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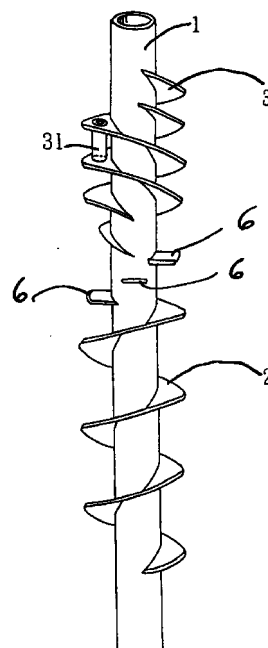
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(54) **Auger drill**

(57) A method of constructing high-friction piles in the ground is provided, wherein the amount of excavated soil from prebored holes can be reduced, and the total number of piles which must be set for a pile foundation can be reduced. An auger is utilized which comprises an elongated shaft (1) and a helical blade (2, 3) extending around the shaft (1) and projecting radially from the periphery of the shaft (1). The shaft comprises a first helical blade (2) along the length of the main portion thereof with an inclination angle in the positive direction of rotation and at least one second helical blade (3) only along the top portion of the shaft (1) with an inclination angle in the opposite or reverse direction as that of the first helical blade (2). When drilling such an auger into the ground, the agitated soil is thrust sideways into the ground so that a plastic zone (A) is formed around the hole up to a prescribed range. Next, a hardening agent (4) is poured into the hole, and then a support or reinforcement material (5) is inserted into the hardening agent (4) before the hardening agent (4) hardens completely. The support material (5) and the plastic zone (A) surrounding the hole form together a monolithic pile.

Fig. 2



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Description

[0001] The present invention relates to an auger for construction purposes, in particular for drilling holes into the ground, and a method of constructing high-friction piles in the ground utilizing such an auger.

[0002] Conventionally, two methods are in use to build a pile foundation using precast piles such as concrete piles or steel posts, namely, a pile-driving method and an embedding method. In the pile-driving method, precast piles are driven directly into the ground, and in the embedding method, precast piles are inserted into prebored holes in the ground.

[0003] Among the two aforementioned methods, the embedding method does have many advantages, but the boring of the holes requires the excavation of soil in excess of the volume of the piles. The disposal of this soil adds to the construction cost.

[0004] This invention was undertaken to resolve the aforementioned problems arising from the conventional method, and to this end aims at an auger for construction purposes and a method of constructing high-friction piles in which the amount of excavated soil can be reduced, and by which the number of piles that must be set for a pile foundation can also be reduced.

[0005] According to the present invention, the object is solved in a satisfying and advantageous manner.

[0006] According to a first aspect according to the present invention, an auger for constructing purposes is disclosed for drilling holes into the ground, comprising an elongated shaft with a top portion and an extended main portion, and a helical blade extending around the shaft and projecting radially from the periphery of the shaft, wherein the shaft comprises a first helical blade along the length of the main portion thereof with an inclination angle in the positive direction of rotation and at least one second helical blade only along the top portion of the shaft with an inclination angle in the opposite or reverse direction as that of the first helical blade.

[0007] According to a further development of the auger according to the invention, at least one hollow pipe is provided, extending in parallel with the shaft and communicating an upper surface of a first helical winding with a lower surface of a second helical winding of the second helical blade.

[0008] According to a further development of the auger according to the invention, the second helical blade comprises a pair of helical windings inserted between each other in the axial direction and extending in parallel with each other around the shaft.

[0009] According to a further development of the auger according to the invention, adjacent helical windings of the second helical blade are connected with each other at their outer peripheries by means of an exterior barrier.

[0010] In a specific embodiment of the auger according to the invention, a transition portion without

any helical winding is provided along the shaft between the first helical blade and the second helical blade.

[0011] According to a further development of the auger according to the invention, plates extending radially from the periphery of the shaft and being spaced apart in axial and circumferential direction are provided between the first helical blade and the second helical blade.

[0012] According to a specific embodiment of the auger according to the present invention, the axial distance between adjacent helical windings of the second helical blade is about half the axial distance of the helical windings of the first helical blade.

[0013] According to a second aspect of the present invention, a method of constructing high-friction piles in the ground is disclosed which comprises the following steps:

- (a) using an auger according to the first aspect of the present invention for preboring a hole in the ground by rotatingly driving the auger into the ground, wherein, as the hole is being bored, a portion of the soil agitated by the positive rotation first helical blade is prevented from being pushed upward by the reverse rotation second helical blade and is instead thrust into the area surrounding the hole, and wherein a plastic zone is formed up to a prescribed width around the hole;
- (b) a hardening agent is poured into the hole obtained in the first step;
- (c) a support material is inserted into the hardening agent in the hole before the hardening agent is completely hardened; and
- (d) the hardening agent is allowed to harden so that the support material and the plastic zone surrounding the hole form together a monolithic pile.

[0014] The invention will be explained in more detail with reference to the accompanying drawings and with reference to examples of the auger and the method according to the present invention.

Fig. 1 illustrates a high-friction pile with a surrounding plastic zone obtained according to the method of the present invention;

Fig. 2 is a diagrammatic view showing a first embodiment of the configuration of the auger according to the present invention used in constructing friction piles; and

Fig. 3 is a diagrammatic view showing another embodiment of the configuration of the auger.

[0015] In the following description, the auger for construction purposes and methods using the same will be disclosed in more detail.

Auger

[0016] An auger of the type as shown in Fig. 2 of the drawings is used for the construction of piles according to the invention. In particular, a helical blade 2 is molded at an angle around the virtual length of a rotatable shaft or shank 1 in the positive direction of rotation, except for the upper tip or top portion of the shaft. Such a positive rotation helical blade 2 is of the same configuration as a blade used on conventional augers for boring.

Reverse Rotation Blade

[0017] On the other hand, a helical blade 3 is molded at an angle around the top portion or upper tip of the rotatable shank or shaft 1 in the reverse direction of rotation from that of the positive rotation helical blade. In other words, when rotating the shaft 1 according to Fig. 2 from the top side in a clockwise direction, the first, positive rotation helical blade 2 moves forward, whereas the second, reverse direction helical blade 3 moves backward.

[0018] When drilling such an auger into ground, it is the reverse direction helical blade 3 provided on the upper part of the rotating shaft 1 which prevents the soil agitated by the positive rotation helical blade 2 from being pushed upwards. This is due to the fact that the helical blade 3 causes a movement in the opposite direction.

[0019] In a specific embodiment of the auger according to the invention, at least one hollow pipe 31 is provided extending in parallel with the shaft 1 and communicating an upper surface of a first helical winding with a lower surface of a second helical winding of the second helical blade 3.

[0020] The hollow pipe 31 forms a vertical passage between the helical windings of the second helical blade 3. Such a hollow pipe 31 can be advantageous when drilling holes into the ground with the auger, since the quantity of excavated soil will at once increase, depending on the circumstances, when drilling the auger into the ground.

[0021] In one embodiment of the present invention, there is only one second helical blade 3 with a suitable number of helical windings around the circumference of the shaft 1. In another embodiment of the present invention, the second helical blade 3 comprises a pair of helical windings inserted between each other in the axial direction and extending in parallel with each other around the shaft 1. This situation is shown in Fig. 2 of the drawings.

[0022] In a specific embodiment of the present invention, the adjacent helical windings of the second helical blade 3 are connected with each other at their outer peripheries by means of an exterior barrier 32. This configuration is shown in Fig. 3 of the drawings. Again, a hollow pipe 31 may be provided with a vertical passage formed between respective windings of the

second helical blade 3.

[0023] As can be seen in Fig. 2 and Fig. 3 of the drawings, there is a transition portion without any helical blades between the first positive rotation helical blade 2 and the second, reverse direction helical blade 3.

[0024] In this transition portion, plates (6) extending radially from the periphery of the shaft 1 and being spaced apart in axial and circumferential direction are provided between the first helical blade 2 and the second helical blade 3.

[0025] The transition portion is provided and adapted to agitate the soil when rotating the auger and to reduce the upward pressure which is caused by the positive rotation of the helical blade 2. Hence the transition portion contributes to preventing the soil from rising towards the top surface of the ground where drilling takes place.

Preventing Upward Thrust of Drilled Soil

[0026] In order to drill holes in the ground, the auger as shown in Fig. 2 or Fig. 3 of the drawings is used and positioned on the ground. Then, rotation of the shaft 1 causes the positive rotation helical blade 2, the principal segment of the auger, to bore into the ground. By doing so, all or at least a portion of the soil pushed up by the rotation of the positive rotation helical blade 2 is prevented from rising towards the surface by the reverse rotation helical blade 3 mounted above the positive rotation blade 2. As a result, soil being agitated will not be discharged externally, but will instead be pushed back downward and thrust sideways into the surrounding soil.

[0027] Depending on the situation, a bentonite or other slurry can be admixed into the soil simultaneously with the boring procedure.

Formation of a Plastic Zone

[0028] During the boring operation for boring a hole, soil of an amount equivalent to the total volume of the shaft 1 and the helical blades 2 should inherently be discharged, leaving a cavity. However, by preventing this discharge, the volume of soil is instead thrust into the area of the surrounding soil. This thrust compacts the surrounding earth causing it to lose pore space, in other words the sum of the interstitial water and air within the soil particles, so that a plastic zone A of a prescribed width is formed in the soil surrounding the hole.

Setting Size of Plastic Zone

[0029] The size of the plastic zone A is determined by the modulus of elasticity of the shear and the adhesion of the soil. For example, the width of the plastic zone A can be determined by the following Formula 1.

$$R = (2 \cdot \delta \cdot a_0 \cdot G/C_u)^{1/2} \quad \text{Formula 1:}$$

$$= \sqrt{\frac{2 \times 0.1 \times 0.15 \times 234.375}{3.125}}$$

$$= 1.5 \text{ meters}$$

wherein

R = Radius from the center of the hole to the outer boundary of plastic zone A 10
 G = Modulus of elasticity in shear of the soil
 Cu = Undrained shear strength (adhesion) of the soil
 a0 = Diameter of small-diameter shaft 15
 δ = Variation in surface of hole wall.

Introduction of Hardening Agent and Insertion of Support Material

[0030] When a hole has been formed by the auger described above, mortar or another hardening agent 4 is poured into the cavity being supported by the plastic zone A as explained above. Next, a support material 5 is inserted into the hole before the hardening material 4 is completely hardened. The support material 5 can be, for example, an H-steel profile. 20

[0031] In such a method, the hardening agent 4 should only be introduced in an amount so that, when the support material or reinforcement material 5 is inserted, the hardening agent 4 is only displaced up to the top of the hole, but should not spill out of the hole after the support material or reinforcement material 5 has been inserted. 25

[0032] Once the hardening agent 4 is completely hardened, a pile is built in which the support material 5 and the plastic zone A surrounding the bored hole, now filled by the hardening agent 4 and the support material 5, form a monolithic body. 30

Effectiveness of the Invention

[0033] As can be inferred from the above explanations, the method of this invention is highly effective for constructing high-friction piles wherein soil from the boring of the hole is virtually prevented from being pushed up and discharged above ground. Instead of this, it is thrust, up to a prescribed range, into the soil surrounding the hole to create a plastic zone A. A hardening agent 4 is then poured into the hole, whereupon a supporting or reinforcement material 5 is inserted. Hence, the method according to the invention provides the following advantages. 35

[0034] The ground surrounding the pile is compacted and becomes more dense, wherein the plastic zone A, established up to a prescribed range around the pile, can be utilized effectively as part of monolithic pile body. Consequently, the number of piles which must be 40

set into the ground is greatly reduced from that required by a conventional method so that construction costs can be reduced.

[0035] Virtually all of the bored soil is thrust into the surrounding earth with only a minimum amount being discharged above ground. Soil disposal cost is therefore minimal and construction costs are reduced. 45

Claims

1. An auger for construction purposes for drilling holes into the ground, comprising
 - an elongated shaft (1) with a top portion and an extended main portion, and
 - a helical blade (2) extending around the shaft (1) and projecting radially from the periphery of the shaft (1),
 wherein the shaft (1) comprises a first helical blade (2) along the length of the main portion thereof with an inclination angle in the positive direction of rotation and at least one second helical blade (3) only along the top portion of the shaft (1) with an inclination angle in the opposite or reverse direction as that of the first helical blade (2). 50
2. The auger according to claim 1, wherein at least one hollow pipe (31) is provided extending in parallel with the shaft (1) and communicating an upper surface of a first helical winding with a lower surface of a second helical winding of the second helical blade (3).
3. The auger according to claim 1 or 2, wherein the second helical blade (3) comprises a pair of helical windings inserted between each other in the axial direction and extending in parallel with each other around the shaft (1).
4. The auger according to any of claims 1 to 3, wherein adjacent helical windings of the second helical blade (3) are connected with each other at their outer peripheries by means of an exterior barrier (32).
5. The auger according to any of claims 1 to 4, wherein a transition portion without any helical winding is provided along the shaft (1) between the first helical blade (2) and the second helical blade (3).
6. The auger according to any of claims 1 to 5, wherein plates extending radially from the periphery of the shaft (1) and being spaced apart in axial and circumferential direction are provided between the first helical blade (2) and the second helical blade (3). 55

7. The auger according to any of claims 1 to 6,
wherein the axial distance between adjacent helical
windings of the second helical blade (3) is about
half the axial distance of the helical windings of the
first helical blade (2). 5
8. A method of constructing high-friction piles in the
ground,
comprising the following steps: 10
- (a) using an auger according to any of claims 1
to 7 for preboring a hole in the ground by rotat-
ingly driving the auger into the ground,
wherein, as the hole is being bored, a portion of
the soil agitated by the positive rotation first 15
helical blade (2) is prevented from being
pushed upward by the reverse rotation second
helical blade (3) and is instead thrust into the
area surrounding the hole, and wherein a plas-
tic zone (A) is formed up to a prescribed width 20
around the hole;
- (b) a hardening agent (4) is poured into the
hole obtained in step (a);
- (c) a support material (5) is inserted into the
hardening agent (4) in the hole before the hard- 25
ening agent (4) is completely hardened; and
- (d) the hardening agent (4) is allowed to harden
so that the support material (5) and the plastic
zone (A) surrounding the hole form together a
monolithic pile. 30

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Fig. 1

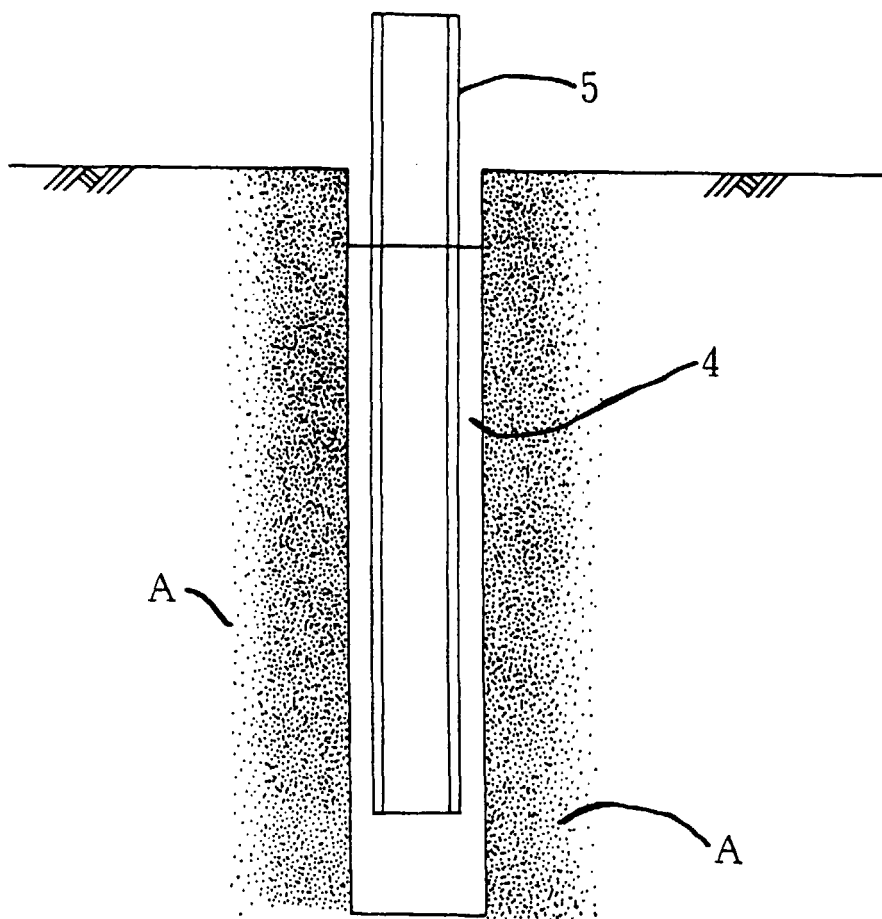


Fig. 2

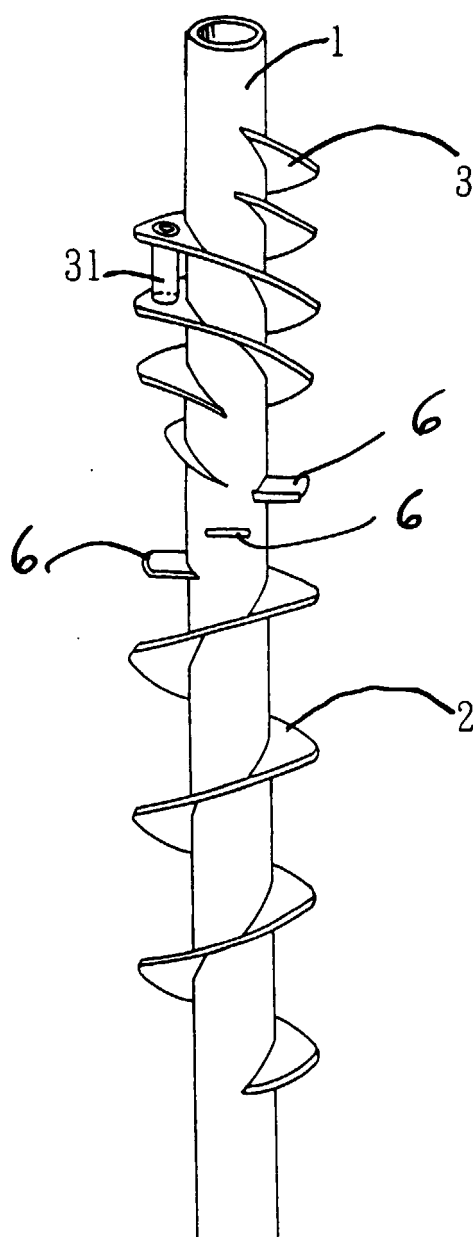


Fig. 3

