

[54] **METHOD AND DEVICE FOR A FOUNDATION BY DEPRESSION IN AN AQUATIC SITE**

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[58] Field of Search 61/46.5, 50, 52, 46, 64

[56] **References Cited**

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[57] **ABSTRACT**

Method and device for a foundation by depression in an aquatic site in connection with a structure comprising a tank with an apron provided with ridges digging into the ground and passing through a permeable sandy surface layer resting on an impermeable clay layer, characterized in that the ridges, arranged continuously at the periphery of the apron, enclose the said sandy layer in a confined space comprised between the said apron and the said clay layer and in that the suction of the trapped water sets up a depression ensuring the continuation of the sinking of the said tank.

4 Claims, 3 Drawing Figures

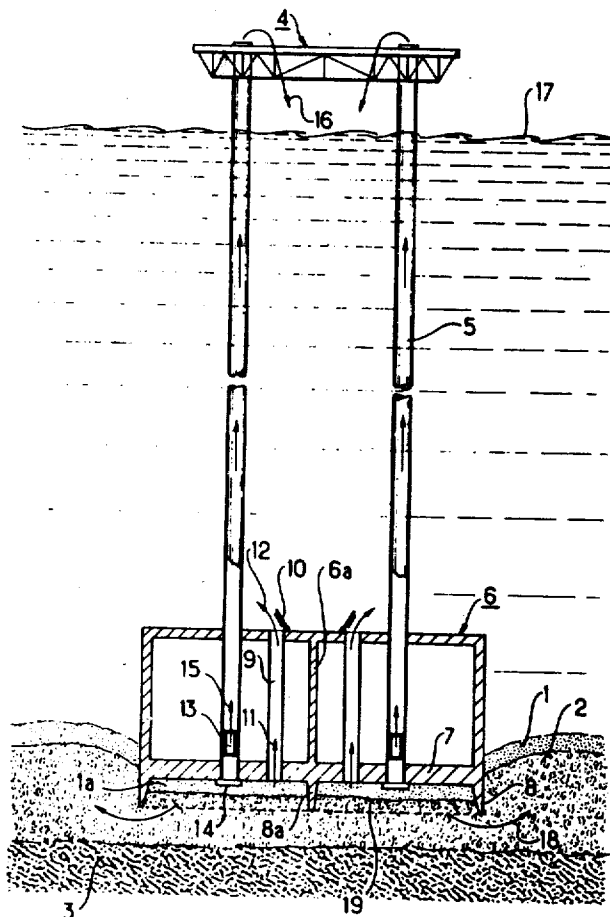
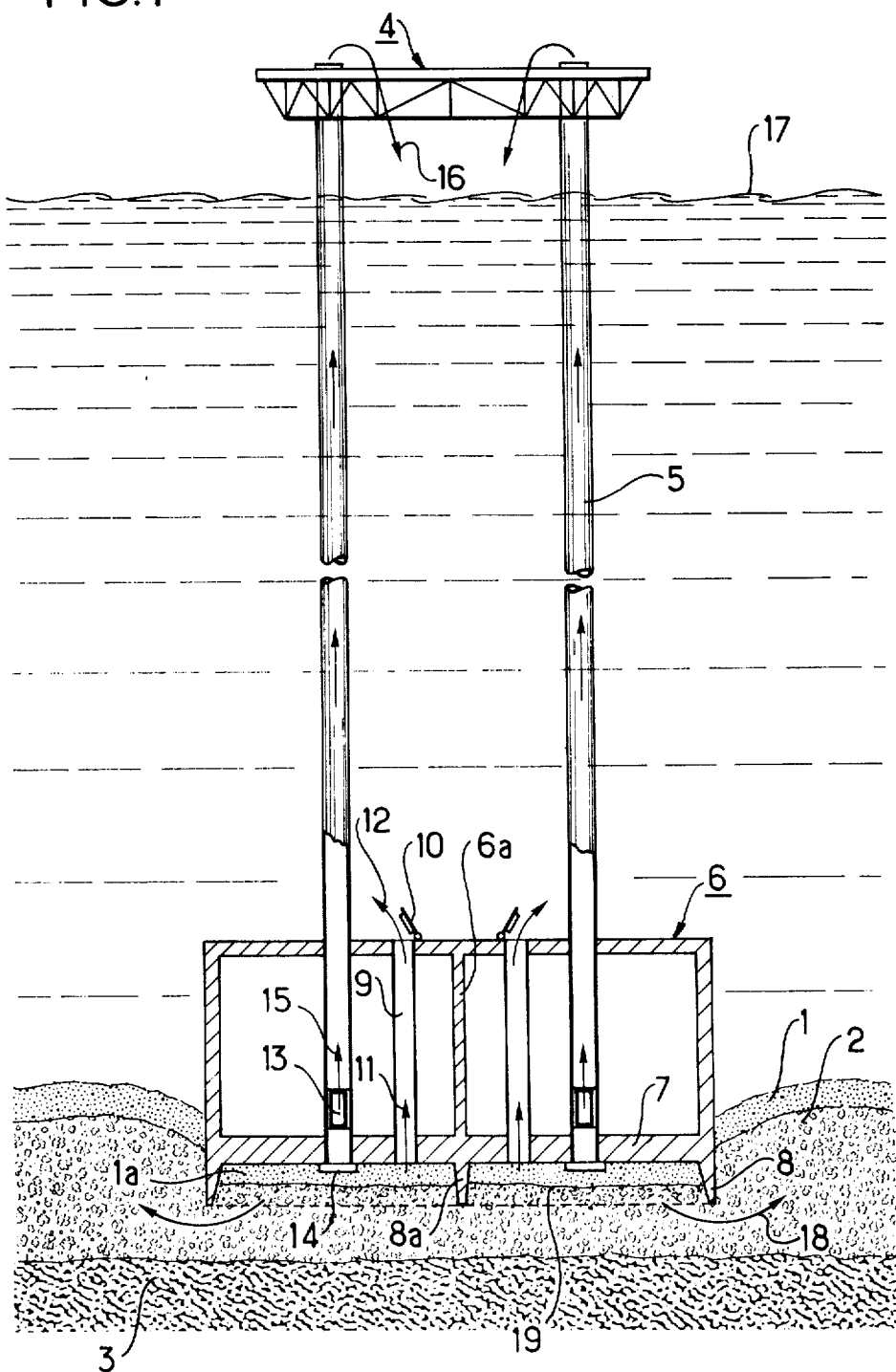


FIG. 1



METHOD AND DEVICE FOR A FOUNDATION BY DEPRESSION IN AN AQUATIC SITE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention concerns a method and device for a foundation by depression in an aquatic site for a structure comprising a tank with an apron provided with fixing ridges for securing the tank set on the ground and relates more particularly to the case where the ground has stratified layers, having a slight thickness in relation to the dimensions of the said apron and comprising a surface layer of permeable sand covering an impermeable layer of clay which is compressible. As the layer of sand is insufficient to bear the structure, means are provided for forming a closed space under the apron in which a depression is set up to ensure fixing by a suction effect resulting from the removal of the water contained in the sandy layer.

2. Description of the Prior Art

It is known, indeed, that to ensure the stability of a tank submerged in an aquatic site on a ground whose surface condition is doubtful, it is compulsory to fix it by means of piles driven through it into the ground or to remove the compressible layer by dredging.

It has been proposed, when the submerging becomes great and when the use of piles is made more difficult, to arrange above the apron, a ballast so as to increase the sinking of the tank into the ground whose different layers must be homogenous to ensure the evenness of the sinking.

The object of the present invention is to avoid the disadvantage on the hand, of piles to be driven in and means to be implemented for effecting such an operation, on the other hand, the excess weight due to the ballasting of a tank, while obtaining the same quality of stability of the foundation obtained, in the case where the ground has stratified layers having the thicknesses and compositions previously defined. It may be used when the great depth allows neither dredging nor filling in.

SUMMARY OF THE INVENTION

The essential feature of the invention consists in the fitting of the apron with fixing ridges having a height greater than the thickness of the impermeable sandy layer and constituting a continuous wall at the periphery of the said apron, so as to form, after the submerging and complete sinking of the tank, a closed space between the apron and the impermeable clay layer and so as to obtain, by suction of the water of the enclosed sandy layer, the creation of a depression ensuring, for the tank, the continuation of its sinking by undercutting and the fixing thereof.

The suction effect, with cutting edges, resulting from the depression thus set up, is the equivalent, for the structure, of an extra weight, whose heaviness is in proportion with the submerging depth of the tank or tanks acting as its foundation. In order better to define and specify the aims and other advantages of the present invention, examples of the embodiment thereof, having no limiting character, relating to sites having stratified upper layers with various structures, are described in connection with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial, sectional elevation of an emerging platform of the present invention whose tank rests on a site having two stratified layers.

FIG. 2 is a partial, sectional elevation of platform forming another embodiment of the invention whose foundations rest on a site having three stratified layers.

FIG. 3 is a partial sectional view of platform similar to that in FIG. 1 whose foundations have been submerged in an aquatic site having only one surface layer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, the submerging site comprises two surface stratification layers, the one, 1, being a layer of permeable sand, the other, 2, being a layer of compressible clay comprised between the layer 1 and the compact clay ground 3. The structure is a platform 4 resting on hollow columns 5 sealingly extending through the tank 6 having multiple partitions, only one of which, 6a, has been shown, for clearness' sake in the figure and whose apron or plate 7 is provided with fixing ridges or skirt 8 forming a continuous wall as an extension of or in the vicinity of the lateral walls of the said tank 6.

The various phases of execution of that structure comprise: the manufacturing thereof, the transferring thereof to the site, the submerging thereof and the fixing thereof, by depression, in the sub-aquatic ground.

The manufacturing of the multi-cellular tank 6 is effected in an excavation on the edge of the water, the ridges or skirt being comprised and having a greater height than the thickness of the layer of sand on the said submerging site. The transfer of the tank is effected by floating up to the site; then the complete submerging of the tank and the sinking thereof to the bottom by progressive and partial ballasting. As soon as the ridges 8 penetrate into the layer 2 of sub-jacent clay, the water of the layer 1, trapped between the ground and the apron 7, escapes through the vertical funnels 9 extending through the tank 6, in the direction of the arrows 11 and 12.

The verticality of the tank 6, controlled by that of the columns 5, is ensured by the filling of various fluid-tight cells separated by the partitions 6a and by the possible transfer of water from one to another.

Then, after having ensured the balance of the structure on the ground, under the effect of its own weight, the lowering of the volume of water trapped in the layer 1a and that under the apron 7 is effected, by suction from the submerged pumps 13, through the filters 14, which are, to great advantage, constituted by resins impermeable to the finest sand. The water is removed in the direction of the arrows 15 and 16 up the free surface 17 of the water covering the submerging site; whereas the valves 10 or any other closing means ensure automatically, the fluid-tight closing of the tunnels 9 as soon as the pumps 13 are started up. Thus, the sinking of the tank 6 by lateral flowage in the direction of the arrows 18, of the compressible clay in the layer 2, containing enough water to be still deformable and by expulsion of a part of the water which the said layer 2 ensuring its consolidation contained, is thus effected, the line 19 representing the separation surface, at the end of the operation, of the trapped parts of the said layers 1 and 2.

The depression thus created under the apron 7 makes it possible to exert a pressure on the layers on which it rests and whose value is limited only by the height of water covering the box 6. Such a pressure may be maintained a certain time, this attenuating, proportionally, long-term subsidence. Moreover, such a pressure exerted on the foundations by means of pressure gauges (not shown) having electrical contacts affecting relays and controlling the pumps from a floor of the platform 4 may be maintained permanently.

Furthermore, it is possible to provide the partitioning of the apron by internal ridges such as 8a thus forming compartments, each compartment having its own funnel 9 and its column 5 used for draining so as to be able to exert different pressures in the various compartments in order to put the tank back into position if it tends to become inclined.

In FIG. 2, the submerging site comprises three stratified surface layers: permeable sand 1, compressible clay 2 and slightly permeable sand covering compacted clay layer 3.

To avoid the forming of a fissure between the layers 1 and 20 which too great a difference in pressure between them would cause, it is sufficient to drain the layer 20 independently from the layer 1 by means of drains 22 sucking through a filter 23 the water contained in the layer 20, as soon as the pump 13 is started up, ensuring the removal thereof in the direction of the arrows 24 and 25. As the ridges 8 do not cut the later 20, the volume of water which it contains is fed to its periphery, but its slight permeability enables the lowering of the volume layer 20.

If, on the other hand, the layer 20 were very permeable and did not have a limited extent, the forming of fissures could be avoided only by trapping the volume, providing ridges extending right through the said layer 20.

The checking of the true thickness of the various layers of ground is effected at the four angles of the tank 6 by four corresponding borings, effected after immersion of the box and before the starting up of the suction pumps.

Moreover, the checking of the sinking is provided by beating, at the same time, a reference tube which is, to great advantage, in the axis of the tank.

It is self-evident that it is possible to combine, with the implementing of this method, other known means, either for making the sinking of the tank 6 easier when the compressible layer is thick enough, or to help the re-establishing of the verticality of the said tank 6.

Thus, before the lowering of the volume of water in the layer 1 of permeable sand, a part of the compressible clay may be dredged by pumping and reverse flow in a series of wells spaced out under the surface of the apron 7 and equipped, for that purpose, with disintegrators. Likewise, after the sinking of the tank 6 has been effected, cement may be injected into the upper layer 1a of trapped sand.

In FIG. 3, the submerging site comprises only one sandy surface layer 1 covering the compacted clay ground 3. The platform 4 resting on the tank 6 through columns 5 forms a structure whose weight is insufficient for ensuring its stability with respect to horizontal forces to which it could be subjected; moreover, the lowering of the trapped volume 1a by suction of the water which it contains, by means of the pumps 13 operating permanently to exhaust the slight leakage discharge due to the incompleteness of the fluid-tight

sealing of clay, provides the extra weight, which is great when the foundations of the structure are deeply sunk and necessary for its stability.

It is self-evident that the examples described of the application of the method according to the present invention do not have any exhaustive character and that all means equivalent to those corresponding to the general definition which has been given thereof form a part of the branch which the present application is intended to protect.

Thus, it is possible to design a light and economical construction for a submerging site not comprising a permeable sandy layer and on which just the necessary quantity of sand is spread over the surface which is to be covered by the apron having fixing ridges, so as to implement the depression method according to the invention, having a suction effect with cutting edges.

Therefore, it appears that this method is very interesting when the ground in which the foundations are laid lies under a great depth of water and is more particularly inaccessible to civil engineering machines and when the structure resting on the foundations is light, for there is double economy, on the one hand in the saving of the material of the structure, on the other hand, in the implementing of the method by the simple means described, while obtaining the advantages of a heavy structure to which it may be compared.

What is claimed is:

1. In an underwater foundation structure for controlled submerged depression in an aquatic site, including: a tank having an apron forming the bottom of said structure with a ridge projecting downwardly therefrom and digging into the ground, which ground comprises at least two stratified layers in the form of a surface layer of permeable sand resting on an impermeable layer of clay, the improvement comprising:

said ridge having a height greater than the thickness of said sandy layer and extending continuously about the periphery of said apron to enclose the sandy layer within a confined space between said apron, the ridge and said clay layer after initial submergence of said tank, tubular funnels extending vertically through the tank from said apron to the top of said tank with said funnels being provided with closures at their upper ends to permit the removal of water trapped beneath said apron during initial submergence of said foundation structure, tubular drains extending through the tank and having their lower ends entering the sand layer and their upper ends projecting above the surface of the water of the aquatic site, filters provided at the lower ends of said drains where the drains enter the sandy layer to insure the removal of water, and pumps housed internally of the drains for pumping water through the drains to create said depression and for expelling water from the upper ends of the drains captured within the layer of permeable sand above the surface of said aquatic site.

2. The foundation structure according to claim 1, for use with respect to a site having two stratified surface layers of permeable sand and compressible clay and covering a ground consisting of compacted clay, said structure further comprising: partition ridges depending from said apron and acting in conjunction with the peripheral ridge for subdividing the confined space into compartments which are fluid tight after submerging, and wherein a tubular funnel and a drain are provided

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for each compartment to separately remove the water trapped therein by applied suction.

3. The foundation structure as claimed in claim 1, for use on a site having three surface layers of: permeable sand, compressible clay and slightly permeable sand, covering a compacted clay ground, said foundation structure further comprising extra drains extending through said tank and having their lower ends penetrating the layer of slightly permeable sand, said extra drains extending upwardly to the surface of the water of said aquatic site, pumps housed within said extra drains to exhaust water from said slightly permeable sand layer independently of that water being exhausted from the layer of permeable sand above said layer of compressible clay.

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4. The foundation structure as claimed in claim 2, for use on a site having three surface layers of: permeable sand, compressible clay and slightly permeable sand, covering a compacted clay ground, said foundation structure further comprising extra drains extending through said tank and having their lower ends penetrating the layer of slightly permeable sand, said extra drains extending upwardly to the surface of the water of said aquatic site, pumps housed within said extra drains to exhaust water from said slightly permeable sand layer independently of that water being exhausted from the layer of permeable sand above said layer of compressible clay.

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