PRECAST PILING AND SPLICE JOINT THEREFOR

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This invention pertains to improvements in shell type concrete piles, and more particularly to a method and device for precasting and prestressing tubular, sectional piles, and to and improved form of splicing connection for uniting abutting such pile sections in a joint capable of withstanding the driving impact without injury to the joint or pile sections.

An advantage of precast, shell type, sectional piling, is that the pile sections may be hammer driven directly to any desired depth or being loaded, be covered by superimposing and splicing successive sections at the driving site to the extent required as the driving proceeds.

However, serious problems have been encountered in providing ways and means for so terminating and splicing such pile sections as to avoid spalling or breakage of the concrete shell during driving or in subsequent service. It has been proposed, for example, to terminate the opposite ends of precast and reinforced concrete shell sections, with annular metal face plates having circumferentially extending thereabout, metal collars welded thereon and to the corinice between which the reinforcing bars of the shell are extended out at an angle to the axis of the shell and welded. Splicing is effected by peripheral welding of the abutting face plates of superimposed shell sections.

This arrangement has definite disadvantages in that it requires bending of the reinforcing rods in order to bring out their ends as closely as possible to the weld zone, thereby to transmit the stresses between abutting shell sections. This in turn brings the ends of the reinforcing rods very near the surface of the concrete. The objection to this is that, in order to prevent rusting of these rods, sound driving practice requires that they be covered with at least one inch and preferably one and one-half inches of concrete, as against the above construction which subjects the ends of the reinforcing rods to the hazard of corrosion. Corrosion of rebars buried in concrete is extremely undesirable because it tends to produce splitting of the concrete, which results in more corrosion and more splitting, etc.

A further disadvantage of this arrangement is that stresses between abutting shell sections are transmitted eccentrically, in that the forces are applied from one section to another primarily through the weld which is eccentric with respect to the abutting surfaces of the pile sections. In order to withstand high driving stresses, the pile sections and splicing thereof must be so designed that eccentricities are held to a minimum and such that all parts of the concrete carry the load equally. In this connection it is to be noted that pile driving involves tensile as well as compressive stresses and that under certain ground conditions, tensile stresses can be quite high.

Hence eccentricity of stressing is highly objectionable. It has also been proposed to terminate the opposite ends of the reinforced concrete shell sections with mating male and female metal sleeves, secured to the reinforcing bars of the respective shell sections, for providing a telescopic splice joint between abutting pile sections, which joint may optionally be threaded or unthreaded. But all such modifications are objectionable in that the stress is transmitted eccentrically between pile sections.

This same objection applies to still another previously known construction according to which the concrete shell sections are precast about metal tubes having flanged termini extending radially inward and drilled for uniting by bolting. Further objections to this construction are the added expense of the metal tubes and the fact that they are subject to rusting, corrosion and disintegration in service.

In accordance with the present invention, splicing is accomplished by means of a pair of coating cast steel splice caps, cast respectively into the opposite ends of the pile sections to be joined. These caps are of annular configuration in plan and of a radial width corresponding to that of the concrete shell and channeled on the underside by means of outer and inner flanges confluent with the inner and outer walls of the shell. They have formed on the upper side a series of upstanding, arcuate ribs, circularly disposed in spaced relation along a circle described by the median radius of the shell, and in alternating relation with taper-cored holes drilled through the cap for extension of the reinforcing wires therethrough and for anchoring the same.

Anchorage of each cap in the concrete is effected by a series of rods threaded at circumferentially spaced intervals into its underside, these rods being embedded in the concrete. The caps are formed integral with the concrete shell by centrifugal casting or spooling of the fluid concrete in the manner described, for example, in Patent No. 2,602,979, M. Van Buren. As described in this patent, the shells are spun in such manner as to provide longitudinally extending bores for subsequent insertion of the prestressing wires, the prestressing being accomplished in the manner described, for example, in Patent No. 2,609,586, R. M. Parry, as discussed below.

The upstanding ribs referred to are formed with shouldered extensions or tongues of lesser and greater radii for the caps at the opposite ends of a shell section, respectively, such that for abutting shell sections, the shouldered extensions or tongues of one cap will sleeve over those of the opposed cap, thus concentrically to seat the upper shell section on the lower. As thus disposed, the caps are welded together in the extension portions of the ribs, by consumable electrode welding to fill up all interstices with the weld metal. Also if it is desired to unite the caps in a watertight joint, the crevices between the abutting faces of the anchoring holes for the reinforcing wires, are additionally sealed with the weld metal.

With the foresaid splicing arrangement of the invention, all stresses are centered at the middle of the concrete shell. The weld is along the middle and the steel splice caps are designed to spread the load evenly over the end area of the concrete. The driving and other stresses are transmitted between shell sections through the welded together upstanding ribs of these caps and uniformly distributed thence through the annular base portions of the caps, to the concrete shell, both radially and circumferentially thereof.

The shell sections as thus described embodying the cast-in-place splice caps at each end, are of such rugged construction that they may be driven directly by hammer blows without necessity for a driving mandrel. Owing to the centering of the driving impact medially of the shell and the uniform distribution of the load from cap to shell, no bending forces are introduced such as would tend to crack or spall the concrete during driving. This is further assured by the fact that the steel caps completely face the terminal portions of the concrete shells both across the face and along the sidewalls for a sufficient distance to protect against corner cracking.

For driving such pile sections, a cast steel driving ring as described below is fitted over the uppermost splice cap and is tack welded in place. Driving may be conveniently accomplished by means of a steam hammer in conjunction with a driving bell to position the hammer and by the
interposition of a hardwood cushion between the hammer and the driving ring above mentioned.

Other advantages of the invention will be pointed out or become apparent from the following more detailed description of preferred embodiments in conjunction with the accompanying drawings, wherein:

FIG. 1 is a view in elevation of a pile comprising a pair of shell sections, spliced according to the invention, and being driven into the ground by a hammer shown schematically. FIG. 2 is an enlarged view in axial section through the pile structure of FIG. 1. FIGS. 3 and 4 are respectively enlarged fragmentary sectional views as taken radially at 3--3 and 4--4 of FIG. 2.

FIGS. 5 and 6 are views in perspective of the lower and upper ends of shell sections embodying, respectively, the two types of cooperating splice caps employed for splicing the two sections together.

FIG. 7 is a perspective view in elevation of the upper and lower shell sections of FIGS. 5 and 6 as assembled and spliced, with parts broken away to illustrate the anchoring of the upper splice cap in the concrete shell and also the reinforcement.

FIG. 8 is a plan view showing the underside of one of the splice caps, i.e., the side which carries the anchoring rods for anchoring in the concrete shell.

FIG. 9 is a plan view of the underside of the above-mentioned driving cap.

Referring to the drawings, there is shown in FIGS. 1 and 2, a pair of precast concrete pile sections 10, 11, terminated at their opposite ends, respectively, by splice caps according to the invention, as at 12, 13, and 14, 15. Pile section 10 is shown superimposed on section 11, with splice cap 13 sleeved over splice cap 14 and welded thereto, as at 16, 17, to form the spliced joint, as discussed below.

The uppermost splice cap 12, is surrounded by a driving ring 19, to protect cap 12 during driving, the driving ring being in turn surrounded by a hardwood cushion 20, impacted by a driving hammer shown generally at 21. The hammer is equipped with a driving bell 22, to position the hammer over the pile assembly 10, 11, for driving the same into the ground, as at 22a.

For purposes of driving, the pile 10, 11, may or may not be assembled on a driving boot, as at 23, depending on whether or not it is desired to have the earth fill the interior of the pile to the driven depth. Also depending on conditions, the driving boot or shoe 23 where employed may be substantially squarerounded, or alternatively pointed and possibly reinforced in accordance with well known conventional practices.

Referring to FIGS. 3--8, inclusive, the splice caps, such as 13, 14, are of generally annular configuration, as best shown in FIGS. 5 and 6, and of a radial width corresponding to that of the wall thickness of the associated concrete shell pile, as shown in FIGS. 3 and 4. The caps have formed on their anterior or exposed annular surfaces, a series of upstanding arcuate ribs, as at 25--28, inclusive, FIGS. 5 and 6, which are centered transversely of each cap, as at 29, 30. FIG. 5, the centerline of those ribs lying along the path of a circle corresponding to the medial radius of the cap width.

Referring to FIGS. 5 and 6, these ribs, as at 25, 26, and 27, 28, are spaced apart circumferentially, by interposed bosses, as at 31, 32 and 33, 34, through which are bored holes of triangular cross section, as at 35, 36, FIG. 4, for the bosses 27, 28. Through these holes and aligned holes in the concrete shells, as at 35a, 36a, extend prestressing cables, as at 39, 40, which are anchored by grouting, as at 41, 42.

As shown in FIGS. 3, 4 and 8, the posterior side of each splice cap, is circumferentially channelled by means of cutouts of triangular cross section, as at 35, 36, FIG. 4, for the bosses 27, 28, integral with that might be termed the base portions 47, 48 of the splice caps 13, 14, for reception of the cast concrete of the shells 10, 11.

Also as shown in FIGS. 3, 7 and 8, the base portions 47, 48 of the splice caps are tapped at equi-spaced intervals along the circle of medium radius, as at 50--53, inclusive, for threaded reception of anchoring rods, as at 55--58, inclusive, which are embedded in the cast concrete of the shells 10, 11, as shown, for firmly anchoring the splice caps integral with the shells.

Referring to FIGS. 3--6, inclusive, the upstanding ribs on splice cap 13, such as 25, 26 and 29, are rectangularly cut away or grooved along upper portions of their inner walls to form thereon, thinner extension ribs or tongues, as at 60--62, inclusive, having a wall thickness as shown for the extension rib 69 in FIG. 3, which extends substantially from the centerline of the rib 29, to the outer surface thereof. The upstanding ribs of the opposed splice cap 19, such as 27, 28 and 39, are similarly rectangularly cut away or grooved along the upper portions of their outer walls, to form thereon, extension ribs or tongues, as at 63--65, inclusive, having a wall thickness as shown for extension rib 65, FIG. 3, which extends from the inner surface of rib 30 to a distance slightly less than the centerline thereof, thus leaving a slight clearance space, as at 66, between the tongue 65 of cap 14 and the opposed tongue 69 of cap 13. It will further be seen from FIG. 3, that the tongues on cap 14, such as 65, are of slightly greater height than those, such as 69, on cap 13, and also that the tongue 65 is squared off at the top with an outer chamfered corner, as at 67.

By virtue of this construction, the tongues 60--65, inclusive, of cap 13 are easily sleeved over the tongues 63--65, inclusive, of cap 14, until the latter seat on the shouldered portions of the ribs from which the tongues extend, as at 69, for rib 29. As thus relatively positioned, as shown in FIG. 3, the opposed caps 13 and 14 are welded together, by means of consumable electrode welding, by deposition of weld metal, as at 16, in the space between the lower end of tongue 60 and the shouldered portion 70 of rib 39. To facilitate deposit of the weld metal 16, the tongues on cap 13, are chamfered, as at 71, for tongue 60, away from the capped shoulder 70 of rib 30 on cap 14.

Referring to FIG. 7, it will be seen that the weld metal deposit extends the arcuate length of the ribs, as at 71, 72, for the opposed ribs 74, 75 and 76, 77, of splice caps 13, 14. If it is desired to make the splice a completely watertight joint, the weld metal may also be deposited in the space between the series of bosses, such as 73, 79, of caps 13, 14, in which case the added weld deposit would be as at 80. To facilitate this, the clearance between the opposed bosses may be reduced to a minimum so that very little weld deposit will be required.

Referring to FIGS. 2 and 9, the underside of the cast steel driving ring 19, is cored and slotted, as at 73, 74, for a sufficient depth to receive the splice cap bosses, as at 33, 34, FIG. 6, and the interposed ribs, as at 27, 28, including their extensions, as at 63, 64, the latter in the manner shown at 75, FIG. 2.

What is claimed is:

1. A prestressed, sectional pile comprising, a series of tubular shells of cast concrete having holes extending longitudinally therethrough at circumferentially spaced intervals, each shell being capped at its opposite ends by metal rings, each ring circumferentially channelled on one side thereof for reception of said concrete therein, and having formed on the other side thereof, a plurality of centrally disposed upstanding ribs extending arcuately thereabout, said ribs alternated with conically cored bosses disposed in alignment with the holes in said shells, respectively, tensioned cables extending through the holes of said shells and bosses, said cables being bonded under tension 83, 84, and 85, 86, the said rings being grooved along their inner and outer walls, respectively, to provide complementarily disposed tongues whereby the tongues of one ring may be sleeved relatively to the
tongues of a ring on an adjacent shell to form a splice joint therewith, and anchoring rods secured to each ring and extending into and embedded in said concrete.

2. In combination, a pair of prestressed, pile sections, disposed in superimposed relation, each comprising a tubular shell of cast concrete having holes extending longitudinally therethrough at circumferentially spaced intervals, said shells being capped at their opposed ends by metal rings, said rings being circumferentially channeled on the sides thereof facing the shell of concrete for reception of said concrete cast therein, said rings having formed on other sides thereof, a plurality of centrally disposed ribs extending arcuately relatively thereto, said ribs alternating with conically bored bosses disposed in alignment with the holes in said shells, respectively, tensioned cables extending through the holes of each said shell and the bosses of the associated ring, said cables being bonded under tension by grouting, the ribs of the respective rings being grooved to provide complementarily disposed tongues, such that the tongues of the adjacent rings of adjacent pile sections are adapted to be sleeved relatively to one another and then welded together.

3. A prestressed, sectional pile, comprising, a tubular shell of cast concrete having holes extending longitudinally therethrough at circumferentially spaced intervals, said shell being capped at its opposite ends by metal rings against one side of each of which said concrete is cast, said rings having formed on the other sides thereof, a plurality of centrally disposed ribs extending arcuately therewith, said ribs alternating with bored bosses disposed in alignment with the holes in said shell, respectively, tensioned cables extending through the holes of said shell and bosses, said cables being bonded under tension, the ribs of the respective rings having substantially rectangular grooves extending therealong to provide complementarily disposed tongues adapted to be sleeved relatively to those of an adjacent ring on an adjacent pile section in a splice joint, the outer circle of tongues being somewhat shorter than those of the inner circle, whereby the tongues of the inner circle are adapted to rest on portions of the ribs of the opposite ring, and anchoring rods secured to each ring and extending into and embedded in said concrete.

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