Title: METHOD FOR SUPPORTING AN OBJECT, IN PARTICULAR AN EXISTING OBJECT

Abstract: The present invention relates to a method for supporting an object, in particular an existing object, in which a pile is sunk into the ground and is used to support the object. The method is characterized by the steps of providing displaceable material around or next to the pile before, during and/or after the operation of sinking the pile into the ground, moving an upper section of the pile sideways, so as to displace the displaceable material, and fixing the pile. It is preferable for the upper section of the pile to be moved sideways until a top end of the pile is positioned at least partially inside or beneath the object which is to be supported or beneath a position where the object to be supported will be placed. The invention also relates to a pile which is suitable for carrying out the above method.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Short title: Method for supporting an object, in particular an existing object

The present invention relates to a method for supporting an object, in particular an existing object, in which a pile is sunk into the ground and is used to support the object.

It is possible that an existing foundation or the like will at a given time no longer provide sufficient support to the structure located on the foundation, for example as a result of ageing. In such a situation, it may be desirable or even necessary to strengthen the existing object.

It is known to sink a pile into the ground next to the existing object, for example using a pile-driving device. After the pile has been sunk into the ground, a bearing structure which projects sideways is fitted to an upper section of the pile and extends sideways to below or inside the existing structure, thereby supporting the existing object.

One drawback of a solution of this nature is that the pile is subject to a relatively high bending load on account of the lateral bearing structure. To enable a bending load of this type to be absorbed successfully, it is necessary to use a pile which in relative terms is very strong and therefore also expensive.

Another drawback of the known structure is that the top end of the pile is located entirely next to the existing object. If the soil located outside the foundation sinks downwards, the top end of the pile may project above the ground. This is not generally desirable. In this case, in the event of sinking ground the presence of a pile will damage a patio, fence or the like positioned thereon. An additional drawback in this case is that less space is available for future building work at the location of the pile.
A further drawback of the known method is that the supporting structure comprising pile and lateral bearing structure is not (completely) stable, on account of the bending load. Consequently, it is possible that stability problems may occur next to the pile and the object supported by the pile in the event of excavation work or the like, for example for digging a cellar or sewer, and this may give rise to a risk of subsidence.

Yet a further drawback of the known method is that the structure bends considerably under standard loads, and consequently the structure often has to be made extremely heavy or alternatively the structure has to be placed under a prestress.

The object of the invention is to create an alternative method for supporting an object, in particular an existing object.

The object is achieved by a method in accordance with the preamble of claim 1 which is characterized by the method comprising the following steps:

- providing displaceable material around or next to the pile before, during and/or after the sinking of the pile into the ground,
- moving an upper section of the pile sideways whereby the displaceable material is being displaced, and
- fixing the pile.

The term displaceable material is to be understood as meaning a material which, during the sideways movement of the pile, can as it were move, in particular flow, around the pile and can fill up the space which is left on that side of the pile which faces away from the direction of movement. It is preferable for the displaceable material to be relatively thin/liquid when it is being introduced and to dry out and/or set over the course of time.

The displaceable material may, for example, be provided by mixing an added material with the ground. In the case of some types of ground, it is also possible to make the ground fluid.
and therefore displaceable by a mechanical action, in particular by vibration.

As a result of a quantity of displaceable material being provided at least at the location where the pile is ultimately to be positioned before, during or after the operation of sinking the pile into the ground, it is easy for the pile to be placed in a better position beneath the foundation or the like by moving its upper section sideways. As a result of the pile then being fixed in this position, preferably as a result of the displaceable material being allowed to dry and/or set, the pile will be held in its correct supporting position.

With the method according to the invention, it is possible for the upper section of the pile to be placed considerably closer to the object which is to be supported than in the known method. Consequently, it possible for the lateral bearing structure which is used to be of smaller and more lightweight design, since the pile will be subject to less bending load.

A further advantage is that the method according to the invention, given the more or less central loading or at least considerably reduced eccentric loading, does not require any prestress or at least only a slight prestress in the structure.

Moreover, the structure obtained in accordance with the method generally uses less material yet is considerably stronger, which greatly reduces the movements in the event of fluctuating loads.

An additional advantage of the method according to the invention is that a pile can be sunk into the ground using a relatively simple installation, meaning that the installation costs are relatively low.

A further additional advantage is that a pile which has been prefabricated and is therefore reliable is sunk into the ground and then remains in place in the ground.
Yet another additional advantage of the method according to the invention is that the support provided is relatively independent of the type of ground in which the method is used. Consequently, much less preparation, in particular soil analysis, is required for the sinking of a pile.

In addition to the other uses mentioned in the application, the method according to the invention also makes it possible, for example, for a pile which has shifted as it is sunk into the ground to be moved back into the original, intended position. In this method, therefore, after the pile has been sunk into the ground, it is determined whether the pile has been positioned correctly as intended in the ground. If not, it is then possible, by moving the upper section of the pile sideways, to shift the pile into the intended position, with the displaceable material provided for this purpose being displaced.

Furthermore, with the method according to the invention it is also advantageously possible to arrange a supporting pile beneath an existing building for a new object which is to be installed in the building. In a situation of this type, by way of example, a pile is driven obliquely under the existing building, and a quantity of displaceable material is provided next to or around the pile beforehand, at the same time or subsequently.

Then, at least the upper section of the pile is moved sideways, so as to displace the displaceable material, until the top end of the pile is located at least partially beneath or close to the position of the object which is subsequently to be put in place and supported.

The advantage of a method of this type is that the existing building can remain more intact, since it is no longer necessary for all the piles for a new foundation to be sunk through the floor of a building, on account of the fact that they can be placed beneath the building from outside. For the piles which are placed beneath the floor from the inside, it is merely
necessary to make a small opening in the floor. This means that it is not necessary to remove the entire floor. With a method of this type, it is also readily possible to form a partially new foundation.

The pile which is used in the method according to the invention may also be a sheet piling section. It is also possible for a number of piles or sheet piling sections or a combination thereof to be sunk into the ground using the method according to the invention, it being possible for them to be coupled to one another, before during or after the method has been carried out.

With a method of this type it is possible, for example, to leave more space free for a cellar which is to be positioned next to an existing building by positioning an earth-retaining wall composed of piles and/or sheet piling sections closer to or preferably at least partially beneath the existing building.

Preferably, the upper section of the pile is moved sideways until an upper end of the pile is located at least partially within or beneath the object which is to be supported or beneath a position where the object to be supported will be placed. With a method of this type, it is no longer necessary for a lateral bearing structure to be arranged on an upper section of the pile. This has the further advantage that the top of the pile no longer has to be largely dug clear in order for the lateral bearing structure to be fitted. In the known method, excavation to a depth of approximately 50 cm is required to fit a lateral bearing structure of this type. For the method according to the invention, excavation to a depth of just 2 - 10 cm may even be sufficient for the pile to be positioned at least partially beneath the object, or in some cases no excavation whatsoever is required.

On account of its end position, in which the top end of the pile is located at least partially beneath the object to be supported, the pile will be subject to little or no bending load. Consequently, the pile does not have to be as strong or
alternatively a higher load can be supported using the pile.

Moreover, the upper section of the pile, since it is located at least partially beneath the object, will project less far outside the foundation, and consequently will have a less disruptive effect in the event of the surrounding ground sinking. In this case, the damage caused by the projecting pile to any patio or fence located in the vicinity of the pile in the event of the surrounding ground sinking will be considerably reduced.

In its end position, it is preferable for the top end of the pile to be located completely beneath the existing object.

Alternatively, it is also possible for a vertical slot to be provided in the object, in which the upper section of the pile can be completely or partially positioned during its sideways movement. The pile can then be attached to the top or side of this vertical slot.

The displaceable material is advantageously grout which is preferably introduced while the pile is being sunk into the ground. Grout is generally sufficiently displaceable, just after it has been introduced, to allow the pile to move. The grout in this case sets over the course of time. The set grout successfully fixes the pile in its end position.

A further advantage of using grout is that the set grout makes a substantial contribution to the load-bearing capacity of the pile.

The method according to the invention advantageously uses a pile which, for example at its bottom end, has a widened section with a larger cross-sectional area than the pile. A widened section of this type can be used to clear the space next to or around the pile as it is being sunk into the ground for a quantity of displaceable material subsequently to be provided therein.
In this case, it is possible to use a support element which, while the pile is being sunk into the ground, reinforces the pile and the widened section(s), which support element extends over part of the length of the pile and increases in cross section in the direction of the bottom end of the pile. With a support element of this type, it is possible for the force which is exerted on the bottom end of the widened section while the pile is being sunk into the ground to be absorbed more successfully by the pile. This improved transmission of force means that the pile has less tendency to buckle while it is being sunk into the ground and consequently less pile-driving energy is lost.

In the longitudinal direction of the pile, the support element is advantageously composed of a number of segments which can be fitted in succession while the pile is being sunk into the ground. With an embodiment of this type, the support element can in each case be arranged beneath the object, and consequently the pile can be placed closer to the object in the ground. After all, if the support element which extends over part of the length of the pile has already been completely fitted before the pile is sunk into the ground, the pile will have to be positioned at a certain distance from the object, since the support element has to be positioned between the pile and the object. This problem can be avoided by using the support element divided into segments.

The invention also relates to a pile which is to be sunk into the ground and is particularly suitable for carrying out a method according to one or more of claims 1 - 25.

The invention will be explained in more detail below on the basis of three exemplary embodiments, in which reference is made to the appended drawing, wherein:

Fig. 1 shows a pile which has been sunk into the ground using the method of the invention,
Fig. 2 shows a first embodiment of a pile suitable in particular for a method according to the invention.

Fig. 3 shows a second embodiment of a pile suitable in particular for the method according to the invention, and

Fig. 4 shows a third embodiment of a pile suitable in particular for the method according to the invention.

Figure 1 shows a pile, denoted by reference numeral 1, which has been positioned using the method according to the invention. The pile 1 is supporting an existing wall base 2 of in this case an outer wall 3 or the like.

The pile 1 was first of all sunk in to the ground 4 in a known way, for example by means of a pile-driving device. The pile 1 is tubular but may also be an I-section or an H-section or any other suitable profiled section. The position of the pile 1 after it has been sunk into the ground is indicated by a dashed line and is denoted by 1'.

A quantity of displaceable material 5 has been introduced into or formed in the ground next to the pile 1' before, during or after the operation of sinking the pile 1' into the ground. The displaceable material 5 may, for example, be introduced into the ground after the ground located at those locations has been washed away, displaced or dug out. In this case, the displaceable material used may, for example, be a bentonite-water mixture or a bentonite-cement-water mixture.

It is also possible for the displaceable material 5 to be formed in the ground 4 by softening the ground 4 which is already present at that location, for example by injection of a liquid, such as water. In the case of some types of ground, it is also possible to make the soil fluid by vibrating it, so that this soil itself can function as a displaceable material.

The displaceable material 5 is provided at least at the location
where the pile 1 is ultimately desired to be, the top end of the pile 1 then being located beneath the wall base 2, in such a manner that it supports the wall base 2.

After the displaceable material 5 has been introduced into or formed in the ground 4, the pile 1 is moved in the direction indicated by arrow A as a result of the top end of the pile 1' being pushed towards the wall base 2. In this way, the pile 1 can be moved into the position 1 in which the top end of the pile 1 supports the wall base 2.

After the pile 1 has been moved, during which process the displaceable material is displaced, until it is in the position which is ultimately desired, the pile 1 is fixed in this position. This fixing operation can be performed by mechanically securing the pile 1, for example to the wall base 2. It is also possible for the pile 1 to be fixed by allowing the displaceable material 5 to dry out or set.

The bottom end of the pile 1 is advantageously located beneath the wall 3 immediately after it has been sunk into the ground. After the top end of the pile 1 has then been moved sideways to beneath the object, the pile 1 is then in an upright position. This means that the pile 1 is subject to minimal bending load from the wall base 2 supported thereon.

Figure 2 shows an embodiment of a pile 11 which is suitable in particular for the method according to the invention. The pile 11 is shown in the position just after it has been sunk into the ground. After it has been introduced, at least an upper section of the pile will be moved sideways into an end position. This end position is indicated in the drawing by a dashed line and the reference numeral 11'. In this end position of the pile 11', a top end of the pile 11' supports the wall base 12 of an outside wall 13 or the like.

A layer of displaceable material 15 is provided around the pile 11. This displaceable material 15 is preferably grout which has
been introduced while the pile was being sunk into the ground. Grout is a good material to use, in particular because grout is relatively fluid (immediately) after it has been introduced and therefore the top end of the pile 11 can easily be moved through the displaceable material towards the wall base 12. The grout then sets in such a manner that it successfully fixes the pile in its end position 11'. Moreover, the set grout makes a substantial contribution to the load-bearing capacity of the pile.

To position the layer of grout 15 around the pile, the pile 11 comprises a widened section in the form of a widened pile base 16 which clears a space around the pile 11 while the pile 11 is being sunk into the ground 14. While the pile is being sunk into the ground 14, this space is filled with grout, which is in this case discharged via the passage 17 which runs in the longitudinal direction of the pile 11 and opens out at the discharge openings 18. These discharge openings 18 open out just above the widened pile base 16 in the vicinity of the bottom end.

Alternatively, it is possible for the grout or another suitable displaceable material to be supplied by means of lines and/or hoses which run through or along the pile.

The advantage of a device and method shown Figure 2, in which a pile 11 with a widened pile base 16 is used, is that the displaceable material 15 can be supplied with a low pressure, since the space which it needs has already been cleared by means of the widened pile base 16. In general, the hydrostatic pressure of the column of displaceable material 15 in the pile 11 will be sufficient for the displaceable material 15 to be supplied.

Figure 3 shows a second embodiment of a pile 21, which is suitable in particular for carrying out the method according to the invention. This pile 21 too is sunk into the ground in order to support an existing object 22 or the like, which in this case
in turn supports a wall 23.

While the pile 21 is being introduced into the ground 24, a layer of displaceable material 25, in the form of a layer of grout or the like, is provided around the pile 21. In this case, an additional quantity of displaceable material 25a is positioned directly beneath the wall base 22.

To clear the space for the layer of displaceable material 25 to be introduced, a widened pile base 26, which displaces the ground 24 as the pile 21 is being introduced, is provided at the bottom end of the pile.

The widened pile base 26 is of asymmetrical design in the device shown in Figure 3, and is introduced into the ground in such a manner that that section of the pile base 26 which is at the greatest distance from the pile is located on that side of the pile 21 towards which the upper section of the pile 21 is pushed during the sideways movement of the method of the invention. One advantage of an asymmetric pile base 26 of this type is that less grout is required, in particular on that side of the pile which is remote from the object. This represents a considerable cost saving. Another advantage of an asymmetrical pile base is that the cross-sectional area is smaller, and consequently the pile is subject to less resistance as it is being sunk into the ground, for example by pile-driving.

As the pile with an asymmetric widened section, in particular an asymmetric pile base, is being driven or sunk into the ground in some other way, it may have a tendency to buckle at one or more locations. Therefore, while the pile 21 is being sunk into the ground, it is preferable for a force centre point of a force in the longitudinal direction which is transmitted, for example, to the pile 21 while it is being driven is preferably located outside the longitudinal centre axis of the pile and in the direction of the object.

With a method of this type, it is possible to reduce the
likelihood of buckling. In this case, it is possible to influence the likelihood of buckling, in such a manner that the pile tends to buckle in the direction facing away from the object. This is advantageous since there is less grout on this side, and therefore the pile will be better supported by the surrounding soil on this side.

In a preferred embodiment, the asymmetric widened section of a pile is designed in such a manner that the widened section is short and wide on one side of the pile and long and narrow on an opposite side of the pile, with the short and wide side of the pile being arranged towards and/or beneath the object while the pile is being sunk into the ground.

It is preferable for the short, wide part and the long, narrow part to be designed in such a way that the moments which are transmitted to the pile by these parts while the pile is being sunk into the ground are substantially equal. This will make it easier for the pile to be sunk into the ground straight, with little likelihood of buckling. Since in this case the moment arm of the long, narrow part is longer, the surface area of this part will be smaller. Consequently, in relative terms less displaceable material is used to fill the space which is cleared above this long, narrow part.

It is also possible to create an asymmetric, widened pile base, in which case no grout is provided on one side of the pile. Consequently, a different resistance would be generated on the two sides of the pile as the latter is being sunk into the ground, which can give rise to difficulties with regard to sinking the pile into the ground in a straight position.

Therefore, it is preferable for the widened asymmetric pile base to be designed in such a manner that at least a thin layer of displaceable material, in particular grout, can be arranged on all sides of the pile.

While the pile 21 is being sunk into the ground, displaceable
material 25 which fills the space which has been cleared is discharged through the passage 27 and the discharge openings 28.

In this embodiment of the pile 21, it is possible to provide a plurality of passages 27 running in the longitudinal direction of the pile and/or a plurality of discharge openings 28, located around the periphery and in the longitudinal direction, for discharging the displaceable material 25. As an alternative to the passages, it is also possible to provide one or more lines or hoses which run in the longitudinal direction of the pile 21 inside or along the pile 21 for supplying the displaceable material 25.

The upper section of the pile 21 can advantageously be pivoted with respect to the lower section, by means of a pivot 29. During the sideways movement of the upper section of the pile 21 towards the position 21' in which the wall base is at least partially supported by the top end of the pile, it is then only necessary for the top section of the pile 21 to be moved through the displaceable material, whereas the lower section can remain in a fixed position with respect to the ground 24.

After the pile has been moved into the end position 21', it will be fixed in this position. Preferably, the displaceable material 25 will dry out and/or set and thereby fix the pile in place. It is also possible for the pile to be mechanically fixed or for the displaceable material 25 to be replaced with a harder material or a material which does dry out or set sufficiently to fix the pile.

It is not inherently imperative for a layer of displaceable material 25 to be arranged beneath the pivot 29. Therefore as an alternative to the widened pile base 26, it is also possible to provide a widened section in the vicinity of the pivot 29 for clearing the space required for the sideways movement of the upper section of the pile 21.

While the pile 21 is being sunk into the ground 24, the pivot 29
is preferably fixed in the position in which the upper section and the lower section of the pile 21 are in line with one another. After the pile 21 has been sunk into the ground, the pivot 29 can be released, so that the upper section of the pile 21 can be pushed through the displaceable material 25 towards the wall base 22 while the lower section of the pile 21 can remain in its original position.

The pile 21 preferably comprises a cavity which, after the pile has been moved into its end position 21', can be filled with (cement) grout, concrete or the like, so that the upper section and the lower section of the pile 21' are fixed with respect to one another as a result of the (cement) grout, concrete or the like drying out and/or setting. If appropriate, a reinforcement may in this case be provided in the cavity. It is possible for the passage 27 to be used as the cavity for filling the pile, which passage has previously, during the sinking of the pile into the ground 24, been used to supply the displaceable material 25.

Figure 4 shows a third embodiment of a pile which is suitable for carrying out a method according to the invention. The pile is denoted by reference numeral 31. The pile 31 is used to support a new object to be put in place, in this case a machine or the like denoted by M, which object M is being installed in an existing building 32, 33. In the exemplary embodiment shown, the method according to the invention has the advantage that the pile can be moved into a position beneath the object which is to be put in place from the outside without having to (temporarily) damage part of the existing building.

The figure shows the pile 31 in its end position. To obtain the pile 31 in this position, the pile has first been sunk into the ground 34 while a suitable displaceable material 35, preferably grout, is arranged around the pile 31. Then, the top end of the pile 31 has been moved sideways, displacing the displaceable material 35. Then, the displaceable material 35 has preferably been set and/or dried, so that the pile 31 is fixed in its end
position.

At its bottom end, the pile 31 comprises an asymmetric widened pile base 36, and approximately halfway along its longitudinal direction also comprises an additional widened section 40, which in this case is likewise asymmetrical, the cross-sectional area of this additional widened section 40 being larger than the widened pile base 36 of the pile 31. The provision of widened sections of this type which increase in cross section in the direction of the top end of the pile 31, results in a layer of displaceable material 5 next to the pile 31 which increases in size towards the top end of the pile 31 in, in this case one, or more steps, being formed at least on that side of the pile which faces towards the object which is to be supported. This is advantageous since in particular the top end of the pile 31 has to be moved through the layer of displaceable material 35 during the sideways movement of the pile. Consequently, the quantity of displaceable material 35 which is required to carry out the method is limited still further, which is advantageous with regard to the costs entailed by carrying out the method.

At least one of the one or more widened sections can advantageously be removed, slid away or folded away. After the pile has been sunk into the ground and if appropriate the displaceable material has been introduced, the widened sections can then be removed, slid away or folded away, so that they do not form any obstacle during the sideways movement of at least the upper section of the pile.

The widened section can be removed in various ways. For example, it is even possible for the widened section to be removed by chemical means, by exploding it or by dissolving it in the ground water, in which case if appropriate a timer mechanism can be provided to start the process.

Alternatively, if appropriate it is possible for a suitable displaceable material to be introduced into the ground under a high pressure and/or at great speed, so that the displaceable
material is also provided at a certain distance from the pile shaft. If the displaceable material then penetrates far enough into the ground, it is possible for the widened section to move through this displaceable material, which has been moved outside the pile, during the sideways movement, without impeding the movement of the pile. A method of this nature has the advantage that a spray nozzle for introducing displaceable material does not have to project far from the pile and that the one or more widened sections do not have to be designed such that they can be removed, slid away or folded away.

The widened section of the pile 31 shown in Figure 4 is designed so that it can be folded away. The drawing indicates the folded-away widened section by means of a dashed line and the direction in which it is folded away by means of an arrow. In reality, in the end position the widened section will already be in its folded-away position, since this folding operation takes place before the sideways movement of at least a top end of the pile.

It is preferable for one or more discharge openings 38 for discharging the displaceable material 5 to be provided above each of the widened sections. In this case, this displaceable material 35 is supplied, for example, via one or more passages, lines or hoses which run in the longitudinal direction through and/or along the pile 31. Even if there are no additional widened sections, it is advantageous for a number of discharge openings for discharging the displaceable material 35 to be provided in the longitudinal direction of the pile. It is also advantageous to provide two or more openings on the periphery of the pile, in such a manner that displaceable material 35 is discharged in a plurality of directions at a certain height. The displaceable material 35 can be supplied to the passage 37 in the pile 11 using a device which is known for this purpose, for example a suitable pump.
CLAIMS

1. Method for supporting an object, in particular an existing object, in which a pile is sunk into the ground and is used to support the object, characterized in that the method comprises the following steps:
   - providing displaceable material around or next to the pile before, during and/or after the sinking of the pile into the ground,
   - moving an upper section of the pile sideways whereby the displaceable material is being displaced, and
   - fixing the pile.

2. Method according to claim 1, characterized in that the upper section of the pile is moved sideways until an upper end of the pile is located at least partially within or beneath the object which is to be supported or beneath a position where the object to be supported will be placed.

3. Method according to claim 1 or 2, characterized in that the object is an existing building.

4. Method according to one or more of claims 1 - 3, characterized in that the pile is fixed by allowing the displaceable material to dry and/or set.

5. Method according to one or more of claims 1 - 4, characterized in that the displaceable material is grout which is introduced preferably while the pile is being sunk into the ground.

6. Method according to one or more of claims 1 - 5, characterized in that the pile is sunk into the ground obliquely, so that a bottom end of the pile, after it has been introduced, is located beneath the object which is to be supported, so that the pile, after its top section has been moved sideways, is in a substantially vertical position.
7. Method according to one or more of claims 1 - 6, characterized in that more displaceable material is provided towards the surface of the ground.

8. Method according to one or more of claims 1 - 7, characterized in that an additional quantity of displaceable material is placed at least partially beneath the object which is to be supported or beneath the position of the object which is to be put in place, in such a manner that the upper section of the pile can easily be moved into its position which is to be fixed.

9. Method according to one or more of claims 1 - 8, characterized in that the pile, for example at its bottom end, is provided with a widened section which has a larger cross-sectional area than the pile.

10. Method according to one or more of claims 1 - 9, characterized in that the pile is provided, over its length, with two or more widened sections, the cross-sectional area of which increases towards the top end of the pile.

11. Method according to claim 9 or 10, characterized in that at least one of the one or more widened sections can be removed, slid away or folded away.

12. Method according to one or more of claims 9 - 11, characterized in that the widened section or widened sections is/are asymmetrical.

13. Method according to claim 12, characterized in that the widened section or widened sections is/are short and wide on one side of the pile and long and narrow on an opposite side of the pile, with the short and wide side of the pile being arranged so as to face and/or lie beneath the object when the pile is being sunk into the ground.

14. Method according to one or more of claims 9 - 13,
characterized in that a supporting element which, while the pile is being sunk into the ground, reinforces the pile and the widened section(s) is used, which support element extends over part of the length of the pile and has a cross section which increases in size in the direction of the bottom end of the pile.

15. Method according to claim 14, characterized in that the support element, in the longitudinal direction of the pile, is composed of a number of segments which can be fitted in succession as the pile is being sunk into the ground.

16. Method according to one or more of claims 1 - 15, characterized in that the operation of sinking the pile into the ground is carried out in such a manner that a force centre point of a force in the longitudinal direction which is transmitted to the pile as the pile is being sunk into the ground lies outside the longitudinal axis of the pile, in the direction of the object.

17. Method according to one or more of claims 12 - 16, characterized in that the pile is provided with at least one passage, line, hose or the like which runs in the longitudinal direction of the pile, opens out at one or more locations on the outer periphery of the pile and is suitable for discharging the displaceable material, in particular grout, at those locations.

18. Method according to one or more of claims 1 - 17, characterized in that the passage, line, hose or the like opens out at least in the vicinity of a bottom end of the pile.

19. Method according to one or more of claims 1 - 18, characterized in that the pile comprises a pivot, it being possible for the upper section of the pile to pivot with respect to a remaining section of the pile.

20. Method according to claim 19, characterized in that the pivot can be fixed, preferably at least when the upper and the
remaining section of the pile are in line with one another.

21. Method according to one or more of claims 1 - 20, characterized in that the pile is tubular, in particular a box section.

22. Method according to one or more of claims 1 - 21, characterized in that the pile is an H-section or an I-section.

23. Method according to one or more of claims 1 - 22, characterized in that the pile comprises a cavity which extends in the longitudinal direction of the pile over a considerable part thereof.

24. Method according to one or more of claims 1 - 23, characterized in that the pile is positioned substantially vertically after it has been sunk.

25. Method according to one or more of claims 1 - 24, characterized in that the pile is under substantially vertical load after it has been sunk.

26. Pile to be sunk into the ground, which is particularly suitable for carrying out a method according to one or more of claims 1 - 25.

27. Pile according to claim 26, characterized in that the pile is provided, for example at its bottom end, with a widened section which has a larger cross-sectional area than the pile.

28. Pile according to one or more of claims 26 or 27, characterized in that the pile is provided over its length with two or more widened sections, the cross-sectional area of which increases towards the top end of the pile.

29. Pile according to claim 28, characterized in that at least one of the one or more widened sections can be removed, slid away or folded away.
30. Pile according to one or more of claims 27 - 29, characterized in that the widened section or widened sections is/are asymmetrical.

31. Pile according to claim 30, characterized in that the widened section or widened sections is/are short and wide on one side of the pile and long and narrow on an opposite side, with the short and wide side of the pile being arranged facing and/or beneath the object as the pile is being sunk into the ground.

32. Pile according to one or more of claims 27 - 31, characterized in that the pile comprises a supporting element which, while the pile is being sunk into the ground, reinforces the pile and the widened section(s), which support element extends over part of the length of the pile and increases in cross section in the direction of the bottom end of the pile.

33. Pile according to claim 32, characterized in that the support element, in the longitudinal direction of the pile, is composed of a number of segments which can be fitted in succession as the pile is being sunk into the ground.

34. Pile according to one or more of claims 26 - 33, characterized in that the pile is provided with at least one passage, line, hose or the like which runs in the longitudinal direction of the pile, opens out at one or more locations on the outer periphery of the pile and is suitable for discharging the displaceable material, in particular grout, at those locations.

35. Pile according to claim 34, characterized in that the passage, line, hose or the like opens out at least in the vicinity of a bottom end of the pile.

36. Pile according to one or more of claims 26 - 35, characterized in that the pile comprises a pivot, it being possible for the upper section of the pile to pivot with respect to a remaining section of the pile.
37. Pile according to claim 36, characterized in that the pivot can be fixed, preferably at least when the upper section and the remaining section of the pile are in line with one another.

38. Pile according to one or more of claims 26 - 37, characterized in that the pile is tubular, in particular a box section.

39. Pile according to one or more of claims 26 - 38, characterized in that the pile is an H-section or an I-section.

40. Pile according to one or more of claims 26 - 39, characterized in that the pile comprises a cavity which extends in the longitudinal direction of the pile over a considerable part thereof.

41. Pile according to one or more of claims 26 - 40, characterized in that the pile is made from metal.

42. Pile according to one or more of claims 26 - 40, characterized in that the pile is made from steel.

43. Pile according to one or more of claims 26 - 40, characterized in that the pile is made from reinforced concrete.

44. Pile according to one or more of claims 26 - 40, characterized in that the pile is made from plastic.

45. Pile according to one or more of claims 26 - 44, characterized in that the pile is a sheet piling section.

46. Pile according to one or more of claims 26 - 45, characterized in that the pile is composed of two or more separate piles and/or sheet piling sections.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E02D27/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
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<td>A</td>
<td>DE 27 10 456 A (BRECHTEL JOHANNES) 14 September 1978 (1978-09-14) claims 1,6; figure 1</td>
<td>1,26</td>
</tr>
</tbody>
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Further documents are listed in the continuation of box C.

X Patent family members are listed in annex.

* Special categories of cited documents:
  *"A"* document defining the general state of the art which is not considered to be of particular relevance
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  *"O"* document referring to an oral disclosure, use, exhibition or other means
  *"P"* document published prior to the international filing date but later than the priority date claimed

  *"P"* document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search: 23 February 2004

Date of mailing of the international search report: 27/02/2004

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<th>Publication date</th>
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<td>DE 2710456 A</td>
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<td>DE 2710456 A1</td>
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