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(54) **METHOD FOR MANUFACTURING A PILE**

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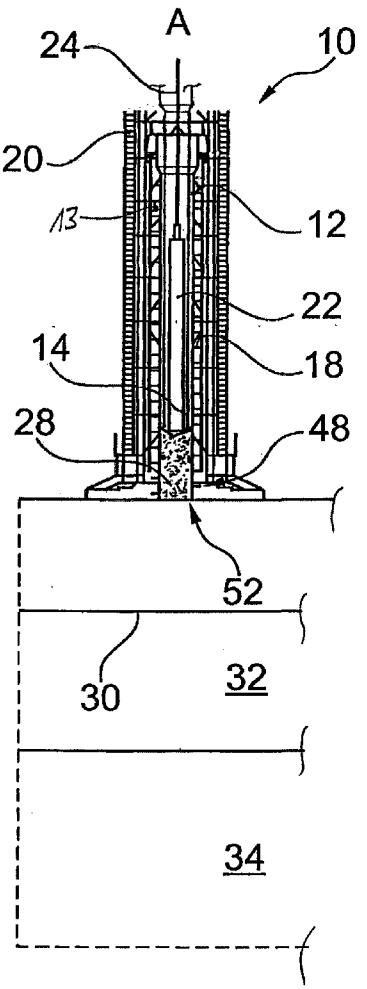
(57) **ABSTRACT**

The invention relates to a pile, wherein a drilling tube comprising at least one cutting helix arranged in a partial section of an outer wall of the same is drilled until a subsoil having good bearing capacity is reached, a pile foot formed by an inner tube that can be arranged in the drilling tube, at least one end region of the inner tube is inserted into the pile foot, at least one grany material comprising at least one binder is filled via the inner tube and the drilling tube and the inner tube are removed from the subsoil.



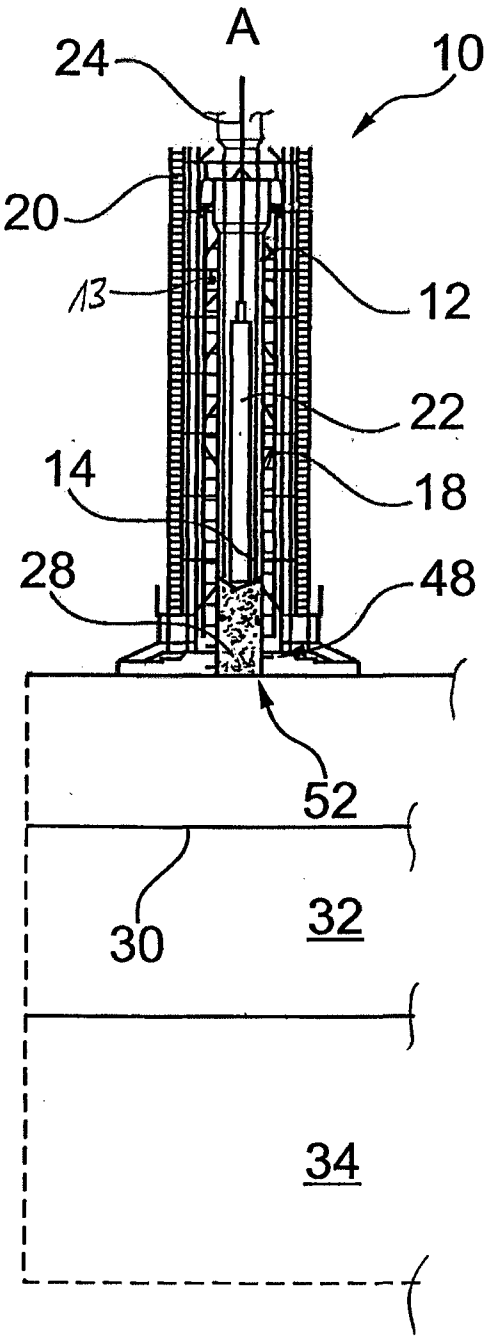


Fig. 1A

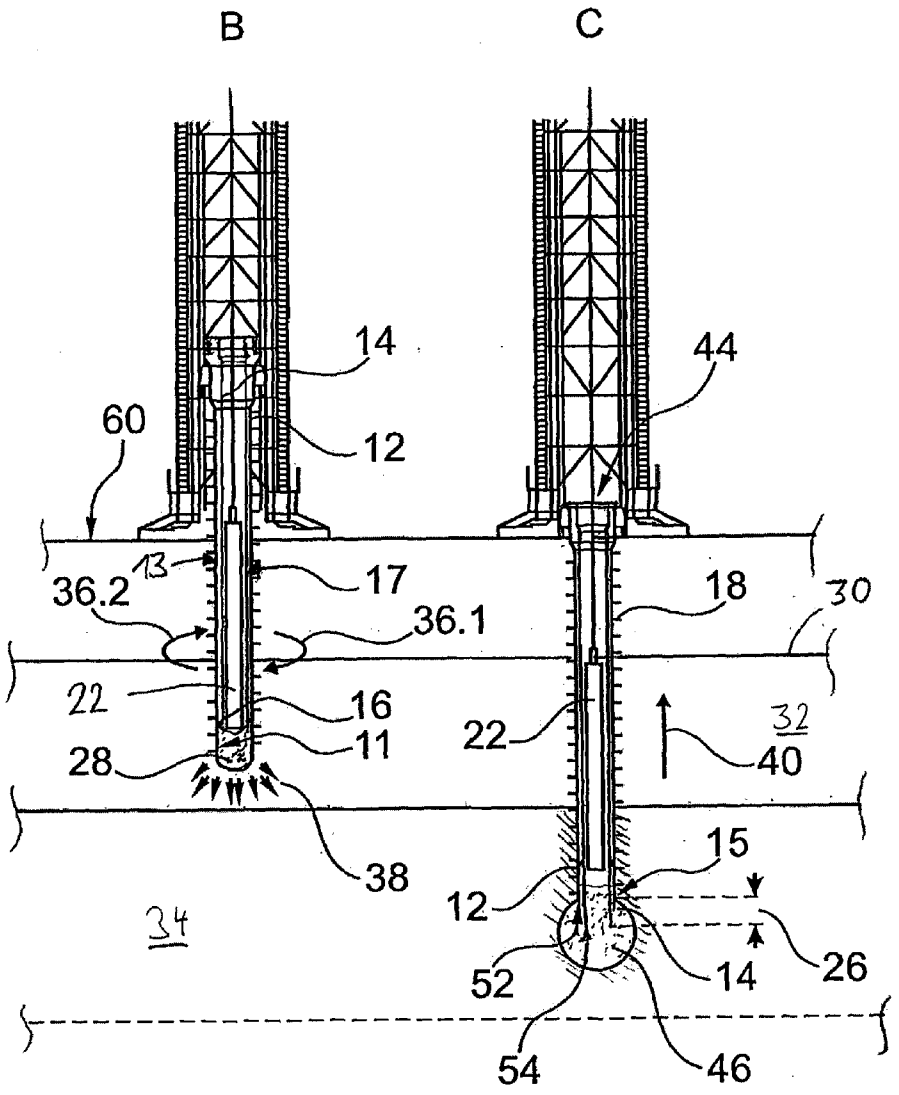

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Fig. 1 B/C

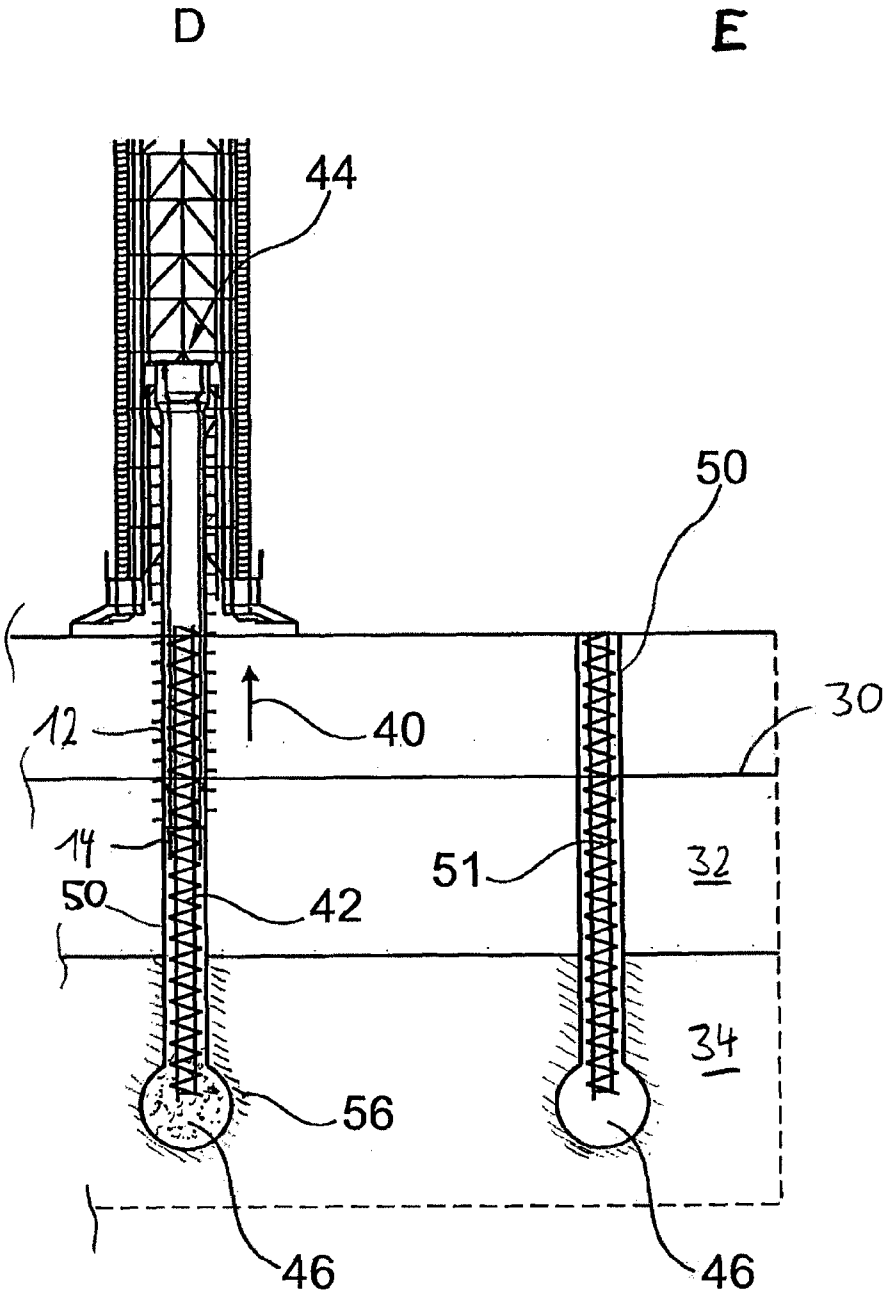

Fig. 1D/E

METHOD FOR MANUFACTURING A PILE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is the U.S. national phase of PCT/EP2013/003586 filed Nov. 27, 2013, which claims priority of German Patent Application 10 2012 023 185.7 filed Nov. 28, 2012.

FIELD OF THE INVENTION

[0002] The present invention relates to a method for producing a pile, whereby both a bore as well as a ramming take place.

BACKGROUND OF THE INVENTION

[0003] Piles are generally used in the building industry in many applications. In particular, in the field of foundation engineering, besides drilled piles it is rammed piles that are particularly used, in which a pilot drive pipe is driven/rammed into the ground by inner or outer ramming. By means of the so-called "inner ramming", for example, a FRANKIPFAHL* ("FRANKIPFAHL" is a registered trademark of FRANKI Grundbau GmbH & Co. KG, Seevetal, Germany) is sunk into the ground as a pilot drive pipe. The pilot drive pipe is aligned by a leader mast and is connected to a first winch usually by two cables via a deflection arranged in the head region of the leader mast. Another cable, which is also guided over the deflection in the head region of the leader mast, holds a ram, which is guided or works in the pilot drive pipe. When a load-bearing ground is reached, the closing means serving as a closure for the piling pipe, for example sand or other material, is expelled by the ramming hammer to form a pile base. Concrete or similar material can also be added. Then, a reinforcement cage is set up, concrete is filled in and the pilot drive pipe is again pulled. It is also possible to perform a so-called preliminary gravel compaction, wherein the subsoil in a corresponding region below and above the pile sitting depth is improved by tamping gravel and also somewhat compressed.

[0004] In differing from the internal driving described above, foot plate-piles, for example, are produced by means of an external driving, wherein, in order to produce said piles, driven casing pipes are used, which are closed at their lower end region by a foot plate that becomes lost, serving as the closure means. Techniques are also known in which the foot plate does not disappear. Using a leader, the driven casing pipe/piling pipe is driven into the subsoil via a pile driver, which can be designed, in particular, as a free-falling pile driver, a diesel pile driver, or a hydraulic pile driver. The pile driver acts thereby on the head of the piling pipe. The driving is conducted as far as the load bearing ground region, as described above for the internal driving. Subsequently, a reinforcing cage is inserted and concrete is poured into the pile shaft while simultaneously, or subsequently, removing the pile pipe in increments. With an external driving, the foot plate may become lost thereby, depending on the technology employed. Concrete slides out of the, now open, bottom of the pile pipe and fills the pile shaft up to approximately the outer edge of the pile pipe. The foot plate, which has disappeared thereby into the ground, can form the support surface for the pile.

[0005] With the methods described above, both the internal driving as well as the external driving, the considerable vibrations associated therewith are a disadvantage. In particular in densely constructed areas, this leads to considerable adverse effects in the immediate surroundings.

[0006] The object of the invention is to provide a method for manufacturing a pile and a corresponding device, with which, in particular, vibrations are reduced.

SUMMARY OF THE INVENTION

[0007] The technical task of the present invention is to provide a method for producing a pile, with which in particular vibrations are reduced.

[0008] This task is solved by a method for making a pile, wherein a drilling pipe with at least one cutting helix preferably arranged in a lower section of an outer wall thereof is drilled into a load-bearing subsoil forming a pile base by an additional drilling pipe that can be arranged in the drilling pipe, at least an end section of the inner pipe is introduced into the pile base, granular material containing at least one binder is filled through the inner pipe, and the drilling pipe and the inner pipe are removed from the ground, wherein the pile base is formed by inner ramming and the inner pipe protrudes with its end-side end face that faces the load-bearing subsoil an end-side end face of the drilling pipe.

[0009] The drilling pipe may also be referred to as an auger with a large core pipe. The drilling pipe preferably comprises a cutting helix along its entire sinkable outer wall. There can also be provided two, three or four cutting helixes. The cutting helix is advantageously adjacent in the lower end of the drilling pipe to the outer wall. It is preferably immediately adjacent to a lower end surface of the drilling pipe on the outer wall and extends further advantageously up to an upper end section of the sinkable outer wall of the drilling pipe, i.e. up to an upper end section of the drilling pipe below a top opening area, by means of which the drilling pipe is attached to a drilling apparatus, in particular a rotary motor, and wherein material can be filled in through an opening provided therein.

[0010] The inner pipe, which has no cutting helix on its outer wall, is arranged within the drilling pipe. The ratio of the diameter of the drilling pipe to the diameter of the inner pipe, measured in each case starting from the respective outer walls of the pipes, is in a range of about 1.1:1 to about 2.5:1, preferably in a range between about 1.25:1 and about 1.75:1.

[0011] An inner wall of the drilling pipe is preferably sealed against the outer wall of the inner pipe with at least a sealant. The sealant is to serve the function of preventing the penetration of subsoil into the area between the inner wall of the drilling pipe and the outer wall of the inner pipe. The sealant can for example be designed as an annular seal, wherein the sealing profile in the cross section can be designed as double-dovetail or easy-dovetailed, but other embodiments of the sealant are possible. The sealant is advantageously arranged fixed to the inner wall of the drilling pipe, but can also be arranged fixedly on the outer wall of the inner pipe. The sealant can be made of any suitable material possible, in particular of high-solid plastic materials, although still exhibiting a sufficient elasticity, for example a filler-reinforced rubber material or the like. In particular, a plurality of sealing means can be arranged over the length of the drilling pipe or the inner pipe at its inner wall or outer wall.

[0012] The inner pipe can already before the start of drilling protrude with an end-side end face, which faces the construction ground, an end face of the drilling pipe, which is also facing the construction ground. The overhang of the end-side end face of the inner pipe over the end-side end face of the

drilling pipe is preferably within a range between about 20 cm and 200 cm, more preferably within a range between about 50 cm and about 120 cm, but may in some construction ground situations be also greater than 200 cm. However, the overhang can also be generated only after reaching a final depth in the ground by corresponding displacement of the inner pipe relative to the drilling pipe. The shift can be done by rotational movements or by a longitudinal, non-rotating sliding movement and/or both by inner and top ramming. It can also be provided to produce an overhang in that the inner pipe is driven by inner ramming down to a load-bearing ground, while the drilling pipe is drilled to a certain depth. Also, for example, the inner pipe and the drilling pipe can be drilled only into a load-bearing ground, and then an overhang is formed by further sinking the inner pipe by inner ramming.

[0013] The pile base produced by the inventive method is made according to the principle of FRANKIPFAHL*. According to the invention, the pile base is formed by inner ramming that can also be called inner pipe ramming. A top ramming by hydraulic or diesel rams would be possible. With an inner ramming, a ram is preferably introduced into the inner pipe, more preferably the ram is introduced into a closing means, which is arranged in the end region of the drilling pipe and/or inner pipe facing the load-bearing ground. The ram is advantageously used in the clamped state. The resting on the closing means can be carried out before the drilling, more preferably it is carried out during the drilling of the drilling pipe, more preferably the resting of the piling ram takes place both before the drilling and during the drilling when a final depth is reached.

[0014] The pile base is advantageously formed by tamping by inner ramming or inner pipe ramming the granular material in the inner pipe, which can also contain a binder, and preferably is it dry concrete, and ultimately can also serve as a closing means, as described below, which process can be repeated by adding further batches of granular material until the ramming is done over a desired length, which ultimately allows to vary or adjust the length of the pile base. The pile base preferably has an outer diameter, which [missing verb] the outer wall of the inner pipe, and more preferably also extends beyond the outer wall of the drill pipe. By driving the inner pipe into the pile foot, preferably a pile narrowing directly above and bordering on the pile foot is avoided.

[0015] The drilling, preferably as far as a load bearing subsoil, occurs by means of the drill pipe, as specified above, advantageously with the provision of at least one closure means in the end region of the drill pipe and/or inner pipe facing the load bearing subsoil. As a closure means, a foot plate, for example, can be provided thereby, which can be designed as a lost foot plate, but can also be designed as a foot plate that can be recovered. Alternatively, a type of cover can be provided, which, seen in its cross-section, can be regarded as a triangle standing on its head. An alternative closure means is the provision of a plug made of gravel and/or sand and/or a granular material having at least one binder, in particular made of concrete, in particular dry concrete, by means of which the drill pipe and/or the inner pipe are closed off. Both a foot plate or cover, as well as a plug made of a granular material etc. could be provided. A foot plate or cover as a closure means are preferably disposed on, in particular attached to, the end region of the drill pipe facing the subsoil. They can additionally be disposed on the end region of the inner pipe, in particular on the terminal end surface thereof. The foot plate, or the cover, respectively, are disposed on the end region of the drill pipe such that they do not extend beyond the outer wall of the drill pipe. The foot plate or cover are knocked away by means of driving, preferably internal driving, through the inner pipe, thus formed as a lost foot plate or cover, or opened, respectively, in order to then enable a further sinking of the inner pipe and/or the formation of the pile foot.

[0016] The pile foot is formed solely by means of the inner pipe. The drill pipe is there in order to introduce a drilling into the subsoil that has emissions that are as low as possible, preferably as far as the load bearing subsoil. The inner pipe thus also substantially determines the diameter of the pile, which basically corresponds to the inner diameter of the inner pipe. Preferably the pile produced with the method according to the invention has a pile diameter having basically the inner diameter of the inner pipe over its entire length. It can, however, also be provided that, for example, the inner pipe is removed from the subsoil in the course of the introduction of material, until its terminal end surface no longer extends beyond that of the drill pipe, such that then an expansion of the pile diameter can occur at this point, in particular when the inner pipe is fully removed from the subsoil, while the drill pipe remains therein, and material is then poured in via said drill pipe, in order to form the pile.

[0017] A pile can advantageously be produced at a high speed with only limited vibrations by means of the method according to the invention, having a load bearing capability that is nearly identical, or similar, to a FRANKIPFAHL. The major advantage with respect to a FRANKIPFAHL is that this pile, due to the complete displacement thereof, by means of driving the piling pipe, is characterized by a long ramming time and high vibrations. Compared to known piles such as the VB pile or the SOB pile, a significantly increased load capacity is achieved. The low vibrations are achieved by a deep ramming, because the ram works by inner ramming in the final depth and/or not at the beginning of the drilling process, definitely below the subsoil surface, from which the drilling has been done.

[0018] The drilling is carried out by screwing the drilling pipe up into a particularly load-bearing ground. The inner pipe is advantageously introduced into the construction ground together with the drilling pipe. Particularly preferably, the inner pipe is rotated when being introduced. More preferably, the rotation is performed during the drilling action of the drilling pipe. Advantageously, a control is provided such that the rotary motion of the drilling pipe and the inner pipe are synchronized with each other. Preferably, during the drilling process the inner pipe while drilling has no drive, which generates torque that is then transmitted via the inner pipe into the existing subsoil. Conversely, during its removal from the ground the inner pipe can be provided with a drive. An entrainment of the inner pipe (rotating, sliding, shifting, vibrating, etc.) while drilling is preferably carried out by the movement of the drilling pipe. Alternatively it can be provided that by means of one or more sealants the inner pipe is firmly held by the drilling pipe, and upon setting an overhang before the drilling, the rotating inner pipe is then moving, together with the drilling pipe, into the construction ground due to entrainment without the need for additional control.

[0019] Advantageously, rinse fluids, for example, bentonite suspensions, water or the like are introduced through the inner pipe. By means of the rinse fluids, which are introduced through an upper opening of the inner pipe and/or drilling pipe, for example by means of hoses, and which can escape

via openings provided in the wall of the inner pipe, the drilling speed and also the pile bearing behavior can be improved. If the material used as a rinse fluid also includes one binder, the surrounding subsoil can be solidified. The rinse fluids can be used both while drilling, as well as after achieving the final depth and during the subsequent removal of the drilling pipe and the inner pipe from the ground.

[0020] Alternatively to rotating both the drilling pipe and the inner pipe during the drilling it can be provided that only the drilling pipe is rotated, and the inner pipe is held and is tracked within the drilling pipe in the drilling progress. For this purpose, the inner pipe can be fixed, above the drilling pipe, to a leader mast, which also leads the drilling pipe. For example, one can proceed in such a manner that the drilling pipe is provided with a closing means, and the inner pipe is disposed in its lower end by a sealing means between the outer wall of the inner pipe and the inner wall of the drilling pipe; however, the sealing means does not transmit the rotational movement of the drilling pipe to the inner pipe, because it is not sufficiently firmly arranged at it. The inner pipe can also be synchronously moved with, or subsequently guided into, the drill pipe during the sinking, above the at least one sealing means, for example, and, upon first reaching the final depth, be moved toward the load bearing subsoil, in order to obtain the excess length in relation to the drill pipe, such that then, subsequently, the at least one sealing means is brought to rest against the outer wall of the inner pipe. The inner pipe and/or the drill pipe can, moreover, also have spacing means and guidance means disposed on their outer walls, which facilitate a guidance of the inner pipe into the drill pipe.

[0021] The pile foot can be produced in accordance with the method according to the invention, without such an excess length between the end surface of the inner pipe and the end surface of the drill pipe being provided, but it can also be generated when there is an excess length of the inner pipe. Following the formation of the pile foot, preferably by compression, the excess length between the end surface of the inner pipe and the end surface of the drill pipe is then either increased, or retained, and the inner pipe is inserted into the pile foot, optionally while also displacing the drill pipe along with it, or it is guided into the pile foot through the formation of the excess length of the inner pipe. The insertion of the inner pipe into the pile foot can occur in a turning manner, or through a longitudinal sliding movement of the inner pipe toward the pile foot, through driving, for example. In a further preferred embodiment of the present invention, not only the inner pipe, but also the drill pipe can be slid, preferably, into the pile foot, preferably by means of a turning movement. The insertion of the inner pipe into the pile foot advantageously occurs at least so far that the end surface of the drill pipe lies on the surface of the pile foot.

[0022] The removal of the drilling pipe and the inner pipe can be done such that the overhang of the inner pipe is maintained during the removal. However, the overhang can also be reduced or led back to zero in direction of the bottom surface, for example during the removal, by an additional movement of the inner pipe relative to the drilling pipe, insofar as both are removed from the ground together so that an end face of the inner pipe is at least on the same level as an end face of the drilling pipe or is even arranged with a recess within the drilling pipe. The drilling pipe can be removed from the ground by pulling or by turning, as can the inner pipe. The above-mentioned various ways of removing the drilling pipe and the inner pipe allow realizing different pile diameters.

[0023] The inventive method provides piles, which have no weakening above the pile base. In addition, depending on the ground conditions, different shank diameters can be created, for example, a larger near the surface and lower in the area above the pile base, in order to economize the energy and materials spent. Even gravel pre-compaction is possible with the inventive method.

[0024] Furthermore, according to the invention the inner pipe can have a widening in its lower end region facing the ground. This widening can also serve as a guide means of the inner pipe in the drilling pipe. In particular, if prior to drilling an overhang between the inner pipe and the drilling pipe is provided, the expansion of the inner pipe can also be equal to the outer diameter of the drilling pipe, or extend beyond this. By filling the inner pipe with a granular material containing at least one binder, the widening allows to achieve a widened pile diameter when removing it from the load-bearing and non-load-bearing ground, whether this is achieved by turning or pulling. In addition, the connection of the pile to the pile base is thereby improved. With such design, the drilling pipe is advantageously removed from the construction ground first by pulling or rotating, preferably pulling, and then the same is done with the inner pipe.

[0025] In the context of the present invention, it can basically be provided for the removal of the drilling pipe and the inner pipe from the ground that during the removal of the drilling pipe the inner pipe is removed from the ground with a time lag, but simultaneously in some time periods, and vice versa.

[0026] The inventive method can be implemented with an apparatus for producing a drilled pile with a pile base, comprising a drilling pipe and an inner pipe arranged in it, wherein between an outer wall of the inner pipe and an inner wall of the drilling pipe at least one sealing means for prevention of the entry of in particular non-load-bearing and/or load-bearing ground is arranged.

[0027] The inventive apparatus further advantageously has an overhang between an end-side end surface of the inner pipe and an end-side end surface of the drilling pipe, so that the inner pipe protrudes over the drilling pipe facing the construction ground. The sealant may be formed as already illustrated above in connection with the inventive method. The inner pipe is advantageously fixed by a holding device, preferably a leader mast, above the upper edge of the drilling pipe. The drilling pipe of the inventive apparatus can be formed as shown in connection with the method according to the invention, and in particular can have at least one cutting helix. Also closing means may be provided, for example in the form of permanent or not permanent continuous bed plates which are mounted on the drilling pipe, or as a plug, as also described in connection with the inventive method.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] These and other advantages of the present invention are explained in detail based on the following FIG. **1** A, **1** B/C and **1** D/E, which show five process states A, B, C, D and E.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] First, it is pointed out that the embodiment of the inventive method shown in the figures and the inventive apparatus should not be interpreted as limiting. Rather, the features described therein can be combined with each other and

with the features described above to form further embodiments. It should also be noted that the reference numerals given in the description of the figures do not limit the scope of the present invention, but merely refer to the embodiments shown in the figures. Same parts or parts with the same function have in the following text the same reference numerals. It should be especially noted that the process shown in the figures according to the invention with an inner ramming represents only one possible embodiment, and that the common sinking and removal of a drilling pipe having an inner pipe as shown in the embodiment, is only one of the possible embodiments of the present invention.

[0030] FIG. **1** A shows in section A an apparatus **10** according to the invention, in which an inner pipe **14** is arranged in a drilling pipe **12**. Drilling pipe **12** and inner pipe **14** are attached to a leader mast **20**. In the inner pipe **14** a ram **22**, held by a rope **24** to the leader mast **20**, is held on a winch, not shown here, and lies on a closing means **28**, designed as a plug, formed for example of gravel or dry concrete. The drilling pipe **12** comprises an outer wall **13** on which is arranged a cutting helix **18**, which outer wall **13** is arranged, starting from an end-side end surface **52** on the outer wall **13** into the upper area below the attachment of the drilling pipe **12** on the leader mast **20**.

[0031] The closing means **28** is arranged in the lower end of the drilling pipe **12**, and can be alternatively or additionally formed as a plate or a cover.

[0032] The apparatus **10** stands on a bottom surface **60**. Below the bottom surface **60** there is a water table **30** within a non-load-bearing ground **32**, below the non-load-bearing ground **32** is the load-bearing construction ground **34**.

[0033] In Section B of FIG. **1** B/C, the drilling pipe **12** is rotationally sunk into the ground **32** and **34**, wherein the rotational movement is indicated by the arrows **36.1** and **36.2**. The inner pipe **14** is thereby entrained by the drilling pipe **12**, and, moreover, is protected from the entry of construction ground **32**, **34** into the space between outer wall **17** of inner pipe **14** and inner wall **11** of the drilling pipe **12** by a seal **16**, preferably in the form of a ring.

[0034] The ram **22** further rests on the plug **28**. Upon reaching a final depth in load-bearing ground **34** is expelled a pile base **46** in the direction of arrows **38** through the piling hammer **22** in the form of a deep ramming shown in section C of FIG. **1** B/C. Should a plate or a cover be provided alternatively or additionally as a closing means **28**, it would be knocked away by ramming it. A compacted subsoil area **56** is formed around the pile base **46** at sinking the drilling pipe to the inner pipe (see Section D, FIG. **1** D/E).

[0035] For the production of the pile base can also, for example, dry concrete be introduced into the inner pipe **14**, also more than once, which is then tamped with the material of the plug **28** and forms the pile base **46**. After the pile base **46** is tamped, the inner pipe **14** is advanced into the pile base **46** until an overhang **26** is formed between an end-side end face **54** of the inner pipe **14** and an end-side end face **52** of the drilling pipe **12**, which is for example **100** cm. Subsequently, the ram **22** is removed from the inner pipe **14**, and a granular material containing at least one binder, such as in particular liquid concrete **44**, symbolized by the arrow, is filled into the inner pipe and/or the drilling pipe **12**, **14** up to the pile base **30** **46**.

[0036] Here, a reinforcement cage **42**, as shown in Section D of FIG. **1** D/E, can be set up in the drilling pipe **12** or inner pipe **14** before the filling with the concrete **44**, but also during the filling with the concrete **44** or simultaneously.

[0037] During the filling with the concrete, the drilling pipe **12** is removed, by pulling in the direction of an arrow **40**, from the ground **32**, **34** together with the inner pipe **14**, as described in Section D of FIG. **1** D/E so that a pile **50** is formed as shown in section E of FIG. **1** D/E. It comprises a pile base **46** which merges without any weakening above the pile base **46** in a pile shaft **51**.

1. A method for producing a pile (**50**), wherein a drill pipe (**12**) having at least one cutting helix (**18**) disposed in a subsection of an outer wall (**13**) thereof, drills into a subsoil (**34**), a pile foot (**46**) is formed by means of an inner pipe (**14**) that can be disposed in the drill pipe (**12**), at least an end region (**15**) of the inner pipe (**14**) is inserted into the pile foot (**46**), a granular material having at least one binder is poured in via the inner pipe (**14**), and the drill pipe (**12**) and the inner pipe (**14**) are removed from the subsoil (**32**, **34**).

2. The method according to claim **1**, characterized in that the removal of the drill pipe (**40**) and/or the inner pipe (**14**) occurs by means of pulling and/or turning (**40**).

3. The method according to one of the preceding claims, characterized in that an outer wall (**17**) of the inner pipe (**14**) is sealed against an inner wall (**11**) of the drill pipe (**12**) with at least one sealing means (**16**).

4. The method according to one of the preceding claims, characterized in that the pile foot (**46**) is formed by means of internal driving.

5. The method according to claim **4**, characterized in that a pile driver (**22**) is inserted in the inner pipe (**14**) for the internal driving.

6. The method according to one of the preceding claims, characterized in that the drill pipe (**12**) has at least one closure means (**28**) an its end region (**48**) facing the load bearing subsoil (**34**).

7. The method according to one of the preceding claims, characterized in that the inner pipe (**14**) and the drill pipe (**12**) are inserted into the pile foot (**46**).

8. The method according to one of the preceding claims, characterized in that the inner pipe (**14**), with its end surface (**54**) facing the load bearing subsoil (**34**), extends beyond the end surface (**52**) of the drill pipe (**12**).

9. The method according to one of the preceding claims, characterized in that the drill pipe (**12**) and/or the inner pipe (**14**) are provided with a plug (**28**) made of gravel and/or sand and/or a granular material having at least one binder.

10. The method according to claim **9**, characterized in that the pile driver (**22**) is placed on the plug (**28**).

11. The method according to one of the preceding claims, characterized in that the inner pipe (**14**), together with the drill pipe (**12**), is removed from the subsoil (**32**, **34**).

12. The method according to one of the preceding claims, characterized in that the removal of the inner pipe (**14**) and/or the drill pipe (**12**) occurs during the pouring of the granular material (**44**) having at least one binder.

13. The method according to one of the preceding claims, characterized in that the inner pipe (**14**) is inserted into the load bearing subsoil (**34**) together with the drill pipe (**12**).

14. The method according to one of the preceding claims, characterized in that the inner pipe (**14**) is turned during the insertion.

15. The method according to claim **14**, characterized in that the turning occurs during the drilling movement of the drill pipe (**12**).

16. The method according to one of the preceding claims, characterized in that rinsing agents are introduced through the inner pipe (**14**).

17. A device (**10**) for producing a drilled pile (**50**) having a pile foot (**46**), comprising a drill pipe (**12**) and an inner pipe (**14**) disposed therein, wherein at least one sealing means (**16**) is disposed between an outer wall (**17**) of the inner pipe (**14**) and an inner wall (**11**) of the drill pipe (**12**), for preventing the ingress of subsoil (**32**, **34**).

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