

CONCRETE PILES

This invention relates to concrete piles and is particularly concerned with concrete piles of the kind that are driven and cast in situ.

It is common practice in many methods of installing concrete piles that are driven and cast in situ to form, at the lowermost end of the concrete pile during its installation, an enlarged or bulbous base which will serve to distribute any downwardly compressive load to which the pile will be subjected. It is also common practice when installing piles of this kind to drive a metal tube downwardly into the ground and, at some later stage during introduction into the tube of charges of wet concrete and compaction of the concrete, to withdraw the tube gradually upwardly. Installation methods employing a withdrawable tube have the serious disadvantage that large and heavy equipment is required to withdraw the tube while charges of wet concrete are being driven downwardly and, because such large and heavy equipment is required, such installation techniques cannot always be employed at sites where problems of access arise.

It is an object of the present invention to provide an improved method of installing a concrete pile of the kind which is driven and cast in situ, which method employs lighter equipment and is less expensive to carry out than methods of installation hitherto proposed and used.

According to the invention the method comprises the steps of driving a tube of metal or metal alloy closed at its lowermost end downwardly into the ground, the tube having in its circumferential wall over a part of its length close to but spaced from its lowermost end a plurality of circumferentially spaced holes; introducing at least one charge of wet concrete into the tube to a depth such that it substantially fills at least a substantial part of said perforated length of the tube and hammering downwardly on said charge or charges of wet concrete to force wet concrete radially outwardly through the holes in the circumferential wall of the tube to form a bulbous mass of concrete at a position close to but spaced from the lowermost end of the tube; introducing a plurality of charges of wet concrete into the tube and hammering downwardly on successive charges of concrete to compact the concrete; and, when the tube is substantially filled with compacted concrete, permitting the concrete to set.

Preferably, the circumferentially spaced holes in the perforated length of the tube are in the form of a plurality of circumferentially spaced slots extending lengthwise of the tube and preferably, also, the lowermost end of the hammer employed to hammer downwardly on the charge or charges of wet concrete filling the perforated length of the tube is so shaped as to force wet concrete radially outwardly through the circumferentially spaced slots or other holes. To this

end, preferably the lowermost end of the hammer used for this purpose is of a shape approximating to an inverted frustum of a cone.

Arranging for the circumferentially spaced holes in the perforated length of the tube to be circumferentially spaced slots extending lengthwise of the tube has the important advantage that, downward hammering of wet concrete may be effected with such force that, when wet concrete is forced radially outwardly, wet concrete also forces radially outwardly those parts of the tube extending lengthwise between the slots, thereby providing a firm anchorage for the tube in the ground. Furthermore, this particular arrangement offers good security against ground water problems.

The part of the tube between its closed lowermost end and the perforated length of the tube is preferably substantially filled with dry concrete prior to the introduction of the charge or charges of wet concrete. Preferably, the dry concrete is in the form of a precast concrete plug and the uppermost end part of the precast concrete plug may be of a shape approximating to a frustum of a cone or of other preformed shape which will serve to assist in forcing wet concrete radially outwardly through the circumferentially spaced slots or other holes when the wet concrete is hammered downwardly. Alternatively, a precast concrete plug in

the shape of a frustum of a cone separately formed with respect to the dry concrete may be introduced into the tube after the dry concrete has been introduced and prior to introduction of any charge of wet concrete.

- 5 Where a concrete pile that is to be driven and cast in situ is likely to be subjected to uplift loads, as may be the case where the pile is to form a part of the foundation of a tower of an overhead electric transmission line, preferably, prior to introduction of any charge of wet
- 10 concrete, at least one elongate reinforcing member is introduced into, and is arranged substantially centrally of, the tube and hammering of the charge or charges of wet concrete is effected by a hammer having a bore through which the or each reinforcing member will protrude during
- 15 the hammering operation. In this case, preferably, at least two elongate reinforcing members are introduced into the tube after the dry concrete has been introduced, the lowermost end of each reinforcing member is folded to form a transversely extending foot bearing against the upper end
- 20 of the dry concrete. Where a separately formed precast concrete frustum of a cone is employed it will be of tubular form and will be threaded onto the reinforcing members prior to introduction of any charge of wet concrete.

If desired, after formation of the bulbous mass of concrete and prior to the introduction of subsequent charges of wet concrete, at least one charge of dry concrete may be introduced into the tube to soak up any water that may have gathered at the upper end of the bulbous mass and to reduce the risk that any wet concrete may be forced upwardly between the hammer and the internal surface of the tube.

In certain soils it may be necessary to seal the holes in the tube temporarily to prevent water entering the tube while it is being driven. For this purpose, preferably, prior to driving the tube into the ground, a plate of metal or metal alloy is attached to the outer surface of the tube and over each hole, a sealing material, for example a mastic, being used to form a seal between each plate and the tube. When concrete is forced radially outwards through the holes, it displaces the sealing material and forces the plates radially outwardly. The plates are preferably attached to the outer surface of the tube by tack welding the upper and lower edge of each plate to the tube.

The invention is further illustrated by a description, by way of example, of the preferred method of installing a concrete pile that is driven and cast in situ with reference to the accompanying diagrammatic drawing which shows sectional side views of three stages of the concrete pile installation.

Referring to Figure 1, a steel tube 1, closed at its lowermost end 2 by a welded cap 3, is driven to depth in the ground G and a plug 4 of dry concrete is hammered downwardly by a hammer 5 into the lowermost end part of the tube. A length of the tube 1 immediately upwardly of the plug 4 has a plurality of circumferentially spaced slots 6 extending lengthwise of the tube.

As shown in Figure 2, two steel reinforcing rods 7, each folded at its lowermost end to form a transversely extending foot 8 and having, threaded on the rods, a separately formed precast tubular concrete plug 9 in the shape of a frustrum of a cone, are introduced into the tube 1 until the feet 8 bear against the upper end of the dry concrete plug 4. Charges 10 of wet concrete are then introduced into the tube 1 until the wet concrete fills the perforated length of the tube and the wet concrete is hammered downwardly by means of a tubular hammer 11 having at its lowermost end 12 a shape approximating to an inverted frustrum of a cone to force wet concrete radially outwardly through the circumferentially spaced slots 5 and to force radially outwardly those parts 14 (Figure 3) of the tube extending lengthwise between the slots thereby forming a bulbous mass 15 of concrete at a position close to but spaced from the lowermost end 2 of the tube and providing a firm anchorage for the tube in the ground G.

Figure 3 shows the stage at which wet concrete 10 shown in Figure 2 has been forced radially outwardly through the slots 6 to form the bulbous mass 15 of concrete and to distort radially outwardly those parts 14 of the tube 1 between the slots and at which the tube is ready for introduction and compaction by the hammer 5 of subsequent charges of wet concrete.

The improved method of the present invention has the additional important advantage that it gives to each concrete pile of substantially the same diameter at a lower part of the pile a bulbous mass of a predictable and repeatable shape.

CLAIMS:

1. A method of installing a concrete pile of the kind which is driven and cast in situ, which method comprises the steps of driving a tube of metal or metal alloy closed at its lowermost end downwardly into the
5 ground, the tube having in its circumferential wall over a part of its length close to but spaced from its lowermost end a plurality of circumferentially spaced holes; introducing at least one charge of wet concrete into the tube to a depth such that it substantially
10 fills at least a substantial part of said perforated length of the tube and hammering downwardly on said charge or charges of wet concrete to force wet concrete radially outwardly through the holes in the circumferential wall of the tube to form a bulbous mass
15 of concrete at a position close to but spaced from the lowermost end of the tube; introducing a plurality of charges of wet concrete into the tube and hammering downwardly on successive charges of concrete to compact the concrete; and, when the tube is substantially filled
20 with compacted concrete, permitting the concrete to set.

2. A method as claimed in Claim 1, wherein the circumferentially spaced holes in the perforated length of the tube are in the form of a plurality of
25 circumferentially spaced slots extending lengthwise of the tube.



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3. A method as claimed in Claim 2, wherein hammering downwardly on the charge or charges of wet concrete substantially filling at least a substantial part of said perforated length of the tube is effected with such force that, when wet concrete is forced radially outwardly, wet concrete also forces radially outwardly those parts of the tube extending lengthwise between the slots, thereby providing a firm anchorage for the tube in the ground.
4. A method as claimed in any one of the preceding Claims, wherein the lowermost end of the hammer employed to hammer downwardly on the charge or charges of wet concrete filling the perforated length of the tube is so shaped as to force wet concrete radially outwardly through the circumferentially spaced slots or other holes.
5. A method as claimed in Claim 4, wherein the lowermost end of the hammer is of a shape approximating to an inverted frustum of a cone.
6. A method as claimed in any one of the preceding Claims, wherein the part of the tube between its closed lowermost end and the perforated length of the tube is substantially filled with dry concrete prior to the introduction of the charge or charges of wet concrete.



7. A method as claimed in Claim 6, wherein the dry concrete is in the form of a precast concrete plug.
8. A method as claimed in Claim 7, wherein the uppermost end part of the precast concrete plug is of a shape approximating to a frustum of a cone or of other preformed shape which will serve to assist in forcing wet concrete radially outwardly through the circumferentially spaced slots or other holes when the wet concrete is hammered downwardly.
9. A method as claimed in Claim 6, wherein a precast concrete plug in the shape of a frustum of a cone separately formed with respect to the dry concrete is introduced into the tube after the dry concrete has been introduced and prior to introduction of any charge of wet concrete.
10. A method as claimed in any one of Claims 1 to 6, wherein, prior to introduction of any charge of wet concrete, at least one elongate reinforcing member is introduced into, and is arranged substantially centrally of, the tube and hammering of the charge or charges of wet concrete is effected by a hammer having a bore through which the or each reinforcing member will protrude during the hammering operation.



11. A method as claimed in Claim 6, wherein, prior to introduction of any charge of wet concrete, at least two elongate reinforcing members are introduced into the tube after the dry concrete has been introduced, the lowermost end of each reinforcing member being folded to form a transversely extending foot bearing against the upper end of the dry concrete.
12. A method as claimed in Claim 11, wherein, a precast concrete plug in the shape of a frustum of a cone separately formed with respect to the dry concrete and of tubular form is threaded onto the reinforcing members and introduced into the tube prior to introduction of any charge of wet concrete.
13. A method as claimed in any one of the preceding Claims, wherein, after formation of the bulbous mass of concrete and prior to the introduction of subsequent charges of wet concrete, at least one charge of dry concrete is introduced into the tube.
14. A method as claimed in any one of the preceding Claims, wherein, prior to driving the tube into the ground, a plate of metal or metal alloy is attached to the outer surface of the tube and over each hole, a sealing material being used to form a seal between each

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plate and the tube, and wherein wet concrete forced radially outwardly through the holes by downward hammering displaces the sealing material and forces the plates radially outwardly.

5 15. A method as claimed in Claim 14, wherein each plate is attached to the outer surface of the tube by tack welding its upper and lower edges to the tube.

16. A method of installing a concrete pile of the kind which is driven and cast in situ substantially as
10 hereinbefore described with reference to the accompanying diagrammatic drawing.

17. A concrete pile installed by the method claimed in any one of the preceding Claims.
