

Method for delivering large quantities of under water soil to a reclamation area

The invention relates to a method for delivering large quantities of under water soil from borrow areas to a reclamation and/or disposal site. The invention in particular relates to a method for
5 delivering large quantities of under water sand from borrow areas to a reclamation and/or disposal site. The invention also relates to a method for mining large quantities of ore by delivering ore containing sand from borrow areas to a reclamation and/or disposal site.

In many areas of the world, buildable land is scarce. This is for instance the case in and around
10 Singapore, which, fortunately, is surrounded by an immense mass of sea. In such areas, land is frequently reclaimed from the sea by supplying parts of the sea to be build with soil. This usually requires the deposit of large volumes of soil, thus requiring the searching for and the locating of large soil deposits. Typically, a sufficient deposit of soil is found in the gulfs, bays, channels and oceans around the reclamation site. This soil is then dredged in a conventional
15 manner. With the conventional manner of dredging it is required to locate large soil or sand deposits (borrow areas) in the vicinity of the reclamation site. It is becoming increasingly difficult to locate sufficient sand deposits for conventional dredging methods and systems. Additionally, these borrow areas are being located farther from shore than in the past, increasing the expense of the operation.

20 Conventional dredging of under water soil bottoms is usually carried out by suction dredging. In suction dredging operations, a typical system consists of a dredging barge floating upon the water surface and the inlet of a pump suction system positioned below the barge permitting the pumping, and removal, of a slurry formed by the bottom soil materials and water. The loosened
25 soil material slurry is typically pumped through a conduit to a storage area of the barge. As the soil is dredged it is often necessary to transport the soil via a pipeline several kilometers to a site. The remote borrow sites commonly require several vessels for operation, expensive booster pumps to transport the dredged material to a site, and additional vessels carrying pipe for forming a conduit from the remote site to a deposit site. The equipment and logistics of these
30 operations undesirably limit the process to being utilized only when absolutely necessary.

Prior art methods deliver soil to the land reclamation site by transporting soil over land and dumping it into the sea. Another known method involves dredging under water soil in the vicinity of the reclamation site and delivering it to the reclamation site with the aid of the
35 dredging barge.

Although the known methods have proven to be reliable and quite adapted to deliver soil in the majority of land reclamation projects, they may be improved further, in particular when the quantities of soil required are large.

- 5 The aim of the present invention is to provide an improved method for delivering quantities of under water soil from borrow areas to a reclamation site, and in particular large quantities.

The invention thereto provides methods for delivering large quantities of under water soil from long-distance borrow areas to a reclamation site, comprising the steps of mooring at least one
10 seagoing transport vessel in the vicinity of the at least one borrow area with a size considerably larger than the size of a dredging vessel and adapted to receive a large quantity of soil, providing at least one dredging vessel that dredges soil at the at least one borrow area and transports it to the transport vessel, loading the soil into the transport vessel, transporting the soil to the long-distance reclamation site with the aid of the transport vessel, mooring the
15 transport vessel in the reclamation site, and unloading the soil from the transport vessel to the reclamation site. The method according to the invention allows to deliver large quantities of soil to the land reclamation areas at considerable lower cost than known hitherto. With large quantities in the context of the present invention are meant quantities of soil in excess of 10 million m³ per year (10⁷ m³), more preferably in excess of 15 million m³ per year, even more
20 preferably in excess of 20 million m³ per year, and most preferably in excess of 25 million m³ per year. These quantities are unprecedented in the art. These quantities refer to soil and to soil slurry's (a mixture of soil particles and water).

In the method of the invention, the transport vessel has a size considerably larger than the
25 typical size of a dredging vessel or barge, and is adapted to receive a large quantity of soil. Preferred sizes of the transport vessel are at least 50000 DWT (DWT means dead weight tons), more preferred at least 100000 DWT, even more preferred at least 150000 DWT, and most preferred at least 200000 DWT or larger. Very suitable transport vessels comprise modified Capesize and Panamax vessels, which are traditionally used to carry cargo from one main port
30 to another. Another method is to use purpose modified VLCC's (very large crude carriers). Such transport vessels are modified to receive a large quantity of soil slurry, which slurry, as can be appreciated, has a high specific weight due to the amount of water in it, and further offers stability problems. The adaptation preferably involves providing the transport vessel with side tanks. Side tanks provide the transport vessel with the necessary buoyancy or floating power.
35 The width of the cavity between the opposing side walls of the side tanks may be as large as the width of the holds, thereby sacrificing storage volume at the expense of buoyancy. Surprisingly

this sacrifice still leads to a cost effective solution for delivering the large quantities of soil mentioned above over large distances.

It is possible to transport the dredged soil with one transport vessel. Usually however, several vessels will sail forming a so called train. With conventional methods where dredging vessels are used only, the transportable amount of dredged soil per year is approximately 4 million m³, or even 3 million m³ only, depending on the distance to be covered. The method according to the invention allows to deliver up to 20 million m³ per year in a preferred embodiment where the soil is transported in a moist state. This embodiment will be described further below.

A further advantage of the method according to the invention is that soil with virtually any required quality may be delivered to the land reclamation site. The known methods depend on the quality of soil present in the vicinity of the land reclamation site or are too expensive. The required soil quality may for instance be expressed in terms of its particle size distribution.

Generally speaking, the finer the soil, the better its quality. Other quality measures, known to the skilled person in the art may be used.

A drawback of the known method is that in order to accommodate the required soil delivering rate, many dredging devices may be required in the vicinity of the land reclamation area, which as a result is crowded with dredging vessels. This requires detailed coordination and logistics. Moreover, the situation at the site may require additional safety measures. The method according to the invention does not have this drawback.

The method according to the invention is particularly suitable for delivering soil to land reclamation sites at a long-distance from the borrow areas. Preferred long distances are above 500 kilometers single sailing distance, more preferably above 1000 kilometers single sailing distance, and most preferably above 1500 kilometers single sailing distance.

In a further aspect of the invention, the method comprises dredging the soil at the at least one borrow area and transporting it to the transport vessel with the aid of a fitting to the purpose dredging device. Preferred dredging devices include a cutter section dredger and/or a trailing suction hopper dredger.

In a further embodiment of the method according to the invention, the dredged soil, prior to loading it into the transport vessel, is dried to a water content within allowable transportable moisture limits for dry bulk vessels (also referred to as the dry embodiment). Allowable transportable moisture limits comprise water contents of less than 20% of the total weight of the

dredged soil, and more preferably less than 15% of the total weight of the dredged soil. The water contents of the present preferred embodiments of the method according to the invention are preferably effectuated by loading the dredged soil into at least one buffer vessel to effectuate the drying before loading it into the transport vessel.

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In still another aspect of the invention, the method according to the invention comprises unloading the soil from the transport vessel to the reclamation site mechanically, suitably by a crane or by any other means of excavating and elevating soil out of the holds of the transport vessel. This is particularly preferred in the dry embodiment of the method.

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In yet another embodiment of the method according to the invention, the dredging vessel comprises a trailing suction hopper dredger. When using such a trailing suction hopper dredger, the method according to the invention preferably comprises a trailing suction hopper dredger with a loading unit for the dredged soil and an overflow for excess water, and the overflow is provided such that the dredged soil, prior to loading it into the transport vessel, has a water content of larger than 20% of the total weight of the dredged soil, and more preferably of between 20 and 35% of the total weight of the dredged soil. Even more preferred, the dredged soil, prior to loading it into the transport vessel, has a water content of between 25 and 30% of the total weight of the dredged soil (also referred to as the moist embodiment).

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In yet another preferred embodiment of the method according to the invention, unloading the soil from the transport vessel to the reclamation site is carried out hydraulically by a pump, provided with high pressure jets that fluidize the soil in the transport vessel, prior to pumping it away. This is particularly preferred in the moist embodiment of the method.

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The method according to the invention is used advantageously to deliver large quantities of under water soil, and in particular sand, from long-distance borrow areas to a reclamation site. In another preferred embodiment, the method according to the invention is used to dredge and deliver large quantities of under water sand comprising ore.

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The present invention will now be described in more detail with reference to the following figures, without however being limited to this detailed description. In the figures:

Fig. 1 schematically represents a transport vessel, used in a first embodiment of the method according to the invention;

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Fig. 2 represents a schematic view in perspective of an assembly of a transport vessel and a dredging barge, as typically used in the first embodiment of the method of the invention;

Fig. 3 schematically represents a view in perspective of an assembly of a buffer vessel and a transport vessel, as typically used in the first embodiment of the method of the invention;

Fig. 4 schematically represents two transport vessels as used in the first embodiment of the method according to the invention;

5 Fig. 5 represents a schematic front view of an unloading system, used in the first embodiment of the method according to the invention;

Fig. 6 represents a schematic view in perspective of a land reclamation site being provided with soil by the first embodiment of the invented method;

10 Fig. 7 schematically represents a transport vessel, used in a second embodiment of the method according to the invention;

Fig. 8 represents a schematic view in perspective of an assembly of a transport vessel and a dredging barge, as typically used in the second embodiment of the method of the invention;

15 Fig. 9 schematically represents a view in perspective of an assembly of a transport vessel and a dredging barge during loading of the transport vessel, as typically carried out in the second embodiment of the method of the invention;

Fig. 10 schematically represents a transport vessel as used in the second embodiment of the method according to the invention in a loaded state; and finally

Fig. 11 represents a schematic front view of an unloading system, used in the second embodiment of the method according to the invention.

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Referring to figure 1, a transport vessel 1 is shown as used in a first embodiment of the invention. The transport vessel 1 has a size considerably larger than the typical size of a dredging vessel or barge, and is adapted to receive a large quantity of soil into the holds 2, which are shown in their covered state. Preferred sizes of the transport vessel 1 are at least

25 50,000 DWT (DWT means dead weight tons), more preferred at least 100,000 DWT, even more preferred at least 150,000 DWT, and most preferred at least 200,000 DWT or larger. In order to be able to carry large to very large amounts of dredged soil (or dredged slurry), transport vessel 1 is equipped with side tanks and center cargo compartments (not shown). Side tanks are preferred to provide the transport vessel with the necessary buoyancy supporting the stability.

30 Further, the transport vessel 1 is preferably provided with reinforcements to the holds 2, in order to hold the soil slurry, which is generally abrasive and has a large density of the order of around 2 tons/m³. The vessel 1 is further provided with bow coupling, and pipelines on deck to the different holds 2. The holds 2 may further be provided with overflow systems and diffuser pipes.

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Referring to figure 2, the method for delivering large quantities of under water soil from long-distance borrow areas to a land reclamation site comprises the steps of mooring at least one

seagoing transport vessel 1 in the vicinity of a borrow area. In the method according to the invention a dredging vessel 3 (a plurality is also possible) is used to gather underwater soil. In the method of the invention, at least one dredging vessel 3 is provided that dredges soil under water at the borrow area and transports it to the transport vessel 1, preferably through pipe lines 5, and loads the soil into the transport vessel, until the desired filling level is reached. The dredging vessel 3 may be any dredging device, suitable for its purpose. The dredged soil is then transported over large distances to the land reclamation site with the aid of the transport vessel 1.

10 In figures 2 to 7, a first embodiment of the method according to the invention is shown. As shown in figure 2, this embodiment comprises dredging the soil at the borrow area and transporting it to a buffering vessel 4 with the aid of a cutter section dredger 3, known per se. The cutter suction dredger 3 is anchored to the ground and provided with a rotating cutter head, which, in operation, is trailed over the bottom alternately from port side to starboard side so that
15 a more or less circular soil path is worked. The dredged soil is transported to the buffering vessel 4, which in this embodiment is a Capesize bulk carrier of about 250000 DWT, by a pipe line 5, that is preferably floating on the water surface. The buffering vessel 4 serves the purpose of drying the dredged soil to a water content of below about 20% of the total weight of the dredged soil, and more preferably below 15%. Drying is for instance effectuated by storing the
20 soil slurry onto gratings and let the water drain away under the action of gravity or by having the floors of the buffering vessel provided with perforations, adapted to let through water but to retain the soil particles. The buffering vessel may also be provided with reinforcements to the holds, in order to hold the abrasive and quite heavy soil slurry, with bow coupling, and with pipelines on deck to the different holds. The holds may further be provided with overflow
25 systems and diffuser pipes.

As shown in figure 3, the soil 7 that has been dried in buffering vessel 4, is in a next step of the first embodiment transferred from the holds 6 of the buffering vessel 4 to the holds 2 of the transport vessel 1. Transferring the dried soil 7 from buffering vessel 4 to transport vessel 1
30 may be carried out mechanically, by a crane or by any other means of excavating and elevating soil out of holds of a vessel, as is schematically shown by the arrow.

In a further step of the method, the dried soil is then transported in its transportable state (meaning within the indicated water content range) to the long-distance reclamation site with
35 the aid of the transport vessel. Transport is conveniently carried out back and forth, whereby a filled transport vessel 1a is underway to the reclamation site, and an empty transport vessel 1b returns to the borrow area, to collect dredged soil, as is shown schematically in figure 4.

Upon arrival at the land reclamation site or in its vicinity, the transport vessel is moored along a quay or anchored in any other suitable way. Unloading the soil from the transport vessel 1 to the reclamation site can be performed in a number of ways. In the present embodiment of the method, wherein the water content of the dredged slurry is relatively low, unloading the soil from the transport vessel 1 to the reclamation site directly, to land, or to another (smaller) vessel is performed mechanically by a crane, such as crane 8, shown in figure 5. Suitable cranes for such work are 50 tons SWL, high speed, heavy duty grab cranes. The slurry is transferred with crane 6 to a buffering unit, where it is fluidized by injecting water in it. The fluidized slurry is then pumped through pipeline 9, preferably directly to the land reclamation site, as shown in figure 6.

Referring to figure 7, a transport vessel 10 is shown as used in a second embodiment of the invention. The transport vessel 10 again has a size considerably larger than the typical size of a dredging vessel or barge, and is adapted to receive a large quantity of soil into its holds 20, which are shown in their covered state. A suitable vessel 10 is a VLCC (very large crude carrier) of about 350000 DWT. In order to be able to carry large to very large amounts of dredged soil (or dredged slurry), transport vessel 10 is equipped with side tanks and center cargo compartments (not shown), and with reinforcements to the holds 20.

Referring to figure 8, the method for delivering large quantities of under water soil from long-distance borrow areas to a land reclamation site comprises the steps of mooring the transport vessel 10 in the vicinity of a borrow area, and gather underwater soil with a dredging vessel 30 (a plurality is also possible), which in the present embodiment is a trailing suction hopper dredger. The trailing suction hopper dredger 30 dredges soil under water and transports it to the transport vessel 10 through pipe lines 50, as shown in figure 9. In the present embodiment the dredging vessel comprises a loading unit for the dredged soil with an overflow for excess water, and the overflow is provided such that the dredged soil, prior to loading it into the transport vessel 10, has a water content larger than 20% of the total weight of the dredged soil. This makes the dredged soil directly transportable to the holds 20 of transport vessel 10 by pipelines 50.

In a further step of the method, the moist dredged soil is then transported in this transportable state (meaning within the indicated water content range) to the long-distance reclamation site with the aid of the transport vessel 10, as shown in figure 10. Upon arrival at the land reclamation site or in its vicinity, the transport vessel is moored along a quay or anchored in any other suitable way, and unloaded. In the present embodiment, unloading the soil from the

transport vessel 10 to the reclamation site is preferably carried out hydraulically by one or several pumps, as is shown in figure 11. In this embodiment the transport vessel 10 is moored to a trans-shipper 11, pontoon or the like. The trans-shipper 11 is provided with an arm 12 that can reach into the holds 20 of the transport vessel 10. On the arm 12, an hydraulic or electric driven dredge pump 13 is mounted. The pump or pumps are connected to several pipe lines 14 that are positioned with their suction mouths in or in close proximity to the dredged soil present in the holds 20 of transport vessel 10. The arm 12 is preferably provided with a plurality of high pressure jets (not shown), aimed at fluidizing the dredged soil in the vicinity of the suction mouths. Due to the claimed combination of initial water content and fluidization, the dredged soil is readily sucked up by the pipe lines 14 and transported through pipe line 15 to the reclamation site directly, to land, or to another (smaller) vessel for further transport.

In still another preferred embodiment, the method according to the invention is used to dredge and deliver large quantities of under water sand comprising ore. It is well known that large quantities of ore, such as copper, iron, manganese, and others, are present in large sand banks, which have not been mined yet, due to lack of a suitable technology. It has turned out that the method according to the present invention is also particularly suitable for mining such ore containing sand banks.

Claims

1. Method for delivering large quantities of under water soil (7) from long-distance (being above 500 kilometers single sailing distance) borrow areas to a reclamation and/or disposal site, comprising the steps of mooring at least one seagoing transport vessel (1, 10) in the vicinity of the at least one borrow area with a size of at least 50000 DWT (dead weight tons) and considerably larger than the size of a dredging vessel (3, 30), and adapted to receive a large quantity of soil (7),
providing at least one dredging vessel that dredges soil at the at least one borrow area and
transports it to the at least one transport vessel (1, 10), loading the soil into the transport vessel,
transporting the soil in a transportable state to the long-distance reclamation and/or disposal site,
mooring the transport vessel in the site, and unloading the soil from the transport vessel to the site.
2. Method according to claim 1, wherein the dredging vessel (3, 30) comprises a fitting to the purpose dredging device, such as a cutter suction dredger and/or a trailing suction hopper dredger.
3. Method according to claim 1 or 2, wherein the dredged soil (7), prior to loading it into the transport vessel (1, 10), is dried to a water content of less than 15% of the total weight of the dredged soil (7).
4. Method according to claim 3, wherein the dredged soil (7) is loaded into at least one buffering vessel (4) to effectuate the drying before loading it into the transport vessel (1, 10).

5. Method according to claim 3 or 4, wherein unloading the soil from the transport vessel (1, 10) to the reclamation site is carried out mechanically, by a crane (8) or by any other means of excavating and elevating soil out of the holds (2, 20) of the transport vessel (1, 10).
6. Method according to claim 1 or 2 wherein the dredging vessel (3, 30) comprises a loading unit for the dredged soil with an overflow for excess water, and the overflow is provided such that the dredged soil, prior to loading it into the transport vessel (1, 10), has a water content larger than 20% of the total weight of the dredged soil (7).
7. Method according to claim 6, wherein the dredged soil, prior to loading it into the transport vessel (1, 10) has a water content of between 20 and 35% of the total weight of the dredged soil (7).
8. Method according to claim 6 or 7, wherein the dredging vessel (3, 30) comprises a trailing suction hopper dredger.
9. Method according to any one of claims 6-8, wherein unloading the soil (7) from the transport vessel (1, 10) the reclamation site is carried out hydraulically by a pump, provided with high pressure jets that fluidize the soil in the transport vessel, prior to pumping it away.
10. Method according to any one of the preceding claims, wherein the under water soil (7) comprises ore.