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(54) **Method for producing a foundation pile in the ground**

Verfahren zur Erzeugung eines Gründungspfahls in den Untergrund

Méthode de formation d'un pieu de fondation dans le sol

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Description

[0001] The invention relates to the production of a foundation pile in the ground. In a technique of this nature, the first step is to form a hole in the ground by means of a pipe which is provided with an external screw thread and which is then filled with a settable material, such as a mortar. After this material has set and the pipe has been removed, the pile is ready for use.

[0002] The advantage of this technique is that no vibrations are generated when the pile is put in place. This technique is preferred to pile-driving in particular in a sensitive environment, for example in old town centres, in the vicinity of buildings containing sensitive equipment and the like.

[0003] Furthermore, it is known from NL-A-9200855 to use both mortar and a prefabricated pile element. In this case, the pile element is firstly placed in the pipe which has been positioned in the ground. Then, the space which remains between the pile element and the internal wall of the pipe has to be filled with grout. Then, the pipe is pulled upwards, in order to form a hole into which the grout has to flow out. Meanwhile, the pile element remains in the same position, specifically on the base component which remains behind in the bottom of the hole and initially closes off the pipe.

[0004] There are various drawbacks associated with this known method. Firstly, placing grout or concrete mortar in the somewhat limited space between pile element and pipe has been found to cause problems. This space is so limited that it is impossible to ensure that it is filled completely with the relatively pasty grout without taking additional measures.

[0005] A further drawback is that when the pipe is pulled upwards, the grout flowing out into the hole is not pressed against the wall of the hole to a sufficient extent, and there is a considerable risk of groundwater-filled cavities in the grout. However, a certain pressure is required with a view to obtaining the desired load-bearing capacity for the pile.

[0006] However, when the pipe is pulled upwards, an upwardly directed force is exerted on the grout, leading to the grout initially moving upwards with the pipe. This in fact counteracts the desired effect of pressing the grout against the wall of the hole, and cavities are created in the grout.

[0007] This has an adverse effect on the positive skin friction with respect to the load-bearing layer of soil. Also, the grout does not bear correctly against the pile element. The cavities in the grout means that the skin friction forces and the point force cannot be utilized to their maximum extent, because the set body of grout is ruptured earlier under load due to crack formation than would be the case if there were no cavities and the grout were correctly joined to the pile element.

[0008] In the said known method, it is attempted to overcome this problem by exerting a high pressure of 8 bar on the grout while the pipe is being pulled upwards,

but owing to the narrow space between the pile element and the pipe, together with the arching action of the grout, it has been found that this high pressure has little effect, since the pressure in the space decreases quickly in the downwards direction. In addition, the pipe has to be rotated in such a manner that the screw thread can exert an additional pressure on the grout.

[0009] A procedure of this nature is complicated. The high pressure to which the grout has to be exposed requires the use of additional equipment. Moreover, it is necessary to take measures to prevent the grout from disappearing at other locations, for example in the weak layers which are able to bear less load.

[0010] Therefore, the object of the invention is to provide a different approach, in which it is also possible to use a screw-in hollow pipe in combination with a pile element and settable material. According to the invention, this is achieved by means of a method for producing a foundation pile which can be subjected to compressive and/or tensile loads in the ground, comprising the consecutive steps of:

- screwing into the ground a pipe which is closed off at the bottom by a base part and has a screw thread on the circumference,
- introducing a quantity of mortar into the pipe,
- pulling the pipe upwards, leaving the base part behind, in such a manner that the mortar collects in the hole formed when the pipe is pulled upwards,
- then lowering a prefabricated pile element, the transverse dimensions of which are smaller than the corresponding internal dimensions of the pipe, into the mortar which has collected in the hole, and down as far as the base part,
- removing the pipe.

[0011] The advantage of the method according to the invention is that the mortar can be introduced into the pipe without problems, since the mortar is introduced before the pile element is placed in the pipe. Consequently, a quantity of mortar can collect in the bottom of the pipe without inclusions being formed in this mortar. Moreover, the mortar can flow in freely when the pipe is pulled upwards and can completely fill the hole formed in this way.

[0012] When the pipe is pulled upwards, no frictional forces which could impair the flow and therefore inclusion-free filling of the hole are generated. Consequently, the mortar bears correctly against the wall of the said hole, this being a necessary precondition if the intended point resistance and positive skin friction are to be obtained in the finished foundation pile.

[0013] When the pile element then penetrates into the mortar, these beneficial effects are only intensified. The pile element drives the mortar downwards and sideways, thus further improving the way in which it bears against the wall of the hole, and also ensuring that it bears correctly against the pile element.

[0014] Preferably, in the method according to the invention, the prefabricated pile element is positioned in the pipe in such a manner that the bottom end of the pile is situated at the level of the mortar level.

[0015] The bottom surface of the pile element is always situated directly above the mortar level. The advantage of this is that the mortar can move freely when flowing out into the hole, without any bridging of the mortar. This is because the cross section of the pipe is large enough to prevent this phenomenon.

[0016] In addition, the pipe may be filled with water above the mortar level, thus further helping the mortar to flow out.

[0017] The method according to the invention may comprise the steps of lowering the pile element as the mortar level falls while the pipe is being pulled upwards, and of forcing the pile element into the mortar after the mortar has collected in the hole formed when the pipe is pulled upwards.

[0018] To maintain the desired pressure in the mortar, the method according to the invention may comprise the step of supplying additional water above the mortar level while the mortar level is falling.

[0019] Finally, the method may comprise the step of rotating the pipe in such a manner that the soil which has collected in the screw thread is pressed downwards when the pipe is moved upwards after the pile has been forced into the mortar.

[0020] The invention will now be explained in more detail with reference to the method steps shown in the figures.

[0021] As shown in Figure 1, an auger, which is denoted overall by 3 and comprises a hollow pipe 4 with a screw thread 5 on its outer side, is screwed into the ground 1, in the space 2. On the underside, the hollow pipe is closed off by the base component 6.

[0022] After auger 3 has reached the desired depth, the hollow pipe 4 is filled with a quantity of mortar 7. Then, as illustrated in Figure 3, a prefabricated pile element 9 is placed in the hollow pipe 4, the bottom end of this pile element being held just at the level of the mortar level 8.

[0023] In the method step shown in Figure 4, the auger 3 is pulled upwards without being rotated, thus forming a hole 10, the internal diameter of which corresponds to the external diameter of the screw thread 5. This hole 10 is situated in the load-bearing layer of soil material 11, and may also extend into the less strong layers 12.

[0024] When the auger 3 is pulled upwards, the base component 6 remains behind at the bottom of the hole 10. The mortar 7 also collects in the hole 10 formed in this way. The pile element is allowed to fall with the mortar level 8, but without allowing the pile element 9 to penetrate into the mortar.

[0025] The desired pressure in the mortar 7 can be maintained by means of a column of water 13, which is situated above the mortar level 8. As a result, the pressure of the mortar 7 may be approximately equal to the

earth pressure.

[0026] After the mortar 7 has flowed out into the hole 10 formed in this way, the pile element 9 can be moved downwards, in such a manner that it penetrates into the mortar 7. In the process, some of the mortar rises into the auger 3: cf. the mortar 14. The prefabricated element 9 ultimately reaches the base component 6.

[0027] Then, the auger 3 can be removed. To do this, the auger 3 is pulled upwards and is rotated in such a manner that the soil which has collected inside the screw thread 5 is pressed downwards above the mortar 7. This quantity of soil is denoted in Figure 6 by reference numeral 15.

[0028] As shown in Figure 7, all the space around the pile element 9 is thus filled with replaced earth. The finished foundation pile as illustrated in Figure 7 therefore comprises, extending from the base component 6, a casing 16 which consists of set mortar and is pressed firmly against the load-bearing layer of soil material 11, the prefabricated pile element 9, the bottom of the hole 10 and the replaced soil 15 which has been pressed on to it.

Claims

1. Method for producing a foundation pile which can be subjected to compressive and/or tensile loads in the ground, comprising the consecutive steps of:
 - screwing into the ground a pipe (4) which is closed off at the bottom by a base part (6) and has a screw thread (5) on the circumference,
 - introducing a quantity of mortar (7) into the pipe (4),
 - pulling the pipe (4) upwards, leaving the base part (6) behind, in such a manner that the mortar (7) collects in the hole (10) formed when the pipe is pulled upwards,
 - then lowering a prefabricated pile element (9), the transverse dimensions of which are smaller than the corresponding internal dimensions of the pipe (4), into the mortar (7) which has collected in the hole (10), and down as far as the base part (6),
 - removing the pipe.
2. Method according to Claim 1, comprising the step of positioning the prefabricated pile element (9) in the pipe (4) in such a manner that the bottom end of the pile (9) is situated level with the mortar level (8).
3. Method according to Claim 2, comprising the step of filling the pipe (4) with water (13) above the mortar level (8).
4. Method according to Claim 2 or 3, comprising the

step of lowering the pile (9) so as to match the fall in the mortar level (8) while the pipe is being pulled upwards.

5. Method according to Claim 3 or 4, comprising the step of supplying additional water (13) above the mortar level (8) while the mortar level (8) is falling. 5
6. Method according to one of the preceding claims, comprising the step of forcing the pile (9) into the mortar (7) after the mortar (7) has collected in the hole (10) formed when the pipe (4) is pulled upwards. 10
7. Method according to one of the preceding claims, comprising the step of rotating the pipe (4) in such a manner that the soil (15) which has collected in the screw thread (5) is pressed downwards when the pipe (4) is moved upwards after the pile element (9) has been forced into the mortar (7). 15 20

Patentansprüche

1. Verfahren zur Herstellung bzw. Erzeugung eines Grundpfahls bzw. Gründungspfahls, der Kompressions- und/oder Zuglasten unterzogen werden kann, im Untergrund, mit den aufeinanderfolgenden Schritten: 25
 - Einschrauben eines Rohrs (4), welches am Boden durch ein Basisteil (6) geschlossen ist und ein Schraubgewinde (5) am Umfang aufweist, in den Untergrund, 30
 - Einbringen einer Menge an Mörtel (7) in das Rohr (4), 35
 - Ziehen des Rohrs (4) nach oben, wobei das Basisteil (6) zurückgelassen wird, in einer solchen Weise, dass der Mörtel (7) sich in dem Loch (10) ansammelt, das ausgebildet wird, wenn das Rohr nach oben gezogen wird, 40
 - Absenken eines vorgefertigten Pfahlelements (9), dessen Querabmessungen kleiner sind als die entsprechenden Innenabmessungen des Rohrs (4), in den Mörtel (7), welcher sich in dem Loch (10) angesammelt hat, und nach unten bis zum Basisteil (6), 45
 - Entfernen des Rohrs.
2. Verfahren nach Anspruch 1, welches den Schritt der Positionierung des vorgefertigten Pfahlelements (9) im Rohr (4) in einer solchen Weise aufweist, dass das untere Ende des Pfahls (9) auf der gleichen Höhe angeordnet ist wie die Mörtelhöhe (8). 50
3. Verfahren nach Anspruch 2, welches den Schritt des Füllens des Rohrs (4) mit Wasser (13) oberhalb 55

der Mörtelhöhe (8) aufweist.

4. Verfahren nach Anspruch 2 oder 3, welches den Schritt des Absenkens des Pfahls (9) aufweist, so dass ein Ausgleich des Abfallens der Mörtelhöhe (8) erreicht wird, während das Rohr nach oben gezogen wird.
5. Verfahren nach Anspruch 3 oder 4, welches den Schritt des Zuführens zusätzlichen Wassers (13) oberhalb der Mörtelhöhe (8) aufweist, während die Mörtelhöhe (8) abfällt.
6. Verfahren nach einem der vorhergehenden Ansprüche, welches den Schritt des Einpressens des Pfahls (9) in den Mörtel (7) aufweist, nachdem der Mörtel (7) sich in dem Loch (10) angesammelt hat, welches ausgebildet wird wenn das Rohr (4) nach oben gezogen wird.
7. Verfahren nach einem der vorhergehenden Ansprüche, welches den Schritt des Drehens des Rohrs (4) in einer solchen Weise umfasst, dass die Erde (15), welche sich in dem Schraubgewinde (5) angesammelt hat, nach unten gedrückt wird, wenn das Rohr (4) nach oben bewegt wird, nachdem das Pfahlelement (9) in den Mörtel (7) eingepresst worden ist.

Revendications

1. Procédé de fabrication d'un pieu de fondation qui peut être soumis à des charges de compression et/ou de traction dans le sol, comprenant les étapes consécutives consistant à :
 - visser dans le sol un tube (4) qui est obturé dans sa partie inférieure par une partie de base (6) et qui comporte un filetage (5) sur sa circonférence,
 - introduire une quantité de mortier (7) dans le tube (4),
 - tirer le tube (4) vers le haut, en laissant sur place la partie de base (6), de telle manière que le mortier (7) s'accumule dans le trou (10) formé lorsque le tube est tiré vers le haut,
 - puis abaisser un élément de pieu préfabriqué (9), dont les dimensions transversales sont inférieures aux dimensions intérieures correspondantes du tube (4), dans le mortier (7) qui s'est accumulé dans le trou (10), en descendant jusqu'à la partie de base (6),
 - retirer le tube.
2. Procédé selon la revendication 1, comprenant l'étape consistant à positionner l'élément de pieu préfabriqué (9) dans le tube (4) de telle manière que l'ex-

trémité inférieure du pieu (9) se trouve à niveau avec le niveau du mortier (8).

3. Procédé selon la revendication 2, comprenant l'étape consistant à remplir le tube (4) d'eau (13) au-dessus du niveau du mortier (8). 5
4. Procédé selon la revendication 2 ou 3, comprenant l'étape consistant à abaisser le pieu (9) de façon à s'adapter à la baisse du niveau du mortier (8) lorsque le tube est tiré vers le haut. 10
5. Procédé selon la revendication 3 ou 4, comprenant l'étape consistant à ajouter de l'eau supplémentaire (13) au-dessus du niveau du mortier (8) pendant que le niveau du mortier (8) descend. 15
6. Procédé selon l'une quelconque des revendications précédentes, comprenant l'étape consistant à pousser le pieu (9) dans le mortier (7) après que le mortier (7) s'est accumulé dans le trou (10) formé lorsque le tube (4) est tiré vers le haut. 20
7. Procédé selon l'une quelconque des revendications précédentes, comprenant l'étape consistant à faire tourner le tube (4) de telle manière que la terre (15) qui s'est accumulée dans le filetage (5) est pressée vers le bas lorsque le tube (4) est déplacé vers le haut après que l'élément de pieu (9) a été poussé dans le mortier (7). 25
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fig-1

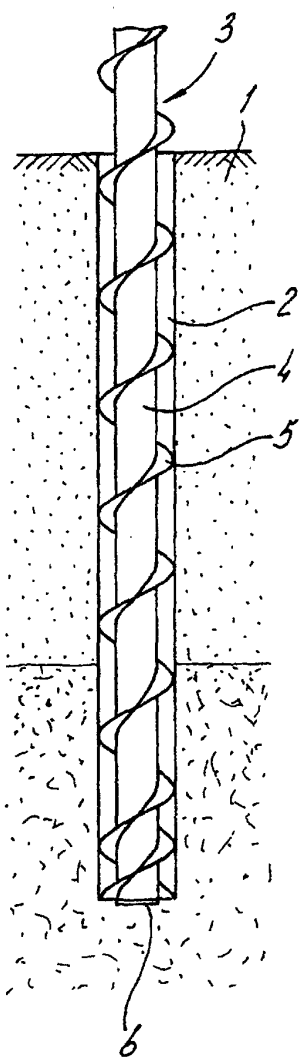


fig-2

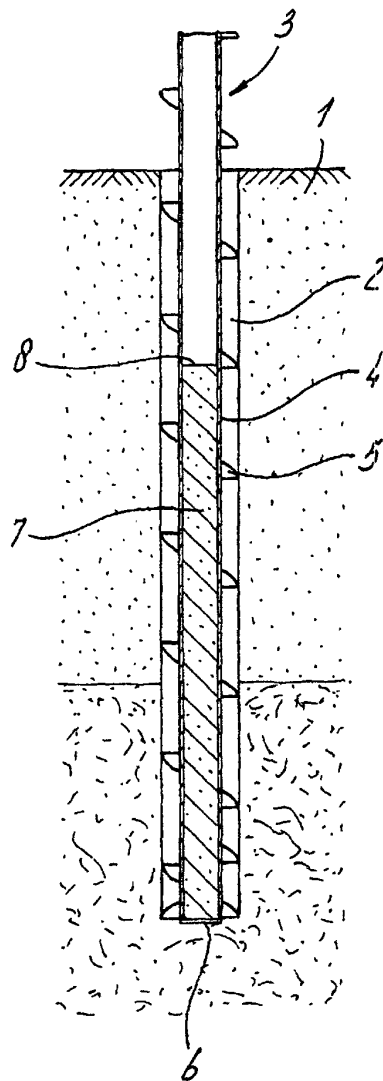


fig-3

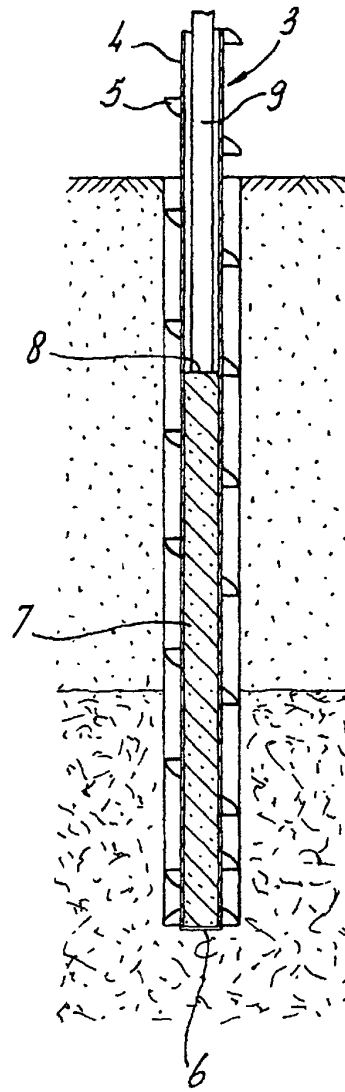


fig-4

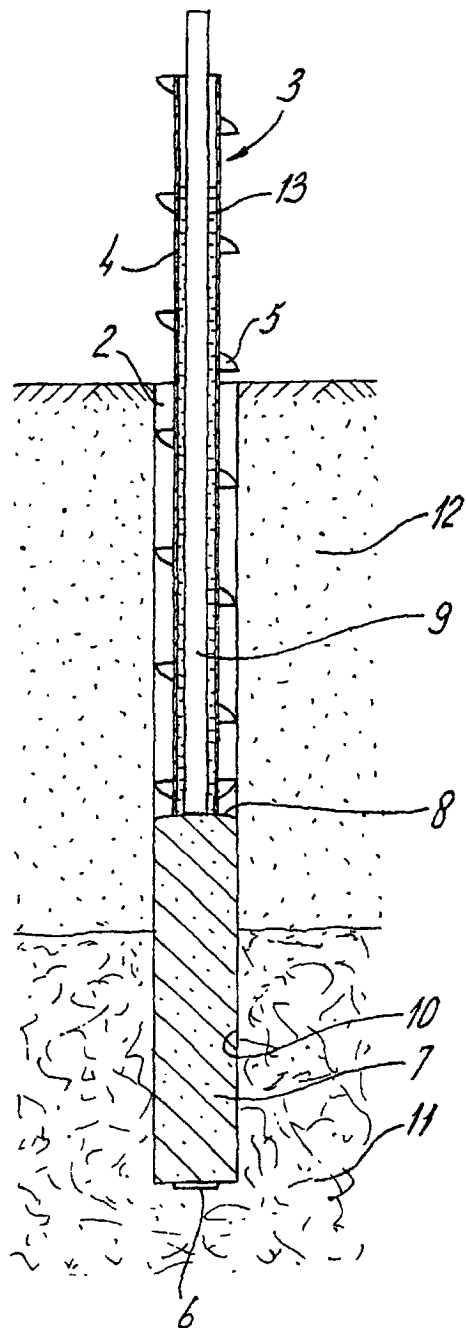


fig-5

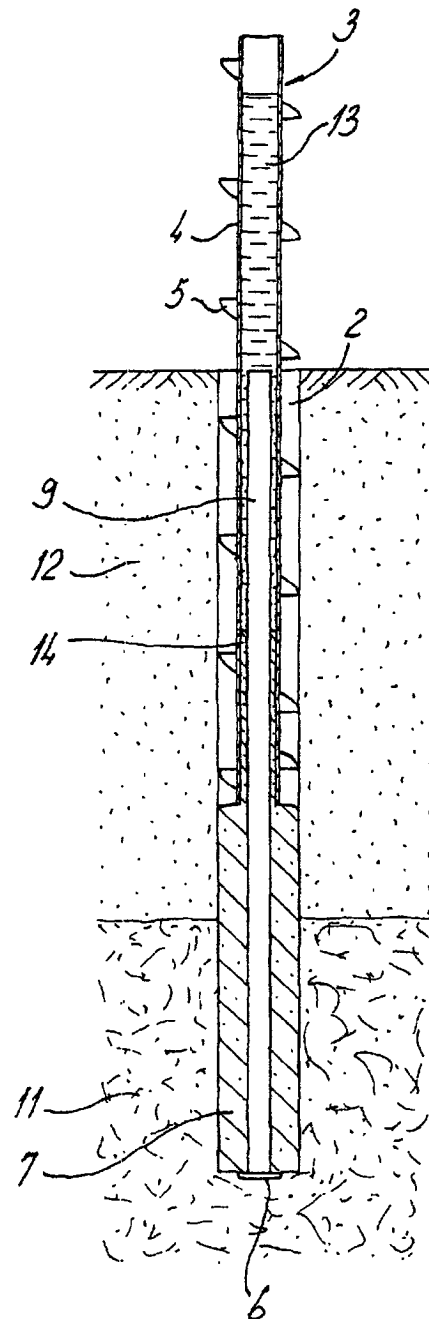


fig-6

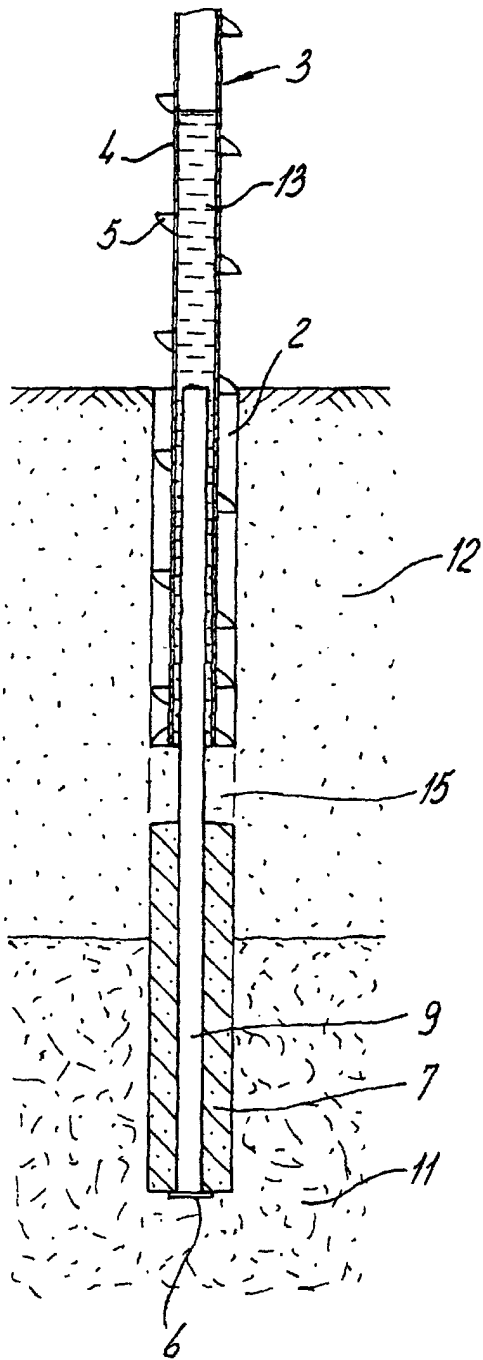


fig-7

