A method of coaxially splicing a pair of tubular foundation piles in an end-to-end relationship includes the step of constructing a tubular splice from a resilient material, the tubular splice having the same outer diameter as the pair of foundation piles and being shaped to define a longitudinal slit which extends the entirety of its length. A strap is cinched tightly around the splice which renders its outer diameter less than the inner diameter of the pair of foundation piles. Each end of the compressed splice is then inserted into an adhesive coated end of a corresponding foundation pile. With the pair of foundation piles telescopingly mounted over the compressed splice, the cinched strap is removed which causes the splice to resiliently expand radially outward and thinly spread the adhesive. The foundation piles are then preferably drawn together and the adhesive is allowed to cure.
METHOD OF SPLICING A PAIR OF FOUNDATION PILES

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to foundation piles and more particularly to methods for joining the adjacent ends of two or more coaxially disposed foundation piles.

[0002] A foundation pile (also referred to herein simply as a pile or piling) is an elongated beam that is driven deeply into the ground, often under water, in a substantially vertical manner. In this capacity, a foundation pile is commonly used as a support member (i.e., a load carrying element) for various types of structures, such as buildings, piers, docks and bridges.

[0003] Piling are traditionally constructed out of wood, concrete or steel. However, it has been found that wood pilings tend to rot and steel pilings tend to rust when utilized in a marine environment. The rotting and rusting of such pilings not only detracts from their natural aesthetic value but also compromises their structural integrity. As a consequence, wood and steel pilings that are habitually exposed to moisture often require significant maintenance and/or replacement, which is highly undesirable.

[0004] Accordingly, composite pilings are well known and widely used in the art as support members in marine environments. For example, in U.S. patent application Ser. No. 11/184,722 to Everett A. Pearson et al., which is hereby incorporated by reference, there is disclosed a tubular composite piling which includes a fiberglass laminate comprising a plurality of fiberglass type layers and an impermeable tube array. The tubular composite piling additionally includes plastic inner and outer skins and a resin injected into the laminate. As can be appreciated, this type of composite piling is characterized as having (i) exceptional shear, stiffness, and strength properties, (ii) an outstanding damage tolerance, and (iii) a relatively light overall weight, all of which are highly desirable.

[0005] Tubular composite pilings of the type as described above are typically manufactured in a wide variety of different diameters (e.g., 10, 12, 14 and/or 24 inches in outer diameter), thicknesses and lengths. In this manner, the properties of each piling (e.g., strength, stiffness) can be customized to meet the particular need of the customer which, in turn, serves to minimize costs, which is highly desirable.

[0006] In certain applications, the upper portion of the ground into which a piling is driven is relatively loose and unstable. As a result, in these circumstances, a piling of considerable length (e.g., an 60 foot piling) is required to ensure proper foundational support. Although a longer composite piling can be readily constructed by a piling manufacturer, it has been found that the transport of such a piling is rather difficult in nature.

[0007] As a result, it is well known in the art for pilings of considerable length (e.g., pilings greater than 40 feet in length) to be constructed and shipped as a plurality of shorter individual pilings which have identical dimensions in lateral cross-section. Once received at or near its intended place of use, the plurality of individual pilings are coaxially joined together in an end-to-end relationship through a multi-stepped splicing process.

[0008] One splicing process which is well known in the art involves the creation of a rigid tubular splice which is used to join the ends of a pair of piles. The splice is typically machined as a shortened, unitary piece which has a fixed outer diameter that is approximately equal to the inner diameter of the pair of piles. As part of the splicing process, an adhesive (e.g., glue) is applied to the inner surface of each pile at one of its ends. Each end of the splice is then forcibly urged into the adhesive coated end of a corresponding pile. As can be appreciated, the frictional and adhesive-based engagement of the outer surface of the splice with the inner surface of each pile serves to permanently join the pair of piles together in an end-to-end relationship.

[0009] Although well known in the art, the above-described pile splicing process suffers from a couple notable shortcomings.

[0010] As a first shortcoming, the above-described pile splicing process is relatively labor intensive and time-consuming. Specifically, it has been found that the step of driving each end of the rigid splice into the adhesive coated end of a corresponding pile requires a considerable amount of force.

[0011] As a second shortcoming, the above-described pile splicing process does not suitably allow for manufacturing tolerances. Specifically, if the splice is not properly dimensioned in such a manner so as to make uniform contact against the inner surface of the pair of joined piles, the adhesive layer may be inadequately applied between the splice and the pair of piles, thereby compromising the structural integrity of the spliced piles.

SUMMARY OF THE INVENTION

[0012] It is an object of the present invention to provide a novel method of splicing a pair of foundation piles.

[0013] It is another object of the present invention to provide a method of the type as described above which is neither labor intensive nor unduly burdensome.

[0014] It is yet another object of the present invention to provide a method of the type as described above which yields a pile assembly with exceptional axial stiffness and strength.

[0015] Accordingly, there is provided a method of splicing first and second tubular foundation piles, the first and second foundation piles having equal inner and outer diameters, each of the first and second foundation piles including an inner surface, an outer surface, a first end and a second end, the method comprising the steps of (a) providing a tubular splice that is constructed of a resilient material, the tubular splice including an inner surface, an outer surface, a first end and a second end, the outer diameter of the tubular splice being approximately equal to the outer diameter of each of the first and second foundation piles, the tubular splice being shaped to define a longitudinal slit which extends the entirety of the length of the splice, (b) applying a radially inward compressive force to the splice which renders the outer diameter of the splice less than the inner diameter of each of the first and second foundation piles, (c) coating an adhesive to the inner surface of the first foundation pile at its first end and to the inner surface of the second foundation pile at its first end, (d) inserting the first end of the compressed splice into the first end of the first foundation pile, (e) displacing the second foundation pile such that the second end of the compressed splice inserts into the first end of the second foundation pile, and (f) withdrawing the radially inward compressive force from the splice.

[0016] Various other features and advantages will appear from the description to follow. In the description, reference is made to the accompanying drawings which form a part thereof, and in which is shown by way of illustration, an
embodiment for practicing the invention. The embodiment will be described in sufficient detail to enable those skilled in
the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural
changes may be made without departing from the scope of the invention. The following detailed description is therefore, not
to be taken in a limiting sense, and the scope of the present invention is best defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In the drawings wherein like reference numerals represent like parts:

[0018] FIGS. 1(a)-(h) are a series of fragmentary, front perspective views which are useful in understanding the method of the present invention of joining a pair of foundation piles using a splice, a removable cinch strap and an adhesive; and

[0019] FIG. 2 is an enlarged section view of the pile assembly shown in FIG. 1(b) taken along lines 2-2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Referring now to FIGS. 1(a)-(h), there are shown a series of fragmentary, front perspective views which are useful in understanding the method of the present invention of joining a pair of foundation piles 11 and 13 using a splice 15, a removable cinch strap 17 and an adhesive 19.

[0021] For purposes of simplicity only, the splicing process of the present invention is described in detail herein in connection with a pair of uninstalled foundation piles. However, it is to be understood that the splicing process of the present invention could be similarly implemented when one of the pair of foundation piles is at least partially installed (i.e., vertically driven into ground) without departing from the spirit of the present invention.

[0022] Foundation pile 11 is represented herein as being in the form of an elongated, tubular member which includes an inner surface 11-1, an outer surface 11-2, a first end 11-3 and a second end (not shown). Similarly, foundation pile 13 is represented herein as being in the form of an elongated, tubular member which includes an inner surface 13-1, an outer surface 13-2, a first end 13-3 and a second end (not shown).

[0023] Each of foundation piles 11 and 13 is preferably constructed out of a rigid, durable and lightweight composite material. For example, each of foundation piles 11 and 13 may be constructed out of the fiberglass-based composite material described in U.S. patent application Ser. No. 11/184, 722 to Everett A. Pearson, et al. However, it is to be understood that the method of the present invention could be utilized to splice together foundation piles which include alternative types of materials, such as carbon-fibers and/or steel, without departing from the spirit of the present invention.

[0024] As defined herein, use of the term “foundation pile” relates to any elongated, hollowed, load carrying element which is vertically driven into ground, such as a dock piling, utility pole, flagpole, mast or the like.

[0025] Foundation piles 11 and 13 are preferably identical in lateral cross-section (i.e., have equal inner and outer diameters.). Accordingly, when joined end to end in the manner set forth below, foundation piles 11 and 13 together create a single pile assembly which has a constant outer diameter along the entirety of its length, which is highly desirable.

[0026] To facilitate the splicing process, the separate foundation piles 11 and 13 are preferably held horizontally, end-to-end, in coaxial alignment with one another, as shown in FIG. 1(a). Although not shown herein, it is to be understood that each of piles 11 and 13 is held in a horizontal manner by a support table or other similar structure.

[0027] As can be seen in FIG. 1(b), a tubular splice 15 is created which has the same outer diameter \( D_o \) and inner diameter \( D_i \), as each of foundation piles 11 and 13, splice 15 comprising an inner surface 15-1, an outer surface 15-2, a first end 15-3 and a second end 15-4. A longitudinal slit 16 is formed into and extends along the entire length \( L \) of splice 15 (i.e., from first end 15-3 to second end 15-4). Preferably, the width \( W \) of slit 16 is uniform along the entirety of the length of splice 15 and is sized based on the particular cross-sectional dimensions of foundation piles 11 and 13, as will be described further below.

[0028] As will be described in detail below, slit 16 enables the outer diameter \( D_o \) of rigid splice 15 to be substantially reduced upon the application of a significant compressive force. Furthermore, upon the removal of said compressive force, splice 15 is constructed to resiliently expand back to its original dimensions in lateral cross-section (most notably, to its original outer diameter \( D_o \)).

[0029] Splice 15 is preferably formed by cutting a length of either of foundation piles 11 and 13 (or, in the alternative, a pile identical in lateral cross-section with piles 11 and 13). With the length of tubing separated from the pile, slit 16 is formed into the length of tubing using any suitable cutting instrument.

[0030] It should be noted that the foundation pile from which splice 15 is formed may include an outer protective coating (e.g., polyethylene terephthalate (PET), propylene, propylene terephthalate (PTT) or the like). In this case, it is preferred that any outer protective coating present on splice 15 be removed.

[0031] It is preferred that the length \( L \) of splice 15 be approximately three times the outer diameter \( D_o \) of the foundation piles 11 and 13 to be joined together. Accordingly, in order to effectively splice a pair of foundation piles 11 and 13 each of which has an outer diameter \( D_o \) of approximately 10 inches, it is recommended that the splice 15 used to join said piles has a length of approximately 30 inches. Similarly, in order to effectively splice a pair of foundation piles 11 and 13 each of which has an outer diameter \( D_o \) of approximately 12 inches, it is recommended that the splice 15 used to join said piles has a length of approximately 36 inches. Further, in order to effectively splice a pair of foundation piles 11 and 13 each of which has an outer diameter \( D_o \) of approximately 14 inches, it is recommended that the splice 15 used to join said piles has a length of approximately 42 inches.

[0032] Having formed splice 15 in the manner set forth above, splice 15 is compressed radially inward until its outer diameter \( D_o \) is slightly less (e.g., approximately 0.25 inches) than the inner diameter \( D_i \) of each of foundation piles 11 and 13, as shown in FIG. 1(c). In the method of the present invention, a metal tie strap 17 is wrapped around outer surface 15-2 and is cinched tightly therearound (e.g., using a complementary strap cinching tool) to retain splice 15 in its radially compressed state. However, it is to be understood that
alternative means for releasably compressing splice 15 could be utilized without departing from the spirit of the present invention.

[0033] As mentioned briefly above, the particular width W of slit 16 is calculated based upon the degree of radial inward compression required so that splice 15 can be telescopingly inserted into piles 11 and 13. For example, to compress splice 15 to the degree necessary that its outer diameter D_2 is approximately 0.25 inches less than the inner diameter D_1 of each of foundation piles 11 and 13, the width W of slit 16 is preferably approximately 4 inches.

[0034] After splice 15 is radially compressed in the manner set forth above, inner surface 11-1 of foundation pile 11 is uniformly coated with an adhesive 19 at first end 11-3, as seen most clearly in FIG. 1(a). Similarly, inner surface 13-1 of foundation pile 13 is uniformly coated with an adhesive 19 at first end 13-3. It should be noted that the distance in from first ends 11-3 and 13-3 that adhesive 19 is applied is preferably one-half the length of splice 15. Accordingly, for a splice 15 which is 30 inches in length, adhesive 19 is preferably applied to piles 11 and 13 for a length of approximately 15 inches in from first ends 11-3 and 13-3, respectively.

[0035] It should be noted that inner surfaces 11-1 and 13-1 are preferably cleaned prior to the application of adhesive 19 to maximize bonding properties.

[0036] It should also be noted that adhesive 19 is not limited to any particular composition. Rather, it is to be understood that adhesive 19 represents any bonding agent which is well known in the art, such as epoxy, thermosetting resin, synthetic foam, acrylic adhesive, and thickened vinyl ester. Preferably, the particular composition of adhesive 19 is dependent upon the type of materials which are used to form foundation piles 11 and 13 (i.e., an adhesive with optimal adhesive properties in relation to piles 11 and 13).

[0037] With adhesive 19 applied to foundation piles 11 and 13, first end 15-3 of compressed splice 15 is inserted into first end 13-3 of pile 13, as shown in FIG. 1(c). It is to be understood that compressed splice 15 is advanced into pile 13 until strap 17 abuts against (or otherwise approaches) first end 13-3. At this time, foundation pile 11 is displaced towards foundation pile 13 until second end 15-4 of compressed splice 15 extends into first end 11-3 of pile 11. Preferably, foundation pile 11 is advanced over second end 15-4 of splice 15 until strap 17 approaches first end 11-3, as shown in FIG. 1(f).

[0038] With splice 15 positioned within foundation piles 11 and 13 in the manner set forth above, cinching strap 17 is removed. Due to its resilient construction, splice 15 expands radially outward upon the removal of strap 17, as shown in FIG. 1(g). It should be noted that the splice 15 expands radially outward such that its outer surface 15-2 is drawn firmly into contact against adhesive 19 which is applied to inner surfaces 11-1 and 13-1. As a result of this firm contact, adhesive 19 is spread uniformly as a thin layer between splice 15 and foundation piles 11 and 13.

[0039] Having removed strap 17, foundation piles 11 and 13 are preferably pushed together by any suitable machine to minimize any gaps present therebetween, as shown in FIG. 1(h). This pushing process may result in excess adhesive 19 to accumulate between foundation piles 11 and 13. In this case, it is recommended that some of the excess adhesive 19 be spread evenly between any remaining gaps present between piles 11 and 13. In this manner, a thin seam 21 is formed between foundation piles.

[0040] At this time, adhesive 19 is allowed to cure (e.g., by waiting a pre-determined period of time). Once adhesive 19 cures, the splicing process is completed. As a result, foundation piles 11 and 13 are permanently coaxially joined together in an end-to-end relationship so as to yield a single, elongated foundation pile assembly 23 which has a constant outer diameter D_2 along the entirety of its length, as seen most clearly in FIG. 2.

[0041] As can be appreciated, the above-described method of splicing a pair of foundation piles 11 and 13 introduces a number of notable benefits.

[0042] As an example, because splice 15 expands radially outward upon the release of band 17, adhesive 19 is spread out in a thin, even and broad manner between splice 15 and foundation piles 11 and 13. As a result, the strength of the foundation pile assembly 23 at the juncture of piles 11 and 13 is maximized, which is highly desirable.

[0043] As another example, splice 15 ensures that foundation piles 11 and 13 are permanently joined in coaxial alignment with one another which, in turn, serves to maximize the strength of the resultant foundation pile assembly 23, which is highly desirable.

[0044] The embodiment shown of the present invention is intended to be merely exemplary and those skilled in the art shall be able to make numerous variations and modifications to them without departing from the spirit of the present invention. All such variations and modifications are intended to be within the scope of the present invention as defined in the appended claims.

What is claimed is:

1. A method of splicing first and second tubular foundation piles, the first and second foundation piles having equal inner and outer diameters, each of the first and second foundation piles including an inner surface, an outer surface, a first end and a second end, the method comprising the steps of:

(a) providing a tubular splice that is constructed of a resilient material, the tubular splice including an inner surface, an outer surface, a first end and a second end, the outer diameter of the tubular splice being approximately equal to the outer diameter of each of the first and second foundation piles, the tubular splice being shaped to define a longitudinal slit which extends the entirety of the length of the splice;

(b) applying a radially inward compressive force to the splice which renders the outer diameter of the splice less than the inner diameter of each of the first and second foundation piles;

(c) coating an adhesive to the inner surface of the first foundation pile at its first end and to the inner surface of the second foundation pile at its first end;

(d) inserting the first end of the compressed splice into the first end of the first foundation pile;

(e) displacing the second foundation pile such that the second end of the compressed splice inserts into the first end of the second foundation pile; and

(f) withdrawing the radially inward compressive force from the splice.

2. The method as claimed in claim 1 wherein, upon release of the compressive force in the withdrawal step, the tubular splice resiliently expands radially outward.

3. The method as claimed in claim 2 wherein the tubular splice expands radially outward and into contact against the adhesive provided on the inner surface of the first and second foundation piles.
4. The method as claimed in claim 3 wherein the tubular splice spreads the adhesive uniformly as a thin layer between the splice and the first and second foundation piles.

5. The method as claimed in claim 1 further comprising the step of, after the withdrawal step, allowing the adhesive to cure.

6. The method as claimed in claim 5 further comprising the step of, after the withdrawal step but prior to the adhesive curing step, further drawing the first ends of the first and second foundation piles closer together to reduce any gap present therebetween.

7. The method as claimed in claim 1 wherein the slit has a uniform width along the entirety of the length of the splice.

8. The method as claimed in claim 7 wherein the width of the slit is directly proportional to the inner diameter of each of the first and second foundation piles.

9. The method as claimed in claim 1 wherein, in the splice providing step, the length of the splice is directly proportional to the outer diameter of each of the first and second foundation piles.

10. The method as claimed in claim 1 wherein the splice compression step is accomplished by cinching a strap around the outer surface of the splice.

11. The method as claimed in claim 1 wherein, in the adhesive coating step, the distance in from the first ends of first and second foundation piles that the adhesive is applied is approximately one-half the overall length of the splice.

12. The method as claimed in claim 1 wherein, in the splice insertion step, the first end of the compressed splice is advanced into the first foundation pile until the strap is disposed in close proximity to the first end of the first foundation pile.

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