

DESCRIPTION

[Title of Invention]

REMOVAL METHOD FOR EARTH-RETAINING MEMBER

[Technical Field]

[0001]

The present invention relates to a method for extracting earth-retaining members used in an earth-retaining construction to remove from inside of ground without ground fissure, softened ground, or others.

[Background Art]

[0002]

Construction for embedding a water pipe, a sewer pipe, a gas pipe, a box culvert, or the like, which is embedded at the location relatively shallow from the ground surface, includes works for installing first an earth-retaining member such as a steel sheet pile or an H-shaped steel beam at the location where both side walls of a ditch are to be build, supporting the ditch walls so as to prevent their collapse, then excavating the ground to form the ditch, and laying down a water pipe or the like within the ditch.

[0003]

Removal of an earth-retaining member located around a building or embedded structures generates subsidence or cracks of the building or the embedded structures, and thus the earth-retaining member is usually kept underground without recovery thereof. However, in recent years, the recovery thereof has become popular for utilizing resources effectively or suppressing generation of greenhouse-effect gas.

[0004]

The recovery of an embedded earth-retaining member may be practiced by extracting it from the inside of the ground using an earth-retaining member pressure extraction machine. However, since the extraction forms a cavity within the ground to generate settlement or cracks of a building, a method of injecting a sealing material such as a soil stabilizer into the cavity has been proposed (for example see Patent Literature 1).

[Citation List]

[Patent Literature]

[0005]

1. Japanese Patent Publication No. 2013—036280

[Summary of Invention]

[Technical Problem]

[0006]

However, the method described above requires an injection tube embedded adjacent or close to every series of three or four earth-retaining members, and there was a problem in that such too many injection tubes are consumed and significant time and cost for removal of the earth-retaining members are required.

[Solution to Problem]

[0007]

In consideration of the above-mentioned problem, the present invention may provide a removal method for earth-retaining members which comprises the steps of: defining one block including at least 5 earth-retaining members consecutively arranged, inserting an injection tube adjacent or close to an earth-retaining member located in the center of the block and then installing the injection pipe within the ground without fixing to the earth-retaining member; and allowing a sealing material to flow from the injection tube and the sealing material to flow into a cavity generated within the ground so as to fill up the cavity, each time one earth-retaining member in the block being pulled up to a certain level one after another.

[Advantageous Effects of Invention]

[0008]

The method of the present invention can be used to reduce the number of injection tubes to be installed, to shorten the time taken for the removal of earth-retaining members, and to trim the construction cost.

[Brief Description of Drawings]

[0009]

Fig. 1 illustrates a drawing of a sheet pile as an earth-retaining member.

Fig. 2 illustrates a front elevation view of an earth-retaining member pressure extraction machine.

Fig. 3 depicts an exemplary lower structure of an injection tube.

Fig. 4 depicts an another exemplary lower structure of an injection tube.

Fig. 5 depicts a location in the case of installing an injection tube adjacent to a buried earth-retaining member.

Fig. 6 illustrates a flowchart illustrating a process of the removal method of an earth-retaining member.

Fig. 7 illustrates pulling up an earth-retaining member with an earth-retaining member pressure extraction machine along with draining a sealing material from an earth-retaining member injection tube.

[Description of Embodiments]

[0010]

Before explaining the removal method for the earth-retaining member of the present invention, the earth-retaining member embedded in the ground will be described below. A frame called as an earth retainer may be constructed to prevent collapse of earth and sand of an excavated slope or inclined face. The earth-retainer comprises an earth-retaining wall and timbering members: for the earth-retaining wall, an earth-retaining member such as a steel sheet pile (sheet pile) may be used, and for the timbering members, an H-shaped steel beam having an H-shaped section, I-shaped beam having an I-shaped section, or the like.

[0011]

Fig. 1 illustrates a drawing of a sheet pile as an earth-retaining member. A sheet pile 10 may be a U-shape, Z-shape, linear shape, or H-shape depending on a cross-sectional shape thereof, and a plurality of such piles may be driven into the ground in a row to construct a gapless wall. Such shapes are selected for providing strength that can resist the earth pressure or water pressure applied to the sheet pile 10, and in use for a temporary work, for providing stiffness that can be durable to repeated use with driving and extraction. For reference, the sheet pile 10 depicted in Fig. 1 represents a U-shaped steel sheet pile.

[0012]

The U-shaped steel sheet pile may have joints 11 on the both sides for hooking to connect, and a plurality of such piles may be connected to form a concavo-convex wall face in Fig. 5. Formation of such wall face may provide higher strength relative to a simple linear wall face. The sheet pile 10 may contain copper for preventing corrosion, and may be used one that is coated on the surface with polyethylene resin, polyurethane resin, or the like.

[0013]

A plurality of the sheet piles 10 may be connected each other with the joints 11 to construct an earth-retaining wall, and then after workings for construction such as laying of water pipes, the plurality of the sheet piles 10 may be extracted and removed if there is no construct, underground structure, or the like around there. In contrast, if there is a construct, underground structure, or the like around there, the sheet pile could, when extracted, touch and break the underground structure; could form a cavity within the ground in which the cavity may then break to cause ground subsidence to fall down the construct; or the like. Therefore, if there is a construct, underground structure, or the like around there, the sheet pile 10 was left without being extracted. As a result, a huge number of the sheet piles 10 have been kept underground.

[0014]

Most of the sheet piles 10 kept underground are reusable. Reusing such piles may lead to an effective utilization of resources, and may suppress the generation of carbon dioxide in manufacturing the sheet piles 10. Hereinafter, a method of extracting and removing the sheet piles 10, without breaking an underground structure, without falling down a construct, and also without consuming time and costs, will be described in detail below.

[0015]

According to the present invention, in removing the sheet piles 10, an injection pipe for injecting a sealing material, a supply pump for supplying the sealing material into the injection pipe, a container for containing the sealing material, a boring apparatus for boring the ground, an injection pipe insertion apparatus for inserting and installing the injection pipe into an opening formed by the boring apparatus, and an earth-retaining member pressure extraction machine for extracting the sheet piles 10 may be used. As the supply pump, the container, the boring apparatus, and the injection pipe insertion apparatus, those commonly used may be employed.

[0016]

As the supply pump, a centrifugal pump such as a gear pump, a reciprocating pump such as a plunger pump may be used. The container may take any form made of steel, plastic resin such as polyvinyl chloride or FRP (Fiber Reinforced Plastics), and the one with an adequate volume depending on the usage of the sealing material may be used.

[0017]

The boring apparatus may include a monitor which is a boring member that has a pointed conical tip and a spiral ditch formed thereon, a bar rod to be connected with the monitor, and clamping members which may clamp the rod to be able to rotate while being up and down. The monitor is not limited to the one that has a pointed conical tip and a spiral ditch formed thereon, but may be a bit having a plurality of blades (chips) at the top which may cut and penetrate into the ground, or the like.

[0018]

The injection pipe insertion apparatus may include clamping members for clamping the injection pipe, and may regulate the power for clamping the injection pipe, thereby inserting the injection pipe by descending thereof at a certain rate so as to install the injection pipe through the insertion opening. An example has been described above, and the present invention is not limited to these apparatuses.

[0019]

With referring to Fig. 2, an earth-retaining member pressure extraction machine will be described below. Earth-retaining member pressure extraction machine 20 is a widely known apparatus which is popular as a noise-free and vibration-free pile pressure extraction machine. The earth-retaining member pressure extraction machine 20 performs a press-extraction and an extraction of the earth-retaining member 21 with oil pressure. Particularly, the earth-retaining member pressure extraction machine 20 includes a chuck 22 for grabbing the earth-retaining member 21, which is an object to be press-extracted or extracted, and a lift apparatus 23 for ascending and descending the chuck 22.

[0020]

The chuck 22 may have around the top thereof an unillustrated small circular aperture through which the earth-retaining member 21 can pass. In addition, the earth-retaining member pressure extraction machine 20 may have a plurality of grab parts 25 for grabbing the tops of earth-retaining member 24 embedded in the ground. The grab part 25 may grab the top of previously installed piles thereby removing reaction force from the previously installed piles to allow the earth-retaining member 21 to be pressed into or to be extracted from the ground with the chuck 22. The earth-retaining member pressure extraction machine 20 also may be configured so as to

move along the tops of the earth-retaining members 24 aligned in a row allowing to shift to the direction of the alignment.

[0021]

Then with referring to Fig. 3, an injection pipe will be described below. As the injection pipe 30, a steel pipes, a plastic resin pipe such as polyvinyl chloride pipe, or the like and also ones of which tip parts are formed to various shapes may be used. For example, one may be used that is formed as shown in Fig. 3(a) and has an inner structure also shown in Fig. 3(a).

[0022]

The injection pipe 30 may be installed in a manner such that an opening for inserting the injection pipe 30 therethrough is formed with the boring apparatus described above and then the injection pipe 30 is inserted into the opening with the injection pipe pitching apparatus described above. Thus, the tip part of the injection pipe 30 desirably has a tapered shape toward the end thereof for easy insertion of the opening. The tip part may also have a flow outlet 31, which is horizontal to the ground, for flowing out the sealing material to the pipe wall, and may include inside a cylindrical plug 32 and an elastic body 33 which is connected to one end of the plug 32 and is able to extend and contract in the direction of the length of the injection pipe 30.

[0023]

In the plug 32, the outer wall face thereof may be adjacent to the inner wall face of the injection pipe 30 so as not to form any gap; without supplying the sealing material, elastic body 33 may extend and then move up the position thereof so as to plug the flow outlet 31 as in Fig. 3(a). In contrast, with supplying the sealing material into the injection pipe 30, the load thereof may lead to contraction of the elastic body 33 and then move down the plug 32 so as to open the flow outlet 31 to flow out the continuously supplied sealing material into the surrounding soil as shown by the arrow in Fig. 3(b).

[0024]

As the elastic body 33, for example, a coil spring may be used. An O-ring may be also placed between the plug 3 and the inner wall of the injection pipe 30 to make prevention of leakage of the sealing material more certainly.

[0025]

In this embodiment, the explanation is provided such that a rod with a monitor at the tip is used for boring, and that after boring, the injection pipe 30 is inserted and installed within the opening, but the present invention is not limited to such embodiment. For example, a monitor used for boring may be attached to the tip of the injection pipe 30, and only a boring apparatus may be used to insert and to install the injection pipe 30 at the same time as boring, thereby further shortening construction time and cutting construction cost. The monitor may be later removed and checked when the injection pipe 30 will be recovered and then may be used again.

[0026]

The injection pipe 30 having the structure depicted in Fig. 3 might cause the problem in that the elastic body 33 moves to lower the plug 32 and open the flow outlet 31 thereby allowing earth and sand to flow backward and plug inside because the boring must be performed with applying vibration to the soil with a high N value including cobble stones and sand. If this problem happens, the injection pipe must be extract on the ground, cleaned and inserted again, thereby taking a lot of time-consuming processes. For this reason, the injection pipe 30 depicted in Fig. 4 may be employed in the soil with a high N value.

[0027]

The injection pipe 30 depicted in Fig. 4 may be formed without the plug 32 and the elastic body 33 while providing a flow outlet 31 comprising a first hole 31a with a first diameter and a second hole 31b with a diameter larger than the first diameter connected to the first hole, in which the second hole 31b may be closed inside by a disc-shaped cap 34 as a closing member. Thus, earth and sand forced to flow backwardly into the injection pipe 30 may be restrained with the cap 34; the cap 34 may be pushed out with the sealing material and then may be automatically removed from the second hole 31b when the sealing material flows outside.

[0028]

Fig. 4 depicts a single cap 34, but the structure may be a double cap 34 to improve sealing level to ensure to prevent back-flow. In such case, the inner cap may be a cap made of plastic resin with a predetermined strength durable to pressure of the back-flowing earth and sand, and the outer cap may be a cap made of silicon resin for improving sealing performance. In Fig. 4, a boring member 35 is attached to an

injection pipe 30 to close the tip. Fig. 4 also illustrates a combining part 36 which combines two types of sealing materials.

[0029]

Next, a brief explanation will be provided of the sealing material to be injected from the injection pipe 30. Extraction of the sheet pile 10 shown in Fig. 1 using the earth-retaining member pressure extraction machine 20 shown in Fig. 2 may form a cavity derived from the soil part where previously the sheet pile 10 was present. If the sealing material remained as a liquid form for a long time, it may come to permeate over the soil due to numerous fine spaces in the soil. In such case, another cavity may be generate and cause ground subsidence or the like. To prevent this problem, the sealing material used in the present invention is desirably gelled immediately after being injected from the injection pipe 30, in order to avoid permeating over the soil.

[0030]

To prevent the permeation, the time that the sealing material may lacks its fluidity and rapidly increase in viscosity (gelling time), is preferably about 20-70 seconds. It is desirable because adjustment of the time to such level may allow the sealing material to move into the cavity, to fill the cavity and then to be gelled therein; the sealing material may then remain at the position without permeating into the soil.

[0031]

As the sealing material, for example, a blast-furnace cement type B which is widely used for common civil engineering and architectural construction, an accelerator primarily containing calcium hydroxide, a hardener primarily containing sodium carbonate and sodium aluminate, and water may be used to prepare and a liquid A comprising the blast-furnace cement type B, the accelerator, and water, and a liquid B comprising a hardener and water may be used respectively. These liquids A and B may be gelled in a short time by combining. The time for gelling may be adjusted by their ratio. Incidentally, liquids A and B may be preferably combined just before injecting into soil, since upon being combined, they may be gelled in a short time.

[0032]

As an example, the liquid A may contain an accelerator, a blast-furnace cement type B, and water at a mass ratio of 1:20-30:40-45, and the liquid B may contain a hardener and water at a mass ratio of 1:15-20.

[0033]

The injection pipe 30 which allows the liquids A and B combined just before the injection may have a structure comprising two paths inside, where a path 1 passes the liquid A therethrough and a path 2 passes the liquid B therethrough, which form a single path just before the plug 32. Therefore, the terminal part opposite to the tip part of the injection pipe 30 may also have a structure arranged with two injection nozzles so as to supply the liquids A and B to each path.

[0034]

Fig. 5 depicts the position for installing the injection pipe 30. The ground may be slightly excavated to expose the top of the earth-retaining member 40, and may be seen from the upper side as the drawing shown in Fig. 5. Earth-retaining members 40 shown as U-shaped steel sheet piles, a plurality of the piles may be connected so as to be aligned in a row and may be embedded in the ground. Extraction of the earth-retaining member 40 as they are may form a cavity from the part where previously they were; and the cavity may collapse to generate subsidence or cracks. For this reason, the injection pipe 30 may be installed and the sealing material may be embedded into the cavity. The location for the formation of opening 41 may be important for installing the injection pipe 30.

[0035]

The location for the formation of the opening 41 may be a location adjacent or close to the earth-retaining member 40 at the center of one block, in which the one block may be defined to include a certain number of the earth-retaining members consecutively arranged. The number of the earth-retaining member 40 included in the one block may desirably be odd numbers, for example, 5 or 7, but not limited thereto, the odd numbers at least 9 may be allowed. The location for the formation of the opening 41 may be any location as long as it is adjacent or close to the earth-retaining member 40 located in the center, however the center location of the earth-retaining member 40 in the direction of the line of the earth-retaining members 40 may be preferable. Moreover, the location may be preferable to be the center location adjacent or close to the concave face side opposite to the convex face side rather than the convex face side of the earth-retaining member 40. As this reason, since the cavities may be created in the direction of the aligned earth-retaining members 40, the two flow outlets

31 of the injection pipe 30 may be positioned at the concave face side in the direction of the aligned earth-retaining members 40, thereby allowing to flow the sealing material appropriately.

[0036]

Furthermore, the block is not limited to be composed of odd-numbered earth-retaining members 40, and may be composed of even-numbered members. In this embodiment, the location adjacent or close to joint 11 that connects two central earth-retaining members 40 may be defined as the location for the formation of opening 41. The reason is because it is preferable to efficiently embed the cavity that the injection pipe 30 is installed at the location as close to the earth-retaining member 40 as possible.

[0037]

In the present invention, the opening 41 is formed by using a boring apparatus; the injection pipe 30 is inserted and installed and then the injection pipe 30 is left without fixing to an adjacent or close earth-retaining member 40 by welding or the like. Such fixing may cause time-consumption or elaboration to transfer or install an earth-retaining member pressure extraction machine, because the earth-retaining members may be extracted not sequentially from one side but side-to-side from the most distant members of both sides of the block, and then finally the central earth-retaining member 40 fixed to the injection pipe 30 may be extracted. Particularly, this reason is as follows: if the earth-retaining members on both sides have not been extracted yet and the central earth-retaining member is extracted first, the resistance of the connection part between the earth-retaining members is too great which makes it uneasy to extract thereof. Additionally, the troubles may easily occur in which nevertheless an earth-retaining member 40 to be extracted in the block is left; the earth-retaining member, to which the injection pipe 30 is fixed, is extracted prior to the extraction of others.

[0038]

As described above, the earth-retaining members 40 may be extracted in turn from one side by not fixing the injection pipe 30 to the adjacent or close earth-retaining member 40, thereby allowing to improve working efficiency.

[0039]

With referring to Fig. 6, the removal method of an earth-retaining member of the present invention will be described in detail below. Fig. 6 depicts a flowchart showing the method, and the method may comprise preparation of the injection pipe 30, the boring apparatus, the earth-retaining member pressure extraction machine 20, the sealing material, and the like, and starts from the step 600. In the step 605, one block including at least five earth-retaining members consecutively arranged is defined and then forming an opening 41 for inserting the injection pipe 30 adjacent or close to the earth-retaining member 40 located in the center of the block using the boring apparatus. Then, the injection pipe 30 is inserted and installed within the opening 41 using the injection pipe pitching apparatus.

[0040]

The injection pipe 30 is desirably embedded in the ground, because a gap between the opening 41 and the injection pipe 30 may allow the sealing material to concentrate to flow into the gap and thus fail to fill the cavity appropriately, and may also need more sealing material to fill the cavity. Furthermore, the injection pipe 30 may be not fixed to the adjacent or close earth-retaining member 40, and may be left free.

[0041]

In the step 610, the injection pipe 30 and a container containing the sealing material are connected via a pump, an earth-retaining member 40 to be extracted is grabbed and is made ready to be pulled up by the chuck 22 of the earth-retaining member pressure extraction machine 20. Moreover, the pump is started up and is made ready to start injection. In the step 615, pulling-up of the earth-retaining member 40 is started and in the step 620, the earth-retaining member 40 is pulled up to a certain level.

[0042]

In the step 625, the sealing material is injected for a certain duration. The step 620 and the step 625 may also be performed simultaneously. If the pull-up level is as low as about 500 mm, the steps may be performed in this order because great ground subsidence or big cracks may not occur. In this connection, the sealing material may move in the direction of extraction of the earth-retaining member 40 resulting in generation of a cavity, may flow into the cavity and may fill the cavity. The sealing

material filling the cavity may be gelled in a short time and may remain there, thereby allowing to prevent occurrence of subsidence or cracks.

[0043]

In the step 620, extraction of an earth-retaining member 40 is stopped, for example, at every 500 mm extraction, and then in the step 625, the injection of the sealing material is continued for a certain duration. The duration may be measured with a timer, and the injection for the certain duration may achieve the injection of a predetermined amount. The injection duration may be determined by calculating the volume of 500 mm level of the earth-retaining member 40 and applying the calculated volume and the capacity of a supply pump.

[0044]

In the step 630, completion of extraction of the earth-retaining member 40 is determined. If not completed, the process reverts to the step 610 to repeat again the works of pulling up to a certain level, injecting the sealing material, and filling the cavity. If the method is completed in the step 630, the method proceeds to the step 635 to determine the presence of any earth-retaining member 40 to be extracted in the block. If there remains any earth-retaining member 40, the method reverts to the step 610 to transfer the earth-retaining member pressure extraction machine 20; grabs the next earth-retaining member 40 to be extracted with the chuck 22; and makes ready to be pulled up anytime desired. In this step, the injection pipe 30 has remained installed, and thus if necessary, the sealing material can be also reinjected. The reinjection can be also performed at the time of extraction of the earth-retaining member 40.

[0045]

In the step 635, if there is no earth-retaining member 40 to be extracted in the block, the process proceeds to the step 640 to extract the injection pipe 30 with a crane or the like while injecting the sealing material. In extraction of the injection pipe 30, an U-shaped connecting member called a shackle is attached to a swivel quipped on the injection pipe 30, and then an wire may be connected to the connecting member to hung and to extract the injection pipe. After extraction, the injection pipe 30 is checked of reusability by an operator, and the injection tube, if reusable, may be diverted for extraction of the earth-retaining member in the next block or utilization in another site.

[0046]

In the step 645, the presence of any untreated block may be determined. If such block is present, the process turns to the step 605, and performs installation of the injection pipe 30 in the next block. If such block is absent, the process turns to the step 650, and finishes the removal work of the earth-retaining member 40.

[0047]

Exudation of the sealing material on the ground surface may be checked while the cavity is filled, and if the exudation is detected, the injection volume may be adjusted. The exudation indicates too much injection volume, and the injection volume may be reduced by shortening the injection duration for injection or diminishing a flow amount to be injected. The exudation of the sealing material may be detected, for example, with a detecting part such as a sensor installed on the ground surface. Therefore, in response to detection by a detecting part, the setting value of the flow amount may be changed for a pump, which is a supplying part for the sealing material, and to adjust the flow amounts of the sealing material.

[0048]

With referring to Fig. 7, a method of filling with a sealing material by composing a block of five earth-retaining members 40, forming an opening 41 in each block, and inserting a tube 30 into the opening 41 will be described in detail below. No matter whether the injection pipe 30 has a flow outlet or two flow outlets, the flow outlet is preferably arranged in the direction of the formation of cavities. The opening 41 may be formed adjacent or close to an earth-retaining member located at the center of the five earth-retaining members 40, and then the five earth-retaining members 40 may be extracted one after another from one side. Therefore, as shown in the example of Fig. 7, the earth-retaining members 40 may be extracted with the earth-retaining member pressure extraction machine 20 in order of Fig. 7(a), Fig. 7(b), Fig. 7(c), Fig. 7(d), and Fig. 7(e). Then, the injection pipe 30 shown as in Fig. 7(f) may be extracted with a crane or the like. Each figure depicts the earth-retaining members 40 as in the middle of extraction, and the sealing material is filled in the parts where previously the earth-retaining members 40 were.

[0049]

The sealing material may be a liquid to flow out in substantially horizontal direction, and thus the sealing material may flow into a cavity generated by extraction

of the earth-retaining member 40 and immediately fill the cavity. The sealing material filling the cavity may be gelled after a certain duration has passed. As described above, the cavity sequentially generated from bottom may be filled with the sealing material, and then even after the earth-retaining member 40 is completely extracted, the cavity may be filled with the sealing material to the ground surface.

[0050]

Next, the earth-retaining member 40 adjacent to the earth-retaining member 40 previously extracted may be extracted in the same manner, and the cavity may be filled in the same manner. Such process may be repeated to extract five earth-retaining members 40 consecutively arranged, in turn from one side, and to fill with the sealing material, and then removal of the block may be completed. After completion, the sealing material may be injected from the injection pipe 30 still installed within the ground, if necessary. The injection pipe 30 may be extracted and checked before construction for the next block starts, and if it is available, it may be reused in construction for the next block.

[0051]

As described above, the method of the present invention can prevent occurrence of subsidence or cracks in the ground as well as reduce the number of the injection pipes 30 to be installed, to shorten the time taken for removal of the earth-retaining members, and to reduce the construction cost. Even the earth-retaining member 40 bends into an arch during extraction, the injection pipe 30 may be extracted without bending into an arch and may be reused, since the injection pipe 30 is not fixed to the earth-retaining member 40 by welding or the like,

[0052]

The sealing material may also be filled in a cavity originally present in the soil, and thus adhesiveness to the surrounding ground may be improved. The method of the present invention may not require press-injection of the sealing material, thereby allowing to prevent waste of the sealing material as well as eliminating the need for installation of an expensive pump for supplying with high pressure.

[0053]

Additionally, in the method of the present invention, appropriate filling of the cavity may be determined by exudation of the sealing material on the ground surface,

thereby allowing to securely perform cavity filling in extraction of the earth-retaining member 40, to securely prevent occurrence of subsidence or cracks, and to reduce excess cost of the sealing material. Furthermore, the earth-retaining member 40 may be reusable, thereby reducing production volume of the earth-retaining members 40, lowering construction cost for earth-retaining construction, and also, suppressing the generation of global warming gas in accordance with decreasing production volume of the earth-retaining members 40.

[0054]

Incidentally, since exudation also may not occur on the surface in gravel-layered ground or sandy ground, measurement may be performed, for example, for the level of ground subsidence with a settlement gauge, and for the incline of the ground with a clinometer, to determine the effect of the cavity filling from the measurement result. Particularly, the effect is determined by whether or not the subsidence level or incline is within a predetermined range of a first control value.

[0055]

In the present invention, besides using the earth-retaining member pressure extraction machine 20 depicted in Fig. 2, a crane, a vibrohammer, which is a vibropile driver, and the like may also be used to pull up. Such crane and the like might overturn if the ground is not stable. However, in the present invention, since the sealing material may fill in the cavity in parallel with generation of the cavity, as well as may solidify in a short time to obtain a certain strength, the ground may be stably maintained even if the crane and the like are used. Moreover, the use of a crane and the like may eliminate the use of a chuck as used in the earth-retaining member pressure extraction machine 20, thereby allowing to pull up even if the sheet pile is installed with curving while enabling the earth-retaining member 40 to be extracted either in ascending order of distance from the injection pipe 30 or in turn from one side.

[0056]

Furthermore, the use of a crane or the like may be easy in preparation and eliminate usage of an engine unit, a carrier car, a hydraulic hose, and the like as used in the earth-retaining member pressure extraction machine 20 while allowing the extracted sheet pile to be loaded directly on a truck. Thus, even if the construction location is narrow, the construction can be possible, and may not let apparatuses or equipment be

placed messily, thereby providing safe operation.

[0057]

Hereinbefore, the removal method of earth-retaining members of the present invention is described in detail with referring to embodiments depicted in the drawing so far, the present invention is not limited to the above-mentioned embodiments, and modifications such as other embodiments, additions, alterations, and deletions may be made so far as a person with an ordinary skill in the art may reach, and any aspect should be included within the scope of the present invention as far as it may provide the action and function of the present invention.

[Description of Signs]

[0058]

10-sheet pile, 11-joint, 20-earth-retaining member pressure extraction machine, 21-earth-retaining member, 22-chuck, 23-lift apparatus, 24-earth-retaining member, 25-grab part, 30-injection pipe, 31-flow outlet, 31a-first hole, 31b-second hole, 32-plug, 33-elastic body, 34-cap, 35-boring member, 36-combining part 、 40-earth-retaining member, 41-opening

CLAIMS

1. A removal method for earth-retaining members comprising:

defining one block including at least 5 earth-retaining members, inserting an injection pipe adjacent or close to the earth-retaining member located in the center of the block and then installing the injection pipe within the ground without fixing to the earth-retaining member; and

allowing a sealing material to flow from the injection pipe and the sealing material to flow into a cavity generated within the ground and filling up the cavity, each time the earth-retaining members in the block being pulled up to a certain level one after another.

2. The removal method for earth-retaining member of claim 1, wherein the step of installing within the ground comprises installing the injection pipe into the ground while drilling and installing the ground using the injection pipe equipping a boring member for boring soil at the tip.

3. The removal method for earth-retaining member of claim 1 or 2, wherein the injection pipe comprises a first hole having a first diameter and a second hole having a diameter larger than the first diameter connected to the first hole, the second hole being closed with a closing member,

wherein the step of filling up the cavity comprises flowing the sealing material outwardly after the closing member is pushed out to the surrounding ground with the sealing material from the second hole.

4. The removal method for earth-retaining member of any one of claims 1 to 3, wherein the step of filling up the cavity comprises pulling up an earth-retaining member in turn from one side of the block using a pressure extraction machine, pulling up the earth-retaining members in turn from one side of the block or pulling up the earth-retaining members in turn from one side of the block from the earth-retaining member farthest from the injection pipe in the block by using a crane.

5. The removal method for earth-retaining member of any one of claims 1 to 4,

wherein the method further comprises pulling up all of at least 5 earth-retaining members in the block and then pulling up the injection pipe installed within the ground.