

A very large sand carrier

The present invention relates to sand carrier vessel systems for land reclamation operations. More specifically the invention relates to a system of one or more very large sand carriers with huge loading capacity in combination with one or more dredging vessels for loading sand slurry from a marine sand reservoir to the very large sand carrier, directly or indirectly. Other applications can be to dump sand/gravel to prepare the seafloor for pipelines or cable laying or to cover large areas / objects on the seabed such as a ship wreck.

Background art

Present sand transport operations for maintaining or increasing the land area of a coastal nation is presently conducted by combined dredging and transport vessels having relatively small transport capacity. Further, the vessels are arranged for short-range transport and may not feasibly be used for long-distance transport of sand. An alternative method is to dry out the dredged sand ashore or on barges after it has been pumped up and before the sufficiently dry sand is loaded to dry bulk carriers. This is a time consuming and costly exercise. The increased land area may be either an extension seawards of the coastline or extension of an island, or even establishment of a novel island, all in shallow water. Such land extension operations have been conducted in many places in the world such as Holland, Great Britain, the Middle East, and at present such operations are particularly relevant for being conducted in Singapore.

In one such land extension operation, please see the map in Fig. 5 which comprises Indonesia, Malaysia, part of the Philippines, and the very important state of Singapore. Sand is dredged from marine reservoirs at nearby shallow sea locations across the local Singapore Strait, at less than 20 km distance from the dumping range in Singapore. When building up at the seabed the dumped sand slurry displaces mud and compacts itself as the sand layer thickness increases. For improving the stability of the compacted dumped sand, layers of

so-called "rip-rap", i.e. inclined frontal layers of large cobbles, are arranged along the front of the sand layers to dissipate sea wave energy. Such rip-rap layers may also be arranged as intermediate frontal layers to remain within the sand layers when further sand layer build-up is conducted. Further, geotextile membranes may be used to prevent sand or mud loss. When having reached a depth which is too shallow to allow further dumping, pumping of sand slurry may continue to build up the sand level to a desired elevation above sea level.

The vessels presently used for the above-mentioned combined dredging and short range transport are open deck vessels without hatch covers, and provided with their own dredging equipment and have a transport capacity of up to about 33000 m³ wet sand. The sand is pumped on board as wet sand slurry comprising about 60 % to 80 % water. The excess water is drained from the top of the cargo holds until it is loaded to a desired level with wet sand. When loaded the vessel crosses the Singapore Strait and dumps the wet sand at the dumping range less than 20 km sailing distance.

Some dredging vessels presently used may have a loading capacity of approximately 20000 tons/hr of slurry, thereof about 4000 to 6000 tons/hr of sand. The sand content may vary between 20 % and 40 % of the combined slurry during loading. The density of the wet settled sand may be about 1850 kg/m³ depending on the nature of the sand: calcareous sand has a higher density than quartz sand. However, such dredging vessels presently in use is only used for local dredging and corresponding local land reclamation and does not transport sand over any significant distance. Such small dredgers may have bottom doors hinged in bottom hatch frames generally arranged in the lower level of the web frame. The bottom doors are held in place by a vertical hatch rod extending from a hydraulically operated hatch actuator which is arranged above the cargo hold. The bottom doors thus may be opened by lowering the hatch rod. The open hatch doors thus extend below the ship when open, and the cargo is dumped.

Japanese patent application 11220346 relates to a marine reclamation method for charging sea sand carried into a country by a large-scale ship from foreign countries into a reclaimed sea area. The JP application uses the medium size ship with a dredging system (Fig. 1) for loading sand slurry into tanks, and transporting the sand to near the destination. The sand is then added sea water and pumped as sand slurry up from the tanks and sent through a floating unloading hose to an intermediate sand depot on land, on an island, on an artificial island or onto an intermediate depot ship. Then sand is pumped from the intermediate depot to two or small barges which dump the sand on its destination. Thus the JP specification describes the use of at least one large sand transport ship and two small barges for unloading the sand to the destination.

European patent application EP 0 158 385 describes a hopper barge without hatch covers with a cargo hold of which a fore and an aft discharging trap door is arranged higher than the bottom skin of the vessel. The elevated fore and aft bottom discharging trap door is for enabling starting dumping of sand at shallow grounds, so as for the remaining doors in level with the bottom skin may be opened when the draft of the ship is reduced after the initial dumping. The open, small hopper barge of the EP application may not be used for long range transport and would be of insufficient size.

Problems related to the background art

There are several problems connected to the present form of land reclamation by sand dumping.

- * The nearest, local sources of sand to a desired dumping range may be utilized to an undesirably large degree as considered from an environment conservational point of view.
- * Due to the size of the operation, with millions of tonnes of sand required, a restricted transport range may lead to only a few sources are selected, and the risk of local conflicts of interest may be incurred.

- * Further, the sand volumes available for present and coming land reclamation projects may be insufficient.
- * The present combined open deck vessels without hatchcovers are not necessarily designed nor certified to run over long distances.
- * The relatively small dredgers of the prior art having bottom doors hinged in bottom hatch frames generally arranged in the lower level of the web frame, extend their bottom doors below the bottom of the ship when open. Thus the doors are particularly vulnerable to touching the seafloor when operating in shallow waters. Even when closed the hatch and doors of prior art vessels may touch the seafloor and are thus vulnerable if grounding.
- * With the present background art sand transport system, each transport vessel is required to have its own dredging system.
- * The present combined vessels' dredging equipment is very costly to install and maintain. After loading the vessel, the dredging equipment on board the vessel is passive during the relatively short sailing to the dumping range and the return. The back-and-forth transport of the dredging equipment with a mass of about 1000 tonnes further incurs the increased transport cost for the sand while obtaining nothing by transporting the dredging equipment. Those compulsory downtimes for the dredging equipment dictated by the present system is a severe economical disadvantage of the background art combined dredging and transport vessels.

Brief summary of the invention

The above disadvantages of the background art land reclamation sand transport systems may be significantly reduced by the present invention. The invention has three aspects as a vessel, as a method, and as a system.

A: vessel

In one aspect of the invention it is a very large sand carrier broadly defined below.

B: method

In another aspect of the invention it is a method for dredging and marine transport of sand, also defined below.

C: system

In a further aspect the invention is a system of a dredging vessel and a very large sand carrier defined further below.

A: The invention embodied as a vessel:

In one embodiment of the invention it is a very large sand carrier (100) having a hull (1) comprising

- one or more cargo tanks (2) such as a sand slurry tank, provided with a cargo tank deck (31);
- two or more wing tanks (15) separated from said cargo tank (2) by longitudinal bulkheads (4);
- said one or more of said cargo tanks (2) provided with one or more slurry loading line (5, 55) arranged for loading sand to said tanks (2), and one or more overflow trunks (25) with a first, upper drain threshold (27) arranged at an upper desired level (251) for draining excess water during loading of sand, and an outlet (29) for releasing said excess water to the sea, and one or more hopper trunks (6), with a bottom hatchway (7) for dumping sand.

As an alternative to the bottom hatchways (7) with horizontally hinged bottom doors (71), the hopper trunks (6) hatchway (7) may be provided with vertically operated conical valves (77) opening downwards. One significant advantage of bottom doors (71) over conical valves (77) is that the bottom doors (71) open a larger proportion of the hatchway (7) cross-section than a conical valve (77) does.

The overflow trunk (25) can be made telescopic in the upper part so as for the upper drain threshold (27) to be vertically adjustable in order to adjust the maximum filling level in the cargo tanks.

Advantages of the invention embodied as a vessel

The foremost advantage of the vessel according to the invention is the enormously increased loading capacity resulting from using a very large sand carrier which has at least more than three to four times the loading capacity of existing combined dredging and sand transport vessels. Secondly, the very large sand carrier of the invention is provided with cargo tanks instead of open deck compartments without hatchcovers. The vessel according to the invention thus is suitable for long range transport of sand and significantly increases the (allowed) sailing range for the vessels to comprise effectively all open seas of the world.

In an advantageous preferred embodiment the very large sand carrier of the invention, the overflow trunk (25) is provided with a second drain inlet (28) at a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level, so as for avoiding undesired liquefaction and sloshing in the tank (2).

An advantage to very large sand carrier according to the present invention is the hatch door arrangement which is retracted to a higher elevation than the bottom skin. Having the hatch doors arranged in generally the same level as the top flange of the bottom web frame results in reduced vulnerability of the bottom doors. Further, when open, the bottom doors do not extend below the bottom skin of the vessel, and may thus hardly be damaged if touching the sand banks during the dumping operation. This is a significant advantage over the prior art dredgers having bottom doors hinged in bottom hatch frames generally arranged in the lower level of the web frame, which doors are particularly vulnerable to damage if touching the seafloor when operating in shallow waters. It is also a significant advantage over conical valves extending below the bottom of prior art vessels, as such extending conical valves are vulnerable to touching the ground, too.

B: The invention embodied as a method

According to another aspect of the invention it is a method for long-range transporting of sand using a very large sand carrier (100) with a hull (1) with one or more cargo tanks (2), said one or more cargo tanks (2) having a cargo tank deck (31) and provided with one or more hopper trunks (6), with one or more bottom hatchways (7) with hatch actuators (11). The method of the invention comprises one or more rounds of the following steps of generally loading and discharging:

- letting water bleed into said one or more cargo tanks (2) through said one or more bottom hatchways (7) so as for preparing said tanks (2) for loading sand slurry;
 - closing said one or more bottom hatchways (7) using said hatch actuators (11)
 - using a dredging vessel (200) at a dredging range (A) for loading sand slurry through at least one slurry loading line (5, 55) arranged for loading sand;
 - allowing said sand slurry to dump into said water and settle in said one or more tanks (2);
 - draining excess water from said tanks (2) through a first, upper drain threshold (27) arranged at an upper desired level (251) of one or more overflow trunks (25) in said one or more tanks (2) and releasing said excess water to the sea through an outlet (29);
- until said tanks (2) are filled with sand to a desired degree,
- sailing to a remote dumping range (B);
 - when arriving at said dumping range (B), opening cargo tank dumping vents (33) in said cargo tank deck (31);
 - opening one or more of said hatchways (7) and dumping sand at the dumping range (B), while allowing water to bleed into said one or more tanks,
 - sailing back to said remote dredging range (A) for renewed loading of sand.

In an advantageous embodiment of the method of the invention, one may, after the step of having filled said tanks (2) to a desired degree, draining said tanks (2)

through a second drain inlet (28) of said overflow trunk (25) partly or entirely down to a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level.

Advantages of the invention embodied as a method

In the method of the invention, letting water bleed into the tanks increases the draft of the ship and reduces the required pumping elevation. Further, letting water bleed into the tanks before loading reduces the structural load on the hull between sand-filled and water-filled tank compartments. A significant advantage of the invention is further that dumping the sand slurry in water in the tank allows the sand to distribute better in the tank. Even further, dumping the sand slurry in water prevents sand smashing onto the bottom of the tank and the hatches, a feature of the invention for preserving the mechanical integrity of the vessel.

In the above-mentioned advantageous embodiment of the method of the invention, draining the tanks (2) through the second drain inlet (28) of the overflow trunk (25) partly or entirely down to the level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level, this may have the advantage of reducing the transported mass, but far more significant is the advantage of forming the crust in the sand to prevent liquefaction and thus avoid sloshing. Sloshing in tanks as large as for the present vessel may pose a significant threat to the mechanical structure of the bulkheads. Thus this crust forming draining operation is a very important way of protecting the mechanical structure of the tanks from damage, and will increase the stability of the vessel during transit.

C: The invention embodied as a system

The third aspect of the invention is thus a marine sand transport system comprising

- at least one dredging vessel (200) arranged for being stationary at a marine sand source (A) for loading sand slurry (ss), the system characterized in that said dredging vessel (200) arranged for loading sand slurry to one or more very large sand carriers (100). The one or more very large sand carriers (100) comprises cargo tanks (2) arranged for transporting said sand slurry (ss) over a long marine distance to a sand dumping range (B) for dumping said sand slurry (ss) for land reclamation, and for returning to said dredging vessel (200) at said marine sand source site (A),
so as for extending the possible transporting range between said marine sand source (A) and said dumping range (B).

Advantages of the invention embodied as a system

Significant advantages of the invention comprises splitting the prior art combined dredging and transporting tasks to specialized vessels, thus reducing the costs incurred by having unnecessary functions on one ship.

Loading such huge amounts of sand slurry as can be accommodated by the very large sand carrier (VLSC) tank vessels according to the invention requires efficient dredging equipment for loading. An additional advantage of the invention embodied as a system is, that the occupation efficiency of the existing dredging vessel's pumping equipment is increased as the dredging vessel may stay operating on the source location and not waste its time transporting its relatively small cargo. Thus the cost of building new dredging vessels may be generally avoided by the system of the invention while the dredging capacity of the dredging vessels is increased and the sand transporting task is transferred to the very large sand carrier vessels according to the invention. Thus the overall dredging and sand transporting capacity may be multiplied, which is a significant advantage to land recuperation projects. In other words, splitting the prior art combined dredging and transporting tasks to specialized vessels is advantageous: Extending the transporting range to open sea journeys increases the transport range and improving the transport capacity significantly. As mentioned above, omitting the back-and-forth transport of the dredging equipment is money-saving. Further, the number of dredging equipments may

be thus reduced to the number of dredging vessels required for loading the specialized tankers of the invention, not for transporting by dredging vessels.

The invention extends the economical transporting range from short trips in sheltered waters to open sea journeys of unlimited length. Further, the system of the invention improves the transport capacity significantly over the prior art combined dredging and transport vessels. Omitting the back-and-forth transport of the dredging equipment reduces the transport cost of the sand as such. Further, the number of dredging equipments may be reduced to the number of dredging vessels required.

Advantages of the invention

The invention has several advantages over the prior art:

Increased overall capacity

One significant advantage of the present invention is the mere increase in sand transport capacity from a maximum of about 60000 tonnes to more than 150000 tonnes, or even more than 300000 tonnes. The invention will also significantly increase the sand volumes available for providing sand for each dumping range, and may thus decrease the costs for land reclamation.

Increased transport range

Another advantage of the invention is the significant extension the economical transport range due to the fact that the transport is in tanks and not in open deck vessels without hatchcovers. This may allow utilizing hitherto inaccessible dredging ranges and may allow for spreading the dredging consumption to other marine dredging ranges than the ones presently exploited with the short-range background art transport systems. This may thus reduce the inevitable environmental load incurred on each dredging range to a sustainable minimum.

Improved sand transport vessels

The present invention with the sand transported in large tanks instead of in open deck compartments, combined with the ships of the invention being designed for long distance marine transport compensates for the disadvantage of the present background art vessels which may not conduct long sea journeys .

New possible dumping ranges

As the transport range is increased, more coastal regions around the world may receive sand which would otherwise be prohibitively costly to supply with sand using the background art vessels.

Separate function of loading vessels and transport vessels

The present invention annuls the problem of each of the present combined vessels' to have their own dredging equipment. Only one or a few small dredging vessels with sufficient loading speed are required at the dredging range. Thus the number of dredging systems is significantly reduced. Further, with two or more very large sand carriers according to the invention in operation, a first sand carrier may be loaded while a second sand carrier sails to the dumping range and returns to the dredging range in time for the first vessel to leave fully loaded. Thus the downtime for the dredging equipment dictated by the present system may be significantly reduced.

No need for transport capacity of dredging vessels

A further advantage of the present invention is that small stationary dredging vessels with high dredging capacity which are presently used for local pumping for moving sand locally may be utilized with the new system. The transport capacity of the presently used combined dredging and transport vessels is thus not required with the new system of the invention.

New vessel or converted tanker

The vessel of the invention may advantageously be converted from a VLCC tanker by installing the sand slurry loading lines and arranging the hatches in the bottom of the tanks with associated hoppers, and reinforcing the tank and the

hull accordingly and for allowing the tank load density to be increased from 1.025 tons / m³ to 1.850 tons / m³. Advantageously the vessel of the invention may alternatively be newbuilt in order to adapt the construction to the cargo as wet sand has a far higher density than crude petroleum, which may be technically advantageous compared to adapting an existing vessel to the cargo.

Figure captions

The invention is illustrated in the attached drawings, which shall be used for illustration purposes only and which shall not be construed as limiting for the invention.

Fig. 1 is a cross-section of the hull (1) of a very large sand carrier according to the invention, showing two embodiments of a sand slurry tank (2) at either side of a centreline, a loading line and venting system in the tank deck, a hatchway system in the bottom of the tank and associated hoppers, and one wing tank.

Fig. 2 is a longitudinal vertical section of the bow and three cargo tank compartments of the hull (1) of the very large sand carrier of the invention.

Fig. 3 is a tank plan view of the very large sand carrier of the invention, showing the two foremost tanks of the hull from Fig. 2, and the bow section. Please notice the vertical overflow trunks in the corners near the longitudinal and transverse bulkheads of the tanks.

Fig. 4 is a general arrangement of a tank vessel according to an embodiment of the invention.

Fig. 5 is a map of Indonesia, Malaysia, part of the Philippines, and Singapore which comprises a significant part of the geographical regions relevant for the present invention.

Embodiments of the invention

Below follows a description of the invention with reference to the drawing figures. Fig. 1 is a cross-section of the hull (1) of a very large sand carrier according to the invention, showing two embodiments of a sand slurry tank (2) at either side of a centreline, a loading line and venting system in the tank deck, a hatchway system in the bottom of the tank and associated hoppers, and one wing tank. Further, in the right portion of the drawing is illustrated an overflow trunk for excess water during loading, and advantageously for draining the tank to a desired level for transit. Such overflow trunks are here generally vertical and may be arranged in corners of each tank as illustrated in the tank plan of Fig. 3. The relatively fine mesh structure shown in Fig. 1, about the tank and the wing tank is the steel structure of the web frames in general.

General

A general arrangement of a vessel according to the invention is provided in Fig. 4. The vessel according to the invention is a very large sand carrier being comparable in size to a very large crude carrier (VLCC), and having an MTDW range from about 150000 tonnes to about 350000 tonnes. The very large sand carrier according to the invention is not limited to transporting sand or sand slurry; the sand slurry may contain larger particles such as gravel in the sand slurry, or finer particles such as silt, clay or mud. The very large sand carrier according to the invention has the main constructional features as follows: The hull (1) comprises one or more cargo tanks (2) with a cargo tank deck (31). The one or more cargo tanks (2) may comprise one longitudinally extending tank (2) with a series of interconnected tank compartments via one or more wash bulkheads, or as a series of segregated tanks (2). Two or more wing tanks (15) for being used generally for ballasting and adjusting draft are separated from said cargo tank (2) by longitudinal bulkheads (4). The vessel may be provided with one or more main slurry loading lines (5) for receiving sand slurry (ss) from a dredger vessel and one or more branch loading lines (55) to one or more of said cargo tanks (2). Each branch loading line may be provided with a separate

valve as illustrated in Fig. 1 and in Fig. 2, for controlling the supply rate and distribution of sand slurry during loading sand slurry to said tanks (2). For releasing excess water to the sea, one or more overflow trunks (25) are arranged in one or more of the tanks, each overflow trunk provided with a first, upper drain threshold (27) arranged at an upper desired level (251) for draining excess water during loading of sand slurry, and an outlet (29) for the excess water. Each tank (2) is provided with one or more hopper trunks (6), with a bottom hatchway (7) for dumping sand when opened.

Overflow trunks

In an advantageous embodiment of the invention, the overflow trunk (25) is provided with a second drain inlet (28) at a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level. (A further advantage of lowering the water level in the sand load is that it reduces the pressure on the bottom hatchway (7) and particularly the hatch doors (71), and further the load on the vertical hatch rod (9) and the hatch rod actuator (11), and it improves the stability of the ship.)

Alternatively, the tanks (2) may be drained completely of water before or during transit, using ballast tanks and possibly cascade tanks before dumping the water. This may further reduce the transported mass during transit, and further reduce the risk of liquefaction and sloshing.

Overflow trunk, bottom outlet

In an advantageous embodiment of the present invention the overflow trunk (25) is generally vertical, with the outlet (29) arranged through the bottom of said tank (2) and thus through the bottom of the hull (1). An advantage of having the outlet for excess water from the slurry through the bottom of the hull is that the trunk (25) may be relatively short depending on cargo- and wing tank configuration. Further, it may reduce the undesired spread of sediments such as clay, silt and mud about the ship during loading, as well as avoiding the rather less aesthetic view of grey excess water being released through the hull side. The upper drain

threshold (27) may be arranged with an actuator or valve system for being vertically adjustable for adjusting the upper desired level (251).

Hatch actuating details

In an advantageous embodiment of the ship of the invention, the bottom hatchway (7) may comprise a vertical hatch rod (9) extending to a hatch rod actuator (11) on said cargo tank deck (31). The hatch rod (9) may move the hatch doors (71) or alternatively the conical valves (98) if installed. The hatch rod (9) may advantageously be provided with a hatch rod securing wedge (13) arranged at deck level for taking the load off said rod actuator (11) when said bottom hatchway (7) is closed. The securing wedge is for taking the load off the rod actuator after closing of the hatch, and for securing the hatch during sailing. This will prevent the hatchway from opening and releasing the load by accident or by actuator failure such as incurred by power loss or by a failure of a hydraulic line. Further, it may allow the actuators (11) to be turned off during sailing in order for not having to maintain operating pressure during the entire transit. One significant advantage of the vertical hatch rods and the deck level arranged actuator is that each of the hatches may be controlled from deck level. Actuator repair and operation of the rod securing wedge may take place at deck level. 13. The hatch doors (71) may comprise one or more hatch rod link arms (73) to a lower portion of said vertical hatch rod (9) as shown in Fig. 1. Horizontal rod bearing arms (91, 91L, 91U) may be arranged in several elevation levels in the tank to avoid undesired vibrations of the vertical hatch rods (9) both due to the cargo's forces and the vessel's accelerations and motions.

Hatchway interlinking

In a preferred embodiment of the invention, two or more of said hatchways (7) are arranged for opening simultaneously, i.e. that said hatch rod securing wedge (13) of each hatch door (71) to be operated so as for avoiding one single hatchway (7) to open alone. The advantage of such an interlink arrangement is that it assures a desirable simultaneous opening of two or more hatches and avoids the danger of accidentally opening one hatchway separately, which could unload one single tank or part of one single tank, and thus create undesired list

and trim, as well as creating structural loads on the hull which may incur damage to the mechanical structure of the hull.

Tank discharge vents

One or more of said tanks (2) may preferably be provided with one or more tank deck dumping vents (33) for letting in air during dumping. This is in order to avoid having the deck or longitudinal bulkhead sucked in and thus become mechanically deformed while dumping sand.

Tank hoppers

Any sediment requires a minimum angle of repose for the sediment to slide. For assuring sliding one or more of the tanks (2) are provided with one or more hoppers (6) with hopper surfaces (60, 8, 61, 62) about said one or more hatchways (7). The hopper (6) surfaces may comprise a port and a starboard main lateral hopper surface (60) arranged between the hopper and the longitudinal bulkhead as shown to the left of the vertical centreline of Fig. 1, and further illustrated in Fig. 3. Further, the hopper (6) may further be provided with secondary, auxiliary lateral hopper surfaces (61) which are steeper than said main lateral hopper surfaces (60), such as illustrated to the right of the vertical centreline of Fig. 1. If the tank (2) is provided with parallelly arranged port and starboard hatchways (7), an intermediate central hopper (8) may be arranged. Hopper arrangements as described and illustrated may avoid residual sand to remain at the end of the dumping operation while reducing the tank volume to a small degree. The hopper surface inclination angle must be balanced between the angle of repose of sand and the volume reduction with increasing hopper surface angle.

Water jets

In an embodiment of the invention, the very large sand carrier's hoppers (6) with hopper surfaces (60, 61, 80) may be provided with water jet nozzles (75) to facilitate slumping during dumping. This may advantageously reduce the requirement of having an angle of repose that initiates slumping of the sand, thus water jet nozzles may allow more shallowly inclined hoppers and thus an

increased allowable tank volume, and increased stability of the vessel in general, as the cargo centre of mass is lowered. Through a combination of relatively low hopper angles and an efficient water jet system the water jets can be used to initiate and maintain the cargo flow through the bottom hatchways.

Hatch door arrangement

In the preferred embodiment of the invention said hatchways (7) comprise one or hatch closing devices (71, 77, 71') such as one or more laterally hinged hatch doors (71) arranged for opening downwards. The hatch doors are hinged to the hatch frames (72) which may be generally arranged in between crossing longitudinal and lateral web frames over the bottom shell plate (190). If power is lost on the hatch rod actuator (11), then the hatchway (7) may be opened by operating the hatch rod securing wedge (13) and hatch rod actuator in manually controlled emergency operations. The hatch doors (71) are arranged for being closed in a generally horizontal position to the hatch frame (72) after dumping. The hatch frame should be provided with a frame gasket (76) in order to prevent significant sand leakage during loading and transport, but it is not required that the frame gasket (76) be entirely watertight.

According to a preferred embodiment of the invention, said hatch frames (72) with said hatch doors (71) are mounted in a level near a lower tank web frame's (21) top flange (211) as illustrated in Fig. 1 and in Fig. 2. The hatch doors (71) are advantageously arranged for opening downwards into a generally vertically extending bottom hatchway gate shaft (74) having generally the height of the lower tank web frame. The gate shaft (74), which may also be called an outlet trunk, then acts as a hopper throat when the hatchway closing device is open. An advantage of such a bottom hatch gate shaft (74) is that the hatch doors (71) may then extend down into the gate shafts (74) and be protected by the vertical walls of the gate shaft (74) and not extend below the bottom shell plates (190) of the hull. This feature makes the hatch doors less vulnerable in case of being inadvertently opened during transit or open during manoeuvring and protected while open on a shallow dumping range, and avoiding the doors from being

undesirably blocked in an open position after dumping. The doors will in this manner also be better protected in case of grounding.

Filling water during slurry loading

The tanks may preferably be arranged for being partially or entirely filled with sea water before loading sand slurry. This is most easily achieved by opening the hatchways (7). Filling water into the tanks before loading the sand slurry will allow the bottom structure of the tank (2) to be protected from sand slurry dumping masses falling from the loading line (5, 55) to the bottom of the tank if otherwise dry. Moreover, the sand slurry will distribute far better in the tank if allowed to fall in water and an undesirable sand cone is avoided. Another advantage of increasing the draft of the vlsc according to the invention during loading is reducing the lifting height for pumping the sand slurry on board, and saves energy. This is particularly important when lifting hundreds of thousands of tonnes of sand slurry to deck level.

Alternative hatchway embodiments may be used. The hatch doors (71) may be replaced by conical bottom valves (78) (not illustrated) in conical bottom gate shafts (79), said conical bottom valves (78) arranged for opening vertically downwards. An advantage of a circular shape of the frame of the conical valve gate shaft (79) reduces otherwise corner stresses in a rectangular frame.

Another alternative hatchway solution is a vertical hatchway (7) as described above but having one or more horizontally sliding gate doors (71), sliding relative to said hatch frame (72) located above the bottom plate of the vessel. This solution will have the same advantages with respect to a protected location above the shell plating such as not being blocked from opening or closing due to touching ground, particularly during dumping.

A method of operation according to the invention

The invention comprises a method for long-range transporting of sand using a very large sand carrier (100) with a hull (1) with one or more cargo tanks (2),

said one or more cargo tanks (2) having a cargo tank deck (31) and provided with one or more hopper trunks (6), with one or more bottom hatchways (7) with hatch actuators (11) for opening and closing hatch closing devices, such as hatch doors (71) as illustrated in Figs. 1 and 2, or conical valves or sliding hatch doors described as alternative hatch closing devices.

The method of the invention comprises one or more rounds of the following steps:

- first, letting water bleed into said one or more cargo tanks (2) through said one or more bottom hatchways (7), then closing said one or more bottom hatchways (7) using said hatch actuators (11). This will prepare the tanks for loading at the dredging range (A).
- then a dredging vessel (200) is used at the dredging range (A) for loading sand slurry through at least one slurry loading line (5, 55) arranged for loading sand.
- the sand slurry is dumped into the water and settles in said one or more tanks (2). The sand slurry will separate into wet settled but compact sand, and excess water.
- the excess water is simultaneously drained from said tanks (2) through a first, upper drain threshold (27) arranged at an upper desired level (251) of one or more overflow trunks (25) in said one or more tanks (2). The excess water is released to the sea through an outlet (29), preferably through the bottom. The ship's draft is controlled using the wing tanks.

The loading of sand slurry is continued until said tanks (2) are filled with sand to a desired degree.

- Then the vessel according to the invention sails to a dumping range (B) (preferably remote due to general economical aspects).
- when arriving at said dumping range (B), the cargo tank dumping vents (33) are opened in said cargo tank deck (31) to allow free passage of air into the tanks as sand is dumped through the bottom. This prevents formation of underpressure in the tanks.
- when the vents are opened, one may systematically open one or more of said hatchways (7) and dumping sand at the dumping range (B), while allowing water to bleed into said one or more tanks. As opening all tanks simultaneously may

be dangerous from several aspects, preferably every odd-numbered tank or tank section 1, 3, 5, 7, 9 as illustrated in Fig. 4, may be opened first and dumped free of sand. Then water will flow into tanks 1, 3, 5 and the ship remains deep draught in the sea. Structural loads on the hull are then controlled to reside below a given limit. Subsequently, even-numbered tanks or tank sections 2, 4, 6, 8 may be dumped free of sand and immediately ballasted with water. Thereby the vessel may be adjusted to the desired draft and trim using the wing tanks.

- the vessel may then sail back to said remote dredging range (A) for renewed loading of sand.

During the absence of the vessel of the present invention from the dredging range (A) one or more very large sand carriers according to the invention may be loaded at the dredging range in order to utilize the occupation efficiency of the one or more dredging vessels.

There are several advantages of conducting the operation in this manner. Letting water bleed into the tanks increases the draft and reduces the required pumping elevation. Letting water bleed into the tanks before loading reduces the structural load between sand-filled and water-filled tanks. Dumping the sand slurry in water during loading allows the sand to distribute better in the tank. Dumping the sand slurry in water prevents sand smashing onto the bottom of the tank and the hatches.

The above method may be improved further by introducing, after the step of having filled said tanks (2) to a desired degree, to drain said tanks (2) through a second drain inlet (28) of said overflow trunk (25) partly or entirely down to a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level. Again, the ship's draft is controlled using the wing tanks in order to adjust the water level so as for draining water from the tanks. Draining the tanks to a lower internal water level increases the stability of the vessel, reduces the transported mass and reduces fuel consumption. Further, draining the water level in the sand forms a more or less wet but more

stable upper crust of sand in the tank. The crust will prevent liquefaction and sloshing and is an advantage both with regard to stability and to prevent sloshing damage to the bulkheads.

According to an embodiment of the method of the invention, one may, during the step of loading sand slurry at the dredging range (A) or during the step of dumping sand at the dumping range (B), use the wing tanks (15) for circulating cooling water for engines on board the very large sand carrier (100). This step may provide advantages both at the dredging range (A) and the dumping range (B) where the water may be locally polluted by sedimentary particles around the sand carrier (100) and the dredger by sand, silt, clay and mud due to the vast amounts of sand slurry being dredged or pumped or dumped. Using the wing tanks (15) for circulating cooling water for power producing engines on board the very large sand carrier (100) will assure that the engines are provided with clean sea water during the loading or the dumping process. This is a significant advantage over having a cooling circuit in the sea. When sailing, the slightly heated water of the wing tanks may be partially dumped to the sea or partially or entirely exchanged or simply allowed to cool.

Further, during the step of loading sand slurry at the dredging range (A), temporarily using the wing tanks (15) for circulating cooling water for engines on board the dredging vessel (200) may allow the dredging vessel to use clean, particle-free wing tank water to cool its engines while cleaning cooling water filters.

In an embodiment of the invention the ship according to the invention may unload its sand cargo by mixing it with sea water and pumping it via a discharge line from the tank (2) to the bow and onto the land to be extended, either directly through a "rainbowing" nozzle or via an auxiliary barge.

We claim:

1. A very large sand carrier (100) with a hull (1) comprising:
 - one or more cargo tanks (2) with a cargo tank deck (31);
 - two or more wing tanks (15) separated from said cargo tank (2) by longitudinal bulkheads (4);
 - said one or more of said cargo tanks (2) provided with
 - one or more slurry loading line (5, 55) arranged for receiving sand slurry (ss) from a dredger vessel and loading said sand slurry (ss) to said tanks (2);
 - one or more overflow trunks (25) with a first, upper drain threshold (27) arranged at an upper desired level (251) for draining excess water during loading of said sand slurry (ss), and an outlet (29) for releasing said excess water to the sea,
 - one or more hopper trunks (6) provided with a bottom hatchway (7) through the bottom shell plate (190), said hatchway provided with a hatch closing device (71, 71' 77) for releasing said sand slurry (ss).
2. The very large sand carrier of claim 1,
said bottom hatchway (7) provided with a hatch frame (72) with the hatch closing device (71, 71' 77) in the form of one or more hinged hatch doors (71), or one or more conical valves (77) or one or more sliding hatch doors (71').
3. The very large sand carrier of claim 2,
said hatch frame (72) with said hatch closing device (71, 77, 71') arranged above the bottom shell plate's (190) level of said hull (1) so as for said hatch closing device (71, 77, 71') being retracted from said bottom shell plate (190) level when open.
4. The very large sand carrier of claim 3,
said hatch frame (72) arranged near the level of a top flange (211) of a bottom web frame (21).

5. The very large sand carrier of claim 3, said hatchway (7) provided with a gate shaft (74) extending between said hatch frame (72) and said bottom shell plate (190).

6. The very large sand carrier of claim 1, said overflow trunk (25) provided with a second drain inlet (28) at a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level.

7. The very large sand carrier of claim 1, said overflow trunk (25) being generally vertical, said outlet (29) arranged through the bottom of said tank (2) and through the bottom of said hull (1).

8. The very large sand carrier of claim 1,
* said bottom hatchway (7) comprising a vertical hatch rod (9) for extending from said hatch closing device (71, 77, 71') to a hatch rod actuator (11) on said cargo tank deck (31),
* said hatch rod (9) provided with a hatch rod securing wedge (13) for unloading said rod actuator (11) when said bottom hatchway (7) is closed.

9. The very large sand carrier of claim 1, said upper drain threshold (27) being vertically adjustable for adjusting said upper desired level (251).

10. The very large sand carrier of claim 9, said upper drain threshold (27) constituted by a telescoping upper portion of said overflow trunk (25).

11. The very large sand carrier of claim 1, one or more of said tanks (2) provided with one or more tank deck dumping vents (33) for letting in air during dumping.

12. The very large sand carrier of claim 8,
two or more of said hatchways (7) arranged for opening simultaneously, i.e. two
or more of said hatch rod securing wedges (13) to be operated using an interlock
so as for avoiding one single hatchway (7) to open alone.

13. The very large sand carrier of claim 1,
said tank (2) provided with one or more hoppers (6) with hopper surfaces (60, 8,
61, 62) about said one or more hatchways (7).

14. The very large sand carrier of claim 13,
said hopper (6) surfaces comprising port and a starboard main lateral hopper
surfaces (60).

15. The very large sand carrier of claim 14,
said hopper (6) further provided with secondary lateral hopper surfaces (61)
steeper than said main lateral hopper surfaces (60).

16. The very large sand carrier of claim 9,
said tank (2) provided with parallel port and starboard hatchways (7) and an
intermediate central hopper surface (8).

17. The very large sand carrier of claim 2,
said hatchways (7) comprising one or more laterally hinged hatch doors (71)
arranged for opening downwards and arranged for being closed to the hatch
frame (72) in a generally horizontal position.

18. The very large sand carrier of claim 8,
said hatch doors (71) comprising one or more hatch rod link arms (73) to a lower
portion of said vertical hatch rod (9).

19. The very large sand carrier of claim 4,
* said hatch frame (72) with said hatch doors (71) mounted in a level near a
lower tank web frame flange (211),

* said hatch doors (71) arranged for opening downwards into a bottom hatch gate shaft (74) having generally the height of the lower tank web frame (21).

20. The very large sand carrier of claim 1, the tank (2) arranged for being partially or entirely filled with sea water before loading sand slurry.

21. The very large sand carrier of claim 13, said one or more hopper surfaces (6, 60, 61, 80) provided with water jet nozzles (75) to facilitate slumping during dumping.

22. The very large sand carrier of claim 1, said hatchways (7) comprising conical bottom valves (78) in conical bottom hatchway gate shafts (79), said conical bottom valves (78) arranged for opening vertically downwards.

23. The very large sand carrier of claim 1, said very large sand carrier being comparable in size to a very large crude carrier (VLCC), and having an MTDW range from abt 150 000 tonnes to abt 350 000 tonnes.

24. The very large sand carrier claim 1, said wing tanks (15) separated from said cargo tanks by longitudinal bulkheads (4) with longitudinal bulkhead web frames (41).

25. A method for long-range transporting of sand using a very large sand carrier (100) with a hull (1) with one or more cargo tanks (2), said one or more cargo tanks (2) having a cargo tank deck (31) and provided with one or more hopper trunks (6), with one or more bottom hatchways (7) with closing devices (71, 77) operated by hatch actuators (11),

comprising one or more rounds of the following steps:

- letting water bleed into said one or more cargo tanks (2) through said one or more bottom hatchways (7);
- closing said closing devices (71, 77) in one or more of said bottom hatchways (7) using said hatch actuators (11),

- using a dredging vessel (200) at a dredging range (A) for loading sand slurry through at least one slurry loading line (5, 55) arranged for loading sand;
 - allowing said sand slurry to dump into said water and settle in said one or more tanks (2);
 - draining excess water from said tanks (2) through a first, upper drain threshold (27) arranged at an upper desired level (251) of one or more overflow trunks (25) in said one or more tanks (2) and releasing said excess water to the sea through an outlet (29);
- until said tanks (2) are filled with wet sand to a desired degree,
- sailing to a remote dumping range (B);
 - when arriving at said dumping range (B), opening cargo tank dumping vents (33) in said cargo tank deck (31);
 - opening one or more of said hatchways (7) and dumping sand at the dumping range (B), while allowing water to bleed into said one or more tanks (2)
 - sailing back to said remote dredging range (A) for renewed loading of sand.

26. The method according to claim 25,

- after the step of having filled said tanks (2) to a desired degree,
- draining said tanks (2) through a second drain inlet (28) of said overflow trunk (25), or of a different trunk (25'), partly or entirely down to a level (281) so as for draining water from sand in said cargo tank (2) to a desired level in order to provide an upper crust of reduced water content of said sand residing above said desired level in order to prevent liquefaction and sloshing.

27. The method according to claim 25,

- during the step of loading sand slurry at the dredging range (A) or
 - during the step of dumping sand at the dumping range (B),
- using the wing tanks (15) for circulating cooling water for engines on board the very large sand carrier (100).

28. A marine sand transport system comprising

- at least one dredging vessel (200) arranged for being generally stationary at a marine sand source (A) for loading sand slurry (ss), characterized by

- said dredging vessel (200) arranged for loading sand slurry to one or more very large sand carriers (100) ;

- said one or more very large sand carriers (100) comprising one or more cargo tanks (2) arranged for transporting said sand slurry (ss) over a long marine distance to a sand dumping range (B) for dumping said sand slurry (ss), and for returning to said dredging vessel (200) at said marine sand source site (A), so as for extending the possible transporting range between said marine sand source (A) and said dumping range (B).

29. The marine sand transport system of claim 30, dumping said sand slurry (ss) for land reclamation.

30. The marine sand transport system of claim 30, dumping said sand slurry (ss) for seabed preparation such as for preparing the seabed for pipelines or bottom standing constructions.

31. The marine sand transport system according to claim 30, said very large sand carrier being comparable in size to a very large crude carrier (VLCC), thus having a deadweight range from 150 000 tonnes to 350 000 tonnes.

32. The marine sand transport system according to claim 30, said dredging vessel (200) having a loading capacity of approximately 20 000 tons/hr of slurry, thereof about 5000 tons/hr of sand.