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METHOD OF FORMING DRILLED CAST-IN-PLACE PILES

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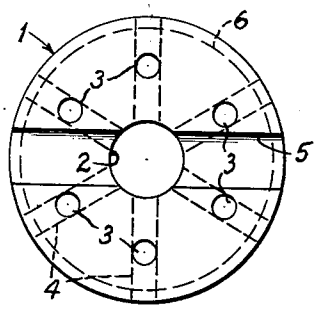


FIG. 1.

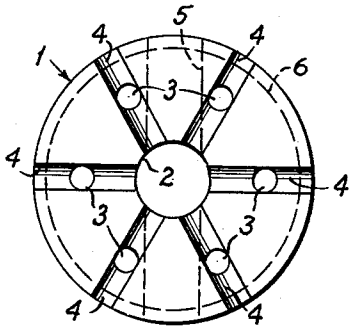


FIG. 2.

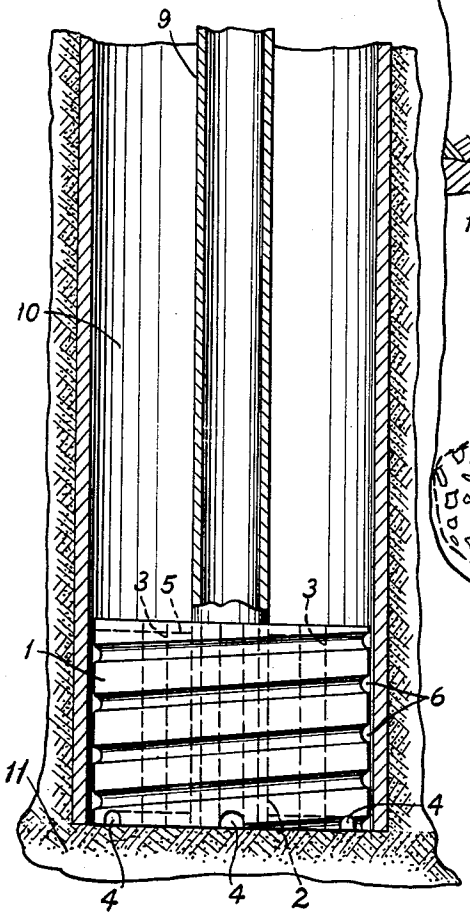


FIG. 4.

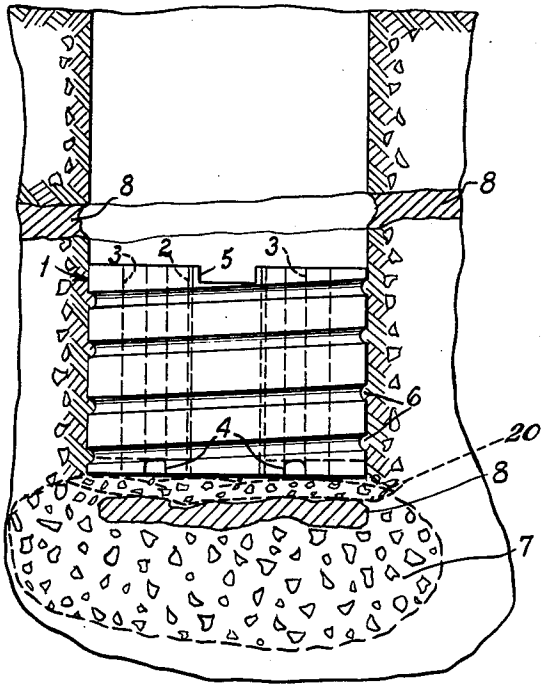


FIG. 3.

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METHOD OF FORMING DRILLED CAST-IN-PLACE PILES

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The invention relates primarily to an extremely efficient construction for a piling designed and tested in final position to carry a certain and definite prescribed load. Heretofore it has been impossible to place a pile in position and be certain that it will carry a certain load.

An object of my invention is to provide a piling which has a precast base which is threaded into final position and which therefor provides a stabilized base for the remainder of the piling which it supports and forms a part of.

Another object of my invention is to provide a unique way of setting the precast base in position so that it compacts the materials which lie in its path of descent into final position, forming a compacted "plug" upon which the precast base rests and with which it is integral.

A further object of my invention is to provide a novel way of driving my precast base, utilizing rotary motion as well as, and in continuous combination with, driving pressure to accomplish two purposes: first an easier and more efficient driving of the piling, and second a most effective formation of the compacted "plug" mentioned above.

An additional object of my invention is to provide a construction for the formation of a cast-in-place piling in which the precast base used in drilling and in compacting, forms an integral part of the base for the entire pile.

With the above general objects in view and others which will be obvious to those skilled in the art from the description hereinafter, the invention consists in the steps and features which will be first described in connection with the accompanying drawings and then more particularly pointed out.

In the drawings:

FIGURE 1 is a plan view of the pile base;

FIGURE 2 is a bottom view of the pile base;

FIGURE 3 is a cutaway view of the pile base after it has been driven by rotation and driving, partially into the earth, showing the formation of the compacted "plug" under the pile base.

FIGURE 4 is an elevational view, partially in cross-section, showing the pile base in position, inside a pile casing and with a pipe attached to the base for grout pumping.

For my invention I precase cylindrical pile bases in the manner shown in FIGURES 1, 2 and 3. Numeral 1 is the pile base. Through the central longitudinal axis of the pile base is disposed a grout pipe hole 2, which pierces the base completely. Similarly piercing the pile base 1 also along its longitudinal axis are six grout return holes 3. On the bottom surface of the pile base are six channels 4, which communicate with the cylindrical outer surface of the pile base.

On the top surface, shown in FIGURE 1, the pile base is provided with an auger slot 5. The purpose of this slot is to provide a keyed arrangement whereby the pile base may be rotated while it is being driven, by an ordinary auger arrangement. The auger is provided with a bar which lies in the slot; turning the auger under power turns the bar and hence the pile base rotates under power.

On its outer cylindrical surface the pile base is ringed with "threads" or annular depressions 6, which are shown in FIGURES 3 and 4. These threads provide relief to great friction created by the rotational and translatory

movement of the pile base as it penetrates layer after successive layer of the earth.

For my invention the pile base is actually drilled into place, a practice which is entirely novel. It will also be noted that the bottom surface is flat so that the drilling requires considerable pressures. There are however several advantages flowing from such a usage. First, since the pile base is twisted or screwed or rotated as it moves translatorily, it shears off the various strata which lie in its path. Secondly, since one is not merely driving, by impulses, that is by hammer blows, one is not pushing the earth and other materials in the translational path aside; I actually compact the materials which lie in the path of the pile base. The pile is not hammered through the various strata, as a nail is driven by repeated blows through a board. By rotating the base and shearing as the steady driving pressure is maintained, you gather the materials in the pile path ahead of the pile and push them along. Thus there is formed what I call a compacted "plug" which is best shown cross-sectionally in FIGURE 3, where it is numbered 7.

The compacted plug consists of a mushroom-like mass of compacted materials which previously lay in the path of the rotated pile base. This plug has a much greater density than that of the surrounding materials. In order to show this clearly, it will be necessary to note the sparse distribution of the small rocks along the sides of the pile path, in FIG. 3. It will be noted that the plug under the base in FIG. 3 is filled with such rocks which have been gathered along the way and compressed toward each other. As the plug is formed its central portion moves faster than its peripheral portion. The compaction however does spread transverse to the longitudinal axis of the pile and the base, which results in the mushroom shape of the plug.

It will be noted that the rock strata 8 near the top of the hole in which the base lies, has been sheared off by the rotational and driving movement. Although this strata is separated from the top of the hole by a distance approximately equal to the length of the pile base, the distance which the center of the strata 8 lies from the bottom of the base is much smaller. This illustrates also the relative compaction of the materials under the pile base.

For piling in soil I use pure compaction as described above. The degree of compaction attainable is remarkable in that the rotation or "drilling" of the flat-ended pile base 1 in soil lowers greatly the amount of pressure to penetrate a given depth. The advantage of the formation of the plug with the use of the rotated pile base is this: if it is desired to drive a pile which will support exactly a load of ten tons, including a safety factor, the answer is to rotate the pile base and load it up until slightly over ten tons is employed as the driving pressure. In this condition a plug is formed under the pile base which will sustain a load of ten tons. This is proven by using a ten ton pressure to form the plug. This of course is a simple illustration of the way I form a base for a pile in ordinary soil.

In order to form my compacted plug integrally with the base and later with the rest of the cast-in-place pile, I begin by placing a paper bag of dry concrete in the hole under the pile base before driving or rotating the base. The paper bag is shown in dotted lines in FIG. 3 and given the numeral 20. It lies on the rock strata which is later broken off. The pressures of rotation and the driving force immediately rupture the bag. The concrete within migrates under the pressures involved, picking up water from the soil and uniting with the water. As the compacted plug is formed the wetted concrete is distributed through the soil in the plug. Con-

tinuous rotation of the pile base results in carrying some of the concrete up the threads or depressions 6. The result of the foregoing is that the compacted plug is bonded together in an extremely tight condition, when the concrete within has hardened, to itself and to the pile base.

After the base has been rotated and driven into the position shown in FIG. 3, I remove the auger rig and place grout or concrete in the hole to fill it. In this manner the body of the piling is cast-in-place upon a base which has already been tested to carry a stated load.

To be sure that the pile base is integral with the remainder of the piling it supports, I place a piece of pipe in the central grout pipe hole 2, in the position shown in FIGURE 4. The pipe is numbered 9. To this pipe at its opposite end I attach a grout pump which is not shown. This grout pump forces grout down the pipe 9 and through the central hole 2. At the base the grout is forced under pressure to flow up the sides of the outer cylindrical surface of the pipe base through the threads 6. The grout also is forced through the six channels numbered 4, of which only two are shown in FIG. 3. These channels 4 communicate along the bottom surface of the pipe base with the six grout return holes 3. Thus grout is by the several paths forced through the pipe base to fill the void above the base and form a cast-in-place pile. Also I can place reinforcing bars in the grout return holes to provide rigidity to the pile.

In order to test the bonding properties of the compacted plug and the pile base, I have employed a power winch to pull a hardened pile base and its integral plug from its hole. This experiment has proved that the plug spreads as it is formed to make a much wider base for the plug and pile case combination. The plug is much bigger than the hole formed by the pile base during its descent, since the concrete and the compacted materials have moved transverse to the longitudinal axis of the pile base. The power winch has pulled up plugs having a diameter four and five times as great as the diameter of the pile, and these plugs are bonded together integrally to the pile base. Thus the pile base is seen to be resting on a much broader compacted plug which has become part of the base and provides a much better support for the pile than the ordinary pile construction ever attains. At the same time the rotation of the pile base under steady pressure causes the base to sink much more easily and rapidly, that is efficiently, than mere pile driving will accomplish.

In FIG. 4 it will be noted that there is shown a casing 10 which is cylindrical in form and which surrounds the pile base. It is not necessary to use such a casing in ordinary soil compaction problems such as I have above discussed. However there are conditions which require such usage.

In a situation in which I drill the pile base through perhaps five or six feet of sand, I use the casing 10 to prevent the walls from collapsing or "necking in." In such a situation or in one which requires penetrating a greater strata of sand, I may also use three or four of my pile bases. These I place one directly upon top of each other and I rotate as well as drive the entire group of bases. Thus I drive into position a compacting base which is longer. This works quite as satisfactorily as using a much longer base in such conditions. If no base were placed in such a position the sand may squeeze in, resulting in the common condition known as "necking down." Such a necking down prevents concrete from flowing past the neck or obstruction, and the result is that a complete pile cannot be cast in such a condition. This is also possible where a casing is withdrawn and the outer wall of the hole caves in. By using my base or bases, I obtain a positive precase section for the piling which cannot neck down.

Another condition which my precast pile base solves is the situation in which I must place piles in a spongy soil, permeated with sand strata and with water. In this situation I use a casing 10 such as shown in FIG. 4, and I use the pipe 9 to carry water down to the base when it has been forced down to a predetermined load level. Through the pipe I force water under pressure, the water returns through the channels 4 and the return holes 3 and also around the pile base, between the pile base and the casing 10. This water under pressure flushes out any sand and light rock which may have crept back inside the casing during the formation of the compacted plug 7, while the pile base was being rotated and driven into final position. Then I disconnect the water and, using the pipe 9 again as shown in FIG. 4, I force grout down the pipe with a grout pump as described previously.

I wish now to describe the method I use to form the compacted plug when driving a pile base through an extremely swampy or porous condition. For such purposes I first dig a hole to start the pile base in, or I merely force the base in a distance of five or six feet and then withdraw the base. In either case I fill the resulting hole with steel slag or trap rock or iron ore. Then I begin with the pile base as before, laying the pile base on the slag, and so forth in the hole. The effect of this is to drive a stabilizing plug ahead of the pile base. This stabilizing plug is forced into position at the bottom of the hole where leakage could occur to the surrounding strata, since water is present. As the plug here is the core of the compacted plug described before, which is larger than the bore of the pile base hole, leakage is prevented. As before the hole above the pile base is filled with grout under pressure, forming an integral cast-in-place pile.

In a situation such as shown in FIG. 4, the pile base may be driven to a thick rock stratum as shown at 11. The descent of the pile base will in such a situation form "crumbs" at the bottom of the hole, that is fragments of rock, earth and the like. Continued rotation of the pile base at the bottom will cause the "crumbs" to climb the threads or depressions 6 and the pile base 1 can be driven to the condition of refusal against the rock strata, insuring a positive placement of the base.

Another situation in which I use the pile base in a cast-in-place technique is that in which I am forming a pile in a thick strata of rock. In this situation I drill with a rock bit, forming a socket or hole in the rock strata. After drilling the socket, I remove the rock bit and place the pile base in position in the bottom of the socket. Then I continuously rotate the base as before and thereby crush any "crumbs" lying in the bottom of the socket and also cause them to climb the threads on the outer surface of the base. Then the base is forced firmly to refusal against the bottom of the socket. Then I pump grout in under pressure causing it to flow out in a similar series of paths around the base as described before. In such a situation the pile base is bonded to the rock walls of the socket so that truly enormous forces are required to remove the base. The concrete has filled the threads of the base and has, under pressure, been forced into the tiny crevices of the rock walls of the socket.

While I have shown the preferred form of my invention as it is now known to me, it will be evident that various changes, modifications and variations in the combination, construction, and arrangement of parts may be made by those skilled in the art without departing from the spirit of my invention.

What I claim is:

1. A method of forming piling, consisting of casting a cylindrical pile base of concrete provided with a central longitudinal hole a plurality of smaller longitudinal holes disposed around the central hole, an auger slot in the top flat surface of said base, and a series of threads in the outer cylindrical surface of said base, and a series of channels in the bottom face of the cylinder communicating with the plurality of smaller longitudinal holes

and the outer surface of the pile base and the central hole, threading said cast concrete pile base into final position by rotating the base constantly with rotational forces applied in said auger slot while steadily forcing it downward into position at a constant rate, whereby there are formed crumbs by the simultaneous rotation and downward forcing of said base, said rotation crushing said crumbs and causing them to fill and climb the series of threads in the outer cylindrical surface of said base, placing a pipe in the central hole of the base and forcing grout through said pipe, down through said central hole and back up through said plurality of smaller holes disposed around the central hole to form a cast-in-place concrete body above the base and integral therewith and said forcing of grout under pressure through said holes bonding the crushed crumbs in said threads to said threads and in final position.

2. A method of forming piling, consisting of casting a cylindrical pile base of concrete on top of a bag of cement, said pile base being provided with a central longitudinal hole, an auger slot in the top flat surface of said base, and a series of threads in the outer cylindrical surface of said base, a plurality of smaller longitudinal holes disposed around the central hole and a series of channels in the bottom face of the cylinder communicating with the smaller longitudinal holes and the outer surface of the pile base and the central hole, threading said cast concrete pile base into position by rotating the base constantly by means of rotational forces applied in said auger slot, while forcing it downward at a constant rate to compact the materials and cement lying under the base and moving said compacted materials along with the base into final position at a predetermined load level, thereby forming a mushroomed compacted plug integral with said base, whereby there are formed crumbs by the simultaneous application of rotational forces and forcing said base downward, said rotation crushing said crumbs and causing them to fill and climb the series of threads in the outer surface of said base, placing a pipe in the central hole of the base and forcing water through said pipe and said hole, through said channels and said longitudinal smaller holes to flush out the pile hole, then forcing grout through said pipe, through said hole, through said channels and said longitudinal smaller holes and in said threads bonding said crushed crumbs to said threads, to form a cast-in-place concrete body above the precast base and plug and integral therewith.

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