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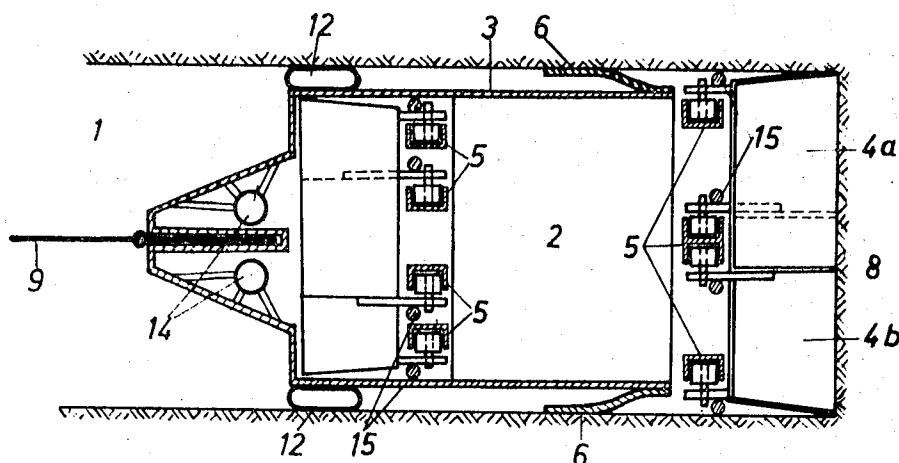
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METHOD AND DEVICE FOR MAKING SLIT WALLS

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3 Sheets-Sheet 1

Fig. 1a



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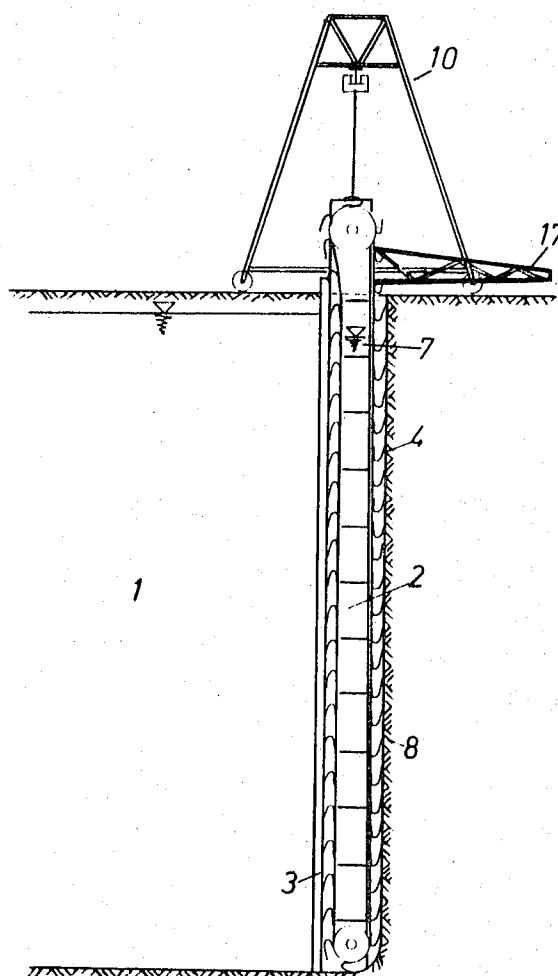
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Fig. 2



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3,564,855 METHOD AND DEVICE FOR MAKING SLIT WALLS

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14 Claims

ABSTRACT OF THE DISCLOSURE

Proposed is a method of making slit walls, wherein a slit wall section present in the soil and filled with a thixotropic liquid in a known manner is excavated and respectively driven ahead at a front end by means of a bucket chain excavator. On this occasion, the bucket chain excavator is sealed off against the side walls of the excavated slit and against the sole of the slit so that liquid-filled spaces separate from each other are created in front and in the rear of the bucket chain excavator respectively. For producing the drive-on force for the bucket chain excavator, the liquid level in the space located in front of the bucket chain excavator is lowered as compared to the liquid level in the space located behind the bucket chain excavator so that the bucket chain excavator is driven forward by the hydrostatic pressure differential. The slit made in this manner is subsequently filled up with concrete.

BACKGROUND OF THE INVENTION

This invention relates to methods and devices for making slit walls.

The slit wall construction practice has acquired a great technical importance in recent years especially for the municipal traffic engineering, e.g., for constructing subways. Yet for making constructions in busy townships it is particularly important to maintain the time of construction as short as possible in order to reduce any interruptions of the traffic.

A number of various methods have heretofore been developed for making slit walls, and the slits for the slit walls are excavated mostly by means of rope grabs.

However, it turned out that the grab dredging technique just as the various other methods are very time-consuming, which has unfavourable consequences and in some cases particularly jeopardizes the profitability of the slit wall building technique.

Also, by the prior art methods it is mostly impossible to avoid cavities which are formed in adjacent earth areas and lead to a needlessly high consumption of concrete as well as to uneven wall surfaces; according to the known methods, it is also necessary to employ separate end shuttings-off or end shutterings such as, e.g., steel tubes for concreting the slit walls, which is a complicated and expensive practice.

SUMMARY OF THE INVENTION

The object of the invention is to provide a method permitting a more rapid, rationalized and economical execution of the construction work for making slit walls.

This and other objects of the invention are achieved by a method of making slit walls, wherein a slit section present in the ground is filled with a fluid and excavated at a front end substantially continuously by means of a bucket chain excavator, wherein the bucket chain excavator is sealed off against the side walls of the excavated slit and against the sole of the slit so that at the side of the bucket chain excavator facing said front end of the slit and within the slit there is formed a first fluid-filled

space separate from the second fluid-filled space located behind the bucket chain excavator, and wherein the fluid level in said first fluid-filled space is lowered as compared to the fluid level in said second fluid-filled space so that the bucket chain excavator is driven forward by the hydrostatic pressure differential, and finally, wherein the formed slit is subsequently filled up with concrete.

For securing the earth, the slit is filled with a thixotropic fluid in any case. Hence the force required for the forward drive is obtained in that the liquid level in the working space surrounded by the bucket chain excavator at the end face of the slit is maintained lower than in the slit region lying therebehind. In this manner it is achieved that a practically uniformly distributed drive-on force acts on the bucket chain excavator, whereby providing the possibility of the effective use of a bucket chain excavator.

A further object of the invention is to provide a device for carrying out the method according to the invention. The device includes a vertical U-shaped steel box, on which two endless and laterally telescoping bucket chains are disposed so that, running from below upwards, they break the soil loose at the front side of the slit and dig it. The steel box is slightly narrower than the slit to be formed. The space between the steel box and the lateral earth is bridged over by suitable seals so that the working space enclosed by the steel box is sealed off from the remaining slit.

According to a preferred embodiment of the invention, the back side of the steel box is formed in a fashion favourable for the concreting joints so that during the concreting of the slit walls the steel box can be simultaneously utilized as a joint shuttering too.

The guidance of the bucket chain excavator in the forward drive direction, especially when curved slit walls are to be produced, is enabled by a guide arm arranged on the device above the level of the terrain.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is elucidated in greater detail hereinafter in the light of exemplary embodiments with reference to the drawings, in which:

FIG. 1a shows a horizontal section through a bucket chain excavator according to the invention,

FIG. 1b shows a horizontal section through a bucket chain excavator with another structure of the back side of the steel box, and

FIG. 2 shows a vertical longitudinal section in the center axis of a bucket chain excavator according to the invention.

In the drawings are elucidated and respectively represented a method and a device for making a slit wall. The slit 1 is excavated by means of a bucket chain excavator 2 by digging the ground 8 at the front side.

As shown especially in FIGS. 1a and 1b, the bucket chain excavator 2 contains a steel box 3 which is U-shaped with respect to a horizontal sectional plane and which is slightly narrower than the slit 1 to be formed. The bucket chains 4 are arranged so that, running from below upwards, they break the ground 8 loose and dig it at the front side of the slit. There are provided at least two bucket chains 4a and 4b which are formed so that they are adapted to be telescoped laterally and can run downwards within the steel box 3, as the man skilled in the art may easily learn from FIGS. 1a and 1b. The bucket chains 4a and 4b are formed suitably in that the individual buckets are screwed on cables 15. In the present illustrative embodiment, the guidance of the buckets takes place by means of guide rails 5.

With the aid of sealing sheets 6, the working space surrounded by the steel box 3 can be separated from the slit region lying therebehind so that the liquid level 7 in the

working space can be lowered in comparison with the liquid level in the slit region lying therebehind. Due to such a lowering, a practically uniformly distributed drive-on force acts on the steel box 3. In this way, it is possible to drive the bucket chain excavator forward and to press the buckets onto the front side earth 8 as intensely as desired so that an optimum digging capacity can be achieved.

According to the invention, it is furthermore possible during the concreting of the slit wall to simultaneously utilize said steel box as a joint shuttering. As shown in FIG. 1a, to this end the back side of the steel box 3 is formed in a manner corresponding to the desired concreting joint, while at the same time a possibility for incorporating joint straps 9 may be envisaged.

In order to prevent fresh concrete from penetrating the free space between the steel box 3 and the lateral earth, the rear corners of the steel box are provided with further seals 12 which may, e.g., have the form of inflatable hoses of some resilient material.

In order to achieve a reliable detaching of the bucket chain excavator 2 from the concrete 13 after the setting thereof, pipes 14 are arranged within the steel box, through which water, a thixotropic liquid or air can be pressed via nozzles into the joint between the steel box 3 and the concrete 13. As soon as a sufficiently large gap has been formed after detaching the steel box from the concrete, the forward drive of the bucket chain excavator can be continued in the above-described manner according to the invention.

FIG. 1b shows an alternative to the embodiment according to FIG. 1a. In this case, the joint shuttering 16 is separated from the bucket chain excavator 2 during the forward drive and is inserted always prior to the concreting of the slit wall into the slit so that it abuts the steel box 3. In this manner, the difficult operative phase of the detaching from the concrete is avoided at the bucket chain excavator itself, because a liquid column necessary for the forward drive is available at any rate on the back side of the steel box. It is advisable to underprop the joint shuttering 16 at the steel box 3 not directly but by means of detachable connectors. As shown in FIG. 1b, this can be realized by two inflatable hoses 18. When the pressure in the hoses is eliminated before the resumption of the forward drive, the bucket chains 4 pressed against the earth 8 due to the pressure of the fresh concrete will become free again and can start running without load.

The drawing of the joint shuttering 16 after resumption of the forward drive and after sufficient setting of the concrete 13 can likewise be facilitated by pressing in of suitable means into the joint between the concrete 13 and the joint shuttering 16. Also, the separate arrangement of the joint shuttering from the bucket chain excavator and respectively the removal thereof after each use has the advantage that the joint straps 9 outside of the slot can be inserted into the joint shuttering in a simple manner.

At the beginning of the forward drive, the liquid level 7 in the working space is suitably maintained just as high as in the slit 1 lying therebehind, so that the bucket chains 4a and 4b can start running unloaded. As soon as thixotropic liquid is withdrawn from the working space because of the operation of the bucket chains, the liquid level 7 drops and the necessary drive-on force becomes effective. In the event no effective level lowering should be achieved by the operation of the bucket chains 4a and 4b alone, then the liquid 7 can be lowered or respectively maintained low by additional pumping work. On the other hand, if the liquid level drops too much during the forward drive, then a thixotropic liquid can flow again in the necessary amount through an opening 11 adapted to be shut off, from the slit 1 into the working space.

A guide arm 17 disposed above the level of the terrain serves for controlling the drive-on direction of the bucket chain excavator. If curved slit walls have to be made, then the bucket chain excavator 2 can thus be easily rotated

about its vertical axis because the steel box 3 can be formed sufficiently torsionproof and because the clearance between the steel box and the lateral earth permits rotation.

The weight of the bucket chain excavator 2 and the reaction forces produced during operation of the bucket chains are suitably received by a gantry crane 10. In this manner, the formation of a vertical slit is ensured, and the friction occurring during the forward drive of the bucket chain excavator is minimized. Besides, the depth of the slit can be varied in accordance with the lifting height of the gantry crane 10.

A particular advantage of the invention is the high digging capacity which is achieved in that the bucket chains continuously dig the earth, while at the same time the drive-on force which can be increased at will and which is uniformly effective beyond the depth of the slit is of decisive importance.

Thus, it is possible to considerably reduce the time of construction and hence to correspondingly decrease the costs for wages and for materials which must be kept in stock. Also, the formation of cavities in the lateral earth is practically out of the question so that a needless high consumption of concrete is avoided and completely even slit walls can be produced.

It is to be understood that the invention is not restricted to the described exemplary embodiments but covers a plurality of modification possibilities.

What is claimed is:

1. A method of making slit walls, wherein a slit section present in the ground is filled with a fluid and excavated at a front end substantially continuously by means of a bucket chain excavator, wherein the bucket chain excavator is sealed off against the side walls of the excavated slit and against the sole of the slit so that at the side of the bucket chain excavator facing said front end of the slit and within the slit there is formed a first fluid-filled space separate from the second fluid-filled space located behind the bucket chain excavator, wherein the fluid level in said first fluid-filled space is lowered as compared to the fluid level in said second fluid-filled space so that the bucket chain excavator is driven forward by the hydrostatic pressure differential, and wherein the formed slit is subsequently filled up with concrete.

2. A method according to claim 1, wherein said slit is filled with a thixotropic liquid.

3. A method according to claim 1, wherein the liquid level in said first liquid-filled space is lowered by the operation of the buckets of the bucket chain excavator.

4. A method according to claim 1, wherein the liquid level in said first liquid-filled space is lowered by pumping off the liquid.

5. A device for producing slit walls, comprising a bucket chain excavator which extends down to the sole of the slit wall to be produced and which includes a box which extends along the bucket chains and the breadth of which is less than the breadth of the slit wall to be produced, furthermore containing flexible seals for sealing off said box against the side walls of the excavated slit so that spaces separate from each other can be formed within the excavated slit in front of and behind the bucket chain excavator respectively, said spaces being substantially filled with a liquid and means for lowering the liquid level in said space located in front of the bucket chain excavator as compared to the liquid level in said space located behind the bucket chain excavator.

6. A device according to claim 5, including a guide arm secured to said box above the level of the terrain for rotation of the bucket chain excavator so as to permit the production of curved slit walls.

7. A device according to claim 5, wherein said bucket chain excavator contains bucket chains which can be telescoped with respect to the transverse direction.

8. A device according to claim 5, wherein the back side of said box of the bucket chain excavator is formed

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as a joint shuttering and includes separate sealing means adapted to be placed on the respective side walls of the formed slit.

9. A device according to claim 5, wherein at the back side of said box of the bucket chain excavator there are provided a joint shuttering part extending parallel to said box, as well as separate sealing means adapted to be laid on the respective side walls of the produced slit.

10. A device according to claim 5, wherein at the back side of said box of the bucket chain excavator there are provided a joint shuttering part extending parallel to said box, as well as separate sealing means adapted to be laid on the respective side walls of the produced slit and secured to said box on both sides thereof, and furthermore wherein between said box and said joint shuttering part there are provided propping means having the form of flexible tubes which are arranged at both sides near to the walls of the slit that was formed, and which are adapted to be selectively inflated or relieved.

11. A device according to claim 5, wherein the back side of said box of the bucket chain excavator is formed as a joint shuttering and includes separate sealing means adapted to be laid on the respective side walls of the formed slit as well as pressure conduits which terminate and open in the back side of said box and through which a suitable pressure medium can be introduced into the joint between said box and the concrete to thereby detach said box from the solidified concrete of the finished part of the slit wall.

12. A device according to claim 5, wherein at the back

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side of said box of the bucket chain excavator there are provided a joint shuttering part extending parallel to said box as well as separate sealing means adapted to be laid on the respective side walls of the formed slit, and wherein furthermore said joint shuttering part includes pressure conduits which terminate and open in the back side thereof and through which a suitable pressure medium can be introduced into the joint between said joint shuttering part and the concrete to thereby detach said joint shuttering part from the solidified concrete of the finished part of the slit wall.

13. A device according to claim 5, wherein at the back side of said box of the bucket chain excavator there are provided a joint shuttering part extending parallel to said box, as well as separate sealing means adapted to be laid on the respective side walls of the formed slit, and wherein furthermore said joint shuttering part includes a receiving device for inserting a joint strap to be concreted therein.

14. A device according to claim 5, wherein said bucket chain excavator is suspended on a crane.

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