Jan. 18, 1966 J. W. SCHNELLER 3,229,468

METHOD OF CONSTRUCTING RETAINING WALL

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Fig. 2.

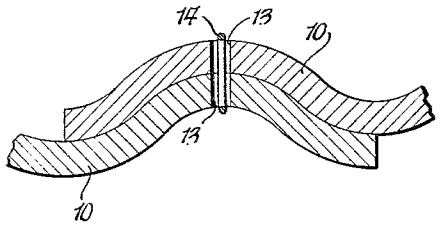


Fig. 1.

Fig. 3.

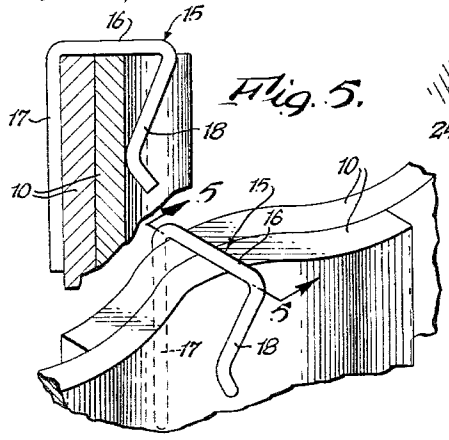


Fig. 5.

Fig. 4.

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METHOD OF CONSTRUCTING RETAINING WALL

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This invention relates to a new and improved method of constructing a retaining wall along the berm line of a body of water such as a canal.

The present invention is especially useful in constructing canal bulkheads in the southern portions of the United States, specifically in States like Florida wherein swampy or low land is being reclaimed for both residential and business building purposes. In such areas it is common practice to form bodies of water such as canals by digging out the swampy or low land and using the dugout earth to build up dry land areas between such canals. Once this initial operation is completed, it is then necessary to prevent erosion of the soil adjourning the canals by building retaining walls or bulkheads, and a primary consideration in constructing such retaining walls is cost, from both the material and labor standpoints.

While reinforced concrete slabs have been used in the past to form such retaining walls, this is a rather expensive process. In a typical installation, these slabs are poured on the job site, and following setting of the concrete, the slabs are then jetted in place by standing the slabs on edge and applying water pressure from a hose nozzle to part the earth and permit the slabs to be partially sunk into the ground along the edge or berm line of the canal. As used herein, the term berm line means the juncture of the upper end of the canal bed or berm with the surface of the ground adjoining such canal.

As will be apparent, these concrete slabs are quite heavy, requiring for a typical installation on a crane and a crane operator to initially position the slabs on edge, two men working on the slab to hold it upright during the sinking operation, and another man using the nozzle of a hose which is connected to a pump supplying water under pressure from the canal for jetting the slabs into place. Moreover, a considerable amount of labor is required to pour the slabs on the job site and a substantial amount of time is lost while the slabs are setting, all adding to the cost of construction. In addition, because of the great weight of such concrete slabs it is extremely difficult to obtain a level wall, as one slab will have a tendency to sink further into the ground than the previously sunk slab.

Accordingly, it is a general object of the present invention to provide a new and improved method of constructing a retaining wall, such as a canal bulkhead, which method results in substantial savings in both material and labor costs.

Another object is to provide such a method wherein corrugated sheets, of economical, light weight and rigid material such as asbestos cement, are used instead of the more costly concrete slabs, thereby eliminating the need for a crane and crane operator in a typical installation, as well as the pouring of such slabs, and also reducing construction time.

A further object is to provide such a method wherein the corrugated sheets may be readily locked together to prevent one sheet from sinking further into the ground than the previously erected sheet, and thereby readily obtain a level retaining wall.

Still another object is to provide such a method wherein stabilized soil is used to reduce the horizontal thrust exerted on the corrugated sheets by the backfill, thereby

to permit using such sheets of minimum weight and strength for further savings in both material and labor costs.

Other objects and advantages of the invention will become apparent upon consideration of the following detailed description and the accompanying drawing wherein:

FIG. 1 is a perspective view illustrating the inventive method wherein the corrugated sheets are jetted in place along the berm line of a body of water such as a canal, and the adjacent sheets are locked together by a loop of wire;

FIG. 2 is an enlarged fragmentary horizontal sectional view taken on line 2—2 of FIG. 1 and illustrates how the wire passes through an opening provided in the overlapping corrugations of adjacent sheets;

FIG. 3 is a vertical sectional view taken along line 3—3 of FIG. 1 and also illustrates the completed retaining wall following (1) formation of the inclined embankment of stabilized soil at the foot of the exposed inland sides of the sheets; (2) the formation of the cap on the upper edges of the sheets and the deadman behind the sheets, and the installation of the anchor rod connecting the cap and deadman; and (3) the back filling operation;

FIG. 4 is an enlarged partial perspective view illustrating a spring wire clip which may be used to lock the sheets together instead of the wire loop of FIGS. 1 and 2, and

FIG. 5 is a vertical sectional view taken on line 5—5 of FIG. 4 and illustrating how the leg portions of the wire clip are sprung against the opposite sides of overlapping corrugations of adjacent sheets.

Referring to the drawing, and particularly FIGS. 1 and 3, a portion of a body of water such as a canal is indicated generally at C. The berm or sloping upper portion of the bed of the canal is indicated at B, and the intersection or juncture of the berm with the surface of the ground or dry land G is indicated at BL. This juncture will be hereinafter referred to as the berm line.

The completed retaining wall or canal bulkhead W includes a plurality of juxtaposed corrugated sheets **10**. These sheets are preferably severally made of a rigid, light-weight mineral fiber-cement material such as asbestos cement, and are commercially available. Typically, the sheets **10** are of elongated rectangular shape, varying in length from about 4 feet to about 12 feet measured longitudinally of the corrugations, and are usually about 42 inches wide. Depending upon the thickness of sheet desired, which usually varies from about 0.4 inch to about 0.61 inch, each such asbestos cement sheet varies in weight from approximately 4.2 lbs. per square foot to about 5.8 lbs. per square foot. As for their pertinent strength characteristics, when saturated with water and measured on a per foot width basis, each sheet has a modulus of elasticity varying from about 3.4×10^6 p.s.i. from the thinnest sheet to about 5.4×10^6 p.s.i. for the thickest sheet. Similarly, the moment of inertia varies from about 0.764 $in.^4$ to about 1.26 $in.^4$; the section modulus from about 1.01 $in.^3$ to about 1.58 $in.^3$; the modulus of rupture of breaking stress from about 3380 p.s.i. to about 6000 p.s.i., and a shear load per foot width from about 2795 lbs. to about 5880 lbs. Since these saturated strength values are approximately 80% of those for a completely dry product, and since these sheets have a high strength to weight ratio, their suitability for retaining wall use is evident.

Each sheet **10** is partially sunk into the ground along the berm line BL, until its corrugations extend downwardly a substantial distance below the surface of the ground as well as a substantial distance above such surface, pref-

erably one-half its length below and above ground, and the sheets are arranged with their adjacent end corrugations overlapping. This sinking or jetting operation is performed by directing water under pressure to part the earth along the berm line BL, the usual nozzle **11** and hose **12**, which are connected to a pump (not shown) drawing the water from the body of water C, being used for this purpose.

The sheets **10** are locked together adjacent their upper ends by suitable unitary wire fastening means. For example, as shown in FIGS. 1 and 2, each sheet may be provided with an opening **13** extending through its end corrugation near its top edge, and a wire **14** may be looped through the alined openings **13**, to extend along the opposite sides of and over the top edges of the overlapping corrugations, after which the ends of the wire are tied together. The purpose of such tie wire **14** is to prevent a later erected sheet from settling further into the ground than the previously erected sheet, and thereby provide a level wall.

Alternatively, as shown in FIGS. 4 and 5, the sheets may be locked together by a generally U-shaped, spring wire clip **15**. This clip may be driven in place so that its flat base or closed end portion **16** straddles the top edges of the overlapping end corrugations of adjacent sheets **10**, while its longer, straight leg **17** extends down along the outside of one sheet and its shorter bent leg **18** extends down along the outer side of the other sheet. As will be apparent, the shortest distance between legs **17** and **18** of clip **15** is slightly smaller than the combined thickness of the sheets **10**. Thus, the legs **17** and **18** are sprung into frictional engagement with the opposite sides of the overlapping corrugations, in order to securely lock the sheets together. The bending of leg **18** enhances this function, and its diverging outer end portion facilitates installation of the clip.

Referring specifically to FIG. 3, it will be noted that the base or lower portions of the exposed inland sides of sheets **10** are reinforced by a quantity of stabilized soil S. Typically, this stabilized soil is a mixture of from 3 to 12 percent self-setting cementitious material, i.e. Portland cement or equivalent, and from 88 to 97 percent of the available soil. The precise ration of cementitious material to soil will depend on the type of soil available and the strength desired.

The stabilized soil S is formed into an inclined embankment E of generally triangular cross section and is bounded by the berm line BL, the exposed inland sides of sheets **10** and the surface of the ground G leading inland from the berm line BL. While the embankment E of stabilized soil S may extend almost to the top edges of the sheets **10**, it has been found sufficient to make the height of such embankment about one-half the height of the exposed portions of sheets **10**. Likewise, the cross section of the embankment forms generally an isosceles right triangle when the sheets are sunk in a vertical position, which is usually, but not necessarily the case.

The top edges of the sheets are reinforced by a concrete cap **20** which is poured in place by employing temporary forms (not shown) secured to the top portions of the sheets **10** in any suitable manner. These caps are in turn reinforced by the usual rods **21**.

In addition, at spaced points along the length of the wall a block of concrete **22**, commonly known as a deadman is sunk into the ground G the desired distance inland from sheets **10**. Each deadman **22** and the cap **20** are connected by an anchor rod **23** provided with a larger hook **24** at its lower end which is embedded in deadman **22**, and a smaller hook **25** which is secured around a reinforcing rod **21** and embeded in cap **20**. As will be apparent, when the space behind the exposed inland portions of the sheets **10** is filled by the earth backfill BF, the anchor rods **23** are loaded to reinforce the upper portion of the retaining wall W.

The inventive method is practiced by standing the sheets **10** on edge with their corrugations extending upwardly, along the berm line BL. Each sheet is sunk or jetted into the ground by water pressure from nozzle **11** which parts the earth along the berm line BL and permits each sheet to settle to the desired level. Typically, two men initially position and guide the sheet as the third man uses the nozzle **11** and hose **12** to perform the jetting operation. Normally, the jetting takes place on the seaward side of the sheets, but it could also be done on the inland side thereof.

Assuming that a first sheet has been sunk to the desired level, the next or second sheet is positioned adjacent the sunken sheet in the same manner, but with its end corrugation overlapping, either on the inland or seaward side, the end corrugation of the sunken sheet. As this second sheet is sunk to the same level as the first sheet, these sheets are locked together to prevent further settling of the second sheet.

As referred to above, this locking operation can be performed by use of the tie wire **14** which is passed through the alined holes **13** in the overlapping corrugations, and these holes may be either preformed in the sheets prior to the jetting operation, or drilled following such jetting operation, as desired. Alternatively, this locking operation can be performed by utilizing the spring or clip **15** illustrated in FIGS. 4 and 5, the clip being driven in place by any suitable means such as a hammer.

The aforedescribed sinking or jetting and locking operations are repeated until the desired length of retaining wall or bulkhead W is obtained.

Following the erection of sheets **10**, the concrete cap **20** is formed on the top edges of the sheets, and the desired number of deadmen each in the form of a concrete block **22** are embedded in the ground G; the cap **20** and each deadman **22** being connected by an anchor rod **23**. Once the cap **20**, deadmen **22** and another rods **23** are in place, the joints between sheets **10** are sealed in any suitable manner, such as with tar or tar paper, or mortar grout.

Following this, and prior to backfilling, a stabilized soil mixture S may be arranged at the base of the exposed inland sides of the sheets in the desired quantity to form the inclined embankment E. While the use of such an embankment is not absolutely necessary for every installation, it is quite advantageous because it permits sheets **10** of minimum thickness and strength to be used. As is well known, the backfill BF exerts a horizontal thrust on the sheets **10**, and this thrust increases toward the base of the exposed portions of the sheets, thereby forming a generally triangular force pattern. By employing the inclined embankment of stabilized soil S, much of the horizontal thrust from the backfill BF is directed vertically through the stabilized soil S toward the ground, and thereby removed from sheets **10**.

Finally, the backfill BF is moved into place to build up the land behind the sheets **10** of retaining wall W.

It will now be seen how the inventive method accomplishes its various objects. For example, the light-weight rigid corrugated sheets of asbestos cement are easy to handle normally without the need for a crane or a crane operator to position them for the jetting or sinking operation. Likewise, such sheets are economical to manufacture and are preformed prior to being located on the job site. In addition, the sheets may be effectively locked together to prevent one sheet from sinking further than the adjacent sheet, thereby facilitating the formation of a level wall, as well as the formation of the concrete cap **20** along the top of the wall. Moreover, by using an inclined embankment of stabilized soil, sheets of minimum thickness and strength can be employed, thereby further reducing cost of installation of such retaining wall.

While the invention has been described and illustrated with reference to certain preferred embodiments, it is to be understood that various changes and modifications may

be made in the invention by those skilled in the art without departing therefrom, and that the scope of the invention is to be determined by the appended claims.

What is claimed is:

1. In the method of constructing a retaining wall above ground along the berm line of a body of water, the steps comprising: arranging a first corrugated sheet of light weight and rigid, mineral fiber-cement material on edge along said berm line with the corrugations extending upwardly; sinking said first sheet into said ground by applying fluid pressure to part the earth along said berm line, until the corrugations of said sheet extend downwardly a substantial distance below the surface of said ground as well as a substantial distance above the surface; arranging and sinking a second sheet of said material in the same manner and to the same level as said first sheet; but with a corrugation overlapping a corrugation of said first sheet; as said second sheet is sunk to said level, locking said sheets together adjacent their upper ends by attaching unitary wire fastening means extending over the top edges and along the opposite sides of said overlapping corrugations, in order to prevent said second sheet from sinking further into the ground than said first sheet; and after said locking step, forming an inclined embankment of stabilized soil of triangular cross section and bounded by said berm line, at least about one-half the height of the exposed inland sides of said sheets and said surface leading inland from said berm line, in order to reduce the horizontal thrust exerted on said sheets by the later applied backfill, said stabilized soil being a mixture of from 3 to 12% self-setting cementitious material and from 97 to 88% soil.

2. In the method of constructing a retaining wall above ground along the berm line of a body of water, the steps comprising: arranging a first corrugated sheet of light weight and rigid, mineral fiber-cement material on edge along said berm line with the corrugations extending upwardly; sinking said first sheet into said ground by applying fluid pressure to part the earth along said berm line, until the corrugations of said sheet extend downwardly a substantial distance below the surface of said ground as well as a substantial distance above said surface; arranging and sinking a second sheet of said material in the same manner and to the same level as said first sheet, but with a corrugation overlapping a corrugation of said first sheet; as said second sheet is sunk to said level, locking said sheets together adjacent their upper ends by attaching a unitary wire loop fastener extending over the top edges of, along the opposite sides of and through an opening provided in said overlapping corrugations, in order to prevent said second sheet from sinking further into said ground than said first sheet; and after said locking step, forming an inclined embankment of stabilized soil of triangular cross section and bounded by said berm line, at least about one-half the height of the exposed inland sides of said sheets and said surface leading inland from said berm line, in order to reduce the horizontal thrust exerted on said sheets by the later applied backfill, said stabilized soil being a mixture of from 3 to 12% self-setting cementitious material and from 97 to 88% soil.

3. In the method of constructing a retaining wall above ground along the berm line of a body of water, the steps comprising: arranging a first corrugated sheet of light weight and rigid, mineral fiber-cement material on edge along said berm line with the corrugations extending upwardly; sinking said first sheet into said ground by applying fluid pressure to part the earth along said berm line, until the corrugations of said sheet extend downwardly a substantial distance below the surface of said ground as well as a substantial distance above said surface; arranging and sinking a second sheet of said material in the same manner and to the same level as said first sheet, but with a corrugation overlapping a corrugation of said first sheet; as said second sheet is sunk to said level, locking said sheets together adjacent their upper ends by attaching a generally U-shaped, unitary spring wire clip having its closed end portion extending over the top edges of and its leg portions extending along and sprung into frictional engagement with the opposite sides of said overlapping corrugations, in order to prevent said second sheet from sinking further into said ground than said first sheet; and after said locking step, forming an inclined embankment of stabilized soil of triangular cross section and bounded by said berm line, at least about one-half the height of the exposed inland sides of said sheets and said surface leading inland from said berm line, in order to reduce the horizontal thrust exerted on said sheets by the later applied backfill, said stabilized soil being a mixture of from 3 to 12% self-setting cementitious material and from 97 to 88% soil.

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