is foreseen that the detection unit comprises at least one sensor, which is arranged in a manner to measure the position data of the pile element and to transfer the data to the detection unit. The sensor can particularly be designed in a manner to recognize the pile element based on a sensor-specific material portion and to send the measured data to the detection unit, which recognizes the position and/or the location of the pile element based on these data.

The sensor measurement can particularly be a ferromagnetic measurement, which recognizes a ferromagnetic material portion, particularly an iron content of the pile element. For this purpose in particular a magnetic field measurement can be performed. The

sensor can also be designed as radar or sensor for receiving and/or sending seismic waves, X-rays or ultrasound, which can be advantageous for determining a position as well as a location of the pile element in the ground.

The invention is described in more detail hereunder, referring to the attached schematic drawing. In the drawing the following is shown:

Fig. 1 is a preferred embodiment of the method for extracting a pile element from a ground according to the invention.

Fig. 1 illustrates a preferred embodiment of the method according to the invention by means of a sequence of possible individual steps (steps 1 to 9). Before extracting a pile element 10 from the ground, first its position and/or location in the ground is determined. The pile element 10 may be covered by soil and its upper end might be located particularly at a depth of up to 10 m or more. In order to determine the position as well as the location of the pile element 10 in the ground, at least one sensor 22 can be introduced in the ground. Particularly preferred is that at least three sensors 22 are introduced in the ground (step 1) whereby the pile element to be extracted may be surrounded by the at least three sensors 22 in a top view. This is schematically shown in the drawing regarding step 1 above the ground in the form of a circle, on which three points spanning a triangle are apparent. The points of the triangle can thereby represent the positions of the sensors 22 in the ground, whereby the area within the triangle preferably represents the area, within which the pile element 10 is arranged in the ground.

The at least one sensor 22 can be introduced in the ground by means of a corresponding device, for instance a drilling rig 23. This device, i.e. the device 30 for introducing the first and the second drilling tools 21, 31, may have smaller dimensions. At least one drill hole can be provided around the pile element for the at least one sensor 22 by means of the drilling rig 23, which drill hole can particularly have a small diameter of only a few centimetres. In this at least one small drill hole the at least one sensor 22 can be introduced.

It is also imaginable to provide the at least one sensor 22 directly in a drilling element for a sounding drilling, which remains in the ground at least for the measurement, together with the at least one sensor 22. The at least one sensor 22 can also be caved in

the ground, whereby position data of the at least one pile element can be measured already during the caving in the ground by the at least one sensor 22. In order to collect the position and/or location data of the pile element a detection unit 24 may be provided, which is connected to the at least one sensor 22. The measured signals/data of the at least one sensor 22 can be transferred to the detection unit 24, which detects and respectively determines the position and/or location of the pile element by means of the determined signals/data.

Once the position as well as the location of the pile element 10 in the ground is determined, at first a lined drilling can be performed at that position and also with the corresponding inclination of the pile element 10. The lined drilling can be performed at least down to a depth of the upper part of the pile element 10 (step 2). With the lined drilling, it is possible to introduce at least one guide tube 20 in the ground, whereby soil material that exists within the introduced guide tube 20, can be removed from the boring tube by means of a first drilling tool 21. The guide tube 20 is preferably introduced in the ground contemporaneously and together with the first drilling tool 21 (step 2). The guide tube 20 can be guided up to an area at the upper end, i.e. the head end of the pile element 10, or even encase the pile element 10 to some part.

As soon as the guide tube 20 has reached the desired depth, the first drilling tool 21 can be pulled out of the guide tube 20, for instance by means of the drilling rig 30 (step 3). The adjustment of the guide tube 20 can be provided particularly by way of the position and/or location data of the pile element 10 measured by the sensors 22 in such a manner that the pile element is aligned coaxially relative to a longitudinal axis of the guide tube 20.

Particularly preferred is that the pile element 10 is located within the circumference of the guide tube 20 from a top view. In another step (step 4), a second drilling tool 31 can be inserted through the guide tube 20, which can overdrill the pile element 10 at least partially. For this purpose, the second drilling tool 31 may comprise a hollow drill shank, which can receive at least the pile element 10 as well as some soil surrounding the pile element. Once the pile element 10 is sufficiently overdrilled in order to provide a sufficient static friction between the hollow drill shank of the second drilling tool and the received pile element 10, the second drilling tool 31 can be pulled out of the ground to-

gether with the pile element 10, for example by means of a crane 40 (step 5). Instead of the crane 40, the second drilling element 31 can be extracted from the ground by means of a drilling rig as well, as for instance, it can be used for driving in the first drilling tool 21 with the guide tube 20 and the second drilling tool 31. For this purpose, the second drilling tool 31 can be driven in a direction opposite to the direction of rotation of the drilling and at the same time be pulled out from the ground. In this manner, the soil material that was transported upwards when overdrilling the pile element 10 now can be transported back into the drill hole 11 emerging during the pulling out of the pile element 10.

The drill hole 11 particularly defines the area, which was previously filled by the pile element 10 in the ground (step 5). Through the guide tube 20 that remains in the ground the drill hole 11 can be filled, for example with soil or other filling material (step 6). As illustrated in steps 7 and 8, the guide tube 20 can be pulled out from the ground afterwards. For this purpose, a tool for pulling the guide tube 20, for instance the first drilling tool 21, can be inserted into the guide tube 20, and the guide tube 20 can be extracted from the ground together with the tool.

Subsequently, the area of the drill hole that was previously supported by the guide tube 20 can be filled with soil material, by means of which a caving in of the soil around the drill hole can be prevented. Principally, the sequence of the procedural steps may vary, particularly after pulling out/extracting the pile element 10.

PATENT CLAIMS

1. Method for extracting a pile element from a ground, in which
 - a position and/or location of the pile element in the ground is determined by means of a detection unit,
 - a first bore with a first drilling tool is carried out to an upper end of the pile element, depending on the determined position and/or location, whereby the first bore is carried out as cased bore with an outer guide tube;
 - when extracting the first drilling tool the guide tube remains in the ground,
 - a second drilling tool with a hollow drill shank is brought to the pile element through the guide tube,
 - the pile element is at least partially overdrilled by the second drilling tool, and the pile element is taken up in the drill shank, and
 - the overdrilled pile element is extracted from the ground.

2. Device according to claim 1,
wherein
for determining the position and/or location of the pile element in the ground at least one sounding bore hole is provided in the area surrounding the pile element, in which at least one sensor is introduced, which is connected to the detection unit and submits position and/or location data of the pile element to said detection unit, whereby the detection unit determines a position and/or location of the pile element based on the submitted data.

3. Method according to the claim 1,
wherein
at least three sensors are introduced in the ground and that by means of triangulation or respectively combination of the measuring signals of the introduced sensors, in particular by the detection unit, the location and/or the position of the pile element in the ground can be determined particularly accurately.
4. Method according to the claim 1,
wherein
the pile element is extracted from the ground through the guide tube in the drill shank together with the second drilling tool.
5. Method according to the claim 1,
wherein
before pulling out of the pile element soil material surrounding the pile element is loosened, at least by means of the second drilling tool.
6. Method according to the claim 1,
wherein
the second drilling tool is pulled out from the ground with the pile element by twisting, whereby the emerging hole in the ground is filled with soil material at least to some extent.
7. Method according to the claim 1,
wherein
the second drilling tool is pulled out from the ground with the pile element without rotation.
8. Device for extracting a pile element from a ground, comprising
 - a support frame, at which a mast is arranged,
 - a guide tube, that is disposed to be rotatably drivable at the mast and that is insertable in the ground for producing an exit opening for the pile element,
 - a first drilling tool that is designed to remove soil material above the pile element at least in the guide tube,

- a second drilling tool, which comprises a hollow drill shank which is designed to receive the pile element at least partially, whereby the second drilling tool can be brought to the pile element approximately coaxially through the guide tube, and
 - at least one detection unit, which is designed to determine a position and/or location of the pile element in the ground.
9. Device according to claim 8,
wherein
the first drilling tool and/or the second drilling tool comprises a drill flight, whereby at least the second drilling tool is formed to loosen soil material surrounding the pile element before extracting said pile element.
10. Device according to the claim 8,
wherein
an extraction arrangement is provided, which is designed to extract the pile element from the ground together with the second drilling tool.
11. Device according to the claim 8,
wherein
the extraction arrangement is designed to pull out the second drilling tool together with the pile element from the ground without involving a rotation.
12. Device according to the claim 8,
wherein
the extraction arrangement is designed to pull out the second drilling tool together with the pile element from the ground by twisting, in particular in a direction of rotation opposite to the direction of rotation of the drilling.
13. Device according to the claim 8,
wherein
the detection unit comprises at least one sensor, which is designed to measure the position data of the pile element and transfer them to the detection unit.