

METHOD AND APPARATUS FOR PUMPING AND DISCHARGING SOIL FOR RECLAMATION

CROSS-REFERENCE TO RELATED APPLICATION

5 [0001] This application claims priority to Korean Patent Application No. 10-2019-0044766, filed on April 17, 2019, the disclosure of which is incorporated herein by reference in its entirety.

10 BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a method and apparatus for pumping and discharging soil for reclamation, and more particularly, to a method and apparatus capable of
15 immediately, rapidly, and uniformly spreading or depositing soil on a remote reclamation site by allowing a centrifugal pump to pump the soil together with water from a hopper barge loaded with the soil.

20 2. Related Art

[0003] A typical method of reclamation is carried out, for example, in such a manner that hopper barges or barges loaded with soil move directly to a reclaimable marine point and the soil is directly released and spread on the
25 sea-floor of a submarine reclamation site through grabs or

split hoppers of the hopper barges or barges.

[0004] These hopper barges or barges must run to the specific reclaimable marine point, for example, with approximately 500 to 5,000 cubic meters of soil loaded
5 thereon.

[0005] Then, the soil loaded on the hopper barges or barges is directly released and spread on the sea-floor of the submarine reclamation site through the grabs or split hoppers thereof for reclamation. Of course, the soil
10 loaded on the hopper barges or barges may be sucked through suction devices connected to cranes to be released and spread on the floor of the submarine reclamation site.

[0006] For such existing method of reclamation, it is necessary to operate all hopper barges or barges to a
15 specific reclaimable marine point. However, it may be impossible for the hopper barges or barges to enter the marine point due to the low depth of water, resulting in a decrease in productivity and an increase in construction cost for reclamation.

20 [0007] In particular, it is more difficult to apply the existing method of reclamation such as in harbors of Hong Kong with narrow topography. That is, since the harbors of Hong Kong have narrow marine topography unlike other countries' harbors and a large number of ships are running
25 within the harbors of Hong Kong Harbor, contact or

collision accidents due to frequent interference between running ships occur frequently.

[0008] The hopper barges loaded with, for example, approximately 5,000 tons of soil, which is typically
5 required for reclamation, should require a depth of 5 m or more. However, since the submarine reclamation sites of Hong Kong are low in depth, it is not easy for the hopper barges to reach a specific reclaimable marine area for direct reclamation with a maximum allowable amount of soil
10 loaded thereon.

[0009] [Patent Document 1] Japanese Patent Application No. H02-409277 (filed on December 28, 1990)

SUMMARY

15 [0010] Various embodiments are directed to a method and apparatus for pumping and discharging soil for reclamation, which can selectively implement uniform or general spreading of soil on a submarine reclamation site in a specific reclaimable marine zone from a nearby shore or a
20 coastal area, without soil-loaded vessels running to a specific reclaimable marine point.

[0011] In an embodiment, there is provided a method of pumping and discharging soil for reclamation, in which dry or semi-dry soil is mixed with water in a water-adding hole,
25 forcibly formed in a handling vessel anchored at a certain

shore or coastal point where it facilitates to be loaded with soil, and is vacuum-sucked from the water-adding hole, to be conveyed in a one-step manner through a release hose (soil distribution pipe) extending to a specific
5 reclaimable marine point remote from the handling vessel, so that the soil is continuously spread on a reclamation site for reclamation.

[0012] In the method, a suction/release device may be further used, which consists of a suction unit configured
10 to forcibly vacuum-suck the mixture of water and soil and a release unit configured to continuously spread the sucked mixture.

[0013] The method may include: anchoring the single handling vessel, consisting of a hopper barge and an auxiliary barge,
15 at the specific shore or coastal point where it facilitates to be loaded with soil, and coupling the suction unit, configured to vacuum-suck the soil, to a tip of an adjustment device mounted on the auxiliary barge; forcibly jetting, by the suction unit, water onto a local portion of
20 the soil loaded on the hopper barge from one side to the other side of the soil to form the water-adding hole and simultaneously perform a water-adding process; vacuum-sucking, by the suction unit, the mixture of water and soil from the water-adding hole formed in the local portion of
25 the soil to gradually exhaust the soil loaded on the hopper

barge; conveying the sucked mixture through the release hose extending to the reclaimable marine point remote from the handling vessel to release the mixture through the release unit connected to the end of the release hose so
5 that the soil is spread on the submarine reclamation site; and when the soil loaded on the hopper barge is sucked and exhausted by the suction unit, replenishing soil as much as the exhausted amount of soil in the hopper barge, the replenished soil being supplied through a conveyer belt
10 from soil-loaded replenishment vessels always waiting in the vicinity of the hopper barge after the replenishment vessels come alongside the hopper barge.

[0014] The mixture may be made by mixing 50 m³ to 90 m³ of water with 10 m³ to 50 m³ of soil.

15 **[0015]** In another embodiment, there is provided an apparatus for pumping and discharging soil for reclamation, in which a water-adding hole configured to change dry soil into a mixture of soil and water is forcibly formed in a handling vessel anchored at a certain shore or coastal point where
20 it facilitates to be loaded with soil and is remote from a specific submarine reclamation site, so that the mixture is vacuum-sucked from the water-adding hole by a suction unit to be conveyed in a one-step manner through a release hose extending to the marine point from the handling vessel, and
25 is continuously spread on the reclamation site from a

release unit connected to the end of the release hose for reclamation.

[0016] The apparatus may include the handling vessel consisting of a hopper barge and an auxiliary barge, the
5 hopper barge being loaded with soil and anchored at the certain shore or coastal point where it facilitates to be loaded with soil and is remote from the marine point, the auxiliary barge being equipped with an adjustment device coupled with the suction unit disposed on one side of the
10 hopper barge to vacuum-suck and exhaust the soil loaded on the hopper barge from one side to the other side of the soil, and a suction/release device including the suction unit and the release unit, the suction unit being coupled to a tip of the adjustment device to forcibly form the
15 water-adding hole in a local portion of the soil loaded on the hopper barge while performing water-adding and to vacuum-suck the mixture of water and soil from the water-adding hole using a centrifugal pump, the release unit being connected to the end of the release hose to release
20 the mixture so that the soil is continuously spread on the reclamation site.

[0017] The suction unit may be the cylindrical centrifugal pump that has a suction head coupled to a lower end of a cylindrical housing thereof to vacuum-suck the mixture from
25 the water-adding hole, the suction head having a flat and

wide bottom to allow a vacuum suction area to be easily secured. The centrifugal pump may be directly coupled to the adjustment device to exhaust the soil while precisely moving. The adjustment device may be an excavator and the centrifugal pump may be directly coupled to an end of a boom of the excavator. The suction unit may be the centrifugal pump further including a water supply pipe formed on one outer side of the cylindrical housing of the centrifugal pump to supply water, a jet injection nozzle formed on one inner side of the cylindrical housing of the centrifugal pump to jet water, a valve device configured to selectively use the water supply pipe and the jet injection nozzle, a discharge/connection pipe formed on another outer side of the cylindrical housing of the centrifugal pump to supply the sucked mixture to the release hose, and an air relief ball valve formed on a still another outer side of the cylindrical housing of the centrifugal pump to discharge bubbles, caused by generation of air during the suction of the mixture, to the outside. The mixture may be made by mixing 50 m³ to 90 m³ of water with 10 m³ to 50 m³ of soil.

[0018] The release unit may include: a release/distribution discharge pipe connected to the end of the release hose and having a plurality of outlets spaced at regular intervals, to distribute and release the mixture sucked from the

suction unit so that the mixture is spread on the reclamation site, in which case the soil is evenly distributed and released through the plurality of outlets and is uniformly spread on the reclamation site; or a
5 release/distribution discharge pipe having a single outlet, in which case the soil is released through the single outlet and is generally spread, namely, non-uniformly spread on the reclamation site.

[0019] The apparatus may further include a buoyancy
10 adjustment device movably connected to the adjacent release hose of the release/distribution discharge pipe to easily handle the release/distribution discharge pipe while the mixture is spread on the reclamation site, the buoyancy adjustment device being configured to properly adjust a
15 buoyancy of the release/distribution discharge pipe.

[0020] The buoyancy adjustment device may further include a pontoon as a floating structure, the pontoon consisting of first and second pontoons formed respectively at both ends thereof, a GPS installed in the pontoon and configured to
20 communicate with a satellite and locate the release/distribution discharge pipe, a control unit installed in the pontoon and configured to instruct a winch to wind coils around the first and second pontoons by locating the release/distribution discharge pipe in
25 response to a signal transmitted from the GPS and to

control movement of the pontoon in a direction of a new location coordinate value of the GPS, and a measuring instrument configured to monitor a thickness of a spread layer of the soil on the reclamation site and generate echo sounding data.

[0021] The hopper barge may have a loading chamber configured to move to one side according to the exhaustion of the soil by the vacuum suction of the centrifugal pump as the suction unit, an excavator having a boom whose end is coupled with the centrifugal pump may be mounted on the auxiliary barge and only operate the boom without moving so as to form the water-adding hole using the centrifugal pump, and the centrifugal pump may be operated only in a radius region of operation of the boom, and continuously exhaust the soil, loaded in the loading chamber, by vacuum-sucking the soil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a block flowchart conceptually illustrating a method of pumping and discharging soil for reclamation according to the present disclosure.

[0023] FIG. 2 is a conceptual view illustrating an exemplary situation where soil is spread on a submarine reclamation site using an apparatus for pumping and discharging soil for reclamation according to the present disclosure.

[0024] FIG. 3 is a conceptual top view illustrating an exemplary handling vessel, consisting of a hopper barge and an auxiliary barge, in the apparatus for pumping and discharging soil for reclamation according to the present disclosure.

[0025] FIG. 4 is a conceptual side view illustrating an exemplary adjustment device mounted on the auxiliary barge of FIG. 3.

[0026] FIG. 5 is a conceptual view illustrating a detailed configuration of the exemplary suction unit of FIG. 4.

[0027] FIG. 6 is a conceptual view illustrating a detailed configuration of the exemplary release unit of FIG. 2.

[0028] FIG. 7 is a conceptual top view illustrating another exemplary handling vessel, consisting of a hopper barge and an auxiliary barge, in the apparatus for pumping and discharging soil for reclamation according to the present disclosure, and illustrates that a loading chamber of the hopper barge moves according to the local exhaustion of the soil loaded in the loading chamber.

[0029] FIG. 8 is a side view taken along cut line A of FIG. 7.

[0030] FIG. 9 is a side view taken along cut line B of FIG. 7.

[0031] FIG. 10 is a conceptual top view illustrating an exemplary state in which soil is supplied from

replenishment vessels when the soil loaded on the hopper barge is exhausted in the apparatus for pumping and discharging soil for reclamation according to the present disclosure.

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DETAILED DESCRIPTION

[0032] The present disclosure should be interpreted as a way to encompass the range of rights as well as technical spirit thereof through various modified embodiments. The
10 embodiments set forth herein are only provided so that the disclosure will be thorough and complete and will fully convey the scope of the disclosure to those skilled in the art. The present disclosure is defined only by the scope of the appended claims.

15 [0033] Moreover, the accompanying drawings of the present disclosure aim to facilitate understanding of the disclosure and the technical spirit of the present disclosure should not be construed as limited to the accompanying drawings.

20 [0034] Hereinafter, a method and apparatus for pumping and discharging soil for reclamation according to the present disclosure will be described in more detail with reference to the accompanying drawings.

[0035] The present disclosure is technically characterized
25 in that, in order to supply and spread soil for reclamation

to a specific reclaimable marine zone from a certain country's harbor such as a narrow harbor in Hong Kong, the soil is vacuum-sucked from a nearby shore or a coastal area and immediately and continuously released to the remote
5 marine zone of, e.g., approximately 800 to 1,200 m therefrom, through a release hose extending to the marine zone, without vessels running close to the marine zone, so that the soil is spread on a submarine reclamation site in the marine zone.

10 **[0036]** The method of pumping and discharging soil for reclamation according to the present disclosure may include an anchoring step S10, a water-adding step S20, a pumping step S30, a spreading step S40, and a replenishing step S50 as illustrated in FIG. 1.

15 **[0037]** Anchoring Step S10

[0038] The anchoring step S10 is a process in which after a handling vessel 100 is anchored on a specific nearby shore or coastal area where it facilitates to be loaded with soil, the soil is loaded on a constituent hopper barge 110 of the
20 handling vessel 100.

[0039] Of course, in an auxiliary barge 120 located on one side of the hopper barge 110, an adjustment device 121 may fixedly mounted while a suction/release device 200 may be installed to suck and release soil to a submarine
25 reclamation site in a specific reclaimable marine zone.

[0040] Water-Adding Step S20

[0041] The water-adding step S20 is a process of creating a water-adding environment in one local portion of the soil loaded on the hopper barge 110 and forming a local water-adding hole WH by dispensing water to one local portion of the soil.

[0042] In this case, for the mixing ratio of water and soil required in the local water-adding hole WH of the soil, 50 m³ to 90 m³ of water and 10 m³ to 50 m³ of soil may be preferably mixed with each other. The above soil may be specified only as soil in the process which will be described later, and the type of the soil used herein need not be particularly limited. The soil may be interpreted as a generic term for earth, silt, sand, and other types of soil.

[0043] Therefore, it should be understood that the soil used in the exemplary description of the process which will be described later may include, for example, all of earth, silt, sand, and other types of soil.

[0044] Accordingly, the required range of the mixing ratio of water and soil is limited in order to improve a suction force of a suction unit 210 under vacuum pressure, wherein the suction unit 210 is a component of the suction/release device 200 to be described later. The suction unit 210 may be preferably a centrifugal pump having a flat suction head

217.

[0045] If less than 50 m³ of the water is used, the soil content of the mixture is relatively high, whereas the water content of the mixture is relatively low, which may act as a factor that decreases a degree of vacuum to reduce the suction force of the suction unit 210 in a vacuum condition. On the other hand, if more than 90 m³ of the water is used, the soil content of the mixture is relatively low, whereas the water content of the mixture is relatively high, which may increase the suction force of the suction unit 210 in a vacuum pressure condition but may reduce the suction amount of soil. This may in turn act as a factor that delays the unloading of soil due to a reduction in the release amount of soil to be spread on the corresponding submarine reclamation site.

[0046] Of course, the local water-adding hole (WH) of the soil may be formed by the water sprayed from a water supply pipe 216 and the water jetted from a jet injection nozzle 218, wherein the water supply pipe 216 and the jet injection nozzle 218 are installed around the suction unit 210 of the suction/release device 200. The number of water supply pipes or jet injection nozzles may be increased or decreased depending on the design environment.

[0047] In particular, the water sprayed from the water supply pipe 216 also functions to pulverize masses of soil,

attached to a wall of a loading chamber 110a of the hopper barge 110, by injection pressure so that the pulverized masses of soil are concentrated on the lower center of the loading chamber 110a and guided to the inlet of the centrifugal pump.

[0048] In this case, the above water may be composed of water sprayed from the water supply pipe 216 and water jetted from the jet injection nozzle 218, the flow rate of the sprayed water and the flow rate of the jetted water may be controlled individually using a valve device, and the water may be sprayed at various angles of spray by varying the angle of the water supply pipe 216. The water supply pipe 216 and the jet injection nozzle 218 may be installed around the suction unit 210 such that the number of water supply pipes and jet injection nozzles is increased or decreased depending on the design environment to implement various water spray angles.

[0049] Although not illustrated in the drawings, a video camera lens may be further installed in the vicinity of the water supply pipe 216 and the jet injection nozzle 218 to monitor the shape of the inclined wall of the soil in real time for efficient formation of the water-adding hole WH with the spraying and jetting of water. The information of the image captured by the video camera lens may be analyzed through an image detection unit provided in the control

room of the adjustment device 121 and be used to determine an amount of injection of air pressure into an air line based on the values of gradient information of various inclined walls (e.g., a first inclined wall, a second
5 inclined wall, a third inclined wall, and the like) of the local portions of the soil. In addition, water may be sprayed while the inclination of the water supply pipe 216 changes in real time depending on the degree of expansion of the tube in response to the amount of injection of air
10 pressure. Thus, the water-adding hole WH can be forcibly formed rapidly and efficiently.

[0050] In this case, a floating amount of soil mixed with water may be measured and checked, for example, by a turbidity measuring instrument (not illustrated). When the
15 floating amount of soil coincides with an arbitrary value of floating amount at which the centrifugal pump as the suction unit 210 may reach a maximum degree of suction, the centrifugal pump as the suction unit 210 may start to operate for suction.

20 **[0051]** In particular, the turbidity measuring instrument may be, for example, preferably a turbidity meter, more preferably a photoconductive turbidity meter.

[0052] Pumping Step S30

[0053] The pumping step S30 is a process in which, when the
25 local water-adding hole WH of the soil is formed, the

mixing ratio of water and soil is determined, and the value of floating amount of soil in the water is satisfied in the above processes, the centrifugal pump as the suction unit 210 of the suction/release device 200 operates to suck and
5 pump a mixture (water + soil).

[0054] That is, the centrifugal pump is fixedly coupled to the adjustment device 121 fixedly mounted on the auxiliary barge 120 and operates to suck the mixture (water + soil) from the water-adding hole WH formed at the local point of
10 the soil loaded in the loading chamber 110a of the hopper barge 110.

[0055] In particular, the centrifugal pump may continuously suck the mixture (water + soil) without stopping of suction due to the exhaustion of soil at its local point. This
15 continuous suction may also be performed while the loading chamber 110a of the hopper barge 110 moves in one direction or while the auxiliary barge 120 moves, for example, from stem to stern of the hopper barge 110.

[0056] That is, the centrifugal pump as the suction unit 210
20 may continuously suck the mixture (water + soil) while the hopper barge 110 moves in one direction so that the soil is continuously exhausted according to the movement of the loading chamber 110a or while, when the hopper barge 110 does not move, the auxiliary barge 120 moves in one
25 direction in the same way that the loading chamber 110a

moves.

[0057] Of course, the auxiliary barge 120 may move while checking the degree that some at the local point of the soil loaded in the loading chamber 110a of the hopper barge 110 is exhausted, and the degree of exhaustion of soil may be checked based on the signal detected by the sensor installed on the partition wall of the loading chamber 110a.

[0058] Spreading Step S40

[0059] The spreading step S40 is a process in which the mixture (water + soil) sucked by the centrifugal pump of the suction unit 210 is released through a release hose 220 and a release unit 230 of the suction/release device 200 and spread and deposited on the sea-floor of the submarine reclamation site.

[0060] In this case, the mixture (water + soil) is conveyed through the release hose 220 extending from the handling vessel 100, anchored on the shore or coastal area whose depth may be secured for the handling vessel 100 or a soil carrier, to a remote reclaimable marine zone, and evenly distributed and released from a plurality of outlets 231a formed at a release/distribution discharge pipe 231 as the release unit 230 connected to the end of the release hose 220. Thus, the mixture may be uniformly spread on the reclamation site.

[0061] That is, the soil in the mixture may be evenly spread

on the reclamation site through the outlets 231a formed at the release/distribution discharge pipe 231. This uniform spreading on the reclamation site is available since the soil contained in the mixture is evenly distributed and released from the outlets 231a.

[0062] Of course, the soil may be generally spread through a single outlet, as well as may be uniformly spread through the outlets 231a formed at the release/distribution discharge pipe 231, according to the purpose of reclamation.

That is, the soil contained in the mixture, which is released from the single outlet, is generally, namely, non-uniformly spread on the reclamation site. Besides, the soil may also be spread in an irregular form.

[0063] As described above, the soil may be continuously spread on the reclamation site because the soil is able to be continuously and rapidly supplied from the handling vessel 100 anchored at a position remote from the sea where the reclamation site is located, namely, on a specific shore or coastal area where it facilitates to be loaded.

[0064] In particular, since the mixture (water + soil) is compressed inside the release hose 220, a density meter may be installed at a certain point of the length of the release hose 220 so as to monitor, in real time, whether the mixture (water + soil) is conveyed in an amount corresponding to a threshold. The density meter measures,

at a specific point of the release hose 220, a density of soil contained in water in the conveyed mixture, and the measured density of soil may be utilized as a reference density value to calculate an average value of the amount
5 of soil conveyed in the entire section of the release hose 220.

[0065] Replenishing Step S50

[0066] The replenishment step S50 is a process of replenishing the loading chamber 110a with soil according
10 to the degree of exhaustion of the soil loaded in the loading chamber 110a of the hopper barge 110 of the handling vessel 100 anchored on a specific shore or coastal area.

[0067] When the soil in the loading chamber 110a of the
15 hopper barge 110 is sucked and exhausted by the suction unit 210 of the suction/release device 200, it is necessary to supply new soil to the loading chamber 110a as much as the exhausted amount of soil. To this end, replenishment vessels 300 loaded with soil always wait in the surrounding
20 sea of the hopper barge 110, and then, when the soil in the loading chamber 110a is exhausted, the replenishment vessels 300 may come alongside the hopper barge 110 to replenish the loading chamber 110a with new soil through conveyer belts 310 as much as the exhausted amount of soil,
25 as illustrated in FIG. 10.

[0068] Meanwhile, the apparatus for pumping and discharging soil for reclamation according to the present disclosure does not need to operate the handling vessel 100 to a reclaimable marine point where a specific submarine
5 reclamation site is located. As illustrated in FIG. 2, the apparatus for pumping and discharging soil for reclamation according to the present disclosure is an apparatus capable of vacuum-sucking soil loaded on a handling vessel 100, which is anchored in the vicinity of a specific shore where
10 it facilitates to be loaded with soil, of conveying the sucked soil through a release hose 220 of a suction/release device 200 extending to the reclamation site, and of releasing the conveyed soil from a release unit 230 connected to the end of the release hose 220, so that the
15 soil is spread on the reclamation site.

[0069] That is, the apparatus for pumping and discharging soil for reclamation according to the present disclosure is a reclaimable system capable of rapidly and continuously spreading the dry or semi-dry soil, loaded on the handling
20 vessel 100, on the reclamation site in a one-step (suction + conveyance) manner.

[0070] The handling vessel 100 may be, for example, a single construction vessel consisting of a hopper barge 110 loaded with soil and an auxiliary barge 120 located on one side of
25 the hopper barge 110, as illustrated in FIGS. 3 and 4. Of

course, the soil loaded on the hopper barge 110 may be preferably dry or semi-dry soil, but the present disclosure is not limited thereto.

[0071] The hopper barge 110 may have a loading chamber 110a loaded with soil, and the auxiliary barge 120 may be equipped with an adjustment device 121. The adjustment device 121 may be coupled to a suction unit 210 which is a component of the suction/release device 200.

[0072] The suction unit 210 may continuously suck and exhaust, in place, the soil loaded in the loading chamber 110a, for example, according to the movement of the hopper barge 110. A description thereof will be given with reference to FIGS. 7 to 9.

[0073] In particular, the masses of soil, attached to the loading chamber 110a moved along with the movement of the hopper barge 110, may be pulverized into individual particles in the process in which the suction unit 210 sucks soil. Alternatively, the masses of soil attached to the partition wall of the loading chamber 110a may be pulverized and dropped even by vibration transmitted through the operation of a plurality of vibration motors VM installed on the back surface of the loading chamber 110a.

[0074] The adjustment device 121 may be preferably, for example, an excavator for precise and rapid manipulation of the suction unit 210. The suction unit 210 may be

preferably, for example, a centrifugal pump consisting of a water supply pipe 216, a jet injection nozzle 218, and a flat suction head 217, which may perform both a water-adding operation to forcibly create a water-adding hole WH environment for a local portion of the soil loaded in the loading chamber 110a and an operation to vacuum-suck a mixture of water and soil from a water-adding hole WH.

[0075] As illustrated in FIG. 4, the exemplary centrifugal pump as the suction unit 210 may be fixedly coupled to an end of a boom 121a of the exemplary excavator as the adjustment device 121. The boom 121a of the excavator may be configured to traverse from the auxiliary barge 120 to the loading chamber 110a of the hopper barge 110. The centrifugal pump coupled to the end of the boom 121a may form, by the forcible water-adding operation, the water-adding hole WH for the dry soil present at the local portion of the loading chamber 110a based on the precise actuation of the boom 121a.

[0076] The centrifugal pump may be driven by electric power supplied from a power supply 122 provided on the auxiliary barge 120, and a water supply pump 123 provided near the power supply may also be supplied with electric power from the power supply 122 to pump the water (sea water) required for water-adding.

[0077] As illustrated in FIG. 5, the centrifugal pump, for

example, unlike an existing centrifugal pump, may include a shaft 213 installed at the center of the cylindrical housing thereof, a motor 211 configured to provide a rotational force of the shaft, an impeller 212 coupled to one section of the shaft to generate a suction force while rotating together with the shaft, an inlet 214 coupled to one section of the shaft 213 at the lower end of the impeller to suck a mixture (water + soil) contained in the water-adding hole WH in a vacuum environment while rotating together with the shaft, a jet injection nozzle 218 formed on one outer side of the housing to jet and release the water pumped by the water supply pump 123 for water-adding, a discharge/connection pipe 215 configured to supply the mixture (water + soil), sucked from the inlet, to the release hose 220 extending to the reclamation site, and a suction head 217 formed on the bottom of the housing and having a flat bottom structure for enhancing the vacuum suction of the mixture (water + soil).

[0078] Of course, for water-adding, the water supply pump 123 may supply a local portion of the dry soil with water for water-adding together with the water sprayed from the water supply pipe 216. The number of water supply pipes and jet injection nozzles may be increased or decreased in order to perform the water-adding and form the water-adding hole WH with effectiveness. Some of the water in the water

supply pipe 216 makes it possible to expect effects of dropping the soil, attached to the partition wall of the loading chamber 110a, with the pressure of sprayed water, of pulverizing a mass of soil into individual particles, and of forcibly forming the water-adding hole WH. The rest of the water in the water supply pipe 216 makes it possible to expect a water-adding effect of replenishing water in the water-adding hole WH.

[0079] Moreover, the angle of spray of the water supply pipe 216 may be set differently to rapidly pulverize the mass of soil and form the water-adding hole WH, which enables the mixture, namely, the water and the soil to be uniformly mixed in the water-adding hole WH.

[0080] In particular, the amount of water added and sprayed to the water-adding hole WH may be controlled by a control unit (not illustrated) in a such a way to detect a level of water by a water-level sensor (not illustrated) installed on the partition wall of the loading chamber 110a. Of course, the control unit (not illustrated) may be provided at one portion of the hopper barge 110, independently of a control unit 242 which will be described later.

[0081] The centrifugal pump may be preferably, for example, a DOP centrifugal pump which is a type of high-performance hydraulic centrifugal pump manufactured in the Netherlands.

[0082] The centrifugal pump may locally exhaust soil by

spraying water from one side to the other side of the dry soil loaded in the loading chamber 110a according to the operation of the boom 121a of the excavator to forcibly form the water-adding hole WH and create the water-adding condition in a portion of the dry soil and by effectively vacuum-sucking the mixture of water and soil mixed uniformly in the water-adding hole WH.

[0083] Of course, since the centrifugal pump further includes the flat and wide suction head 217 which allows adsorption to be easily performed on the bottom of the water-adding hole WH for vacuum suction of the mixture (water + soil), a large suction area for the mixture may be secured. Thus, the vacuum suction of the mixture (water + soil) can be improved, the mixing ratio of water and soil in the mixture can be within the range described in above the method of pumping and discharging soil for reclamation, and the range of the mixing ratio of water and soil can also contribute to the improvement in vacuum suction of the centrifugal pump.

[0084] The centrifugal pump may be, for example, a hydraulic centrifugal pump, and, as illustrated in FIG. 5, may include an oil line (OIL LINE in FIG. 5) through which a hydraulic pressure is injectable, and an air relief ball valve as an air discharge device formed at one portion of the housing to discharge bubbles, which may be generated by

air during the vacuum suction of the mixture, to the outside. In FIG. 5, it can be noted that the air relief ball valve is indicated as AIR RELIEF V/V. Accordingly, as the bubbles are discharged to the outside while the ball of the air relief ball valve is lifted, the air is discharged to the outside.

[0085] As described above, the centrifugal pump is coupled to the tip of the boom 121a precisely and rapidly operated, to rapidly form the water-adding hole WH in a local portion of the dry soil and vacuum-suck the mixture from the water-adding hole, which may continuously and rapidly exhaust and spread the loaded soil. Ultimately, these continuous exhaustion and spreading make it possible to expect effects of reducing the construction period and thus the cost of construction.

[0086] The sucked mixture may be transported through the release hose 220 to the deep-sea reclamation site remote from the handling vessel 100, and be spread on the reclamation site from the release unit 230 connected to the end of the release hose 220 for reclamation.

[0087] The release unit 230 may include a release/distribution discharge pipe 231 having a plurality of outlets 231a configured to distribute and release the mixture as illustrated in FIG. 6. A buoyancy adjustment device 240 may be further installed and connected to a

section of the release hose 220 at a position spaced apart from the release/distribution discharge pipe 231 by a predetermined interval.

5 **[0088]** The buoyancy adjustment device 240 may provide constant buoyancy to the release hose 220, and be utilized to move to a specific coordinate point, obtained through communication with a GPS, by unwinding or winding a coil S formed in the buoyancy adjustment device 240.

10 **[0089]** The buoyancy adjustment device 240 is required to easily induce the operation in which the soil is efficiently spread on the reclamation site when the mixture is discharged from the release/distribution discharge pipe 231.

15 **[0090]** In other words, if the buoyancy adjustment device 240 is not provided, it is difficult to handle the release/distribution discharge pipe 231 due to its heavy weight, even though the release/distribution discharge pipe 231 is connected to the end of the release hose 220. That is, the provision of the buoyancy adjusting device 240
20 allows the release/distribution discharge pipe 231 to be easily handled while the mixture is easily released and spread. Therefore, the buoyancy adjustment device 240 is necessary for easy handling of the release/distribution discharge pipe 231.

25 **[0091]** The buoyancy adjustment device 240 may include a

pontoon 241 as a floating structure, the pontoon 241 consisting of a first pontoon 241a and a second pontoon 241b formed at both ends thereof, a control unit 242 provided between the first and second pontoons 241a and 241b, a generator 243 provided adjacent to the control unit, and a coil S wound around each of the first and second pontoons 241a and 241b.

[0092] The control unit 242 may instruct a winch W to wind the coil S in response to the signal transmitted from a GPS and an infrared camera installed in the pontoon 241. That is, the control unit 242 may read the image data of the infrared camera, which monitors the thickness layer of the soil, spread on the reclamation site, in the process of releasing the mixture from the outlets 231a of the release/distribution discharge pipe 231 connected to the end of the release hose 220, and may transmit a signal for instructing the winch W to wind or unwind the coil S in response to the signal transmitted from the GPS based on the read data.

[0093] When the spreading on the specific reclamation site is completed, the GPS transmits another location coordinate value and the control unit 242 transmits to the winch W a signal necessary for winding or unwinding the coil S based on the transmitted location coordinate value. The winch W winds or unwinds the coil S based on the signal transmitted

from the control unit 242, thereby enabling the movement direction of the pontoon 241 of the buoyancy adjustment device 240 to be determined.

5 [0094] Accordingly, as the pontoon 241 may move in a direction of another location coordinate value transmitted from the GPS, the soil in the mixture released from the release/distribution discharge pipe 231 may be spread on another reclamation site for reclamation.

10 [0095] Of course, as illustrated in FIG. 6, the pontoon 241 may be fixedly connected through an A-frame F to an adjacent hose of the release/distribution discharge pipe 231 of the release unit 230 connected to the end of the release hose 220, namely, a flexible hose. Alternatively, in some cases, the pontoon 241 may also be movably
15 connected to the release hose 220.

[0096] When the soil is spread on the reclamation site to form a required thickness layer in the process of releasing the mixture from the outlets 231a of the release/distribution discharge pipe 231 connected to the
20 end of the release hose 220, the control unit 242 may determine that the control unit 242 is positioned in which section of the release hose 220 through the signal received from the GPS by receiving the image data captured by the infrared camera that monitors the thickness layer.
25 Accordingly, the control unit 242 may instruct the winch W

to wind or unwind the coil S in order to properly adjust the buoyancy of the release/distribution discharge pipe 231. Thus, the pontoon 241 may move to the location coordinate value provided from the GPS while the coil S is wound or
5 unwound, so that the soil may be automatically spread on another reclamation site.

[0097] As described above, when the release/distribution discharge pipe 231 is easily handled, the soil may be rapidly and easily spread from the outlets 231a of the
10 release/distribution discharge pipe 231. Therefore, it is possible to conveniently spread the soil for reclamation.

[0098] As described above, the apparatus for pumping and discharging soil for reclamation according to the present disclosure is an apparatus capable of continuously and
15 rapidly spreading the dry soil, loaded on the hopper barge, on the remote submarine reclamation site in the one-step (suction + conveyance) manner. The apparatus for pumping and discharging soil for reclamation may perform reclamation over a target discharge distance of, for
20 example, 800 m to 1,200 m, but the present disclosure is not limited thereto.

[0099] Furthermore, the apparatus of the present disclosure can add the water, for example, at a rate of 1,200 m³/hr or more by the water supply pipe and the jet injection nozzle,
25 can release soil, for example, at a rate of 200 m³/hr or

more by the centrifugal pump, and can implement the local water-adding and the pumping of the mixture using the centrifugal pump in the hopper barge.

[00100] The apparatus is expected to process, for example, a
5 deposit amount of soil per day (for example, 10 hours working basis) of approximately 2,000 m³ or more, and can minimize the movement of the hopper barge within the reclamation site, thereby improving work safety due to vessel collision. In addition, unlike the discontinuous
10 discharge of soil in the conventional soil-loaded ship, the apparatus of the present disclosure can continuously discharge and spread the soil. Therefore, it is possible to expect a significant reduction in construction period and a significant reduction in cost by improving the
15 duration of discharge process.

[00101] As apparent from the above description, according to the present disclosure, the soil loaded on the handling vessel anchored at the specific point of the shore where it facilitates to be loaded with soil is vacuum-sucked and
20 conveyed through the release hose extending to the reclaimable marine point remote from the shore so that the soil is directly spread on the reclamation site. Thus, it is possible to spread the soil on the reclamation site in the one-step manner for reclamation, without operating
25 soil-loaded ships to the marine point where the reclamation

site is located. Therefore, it is possible to perform the reclamation even in shallow sea conditions, to continuously perform the reclamation regardless of changes in water depth, and to significantly reduce the construction period
5 for reclamation and thus the cost of construction.

[00102] In addition, according to the present disclosure, since there is no need to operate soil-loaded ships to the marine point where the reclamation site is located for reclamation, it is possible to fundamentally prevent
10 contact or collision accidents due to interference with other ships running within the reclamation zone. Therefore, it is possible to perform reclamation while ensuring safety.

[00103] Furthermore, according to the present disclosure, the soil is vacuum-sucked directly from the anchored handling
15 vessel loaded with soil and is spread on the remote reclamation site for reclamation. Therefore, as the reclamation is performed in the one-step manner, it is possible to easily and conveniently perform the operation of the reclamation.

20 **[00104]** While various embodiments have been described above, it will be understood to those skilled in the art that the embodiments described are by way of example only. Accordingly, the disclosure described herein should not be limited based on the described embodiments.

WHAT IS CLAIMED IS:

1. A method of pumping and discharging soil for reclamation, in which dry or semi-dry soil is vacuum-sucked
5 in a mixture form from a water-adding hole, forcibly formed in a handling vessel anchored at a certain shore or coastal point where it facilitates to be loaded with soil, and is conveyed in a one-step manner through a release hose extending to a specific reclaimable marine point remote
10 from the handling vessel, so that the soil is continuously spread on a reclamation site for reclamation.

2. The method according to claim 1, wherein a suction/release device is further used, which consists of a
15 suction unit configured to forcibly vacuum-suck the mixture and a release unit configured to continuously spread the sucked mixture.

3. The method according to claim 2, comprising:
20 anchoring the single handling vessel, consisting of a hopper barge and an auxiliary barge, at the specific shore or coastal point where it facilitates to be loaded with soil, and coupling the suction unit, configured to vacuum-suck the soil, to a tip of an adjustment device mounted on

the auxiliary barge;

forcibly jetting, by the suction unit, water onto a local portion of the soil loaded on the hopper barge from one side to the other side of the soil to form the water-
5 adding hole and simultaneously perform a water-adding process;

vacuum-sucking, by the suction unit, the mixture of water and soil from the water-adding hole formed in the local portion of the soil to gradually exhaust the soil
10 loaded on the hopper barge;

conveying the sucked mixture through the release hose extending to the reclaimable marine point remote from the handling vessel to release the mixture through the release unit connected to the end of the release hose, so that the
15 soil is spread on the reclamation site; and

when the soil loaded on the hopper barge is sucked and exhausted by the suction unit, replenishing soil as much as the exhausted amount of soil in the hopper barge, the replenished soil being supplied through a conveyer belt
20 from soil-loaded replenishment vessels always waiting in the vicinity of the hopper barge after the replenishment vessels come alongside the hopper barge.

4. The method according to claim 3, wherein the

mixture is made by mixing 50 m³ to 90 m³ of water with 10 m³ to 50 m³ of soil.

5. An apparatus for pumping and discharging soil
5 for reclamation, in which a water-adding hole configured to
change dry or semi-dry soil into a mixture is forcibly
formed in a handling vessel anchored at a certain shore or
coastal point where it facilitates to be loaded with soil
and is remote from a specific reclaimable marine point, so
10 that the mixture is vacuum-sucked from the water-adding
hole by a suction unit to be conveyed in a one-step manner
through a release hose extending to the marine point from
the handling vessel, and is continuously spread on a
reclamation site from a release unit connected to the end
15 of the release hose for reclamation.

6. The apparatus according to claim 5, comprising:
the handling vessel consisting of a hopper barge and
an auxiliary barge, the hopper barge being loaded with soil
20 and anchored at the certain shore or coastal point where it
facilitates to be loaded with soil and is remote from the
marine point, the auxiliary barge being equipped with an
adjustment device coupled with the suction unit disposed on
one side of the hopper barge to vacuum-suck and exhaust the

soil loaded on the hopper barge from one side to the other side of the soil; and

a suction/release device comprising the suction unit and the release unit, the suction unit being coupled to a tip of the adjustment device to forcibly form the water-adding hole in a local portion of the soil loaded on the hopper barge while performing water-adding and to vacuum-suck the mixture of water and soil from the water-adding hole using a centrifugal pump, the release unit being connected to the end of the release hose to release the mixture so that the soil is continuously spread on the reclamation site.

7. The apparatus according to claim 6, wherein:

the suction unit is the cylindrical centrifugal pump that has a suction head coupled to a lower end of a cylindrical housing thereof to vacuum-suck the mixture from the water-adding hole, the suction head having a flat and wide bottom to allow a vacuum suction area to be easily secured;

the centrifugal pump is directly coupled to the adjustment device to exhaust the soil while precisely moving;

the adjustment device is an excavator and the

centrifugal pump is directly coupled to an end of a boom of the excavator;

the suction unit is the centrifugal pump further comprising:

5 a water supply pipe formed on one outer side of the cylindrical housing of the centrifugal pump to supply water;

a jet injection nozzle formed on one inner side of the cylindrical housing of the centrifugal pump to jet water;

10 a valve device configured to selectively use the water supply pipe and the jet injection nozzle;

a discharge/connection pipe formed on another outer side of the cylindrical housing of the centrifugal pump to supply the sucked mixture to the release hose; and

15 an air relief ball valve formed on a still another outer side of the cylindrical housing of the centrifugal pump to discharge bubbles, caused by generation of air during the suction of the mixture, to the outside; and

the mixture is made by mixing 50 m³ to 90 m³ of water
20 with 10 m³ to 50 m³ of soil.

8. The apparatus according to claim 6, wherein the release unit comprises:

a release/distribution discharge pipe connected to the

end of the release hose and having a plurality of outlets spaced at regular intervals, to distribute and release the mixture sucked from the suction unit so that the mixture is spread on the reclamation site, in which case the soil is
5 evenly distributed and released through the plurality of outlets and is uniformly spread on the reclamation site; or

a release/distribution discharge pipe having a single outlet, in which case the soil is released through the single outlet and is generally spread, namely, non-
10 uniformly spread on the reclamation site.

9. The apparatus according to claim 8, further comprising a buoyancy adjustment device movably connected to the adjacent release hose of the release/distribution
15 discharge pipe to easily handle the release/distribution discharge pipe while the mixture is spread on the reclamation site, the buoyancy adjustment device being configured to properly adjust a buoyancy of the release/distribution discharge pipe.

20

10. The apparatus according to claim 9, wherein the buoyancy adjustment device further comprises:

a pontoon as a floating structure, the pontoon consisting of first and second pontoons formed respectively

at both ends thereof;

a GPS installed in the pontoon and configured to communicate with a satellite and locate the release/distribution discharge pipe;

5 a control unit installed in the pontoon and configured to instruct a winch to wind coils around the first and second pontoons by locating the release/distribution discharge pipe in response to a signal transmitted from the GPS and to control movement of the pontoon in a direction
10 of a new location coordinate value of the GPS; and

an infrared camera configured to monitor a thickness of a spread layer of the soil on the reclamation site and generate image data.

15 11. The apparatus according to claim 6, wherein the hopper barge has a loading chamber configured to move to one side according to the exhaustion of the soil by the vacuum suction of the centrifugal pump as the suction unit, an excavator having a boom whose end is coupled with the
20 centrifugal pump is mounted on the auxiliary barge and only operates the boom without moving so as to form the water-adding hole using the centrifugal pump, and the centrifugal pump is operated only in a radius region of operation of the boom, and continuously exhausts the soil, loaded in the

loading chamber, by vacuum-sucking the soil.