

PILE HEAD TREATMENT METHOD

TECHNICAL FIELD

[0001]

The present invention relates to a pile head treatment method of a cast-in-place pile.

BACKGROUND ART

[0002]

Underground piles such as foundation piles are sometimes constructed in situ. Fig. 11 illustrates an example of in-situ piling. In this example, after a ground 100 is excavated to form a hole 101 as illustrated in Fig. 11(a), a reinforcing bar cage 102 is built in the hole 101 as illustrated in Fig. 11(b), and then concrete 103 is placed with a tremie pipe and the like as illustrated in Fig. 11(c).

[0003]

As illustrated in Fig. 11(d), as the placement of the concrete 103 progresses, the concrete placed at the beginning is elevated to become extra concrete 103a of a pile head. While the concrete 103 is hardened to form a pile, the extra concrete 103a needs to be demolished and removed, because the extra concrete 103a contains impurities such as sand existed at the bottom of the hole 101 and, thus, cannot be used as structure. In this example, after the ground 100 around the pile head is excavated as illustrated in Fig. 11(e), the extra concrete 103a is demolished and removed on the ground as illustrated in Fig. 11(f).

[0004]

To demolish the extra concrete, it is common to use a method in which the extra concrete is demolished manually with a hand breaker and the like.

[0005]

Further, Patent Document 1 describes a demolition method using a demolition agent such as low and high explosives. In the method, the extra concrete is bored to form vertical charging holes and transverse charging holes next to a lower portion of the extra concrete that is not to be demolished, and a demolition agent is charged into the charging holes. Then, the demolition agent charged in the vertical charging holes and the demolition agent charged in the transverse charging holes are sequentially blasted in this order, or the demolition agent charged in the vertical charging holes and the demolition agent charged in the transverse charging holes are simultaneously blasted, whereby the extra concrete is demolished.

[0006]

Beyond that, a demolition method that uses a static demolition agent is also known. In the method, for example, a reinforcing bar cage to which a static demolition agent (demolition agent having hydration swelling property) is provided in advance is built, and then concrete is placed. When the concrete is hardened, hydration heat is produced to gradually expand the demolition agent. Consequently, the concrete is divided. The divided concrete is lifted and removed.

BACKGROUND ART DOCUMENT

PATENT DOCUMENT

[0007]

[Patent Document 1] JP S50-120103 A

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0008]

In the case where the extra concrete is manually demolished with a hand breaker and the like, the extra concrete can unfailingly be removed, but there are problems such as generation of noise and vibration and low operation efficiency. To reduce the generation of noise and the like, a

makeshift cover is provided using single pipes, a sound-proof sheet and the like in some cases. However, this is ineffective, because the makeshift cover needs to be provided again and again as the work progresses, as multiple piles are usually constructed.

[0009]

Further, the method described in Patent Document 1 also causes generation of significant noise and vibration, because the demolition with a high explosive or the like is conducted in both vertical and transverse directions. Furthermore, the high explosive or the like may cause damage such as cracks and breakages to the portion that is not to be demolished. In the case where the method is used in the pile head treatment, the main reinforcing bar of an upper end of the reinforcing bar cage may be bent to deteriorate the functions of reinforcing steel. In a case where, for example, the main reinforcing bar of the upper end of the reinforcing bar cage is to be inserted and used in a structure such as a concrete foundation to be provided above the pile, the bending of the main reinforcing bar is not desirable.

[0010]

The method using the static demolition agent is a technique developed to reduce noise and the like and improve operation efficiency. The static demolition agent is provided to the reinforcing bar cage prior to the placement of the concrete, and when the concrete is placed, the concrete is hardened and cracks occur inside the holes. Thus, it is difficult to control the cracks. Since finished size of piles often vary, it is difficult to cause the static demolition agent to act accurately. In the case where the method is used in the pile head treatment, the main reinforcing bar of the upper end of the reinforcing bar cage may be bent as in Patent Document 1. In this case, it becomes difficult to lift the divided concrete, additionally. Furthermore, since the static demolition agent needs to be provided to the reinforcing bar cage such that the static demolition agent does not interfere with a tremie pipe and

the like when the concrete is placed, it is difficult to make an arrangement to dissect the concrete. Thus, the weight of concrete rubble after the demolition is so large that use of a large crane is often required. In this case, there arise problems that it may be impossible to dispose a crane depending on the field or that a makeshift gantry on which a crane is to be placed is overengineered.

[0011]

Embodiments of the present invention seek to provide a pile head treatment method that may enable suitable demolition and removal of extra concrete of a pile head with high operation efficiency.

TECHNICAL SOLUTION

[0012]

According to an aspect of the present invention, there is provided pile head treatment method including: the step (a) of linearly charging a non-explosive demolition agent inward from a side surface of concrete of a pile head exposed on a ground, the pile head having a main reinforcing bar buried in a vertical direction in an outer periphery portion thereof, and charging a demolition agent into the concrete situated above the non-explosive demolition agent, at the time of constructing a pile in situ; and the step (b) of activating of the non-explosive demolition agent to divide the concrete into upper concrete and lower concrete and thereafter activating of the demolition agent to demolish the divided upper concrete, wherein a restraining member for restraining the main reinforcing bar from deforming is provided on an outer periphery surface thereof.

[0013]

Embodiments of the present invention make it possible to divide the extra concrete of the pile head from the lower concrete with the non-explosive demolition agent and thereafter demolish the divided extra concrete with the demolition agent such as a high explosive. Since the non-explosive demolition agent causes less noise and vibration, if the extra concrete is demolished with the non-explosive demolition agent and the demolition agent in this way, noise and vibration are generated only instantaneously and at minimum levels. In

addition, generation time can be set freely according to a surrounding environment. Furthermore, since the extra concrete is divided from the concrete situated below the extra concrete with the non-explosive demolition agent, which does not cause shock waves, and thereafter the divided extra concrete is demolished, the concrete situated below the extra concrete may not be given any damage by the division and demolition of the extra concrete. [0014]

Further, since the charging and demolition are carried out as post processes on the ground, it is possible to adjust the charging positions and the like to appropriate positions according to the finished pile size so that the extra concrete can unfailingly be demolished into concrete rubble of the size of a human head. Thus, the demolished concrete rubble can be removed manually or with small heavy equipment. Furthermore, after the charging operations are finished, the extra concrete can be demolished instantaneously. Thus, the work efficiency may be high. [0015]

A main reinforcing bar is buried in a vertical direction in an outer periphery portion of the concrete, and desirably in the step (a), a high explosive as a first demolition agent is linearly charged in a vicinity of the main reinforcing bar, and a high explosive as a second demolition agent is linearly charged in the vertical direction interiorly to the first demolition agent.

Also desirably, in the step (b), the first demolition agent and the second demolition agent are sequentially blasted such that the closest demolition agent to the outer periphery portion of the concrete is blasted first, followed by the interior demolition agents.

In this way, the respective demolition agents are disposed and then control blasted sequentially so that the extra concrete is sequentially extruded outward and demolished, whereby the extra concrete can be dismantled

efficiently with a small amount of demolition agents. As a result, noise and vibration may be reduced, and the amount of dust may also be decreased.

[0016]

Desirably, prior to the step (b), a restraining member for restraining the main reinforcing bar from deforming is provided.

In this way, the main reinforcing bar can be restrained from deforming at the time of the demolition of the extra concrete.

[0017]

Also desirably, an elastic protecting member is provided in advance around the main reinforcing bar.

In this way, the main reinforcing bar can be protected, and also the moving width of the extra concrete at the time of the demolition can be reserved so that cracks are unfailingly produced, whereby the demolition can be carried out suitably.

[0018]

Desirably, in the step (a), the first demolition agent is charged into a duct that is spirally provided in advance along a circumferential direction of the concrete in the vicinity of the main reinforcing bar.

Or desirably, the first demolition agent is charged into a duct that is provided in advance along the vertical direction in the vicinity of the main reinforcing bar

[0019]

In this way, the duct for charging the demolition agent is provided in advance at the position where the duct does not interfere with the tremie pipe and the like for placing the concrete, whereby boring of charging holes after the placement of the concrete can be omitted. In the former case, the number of ducts and the number of charging operations can be reduced. In the latter case, the charging can be carried out with ease.

[0020]

Also desirably, prior to the step (b), the concrete of the pile head is covered with a sheet.

In this way, dispersion of the demolished extra concrete can be prevented.

ADVANTAGEOUS EFFECT OF THE INVENTION

[0021]

Embodiments of the present invention provide a pile head treatment method that may enable suitable demolition and removal of extra concrete of a pile head with high operation efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

[Fig. 1] A figure illustrating a cast-in-place pile 1.

[Fig. 2] A figure illustrating a reinforcing bar cage 25.

[Fig. 3] A figure illustrating charging holes 9 and 37 and a combined duct 31.

[Fig. 4] A figure illustrating the charging of a demolition agent.

[Fig. 5] A figure illustrating a non-explosive demolition agent 15.

[Fig. 6] A figure illustrating a pile head treatment method.

[Fig. 7] A figure illustrating a pile head treatment method.

[Fig. 8] A figure illustrating a pile head treatment method.

[Fig. 9] A figure illustrating a reinforcing bar cage 25.

[Fig. 10] A figure illustrating charging holes 37 and a combined duct 43.

[Fig. 11] A figure illustrating the steps of constructing a pile in situ.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023]

The following describes embodiments of the present invention in detail with reference to the attached drawings.

[0024]

[First embodiment]

(Cast-in-place pile 1)

Fig. 1 illustrates a cast-in-place pile 1 from which extra concrete is to be demolished and removed by a pile head treatment method according to an embodiment of the present invention. The cast-in-place pile 1 is constructed by a method similar to that illustrated in Fig. 11 in which a reinforcing bar cage 25 is built in a hole 2 formed in a ground and concrete is cast in the hole 2. Fig. 1 illustrates the state in which a pile head is exposed on the ground by digging the surrounding ground and the like after the concrete is hardened, as in Fig. 11(e) described above.

[0025]

As illustrated in Fig. 1, the concrete of the cast-in-place pile 1 includes extra concrete 3 and structural concrete 27 situated below the extra concrete 3. The extra concrete 3 is the concrete of a pile head portion exposed on the ground. The structural concrete 27 is a portion that is to be used as a pile. Main reinforcing bars 7 of the reinforcing bar cage 25 are buried in an outer periphery portion of the cast-in-place pile 1. The cast-in-place pile 1 is a cylinder having a diameter of about 2.0 m, and the height of the extra concrete 3 is about 800 mm. The size and shape of the cast-in-place pile 1 are not limited to the foregoing size and shape.

[0026]

Fig. 2 illustrates the reinforcing bar cage 25 used to construct the cast-in-place pile 1. Fig. 2(a) is a side view of an upper portion of the reinforcing bar cage 25, and Fig. 2(b) is a top view of the reinforcing bar cage 25. The reinforcing bar cage 25 includes multiple main reinforcing bars 7 along the vertical direction and multiple hoop reinforcing bars 8. The main reinforcing bars 7 are arranged circumferentially and spaced out. The hoop reinforcing bars 8 are disposed around the main reinforcing bars 7 and spaced out along the vertical direction.

[0027]

The reinforcing bar cage 25 includes a protecting member 29

disposed around an upper end portion of each main reinforcing bar 7. The protecting member 29 is an elastic member such as sponge. No hoop reinforcing bar 8 is provided to the upper end portions of the main reinforcing bars 7.

[0028]

An upper end portion of the reinforcing bar cage 25 includes a combined duct 31 spirally provided in the vicinity of inner sides of the main reinforcing bars 7. The combined duct 31 is, for example, a flexible duct made of polyvinyl chloride and having a diameter of about 15 mm. In the extra concrete 3 illustrated in Fig. 1, the combined duct 31 is buried in the vicinity of the inner sides of the main reinforcing bars 7 along the circumferential direction of the extra concrete 3. The combined duct 31 is used as a charging hole for charging a linear explosive, which will be described below. The combined duct 31 is provided such that an end portion 31a of the combined duct 31 extends outward from the extra concrete 3 (refer to Fig. 1). The combined duct 31 may be divided into multiple pieces and provided.

[0029]

(Pile head treatment method)

Next, the following describes a pile head treatment method in which the extra concrete 3 of the cast-in-place pile 1 is demolished and removed.

[0030]

(1. Forming charging holes)

In the present embodiment, first, the extra concrete 3 in the state illustrated in Fig. 1 is bored to form small-diameter charging holes. Fig. 3 illustrates charging holes 9 and 37 and the combined duct 31. Fig. 3(a) is a top view of the extra concrete 3. Fig. 3(b) is a cross-sectional view in the vertical direction along a line A-A specified in Fig. 3(a). Fig. 3(c) illustrates a boundary surface 5 (refer to Fig. 1) between the extra concrete 3 and the

structural concrete 27 situated below the extra concrete 3.

[0031]

In this embodiment, as illustrated in Figs. 3(a) and 3(b), a portion of the extra concrete 3 that is inside of the combined duct 31 provided in the vicinity of the main reinforcing bars 7 is bored downward from an upper surface of the extra concrete 3 to form the charging holes 37 above the boundary surface 5.

[0032]

In the present embodiment, charging holes 37a, 37b, 37c, and 37d are formed as the charging holes 37. The charging hole 37d is formed at the center of the extra concrete 3, and the charging holes 37a, 37b, and 37c are respectively formed along three concentric circles of different diameters with the charging hole 37d being a common center. The charging holes 37a, the charging holes 37b, and the charging holes 37c are respectively formed circularly and spaced at intervals of, for example, about 200 mm to about 300 mm. The charging holes 37a are farthest from the center, and the charging holes 37b and the charging holes 37c are formed in this order toward the center.

[0033]

The diameter and depth of each charging hole 37 (37a to 37d) are, for example, about 22 mm and about 600 mm, respectively. The positions of the charging holes 37a, 37b, and 37c in the circumferential direction are arranged zigzag at least partially such that the charging holes 37a, 37b, and 37c are not aligned (refer to a, b, and c in Fig. 3(a)).

[0034]

On the other hand, as illustrated in Fig. 3(c), the boundary surface 5 between the extra concrete 3 and the structural concrete 27 situated below the extra concrete 3 is horizontally bored inward from a side surface toward the center of the concrete to form the charging holes 9. In the present

embodiment, eight charging holes 9 are formed such that the positions of the eight charging holes 9 in the circumferential direction are shifted by 45 degrees. The depth of each charging hole 9 is set to about 70% to 80% of the radius of the cast-in-place pile 1, e.g., about 700 mm to about 800 mm. The diameter of each charging hole 9 is set to, for example, about 22 mm.

[0035]

(2. Charging demolition agent)

After the charging holes are formed as described above, a demolition agent is charged. The demolition agent is a high-energy substance such as a high explosive, a low explosive, and a non-explosive demolition agent.

Ignition (initiation) of the demolition agent generates explosion shock waves or gas pressure to thereby demolish a target object. In the case of using a high explosive, explosion shock waves are generated. In the case of using a low explosive or a non-explosive demolition agent, gas pressure is generated.

[0036]

Fig. 4 illustrates the charging of demolition agents. As in Fig. 3, Fig. 4(a) is a top view of the extra concrete 3. Fig. 4(b) is a cross sectional view in the vertical direction along a line A-A specified in Fig. 4(a). Fig. 4(c) illustrates the boundary surface 5.

[0037]

In the present embodiment, the combined duct 31 spirally provided in the vicinity of the main reinforcing bars 7 is used as a charging hole, and a demolition agent 36 (first demolition agent) is charged into the combined duct 31 above the boundary surface 5, as illustrated in Figs. 4(a). Further, a demolition agent 38 (second demolition agent) is charged into the charging holes 37 (37a to 37d) formed as described above as illustrated in Figs. 4(b).

[0038]

The demolition agent 36 is for demolishing a portion of the extra concrete 3 that is situated outside of the vicinity of the main reinforcing bars

7. The demolition agent 38 is provided interiorly to the demolition agent 36 to demolish a portion of the extra concrete 3 that is situated within the main reinforcing bars 7. In the present embodiment, linear explosives are used as the demolition agents 36 and 38. The linear explosives are prepared by processing a high explosive into a linear shape with a suitable length and then attaching an electric blasting cap and a leading wire. A delay electric blasting cap may be used as the electric blasting cap.

[0039]

In the present embodiment, the demolition agent 36 is charged into the combined duct 31 from the end portion 31a of the combined duct 31 to the bottom of the combined duct 31 to fill nearly the entire combined duct 31, and sand (not illustrated) is charged into the vicinity of the end portion 31a. Further, as illustrated in Fig. 4(b), the demolition agent 38 is charged into the charging holes 37 up to the bottoms of the charging holes 37, and sand 39 is charged into the vicinities of openings of the charging holes 37. The demolition agent 38 is processed to a length of, for example, about 400 mm.

[0040]

On the other hand, a linear non-explosive demolition agent 15 is charged into the charging holes 9 along the horizontal direction of the boundary surface 5 up to the bottoms of the charging holes 9, and sand 17 is charged into the vicinities of the openings of the charging holes 9, as illustrated in Fig. 4(c). The length of the non-explosive demolition agent 15 is set to about 70% of the length of each charging hole 9, e.g., about 500 mm. While sand is charged as a stemming material into the vicinities of the end portion 31a of the combined duct 31 and the vicinities of the openings of the charging holes 9 and 37 in the present embodiment, the stemming material may be any material other than sand.

[0041]

Fig. 5 illustrates the non-explosive demolition agent 15. As

illustrated in Fig. 5, the non-explosive demolition agent 15 is housed in, for example, a hose 22 having an outer diameter of about 18 mm and made of polyvinyl chloride, and a leading wire 23 is connected to an ignition portion 15a of an end portion of the non-explosive demolition agent 15. A small opening of the hose 22 is sealed with a vinyl tape 24 or the like. The non-explosive demolition agent 15 is a high-energy substance that generates gas pressure by ignition to demolish a target object. The non-explosive demolition agent 15 refers to a demolition agent other than low explosives. Leading wires of the demolition agents 36 and 38 and the leading wire 23 of the non-explosive demolish agent 15 are arranged to extend outward from the combined duct 31 or the charging holes 37 or 9 and used as connecting wires. In Fig. 4, illustration of the leading wires is omitted.

[0042]

(3. Covering extra concrete 3)

After the charging is carried out as described above, the extra concrete 3 is covered with a high-strength sheet 40 such as an aramid fiber sheet, as illustrated in Fig. 6. Then, a wire 41 is wound around the sheet 40 and fixed, and the extra concrete 3 is bound. Any sheet with sufficient strength other than an aramid fiber sheet may be used as the sheet 40. Further, a method of fixing the sheet 40 is not limited to the method using the wire 41. The wire 41 may be omitted if, for example, end portions of the sheet 40 are firmly connected together such that the sheet 40 is fixed along the outer periphery of the extra concrete 3.

[0043]

(4. Demolition of extra concrete 3)

Next, the extra concrete 3 is demolished. In the present embodiment, the wires of the non-explosive demolition agent 15 and the demolition agents 36 and 38 are connected, and the controlled blasting of the non-explosive demolition agent 15 and the demolition agents 36 and 38 is carried out at

predetermined time intervals, as described below.

[0044]

In the present embodiment, first, the blasting of the non-explosive demolition agent 15 in the horizontal direction is carried out. Due to gas expansion pressure generated by the blasting of the non-explosive demolition agent 15, tensile stress is continuously applied to the concrete to vertically divide the extra concrete 3 and the structural concrete 27 of the cast-in-place pile 1 at the boundary surface 5 as indicated by an arrow A specified in Fig. 7(a). Unlike the high explosives and the like, the blasting of the non-explosive demolition agent 15 does not generate shock waves. Thus, the structural concrete 27 situated below the extra concrete 3 is free from damage, and noise and vibration are small. In Fig. 7, illustration of the sheet 40 and the like is omitted.

[0045]

After the blasting of the non-explosive demolition agent 15 in the horizontal direction is carried out, the demolition agent 36 in the combined duct 31 is blasted at an interval of about several tens of milliseconds, e.g., about 30 milliseconds. The blasting of the demolition agent 36 causes the portion of the extra concrete 3 situated outside the vicinity of the inner sides of the main reinforcing bars 7 to be extruded outward and moved toward an outer periphery surface of the extra concrete 3, which is a free surface, as indicated by an arrow B in Fig. 8(a), and the portion of the extra concrete 3 cracks and is demolished.

[0046]

After the blasting of the demolition agent 36, the demolition agent 38 in the charging holes 37a, which are circularly formed interiorly to the demolition agent 36, is blasted at a time interval of about 50 milliseconds. Consequently, as indicated by an arrow C in Fig. 8(b), the extra concrete 3 situated outside of the charging holes 37a is extruded outward and moved

toward the cracked surface formed as described above, whereby new cracks are generated within the main reinforcing bars 7 to demolish the extra concrete 3.

[0047]

Similarly, the demolition agents 38 in the charging holes 37b and 37c, which are circularly arranged, and the charging hole 37d at the center are sequentially blasted from the outside to the inside at an interval of about 50 milliseconds. Consequently, the extra concrete 3 situated outside of the charging holes 37b, 37c, and 37d is sequentially extruded outward and moved as described above so that the extra concrete 3 is demolished.

[0048]

The protecting members 29 provided to the main reinforcing bars 7 protect the main reinforcing bars 7 and also reserve a space to allow the extra concrete 3 to be moved by the demolition. The sheet 40 and the wire 41 wound around the outer periphery of the extra concrete 3 play a role as a restraining member for preventing excessive movement of the demolished extra concrete 3 to restrain the deformation of the main reinforcing bars 7 due to the movement of the concrete. Further, the sheet 40 prevents dispersion of the demolished extra concrete 3. Fig. 7(b) illustrates an example in which the extra concrete 3 is demolished as described above.

[0049]

As illustrated in Fig. 7(b), the blasting of the demolition agents 36 and 38 causes the extra concrete 3 to be demolished to the size of about a human head. Although the blasting of the demolition agents 36 and 38 generates shock waves, since edges of the extra concrete 3 situated above and the structural concrete 27 situated below are already cut at the time of the demolition, the structural concrete 27 is not damaged. Since the series of blasting operations end in about one second, noise and vibration are generated only instantaneously.

[0050]

(5. Removal of extra concrete 3)

After the demolition of the extra concrete 3 is completed, the demolished concrete rubble, the sheet 40, the wire 41 and the like are removed, and the pile head treatment is completed. The concrete rubble and the like can be collected and transported with small heavy equipment or manually.

[0051]

As the foregoing describes, in the present embodiment, the extra concrete 3 of the pile head and the structural concrete 27 situated below the extra concrete 3 are vertically divided with the non-explosive demolition agent 15, and thereafter the divided extra concrete 3 can be demolished with the demolition agents 36 and 38 such as high explosives. Since the non-explosive demolition agent 15 causes less noise and vibration, if the extra concrete 3 is dismantled with the non-explosive demolition agent 15 and the demolition agents 36 and 38 in this way, noise and vibration are generated only instantaneously and at minimum levels. The generation time can also be set freely according to a surrounding environment. Furthermore, since the extra concrete 3 is divided from the structural concrete 27 situated below the extra concrete 3 with the non-explosive demolition agent 15, which does not cause shock waves, and thereafter the divided extra concrete 3 is demolished, the structural concrete 27 is not given any damage by the division and demolition of the extra concrete 3.

[0052]

Further, since the charging and demolition are carried out as post processes on the ground, it is possible to adjust the charging positions and the like to appropriate positions according to the finished pile size so that the extra concrete 3 can unfailingly be demolished into concrete rubble of the size of a human head. Thus, the demolished concrete rubble can be removed

manually or with small heavy equipment. Furthermore, after the charging operations are finished, the extra concrete 3 can be demolished instantaneously. Thus, the work efficiency is high. The method of the present embodiment can reduce the construction period at the same level of cost, compared with a pile head treatment using a hand breaker. In a trial calculation concerning a pile of a diameter of 2.0 m (number of construction workers: 5) based on experimental results, the cost level was about the same, but the work efficiency was about 1.6 times higher.

[0053]

Further, in the present embodiment, a linear explosive is charged as the demolition agent 36 into the vicinity of the main reinforcing bars 7 in the outer periphery portion of the extra concrete 3, and a linear explosive is vertically charged as the demolition agent 38 interiorly to the demolition agent 36. Then, the demolition agents are control blasted sequentially such that the closest demolition agent to the outer periphery portion of the extra concrete 3 is blasted first, followed by the interior demolition agents. In this way, the portion of the extra concrete 3 that is situated outside of the vicinity of the main reinforcing bars 7 can be extruded outward and demolished with the demolition agent 36, while the portion of the extra concrete 3 that is situated inside of the main reinforcing bars 7 can be extruded outward and demolished with the demolition agent 38, whereby the extra concrete 3 can be dismantled efficiently with a small amount of demolition agents. As a result, noise and vibration are reduced, and the amount of dust is also decreased.

[0054]

Further, since the sheet 40 and the wire 41 restrain the main reinforcing bars 7 from deforming at the time of the demolition of the extra concrete 3, the main reinforcing bars 7 can be prevented from bending. The sheet 40 also plays a role to prevent dispersion of the demolished extra concrete 3.

[0055]

Further, since the elastic protecting members 29 are provided around the main reinforcing bars 7, the main reinforcing bars 7 can be protected, and also the moving width of the extra concrete 3 at the time of the demolition can be reserved so that cracks are unfailingly produced, whereby the demolition can be carried out suitably.

[0056]

Further, in the first embodiment, the spiral combined duct 31 is provided in advance in the vicinity of the main reinforcing bars 7 of the reinforcing bar cage 25, and the demolition agent 36 is charged into the spiral combined duct 31, making it possible to omit the boring of charging holes. The combined duct 31 does not interfere with a tremie pipe or the like for placing concrete. Further, since the combined duct 31 is spirally provided, it is only required to provide one to several combined ducts 31 with respect to the concrete in the vicinity of the main reinforcing bars 7 that requires relatively large energy at the time of the demolition, and the charging is required to be carried out only once, which are advantages.

[0057]

Further, while the positions of the charging holes 37a, 37b, and 37c in the circumferential direction are arranged zigzag at least partially such that the charging holes 37a, 37b, and 37c are not aligned in the present embodiment, the positions of all of the charging holes 37a, 37b, and 37c in the circumferential direction may be aligned. It is to be noted, however, that the case in which the positions of the charging holes 37a, 37b, and 37c in the circumferential direction are arranged zigzag not to align as in the present embodiment is advantageous in that compared with the case in which the positions of the charging holes 37a, 37b, and 37c in the circumferential direction are aligned, the size of demolished concrete rubble can further be reduced with a small number of charging holes.

[0058]

Further, while the charging holes 37 (37a, 37b, 37c, 37d) are formed by boring in the present embodiment, the boring of the charging holes 37 can be omitted if a duct such as a combined duct is provided in advance in the vertical direction within the main reinforcing bars 7 of the reinforcing bar cage 25. It is to be noted, however, that when a combined duct or the like is provided within the main reinforcing bars 7, interference with a tremie pipe and the like for the placement of concrete needs to be taken into consideration.

[0059]

Further, while the sheet 40 and the wire 41 are wound around the extra concrete 3 to restrain the deformation of the main reinforcing bars 7 at the time of demolition of the extra concrete 3 in the present embodiment, a method of restraining the deformation of the main reinforcing bars 7 is not limited to the method described in the present embodiment. For example, a restraining member such as a hoop reinforcing bar that is easily removable by cutting or the like may be provided in advance around the main reinforcing bars 7 of the reinforcing bar cage 25. In this case, the restraining member may be removed by cutting or the like after the extra concrete 3 is demolished.

[0060]

Further, the arrangement, size, and number of the charging holes are not limited to those described in the present embodiment and may be set freely according to the specification of the cast-in-place pile 1, construction scheme, and the like. For example, while eight horizontal charging holes 9 are formed at an interval of 45 degrees as illustrated in Fig. 3(c) in the first embodiment, the number of horizontal charging holes 9 may be changed according to the diameter of the pile in order to efficiently divide at the boundary surface 5. In a case where the diameter of the cast-in-place pile 1 is

small (for example, 1.3 m or smaller), four charging holes 9 may be formed at an interval of 90 degrees.

[0061]

Further, while linear high-explosives are used as the demolition agents 36 and 38 in the present embodiment, the same controlled blasting may be carried out with other demolition agents such as a low explosive and a non-explosive demolition agent in place of the linear explosives. A non-explosive demolition agent is advantageous in that no prior prescribed permission in Japan is required at the time of the pile head treatment, although the non-explosive demolition agent needs to be charged in more places because the energy that is produced by the non-explosive demolition agent at the time of blasting is slightly small. Further, the pile head treatment method described above is also applicable to a case where a cast-in-place pile is constructed with plain concrete.

[0062]

[Second embodiment]

Next, the following describes a second embodiment of the present invention. The second embodiment is an example in which in place of the spiral combined duct, combined ducts are vertically provided in the vicinities of main reinforcing bars of a reinforcing bar cage and are used as charging holes. Other points are similar to those in the first embodiment, so the same reference numerals are given in the drawings and the like, and description is omitted.

[0063]

Fig. 9 illustrates a reinforcing bar cage 25 according to the second embodiment. Fig. 9(a) is a side view of an upper portion of the reinforcing bar cage 25, and Fig. 9(b) is a top view of the reinforcing bar cage 25.

[0064]

As illustrated in Fig. 9, in the present embodiment, combined ducts

43 are provided along the vertical direction parallel to the main reinforcing bars 7 in the vicinities of inner sides of the intervals of the main reinforcing bars 7 of an upper end portion of the reinforcing bar cage 25. Each combined duct 43 is, for example, a duct made of polyvinyl chloride and having a diameter of about 15 mm and a length of about 600 mm. At the time of constructing the pile in situ, the combined ducts 43 are placed with a setting jig 44 and the like such that upper ends of the combined ducts 43 extend from an upper surface of the extra concrete.

[0065]

In the present embodiment, a cast-in-place pile 1 is constructed by use of the reinforcing bar cage 25 as described above. Thereafter, the extra concrete 3 of a pile head is divided and demolished by use of a non-explosive demolition agent and a demolition agent, and is removed.

[0066]

Fig. 10 is a top view of the extra concrete 3, illustrating charging holes 37 and the combined ducts 43. In the present embodiment, the charging holes 9 in the boundary surface 5 (refer to Fig. 1) and the charging holes 37a to 37d within the main reinforcing bars 7 are formed as in the first embodiment, and the non-explosive demolition agent 15 and the demolition agent 38 are charged into the charging holes as described above. In the vicinities of the main reinforcing bars 7, a linear explosive similar to the demolition agent 38 as a first demolition agent for demolishing the portion outside of the vicinity of the main reinforcing bars 7 is charged into the combined ducts 43, which are charging holes, up to the bottoms of the combined ducts 43, and a stemming material such as sand is charged into the vicinities of the openings of the combined ducts 43. The length of the linear explosive is, for example, shorter by about 300 mm than the length of each buried combined duct 43.

[0067]

Thereafter, as in the first embodiment, the extra concrete 3 is bound with a sheet and a wire. Then, wires of the non-explosive demolition agent 15 and the demolition agent are connected, and the controlled blasting is carried out. At this time, first, the non-explosive demolition agent 15 is blasted to divide the extra concrete 3 from the structural concrete 27 situated below, and then the demolition agent in the combined ducts 43 is blasted at a time interval of about 30 milliseconds such that the extra concrete 3 situated outside of the vicinity of the inner sides of the main reinforcing bars 7 is extruded outward and demolished. Then, as in the first embodiment, the demolition agent 38 in the charging holes 37a to 37d is sequentially blasted at a time interval of about 50 milliseconds, whereby the extra concrete 3 is demolished to the size of about a human head as in the example illustrated in Fig. 7(b).

[0068]

The second embodiment also produces similar advantages to those produced by the first embodiment. Further, the combined ducts 43 are provided in the vicinity of the main reinforcing bars 7 to produce an advantage that the charging hole boring operation can be reduced, and use of the combined ducts 43 provided in the vertical direction produces an advantage that the charging can be carried out with ease. It is to be noted that instead of using the combined ducts 43, the extra concrete 3 in the vicinities of the inner sides of the intervals of the main reinforcing bars 7 may be bored in the vertical direction to charge the demolition agent such as a linear explosive into the bored holes.

[0069]

While the foregoing describes the embodiments of the present invention with reference to the attached drawings, the scope of the invention is not limited to the embodiments. It will be apparent to those skilled in the art that various modifications and variations can be made to the present

invention without departing from the spirit and scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the invention set forth in the appended claims.

EXPLANATION OF REFERENCE NUMERALS

[0070]

- 1.....Cast-in-place pile
- 3.....Extra concrete
- 5.....Boundary surface
- 7.....Main reinforcing bar
- 9, 37, 37a, 37b, 37c, 37d.....Charging hole
- 15.....Non-explosive demolition agent
- 36, 38.....Demolition agent
- 25.....Reinforcing bar cage
- 27.....Structural concrete
- 29.....Protecting member
- 31, 43.....Combined duct
- 40.....Sheet
- 41.....Wire

CLAIMS

[Claim 1]

A pile head treatment method comprising:

the step (a) of linearly charging a non-explosive demolition agent inward from a side surface of concrete of a pile head exposed on a ground, the pile head having a main reinforcing bar buried in a vertical direction in an outer periphery portion thereof, and charging a demolition agent into the concrete situated above the non-explosive demolition agent, at the time of constructing a pile in situ; and

the step (b) of activating of the non-explosive demolition agent to divide the concrete into upper concrete and lower concrete and thereafter activating of the demolition agent to demolish the divided upper concrete, wherein a restraining member for restraining the main reinforcing bar from deforming is provided on an outer periphery surface thereof.

[Claim 2]

The pile head treatment method of claim 1,

wherein in the step (a), a high explosive as a first demolition agent is linearly charged in a vicinity of the main reinforcing bar, and a high explosive as a second demolition agent is linearly charged in the vertical direction interiorly to the first demolition agent.

[Claim 3]

The pile head treatment method of claim 2, wherein in the step (b), the first demolition agent and the second demolition agent are sequentially activated such that the closest demolition agent to the outer periphery portion of the concrete is activated first, followed by the interior demolition agents.

[Claim 4]

The pile head treatment method of claim 1, wherein an elastic protecting member is provided in advance around the main reinforcing bar.

[Claim 5]

The pile head treatment method of any one of claims 2 to 3, wherein in the step (a), the first demolition agent is charged into a duct that is spirally provided in advance along a circumferential direction of the concrete in the vicinity of the main reinforcing bar.

[Claim 6]

The pile head treatment method of any one of claims 2, 3 and 5, wherein in the step (a), the first demolition agent is charged into a duct that is provided in advance along the vertical direction in the vicinity of the main reinforcing bar.

[Claim 7]

The pile head treatment method of any one of claims 1 to 6, wherein prior to the step (b), the concrete of the pile head is covered with a sheet.