PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in or relating to Concrete Piles.

We, RAYMOND CONCRETE PILE COMPANY, a Corporation organised under the laws of the State of New Jersey, United States of America, of 140, Cedar Street, New York 6, New York, United States of America, (assignees of Maxwell Mayhew Upson), do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

An object of this invention is to improve the design and construction of concrete piles, particularly piles of unusual length.

In piles of long length the design is usually based on strains arising from the handling of the pile. As a consequence very much more steel reinforcing is required than is needed for its intended purpose after the pile is in place. Since concrete shrinks when it sets and the steel has no physical deformation during the time of the setting, the firm contact between the cement and the steel places the steel in compression due to the shrinking of the concrete.

When the pile is lifted and put in flexure the steel must take care of the tension stresses. But before it can work in tension it must relieve itself of compression. In large piles this compression may amount to as much as 12,000 pounds per square inch. It is obvious that during this period of transition from the 12,000 pounds of compression to possibly 15,000 or 20,000 pounds of tension the surrounding concrete must in itself yield. This results in either breaking the bond between the steel and the concrete or opening up a series of very fine cracks in the concrete. These cracks permit the entrance of moisture or chemicals which frequently deteriorate the concrete to a degree that greatly weakens the pile.

The invention obviates the above difficulty by precasting the piles in sections and pulling the sections together with high tension reinforcement which puts the concrete in the pile under sufficient compression to take care of any tension to which the concrete may be subjected in service or in handling. The wires may be within, or without, the pile, but it is preferred to place them in holes precast in the concrete, the holes then being filled with grout if desired.

Since the design of the pile so far as reinforcement is concerned is largely predicated on the strains to which the pile is subjected while it is being handled, it follows that the weight of the unit is a material factor in determining the amount of necessary reinforcing steel. It is therefore desirable to reduce that weight to a minimum. In consequence a hollow pile is highly desirable since it very greatly reduces weight and provides a maximum sectional modulus with the minimum of material.

Since ordinary reinforcing steel usually has an ultimate strength of about 50,000 pounds per square inch and cannot be safely used for a working strain of more than 20,000 to 25,000 pounds per square inch, it is desirable that a reinforcing steel of higher strength be employed. There is therefore a great economical advantage in using hard drawn wires of small diameter providing an ultimate strength approximating 200,000 pounds per square inch. This permits a working stress in the neighborhood of 125,000 to 150,000 pounds per square inch. These wires also have the advantage of occupying a comparatively small cross-section area which makes it possible to thread them through comparatively small holes in the pre-cast concrete.

Since it is uneconomical to cast long continuous members of hollow concrete the design contemplates casting or spinning the body of the pile in short tubular sections placed end to end and clamped together. This requires very accurate forming of the ends of the sections so that when they are put under longitudinal stress the end surfaces will be in uniform contact and, in consequence, be able to take the pre-stressing compression that is essential in order to make a unit that can be safely handled and driven.

Since the impact of a hammer on a pile involves the absorbing of a very great amount of energy, it is practically impossible to drive a shell of this kind without some method of distributing the hammer energy both at the point and at the top of the pile. To accomplish this we pre-cast the top and bottom sections, which are united with the tubular shell assembly by means of the pre-stressed constraining wires. The top and bottom sections are solid, and are very heavily spirally reinforced to take the impact of the hammer

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and the forces developed at the point in penetrating hard material. These solid sections at the upper and lower ends provide means for economically fastening the ends of the reinforcing wires, which are continuously under tension.

After the tension has been attained in the wires the holes containing the wires may be grouted in order to protect the wires from rusting and to enable the wires to maintain their tension irrespective of any anchorage at their ends.

Further and other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate what is now considered the preferred embodiment of the invention.

In the drawings:—

Fig. 1 shows the complete pile;

Fig. 2 is an enlarged view of the top section of the pile, and the portion of the next section below it;

Fig. 3 is an enlarged view of the bottom section of the pile and a portion of the next section above it;

Fig. 4 is a view on line 4—4 of Fig. 2;

Fig. 5 is a sectional view on line 5—5 of Fig. 2;

Fig. 6 is a view on line 6—6 of Fig. 3;

Fig. 7 is an enlarged vertical section on line 7—7 of Fig. 5 showing the longitudinal reinforcing of the upper, lower and middle sections of the pile;

Fig. 8 is an enlarged sectional view on line 8—8 of Fig. 7, showing the reinforcing wires in their tube, before grouting;

Fig. 9 is a view of the upper part of Fig. 7 after the tubes enclosing the reinforcing wires have been filled with grout;

Fig. 10 is an enlarged view showing details of the joints between the tubular shell sections; and

Fig. 11 is a view on line 11—11 of Fig. 10.

An outline of a complete pile is shown in Fig. 1 in which 20 is the top section—designed to take the blows of the hammer; 22 is the lowermost section—designed to pierce the ground; and 24 are the intermediate tubular sections joining sections 20 and 22.

The structure, as illustrated, is provided with three (any desired number may be used) similar groups of pre-stressed reinforcing wires and the line 26 in Fig. 1 indicates the position of one of these groups.

Chambers 28 at the top, and 30 at the bottom of the pile are provided for anchoring the ends of the wires, as will be described. The top section (Fig. 2) is provided with spiral reinforcing wires 32 so distributed as to best enable the section to resist the blows of the hammer. In like manner the bottom section 22 (Fig. 3) is provided with spiral wires 34 to enable the section to overcome the resistance of the ground.

The intermediate sections 24 also have a certain amount of reinforcement provided by spiral sections 36 and vertical wires 38.

The three groups of wires are in three tubular conduits 40 spaced 120° apart and extending from top to bottom of the pile and each following a line 26 (Fig. 1). In sections 20 and 24 the passages are substantially vertical but in the bottom section 22 they are bent so that their lower openings 30 are on the flat surface 44, which are on opposite sides of the pile from their points of entry 28, as indicated by details shown in Figs. 4 and 6. If preferred, the passages in section 22 may continue substantially vertically downwardly to a horizontal flat bottom instead of being bent as illustrated, and the bottom pile surface may be horizontal. The conduits may be lined with metal tubes 42 if desired.

After the pile is assembled as in Fig. 1, pre-stressing wires 46 (Figs. 7, 8 and 9) are inserted in their conduits 40, are pre-stressed by hydraulic jacks or other suitable means, and are locked by wedges or otherwise to maintain the tension.

The end surfaces of contacting pile sections, such as shown in Figs. 10 and 11, must be carefully fitted together, in order to take the stresses and strains encountered in handling and driving operations. The edges of the contacting surfaces are usually bevelled as at 50, 52 in order to avoid the bringing of excessive pressure on the edges where tension is applied and to avoid damage to the edges during handling of the sections. One of the objects of the tension of the steel is to place all the concrete in sufficient compression to avoid any negative tension on the concrete during handling and driving.

In order to aid in maintaining the adjoining shell sections in alignment, a circumferential groove 54 is provided in the end of each section (Figs. 8, 10 and 11) which, when the sections are assembled end to end (Fig. 10), form annular horizontal tubes intersecting vertical tubes 40 (Fig. 11). During the pressure grouting of tubes 40 as described above, tubes 54 will also be grouted, thus firmly interlocking the adjoining shell sections. The tubes are usually left in the concrete, but by forming the tubes of rubber or other suitable material the tubes can be withdrawn after the concrete has set.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claims.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of forming a tubular, pre-stressed concrete structure by the use of tensioned wire, which comprises placing a series of tubular concrete section members in end-to-end relationship with circumferentially spaced, longitudinal holes located inside of and surrounded by the concrete of the walls of each section, said holes being aligned with corresponding holes in the adjacent section, threading wires through said holes and stressing said wires in tension by applying force subjecting the series of sections to compression,

and the forces developed at the point in penetrating hard material. These solid sections at the upper and lower ends provide means for economically fastening the ends of the reinforcing wires, which are continuously under tension.

After the tension has been attained in the wires the holes containing the wires may be grouted in order to protect the wires from rusting and to enable the wires to maintain their tension irrespective of any anchorage at their ends.

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It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claims.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of forming a tubular, pre-stressed concrete structure by the use of tensioned wire, which comprises placing a series of tubular concrete section members in end-to-end relationship with circumferentially spaced, longitudinal holes located inside of and surrounded by the concrete of the walls of each section, said holes being aligned with corresponding holes in the adjacent section, threading wires through said holes and stressing said wires in tension by applying force subjecting the series of sections to compression,

and bonding the successive portions of the wires directly to the adjacent portions of the concrete by injecting a filling of grout under pressure into and along the holes to hold the wires substantially throughout under tension and the concrete sections under end-to-end compression, said grout being retained in place under pressure by reason of its being surrounded by the concrete of the walls of each section.

2. A method according to Claim 1, characterized by forming said tubular section members with circumferential reinforcing means imbedded within the concrete of the walls in a position to surround and embrace said holes.

3. A method according to Claim 1 or 2, characterized by joining the adjacent ends of said tubular sections so as to provide sealing means therebetween.

4. A method according to Claim 3, characterized by the fact that said sealing means is provided by forming a peripheral groove in the abutting surfaces of said tube sections and in communication with at least some of said longitudinal holes and forcing bonding material into said groove during the pressure grouting operation.

5. A concrete structure comprising a series of tubular concrete section members positioned in end-to-end relationship and having circumferentially spaced, longitudinal holes extending from end to end of each section within and surrounded by the concrete of the walls thereof, said holes being aligned with corresponding cavities in the adjacent section, and prestressed-wires threaded through said holes and having successive portions bonded directly to the adjacent portions of the concrete by a filling of grout which has been injected under pressure into the holes to hold the wires substantially throughout under tension and the concrete sections under end-to-end compression.

6. A pre-stressed tubular structure comprising a plurality of tubular concrete sections positioned end to end axially in alignment, the walls of each section being integrated and having formed therein a plurality of longitudinal holes at circumferentially spaced positions extending and surrounded by the concrete from end to end of the section, each such hole communicating with a corresponding hole through the next adjacent section or sections, highly tensioned wires extending through the communicating holes of succeeding sections, means binding said wires to the concrete of each section to maintain said wires under such tension, with the wires acting through such means to maintain the concrete under substantial compression longitudinally of the sections and to maintain the sections under pressure in end-to-end relation.

7. A tubular structure according to Claim 6, wherein a filling of grout is provided in said cavities to bond the successive portions of said wire means to the concrete, thereby insuring maintenance of said tension in the wire means, and the tensioned wires act through such grout bond.

8. A tubular structure according to Claim 5, 6 or 7, including sealing means between the ends of adjacent sections through which said highly tensioned wire means extend.

9. A concrete structure according to any one of claims 5 to 8, characterized by the fact that it is in the form of a pile having a driving head at one end and a driving point at the other end.

10. A concrete structure according to Claim 9, characterized by the fact that said wires are secured to said driving head and said driving point.

11. The method of forming a tubular, prestressed concrete structure substantially as hereinbefore described.

12. The pre-stressed tubular concrete structure substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Dated the 28th day of September, 1948.

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