A method and apparatus for carrying out the underpinning and raising of portions of a building foundation uses the steps of forming a pit alongside the foundation portion to be raised, disposing an elongate pipe upright in the pit, gripping the side of the pipe while progressively extending hydraulic drive means against the reactive force of the weight of the foundation portion so as to urge the pipe into the ground. The last step is repeated until the pipe has been driven to a desired depth and then a jacking pad is formed and supported upon the upper end of the pipe. Subsequently after the pad hardens, the foundation portion is jacked upwardly away from the pad to a predetermined position. Jacks at each of a number of stations are operated simultaneously whereby the foundation portion acts as a beam in lifting both the foundation and the building thereon.

8 Claims, 8 Drawing Figures
METHOD AND APPARATUS FOR UNDERPINNING AND RAISING A BUILDING FOUNDATION

BACKGROUND OF THE INVENTION

This invention pertains to a method and apparatus for underpinning and raising building foundations as, for example, where the soil has failed to maintain support of the building as may be caused by various circumstances.

Typically, various prior schemes for underpinning and supporting a building foundation and for raising the building foundation have involved awkward procedures and apparatus, such as cumbersome drilling rigs, etc., as is known. Usually the foundation, in its sunken condition, is underpinned to prevent further settlement and then the building is raised from the foundation. This technique typically entails substantial cracking of the walls and other damage.

Thus, there has been a long-standing and continuing need to provide a method and apparatus for underpinning and raising building foundations which may have settled utilizing relatively simple techniques and equipment.

SUMMARY OF THE INVENTION AND OBJECTS

According to the invention, a method of understanding and raising portions of a building foundation is pursued characterized by the steps of forming a pit alongside the foundation portion to be raised, disposing an elongate pipe upright in the pit, gripping the side of the pipe while progressively extending hydraulic drive means against the reactive force of the weight of the foundation portion so as to urge the pipe into the ground, repeating the progressively extending step until the pipe has been driven to a desired depth and then forming a jacking pad supported upon the upper end of the pipe. Subsequently, after the pad hardens, the foundation portion is jacked upwardly away from the pad to a predetermined position. Preferably, the jacks at each of a number of stations 12 are operated simultaneously whereby the foundation portion acts as a beam in lifting both the foundation and the building thereon.

In carrying out the method, relatively simple apparatus is involved characterized by a support member variously movable to positions along the pipe to be driven and fixed at such positions to extend laterally from the side of the pipe. A drive bracket is carried by the pipe and movable relative thereto along the pipe as the pipe is driven. The bracket includes a protruding support lip for engaging and taking the load of the foundation to be raised. Extensible means have been interposed between the bracket and support member to act upon each for urging the bracket and support member apart so as to apply the load of the building as a resistance to upward movement of the bracket and thereby drive the pipe downwardly. In addition, various preferred features of the invention are pointed out herebelow.

In general, it is an object of the present invention to provide an improved method and apparatus for underpinning and raising building foundations.

Another object of the invention is to provide an improved method and apparatus for underpinning and raising building foundations in unstable soil conditions.

Yet another object of the invention is to provide an improved method and means for coupling the load of the building foundation to provide driving and placement of the pipe piles.

Yet another object of the invention is to provide an improved foundation support assembly characterized by an extensible soldier submerged in a body of supporting concrete interposed between a pipe pile-supported concrete jacking pad and the underside of the foundation portion to be supported.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic perspective view of a system for carrying out the method according to the invention;

FIG. 2 shows an enlarged schematic perspective view of a pipe driving assembly according to the invention;

FIG. 3 is an enlarged transverse section view of a detail taken along the line 3—3 of FIG. 1;

FIG. 4 is a side elevation view in enlarged detail partially broken away taken in the region of the line 4;

FIG. 5 shows a side elevation view in enlarged detail taken along the line 5—5 of FIG. 1;

FIG. 6 shows in enlarged detail a side elevation view taken from the left side as shown in FIG. 1;

FIG. 7 shows in enlarged detail a front elevation schematic section view taken along the line 7—7 of FIG. 6 illustrating apparatus employed in carrying out the method herein;

FIG. 8 shows a view similar to FIG. 6 schematically illustrating the completion of additional steps of the method according to the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The building foundation portion 10 shown in FIG. 1 can be readily underpinned and raised as now to be described by the method of forming a pit 11 at a number of stations 12 along the building foundation and then preparing each of the stations 12 with an elongate pipe pile 13 (FIG. 8) extending downwardly to solid supporting earth or, as will be further described below, to a subterranean region 14 of reinforced grouted earth.

At a given station 12 after the pit 11 has been formed, a pipe pile 13 is disposed upright to be driven downwardly into the ground and such pipe pile is preferably fitted with a hollow pointed driving head 16 shown best in FIG. 5. Head 16 includes a hollow cylindrically shaped interior 17 formed with a cylindrical mounting body 18 having a peripheral diameter substantially corresponding to the interior diameter of the lower end of pipe pile 13 so as to form a snug fit therein.

The conical surface of heat 16 includes a number of downwardly directed fluid discharge ports 19 of a size and scope for passing cementitious fluid material into the subterranean earth surrounding the head when disposed at its lowermost position whereby a subterranean zone of support can be formed beneath the pipe pile 13 where there otherwise might be none.

Typically, the use of cementitious grout material or other fluid cementitious material will not be necessary to be injected into the support region 14 inasmuch as pipe pile 13 will usually be extended downwardly sufficiently to engage solid ground or other solid material which can support the foundation 10.
A driving assembly 21 carried by pipe piles 13 serves to readily releasably engage the underside of foundation portion 10 and, while the foundation portion 10 as a restraining load, hydraulically drives pipe pile 13 downwardly into the ground by gripping the pipe at the side of the pipe by means of a hinged clamp 22.

Clamp 22 can be positioned variously along the length of pipe pile 13 and is formed with downwardly directed teeth 23 clamped tightly into engagement with the outer periphery of pipe pile 13 by means of bolt 15 disposed to extend between the two projecting ears 24 formed on clamp 22.

As thus arranged, clamp 22 serves to form a drive coupling whereby driving forces can be coupled or applied to pipe pile 13 at the side of the pipe pile 13 as by means of the double acting hydraulic ram 26. In this way, great lengths of pipe can be handled with requiring means to drive the pipe from its upper end.

Ram 26 carried by the stud 27 attaches to the top of a drive bracket 28. Pipe pile 13 supports bracket 28 to be carried by the pile in a manner whereby it is movable relative to the pipe pile as the pipe is driven.

Thus, bracket 28 includes the opening 29 formed through the upper end surface 31 thereof. Bracket 28 further includes a laterally protruding support lip 32 for engaging and taking the load of the foundation portion 10 to be raised.

The extensible hydraulic means 26 includes a piston rod or hydraulic drive rod 33 which moves between advanced and retracted positions into and out of the cylinder 34. Accordingly, clamp 22 serves to support rod 33 which in turn supports bracket 28 in position beneath foundation 10.

At that point, pressure from a power supply or pump, P.S., can be applied to the hydraulic supply hose 36 to drive the piston (not shown) within cylinder 34 downwardly to extend drive rod 33 and thereby drive bracket 28 away from clamp 22. Ultimately, of course, lip 32 will engage the bottom surface of foundation 10 and the load thereof will cause the further extension of rod 33 to be resisted by such load. At that point, pipe pile 13 becomes driven downwardly into the ground as far as desired.

It will be readily evident that the downward driving of each pipe pile 13 is conducted in a number of short stages limited by the extent of drive rod 33. After drive rod 33 has been extended to its maximum displacement, clamp 22 and drive rod 33 are elevated while bracket 28 is held in position beneath foundation 10. This is simply accomplished merely by reversing the action on ram 26 by supplying pressure to hydraulic line 37 and exhausting hydraulic fluid via line 36 and then simply releasing clamp 22 from its position at 22 (FIG. 6) by means of bolt 15. The driving step is repeated as above described starting with a reattachment of clamp 22 to pipe pile 13.

While relatively long lengths of pipe can be used, it is usually anticipated that it will be necessary to employ several sections, one following the next in tandem, to be driven sufficiently deep to encounter bedrock or other supporting earth material deep in the ground.

Accordingly, pipe sections of a common diameter are interconnected so as to form an elongate length of pipe having an uninterrupted, or substantially uninterrupted, exterior periphery comprising the steps of inserting a short length of pipe carrying a collar of predetermined diameter intermediate its ends into the corresponding ends of tandem lengths of pipe. The predetermined diameter of the collar corresponds substantially to the outer diameter of the pipe.

Accordingly, one such insert 42 is shown having a hollow cylindrical interior 43 in open communication between the two pipe sections 13a, 13b and a flanged collar 44 of a diameter common to the outer periphery of pipe sections 13a, 13b. Collar 44 is formed integral with the cylindrical insert 42 so as to support the two sections 13a, 13b in driving relation.

In the normal circumstance, it is anticipated that the pipe pile will ultimately encounter bedrock or solid ground at a proper depth. This can be determined by monitoring system pressure as shown on the gauge 40 whereby when the pressure increases substantially it can be assumed that the pile 13 has encountered stable soil. At that time, the excess of pipe pile 13 extending above the floor of pit 11 is substantially all removed leaving only enough for the insertion and placement of a sealing cap member 38 having a flanged head 41 and a cylindrical re-entrant mounting guide 39 disposed co-axially of pipe pile 13.

In certain circumstances, however, where bedrock or solid ground is not encountered in the driving of the pipe pile, a body of hardenable cementitious material in fluid condition is dispensed outwardly of the lower end of the pipe into the ground and permitted to harden in the ground so as to form the enlarged hardened region 14 of subterranean earth serving to support pipe 13 from beneath. This is accomplished as above described by dispensing the fluid cementitious material such as grout outwardly of the discharge ports 19 under fluid pressure.

Having properly lodged pipe pile 13 in the ground and capped its upper end with the cap member 38, the upper end of the pipe is then submerged in a body of concrete at each station 12 to form a steel reinforced jacking pad 46 using a reinforcing steel matrix 50. The base 48 of an extensible support soldier 47 is disposed or anchored in the concrete of jacking pad 46 whereby after the foundation construction 10 has been jacked to a predetermined level as by means of mechanical jacks 52 disposed at the stations 12, support soldier 47 can then be extended by unscrewing the threaded support element 49 outwardly of base 48 and into engagement with the underside of foundation 10. Element 49 threadedly engages an opening in the upper end of base 48 whereby as the support element 49 is moved to a position contacting the underside of foundation 10, a lock nut 51 carried by element 49 can be screwed downwardly into engagement with the top surface of base 48. In this manner, temporary support is given to foundation 10 whereby the mechanical jack 52 can be lowered and removed.

After a jacking pad 46 has been formed at each of the stations 12 along foundation portion 10 to be raised, the jacks 52 are disposed at each of the stations in position between the jacking pad 46 and foundation portion 10 at its associated station whereby all of the jacks can be simultaneously operated in raising the foundation portion 10. In this manner, foundation portion 10 acts as an elongate rigid beam in lifting the building construction.

Subsequently (FIG. 8), a second body of concrete 53 is interposed between the underside of foundation 10 and jacking pad 46 to form a permanent support beneath foundation portion 10.
Use of the foundation as a beam or lever has a considerable advantage over former methods wherein the foundation which has sunk is merely anchored in its sunken position on pipe piles or otherwise and then the building structure is lifted from the foundation. The latter procedure causes many cracks in the walls and structural portions of the building whereas the disclosed invention herein, utilizing the foundation portion being raised to act as a lever or beam in lifting the building construction avoids damage to the building being raised.

It will also be evident from the foregoing that there has been provided an improved method and apparatus for readily and simply raising a foundation construction and the building supported thereon without requiring large awkward drilling equipment normally associated with such projects.

It will be further evident that the method and apparatus for underpinning and raising building foundations as above described permits access for working in close quarters where the usual heavy equipment could not be brought in to do the job. Further, by employing a uniform raising of the building, minimum cracking of the internal walls of the building is involved.

1. In the method of underpinning and raising portions of a building foundation, the steps of forming a pit alongside said foundation portion, said pit having a portion unobstructed from above so as to be free of overhanging structure, disposing an elongate pipe upright in said portion of said pit free of overhanging structure, gripping the side of said pipe while hydraulically urging said pipe therefrom downwardly into the ground, capping the upper end of the pipe, submerging the upper end of the pipe in a pad of concrete poured into the pit, permitting the concrete to harden, interposing jacking means between said pad and said foundation portion, jacking the foundation portion to raise same upwardly by said jacking means, and interposing a support between the foundation portion and said pad to retain the foundation at its raised position.

2. In the method of underpinning and raising portions of a building foundation, the steps of disposing an elongate length of pipe upright at a position alongside a foundation portion of the building, said position being free of overhanging structure thereabove, driving said length of pipe into the ground at said position by means supported between a laterally extending support member projecting from the side of the pipe and a support bracket carried by and movable along the pipe and protruding beneath the foundation portion in supporting relation thereto as to transfer the load of said foundation to the pipe via said bracket and support member extending from the side of the pipe, continuing said driving until the length of pipe reaches a desired depth in the ground, forming a jacking pad supported upon said pipe, and jacking said foundation portion upwardly away from said pad to a predetermined position by jacking mechanism interposed between said foundation portion and pad.

3. In the method of underpinning and raising portions of a building foundation according to claim 2 wherein said driving step proceeds in a succession of stages including the intermediate step between stages of elevating said support member, bracket and hydraulic mechanism relatively along said pipe following each said driving stage.

4. In the method of underpinning and raising portions of a building foundation according to claim 2 including the steps of anchoring the lower end of an extensible soldier support in said pad, extending said soldier support into engagement with said foundation portion following jacking of said portion of said predetermined position, locking the soldier support at its extended length, lowering said foundation portion for engagement with said extended and locked soldier to temporarily take the load of said foundation portion, and interposing a body of concrete between said pad and said portion to permanently take the load of said foundation portion.

5. In the method of underpinning and raising portions of a building foundation according to claim 2 wherein said forming step includes the step submerging the upper end of said pipe in a body of concrete and permitting the concrete to harden to form said jacking pad.

6. In the method of underpinning and raising portions of a building foundation according to claim 2 further including the step of dispersing a body of hardenable cementitious material outwardly of and below the lower end of said pipe into the ground, and permitting said material to harden in the ground to form an enlarged hardened region of subterranean support serving to support said pipe from beneath.

7. In the method of underpinning and raising portions of a building foundation, the steps of forming a pit alongside said foundation portion, said pit having a portion unobstructed from above so as to be free of overhanging structure thereabove, disposing an elongate rigid pipe upright in said portion of said pit, securing a drive coupling to said pipe, disposing a support bracket upon said coupling, hydraulically urged said bracket relatively away from said drive coupling, and along said pipe while engaging said pipe into the ground, repeating the aforesaid steps while monitoring the resistance to driving experienced by said pipe, capping off the top of said pipe at a level spaced above the bottom of said pit portion, filling said pit with concrete to a level submerging the capped off end of said pipe to form a jacking pad, embedding an elongate extensible support in said concrete to extend upwardly toward the underside of said foundation portion, interposing jacking means between said foundation portion and said concrete for upwardly jacking said portion therefrom to a predetermined level, extending said support soldier to engage and support said foundation portion at the same level, locking said extensible soldier as thus extended and removing said jacking means.

8. In the method of underpinning and raising portions of a building foundation according to claim 7 further including the step of interposing additional concrete between said portion and said jacking pad to permanently support said portion.