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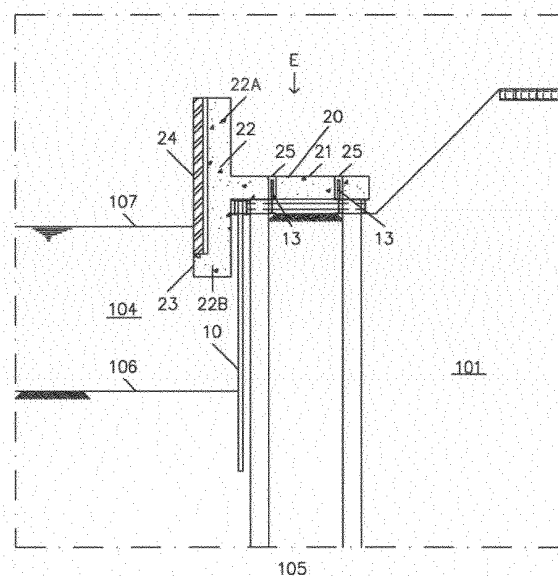
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Claims 17- 58 are deemed to be abandoned due to non-payment of the claims fees (Rule 45(3) EPC).

(54) **QUAY WALL AND METHOD FOR BUILDING A QUAY WALL**

(57) Method for the construction of a quay wall bounding a soil body to separate a water body from a soil body, wherein the quay wall is built up with a first ground retaining wall and a second ground retaining wall, wherein the following steps are carried out:

- installing a foundation in the soil body at the landside of the position of the first ground retaining wall;
- installing a quay body and connecting it to the foundation, which quay body includes the vertical, second ground retaining wall as well as a quay body section extending from the vertical wall in land direction and together with the quay body being supported by the foundation, - wherein the first ground retaining wall extends in upward direction up to the quay body section and the second ground retaining wall extends above the first ground retaining wall.



Figuur 9

Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for constructing a quay wall. The invention in particular relates to a method for constructing a quay wall in an urban environment, such as the quay wall of a city canal. Constructing the quay wall can take place by way of replacing an existing quay wall or as new build. The invention further relates to a quay wall.

[0002] Medieval towns, especially in the Netherlands, may have a system of canals bounded by quay walls at one or two sides. At the landside of the quay walls, a road surface for road traffic may be situated. A quay wall may be placed for directly bounding the water body. Alternatively, the quay wall may be situated recessed relative to the water body, such as with so-called wharves, where in between the quay wall and the water body a low-lying area for storage and pedestrians is realized, which at the waterside is bounded by a secondary, low quay wall.

[0003] Quay walls require a lot of maintenance and need restoration work regularly and even need to be replaced. Executing the work often requires rendering the quay wall free from the water (in part or as a whole) if it is directly bounded by the water body. For that purpose, a temporary sheet-pile wall is arranged in the water-course, after which the area between sheet-pile wall and quay wall is pumped dry (in part or as a whole). This could entail considerable costs. Comparable issues may arise when quay walls are newly built.

[0004] It is known to replace a quay wall by first removing the existing quay wall and paving and partially excavating the soil body and then vibrating a steel sheet-pile wall into the ground. The sheet-pile wall is anchored at the landside using anchors, which may require removing soil locally. A support strip is attached to the sheet-pile wall at the side facing the water, on which support strip the masonry wall to be arranged in situ can be built up. A concrete head beam is installed on the upper edge of the sheet-pile wall. The sheet-pile wall has a ground-retaining function as well as a bearing function for the masonry.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide a method of the type mentioned in the preamble, which does not require the quay wall that is to be replaced to be rendered free from the water (in part or as a whole).

[0006] It is an object of the invention to provide a method of the type mentioned in the preamble which may keep the costs within limits.

[0007] It is an object of the invention to provide a method of the type mentioned in the preamble which can be executed in relatively little time.

[0008] It is an object of the invention to provide a method of the type mentioned in the preamble, wherein the

hindrance and/or inconvenience to the environment can remain limited.

[0009] According to one aspect, the invention provides a method for the construction of a quay wall bounding a soil body to separate a water body from a soil body, wherein the quay wall is built up with a first ground retaining wall and a second ground retaining wall, wherein the following steps are carried out:

- a) installing a foundation in the soil body at the land-side of the position of the first ground retaining wall;
- b) installing a quay body and connecting it to the foundation, which quay body includes the vertical, second ground retaining wall as well as a quay body section extending from the vertical wall in land direction and together with the quay body being supported by the foundation,

- wherein the first ground retaining wall extends in upward direction up to the quay body section and the second ground retaining wall extends above the first ground retaining wall.

[0010] In the method according to the invention a division in function can be made. The first ground retaining wall only serves to separate the soil and the water and does not need to absorb any vertical forces other than its own weight. The first ground retaining wall can remain hidden from view in the completed wall quay wall, which may simplify the design. Special functions can be provided in/at the second ground retaining wall. The second ground retaining wall can be designed for retaining the soil above the foundation and absorbing horizontal forces from the waterside, such as vessel loads, wave loads. The loads resulting from the soil above the horizontal wall of the quay body, the second ground retaining wall's own weight and any traffic loads can be transferred via the foundation, bypassing the first ground retaining wall. In that way, different demands can be made on the first and second ground retaining walls.

[0011] In one embodiment, in step a), for creating the foundation, a number of foundation piles are installed in the soil body, preferably at positions that are situated at different distances from the location of the position of the quay wall to be constructed.

[0012] In one embodiment the method comprises the steps of:

- c) installing a coupling body; and
- d) by means of the coupling body connecting the upper ends of the foundation piles to each other for transfer of forces.

[0013] Due to the force-transferring connection of the foundation piles to each other, the foundation piles cooperate in absorbing the forces exerted on the quay body. The coupling body can be a part of the foundation.

[0014] With its upper end the foundation can be in-

stalled at a level situated above the level of groundwater and/or the design water level of the water body. The same may be the case for the coupling body.

[0015] Prior to step a) soil can be removed from the soil body to a level near the design water level of the water body, wherein the foundation piles are installed in the soil body so that their upper ends end up at the level of the design water level, preferably even above that level.

[0016] As the lower section of the old quay wall no longer needs to bear the load of the removed section of the old quay wall and the load on the first ground retaining wall will be lower than in the condition of the old quay wall, the invention may enable the use of a lower section of the existing quay wall as first ground retaining wall, extending up to near the design water level, for instance to just below it and therefore being hidden from view. Prior to step a) an upper section of the old quay wall can then be removed, preferably to a level near the design water level of the water body, for instance down to an area of between + 3 dm and 0 dm of the design water level.

[0017] The first ground retaining wall may also serve as replacement of that part of the existing quay wall, in which case the entire existing quay wall will be removed, in particular prior to step a). The first ground retaining wall will then be supplied (as a whole or in parts) and can be installed in the work. Regarding the arising forces, the first ground retaining wall does not have to be inserted so deep for stability, in many cases less deep than the bottom side of the existing quay wall. This is particularly the case when the first ground retaining wall is coupled in the horizontal sense to the foundation for the second ground retaining wall. The first ground retaining wall further does not need to extend higher than the level of the top of that foundation, in particular not higher than the aforementioned coupling body, above that the ground retaining function is met by the second ground retaining wall of the quay body, wherein the horizontal forces and the moments are deflected to the substratum via the said foundation, in particular via the coupling body and the piles. The first ground retaining wall can be designed relatively lightweight and be introduced into the soil with little effort.

[0018] If the constitution of the soil body requires so and/or if the entire existing quay wall is removed, it may be opted for that prior to step a) a temporary secondary wall is placed at the waterside of the quay wall and the resulting intermediate space is filled with soil material. The secondary wall may extend to the level at which the soil body is excavated. An example of such a temporary secondary wall is a Berlin-wall.

[0019] The method according to the invention can also be carried out in case there is no quay wall yet, so as a new build project, wherein the first ground retaining wall is supplied and installed in the work.

[0020] In one embodiment the first ground retaining wall is installed after installing the coupling body.

[0021] The coupling body may comprise a guide for guiding the first ground retaining wall during its introduction into the soil body, wherein the coupling body is positioned prior to introducing the first ground retaining wall.

[0022] The first ground retaining wall can be introduced until its upper edge has arrived at the level of the coupling body.

[0023] As already stated, due to the limited load on the first ground retaining wall, it can be designed lightweight, for instance made of a synthetic composite material.

[0024] In one embodiment the upper end of the first ground retaining wall is coupled such to the foundation, directly or indirectly, that said upper end remains in its place in horizontal direction during use. In one embodiment said upper end is coupled to the quay body, in another embodiment to the foundation, in particular to said coupling body. This can for instance be done by means of a confinement device engaging over it which is attached the coupling body or the quay body, which confinement device secures the upper end of the first ground retaining wall counter to a horizontal displacement away from the foundation/the coupling body.

[0025] Generally, attention will be paid to a soil-proof connection of the upper end of the first ground retaining wall to the rest of the quay, for instance by means of a geotextile.

[0026] In one embodiment, wherein the activities in situ remain limited, a quay body is prefabricated and supplied to the site of the work.

[0027] The application of a prefabricated quay body makes it possible to provide it with a leaf of facing masonry as early as at the factory. For that purpose, at the vertical wall, the prefabricated quay body can be provided with a support edge for the masonry. It is also simple to prepare the prefabricated quay body in the factory for a few facilities for use, such as attachments for ground anchors, bollards, and bollard recesses. Optionally the facilities may already be installed at the factory. The coupling body can be designed in advance for absorbing the forces exerted on the bollards during use.

[0028] The said quay body section may be configured as a horizontal wall. The quay body can then define an L-shape or a lying T-shape. Preferably, the second ground retaining wall extends downward to a level below the coupling body. In one embodiment, at the waterside, the second ground retaining wall extends downward in front of the upper end of the first ground retaining wall. As a result, the upper end of the first ground retaining wall is shielded. The second ground retaining wall may for instance extend to below the design water level, yet remain spaced apart above the bottom of said watercourse.

[0029] After installing the quay body, the soil body can be replenished again, against the landside of the second ground retaining wall, to approximately the original level, and a top layer can be installed, such as a grass layer, a surfacing, in particular paving can be placed and/or sewer facilities and/or utility pipes can be placed.

[0030] In one embodiment, wherein the coupling body is placed prior to installing the foundation piles, the coupling body is provided with passages for guiding the foundation piles or their constituent pipes during their introduction into the soil body, wherein the coupling body is positioned prior to the introduction of the foundation piles or their constituent parts. This does not only provide for a guiding of the piles but also an optimal attunement in position between piles and coupling body, which is advantageous for making a connection between them later on.

[0031] Several passages may each time be provided next to each other, in other words, the passages may each time be provided in groups, wherein the groups are situated at a distance from each other, for instance at the location of junctions of a framework.

[0032] The passages may be oriented vertically. If so desired, to increase the resistance against horizontal loads, for instance for a shipping quay, it may be opted for to allow a few or several of the passages to slope. The foundation piles extending through them may for instance be sloping in a vertical plane transverse to the main direction of the quay, in particular the piles situated at the landside of the coupling body. Depending on the loads to be expected, the slope may be such that the pile tip is situated further away from the waterside than the pile head or vice versa. Combinations are also possible.

[0033] The foundation piles may be prefab. Preferably, the foundation piles are formed in the soil, as in the case of tubular steel piles and screw piles (concrete mortar screw pile, tubular screw pile, screw injection pile) whether or not to be built up from pipe parts, as a result of which the disadvantageous vibrations in the soil can be kept limited or even remain absent. In one embodiment, foundation piles can be used that are configured for a geothermal function.

[0034] In one embodiment, in step e) the quay body is connected to the coupling body or the foundation piles, to be coupled thereto in the horizontal plane, for promoting the transfer of horizontal forces from the quay body to the coupling body. For that purpose, pins may be provided on the upper side of the coupling body or on the upper end of the foundation piles. The horizontal wall of the prefab quay body may have been provided with recesses beforehand in which the pins can be accommodated, optionally supplemented with a casting mortar. Other suitable methods of coupling are possible and will be known to the expert.

[0035] The coupling body can be prefab and be supplied from the factory. The coupling body may also be manufactured at or in the work. The coupling body may consist of parts that are to be connected to each other. The coupling body may be configured like a coupling frame, with girders, in particular like a horizontal truss. The coupling frame can be manufactured of steel and the foundation piles may have steel casings, wherein the piles and the coupling frame are welded together.

[0036] According to a further aspect, the invention pro-

vides a quay wall retaining a soil body towards a water body, comprising:

- a) a first ground retaining wall forming a lower section of a quay and being located between the soil body and the water body and extending to below the bottom of the water body;
- b) a second ground retaining wall forming an upper section of the quay and extending above the first ground retaining wall, preferably up to ground level;
- c) a foundation for the second ground retaining wall, which foundation is positioned at the landside adjacent to the first ground retaining wall.

[0037] The foundation may comprise a number of foundation piles installed in the soil body, which piles, preferably, are situated at positions that are situated at different distances from the first ground retaining wall.

[0038] For coupling of the foundation piles one to the other, the quay may comprise:

- d) a substantially horizontal coupling body connecting the upper ends of the foundation piles to each other;
- wherein the second ground retaining wall is founded on the coupling body for transfer of at least almost the entire own weight of the second ground retaining wall to the coupling body.

[0039] The second ground retaining wall may be part of a prefab quay body and form a vertical wall thereof, wherein, with a section extending toward the land, the quay body is further attached to the foundation, in particular to the top of the coupling body. The quay body may be manufactured of concrete.

[0040] The second ground retaining wall may be continued downward and extend to below an upper edge area of the first ground retaining wall, in one embodiment to below the water level. The second ground retaining wall, considered in horizontal direction, at the waterside, can be situated in front of the upper edge area of the first ground retaining wall.

[0041] The upper edge area of the first ground retaining wall can be situated between the landside of the second ground retaining wall and the coupling body. The upper edge area of the first ground retaining wall can be situated at the level of the coupling body.

[0042] The first ground retaining wall can be formed by a lower section of the old quay wall, in particular a quay wall of masonry.

[0043] The first ground retaining wall can be made of a synthetic material.

[0044] The second ground retaining wall can at least partially be made of concrete and at the waterside may be provided with a leaf of facing masonry.

[0045] The aspects and measures described in this description and the claims of the application and/or shown in the drawings of this application may where possible also be used individually. Said individual aspects may be

the subject of divisional patent applications relating thereto. This particularly applies to the measures and aspects that are described per se in the sub claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1 shows a vertical cross-section of an arrangement with a quay wall that is to be replaced; Figure 2 shows a vertical cross-section of an arrangement with a temporary secondary wall; Figure 3 shows a vertical cross-section after excavation of the existing quay to just above the water level;

Figure 4A shows a vertical cross-section of an arrangement after removal of the quay wall of figure 1 and in an initial stage of an example of a method according to the invention, including placement of an example of a coupling body according to the invention;

Figure 4B shows a top view of the coupling body of figure 4A;

Figures 5A and 5B show a vertical cross-section and an isometric view, respectively, of a next step in a method according to the invention, wherein foundation piles are installed;

Figure 5C shows an alternative of the arrangement of figure 5A;

Figures 6A and 6B, show a vertical cross-section and an isometric view, respectively, of a next step in a method according to the invention, wherein a first ground retaining wall is being placed and connected to the coupling body;

Figure 7 shows a vertical cross-section of an arrangement after installing pins at the upper ends of the foundation piles;

Figure 8 shows a vertical cross-section of an arrangement after removing the temporary secondary wall;

Figure 9 shows a vertical cross-section of an arrangement after placing a prefab ground retaining wall at the coupling body;

Figure 10 shows a vertical cross-section of a completed arrangement with a quay body realized according to a method according to the invention;

Figures 11A and 11B show the preparation of placing a quay wall according to the invention as a new build; and

Figures 12A-F show a number of steps in the process of placing a quay wall according to the invention as a new build.

DETAILED DESCRIPTION OF THE DRAWINGS

[0047] Figure 1 depicts an arrangement 1 with an old

quay wall 103 that is to be replaced and retains a soil body 101 on which a paving 102 is placed. There is a watercourse 104 at the waterside of the quay wall 103, the watercourse having water bottom 106 and (design) water level 107. The quay wall 103 is founded on a bearing substratum 105.

[0048] In figure 2, a temporary secondary wall or ground retainer 108 (in this case a so-called Berlin-wall) has been placed in front of the old quay wall 103. The space between the old quay wall 103 and the temporary ground retainer 108 is filled with sand 109. Water level 107 and water bottom 106 remain unchanged here. It is noted that the secondary wall is merely shown for illustration purposes of a possible situation, in many cases a secondary wall will not be necessary.

[0049] In figure 3, the old quay wall 103 has been removed entirely, as well as a top section 110 of the soil body 101, so that ground level 111 now sits a few decimetres above the water level 107 and a slope 112 is formed. The rest of the soil body 101 now connects to the sand that had been installed at the landside of the temporary ground retainer 108.

[0050] Figure 4A depicts that at ground level 109 a steel coupling body 1 has been placed. The coupling body 1 forms a coupling frame and more or less has the shape of a truss and comprises girders 2a,b,c,d and bond rods connecting them to each other, namely cross-rods 3 and slanting rods 5, see the top view of figure 4B. The girders 2a and 2b and cross-rods 3 form passages 4. The same goes for the girders 2c and 2d and cross-rods 3. The passages 4 are adjusted to the diameter of the foundation piles 9 yet to be introduced and sit in series that are offset relative to each other. The passages 4 indicate where the piles will have to be introduced. As can be seen in figure 4B, several passages are each time provided adjacent to each other, in other words the passages are each time provided in groups. The advantage thereof is that if as a result of an unforeseen condition in situ the originally intended introduction location of a foundation pile is not available (for instance due to the surprising presence of a utility pipe), a foundation pile can nonetheless be installed in the immediate vicinity and the demands of the design can be complied with. Steel dowels or pins 13 that extend upward, are further attached to the coupling frame.

[0051] In figures 5A and 5B, the piles 9, that have steel casings, have in this example been introduced into the soil body 101 by way of screw piles in direction A, rotating in the direction B, until their tips have ended up in the bearing substratum 105 to a sufficient extent. The piles 9 have then been guided in the passages 4.

[0052] If so desired, to increase the resistance against horizontal loads, for instance for a shipping quay, it may be opted for to allow the passages 4 that are situated at the landside of the coupling frame, to slope as can be seen in figure 5C. The piles 9B introduced therein are sloping, the piles 9A situated closer to the water are vertical here.

[0053] At the waterside of the longitudinal girder 2d, the longitudinal edges of the flanges of the longitudinal girder 2d form guide means for guiding the first ground retaining wall 10 that is to be installed next. In this example, the first ground retaining wall 10 is made of a synthetic composite material and has a height that is considerably smaller than the length of the piles 9. In figures 6A and 6B, the first ground retaining wall 10 is introduced into the soil body 101 in the direction C, for instance by means of a vibration tool, guided by strip 7, for instance to one metre below the water bottom 106, but up to a distance above the soil layer 105.

[0054] The piles 9 are subsequently (figure 6B) welded or bolted to the steel coupling frame 1 by their steel casings. The coupling frame is then vertically and horizontally secured in its place. Furthermore, a steel U-profile 11 is placed over the upper edge of the first ground retaining wall 10, engaging about the upper edge. The steel U-profile is welded/bolted to the coupling frame 1. The first ground retaining wall 10 is thus restrained from moving away from the coupling frame 1 in horizontal direction. The first ground retaining wall 10 remains in its place in vertical direction due to engagement thereon of the soil present on either side thereof.

[0055] In figure 8 the temporary ground retainer 108 and the filling sand 109 are removed, so that the first ground retaining wall 10 already fulfils the function of quay wall up to a short distance above the waterline.

[0056] In figure 9 the placement of a prefab quay body 20 is shown. Several quay bodies 20 are placed like a quay, connecting to each other in horizontal quay direction. The quay body 20 comprises a reinforced concrete body manufactured as one unity, having a horizontal wall 21 and a vertical wall 22. With upper section 22a, the vertical wall 22 forms a second ground retaining wall and as its downward continuation has a lower section 22b, which extends downward from the wall 21 like a skirt and at the bottom forms a supporting strip 23. The quay body 20 thus has the appearance of a lying T. A leaf 24 of facing masonry has been installed on the supporting strip 23, attached against the vertical wall 22. There are recesses 25 at the bottom side of the horizontal wall 21, which recesses have been made in the factory and in which the above-mentioned dowels or pins 13 extending upright from the coupling frame can be accommodated.

[0057] By means of a hoist tool, the elements 20 can be placed with the horizontal walls 21 onto the upper side of the coupling frame 1 (direction E), so that the supporting strip 23 extends to below the water level 107 and the bottom part or skirt 22b is situated right in front of the first ground retaining wall 10.

[0058] After the horizontal wall 21 has been placed on the coupling frame 1, the recesses 25 within which the dowels 13 are situated, are filled using casting mortar, as a result of which a constructional connection is created between the steel casings of the piles 9, the coupling frame 1 and the quay body 20.

[0059] Figure 10 depicts that subsequently the soil

body is replenished again with soil 113, and the paving 114 has been installed again.

[0060] The vertical wall 22 including masonry 24 forms the visible quay wall, that can be loaded by floating objects, and second (higher) ground retaining wall, whereas the first ground retaining wall 10 that is situated inside it and largely below it, only needs to retain soil and then only that part of the height of the soil body above the water bottom. Own weight of the quay body 20 and the external loads exerted thereon are transferred to the soil via the coupling frame and the piles.

[0061] It is also possible that the existing quay wall can still be suitable to function in the concept of the invention as first ground retaining wall. In that case a lower section of the quay wall in question can be left standing, with the upper end at the level of the upper end of the wall 10 of the embodiment discussed above.

[0062] The invention can also be applied in a new build, which is illustrated in figures 11A, B and 12A-F.

[0063] In figure 11A, a soil body 101 is shown, provided with a top layer 102, for instance a grass layer. A ditch 110 is excavated, having bottom 111 and slope 112, figure 11B. The bottom 111 is laid at a level just above the design water level or groundwater level.

[0064] Coupling frame 1 is placed on the bottom 111, figure 12A. Subsequently, figure 12B, the foundation piles 9 are introduced, again guided in holes 4 of the coupling frame 1, up to the bearing substratum 105. Subsequently the first ground retaining wall 10 is introduced into the soil body 101, until its upper edge can be connected to the coupling frame 1, as described above.

[0065] Then the actual profile 115 of the water body can be excavated, see figure 12D. The first ground retaining wall 10 extends to below the bottom 106 of said water body.

[0066] The quay body 20, that has been supplied as a prefab unit, can subsequently be placed on the coupling body 1 (as in a consecutive series in quay direction, with identical further quay bodies 20) and be attached thereto, as described above, see figure 12E.

[0067] Finally, the soil (113) can be replenished again at the landside of the second ground retaining wall and the top layer 114 can be restored. The water can be allowed up to the design water level 107.

[0068] The invention is/inventions are not at all limited to the embodiments discussed in the description and shown in the drawings. The above description has been included to illustrate the operation of preferred embodiments of the invention and not to limit the scope of the invention. Starting from the above explanation many variations that fall within the spirit and scope of the present invention will be evident to an expert. Variations of the parts described in the description and shown in the drawings are possible. They can be used individually in other embodiments of the invention(s). Parts of the various examples given can be combined together.

Claims

1. Method for the construction of a quay wall bounding a soil body to separate a water body from a soil body, wherein the quay wall is built up with a first ground retaining wall and a second ground retaining wall, wherein the following steps are carried out:
 - a) installing a foundation in the soil body at the landside of the position of the first ground retaining wall;
 - b) installing a quay body and connecting it to the foundation, which quay body includes the vertical, second ground retaining wall as well as a quay body section extending from the vertical wall in land direction, for example configured as a horizontal wall, and together with the quay body being supported by the foundation,
 - wherein the first ground retaining wall extends in upward direction up to the quay body section and the second ground retaining wall extends above the first ground retaining wall,

wherein in step a), for creating the foundation, a number of foundation piles are installed in the soil body, preferably at positions that are situated at different distances from the location of the position of the quay wall to be constructed, wherein the method further comprises the steps of:

 - c) installing a coupling body; and
 - d) by means of the coupling body connecting the upper ends of the foundation piles to each other for transfer of forces.
2. Method according to claim 1, wherein the coupling body is provided with passages and/or guides for guiding the foundation piles or their constituent pipes during their introduction into the soil body, wherein the coupling body is positioned prior to the introduction of the foundation piles or their constituent parts.
3. Method according to claim 1 or 2, wherein the coupling body is installed at a level situated above the level of groundwater and/or the design water level of the water body.
4. Method according to claim 1, 2 or 3, wherein prior to step a) soil is removed from the soil body to a level near the design water level of the water body, wherein the foundation piles are installed in the soil body so that their upper ends end up at the level of the water level, preferably even above that level.
5. Method according to any one of the preceding claims, wherein the quay wall is constructed as replacement for an existing quay wall, wherein a lower section of a quay wall existing prior to step a) is used for the first retaining wall, wherein, preferably, prior to step a) an upper section of the old quay wall is removed, preferably to a level near the design water level of the water body, wherein, preferably, the quay wall is removed down to an area between + 3 dm and 0 dm of the design water level.
6. Method according to any one of the claims 1 - 5, wherein the entire quay wall is removed, preferably prior to step a), or wherein the quay wall is constructed as a new build, wherein, preferably, the first ground retaining wall, which, for example, is made of a synthetic composite material, is supplied to and installed in the work, wherein, preferably prior to step a), a temporary secondary wall is placed at the waterside of the quay wall and the resulting intermediate space is filled with soil material.
7. Method according to claim 5 or 6, wherein the first ground retaining wall is installed after installing the coupling body, wherein, preferably during installing the first ground retaining wall the coupling body is used as a guide for the first ground retaining wall.
8. Method according to any one of the preceding claims, wherein the first ground retaining wall is connected/coupled to the quay body or the foundation, in particular to the coupling body, wherein, preferably, the upper end of the first ground retaining wall is connected/coupled to the quay body or the foundation, in particular to the coupling body, counter to a horizontal displacement away from it, preferably is secured to counter a horizontal displacement away from it by means of a confinement device engaging over it which is attached to the foundation, in particular the coupling body, or to the quay body.
9. Method according to any one of the preceding claims, wherein the quay body is prefab and supplied to the site of the work.
10. Method according to any one of the preceding claims, wherein the foundation piles are formed in the soil, as in the case of tubular steel piles and screw piles (concrete mortar screw pile, tubular screw pile, screw injection pile) whether or not to be built up from pipe parts.
11. Method according to any one of the preceding claims, wherein the coupling body is formed as a coupling frame, with girders, wherein, preferably,
 - the coupling frame forms a horizontal truss and/or the coupling frame is made of steel and the foundation piles have steel casings, wherein

the piles and the coupling frame are welded together.

12. Method according to any one of the preceding claims, wherein the second ground retaining wall is continued downward to below the upper edge of the first ground retaining wall and in that way extends at the waterside in front of the first ground retaining wall, wherein, preferably the second ground retaining wall is continued downward to a level below the coupling body.
13. Quay wall retaining a soil body towards a water body, comprising:
 - a) a first ground retaining wall forming a lower section of a quay and being located between the soil body and the water body and extending to below the bottom of the water body;
 - b) a second ground retaining wall forming an upper section of the quay and extending above the first ground retaining wall, preferably up to ground level;
 - c) a foundation for the second ground retaining wall, which foundation is positioned at the land-side adjacent to the first ground retaining wall, wherein the foundation comprises a number of foundation piles installed in the soil body, that are preferably situated at positions at different distances from the first ground retaining wall, furthermore comprising:
 - d) a substantially horizontal coupling body connecting the upper ends of the foundation piles to each other;
 - wherein the second ground retaining wall is founded on the coupling body for transfer of at least almost the entire own weight of the second ground retaining wall to the coupling body.
14. Quay wall according to claim 13, wherein the second ground retaining wall is part of a prefab quay body and forms a vertical wall thereof, wherein, with a section extending toward the land, the quay body is further attached to the foundation in particular to the top of the coupling body, wherein, preferably the quay body is made of concrete.
15. Quay wall according to claim 13 or 14, wherein the second ground retaining wall continues downward in a skirt and extends to below an upper edge area of the first ground retaining wall, in one embodiment to below the water level, wherein the skirt of the second ground retaining wall considered in a horizontal direction, at the waterside, is located in front of the upper edge area of the first ground retaining wall, wherein, preferably, the upper edge area of the first ground retaining wall is located between the landside of the skirt of the second ground retaining wall and the coupling body, wherein, preferably, the upper edge area of the first ground retaining wall may be situated at the level of the coupling body.
16. Quay wall according to any one of claims 13 - 15, wherein the first ground retaining wall is formed by a lower section of an old quay wall, in particular a quay wall of masonry, and/or where the first ground retaining wall is made of a synthetic material.
17. Method for the construction of a quay wall bounding a soil body to separate a water body from a soil body, wherein the quay wall is built up with a first ground retaining wall and a second ground retaining wall, wherein the following steps are carried out:
 - a) installing a foundation in the soil body at the landside of the position of the first ground retaining wall;
 - b) installing a quay body and connecting it to the foundation, which quay body includes the vertical, second ground retaining wall as well as a quay body section extending from the vertical wall in land direction and together with the quay body being supported by the foundation,
 - wherein the first ground retaining wall extends in upward direction up to the quay body section and the second ground retaining wall extends above the first ground retaining wall.
18. Method according to claim 17, wherein in step a), for creating the foundation, a number of foundation piles are installed in the soil body, preferably at positions that are situated at different distances from the location of the position of the quay wall to be constructed.
19. Method according to claim 18, comprising the following steps:
 - c) installing a coupling body; and
 - d) by means of the coupling body connecting the upper ends of the foundation piles to each other for transfer of forces.
20. Method according to claim 19, wherein the coupling body is installed at a level situated above the level of groundwater and/or the design water level of the water body.
21. Method according to claim 18, 19 or 20, wherein prior to step a) soil is removed from the soil body to a level near the design water level of the water body, wherein the foundation piles are installed in the soil body

so that their upper ends end up at the level of the water level, preferably even above that level.

22. Method according to any one of the claims 17 - 21, wherein the quay wall is constructed as replacement of an existing quay wall, wherein for the first ground retaining wall use is made of a lower section of a quay wall existing prior to step a).
23. Method according to claim 22, wherein prior to step a) an upper section of the old quay wall is removed, preferably down to a level near the design water level of the water body.
24. Method according to claim 23, wherein the quay wall is removed to an area between + 3 dm and 0 dm of the design water level.
25. Method according to any one of the claims 17 - 21, wherein the entire quay wall is removed, preferably prior to step a).
26. Method according to claim 25, wherein the first ground retaining wall is supplied to and installed in the work.
27. Method according to claim 26, wherein prior to step a) a temporary secondary wall is placed at the waterside of the quay wall and the resulting intermediate space is filled with soil material.
28. Method according to any one of the claims 17 - 21, wherein the quay wall is constructed as a new build, wherein the first ground retaining wall is supplied to and installed in the work.
29. Method according to claim 26, 27 or 28, when depending on claim 19, wherein the first ground retaining wall is installed after installing the coupling body.
30. Method according to claim 29, wherein during installing the first ground retaining wall the coupling body is used as a guide for the first ground retaining wall.
31. Method according to any one of the claims 26 - 30, wherein the first ground retaining wall is made of a synthetic composite material.
32. Method according to any one of the claims 17 - 31, wherein the first ground retaining wall is connected/coupled to the quay body or the foundation, in particular the coupling body.
33. Method according to claim 32, wherein the upper end of the first ground retaining wall is connected/coupled to the quay body or the foundation, in particular to the coupling body, counter to a horizontal displacement away from it, preferably is secured

to counter a horizontal displacement away from it by means of a confinement device engaging over it which is attached to the foundation, in particular the coupling body, or to the quay body.

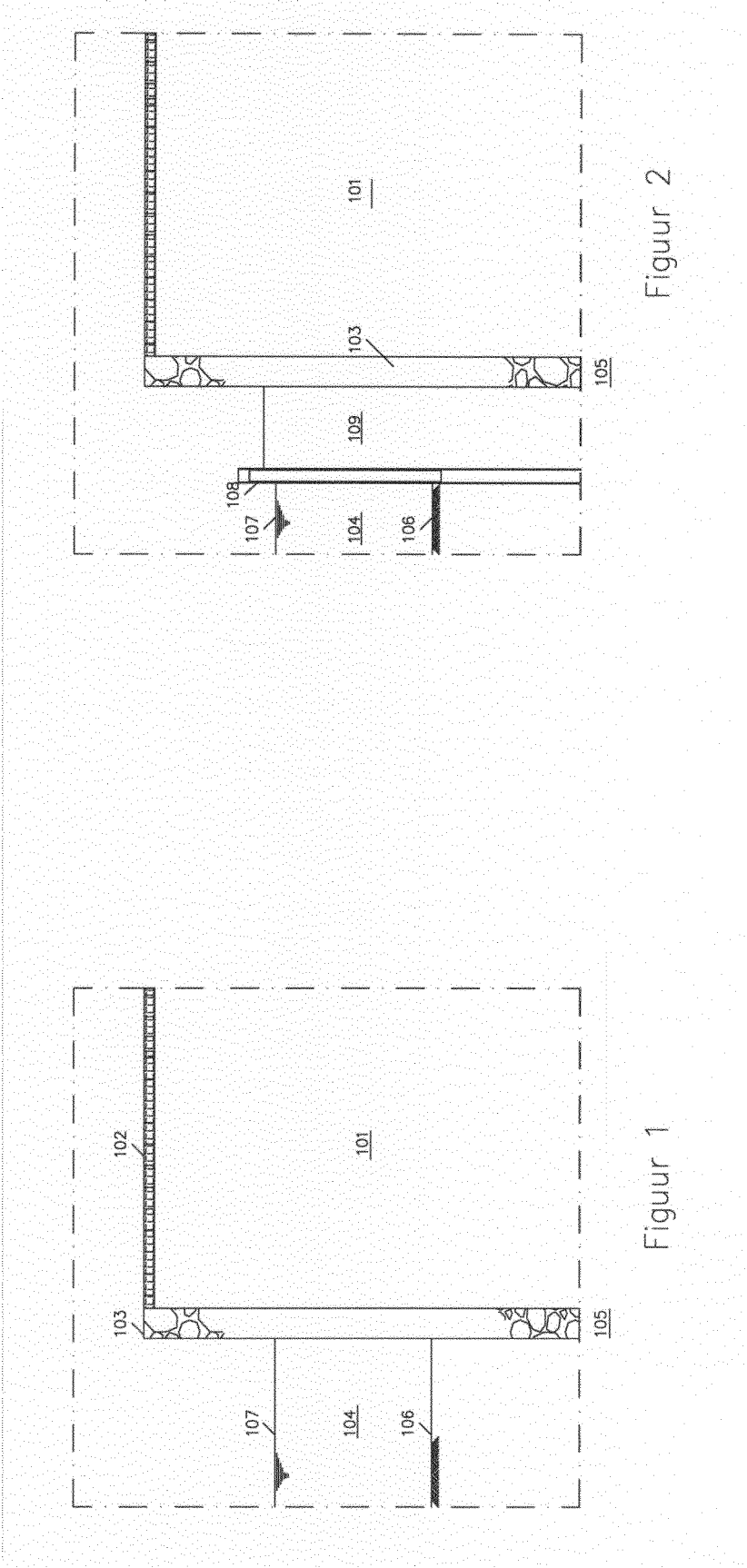
34. Method according to any one of the claims 17 - 33, wherein the quay body is prefab and supplied to the site of the work.
35. Method according to any one of the claims 17 - 34, wherein said quay body section is configured as a horizontal wall.
36. Method according to any one of the claims 17 - 35, when depending on claim 19, wherein the coupling body is placed prior to installing the foundation piles, wherein the coupling body is provided with passages and/or guides for guiding the foundation piles or their constituent pipes during their introduction into the soil body, wherein the coupling body is positioned prior to the introduction of the foundation piles or their constituent parts.
37. Method according to any one of the claims 17 - 36, wherein after arranging the quay body the soil body is replenished again to approximately the original level, and a top layer is installed, such as a grass layer, a surfacing, in particular paving and/or sewer facilities and/or utility pipes.
38. Method according to any one of the claims 17 - 36, wherein the quay body is installed to extend to below the design water level of the water body, yet at a distance above the bottom of the water body.
39. Method according to any one of the claims 17 - 38, when depending on claim 18, wherein the foundation piles are formed in the soil, as in the case of tubular steel piles and screw piles (concrete mortar screw pile, tubular screw pile, screw injection pile) whether or not to be built up from pipe parts.
40. Method according to any one of the claims 17 - 39, when depending on claim 19, wherein the coupling body is formed like a coupling frame, with girders, wherein preferably,
 - the coupling frame forms a horizontal truss and/or the coupling frame is made of steel and the foundation piles have steel casings, wherein the piles and the coupling frame are welded together.
41. Method according to any one of the claims 17 - 40, when depending on claim 19, wherein the coupling body forms a horizontal truss.
42. Method according to any one of the claims 17 - 41,

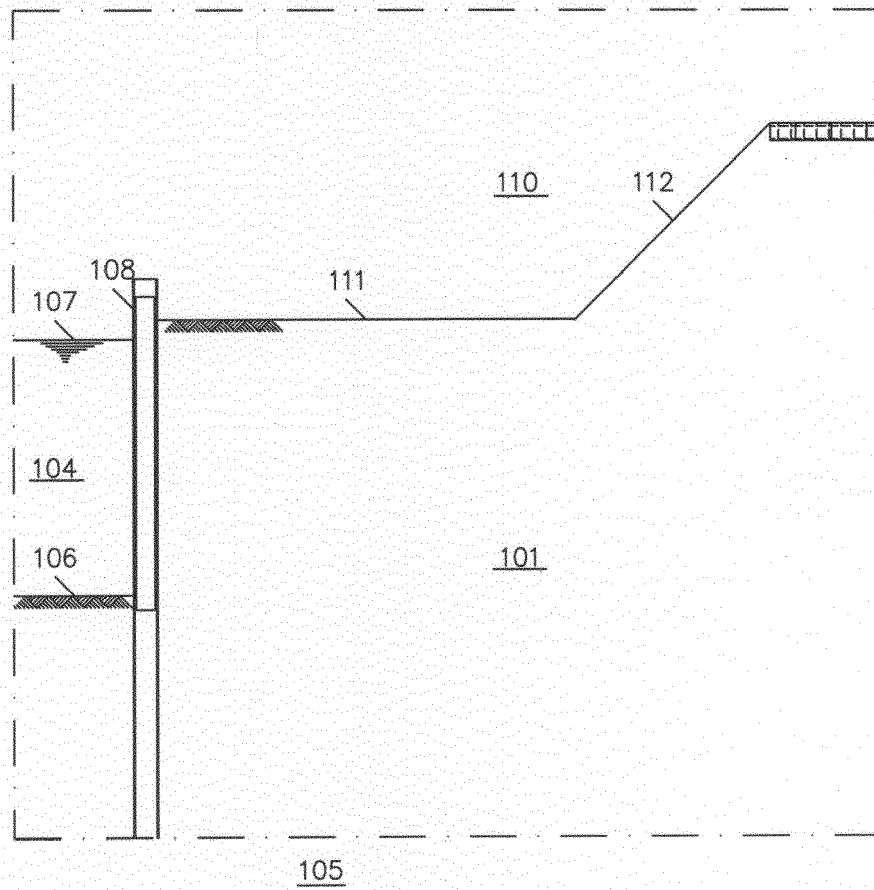
wherein the quay body at the waterside of the vertical wall is/has been provided with a wall of facing masonry, preferably a prefab wall of facing masonry.

43. Method according to claim 42, wherein at the vertical wall the quay body is provided with a support edge for the masonry. 5
44. Method according to any one of the claims 17 - 43, wherein the quay body is prepared for or has already been provided with a few facilities for use, such as attachments for ground anchors, bollards, and bollard recesses. 10
45. Method according to any one of the claims 17 - 44, wherein the second ground retaining wall is continued downward to below the upper edge of the first ground retaining wall and as a result, at the waterside, extends in front of the first ground retaining wall. 15
46. Method according to claim 45, when depending on claim 19, wherein the second ground retaining wall is continued downward to a level below the coupling body. 20
47. Quay wall retaining a soil body towards a water body, comprising: 25
- a) a first ground retaining wall forming a lower section of a quay and being located between the soil body and the water body and extending to below the bottom of the water body; 30
 - b) a second ground retaining wall forming an upper section of the quay and extending above the first ground retaining wall, preferably up to ground level; 35
 - c) a foundation for the second ground retaining wall, which foundation is positioned at the land-side adjacent to the first ground retaining wall. 40
48. Quay wall according to claim 47, wherein the foundation comprises a number of foundation piles installed in the soil body, which piles, preferably, are situated at positions that are situated at different distances from the first ground retaining wall. 45
49. Quay wall according to claim 48, furthermore comprising: 50
- d) a substantially horizontal coupling body connecting the upper ends of the foundation piles to each other;
- wherein the second ground retaining wall is founded on the coupling body for transfer of at least almost the entire own weight of the second ground retaining wall to the coupling body. 55
50. Quay wall according to claim 47, 48 or 49, wherein

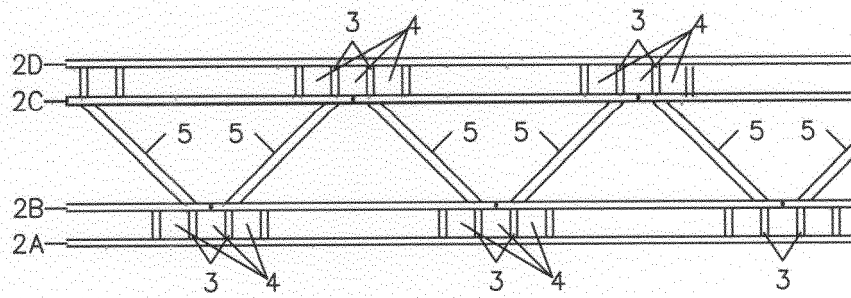
the second ground retaining wall is part of a prefab quay body and forms a vertical wall thereof, wherein, with a section extending toward the land, the quay body is further attached to the foundation in particular to the top of the coupling body.

51. Quay wall according to claim 50, wherein the quay body is made of concrete.
52. Quay wall according to any one of the claims 47 - 51, wherein the second ground retaining wall is continued downward in a skirt and extends to below an upper edge area of the first ground retaining wall, in one embodiment to below the water level.
53. Quay wall according to claim 52, wherein the skirt of the second ground retaining wall, when considered in horizontal direction, at the waterside is situated in front of the upper edge area of the first ground retaining wall.
54. Quay wall according to claim 52 or 53, when depending on claim 48, wherein the upper edge area of the first ground retaining wall is situated between the landside of the skirt of the second ground retaining wall and the coupling body.
55. Quay wall according to claim 54, wherein the upper edge area of the first ground retaining wall can be situated at the level of the coupling body.
56. Quay wall according to any one of the claims 47 - 55, wherein the first ground retaining wall is formed by a lower section of an old quay wall, in particular a quay wall of masonry.
57. Quay wall according to any one of the claims 47 - 56, wherein the first ground retaining wall is made of a synthetic material.
58. Quay wall according to any one of the claims 47 - 57, wherein the second ground retaining wall is at least partially made of concrete and at the waterside may be provided with a leaf of facing masonry.

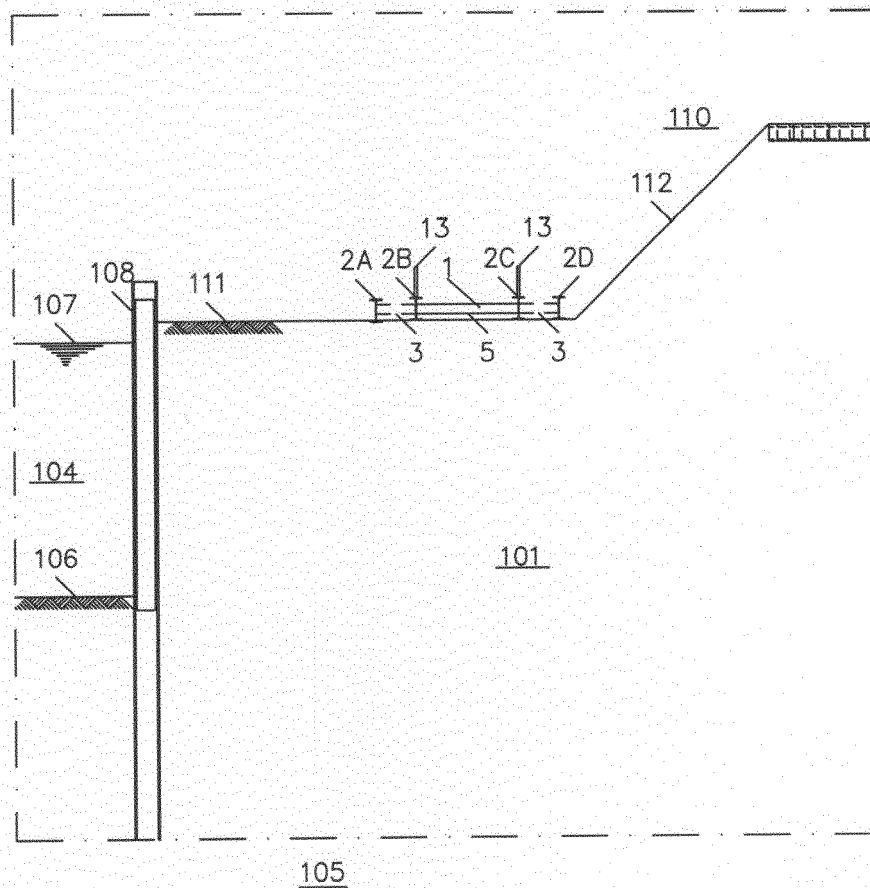




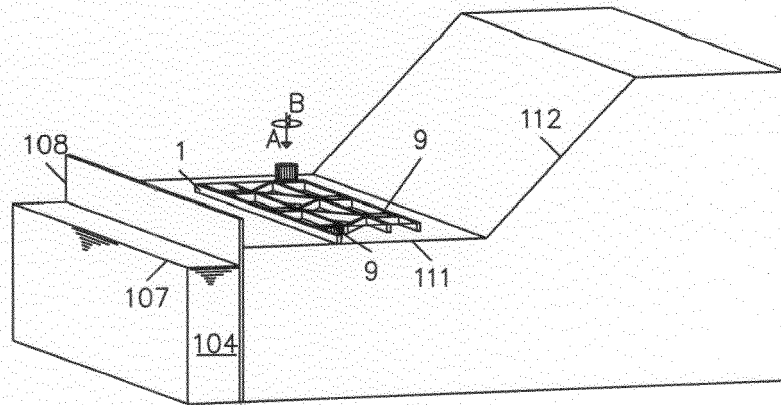
Figuur 3



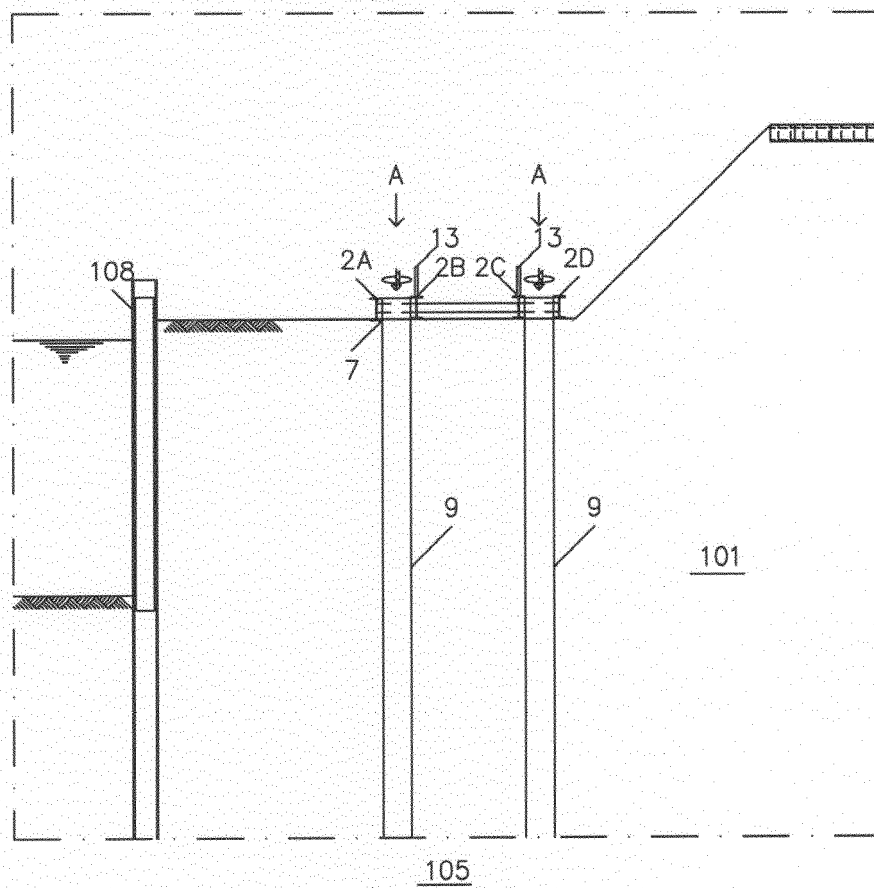
Figuur 4B



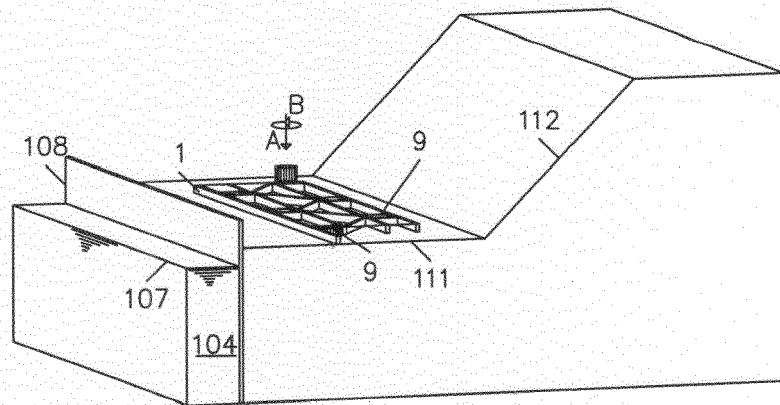
Figuur 4A



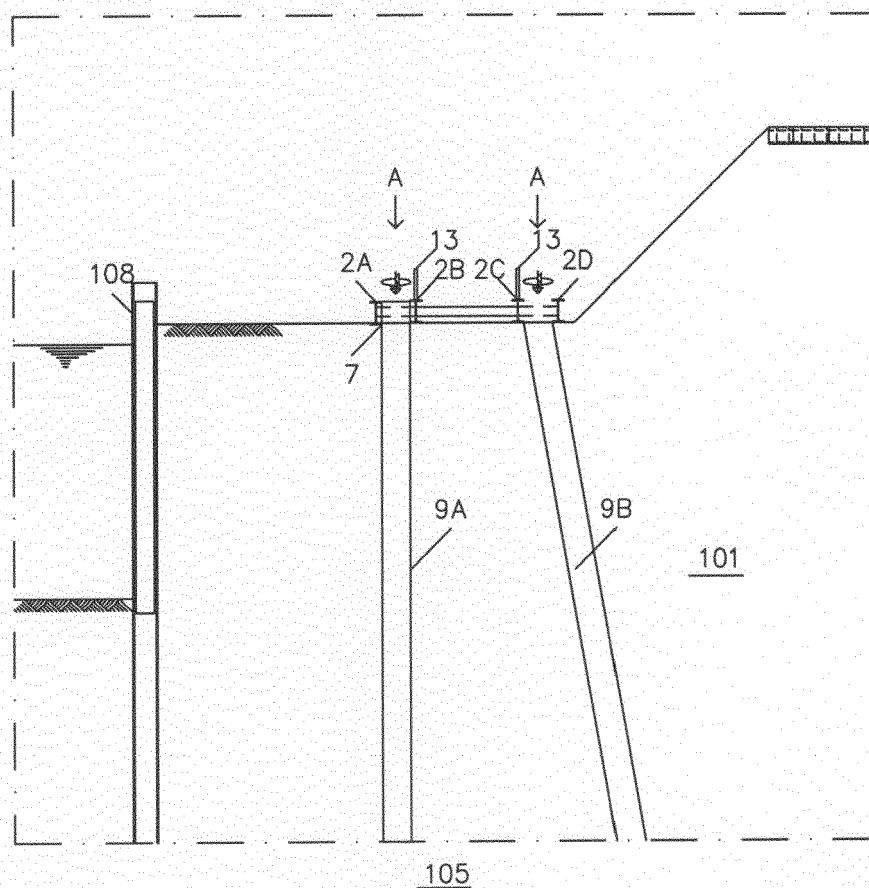
Figuur 5B



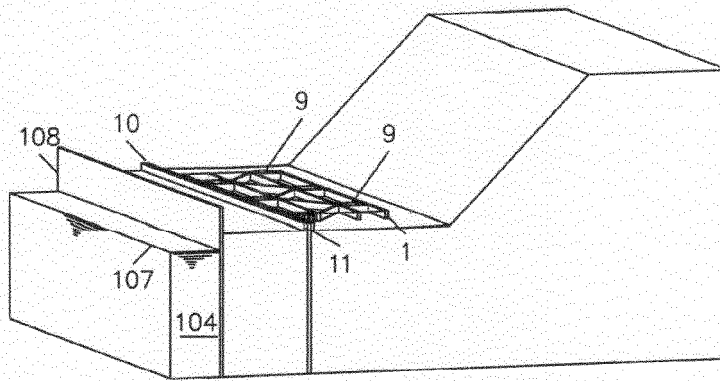
Figuur 5A



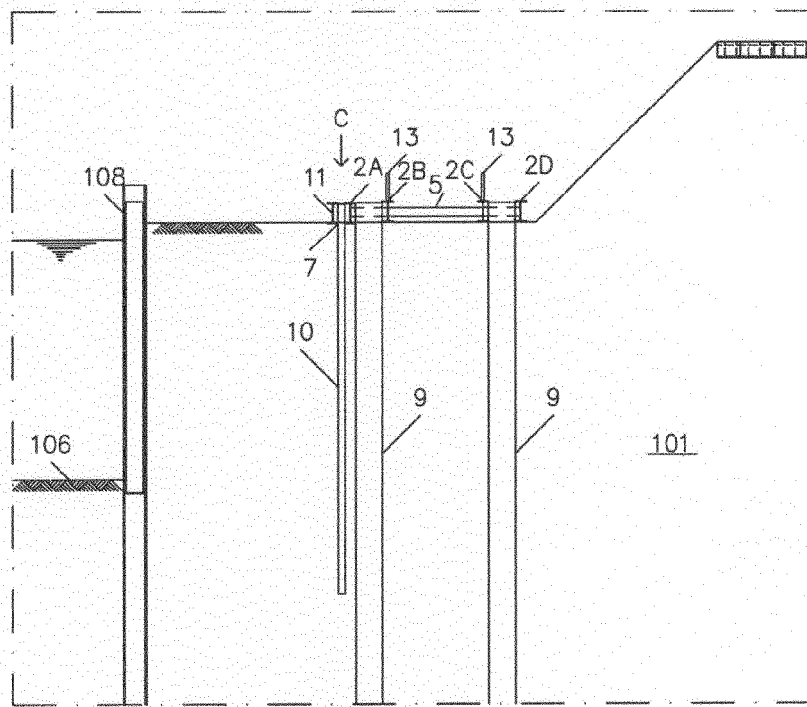
Figuur 5B



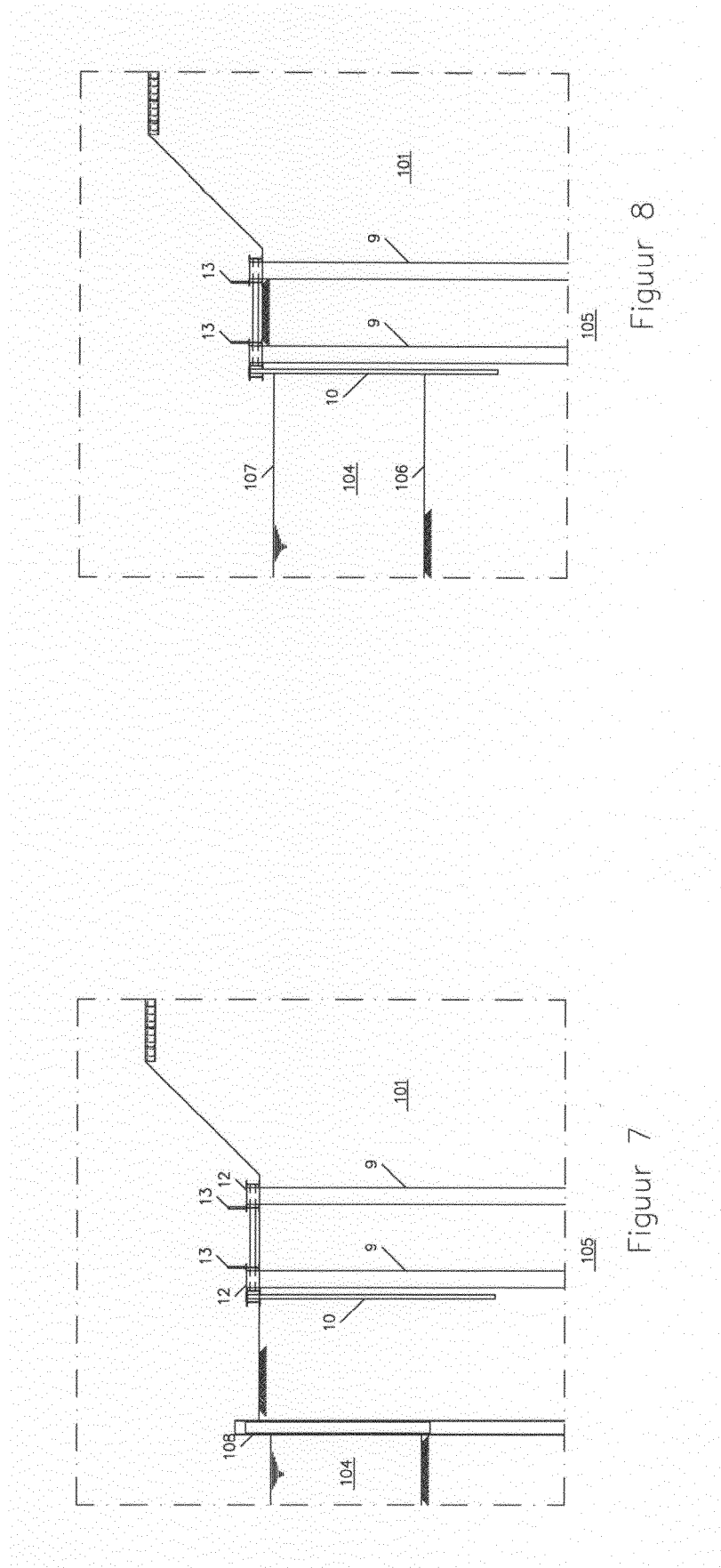
Figuur 5C

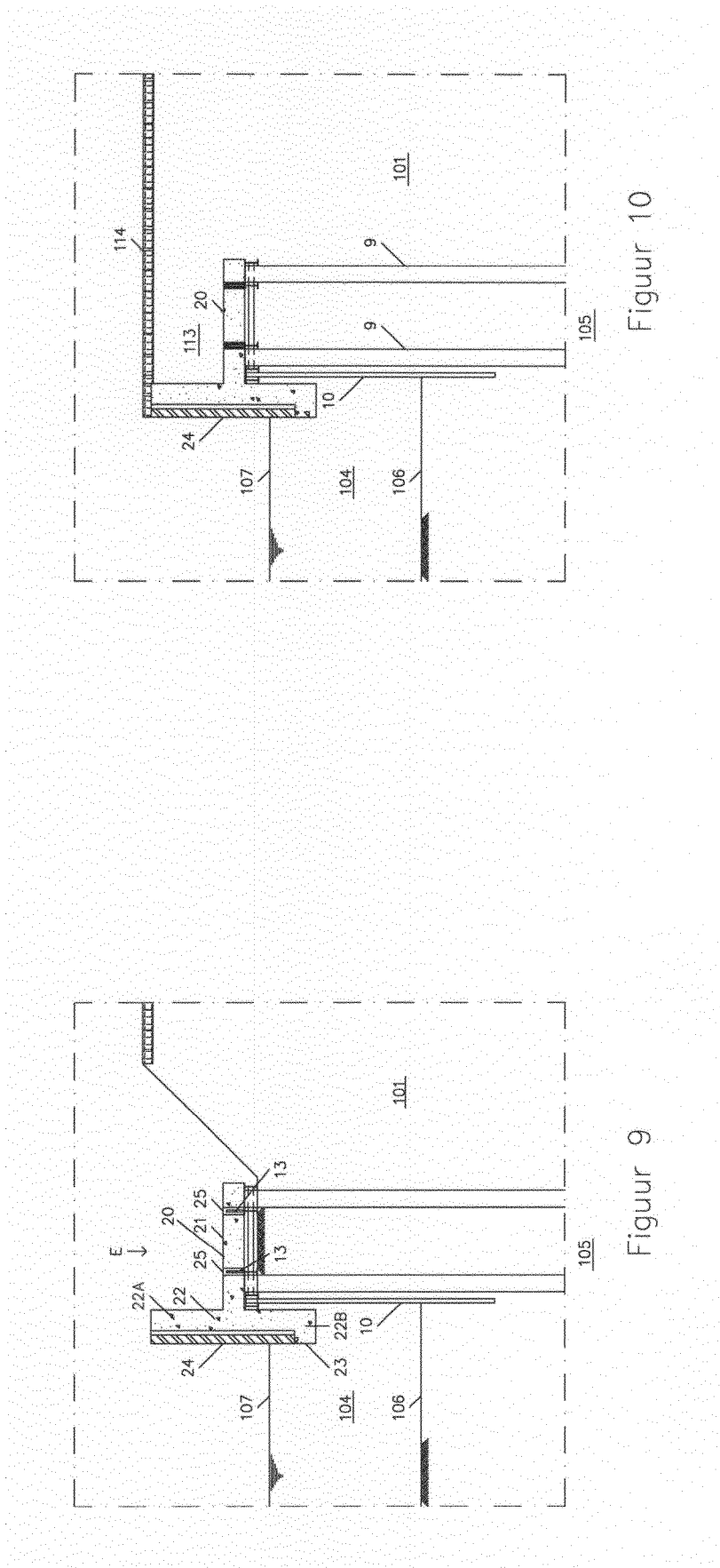


Figuur 6B



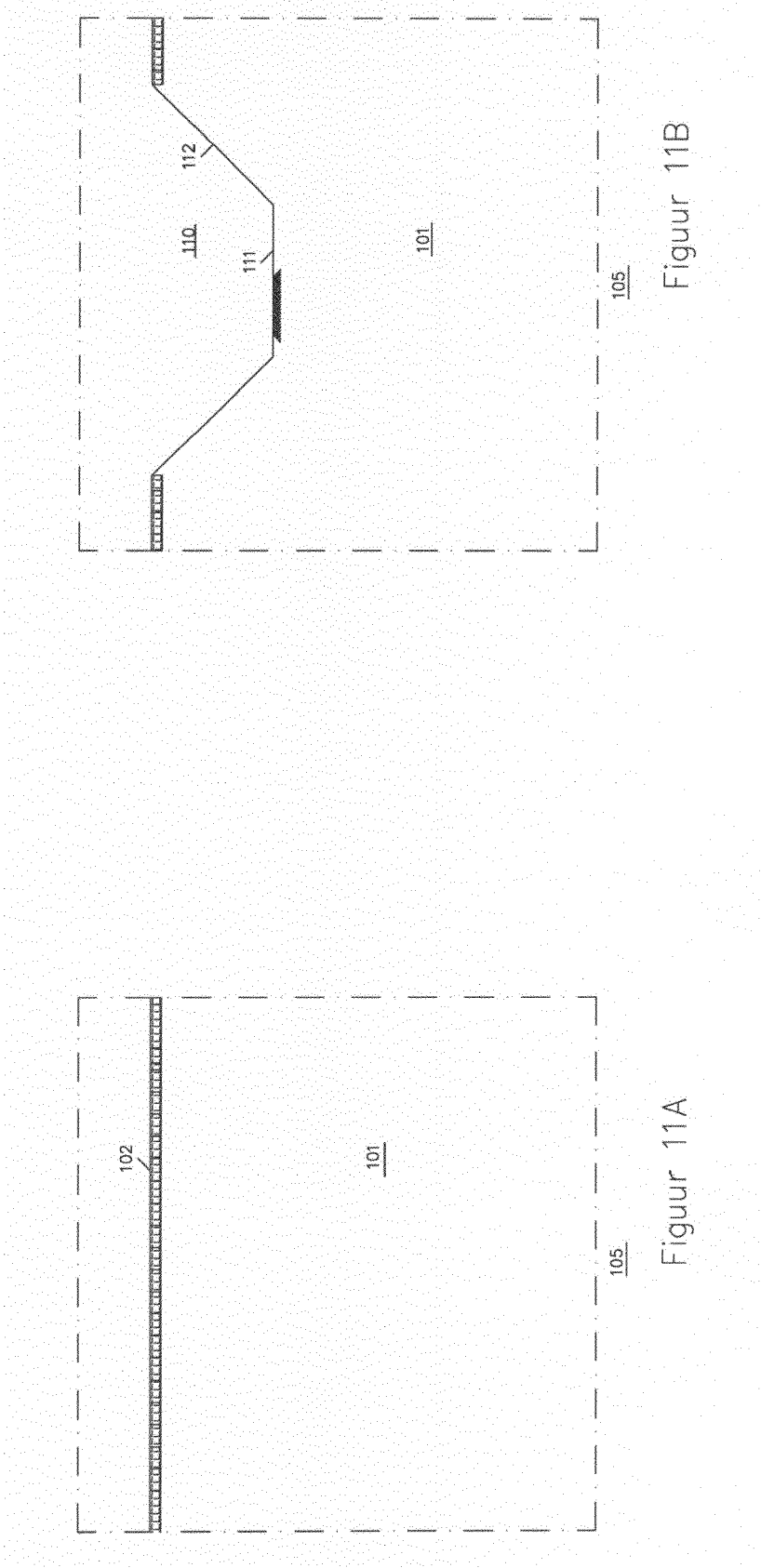
Figuur 6A





Figuur 10

Figur 9



Figuur 11B

Figuur 11A

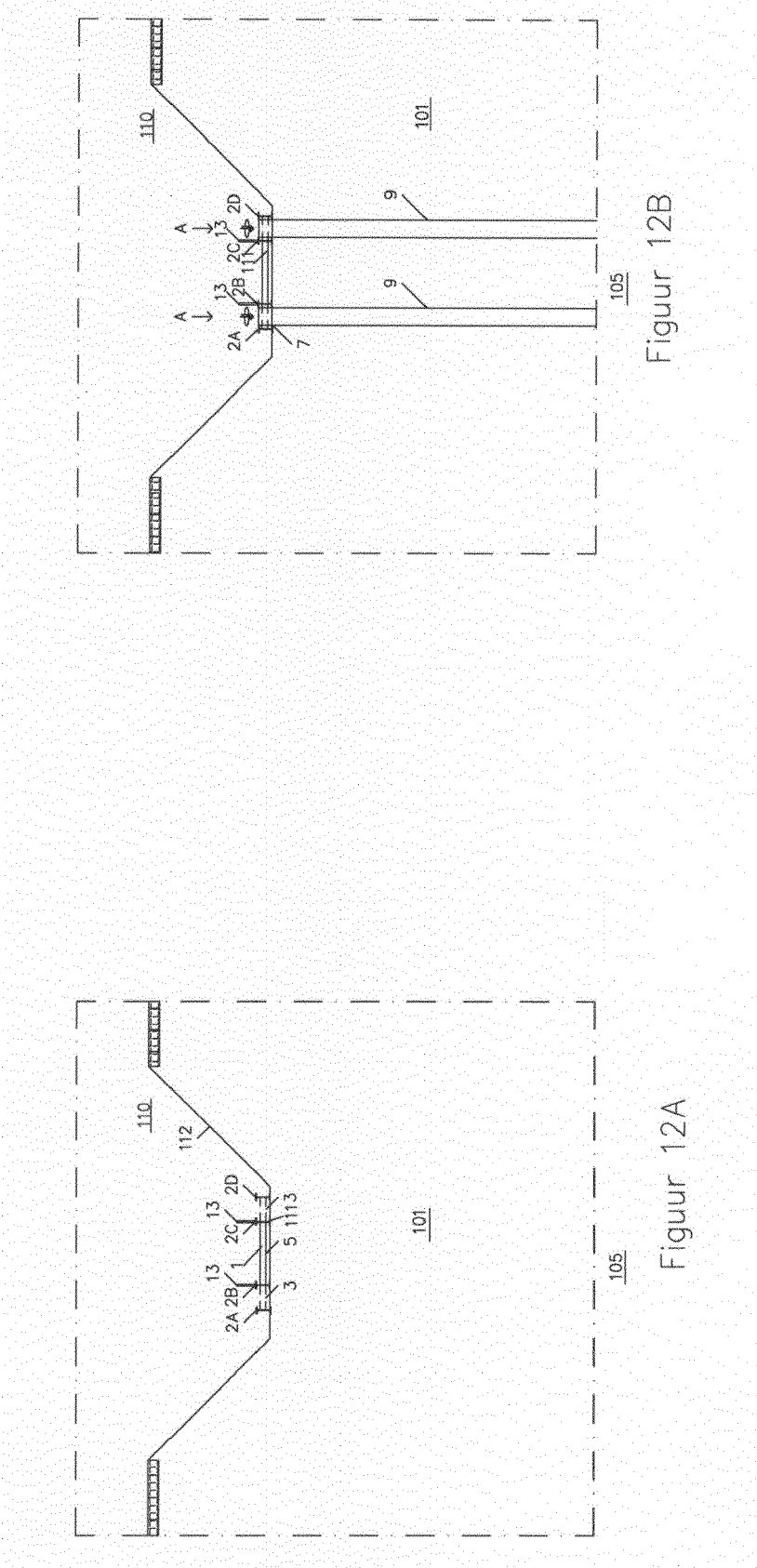
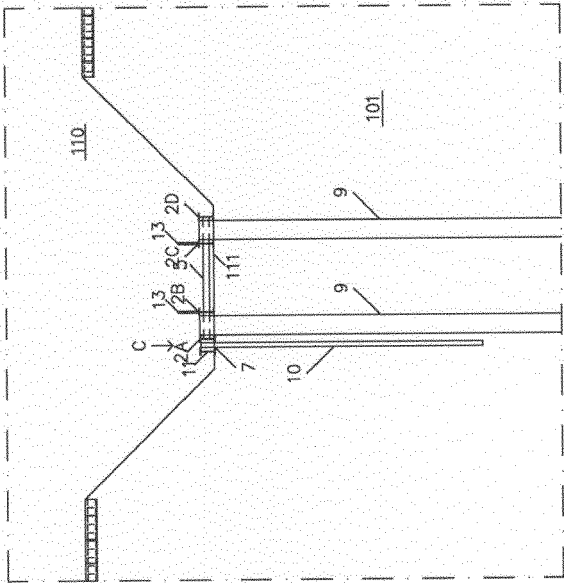
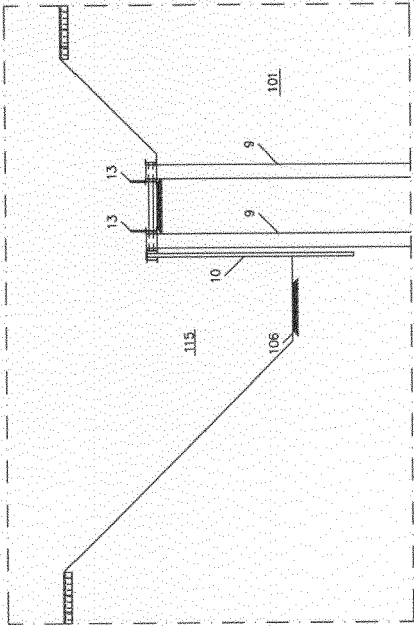


Figure 12B

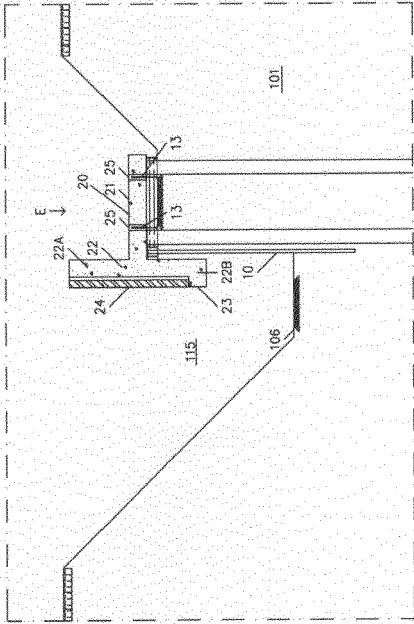
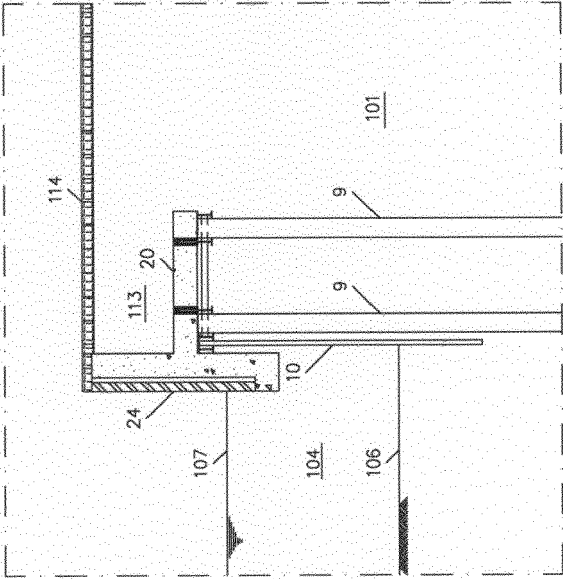
Figure 12A



Figuur 12C



Figuur 12D





EUROPEAN SEARCH REPORT

 Application Number
 EP 20 16 4519

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 592 575 A (THOREL) 5 August 1925 (1925-08-05) * the whole document *	1,3-10, 13,14,16	INV. E02B3/06
Y		11,12,15	
A		2	
X	US 4 045 965 A (VIDAL HENRI C) 6 September 1977 (1977-09-06) * column 3, line 6 - column 5, line 33; figures 2,7-9 *	1,5,6,9, 13,14	
Y	DE 12 09 067 B (HOERDER HUETTENUNION AG) 13 January 1966 (1966-01-13) * figures 3,4 *	11,12,15	
A		1	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 January 2021	Examiner Zuurveld, Gerben
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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 EPO FORM 1503 03.82 (P04C01)



Application Number

EP 20 16 4519

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

- ☒ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

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- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

- ☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 16 4519

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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15-01-2021

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