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TITLE OF THE INVENTION

A METHOD OF CONSTRUCTING COLUMN IN A CONCRETE REVERSE
PLACING METHOD

BACKGROUND OF THE INVENTION

This invention relates to a method of constructing column in a concrete reverse placing method to be applied when a subsurface structure is constructed according to the concrete reverse placing method.

A concrete reverse placing method has been known, in this method, in case where a relatively big scale subsurface structure is constructed, digging work is executed from a ground surface to a lower hand step by step, and a structure is constructed every story digged for the underneath.

In this concrete reverse placing method, as shown in Fig.16, firstly, the ground is digged to a predetermined depth so as to form a hole, and a pile 41 is made by placing concrete in the hole. Next, a steel frame material 43 extending above ground is inserted and disposed in the pile 41 of the hole digged, thereafter the hole is refilled. On this occasion, the ground is stabilized by an earth retaining wall 44. In this way, digging work is executed starting from the ground surface step by step, being supported by the steel frame material 43. Construction work is executed, starting



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from constructing a slab 45a of the grand floor, and continuing to construct a slab 45b of the first basement floor, then a column 46a between the grand floor and the first basement floor, a slab 45c of the second basement floor, and a column 46b between the first basement floor and the second basement floor.

In this concrete reverse placing method, however, while digging work is executed step by step, works of a form, reinforcing bars, concrete placing for the slab 45 are executed, and after these works are finished, works of a form, reinforcing bars, and concrete placing for the column 46 should be executed making use of the steel frame material 43. Therefore, its work routine is extremely complicated, and in particular, the construction of the columns is troublesome, this point becomes a defect. Therefore, simplification of the column construction work in the concrete reverse placing method is strongly desired.

An object of the present invention is to provide a method of constructing column in a concrete reverse placing method capable of making the construction work of columns in the concrete reverse placing method simplified, taking the above-mentioned circumstances into consideration.

SUMMARY OF THE INVENTION

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The 1st invention of the present invention comprises a method of constructing columns in a concrete reverse placing method wherein when a subsurface structure is constructed by said concrete reverse placing method, pits are formed in a ground from a ground surface, a hardening material with time is placed in a deep portion of said each pit so as to construct an underground piles, columns are built up and connected with said underground piles, said method further comprising:

inserting a steel pipe column having a steel pipe body provided a leg portion for connection at the lower end of said steel pipe body, projecting the underneath of said steel pipe body, into said pit;

inserting said leg portion for connection of said steel pipe column into said hardening material with time of said underground pile, which is not yet hardened; and

fixing said steel pipe column by said underground pile through said leg portion for connection so as to construct said column.

Since the steel pipe column is built up so as to fix the leg portion for connection by the underground pile, it is not necessary to insert the steel pipe body portion into the hardening material with time which is not yet hardened of the underground pile. Therefore, there is no fear of occurrence of big insertion resistance as the case where the steel pipe

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body itself is inserted into the hardening material with time of the underground pile when the steel pipe column is built up. For this reason, it is possible to easily dispose the steel pipe column in the underground. In this way, the steel pipe column built up in the pit, fixing the leg portion for connection by the hardening material with time of the underground pile, immediately functions as a column. Therefore, according to the present invention, a column which is a steel pipe column can be easily built up when the subsurface structure 1 is constructed by a concrete reverse placing method. Then, the work of arrangement of a form or the like for placing concrete for columns, which is necessary in a conventional method, is omitted, thereby the whole work routine in the construction of the subsurface structure 1 is made simplified in the proportion to the simplification of the construction work of the column, and the construction period is shortened.

The 2nd invention of the present invention comprises the method of constructing columns in said concrete reverse placing method as set forth in the 1st invention wherein in case where said pit is filled with a stable liquid, said steel pipe column is inserted into said pit filled with said stable liquid while buoyancy acting on said steel pipe column is being adjusted so as to prevent flotation at the time of insertion of said steel pipe column into said pit.



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Then, the steel pipe column can be inserted into the pit, sinking in the stable liquid, without floating up by buoyancy. For this reason, even if the pit is filled with the stable liquid for the preservation of the pit in a poor ground or the like, the steel pipe column, which inside is still empty (that is, which is not filled with the hardening material with time, such as concrete), can be built up without the obstacle of buoyancy, thereby certainty concerning the execution of the column in the subsurface structure is increased.

The 3rd invention of the present invention comprises the method of constructing columns in said concrete reverse placing method as set forth in the 1st invention wherein said steel pipe column is fixed by said underground pile, thereafter a hardening material with time is placed inside said steel pipe body so as to fill therewith, said hardening material with time filled is made a part of said column.

Then, the steel pipe column is light so that it is easy to deal with the steel pipe column when it is carried and lifted before it is built up into the underground since the inside thereof is empty at this time. After disposing it into the underground and the hardening material with time is hardened, it is possible to retain a big strength by the hardening material with time united with the steel pipe body. As a result, the underground structure can become to be



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further firm structure state.

The 4th invention of the present invention comprises a method of building columns in a concrete reverse placing method wherein in case where a subsurface structure is constructed by said concrete reverse placing method, pits are formed in a ground from a ground surface, a hardening material with time is placed in a deep portion of said each pit so as to construct an underground pile, and columns are built up and connected with said underground piles, said method further comprising:

a steel pipe column having a steel pipe body, filling said inside of said steel pipe body with a hardening material with time, closing a lower end portion of said steel pipe body so as to block inside and outside of said steel pipe body, providing a leg portion for connection projecting the underneath of said steel pipe body at a lower end of said steel pipe body;

using said steel pipe column as said column;

inserting said steel pipe column in said pit filled with a stable liquid;

inserting said leg portion for connection of said steel pipe column into said hardening material with time of said underground pile, which is not yet hardened; and

fixing said steel pipe column by said underground pile through said leg portion for connection.



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Then, when the steel pipe column is inserted into the pit, the steel pipe column can sink into the pit by the weight of the hardening material with time filling the inside of the steel pipe body therewith. Therefore, according to the present invention, there is no fear of having difficulty when the steel pipe column is inserted into the pit by buoyancy of the stable liquid. For this reason, it is not necessary to adjust the buoyancy acting on the steel pipe column as the case where the steel pipe body, which inside is empty (that is, which is not filled with the hardening material with time, such as concrete), is arranged. Besides, since the steel pipe column is built up so as to fix the leg portion for connection, similar to the case of the steel pipe column mentioned in the first invention, it is not necessary to insert the steel pipe body portion into the hardening material with time of the underground pile, which is not yet hardened. Therefore, there is no fear of the occurrence of big insertion resistance as the case where the steel pipe body itself is inserted into the hardening material with time of the underground pile, thereby the steel pipe column can be easily built up in the underground. Furthermore, since the lower end portion of the steel pipe body is closed in the 4th invention, the hardening material with time which is small in its strength formed on the top portion of the underground pile (the extrabanking concrete 2a portion) is not entered



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inside the steel pipe body even if the steel pipe column is inserted into the hardening material with time of the underground pile, which is not yet hardened. Then, the leg portion for connection is inserted into the hardening material with time of the underground pile a predetermined depth in the design, and the bad top portion of the hardening material with time is removed from the surroundings of the leg portion for connection, thereby the steel pipe concrete column is connected and united with the good quality underground pile through the leg portion for connection. Furthermore, the steel pipe column built up in the pit so as to fix the leg portion for connection in the hardening material with time of the underground pile in this way, immediately functions as a column without placing the hardening material with time inside the steel pipe body in site. Therefore, according to the present invention, a column which is a steel pipe column can be easily built up when the subsurface structure is constructed by a concrete reverse placing method. Then, the work of arrangement of a form or the like, which is necessary in a conventional method, is omitted, thereby the whole work routine in the construction of the subsurface structure is made simplified in the proportion to the simplification of the construction work of the column, and the construction period is shortened.

The 5th invention of the present invention comprises

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the method of constructing columns in said concrete reverse placing method as set forth in the 4th invention wherein a lower end portion of said steel pipe body is closed, blocking inside and outside of said steel pipe body by said hardening material with time filling said inside of said steel pipe body.

Then, the inside of the steel pipe body is closed by the hardening material with time filling therewith, thereby another material excluding the hardening material with time is not entered in the inside. Therefore, even if the leg portion for connection of the steel pipe column is inserted into the hardening material which is not yet hardened of the underground pile, there is not such a danger that the deteriorated material of the most upper portion of the underground pile which strength is small is entered into the inside of the steel pipe. Besides, it is not necessary to install a bottom member on the steel pipe body by welding etc. in order to obtain the steel pipe column which lower end portion is closed. As a result, the composition materials of the steel pipe column is made simplified. The bottom member is not installed on the steel pipe body, thereby the upper side rather than the portion projecting to the lower hand of the steel pipe body of the leg portion for connection can be easily extended and disposed inside the steel pipe body. For this reason, it is possible to freely select and adjust the



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strength of the steel pipe column on design.

The 6th invention of the present invention comprises the method of constructing columns in said concrete reverse placing method as set forth in the 1st invention wherein flexural rigidity of said leg portion for connection is set smaller than one of said steel pipe body.

Then, it is avoidable to act the excessive bending stress on the steel pipe body by the deformation of the leg portion for connection. That is, if the method according to the present invention is adopted in a poor ground, an earth retaining wall may be deformed so as to deform the head portion of the underground pile relatively moving in a horizontal direction to the steel pipe body. Then, there is such a danger that an unexpected excessive bending stress generates on the column already built up in the underground by the relative displacement of the head portion of the underground pile. However, in the present invention the leg portion for connection deforms prior to the steel pipe body, thereby the relative displacement of the head portion of the underground pile is properly absorbed in the deformation of the leg portion for connection. As a result, the bending stress of the column is widely reduced so as to prevent the damage of the function of the column.

The 7th invention of the present invention comprises the method of constructing columns in said concrete reverse



placing method as set forth in the 3rd invention or the 4th invention wherein flexural rigidity of said leg portion for connection is set smaller than one of said steel pipe body filled with said hardening material with time.

Then, similar to the 6th invention, it is possible to avoid the generation of an excessive bending stress on the steel pipe body filled with the hardening material with time by the deformation of the leg portion for connection. As a result, the bending stress of the column by the steel pipe body filled with the hardening material with time is widely reduced so as to prevent the damage of the function of the column.

The 8th invention of the present invention comprises the method of constructing columns in said concrete reverse placing method as set forth in the 1st invention or the 4th invention wherein said leg portion for connection has a sectional shape opened in horizontal directions, when said leg portion for connection is inserted into said hardening material with time which is not yet hardened of said underground pile, said hardening material with time of surroundings of said leg portion for connection is prevented from choking.

Then, when the leg portion for connection is inserted into the hardening material with time of the underground pile, which is not yet hardened, the insertion resistance can



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be reduced with the hardening material with time flowing to the leg portion for connection. That is, when the steel pipe column is built up and connected with the underground pile, the hardening material with time which is not yet hardened of the underground pile, received the insertion of the leg portion for connection, does not have a place to go, and starts to choke in the section of the leg portion for connection. As a result, there is such a danger that the insertion resistance increases. However, in the present invention the hardening material with time which is not yet hardened, pushed by the leg portion for connection, escapes to the sides through the portions opened in the horizontal directions of the leg portion for connection. As a result, the hardening material with time of the surroundings of the leg portion for connection is prevented from choking. Then, the insertion resistance when the steel pipe column is built up is small, thereby the works are efficiently executed. Besides, the leg portion for connection can be certainly inserted into the hardening material with time of the underground pile to the predetermined depth on design. For this reason, the works can be executed with high credit.

The 9th invention of the present invention comprises the method of constructing columns in said concrete reverse placing method as set forth in any claim of the 1st invention through the 8th invention wherein said hardening material



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with time is a concrete.

Then, the present invention can be used for various purposes. Besides, the underground pile and the steel pipe column can be certainly executed making the best using of the property of the concrete material capable of exhibiting stable strength by the known method of mixing and placing, then the execution of the column can be simplified.

"The steel pile column" described in the present specification is not only the hollow one which inside is empty, and includes so-called "a steel pipe concrete column" which inside is filled with the hardening material with time, such as a concrete.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a view showing an example of a subsurface structure under construction according to the present invention;

Fig.2 is a sectional view shown from the arrows II, II of Fig.1;

Fig.3 is a view showing another example of a steel pipe column to be applied to the structure as shown in Fig.1;

Fig.4 (a) through Fig.4 (c) and Fig.5 (a) through Fig.5 (c) are a series of views showing construction routines of the subsurface structure as shown in Fig.1;

Fig.6 is a view showing such a state that a head por-



tion of a pile is deformed by the earth pressure of a natural ground in the subsurface structure as shown in Fig.1; and

Fig.7 through Fig.11 are views showing another examples of a sectional shape of a leg portion for connection of a steel pipe column for use in the present invention;

Fig.12 is a view showing an another example of the steel pipe column for use in the present invention;

Fig.13 is a view showing an another example of the steel pipe column for use in the present invention;

Fig.14 (a) and Fig.14 (b) are a series of views showing routines wherein the steel pipe column as shown in Fig.12 is built up in a pit; and

Fig.15 (a) and Fig.15 (b) are a series of views showing routines wherein the steel pipe column as shown in Fig.13 is built up in the pit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Embodiments of the present invention are now explained on the basis of drawings hereinafter.

As shown in Fig.1, a subsurface structure 1 under construction is constructed on a plurality of piles 2 driven into a ground 40 having a predetermined depth under a ground line GL which is a ground surface before the subsurface structure 1 is constructed. The piles 2 are provided at a predetermined pitch in the right and left direction of Fig.1



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and the direction perpendicular to the paper of Fig.1. Each pile 2 is comprised of a cast-in-place concrete 21, which is an example of a hardening material with time, provided at a deep part of a drilled hole 2s which is a pit formed in the ground 40 from the ground line GL, and a reinforcing bar 22 buried into the concrete 21. On the pile 2, a column 3 which is a steel pipe concrete column is provided, that is, a plurality of columns 3 are provided at a predetermined pitch in the right and left direction of Fig.1 and in the direction perpendicular to the paper of Fig.1, each being supported by the pile 2.

The top portion of each pile 2 is an extrabanking concrete 2a, as shown in Fig.1. The extrabanking concrete 2a is chipped afterwards, and becomes to be a basic portion 23 by the concrete placed herein, and then the pile 2 surviving as an actual structure is the portion lower than a top end of design pile PL. The reinforcing bar 22 buried into the concrete 21 of the pile 2 projects on the upper side from the top end of the extrabanking concrete 2a.

As shown in Fig.1 or Fig.2, each column 3 has a steel pipe 31 in the square shape in this embodiment (of course, the steel pipe may be a circle shape), and the steel pipe 31 constructs a peripheral portion of the column 3 as a steel pipe body. The inside of the steel pipe 31 is filled with concrete 32. The lower end portion of the steel pipe 31 is

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closed, blocking the inside and the outside of the steel pipe body 31 by the concrete 32. A leg portion 33 which is comprised of a shape steel is provided at the lower portion of the column 3 as a leg portion for connection, projecting on the lower hand from the lower end portion of the steel pipe 31. While the top portion of the leg portion 33 is fixed into the concrete 32 which is provided in the steel pipe 31 in advance, the lower portion of the leg portion 33 is buried into and fixed by the concrete 21 of the pile 2 in the embodiment as shown in Fig.1. As shown in Fig.2, the leg portion 33 has an opened sectional shape in the horizontal directions having no closed horizontal sectional portion (a horizontal sectional portion completely surrounded by a flange of the leg portion 33 or the like). A flexural rigidity G_1 of the leg portion 33 is smaller than one of the steel pipe 31 filled with the concrete 32. And, an exposed portion 33a is disposed between the upper portion positioned inside the steel pipe 31 and the lower portion positioned in the pile 2 in the leg portion 33 as a small sectional portion in the column 3. As shown in the dashed line in Fig.1, the exposed portion 33a becomes to be one part of the basic portion 23 thereafter.

As shown in Fig.1, slabs 5, which are underground slabs, are provided with the subsurface structure 1 at a predetermined pitch in the upper and lower direction, con-

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necting the columns 3, 3 adjacent to each other. The slab 5 in this embodiment is comprised of the cast-in-place concrete 51 and the reinforcing bars 52 which are shape steels. The subsurface structure 1 is flat slab structure form in which the slab 5 is directly supported by the columns 3 without any joist.

Between the slabs 5 adjacent to each other in the up and down direction, a subsurface space 6 is provided, being separated by the slab 5 every story of the underground floors. On a digging face DL of the story where construction work is now executed, a concrete subslab 37 is provided for placing the slab 5 of this story (as shown in the dashed line of Fig.1).

A plurality of the columns 3 also extends and are disposed on the upper side of the ground line GL, as shown in Fig.1. The portion upper than the ground line GL in the column 3 is used as an aboveground column 3X of an above-ground structure 1X constructed on the upper side of the subsurface structure 1.

The subsurface structure 1 is comprised as shown hereinbefore. Then, the subsurface structure 1 is constructed according to the work routines as shown in Fig.4 (a) through (c) and Fig.5 (a) through (c), executing a concrete reverse placing method.

At first, as shown in Fig.4 (a), a stand pipe 38 is set



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under the ground line GL of the position to be provided the pile 2. The drilled hole 2s is drilled and formed as a pit, filling with an adequate stable liquid 39 in a liquid state, such as fresh water or bentonite solution according to the state of the ground, from the ground line GL to a predetermined depth of the ground 40. The reinforcing bars 22 for the pile 2 are set at the deep portion of the drilled hole 2s drilled and formed.

As shown in Fig.4 (b), the concrete 21 is poured into the deep portion of the drilled hole 2s, where the reinforcing bars 22 are set, to the pile concrete placing expected level CL higher the length of the extrabanking concrete 2a than the top end of the design pile PL.

Then, the columns 3 are immediately disposed. The work of disposing the columns 3 must be executed when the concrete 21 of the pile 2 is not yet hardened. Firstly, in the site where the subsurface structure 1 is constructed, a shape steel is set as the leg portion 33, projecting a predetermined length to one end from the inside of the steel pipe 31, and in this state, the concrete 32 is poured into the steel pipe 31 so as to harden. Then, the shape steel becomes to be the leg portion 33 projecting on the lower hand when the column 3 is built up, being fixed and supported by the concrete 32 in the steel pipe 31. The column 3 which is comprised of the hardened concrete 32 and the steel pipe 31 is



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then produced in advance as a steel pipe concrete column of precast.

The column 3 produced in advance as the steel pipe concrete column is hung down with a crane (not shown) in the longitudinal direction as shown in Fig.4 (c) so as to position on the upper hand of the pile 2 of a predetermined position. In the aforementioned state, the column 3 is lowered by the operation of a crane. The column 3 sinks into the drilled hole 2s filled with the stable liquid 39 by its weight since the column 3 is the steel pipe column filling the inside of the steel pipe 31 with the concrete 32. Therefore, the stable liquid 39 filling in the drilled hole 2s overflows the amount the column 3 sinks, and then while the overflowing stable liquid 39 is removed by a pump or the like, the column 3 is inserted in the drilled hole 2s to a predetermined position (that is, the stable liquid 39 is displaced by the column 3). As shown in Fig.5 (a), the leg portion 33 of the column 3 is then inserted a predetermined distance into the concrete 21 of the pile 2 which is not yet hardened, and the column 3 is fixed and supported by the pile 2 through the leg portion 33 by hardening of the concrete 21. Accordingly, the column 3 is easily built up in the underground without floating by buoyancy. Besides, since the leg portion 33 of the column 3 has the sectional shape opened in the horizontal directions, when the leg portion 33 is insert-

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ed into the concrete 21, the concrete 21 which is pushed down by the leg portion 33, can move, running away from a section opening portions 33b in the horizontal directions. As a result, choking of the concrete 21 of the surroundings of the leg portion 33 can be prevented, thereby insertion resistance is small. Therefore, the leg portion 33 can be inserted smoothly and certainly so as to obtain a predetermined length of insertion. Furthermore, since the lower end portion of the steel pipe 31 is closed by the concrete 32 filling the inside the steel pipe 31 in advance, the stable liquid 39 or the concrete 21 of the pile 2 does not entered into the steel pipe 31.

In this way, after the column 3 is disposed in the drilled hole 2s in the ground 40, the drilled hole 2s of the surroundings of the column 3 is refilled with earth and sand 36 or the like, as shown in Fig.5 (a), thereby the stable liquid 39 left in the drilled hole 2s is collected, and is displaced with the earth and sand 36. After a plurality of the columns 3 are built up in the ground 40, digging work is executed in such a way that the ground 40 is dug down starting from the ground line GL step by step so as to remove. Then, the subsurface space 6 is formed with digging, thereby the column 3 is exposed in the subsurface space 6 on the side upper than a digging face DL, as shown in Fig.5 (b). The column 3 is stably disposed under the ground line GL as a

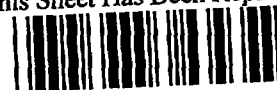


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column of the main structure in the subsurface structure 1 even if the column 3 appears in the subsurface space by removing the ground 40 since the leg portion 33 is fixed and supported by the pile 2, and the steel pipe concrete itself, which is comprised of the steel pipe 31 and the concrete 32, has sufficient strength. After the ground 40 is dug to a predetermined position corresponding to the subsurface slab 5, the concrete subslab 37 is placed on the digging face DL and its surface 37a is leveled, as shown in Fig.5 (c).

Next, an antisticking material for concrete is coated or disposed on the concrete subslab 37. Then, necessary reinforcing bars 52 are disposed in the subsurface slab 5 in a predetermined reinforcement state. After the reinforcing bars 52 are arranged in this way, the concrete 51 is placed a predetermined thickness corresponding to one of the subsurface slab 5 on the concrete subslab 37, as shown by the dashed line in Fig.5 (c).

Then, the slab 5 is constructed, making the concrete subslab 37 placed on the digging face DL as an under form. Therefore, a form for constructing the slab 5 is unnecessary. Besides, since the column 3 is the steel pipe concrete column disposed prior to the construction of the slab 5 as a column of the main structure, and is already exposed in the subsurface space 6 by digging the ground 40 as described before, slab construction finishes after the slab 5 is only



constructed so as to connect with the column 3 in the orthogonal direction in the flat slab shape. Thereby it is possible to avoid the concrete placing work for constructing the columns and the occurrence of concrete construction joint of a column accompanied by the concrete placing work since the columns already exist as steel pipe concrete columns when the subsurface structure 1 is constructed by the concrete reverse placing method. As a result, execution of works is easy, and besides, it is possible to avoid the occurrence of a weak-point owing to a bad concrete construction joint in the subsurface structure finished.

By repeating the routines above-mentioned, the subsurface structure 1 is constructed in a short construction period. After the subsurface space 6 is formed to the depth to be placed the basic portion 23, the basic portion 23 is constructed by concrete as shown in the dashed line of Fig.1. On this occasion, the top portion of the concrete 21 of the pile 2, that is, the portion of the extrabanking concrete 2a is in such a state that its strength is slow since the stable liquid 39 or the like is mixed therein, and then the extrabanking 2a portion should be removed. However, since such a bad concrete 21a is not entered into the steel pipe 31 of the column 3 as described before, chipping work of the extrabanking concrete 2a is smoothly executed.

In this way, the basic portion 23 is constructed,

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connecting a plurality of the piles 2 in the right and left direction of Fig.1, thereby the basic portion of the subsurface structure 1 is firmly constructed. On this occasion, concrete placing is executed on the basic portion 23 as shown by the dashed line of Fig.1, connecting respective leg portions 33 of a plurality of columns 3 one another. The portion which is a leg portion for connection for fixing and supporting the column 3 by the pile 2 during the digging work and the slab placing work can be used as a part of the structure of the subsurface structure 1. That is, in the leg portion 33 its upper portion is buried in the concrete 32 inside the steel pipe 31, its intermediate portion is fixed in the basic portion 23, and its lower portion is buried into the concrete 21 of the pile 2, thereby the leg portion 33 has a function of appropriately connecting and reinforcing the basic portion of the subsurface structure 1. Accordingly, the basic portion of the subsurface structure 1 becomes to be an extremely stable structure.

The leg portion 33 of the column 3 has a function of transmitting the weight of a building under construction to the pile 2 till the basic portion 23 is constructed. In case where this method is adopted at the weak ground, however, as shown in Fig.6, when deformation occurs on the earth retaining wall 25 with digging work as shown by the dotted line of Fig.6, a head portion 2b of the pile 2 may be relatively



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moved being accompanied by such a deformation in the horizontal direction as shown in the direction by the arrow A of Fig.6 relative to the column 3. Generally, there is such a fear that an excessive bending stress which is unexpected at a design stage occurs on the column 3 by such a relative movement of the head portion 2b of the pile 2. However, according to the present method, in the leg portion 33 the section of the steel is small in comparison with the steel pipe 31 filled with the concrete 32, that is, the column 3 of the main structure, and its flexural rigidity G_1 is set small, thereby the leg portion 33 deforms as shown in Fig.6 so as to absorb almost the relative displacement of the head portion 2b.

In this way, the construction work of the subsurface structure 1 is effectively and safely executed in the ground 40 on the lower side from the ground line GL, and then the construction work of the above-ground structure 1X can be executed on the upper side from the ground line GL, simultaneously proceeding with the construction of the subsurface structure 1. On this occasion, the above-ground column 3X is constructed making use of the column 3 of the subsurface main structure supported by the pile 2, thereby the construction work of the above-ground structure 1X can be adequately executed. Besides, the construction of the subsurface structure 1 is executed under the ground line GL in such a state



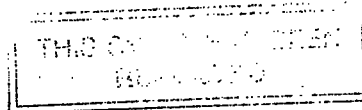
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that the ground is always stabilized without digging the whole ground 40 at one time, thereby above-ground work is also safe and the whole construction of the structure can be effectively executed.

In the embodiment above-mentioned, a ground is stabilized in such a way that the digged hole 2s is filled with the stable liquid 39, such as fresh water or bentonite. However, the stable liquid is not restricted by these as long as it is in a liquid state, its kind is optional. Furthermore, as long as the digged hole 2s, which is a pit, is formed in a predetermined shape in the ground 40 by digging from the ground line so as to construct the columns 3, the shape of the digged hole 2s may be kept by the means excluding the method of filling with the stable liquid 39 as described in the embodiment (for instance, by making use of hole wall protecting material or making use of the supporting force which the ground itself has). That is, the digged hole 2s may not be filled with the stable liquid 39.

Besides, the shape of the steel pipe 31 and the leg portion 33 comprising the column 3 are optional. That is, a circle section steel pipe may be used and a steel material having sectional shape excluding one shown in the figures may be used as the leg portion for connection. And, some concrete reinforcing material, such as the steel material different from the reinforcing bar for reinforcement and the leg





portion, or a steel fiber, may be provided inside the steel pipe 31 of the column 3.

The steel material comprising the leg portion 33 of the column 3 may be disposed only on the lower portion of the steel pipe 31. Alternatively, the steel material may be disposed extending along the whole length of the steel pipe 31.

Therefore, in another embodiment of the column 3 which is a steel pipe concrete column, as shown in Fig.3, a bottom portion 34 comprised of an iron plate or the like may be provided at the lower end portion of the steel pipe 31 filled with the concrete 32 therein, blocking the steel pipe, and the leg portion 33 may be connected with the lower side of the bottom portion 34 by welding through reinforcing plates 35, 35, thereby the leg portion 33 projects on the lower hand of the steel pipe 31 as the leg portion for connection. Then, the column 3 as shown in Fig.3 can be easily produced while it has a function almost equivalent to the column 3 shown in Fig. 1 or Fig.2 as described before, in use.

In the embodiment described before, the sectional shape of the leg portion 33 is shown in Fig.2 as such an example that the leg portion 33 has a sectional shape opened in the horizontal directions, thereby choking in case of the insertion into the concrete 21 is prevented so as to reduce insertion resistance. However, another sectional shape opened in



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the horizontal directions of the leg portion 33 is available as long as forming sectional opening portions 33b. For instance, as shown in Fig.7, steel materials 331 in the shape of a plate are arranged in the shape of a comb symmetrizing in the up and down direction in Fig.7, or as shown in Fig.8, may be radially arranged, thereby flowage of the concrete 21 in the direction as shown by the arrow B is done, that is, choking can be prevented. Alternatively, as shown in Fig.9 or Fig.10, some ribs 332 may be provided. Furthermore, as shown in Fig.11, a plurality of bar materials, such as reinforcing bars 333 may be arranged, aligning each extending direction to the vertical direction so as to make them a leg portion for connection. The shape of the leg portion for connection, such as the leg portion 33, is optional as long as the column 3 can be fixed by the pile 2 through the leg portion for connection. Any leg portion excluding one having a sectional shape as shown in Fig.7 through Fig.11, such as the leg portion contrived in the insertion resistance to the concrete 21 or adhesion for concrete, is available.

In the embodiment as mentioned above, the column 3 is one filling the inside of the steel pipe 31 with the concrete 32 in advance as the hardening material with time. However, a column 4 which is the steel pipe column not filling therein with concrete may be built up in the digged hole 2s as the other example of a column, as shown in Fig.12. That is, the



column 4 has the steel pipe 31 as a steel pipe body, similar to the column 3 before-mentioned, and the bottom portion 34 is provided with the lower end portion of the steel pipe 31, blocking the outside and inside of the steel pipe 31. The leg portion 33 which is a shape steel, similar to the column 3 before-mentioned is provided with the bottom portion 34, being united with the steel pipe 31 by welding or the like, projecting on the lower hand of the steel pipe 31 through reinforcing plates 35. The inside of the steel pipe 31 prior to arrangement in the digged hole 2s is in an empty state, filling with only air 41, thereby the column 4 before arrangement in the underground is light, and the treatment of carrying of materials and lifting is easy.

When the column 4 is built up into the underground, then, if the stable liquid 39 exists in the digged hole 2s, it is difficult to insert the column 4 into the digged hole 2s by receiving buoyancy from the stable liquid 39 in this state (that is, since only air 41 exists inside in such a state that the inside and the outside of the steel pipe 31 are blocked by the bottom portion 34). Then, in case where the column 4 is inserted into the digged hole 2s filled with the stable liquid 39, as shown in Fig.14 (a), a ballast, such as fresh water, is entered inside the steel pipe 31, and the column 4 is inserted, adjusting buoyancy acting on the column 4 from the stable liquid 39 by the weight of the ballast 42.



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Then, the column 4 smoothly sinks into the stable liquid 39 in the digged hole 2s by preventing flotation by buoyancy. As a result, the column 4 is inserted into and fixed by the concrete which is not yet hardened of the pile 2 without any problem of buoyancy. On this occasion, the column 4 is fixed and supported by the pile 2, only inserting the leg portion 33 into the concrete 21 while the steel pipe 31 portion is arranged above the pile 2. Therefore, it is not necessary to push the steel pipe 31 portion into the concrete 21, and the column 4 is smoothly built up into the ground 40. Accordingly, there is no problem of insertion resistance into the concrete 21 of the pile 2 even if the bottom portion 34 is provided at the lower end of the steel pipe 31.

After the column 4 is supported by the concrete 21 of the pile 2 to a predetermined depth by fixing it by concrete 21, as shown in Fig.14 (b), the digged hole 2s of the surroundings of the column 4 is refilled with the earth and sand 36, and the ballast 42 inside the steel pipe 31 is collected through a pump or the like. Then, since the column 4 which is a steel pipe column can be smoothly built up into the ground 40, the column 4 can be utilized as a column of a main structure so as to effectively construct a subsurface structure by digging work of the ground 40 and constructing of the slab 5, similar to the case of the column 3 in the embodiment above-mentioned.

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After the column 4 is fixed by the pile 2 as mentioned before, for instance, the concrete 32 is placed inside the steel pipe 31 of the column 4 in site as the hardening material with time, thereby the concrete 32 filled can be easily made a part of the column 4. By doing so, the column 4 becomes to be the steel pipe concrete column substantially equal to the column 3 before-mentioned, as a result. That is, the steel pipe column or the steel pipe concrete column can be freely selected by using the column 4.

As shown in Fig.13, the another example of the column is a column 7 which is the steel pipe column, which inside is not filled with the concrete 32 similar to the above-mentioned column 4. In the column 7, some through holes 30 are formed communicating the inside and the outside of the steel pipe 31 at the lower end portion of the steel pipe 31 and near the bottom portion 34 provided here.

Then, when the column 7 is built up into the underground, even if the digged hole 2s is filled with the stable liquid 39, as shown in Fig.15 (a), the stable liquid 39 can freely enter into the steel pipe 31 through the through holes 30. Then, the column 7 acting the adjusted buoyancy thereon sinks into the stable liquid 39 and is smoothly inserted into the digged hole 2s, and its leg portion 33 is smoothly inserted into and fixed by the concrete 21 which is not yet hardened of the pile 2.

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After the column 7 is fixed and supported by the pile 2 through the leg portion 33, as shown in Fig.15 (b), in this way, the digged hole 2s of the surroundings of the column 4 is refilled with the earth and sand 36 and the stable liquid 39 entered inside the steel pipe 31 is collected through a pump or the like. Then, similar to the columns 3, 4 before-mentioned, the column 7 can be utilized as a column of a main structure. The column 7 is fixed by the pile 2, similar to the column 4, thereafter the concrete 32 as the hardening material with time is placed in the steel pipe 31 at site, thereby the column 7 can be made a steel pipe concrete column. Then, you can select the steel pipe column or the steel pipe concrete column.

On this occasion, if the leg portion 33 has a sectional shape opened in horizontal directions in the columns 4, 7 above-mentioned in Figs. 12, 13, similar to the column 3 above-mentioned, the concrete 21 of the surroundings of the leg portion 33 is prevented from choking when the leg portion 33 is inserted into the concrete 21 of the pile 2, and the concrete 21 flows escaping in horizontal directions with entering of the leg portion 33. As a result, the leg portion 33 of the column 4 or 7 is smoothly inserted into and fixed by the concrete 21, which is not yet hardened, of the pile 2 with a small insertion resistance.

If the bending rigidity G_1 of the leg portion 33 is



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smaller than one of the steel pipe 31 portion in the columns 4, 7, acting the excessive bending stress on the columns 4, 7 is prevented when the earth retaining wall 25 is deformed, similar to the before-mentioned case. Furthermore, the bending rigidity G_I of the leg portion 33 in the columns 4, 7 is smaller than one of the steel pipe 31 filled with the hardening material with time, such as a concrete, the deformation of the earth retaining wall 25 is absorbed in the deformation of the leg portion 33 so as to reduce the bending stress acting on the column after the columns 4, 7 become to be the steel pipe concrete column.

In the embodiments, the hardening material with time which is used for the columns 3, 4, 7 and the pile 2 is the concrete 32. However, the hardening material with time is optional, not limiting the concrete as long as it is proper as a construction material of a subsurface structure, and it can be placed in the deep portion of the digged hole 2s or the steel pipe 31. Therefore, the cement type material, such as mortar, cement milk, or the resin type material, or some material capable of hardening with time after placing may be used in place of the concrete.

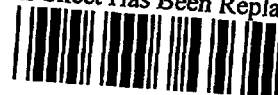
The present invention has been explained on the basis of the embodiments presented herein. However, the embodiments which are described in the present specification are illustrative and not limiting. The scope of the invention is



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designated by the accompanying claims and is not restricted by the descriptions of the specific embodiments. Accordingly, all the transformations and changes belonging to the claims are included in the scope of the present invention.

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CLAIMS

1. A method of constructing column in a concrete reverse placing method wherein when a subsurface structure is constructed by said concrete reverse placing method, a pit is formed in a ground from a ground line, a hardening material with time is placed in a deep portion of said pit so as to construct an underground pile, column is built up and connected with said underground pile, said method comprising:

inserting a steel pipe column having a steel pipe body, said steel pipe column provided a leg portion for connection at the lower end of said steel pipe body, projecting underneath of said steel pipe body, into said pit;

inserting said leg portion for connection of said steel pipe column into said hardening material with time which is not yet hardened, of said underground pile; and

fixing said steel pipe column by said underground pile through said leg portion for connection so as to construct said column.

2. The method of constructing column in said concrete reverse placing method as set forth in claim 1 wherein in case where said pit is filled with a stable liquid, said steel pipe column is inserted into said pit filled with said stable liquid while buoyancy acting on said steel pipe column is

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being adjusted so as to prevent flotation at the time of insertion of said steel pipe column into said pit.

3. The method of constructing column in said concrete reverse placing method as set forth in claim 1 wherein said steel pipe column is fixed by said underground pile, thereafter a hardening material with time is placed inside said steel pipe body so as to fill therewith, said hardening material with time filled is made a part of said column.

4. A method of constructing column in a concrete reverse placing method wherein in case where a subsurface structure is constructed by said concrete reverse placing method, a pit is formed in a ground from a ground line, a hardening material with time is placed in a deep portion of said pit so as to construct an underground pile, and column is built up and connected with said underground pile, said method comprising:

a steel pipe column having a steel pipe body, filling said inside of said steel pipe body with a hardening material with time, closing a lower end portion of said steel pipe body so as to block inside and outside of said steel pipe body, providing a leg portion for connection at a lower end of said steel pipe body, projecting the underneath of said steel pipe body;

using said steel pipe column as said column;

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inserting said steel pipe column in said pit filled with a stable liquid;

inserting said leg portion for connection of said steel pipe column into said hardening material with time, which is not yet hardened, of said underground pile; and

fixing said steel pipe column by said underground pile through said leg portion for connection.

5. The method of constructing column in said concrete reverse placing method as set forth in claim 4 wherein a lower end portion of said steel pipe body is closed, blocking inside and outside of said steel pipe body by said hardening material with time filling said inside of said steel pipe body.

6. The method of constructing column in said concrete reverse placing method as set forth in claim 1 wherein flexural rigidity of said leg portion for connection is set smaller than one of said steel pipe body.

7. The method of constructing column in said concrete reverse placing method as set forth in claim 3 or claim 4 wherein flexural rigidity of said leg portion for connection is set smaller than one of said steel pipe body filled with said hardening material with time.

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8. The method of constructing column in said concrete reverse placing method as set forth in claim 1 or claim 4 wherein said leg portion for connection has a sectional shape opened in horizontal directions, when said leg portion for connection is inserted into said hardening material with time, which is not yet hardened, of said underground pile, said hardening material with time of surroundings of said leg portion for connection is prevented from choking.

9. The method of constructing column in said concrete reverse placing method as set forth in any claim of claims 1 through 8 wherein said hardening material with time is a concrete.

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