June 4, 1963 H. SCHNABEL, JR 3,091,938

METHOD AND STRUCTURE FOR UNDERPINNING

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FIG. 1

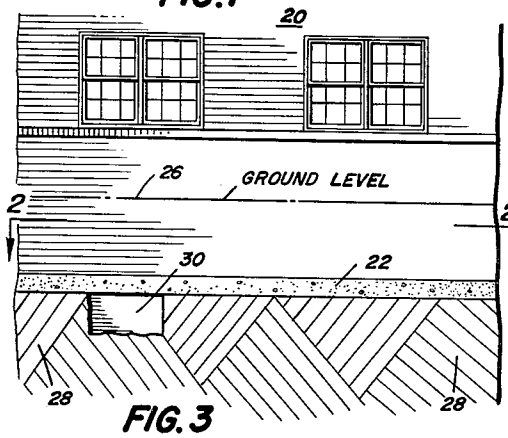


FIG. 2

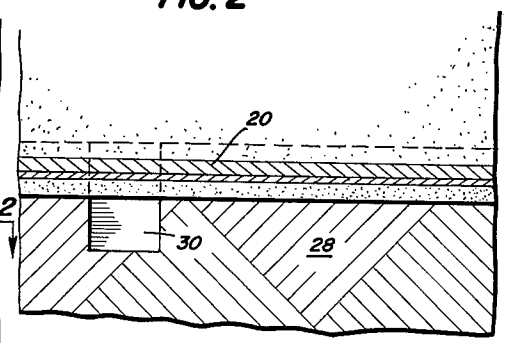


FIG. 3

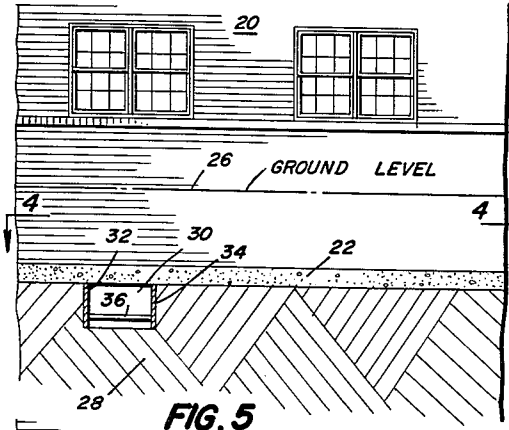


FIG. 4

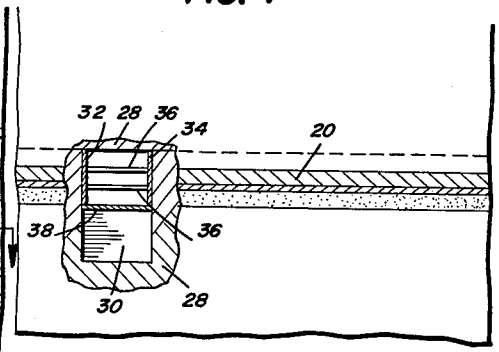


FIG. 5

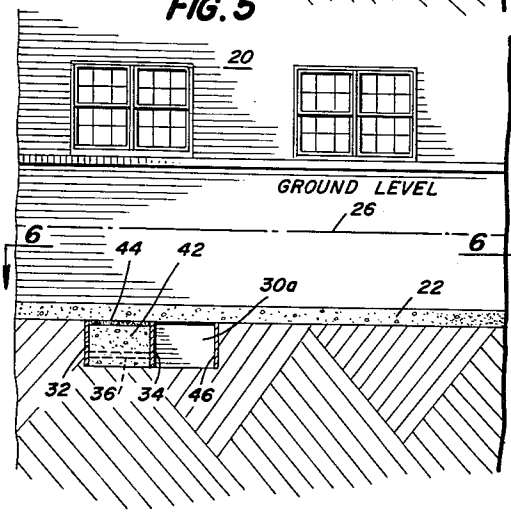
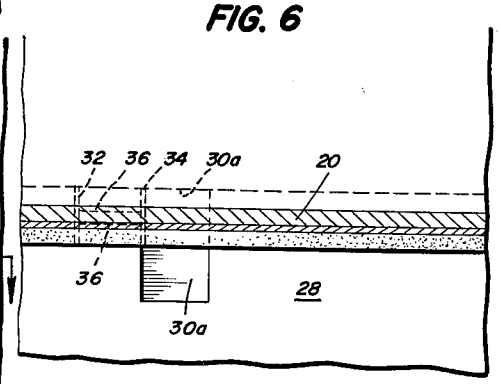


FIG. 6



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FIG. 7

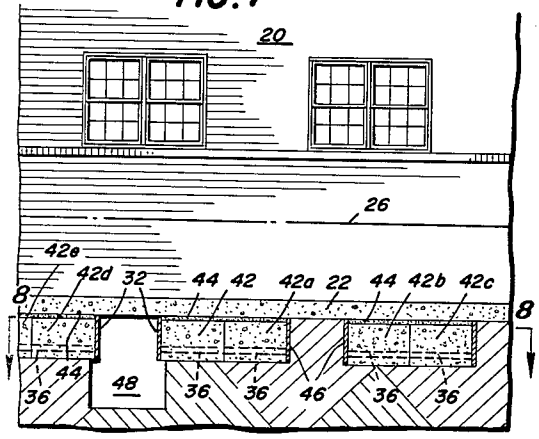


FIG. 8

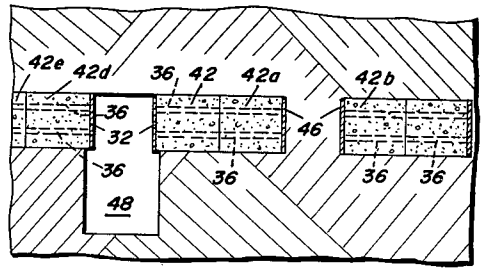


FIG. 9

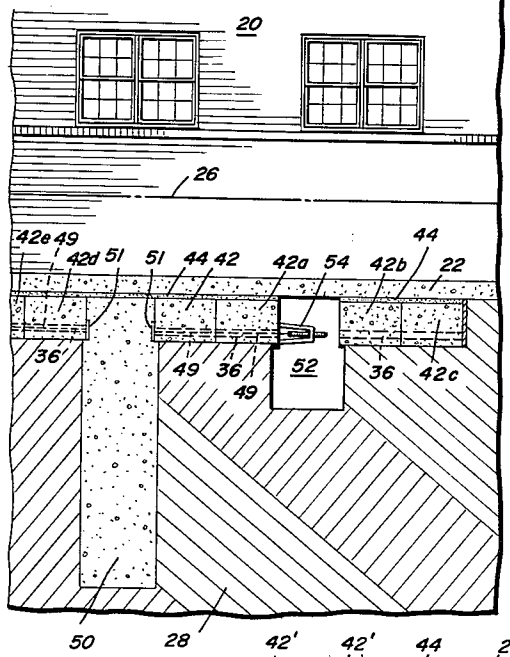


FIG. 10

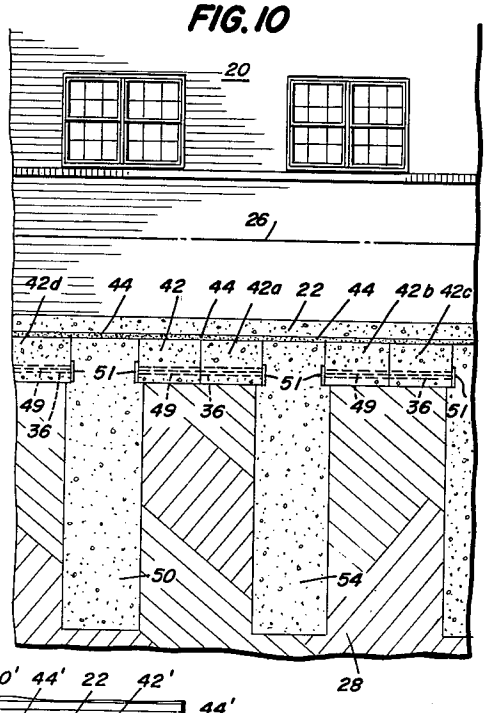
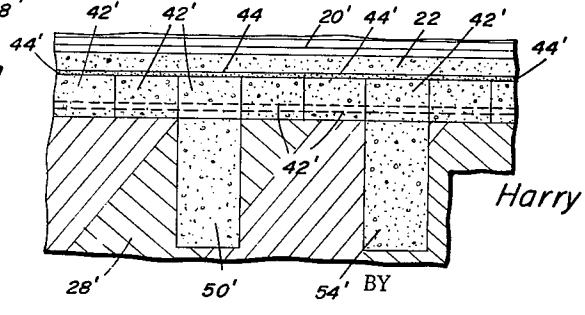


FIG. 11



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METHOD AND STRUCTURE FOR UNDERPINNING

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Filed July 27, 1960, Ser. No. 45,572
8 Claims. (Cl. 61—51)

This invention relates to the underpinning of buildings, and in particular, it relates to new and useful techniques and methods for placing new foundations under existing building walls, and also to novel underpinning structure.

In general, underpinning is most often made necessary by contemplated excavation near an existing structure, thereby making it necessary to extend the foundation down to a lower level. The most common method presently employed for this purpose is to construct a new concrete wall directly beneath the foundation to be underpinned, with the bottom of the new wall at the desired lower level. Since this wall must be built beneath an existing wall, it is usually built in a series of short sections, generally four to five feet long, inasmuch as experience has shown this is the longest length of existing foundation which can safely be undermined without risking damage to the building. Each section is built by hand excavating a pit, say 3′ wide, 4′ long, and perhaps 7′–10′ deep, or as deep as required, directly beneath the footing. For the safety of the building and the workmen, these pits are commonly ringed with wooden planks. When the pit is dug down to the desired elevation for the new wall, concrete is poured into it. A space of about 2 inches is frequently left between the top surface of the new concrete and the bottom of the foundation. After the concrete has hardened, this two-inch space may be tightly rammed with a sand-cement mixture commonly known as "dry pack." If they can be spaced far enough apart along a wall, several of such sections may be worked simultaneously. As can be seen, after one section has hardened and been dry packed, another section adjacent thereto can be started, so that by repeating this process for all the sections, a continuous concrete wall, composed of contiguous sections of concrete, is built. As stated, this is the most common way of performing underpinning. Numerous variations have been used, such as substituting brick for concrete, steel wedges for drypack, etc., but most basically call for constructing a new wall beneath the existing wall.

Another scheme involved the use of pier-type underpinning in lieu of a continuous wall. In this case, concrete sections are constructed in much the same manner as that just described, except that when completed, instead of forming a continuous wall the sections form a series of isolated or spaced piers beneath the footing, with short lengths or spans of the footing not supported between piers. The wall arches over these lengths or spaces in much the same manner as a wall may arch over a window or over an underpinning pit. Ordinarily, these spaces cannot be greater than about four feet in length, since the wall will not support itself over a longer span. A variation of this method is the use of spaced piles or caissons at short intervals, instead of concrete piers, with the wall supporting itself by arching over the spaces.

As will be evident from the foregoing, whether piles, caissons or concrete piers are used, they must be spaced closely, since the wall will not span more than about four or five feet between points of support.

One seldom used technique was to place a steel beam inside the wall, another steel beam of equal size outside the wall and opposite from the first beam, then to bolt the beams together through the wall, and pour concrete between the beams and walls. In this way, the distance between supports may be increased, but in practice this usually means entering into the premises you are working to protect, placing steel and concrete against the wall near the floor line, where it is clearly visible, and knocking holes in partitions. Furthermore, because the beams can not be placed beneath the foundation except in five foot lengths, it is difficult and not economical to place the beams beneath the foundation. This is chiefly due to the great amount of temporary shoring required. Mainly for these reasons, this technique has seldom been used.

The principal object of the present invention is to provide novel and improved techniques and structures for underpinning existing foundation walls or the like, and designed to overcome disadvantages and drawbacks of existing practices, such as those noted above.

In the illustrative embodiments of the invention, to be described in more detail hereinafter, it is contemplated that a prestressed concrete beam or beams be constructed directly beneath the existing wall foundation to be underpinned without requiring temporary shoring, and of such strength that the distance between supports, such as piers, piles or caissons, can be much greater than the four or five feet permitted by current practice.

By reason of this arrangement, the existing wall foundation may be positively supported without relying on arching, and at the same time, the number of piers, piles or caissons used in the underpinning may be decreased. Thus, a safer and yet more economical job is possible.

It will be understood that the term "pier" where used hereinbelow comprehends such other structures as piles or caissons in view of the interchangeable use of these members in the construction art.

The present invention, broadly speaking, comprises providing a plurality of relatively shallow structural sections in end-to-end relation under and in operative supporting engagement to an existing wall foundation of the building or structure to be underpinned, and providing for the conversion of said sections into a single horizontal beam. The sections preferably are made of concrete and preferably are converted into a beam by prestressing cable means extending therethrough.

In one embodiment, a plurality of such beams are provided, each beam being composed of two concrete sections, and the beams being horizontally spaced apart and in longitudinal alignment, with a concrete pier constructed between each two adjacent beams. These piers are in supporting engagement with the wall foundation to be underpinned and also with the adjacent and opposed ends of adjacent beams, and are of a greater depth or height than said concrete sections whereby they operate to directly support the wall foundation and the beams engaged thereto.

In another embodiment of the invention, the concrete sections define a continuous beam extending horizontally underneath the wall foundation for the full length to be underpinned, and a plurality of vertical concrete piers are arranged in horizontally-spaced and parallel relation under said continuous beam, with the upper ends of said piers directly supportingly engaging the undersurface of said continuous beam at spaced points therealong.

Further objects and advantages of the invention will be in part obvious and in part pointed out hereinafter.

The novel features of the invention may be best made clear from the following description and accompanying drawings in which:

FIGURE 1 is a fragmentary side elevational view of an illustrative building, and showing the existing foundation for the building and one of the initial steps in the process of the invention for lowering the foundation;

FIGURE 2 is a horizontal sectional view taken generally along line 2—2 of FIGURE 1;

FIGURE 3 is a view corresponding to FIGURE 1 and showing a subsequent step in the process of the invention;

FIGURE 4 is a horizontal sectional view taken generally along line 4—4 of FIGURE 3;

FIGURE 5 is a view corresponding to FIGURE 3 and showing a subsequent step in the process of the invention;

FIGURE 6 is a horizontal sectional view taken generally along line 6—6 of FIGURE 5;

FIGURE 7 is a view corresponding to FIGURE 5 and showing a subsequent step in the process of the invention;

FIGURE 8 is a horizontal sectional view taken generally along the line of 8—8 of FIGURE 7;

FIGURES 9 and 10 are views corresponding to FIGURE 7 and showing subsequent steps in the process of the invention; and

FIGURE 11 is a fragmentary and elevational view of a modified form of underpinning embodying the invention.

Referring now to the drawings, FIGURES 1–10 illustrate various steps in one embodiment of the process of the invention for constructing a novel underpinning beneath an existing foundation. A building wall **20** is shown in FIGURE 1, having an existing footing or foundation **22** thereunder. The ground level is indicated by the numeral **26** and the earth underneath the existing wall foundation is indicated by the numeral **28**. Assuming that it is desired to provide a foundation for the building wall **20** extending down to a lower level than the foundation **22** due, for example, to the needs of construction for an adjacent site, the present invention contemplates the excavation of a shallow pit **30** beneath the footing as shown in FIGURES 1 and 2. This pit **30** usually will be excavated from the level of the earth outside the building to about 2 or 3 feet beneath the footing. Then the earth directly beneath the footing or foundation **22** will be excavated so that a short length of the foundation will be undermined or unsupported for its entire width. The condition of the pit **30** will then be approximately that shown in FIGURES 1 and 2.

Then, as shown in FIGURES 3 and 4, a suitable form will be placed beneath the foundation **22** so as to define the perimeter or outline of a proposed concrete section. These forms may be made of wood or steel, and it is preferred that conduits be connected thereto for the later insertion therethrough of prestressing cable means or strands, as will be explained in more detail hereinafter. The end forms are indicated by the numerals **32**, **34**, and two hollow conduits or tubular members **36** are suitably connected to these forms, extending therebetween and therethrough. The conduits **36** are open at either end thereof for the reception of the cable means referred to above.

No form would be required in back of the pit **30**, inasmuch as the concrete could be poured directly against the earth or wood planks bracing the pit. The forms **32**, **34** at the ends of the pit **30** may be of any suitable construction, as long as they provide means of supporting the conduits **36**, as discussed.

When the end forms **32**, **34** are in place, and the conduits **36** secured thereto, the front form **38** may then be arranged in position, as indicated in FIGURE 4. The space defined by these forms and the earth is then suitably filled with concrete. The concrete may be poured or injected into such space by any suitable means or in any suitable manner. It is preferred that a space be left between the undersurface of the existing footing or foundation **22** and the newly poured concrete. This space may be approximately 2 inches in height, and will be substantially coextensive with the space defined by the forms. A suitable material, such as that commercially known as

"dry pack," may then be rammed into this space between the top of the newly poured concrete section **42** and the undersurface of the existing footing or foundation **22**, as best seen in FIGURE 5. The dry pack is indicated by numeral **44**. It will be understood that any other suitable means may be utilized for effecting such wedging action between the concrete section **42** and the bottom of the footing **22**. For example, wood or metal wedges may be used.

After the first concrete section **42** has been completed, as described, an adjacent section will then be excavated to define another pit **30***a* of generally the same size and proportions as the first pit **30**. The end form **34** for the adjacent section **42** is then removed so that the concrete for the new section may be poured directly against the concrete of the first section **42**. A form **46** will be arranged adjacent the opposite end of the pit **30***a*, as seen in FIGURE 5, and additional conduit sections will be connected to this form and to the initial conduit sections **36**. A front form (not shown but similar to form **38**) will then be arranged in the second pit **30***a* so as to define a space substantially the same size as the first concrete section **42**, and the concrete will then be poured into this space in the second pit **30***a* to define the second concrete section **42***a*, as indicated in FIGURE 7. Again, a space preferably is left between the second concrete section and the undersurface of the existing footing **22**, and this space preferably is carefully rammed with dry pack or any other suitable material or wedging means.

At this point, two adjacent shallow pits have been concreted so that a new concrete footing of about the same width as the existing footing **22** and about 2 or 3 feet deep, has been completed. No reinforcing steel is necessary, and the conduit sections **36** provide a continuous passage lengthwise of this new footing defined by the concrete sections **42**, **42***a* so that prestressing cable means or strands may be later inserted therethrough. By proper prestressing of these cable means, together with selecting the proper dimensions for the concrete sections **42**, **42***a*, the new footing can now be converted into a prestressed beam. It will be understood that more than two sections may be converted into such a beam simply by making the conduit passageway continuous through all of the sections. For illustrative purposes, it will be assumed that two concrete sections, each approximately 5 feet long, have been completed in this manner.

As best seen in FIGURE 7, there will be a space provided between each pair of adjacent concrete sections, the concrete sections **42***b*, **42***c* and **42***d*, **42***e* being constructed and arranged in a manner similar to that described for the construction of the sections **42**, **42***a*. After all of the shallow pits have been constructed in this manner, it is then contemplated that excavation will begin for one of the deep piers to be constructed in the space adjacent pairs of the concrete sections. This excavation preferably should be allowed to proceed to a point where ready access is provided to the ends of the conduits in the sections. One such partially excavated pit is shown in FIGURE 7 and is identified by numeral **48**. The end forms **32** in pit **48** are removed and prestressing cables or strands **49** preferably are then inserted into the conduits, through the adjacent open ends thereof, and anchored by suitable means, as by anchoring plates **51**, abutting against the free or accessible ends of the concrete sections so that pressure or tension can later be exerted on the cables from the opposite ends, as shown in FIGURE 9. After this is completed, the excavation for the pit **48** may be completed, and the concrete poured thereinto to define a concrete pier **50**, as shown in FIGURE 9. Dry pack **44** or any other suitable material may be rammed into the space between the top of this pier **50** and the undersurface of the existing footing **22**, as indicated. Although not shown, it will be understood that suitable forms may be used in the pit **48** before the concrete is poured to define the pier **50**.

After the pier 50 has been so constructed, the pier at the other end of the beam formed by the concrete sections 42, 42*a* will be started. A pit 52 will be excavated, as shown in FIGURE 9, and the excavation may be temporarily stopped when it has proceeded to the point where working access will be provided to the adjacent end of the beams defined by the concrete section 42, 42*a* and 42*b*, 42*c*. The forms 46 can then be removed, and the ends of the prestressing cables 49 are then pulled from the adjacent end of the conduits 36. Prestressing loads may then be applied to the concrete sections 42, 42*a* through these cables 49 in any suitable manner, as, for example, by means of hydraulic jacks (not shown) or the like attached to and operating on the end of the prestressing cables to tension them. For illustrative purposes only, a jack 54 is shown schematically in FIGURE 9 attached to the free end of one of the prestressing cables 49 for the application of a prestressing load or tension thereto. These free ends of the prestressing cables may then be suitably anchored to the adjacent end of the concrete sections 42*a*, and the conduits 36 may then be filled with grout. The concrete sections 42, 42*a* are now converted into a prestressed concrete beam, with one end thereof resting on and being supported by the pier 50. Excavation of the pit 52 may then be resumed, and a second pier 54 poured and completed, in the same manner as that described for the pier 50, as shown in FIGURE 10.

Thus, it will be seen that a prestressed concrete beam defined by the prestressed concrete sections 42, 42*a* has been formed to transmit the wall loads to the piers 50, 54, which then carry it down to the lower elevation required. At no time will a length of the existing footing or foundation 22 greater than about 4 or 5 feet be undermined, and the entire job can be performed without requiring temporary shoring or access into the building being underpinned.

It will be apparent that the other concrete sections 42*b*, 42*c*, and 42*d*, 42*e* shown in FIGURES 7–10 will be prestressed to form prestressed concrete beams in the same manner as that described above for the concrete sections 42, 42*a*, and additional concrete piers will be constructed in supporting engagement with the opposite ends of these beams in the same manner as that described for the piers 50, 54. It will be noted that in constructing the piers 50, 54, and before the concrete is poured therefor, prestressing cables will be inserted into the conduits in the adjacent concrete sections 42*b*, 42*c* and 42*d*, 42*e*, and will be anchored thereto, in the same manner as that described above for the prestressing cables 49.

It will be understood that the length of the spaces between adjacent pairs of concrete sections (42, 42*a*, etc.) may be varied depending, for example, on the nature of the building, and the existing foundation 22. As an illustration, building codes usually limit the space to 4'.

As many pairs of concrete sections (42, 42*a*, etc.) will be constructed and arranged under the existing footing 22 as are necessary or desirable, as will be evident.

FIGURE 11 illustrates a modification of the underpinning construction shown in FIGURE 10, and wherein similar reference numerals have been used to designate similar parts. In FIGURE 11, the underpinning comprises a plurality of concrete sections 42', all arranged in end-to-end relation to define a continuous beam. Each of these sections 42' may be constructed in a manner similar to that described above for the concrete section 42, and conduit sections similar to conduits 36 may similarly be provided in these concrete sections 42' to provide a continuous passageway through all of the concrete sections 42' whereby prestressing cables may be inserted all the way through these sections 42'. These cables will be suitably prestressed and anchored to the end sections 42' whereby all of the sections 42' will be converted into a single, continuous, prestressed concrete beam underneath the existing footing 22'. Concrete piers 50', 54' may then be constructed at suitably spaced locations underneath the sections 42', as indicated in FIGURE 11, to carry the wall loads down to the lower elevation desired.

These concrete piers may be constructed either before or after the prestressing of the sections 42', and they will not be an integral part of such sections, whereby if such sections are prestressed after the piers 50', 54' are constructed, some sliding or slippage between the sections 42' and the piers will be permitted.

The present invention will thus be seen to completely and effectively accomplish the objects enumerated hereinabove. It will be realized, however, that various changes and substitutions may be made to the specific embodiments disclosed herein for the purpose of illustrating the principles of this invention, without departing from these principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

What is claimed is:

1. A method of underpinning structures having an existing foundation wall resting on the earth comprising the steps of separately removing a plurality of relatively shallow earth sections from contiguous locations directly under the foundation wall, each of said earth sections having a length no greater than a self-supporting span of said wall, positioning a plurality of relatively shallow structural supporting means in contiguous end to end disposition in said locations in operative supporting relation to said wall, said positioning of each of said structural supporting means being in sequence to replace each of said removed earth sections while the wall is supported at both ends thereof, said end support being provided as the successive structural supporting means are positioned by unremoved earth and previously positioned structural supporting means, connecting said contiguous structural supporting means together by elongated reinforcing means, said structural supporting means comprising continuous horizontal members resistant to horizontal compression so that said members in addition to providing said end support before the connection of said elongated reinforcing means are converted by said connection into a continuous beam supporting said wall, and emplacing a plurality of piers of substantially greater depth than said structural supporting means at locations spaced apart a distance greater than said earth section length and supporting said beam directly under said wall.

2. A method as recited in claim 1 wherein said structural supporting means are molded in situ of concrete, and said connecting is accomplished by extending said elongated reinforcing elements through said structural supporting means, applying tension to said elements and anchoring the ends of said elements to permanently maintain said tension.

3. The method as recited in claim 1 wherein said structural supporting means extend continuously in abutting end to end relation along the entire length of the underpinning.

4. A method as recited in claim 3 wherein said structural supporting means are molded in situ of concrete, and said connecting is accomplished by extending said elongated reinforcing elements through said structural supporting means, applying tension to said elements and anchoring the ends of said elements to permanently maintain said tension.

5. The method as recited in claim 1 wherein said continuous beam extends along a portion only of the periphery of the existing foundation wall and further comprising the steps of positioning in the same manner additional continuous beams and piers at other portions of said periphery to provide substantially continuous support along the entire length of the underpinning.

6. A method as recited in claim 5 wherein said structural supporting means are molded in situ of concrete, and said connecting is accomplished by extending elongated reinforcing elements through said structural sup-

porting means, applying tension to said elements and anchoring the ends of said elements to permanently maintain said tension.

7. The method as recited in claim 5 wherein the ends of said continuous beams are positioned at spaced locations and said piers are positioned between said ends in supporting engagement with said ends and with the foundation wall between said ends.

8. A method as recited in claim 7 wherein said structural supporting means are molded in situ of concrete, and said connecting is accomplished by extending said elongated reinforcing elements through said structural supporting means, applying tension to said elements and anchoring the ends of said elements to permanently maintain said tension.

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