Title: FOUNDATION PILING BASE AND METHOD OF UNDERRPINNING THEREFOR

Abstract: A piling base apparatus, method for making same, a corresponding foundation pile system, and process for installation, the piling base apparatus having a generally solid body, a top end surface, a bottom end surface, and a side surface extending between the top end surface and the bottom end surface. The surface area of the bottom end surface is less than the surface area of the top end surface. At least one ridge extends generally about the side surface in a generally downward direction from the top end surface to the bottom end surface. Each ridge has an offset surface extending generally outward from the surface of the side surface. An end of a strand is fixed to the piling base apparatus, the strand extending outwardly from the top end surface.
Field of the Invention

[0002] The present invention relates generally to segmented underpinning piles for supporting a structure disposed upon the Earth's surface and, in a specific though non-limiting example embodiment, to a piling base apparatus that enables a more effective installation of segmented underpinning piles into the Earth.

Background of the Invention

[0003] Known foundation pile segments (or, more simply, "foundation piles") are used to transfer loads applied to or resulting from disposition of aboveground structures, such as buildings, slabs, walls and columns. A first pile segment is typically driven into the Earth by means of a driving force, and is then followed by additional pile segments being inserted into the ground space created by the first pile segment. A cable or strand may be fixed to the first pile segment and threaded through successive additional pile segments, thereby enabling a linear stacking of all the pile segments.

Summary of the Invention

[0004] Presented herein is a piling base apparatus having a generally solid body, a top end surface, a bottom end surface, and a side surface extending between the top end surface and the bottom end surface. In some embodiments, the surface area of the bottom end surface is less than the surface area of the top end surface. In other embodiments, at least one ridge extends generally about a side surface in a generally downward direction measured from the top end surface toward the bottom end surface. In still other
embodiments, each ridge has an offset surface extending generally outward from the surface of the side surface. In further embodiments still, one end of a strand is fixed to the piling base apparatus, with the strand extending outwardly from the top end surface.

[0005] A method of making a piling base apparatus is also provided, the method including the steps of: forming two conical section halves, each having a top end surface, a bottom end surface, a side surface, and a cord surface; mutually facing the cord surfaces of the two section halves to one another, aligning the two top end surfaces; and laterally displacing the two side surfaces, thereby forming at least one ridge extending generally about the side surfaces and in a generally downward direction from the top end surfaces to the bottom end surfaces. In a presently preferred embodiment, at least one ridge has an offset surface extending generally outward from at least one of the side surfaces.

[0006] Further, a foundation pile system for supporting a structure having a spiral lock starter segment is provided, the system including a pile segment, a cap member, and a support member. In one embodiment, the spiral lock starter has a generally solid body portion, a top end surface, a bottom end surface, and a side surface extending from the top end surface down toward the bottom end surface. In another embodiment, the surface area of the bottom end surface is less than the surface area of the top end surface. In further embodiments, at least one ridge extends generally about the side surface in a generally downward direction from the top end surface to the bottom end surface. It is presently contemplated that each ridge should include an offset surface extending generally outward from the surface of the side surface, and that an end of a strand should be fixed to the piling base apparatus, with the strand extending outwardly from the top end surface. In further embodiments, the pile segment has a hole extending longitudinally therethrough, thereby allowing the strand of the spiral lock starter segment to be threaded there through. A capping member is then placed between the structure and the pile segment, whereby a second end of the strand may be affixed. Finally, a support member abuts between a side of the cap member opposite the pile segment and the structure.

[0007] Further, a process for installing segmented underpinning piles for supporting a
structure upon the earth is provided, wherein the process includes at least the steps of: driving a threaded piling base having an end of a strand into unexcavated earth a desired distance from the structure; sliding a pile segment on the strand until the pile segment contacts the end of the threaded piling base; and driving the pile segment a further desired distance into the earth. The threaded piling base has a generally solid body, a top end surface, a bottom end surface, and a side surface extending between the top end surface and the bottom end surface. The surface area of the bottom end surface is less than the surface area of the top end surface. At least one ridge extends generally about the side surface in a generally downward direction from the top end surface to the bottom end surface. Each ridge has an offset surface extending generally outward from the surface of the side surface. The end of the strand is fixed to the threaded piling base, the strand extending outwardly from the top end surface.

Brief Description of the Several Drawings

[0008] FIG. 1 is a perspective view of a threaded piling base according to the present invention.

[0009] FIG. 2 is a top view of a threaded piling base according to the present invention.

[0010] FIG. 3 is a bottom view of a threaded piling base according to the present invention.

[0011] FIG. 4 is a side view of a foundation pile system according to the present invention.
Detailed Description

[0012] Each of FIGS. 1-4 illustrates a threaded piling base and foundation pile system (and method of installing same) embodying various aspects of the present invention. While these particular piling bases are illustrated and described herein for exemplary purposes, variations of the piling base and methods of utilizing or installing the same will become readily apparent to one skilled in the relevant structural or mechanical arts after reading the present Description and / or reviewing the accompanying Drawings. Thus, disclosure herein of representative embodiments of the present invention does not limit the scope of the structures, systems, and methods described and claimed below.

[0013] Referring now to FIG. 1, a piling base apparatus according to the invention is depicted in the form of a precast pile 1, which may also be referred to as a spiral lock starter segment, a first pile segment, a first segmented underpinning pile, a threaded piling base, or using other similar terms. Pile 1 may be formed from materials, mixtures, and components generally known in the art, such as wood, metal and epoxy, or using other materials including those generally known and used for foundation pile construction. In a presently preferred embodiment, pile 1 is composed of an epoxy containing composite material. Pile 1 is a generally solid body, having a top end surface 5, a bottom end surface 6, and a side surface 3 extending between top end surface 5 and bottom end surface 6. At least one ridge offset surface 4 extends from top end surface 5 to bottom end surface 6. Ridge offset surface 4 extends generally outward from side surface 3. Top end surface 5 is designed to sustain a downwardly directed driving force (e.g., a force applied by a hydraulic ram or using other pile segments) during installation of pile 1 into the soil or earth.

[0014] In the proposed embodiment of FIG. 1, pile 1 is generally a solid body that forms a frustum between top end surface 5 and bottom end surface 6. In some embodiments, side surface 3 tapers from top end surface 5 to bottom end surface 6, with bottom end surface 6 having a surface area less than top end surface 5. In a presently preferred embodiment, the eccentricity of the taper of side surface 3 from top end surface 5 to bottom end surface 6 is
approximately sixty (60) degrees.

[0015] Means may be provided for connecting pile 1 to other pile segments. In one embodiment, one end of strand 7 is fixedly received by pile 1, anchored or bonded within pile 1 using known bonding means. In a presently preferred embodiment, strand 7 extends outwardly from top end surface 5, typically outward along a common axis established between top end surface 5 and bottom end surface 6. In a particular, though non-limiting, embodiment, strand 7 comprises a steel cable having a high strength, e.g., a steel having approximately 200,000 psi yield strength. The ends of the cable may be painted to indicate cable length. Other materials and methods may be used for connecting pile 1 to other pile segments. Strand 7 may be a solid rod, a single filament wire, composed of metal or plastic, or a material having rope like properties. In an equivalent manner, one or more fasteners distributed on pile 1 may function for strand 7. A female receiving receptacle may be placed on pile 1 for later insertion of a connecting component. A glue or epoxy may be alternatively or conjunctively used as a means for securing or connecting pile 1 to other pile segments.

[0016] In an alternate embodiment, ridge offset surface 4 comprises a non-planar ribbon surface, formed by imparting a rotation force relative to top end surface 5 on the narrow dimension of the ribbon surface, as ridge offset surface 4 extends downward toward bottom end surface 6. The non-planar ribbon surface may also be called a flaring screw plane, i.e., a flaring screw plane having a slight curve or curl.

[0017] In a further embodiment, ridge offset surface 4 may be formed into the shape of a flaring screw plane through a rotation of ridge offset surface 4 about the common axis of top end surface 5 and bottom end surface 6 as ridge offset surface 4 traverses from top end surface 5 toward bottom end surface 6. As illustrated in FIG. 1, ridge offset surface 4 traverses about side surface 3 an arc distance of approximately fifteen degrees from top end surface 5 to bottom end surface 6, thereby forming the flaring screw plane of ridge offset surface 4, demonstrating a slight recurve, or curl.
[0018] FIG. 2 illustrates a top view of top end surface 5 of pile 1. Side surface 3 generally encompasses top end surface 5, except for one or more ridge offset surfaces 4. Strand 7 is shown embedded in pile 1, extending outward generally perpendicular from the average center of top end surface 5 and generally parallel to the common axis of top end surface 5 and bottom end surface 6 (not illustrated).

[0019] In the embodiment as shown in FIG. 2, ridge offset surfaces 4 deviates from the generally circular shape of side surface 3 about top end surface 5. Top end surface 5 exhibits variations in diameter due to the deviations caused by ridge offset surfaces 4. As shown in FIG. 2, the approximate diameter of top end surface 5 has a maximum along the axis connecting the ridge offset surfaces 4, representing the major axis of top end surface 5. The approximate diameter of top end surface 5 exhibits a minimum at a location approximately perpendicular from the location of ridge offset surfaces 4, representing the minor axis of top end surface 5. Although variations in the diameter of top end surface 5 may exist, an average diameter for top end surface 5 may be calculated.

[0020] FIG. 3 illustrates a bottom view of bottom end surface 6 of pile 1. Side surface 3 generally encompasses bottom end surface 6, except for one or more ridge offset surfaces 4.

[0021] In the embodiment as shown in FIG. 3, ridge offset surfaces 4 deviates from the generally circular shape of side surface 3 about bottom end surface 6. Bottom end surface 6 exhibits variations in diameter due to the deviations caused by ridge offset surfaces 4. As shown in FIG. 3, the approximate diameter of bottom end surface 6 has a maximum along the axis connecting the ridge offset surfaces 4, representing the major axis of bottom end surface 6. The approximate diameter of bottom end surface 6 exhibits a minimum at a location approximately perpendicular from the location of ridge offset surfaces 4, representing the minor axis of bottom end surface 6. Although variations in the diameter of bottom end surface 6 may exist, an average diameter for bottom end surface 6 may be calculated.
[0022] In a presently preferred embodiment, bottom end surface 6 has a minor axis length of approximately three quarters of an inch, with a major axis length of approximately one and three quarters of an inch.

[0023] In one embodiment, the longitudinal distance from top end surface 5 to bottom end surface 6 is typically four and one half inches (4.5"). It will be apparent to one skilled in the art that other dimensions of the piling base may be obtained, as required. For example, piling bases may be made longer or shorter and bigger or smaller than the five inch (5") diameter piles depicted in the Figures. It will also be apparent to those skilled in the art that there may be certain practical limitations, i.e., strength, to the size and dimensions of the piling base design.

[0024] In a presently preferred embodiment, the ratio of the average diameter of top end surface 5 to the average diameter of bottom end surface 6 is approximately six to one (6:1).

[0025] A method of making a piling base apparatus of the present invention is to form two conical section halves, each having a top end surface, a bottom end surface, a side surface, and a chord surface. The cord surface forming the conical section half is a plane generally perpendicular to both the top end surface and bottom end surface, intersecting approximately along the common axis of top end surface and bottom end surface.

[0026] The two chord surfaces are then faced mutually to one another, aligning the two top end surfaces along a common plane. The two conical section halves are laterally displaced from one another, exposing a portion of at least one of the chord surfaces. The exposed portion of the chord surface forms an offset ridge surface extending generally between the side surfaces and in a generally downward direction from the top end surfaces to the bottom end surfaces.

[0027] FIG. 4 illustrates the piling base apparatus according to the present invention used in a foundation pile system that is used to provide support to an existing structure 9. Pile 1 is a spiral lock starter segment fixedly receiving one end of strand 7. Pile 1 is located underneath existing structure 9. A hole extends longitudinally through each of pile
segments 13. Strand 7 is threaded through pile segments 13, causing pile segments 13 to generally stack on top or over pile 1. A pile cap 16 receives the other end of strand 7. Support blocks 14 typically abut between structure 9 and pile cap 16, connecting and transferring the load of structure 9 to pile cap 16. Space 14 is used to accommodate lifting jacks during the installation process. Void or takeup spaces 17, located beneath pile cap 16, reduce the possibility of damage due to swelling or heaving of clay soils.

[0028] In an alternate embodiment, pile segments 13 may also be threaded, having ridge offset surfaces along the side surface of pile segments 13.

[0029] The piling base apparatus according to the present invention may be used in the process of installing segmented underpinning piles for supporting a structure upon the earth. First, a threaded piling base, pile 1 is driven into unexcavated earth a desired distance from an existing structure 9. One end of strand 7 is fixed to pile 1. A pile segment 13 is slid on strand 7 until pile segment 13 contacts top end surface 5 of pile 1. Pile segment 13 is then driven another desired distance into the earth. These steps may be repeated until the desired total depth is reached, such as until the resistance from the earth reaches a certain required driving force.

[0030] In an alternate embodiment, the process of installing segmented underpinning piles may use pile segments that are threaded in conjunction with the threaded piling base.

[0031] The use of the threaded piling base, which may also be called a spiral lock starter, when used with threaded pile segments typically enables penetration deeper into the earth and increases efficiency during the installation process.

[0032] Thus, the foregoing description is presented for purposes of illustration and description, and is not intended to limit the invention to the forms disclosed herein. Consequently, variations and modifications commensurate with the above teachings and the teaching of the relevant art are within the spirit of the invention. Such variations will readily suggest themselves to those skilled in the relevant structural or mechanical art. Further, the embodiments described are also intended to explain the best mode for
practicing the invention, and to enable others skilled in the art to utilize the invention and such or other embodiments and with various modifications required by the particular applications or uses of the invention. It is intended that the appended claims be construed to include alternative embodiments to the extent that is permitted by prior art.
Claims

What is claimed is:

5 L. A piling base apparatus comprising:
    a generally solid body having,
    a top end surface;
    a bottom end surface, said bottom end surface having a surface area that is less
    than the surface area of said top end surface;
    a side surface extending between said top end surface and said bottom end
    surface; and
    said side surface having at least one ridge extending generally about said side
    surface and in a generally downward direction from said top end surface to
    said bottom end surface, wherein said at least one ridge has an offset
    surface extending generally outward from the surface of said side surface.

2. The piling base of Claim 1 wherein said generally solid body further comprises means
   for connecting pile segments to the piling base.

3. The piling base of Claim 1 wherein said generally solid body further comprises an end
   of a strand fixedly received therein, said strand extending outwardly from said top end
   surface of the piling base.

4. The piling base of Claim 1 wherein said generally solid body forms a frustum between
   said top end surface and said bottom end surface.

5. The piling base apparatus of Claim 1 wherein each said ridge extending generally
   about said side surface and in a generally downward direction from said top end
   surface to said bottom end surface traverses about said side surface an arc distance of
   approximately fifteen degrees.
6. The piling base apparatus of Claim 1 wherein said side surface tapers approximately sixty degrees from said top end surface to said bottom end surface.

7. The piling base apparatus of Claim 1 wherein said bottom end surface has a minor axis length of approximately three quarters of an inch.

8. The piling base apparatus of Claim 1 wherein said bottom end surface has a major axis length of approximately one and three quarters of an inch.

9. The piling base apparatus of Claim 1 wherein the ratio of the average diameter of said top end surface to the average diameter of said bottom end surface is approximately six to one (6:1).

10. The piling base apparatus of Claim 1 wherein said offset surface of said at least one ridge forms a flaring screw plane, having a curl on said flaring screw plane.

11. The piling base apparatus of Claim 1 wherein said extension about said side surface of said ridge traverses about said side surface an arc distance of approximately fifteen degrees, whereby said offset surface of said ridge forms a flaring screw plane, having a curl on said flaring screw plane.

12. The piling base apparatus of Claim 1 wherein said generally solid body is a composite material.

13. The piling base apparatus of Claim 1 wherein said generally solid body further comprises an epoxy resin composition.
14. A foundation pile system for supporting a structure comprising:
   a spiral lock starter segment having a generally solid body having,
      a top end surface;
      a bottom end surface, having a surface area of said bottom end surface that is
      less than the surface area of said top end surface;
      a side surface extending between said top end surface and said bottom end
      surface; and
      said side surface having a ridge extending generally about said side surface and in a generally downward direction from
      said top end surface to said bottom end surface, wherein said ridge has an offset surface extending generally
      outward from the surface of said side surface;
   a pile segment disposed on said spiral lock starter segment;
   a cap member disposed between the structure and said pile segment; and
   a support member on a side of said cap member opposite said pile segment, said
   support member for abutment with said structure.

15. The foundation pile system of Claim 14 wherein said spiral lock starter segment further
    comprises means for connecting said pile segment to said spiral lock starter segment.

16. The foundation pile system of Claim 14 wherein said generally solid body of said
    spiral lock starter segment forms a frustum between said top end surface and said
    bottom end surface.

17. The foundation pile system of Claim 14 wherein each said ridge extending generally
    about said side surface and in a generally downward direction from said top end
    surface to said bottom end surface of said spiral lock starter segment traverses about
    said side surface an arc distance of approximately fifteen degrees.

18. The foundation pile system of Claim 14 wherein said side surface of said spiral lock
    starter segment tapers approximately sixty degrees from said top end surface to said
    bottom end surface.
19. The foundation pile system of Claim 14 wherein said bottom end surface of said spiral lock starter segment has a minor axis length of approximately three quarters of an inch.

20. The foundation pile system of Claim 14 wherein said bottom end surface of said spiral lock starter segment has a major axis length of approximately one and three quarters of an inch.

21. The foundation pile system of Claim 14 wherein the ratio of the average diameter of said top end surface to the average diameter of said bottom end surface of said spiral lock starter segment is approximately six to one (6:1).

22. The foundation pile system of Claim 14 wherein said offset surface of said at least one ridge of said spiral lock starter segment forms a flaring screw plane, having a curl on said flaring screw plane.

23. The foundation pile system of Claim 14 wherein said extension about said side surface of said ridge of said spiral lock starter segment traverses about said side surface an arc distance of approximately fifteen degrees, whereby said offset surface of said ridge forms a flaring screw plane, having a curl on said flaring screw plane.

24. The foundation pile system of Claim 14 wherein the generally solid body of said spiral lock starter segment is a composite material.

25. The foundation pile system of Claim 14 wherein the generally solid body of said spiral lock starter segment further comprises an epoxy resin composition.

26. The foundation pile system of Claim 14 wherein said pile segment further comprises a threaded sidewall surface.
27. A foundation pile system for supporting a structure comprising:
   a spiral lock starter segment having a generally solid body having,
      a top end surface;
      a bottom end surface, having a surface area of said bottom end surface that is
      less than the surface area of said top end surface;
      a side surface extending between said top end surface and said bottom end
      surface;
      said side surface having a ridge extending generally about said side surface and in a generally downward direction from
      said top end surface to said bottom end surface, wherein said ridge has an offset surface extending generally
      outward from the surface of said side surface; and
   an end of a strand fixedly received therein, said strand extending outwardly
   from said top end surface of said spiral lock starter segment;
   a pile segment having a hole extending longitudinally there through, whereby said strand may be threaded;
   a cap member between the structure and said pile segment, whereby a second end
   of said strand may be affixed; and
   a support member on a side of said cap member opposite said pile segment, said
   support member for abutment with said structure.

28. The foundation pile system of Claim 27 wherein said generally solid body of said
   spiral lock starter segment forms a frustum between said top end surface and said
   bottom end surface.

29. The foundation pile system of Claim 27 wherein each said ridge extending generally
   about said side surface and in a generally downward direction from said top end
   surface to said bottom end surface of said spiral lock starter segment traverses about
   said side surface an arc distance of approximately fifteen degrees.

30. The foundation pile system of Claim 27 wherein said side surface of said spiral lock
   starter segment tapers approximately sixty degrees from said top end surface to said
   bottom end surface.
31. The foundation pile system of Claim 27 wherein said bottom end surface of said spiral lock starter segment has a minor axis length of approximately three quarters of an inch.

32. The foundation pile system of Claim 27 wherein said bottom end surface of said spiral lock starter segment has a major axis length of approximately one and three quarters of an inch.

33. The foundation pile system of Claim 27 wherein the ratio of the average diameter of said top end surface to the average diameter of said bottom end surface of said spiral lock starter segment is approximately six to one (6:1).

34. The foundation pile system of Claim 27 wherein said offset surface of said at least one ridge of said spiral lock starter segment forms a flaring screw plane, having a curl on said flaring screw plane.

35. The foundation pile system of Claim 27 wherein said extension about said side surface of said ridge of said spiral lock starter segment traverses about said side surface an arc distance of approximately fifteen degrees, whereby said offset surface of said ridge forms a flaring screw plane, having a curl on said flaring screw plane.

36. The foundation pile system of Claim 27 wherein the generally solid body of said spiral lock starter segment is a composite material.

37. The foundation pile system of Claim 27 wherein the generally solid body of said spiral lock starter segment further comprises an epoxy resin composition.

38. The foundation pile system of Claim 27 wherein said pile segment further comprises a threaded sidewall surface.
39. A process of installing segmented underpinning piles for supporting a structure upon
the earth comprising the steps of:
driving a threaded piling base into unexcavated earth a desired distance from said structure,
said threaded piling base having,
a top end surface;
a bottom end surface, having a surface area of said bottom end surface that is less than the
surface area of said top end surface;
a side surface extending between said top end surface and said bottom end surface;
and
said side surface having at least one ridge extending generally about said side
surface and in a generally downward direction from said top end surface to said
bottom end surface, wherein said at least one ridge has an offset surface
extending generally outward from a surface of said side surface;
disposing a pile segment on said threaded piling base; and

driving said pile segment another desired distance into the earth.

40. The process of Claim 39 wherein said pile segment further comprises a threaded
sidewall surface.
41. A process of installing segmented underpinning piles for supporting a structure upon
the earth comprising the steps of:
    driving a threaded piling base into unexcavated earth a desired distance from said structure,
said threaded piling base having,
a top end surface;
a bottom end surface, having a surface area of said bottom end surface that is less than the
surface area of said top end surface;
a side surface extending between said top end surface and said bottom end surface;
said side surface having at least one ridge extending generally about said side
surface and in a generally downward direction from said top end surface to said
bottom end surface, wherein said at least one ridge has an offset surface
extending generally outward from a surface of said side surface; and
an end of a strand fixedly received therein, said strand extending outwardly from
said top end surface of said threaded piling base;
sliding a pile segment on said strand until said pile segment contacts said top end surface of
said threaded piling base; and
driving said pile segment another desired distance into the earth.

42. The process of Claim 41 wherein said pile segment further comprises a threaded
sidewall surface.
FIG. 1