

Presetting Type High Vacuum Compact Method for Treating Soft Ground

Technical Field of the Invention

The present invention belongs to the method for treating soft ground. In particular,
5 the present invention relates to a method for treating soft ground of sea reclamation,
and more particularly, to a presetting type high vacuum compact method for treating
soft ground.

Background of the Invention

10 At present, for treating soft ground of sea reclamation, either conventional
methods or novel techniques, such as soil cement mixed pile, high vacuum compact,
and dynamic consolidation are all passive ground treating methods, which means that
only after formation of soft ground by sea reclamation and backfilling, soft ground
consolidation could be carried out. So, at present, passive treating methods often
15 encounter embarrassments that bearing capacity of nascent land is too low to support
people and apparatuses. Thus, pre-treatment of extra-soft ground has to be carried out
with large amounts of money and time to make sure apparatuses could be put into the
construction region. However, a high risk of crash accident existed in the said
pre-treatment work. The above said methods usually have common failings of high
20 investment and high risk.

Consequently, it is in desire need of a novel active method to treat soft ground of
sea reclamation and overcome the above said disadvantages.

Abstract of the Invention

25 A presetting type high vacuum compact method for treating soft ground requiring
backfilling soil is provided in the present invention to overcome the above said
disadvantages in passive methods for treating ground.

The method provided by the present invention comprises presetting drainage
apparatuses required by the high vacuum compact method on an original subsoil of
30 the construction region before backfilling soil.

According to a preferred embodiment of the present invention, the method
provided by the present invention comprises the following steps:

A) on an original subsoil, setting horizontal drainage apparatuses and vertical
water collecting apparatuses, linking said horizontal drainage apparatuses with said

vertical water collecting apparatuses,

B) backfilling soil, laying water pumping apparatuses when the backfilled soil reaches the designed elevation, linking said pumping apparatuses with said vertical water collecting apparatuses,

5 C) executing several cycles of high vacuum compact, and terminating the construction when the backfilled soil reaches the designed degree of consolidation.

According to a preferred embodiment of the present invention, soil permeability should be measured before setting horizontal drainage apparatuses and vertical water collecting apparatuses, to determine whether the backfilled soil is permeable soil or
10 not, where sandy soil and silt with permeability coefficient greater than or equal to 10^{-6} cm/s are called permeable soil, and clay and mud with permeability coefficient lower than 10^{-6} cm/s are called impermeable soil.

According to a preferred embodiment of the present invention, when backfilled soil is permeable soil, horizontal permeable blind ditches are used as horizontal
15 drainage apparatuses and vertical water collecting wells are used as vertical water collecting apparatuses. The said vertical water collecting wells are set at both ends of the blind ditches, whose height above the ground are not lower than the designed elevation of backfilled soil. Submersible type water pumping apparatuses are used as water pumping apparatuses to pump water outside the construction region.

20 According to a preferred embodiment of the present invention, when backfilled soil is impermeable soil, rectangle densely placed horizontal permeable drainage boards are used as horizontal drainage apparatuses and grid-patterned ventilating frames are used as vertical water collecting apparatuses. The grid-patterned ventilating frames, which are used to install horizontal permeable drainage boards, are
25 embedded into original seabeach vertically. The ventilating frames are provided with interlinked horizontal and vertical pipelines. The height of top layer horizontal pipeline of ventilating frame is lower than the designed elevation of backfilled soil at a reasonable distance. A membrane-penetrated pipe is set on each ventilating frame to link with water pumping apparatus. The top of the membrane-penetrated pipe is
30 higher than the designed elevation of backfilled soil. The horizontal pipeline of horizontal permeable drainage board, which is along with ventilating frame, is layered densely placed. Each layer of drainage board is kept on the same level with the horizontal pipeline of the corresponding layer of ventilating frame. A layer of ventilating soft plastic drainage board is spread on the surface of backfilled soil,

which reaches the designed elevation. A set of vacuum system is set on the ventilating soft plastic drainage board to pump vacuum.

The method provided by the present invention has the advantage of saving construction cost greater than 30%, meanwhile, shortening the construction period, ensuring safety in construction and also being environmental friendly.

Descriptions of the Drawings

FIG.1 is a schematic diagram for setting model of blind ditches and water collecting walls as described in embodiment 1 of the present invention, wherein, 1 stands for blind ditch, 2 stands for water collecting wall.

FIG.2 is a schematic diagram of structure of special ventilating frame as described in embodiment 2 of the present invention, wherein, 31 stands for horizontal pipeline, 32 stands for vertical pipeline, 4 stands for membrane-penetrated pipe.

FIG.3 is a schematic diagram of structure of ventilating soft plastic drainage board as described in embodiment 2 of the present invention, wherein, 5 stands for ventilating geocloth.

FIG.4 is a setting model of ventilating soft plastic drainage board as described in embodiment 2 of the present invention.

Detailed Description of the Invention

As for sea reclamation, backfilling soil and pumping out large amount of water contained in backfilled soil are required when soil doesn't reach the designed elevation. As a rule, passive treating methods are employed, however, an active method for treating ground, which is named as presetting type high vacuum compact method for treating soft ground, is provided by the present invention. The method comprises presetting drainage apparatuses required by the high vacuum compact method on an original subsoil of the construction region before backfilling soil. The said drainage apparatuses include horizontal drainage apparatuses and vertical water collecting apparatuses.

Particularly, the method provided by the present invention comprises the following steps:

A) on an original subsoil, setting horizontal drainage apparatuses and vertical water collecting apparatuses, linking said horizontal drainage apparatuses with said vertical water collecting apparatuses,

B) backfilling soil, laying water pumping apparatuses when the backfilled soil reaches the designed elevation, linking said pumping apparatuses with said vertical water collecting apparatuses,

C) executing several cycles of high vacuum compact, and terminating the
5 construction when the backfilled soil reaches the designed degree of consolidation.

However, the permeability varies with different kind of soils. Presetting treating method also varies with the soils having different permeability. So as for sea reclamation, geology mechanical properties of backfilled soil should be measured
10 firstly. According to the backfilled soil property, mainly the soil permeability, backfilled soil can be divided into permeable soil (sandy soil and silt etc. with permeability coefficient greater than or equal to 10^{-6} cm/s, A type) and impermeable soil (clay and mud etc. with permeability coefficient lower than 10^{-6} cm/s, B type) based on different permeability coefficients measured at the construction region.
15 Further, on the basis of different kinds of backfilled soil permeability, special presetting type high vacuum compact method for treating soft ground is carried out as described in detail hereinafter:

When backfilled soil is permeable soil, horizontal permeable blind ditches are used as horizontal drainage apparatuses and vertical water collecting wells are used as
20 vertical water collecting apparatuses. The said vertical water collecting wells are set at both ends of the blind ditches, whose height above the ground are not lower than the designed elevation of backfilled soil. Submersible type water pumping apparatuses are used as water pumping apparatuses to pump water outside the construction region.

When backfilled soil is impermeable soil, rectangle densely placed horizontal
25 permeable drainage boards are used as horizontal drainage apparatuses and grid-patterned ventilating frames are used as vertical water collecting apparatuses. The grid-patterned ventilating frames, which are used to install horizontal permeable drainage boards, are embedded into original seabeach vertically. The ventilating frames are provided with interlinked horizontal and vertical pipelines. The height of
30 top layer horizontal pipeline of ventilating frame is lower than the designed elevation of backfilled soil at a reasonable distance. A membrane-penetrated pipe is set on each ventilating frame to link with water pumping apparatus. The top of membrane-penetrated pipe is higher than the designed elevation of backfilled soil. The horizontal pipeline of horizontal permeable drainage board, which is along with

ventilating frame, is layered densely placed. Each layer of drainage board is kept on the same level with the horizontal pipeline of the corresponding layer of ventilating frame. A layer of ventilating soft plastic drainage board is spread on the surface of backfilled soil, which reaches the designed elevation. A set of vacuum system is set on the ventilating soft plastic drainage board to pump vacuum.

The present invention is further illustrated by the following particular embodiments. It should be understood that the following embodiments, which are only used to illustrate the present invention, but not to limit the scope of the present invention.

Example 1、Method for treating permeable soil

For a certain project of sea reclamation, the backfilled soil, whose permeability coefficient is measured as 10^{-4} cm/s, is belonged to permeable soil. According to this measured result, the following steps are determined to be carried out:

Step 1: Before backfilling soil, as shown in FIG.1, a horizontal permeable blind ditch 1, which is about 60~150 m in length, is set on original seabeach every 10~30 m. A vertical water collecting well 2 is set on each end of the blind ditch 1. The vertical water collecting well 2, whose height above the ground is not lower than the designed elevation of backfilled soil, is usually embedded into original seabeach over 80 cm in depth.

Wherein, the permeable blind ditch 1, which is made by ordinary plastic blind ditch or old plastic material, is a circle type permeable pipe with permeable geocloth wrapped and 100 mm~950 mm in diameter.

The vertical water collecting well 2 is a horniness permeable pipe with 150 mm~600 mm in diameter.

Step 2: Backfilling soil is carried out. As the backfilled soil reaches the designed elevation (the dredgerfilled soil of sea reclamation is general 2~8 m in height), the submersible type water pumping apparatus is embedded into the vertical water collecting well to pump water outside the construction region.

Step 3: According to the method provided by CN patent No 01127046.2, when the compaction of backfilled soil reaches the designed requirement after carrying out two or three cycles of high vacuum compact, the apparatuses should be terminated.

Example 2、Method for treating impermeable soil

For a certain project of sea reclamation, the backfilled soil, whose permeability coefficient is measured as 10^{-7} cm/s, is belonged to impermeable soil. According to this measured result, the following steps are determined to be carried out:

Step 1: A grid-patterned ventilating frame, which is used to install horizontal permeable drainage board, is embedded into original seabeach before backfilling soil. The height of top layer horizontal pipeline of ventilating frame is lower than the designed elevation of backfilled soil at space reasonable distance of about 1 m generally. Each ventilating frame is about 2~5 m in length, and is placed at regular intervals of 20~50 m. The structure of grid-patterned ventilating frame, as shown in FIG.2, is consisted of porous plastic rectangle pipes with geoclothes wrapped outside. The space between grid-patterned rectangle pipes is 0.6~1.5 m, and the pipelines (horizontal pipeline 32 and vertical pipeline 31) are interlinked. A membrane-penetrated pipe 4, which is employed to connect vacuum system, is set on each frame.

The horizontal pipeline 32 of horizontal permeable drainage board, which is along with ventilating frame, is then layered densely placed (the drainage board, whose space between each other is generally 0.6~1.5 m, is arranged in parallel and also can be adjusted according to the property of backfilled soil). Each layer of drainage board is kept on the same level with the horizontal pipeline of the corresponding layer of ventilating frame. The plastic ventilating frame is horizontally connected with the ventilating frame.

According to the treating capacity of vacuum system, ventilating frames are set in groups of 60~100 bars. The setting model of frames can be adjusted based on the bearing capacity of construction regions, the thickness of silt and convenience for walk and arrangement. Wherein, conventional A or B type plastic drainage board can be used as horizontal permeable draining boards.

The ventilating frame is mainly used to set the parallel drainage boards and collect percolating water from silt. The percolating water can be pumped out by vacuum during the following steps.

Step 2: Backfilling soil is carried out. As backfilled soil reaches the designed elevation, a layer of ventilating soft plastic drainage board is spread on the surface of

backfilled soil.

As shown in FIG.3, the ventilating soft plastic drainage board is a permeable concave-conve type drainage board with 20~50 m in length, 50~150 mm in width, 10~50 mm in thickness and geocloth 5 wrapped outside.

5 The setting model of the ventilating soft plastic drainage board, as shown in FIG.4, is placed rectangular in a row. Wherein, a single rectangle is 10~15 m in length and 2~5 m in width. The vacuum membrane, with which water can be overlaid 1~1.5 m in depth to accelerated consolidation of silt as vacuum required, is then overlaid on ventilating plastic drainage board.

10 Step 3: Two sets of vacuum systems are set per 600~1200 m². Wherein, one set of vacuum system is linked with membrane-penetrated pipe of the ventilating frame for pumping vacuum, where another set is set on the ventilating soft drainage board for pumping vacuum. 2~4 months later, the apparatus should be terminated when the compaction of backfilled soil reaches designed requirement.

15 Although as described in example 2 of the present invention, the plane frames used are consist of porous plastic rectangle pipes, for that skilled in the present technical field, it is obvious that the frames with other configurations, such as stereo configuration encircled by four sides, can also be used to set drainage board, and obtain the same effect. Thus, it is also claimed to be protected by the present
20 invention.

Compared to conventional methods such as high vacuum compact and vacuum preloading, the method provided by the present invention has present with the following advantages:

Because the bearing capacity of backfilled soil almost reaches zero, geocloth,
25 which is need to backfill rough sand with 80 cm in thickness, is required to be spread on the soil for setting drainage boards by apparatuses. As the method provided by the present invention is used to preset horizontal drainage boards, a great expense for a mass of rough sand layers and setting drainage boards by apparatuses could be reduced. Consequently, the method provided by the present invention has the
30 advantages of saving construction cost greater than 30%, shortening the construction periods and ensuring safety in construction. Moreover, the method is environment friendly because of saving large cost of sand resource, employing presetting high vacuum compact throughout project with output of pure water but not mud without adding chemical agent, and reusing of the ventilating soft drainage boards.

What is claimed is:

1. A presetting type high vacuum compact method for treating soft ground requiring backfilling soil, wherein said method comprises presetting said drainage apparatuses required by the high vacuum compact method on an original subsoil of the construction region before backfilling soil.
2. The method as said in claim 1, wherein said drainage apparatuses includes horizontal drainage apparatuses and vertical water collecting apparatuses.
3. The method as said in claim 2, wherein said method comprises the following steps:
 - A. on an original subsoil, setting said horizontal drainage apparatuses and said vertical water collecting apparatuses, linking said horizontal drainage apparatuses with said vertical water collecting apparatuses,
 - B. backfilling soil, laying water pumping apparatuses when the backfilled soil reaches the designed elevation, linking said pumping apparatuses with said vertical water collecting apparatuses,
 - C. executing several cycles of high vacuum compact, and terminating the construction when the backfilled soil reaches the degree of consolidation.
4. The method as said in claim 1, wherein soil permeability should be measured before setting said horizontal drainage apparatuses and said vertical water collecting apparatuses, to determine whether the backfilled soil is permeable soil or not.
5. The method as said in claim 4, wherein sandy soil and silt with permeability coefficient greater than or equal to 10^{-6} cm/s are said permeable soil.
6. The method as said in claim 4, wherein clay and mud with permeability coefficient lower than 10^{-6} cm/s are said impermeable soil.
7. The method as said in claim 3, wherein when backfilled soil is permeable soil, horizontal permeable blind ditches are used as said horizontal drainage apparatuses and vertical water collecting wells are used as said vertical water collecting

apparatuses, the said vertical water collecting wells are set at both ends of said blind ditches, whose height above the ground are not lower than the designed elevation of backfilled soil, submersible type water pumping apparatuses are used as said water pumping apparatuses to pump water outside the construction region.

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8. The method as said in claim 7, wherein said permeable blind ditch is made by ordinary plastic blind ditch.

9. The method as said in claim 7, wherein said permeable blind ditch, which is made by old plastic material, is a circle type permeable pipe with wrapped permeable geocloth and 100 mm~950 mm in diameter.

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10. The method as said in claim 7, wherein said permeable blind ditch is about 60~150 m in length.

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11. The method as said in claim 7, wherein the space between said permeable blind ditch is about 10~30 m.

12. The method as said in claim 7, wherein said vertical water collecting well is a horniness permeable pipe with 150 mm~600 mm in diameter.

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13. The method as said in claim 7, wherein said water collecting well is embedded into original seabeach over 80 cm in depth.

14. The method as said in claim 7, wherein said submersible type water pumping apparatus is embedded into said water collecting well.

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15. The method as said in claim 3, wherein when backfilled soil is impermeable soil, rectangle densely placed horizontal permeable drainage boards are used as said horizontal drainage apparatuses and grid-patterned ventilating frames are used as said vertical water collecting apparatuses; the said grid-patterned ventilating frames, which are used to install horizontal permeable drainage boards, are embedded into original seabeach vertically; the said ventilating frames are provided with interlinked horizontal and vertical pipelines; the height of top layer horizontal pipeline of said

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ventilating frame is lower than the designed elevation of backfilled soil at a reasonable distance; a membrane-penetrated pipe is set on each ventilating frame to link with said water pumping apparatus; the top of said membrane-penetrated pipe is higher than the designed elevation of backfilled soil; the horizontal pipeline of said horizontal permeable drainage board, which is along with said ventilating frame, is layered densely placed; each layer of said drainage board is kept on the same level with the horizontal pipeline of the corresponding layer of said ventilating frame; a layer of ventilating soft plastic drainage board is spread on the surface of said backfilled soil, which reaches the designed elevation; a set of vacuum system is set on said ventilating soft plastic drainage board to pump vacuum.

16. The method as said in claim 15, wherein said ventilating frame is about 2~5 m in length.

17. The method as said in claim 15, wherein said ventilating frame is placed at regular intervals of 20~50 m.

18. The method as said in claim 15, wherein conventional A or B type plastic drainage board are used as said horizontal permeable drainage boards.

19. The method as said in claim 15, wherein the structure of said grid-patterned ventilating frame is consisted of porous plastic rectangle pipes with geoclothes wrapped outside; the space between said grid-patterned rectangle pipes is 0.6~1.5 m.

20. The method as said in claim 15, wherein said ventilating soft plastic drainage board is a permeable concave-conve type drainage board with 20~50 m in length, 50~150 mm in width, 10~50 mm in thickness and geocloth wrapped outside.

21. The method as said in claim 15, wherein said setting model of the ventilating soft plastic drainage board is laid rectangular in a row.

22. The method as said in claim 21, wherein a single rectangle of said ventilating soft plastic drainage board laid rectangular in a row is 10~15 m in length and 2~5 m in width.

23. The method as said in claim 15, wherein the height of top layer horizontal pipeline of said ventilating frame is lower than the designed elevation of backfilled soil at a reasonable distance of about 1 m generally.

5 24. The method as said in claim 15, wherein the vacuum system is the water pumping apparatus.

25. The method as said in claim 15, wherein the vacuum membrane is overlaid on said ventilating plastic drainage board.

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26. The method as said in claim 25, wherein pressure is overlaid on said vacuum membrane.

15 27. The method as said in claim 26, wherein water is overlaid with 1~1.5 m in depth.

28. The method as said in claim 15, wherein after backfilling soil, one set of said water pumping apparatus is set on said backfilled soil per 600~1200 m², and one set of said vacuum system is set per 600~1200 m².