United States Patent [19]

Meredith

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[54] **SHORING SYSTEM AND COMPONENTS THEREFOR**

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[52] **U.S. Cl.** **61/39,** 52/162

[51] **Int. Cl.** **E02d 17/04**

[58] **Field of Search** .....61/39, 47, 49; 52/297, 296, 159, 162, 155, 223 R

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Assistant Examiner—Philip C. Kannan
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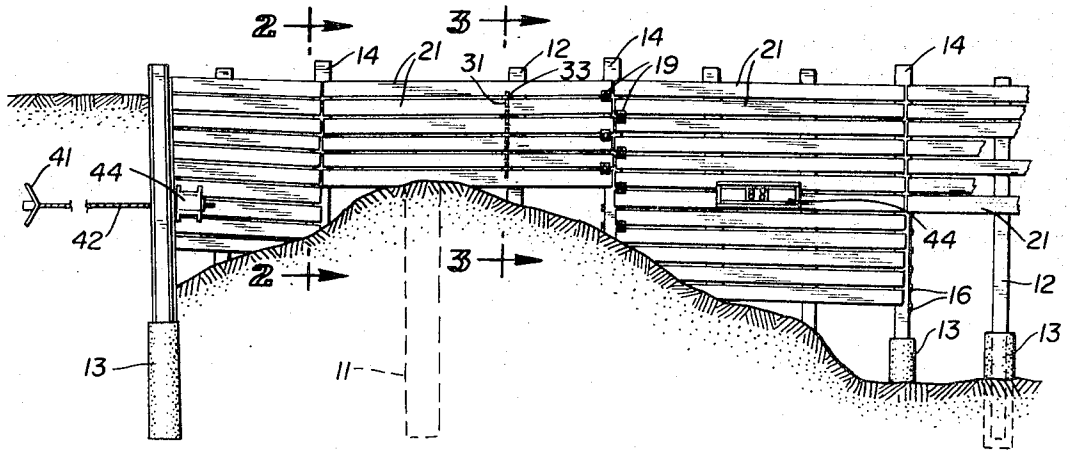
[57] **ABSTRACT**

A shoring system for building site excavating operations utilizing caisson holes drilled in spaced positions outside the building perimeter and receiving flanged pile elements with paired main piles disposed at regulated elevations and spacing and having vertically spaced support sockets adapted to receive fastener components for the support of horizontally disposed cribbing pieces that are placed progressively in inverted order to hold back loose materials as the foundation excavation is deepened. Threaded or wedge-set flange clamps are inserted in slots between adjacent cribbing pieces to engage the flanges of intermediate pile elements to provide additional cribbing support. Deadman anchors are driven outwardly into the surrounding loose materials on earth, and a cable tensioning system interconnects the anchor and waler frames placed inwardly to additionally resist forces tending to collapse the shoring system.

12 Claims, 18 Drawing Figures



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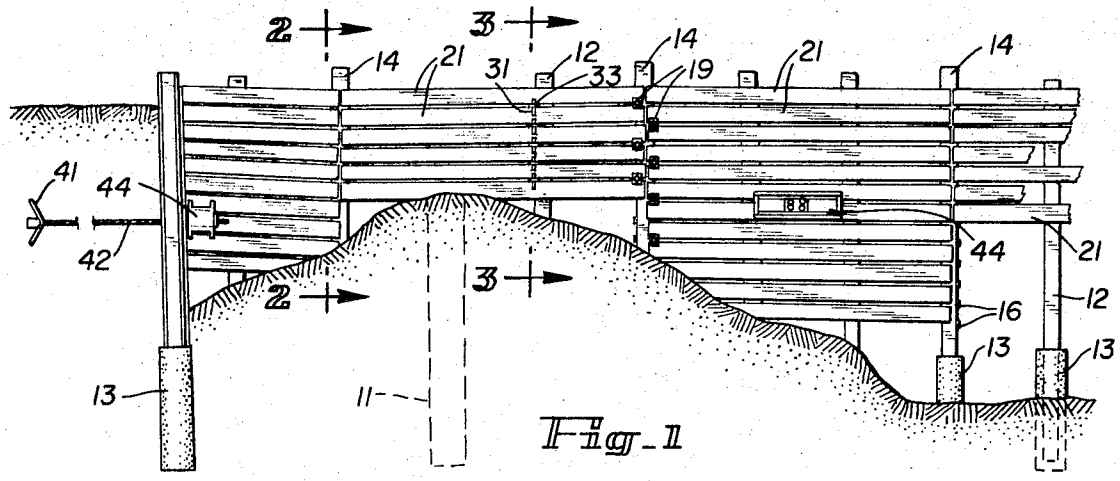


Fig_1

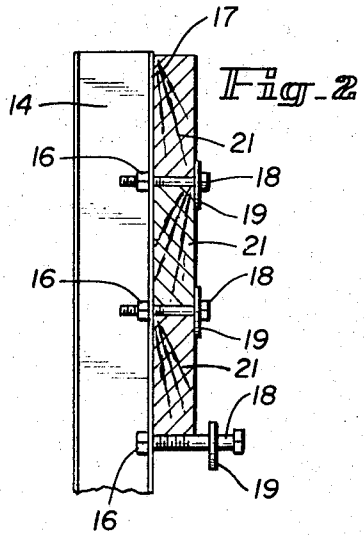


Fig_2

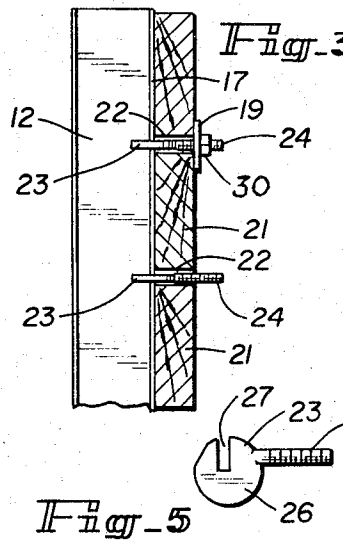


Fig_3

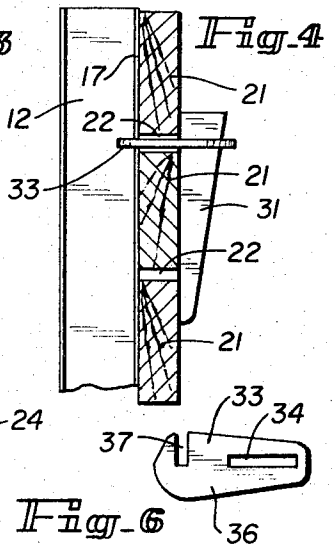
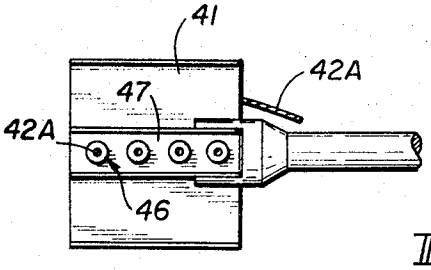


Fig_4

Fig_5

Fig_6



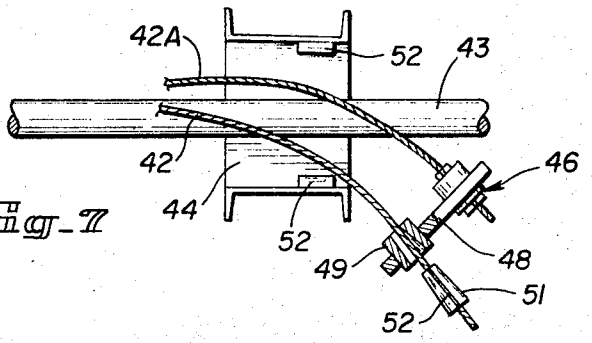


Fig_7

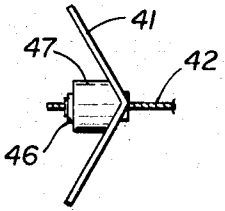


Fig_8

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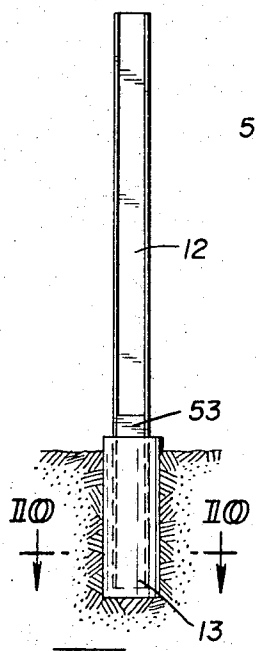


Fig_9

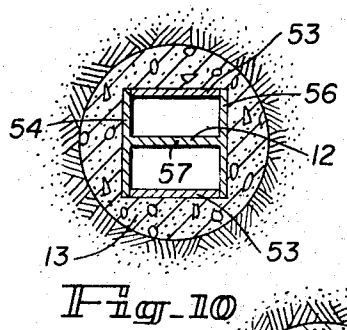


Fig_10

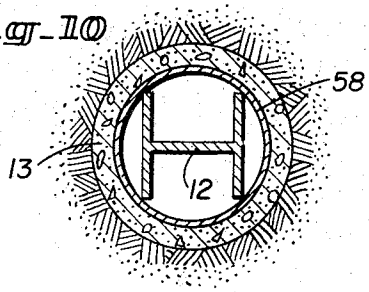


Fig_12

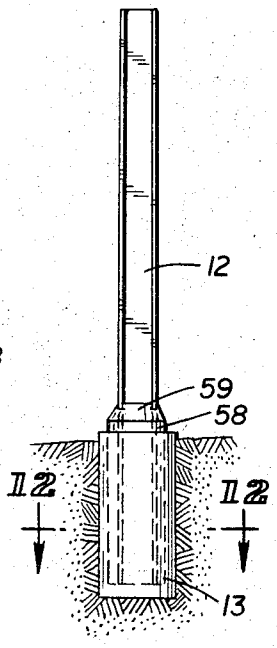
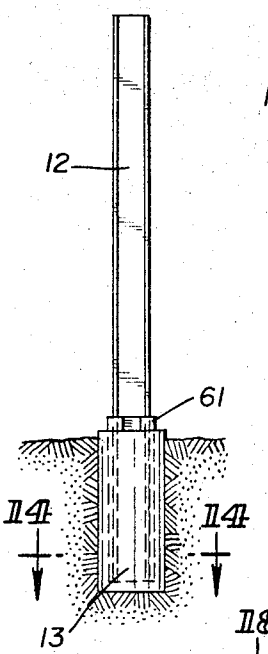


Fig_11



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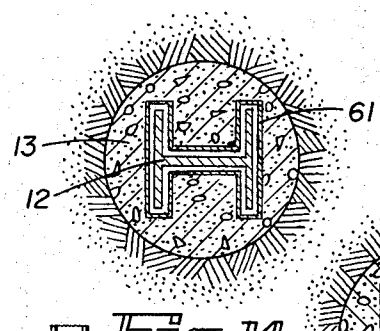

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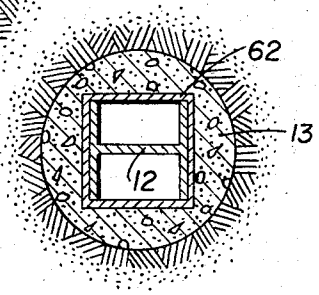

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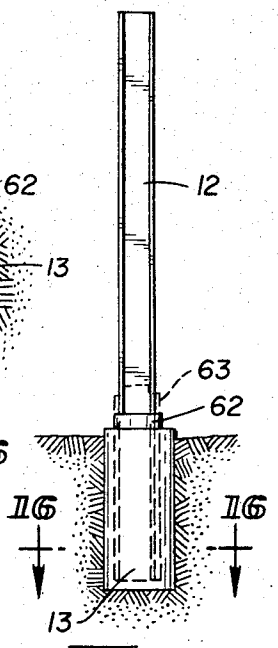

Fig_15

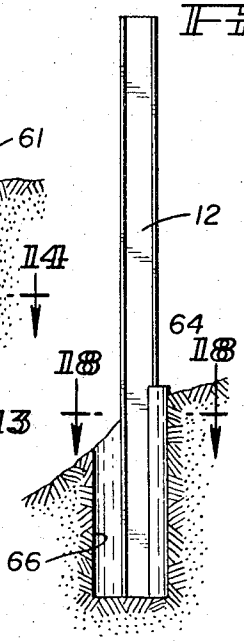

Fig_17

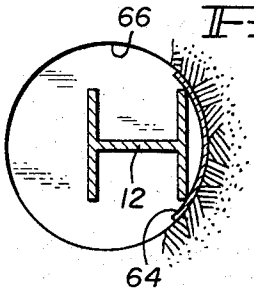

Fig_18

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SHORING SYSTEM AND COMPONENTS THEREFOR

BACKGROUND OF THE INVENTION

Where large buildings are to be erected at sites having a substantial layer of loose materials overlaying an adequate foundation support layer, it has always been advisable to excavate the loose materials to establish a foundation for the building. The space excavated is generally used for basement floors providing storage, utility or parking areas. Support columns for the building and exterior walls that are generally of concrete for permanently holding back the loose materials are raised to a ground level. From such ground level reinforced concrete or steel frame construction may be used. At sites where a substantial depth of loose material is encountered, the problem of holding back the loose materials or earth while foundations are placed is substantial. Previously, shoring systems have been used that require the expenditure of excessive hand labor. Further, where machinery is used, as in the driving of continuous pile, the process is costly and time consuming. Usually most excavation operations are delayed until the full shorting system has been set. A faster, more economical, system is desirable.

SUMMARY OF THE INVENTION

With full recognition of the problems and hazards involved in the use of present shoring systems, the present inventor has developed a system that is readily adaptable for use when excavation operations are to be carried out at sites where the loose materials to be excavated might be 20 feet or more in depth. Use of the system involves the drilling of a plurality of caisson holes in aligned positions along the periphery of the building with the caisson holes being spaced one from the other. The caisson holes are drilled to a depth extending beneath the maximum depth to be excavated. Main pile elements having vertically spaced support sockets are disposed in paired holes placed apart one from the other a distance corresponding to the length of the cribbing members to be used. The elevation of the support sockets on paired main pile elements is regulated so that when the cribbing members are applied they will be disposed in near horizontal positions. The pile elements are installed and tamped earth or concrete is placed in the caisson holes to hold the pile elements in place.

After a line of piles have been set, excavation processes can be initiated to uncover the support sockets on the paired main pile elements. As each support socket is uncovered, a fastener may be applied, and thereafter a cribbing element is disposed on the fastener supports to be held in near horizontal position thereby. Since the fasteners extend beneath the cribbing members, a slot space will be preserved between adjacent cribbing members. In the usual system intermediate pile elements are disposed in aligned positions along with the main pile elements, and flange clamps are provided which can be extended through the slot spaces to engage the intermediate piles. When the flange clamps are engaged, the cribbing members will be securely held to the row of pile elements, and the inwardly directed force of loose materials disposed behind the pile elements will be resisted by the piles and the cribbing members. As the excavation proceeds, additional cribbing members will be applied in inverted order as excavation operations continue. The pile elements themselves are of substantial strength having a section modulus adequate to resist the collapsing forces exerted by a substantial wall of loose materials. Once excavation has progressed to a depth of 15 to 20 feet, however, some additional lateral support may be required. For such additional support, deadman anchors are driven outwardly past the cribbing members and into the loose materials. The deadman anchors are of a flat or flared plate type construction having a small frontal area when driven sideways. When the anchors are disposed outwardly past the natural angle of repose for the loose materials, a cable tension system is used to rotate the anchors in place to bring the substantial area of the plate sections into normal position with respect to the tension forces exerted by tensioning cables. The inner ends of the tension cables are attached to a waler frame disposed inwardly of the cribbing members whereby the shore system is enabled to withstand additional collapsing forces. The components of the shoring system are removed in an inverse order. As the cribbing timbers are removed, the loose materials will cave back to fill the space outside the basement walls. Once all the cribbing, walers and hardware elements have been removed, it is desirable that the pile elements themselves be removed. This operation is facilitated by the provision of shield pieces that cover the lower end of the H beam pile elements. Alternately, the shield pieces can be removed with the pile elements, or they may be left in place.

Components used in practice of the system include the pile elements having the vertically spaced support sockets that determine the positioning and spacing of the cribbing members, the flange clamp and flange combination provided for intermediate support of the cribbing members, a wedge type lock to be used with the flange clamp for engaging and holding a plurality of cribbing members, and the pile shield pieces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation in partial section showing details of the present shoring system,

FIG. 2 is a cross-section taken along the line 2—2 showing main pile supports for the cribbing pieces,

FIG. 3 is a cross-section taken along the line 3—3 showing details of an intermediate flange-clamp type support,

FIG. 4 is a cross-section similar to that of

FIG. 3 showing a modified type of flange-clamp,

fig. 5 is an enlarged detail of the flange-clamp used in FIG. 3,

FIG. 6 is an enlarged detail of the flange-clamp used in FIG. 4,

FIG. 7 is a diagrammatic representation in partial cross-section showing installation of tie-back components with a rear view of a deadman anchor,

FIG. is a side elevation of the anchor of FIG. 7 to illustrate further details thereof,

FIG. 9 is an elevation showing a first shield piece installation,

FIG. 10 is a cross-sectional view along the line 10—10 of FIG. 9,

FIG. 11 is an elevation showing a second shield piece installation,

FIG. 12 is a cross-sectional view along the line 12—12 of FIG. 11,

FIG. 13 is an elevation showing a shield of open H form,

FIG. 14 is a cross-section taken along the line 14–of FIG. 13,

FIG. 15 is an elevation showing a box shield,

FIG. 16 is a cross-section taken along the line16—16 of FIG. 15,

FIG. 17 is an elevation of a shield piece for dirt operations, and

FIG. 18 is a cross-section taken along the line 18—18 of FIG. 17.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a shoring system to be used when deep excavations are being made in loose soil in order to provide clearance for foundation and basement structures. The system utilized is used so that loose dirt can be held back and so that construction operations can be carried on in the excavated area. The system can be described as a step process. As a first operation, a plurality of caisson holes 11 are drilled in aligned positions at locations that will be outside the finish line for any foundation or building components. The caissons are spaced apart a distance of 5 to 10 feet depending upon the length of cribbing elements that are later to be used and the inherent stability or free standing nature of the soil being excavated. As the holes 11 are completed to a depth greater than the intended excavation, H beam pile elements 12 and 14 are lowered in the separate holes, and thereafter tamped earth or concrete footing 13 is placed in the bottom of the hole to securely hold the pile elements in place. Preferably, the vertical height of main pile elements 14 is regulated, since the positioning of these piles will determine the horizontal organization of the cribbing elements that are later applied.

As shown in FIG. 2, the main pile elements 14 all have a plurality of threaded receptacle support sockets or nuts 16 applied to the inwardly disposed flanges thereof. These nuts are welded to the back of the inwardly disposed flange 17 so that a cribbing support fastener or bolt 18 may be threaded therein.

Once all of the pile elements 12 and 14 are in place, the excavation process can continue so that the level of dirt is gradually reduced. As the dirt is removed, the in-place pile elements 12 and 14 will be exposed. As the main piles 14 are exposed, successive nuts 16 will be exposed, and thereafter end support bolts 18 with washers 19 thereon may be engaged in the nuts. With the bolts partially engaged but still loose, cribbing timbers 21 are applied in inverted or descending order. If the cribbing timbers 21 are each 20 feet long, the main piles 14 will be maintained at a 20-foot center to center spacing. If the piles are 12-inch wide-flange beams or 12-inch H bearing pile sections, the ends of the cribbing pieces will be supported approximately 6 inches from each end by the end support bolts 18 on paired main piles 14. As each cribbing timber is placed, the bolts 18 for the crib next above may be tightened to hold the adjacent cribbing in place.

In order to hold back the unexcavated dirt, even where 3 × 12 timbers are used for cribbing, some support should be provided for the cribbing elements at points intermediate the ends thereof. To provide this intermediate support, alternate types of flange-clamps as shown in FIGS. 3 through 6 are provided. These clamps are of relatively narrow configuration so that they may be inserted through the slots or gaps 22 left between adjacent cribbing timbers 21. FIGS. 3 and 5 show a flange-clamp 23 that has a threaded end 24 that extends out past the cribbing members 21. Threaded flange-clamp 23 has a C shaped body 26 providing a slot 27. The slot 27 can be engaged on the edge of the H beam flanges 17 of intermediate piles 12. A washer 19 will be applied to the threaded end 24 of the flange-clamp 23, and thereafter a nut 30 is applied to establish tension forces in the clamp element to hold the cribbing pieces in place against the intermediate pile elements 12.

An alternate type of wedge flange-clamp is shown in FIGS. 4 and 6. Wedge clamp 33 has a longer body 36 which provides a wedge receiving opening 34. The head end of flange-clamp 33 again provides a slot 37 for engagement with the inwardly disposed flanges 17 of intermediate pile elements 12. A wedge 31 of length greater than the width of the cribbing timbers 21 is inserted through the wedge slot 34 and driven into place. As shown in FIG. 4, each wedge 31 will engage as many as three cribbing timbers to hold the boards tightly against the intermediate piles 12. Wedge type flange-clamps 33 can be speedily applied and removed, since blows directed against the wedge by a sledge hammer are used to set or remove them.

Since the present system is well adapted for use when deep excavations are required, it is possible that unexcavated but still loose materials will exert excessive side forces against the shoring system. In order to better withstand these forces, a tie-back capability is provided. When the excavation has progressed to an intermediate point, deadman anchors 41 are driven outwardly into the unexcavated soil. The anchors 41 are attached to tension cables 42 that move outwardly with the anchor and that are subsequently used to revolve the anchor into a maximum resistance position when the tensioning cables are pulled. Hydraulic tensioning systems are further used to exert a force that will hold the piling system in place. Features of such a tie-back or anchor system are shown in FIGS. 1, 7 and 8.

FIG. 7 a driver 43 is shown engaged to a deadman anchor 41 which is disposed in a sideways configuration. A mechanism is used that will move the driver 43 horizontally and outwardly past the shoring system a distance that may be 20 or 30 feet depending on the nature of the unexcavated soil. Various types of air or hydraulically powered equipment may be conveniently used. Since little frontal area is exposed when the anchors are in the sideways position, track mounted units are usually capable of driving the anchors without auxiliary support.

A plurality of cables 42 are trailed behind the deadman anchor 41 with the free ends of the cable disposed to pass through a strongback or waler frame 44 positioned inwardly of the cribbing timbers on the assembled shoring system. In the embodiment illustrated, four cables are used. The outer ends of the cables are secured to the anchor 41 by prestress socket and lock assemblies 46 in anchor block 47. The socket and lock assemblies on the anchor 41 are similar to identical as-

semblies used on the inwardly disposed ends of the cable at the tension plates **48**. Here the sockets **49** have a tapered inner surface, while the cable lock **51** is of collet type having a tapered outer surface and a slot **52**. The inner surface of the lock **51** engages the outer surface of the cable, and the tapered surface of the socket **49** cooperates with the tapered surface on the lock **51** to hold the cable tightly engaged when tension forces previously established in the cable are released pulling the lock **51** into socket **49**. The socket and lock assemblies **46** on the anchor **41** are preset to engage the cable end carried by the anchor **41**. When the full desired extension of the anchor **41** has been obtained, the driver **43** will be withdrawn at least a slight distance to disengage it from the anchor block **47**, and cable **42A** will then be pulled to rotate the anchor **41** from its sideways orientation to the head-on configuration as shown in FIGS. **1** and **8**. Sometimes driver **43** may be left in position adjacent the anchor **41** to provide a pivot for the rotation thereof as cable **42A** is pulled. Once the anchor has been rotated, or as part of such rotation operation, tension plate **43** will be positioned within the waler assembly **44** and against the stop blocks **52**. Thereafter all of the cables **42** may be pulled until the required tension forces have been established as necessary to hold the waler assemblies **44** and the shoring system itself in place.

A plurality of waler assemblies **44** may be used with the tie-back anchors being disposed in regularly dispersed or in random positions depending upon the soil conditions expected or encountered at various locations. Usually the waler assemblies **44** will be of a length to substantially span the distance between adjacent pile elements. The waler assemblies can, of course, be made longer or even continuous where more difficult soil conditions are involved.

When the full desired depth of excavation has been attained, building operations can be undertaken. After the basement walls and support columns have been completed, the shoring system and components thereof can be recovered. In the recovery process the cribbing members **21** at the bottom of the excavation will be removed first. In most instances this will permit the collapse of the loose materials against the finished basement walls. As the cribbing members are removed, the hardware pieces, such as the bolts **18**, washers **19**, flange-clamps **23** and **33**, and wedges **31**, will be recovered. The waler frames **44** and tension plates **48** likewise will be recovered. Usually the anchors **41** and cables **42** will be left in place. Once all of the cribbing members have been removed, the pile elements **12** and **14** can be recovered.

Where the pile elements were initially installed at a slight angle with respect to the vertical, as shown in FIG. **1**, and forces exerted by the loose materials are decreased, and the safety of recovery operations are improved. Where waler frames **44** have been utilized, pile elements **12** or **14** that otherwise might be entrapped by the concrete **13** can be cut loose to free the portions thereof above the concrete. To increase the safety of such operations, temporary blocks may be established between the freed end of the pile elements and the permanent basement walls or columns that would then be in place. If tamping of the backfill is required, removal of cribbing members can be regulated to permit the periodic ingress of added layers of loose materials. The regulation of cave-back operations can help to avoid the imposition of excessive side loadings on the in-place finished basement wall. At some building sites, the cable and anchor components may be recovered in connection with cave-back and back-fill operations.

Components facilitating recovery of the pile elements are shown in FIGS. **9–18**. In these figures various types of shield pieces are shown that are adapted for use with the pile elements **12** and **14** to facilitate the recovery of the pile elements after the cribbing members have been removed. In all instances, the use of the shield pieces is described in connection with an intermediate pile element **12**.

In FIGS. **9** and **10** the basic pile element **12**, which is an H beam pile section, is provided with shield pieces **53** that extend between the flanges **54** and **56** in position parallel to the web **57** to provide an enclosed box type section. Before the concrete pier **13** is poured about this lower end of the pile **12**, grease or mold release agent will be applied to all of the exterior surfaces of the pile **12** and shield **53** combination. After all excavation operations are completed, the pile **12** can then be withdrawn from the concrete pier **13**.

In FIGS. **11** and **12** a cylindrical shield **58** is provided to surround the H beam pile **12**. Under alternate systems of useage the shield **58** can be loose and separate therefrom or it may be welded or otherwise attached to the pile element **12**. In a first system the shield piece **58** is to be left in the concrete pier **13** when the pile **12** is recovered. Under a second system of useage, a tapered transition **59** is provided on the upper end of the shield piece **58**, and the transition and shield are joined to the pile **12** so that the entire assembly is extracted when the pile elements are to be recovered. Where the shield is to be recovered, mold release agents or lubricants will be applied to the exterior surface of the shield **58**.

In FIGS. **13** and **14** an open "H" shaped shield **61** is used that fits closely about the flanges and web of the pile **12**. Oil or grease will be introduced into this open H shield **61** before the pile **12** is inserted in order to facilitate removal of the pile when desired. For usual operations the open H shield will be entrapped in the concrete **13**.

In FIGS. **15** and **16** a box shield **62** is provided which completely surrounds the H beam pile element **12**. In a first method of operation the box shield **62** will be left in place as the pile is removed. Alternately, a tapered transition **63** may be provided, and the shield may then be joined to the pile for removal therewith when suitable release agents are used.

FIGS. **17** and **18** illustrate the use of a shield **64** in conjunction with placement of H beam piles in a drilled caisson hole where no concrete is used. Here a segment shield **64** is attached to an H beam pile **12**. The shield is of circular arc corresponding to the drilled caisson hole **66** thus assuring firm contact between the shield **64** and one side of the drilled caisson footing. This system has practical use where the caisson holes are continued into a relatively stable earth structure that is capable of withstanding the side thrust exerted by the loose materials disposed thereabove and behind the shoring system.

The economy of operations where the total length of pile elements may be recovered is substantially increased without endangering the safety or efficiency of the system.

I claim

1. A shoring system and method for excavation operations at building sites where loose materials may be encountered comprising the steps of drilling a plurality of caisson holes of depth greater than the depth of the intended excavation at spaced separated and aligned positions about the site to be excavated, inserting intermixed main and intermediate piles in said caisson holes with the vertical positioning of paired main piles being regulated, establishing footings of consolidated materials placed about the ends of said pile elements at the bottom of said caisson holes for resisting the transversely directed forces exerted by the unexcavated loose materials, initiating excavation operations to progressively reduce the operating level inwardly of said shoring system to expose the in-place pile elements, applying regularly spaced free standing cribbing supports disposed vertically along said main pile elements and extending inwardly therefrom, placing and supporting horizontally oriented cribbing members on and between the cribbing supports of paired main pile elements in an inverted order with the in-place cribbing supports thereby providing slot openings between adjacent cribbing members, extending additional clamping members through said slot openings to engage intermediate piles disposed between the paired main piles for the added support of said cribbing members, and, after excavation operations are completed, removing said cribbing members and supports in a bottom to top order, and subsequently removing said pile elements while leaving said footings in place.

2. The method as set forth in claim 1 and additionally disposing shield pieces about the lower ends of said pile elements for direct engagement with the established footings.

3. The method as set forth in claim 2 wherein said shield pieces remain in place with the footings.

4. The method as set forth in claim 2 and additionally applying a release agent to said shield pieces and wherein said shield pieces are removed with the pile elements.

5. A shoring system for excavation operations at building sites where loose materials may be encountered comprising flanged main and intermediate piles disposed in intermixed spaced separated and aligned positions about the periphery of a site to be excavated, cribbing support elements disposed at spaced vertical positions along paired main piles, cribbing fasteners for application to the support elements of paired main piles in top to bottom order providing inwardly standing supports, cribbing members for placement on the standing support elements of said main piles for extension between main pile elements and past intermediate piles with said standing support elements preserving a slot opening between adjacent cribbing members, and auxiliary clamping members for extension through the provided slot openings for engagement with the flanges of intermediate piles disposed between the paired main piles for the added support of said cribbing members.

6. Structure as set forth in claim 5 wherein said clamping members are flange-clamps having a "C" shaped body providing a slot for engagement with the flanges of said pile elements, and a body extension rigidly joined to said "C" shaped body for extension inwardly through said slot openings to an easy access working position.

7. Structure as set forth in claim 6 wherein said flange-clamp has a threaded body extension passing through the slot openings between adjacent cribbing members.

8. Structure as set forth in claim 6 wherein the body extension of said flange-clamp extends inwardly through the slot openings between adjacent cribbing members, and further comprising a lock element for engaging said body for the added support of said cribbing members.

9. Structure as set forth in claim 5 wherein said piles are disposed in caisson holes provided at the building site of depth greater than the depth of the intended excavation at space separated and aligned positions about the site, and further comprising footings of consolidated materials replaced about the ends of said piles at the bottom of said caisson holes for resisting the transversely directed forces exerted by the loose materials, and release means provided intermediate said piles and footings for facilitating the removal of said piles from said footings after excavation operations have been completed.

10. Structure as set forth in claim 9 wherein said footings are of poured concrete.

11. Structure as set forth in claim 9 wherein said release means is inclusive of shield pieces about the lower ends of said pile elements for direct engagement with said footings.

12. Structure as set forth in claim 11 wherein said shield pieces are engaged to said pile elements for removal therewith after excavation operations are completed, and wherein said footings are of poured concrete.

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