

ENVIRONMENT-FRIENDLY RETAINING WALL AND CONSTRUCTION

METHOD THEREOF

Technical Field

The present invention relates to a retaining wall or a cutoff wall and a
5 construction method a retaining wall, wherein the retaining wall or the cutoff wall
are installed as temporary works at excavated areas so as to prevent the
excavated areas from collapsing or to prevent a groundwater from entering for a
foundation work of building structures.

10 Background Art

The ground, in general, is excavated for a foundation work of a building
structure. A retaining wall is installed to prevent the excavated areas from
collapsing. Also, the retaining wall may be used as a cutoff wall to prevent a
groundwater from entering.

15 The structure of this retaining wall has been developed into various
types and various construction methods are being used according to the
structure of a retaining wall. For example, a method for using a sheet pile is
suggested. This method, however, has a problem in the way that the sheet pile
may penetrate into an earth and sand layer and a weathered rock which have
20 weakened due to a long time weathering, not penetrate into a soft rock or hard

rock layer. In order to resolve this problem, such as shown in Figure 1, at first, an H-shaped steel pile is penetrated into up to a bedrock layer, and then a sheet pile is installed at the back face thereof. More specifically describing the construction method of sheet pile works, the H-shape steel pile is integrated (unified) to be hung over a wale front of it. Not shown in the drawing, there is a way that a strut and an anchor are installed to interconnect the wales installed on the opposing wall.

In recent years, a method of using a cement wall (a soil cement or a concrete wall) instead of a sheet pile is being used. In the method of using a cement wall, a bored hole be formed up to a bedrock layer using an auger screw. This bored hole is continuously formed along a boundary line of a region which needs a foundation work. It will be constructed as the continuous cement wall with H-shaped steel pile as following construction processing; i) The cement (a grout material) is injected the bored hole, ii) H-shaped steel pile is driven to the bored hole, iii) finally, the cement (a grout material) will is harden. The continuous cement wall with it is able to be carried out a retaining wall and cutoff wall function.

But in the conventional construction method, the retaining wall and cutoff wall has a limited application. There may be an exposed weakness when it has to remove structural bodies after completing the foundation work as a

temporary work.

In other words, in case of the conventional construction method, a mainly applicable object is limited to a soft clay layer. Not only it is difficult for it to apply the soil conditions where a permeability coefficient is high, and the ground near a river and a sea waterfront due to the underwater separation and the leaching of a material. But also a problem may occur in quality even after the completion of the construction, so a required durability (a strength and a cutoff) cannot be secured. Moreover, since the H-shaped pile is a ready-made product and is fabricated with a predetermined height, if the bored hole is deep, it should be used to connect several H-shaped steel pile in series. When interconnecting the H-shape piles, a structural steel should be additionally attached to the outer surface of a pile, for which an intermediate portion of the H-shaped pile may protrude. This protruding portion may become a raised spot which makes it hard to pull out the H-shaped pile from the hardened cement wall. This may not matter if the retaining wall is constructed as a permanent structure; however if it needs to remove as a temporary structure, it is hard to remove it. This problem makes it difficult to reuse H-shape steel pile.

In case of using the cement, it can cause environmental problems. Cement, in general, is a strong alkaline and may contain heavy metals. When the cement comes into contact with underground water, harmful components

may flow out. These harmful components affect the nearby water system, and an ecosystem while moving along the groundwater. For this reason, a countermeasures is required.

5 Disclosure of Invention

Accordingly, it is an object of the present invention to provide an ecofriendly retaining wall and construction method thereof, which are favorable for heavy metal contamination and pollution prevention by renewing the composition of the grout material.

10 In addition, it has a wide range of application regardless of the soil characteristics, and it is not only improved in durability such as strength, cutoff, strain, and anti-salt-preventing performance, but also economical because it is easy to install and dismantle.

To achieve the above object, there is provided a construction method of
15 an ecofriendly retaining wall, which may include, but is not limited to, a structural steel installation step (a) wherein the ground is excavated along a boundary line of a region where a predetermined building will be built, and a plurality of bored holes are bored spaced apart from each other, and a structural steel is penetrated into each bored hole; a wall forming step (b) wherein a
20 cement continuous wall is formed behind a region where the structural steel has

been disposed, and a cement stabilizer is injected at any moment when an excavation equipment is penetrated into the underground up to a design depth and is drawn out, and the injected cement stabilizer is mixed with the soil excavated at the excavated ground, so the cement stabilizer is hardened, thus
5 forming a cement continuous wall; and a wale installation step (c) wherein a wale interconnecting the structural steels is installed.

In the present invention, when the cement stabilizer and the earth and sand are mixed, a heavy metal adsorbent is injected together with the cement stabilizer, and it is preferred that when the cement stabilizer and the earth and
10 sand are being mixed, a compressed air is sprayed, and the heavy metal adsorbent is brought in and injected with the aid of the compressed air.

In particular, the heavy metal adsorbent is prepared in such a way to mix a polymer substance prepared through a secondary emulsion polymerization reaction by adding a plurality of monomers having 1~3 acid
15 functional groups to a resin prepared by polymerizing a plurality of alkyl methacrylate containing the carbons of C4~C8 and 2-dimethylaminoethylmethacrylate, with a chelate resin containing a carboxylic metal group.

Meanwhile, the embodiment of the present invention may include a
20 process for a groove filling between the wale and the cement continuous wall.

The groove filling process may be carried out in such a way that a connection part to be connected to the wale is formed at the front surface of the top thereof, and the back surface is formed inclined for the lower portion to have a wider cross section than the upper portion, and a first block installed in a space
5 between the back surface of the wale and the front surface of the cement continuous wall is hung over the wale, and the front surface thereof is formed inclined to correspond to the inclination of the back surface of the first block for the upper portion to have a wider cross section than the lower portion, and the back surface thereof may be formed corresponding to the shape of the outer
10 surface of the cement continuous wall, and a second block containing close to the cement continuous wall is inserted between the first block and the cement continuous wall.

Moreover, if the interval between the wale and the cement continuous wall is wide, both the front surface and the back surface are formed
15 corresponding to the inclination of the back surface of the first block between the first block and the second block. In this state, at least one connection block may be further installed, which is inserted between the first block and the second block.

The groove filling process according to the present invention may use
20 various filling materials, for example, concrete, a structural steel, a wooden, a

plastic, etc. In the present invention, a support member with a unique configuration may be used when carrying out a groove filling process through a cast-in-place concrete. More specifically, the aforementioned support member may include an engaging part which is installed detachable at the wale, and a
5 support bar which may be disposed horizontal at the lower side of the space formed between the wale and the cement continuous wall when it is hinged-engaged to the engaging part and rotates.

For the sake of the increased durability of the cement wall, a stiffening member, for example, a carbon fiber, a reinforced fiber, a geotextile, etc. may be
10 mixed and used.

Advantageous Effects of the Invention

The present invention may provide a retaining wall formed in a structure which is able to stably withstand an earth pressure applied to an excavated
15 surface, and a construction method of the retaining wall.

The present invention may also provide a retaining wall and a construction method thereof, wherein a retaining wall used as a temporary facility can be easily removed and recycled. More specifically, the H-shaped pile is installed separate, not inserting it into the cement continuous wall. A plurality
20 of blocks are used as a groove filling material, thus providing an advantage.

Moreover, a cement stabilizer and a heavy metal adsorbent are used together as a material for forming a cement continuous wall, so an environmental problem is not caused, wherein the heavy metal flows out due to the inflow of underground water and disturbs, for example, a nearby water system and an ecosystem. The slime generating during the formation of the cement continuous wall can be recycled.

In addition, the present invention may allow a construction work even near a river and a sea waterfront which has a high permeability coefficient, where the conventional construction method is not applicable. The present invention is able to provide, for example, a wide and good applicability and durability. The retaining wall according to the present invention is able to provide a salt tolerance owing to the characteristic of a cement stabilizer, for which if the retaining wall of the present invention is constructed near a sea waterfront, a salt damage can be prevented.

Brief Description of Drawings

The present invention will become better understood with reference to the accompanying drawings which are given only by way of drawing and thus are not limitative of the present invention, wherein;

Figure 1 is a schematic drawing for describing a conventional

construction method of retaining wall;

Figure 2 is a schematic flow chart for describing a construction method of retaining wall according to an example of the present invention;

Figure 3 is a schematic drawing of a retaining wall made by the
5 construction method in Figure 2;

Figures 4 and 5 are views for describing two methods for carrying out a wall forming step, of which Figure 4 shows a drawing of an intrusion and effusion method, and Figure 5 shows a drawing of an effusion method;

Figure 6 is a schematic drawing injection tube of a heavy metal
10 adsorbent injection tube;

Figure 7 is a schematic drawing of a first block, a second block, and a connection block used in the present invention;

Figures 8 and 9 are drawings for describing a state where blocks are filled in a groove between a wale and a cement continuous wall, of which Figure
15 8 is a cross sectional view taken along the line a-a in Figure 7, and Figure 9 is a cross sectional drawing taken along the line b-b in Figure 7;

Figure 10 is a schematic drawing of the configuration of a support member used in an embodiment of the present invention;

Figure 11 is a schematic cross sectional drawing taken along the line c-c
20 in Figure 10;

Figure 12 is a table showing criteria to test the mixture of a cement stabilizer and a heavy metal adsorbent used in the present invention;

Figure 13 is a table of mix proportion for a mixture sample mixed with a cement stabilizer and a heavy metal adsorbent used in the present invention
5 and a comparative example sample;

Figures 14 and 15 show a result of the test carried out using a table of mix proportion in Figure 13, of which Figure 14 is a table showing a result value, and Figure 15 is a photo showing a volume change factor;

Figure 16 is a table of mix proportion for showing a mixture sample
10 mixed with a cement stabilizer, a heavy metal adsorbent and an earth and sand under in the present invention, and a comparative example sample;

Figures 17 and 18 show a result of tests carried out using a table of mix proportion in Figure 16, of which Figure 17 is a table showing a result value, and Figure 18 is a photo showing a volume change factor; and

15 Figure 19 is a photo showing a result of a test of non-separation underwater carried out with respect to a cement stabilizer added with a heavy metal adsorbent according to the present invention.

Modes for carrying out the invention

20 The construction method of retaining wall according to the present

invention has the following two advantages.

The first advantage is that a retaining wall of the present invention is a temporary facility. More specifically, the retaining wall which is a temporary facility, should be removed after the main construction, for example, a building foundation, has been completed. In the construction method of the present invention, materials, for example, an H-shaped pile, a filling material, etc. can be easily removed. In the conventional construction method, a method is employed, wherein structural steels are installed inside of the cement wall; however in the present invention, the structural steels and the cement wall bodies will be constructed separate from each other. Moreover, the present invention uses a prefabricated filling material.

The second advantage is that the present invention is ecofriendly. If the construction method of retaining wall uses a cement continuous wall, a nearby water system and an ecosystem may be continuously disturbed due to, such as, the harmful components contained in the cement. In the present invention, an environmental problem is not caused because of using the cement of a unique and ecofriendly composition, while securing the required strength of a cement continuous wall.

The easiness in terms of the construction and removal corresponding to the first advantage of aforementioned advantages may be caused by the

structure of the retaining wall, for which the structure and construction method of the retaining wall will be first described, and since the eco-friendly and structural strength of the cement continuous wall corresponding to the second advantage are caused by the material characteristics of the cement, this will be
5 descried.

The construction method of retaining wall and the structure of the retaining wall to be constructed by the above construction method according to an embodiment of the present invention will be described with reference to the accompanying drawings.

10 Figure 2 is a schematic flow chart for describing a construction method of retaining wall according to an example of the present invention, and Figure 3 is a schematic drawing of a retaining wall to be made by the construction method to be shown in Figure 2.

Referring to Figures 2 and 3, the construction method of retaining wall
15 according to an embodiment of the present invention may include, but is not limited to, a structural steel installation step (M10), a wall forming step (M20) and a wale installation step (M30).

In the structural steel installation step (M10), a ground is excavated at predetermined intervals like in the conventional retaining wall construction
20 method, thus perforating a plurality of bored holes (h). For example, the bored

holes (h) may be formed at regular intervals along the boundary line of a square region of 30m long in horizontal and vertical directions. The structural steel, for example, an H-shaped pile 10, is filled in each bored hole (h). The depth that the H-shaped pile 10 is inserted, may be up to a bedrock layer (r) through an earth and sand layer. If the structural steel penetrates up to the bedrock layer, a support strength of the earth pressure can be secured, alternatively, the structural steel may penetrate up to the earth and sand layer depending on the ground condition or the construction conditions. If the depth of the bored hole (h) is deep, a plurality of the structural steels may be interconnected and used.

Since the structural steel is a prefabricated product to be manufactured with a general standard, it may need to interconnect a plurality of structural steels. For example, in case of the H-shaped piles, two structural steels may be disposed in series and may be connected after a connection plate (not shown) is attached to an outer side surface of each of two structural steels.

In the conventional technology, the H-shaped pile is inserted before the cement is cured in a state where a plurality of the H-shaped piles are connected. If it needs to remove the H-shaped pile from the cement continuous wall at the time when the cement is cured, and the foundation work is completed, the portion of the connection plate may become a ridge which interferes with the removal of the H-shaped pile, so it becomes hard to remove the H-shaped piles.

In the present invention, unlike the conventional method, the
aforementioned problem is solved by installing the H-shaped pile in the ground
instead of the H-Shaped pile the cement wall separately each other, the
construction may become a little complicated. This problem can be easily
5 solved by increasing the stiffness and supporting force of the earth retaining
wall by adopting the construction method of the present invention. The most
fundamental and important functions in the retaining wall are a resistance
against the earth pressure. If the H-shaped piles and the cement wall are
installed separately like in the present invention, the resistance against the
10 earth pressure can be increased.

The wall forming step (M20) will be carried out after the structural steel
like as the H-shaped pile 10 to be installed. The wall 20 is continuously formed
the H-shaped pile 10 to prevent the groundwater from flowing into the area
where foundation work is performed, and to withstand the earth pressure.

15 In the wall forming step (M20), it may be carried out using like as an
auger screw, an excavation and mixing equipment. Figure 4 shows a 2-rod
auger screw(s). The auger screw (s) may be implemented in various forms from
a 1-rod type to a 4-rod type based on the number of rods. In the present
invention, the auger screw can be selected the condition of the wall. The rod of
20 the auger screw (s) may penetrate into the ground while rotating. The rod is

made hollow. When the cement stabilizer and heavy metal adsorbent are supplied through the upper part of the rod, the cement stabilizer is injected unto the ground through the lower part of rod. Each rod may be equipped with a plurality of blades, so the cement stabilizer and the excavated soil can be stirred
5 together.

More specifically, the wall forming step (M20) may be carried out in the sequence of a penetration, a mixing, a drawing and a curing. As seen in the first drawing to the third drawing in Figure 4, the auger screw(s) may be penetrated into the ground up to the design depth. If the auger screw(s) is penetrated up to
10 the design depth, the auger screw is pull-out.

The mixing may change depending on the penetration and effusion method or the pull-out effusion method. As shown in Figure 4, if the penetration effusion method is adapted, a cement stabilizer and a heavy metal adsorbent are injected and mixed together during a procedure where the auger screw(s) is
15 penetrated into the ground. As shown in Figure 5, if the shown effusion method is selected, the cement stabilizer is injected while pulling-out the auger screw(s) and is mixed with the earth and sand. Alternatively, all the cement stabilizer and heavy metal adsorbent may be injected together and then may be agitated with excavated soil.

20 In the present invention, the heavy metal adsorbent is supplied together

with the cement stabilizer to form a cement wall 20. The cement stabilizer may be flowed through an injection passage inside the auger screw rod by a supply tube (not shown), and in case of the heavy metal adsorbent, as shown in Figure 6, it may be transferred into the injection passage inside the auger screw rod through an injection tube separately. In particular, in the present invention, an air supply tube for supplying a high pressure compressed air may be attached to the injection tube provided to supply a heavy metal adsorbent.

A liquid or powder of heavy metal adsorbent is supplied to the injection tube, and a high pressure compressed air is blown into, and the heavy metal adsorbent is guided into the inside (an upper part or a lower part) of the rod (a rod) by means of the compressed air. In this embodiment, the injection tube of heavy metal adsorbent is connected to a lower part of the rod. The compressed air is ejected at a pressure of 5~15kgf/cm². In addition the injection tube of heavy metal adsorbent is equipped with a check valve to prevent backflow of the heavy metal adsorbent.

The heavy metal adsorbent and the cement stabilizer may be agitated together under the ground, thus to form a slime. The compressed air may cause air bubbles, which may enhance the mixing performance of the cement stabilizer, the heavy metal adsorbent and the excavated soil.

In the embodiment of the present invention, a reinforced fiber, such as, a

carbon fiber, a steel fiber, etc. may be mixed with the cement stabilizer, to improve the strength (in particularly tensile strength) of the cement wall to reduce crack.

If the pull-out of the auger screw is completed, the cement stabilizer and
5 the soil may turn into a slime state, after a certain period of time, the slime may be cured, to form a cement continuous wall 20.

After reinforcing the ground by forming the steel material 10 and the cement continuous wall 20 along the boundary of the region where the structure is to be built the region surrounded by the boundary region, that is, the region
10 surrounded by the cement continuous wall 20, is excavated. If the boundary region is excavated, as illustrated in Figure 3, one side surface of each of the H-shaped pile 10 and the cement continuous wall 20 will be exposed to the outside. Then, in the process of the downwardly digging the inside of the boundary region, a wale installation step 30 is performed in which a wale band
15 30 is installed on the front side of the H-shaped pile 10. The wale 30 horizontally arranges the H-shaped steel material so that the H-shaped pile 10 installed vertically are constrained to be integrally formed. The plurality of the H-shaped pile 10 by the wale 30 as moving one body tends to withstand the earth pressure of the excavated section, it becomes possible to withstand the earth
20 pressure of the excavated surface. Moreover, a strut (not shown) and a jack

(not shown may be installed, which is able to interconnect the wale to be installed at the opposing excavated surfaces.

In this way, the groove filling step (M40) may be carried out after the main structure of the retaining wall temporary facility has been completed. In the
5 groove filling step, a filling material may be filled into a space between the wale 30 and the cement continuous wall 20, thus reinforcing the support strength and strength of the retaining wall.

In the embodiment of the present invention, the blocks are used as a filling material for easier installation and removal of the retaining wall as a
10 temporary facility. Figures 7 and 9 show the blocks used in the present invention. Figure 7 is a schematic drawing as a first block, a second block, and a connection block used in the present invention, and Figures 8 and 9 are shown as a state where blocks are filled in a groove between a wale and a cement continuous wall, of which Figure 8 is a cross section of the line a-a in
15 Figure 7, and Figure 9 is a cross section of the line b-b in Figure 7.

Referring to Figures 7 or 9, the first block 41 is configured to be hooked and supported by the wale 30 and is formed in a hexagonal shape in whole. More specifically, the front surface being opposite to the wale 30 in the first block 41 may be formed vertical, but the back surface 412 facing the cement
20 continuous wall 20 is formed obliquity so that the section area of the upper part

is narrow than the lower part.

In the upper part of the first block 41, a hooking part 413 is provided which can be installed on one side 31 of the H-shaped pile used as a wale. The width of insert groove 414 of the hooking part 413 is substantially equal to the thickness of the wale 30 so that the first block 41 can be vertically arranged and stable supported on the wale 30.

The second block 42 may be inserted between the first block 41 and the cement continuous wall 20, by which the space between the wale 30 and the cement continuous wall 20 can be filled by the first block 41 and the second block 42. If the interval between the wale 30 and the cement continuous wall 20 is wide, as shown in Figure 7, a connection block 43 may be interposed between the first block 41 and the second block 42.

The front surface 421 of the second block 42 may be formed as a curved surface corresponding to the exterior of the outer surface of the cement continuous wall 20, and the back surface 422 thereof may be formed inclined to correspond to the front surface of the first block 41 or the front surface of the connection block 43 (if the connection block has been interposed). Accordingly, the second block 42 is formed so that the cross-section area of the upper part is larger than that of the lower part, as opposed to the first block 41.

The front surface 431 of the connection block 43 may contact close with

the first block 41, and the back surface 432 may contact close with the second block 42. The front surface 431 and the back surface 432 of the connection block 43 are formed inclined.

If the space between the wale 30 and the cement continuous wall 20 is
5 filled by only the first block 41 and the second block 42, without using the connection block 43, when the second block 42 is inserted between the first block 41 and the cement continuous wall 20 in a state where the first block 41 has been hooked and supported by the wale 41, the second block 42 can be supported by the inclined back surface 412 of the first block 41, whereby the
10 second block 41 is not separated downward.

In case where the connection block 43 is interposed, the same operation as the above will be carried out. Since the first block 41 is supported by the wale, and the connection block 43 and the second block 42 are supported in sequence by the inclined back surface, the connection block 43 and the second
15 block 42 can be installed between the wale 30 and the cement continuous wall 20, not separating downward.

The important point is the angle of the inclined surface formed at the blocks. If the angle of the inclined surface is gradual, the blocks may be more stably supported. However, If the inclination is gradual, the fundamental function
20 of the groove filling material to transfer the earth pressure acting on the cement

continuous wall 20 to the H-shaped pile 10 integrated by the wale 30 may be degraded. More specifically, the earth pressure on the excavated surface acts in the horizontal direction. Since the second block 42 or the connection block 43 is supported on the inclined surface, therefore, when the horizontal earth pressure is received, the earth pressure cannot be transmitted to the wale 30, the second block 42 or the connection block 43 may be separated upwardly along the inclined plan.

More specifically, the inclined surface of the block should be formed gradual in terms of preventing the block form from being detached downward, has a kind of inconsistency that have to be formed abruptly in order to fulfill the fundamental function as a groove filling material. In order to solve the both of these functions, the present invention forms an inclined surface in a range of about 70~90°.

Even though the inclinations are formed within the aforementioned range, the blocks can be supported stable; however a support part and an insertion part are provided at the lower part of the blocks according to an embodiment of the present invention so as to more enhance the support strengths between the blocks.

A main support part 415 is formed at a lower part of the first block 41 so as to protrude the back surface. Corresponding thereto, a main insertion part

423 is formed concavely below the front surface 412 of the second block 42 so as to insert the main support part 41, there in the second block 42 can be stably supported the first part 41 by the fitting the main support part 415 into the main insertion part 423.

5 In case where the connection block 43 is interposed, the same operation as the above will be carried out. An insertion part 433 for fitting the main support part 415 of the first block 41 is formed on the front surface 431 of the connection block 43. On the back surface 432 of the connection block 43, a support part 434 inserted into the main insertion part 423 of the second block 42
10 may formed. Moreover, if a plurality of connection blocks are interposed, the support part and the insertion part may be installed at each connection block, the groove filling work can be carried out in a structure where they are continuously inserted from the first block to the second block through a plurality of the connection blocks.

15 The configurations of the support part and the insertion part are provided to make a stable support structure between the first block and the second block or between the first block, the connection block and the second block. This support structure may be applied same to between the neighboring first blocks, the second blocks and the connection blocks. That is, when performing the
20 groove filling in the present invention, the first blocks are continuously arranged

along the wale length direction, and the second blocks are likewise arranged continuously. Assistant support parts 416, 424 and 435 protruding from one side surface may be formed at the lower parts of these blocks. Corresponding to the assistant support parts 416, 424 and 435, assistant insertion parts 417, 425 and 436 may be formed to be concaved at the other side surfaces of the blocks. The structure can be stabilized in such a way that the neighboring blocks are supported each other in the longitudinal direction with the aid of the assistant support parts and the assistant insertion parts.

So far, the method for using the blocks when implementing the groove filling has been described. The groove filling method is not limited thereto, and alternatively, a method for casting a filling material, such as, cement, concrete, etc. may be cast like in a conventional technology. In the present invention, for the convenience of installation, it is characterized by the use of a unique structure of support as shown in Figure 10.

Figure 10 is a schematic drawing for the configuration of a support member used in an embodiment of the present invention, and Figure 11 is a schematic cross section drawing taken along the line c-c in Figure 10.

Referring to Figure 10, the support part 50 is equipped with an anchorage part 51 disposed in the vertical direction. A hanging part 511 may be provided at the top of the anchorage part 51, wherein the hanging part 511 is

hung over the side surface plate 32 of the wale 30. Since the installation is carried out in such a way that the hanging part 511 is simply hung over the side surface plate 32 of the wale 30, the support part 50 can be easily installed at the wale 30 and can easily separate therefrom. A strut 52 may be anchored to the hanging part 511. The strut 52 is disposed in the horizontal direction and is installed between the hanging part 511 and one side surface 31 of the wale.

The strut 52 may be configured in a flexible structure wherein the length thereof can extend or contract. As shown in Figures 10 and 11, the strut 52 may include a hollow fixed part 521m and a movable part 522 which can come into or come out of the inside of the fixed part 521. A spring 53 (or a screw) may be inserted supported into the movable part 522. The compressed spring 53 serves to press the hanging part 511 toward the side surface plate 32 of the wale 30 by an elastic recovery force. The anchorage part 51, therefore, can contact close with the side surface plate 32 of the wale 30, thus being supported stable.

A support bar 54 may be hinge-engaged to the engaging part 51 by a rotary 542. When it rotates toward one side, the support part 54 can be disposed horizontal at the lower part of the wale 30 and the cement wall 20. In order to fix the support bar 54, one end thereof is combined to the support part 54, and the other end is provided with a connection member 55 to be engaged

to the anchorage part 54. Since the connection member 55 is separately combined to the anchorage part 54 through a bolt, the screw 551 can be separated when it needs to rotary the support part 54. Like the strut 52, the connection member 55 may be constructed in a structure formed of a fixing member (not illustrated), a movable member (not shown), and a spring (not shown), so the connection member 55 can elastically press the support bar 54. It is possible to assist that the support bar 54 is disposed horizontal in the under space between the wale 30 and the cement continuous wall 20.

A plurality of the support parts 50 formed in the aforementioned structure are simple hung over the wale 30, and then a support plate is installed on a plurality of the support parts 50, and vinyl is covered, and concrete is cast-in place, thus carrying out the groove filling work. A wire mesh or a stiffening member may be used, if necessary, when the concrete is cast-in-place. The concrete cast-in-place may be continuously carried out for a predetermined section. In the conventional technology, it takes a lot of time and effort to install and separate forms for each section; however in the present invention, the support part 50 can be easily installed and separated, for which the groove filling work can be easily carried out.

In the present invention, since the H-shaped piles are installed separate, not installed in the cement continuous wall, it is easy to separate and recycle

the H-shaped pipes. Since the H-shaped piles and the cement continuous wall doubly support the excavated surface, it is possible to effectively prevent the excavated surface from collapsing due to the earth pressure. In the present invention, using the blocks or support parts, the groove filling work can be easily carried out especially. If the blocks are used, the groove filling materials can be easily removed at the time when the construction is completed.

The cement continuous wall which is able to provide another advantage of the present invention, will be described. The present invention has a feature as a cement stabilizer and a heavy metal adsorbent which have unique compositions as the materials of the cement continuous wall so as to enhance an ecofriendly feature and a strength.

In the present invention, the cement stabilizer is mixed in the range of 15 to 35 by weight based on 100 by weight of the excavated soil, and the heavy metal adsorbent is mixed in the range of 0.01 to 10 by weight based on 100 by weight of cement stabilizer. Moreover, water may be added by 50~200 parts by weight of the total powder.

The cement stabilizer may be used of only a cement. Alternatively, it may contain a pozzolan mixture, a quick-setting admixture and a shrinkage reducing agent. In the present invention, it may contain a quick-setting admixture and a shrinkage reducing agent.

The cement may be used of any of an Ordinary Portland cement, a slag cement, a pozzolan cement or a mixture thereof. A fly ash or a slag powder may be added as an admixture so as to enhance the pozzolan reaction of cement. If both the fly ash and the slag powder are used, 40~80% by weight of the cement of the total powder, 5~20% by weight of the fly ash of the total powder, and 10~40% by weight of the slag powder of the total powder are mixed. The admixture added to enhance the pozzolan reaction may contribute to lowering the viscosity of the cement stabilizer, by which the charging and reinforcing against the groove with a large volume can be available with the same weight. The admixture may reduce the bleeding of the cement stabilizer in a state where it is not hardened, and may enhance the chemical resistance and durability of a hardening wall and increase the strength for a long time.

The quick-setting admixture may be any of a calcium aluminate powder, a calcium sulfur aluminate powder, and an alumina cement which contain bauxite as a raw material.

If the cement reacts with water, a calcium silicate hydrate (CSH) and a calcium hydroxide ($\text{Ca}(\text{OH})_2$) hydrate can be created through a hydration reaction, and when a calcium salt, such as, a calcium aluminate or a calcium sulfur aluminate, and a sulfate powder is added thereto, a needle-shaped Ettringite ($3\text{CaOAl}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 32\text{H}_2\text{O}$) may be quickly created. This is because

the quick-setting admixture exhibits the effect of reducing the free water of the grout material(cement stabilizer + water) by forming with water in the process of forming the ettringite.

The mixing amount of the quick-setting admixture in the present embodiment of the present invention is referred to 1~10% by weight with respect to the total amount of powder. In case of the quick-setting admixture, if the water-powder ratio of the cement stabilizer is higher, the adding amount is preferably increased in proportion thereto. A lot of the quick-setting admixture can bond with water during the formation of Ettringite, thus reducing the free water in the grout (a cement stabilizer + water).

Moreover, in the present embodiment of the present invention, a shrinkage reducing agent may be added to the cement stabilizer. In the present embodiment of the present invention, the shrinkage reducing agent may be any of an α -type gypsum hemihydrate ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ type α), an anhydrous gypsum (CaSO_4) and a mixture thereof. The α -type gypsum hemihydrate and the anhydrous gypsum have a fineness of 200~600 m^2/kg , and the mixing amount is referred to 0.5~5% by weight of the total powder amount.

In the present invention, a heavy metal adsorbent is injected together with a cement stabilizer to absorb and immobilize heavy metal (Cr^{6+} , Pb, Cd, Hg) generated from the cement to thereby allow the heavy metal to be eluted from

the cement stabilizer prevent.

Also, the heavy metal adsorbent is supplied with the cement stabilizer to increase the viscosity of the mixture, thereby preventing the mixture from being lost by the groundwater, as well as inducing no volume change of the mixture.

5 Since the heavy metal absorbent to be air bubbled is applied, the mixing efficiency both the excavated soil and the cement stabilizer can be enhanced, and the adhering strength between the cement stabilizer and the excavated soil may be weakened, which leads to an easier digging and drawing of the auger screw. This method will be very useful to overcome the limitations applied only
10 to the waterfront where the sand is composed. Not the general soil, by forming the pile by stirring the cement stabilizer and soil.

The heavy metal adsorbent used in the present invention is referred to a resin polymerized with two or more alkyl methacrylate and 2-
dimethylaminoethylmethacrylate added as main components and containing the
15 carbons of C4~C8 and may be prepared in such a way that two or more than two monomers having 1 to 3 acid functional groups are added and subjected to a secondary emulsion polymerization reaction (reacted for 8 hours at 80°C), thus preparing a polymer substance, and a chelate resin containing a carboxylic
methyl group, other chelate resins, etc. are mixed. The monomer may be
20 formed of two or more than two selected from the group consisting of

butylacrylate, stadien, ethylacrylate, methylmethacrylate, and methacrylic acid.

The heavy metal adsorbent according to the present invention may be manufactured into the form of liquid or powder and has a function to adsorb heavy metals, such as, Cr^{6+} , and shows a strong thickening effect against the liquid having an alkali component.

In the present invention, the heavy metal adsorbent is used to prevent the heavy metal from leaching out of the cement stabilizer, so the slime (an earth and sand + a cement stabilizer + a heavy metal adsorbent) ejected through the construction can be used as a reclamation soil. For example, it may be used as an earth and sand which is able to utilize anti-frost layer at a road construction site near a construction area.

The performance test of the cement stabilizer and the heavy metal adsorbent used in the present invention was carried out. The test criteria was adopted to the criteria shown in the table of Figure 12.

In the table of Figure 13, the mixing proportion ratio of the embodiment 1 to 4 in which the mixing proportion ratio of the cement stabilizer and the heavy metal adsorbent used in the present invention are different are shown, and the mixing proportion ration are shown for two sample suing only the Ordinary Portland Cement.

The test for the mixture of the cement stabilizer and the heavy metal

adsorbent used in the present invention was carried out. This test was carried out in a state where the earth was not added. The mixing proportion ratio for each component was referred to the table of Figure 13. A result of the test is shown in the table of Figure 14 and the photo of Figure 15.

5 It can be seen that a significant difference in the shrinkage amount when the cement stabilizer added with the heavy metal adsorbent is used according to present invention(left) using the ordinary Portland cement. Referring to the table of Figure 14, in case of the comparative example 1 and the volumetric change ratios were 55% and 38%, whereas in embodiment 1 to 4 according to
10 the present invention, the volumetric change was almost 2%.

Referring to the table of Figure 14, in case where the heavy metal adsorbent was not used in the comparative example 1 and the bleeding ratio (same as the volume change factor) was very high, and the elution amount of Cr^{6+} was founded to be 8.6 and 8.8ppm respectively, and turbidity was high.
15 Otherwise, in the embodiments 1~4 wherein the heavy metal adsorbent was used, turbidity was very low, and Cr^{6+} was not founded.

In comparative embodiment 1 and 2, the volume shrinkage was too large to form a sample of the strength. However, in embodiment 1 to 4, the volume shrinkage was very small, and sample of strength was able to be formed. In all
20 cases, similar results were obtained.

Meanwhile, the mixture of the cement stabilizer and the heavy metal adsorbent used in the present invention was mixed with soil to conduct experiments. In the table of Figure 16, the mixing proportion ratio shown in Figure13 is shown in the form mixed with excavated soil.

5 In this test, the mixing proportion ratio of the material were mixed according to the table in Figure 11. The results are shown in the table of Figure 17 and the photo of Figure 18.

It can be seen that when the cement stabilizer containing the heavy metal adsorbent is used in the case of using the ordinary Portland cement (left) and in the present invention, there is a difference in the shrinkage amount. Compared with the unmixed soil, the ratio of volumetric change was smaller in the case of using the ordinary Portland cement than in the case of the mixed soil, but the ratio of volumetric change was higher than that the present invention using the heavy metal adsorbent).

15 Referring to the table of Figure 17, the volume change factors in case of the comparative example 1 were 9% and 5%; however any volume change was not observed in the embodiments 1~4 of the present invention.

In terms of elution of Cr^{6+} , the elution was observed at the concentrations of 2.6 and 1.05ppm in case of the comparative example. The elution was not observed in the embodiments of the present invention. In case of turbidity, it

was observed high in the comparative example, but it was observed low in the embodiment of the present invention. In terms of the compressive strength, it was similar in the comparative examples and the embodiments of the present invention.

5 Figure 19 as a photo is showing a result of the non-separation test in underwater against the cement stabilizer (right) and the common cement (left) used in the present invention. The general cement stabilizer have a very fluidity, and when they are added to water, they are loosened immediately to pollute the environment and lose their character as a stabilizer. However, it can be
10 confirmed that the cement stabilizer added with heavy metal adsorbent used in the present invention is not separated from the surrounding water and spread to the surrounding. That is, the cement stabilizer used in the present invention does not contaminate the surrounding environment and shows that durability and water repellency can be maintained by curing of the cement stabilizer.

15 As shown in the above tests, in the present invention, heavy metal adsorbents is mixed with the cement stabilizer, so that the heavy metal elution rarely occurs, and since the fluidity of the cement stabilizer itself is low, there is no possibility of leakage along the groundwater around the cement stabilizer. And that no contamination by water was caused.

20 Also, the heavy metal adsorbent is pressurized and transported by the

compressed air so that the bubbles are mixed in the mixture to increase the mixing proportion ratio of the cement stabilizer, the heavy metal adsorbent, gypsum and adhesive force of mixture become small, so that the penetration and pull-out of the auger can be facilitated.

5 In addition, after the completion of construction, the viscosity of the mixed soil is increased, and the mixture is not lost by the groundwater of volume is not reduced, which is advantageous in the durability and strength are guaranteed).

 As described above, in the present invention, by using a heavy metal
10 adsorbent together with a cement stabilizer as a material for forming a cement continuous wall, the heavy metal is fixed and does not leak out to the environment, so there is no adverse effect on the environment and stiffness of the cement continuous wall is improved.

 In the present invention, the term of a cement, a mortar or a concrete are
15 used together, which is used as a concept including cement itself, mortar mixed with cement and sand, or concrete mixed with mortar and coarse aggregate or mixing soil and aggregate (coarse aggregate and/or fine aggregate) with cement when the mixing cement with excavated soil in the field. For example, if
20 the term of a cement wall is referred in this specification, the cement may mean that the cement and the soil are mixed or the cement and sand and soil

(possibly including aggregate) are mixed.

In the present invention, the reference number 53 is represented by a spring, but the length may be adjusted in a manner that the screw is loosened in addition to the spring. This is equally applicable to the linkage indicated by the
5 reference number 55.

While the present invention has been particular shown and described with reference to exemplary embodiment thereof, it is clearly understood the same by the way of shown an example only and is not to be taken by way of limitation and that those skilled in the art will understand that various
10 modifications and equivalent arrangements may be made therein, it will be possible. Accordingly, the scope of protection of the invention should be determined on by the appended claims.

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Claims:

1. A construction method of an ecofriendly retaining wall, comprising:

a structural steel installation step (a) wherein the ground is excavated

5 along a boundary line of a region where a predetermined building will be built, and a plurality of bored holes are bored spaced apart from each other, and a structural steel is penetrated into each bored hole;

a wall forming step (b) wherein a cement continuous wall is formed

behind a region where the structural steel has been disposed, and a cement

10 stabilizer is injected at any moment when an excavation equipment is penetrated into the underground up to a design depth and is drawn out, and the injected cement stabilizer is mixed with the soil excavated at the excavated ground, so the cement stabilizer is hardened, thus forming a cement continuous wall; and

15 a wale installation step (c) wherein a wale interconnecting the structural steels is installed,

wherein when the cement stabilizer and the earth and sand are mixed,

a heavy metal adsorbent is injected together with the cement stabilizer, and the heavy metal adsorbent is prepared in such a way to mix a polymer substance

20 prepared through a secondary emulsion polymerization reaction by adding a

plurality of monomers having 1~3 acid functional groups to a resin prepared by polymerizing a plurality of alkyl methacrylate containing the carbons of C4~C8 and 2-dimethylaminoethylmethacrylate, with a chelate resin containing a carboxylic metal group.

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2. The method of claim 1, wherein when the cement stabilizer and the earth and sand are mixed, a compressed air is sprayed, so the heavy metal adsorbent is brought in and injected with the aid of the compressed air.

10 3. The method of claim 1, wherein the cement stabilizer is mixed in the range of 15 to 35 by weight based on 100 by weight of the excavated soil, and the heavy metal adsorbent is mixed in the range of 0.01 to 10 by weight based on 100 by weight of cement stabilizer.

15 4. The method of claim 1, wherein the cement stabilizer includes a stiffening member which contains at least one of a carbon fiber, a steel fiber, and a geotextile.

5. The method of claim 1, further comprising a step wherein a space
20 between the cement continuous wall and the wale is filled, wherein the step is

carried out in such a way that a first block is hung over the wale and is installed in a space between the back surface of the wale and the front surface of the cement continuous wall wherein a connection part connected to the wale is formed at the front surface of the top of the first block, and the back surface thereof is formed inclined for the lower side thereof to have a cross section wider than the top thereof, and a second block is inserted between the first block and the cement continuous wall wherein the second block is configured in such a way that the front surface thereof is formed inclined in response to the inclination of the back surface of the first block for the top thereof to have a cross section wider than the lower side, and the back surface thereof is formed in response to the exterior of the outer surface of the cement continuous wall.

6. The method of claim 5, wherein at least one connection block configured in such a way that the front surface thereof and the back surface thereof are formed in response to the inclination of the back surface of the first block between the first block and the second block, is installed inserted between the first block and the second block, wherein the connection block is inserted between the second block and the cement continuous wall.

7. The method of claim 5, wherein the connection part of the first block is

referred to a hanging part wherein the wale is inserted, and the first block can be hung over the wale and can be supported.

8. The method of claim 5, wherein a main support part protruding from the back surface of the first block is formed at the lower side of the first block, and a main insertion part into which a main support part of the first block can be inserted, is formed at the front surface of the lower side of the second block, and the second block is supported over the first block.

9. The method of claim 5, wherein the first blocks are installed in series in the longitudinal direction of the wale, and an assistant support part protruding from a side surface thereof is formed at the lower side of the first block, and an assistant insertion part into which the assistant support part of the neighboring first block can be inserted, is formed at the other side surface of the lower side of the first block, by which the first blocks disposed in series are interconnected with each other.

10. The method of claim 1, wherein a groove filling work is carried to fill a space between the wale and the cement continuous wall in such a way that a support part is engaged to the lower side of the space between the wale and

the cement continuous wall, and a support plate is placed over the support part, and a filling agent is cast over the support plate, and the support part includes an engaging part installed separable at the wale, and a support part which is hinge-engaged to the engaging part, and is disposed horizontal at the lower side of the space between the wale and the cement continuous wall when it rotates in one direction.

11. The method of claim 10, wherein a connection member is installed between the support bar and the engaging part, the connection member being elastically contracted or extended and being configured to elastically press the support bar toward the lower side of the space between the wale and the cement continuous wall.

12. The method of claim 10, wherein the engaging part is disposed in the upward and downward directions, and a hanging part which can be hung over the wale, is formed at the top end of the engaging part.

13. The method of claim 12, wherein a strut which can be elastically compressed and extendable, is installed at the hanging part, and the strut is supported between the hanging part and one side surface of the wale, and the

strut elastically presses the hanging part toward the other side surface of the wale.

14. A retaining wall prepared by the construction method recited in any of claims 1, 2, and 3 to 13.

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