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(54) IMPROVEMENTS IN OR RELATING TO BRIDGES AND LIKE STRUCTURES /

(71) I, HENRI VIDAL a French subject of 8 bis, Boulevard Maillot, 92 Neuilly, France do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates generally to bridges and abutments for use in conjunction therewith. More specifically, the invention relates to a bridge abutment in which the end of the bridge deck is directly supported by a mass of internally stabilized earth.

In the past, bridges spanning a distance between spaced apart bridge abutments have been constructed with load-bearing columns or generally vertical load-bearing walls which vertically support the weight of the bridge deck which extends between the spaced abutments. Typically, such abutments are fabricated from poured concrete and are supported by a suitable footer. Depending on soil characteristics and conditions, it is sometimes necessary to provide a plurality of generally vertical pilings which are driven into the ground to support the footers. Often, side walls or wing walls are provided for the bridge abutment and these walls are frequently fabricated from poured concrete.

The poured concrete method requires accurate placement and positioning of suitable forms to hold concrete while it cures and develops the necessary strength. Moreover, the poured concrete bridge abutments generally require a framework of reinforcing steel which must be assembled at the job site and properly positioned in the forms by workmen.

With abutments poured and cured, a bridge deck is placed spanning the distance between the spaced apart abutments. Concurrently or subsequently, an area defined between each abutment wall and the associated wing walls is filled with earth or other

suitable aggregate and compacted to provide an approach to the bridge deck which conforms with the elevation existing at the end thereof.

There are other common bridge abutment constructions that utilize a combination of steel pilings and concrete. These structures are complex and difficult to construct. Consequently, they are expensive.

Another design aspect relates to the physical dimensions of some bridge abutments. As the abutments become wider, it becomes necessary to form the bridge abutments in piecewise fashion to accommodate differential thermal expansion thereby introducing substantial time delays and substantially increasing the construction expense. Moreover, wide abutments are more susceptible to differential settling of horizontally spaced portions which settling may induce formation of cracks and other structural anomalies.

It is well known that the excavation and site preparation for a bridge abutment are both expensive and time consuming. In view of the above discussion, it should be apparent that the construction of footers and load-bearing walls is both very expensive and very time consuming.

It is a general object of the present invention to overcome disadvantages of existing construction methods such as those generally discussed above.

It is a more specific object of the present invention to provide a bridge abutment construction which requires less time to build, and which is less expensive to build than the conventional concrete structure.

According to the invention there is provided an abutment for supporting one end of a beam-like structure of a bridge, comprising a generally vertical column of particulate material confined within a plurality of vertical external walls, each wall being fashioned from a plurality of facing ele-

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ments to substantially each of which is attached at least one elongate rectilinear substantially horizontal reinforcing member, said reinforcing members being embedded in the particulate material so as to perform a stabilizing function, the upper surface of said column fully supporting a rigid bearing member providing a beam seat adapted to receive the end of the structure.

10 Preferably said external walls comprise an anterior wall having generally vertical spaced apart side edges, and a pair of side walls disposed adjacent the respective side edges of the anterior wall, said beam seat being spaced from the anterior wall and side walls. In this case it is preferably provided that the pair of side walls are generally parallel and at least a portion of the elongate reinforcing members that are attached to one of said side walls are also attached to the other of said side walls to define a plurality of substantially continuous members extending between said side walls.

At the intersecting edges of the walls suitable corner blocks may be provided which have elongate reinforcing members attached thereto and dowel pins for vertical alignment therebetween. The elongate reinforcing members supporting the corner blocks are preferably disposed in one of the generally horizontal layers.

The contiguous aggregate of particulate material is provided with a top surface adjacent the upper edge of the interior wall. On the top surface of the particulate material a suitable pillow block may be provided for direct support of an end of the bridge deck.

A preferred embodiment of the invention is illustrated in the accompanying drawings wherein like reference numerals have been applied to like elements and wherein:

FIGURE 1 is a perspective view of a bridge constructed in accordance with the present invention with the bridge deck shown in phantom lines for the sake of clarity;

FIGURE 2 is a partial elevational view of the bridge showing an anterior wall of one of the abutments and having a portion broken away to illustrate the vertical spacing of reinforcing elements connected to facing elements;

FIGURE 3 is a partial elevational view of the bridge showing a side wall of the bridge abutment and having a portion partially broken away to illustrate the manner in which a bridge deck is supported;

FIGURE 4 is a cross-sectional view of the bridge abutment taken along line 4-4 of FIGURE 3 and illustrating a generally horizontal layer of reinforcing elements;

FIGURE 5 is a cross-sectional view of the bridge abutment similar to FIGURE 4, and illustrates the reinforcing element configuration for a relatively wide bridge abutment;

FIGURE 6 is a detailed cross-sectional view taken along line 6-6 of FIGURE 3 illustrating the relationship of a corner block with respect to the anterior wall and a side wall;

FIGURE 7 is a perspective view of a pair of aligned corner blocks showing a projecting dowel and a corresponding dowel-receiving aperture; and

FIGURE 8 is a partially exploded view illustrating the connection between reinforcing members.

Illustrated in FIGURE 1 is a bridge 10 comprising a deck 12 which is illustrated in phantom lines and which is supported at each end by an abutment 14, 16. As the abutments 14, 16 may be constructed in similar manner, the details of abutment 16 will be described with the understanding that abutment 14 is preferably provided with similar features. It will be apparent to those skilled in the art, however, that one abutment might be fabricated in accordance with conventional techniques without departing from the scope of this invention.

The abutment 16 includes an anterior wall 18 and a pair of wing walls, or side walls, 20, 22. The side walls 20, 22 in combination with the anterior wall 18 comprise a generally U-shaped structure having a space 23 defined thereby. Preferably, the side walls 20, 22 are parallel to one another and perpendicular to the anterior wall 18. Of course, in some situations, the side walls may be in the nature of wing walls that slope outwardly at an angle greater than 90° from the anterior wall.

Turning now to FIGURE 2, the anterior wall 18 is provided with one or more generally horizontal leveling pads 24 which serve the purpose of providing a level surface for construction of the wall 18. It should be noted that while the leveling pads 24 are generally horizontal in the illustration, the leveling pads may be inclined. Moreover, the leveling pads 24 are distinguished from conventional footers in that their function is to provide a base surface on which a wall is constructed. Footers, on the other hand, must provide a base surface and also support the wall and the force loads it transmits thus requiring a larger, heavier member and more expensive construction.

The wall 18 is composed of a plurality of interior facing elements 26 and peripheral facing elements, 26a 26b, 26c 26d, 26e, 26f. The interior facing elements 26 and the peripheral facing elements are arranged in columns which are generally perpendicular to the leveling pads 24 and which are offset relative to one another such that each interior facing element 26 is contiguously adjacent to six other facing elements.

Preferably, each facing element is precast concrete. Moreover, it is preferred that each

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interior facing element 26 conforms to the configuration described in detail by U.S. Patent No. 3,686,873 which is expressly incorporated herein by reference thereto. Similarly, it is preferred that the peripheral facing blocks 26a, 26b, 26c, 26d, 26e, 26f be formed by dividing an interior facing block 26 in half either vertically or horizontally, as required. Conveniently, these peripheral blocks may be formed by walling off a particular part of the form used to cast the interior elements 26.

Where leveling pads 24 underlie portions of the anterior wall 18 at different elevations such as where the original ground surface is not level, the elevation between the adjacent leveling pads 24 is preferably selected to be one half the height of the typical interior facing element 26. In this manner, modular interior facing elements may be used and the required number of special and odd-sized peripheral facing elements is reduced.

As described in U.S. Patent No. 3,686,873, each interior facing element 26 is provided with means for connection with six adjacent facing elements. In the preferred embodiment, this connection is effected by pins received by cylindrical apertures in the elements and interfitting flanges on the edges of the elements. Preferably, each facing element is also provided with one or more integrally cast lugs extending generally perpendicularly from a rear surface thereof to which elongate reinforcing members are attached. In the preferred embodiment, each facing element includes four or more lugs to which elongate reinforcing elements 28 are attached. The reinforcing elements 28 extend laterally in a direction opposite from the exterior face of the corresponding facing element and inwardly toward the area defined by the U-shaped structure.

In a completed structure the reinforcing members attached to the facing elements in combination with the pins connecting adjacent facing elements hold the facing elements vertical. The facing elements themselves support the weight of each other.

Turning now to FIGURE 3, details of the side wall 20 are illustrated which disclose that it is constructed from a plurality of facing elements 26 that are substantially the same as the elements comprising the anterior wall 18. As in the case of the anterior wall 18, the side wall 20 is provided with a leveling pad 29 and may include vertically spaced leveling pads 30, 32, 34, 36 that each partially underlie a corresponding portion of the wall. The vertically spaced leveling pads may have lengths approximately equal to an integral number times the width of a facing element 26. In addition, the piecewise arranged footers reduce the required number of facing elements by allowing the face

of the wall to conform generally with existing ground surface slopes.

Peripheral facing elements 26b, 26c, 26d, and 26g are provided to obtain edges with proper orientation and elevation. These peripheral facing elements are fabricated as discussed above in connection with the anterior wall means 18.

As the wall 22 is constructed in a manner similar to the construction of wall 20, the details thereof will not be repeated with the understanding that wall 20 and wall 22 need not be geometrically congruent or geometrically similar.

Turning now to FIGURE 4, a generally horizontal layer 38 is comprised of the elongate reinforcing members connected to each facing element 26. The elongate reinforcing elements 28 are connected to lugs of facing elements of the anterior wall 18 and extend inwardly to a free end 40.

Elongate reinforcing elements 42 extend inwardly from the facing elements of the side wall 20 and may be endwise connected to the elongate reinforcing elements 44 which extend inwardly from the facing elements of the wall 22, as illustrated. It will be noted that the elongate reinforcing elements 28, 42, 44 overlap one another in generally perpendicular fashion to define a generally horizontal lattice 45 in the layer 38.

With reference to FIGURE 8, it will be apparent that the connection between the reinforcing member 42 and the reinforcing member 44 may be effected by suitable threaded connectors such as the illustrated bolts 46 and nuts 48. By connecting the elongate reinforcing members 42, 44 from the facing elements of the pair of side walls 20, 22, a substantially continuous reinforcing member is provided between the side walls 20, 22.

Returning to FIGURE 4, a portion of the elongate reinforcing members 50 which project inwardly from side wall 22 are not connected with corresponding elongate reinforcing members from side wall 20. This illustrates an embodiment in which the side wall 20 is either shorter than or higher than the corresponding portion of side wall 22.

In FIGURE 5, the side walls 20, 22 are spaced further apart than in the embodiment illustrated in FIGURE 4. Accordingly, some reinforcing elements 51 are not overlapped by the reinforcing members 42, 44 extending from the sides 20, 22. Thus, two generally horizontal lattices 53, 55 are defined in each layer 38 with each lattice being adjacent a corresponding corner of the abutment 16.

Disposed at the adjacent vertical edges of the anterior wall 18 and the side walls 20, 22 is a column 52, 54 (see FIGURE 2) comprised of a plurality of corner blocks 56. As best shown by FIGURE 6, each corner block 56

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is provided with suitable notches 60, 62 that are adapted to receive adjacent edge portions of facing elements 26 such that the corner block 56 is in partially overlapping relationship therewith.

Moreover, each corner block 56 is provided with at least one lug 59 to which an elongate reinforcing member 58 is attached such that it is generally positioned in the plane of a lattice 38 (see FIGURE 4). It will be noted that the elongate reinforcing member 58 from each corner block 56 extends inwardly with respect to the side walls 20, 22 and the anterior wall 18 and may overlie the lattice 38 at a corresponding elevation in the structure. It may be noted here that while the various reinforcing members overlap, there is no physical connection therebetween.

Depicted in FIGURE 7 are two corner blocks 56a, 56b with corresponding portions having the same reference numeral but designated with suffixes *a* and *b*, respectively. Each block is provided with a dowel 61 extending from one end with a dowel receiving aperture 63 in the other end. As the column of corner blocks is constructed, the dowel 61a is received by the aperture 63b to align adjacent blocks and to prevent lateral movement therebetween.

Two lugs 59a and 59b are provided on each corner block 56 for attachment to reinforcing members 58. Preferably, the lugs are provided at opposite ends of a single U-shaped bracket which is precast in the block 56.

Returning now to FIGURE 2, the elongate reinforcing members from the multiplicity of facing elements define vertically spaced layers 38. While the layers 38 need not be uniformly spaced, it is preferred that uniform spacing be provided such that the layers are spaced to maximize the vertical extend of fill layers 64.

To properly appreciate the present invention it will be informative to describe the manner in which an abutment is constructed before proceeding to the manner in which the bridge deck means may be supported by the abutment. Accordingly, it may be noted from FIGURE 2 that a fill layer 64 is interposed between each generally horizontal layer 38 of the vertically spaced array of reinforcing elements.

During construction, the three walls, 18, 20, 22 are built in generally horizontal rows of facing elements. More specifically, a first course of facing members is erected. Subsequently a first fill layer 64 is placed and compacted. Next, a first layer 38 of reinforcing members 28, 42, 44, 50, 51, 58 is positioned and attached to the facing elements. Then a second fill layer is placed and compacted and a second layer of reinforcing members is positioned and attached. Second and subse-

quent courses of facing elements are erected as needed.

The space between the walls 18, 20, 22 is thus filled with layers of reinforcing elements and fill layers 64 of particulate material until another row of elements need to be placed. In this manner, a contiguous aggregate of particulate material is formed which substantially fills the interstices between the reinforcing elements 28, 42, 44 and 58.

When the anterior wall 18 has reached the desired height, the particulate material is provided with a surface 66 (see FIGURE 3) which is adjacent the top edge 68 of the anterior wall 18.

With the elongate reinforcing elements and the compacted earth positioned as described, a suitable beam seat 70, which may be fabricated as a monolithic piece of precast concrete, is rested in position on the surface 66 such that a space 72 is provided between the beam seat 70 and adjacent portions of the anterior wall 18, the corner blocks 56 and the side walls 20, 22. With the bearing seat 70 positioned, the remaining portions of the side walls 20, 22 which extend vertically upwardly above the top edge 78 of the anterior wall may be completed in the manner described above.

In cross section, the beam seat 70 is provided with a generally vertical portion 74 which functions in part as a retaining wall for particulate material adjacent thereto. The vertical portion 74 has a horizontal shoulder 76 on which conventional bearing blocks (not shown) or roller supports 75 are disposed to support an end 78 of each beam 79 (see FIGURE 2) of the bridge deck means 12. A space 80 is provided between the beam end 78 and the vertically upstanding portions 74. The bridge deck means 12 may be designed in any conventional manner.

Since the beam seat 70 is supported directly by the surface 66 of a column of internally stabilized earth which is circumscribed in part by the walls 18, 20, 22, the beam seat 70 need not overlap the top edges of the walls 18, 20, 22. In accordance with the present invention this part of a design is dictated by architectural considerations as distinguished from structural considerations. Accordingly, it will be noted that the walls 18, 20, 22 are non-load bearing in the sense that they support only their own weight and not the bridge deck means.

It should be noted that the particulate material which is used to fill the area between the walls 18, 20, 22 may be naturally occurring material such as sand, stone, earth, or other similar aggregate. Moreover, it is also possible to use such materials as crushed stone and other processed materials which are either non-naturally occurring or processed in some suitable manner.

It should now be apparent that there has been provided in accordance with the present invention a generally vertical mass of internally stabilized earth on which the bridge deck is directly supported such that the walls 18, 20, 22 defining the column of reinforced earth are non-load bearing.

It will, moreover, be apparent to those skilled in the art that many modifications, variations, substitutions and equivalents may be used in lieu of the elements described. It is therefore expressly intended that all such modifications, variations, substitutions and equivalents which lie within the scope of the invention as represented by the appended claims be encompassed thereby.

WHAT I CLAIM IS:-

1. An abutment for supporting one end of a beam-like structure of a bridge, comprising a generally vertical column of particulate material confined within a plurality of vertical external walls, each wall being fashioned from a plurality of facing elements to substantially each of which is attached at least one elongate rectilinear substantially horizontal reinforcing member, said reinforcing members being embedded in the particulate material so as to perform a stabilizing function, the upper surface of said column fully supporting a rigid bearing member providing a beam seat adapted to receive the end of the structure.

2. An abutment according to claim 1, wherein said external walls comprise an anterior wall having generally vertical spaced apart side edges, and a pair of side walls disposed adjacent the respective side edges of the interior wall, said beam seat being spaced from the anterior wall and side walls.

3. An abutment according to claim 2, wherein the pair of side walls are generally parallel and at least a portion of the elongate reinforcing members that are attached to one of said side walls are also attached to the other of said side walls to define a plurality of substantially continuous members extending between said side walls.

4. An abutment according to claim 2 or 3, wherein a plurality of corner blocks are

disposed in a vertical pillar overlapping a side edge of the anterior wall and an adjacent portion of a side wall, each corner block having a reinforcing member attached thereto and embedded in the particulate material.

5. An abutment according to claim 4, wherein each corner block includes a dowel pin extending from one end and a dowel-receiving aperture in the second end, the dowel-receiving aperture being operable to receive a dowel pin of an adjacent block thereby aligning each corner with an adjacent corner block.

6. An abutment according to any of claims 1 to 5, wherein each facing element is fabricated from concrete, the anterior wall and each side wall include peripheral facing elements and interior facing elements, and each interior facing element includes means adaptable for connection with six adjacent facing elements.

7. An abutment according to any of claims 1 to 6, wherein the beam seat is a monolithic concrete member.

8. An abutment according to claim 7, wherein the beam seat has a cross-sectional configuration with a generally horizontal portion, a generally vertical portion and a generally horizontal shoulder, and the column of particulate material extends above the horizontal portion of the beam seat such that the vertical portion of the beam seat functions in part as a retaining wall.

9. An abutment according to any of claims 1 to 8, wherein the particulate material comprises naturally occurring material such as stone, sand, earth and the like.

10. An abutment for supporting one end of a beam-like structure of a bridge, substantially as hereinbefore described with reference to the accompanying drawings.

11. A bridge including an abutment according to any of the preceding claims.

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