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METHOD AND APPARATUS FOR FORMING BULBULAR BASE PILES

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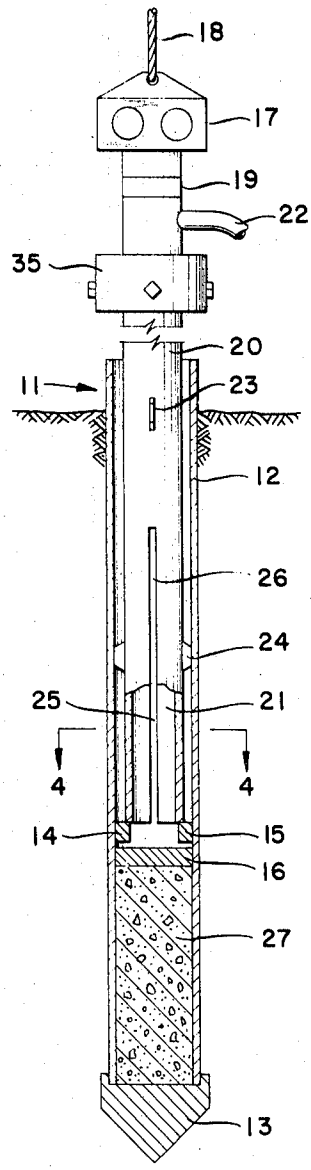


FIG. 1

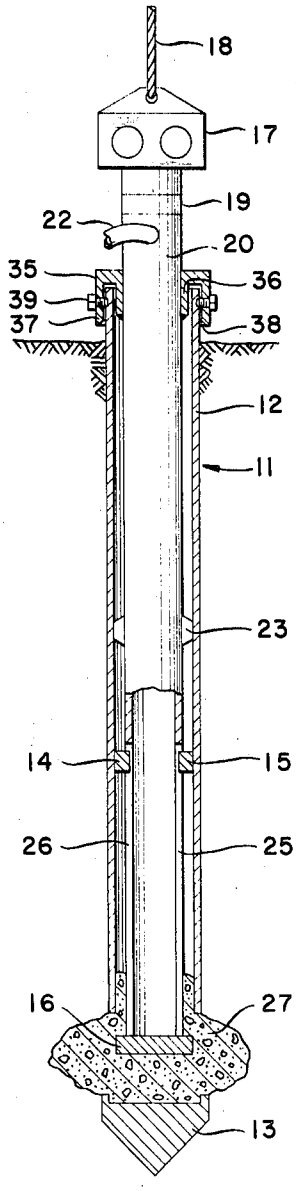


FIG. 2

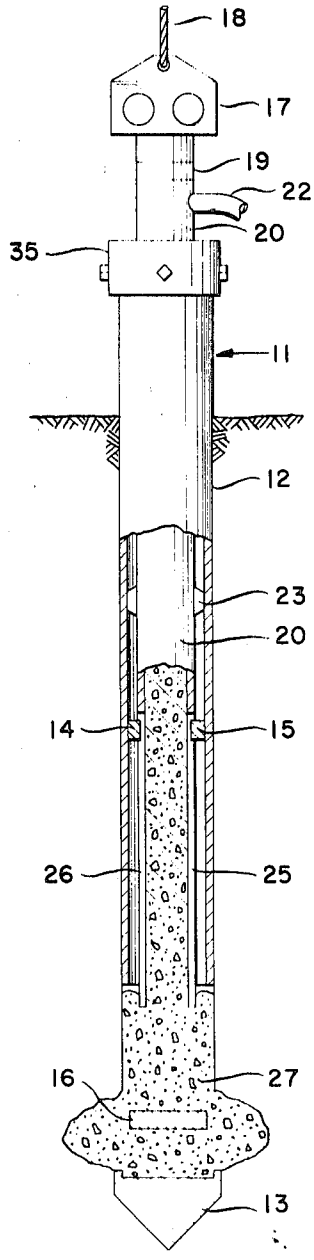


FIG. 3

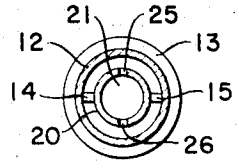


FIG. 4

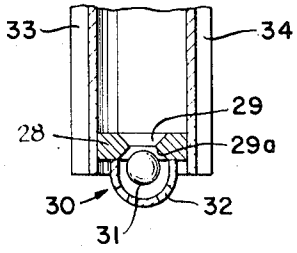


FIG. 5

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METHOD AND APPARATUS FOR FORMING BULBULAR BASE PILES

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U.S. Cl. 61—53.6 4 Claims

ABSTRACT OF THE DISCLOSURE

A borehole forming tool or drive pipe is provided with an ejection chamber at one end and with means for connecting the tool to a sonic driving head. A sonic driving head is provided with a driving mandrel which is constructed to telescopically receive the tool and adapted to drivingly engage the drive pipe in one position and engage a piston in the ejection chamber of the pipe in a second position. The ejection is filled with a charge of solidifiable material such as cement and then driven sonically to the desired depth in an earth formation, the mandrel is then rotated to engage the piston and the charge of material then sonically ejected from the chamber and into the form of a radially-extensible mass in the formation.

BACKGROUND OF THE INVENTION

Field of the invention

In the construction of buildings, bridges, piers, drilling platforms and other similar structures, it is essential that a solid, stable foundation be established on which to rest the structure. Such foundations are generally established by placing a number of piles into the earth on which to rest the structure. The load capacity of these piles depend upon such factors as soil conditions and size, shape and length of pile. The resistance of a pile to displacement in an earth formation is provided by the friction along the length of the pile and on tip resistance. In some soils very little shaft resistance is encountered in which case, tip or end resistance must carry the entire load.

The present invention relates to the construction in place of bulbular base concrete piles and pertains more particularly to a method and apparatus for the forming in place of concrete end-bearing piles having a large bulbular base or foot.

The type of soil into which the pile is driven has an important bearing upon its load carrying capacity. For example, piles which are sunk into clay type soils carry most of the applied load by soil friction along their shaft length. Very little resistance is supplied by the tip. On the other hand, piles which are placed into a sandy type of formation carry most of the applied load by tip resistance when the load acts downward, and very little of the load is carried by soil friction along the shaft.

It has been found that an ideal shape for an end or tip-bearing pile would be one having a large or bulbous base or foot, and a normal or regular sized shaft. Such a shape for such piles would offer great savings in material in that the length and diameter of the shaft of such a pile would be much less than for a pile of constant diameter having the same load carrying capacity.

Description of prior art

Various methods are known for constructing bulbular or large based piles. Perhaps the better known method is the Franki method. In accordance with this method a specially constructed rig is moved to the construction site. A casing or heavy guage, high-tensile alloy steel is raised in place. A portion of very dry concrete is then placed in the bottom of the casing to form a driving

plug. Next, a heavy, solid ram weighing from two to four tons is lowered into the casing and raised and dropped to drive the plug into the ground which pulls or carries the casing with it by means of friction between it and the casing. At the desired level the casing is then anchored to the rig and the plug driven out the bottom of casing. More concrete is then dumped into the casing and rammed out the bottom of the casing to form the bulb. The casing is then raised small increments as more concrete is dumped into the casing and rammed out the bottom to form the rest of the pile.

Among the disadvantages of the prior known methods of constructing such bulbular base piles is that the steps are long and slow and require heavy and cumbersome equipment. Such methods are time consuming and therefore expensive.

Furthermore, the apparatus used being heavy, complicated and cumbersome, is also expensive.

SUMMARY OF THE INVENTION

It is therefore the primary object of the present invention to overcome the above and other disadvantages of such prior methods and apparatus by providing a method and apparatus that is rapid and efficient for the construction in place of high load capacity piles.

It is a further object of the present invention to provide a method that is simple, easy to use and rapid in the formation in place of high load capacity piles.

Still another object of the present invention is to provide a method of forming bulbular base piles that utilizes a sonic driving head as power means for forming the bulbular base.

A further object of the present invention is to provide a method of forming bulbular based piles that takes advantage of the power and efficiency of a sonic driving head to form the borehole and the bulbular base for the pile.

Still a further object of the present invention is to provide a method of forming bulbular base piles that takes maximum advantage of the various load carrying capacities of the various strata in an earth formation.

BRIEF DESCRIPTION OF THE DRAWING

The above and other objects and advantages will become apparent from the following description illustrating a preferred embodiment of the invention when read in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic view taken partially in section showing the apparatus of the present invention imbeded to a predetermined depth in an earth formation.

FIG. 2 is a diagrammatic view of the apparatus of the present invention in the process of forming the bulbular base of the pile.

FIG. 3 is a diagrammatic view partially in section showing the base for the pile formed and the apparatus being withdrawn from the borehole while the shaft of the pile is being formed.

FIG. 4 is a section through 4—4 of FIG. 1 of the apparatus.

FIG. 5 is a sectional view of a modification of the driving mandrel.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIGS. 1–4, a preferred embodiment of the apparatus is illustrated. As seen in FIGS. 1–4, the apparatus comprises a borehole forming tool **11** in the form of an elongated tubular member, pipe or casing section **12** having a driving cap or plug **13** closing the lower or driven end thereof to form an ejection chamber. The tubular member **12** has stop means in the form of lugs **14** and **15** affixed to the inner wall and spaced from the lower end thereof. A piston or plug member **16** is

slidably received in the lower end of the tubular member between the stop means and plug means **13**, thus forming a variable volume chamber, the function of which will be more fully explained hereinbelow.

The driving apparatus comprises a sonic vibratory driving head **17** supported by suitable means such as a cable **18** and a suitable derrick or crane structure (not shown). The driving head **17** is coupled by swivel coupling **19** to an elongated driving mandrel **20** having a central bore **21** therethrough forming a conduit in communication with conduit **22** leading from a suitable source (not shown) of fluid solidifiable material such as cement or concrete. The driving mandrel **20** extends into the tubular member **12** and engages the stops or lugs **14** and **15** to form a driving connection therebetween. Spacers **23** and **24** may be provided between members **12** and **20** to the members with respect to one another. The mandrel **20** is provided with slots **25** and **26** therein for receiving lugs **14** and **15** and permitting the mandrel to slide past lugs **14** and **15** when rotated 180° and engage plug or piston member **16**. This construction permits the driving mandrel to engage the piston member **13** and drive it downwardly and out the bottom of the tubular member **12** as shown in FIGS. 2 and 3.

The aforementioned connection between the mandrel and the bore tool may be reversed. That is, the lugs may be formed on the mandrel and a slotted sleeve be attached to the interior of the bore tool. The driving mandrel may also be connected to the bore tool by means of a bayonet connection or suitable clamp means (not shown). Such a connection would offer a more positive connection between the members.

An alternate form of the piston means which serves as the upper wall of the chamber is shown in FIG. 5. This arrangement eliminates the need of the piston or plug member **16** and also eliminates the need of charging or filling the ejection chamber before the bore-forming tool or drive pipe is driven. In this embodiment the lower end of the driving mandrel **20** is closed off such as by a wall member **28**. The wall member **28** has a central opening pointing up therethrough which may be closed off such as by a check valve **30**. The check valve **30** as illustrated comprises a spherical member **31** which is floatingly retained in a cage **32**. Valve **30** is responsive to pressure from below to move member **31** into engagement with the seat **29***a* of opening **29** to restrict the flow of material therethrough in the upward direction. When subjected to pressure from above, the spherical member **31** will unseat or disengage from the seat **29***a* and permit free flow of material through the opening **29**. Slots **33** and **34** formed in the driving mandrel **25** are provided to permit passage of stop means or lugs **14** and **15**. These slots do not extend completely through the walls of the mandrel **20**.

Suitable means may be provided for retrieving the bore-forming tool or drive pipe. Any suitable means may be provided for this purpose, such as clamp means **35**. Clamp means **35** comprises backup mandrel **36** extending downward along the body of the driving mandrel **20**. A skirt **37** extends downward parallel to the fixed mandrel in spaced relationship thereto to form an annular space **38** into which the end of the drive pipe may be received. A number of screws **39** which extend through this skirt **37** and into the annular space **38** are spaced circumferentially around the skirt **37**. These said screws **39** extend into engagement with the drive pipe or tubular member **12** forcing it into tight engagement with the fixed mandrel **36**, thus providing a tight driving engagement or connection between the driving mandrel **20** and the drive pipe **12**. The clamp means **35** is rigidly connected to the driving mandrel **20** in any suitable manner such as by welding or by brazing.

OPERATION

In forming a bulbular base pile with the above described apparatus, the piston **16** is placed in the lower end of tubular member **12** against stops **14** and **15**. This forms a chamber in which a batch or charge of suitable solidifiable material such as cement or concrete is placed and the lower end is then closed off by plug **13**. The bore forming tool is then vertically positioned in place and the driving mandrel **20** is then inserted into the tool and against the stops **14** and **15** or otherwise connected to tubular member **12**. The driving head **17** is started and lowered with the mandrel **20** as it drives the tool or drive pipe **11** into the earth formation. When the tool reaches the desired depth, the driving is halted and driving mandrel rotated the necessary amount, say 180°, so that lugs **14** and **15** engage slots **25** and **26** and the mandrel slides past the stops and into engagement with piston **16**. The driving action of the head **17** and mandrel **20** is again renewed and the piston **16** driven out the end of member **12** forcing ahead of it the batch or charge of cement **27** and cap **13**. The cement charge, as it is driven out the end of the tubular member **12**, forces the surrounding earth formation radially outwardly forming an enlarged radially-extensible or bulbular base or footing for the pile, as shown in FIG. 2. After the bulbular base is formed for the pile, the driving mandrel **20** and tubular member **12** are clamped together and more concrete or cement in the fluid state is pumped through conduit **22** and bore **21** of the mandrel **20** to fill the borehole and form the shaft of the pile as the driving apparatus and tubular member **12** is vibrated and hoisted or lifted from the borehole, as shown in FIG. 3. The apparatus is then ready to be moved into position for forming the next pile.

The modification of the driving mandrel **35** illustrated in FIG. 5 greatly simplifies the above-described operation by eliminating the necessity of using the plug or piston means **16** and also eliminating the necessity of filling the ejection chamber with a charge of the soidifiable material before driving the tubular member **12** into the earth formation.

The present invention is not intended to be limited to the foregoing illustrative embodiments, as it can be readily seen that various changes may be made in the invention without departing from the intended spirit and scope of the invention as defined by the appended claims.

I claim as my invention:

1. A method of forming a bulbular based pile comprising the steps of:

providing an elongated pile-forming member having an axial bore therein with piston means to form a chamber in the lower end thereof when said end is closed;

placing a fluid mixture of solidifiable material in said chamber;

closing said lower end of said member;

sonically forcing said lower end of said member into an earth formation to a desired level to thereby form a borehole in said formation;

providing a sonic driver having a portion thereof adapted to extend into said tubular member and drivingly engage the upper end of said chamber;

inserting said portion into said tubular member and into driving engagement with the upper end of said chamber; and,

sonically forcing said solidifiable material out of said chamber and into the form of a mass of enlarged diameter in said formation.

2. The method of claim **1** including the step of:

limiting the travel of said piston means within said chamber;

providing said extending means with means to engage said tubular member when in a first position of adjustment and to engage said piston means when in a second position of adjustment.

3. Apparatus for the formation in place of bulbular base piles comprising:

a sonic vibratory driving head;

an elongated driving mandrel attached to said driving head;

a plurality of slots extending partially along said mandrel;

conduit means communicating with one end of said driving mandrel and a point adjacent said driving head;

a bore-forming tool telescopically received on said driving mandrel;

a plurality of lugs extending inward from said bore-forming tool and adapted to be received in said slots;

a variable volume chamber in one end of said tool;

reciprcable piston means forming an upper wall for said chamber;

said driving mandrel engaging said lugs for driving said bore-forming tool in one angle adjustment with respect to said tool and said mandrel by-passing said lugs for driving said upper wall of said chamber in a second angle of adjustment.

4. The apparatus of claim 3 wherein:

the lower end of said driving mandrel forms said piston means.

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JACOB SHAPIRO, Primary Examiner

U.S. Cl. X.R.

61—53.64, 53.7