Apparatus for Extracting a Pile

The invention relates to apparatus for extracting a pile and especially for extracting installed piles from the ground.

Piles are used conventionally to provide foundational support for all types of structures on land and for marine structures that are fixed to the seabed.

However, when a structure supported by piles is removed or demolished, it is extremely difficult to also remove the piles which have been used to support the structure. This can be a problem, for example, where a new building which is built on the same location as the old building, houses sensitive equipment which requires there to be no metal in the ground below the building.

In accordance with a first aspect of the invention, apparatus for extracting a pile from the ground comprises a drive mechanism, a first conduit adapted to be inserted into the ground by the drive mechanism around a pile to be extracted, earth removal means operable to remove earth from within the first conduit when the first conduit is inserted into the ground, and an extraction member having engagement means engageable with a pile to be extracted to remove the pile from the ground when an upward force is applied to the extraction member.

In accordance with a second aspect of the present invention, a method of extracting a pile from the ground comprises inserting a first conduit into the

ground around the pile, removing earth from between the first conduit and the pile, engaging an extraction member with the pile, and applying an upward force to the extraction member to extract the pile from the ground.

An advantage of the invention is that it permits piles that have been installed into the ground to be subsequently extracted without leaving a section of the pile still remaining within the ground.

Preferably, the earth removal means comprises a pumping means to pump fluid into the ground, typically at or adjacent to the lower end of the first conduit, as the first casing is inserted into the ground around the pile to be extracted. Typically, the fluid is a gas and may be compressed air.

Preferably, the drive mechanism is a rotational drive mechanism which rotates the first conduit . Typically, the first conduit comprises a spiral formation which acts to screw the first conduit into the ground as the drive mechanism rotates the first conduit.

Preferably, the first conduit comprises a cutting means at its lower end to facilitate the insertion of the first conduit into the ground. Typically, the cutting means comprises cutting teeth or drill bit.

Typically, the extraction member comprises a second conduit which is adapted to be inserted between the first conduit and the pile.

Preferably, the engagement means is unidirectional to permit the second conduit to be slid downwards over the pile but engages with the pile when the second conduit is moved in the opposite direction.

Typically, the engagement means also comprises a release mechanism which when activated disengages the engagement means from the pile to permit the second conduit to be moved in the opposite direction with respect to the pile.

Typically, the pumping means comprises a fluid conduit that extends along the length of the first conduit. Preferably, the fluid conduit also extends around the outside of the first conduit to form a helical formation on the external surface of the first conduit.

Typically, the drive mechanism comprises an earth auger drive unit, and is preferably a detachable casing auger drive unit. The detachable casing auger drive unit may, for example, be a KCA630 detachable casing auger drive unit as supplied by Kyung In Co., Ltd. of Korea.

An example apparatus for extracting a pile in accordance with the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view of a crane, drive mechanism and an auger casing;

Figure 2 is a cross-sectional view of a portion of a drive mechanism and a casing showing the coupling of the casing to the drive mechanism;

Figure 3 is an enlarged cross-sectional view of a lower end of the casing;

Figure 4 is a cross-sectional view of an extraction casing for use with the apparatus shown in Figure 1;

Figure 5 is an enlarged cross-sectional view of the lower end of the extraction casing; and

Figures 6a to 6h show the apparatus in Figures 1 to 5 being used to extract a pile from the ground.

Figure 1 shows pile extraction apparatus that includes an auger casing 1, a drive mechanism 2 and a support crane 3. An air swivel 7 couples the casing 1 to the drive mechanism 2. The drive mechanism 2 is typically a detachable casing earth auger drive unit such as a KCA630 as supplied by Kyung In Co., Ltd. of Korea. Also shown is a compressor 30 the outlet of which is coupled by a hose 31 to the air swivel 7.

The auger casing 1 has two air pipes 4 extending circumferentially and longitudinally around the auger casing to the lower end of the auger casing 1. The auger casing 1 also has cutting teeth 6 at its lower end. The air pipes 4 extend around and along the casing 1 so as to form two helical formations each supported by a helical support member 25.

As shown in Figure 2, the air swivel 7 comprises an internal section 9 and an external section 10. The external section 9 is rotatable with respect to the external section 10 by means of chevron seals 11 which act as a bearing between the external section 10 and the internal section 9 and also provide a seal between the sections 9, 10. The external section 10 has an air inlet nozzle

12 which communicates with an internal channel 13 which extends circumferentially around the inside of the external section 10 and around the outside of the internal section 9. The inlet nozzle 12 is coupled to the hose 31. The channel 13 communicates with two air inlets 14 within the internal section 9. The lower end of the internal section 9 is fixed to the upper end of the casing 1 and the lower ends of the air conduits 14 are coupled to the upper ends of the air pipes 4. The upper end of the internal section 9 is coupled to a rotating section 15 of the drive mechanism 2, and the external section 10 is fixed to an external housing of the drive mechanism 2 by fixings 8.

Therefore, the air swivel 7 permits the casing 1 to be rotated by the drive mechanism 2 and at the same time permits air to be injected into the air pipes 4 surrounding the casing 1.

Figure 3 shows a cross-sectional view of a lower end of the auger casing 1 where it can be seen that the air pipes 4 terminate in nozzles 5 which are directed into the interior of the casing 1 at the lower edge of the casing 1. Attached to the lower end of the casing 1 are the cutting teeth 6.

Figure 4 shows a cross-sectional view of an extraction casing 20 which includes engagement teeth 21 at its lower end and a coupling means 22 which enables the upper end of the casing 20 to be connected to a cable 40 from the crane 3 to permit the casing 20 to be raised and lowered. As shown in Figure 5, the engagement teeth 21 are cam shaped and are pivotably coupled to the casing 20 by pivots 23. In addition, the teeth 21 also include an aperture 24 that

permits a release wire to be attached to the teeth 21. The release wire (not shown) extends upwardly within the extraction casing 20 and along the full length of the extraction casing 20.

In use, the apparatus described above and shown in Figures 1 to 5 is used by first installing the crane 3 above a pile 35 to be extracted as shown in Figure 6a. The auger casing 1 is then connected to the drive mechanism 2 by means of the air swivel 7 and the drive mechanism 2 is operated to rotate the casing 1. Rotation of the casing causes the helical pipes 4 and support 25 to engage with the ground so that rotation of the casing 1 causes the casing 1 to be driven downwards into the ground by a screw-type action. The casing 1 is driven into the ground around the pile 35 to be extracted, as shown in Figure 6b. Simultaneously with rotating the drive mechanism 2, compressed air from the compressor 30 is injected into the air pipes 4 via the hose 31 from the compressor 30 to the inlet nozzle 12 of the air swivel 7. The compressed air exiting the nozzles 5 liquefies the soil within the auger casing 1 and pumps the liquefied soil up the inside of the casing 1 out of the upper end of the auger casing 1. The drive mechanism 2 continues to drive the casing 1 into the ground around the pile 35 until the lower end of the auger casing 1 reaches the lower end of the pile 35, as shown in Figure 6c.

After the auger casing 1 has been driven full length of the pile 35, the extraction casing 20 is connected to the cable 40 which can be raised and lowered by the crane 3 as shown in Figure 6d. The crane 3 raises the extraction casing 20 using the cable 40 to the position shown in Figure 6e, the extraction casing 20

is then lowered down, through the auger drive unit 2 and the air swivel 7, in to the auger casing 1 and over the pile 35, as shown in Figure 6f. It should be noted that it is not essential that the extraction casing 20 extends the full length of the pile 35 but only that the extraction casing 20 extends over a sufficient length of the pile 35 to enable the locking teeth at the lower end of the extraction casing 20 to make a proper engagement with the sides of the pile 35.

When the extraction casing 20 has been lowered over the pile 35, the crane 3 raises the cable 40, which exerts an upward force on the extraction casing 20. This causes the cam teeth 21 to engage with or "bite" into the sides of the pile 35 to lock the extraction casing 20 onto the pile 35. Further upward pulling of the cable 40 by the crane 3 then removes the pile 35 from the ground as all the earth material around the pile 35, which previously prevented its removal, has been removed during insertion of the auger casing 1.

After the pile 35 has been removed from the ground and from within the auger casing 1, air swivel 7 and the drive mechanism 2, the pile 35 and the attached extraction casing 20 are lowered to the ground with the aid of a second crane 45, as shown in Figure 6g.

After the pile 35 and extraction casing 20 have been lowered to the ground, the rotation of the drive mechanism 2 is reversed and the auger casing 1 is removed from the ground as shown in Figure 6h. Thereafter, the hole left after extraction of the auger casing 1 can be refilled using conventional earth moving equipment.

It will be clear from the above description that the internal width of the extraction casing 20 is greater than the external width of the pile 35, and that the external width of the extraction casing 20 is less than the internal width of the auger casing 1.

Advantages of the invention are that it enables a pile which is installed in the ground to be extracted without leaving any remains of the pile within the ground and therefore removing all metallic material of the pile from the ground.

CLAIMS

1. Apparatus for extracting a pile from the ground comprises a drive mechanism, a first conduit adapted to be inserted into the ground by the drive mechanism around a pile to be extracted, earth removal means operable to remove earth from within the first conduit when the first conduit is inserted into the ground, and an extraction member having engagement means engageable with a pile to be extracted to remove the pile from the ground when an upward force is applied to the extraction member.

2. Apparatus according to claim 1, wherein the earth removal means comprises a pumping means to pump fluid into the ground.

3. Apparatus according to claim 2, wherein the earth removal means further comprises a fluid conduit coupled to the pumping means, the fluid conduit extending along the first conduit and exiting from the fluid conduit adjacent to the lower end of the first conduit.

4. Apparatus according to claim 2 or claim 3, wherein the fluid is a gas.

5. Apparatus according to claim 4, wherein the gas is air.

6. Apparatus according to any of the preceding claims, wherein the drive mechanism is a rotational drive mechanism which rotates the first conduit .

7. Apparatus according to claim 6, wherein the drive mechanism comprises an earth auger drive unit.

8. Apparatus according to claim 7, wherein the earth auger drive unit is a detachable casing auger drive unit.

9. Apparatus according to any of the preceding claims, wherein the first conduit comprises a helical formation.

10. Apparatus according to claim 9 when dependent on any of claims 2 to 5, wherein the helical formation comprises the fluid conduit.

11. Apparatus according to any of the preceding claims, wherein the first conduit comprises a cutting means at its lower end.

12. Apparatus according to any of the preceding claims, wherein the extraction member comprises a second conduit which is adapted to be inserted within the first conduit.

13. Apparatus according to any of the preceding claims, wherein the engagement means is unidirectional.

14. Apparatus according to any of the preceding claims, wherein the engagement means also comprises a release mechanism.

15. A method of extracting a pile from the ground comprises inserting a first conduit into the ground around the pile, removing earth from between the first conduit and the pile, engaging an extraction member with the pile, and applying an upward force to the extraction member to extract the pile from the ground.

16. A method according to claim 15, wherein the earth is removed by pumping a fluid into the earth within the first conduit.

17. A method according to claim 16, wherein the fluid is pumped into the earth adjacent the lower end of the first conduit.

18. A method according to any of claims 15 to 17, wherein the extraction member comprises a second conduit, the second conduit being inserted between the first conduit and the pile.

19. A method according to any of claims 15 to 18, wherein the first conduit is inserted by rotating the first conduit.