METHOD AND APPARATUS FOR PLASTIC HYDRAULIC MATERIAL

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Filed: Mar. 28, 1972

Appl. No.: 238,795

U.S. Cl. 61/63, 61/53, 61/64, 61/53.74, 61/56
Int. Cl. E02d 5/32
Field of Search 61/53, 53.52, 53.5, 61/53.74, 56, 63

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ABSTRACT

Method and apparatus for placing hydraulic material through watertight flexible tubes onto the bottom of a steel column, in which said apparatus consists of watertight flexible tubes for transferring said hydraulic material; supporting pipes holding said tubes therein and having apertures on the wall portions; and a steel column holding said pipes therein and receiving the transferred hydraulic material onto the bottom thereof.

6 Claims, 4 Drawing Figures
This invention relates to a method and apparatus for placing hydraulic material which is hardened in the water such as hydraulic cement mixture.

Further, the invention relates to a method and apparatus for constructing foundations such as piers of bridges on the bottom ground in the water or in the sea.

In the recent construction work, there are several occasions in which the hydraulic material is to be placed with steep inclination from a certain point on the land to the other point in the water, or from a point in the water to the other point in the lower water, in addition to that the construction site is generally narrow in space. In placing the mixture of the hydraulic material, the placement on the horizontal level or from the lower level to the higher level is usually easy owing to the improvements in the apparatus and techniques. While, the placement from the higher level to the lower level seems simple, however it is necessary to control several conditions of the operations, especially when the construction site is placed in a narrow space. For example, the size and inclination of the delivery pipe or conduit for the material to be transferred must be selected. Further in several cases, only the regulations of the size and inclination of the transferring pipes cannot cover the requirements for the construction work. However, if the intake and the outlet for the material are on the land, some other necessary measures can be taken for the difficulties. While, the problem awaiting solution is the case in which the outlet of the pipe for the hydraulic material is placed at a certain point in the water.

Further, in case the head between the intake of the hydraulic material and the outlet is small, the ordinary method to place the hydraulic material can be employed, however, if the head is large, the placement is very difficult. In recent years, exploitations for ocean and coasts, utilizations of the sea and facilities for marine transportation require highly developed constructions. Therefore, the placement of the construction material from a point on the surface of the water or from a point in the water to the far deep bottom with a very steep inclination and within a narrow construction site, must be carried out.

For these constructions, the ordinary methods are not sufficient to meet with several requirements, therefore the scale and structure of the constructions for such facilities are much restricted.

Accordingly, the object of the present invention is to provide a method and apparatus for placing the hydraulic material in order to build such constructions with reliability, in which the hydraulic material can be transferred from a higher place to a lower place within a restricted area of the construction site.

Up to now, when buildings or foundations are built with using the hydraulic material, the plans and designs are made so as to avert the construction from the work in the water, and in an unavoidable case, the vertical head of the transfer of the hydraulic material is to be restricted. The reason is that the result of the placement cannot be observed or checked from above the water surface when the hydraulic material is placed in the water, further even though the defects of the placed material are found, it is impossible to reinforce or repair these defects. In the past, when the hydraulic material is to be placed in the water, careful and complete plans and preparations were made in advance, and the construction work was carried out by skilled engineers with the greatest cares. And the device of the placement must have sufficient capacity, as well as that the flow of the material is not caused pulsation and to be smooth. Further, the device of placement must be installed in the construction site of imperfect conditions. The tube used for transferring the hydraulic material is suspended and the outlet for the hydraulic material is placed near the position to receive the hydraulic material, in addition to that the tube must be so devised as to be moved in the directions of right and left and upward and downward. Further, the water in the tube must be discharged prior to the feed of the hydraulic material, or the tube must be kept from the water by filling with the hydraulic material. When the vertical head is small, these can be carried by the ordinary method. However, the recent constructions which require very high vertical head of the transferring of the hydraulic material cannot be carried out by any of the ordinary technical arts. And if intermissions or pulsations are caused to happen in the transferring tube for the hydraulic material, water comes into the tube from the outlet in the counter direction, therefore the setting-up of the tube must be done over again.

Further, if the velocity of the hydraulic material which is discharged from the outlet of the tube is not adequate, serious troubles are brought about in the construction work. That is, if the downward velocity of the material is slow, the setting of the material happens during the placement, and if the velocity of the material is high beyond a certain degree, complicated fluid motion of the material is caused, therefore the discharged material is stirred and mixed with the surrounding water, and firm construction cannot be built in the water.

In general, when fluid is transferred through a tube, the quantity and the velocity of the material in the tube can be regulated by changing the diameter of the tube or by providing the outlet or intake of the tube with a valve. However, in the case of the hydraulic material, a large quantity of abrasive material is contained in it, therefore the regulation by means of the valve is very difficult. For example, as the specific gravity of water is 1.0, and that of the hydraulic material is 1.5 to 2.4, the pressure caused by the vertical head of the material and Torricelli's vacuum bring about serious troubles in the construction work. As the result, the quantity and the velocity of the material in the tube get out of order, therefore a firm construction cannot be built in the water. Still further, if an unexpectedly long time is taken in the construction work, all of the hydraulic material as well as those in the tube and other devices start setting and all apparatus are damaged.

In accordance with the method of the present invention, all of these defects and disadvantages can be swept away, and therefore the constructions in the water which were impossible to be built by the ordinary method can be turned into possible, in which the material can be transferred from the upper position above the ground to the lower position on the ground or in the water, or from the upper position in the water to the lower position in the water with various vertical heads.

A feature of the present invention is the method for placing the hydraulic material in the water, in which the fluid hydraulic material being fed from the upper intake of the transferring tube can be moved smoothly through said tube without forming a vacuum portion in
the tube, and the transfer of the material is caused by the expansion or contraction of the tube by the difference between the pressure on the outer surface of the tube by the water and the pressure within the tube by the hydraulic material itself. Said transferring tube for the transfer of the hydraulic material is made of a watertight and flexible material.

Another feature of the invention is the apparatus for placing the hydraulic material in the water, in which a steel column built in the water is provided with a plurality of pipes which hold the above-mentioned flexible transferring tubes, and said pipes are provided with a plurality of apertures on the walls of the pipes to pass water therethrough. Thereby the hydraulic material can be transferred smoothly by the expansion or contraction of said tubes without any troubles.

The hydraulic materials referred to in the invention are the materials which cause setting or hardening in the presence of water such as cement paste, cement mortar and concrete or those which are further added with setting retarder, setting promoter, dispersing agents and other additives therein.

These and other objects and features of the invention will be become more apparent from the following descriptions taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic illustration of the apparatus for placing hydraulic material of the present invention;
FIG. 2 is an enlarged vertical sectional view of said apparatus;
FIG. 3 is a cross sectional view of supporting pipes and tubes for transferring the hydraulic material; and
FIG. 4 is a cross sectional view of the lower end portion of said pipe.

Refering now to FIGS. 1 to 4, inclusive, a pit b is dug from the surface of the bottom a into the stratum, and a steel column 1 having the diameter of, for example, 8 to 10 m is inserted into said pit b. The installation of the steel column 1 is different according to the depth of water and the kind of the stratum in the bottom. And when the depth is 30 m or more, the steel column 1 of 8 to 10 m in length is suspended from above the water surface and lowered slowly by the crane of a vessel into the water, and the upper edge of the column 1 is connected with another steel column by welding or riveting, and further the connected column 1 is lowered and still other column is connected to the upper edge of the connected column 1 to form a long column. These procedures are repeated until the length of the column 1 becomes sufficient to reach the bottom of the pit b. In this instance, the inside of the column 1 is filled with water. The shape of the cross section of the column 1 may be circular, square, polygonal, oval or any other shapes. On the inside wall surface of said column 1, reinforcing rings 2 are welded leaving each proper distance apart, and the upper and the lower sides of said rings 2 are provided with struts 3 made of high strength cement mortar, high strength concrete etc., as shown in FIG. 2.

In said steel column 1 having a large diameter, a plurality of supporting pipes 4 (FIG. 3) are installed vertically. Each of these these supporting pipes 4 holds one transferring tube 5 for transferring the hydraulic material. Said tube 5 is made of flexible and watertight materials such as rubber cloth, other watertight cloth, film of synthetic resin, etc. The upper and lower edges of the tube 5 are fixed to the flanges 6 of the supporting pipe 4 with leaving some slack for the expansion and contraction of the tube 5. The inner part of said flange 6 is filled with water or other heavier liquid 7, for example bentonite dispersion, thereby the excess deformation of the tube 5 near the flange 6 caused by water pressure can be prevented, that is said edge portion of the tube 5 is kept in the shape as shown in FIG. 3 until the hydraulic material is passed to said portion, accordingly, the hydraulic material can be introduced smoothly where said fluid 7 acts as a damper zone. In case that a pressure-actuated valve 8 is fixed between the flanges 6 of the supporting pipes 4, the tube 5 beneath said valve 8 is filled with a fluid 9 which is lighter than water, for example oils or air, to form a damper zone.

The above-mentioned damper zones at the edges of the tube 5 in the flange portion 6 are filled with the fluid 7 which is heavier than water or the fluid 9 which is lighter than water, thus they are helpful for introducing the hydraulic material smoothly in the initial stage of the operation, however after the passage of the hydraulic material through said damper zones, the introduced material continues to flow down through the tube 5 without the aid of the fluids 7 and 9.

Further, the steel-made supporting pipe 4 is provided with small apertures 10 at the appropriate portions such as the walls near the flanges 6, through which water is passed in and out. Thereby, as shown by the solid line in FIG. 3, the flexible tube 5 is flattened by the water pressure before the hydraulic material is introduced into the tube. When the hydraulic material is fed into the tube 5, the tube is expanded by the inside pressure caused by the material to form the shape as shown by the chain lines 5' in FIG. 3, at the same time, the water contained in the space between the supporting pipe 4 and the flattened tube 5 is discharged through said small apertures 10. Therefore, the flexible tube 5 is always filled with some materials without forming vacuum portion at all.

The hydraulic material must be transferred to the bottom of the steel column 1 before it causes setting, and the steel pipes 4 with the tube 5 in the inside spaces are to be installed in the column 1 as many as sufficient for the transferring of the hydraulic material before the setting is caused. The inner diameter of said tube 5 is, for example, 15 to 30 cm when it is expanded by the hydraulic material. The space d in the pit b may be filled also with the same hydraulic material by means of the above pipe 4.

In FIG. 1, only one supporting pipe 4 which holds the tube 5 is shown, and other similar pipes are omitted by the convenience of illustration.

The upper end of the steel supporting pipe 4 is connected to the bottom of a feed tank 11 for the hydraulic material and forms an intake port 12, and a needle valve 13 for the controlling of the flow of the material is fixed in the feed tank 11. The tank 11 with the pipe 4 is hung by the hanging device such as chain so as to be moved up and down. The hanging device 14 is held by a frame 15.

The hydraulic material is fed continuously or intermittently through a feed pipe 19 and a pump 18 from a mixer 17 of the hydraulic material which is installed on the vessel 16.

The portion near the lower end of the pipe 4 is provided with a centering device 20 which can be elastically opened or closed by the hydraulic or pneumatic
pressure. Further a watching device 21 is hung by a wire 22 in order to observe the state of the hydraulic material in the bottom of the steel column 1. (As for these devices, the ordinary ones can be used.)

As shown in FIGS. 2 and 3, the pressure-actuated valve 8 is optionally provided between the flanges 6 of the pipes 4. The pressure in the pressure chamber 24 is controlled by the operator above the water surface through the pipe 25, and therefore the diaphragm 23 can be operated hydraulically or pneumatically by said pressure in the chamber 24. Accordingly, the transferring of the hydraulic material can be proceeded smoothly by controlling the amount of the flow of the hydraulic material in the tube 5. The ordinary pressure-actuated valve may be used as said valve 8. In FIG. 3, the diaphragm 23 as indicated by the solid lines shows the condition that the diaphragm 23 is pushed together by the pressure in the pressure chamber 24 to close the passage, and the diaphragm 23' indicated by the chain lines shows the condition that the passage is opened.

Near the lowestmost end of the pipe 4, i.e., the portion near the delivery end 26 for the hydraulic material is provided with a damper device in order to prevent the occurrence of the pulsation of the flow. As shown in FIG. 4, the damper device 28 is provided with an air chamber 27, and the lower end of the pipe 29 is led into this chamber 27, further a delivery pipe 31 is attached to the bottom end by way of a pressure-actuated valve 30 having the same structure as that of the aforementioned valve 8 and a set of a pipe 4 and a tube 5. Thereby, the hydraulic material can be transferred smoothly without the occurrence of pulsation of the flow by controlling the velocity of the hydraulic material, and the material can be placed in the bottom of the steel column in the best condition. In the drawing, the numeral 32 denotes a pressure line for the controlling of the pressure-actuated valve 30.

By using the above-described apparatus, a certain amount of the hydraulic material is transferred to the bottom in the steel column 1 through the tube 5 and the delivery end 26 of the pipe 4, and when the hydraulic material is placed there for a certain depth, the supporting pipe 4 which holding the tube 5 is lifted up for a certain height (for example several meters), and the placed material is left standing for setting and hardening. After the setting and hardening of the material, fresh water is poured through said tube 5 onto the surface of the hardened material to wash the upper surface of the hydraulic material c (see FIG. 1), then the above-described placing of the hydraulic material is repeated to form further higher column of the material.

The steel supporting pipe 4 of the present invention supports the weight of the tube 5 and that of the hydraulic material as being passed through the tube 5, and the total weight of the pipe 4 is heavier than the corresponding buoyancy caused by the water. The waving or swinging of the tube 5 can be prevented by the supporting pipe 4 to pass the hydraulic material smoothly without any troubles in which the tube 5 is expanded according to the amount of the flow of the material, and if the amount of the flow is small, the tube is contracted correspondingly without forming the vacuum portion in the tube 5. Therefore, the inside of the tube 5 is always filled with the material. Further, when the hydraulic material is passed excessively into the tube 5, the tube is not broken by the inside pressure because the expansion of the tube 5 is restricted by the supporting pipe 4. Still further, the transferring tube 5 is made of watertight material, therefore the water around the tube does not enter into the tube and the hydraulic material is not diluted with water.

Accordingly, the placement of the hydraulic material in the amount of, for example, 10 cubic meter or more per hour can be carried out by using the pipe and tube of the present invention without any troubles.

Lastly, it should be emphasized, however, that the specific embodiments described and shown herein are intended as merely illustrative and in no way restrictive of the invention.

What is claimed is:

1. Method for placing hydraulic material through watertight flexible tubes onto the bottom of a steel column in which each of said tubes is held in a supporting pipe having apertures to pass through the surrounding water and each of said tube is expanded or contracted correspondingly to the amount of the flow of said hydraulic material to be transferred by the difference of the pressure between the pressure on the outer surface of said tube and the pressure within said tube caused by said hydraulic material.

2. Method for placing hydraulic material as claimed in claim 1, in which the feed velocity of said hydraulic material to be transferred is controlled by at least one valve device which is fixed to said tube.

3. Method for placing hydraulic material as claimed in claim 2, in which said valve means is fluid pressure-actuated valve means.

4. Apparatus for placing hydraulic material which consists of: watertight flexible tubes for transferring said hydraulic material; supporting pipes holding said tubes therein and having apertures on the walls; and a steel column holding said pipes therein and receiving the transferred hydraulic material onto the bottom thereof.

5. Apparatus for placing hydraulic material as claimed in claim 4, in which each of said tubes is provided with at least one valve device to control the flow of hydraulic material.

6. Apparatus for placing hydraulic material as claimed in claim 5, in which said valve device is fluid pressure-actuated valve device.