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# RELOCATABLE TANK


## Abstract

A relocatable tank, and method of constructing same, have a plurality of precast wall panels retained by a cable tensioning system between a plurality of support members to form a continuous, preferably generally circular, wall. At least some of the support members comprise at least one aperture and at least one elongate slot to receive respective cables of the tensioning system to retain a shape of the tank. The tank can be easily assembled at a site with prefabricated parts and easily deconstructed when no longer needed and be relocated and reinstalled in a range of sizes if desired. The relocatable tank is typically installed on a compacted earthen pad with no requirement for a concrete footing, unless the tank is used in regions with high seismic or wind activity. A liner system comprised of either a single or double arrangement is installed to fluidly seal the tank. The inclusion of water ballast tubes means no minimum liquid level is required to secure the liner in a designated position.



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## Background/Summary

FIELD OF THE INVENTION

[0001] The invention relates to a relocatable tank and a method of assembling a relocatable tank. In particular, the invention relates, but is not limited, to a modular, relocatable liquid storage tank erectable on a site with a plurality of demountable precast concrete panels, steel posts and post tensioning cables.

BACKGROUND TO THE INVENTION

[0002] Tanks of various shapes and sizes are known for storing fluids, in particular liquids, such as water. Such tanks vary in size tremendously from, for example, a personal water storage tank for drinking or irrigation purposes to industrial or commercial storage tanks. Small tanks are relatively easy to assemble and can often be moulded as a single piece (e.g. 1-50 kL water storage tanks). However, as tank sizes increase it becomes increasingly more difficult to construct a sealed tank for storing fluid.

[0003] One of the issues with constructing large tanks is in transporting and building the tank, particularly for remote locations. For example, in mining, oil, and gas applications, water is a common by-product which may be processed and/or stored in tanks, or reservoirs, or the like. The storage of these liquids in the tanks may be long term or temporary. In any event, often the well or mine site is in a remote location with limited infrastructure and building a tank requires significant preparation and logistics.

[0004] Large tanks often suffer from hoop stress and, when empty, wind loading. Furthermore, the walls of the tank may need to be reinforced with an external structure. For example, the walls of the tank may be reinforced with a frame. Such a frame typically has support members which extend radially outwards from the tank walls. In one tank design, the support members are steel ‘A’-frame members. Disadvantageously, such supporting framework requires additional space around the tank walls. As the support members need to be provided with suitable support, the concrete pad or footing also needs to be large enough to extend to at least the outer edge of the framework, further increasing costs and environmental impact of the tank.

[0005] Typically, the foundation area for a tank requires civil preparation including grading, compaction and a concrete pad for the entire tank and a foundation for the walls. A particular tank design involves an annual concrete foundation underneath the perimeter of the tank. The walls area erected on the foundation or pad. As such considerable costs and time are required to prepare the site and wall foundation.

[0006] Consequently, at the end of service the tanks need to be decommissioned and site remediated. This would involve excavation and disposal of the concrete foundation and pad which is costly and time consuming not to mention the creation of additional greenhouse gas emissions. Similarly, an earthen reservoir requires significant civil preparation and remediation.

[0007] Furthermore, the cost of fixed storage tanks is multiplied when the location requirement for the storage tank changes, as is often the case in mining, gas and industrial applications.

[0008] Also due to the fixed nature of earthen ponds and traditional tank structures, the approval, design, procurement and construction phases are long and arduous.

[0009] At least some of the aforementioned problems have been addressed by demountable tanks disclosed in international patent publication number WO2012/142661. Such demountable tanks comprise a wall defined by a plurality of panels which are retained by opposed side edges between adjacent support members. The support members have a base portion and a support portion and are free-standing on the base portion on an earthen floor allowing the tank to be constructed at sites without concrete foundations such as a concrete pad or ring. However, the demountable tanks disclosed in this application still have limitations on the size of tank achievable.

[0010] Another problem encountered with larger tanks is the additional tensioning force required for larger tanks, which increases the inward pressure concentrated at tensioning posts. This can cause inversion of several panels either side of the tensioning post and compromise the circular integrity of the tank.

[0011] Another problem known with prior art tanks is where a liner is deployed to seal the tank and retain the liquid. The liner is susceptible to damage and movement if a minimum liquid level is not maintained in the tank to provide sufficient weight to prevent liner movement due to wind. This reduces the available operating capacity of the tank and for remote locations and areas of high evaporation this minimum water level cannot always be guaranteed.

[0012] Another complication with earthen storage tanks revolves around the specific material composition and properties for lining the earthen dam which if not readily available on site can add significant costs and time to a construction when it needs to be transported in.

[0013] Reference to background art herein is not to be construed as an admission that such art constitutes common general knowledge.

OBJECT OF THE INVENTION

[0014] It is a preferred object of this invention to provide a relocatable tank which overcomes or at least ameliorates one or more of the disadvantages or problems described above, and/or which at least provides a useful alternative.

[0015] Other preferred objects of the present invention will become apparent from the following description.

SUMMARY OF INVENTION

[0016] In one form, although it need not be the only or indeed the broadest form, there is provided a relocatable tank comprising: [0017] a plurality of support members arrangeable in a spaced apart configuration along a perimeter of the tank; [0018] a plurality of precast wall panels arrangeable between, and received at least partially within the plurality of support members to form a continuous wall along the perimeter of the tank; and [0019] a tensioning system comprising a plurality of cables configured to extend around an outside of the continuous wall; [0020] wherein at least some of the support members comprise at least one aperture and at least one elongate slot to receive respective cables of the tensioning system to retain a shape of the tank.

[0021] Suitably, the wall panels: are precast concrete panels; and/or are substantially planar; and/or are pre-stressed; and/or have side walls at a transverse angle to the plane of the panel.

[0022] Suitably, the side walls are angled in opposite directions to form an isosceles trapezoid in a cross-section of the wall panel.

[0023] Suitably, the support members comprise standard support members and tensioning support members.

[0024] Preferably, the support members comprise an I-beam attached to a base portion, the I-beam comprising a central portion and substantially perpendicular flanges coupled to ends of the central portion, wherein the wall panels are received between the flanges of the I-beam.

[0025] Preferably, the support member in the form of the tensioning support member comprises at least one aperture in the central portion thereof and at least one elongate slot in the central portion thereof.

[0026] Preferably, the at least one elongate slot comprises a channel extending into at least one of

the substantially perpendicular flanges to receive a cable therein.
[0027] Preferably, the support member in the form of the tensioning support member comprises a plurality of apertures in the central portion thereof and a plurality of elongate slots below said apertures.
[0028] Preferably, the support member in the form of the tensioning support member comprises a plurality of elongate slots above said apertures, said elongate slots below said apertures being of a greater depth than the elongate slots below the apertures.
[0029] Preferably, the at least one elongate slot comprises a substantially horizontal portion extending from at least one of the flanges coupled to a substantially vertical portion extending downwardly in the central portion of the tensioning support member.
[0030] Preferably, the apertures in a first type of the tensioning support member are vertically offset with respect to the apertures in a second type of the tensioning support member.
[0031] In some embodiments, a plurality of cables collectively extends around the continuous wall. In particular, the tensioning cables may be in greater concentration towards the base of the panels, or in a lower portion of the panels.
[0032] In some embodiments, at least one of the tensioning support members is provided for at least every quarter of a circular tank. Suitably, at least one of the tensioning support members and at least one of the standard support members are provided in a group periodically around a perimeter of a circular tank.
[0033] Preferably, at least one cable anchor or at least one retention bar is provided to retain one or more of the cables at the support member.
[0034] Preferably, a first type of the tensioning support member comprises a plurality of spaced apart cable anchors which are vertically offset with respect to a plurality of spaced apart cable anchors of a second type of the tensioning support member.
[0035] The relocatable tank may further comprise at least one liner configured to fluidly seal the wall panels and a floor of the relocatable tank. Suitably, the liner may be a double liner.
[0036] The relocatable tank may further comprise a leak detection system and the leak detection system may comprise a leak detection layer fluidly connected to an outlet.
[0037] Suitably, the outlet is a sump having a height greater than the continuous wall with a pump configured to return fluid from the sump back into the relocatable tank or discharged elsewhere.
[0038] The relocatable tank may further comprise one or more water ballast tubes inside the perimeter of the tank to retain the at least one liner, for example, when there is insufficient liquid in the tank to do so.
[0039] In some embodiments, a portion of the floor of the tank inside the perimeter of the tank slopes towards the wall of the tank.
[0040] The relocatable tank may further comprise an overflow arrangement, such as a weir situated near the top of one of the panels and/or a floating cover.
[0041] In another form, there is provided a method of assembling a tank on a site, the method comprising the steps of: [0042] erecting a plurality of support members in a spaced apart configuration along a perimeter of the tank, wherein at least some of the support members comprise at least one aperture and/or at least one open ended elongate slot; [0043] erecting a plurality of precast wall panels between, and received at least partially within the plurality of support members to form a continuous wall along the perimeter of the tank; and [0044] substantially surrounding an outside of the continuous wall with a plurality of cables of a tensioning system received within the at least one aperture and/or the at least one elongate slot of the support members to retain a shape of the tank.
[0045] Suitably, the tank assembled by the method comprises one or more of the aforementioned features of the tank and/or one or more of the features of the tank as described herein.
[0046] Further features and advantages of the present invention will become apparent from the following detailed description.

## Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] By way of example only, preferred embodiments of the present invention will be described more fully hereinafter with reference to the accompanying figures, wherein:

[0048] FIG. **1** illustrates a perspective view of a relocatable tank in accordance with embodiments of the present invention;

[0049] FIG. **2** is an enlarged perspective view of a portion of the relocatable tank shown in FIG. **1**;

[0050] FIG. **3** is a cross sectional plan view of adjacent wall panels of the relocatable tank and a standard support member;

[0051] FIG. **4** a cross sectional plan view of adjacent wall panels of the relocatable tank and a tensioning support member;

[0052] FIG. **5** is a front view of the tensioning support member shown in FIG. **4**;

[0053] FIG. **6** is a front view of a variation of the tensioning support member shown in FIG. **4**;

[0054] FIG. **7** is a front view of the standard support member shown in FIG. **3**;

[0055] FIG. **8** is a front view of a variation of the standard support member shown in FIG. **3**;

[0056] FIG. **9** is a front view of the standard support member shown in FIG. **4**;

[0057] FIG. **10** is a side view of the standard support member shown in FIG. **9**;

[0058] FIG. **11** is a cross sectional underside view of the tensioning support member shown in FIG. **9**;

[0059] FIG. **12** is a perspective view of the tensioning support member shown in FIG. **5** comprising cable anchors;

[0060] FIG. **13** is a sectional view showing an arrangement of cables at one of the tensioning support members shown in FIG. **5**;

[0061] FIG. **14** is a cross sectional side view of the relocatable tank showing a typical arrangement for panels erected on earthen ring beam, liner system, capping, and water tube ballast;

[0062] FIG. **15** is a cross sectional view of a sump of the relocatable tank;

[0063] FIG. **16** is a cross sectional view of inlet pipework of the relocatable tank;

[0064] FIG. **17** is a cross sectional view of outlet pipework of the relocatable tank;

[0065] FIG. **18** illustrates a diagrammatic cross-sectional view of a leak detection system of the relocatable tank; and

[0066] FIG. **19** is a cross sectional view of a leak detection system of the relocatable tank.

[0067] Skilled addressees will appreciate that elements in the drawings are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the relative dimensions of some elements in the drawings may be distorted to help improve understanding of embodiments of the present invention. Embodiments of the present invention may be represented schematically and/or the drawings may omit one or more features for the sake of clarity.

DETAILED DESCRIPTION OF THE DRAWINGS

[0068] FIG. **1** illustrates a relocatable tank **100** according to some embodiments of the present invention, with an enlarged section of the tank **100** shown in FIG. **2**. Relocatable tank **100** comprises a plurality of support members **102** arrangeable in a spaced apart configuration along a perimeter of the tank. Relocatable tank **100** also comprises a plurality of precast wall panels **104** arrangeable between and received at least partially within the plurality of support members **102** to form a continuous wall **106** along the perimeter of the tank. Relocatable tank **100** comprises a tensioning system **108** (shown in FIGS. **3-13**) comprising a plurality of cables **110** configured to extend around an outside of the continuous wall **106**. With reference to FIGS. **5-11** in particular, at least some of the support members **102** comprise at least one aperture **112** and at least one elongate slot **126**A-D to receive respective cables of the tensioning system to retain a shape of the tank **100**.

[0069] Preferred embodiments of the relocatable tank **100** comprise different types of support members such as standard support members and tensioning support members, preferably arranged in specific groupings, which will be described in further detail herein along with the tensioning system **108**.

[0070] For many applications, the wall panels **104** are in the form of precast concrete panels. In some embodiments, the panels are pre-stressed comprising reinforcing elements. For many applications, the panels **104** are substantially planar, which facilitates ease of manufacture of the panels, yet still allow circular tanks to be constructed due to the size of the tank. For many applications, the panels **104** have side walls **116** at a transverse angle to the plane of the panel. However, in some embodiments, the side walls **116** are angled in opposite directions to form an isosceles trapezoid in a cross-section of the wall panel **104**. Therefore, in some embodiments, the side wall **116** can be between 0° and 22.5° to an orthogonal axis of the plane of the wall panels **104**.

[0071] With reference to FIGS. **3** and **4**, a plurality of precast wall panels **104** are arranged adjacent one another to form a substantially circular continuous wall **106** with the support members **102** in between each panel. The planar panels **104** each form a circle segment. The number of panels used will depend on the size of the tank. The tank **100** illustrated in FIG. **1** comprises approximately 152 wall panels **104**, but clearly the invention is not limited to the number of wall panels **104**. Once the wall **106** has been erected the panels **104** are retained by the tensioning system **108** whereby post stress cables **110** are run externally through the apertures **112** in the support members **102** and anchored at specifically placed tensioning support members. Temporary props (not shown) can be used to support the wall panels **104** and once the tensioning cables **110** are in place the props can be removed and the continuous wall **106** is self-standing. The cable tensioning system **108** retains the wall panels **104** in such an arrangement and provides support such that the wall panels cannot fall outward. In use, liquid contained in the tank **100** provides radial forces against the wall panels **104**. The tensioning system must therefore be of sufficient strength to not just hold the wall panels **104** in place in a freestanding manner, but also to be able to withstand the radial forces exerted by the liquid contained therein.

[0072] With further reference to FIGS. **9** to **11**, in preferred embodiments, the support members **102** comprise an I-beam **118** attached to a base portion **120**. The I-beam **118** comprises a central portion or web **122** and substantially perpendicular flanges **124** coupled to ends of the central portion or web **122**. As shown most clearly in FIGS. **3** and **4**, the wall panels **104** are received between the flanges **124** of the I-beam.

[0073] In accordance with preferred embodiments of the present invention, different types of the support members **102** are provided with a variety of features and comprise so-called standard support members and tensioning support members which will be described with reference to FIGS. **5** to **12**.

[0074] With reference to FIG. **5**, some of the support members are in the form of the tensioning support members **102**A which comprise at least one aperture **112** in the central portion **122** thereof and at least one elongate slot **126**A in the central portion **112** thereof. In the embodiment shown in FIG. **5**, the tensioning support member **102**A comprises a plurality of spaced apart generally circular apertures **112** in an upper region of the central portion **122** thereof and a plurality of spaced apart elongate slots **126**A extending substantially horizontally in a lower region of the central portion **112** thereof and below the apertures **112**. The plurality of elongate slots **126**A are provided in a greater frequency in the lower region of the central portion **112** of the tensioning support member **102**A than the apertures **112** in the upper region. In this example, five apertures **112** are provided in the upper region and nine elongate slots **126**A are provided in the lower region.

[0075] The tensioning support member **102**A comprises at least one anchor block **128** to retain and secure the tensioning cables **110**. In the embodiment shown in FIG. **5**, the tensioning support member **102**A comprises a plurality of anchor blocks **128**. In this example, anchor blocks **128** are provided in the upper region of the central portion **122** offset from the positions of the apertures **112**. In particular, anchor blocks **128** are both vertically and horizontally offset from the positions of the apertures **112**. In FIG. **5**, anchor blocks **128** are below the positions of the apertures **112** and abutting one of the flanges **124** of the I-beam of the tensioning support member **102**A. In this example, the tensioning support member **102**A also comprises an anchor block **128** spanning the elongate slots **126**A and abutting the same flange **124**.

[0076] FIG. **6** shows another example of one of the support members in the form of a tensioning support member **102**B having a similar configuration to the tensioning support member **102**A. Tensioning support member **102**B comprises a plurality of apertures **112** in the central portion **122** which are vertically offset from the positions of the apertures **112** in the tensioning support member **102**A. For example, four of the apertures **112** are at higher positions of the central portion **122** of tensioning support member **102**B compared with tensioning support member **102**A. Generally, the elongate slots **126**A are in the same locations in the lower region of tensioning support member **102**B compared with tensioning support member **102**A.

[0077] The tensioning support member **102**B comprises at least one anchor block **128** to retain and secure the tensioning cables **110**. In the embodiment shown in FIG. **6**, the tensioning support member **102**B comprises a plurality of anchor blocks **128** provided in the upper region of the central portion **122** offset from the positions of the apertures **112** in the tensioning support member **102**B. In particular, the anchor blocks **128** are vertically and horizontally offset from the apertures **112**. The anchor blocks **128** are also offset from the positions of the anchor blocks **128** of the tensioning support member **102**A. In particular, anchor blocks **128** of the tensioning support member **102**B are above the positions of the apertures **112** of the tensioning support member **102**B. In this example, the tensioning support member **102**A also comprises an anchor block **128** spanning the elongate slots **126**A.

[0078] With reference to FIG. **7**, some of the support members are in the form of the standard support members **102**C which comprise at least one aperture **112** in the central portion **122** thereof. In the embodiment shown in FIG. **7**, the standard support member **102**C comprises a plurality of spaced apart apertures **112** comprising a plurality of generally circular apertures **112** in an upper region of the central portion **122** and a plurality of elongate slots **126**B extending substantially vertically in a lower region of the central portion **112**. In this example, nine apertures **112** are provided in the upper region and nine elongate slots **126**B are provided in the lower region.

[0079] FIG. **8** shows another example of one of the support members in the form of a standard support member **102**D which comprises at least one aperture **112** in the central portion **122** thereof. In the embodiment shown in FIG. **8**, the standard support member **102**D comprises a plurality of spaced apart apertures **112** comprising a plurality of generally circular apertures **112** in a central region of the central portion **122** and a plurality of elongate slots **126**C in an upper region and a plurality of elongate slots **126**D in a lower region of the central portion **112**. The elongate slots **126**C, **126**D in the upper region and in the lower region of the central portion **112** extend substantially vertically. The depth of the elongate slots **126**D in the lower region below the circular apertures **112** is greater than the depth of the elongate slots **126**C above the apertures **112**. The greater depth allows multiple cables **110** to be received therein. In this example, three elongate slots **126**C are provided in the upper region and the lower region comprises one elongate slot **126**B and four elongate slots **126**D. The central region of the central portion **122** comprises six generally circular apertures **112**. Although not shown, standard support member **102**D comprises one at least one retention bar to retain one or more of the cables **110**.

[0080] In the embodiment shown in FIG. **8**, the substantially vertical elongate slots **126**C in the upper region and the substantially vertical elongate slots **126**D in the lower region of the central portion **122** comprise a substantially horizontal channel **130** extending to one of the flanges **124** thus creating an open end **132** to receive one or more cables **110** therein.

[0081] FIGS. **5** to **8** in particular illustrate the alignment of generally circular apertures **112**, elongate slots **126**A, **126**B, **126**C, **126**D and anchor blocks **128** across the tensioning support members **102**A, **102**B and the standard support members **102**C, **102**D. Such configurations of the support members increase the flexibility of routing cables **110** around the outside of the tank **100** according to the different requirements of tanks of different sizes, and in particular the requirements of very large tanks. For example, a wide variety tank sizes can be constructed with just the four different support members **102**A-D shown in FIGS. **5** to **8**.

[0082] In FIGS. **5** to **8** some of the apertures **112** and some of the elongate slots **126**A-D comprise one or more dots indicating the presence of one or more tensioning cables **110**, respectively. Some of the anchor blocks **128** comprise crosses indicating the presence of a tensioning cable **110** anchored or retained therein. Some of the apertures **112**, elongate slots **126**A-D and anchor blocks **128** comprise the notation (SPARE) indicating that that they are not accommodating a tensioning cable **110** in this particular configuration. For different tank sizes, more or fewer apertures **112**, elongate slots **126**A-D and/or anchor blocks **128** can accommodate cables **110** depending on the requirements of the tank.

[0083] Hence, in some embodiments, a plurality of tensioning cables **110** collectively extends around the outside of the continuous wall **106**. In particular, the tensioning cables **110** may be in greater concentration towards the base of the panels **104**, or in a lower portion, as indicated by the higher number of elongate slots **126**A, **126**B and **126**D and anchor blocks **128** in the lower regions of the support members **102**A-D.

[0084] In some embodiments, at least one of the tensioning support members **102**A, **102**B is provided for at least every quarter of a circular tank.

[0085] In some embodiments, at least one of the tensioning support members **102**A, **102**B and at least one of the standard support members **102**C, **102**D are provided in a group periodically around a perimeter of a circular tank.

[0086] In some embodiments, at least two of the tensioning support members **102**A, **102**B and at least two of the standard support members **102**C, **102**D are provided in a group periodically around a perimeter of a circular tank. With reference to FIG. **1**, one group of support members comprises a standard support member **102**C, followed by two tensioning support members **102**A, followed by a standard support member **102**C. Another group of support members comprises a standard support member **102**C, followed by two tensioning support members **102**B, followed by a standard support member **102**C. In between these two groups of support members, a plurality of standard support member **102**C is provided. This sequence of support members is repeated about the perimeter of the circular tank shown in FIG. **1**.

[0087] As shown in FIG. **12** the tensioning support member **102**A, **102**B is configured to accept one or more post tensioning cables **110** and provide anchor points for the post tensioning system. Anchor blocks **128** are installed over the ends of the cables **110** to be secured through a barrel **129** in the anchor block **128**. Wedges **131** secure the cable **110** in the anchor block **128** and tensioning equipment (not shown) is utilised to draw the cables **110** through respective anchor blocks **128** to achieve sufficient tension in the cables **110** which are subsequently held in place by the wedges **131**.

[0088] FIG. **13** shows an example of an arrangement of cables **110** at one of the tensioning support members **102**A shown in FIG. **5**. When the tensioning support members **102**A are configured in pairs, the cables **110** are passed through apertures **112** and retained and tensioned on one side of each of the tensioning support members **102**A in an alternating sequence at anchor blocks **128**. This configuration ameliorates the force distribution from the cable tensioning system and the problem of inversion of the panels **104** is prevented. Where single tensioning support members are used tensioning cables **110** can be anchored on both sides of the tensioning support member **102**A, **102**B.

[0089] Since the volume of liquid increases with the size of the tank, so does the amount of cable required to apply tension to withstand the additional forces. The configuration of the circular apertures **112**, elongate slots **126**A, **126**B, **126**C, **126**D and anchor blocks **128** in the support members of the present invention enable the support members to accommodate an increased number of cables to be run around the circumference of the tank compared with at least some of the prior art and an increased flexibility in their arrangement as required by the size of the tank. For example, fewer of the apertures **112**, elongate slots **126**A-D and/or anchor blocks **128** will have the notation (SPARE) as the size of the tank increases. The additional tension required for larger tanks increases the inward pressure concentrated at the tensioning posts. This can cause inversion of several panels either side of the tensioning post and compromise the circular integrity of the tank. To ameliorate this force transfer some embodiments of the present invention duplicate the tensioning support members **102**A, **102**B periodically around the perimeter of the tank as described herein thus splitting the anchoring points between two tensioning support members. This distributes the force and reduces the force on each tensioning support member and eliminating the inversion movement. This advancement enables significantly larger diameter tanks to be constructed accommodating volumes >50 ML. Additionally, installation of the cables **110** into the slots is simpler as the cables **110** can be dropped into the slots instead of being fed through a hole. Not only does this reduce construction time but also reduces the manual labour component.

[0090] With reference to FIG. **14**, the plurality of wall panels **104** are erected on a prepared earthen pad **139**, such as levelled and compacted earthen ring beam. In preferred embodiments, the relocatable tank **100** further comprises at least one liner **134** installed inside the tank structure and configured to fluidly seal the wall panels **104** and a floor **136** of the relocatable tank. In some embodiments, the liner is in the form of a double liner as described in further detail with reference to FIG. **19**. The liner **134** is secured on top of the wall panels **104** via capping or battens **135**. In some embodiments, water tube ballast **154** is installed to ameliorate the concern of security of the liner **134**. For example, if the tank has insufficient liquid the liner **134** may be disturbed or dislodged from the tank **100** by wind or other action on the tank **100**.

[0091] With reference to FIG. **19**, in preferred embodiments, the relocatable tank **100** further comprises a leak detection system **138**. In some embodiments, the leak detection system comprises a leak detection layer fluidly connected to an outlet **140**. The outlet can be in the form of an external sump **140** located outside the tank **100** having a height greater than the continuous wall **106** with a pump **142** configured to return fluid from the sump **140** back into the relocatable tank **100** or discharged elsewhere.

[0092] In some embodiments, the leak detection system **138** comprises a primary liner **144**, a cushioning layer **150** then a geonet layer **146**. In some embodiments, a leak detection (secondary) liner **148** is also provided. In some embodiments, the cushioning layer **150** may be in the form of a geotextile. Other permutations of these layers can be implemented depending on the size and/or purpose of the tank. An internal sump **152** is fluidly connected to the leak detection liner **148** which is in turn fluidly connected to the outlet **140** in the form of an external sump having a communication system to transmit a signal indicating detection of a leak. The sumps **140**, **152** may also have a pump (not shown) to return leaked fluid back into tank **100**. In the event of a leak in the primary liner **144**, fluid enters a geonet cavity formed by the geonet layer **146** and is caught by the leak detection liner **148** whereby it can flow into the sump and back into the tank **100**. Water from the internal sump **148** is preferably gravity fed to the external sump **140** which can activate a pump, preferably a solar pump, to return water to the tank **100**.

[0093] In preferred embodiments, the relocatable tank **100** can further comprise a ballast system comprising one or more water ballast tubes **154** inside the perimeter of the tank to retain the at least one liner **134**, for example, when there is insufficient liquid in the tank to do so. The ballast system can comprise one or more perimeter water ballast tubes **154**A and one or more radial water ballast tubes **154**B secured by ropes and swages. Each water ballast tube **154** is a long cylindrical tube comprising water that provides sufficient mass to secure the liner **134** in the event the tank **100** is empty.

[0094] In some embodiments, a portion of the floor **136** of the tank inside the perimeter of the tank slopes towards the wall **106** of the tank from a hinge point, beyond which the floor **136** slopes towards the centre of the tank. In particular, the foundation is prepared in such a way that there is a fall towards the continuous wall **106** of the tank offset approximately 1-2 m that prevents the perimeter water ballast tube **154**A from rolling towards the centre of the tank **100**. As the size of the tank increases the water tube ballast system may consist of perimeter water tube ballast and additional water tube ballast secured in and around the centre of the tank. In preferred embodiments, water is used as the ballast material because it floats when the tank has liquid inside keeping the tube off the liner preventing rubbing. Also, if the ballast tube is compromised and the water leaks into the tank the impact is minimal whereas the opposite is true if, for example, sand is used as the ballast material.

[0095] In some embodiments, the relocatable tank **100** comprises an overflow arrangement **156**, such as a weir situated near the top of one of the wall panels **104** of the continuous wall **106**.

[0096] In some embodiments, the relocatable tank **100** comprises a floating cover (not shown) to prevent evaporation of the liquid in the tank **100**. The cover floats on the surface of the liquid and rises and falls with the level of the liquid.

[0097] FIGS. **15** to **18** show details of pipework for the leak detection system **138** including the internal sump **148**, inlet pipework **158**, outlet pipework **160** and the outlet **140** in the form of the external sump.

[0098] In some embodiments, the relocatable tank **100** comprises a concrete pad **162** upon which a viewing platform **164** is constructed to enable observation of the interior of the tank.

[0099] In another form, there is provided a method of assembling a tank **100** on a site. The method comprises the step of erecting a plurality of support members **102** in a spaced apart configuration along a perimeter of the tank **100**. As described herein, at least some of the support members **102** comprise at least one aperture **112** and/or at least one elongate slot **126**A-D.

[0100] The method comprises the step of erecting a plurality of precast wall panels **104** between and received at least partially within the plurality of support members **102** to form a continuous wall **106** along the perimeter of the tank.

[0101] The method comprises the step of substantially surrounding an outside of the continuous wall **106** with a plurality of cables **110** of a tensioning system received within the at least one aperture **112** and/or the at least one elongate slot **126**A-D of the support members **102** to retain a shape of the tank **100**.

[0102] Advantageously, the relocatable tank **100** can be constructed quickly and relatively cost effectively at a site in a modular and adaptable manner. It can be a temporary or permanent installation with casting of the panels performed off-site. Waste liquids, such as effluent or industrial wastes, can then be stored in the relocatable tank **100**. The structure of the tank can also be readily disassembled. The main structural components, namely the precast concrete panels **104** and support members **102** (standard posts and tensioning posts) can be reused to construct a new tank in the same location or elsewhere. The tank size can be either the same or altered with the subtraction or addition of these main components.

[0103] Once tanks according to the present invention are disassembled and materials removed from the site, due to use of an earthen foundation instead of concrete, the tank foundation area can be readily remediated and revegetated.

[0104] As the relocatable tank **100** is an engineered structure with multiple lining arrangements there are several advantages over earthen dams, which require heavy civil design and construction with significant impact to the foundation area making it much harder to remediate. Also, the environmental review and approval is typically much longer, especially for leak detection and prevention requirements. The tank of the present invention can include multiple layered systems for enhanced defect detection prior to use (using conductive geo fabric intermediate layers) and leak detection devices during use.

[0105] The leak detection system installed is uniquely arranged such that it operates as a closed loop system. The collection sump **140** installed external to the tank **100**, which is taller than the

tank wall **106**, is connected via pipe to the lowest point in the tank sealed to the outermost liner. If there is a leak through one of the previous liners the liquid is drained to the sump. Either the liquid can remain here, or a pump can return the liquid to the tank **100**. Since the sump **140** cannot overflow being taller than the tank **100** no liquid is lost or discharged to the environment. Simple devices can be deployed to detect liquid in the sump hence identifying a leak and where a pump is utilized the flowrate can be used to determine the severity of the leak.
[0106] In this specification, adjectives such as first and second, left and right, top and bottom, and the like may be used solely to distinguish one element or action from another element or action without necessarily requiring or implying any actual such relationship or order. Where the context permits, reference to an integer or a component or step (or the like) is not to be interpreted as being limited to only one of that integer, component, or step, but rather could be one or more of that integer, component, or step etc.
[0107] The above description of various embodiments of the present invention is provided for purposes of description to one of ordinary skill in the related art. It is not intended to be exhaustive or to limit the invention to a single disclosed embodiment. As mentioned above, numerous alternatives and variations to the present invention will be apparent to those skilled in the art of the above teaching. Accordingly, while some alternative embodiments have been discussed specifically, other embodiments will be apparent or relatively easily developed by those of ordinary skill in the art. The invention is intended to embrace all alternatives, modifications, and variations of the present invention that have been discussed herein, and other embodiments that fall within the spirit and scope of the above described invention.
[0108] As used herein, an element or operation recited in the singular and proceeded with the word “a” or “an” should be understood as not excluding plural elements or operations, unless such exclusion is explicitly recited. Furthermore, references to “one embodiment” of the present disclosure are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.
[0109] In this specification, the terms ‘comprises’, ‘comprising’, ‘includes’, ‘including’, or similar terms are intended to mean a non-exclusive inclusion, such that a method, system or apparatus that comprises a list of elements does not include those elements solely but may well include other elements not listed.

## Claims

**1**. A relocatable tank comprising: a plurality of support members arrangeable in a spaced apart configuration along a perimeter of the tank; a plurality of precast wall panels arrangeable between, and received at least partially within the plurality of support members to form a continuous wall along the perimeter of the tank; and a tensioning system comprising a plurality of cables configured to extend around an outside of the continuous wall; wherein at least some of the support members comprise at least one aperture and at least one elongate slot to receive respective cables of the tensioning system to retain a shape of the tank.
**2**. The relocatable tank of claim 1, wherein the wall panels: are precast concrete panels; and/or are substantially planar; and/or have side walls at a transverse angle to the plane of the panel.
**3**. The relocatable tank of claim 2, wherein the side walls are angled in opposite directions to form an isosceles trapezoid in a cross-section of the wall panel.
**4**. The relocatable tank of claim 1, wherein the support members comprise standard support members and tensioning support members.
**5**. The relocatable tank of claim 1, wherein the support members comprise an I-beam attached to a base portion, the I-beam comprising a central portion and substantially perpendicular flanges coupled to ends of the central portion, wherein the wall panels are received between the flanges of the I-beam.

**6**. The relocatable tank of claim 4, wherein the support member in the form of the tensioning support member comprises at least one aperture in the central portion thereof and at least one elongate slot in the central portion thereof.
**7**. The relocatable tank of claim 6, wherein the at least one elongate slot comprises a channel extending into at least one of the substantially perpendicular flanges to receive a cable therein.
**8**. The relocatable tank of claim 4, wherein the support member in the form of the tensioning support member comprises a plurality of apertures in the central portion thereof and a plurality of elongate slots below said apertures.
**9**. The relocatable tank of claim 8, wherein the support member in the form of the tensioning support member comprises a plurality of elongate slots above said apertures, said elongate slots below said apertures being of a greater depth than the elongate slots above the apertures.
**10**. The relocatable tank of claim 4, wherein the apertures in a first type of the tensioning support member are vertically offset with respect to the apertures in a second type of the tensioning support member.
**11**. The relocatable tank of claim 1, wherein a plurality of cables collectively extends around the continuous wall.
**12**. The relocatable tank of claim 11, wherein the tensioning cables are in greater concentration towards the base of the panels, or in a lower portion of the panels.
**13**. The relocatable tank of claim 4, wherein at least one of the tensioning support members is provided for at least every quarter of a circular tank.
**14**. The relocatable tank of claim 4, wherein at least one of the tensioning support members and at least one of the standard support members are provided in a group periodically around a perimeter of a circular tank.
**15**. The relocatable tank of claim 4, wherein at least two of the tensioning support members and at least two of the standard support members are provided in a group periodically around a perimeter of a circular tank.
**16**. The relocatable tank of claim 1, wherein at least one cable anchor or at least one retention bar is provided to retain one or more of the cables at the support members.
**17**. The relocatable tank of claim 1, wherein a first type of the tensioning support member comprises a plurality of spaced apart cable anchors which are vertically offset with respect to a plurality of spaced apart cable anchors of a second type of the tensioning support member.
**18**. The relocatable tank of claim 1, further comprising at least one liner configured to fluidly seal the wall panels and a floor of the relocatable tank.
**19**. The relocatable tank of claim 18, wherein the tank comprises a double liner and a leak detection system.
**20**. The relocatable tank of claim 19, wherein the leak detection system comprises a leak detection layer fluidly connected to an outlet.
**21**. The relocatable tank of claim 20, wherein the outlet is a sump having a height greater than the continuous wall with a pump configured to return fluid from the sump back into the relocatable tank or discharged elsewhere.
**22**. The relocatable tank of claim 18, further comprising one or more water ballast tubes inside the perimeter of the tank to retain the at least one liner, for example, when there is insufficient liquid in the tank to do so.
**23**. The relocatable tank of claim 18, wherein a portion of the floor of the tank inside the perimeter of the tank slopes towards the wall of the tank.
**24**. The relocatable tank of claim 1, further comprising an overflow arrangement, such as a weir situated near the top of one of the panels.
**25**. The relocatable tank of claim 1, further comprising a floating cover.
**26**. A method of assembling a tank on a site, the method comprising the steps of: erecting a plurality of support members in a spaced apart configuration along a perimeter of the tank, wherein

at least some of the support members comprise at least one aperture and/or at least one elongate slot; erecting a plurality of precast wall panels between, and received at least partially within the plurality of support members to form a continuous wall along the perimeter of the tank; and substantially surrounding an outside of the continuous wall with a plurality of cables of a tensioning system received within the at least one aperture and/or the at least one elongate slot of the support members to retain a shape of the tank.

**27**. The method of claim 26, wherein the tank comprises one or more of the following: the support members comprise standard support members and tensioning support members; the support members comprise an I-beam attached to a base portion, the I-beam comprising a central portion and substantially perpendicular flanges coupled to ends of the central portion, wherein the wall panels are received between the flanges of the I-beam; the support member in the form of the tensioning support member comprises at least one aperture in the central portion thereof and at least one elongate slot in the central portion thereof; the at least one elongate slot comprises a channel extending into at least one of the substantially perpendicular flanges to receive a cable therein; the support member in the form of the tensioning support member comprises a plurality of apertures in the central portion thereof and a plurality of elongate slots below said apertures; the support member in the form of the tensioning support member comprises a plurality of elongate slots above said apertures, said elongate slots below said apertures being of a greater depth than the elongate slots above the apertures; the apertures in a first type of the tensioning support member are vertically offset with respect to the apertures in a second type of the tensioning support member; a plurality of cables collectively extends around the continuous wall; the tensioning cables are in greater concentration towards the base of the panels, or in a lower portion of the panels; at least one of the tensioning support members is provided for at least every quarter of a circular tank; at least one of the tensioning support members and at least one of the standard support members are provided in a group periodically around a perimeter of a circular tank; at least two of the tensioning support members and at least two of the standard support members are provided in a group periodically around a perimeter of a circular tank; at least one cable anchor or at least one retention bar is provided to retain one or more of the cables at the support members; a first type of the tensioning support member comprises a plurality of spaced apart cable anchors which are vertically offset with respect to a plurality of spaced apart cable anchors of a second type of the tensioning support member.