

A PRE-CAST CONCRETE PILE

This invention relates to a pre-cast concrete pile. The present invention further relates to a method for forming a pre-cast concrete pile.

Pre-cast concrete piles are conventionally formed with a steel reinforcement positioned within the concrete pile itself. The steel reinforcement can be prestressed so that the pile can resist tension stresses during handling and installation.

For hammer-driven piles, more steel reinforcement is generally required in order to offer resistance to dynamic loading exerted by the hammer when the pile is driven into the ground. This is particularly so at the head and steel stirrups all along the length of the pile.

Pre-cast concrete piles of this type have the disadvantage that cracking of the concrete can occur in parts of the pile spaced from the interior steel

reinforcement. Such cracking most severely occurs close to the exterior surface of the pile.

Steel reinforcement included in present piles intended to be driven into the ground by means of the "jack-in" system of installation (see co-pending British patent application No 8808988.3 in the name of the applicant) is provided to reinforce the pile against damage during handling rather than during installation. This is because during installation the direct axial load applied by jacking tends not to cause cracking in the pile.

It is an aim of the present invention to eliminate or at least alleviate the aforementioned problem of cracking during handling and installation of pre-cast piles.

According to the present invention there is provided a pre-cast concrete pile comprising a plurality of elongate metal members for extending along the longitudinal length of the pile, wherein the elongate metal members are connected together by a plurality of metal cross-bands spaced apart at different locations along the longitudinal length of the pile, which metal cross-bands are connected to the inside surface of the elongate metal members so that the cross-bands are at least partially embedded in the surface of the concrete

pile thereby establishing a bonding relationship with the concrete of the pile in order to offer resistance to bending stresses applied thereto.

In embodiments of the invention, the elongate metal members may be positioned so that their inner surface contacts the outer surface of the concrete, are partially embedded at the surface, or are embedded so that the outer surface of the members are flush with the surface of the concrete.

The elongate members preferably each consist of angled metal bars each for locating with the corner of the concrete in the case where the concrete has three or more straight and flat sides. In the case where the concrete has a triangular shaped cross-section, each of the elongate members is "V" shaped. In the case where the concrete has a square or a rectangular cross-section, the bars are "L" shaped. Alternatively, the elongate bars may be substantially flat and rectangular in cross-section for disposal along a curved side of the concrete.

The cross-bands are preferably in the form of steel bands. These bands may be welded or rivetted to the elongate members. The steel bands at the ends of the pile may be thicker than at other locations for enabling better jointing of one pile to another.

The metal bars of the elongate members are preferably of steel.

The reinforcement frame structure will naturally vary in size according to design requirements and the structural environment in which the pile is to be used. However, the frame may, for example, be from 2m to 6m in length, the cross-bands being at half metre intervals. The steel bars of the elongate members may be 3mm thick and 15mm to 30mm wide. The steel bands may each be 20mm wide. For a triangular shaped pile, the band may be such as to separate pairs of adjacent elongate metal members by about 177mm. A concrete pile reinforced with a reinforcement frame structure of these dimensions may be used for a 16 tonne capacity working load.

The width of the steel band may be varied between 20mm and 50mm, and the thickness of the band may vary between 2mm and 6mm depending upon design requirements. Use of the steel band has the advantage that it may be bent easily into the shape of the pile cross-section.

In preferred embodiments of the invention, the cross-bands are completely embedded rather than partially embedded within the concrete in order to prevent slipping.

According to the present invention, there is further provided a method of forming a pre-cast concrete pile comprising forming a frame structure corresponding to the dimensions of the pile to be cast by connecting together a plurality of metal elongate members of length corresponding to the longitudinal length of the pile with a plurality of metal cross-bands spaced along the length of the elongate members, the cross-bands being connected to the inner facing side of the elongate members, constructing formwork around the frame structure, and casting concrete within the formwork and the frame structure so that the cross-bands are at least partially embedded within the concrete thereby establishing a bonding relationship with the concrete of the pile.

The connecting of the cross-bands to the elongate members is preferably carried out by welding or rivetting.

The structure may be coated in a suitable rust resistant material.

Embodiments of the present invention have the advantage that they offer an economical method of providing reinforcement for pre-cast concrete piles while providing a high degree of resistance to bending forces

and tensile stresses owing to the location of the steel reinforcement around the exterior of the concrete pile. Since the steel reinforcement is designed to the limit of the "lever arm" calculation ("lever arm" being a structural engineering term used in calculation of the sectional area of reinforcement required to resist bending moment in a beam), the quantity of steel reinforcement needed to offer suitable resistance to tensile forces during handling and installation can be minimized.

This contrasts with conventional steel reinforced pre-cast concrete piles in which the steel reinforcement is located well below the surface of the pile. In such piles, the bending stresses are not arrested by the interior reinforcement until after some cracking has occurred towards the outer surface of the pile.

The elongate metal members establish some bonding relationship with the concrete and so offer some resistance to bending stresses. The steel bands serve to offer substantial resistance to bending stresses as they are at least partially embedded (preferably fully embedded) in the surface of the concrete. In effect, the reinforcement frame of embodiments of the invention in a sense carries the concrete rather than reinforces the interior of the concrete.

Use of the reinforcement frame structure embodying the invention permits casting of the concrete to be carried out in a horizontal position thereby enabling thorough vibration of the concrete. The frame also provides for a basis for shaping formwork thereby enabling achievement of exact size control. During casting, the presence of the elongate metal members at the corners of the pile provide for a lining preventing spilling or breakage of concrete during handling thereby improving quality of piles especially in the case of piles of small diameter.

Presence of the external reinforcement frame structure provides for easy jointing of one pile to another. Correspondingly, one pile can be cut off from another relatively easily.

Embodiments of the present invention also offer the advantage that the steel frame reinforced concrete pile can be cast to short lengths at short notice and wastage of concrete is reduced to a minimum.

Embodiments of the invention are suitable for providing reinforcement for concrete piles having a cross-section as small as 2 inches by 2 inches. Embodiments of the invention are particularly suited for the jack-in system and especially the indirect jacking system (see applicant's co-pending patent application).

The invention will now be further described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a reinforcement frame structure embodying the present invention;

Figure 2 is a cross sectional view taken along the section A - A of Figure 1; and

Figure 3 illustrates the jointing of two piles embodying the present invention.

Figure 1 illustrates a reinforcement frame structure 1 of triangular cross-section. The structure has three elongate metal members of steel 2 extending along respective corners of the pile. Cross-members in the form of steel bands 3 are positioned at spaced apart locations along the length of the pile. The steel bands 3a and 3b at opposite ends of the pile are of increased thickness to aid jointing of the pile to adjacent pile.

Figure 2 illustrates the relative position of the concrete of the pile and the reinforcement frame structure 1. The steel band 3 is connected, by welding or rivetting, to the inner facing surface of the steel members 2. The concrete 4 is cast so that the outer surface 5 of the elongate members 2 is flush with the outer surface 6 of the concrete. The steel bands 3 are completely embedded within the concrete and so serve to

prevent slippage between the concrete and the frame.

Figure 3 illustrates jointing of a pair of piles constructed in accordance with Figures 1 and 2. A thin steel plate 7 sandwiched between the ends of adjacent piles and acts as packing for direct load transfer from one concrete pile to another. The cross-sectional area of the steel plate 7 is preferably slightly less than the cross-section of the concrete pile. Epoxy can be applied at the joint together with the welding of the steel bands.

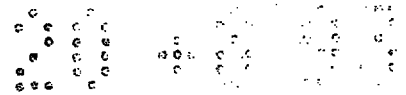
The lower of the two piles has already been jacked into the ground as indicated. The piles can be joined by welding the steel bands 3a and 3b together. The joint can be strengthened by means of corner pieces 9 welded to the elongate members 2. The corner pieces 9 can be welded first onto the lower pile 1 in order to facilitate easy guidance of the adjoining pile into position before welding.

Claims:

1. A pre-cast concrete pile comprising a plurality of elongate metal members extending along the longitudinal length of the pile, wherein the elongate metal members are connected together by a plurality of metal cross-bands spaced apart at different locations along the longitudinal length of the pile, which metal cross-bands are connected to the inside surface of the elongate metal members so that the cross-bands are at least partially embedded in the surface of the concrete pile thereby establishing a bonding relationship with the concrete of the pile in order to offer resistance to any bending stresses which may be applied thereto.

2. A pre-cast concrete pile according to claim 1, wherein the inner surfaces of the elongate members contact the outer surface of the concrete when the pile is cast within the frame structure.

3. A pre-cast concrete pile according to claim 1, wherein the inner surfaces of the elongate members are at least partially embedded in the concrete when the pile is cast within the frame structure.



4. A pre-cast concrete pile according to claim 1, wherein, when the concrete is cast within the frame structure, the elongate members are embedded in the pile such that the outer surfaces of said elongate members are substantially flush with the surface of the concrete.

5. A pre-cast concrete pile according to any preceding claim, wherein the elongate members each consist of metal bars having an angled cross-section, each for locating with the corner of the concrete in the case where the pile has three or more straight and flat sides.

6. A pre-cast concrete pile according to claim 5, wherein said elongate members are substantially V-shaped in cross-section.

7. A pre-cast concrete pile according to claim 5, wherein said elongate members are substantially L-shaped in cross-section.

8. A pre-cast concrete pile according to claim 5, wherein said elongate members are substantially flat and rectangular in cross-section for disposal thereof along a curved side of the concrete.

9. A pre-cast concrete pile according to any



preceding claim, wherein the cross-bands are in the form of steel bands.

10. A pre-cast concrete pile according to any preceding claim, wherein the elongate members are made of steel.

11. A pre-cast concrete pile according to any preceding claim, wherein the cross-bands are connected to the elongate members by rivets or by welded joints.

12. A pre-cast concrete pile according to claim 9, wherein the steel bands located at respective ends of the reinforcement frame structure have greater thickness than cross-bands at other locations.

13. A pre-cast concrete pile according to any preceding claim, wherein the cross-bands are completely embedded in the concrete.

14. A pre-cast concrete pile substantially as described hereinbefore with reference to the accompanying drawings.

15. A pre-cast concrete pile according to claim 14, comprising at least two discrete lengths joined together and having a plate disposed between said discrete lengths in such a manner that said plate can transfer load from one length of said pile to another.



16. A pre-cast concrete pile according to claim 15, the join between said discrete lengths being reinforced by a member welded across the join between adjacent elongate members.

17. A method of forming a pre-cast concrete pile, comprising forming a frame structure corresponding to the dimensions of the pile to be cast by connecting together a plurality of metal elongate members of length corresponding to the longitudinal length of the pile with a plurality of metal cross-bands spaced along the length of the elongate members, the cross-bands being connected to the inner facing side of the elongate members, constructing formwork around the frame structure, and casting concrete within the formwork and the frame structure so that the cross-bands are at least partially embedded within the concrete thereby establishing a bonding relationship with the concrete of the pile.

18. A method of forming a pre-cast concrete pile according to claim 17 and substantially as hereinbefore described.

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