(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 January 2011 (27.01.2011)

PCT

(10) International Publication Number
WO 2011/010924 A1

(51) International Patent Classification:
E02D 23/08 (2006.01)

(21) International Application Number:
PCT/NL2010/050476

(22) International Filing Date:
23 July 2010 (23.07.2010)

(25) Filing Language: Dutch

(26) Publication Language: English

(30) Priority Data:
N2003267 23 July 2009 (23.07.2009) NL

(71) Applicant *(for all designated States except US)*: **MULTI-BOUWSYSTEMEN BV** [NL/NL]; Energieweg 2, NL-3762 ET Soest (NL).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **VAN SCHAIK, Everhardus, Elbertus** [NL/NL]; Wiekslooterweg 35A Westzijde, NL-3763 LJ Soest (NL).

(74) Agents: **De Vries & Metman** et al.; Overschiestraat 180, NL-1062 XK Amsterdam (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: METHOD AND SYSTEM FOR BUILDING AN UNDERGROUND AREA

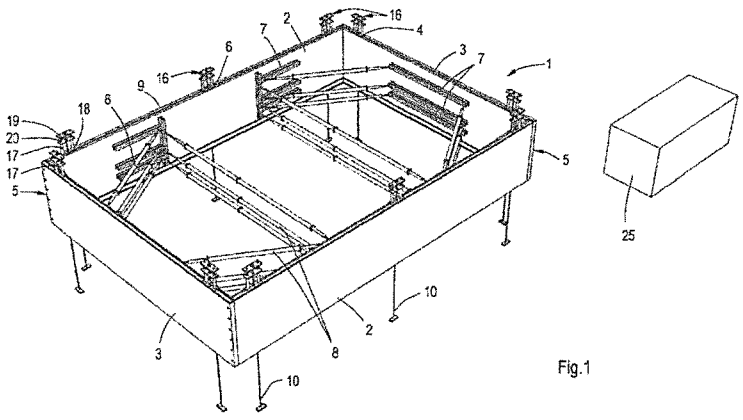

Fig.1

(57) Abstract: Method and building system for building an area which is at least partly- underground. A side wall construction without a floor is placed on the desired location, after which tension members (16) are placed on the side wall construction which are subsequently connected to anchors (10) in the ground via tension cables or bars (11). By pulling the anchors, the tension members force the side wall construction into the ground. The tension cables or bars are guided via internal vertical channels (4,6) in the side walls (2,3) of the side wall construction. The anchors can for instance be a folding anchor which is inserted into the ground via one of the vertical channels in the side wall construction.

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METHOD AND SYSTEM FOR BUILDING AN UNDERGROUND AREA

The present invention relates to a method and a building system for building an area which is at least partly underground, such as a cellar, an underground garage or basement, for instance as an annex to an existing building, such as a house.

European patent application EP 1 348 812 discloses a method for building a cellar, wherein a hollow lateral wall structure without a bottom is pulled into the ground by using jacks, pulling ground anchors positioned in the ground, via tension bars. The tension bars are located at the inside of the cellar wall. This causes strong bending moments exerted on the walls.

Japanese publication JP 10131210 discloses a similar system, using tension wires at both sides of the walls.

It is an object of the invention to provide a building system and method for sinking a room which is at least partly underground, such as a cellar, in a quick, commensurate and controllable way.

The object of the invention is achieved with a method for building an area which is at least partly underground, wherein a side wall construction without a floor having one or more side walls for enclosing the area to be built is placed on a desired location, after which tension members are placed on the side wall construction which are subsequently connected by means of tension cables or bars to anchors placed in the ground, after which the tension members force the side wall

construction into the ground by pulling the anchors. The tension cables or bars are guided via internal vertical channels within the side walls of the side wall construction.

In this respect the expression side wall construction is to be interpreted as being a construction of one or more side walls enclosing an area without a floor and usually without an upper or intermediate deck. The side wall construction can for instance consist of a single, round side wall or of four side walls forming a rectangular or square room, or it can consist of a plurality of side walls defining for instance an L-shaped or polygonal room.

The anchors can for instance be folding anchors inserted into the ground via one of the vertical channels in the side wall construction. Folding anchors have a pivotable anchor head which is inserted into the ground by force and which can subsequently be expanded. Suitable folding anchors are for instance the Duckbill®, Mataray® en Sting Ray® folding anchors, available from JLD International BV and disclosed on the website www.klapanker.nl.

After sinking the side wall construction the vertical channels can be filled with a hardening building material, such as a mortar.

To pull the side wall construction into the ground more easily, its lower edge can wholly or partly be provided with a cutting edge.

The ground can be excavated during the process of pulling down the side wall construction. However, it is also possible to

excavate a first part of the ground before the side wall construction is pulled down. A second part of the ground can then be excavated during the process of sinking the side wall construction.

After the side wall construction is pulled down a floor can be constructed, for instance by placing a reinforcement followed by pouring concrete.

The side wall construction can for instance be assembled from prefabricated wall elements. This can be done in situ or on a different location. It is also possible to prefabricate the side wall construction as a whole or to mould it on the building site.

A water retaining layer can be provided around the side wall construction. This layer can for example be a water repellent foil, such as a plastic foil, for example of polyethylene, polypropylene or other suitable foil materials.

The invention pertains to the method disclosed above as well as to a side wall construction as such, wherein one or more of the side walls are provided with one or more internal channels extending between an upper edge and a lower edge of the side wall.

The invention also pertains to a prefabricated wall element with two side edges provided with coupling elements for coupling with a corresponding wall element, a lower edge and an upper edge, wherein the wall element is provided with one or more internal channels extending between the upper and lower edges. Using such wall elements a side wall construction

according to the present invention can be assembled in a fast and easy manner.

The disclosed method can be practiced in an efficient manner using a building system according to the invention for building an area which is at least partly underground. Such a system can for instance comprise hydraulic tension members and a central control unit for controlling and coordinating the tension members.

The hydraulic tension members can for example comprise two or more hydraulic cylinders between a lower plate which can be positioned upon an upper edge of the side wall construction, and an upper plate attached to the ends of the pistons. The central section of the upper plate can then be connected to the tension bar of the corresponding anchor. The tension bar can be screw threaded to allow height adjustable coupling of the upper plate and the tension bar by means of a setscrew. An intermediate plate can be attached to the upper ends of the cylinder jackets to fixate and stabilise the cylinders relative to each other. The cylinders can be activated by pushing the upper plate and the lower plate apart. This way the cylinders pull the tension bar and the anchor via the upper plate while the side wall construction is pushed down via the lower plate. After a full stroke the height of the upper plate in relation to the tension bar can be adjusted in such way that the piston rod can be retracted again and a new stroke can be made. This way the required number of strokes can be made for bringing the side wall construction to the desired level.

Furthermore, the system can comprise provisions for permanently measuring the height of two or more points on the upper edge of

the side wall construction. If necessary, the control of the tension members can be adjusted to compensate possible differences in height between the two or more points in height. The provisions for monitoring the differences in height can for instance consist of two or more liquid containers, which can be placed on different points on the upper edge of the side wall construction, e.g., at or near one of the tension members and which can be connected as communicating vessels, wherein the liquid containers are provided with sensors for measuring the level of the liquid surface. If the wall inclines the liquid level will rise above a certain level in the lowest liquid container. If the liquid level rises above a certain level the sensor will produce a signal to the unit controlling the neighbouring tension member, which is activated to exert a pulling force, or a stronger pulling force, to the side wall construction, to compensate the difference in height.

Alternatively, other means can be used for monitoring and correcting undesired differences in height between the different point on the side wall construction, such as for instance electronic height gauges.

By practicing the method according to the invention it becomes possible to built very close to the foundation of the associated house or building. Furthermore, larger cellar rooms can be realized with the system and the method according to the invention than was possible hitherto. This way parking garages and cellar rooms of comparable size can be realized.

The invention will be elucidated with reference to the drawing. In the drawing:

Figure 1: shows in perspective view a side wall construction for a cellar to be placed by a method according to the invention;

Figure 2A: shows in detail a folding anchor from Figure 1 before it is expanded;

Figure 2B: shows the folding anchor of Figure 2A after being expanded;

Figure 3: shows in front view the side wall construction from Figure 1 before being sunk provided with a system for monitoring height differences.

Figure 1 shows a side wall construction 1 without a floor, consisting of two long side walls 2 placed opposite to each other, and two shorter side walls 3 placed opposite to each other, which jointly confine a cellar to be placed. The side wall construction 1 can be assembled locally, for instance using prefabricated wall elements. The side walls 2, 3 are provided with internal vertical channels 4 near the corners 5 of the side wall construction 1. The longer side walls 2 are also provided with internal vertical channels 6 in the middle.

Steel profiles 7 are placed at the inner side of the walls 2, 3 with struts 8 clamped in between them to form a strut frame.

Folding anchors 10 are shot into the ground via the vertical channels 4, 6 in the side walls from the upper edge 9 of the side walls 2, 3. The folding anchors 10 are shown in more detail in Figures 2A and 2B. The folding anchors 10 comprise a tension bar 11 having a pivotable anchor head 12 at its outer end, wherein one end of the anchor head comprises a tubular part 13, in which the end 14 of a driving rod 15 can be placed. The other end of the anchor head 12 comprises a cutting face

16. When the driving rod 15 is placed in the tubular part 13 of the anchor head 12 the folding anchor 10 can be driven into the ground with great force. Subsequently the driving rod 15 can be removed. By pulling the tension bar 11 the anchor head 12 pivots in such a way that it fixates itself into the ground.

After anchoring the folding anchors 10 via the vertical channels 4, 6 tensioning means 16 are connected onto the upper edges 9 of the side walls 2, 3, each at the end of the tension bars 11. The tensioning means 16 are shown in more detail in Figure 3, each comprising two hydraulic cylinders 17 between a lower plate 18 resting on the upper edge of the side walls 2, 3 and an upper plate 19, which are connected to the ends of the piston rods 20. The central section of the upper plate 19 is connected to the tension bar 11. Between the lower plate 18 and upper plate 19 an intermediate plate 21 is connected to the upper ends of the cylinder jackets to fixate and stabilise the two cylinders 17 relative to each other.

When the cylinders 17 are activated they push against the upper plate 19, pulling tension bar 11 and folding anchor 10, so as to push down side wall construction 1. After a full stroke the tension bar 11 is detached from the upper plate 19, allowing the cylinders 17 to be retracted for making a new stroke.

The cylinders 17 are controlled and coordinated jointly by a central control unit 25, schematically represented in Figure 1.

Figure 3 shows the side wall construction 1 in front view, the cylinders 17 being provided with means 26 for permanently monitoring height differences between two points on the upper edge 9 of the side wall construction 1. If so desired, such

means 26 can be placed on more points. In this exemplary embodiment, the means 26 for monitoring height differences comprise two liquid containers 27, each being connected to one of the cylinders 17. The two liquid containers 27 are connected to each other as communicating vessels via a liquid channel 28. Both liquid containers 27 are partly filled with a liquid, such as water. The liquid containers 27 are bother provided with sensors for determining the liquid level. When the side wall construction 1 leans, the liquid level rises in the lowest liquid container 27. If the liquid level rises above a certain point the sensor produces a signal to the control unit for the associated cylinder 17 which is subsequently activated to exert a downward force onto the side wall construction 1, in order to correct the difference in height. Alternatively, or additionally, electronic height gauges can be used.

After each stroke by the cylinders 17 ground enclosed by the side wall construction 1 is excavated, particularly near the lower edges of the walls 2, 3. The lower edges of the walls 2, 3 are provided with a cutting edge (not shown) to make it easier to force the side walls into the ground.

When the side wall construction reaches the desired level, the tensioning means 16 are removed and the part of the tension bars projecting from the side wall construction 1 is cut off by sawing. The vertical channels 4 are subsequently filled with a mortar. In a next step, concrete reinforcement is placed on the bottom within the side wall construction and a floor is poured. After hardening of the floor the struts 8 are removed and the cellar room can be completed, including by making an entrance, for instance from the house or building associated with the

cellar room. The cellar room can then be closed off by a cellar deck.

CLAIMS

1. Method for building an area which is at least partly underground, wherein a side wall construction without a floor having one or more side walls for enclosing the area to be built is placed on a desired location, after which tension members are placed on the side wall construction which are subsequently joint by means of tension cables or bars to anchors placed in the ground, after which the tension members force the side wall construction into the ground by pulling the anchors **characterized in that** the tension cables or bars are guided via internal vertical channels within the side walls of the side wall construction.

2. Method according to claim 1 **characterized in that** one or more of the anchors comprise a folding anchor inserted into the ground via one of the vertical channels in the side wall construction.

3. Method according to claim 1 or 2 **characterised in that** after forcing the side wall construction into the ground the vertical channels are filled with a hardening building material.

4. Method according to claim 1 **characterized in that** the side wall construction comprises a lower edge which is at least partly provided with a cutting edge.

5. Method according to any one of the preceding claims **characterized in that** before the side wall construction is pulled down, a first part of the ground enclosed by

the side wall construction is excavated and in that a second part of the ground is excavated during sinking of the side wall construction.

6. Method according to any one of the preceding claims **characterized in that** a floor is constructed after the side wall construction is pulled down.

7. Method according to any one of the preceding claims **characterized in that** the side wall construction is assembled from prefabricated wall elements.

8. Method according to any one of the preceding claims **characterized in that** a water retaining layer, for instance a water repellent foil, is provided around the side wall construction.

9. Side wall construction of interconnected side walls without a floor wherein one or more of the side walls are provided with one or more internal channels extending between an upper edge and a lower edge of the side wall.

10. Side wall construction according to claim 9 **characterized in that** the lower edge of at least a part of the side walls is provided with a cutting edge.

11. Prefab wall element with two side edges provided with coupling elements for coupling with a corresponding wall element, a lower edge and an upper edge, wherein the wall element is provided with one or more internal channels extending between the upper and lower edges.

12. System for building a area which is at least partly underground and which is according to any one of claims 1 - 8 **characterized in that** the system comprises hydraulic tension members and a central control unit for controlling the tension members.

13. System according to claim 12 **characterized in that** the hydraulic tension members comprise two or more hydraulic cylinders between a lower plate which can be positioned upon an upper edge of the side wall construction, and an upper plate attached to the ends of the pistons, wherein a central section of the upper plate is coupled in a height adjustable manner to a tension bar coupled to the corresponding anchor.

14. System according to claim 13 **characterized in that** the tension bar is provided with a screw thread and in that the upper plate is height adjustable by means of a setscrew which cooperates with the screw thread.

15. System according to claim 13 or 14 **characterized in that** below the upper plate an intermediate plate is attached to the upper ends of the cylinder jackets.

16. System according to claim 13, 14, or 15 **characterized in that** the system comprises two or more height gauges for permanently measuring the height of two or more points on the upper edge of the side wall construction.

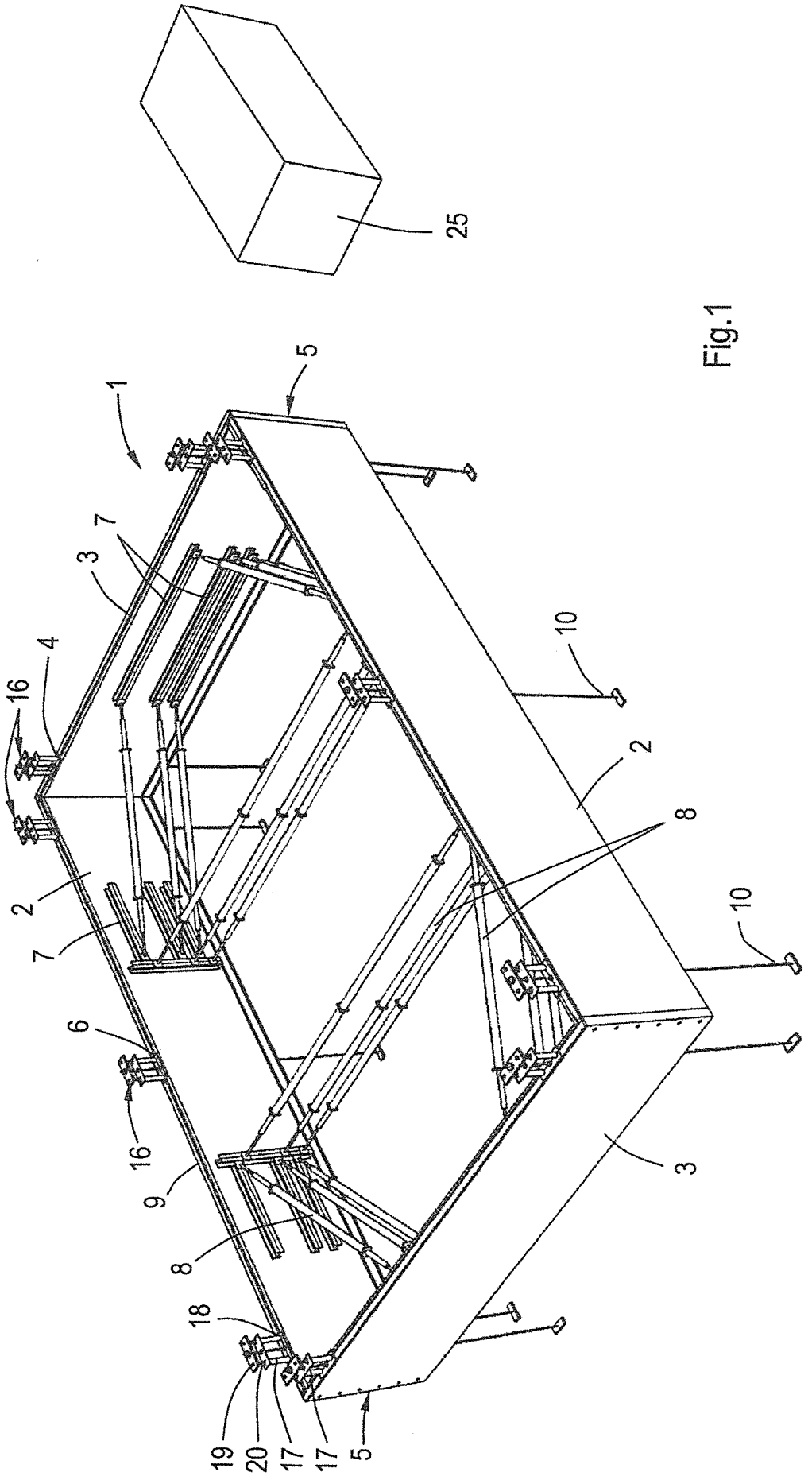

Fig.1