

ENVIRONMENTALLY FRIENDLY ISLAND CONSTRUCTION METHOD

TECHNICAL FIELD

The present invention pertains to the field of coastal land reclamation technology, and particularly relates to an environmentally friendly island construction method.

BACKGROUND

Many countries resort to land reclamation, a process of creating land from oceans, to address the demand for utilizing coastal land for construction projects for improving livelihood, such as industrial parks, ports, airports and power stations, in particular due to the growing populations. Nowadays, the most commonly used method for land reclamation is to use a cutter suction dredger (CSD), which cuts nearby marine or coastal sediment with its cutter head, sucks it up and hydraulically fills it in a designated area to create new land.

However, this method is associated with a number of disadvantages:

1. After being cut by the CSD, the seafloor sediment is drawn together with sea water through a pipeline, and the resulting sediment-water mixture contains water in a proportion generally as high as 80% or above. Consequently, a greater amount of wastewater would be discharged, contaminating the water body.
2. Such an extremely high water content of the sediment-water mixture from the CSD necessitates enclosing the fill area in advance with large dikes for holding the mixture. However, closing of the large dikes is associated with a risk.
3. Due to a limited transport distance of the CSD's pipeline, the method is less suitable for use in large-area projects.

4. Most land reclamation projects take place in coastal areas of cities, where, however, seabed sediments usually have been polluted to varying extents due to human factors, such as historical discharge of industrial and domestic wastewater, solid waste and the like. Accordingly, wastewater generated in such projects, typically huge in amount, must be treated to meet relevant standards before it can be discharged. Such wastewater treatment is very expensive and difficult to implement at site because of a massive workload involved.

SUMMARY

In view of the above described disadvantages of the conventional land reclamation method that is based on cutting, suction and hydraulic filling, the present invention provides an environmentally friendly (“green”) island construction method.

To this end, the subject matter of the present invention lies in:

an environmentally friendly island construction method comprising the steps of:

(1) excavating seabed sediment in a dredging area by a grab or bucket dredger, then transporting the sediment by a dredging barge to a location beside a stockpiling barge, which is deployed at a border of a construction area and equipped with a grab rig, grabbing the sediment from the dredging barge by a grab bucket and dumping the sediment into an island construction area by the grab bucket, wherein a polluted sediment layer of the seabed sediment in the dredging area is excavated first, and the remainder of seabed sediment is non-polluted and is excavated after the polluted sediment layer is completely excavated; and

(2) dividing the island construction area into a number of construction cells each with an area of 100,000 to 200,000 m², successively draining the

construction cells by a vacuum concurrently with each cell being enclosed with small water barrier dikes and guiding water drained by the vacuum within the small dikes, thereby achieving simultaneous increased loading and water surcharge preloading of the construction cells, until sediment strength of each construction cell reaches a predetermined criterion level at the end of construction.

According to the present invention, in step 1, the grab or bucket dredger may be equipped with a grab bucket with a capacity of 1-28 m³.

According to the present invention, in step 1, the grab rig may rotate and then dump the sediment, or the grab rig may dump the sediment with the aid of a belt conveyor or a shaftless screw conveyor.

According to the present invention, in step 2, the vacuum drainage may comprise, for each of the construction cells, installing plastic drainage boards around the construction cell, arranging a vacuum pumping system on top of the plastic drainage boards, covering the construction cell with an airtight membrane and directing wastewater drained by the vacuum within the small dikes.

According to the present invention, the plastic drainage boards may have a depth of 5-38 meters.

According to the present invention, in step 2, the small dikes may have a height of 0.5-4 meters.

Preferably, prior to step 1, the method may further comprise: geologically surveying the seabed sediment in dredging area, which is a sea area near the island construction area, and measuring indicators of an extent of pollution of the seabed sediment.

Further, the seabed sediment may be geologically surveyed by coring up to 15 meters beneath a surface of the seabed sediment at sites in a square arrangement, which are spaced at intervals of 0.5 to 1 kilometer, using a drilling

rig on a ship.

According to the present invention, according to results of the geological survey of the seabed sediment, in step 1, the polluted sediment layer that is excavated first may be a silt layer and is dumped into the island construction area, and after the polluted silt layer in the dredging area is completely excavated, the non-polluted remainder of the sediment may be excavated and dumped onto the polluted sediment to a thickness not less than 2 meters as an overlying layer.

Preferably, the construction method of the present invention may further comprise the step of (3) purifying the wastewater within the dikes and discharging it to the sea after its water quality meets the requirements of a standard.

Additionally, the wastewater may be purified preferably using a photoelectrocatalytic technique for water treatment.

The present invention offers the following benefits:

1. In the method of the present invention, grab buckets are used to excavate, transfer and dump seabed sediment. This significantly reduces polluted water production compared with producing a sediment-water mixture by a CSD's cutting and suction operations, thereby significantly reducing wastewater production in the subsequent construction steps.

2. In the method of the present invention, polluted seafloor sediment is filled as an underlying deep layer of the reclaimed land. This not only enables resourceful utilization of the polluted sediment as fill material for land reclamation, but also improves the environment of the sea area where the sediment is excavated. This can help improve marine environments around developed cities and rehabilitation of fish populations.

3. Enclosing a construction cell with small dikes and directing water drained by vacuum pumping within the small dikes achieves simultaneous

increased loading and water surcharge preloading of the construction cell, facilitating accelerated water drainage from sediment filled in the cell and consolidation thereof and hence speeding up construction.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates rotation and dumping of sediment by a grab rig.

Fig. 2 is a top view of Fig. 1.

Fig. 3 schematically illustrates conveyance and dumping of sediment by a grab rig used in combination with a belt conveyor.

DETAILED DESCRIPTION

The present invention will be described clearly and fully below with reference to the accompanying drawings, which illustrate specific embodiments thereof. It should be understood that these embodiments are presented merely to illustrate the present invention rather than limit its scope in any sense.

Example 1

An environmentally friendly island construction method according to the present invention is used in a 1500-hectare island construction project in a coastal city in East China. The method includes the steps as follows.

Before construction, seabed sediment in a coastal dredging area near an island construction area is surveyed, and indicators of the extent of pollution of the seabed sediment are measured.

Specifically, a drilling rig on a ship is used to collect samples by coring up to 15 meters beneath the seabed in a 10-kilometer wide sea area 50 kilometers away from the island construction area at sites in a square arrangement, which are spaced at intervals of 0.5 to 1 kilometer (samples could

be taken from denser sites in a more geologically complex area).

Geological analysis shows that the sediment is clayey throughout the area. Heavy metal (copper and iron), organic and other pollutants are prevalently detected within 0.5-1.5 meters beneath the seabed surface, while no pollutants are detected below 1.5 meters.

In step 1, grab (bucket) dredgers excavate seabed sediment from the planned dredging area, which is then transported by dredging barges to the vicinity of the stockpiling barges deployed along borders of the construction area. The stockpiling barges are each equipped with two grab rigs, which grab the sediment from the dredging barges using its grab buckets and dump into island construction cells. The stockpiling barges are then moved. Step 1 is repeated until the construction cells are filled up by such sediment.

The seabed sediment grabbed by the grab buckets is substantially free of wastewater overflow, overcoming the problem of massive wastewater production associated with CSD-based dredging.

In this embodiment, 16 m³ grab dredgers are used, each for loading sediment onto four associated 2000-3000 m³ hopper dredging barges, and each stockpiling barge grab rig is equipped with two 16 m³ grab buckets.

Specifically, polluted sediment within 1.5 meters beneath the seabed surface in the marine dredging area (about 50 million m³ in total) is first excavated gradually, and then dumped and filled by the dredging barges into successive construction cells (each having an area of about 200,000 m²) over 3 meters under the surface of water therein (thus forming an underlying layer). After that, with combined reference to Figs. 1 and 2, the dumping stockpiling barges are deployed on the surface of water in the cells (where the polluted sediment has been filled as underlying sediment), and the dredging barges 10 are moored beside the stockpiling barges 20, allowing the grab rigs 30 on the stockpiling barges 20 to grab sediment therefrom using their grab buckets 31.

The sediment is then rotated over areas to be filled in the construction cells and dumped into the areas as overlying sediment.

Fig. 3 shows an alternative filling method, in which sediment excavated by the grab dredgers is transported by the dredging barges 10 to the vicinity of the stockpiling barges 20 and grabbed by the grab rigs 30 on the stockpiling barges 20 using their grab buckets 31. Subsequently, it is conveyed on belts of belt conveyors 40 and dumped into areas to be filled in successive construction cells. In order to facilitate sediment dumping, each belt conveyor 40 is provided at the bottom with a sliding mechanism 41 composed of a sliding track and sliding wheels movable leftward and rightward on the sliding track without moving beyond the track.

Those skilled in the art would readily appreciate that the sediment may be dumped into the areas to be filled using any other approach known in the art, for example, by shaftless screw conveyors or the like. Such dumping approaches are equally applicable to the method of the present invention and may be properly selected in practical construction applications to best address the needs of the applications.

The overlying sediment is filled to a thickness of 6 meters (3 meters under the surface of water and above the surface of the polluted sediment, and another 3 meters above the surface of water). Each stockpiling barge 20 is secured by four anchors from moving forward, backward, leftward or rightward. This enables uniform dumping of the grab buckets on the stockpiling barges 20 and hence achievement of a specified elevation.

In step 2, the island construction area is divided into a number of construction cells each having an area of 100,000-200,000 m², and small dikes are constructed to enclose the construction cells, followed by vacuum plus water surcharge preloading.

Specifically, plastic drainage boards are installed around each construction

cell (by being inserted to a depth of 5-38 meters), and vacuum pumping systems are deployed on top of the plastic drainage boards. Each cell is then covered with an airtight membrane, and the vacuum pumping systems are activated, concurrently with each cell being enclosed with small dikes (0.5-4 meters high), to pump wastewater from the cells into the small dikes, accelerating consolidation of the cells to a predetermined degree of sediment strength (within 3 to 6 months) at the end of construction.

In step 3, the wastewater within the small dikes is purified and discharged to the sea after its water quality meets the requirements of a relevant standard.

In this step, the wastewater is subjected to photoelectrocatalytic (PEC) treatment, which is implemented by a system employing an array of devices made of a nano-composite material containing a visible-light catalyst coupled with an electrocatalyst and deposited on thin-film substrates serving as cathodes and anodes, and organic components and heavy metal ions are effectively removed from the water.

The PEC treatment involves a series of reactions including decomposition of organic molecules in the wastewater into carbon dioxide and water on the surface of the catalytic anodes and reduction of heavy metal ions into their elemental, metallic form on the surface of the cathodes. This treatment method has gained great success in the purification of wastewater from various industrial and agricultural activities, high-salt water, seawater and the like into useful resources, thanks to its advantages of high efficiency, low energy consumption, environmental friendliness and automation. In this project, the wastewater treatment is conducted in a skid-mounted modular plant with a daily capacity of 200,000 tons.

This island construction project has been completed within 2.5 years using eight 16 m³ grab dredgers and associated dredging barges and six dumping stockpiling barges.

Obviously clearer water and more fish have been observed in the coastal sea area beside the city due to the removal of polluted seafloor sediment.

While specific embodiments of the present invention have been described in detail above, they are provided merely by way of example and do not limit the invention in any sense. A person of ordinary skill in the art will appreciate that any equivalent modifications and alternatives made to this invention also fall within the scope of the invention. Accordingly, it is intended that all equivalent changes and modifications made without departing from the spirit and scope of the present invention are embraced within the scope of the invention.

CLAIMS

1. An environmentally friendly island construction method, characterized in comprising the steps of:

(1) excavating seabed sediment in a dredging area by a grab or bucket dredger, then transporting the sediment by a dredging barge to a location beside a stockpiling barge, which is deployed at a border of a construction area and equipped with a grab rig, grabbing the sediment from the dredging barge by a grab bucket and dumping the sediment into an island construction area by the grab bucket, wherein a polluted sediment layer of the seabed sediment in the dredging area is excavated first, and the remainder of seabed sediment is non-polluted and is excavated after the polluted sediment layer is completely excavated; and

(2) dividing the island construction area into a number of construction cells each with an area of 100,000 to 200,000 m², successively draining the construction cells by a vacuum concurrently with each cell being enclosed with small water barrier dikes and guiding water drained by the vacuum within the small dikes, thereby achieving simultaneous increased loading and water surcharge preloading of the construction cells, until sediment strength of each construction cell reaches a predetermined criterion level at the end of construction.

2. The environmentally friendly island construction method according to claim 1, characterized in that in step 1, the grab or bucket dredger is equipped with a grab bucket with a capacity of 1-28 m³.

3. The environmentally friendly island construction method according to claim 1, characterized in that in step 1, the grab rig rotates and then dumps the sediment, or the grab rig dumps the sediment with the aid of a

belt conveyor or a shaftless screw conveyor.

4. The environmentally friendly island construction method according to claim 1, characterized in that in step 2, the vacuum drainage comprises, for each of the construction cells, installing plastic drainage boards around the construction cell, arranging a vacuum pumping system on top of the plastic drainage boards, covering the construction cell with an airtight membrane and directing wastewater drained by the vacuum within the small dikes.

5. The environmentally friendly island construction method according to claim 4, characterized in that the plastic drainage boards have a depth of 5-38 meters.

6. The environmentally friendly island construction method according to claim 1, characterized in that in step 2, the small dikes have a height of 0.5-4 meters.

7. The environmentally friendly island construction method according to claim 1, characterized in further comprising, prior to step 1, geologically surveying the seabed sediment in dredging area, which is a sea area near the island construction area, and measuring indicators of an extent of pollution of the seabed sediment.

8. The environmentally friendly island construction method according to claim 7, characterized in that the seabed sediment is geologically surveyed by coring up to 15 meters beneath a surface of the seabed sediment at sites in a square arrangement, which are spaced at intervals of 0.5 to 1 kilometer, using a drilling rig on a ship.

9. The environmentally friendly island construction method according to claim 7 or 8, characterized in that according to results of the geological survey of the seabed sediment, in step 1, the polluted sediment layer that is excavated first is a silt layer and is dumped into the island construction area, and after the polluted silt layer in the dredging area is completely excavated, the non-polluted remainder of the sediment is excavated and dumped onto the polluted sediment to a thickness not less than 2 meters as an overlying layer.

10. The environmentally friendly island construction method according to claim 1, characterized in further comprising the step of (3) purifying the wastewater within the dikes and discharging it to the sea after its water quality meets the requirements of a standard.

11. The environmentally friendly island construction method according to claim 10, characterized in the wastewater is purified using a photoelectrocatalytic technique for water treatment.