

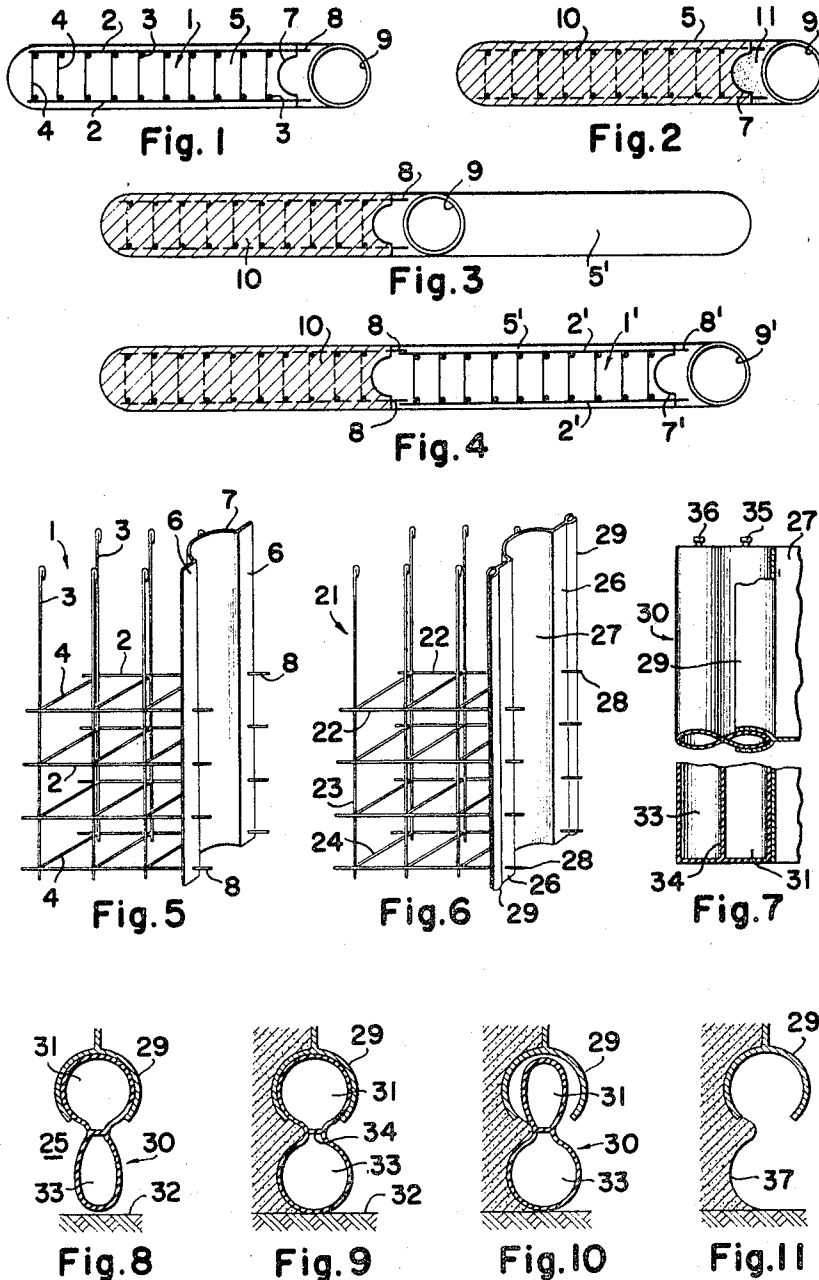
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SHINHACHIRO UEDA

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METHOD OF CONSTRUCTING UNDERGROUND CONCRETE WALLS

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INVENTOR:

SHINHACHIRO UEDA

BY *Bucknam and Archer*
ATTORNEYS

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METHOD OF CONSTRUCTING UNDERGROUND CONCRETE WALLS

Shinhachiro Ueda, Hyogo-ken, Japan

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ABSTRACT OF THE DISCLOSURE

A method of constructing a continuous reinforced concrete underground wall structure in an excavated trench filled with a bentonite solution used to support the trench wall, wherein a reinforcement basket having a partition at one end is placed in said trench, and the concrete is filled from the bottom displacing the bentonite solution, the partition serving as a means for sealing the vertical side walls of the trench.

The present invention relates to a method for constructing a continuous underground concrete wall; more particularly, it relates to a method wherein bentonite solution is used to initially support the walls of an excavated trench and this solution is then displaced by concrete.

A construction method has recently been developed, wherein a sheathing wall of reinforced concrete is constructed above ground before the excavation of the ground. This wall is then used as a sheathing wall, underground outer wall or waterproof wall after the excavation. This method has been attracting the attention of the technicians in the art and is in fact being practised in place of the more conventional method utilizing steel sheet piles. In accordance with this recent method, a hole or trench for the underground wall is excavated to a predetermined depth and length using a special excavator. A deep trench is dug while the excavator simultaneously fills the trench with a bentonite solution so as to prevent the collapse of the soil. A preassembled reinforcement basket is then disposed in the trench, and an interlocking pipe is installed in the trench at an end thereof. The trench is then filled with concrete from the bottom, replacing the bentonite solution and forming an underground reinforced concrete wall structure unit. Concurrently with the concrete depositing operation a second similar hole or trench is excavated in adjacent relation to the first trench. The interlocking pipe is removed when the concrete deposited in the first trench has hardened to such an extent as to be self-retained in its shape and concrete is deposited in the second trench after disposing a reinforcement basket therein.

The bentonite solution is injected into the trench from a point in proximity to a bit of the excavator. It is then led up to the ground surface together with the sediment and gravel excavated and recycled into the trench after having said sediment and gravel separated therefrom. The bentonite solution, while being circulated in the manner described, permeates the peripheral walls of the trench and solidifies the soil, forming a waterproof layer.

One face of the underground concrete wall structure unit is formed in a concave semicircular shape in cross section by the interlocking pipe. The opposite end face of the adjacent underground wall structure unit, to be joined with the concave end of the first wall structure unit, is formed in a convex semicircular shape in cross section. Thus, when joined, the walls are watertight at the joint.

This existing construction method has the drawback

that a series of the underground wall structure units constructed according to the method are not sufficiently resistive to horizontal lateral forces. This is particularly true, because, the reinforcement basket is embedded in each underground wall structure unit as an independent unit, and the adjacent underground wall structure units are joined only by virtue of concrete which has been deposited at different times. The reinforcements in the series of underground wall structure units are substantially noncontinuous, and, therefore, these prior underground wall structures are not suitable for structures which are subjected to pressure and they are not acceptable.

Additionally, according to the prior method described, the interlocking pipe cannot be removed until the concrete is solidified and is well self-retainable in its shape, because the pipe is in direct contact with the concrete deposited. A considerable waiting time is required before the deposition of concrete in the adjacent trench is commenced, with the result that the efficiency of the operation is reduced.

An object of the present invention is to eliminate the aforementioned drawbacks possessed by the conventional method.

Another object of the invention is to provide a novel method of constructing an underground concrete wall structure in which the reinforcements embedded therein are substantially continuous and which has substantial strength against a horizontal lateral pressure.

Still another object of the invention is to provide a novel method of constructing an underground concrete wall structure which does not require idle time during operations.

Still another object of the invention is to provide a novel method of preventing the leakage of fluid concrete occurring in proximity to the end of a trench.

Still another object of the invention is to provide a method of constructing an underground wall structure using a novel reinforcement basket.

Another object of the present invention resides in the provision of a concrete wall structure exhibiting the afore-described desirable characteristics.

Still another object of the present invention resides in an improved reinforcement basket for use in concrete wall structures that permits construction of walls having greater strength in the horizontal direction.

The above and other objects and the advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIGURES 1 to 4 are respective schematic plan views illustrating the various stages of the process of the inventive method in sequence;

FIGURE 5 is a perspective view of a fragment of a reinforcement basket employed in the present invention;

FIGURE 6 is a perspective view, similar to FIG. 5, of a fragment of another reinforcement basket employed in the present invention;

FIGURE 7 is an enlarged end view, with a portion broken away, of the reinforcement basket shown in FIG. 6; and

FIGURES 8 to 11 are respective horizontal cross sectional views of an expansible and contractible tube employed in the present invention.

Referring to the drawings, a trench or hole 5 for an underground wall structure unit is excavated in a conventional manner by a deep trench excavator to a desired depth and length, while injecting a bentonite solution therein from a point in the proximity of a bit of said excavator. As known, a part of the bentonite solution filled in the trench is absorbed by the walls of the trench to prevent the collapse of said walls, while the remainder

is forced up to the ground along with the sediment and gravel through a separately provided suction tube and poured into a settling tank. In the settling tank, the sediment and gravel settle on the bottom thereof and the supernatant bentonite solution is injected into the trench again by means of a pump. When the trench has been excavated to a predetermined depth, the excavator and suction tube are removed from the trench and a cleaning tube is disposed in the trench on a level near the bottom thereof. The cleaning tube has an air tube mounted therein, through which air is jetted under pressure to forcibly discharge the sand accumulated on the bottom of the trench on the ground. The bentonite solution is fed continuously throughout this period so as to prevent the collapse of the trench walls and the cleaning tube is removed upon completion of the cleaning.

After the trench 5 has been formed in the manner described, a reinforcement basket 1 is disposed in the trench and then concrete is deposited. The reinforcement basket 1 employed in the embodiment shown in FIGS. 1 to 5 comprises a reinforcement structure composed of longitudinal reinforcing members 2, vertical reinforcing members 3, and transverse reinforcing members 4 bridging said longitudinal reinforcing members 2; an iron plate partition 7 welded to one end of said reinforcement structure, said partition comprising a central member having a semicircular cross section and integral flanges 6 provided at both edges of said central member, and having substantially the same width as that of the trench; and outwardly projecting longitudinal reinforcing members 8 welded to each of said flanges. These outwardly extending longitudinal reinforcing members 8 may alternatively be provided by extending the longitudinal reinforcing members 2 outwardly through the partition 7.

The reinforcement basket 1 is assembled on the ground beforehand and disposed in the trench 5. Then an interlocking pipe 9 is inserted into the trench in a vertical portion adjacent to partition 7, and the space between the partition 7 and the interlocking pipe 9 is filled with sand or gravel 11. A concrete depositing tube is then inserted into the reinforcement basket, and concrete is deposited in the trench 5 slowly from the bottom thereof to replace the bentonite solution. In this way, an underground wall structure unit 10 is formed. At approximately the same time, another trench 5' is excavated adjacent to the interlocking pipe 9.

When the underground wall structure unit 10 has hardened to such an extent as to be self-retained in its shape, the sand or gravel 11 in the space between the partition 7 and the interlocking pipe 9 is removed by means of air lift or sand pump and, after charging a bentonite solution in that space, the interlocking pipe 9 is pulled out. Upon completion of the excavation of the trench 5' (FIG. 3), a cleaning tube is disposed in the trench which is now filled with the bentonite solution, to discharge the sand accumulated on the bottom of the trench in the manner described previously. Thereafter a reinforcement basket 1' and an interlocking pipe 9' are disposed in the trench. In this case, the reinforcement basket 1' is arranged such that its longitudinal reinforcing members 2' overlap the respective longitudinal reinforcing members 8 extending outwardly from the opposite end face of the underground wall structure unit 10 which has been formed previously. The reinforcement basket 1' similarly has a partition 7' fixed to the other end thereof, from which longitudinal reinforcing members 8' are projecting outwardly. Concrete is then slowly deposited in the trench 5' from the bottom thereof through a concrete depositing tube which is inserted into the reinforcement basket 1', thereby replacing the bentonite solution and forming another underground concrete wall structure unit. The new unit is combined integrally with the adjacent underground wall structure unit 10 formed previously.

According to a further embodiment of the invention, there is provided a reinforcement basket 21 which is used

in the embodiment shown in FIGS. 6 to 11, which comprises a reinforcement structure composed of longitudinal reinforcing members 22, vertical reinforcing members 23, and transverse reinforcing members 24 bridging said longitudinal reinforcing members; a vertically extending iron plate partition 27 welded to one end of said reinforcement structure, said partition comprising a central member having a semicircular cross section and integral flanges 26 provided at both edges of said central members, and having a width slightly smaller than the width of the trench 25; and outwardly extending longitudinal reinforcing members 28 welded to said flanges 26. The outwardly extending reinforcing members 28 may alternatively be provided by extending the longitudinal reinforcing members 22 outwardly through the partition 27.

Each of the flanges 26 is formed along the outer edge thereof with a vertically extending member or grip 29 having an arcuate cross section. An expandable and contractible tube 30 consisting of a bottomed retainer tube 31 is adapted to be interlocked with said member 29. Integrally connected with tube 31, there is a bottomed sealable tube 33 which is adapted to be brought in contact with the wall 32 of the trench 25. Although these tubes are integrally connected, the hollow portions thereof are completely independent from each other, being separated by a partition 34. At the top ends of tubes 31 and 33, air inlet or outlet openings 35, 36 respectively, are provided for the expansion or contraction thereof.

The retainer tube 31 is made of an elastic material, such as rubber, and when it is disposed in the arcuate member 29 and air is introduced in said tube, the tube is inflated to be brought in intimate contact with the member 29 as shown in FIG. 8. The reinforcement basket 21 having the expandable and contractible tubes thus fitted thereto is lowered in the trench 25 and, after disposing the interlocking pipe, the sealable tubes 33 are inflated by injecting air therein so as to be brought in intimate contact with the respective walls 32 of the trench as shown in FIG. 9. The interspace between the partition 27 and the interlocking pipe is filled with sand or gravel to support the partition and then concrete is deposited in the trench slowly from the bottom thereof replacing the bentonite solution through the concrete depositing tube which is inserted in the reinforcement basket 21, and thus an underground wall structure unit 37 is formed. At approximately the same time, another trench is excavated adjacent to the interlocking pipe in the same manner is described previously and, when the underground wall structure unit 37 has been hardened to such extent as to be self-retained in its shape, the sand or gravel in the space is transferred into the interlocking pipe by means of air lift or removed by means of sand pump inserted therein, so as to be replaced by a bentonite solution and then the interlocking pipe is pulled out. Simultaneously the retainer tube 31 is contracted by discharging the air therefrom, whereupon it is released from interlocking with the arcuate member 29 as shown in FIG. 10 and the expandable and contractible tube 30 is pulled up on the ground. Upon completion of the excavation of the adjacent trench, a reinforcement basket and interlocking pipe are placed in said trench which is now filled with a bentonite solution and, after inflating the sealable tubes of the expandable and contractible tubes to bring them in intimate contact with the opposite walls of the trench, concrete is deposited in said trench to form an underground concrete wall structure unit in successive relation to the previously formed underground wall structure unit 37.

In this embodiment, the portion of the trench wherein the reinforcement basket 21 is disposed is completely isolated from the exterior by the expandable and contractible tubes 30 and partition 27, and the concrete wall thus formed has an end as shown in the shaded portion 37 in FIG. 11. An adjacent underground wall structure unit is formed successively to the shaped end portion

of the concrete so that a portion of the partition is embedded in said adjacent wall structure unit.

It will be apparent that use of the partition structure shown in FIGS. 6-11, along with the expansible sealing members 30, provides an effective end wall for the trench, even without the interlocking pipe 9. Thus, it is possible and often advantageous to omit using the interlocking pipe and attendant filling and emptying of the sand and gravel 11.

It will also be apparent, that the sealing members 30, need not be filled with air; in fact, it has been found desirable to use liquid fillers in order to effect the necessary expansion. Of course, there is little difficulty in emptying either air or liquid in order to contract the tubes for extraction from the trench and partition.

According to the present invention, as described hereinabove, since the reinforcement basket used has the partition attached to one end thereof and the longitudinal reinforcing members projecting outwardly from said partition overlap the corresponding longitudinal reinforcing members of the adjacent reinforcement basket, the longitudinal reinforcing members of the preceding underground wall structure unit are embedded in the concrete of the following underground wall structure unit. Further, since the expansible and contractible tubes are removably mounted to both edges of the partition whose width is made slightly smaller than the width of the trench, for sealing contact with the walls of the trench, leakage of the concrete deposited can be prevented before hardening. Still further, since a part of the partition is embedded in the concrete of the adjacent underground wall structure unit as mentioned above, a series of underground wall structure units of reinforced concrete can be formed successively integrally. It is thus possible to obtain a joint of extremely high strength and therefore to construct an underground wall structure with ease which is highly resistive against a horizontal lateral force and which can be used as a part of a complete building. It should also be noted that, since the concrete deposited is held in position by the partition, the next constructing operation can be commenced at any time after the concrete has been solidified to such an extent as to be self-retained in its shape, without waiting until it is solidified completely, so that the construction time can be shortened.

With the use of the expansible and contractible tube, it is possible to provide a lugged cross section at the joint, which is advantageous in bringing about an increased strength and increased waterproofing at the joint. The remarkable advantages which are obtained by the present invention include:

The utility factor of a site is high;
The underground wall may be utilized for construction of a part of the structure of a building;
Temporary work for the construction of underground structure is not needed;
The construction site can be utilized with approximately 100% efficiency;
The construction period can be shortened;
No damage is caused to the adjacent buildings;
There is no subsidence of ground occurring in the vicinity of the construction site;
The construction work does not produce noise, vibration or other public hazards; and
The cost of temporary work is reduced and therefore construction cost is low.

Particular embodiments of the invention have been shown and described. It will be appreciated that these embodiments are for illustrative purposes only. Modifications may be made by those skilled in the art in accordance with the teachings of this disclosure, and it is contemplated in the appended claims to cover any such modi-

fications as fall within the true spirit and scope of the invention.

What I claim is:

1. An improved method of constructing a continuous reinforced concrete underground wall structure in an excavated trench filled with a bentonite solution, the improvement comprising inserting in a first excavated trench a reinforcing basket having a partition at one end and longitudinal reinforcing members projecting outwardly beyond said partition, said partition serving to hold the concrete in position, filling said trench with concrete by displacing said bentonite solution, excavating a series of successive trenches one at a time adjacent to said partition of each reinforcing basket employed, inserting identical reinforcing baskets in said successive trenches in such a manner that horizontal reinforcing members extend to and overlap the longitudinal reinforcing members extending from said partitions, and filling said successive trenches with concrete by displacing said bentonite solution whereby a continuous reinforced concrete underground wall structure of any desired length is formed.

2. The improvement according to claim 1, wherein an interlocking pipe member is installed at the end of said trench adjacent to said partition, and said pipe member is removed subsequent to excavation of said successive trenches and prior to insertion of said reinforcing baskets.

3. The improvement according to claim 2, including the steps of filling the interspace between said interlocking pipe and the partition of said first reinforcing basket with gravel and removing said gravel and said interlocking pipe after the concrete deposited in said first trench has been hardened to such an extent as to be self-retained in its shape.

4. The improvement according to claim 1, wherein said partitions are provided along their vertical edges with gripping means, and said method includes the further steps of inserting expandible and contractible sealing tubes, each having two independent longitudinal hollowed portions, such that one of said hollowed portions is disposed within said gripping means as the other is disposed exteriorly of said gripping means, injecting a pressurized fluid into said hollowed portions for expanding the sealing tube to thereby interlock said first hollowed portion in said gripping means and to engage the other hollowed portion of said sealing tube with the side walls of said trench for sealing engagement with same.

5. The improvement according to claim 4, wherein said gripping means has an accurate cross section.

6. The improvement according to claim 5, wherein said sealing tube has a figure 8 shape in cross section.

7. The improvement according to claim 6, wherein the pressurized fluid is a liquid.

8. The improvement according to claim 4, wherein the pressurized fluid in said sealing tube is released after the deposited concrete has hardened to such an extent as to be self-retaining, and to remove said sealing means from said trench.

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JACOB SHAPIRO, *Primary Examiner*.

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52—169, 648, 742, 743; 61—56, 59