

METHOD OF CONSTRUCTING AN ELEVATED ROADWAY

The present invention relates to a method of constructing an elevated roadway. A roadway in this specification means a highway or other paved surface (e.g. a runway).

Conventional methods for constructing a roadway involve the excavation of large volumes of material, so that a complicated system of supporting strata can be laid and compacted beneath the paved surface, to provide a sufficiently stable foundation.

In regions where the ground is soft, even greater volumes of material must be removed, and replaced by foundation material. To ensure that settlement of the eventual paved surface is not excessive, extensive soil investigations are required before work can proceed.

Where it is necessary to raise the level of the roadway, this has previously been achieved by compacting earth fill or by constructing a multi-span bridge structure onto which was laid a road surface. A common problem with earth filled embankments is to find a suitable source of earth. Often the earth must be transported a considerable distance to the required site. The cost of construction is therefore very high. In addition, the earth fill method requires the imported earth to be properly compacted to the required level and this normally takes a considerable time. Since the compaction procedure requires the compaction of many individual layers of fill. A further complication is the need to provide culverts to maintain the natural water flow underneath the embankment. Despite these many disadvantages the earth fill method of embankment construction is the most common, since the "bridge" type method of embankment construction is even more expensive.

According to the present invention there is provided a method of constructing an elevated roadway

comprising placing piles in the ground so that the upper ends of the piles are substantially at ground level, and supporting preformed slabs on the piles by means of an elevating structure formed from preformed elements having a channel-shaped cross-section, the elevating structure being supported by the upper ends of the piles.

Preferably pile caps are installed on the piles, the performed structural elements being supported on the pile caps. The pile caps may comprise beams which extend across a plurality of the piles.

The preformed slabs, pile caps and preformed structural elements may be made from precast concrete and may be reinforced. They may also be prestressed. A large supply of slabs or elements can be assembled on site before work begins, and so considerable time can be saved during construction, since the amount of in situ casting may be substantially reduced or eliminated.

In addition, extensive soil investigations are not necessary to ensure that the settlement of the paved surface will be within acceptable limits, since the piles may be arranged to transfer load over a greater depth than known paving methods. The use of a Mackintosh probe to determine the soil conditions has been found sufficient. The length and spacing of the piles can be adjusted to suit the particular strata encountered, to ensure that the load is transferred to stronger deeper lying strata, and to minimise differential settlement.

It is also possible to create a roadway with a smooth gradually changing gradient using flat slabs, provided that the slabs are short in length. If necessary, curved slabs could be used to enhance the ride quality.

The amount of excavation required using a piled

foundation system is greatly reduced and backfill does not require the same degree of compaction. The cost of construction is therefore further reduced, as is the likelihood of work being suspended due to adverse weather conditions.

Each preformed structural element preferably extends between adjacent piles in the lengthwise direction of the roadway. The preformed structural elements are channel shaped and may for example, comprise a web provided with flanges which project laterally from the web. The flanges preferably extend from opposite edges of the web and are directed to the same side of the web.

In a preferred embodiment the flanges diverge in the direction away from the web so that the preformed structural elements comprise substantially V-shaped channels which are laid with their longitudinal axes extending transversely of the longitudinal centreline of the embankment or raised roadway. The V-shaped elements are preferably laid inverted, and are supported at the end of each flange or leg on a separate pile cap. Preferably, each pile cap supports respective legs of two adjacent V-shaped elements placed side by side.

Since the span between supports is kept short, the piles, pile cap beams, structural elements and slabs are all easily manageable and transportable and, since these elements are all precast, construction can be made a continuous process which does not suffer from delays whilst large volumes of newly cast concrete cure on site. The overall speed of construction is therefore greater than by a conventional system.

A further advantage of using precast elements and slabs is that quality control at the casting and curing stages is extremely good, whilst the unit cost of the precast elements and slabs is kept low. The high

quality and dimensional accuracy of the precast elements and slabs makes assembly of the roadway and the laying of asphaltic road surfacing easier, and hence improves the ride quality of the finished

5 roadway.

Construction using preformed elements avoids the problems of obtaining, transporting and compacting fill as described above and also eliminates the settlement problems normally encountered in earth fill

10 embankments. In addition, the requirement for providing culverts is effectively eliminated since water can pass freely through the hollow channels of the precast element. Indeed, the natural flow of surface water present before construction, is hardly
15 effected by an embankment or raised roadway according to the present invention.

The environmental advantages of using precast elements to form a raised roadway are significant when compared to the traditional earth fill method,
20 particularly since a far narrower area of land is required to construct an embankment in this way. The overall width of the embankment is also no greater than if a bridge type method is used.

The height of the raised roadway above the ground
25 may be increased by stacking a plurality of rows of preformed structural elements one above the other. In addition, the raised roadway may be provided with a predetermined gradient by successively varying the size of adjacent preformed structural elements.

30 For a better understanding of the present invention, and to show how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a perspective view of an elevated
35 roadway;

Figure 2 is a section through the elevated

roadway;

Figure 3 is a plan view of the elevated roadway;

Figure 4 shows the layout of piles beneath a pile cap beam;

5 Figure 5 is an enlarged fragmentary view of the pile cap beam;

Figure 6 shows the pile cap beam positioned over the piles;

10 Figure 7 shows a V-shaped precast concrete element;

Figure 8 shows the joint detail between two adjacent V-shaped reinforced concrete elements and a pile cap; and

15 Figure 9 shows how the V-shaped precast concrete elements may be stacked.

Referring to Figures 1 to 3, a roadway 2 comprises precast reinforced concrete slabs 4 supported on preformed elements 5 which are themselves supported on precast reinforced concrete pile cap beams 6. The pile cap beams 6 are connected to the tops of precast reinforced concrete piles 8 driven into the ground 6 by means of a conventional jack-in piling system. An asphaltic layer 10 is laid over the slabs 4 by a known process and provides a smooth continuous road surface.

25 Figure 4 shows the distribution of piles 8 beneath a pile cap beam 6. In the embodiment shown, piles 8 are disposed in pairs at equal intervals along the length of the pile cap beam 6.

30 As shown in Figure 5, the pile cap beam 6 is provided with openings 32 when it is cast. The size and spacing of the openings 32 corresponds to the size and spacing of the piles 8, so that the pile cap beams 6 fit freely over exposed ends 44 of the piles 8. Figure 6 shows a pile cap beam 6 in place over a pair of piles 8. After positioning the pile cap beam 6 over
35 the piles 8, concrete is poured into the openings 32

and is compacted by vibration.

The pile cap beam 6 may be set at ground level or a trench may be excavated and the pile cap beam 6 set in the trench. Where back filling is necessary, the back-fill does not have to be compacted as much as in conventional roadway construction.

Where the loading on the roadway will be very large and where it is desirable for the slabs 4, preformed elements 5 and beams 6 to be slender they may be made from prestressed concrete.

Figure 7 shows an enlarged sectioned view of the preformed element. The preformed element comprises a substantially V-shaped inverted channel 5 precast in reinforced concrete. The V-shaped channel or element 5 comprises a web 12 and two flanges 14 which project from either end of the web 12 at approximately 45°. The V-shaped element 5 is reinforced or prestressed by conventional methods according to its design loading. During casting of the V-shaped elements 5 additional steel reinforcement bars 16, 18 are cast into the web 12 and the ends of the flanges 14 furthest from the web 12. The reinforcement bars 16, 18 project outwardly from the V-shaped element 5. Typically, the V-shaped element will be 2 to 4 metres high and 2.5 to 3.5 metres wide, and the flanges 14 will be approximately 0.25m thick.

Figure 8 shows how the reinforcement bars 18, projecting from flanges 14 of adjacent V-shaped elements 5a, 5b, cooperate with a pile cap beam 6. Each pile cap beam 6 is provided with anchoring reinforcement 20 which is embedded in, and projects from, the central portion of the top surface of the pile cap beam 6. A respective flange 14 of adjacent V-shaped elements 5a, 5b rests on either side of the anchoring reinforcement 20 on the top surface of the pile cap beam 6, so that the projecting reinforcement

bars 18 in the foot of a flange 14 of the first V-shaped element 5a cooperates with the reinforcement bars 18 in the foot of the flange 14 of an adjacent V-shaped element 5b, and also with the anchoring
5 reinforcement 20 which projects from the pile cap beam 6. The cooperating and interlocking reinforcement 18, 20 is bonded together by a reinforced concrete joint 22 which is cast in situ. Thus, each pile cap beam 6 supports respective flanges 14 of adjacent V-shaped
10 elements 5a, 5b.

Slabs 4 are supported between two adjacent webs 12 of successive V-shaped elements 5a, 5b and are held in place by reinforced concrete joints 22 cast in situ around the reinforcement 16 projecting from the top of
15 each web 12.

Alternatively, a fixing nut may be cast into the top of the web 12 in place of the reinforcement 16. Laminated elastomeric bearing strips may be placed between the upper surface of the webs 12 and the lower
20 surface of the slabs 4 to ensure that the slabs 4 rest evenly on the webs 12 of the V-shaped elements 5. Bolts provided with washers pass through the slabs 4 and engage the fixing nuts in the webs 12, thereby securing the slabs 4 relative to the webs 12.

25 Once the slabs 4 are in place and have been properly aligned, the asphaltic concrete road surface
10 is laid on top of the slabs 4 in a known manner.

Where a greater elevation of the roadway is required a further row of V-shaped elements 15 may be
30 cast on to the webs 12 of the first row of V-shaped elements 5. A plurality of rows of V-shaped elements may be stacked one above the other in this manner to give the desired elevation, the number of rows being limited by the stability of the structure and by the
35 loads imposed on the lower V-shaped elements 5a, 5b.

Figure 9 shows two rows of V-shaped elements 5, 15

stacked one above the other. The joints between the V-shaped elements of the lower and upper rows are similar to those between the feet of the flanges 14 of the lower row of V-shaped elements 5 and the pile cap beam

- 5 6. An in situ joint 26 is cast between respective flanges 14 of adjacent V-shaped elements 15a, 15b in the upper row, over the reinforcement 16 projecting from the web 12 of the lower V-shaped element 5 and the reinforcement bars 18 projecting from the flanges 14 of
10 adjacent V-shaped elements 15a, 15b.

It should be noted that any combination of size, shape and distribution of piles, pile cap beams 6, preformed elements 5 and slabs 4 is contemplated, depending on the particular soil conditions encountered
15 and the type of roadway required.

A method of constructing a roadway is also described and claimed in our copending Application No. 68 94100724 (Serial No. 682211166).



CLAIMS

1. A method of constructing an elevated roadway comprising placing piles in the ground so that the upper ends of the piles are substantially at ground level, and supporting preformed slabs on the piles by means of an elevating structure formed from preformed structural elements having a channel-shaped cross-section, the elevating structure being supported by the upper ends of the piles.
2. A method as claimed in claim 1, in which pile caps are installed on the piles, the preformed structural elements being supported on the pile caps.
3. A method as claimed in claim 2, in which the pile caps comprise beams which extend across a plurality of the piles.
4. A method as claimed in claim 3, in which the pile cap beams extend transversely of the roadway.
5. A method as claimed in any one of the preceding claims, in which each slab is supported on respective preformed structural elements at opposite edges only of the slab.
6. A method as claimed in any one of the preceding claims, in which the piles are placed in the ground over their full length.
7. A method as claimed in any one of the preceding claims, in which the preformed structural elements provide an open work structure between the piles and the slabs.
8. A method as claimed in any one of the preceding claims, in which the preformed structural elements are arranged in rows which extend transversely of the longitudinal centreline of the roadway.
9. A method as claimed in any one of the preceding claims, in which each preformed structural element comprises a web provided with flanges which diverge from one another as they extend from the web.



10. A method as claimed in claim 9, in which the preformed structural elements are supported at the ends of the flanges furthest from the web.

11. A method as claimed in claim 9 or 10, when
5 appendant to claim 3, in which respective flanges of adjacent preformed structural elements are joined together and bonded to the pile cap beam by means of a cast in-situ concrete joint.

12. A method as claimed in any one of the
10 preceding claims, in which the preformed structural elements are stacked in rows one above the other.

13. A method as claimed in claim 12, when
15 appendant to claim 9, in which the web of a preformed structural element supports respective flanges of two adjacent preformed structural elements in the row above.

14. A method as claimed in claim 12 or 13, when
20 appendant to claim 9, in which successive rows of preformed structural elements are bonded together by means of concrete joints cast in-situ in the regions at which the webs of the preformed structural elements meet the flanges of respective preformed structural elements in the row above.

15. A method as claimed in any one of the
25 preceding claims, in which the preformed slabs are joined to the preformed structural elements by means of cast in-situ concrete joints.

16. A method as claimed in any one of the
30 preceding claims, in which the height of successive preformed structural elements, in the longitudinal direction of the roadway, is gradually varied to provide the finished roadway with a desired gradient.

17. A roadway constructed according to a method as claimed in any one of the preceding claims.

35 18. A method of constructing an elevated roadway substantially as described herein with reference to,

the accompanying drawings.

