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A Bund Wall Building System and associated method

Description of Invention

The present invention relates to a bund wall building system and a method of building an underwater bund wall.

A bund wall is a man-made embankment, dam or dyke, etc. It is used to mark out the boundary or perimeter of an area of sea to be reclaimed. Thus, a bund wall must substantially prevent the free flow of water through the bund wall so as to create an area within the bund wall which can filled with soil, dredged material etc - without any water outside the bund wall perimeter breaching the bund wall. After the land reclamation process has been completed, the level of soil bounded by the bund wall, will be above the level of the water and the land will have thus been "reclaimed" from the sea. Bund walls are equally applicable to use as breakwaters or in forming islands and causeways.

Previous methods of forming bund walls have comprised depositing a large amount of material along the boundary of an area to be reclaimed, such that the material slowly builds up to form a bank, which eventually protrudes above the surface of the water. However, bund walls formed in this way are liable to erosion during and after their formation and require a large amount of material to reach the required height.

A more efficient method of building a bund wall comprises filling a large elongate bag or sack with material (soil, dredged material etc) and then dropping the filled bag on to the seabed. The benefit of using such a bund wall bag is that the material is confined to a space and a number of bags can be laid upon one another to quickly build up a bund wall with the required height. Preferably the bags are built up into a pyramid formation, with their respective central axes being parallel with one another. Further, because the

soil is protected by the membrane of the bag, the elements of the bund wall are much less likely to suffer from erosion or otherwise dispersion of the material held therein. A representation of a bund wall bag (1) is shown in Figure 1.

Referring to Figures 2a – 2c, the bund wall bags (1) are formed on a barge (2). Prior to forming the bund wall bag (1), a large membrane (3) is laid on the base of the barge (2) to form an unfilled bag (1). Material (4) is then dredged from a location away from the bund wall site and the material (4) deposited on to the membrane (3), i.e. into the bag (1). When a sufficient amount of material (4) has been deposited, the bag (1) is sealed so as to create a bund wall bag (1). The membrane (3) of the bag (1) is often a mesh-like material, allowing water to permeate into the bag (1) and also for any air in the bag (1) to escape. More preferably, the membrane is a geotextile. Known bags (1) are available in varying shapes and sizes. For example, bags (1) are provided having volumes ranging between $250m^3$ and $800m^3$. When a $800m^3$ bag (1) is filled with material, it will be appreciated that such a bund wall element (1) is extremely heavy and massive: in the region of 1,200-1,400 tons. The filled and sealed bund wall bags (1), therefore, cannot readily be lifted out of the barge (2) or vessel within which they have been created.

Accordingly, known bund wall building systems comprise "bottom split-open" barges (2). Such a barge (2) is shown schematically in cross-section in Figure 2A. The hull of the barge comprises two parts (2A, 2B) which swing open with respect to one another to open the bottom of the barge. When the two parts (2A, 2B) are in engagement with one another, they form a sealed hull, upon which the membrane (3) can be placed and the bag (1) produced. Following the closure of the bag (1), (see Figure 2B), the two parts (2A, 2B) are moved away from one another so as to open the bottom of the barge (2). As shown in Figure 2C, the bag (1), filled with material, then falls through the base of the barge (2) and sinks towards the seabed. As will be appreciated

from Figure 2C, the filled bag (1) is not self-supporting and can readily change shape and bend along its length.

A representation of the required or ideal structure of a pyramidic bund wall (5) is shown in Figure 3. Each bund wall bag (1) is abutting its neighbour and the respective central axes are parallel. It should be noted that although the ends of the bags (1) shown in Figure 3 are coincident with one another, this is a schematic representation only. In an ideal configuration, the ends of each bag (1) would be axially displaced from one another and abutting against the end of an adjacent bag (1), to offer further structural support to the bund wall (5) – akin to layers of bricks. Further, the bund wall bags (1) shown in Figures 3 and 4 are schematic. Although they are shown as having a circular cross section, bund wall bags (1) may take a variety of shapes. For example, known bags (1) have an elliptical cross section. It is envisaged that bags (1) could also have a substantially oblong or square cross section.

With the known method of forming a bund wall, when the filled bag (1) is released from the bottom split-open barge (2), the bag (1) slowly sinks towards the seabed. As it does so, areas of the bag (1) have a tendency to sag and the bag (1) as a whole becomes misshapen. Further, as a consequence of underwater currents and the shape of the bag (1), the bag (1) tends to sink chaotically. Even at a relatively low depth of 10 metres, the bag (1) can easily deviate by as much as 1 metre from its intended location before resting on the seabed. As a result, when depositing a number of bags (1) to form a bund wall, the bags (1) are <u>not</u> deposited in a neat abutting manner, with the central axes of the bags being parallel as is required. Even worse, as new bags are dropped towards the seabed, they have a tendency to deviate further from their intended position when they come into contact with the existing elements of the bund wall. The bags (1) then become further misaligned and can "slump" over the existing bund wall. A resultant bund wall (6), represented in Figure 4, will be very liable to leaks and will not be structurally sound. It will be

appreciated that due to the sheer mass and size of the filled bags (1) – coupled with the fact that they become even heavier when water-logged – the bags (1) cannot readily be repositioned or reorientated following their release from the barge. Attempting to reposition the waterlogged bags (1) will likely cause damage to the bags (1) and the bund wall (6) as a whole. Moreover, existing methods make it most impossible to locate accurately the bags when they have been dropped from the barge, let alone reposition them. Moreover, misplaced and misorientated bags (1) require more bags to be placed to build up a wall (6) having the required height.

The present invention seeks to overcome the problems associated with the known methods and systems of building bund walls.

Accordingly, the present invention provides a bund wall building system to place pre-formed elements of an underwater bund wall in position on a sea-bed, comprising: a support, operable to be lowered and raised with respect to the sea-bed, to support, place and release an element in a predetermined location and orientation.

Preferably, the support has variable buoyancy.

Advantageously, the bund wall building system further comprises a platform, to which the support is attached, the support being operable to be lowered and raised with respect to the platform.

Conveniently, the platform is a buoyant platform.

Preferably, the platform is operable to be lowered and raised with respect to the sea-bed.

Advantageously, the platform forms part of a vessel.

Conveniently, the bund wall building system further comprises a lowering device, to lower and raise the support, in use.

Preferably, there are a plurality of lowering devices.

Advantageously, the or each lowering device is a winch.

Conveniently, the support comprises a cradle.

Preferably, the cradle is a two part cradle.

Advantageously, the two part cradle comprises a release mechanism, selectably operable to release, in use, an element held in the cradle.

Conveniently, the support comprises a support beam.

Preferably, an element is suspended from the support beam, in use.

Advantageously, the bund wall building system further comprises a sling, within which the element is suspended from the support, in use.

Conveniently, the sling is detachable from the support.

Preferably, the support engages with a portion of the element, in use.

Advantageously, the support engages with at least a portion of the element, in use.

Conveniently, the bund wall building system is operable to form a bund wall element before placing it on the sea-bed.

Another aspect of the present invention provides a method of building an underwater bund wall, comprising: providing a support, operable to be lowered and raised with respect to the sea-bed, to support, place and release an element in a predetermined location and orientation; supporting an element of a bund wall with the support; lowering the support toward the sea-bed; placing the element in a predetermined location and orientation; and releasing the element from the support.

Preferably, the element is supported in a sling and the step of releasing the element from the support includes releasing the sling from the support.

Advantageously, the method of building an underwater bund wall further comprises forming a bund wall element.

Conveniently, a plurality of elements are supported by the support.

The present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

FIGURE 1 shows a filled bund wall bag or element;

FIGURE 2A shows a schematic cross-sectional representation of a known bottom split-open barge;

FIGURES 2B and 2C show the known bottom split-open barge of Figure 2A holding and subsequently dropping a filled bag;

FIGURE 3 shows a representation of an "ideal" bund wall;

FIGURE 4 shows a representation of a resultant bund wall built according to known methods.

FIGURE 5 shows a support of a bund wall building system according to the first embodiment of the present invention;

FIGURE 6 shows a platform of a bund wall building system according to the present invention;

FIGURE 7 shows the support of a bund wall building system according to a second embodiment of the present invention;

FIGURE 8 shows the support of a bund wall building system according to a third embodiment of the present invention;

FIGURE 9 shows the support of a bund wall building system according to a fourth embodiment of the present invention;

FIGURE 10 shows the support of a bund wall building system according to a fifth embodiment of the present invention;

FIGURE 11 shows the support of a bund wall building system according to a sixth embodiment of the present invention;

FIGURE 12 shows the support of a bund wall building system according to a seventh embodiment of the present invention; and

FIGURE 13 shows the support of a bund wall building system according to an eighth embodiment of the present invention.

Figure 5 shows a schematic end view of a support (10) of a bund wall building system according to the present invention. The support is a two-part cradle (11), comprising a first part (11A) and a second part (11B). The two parts (11A, 11B) are coupled to one another so as to provide a supportive cradle (11), in one configuration; but also operable to be moved apart from one another to release any contents held within the cradle (not shown). The two parts (11A, 11B) are mounted to a frame (12). Each part (11A, 11B) comprises two ends (13) and a base portion (14). The base portions (14) of each part (11A, 11B) together define a bucket or cradle for receiving and supporting a bag (1). The bucket defined by the two parts (11A, 11B) may be provided with a membrane (16), in use, to form a bag (1). Each end (13) of each part (11A, 11B) comprises a pivot point (15), allowing each part (11A, 11B) to pivot and swing with respect to the frame (12).

The cradle (11) is operable to be lowered and raised with respect to the seabed by means of connecting wires (17). The cradle (10) is further provided with two shafts (19) connected to the frame (12). The two shafts (19) carry a plurality of pulleys (20) which rotate with respect to the shafts (19). Connecting wires (17) are fed over a respective pulley (20) and connected to a top portion of a respective part (11A, 11B) of the cradle. The point of connection is such that as force is applied to the connecting wire (17), the two parts (11A, 11B) are urged towards one another to define the bucket and to support any contents in the cradle (11). Alternatively, connecting wires (17) may be connected directly to either or both of the frame (12) and shaft (19) for raising and lowering the cradle (10).

Further, each part (11A, 11B) of the two-part cradle (11) comprises a device (18) to swing the two parts of the cradle (11A, 11B) apart with respect to one another. Preferably, a cable (18) is connected to each part (11A, 11B) of the cradle (11), so as to create a moment about the pivot point (15) to open the cradle (11). As shown in Figure 5, each cable (18) is fed over a respective

pulley (20) and connected to a the base portion (14) of the cradle (10). As a force is applied to the cable (18), the two parts (11A, 11B) are swung open, thereby releasing their contents.

Additionally, the two parts (11A, 11B) of the cradle (11) are hydraulically driven to open or, alternatively, close the cradle (11). The two parts (11A, 11B) may be biased toward one another until a force is applied through cables (18) to prise them apart into an "open" configuration.

Figure 6 shows a platform (21) according to the present invention. Preferably, the platform (21) of Figure 6 is used in conjunction with the cradle (11) of the first embodiment of the present invention as shown in Figure 5 but may alternatively be used with any of the embodiments of support described herein.

The platform (21) comprises a plurality of winches (22), which lower or raise a support (10) connected to the winches (22) by a corresponding plurality of wires and cables (17, 18).

When used with the cradle (11) of Figure 5, some of the winches (22) of the platform (21) of Figure 6 may be operable to lower and raise the cradle (11), by means of connecting wires (17), while other winches (22) may be operable to move the two parts (11A, 11B) of the cradle (11) towards or away from one another. The number of winches (22) provided for each operation may be equal or unequal. There may be more, or less, winches than those shown in Figure 6.

Preferably, the cradle (11) is configured and formed to closely match the profile and shape of a bund wall bag (1). Such a configuration allows for the bag (1) to be supported by the cradle (11) as it is being filled and when it is being placed.

Alternatively, the device which moves the two parts (11A, 11B) of the cradle towards or away from one another may be mounted on the cradle (11) itself.

In a still further arrangement, referring back to Figure 5, there may be only one cable (18) provided on one side of the cradle (11) to operate the two parts (11A, 11B).

In preferred embodiments, the winches (22) provided on the platform (21) are closely controlled and provide feedback as to the precise length of cable that has been paid-out from the winch (22). Each winch (22) may be independently controllable or the winches (22) may be controlled as part of a group. As a result, the precise distance between the support and platform can be controlled and monitored.

The platform (21) is preferably buoyant and may form part of a raft or barge. Alternatively, the platform (21) may form part of a larger powered vessel.

Preferably, the platform (21) comprises a global positioning system (23), so that the platform (21) can be positioned to a precise location and orientation. Advantageously, the platform (21) further comprises a depth gauge (24), to calculate the depth of the seabed beneath the platform. Conveniently, the platform (21) further comprises an underwater imaging system, such as sonar (not shown), for detecting and visually displaying underwater bodies within the vicinity of the platform.

In a preferred arrangement of the first embodiment, each part (11A, 11B) of the cradle (11) is manufactured to be structurally sound and rigid along its length. Each part (11A, 11B) may be solid or hollow and preferably manufactured from rust-proof metal. In one arrangement, each of the two parts (11A, 11B) or the cradle (11) as a whole, may be purposefully made to be buoyant. The level of buoyancy can be pre-selected so as to be just below

the weight of a filled bund wall bag (1). Thus, as the cradle (11) is descended from the platform (21) towards the seabed, there will be no undue strain on any wires connecting the platform to the cradle. Instead, the descent of the cradle towards the seabed can be controlled at a set rate. A convenient advantage of making the cradle (11) buoyant is that, following the placement and release of a bund wall bag (1) on the seabed or the existing bundle bags, the buoyancy of the cradle (11) will cause it to return to the surface without mechanical help. Preferably, such an embodiment includes a control element to control the ascent of the cradle (11) toward the surface. Advantageously, the buoyancy of the cradle is controlled and adjusted during its ascent so as to avoid the cradle (11) impinging on the platform (21)

In other alternative arrangements, the cradle (11) could be provided with air chambers throughout its body, which are filled with air following placing a bag, such that the cradle (11) returns to the surface by virtue of the buoyancy of the air pumped into the chambers. In such an arrangement, when the cradle (11) is provided with a further bund wall bag (1), the air can be released from the chambers in a controlled manner so as to control the descent of the cradle (11) back down to the seabed.

It will be readily apparent to the skilled person that there are many different alternative methods of opening the two parts (11A, 11B) of the cradle (11), all of which are encompassed within the scope of the present invention.

Preferably, the cradle (11) and platform (21) may be modular, to accommodate bund wall bags (1) of varying shapes and sizes. Thus, when placing longer bund wall bags (1), two cradles (11) and platforms (21) may be aligned to provide a longer support structure for the bund wall bag (1).

A method of building an underwater bund wall according to the present invention will now be described.

A platform (21) is moved to a location at which a bund wall is to be built. Upon reaching the desired location, the platform (21) may be manoeuvred into its required orientation. Both its position and orientation can be monitored and controlled by the GPS (23) and depth gauge (24). To maintain its position, the platform (21) may be anchored to the sea bed. Alternatively, particularly in deep waters, the position and orientation of the platform (21) may be continually controlled by propellers or other forms of thrust provided on the platform (21)

With the two parts (11A, 11B) of the cradle (11) in the 'closed' configuration, a membrane (16) is placed into the cradle (11). Preferably, the membrane (16) is shaped so as to fit the profile of the cradle (11). Next, a predetermined quantity of material is poured or dumped onto the membrane. The ends of the membrane (16) are brought together and sealed so as to create a bund wall bag (1). The resultant bund wall bag (1) is supported by the cradle (11) and is located at the join line between the two parts (11A, 11B) of the cradle (11). The bag (1) is then ready to be placed.

A selected winch or winches (22) is/are then operated to lower the cradle (11) with respect to the sea-bed and the platform (21), by paying out a length of connecting wire (17). The combined weight of the cradle (11) and bag (1) ensure that the connecting wires (17) are taught during lowering.

The cradle (11) and bag (1) are lowered toward the sea bed, above the site of the bund wall. When the cradle reaches the sea bed, the two parts (11A, 11B) of the cradle (11) are swung open to release the bag (1) from the cradle (11). To swing open the two parts (11A,11B), cables (18) are operated, as described above. The bag (1) is released from the cradle (11) and rests in a predetermined location and orientation, with no deviation. In one embodiment, when cables (18) are operated to open the two parts (11A, 11B), any tension

in the connecting wires (17) is released, the weight of the cradle (11) being supported by the cables (18).

The benefits of the invention are still realised by releasing the bag (1) from the cradle (11) a distance above the sea bed. To ensure most accurate placing of the bag (1), the bag (1) may be released between 0 and 1 metres above the intended location (i.e. on the sea bed itself, or on top of an existing course of elements) more preferably between 0.5m and 1m. However, the bag (1) may be released a greater distance above the sea bed. Although some deviation may occur as a result, the amount of deviation will not be as high as that with known methods where the bags (1) are allowed to drop, unguided, from the surface. It will be appreciated that when building bund walls in water depths of over 10m, even releasing the bag 5m above the sea bed will increase its placement accuracy and reduce any deviation when compared to dropping it from the surface.

A benefit of releasing the bag (1) a distance away from the sea bed is that the risk of the cradle (11) contacting the sea bed is reduced, which may otherwise damage the cradle (11). The term 'place' or 'placed' is used throughout the description. By this is meant that the bag may be placed directly on the sea bed; but is also intended to encompass releasing the bag from a height above the sea bed at which only minimal or negligible deviation will occur.

Having placed the bag (1) on the sea bed, the cradle is lifted back to the surface (i.e. the platform (21)) using connecting wires (17). The two parts (11A, 11B) may be closed before, during or after the cradle's (11) ascent to the platform (21). Preferably, the two parts (11A, 11B) provide drainage holes to allow water to escape from the cradle (11).

A further bag (1) is then formed in the cradle (11) as before. The position and orientation of the platform (21) is adjusted so that the next bag (1) to be placed

is placed at an axial distance from the first bag (1). Preferably, the axial distance is equal to the diameter or width of a bag (1). As a consequence, when the next bag (1) is placed, the two bags (1) will rest on the sea-bed side by side. Subsequent bags (1) are layered on top of previous layers, to build up a pyramid.

Alternatively, a number of bags (1) may be formed into smaller pyramid confirmations on the cradle (11) in one operation. The entire 'pre-formed' pyramid is then lowered toward and placed on the sea-bed. Further pre-formed pyramids are placed to build up the bund wall. Such a modular configuration allows for faster construction times.

Whereas with prior art methods, shown in Figure 2, bags (1) (referred to as "elements" herein) were simply dropped from the water surface, the present invention provides a controlled method of supporting, placing and releasing an element of a bund wall in a predetermined location and orientation. As a consequence, bund wall building systems according to the present invention can accurately place and orientate elements (1) of a bund wall in depths of water far exceeding that of 10 metres. Nevertheless, even when used in water of a depth of 10 metres, the accuracy of the placement and orientation of the elements (1) of the bund wall can be extremely closely controlled. As a consequence, there will be very little, if any, deviation from the required location of the bund wall elements and a bund wall (5) much closer, if not identical, to that shown in Figure 3 can be built.

Bund walls (5) built with the system according to the present invention are such that the central axes of each element (1) are parallel and each element is closely abutting its neighbouring element. As a consequence, the bund wall (5) substantially prevents the free flow of water through the bund wall (5) and acts as a much more efficient, and stable, bund wall (5). The time spent building the bund wall is also reduced when compared with previous methods.

An accurate and structurally sound bund wall (5) can be built with the present invention even in rough waters or locations where there are strong undercurrents.

Figure 7 shows a support (110) of a bund wall building system according to a second embodiment of the present invention. Figure 7 shows a support beam (111), comprising a number of hooks (112) on its base. Each hook (112) engages with a corresponding loop (113) provided on the bund wall element (1). When the bund wall element (1) is in the correct location and orientation, the support beam (111) is rotated about its central axis (114), causing the loops (113) provided on the bund wall element (1) to become disengaged with the hooks (112) provided on the support beam (111). Preferably, this embodiment is used only for relatively lightweight bund wall bags (1), else there may be a tendency for the element (1) to rupture when lifted, as a result of the localised strain afforded by the force on the loops (113).

Figure 8 shows a support (210) of a bund wall building system according to a third embodiment of the present invention. Instead of hooks (112), the support comprises a clamping device (211), which clamps either end of a sling (212) which is wrapped around the bund wall element (1). When supporting and lowering the bund wall element (1) towards the seabed, the two-part clamp arrangement (211A, 211B) firmly holds both ends of the sling (212), such that the bund wall element (1) is hanging and supported by the bund wall building system. When the bund wall element (1) is placed and orientated in the correct location, the clamp (211) releases one or both ends of the sling (212), thereby releasing the bund wall element (1). In the embodiment where both ends of the sling (212) are released, the sling (212) remains on the seabed, beneath the bund wall element (1). Each sling (212) is therefore sacrificial and a new sling (212) is used for each bund wall element (1). The sling may be the same geotextile material as the bag (1).

Alternatively, each bund wall element (1) could be provided with a fabric flange along its length (not shown), to which the clamping arrangement (211) engages. Such an arrangement does not, therefore, require a sacrificial sling (212).

Figure 9 shows a support (310) of a bund wall building system according to a fourth embodiment of the present invention. The arrangement comprises a hooked supporting structure (311), within which the filled bund wall element (1) sits. Upon reaching the desired location and orientation, the supporting structure (311) is rotated about its central axis (312), and the bund wall element (1) is released from the structure (311). Preferably, rotation is effected in a similar way to how the parts (11A, 11B) are rotated about their axes in Figure 5.

Figure 10 shows a support (410) of a bund wall building system according to a fifth embodiment of the present invention. The arrangement comprises a scissor-like support (411), which abuts against a base portion of the bund wall element (1) in use. The arrangement comprises two scissoring arms (412), to the end of which supporting plates (413) are connected. The supporting plates (413) of the arrangement may extend along the length of the bund wall element (1) or the bund wall building system may be provided with a plurality of the supports (411) shown in Figure 8, each supporting a portion of the bund wall element (1).

The weight of the bund wall element (1) when held in the support (411) acts to clamp the bund wall element (1) between the two supporting plates (413). Additionally, the two arms (412) may be spring-loaded so that as soon as the plates (413) engage with the seabed or another element (1), the load on the cable (414) lowering the element (1) reduces and the two arms (412) spring apart, allowing the support to be raised toward the water surface.

Figure 11 shows a support (510) of a bund wall building system according to a sixth embodiment. The arrangement comprises a supporting cradle (511) which is tilted, in use, such that the bund wall element (1) slides with respect to the cradle (511). Following engagement of one end of a bund wall element with the seabed floor or other bund wall elements, the cradle (511) is then moved horizontally, parallel to the central axis of the bund wall element (1), so as to release the bund wall element on to the seabed floor or existing bund wall elements.

Figure 12 shows a support (610) of a bund wall building system according to a seventh embodiment of the present invention. The arrangement comprises a plurality of slings (611) wrapped around the bund wall element (1), which engage with a respective hook (612). The hooks (612) are connected to a winch on the surface (i.e. provided on a platform, according to the present invention) and the distance between the hook (612) and the platform (15) may be independently controllable. Preferably, the slings (611) are sacrificial but, alternatively, there may be provided a ring or eyelet on the bund wall element (1) which engages with each hook directly. Although three slings (611) are shown, there may be more or fewer slings (611), depending upon the weight and rigidity of the bund wall element (1). Preferably, as with the second embodiment shown in Figure 7, this arrangement is used with relatively lightweight elements (1).

All of the embodiments shown in Figures 5 to 12 are preferably used in conjunction with a platform (15) according to the present invention, such as that shown in Figure 4.

In some embodiments of the present invention, both the support and the platform may be raised and lowered with respect to the sea bed. Thus, after

the support is provided with a filled bag (1), the entire structure may be submerged to accurately place the bag (1) on the sea bed.

Figure 13 shows a support (710) of a bund wall building system according to an eighth embodiment of the present invention. The support (710) may take a number of forms but preferably it comprises a two part cradle (711A, 711B), similar to the shown in Figure 5, mounted in a barge, raft or support (712). The support (710) may be raised and lowered with respect to the sea bed by means of buoyancy tanks, which are filled with air or water, as appropriate. When the bag (1) is being filled, the barge floats on the surface of the water, as denoted by the water line (713) shown in Figure 13. When the bag (1) is full, or otherwise ready to be placed, the buoyancy of the barge (712) is reduced so that the barge (712) begins to descend.

Additionally, at least one (preferably four) guides (720) are provided. Each guide (720) comprises a float (714), connected to a guide line (715) which, in turn, is connected to an anchor point (716). Although the anchor point (716) shown in Figure 13 is a large mass, it may equally be a barbed anchor, as used for anchoring boats. The guide line (715) may comprise cable, rope or chain etc. The water line (713) is also shown on the floats (714) in Figure 13.

The support (710) is further provided with a guide attachment (717), which receives and is free to translate along the guide line (715). Preferably, the guide attachment (717) is releasably attachable to the guide line (715).

When the support is lowered with respect to the sea bed, the guide attachment (717) translates along the guide line (715), thereby guiding the descent of the support (710). The position and orientation of the bag (1) is therefore accurately controlled. Following the placement and release of the bag (1) from the support (710), the guide line (715) guides the ascent of the support (710) back toward the surface.

All embodiments of the present invention described herein provide a controlled method of supporting, placing and releasing an element of a bund wall in a predetermined location and orientation, and a bund wall building system therefor. As a consequence, bund wall building systems according to the present invention can accurately place and orientate elements (1) of a bund wall in depths of water far exceeding that of 10 metres. Nevertheless, even when used in water of a depth of 10 metres, the accuracy of the placement and orientation of the elements (1) of the bund wall can be extremely closely controlled. As a consequence, there will be very little, if any, deviation from the required location of the bund wall elements and a bund wall (5) much closer, if not identical, to that shown in Figure 3 can be built.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A bund wall building system to place pre-formed elements of an underwater bund wall in position on a sea-bed, comprising:

a support, operable to be lowered and raised with respect to the sea-bed, to support, place and release an element in a predetermined location and orientation.

2. A bund wall building system according to Claim 1, wherein the support has variable buoyancy.

3. A bund wall building system according to any one of Claims 1 and 2, further comprising a platform, to which the support is attached, the support being operable to be lowered and raised with respect to the platform.

4. A bund wall building system according to Claim 3, wherein the platform is a buoyant platform.

5. A bund wall building system according to Claim 3, wherein the platform is operable to be lowered and raised with respect to the sea-bed.

6. A bund wall building system according to any one of claims 1 to 3, wherein the platform forms part of a vessel.

7. A bund wall building system according to any preceding claim, further comprising a lowering device, to lower and raise the support, in use.

8. A bund wall building system according to Claim 7, comprising a plurality of lowering devices.

9. A bund wall building system according to any one of Claims 7 and 8, wherein the or each lowering device is a winch.

10. A bund wall building system according to any preceding claim, wherein the support comprises a cradle.

11. A bund wall building system according to Claim 10, wherein the cradle is a two part cradle.

12. A bund wall building system according to Claim 11, wherein the two part cradle comprises a release mechanism, selectably operable to release, in use, an element held in the cradle.

13. A bund wall building system according to any one of Claims 1 to 9, wherein the support comprises a support beam.

14. A bund wall building system according to Claim 13, wherein an element is suspended from the support beam, in use.

15. A bund wall building system according to any one of Claims 13 and 14, further comprising a sling, within which the element is suspended from the support, in use.

16. A bund wall building system according to Claim 15, wherein the sling is detachable from the support.

17. A bund wall building system according to any one of claims 13 to 16, wherein the support engages with a portion of the element, in use.

18. A bund wall building system according to any preceding claim, wherein the support engages with at least a portion of the element, in use.

19. A bund wall building system according to any preceding claim, operable to form a bund wall element before placing it on the sea-bed.

20. A method of building an underwater bund wall, comprising:

providing a support, operable to be lowered and raised with respect to the sea-bed, to support, place and release an element in a predetermined location and orientation;

supporting an element of a bund wall with the support;

lowering the support toward the sea-bed;

placing the element in a predetermined location and orientation; and

releasing the element from the support.

21. A method of building an underwater bund wall according to Claim 20, wherein the element is supported in a sling and the step of releasing the element from the support includes releasing the sling from the support.

22. A method of building an underwater bund wall according to any one of Claims 20 and 21, further comprising forming a bund wall element.

23. A method of building an underwater bund wall according to any one of Claims 20 to 22, wherein a plurality of elements are supported by the support.

24. A bund wall building system as hereinbefore described with reference to the description and figures.

25. A method of building an underwater bund wall as hereinbefore described with reference to the description and figures.

26. Any novel matter or combination thereof hereinbefore described.