METHOD FOR ERECTING PRECAST RETAINING WALL

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The present invention relates in general to precast concrete walls and more particularly to precast concrete retaining walls having continuous unitary reinforcing rods which extend into the body of a cast-in-situ concrete footing and the method of erecting such retaining walls.

Although precast concrete walls are known in the prior art, no satisfactory method has yet been developed for providing large dimensional retaining walls capable of withstanding lateral pressures encountered along roadway embankments, hill sides, or back fill areas. In the past, it has been the practice to structurally connect precast vertical walls to an existing footing by means of such devices as metallic clips, angle iron brackets, anchor bolts and the like. For this reason, such walls are of limited size and strength and consequently of limited utility as retaining walls. Other problems have been encountered in the erection of precast concrete walls in the nature of providing sufficient vertical support and stability for the precast concrete slab on existing footings, since elevation and alignment of the slab is usually accomplished after the slab is erected or positioned on the existing footing.

The present invention proposes a combined precast concrete wall and cast-in-situ footing, and method of erecting such a structure, so as to alleviate the problems encountered in the prior art. According to the present invention, the precast concrete retaining wall is fabricated to include unitary reinforcing steel members which ultimately extend into the body of the cast-in-situ footing so as to provide sufficient strength to withstand any lateral pressures created by earth fill on the back side of the wall. In addition, the present invention provides a method for erecting such a structure whereby the precast concrete wall is placed on the structured footing prior to the pouring of the cast-in-situ footing. By this method, the footing is poured about the base of the pre-positioned and precast wall so as to also include within its body portion, the protruding reinforcing steel of the wall. In this manner, adequate support and stability is provided for the precast concrete wall and correct positioning of the wall is insured without further work.

The method of the present invention also removes the limitations of the prior art precast retaining walls and permits the erection of such walls, limited in size only by the ability to transport and handle the precast slabs.

The primary object of the present invention is therefore to provide a method for constructing and erecting a precast concrete wall having individual precast wall sections which are erected and positioned for grade and alignment prior to the formation of a cast-in-situ footing. Another object of the present invention is to provide a method for constructing a precast concrete wall whereby reinforcing rods are imbedded into the body of the wall at the time of casting and which extend beyond the bottom of the wall and are subsequently imbedded into the body of a cast-in-situ footing after the wall is erected and positioned for alignment and grade.

A further object of the present invention is to provide a method whereby a precast concrete wall is supported in place and a cast-in-situ footing is structurally formed about the base of the wall and protruding reinforcing rods of the wall, with the footing providing the entire support for the wall and the reinforcing rods providing an interconnection between the wall and the footing.

A still further object of the present invention is to provide a method for erecting a precast concrete retaining wall wherein the wall is supported by a plurality of removable beams at the base of the wall whereby the wall may be prepositioned prior to pouring of the footing.

The means by which the foregoing objects and other advantages, which will be apparent to those skilled in the art, are accomplished, are set forth in the following specification and claims and are illustrated in the accompanying drawings. Reference is now made to the accompanying drawings in which:

FIG. 1 is a perspective view of an erected portion of the retaining wall of the present invention;
FIG. 2 is a cross sectional view of the joint between abutting sections of the wall taken along the lines 2—2 of FIG. 1;
FIGS. 3, 4, 5 and 6 are perspective views illustrating the successive steps of the method for erecting the retaining wall sections of the present invention;
FIG. 7 is an alternate form of precast retaining wall and footing structure according to the present invention.

Referring now to the drawings, wherein like reference numerals are used to indicate identical parts in the various views, the present invention comprises a plurality of individual precast concrete wall sections 1 shown in abutting relationship in FIG. 1 and a continuous cast-in-situ concrete footing 2. The wall section 1 in the embodiment of FIG. 1 is in the form of a cantilevered slab having a planar vertical face 3 and a tapered back side 4 which has a slope or batter determined in each individual case according to the strength requirement of the wall design. Although the size of the wall sections will also depend upon individual requirements, retaining walls as large as 25—50 feet or more in height may be erected, utilizing the method of the present invention. The wall sections 1 are formed with a flat widened bottom surface 5 and a top surface 6 which may be of any configuration and which is shown as a narrow flat surface merely by way of illustration in FIG. 1. The exact form of the top surface or entire top portion of the wall section 1 may be determined at the time of casting the section so as to present an aesthetically desirable configuration. The front face 3 of the wall section may also include such design features as the striated offset portions 7 which can be easily formed by placing the desired pattern in the bottom of the mold in which the sections 1 are cast.

The ability to form appealing designs on the finished face and top portion of the retaining walls is an advantage gained by the use of precast concrete walls in general since the finished design work may be accomplished at the time the wall is cast with little or no detail finishing work needed at the construction site. In practice, the wall sections 1 of the present invention may be formed in horizontal molds at any convenient site remote from the construction area with any variations in the configuration of the wall sections being easily accomplished without the labor involved in building individual forms for various configurations of wall sections on the job site. The choice of concrete formula may also be varied as desired according to practices well-known in the structural concrete art. After the concrete slabs or wall sections 1 are cast and allowed to completely set, they are removed and transported to be ready for erection at the construction site.

The end faces of the abutting wall sections 1 are generally planar with chamfered edges 8 and 9 being pro-
vided at the front and rear sides respectively as shown in detail in FIG. 2. Each end face of the abutting wall sections will also include a groove 10 extending parallel to the rear face 4 of the wall section along substantially the entire height of wall 2. When identical wall sections 1 are in abutting relation as illustrated in FIG. 2, matching grooves 10 provide a channel for the reception of a sealing member 11 which may be in the form of a continuous circular hose or any other desired configuration. The purpose of the sealing member 11 is to prevent the earth fill on the back side of the retaining walls from sifting between the abutting wall sections. It will be noted that the walls sections 1 in practice, are usually spaced a fraction of an inch apart to form a break joint or an expansion joint between the concrete slabs. It has been found that a hose, such as the member 11, made of well-known polyvinyl chloride material provides an excellent seal to accommodate the function of the break joint and to provide a seal against the earth fill. It will be understood that any desired configuration of sealing member 11 and retaining means therefor may be utilized without departing from the scope of the present invention.

At the time of casting the wall sections 1, a plurality of reinforcing steel rods 12 are suspended in the concrete forms so as to be imbedded at the proper position in the body of the finished wall section. The reinforcing rods 12 are the preferred embodiment in FIG. 1 preferably extend the full height of the wall closely adjacent the back edge. The number and size of the reinforcing rods 12 will vary according to engineering design in each individual case. As illustrated in FIG. 1, the case of the cantilevered wall section, the protruding reinforcing rods 12 include forwardly extending portions 13. The portions 13 extend at approximately 90 degrees to the face 3 of the wall and a substantial distance therefrom. The protruding portions of the reinforcing rods 12 are ultimately imbedded in the cast-in-situ concrete footing in a manner presently to be described. The location of the reinforcing rods 12 within the body of the section 1 may vary within certain limits but the rods should be so placed as to be in tension when the back side of the wall is loaded with fill. Thus, since the wall sections tend to pivot about its front bottom edge when loaded by back fill, the steel rods 12 are located closely adjacent the backside of the wall and will resist overturning of the wall section in tension. It will also be noted that the portion 13 of the reinforcing rod may extend in the opposite direction from that shown since the rod 12 would remain in tension when the wall is loaded.

At the time of casting the wall sections 1, recesses 14 and 15 are formed in the bottom edge, with the recesses being rectangular in cross section and extending completely through the body of the wall section. Although only two recesses are illustrated in FIG. 1, it will be understood that any number of recesses may be formed to provide for the reception of support beams such as the I-beams 16 illustrated in the drawing. It has been found preferable, however, to utilize only two beams and to increase the size and capacity of the beams when working with larger wall sections since it is extremely difficult to get the proper adjustment of the wall when the load is shared by more than two beams. In any event, at least two such beams 16 should be utilized to provide two point support of the wall section and to allow for proper positioning of the section in a manner presently to be described.

To complete the structure of the wall sections, a plurality of angle iron brackets or the like 17 are secured to the top edge 6 of the section by means of bolts or the like, not shown, which are imbedded in the body of the concrete at the time the wall section is formed. A plurality of similar angle brackets 18 will also be securely affixed to the back side 4 of the wall section in the same manner as the bracket 17 with both sets of brackets being utilized for erecting, handling, and stabilizing the wall sections during transport and erection as will be described. The brackets 17 and 18 may be removed once the wall sections are erected and fixed in their final position.

Referring to FIG. 1, the beams 16, which support the wall sections in position during the pouring of the concrete footing, are in turn supported on parallel longitudinal beams 19 which may comprise the forms for pouring the footing 2. The beams 16 may be held in their adjusted position on the beams 19 by means of shims or wedge blocks 19a, the number of which may vary according to the adjustment of the beams 16. The precast walls 1 are additionally held in position during the pouring of the footing by means of adjustable braces 20 which are pivotally connected to the brackets 18 on the back side of the wall and to suitable clevice brackets 21 secured to the ends of the I-beams 16. The brackets 21 may be removable attached to the I-beams by means of bolts 22 and the length of the braces 20 is adjustable by means of turn buckles 23 in a well known manner. With this arrangement, the wall sections 1 may be adjusted for elevation by means of the wedge blocks 19a and vertically aligned by adjustment of the turn buckles 23.

The sub-grade for the cast-in-situ footing 2 may be prepared in any well-known fashion and in some cases provided with a plurality of pilings or the like 24 to provide the necessary support for the footing and the wall section 1. The footing 2 is poured after the wall sections 1 are erected and properly positioned as described, with the footing extending up a slight distance above the bottom face 5 of the wall sections to insure full face contact between the bottom of the sections and the surface of the footing 2. The footing concrete should be introduced on the front side of the wall to create a flow rearwardly in such a manner that voids are eliminated near the front bottom edge of the wall, since the wall, under loading on the back side, tends to pivot about the front bottom edge. In practice, it has been found desirable to raise the level of the footing approximately 1 inch above the bottom face 5 of the wall sections. It will be noted that at this level, the top of the footing is well below the bottom of the I-beam 16 so as to allow the I-beams to be removed once the footing 2 has set about the bent portion 13 of the reinforcing rods and the base of the wall. In most instances, it has been found advisable to include a shrinkage reducing agent entrained as commercially available "Plastiment" or equivalent material in the concrete formula for the footings to reduce the shrinkage factor and insure positive vertical support for the walls. The amount of shrinkage reducing agent used may be determined in each individual case or may even be omitted in some cases as long as the amount of shrinkage is negligible. It will also be understood that the body of the footing 2 may contain any desired quantity or any arrangement of reinforcing material such as steel rods, wire grating or the like.

Referring to FIG. 7, an alternate form of retaining wall structure is illustrated. The type of wall illustrated in FIG. 7 is termed an "L" wall because of its cross sectional configuration. The wall of the alternative form comprises the same basic structural elements as that illustrated in FIG. 1, with the exception that section 25 constituting a precast concrete slab and the footing portion constituting a cast-in-situ concrete footing which extends a slight distance above the bottom face of the wall section 25. It will be understood that the details of the wall structure 25 are identical to that described for the wall section 1 including the provision of a sealing member such as the member 11 shown in FIG. 1, and the prescribed break joint or expansion joint between the abutting wall sections. In the alternative form in FIG. 7, the face side of the wall section 25 is indicated at 27 with the
opposite side being the back side or earth fill side of the wall.

A different arrangement of reinforcing rod members and placement of the wall sections on the cast-in-situ footings is utilized in the alternate embodiment to achieve substantially the same results as those achieved in the preferred embodiment. It will be understood, however, that the method for erecting and aligning the wall sections is identical to that described thus far in connection with the preferred embodiment. A plurality of reinforcing rod members 28, having right angle protruding portions 29, at the body of the wall sections 25 at the time of casting the walls and prior to erection. The protruding portions 29 of the rods extend at right angles with relation to the face 27 and in a rearward direction, opposite to that described with relation to FIG. 1. The wall sections 25 are placed closely adjacent the front edge of the footing 26 and it will be noted that the reinforcing rods 28 lie closely adjacent the back face of the wall section to resist overturning of the wall in tension in the same manner described for the preferred embodiment of FIG. 1. In this manner, the protruding portions 29 of the reinforcing rods extend rearwardly into the body of the footing 26, with a large portion of the back fill material bearing upon the top surface of the footing.

To enable a complete understanding of the method of the present invention, the method steps involved in erecting a single wall section will now be described with the steps being equally applicable to any configuration of wall section. The concrete slabs which comprise the retaining wall sections are prepared in finished form by precasting face down on a bed or form either on or off the construction site. The prepared wall sections will include the recessed areas 14 and 15, the reinforcing steel members and that portion of the form with the only necessary form being that of providing sufficient support for the I-beams 16 which are to support the wall sections until the footing has set. After the beams 19 are properly placed, the I-beams are properly located on top of the beams 19 in position to receive one of the wall sections.

The precast wall sections are hoisted and set in erected position by means of the brackets 17 and 18, with the beams 16 being received within the recesses 14 and 15 of the wall section. Prior to the placing of any particular wall section, a sealing member 11 will be placed in the groove 10 of the precasting wall section and temporarily held in position by means of a suitable adhesive. Once the abutting sections are in place, the sealing member 11 will be held in place by the matching grooves in the sections. The wall section being erected is placed in alignment with the abutting wall section at the time of erection and the adjustable bolts 20 are then installed between the brackets 18 on the back side of the wall and the brackets 21 attached to the ends of the beam 16. The wall section may then be adjusted by the turn buckles 23 to the desired vertical position.

After the wall sections have been properly placed and connected by means of the braces 18, as shown in FIG. 4, suitable jacks 30 are placed beneath each end of each beam 16 and the wall section is raised to the proper elevation for the finished wall. Once the beams have been raised, shims or wedge blocks 19a are driven between the beams 16 and the support beams 19 to positively hold the wall section in its final position. The jacks 29 may then be removed and utilized in erecting other wall sections. The footing 2 is then poured, preferably by chiseling some of the concrete between the ends of the beams 15. The beams 17 are then removed from the recesses 14 and 15 with the wall sections being entirely supported by the footing. The wall section then appears according to FIG. 3 with the forms or beams 19 having been removed and the brackets 17 and 18 stripped from the wall section. The recesses 14 and 15 may be either plugged with cement or allowed to remain open to provide drainage for the back fill indicated at 31 in FIG. 3. In the event that the road surface 32 is to lie a substantial distance above the recesses 14 and 15, additional drain holes, not shown, may be provided in the wall sections at the time they are cast.

It has been found that retaining walls having equal or greater strength capabilities as compared to cast-in-place retaining walls may be constructed according to the present invention. The present method eliminates the need for form materials and construction on the job site, resulting in a cleaner more efficient operation particularly when a project encompasses many phases such as utility, grading, paving, excavation, structures etc. The present invention also eliminates the need for splice bars between footing and wall as a result of inclusion of the complete reinforcing bar in the precast wall section, thus reducing the overall weight of reinforcing steel required. As an added advantage, according to the present invention, the reduction in time between excavation for footings and actual back filling, thus avoiding potential slides, and the cost of pumping to maintain the excavation free from water. It will therefore readily be apparent to those skilled in the art that the present invention provides novel and useful improvements in the construction and in the erection of retaining walls. It will be understood also that the arrangement and types of structural components utilized, as well as the method steps, may be subject to numerous modifications and variations well within the purview of this invention. The applicant herein intends only to be limited to a liberal interpretation of the specification and appended claims.

Having thus described the invention, what is claimed is new and desired to be secured by Letters Patent is:

1. A method of constructing a concrete retaining wall and footing comprising: precasting concrete wall sections with reinforcing rods imbedded therein and protruding a substantial distance from the bottom ends thereof at substantially right angles to the sections, providing a plurality of passages along the bottom edges of said wall sections, preparing a sub-grade to support said wall sections and footing, placing spaced apart parallel forms for casting said footing in situ with said forms being capable of supporting the weight of said wall sections, placing a plurality of cross members between said forms, placing said wall sections in upright end-to-end abutting relation on said cross members with said cross members being received in said passages, adjusting the position of said wall sections to final elevation and alignment, then casting the footing in situ about the bottom ends of said wall sections by introduction of concrete on the front side of the wall sections to surround said reinforcing rods and a portion of the bottom of said wall sections, and subsequently removing said cross members from said passages, thereby supporting said wall sections entirely on said footing.
2. A method of constructing a continuous concrete retaining wall and footing wherein said wall includes a plurality of abutting wall sections comprising; precasting individual wall sections including reinforcing rod members extending a substantial distance from the bottom thereof at substantially right angles to the sections, providing a plurality of spaced passages along the bottom edges of said sections, providing spaced apart forms for casting said footing in situ, supporting said sections in upright end-to-end abutting relation above said forms on cross members passing within said passages, adjusting the position of said wall sections to final elevation and alignment then casting the footing in situ about the bottom end of the wall sections to surround said reinforcing rods and a portion of the bottom of said sections, and subsequently removing said cross members from said passages.

3. A method of constructing a vertical retaining wall and footing comprising; precasting said wall to include reinforcing rods extending beyond the bottom edge thereof at an angle with said wall, providing passages along the bottom edge of said wall, providing forms for said footing, supporting said wall in upright position above said forms on cross members passing within said passages, adjusting said wall to final elevation and alignment then casting the footing in situ about the bottom end of said wall to surround said rods and a portion of the bottom of said wall, and subsequently removing said cross members when said footing has cured.

4. A method for erecting and supporting a precast retaining wall having reinforcing rod members extending beyond the bottom end thereof comprising; providing passages along the bottom edge of the wall, supporting said wall on a plurality of cross members above a footing form with said cross members being received in said passages, adjusting said wall to a final position, casting said footing in situ about the bottom end of said wall with clearance being provided between said cross members and the top of the footing, and removing said cross members after said footing cures.

5. The method according to claim 2 wherein said wall sections are adjusted to final elevation by independently adjusting the ends of said cross members, and said wall sections are adjusted to final alignment by attaching adjustable temporary braces between the back faces of said sections and said cross members.

6. A method of constructing a retaining wall and footing therefor comprising, precasting said wall to include reinforcing rods extending beyond the bottom edge thereof, providing spaced passages through the body of said wall along the bottom edge thereof, providing spaced apart forms for casting said footing in situ, supporting said wall in upright position above said forms on cross members extending through said passages, adjusting the wall to final position, then casting the footing in situ about the bottom end of said wall, and then removing said cross members after said footing cures.

References Cited by the Examiner

UNITED STATES PATENTS

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<tr>
<th>Number</th>
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<tr>
<td>815,687</td>
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<tr>
<td>1,356,319</td>
<td>10/20</td>
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<tr>
<td>1,416,510</td>
<td>6/22</td>
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<tr>
<td>1,746,566</td>
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<tr>
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FOREIGN PATENTS

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EARL J. WITMER, Primary Examiner.

JACOB SHAPIRO, Examiner.