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CAISSON MANUFACTURING AND TRANSFERRING APPARATUS AND METHOD
THEREFOR

BACKGROUND OF THE INVENTION

The present invention relates to a caisson manufacturing and transferring apparatus and method therefor, and more particularly to an apparatus and method therefor in which manufacturing caissons in a casting bed and transferring caissons to the required working or installing place are carried out by a continuous line-up operation requiring smaller space and reduced facilities to increase the operation efficiency and thereby reduce the period and cost of construction.

In the large-sized harbor construction work, a quay wall is usually constructed by building hundreds or thousands of caissons, each of which are composed of steel-reinforced concrete.

However, since caisson is very heavy, e.g. 1,200 tons and big, e.g. 7.4m in width, 13m in length and 19.5m in height, it is difficult to manufacture and transfer such a caisson. Particularly, in order to transfer caisson, enormous supplementary equipments and hands are required.

A conventional apparatus for manufacturing and transferring caissons, as shown in FIG. 1 and 2, has a plurality of

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manufacturing units 1 for respectively forming caisson 2, a plurality of movable carriages 3 for moving caissons, railing system 4 for moving movable carriages, and a launching unit (not shown) for launching caissons to the required installing place. Each of manufacturing units 1 has a manufacturing frame comprising an outer wall form for forming an outer wall of caisson, a plurality of inner wall forms for forming large holes in caisson, a plurality of connection members for connecting and supporting the outer wall form and the inner wall form. Railing system 4 has a forwarding rail for moving the carriages from each of manufacturing units to the launching unit and a returning rail for returning the carriages to the manufacturing units after unloading of caissons from the carriages at the launching unit.

In this apparatus, each manufacturing unit 1 manufactures one caisson at a time. After caisson 2 is formed on movable carriage 3 at manufacturing unit 1, carriage 3 is transferred to railing system 2 by using of a crane (not shown). Then, carriage 3 is transferred to the launching unit through the forwarding rail and returned to manufacturing unit 1 through the returning rail after unloading of caisson 2 at the launching unit.

By virtue of the above stated conventional apparatus, the production capability of caisson has been greatly enhanced. However, since this apparatus uses a large number of

manufacturing units requiring large space to produce caissons and a long separative railing system to return carriages, the cost of facilities has been increased. Further, since caisson manufacturing operation is separatively carried out in each of manufacturing units, the number of hands has been increased, the operation efficiency has been reduced and thereby the period and cost of construction have been increased.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus and method therefor in which manufacturing caissons in a casting bed and transferring caissons to the required working or installing place are carried out by a continuous line-up operation requiring smaller space and reduced facility to increase the operation efficiency and thereby reduce the period and cost of construction.

It is another object of the present invention to provide an apparatus and method therefor in which after caisson is transferred to the required working or installing place, caisson transferring means is able to be easily returned to the required position without using of a long separative railing system such as that in the above stated conventional apparatus.

To accomplish these objects, a caisson manufacturing and transferring apparatus according to the present invention

comprises a casting bed having first working stop for forming a base slab for caisson , second working stop for forming a wall on base slab, and third working stop for curing caisson formed in the second working stop and painting a portion of caisson by epoxy resin to prevent it from corroding, at least one longitudinal trough disposed in the casting bed, base slab form means disposed in and about the trough which is located in the first working stop for forming base slab together with the upper surface of the casting bed, a wall fabricating frame disposed in the second working stop for forming the wall on base slab, floating-up means movably disposed in the trough for floating up caisson or base slab to easily move caisson or base slab, means for transferring caisson or base slab floated by floating-up means.

In the present invention, the base slab form means comprises depressed portion disposed in the trough, soffit form disposed in the depressed portion for forming the bottom of base slab together with the upper surface of casting bed which is located in the first working stop, and a plurality of space blocks disposed on the casting bed having an inner surface adapted to form an outer wall sheeting of base slab. The soffit form is composed of a plurality of inclined supporting portions having respectively a inclined plane thereon disposed at a given width and intervals in the depressed portion of trough, a upper panel having the same width as that of trough

to serve as a form for forming the bottom of base slab together with the upper surface of casting bed, a plurality of inclined sliding portions disposed fixedly on the bottom of upper panel having respectively a inclined plane corresponding to the inclined plane of each of inclined supporting portions to slide thereon, and a hydraulic jack disposed in a wall of depressed portion having a piston rod hinged on one of sliding portions of upper panel.

The floating-up means for floating up caisson or base slab comprises a floating-up panel for loading caisson or base slab thereon having a liquid passage, a plurality of ring-shaped tube disposed under the floating-up panel having respectively an inlet for flowing liquid from the liquid passage of the floating-up panel, a tube protector for protecting ring-shaped tube from being crushed having center landing pads disposed in centers of each ring-shaped tube and corner landing pads disposed in spaces between ring-shaped tubes, a pipe line for flowing liquid into the liquid passage of floating-up panel, and a pump for supplying liquid through the pipe line.

Means for transferring caisson or base slab floated by floating-up means comprises a hydraulic jack for pushing caisson or base slab, a pole for propping up the hydraulic jack, and a plurality of holes for inserting and supporting pole formed in a given intervals and depth in the casting bed.

Wall fabricating frame comprises a slip form for forming a wall on base slab, working deck disposed on the top of slip form for performing steel frame construction and concreting works, a plurality of hydraulic jacks for lifting slip form at a given speed, upper deck disposed on slip form for temporarily storing steel frames and concrete mortars and supplying them to working deck, a plurality of electric hoists for transferring steel frames and concrete mortars to upper deck, weather protection roof supported by a plurality of rods for performing steel frame construction and concreting works regardless of weather and protecting concreted wall of caisson from impairing by rains and sun's ray.

The apparatus according to the present invention further comprises a floating dock for moving caisson to the required installing place including a sitting bed having a trough which is able to join with the trough of casting bed and receive the floating-up means when the floating dock anchors to a caisson launching stop to load caisson, and a plurality of holes for inserting and supporting the pole of caisson transferring means formed in a given intervals and depth along the trough on the sitting bed.

The floating dock further includes floating dock moving means comprising forward winching system having forward wires connecting between the floating dock and the casting bed and forward winches for winding the forward wires to move the

floating dock to the dock launching stop after launching of caisson into the required installing place, and rearward winching system having rearward wires connecting between the floating dock and anchors located on the required installing place and rearward winches for winding the rearward wires to move the floating dock to the required installing place after caisson is transferred to the floating dock.

The floating dock further includes floating dock tilting means having a level controlling space located in one side of floating dock and a pump for filling the level controlling space with seawater to tilt the floating dock at a given degree to ensure the caisson to slide into the required installing place.

Also, the apparatus of the present invention includes means for returning floating-up means to the required position after caisson or base slab is transferred. The returning means comprises towing bar disposed on the rear of floating-up panel, wires connected with the towing bar, vertical/horizontal sheaves for controlling upward and downward level and horizontal direction of wires, and a winch for winding wires disposed on one side of casting bed.

According to the present invention, there is provided a caisson manufacturing and transferring method for use in a caisson manufacturing and transferring apparatus comprising a casting bed having first working stop for forming a base slab,

second working stop for forming a wall on base slab, and third working stop for curing caisson formed in the second working stop and painting a portion of caisson by epoxy resin to prevent it from corroding, at least one longitudinal trough disposed in the casting bed, a base slab form means disposed in and about the trough which is located in the first working stop for forming base slab together with the upper surface of casting bed, wall fabricating means disposed in the second working stop for forming the wall on base slab, floating-up means for floating up caisson or base slab movably disposed in the trough to easily move caisson or base slab, and means for transferring caisson or base slab floated by floating-up means, comprising a base slab fabricating step fabricating base slab at the first working stop, a first transferring step transferring base slab to the second working stop by using of the floating-up means and the transferring means, a wall fabricating step fabricating a wall on base slab at the second working stop, a second transferring step transferring fabricated caisson to third working stop by using of the floating-up means and the transferring means, and a curing and painting step curing caisson formed in the second working stop and painting a portion of caisson by epoxy resin to prevent it from corroding.

In the method according to the present invention, the base slab fabricating step is composed of lifting a upper panel of

soffit form by means of a hydraulic jack to make the upper surface thereof to be level with the upper surface of casting bed, sealing a gap between the upper panel of soffit form and the casting bed, covering polyethylene and vinyl resin sheets on upper surfaces of casting bed and the upper panel of soffit form, disposing space blocks on the casting bed and the upper panel of soffit form to form a outer wall sheeting of base slab, and performing steel frame construction and concreting works.

The first transferring step comprises separating the space blocks from the base slab after a concrete mortar of the base slab is cured, lowering the upper panel of soffit form by means of the hydraulic jack to ensure the floating-up means to freely come into the trough of first working stop, floating up the base slab by supplying liquid into a plurality of ring-shaped tube disposed under the floating-up panel, and transferring base slab to the second working stop by operating a hydraulic jack supported by a pole for propping up the hydraulic jack.

The wall fabricating step comprises setting a slip form on base slab, performing steel frame construction and concreting works, lifting the slip form at a given speed by means of a plurality of hydraulic jack after a start concrete mortar in the slip form is cured, and repeating the steel frame construction and concreting works until the caisson is

completely built.

The slip form comprises an outer wall form for forming an outer wall of caisson, a plurality of inner wall form for forming large holes in caisson, a plurality of connection members for connecting and supporting the outer wall form and the inner wall form.

The second transferring step comprises separating the slip form from caisson after a last concrete mortar is cured, floating up caisson by supplying the liquid into a plurality of ring-shaped tube disposed under floating-up panel, and transferring caisson to the third working stop by operating the hydraulic jack supported by the pole for propping up the hydraulic jack.

The method according to the present invention further comprises loading caisson on a floating dock by using of floating-up means and transferring means, moving the caisson-loaded floating dock to the required installing place by winding the wires connected with the anchor by using of a winch, and launching caisson to the required installing place by filling a level controlling space located in one side of the floating dock with seawater to tilt the floating dock to ensure caisson to slide into the required installing place, the floating dock being connected to the casting bed at its one side and a anchor of the required installing place at its other side by means of wires and including a sitting bed having

a trough which is able to join with the trough of the casting bed and receive the floating-up means when the floating dock loads caisson.

Also, the method according to the present invention includes returning floating-up means to the required position by using of means for returning floating-up means after caisson or base slab is transferred. The returning means comprises towing bar disposed on the rear of the floating-up panel, wires connected with the towing bar, vertical/horizontal sheaves for controlling a upward and downward level and horizontal direction, and winch for winding wires disposed on one side of casting bed.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and other advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG.1A is a plan view of conventional apparatus for manufacturing and transferring caissons;

FIG.1B is a side view of the conventional apparatus for manufacturing and transferring caissons shown in FIG.1A;

FIG.2 is a plan view of a caisson manufacturing and transferring apparatus of the preferred embodiment of the

present invention;

FIG.3 is a cross-sectional view of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention shown in FIG.2;

FIG.4A, 4B, 4C and 4D are schematic plan views to illustrate states in which a base slab and caisson are transferred by floating-up means of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention;

FIG.5A and 5B are cross-sectional views to illustrate states in which a soffit form of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention is operated;

FIG.6 is a schematic plan view of floating-up means of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention;

FIG.7A and 7B are cross-sectional views to illustrate states in which floating-up means of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention is operated, taken along line A-A of FIG.6;

FIG.8 is a side view to illustrate a state in which means for transferring caisson or base slab of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention is operated; and

FIG.9 is a schematic cross-sectional view to illustrate a

state in which a floating dock of the caisson manufacturing and transferring apparatus of the preferred embodiment of the present invention anchored into a caisson launching station.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG.2 and FIG.3, a caisson manufacturing and transferring apparatus according to the embodiment of the present invention includes a casting bed 100 having first working stop 100A for forming a base slab 210, second working stop 100B for forming a wall on base slab 210, and third working stop 100C for curing caisson 200 formed in second working stop 100B and painting a portion of caisson 200 by epoxy resin to prevent it from corroding.

The casting bed 100 has first and second longitudinal rectangular trough 110 and 110' which are respectively extended from one end of casting bed 100 to the seaside and separated each other in a given intervals.

In first working stop 100A of casting bed 100, there is a base slab form comprising depressed portions 120 and 120' (not shown) disposed respectively in corresponding first and second trough 110 or 110', soffit forms 10 and 10' disposed respectively in corresponding depressed portions 120 for forming the bottom of base slab 210 together with the upper

surface of casting bed 100 which is located in first working stop 100A as shown in FIG.5A and 5B, and a plurality of space blocks(not shown) disposed on casting bed 100 having an inner surface adapted to form an outer wall sheeting of base slab 210.

Each of soffit forms 10 and 10' is composed of a plurality of inclined supporting portions 12, 12', 12" and 12'" disposed at a given width and intervals in depressed portion 120 of trough 110 having respectively a inclined plane thereon, a upper panel 13 having the same width as that of trough 110 to serve as the form for forming the bottom of base slab 210, a plurality of inclined sliding portions 14, 14' 14" and 14'" disposed fixedly on the bottom of upper panel 13 having respectively a inclined plane corresponding to the inclined plane of inclined supporting portions 12, 12', 12" and 12'" to slide thereon, and a hydraulic jack 15 disposed in the wall of depressed portion 120 having a piston rod hinged in sliding portion 14 of upper panel 13.

In here, it is appreciated that since each of soffit forms 10 and 10' has same structure, only one soffit form will be explained.

When one 14 of sliding portions are pushed by the piston rod of hydraulic jack 15 hinged therewith and upwardly slided along the inclined plane of supporting portion 12, other sliding portions 14', 14" and 14'" are also upwardly slided

respectively along the inclined planes of supporting portions 12', 12" and 12'" by means of upper panel 13. Thus, as shown in FIG.5B, upper panel 13 is lifted in a position to serve as a form for forming the bottom of base slab 210 together with the upper surface of casting bed 100.

Thereafter, gaps between upper panel 13 of each of soffit forms 10 and 10' and casting bed 100 are sealed. Also, polyethylene and vinyl resin sheets are covered on the upper surfaces of casting bed 100 and upper panel 13 of each of soffit forms 10 and 10' to form a soffit sheeting of base slab 210 and space blocks are disposed thereon to form a outer wall sheeting of base slab 210.

When one 14 of sliding portions are pulled by the piston rod of hydraulic jack 15 hinged therewith and downwardly slid along the inclined plane of supporting portion 12, sliding portions 14', 14" and 14'" are also downwardly slid respectively along the inclined planes of supporting portions 12', 12" and 12'" by upper panel 13. Thus, as shown in FIG.5A, upper panel 13 is lowered in a position to be inserted into depressed portion 120 to let floating-up means 30 and 30' as will be described below to freely pass through trough 110 and 110' of casting bed 100.

The apparatus according to the present invention further includes floating-up means 30 and 30' movably disposed respectively in corresponding trough 110 or 110' to float up

caisson 200 or base slab 210 to easily move them, as shown in FIG.6, 7A and 7B.

Each of floating-up means 30 and 30' for floating up caisson 200 or base slab 210 comprises a floating-up panel 33 for loading caisson 200 or base slab 210 having a liquid passage 33A, a plurality of ring-shaped tube 32 disposed under floating-up panel 33 having respectively an inlet 31 for flowing liquid, i.e. seawater from liquid passage 33A of floating-up panel 33, a tube protector 36 for protecting ring-shaped tubes 32 from being crushed comprising center landing pads 37 disposed in centers of each ring-shaped tube 32 and corner landing pads 38 disposed in spaces between ring-shaped tubes 32, pipe lines 34 for flowing seawater into liquid passage 33A of floating-up panel 33, and a pump 35 for supplying seawater of reservoir 39 through pipe lines 34.

Prior to inflation, floating-up means 30 and 30' are moved under caisson 200 or base slab 210, and load is solidly supported on tube protector 36, as shown in FIG.7A.

When seawater is pumped into floating-up means 30 and 30' at high pressure, for example 6.54 kg/cm² by means of pump 35, ring-shaped tubes 32 of floating-up means 30 and 30' inflate, creating a seal against the floor surfaces of troughs 110 and 110' or the upper surface of upper panels 13 of soffit forms 10 and 10'. At this time, a portion of seawater is flowed into plenum space under center landing pads 37 of tube protector 36.

As shown in FIG.7B, when liquid pressure within plenum space under center landing pads 37 of tube protector 36 is sufficient to offset the weight of caisson 200 or base slab 210, seawater slowly escapes between ring-shaped tubes 32 of floating-up means 30 and 30' and the floor surfaces of troughs 110 and 110' or the upper surface of upper panels 13 of soffit forms 10 and 10'.

The caisson 200 or base slab 210 is literally floated on a thin, frictionless cushion of liquid, 0.08 - 0.13 mm thick.

The apparatus according to the present invention also includes two means 160 for transferring caisson 200 or base slab 210 floated by floating-up means 30 and 30' as shown in FIG.8. Also, it is appreciated that since each of caisson transferring means has same structure, only one caisson transferring means will be illustrated and explained.

Each of two caisson transferring means 160 comprises a hydraulic jack 150 with a capacity of several tens of tons, for example 50 tons for moving caisson 200 or base slab 210, a pole 140 for propping up hydraulic jack 150, and a plurality of holes 130 for inserting and supporting pole 140 formed in a given intervals and depth along each of troughs 110 and 110' on casting bed 100, as shown in FIG.2 and 8.

When a piston rod of hydraulic jack 150 is extended to push pole 140, caisson 200 or base slab 210 is transferred at a extended distance of piston rod by supporting power of pole

140. Then, the piston rod of hydraulic jack 150 is withdrawn and pole 140 is moved and inserted into next hole. Thus, by repeating the operation of hydraulic jack 150 and moving of pole 140, caisson 200 or base slab 210 is transferred to following working stop 100B of casting bed 100.

In second working stop 100B of casting bed 100, there is a wall fabricating frame 25 comprising a slip form 22 for forming a wall of caisson 200 on base slab 210, working deck (not shown) disposed on top of slip form 22 for performing steel frame construction and concreting works, a plurality of, for example 14 hydraulic jacks (not shown) with a capacity of several tens of tons, for example 42 tons for lifting slip form 22 at a given speed, upper deck (not shown) disposed on slip form 22 for temporarily storing steel frames and concrete mortars and supplying them to working deck, a plurality of, for example 7 electric hoists (not shown) with a capacity of several tons, for example 3.2 tons for transferring steel frames and concrete mortars to upper deck, and weather protection roof 21 supported by a plurality of rods 20 for performing steel frame construction and concreting works regardless of weather and protecting concreted wall of caisson 200 from impairing by rains and sun's ray as shown in FIG.3.

The slip form 22 comprises an outer wall form (not shown) for forming an outer wall of the caisson, a plurality of inner wall forms (not shown) for forming large holes in caisson, and

a plurality of connection members (not shown) for connecting and supporting outer wall form and inner wall form. The slip form 22 having 1 m in height is lifted in a given speed, for example about 10-20 cm/hour after curing of start concrete mortar inserted in slip form 22.

The steel frame and concrete mortars are supplied to slip form 22 respectively through corresponding guide tubes connecting between upper deck and working deck.

In third working stop 100C of casting bed 100, there are painting and repairing facilities(not shown). After curing caisson formed in second working stop 100B and painting a portion of caisson by epoxy resin to prevent it from corroding, caisson 200 is transferred to following caisson launching stop 100D.

In the caisson launching stop 100D, there are a floating dock 50 for moving caisson to final installing place, a grounding bed 62 for laying down floating dock 50, and a vertical wall 55 consolidated by sheet piles 61, as shown in FIG.3 and 9.

Floating dock 50 includes a sitting bed 60, a floating dock moving means, and a floating dock tilting means (not shown).

Sitting bed 60 has troughs (not shown) which are able to join with trough 110 and 110' of casting bed 100 and receive floating-up means 30 and 30' when floating dock 50 anchors to caisson launching stop 100D to load caisson 200 thereon, and a

plurality of holes 130' for inserting and supporting poles 140 of caisson transferring means 160 formed in a given intervals and depth along each of troughs on sitting bed 60, as shown in FIG.2.

Floating dock moving means comprises forward winching system 48 having forward wires 51 connecting between floating dock 50 and casting bed 100 and forward winches 53 for winding forward wires 51 to move floating dock 50 to caisson launching stop 100D after launching of caisson 200 to required installing place, and rearward winching system 49 having rearward wires 51' connecting between floating dock 50 and anchor 52 located on required installing place and rearward winches 53' for winding rearward wires 51' to move floating dock 50 to required installing place after loading of caisson 200 on floating dock 50, as shown in FIG.4D and 9. When forward winches 53 wind forward wires 51 to move floating dock 50 to caisson launching stop 100D, rearward winches 53' unwind rearward wires 51' and when rearward winches 53' wind rearward wires 51' to move floating dock 50 to required installing place, forward winches 53 unwind forward wires 51.

Floating dock tilting means has a level controlling space located in one side of floating dock 50 and a pump for filling level controlling space with seawater to tilt floating dock 50 at a given degree, for example $12 - 18^{\circ}$ to ensure caisson 200 to be slid into required installing place.

The height of vertical wall 55 is determined according to the tides and the part of a hull of floating dock 50 immersed in seawater after loading of caisson 200 on floating dock 50 and the horizontal level of grounding bed 62 is determined according to the determined height of vertical wall 55 to let sitting bed 60 of floating dock 50 to be level with casting bed 100. Since a vertical slip or dislocation between contacted ends of floating dock 50 and casting bed 100 can be produced to obstruct caisson 200 from moving when the level of grounding bed 62 is incorrectly determined, an accurate levelling thereof is required.

Also, since grounding bed 62 can be submerged by weight of caisson 200 and floating dock 50 when floating dock 50 loads caisson thereon, consolidating foundation of grounding bed 62 is required.

Also, the apparatus according to the present invention includes means 39 for returning floating-up means 30 and 30' to required position after unloading of caisson 200 or base slab 210 from floating-up means 30 and 30', as shown in FIG.4A, 4B, 4C and 4D. The means 39 for returning floating-up means 30 and 30' comprises towing bars disposed respectively on the rears of floating-up panel 33 and 33', wires 41 connected with towing bars, vertical/horizontal sheaves 42 for controlling upward and downward level and horizontal direction of wires, and a winch 40 for winding wires 41 disposed on one side of

casting bed 100. When caisson 200 or base slab 210 is transferred by transferring means 160 from one working stop to other working stop, winch 40 unwinds wires 41 to let floating-up means 30 and 30' to be freely moved and when floating-up means 30 and 30' is to be moved to required position to transfer other caisson 200 or base slab 210 after unloading of one caisson 200 or base slab 210, winch 40 winds wires 41 to pull and move them to the required position.

Operation of a caisson manufacturing and transferring apparatus according to an embodiment of the present invention will be described, hereinafter.

FIGS 2 - 4 illustrate the operation of the apparatus having first, second, and third working stop 100A, 100B and 100C for manufacturing caisson 200, and caisson launching stop 100D for launching caisson 200 to the required installing place.

At first, in the first working stop 100A fabricating a base slab 210, one sliding portions 14 of each of soffit forms 10 and 10' is pushed by a piston rod of hydraulic jack 15 hinged therewith and upwardly slid along the inclined plane of one supporting portions 12. Other sliding portions 14', 14" and 14''' are also upwardly slid respectively along the inclined planes of other supporting portions 12', 12" and 12''' . Thus, as shown in FIG.5B, the upper panel 13 is lifted in a position to serve as a form for forming the bottom of base slab 210 together with the upper surface of casting bed 100. Thereafter, gaps between

upper panel 13 of each of soffit forms 10 and 10' and casting bed 100 are sealed. Also, polyethylene and vinyl resin sheets are covered on the upper surfaces of casting bed 100 and upper panel 13 of each of soffit form 10 and 10' to form a soffit sheeting of base slab 210, and space blocks are disposed thereon to form a outer wall sheeting of base slab 210. Then, in soffit forms 10 and 10', steel frame works are performed and concrete mortar is filled to form a base slab.

After concreted base slab is cured, one 14 of sliding portions is pulled by the piston rod of hydraulic jack 15 hinged therewith and downwardly slid along the inclined plane of supporting portions 12.

Other sliding portions 14' 14" and 14'" are also downwardly slid respectively along the inclined planes of other supporting portions 12', 12" and 12'" by upper panel 13. Thus, as shown in FIG.5A, the upper panel 13 is lowered in a position to be inserted into depressed portion 120 to let floating means 30 and 30' to freely pass through trough 110 and 110' of first working stop 100A. After space blocks are separated from base slab 210, floating-up means 30 and 30' are moved into trough 110 and 110' of first working stop and positioned under base slab 210 by means 39 for returning floating-up means 30 and 30' , as shown in FIG.4A.

When seawater is pumped into floating-up means 30 and 30' at high pressure, for example 6.54 kg/cm² by means of pump 35,

ring-shaped tubes 32 of floating-up means 30 and 30' inflate, creating a seal against the floor surfaces of troughs 110 and 110' or the upper surface of upper panels 13 of soffit forms 10 and 10', as shown in FIG.7A. At this time, a portion of seawater is flowed into the plenum space under center landing pads 37 of tube protector 36. As shown in FIG.7B, when the liquid pressure within plenum space under center landing pads 37 of tube protector 36 is sufficient to offset the weight of base slab 210, seawater slowly escapes between ring-shaped tubes 32 of floating-up means 30 and 30' and the floor surfaces of troughs 110 and 110' or the upper surface of upper panels 13 of soffit forms 10 and 10'. The base slab 210 is literally floated on a thin, frictionless cushion of liquid, 0.08 - 0.13 mm thick.

Next, hydraulic jack 150 and pole 140 of transferring means 160 are installed respectively in one side of base slab 210 and hole 130, as shown in FIG. 8. When a piston rod of hydraulic jack 150 of transferring means 160 is extended to push pole 140, base slab 210 is transferred in a extended distance of piston rod by supporting power of pole 140.

Then, the piston rod of hydraulic jack 150 is withdrew and pole 140 is moved and inserted into next hole. Thus, by repeating the operation of hydraulic jack 150 and moving of pole 140, base slab 210 is transferred to the following working stop 100B of casting bed 100. After transferring of base slab

210, in first working stop 100A, operation fabricating another base slab is performed as described above.

In second working stop 100B for forming a wall on base slab 210, a slip form 22 is set on base slab, and steel frame construction and concreting work are performed thereon. Steel frames and concrete mortars for these works are supplied respectively through corresponding guide tubes from upper deck to working deck. After curing of the start concrete mortar inserted in slip form, slip form 22 is lifted in a given speed of about 10-20 cm/hr by means of 14 hydraulic jacks with a capacity of 42 tons. With lifting of slip form 22, the steel frame construction and concreting works are continuously performed until the caisson is completely built.

The lifting speed of the slip form 22 is controlled according to curing period of the concrete mortar, mixed rate of concrete, and skill of hands.

After caisson 200 is built in second working stop 100B, it is transferred to third working stop 100C by using of floating-up means 30 and 30' and transferring means 160 as described above. Another base slab formed in first working stop 100A is also transferred to second working stop 100B by using of floating-up means 30 and 30' and transferring means 160 and in second working stop 100B, operation forming a wall thereon is performed by using of wall fabricating frame 25. At this time, returning floating-up means 30 and 30' from third

working stop 100C to first working stop 100A is carried out by pulling wires 41 by means of winches 40 of returning means 39.

Also, in first working stop 100A, operation fabricating third base slab is performed in a manner as described above.

In third working stop 100C, the caisson 200 formed in second working stop 100B is cured and if necessary, repaired. Also, a portion, for example tidal zone of caisson is painted by epoxy resin to prevent it from corroding.

After curing in third working stop 100C, caisson 200 is transferred to a sitting bed 60 of a floating dock 50 by using of floating-up means 30 and 30', transferring means 160, and troughs (not shown) and holes 130' of sitting bed 60, as described above.

When floating dock 50 loads caisson 200 thereon, i.e, caisson 200 is transferred to sitting bed 60 of floating dock 50, troughs of sitting bed 60 and casting bed 100 are temporarily sealed each other on contacted ends thereof to ensure floating-up means 30 and 30' to be perfectly operated.

Another caisson formed in second working stop 100B is transferred to third working stop 100C by using of floating-up means 30 and 30' and transferring means 160 and in third working stop 100C, curing and painting operation therefor is performed. Also, third base slab formed in first working stop 100A is transferred to second working stop 100B by using of floating-up means 30 and 30' and transferring means 160 and in

second working stop 100B, operation forming a wall thereon is performed by using of wall fabricating frame 22. Also, in first working stop 100A, operation fabricating fourth base slab is performed in a manner as described above.

In caisson-loaded floating dock 50 of caisson launching stop 100D, seawater stored in the body of floating dock 50 is pumped out to float up floating dock 50 and moved to the final installing place by pulling rearward wires 51' by means of rearward winches 53' of rearward winching system 49, as shown in Figs 4D and 9.

After floating dock 50 is moved to the final installing place, a level controlling space located in one side of floating dock 50 is filled with seawater by a pump. Thus, floating dock 50 is tilted at a given degree, for example $12 - 18^\circ$ to let caisson 200 to slide into the required installing place and to be launched.

After launching of caisson 200, seawater of level controlling space is pumped out. The floating dock 50 is returned to grounding bed 62 of caisson launching stop 100D by pulling forward wires 51 by means of forward winches 53 of forward winching system 48. When floating dock 50 is positioned on grounding bed 62 in the position which troughs of sitting bed 60 are able to join with trough 110 and 110' of casting bed 100, the body of floating dock 50 is filled with seawater by the pump to submerge and thereby lay down floating

dock 50.

In this way, by repeating operations in each of working stops, caissons are manufactured and launched in the required installing place. Thus, the present invention provides an apparatus and method therefor in which manufacturing caissons in casting bed and transferring caissons to required installing place are carried out by a continuous line-up operation requiring a small space and facility to increase the operation efficiency and thereby reduce the period and cost of construction.

Also, the present invention provides an apparatus and method therefor having a simple structure and operation in a manner which after caisson is transferred to the following or required working stop, caisson transferring means is able to be easily returned to the required position without using of a long separative railing system such as that in the conventional system.



What is claimed is:

1. A caisson manufacturing and transferring apparatus comprising:

a casting bed having first working stop for forming a base slab for caisson , second working stop for forming a wall on base slab, and third working stop for curing caisson formed in the second working stop and painting a portion of caisson by waterproof stuff to prevent it from corroding;

at least one longitudinal trough disposed in said casting bed;

base slab form means disposed in and about said trough which is located in the first working stop for forming base slab together with the upper surface of said casting bed;

wall fabricating means disposed in second working stop for forming the wall on the base slab;

floating-up means movably disposed in said trough for floating up caisson or base slab to easily move caisson or base slab; and

means for transferring caisson or base slab floated by floating-up means to the required position.

2. The apparatus as claimed in claim 1, wherein said base slab form means comprises depressed portion formed in the trough, soffit form disposed in the depressed portion for forming the



bottom of base slab together with the upper surface of casting bed which is located in the first working stop, and a plurality of space blocks disposed on the casting bed having an inner surface adapted to form an outer wall sheeting of base slab.

3. The apparatus as claimed in claim 2, wherein said soffit form is composed of a plurality of inclined supporting portions having respectively a inclined plane thereon disposed at a given width and intervals in the depressed portion of trough, a upper panel having the same width as that of the trough to serve as a form for forming the bottom of base slab together with the upper surface of casting bed, a plurality of inclined sliding portions disposed fixedly on the bottom of upper panel having respectively a inclined plane corresponding to the inclined plane of each of inclined supporting portions to slide thereto, and a hydraulic jack disposed in a wall of depressed portion having a piston rod hinged on one of the sliding portions of upper panel.

4. The apparatus as claimed in claim 1, wherein said floating-up means comprises a floating-up panel for loading caisson or base slab thereon having a liquid passage, a plurality of ring-shaped tube disposed under the floating-up panel having respectively an inlet for flowing liquid from the liquid passage of floating-up panel, a tube protector for



protecting the ring-shaped tube from being crushed having center landing pads disposed in centers of each ring-shaped tube and corner landing pads disposed in spaces between ring-shaped tubes, a pipe line for flowing liquid into the liquid passage of floating-up panel, and a pump for supplying liquid through the pipe line.

5. The apparatus as claimed in claim 1, wherein said transferring means comprises a hydraulic jack for pushing caisson or base slab, a pole for propping up the hydraulic jack, and a plurality of holes for inserting and supporting the pole formed in a given intervals and depth in the casting bed.

6. The apparatus as claimed in claim 1, wherein said wall fabricating means comprises a slip form for forming a wall on base slab, working deck disposed on top of slip form for performing steel frame construction and concreting works, a plurality of hydraulic jacks for lifting slip form at a given speed, upper deck disposed on slip form for temporarily storing steel frames and concrete mortars and supplying them to working deck, a plurality of electric hoists for transferring steel frames and concrete mortars to upper deck, and weather protection roof supported by a plurality of rods for performing steel frame construction and concreting works regardless of weather condition and protecting concreted wall of caisson



from impairing by rains and sun's ray.

7. The apparatus as claimed in claim 1, further comprising a floating dock for moving caisson to the required installing place including a sitting bed having a trough which is able to join with the trough of casting bed and receive the floating-up means when the floating dock anchors to a caisson launching stop to load caisson, and a plurality of holes for inserting and supporting the pole of caisson transferring means formed in a given intervals and depth along the trough on the sitting bed.

8. The apparatus as claimed in claim 7, wherein said floating dock further comprises floating dock moving means comprising forward winching system having forward wires connecting between the floating dock and the casting bed and forward winches for winding the forward wires to move the floating dock to the dock launching stop after launching of caisson to the required installing place, and rearward winching system having rearward wires connecting between the floating dock and the anchor located on the required installing place and rearward winches for winding the rearward wires to move the floating dock to the required installing place after loading of caisson on the floating dock.



9. The apparatus as claimed in claim 7, wherein said floating dock further comprises floating dock tilting means having a level controlling space located in one side of the floating dock and a pump for filling the level controlling space with seawater to tilt the floating dock at a given degree to ensure caisson to slide into the required installing place.

10. The apparatus as claimed in claim 1, further comprising means for returning floating-up means to the required position after the caisson or base slab is transferred.

11. The apparatus as claimed in claim 10, wherein said returning means comprises towing bar disposed on the rear of the floating-up panel, wires connected with the towing bar, vertical/horizontal sheaves for controlling upward and downward level and horizontal direction of wires, and a winch for winding the wires disposed on one side of the casting bed.

12. A caisson manufacturing and transferring method for use in a caisson manufacturing and transferring apparatus comprising a casting bed having first working stop for forming a base slab, second working stop for forming a wall on base slab, and third working stop for curing caisson formed in the second working stop and painting a portion of the caisson by waterproof stuff to prevent it from corroding, at least one



longitudinal trough disposed in the casting bed, a base slab form means disposed in and about the trough which is located in the first working stop for forming base slab of caisson together with the upper surface of casting bed, wall fabricating means disposed in second working stop for forming the wall on base slab, floating-up means for floating up caisson or base slab movably disposed in the trough to easily move caisson or base, and means for transferring caisson or base slab floated by floating-up means to the required position, comprising:

a base slab fabricating step fabricating base slab of caisson at the first working stop;

a first transferring step transferring base slab to the second working stop by using of the floating-up means and the transferring means;

a wall fabricating step fabricating a wall on base slab at the second working stop;

a second transferring step transferring fabricated caisson to third working stop by using of the floating-up means and the transferring means; and

a curing and painting step curing caisson formed in the second working stop and painting a portion of the caisson by waterproof stuff to prevent it from corroding.

13. The method as claimed in claim 12, wherein said base slab



fabricating step comprises lifting soffit form, said soffit form being disposed in depressed portion which is located in the trough of first working stop, and composed of a plurality of inclined supporting portions having respectively a inclined plane thereon disposed at a given width and intervals in the depressed portion of trough, upper panel having the same width as that of the trough to serve as a form for forming the bottom of base slab together with the upper surface of casting bed, a plurality of inclined sliding portions disposed fixedly on the bottom of upper panel having respectively a inclined plane corresponding to the inclined plane of each of inclined supporting portions to slide thereon, and a hydraulic jack disposed in a wall of depressed portion having a piston rod hinged on one of the sliding portions of upper panel, sealing a gap between the upper panel of lifted soffit form and the casting bed, covering polyethylene and vinyl resin sheets on upper surfaces of casting bed and the upper panel of soffit form, disposing space blocks on the casting bed and the upper panel of soffit form to form an outer wall sheeting of base slab, and performing steel frame construction and concreting works.

14. The method as claimed in claim 12, wherein said first transferring step comprises separating the space blocks from base slab after a concrete mortar of base slab is cured,



lowering the upper panel of soffit form by means of the hydraulic jack to ensure the floating-up means to freely come into the trough of first working stop, floating up base slab by means of floating-up means, said floating-up means being comprised a floating-up panel for loading caisson or base slab thereon having a liquid passage, a plurality of ring-shaped tube disposed under the floating-up panel having respectively an inlet for flowing liquid from the liquid passage of floating-up panel, a tube protector for protecting the ring-shaped tube being crushed having center landing pads disposed in centers of each ring-shaped tube and corner landing pads disposed in spaces between ring-shaped tubes, a pipe line for flowing liquid into the liquid passage of floating-up panel, and a pump for supplying liquid through the pipe line, and transferring base slab to the second working stop by means of transferring means, said transferring means being comprised a hydraulic jack for pushing caisson or base slab, a pole for propping up the hydraulic jack, and a plurality of holes for inserting and supporting the pole formed in a given intervals and depth in the casting bed.

15. The method as claimed in claim 12, wherein said wall fabricating step comprises setting a slip form on the base slab, performing steel frame construction and concreting works, lifting the slip form at a given speed by means of a



plurality of hydraulic jack after a start concrete mortar in the slip form is cured, and repeating the steel frame construction and concreting works until caisson is completely built, said slip form being comprised of an outer wall form for forming an outer wall of the caisson, a plurality of inner wall form for forming large holes in caisson, a plurality of connection members for connecting and supporting the outer wall form and the inner wall form.

16. The method as claimed in claim 12, wherein said second transferring step comprises separating the slip form from caisson after a last concrete mortar is cured, floating up caisson by supplying liquid into a plurality of ring-shaped tube disposed under the floating-up panel, and transferring caisson to the third working stop by operating the hydraulic jack supported by the pole for propping up the hydraulic jack.

17. The method as claimed in claim 12, further comprising a step of loading caisson on a floating dock by using of the floating-up means and transferring means, said floating dock being comprised a sitting bed having a trough which is able to join with the trough of casting bed and receive the floating-up means when the floating dock anchors to a caisson launching stop to load caisson, and a plurality of holes for inserting



and supporting the pole of caisson transferring means formed in a given intervals and depth along the trough on the sitting bed.

18. The method as claimed in claim 12, further comprising a step of moving the caisson-loaded floating dock to the required installing place by using of the floating dock moving means, said floating dock moving means being comprised wires connecting between the floating dock and an anchor located on the required installing place and winches for winding the wires to move the floating dock to the required installing place after loading of caisson on the floating dock.

19. The method as claimed in claim 12, further comprising a step of launching caisson to the required installing place by using of floating dock tilting means, said floating dock tilting means being comprised a level controlling space located in one side of the floating dock and a pump for filling the level controlling space with seawater to tilt the floating dock at a given degree to ensure caisson to slide into the required installing place.

20. The method as claimed in claim 12, further comprising a step of returning the floating-up means to the required position by using of means for returning floating-up means



after caisson or base slab is transferred, said means for returning floating-up means being comprised towing bar disposed on the rear of the floating-up panel, wires connected with the towing bar, vertical/horizontal sheaves for controlling a upward and downward level and horizontal direction, and winch for winding wires disposed on one side of casting bed.