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HYDRAULIC PILE CAP REMOVAL

HYDRAULISCHES VERFAHREN ZUM ENTFERNEN VON PFAHLKAPPEN

RETRAIT DE SEMELLE SUR PIEU HYDRAULIQUE

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RETRAIT DE SEMELLE SUR PIEU HYDRAULIQUE

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Description

Background of the Invention

[0001] The present invention relates to the breaking of concrete piles in order to remove the surplus concrete cap or head.

[0002] Reinforced concrete piles are widely used in civil engineering for retaining walls and foundations for structures. In accordance with the Institution of Civil Engineers "Specification for Piling and Embedding Retaining Walls" published on 17 April 1996 under ISBN 0-7277-2566-1, it is taught to cast a pile to a level above a specified cut-off so that there remains a pile head or cap that must be removed. This is to ensure that:

(a) there is a sound concrete connection with the pile when it is incorporated into the remainder of the structure; and

(b) the concrete comprising the top portion of the pile is of good quality and is not, as would otherwise be the case, contaminated with soil or poorly compacted.

[0003] It is standard practice to cast the concrete of the pile so that it covers the entirety of the pile cage or pile reinforcement.

[0004] Traditionally, the breaking of concrete piles is carried out by manual labour and is a slow, arduous and expensive process, which produces a considerable amount of loose debris for disposal. Even if mechanical means are used, close supervision is necessary as the cut-off level is approached, in order to prevent damage to the pile below the cut-off level.

[0005] The use of hand-held pneumatic tools, as employed in manual breaking processes, is associated with industrial injuries including hand-arm vibration syndrome ("HAVS") commonly known as vibration white finger.

[0006] Other health and safety issues arising from manual methods include noise and the risk of injury from displaced concrete fragments.

[0007] One method of breaking a reinforced concrete pile, which is in current use, is described in WO9736058 (Merritt & Elliott). In this method the reinforcement in the pile head to be removed is treated so that it is debonded from the concrete of the pile, a hole is formed in the pile at the desired cut-off level, and a hydraulic tool is applied in the hole to split the pile in a substantially transverse plane. Use of this method reduces the risk of industrial injury but does not eliminate it. The concept of debonding is also described in JP58-11218 (Yahagi Kenseitsu KKK) and WO8102757 (Asakura).

[0008] Chemical methods of splitting the pile head at cut-off level are also used. Such methods include the RECEPIEUX® technique, which uses expanding grout in conjunction with debonding of the reinforcement to break the piles down. It is also possible to leach out the cementitious material, above the cut-off level from the wet concrete of a cast-in-situ pile as part of the construction process. While these chemical techniques avoid the necessity for the use of vibrating hand tools, there are safety and environmental implications in keeping and using chemicals (which may be volatile) on site. There is also an explosion risk if the process is not operated correctly.

[0009] Asakura also attempts to eliminate the need to use mechanical tools by the use of a hydraulic method. A substantially flat metal pipe is placed into the pile cage at the cut-off level. After casting is complete and the concrete has hardened, fluid is supplied with increasing pressure to this pipe to break off the pile cap. The pile cap may then be lifted and removed. As illustrated in Figure 2 of Asakura, the metal pipe is annular in plan view and is shown as tied to the pile cage. The coupling for supply of pressurised fluid is shown positioned within the side wall of the pile and excavation would be necessary in order to locate these connectors once the pile had been cast. Crack propagation, especially around the perimeter of the pile, using the Asakura method is unpredictable.

[0010] JP 59192124A described in Patent Abstracts of Japan Volume 009 no.57 (M.-363) 13th March 1985 shows a pile cage comprising a reinforcement structure having a first part adapted to remain in the pile, the first part terminating at a predefined cut-off level, and a second part that is protected in order to debond it from concrete cast around it; and a crack-inducing ring aligned at the cut-off level, a crack-directing feature on or adjacent the crack-inducing ring, and a crack-attracting feature located at the cut-off level outside the crack-inducing ring. The crack-inducing ring described is a steel tube which is concentrically arranged with a second steel tube to which it is connected by "metals" which may function as a crack directing feature in order to form a multiple tube. A static breaking agent in the tube is expanded to develop cracks.

[0011] Since the priority date of this application GB 23898333 (Skanska) has been published. Skanska teaches a hydraulic method similar to Asakura in which an expandable, ring-shaped element or annular tube is located preferably inside the reinforcement. In one embodiment the element is a tube is made of PVC, rubber, polyurethane, neoprene, butyl or other flexible material and is pressurised with water or hydraulic fluid. In another the element is formed of or loaded with HYDROTITE®, a material that swells when it comes into contact with water. These embodiments work in the same way as Asakura and, although effective for splitting the cap, crack propagation is unpredictable.

[0012] Skanska also states that: "It may also be beneficial to employ the use of a metal loop which is positioned around the outside of the ring-shaped expandable element. This would serve to direct the principal forces generated by the element expansion in a direction which is generally parallel to the axis of the pile." This loop is not further illustrated or claimed.

[0013] Skanska suggests the use of a frame to mount
its expandable element.

Technical Problem

[0014] The present invention therefore addresses the technical problem of controlling crack propagation in pile cap removal using hydraulic power.

[0015] As a subsidiary technical problem it is desired to achieve hydraulic pile cap removal without the use of excessive pressures that might result in accidents or damage to the piles.

Solution of the Invention

[0016] The present invention provides a pile cage comprising a reinforcement structure having a first part adapted to remain in a pile, the first part terminating at a pre-defined cut-off level, and a second part that is protected in order to debond it from concrete cast around it; a crack-inducing ring aligned at the cut-off level, a crack-directing feature on or adjacent the crack-inducing ring, and a crack-attracting feature located at the cut-off level outside the crack-inducing ring; characterised in that the crack-inducing ring is a tube made of extruded rubber or plastics having a slit, a plurality of apertures or a fragile region in a portion of its wall facing towards a centre of the pile; and in that the cage further comprises means for supplying pressurised fluid to the crack-inducing ring.

[0017] The solution differs from Skanska or Asakura in that the crack propagation is controlled and restricted to the cut-off level. This is more effective in achieving a crack in the correct plane than the prior art approach of aiming to ensure that the forces created by the expandable element resolve only parallel to the axis of the pile - usually vertical. The application of pressure to a tubular expandable element will produce a radial outward force in all directions. It is difficult to ensure that the pressure at all points around the ring is the same with a single connection point. In Asakura one end of the metal pipe is closed and the other end is connected to a hose capable of supplying a pressurizing fluid. Without a crack-attracting feature the crack may travel from the ring at any angle up to 45° above or below the cut-off level. If the crack were to travel substantially downwards from the cut-off level in any part of the pile it would result in the crack being formed below the debonded section of the pile head thus precluding the ease removal of the pile head. Inappropriate management of this event in the field could result in a structurally weakened pile. If the crack were to travel substantially upwards from the cut-off level in any part of the pile it would leave a projection that would require further remedial work with percussion tools, thereby negating the main advantage of the invention.

[0018] The crack-inducing ring is adapted to permit fluid to flow substantially inwardly towards a centre of the pile. The crack is propagated and the fluid escapes rather than relying solely on the force created by an expanding metal pipe as described in Asakura. If the Asakura pipe were to burst then its connection with the pile cage would result in the debonding material creating a preferential path for the escape of the fluid.

[0019] The pressurised fluid entering the crack-inducing ring initiates a crack whether by means of the expansion of the ring or directed high pressure water flow or a combination of both effects. The crack-attracting feature situated outside the crack-inducing ring ensures that the crack remains substantially planar as it reaches the edge of the pile. By allowing the fluid to flow out towards the centre of the pile, the crack that is initiated is also driven in a substantially planar direction towards the centre of the pile. The resultant surface of the concrete is within design tolerances and only minimal trimming is necessary. This greatly reduces the health and safety risks associated with the use of hand operated tools and provides a safer working environment.

[0020] In order to enable pile cages to be fabricated easily, the present invention teaches the use of an assembly comprising a planar support frame, having an inner annular member supporting the crack-inducing ring, a concentric outer annular member that is or supports the crack-attracting feature, and a plurality of spaced spokes holding the members together.

[0021] Therefore, all the essential parts of the invention that enable the pile cap to be removed hydraulically can be assembled together off-site as a single rigid unit. This saves time on-site as the assembly simply has to be lowered over the reinforcement bars and secured in place at the cut-off level. Furthermore, as the outer member of the assembly that fits outside of the reinforcement bars and preferably serves as the crack-attracting feature is in the same horizontal plane as the crack-inducing ring, there is no need for manual alignment. By a suitable asymmetric spacing of the spokes, the assembly can be made to fit over various numbers and configurations of reinforcing bars typical of the pile size for which it is made.

[0022] The present invention also provides a method of breaking a reinforced concrete pile comprising the steps of placing a fluid-receiving means into a pile cage at a cut-off level, protecting an upper part of the pile cage with debonding material, casting the pile, and supplying pressurised fluid to the fluid-receiving means, characterised in that the fluid-receiving means is adapted to permit fluid to flow substantially inwardly towards a centre of the pile at the cut-off level.

[0023] Ideally the means for supplying pressurised fluid to the fluid-receiving means comprises a pump that enables the application of pressure to be controlled. Use of excess pressure in this type of device can result in the creation of a shock wave within the concrete that effectively explodes the pile apart and may have an undesirable impact on the remainder of the pile structure. A controllable pressure source allows the method to be used with a variety of pile sizes.

[0024] After the crack has been created by the application of the pressurised fluid, there is no concrete con-
nection between the structural pile and pile head. When such a pile head is grasped by a hydraulic grab or crane, it can simply be lifted off and removed leaving the second part of the reinforcement intact. The fluid-receiving means can be reused several times. As a connection point for the fluid supply is preferably located at or near the top of the pile it is easy to access without the need for any excavation. With a connection point at the top of the pile, the crack can be formed prior to excavation. This enables the piles to be cracked as soon as they are set, when the concrete is relatively weak and easy to crack. It also reduces the risk of construction plant damaging the main pile body prior to or during excavation and significantly reduces the time spent on the whole piling operation.

[0025] Other features of the invention are defined in the appended claims.

Advantages of the Invention

[0026] The method of the invention avoids the need for mechanical tools with their associated HAVS risks. It is fast and economical. In addition the method is safer than Asakura as the pressures required are lower because the fluid is able to act over the entire cracked area of the pile.

[0027] The method of the invention considerably improves the accuracy of the cut.

Brief Description of the Drawings

[0028] In order that the invention may be well understood, some embodiments thereof will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 shows a vertical section through a pile cast around a first embodiment of a pile cage of the present invention;

Figure 2 shows a horizontal section through the pile cage of Figure 1 at a cut-off level;

Figure 3 shows a cross section of an annular tube that acts as the fluid-receiving means and crack-inducing ring in Figure 1 and 2;

Figure 4 shows a sectional detail of a connection of the pressurised fluid supply to the tube of Figure 3;

Figure 5 shows a plan view of the connection of Figure 4;

Figure 6 shows a plan view of a first embodiment of a support frame for use in creating a pile cage;

Figure 7 shows a vertical section on line B-B of Figure 6 of the support frame after it has been used to create a pile cage;

Figure 8 shows a plan view of a second embodiment of a support frame for use in creating a pile cage;

Figure 9 shows a vertical section on line B-B of Figure 8 of the support frame after it has been used to create a pile cage; and

Figure 10 shows a cross section of an alternative embodiment of the annular tube.

Detailed Description of Preferred Embodiments

[0029] A pile cage 2 comprises a reinforcement for a pile. The reinforcement is typically fabricated from an assembly of rebars 4 held together in the desired configuration by means of a coil or links (not shown). Steel mesh may also be used to create the reinforcement. The pile cage 2 has a first part 8 that remains in situ in a cast pile and a second part 10, which will be in a pile head that will be incorporated into reinforced concrete slabs or caps. The first and second parts 8 and 10 are separated by the plane of a cut-off level indicated at 20.

[0030] The rebar 4 of the second part 10 of the reinforcement 2 is protected by means of debonding foam tubing 22. The type of foam tubing that is slit axially like pipe insulation is preferred as this can be easily assembled to the rebar 4 in order to form a protective layer. Other debonding products or techniques may be employed. The debonding terminates at the cut-off level 20.

[0031] A crack-inducing ring 30 is positioned at the cut-off level 20. A crack-inducing ring 30’ is shown in profile in Figure 3. The ring may have various detailed profiles and these are distinguished in the drawings by different prime superscripts. Where reference is made to any design the reference numeral 30 is used. The ring is formed from a tube 30 comprising a length of extruded rubber or plastics tubing with a flattened portion 24 and an axial slit 32 along its length. The tube 30 is installed inwardly of the reinforcement structure of the pile cage leaving a sufficiently large central opening to allow passage of a tremmie tube when the concrete is poured. Note that this is not necessary where the pile is constructed using the CFA (continuous flight-auger) piling technique where the concrete column is formed first and the reinforcement is pushed into it from above. This is a common method for smaller piles.

[0032] The slit 32 is positioned at the level of the cut-off plane 20 so that it faces the centre of the pile cage. The tube 30 can be supported by an inwardly projecting limb 26 of a profile support L bars 28 secured to the sleeved rebars 4 at the correct level. A series of, say, six spaced profile support bars 28 are needed for a large pile cage. The flattened part 24 of the crack-inducing ring...
30 is seated against a face of the limb 26 to ensure the slit 32 is correctly positioned. For large pile cages 2 these components are assembled on-site and held together by, for example, cable ties and tape.

[0033] The slit 32 is formed between two wedge-shaped fins 34 moulded as part of the tube 30. The fins create a beak-like structure 38 that serves as a crack-directing feature. In the ex-factory condition the slit 32 is closed by a thin flangible film 36 of rubber material, which is an artefact of the moulding process.

[0034] The crack-inducing ring can be assembled from a length of tubing of an appropriate length, which has been extruded to the required profile. The tubing has two free ends 40. A pressure supply line hose 50 may be coupled to a free end 40 by inserting it into the open end 40. The ends 40 may be taped closed.

[0035] To complete the assembly a pressure supply line hose 50 is inserted into one of the two free ends 40 of the length of tubing 30 and secured in place with a plastic cable tie.

[0036] In an alternative embodiment illustrated in Figures 2, 4 and 5 the two free ends 40 of the length of tubing 30’ are joined together by a connection piece 42 that also provides a coupling 44 to the pressure supply line hose 50. The fins 34 are removed at the ends 40 of the tube to enable the ends 40 to be close-coupled to the connection piece 42 by means of jubilee clips 52 as shown in Figure 5. The connection piece 42 has a hole 54 to which the hose 50 is coupled. A first end 56 of the hose 50 passes through hole 54 into the piece 42 as shown in Figure 4. A flared connection moulding 58 is attached to the exterior of the hose end 56 and is shaped to fit around the exterior of the connection piece 42 in order to ensure a fluid-tight but removable coupling for the hose 50.

[0037] In either embodiment the hose 50 is protected with debonding foam tubing 22 and is attached to a rebar 4 and passes out of the top of the pile cage or is directed out of the cage at a suitable position. A remote end 60 of the hose 50 is fitted with a standard connector 62 to enable it to be connected by a pressure line 64 to a pump (not shown). A suitable pump for this application for use with very large piles is a MADAN® Mark 7 air-driven pump capable of producing an output pressure of 240 bar with an air supply of 7 bar. A pump that enables the application of pressure to be controlled is preferred so that a pressure appropriate to the size of the pile can be applied. Pressures far less than 240 bar will achieve an acceptable result and the appropriate pressure level can be ascertained simply experimentally for any pile size.

[0038] The annular split tube 30 acts as a fluid-receiving means to receive pressurised fluid via the pressure line 64 and hose 50 from the pump. The tube 30, because it is embedded in concrete, will initially fill with the fluid. As the pressure builds up a crack will be initiated around the tube in the same way as in Asakura, but now the fluid will be forced out between the fins 34 breaking the thin film 36 of rubber material closing the slit thereby permitting the fluid to escape into the pile, providing a jacking mechanism separating the pile head from the remaining pile at the cut-off level.

[0039] The material of the tubing 30 must be sufficiently rigid to avoid being displaced during the concrete pour. This may be achieved by reinforcing that part of the tube wall opposite the slit 32 or inserting a rigid reinforcement link 66 into the tube 30.

[0040] A crack-attracting feature 70 is needed in the cut-off plane 20 outside of the rebars 4. A ring of plastics material such as 32 millimetre spiral ducting, hosing or debonding sleeving will serve as a crack-attracting feature 70 and can readily be assembled to the rebar at the appropriate level by means of cable ties as shown in Figures 1 and 2. Alternative crack-attracting features 70 can be formed of plastics sections of almost any shape, for example circular, triangular, square or rectangular. The dimension of the crack-attracting feature 70 in the cut-off plane 20 should be at least a quarter of the thickness of the nominal cover for the rebar 4 and may be as much as a half of the cover. This size of crack-attracting feature 70 considerably improves the effectiveness of the object in preventing the crack generated by the expanding tube 30 and/or escaping pressurised fluid from the slit 32 being directed out of the cut-off plane 20. The crack-attracting feature 70 should be semi-rigid or rigid in order to maintain its position during the concreting operations.

Support Frame for Smaller Piles

[0041] For piles of diameters 600 to 750mm, it is less convenient to assemble the crack-inducing ring and crack-attracting feature 70 to each pile cage on site. This becomes a fiddly operation due to the reduced rigidity of the rebar cage and alignment errors may arise.

[0042] The reinforcement for such piles may only comprise vertical rebars 4 spaced around the periphery of the pile with nominal helical ties. Depending on the specification there may be four, five, six or more rebars.

[0043] In this case the solution is to provide an assembly on a support frame that can be dropped over the ends of the rebars 4 as a completed assembly of frame, crack-inducing ring 30 and crack-attracting feature 70. Two such designs are illustrated in Figures 6 to 9.

[0044] As shown in Figure 6 a wire assembly comprises a frame made of an inner member 114 and an outer concentric member 116. The inner and outer members 114 and 116 are joined together by spokes 118.

[0045] The inner member 114 shown in Figure 6 consists of two annular wires 122 and 124 also connected by the spokes 118. This support frame is adapted to be used with a crack-inducing ring made of a tube 30 with a flattened base 24 and grooves 120 along its length either side of the flattened base 24 as shown in Figure 7. The wires 122 and 124 fit into the grooves 120 to locate and secure the tube 30 in position. In this embodiment the bare outer member 116 cannot function as the crack-attracting feature as it is too small. However it provides a support for a crack control ring 70 made of clear plastics
reinforced hose. Alternatively the outer member 116 may be sleeved in debonding material with a large diameter to act as the crack control ring 70.

For both support frame embodiments it is preferable to have frames that can be used with a variety of rebar designs possible with the pile diameter for which the frame has been manufactured. This can be achieved by positioning the spokes 118 asymmetrically as shown in Figures 6 and 8 rather than giving them a uniform spacing. In these Figures the rebar positions for a variety of designs have been shown with different chain lines and it is clear that the same spoke positions will allow one design to fit over all the illustrated designs. In Figure 6 the spokes are at 59°, 59°, 84°, 84° and 74° spacings clockwise from the line B-B. In Figure 8 an alternative design is shown where the spokes 118 are at 84°, 59°, 75°, 71° and 71° spacings clockwise from the line B-B.

As before the tube 30 is secured to the inner member 114 with plastics cable ties (not shown).

The assembly 110 is fitted to the pile cage 2 by lowering it over the rebars 4 and securing it in position at the cut-off level 20. The outer ring 116 fits outside reinforcement structure 4 and the inner ring 114 fits inside the reinforcement structure 4.

Alternative Tube Design

Figure 10 illustrates a cross section through an alternative design of split tube 30 that does not require a special extrusion as shown in Figures 1 to 9. In this embodiment the tube has a simple slit 32 cut into it and a 10 millimetre wire reinforcement link 80 located within the tube 30. In order to maintain the slit 32 open, a folded piece of ribbed plastic sheeting 82 is inserted along its length. The sheeting 82 has a W shaped cross section as shown in Figure 10 with the free ends 84, 86 held against the inner wall of the tube 30 at either side of the slit 32, and a longer central fold 88 protruding through the slit 32 in order to keep it open. A number of these spacers 82 can be positioned around the periphery of the ring all facing inwardly. The projecting fold 88 will act as a crack-directing feature to promote cracking in the plane of the cut-off plane 20.

Method of Use

The method of use of such a pile cage 2 will now be described.

The reinforcement 2 is prefabricated and the second part 10 of the reinforcement has debonding tubing foam 22 carefully fitted to the rebar 4 above the cut-off level 20.

The fluid-receiving means, tube 30 is fitted inwardly of the reinforcement and secured to the debonded rebar 4. The slit 32 of the tube 30 is positioned facing towards the centre of the pile at the required cut-off level 20. A crack-attracting feature is also fitted outwardly of the reinforcement. Where a prefabricated assembly 110 is used this is fitted over the reinforcement and secured to the debonded rebar 4 at the required cut-off level 20.

The hose 50 is then connected to the fluid-receiving means as previously described. The hose 50 is protected by debonding foam 22 and passed out of the top or side of the pile cage 2. The hose 50 and the debonding foam 22 are kept in place by attaching them to a rebar 4.

The pile is bored to the desired depth and fully assembled cage 2 installed.

The pile is then concreted resulting in a pile as illustrated in Figure 1. The pile is cast as a single reinforced column 100 comprising a structural element 102 that will remain in place and a pile head or cap 104 that will be removed.

The pile is allowed to set for typically two to five days.

The connector 64 is connected to a pump (not shown). In the embodiments of Figures 1 to 10 the pump pumps pressurised water down the hose 50 into the fluid-receiving means 30. In the embodiment of Figures 4 and 5 the pressure exerted by the fluid entering the connection piece 42 ensures a tight connection between the connection piece 42 and the flared connection moulding 58 reducing the amount of fluid escaping out of the hole 54. The pressure also ensures a tight connection between the flared connection moulding 58 and the surrounding concrete preventing the exterior of the hose 50 and the surrounding foam 22 becoming a preferential path for escaping fluid. The pressure of the fluid expands the tube 30 initiating a crack on either side. The fins 34 create a feature from which the crack will naturally propagate in the cut-off plane 20. As the pressure increases fluid is forced out of the slit 32 between the fins 34 directly into the crack, forcing the crack to extend in a plane towards the center of the pile. The crack on the side of the tube 30 opposite to the fins 34 propagates in the absence of fluid. The crack-attracting feature 70 ensures that this crack also propagates in a substantially planar fashion out of the edges of the concrete pile. Completion of the cracking operation is verifiable by the use of ultrasonic
testing such as crosshole ultrasonic logging or pulse-echo testing. If the pile head is exposed the completion of the crack is signalled by escaping fluid around the entire periphery of the pile at the cut-off level.

[0059] Once a crack has been achieved the hydraulic lines 64 are disconnected and removed. The severed pile head 104 can then be lifted vertically by means of a mechanical grab. As the pile head is pulled upwardly the hose 50 will pull out of the connection piece 42, open end 40 of tube 30 or plates 90 as appropriate leaving these in situ on the surface of the cut-off plane. It is then straightforward to separate the fluid-receiving means and crack-attracting features 70 from the pile cage 2 and remove these items for re-use with another pile cage. If an assembly 110 on a support frame 112 has been used removal is even simpler. The debonding 22 is removed and the pile is finished off. In the embodiment of Figures 4 and 5, provided the outer diameter of the flared connection moulding 58 is greater than the diameter of the connector 62, the flared connection moulding 58, the hose 50 and the connector 62 can be pulled downwardly out of the pile head 104 from the cut face.

[0060] All the components can then be re-used with another pile cage.

Variations

[0061] In place of the continuous slit in the annular tube 30, a series of apertures or perforations may be provided at the cut-off level 20. A projecting fin or other formation adapted to lie in the cut-off plane 20 may be provided between the apertures in order to ensure that the crack propagates in the correct plane.

[0062] It will be appreciated that the pile cage and pile cap removal system described above allows the programme of pile cap removal to be shortened considerably relative to existing methods. The hydraulic pump, if air powered, can readily be moved from pile to pile with its compressed air supply. The time taken to split a pile using this method can be reduced to minutes. The removed pile heads can then be lifted away separately as the programme permits. Note that the positioning of the connectors 64 in an upper surface means that the piles do not need to be excavated before being split.

Claims

1. A pile cage (2) comprising a reinforcement structure (4) having a first part (8) adapted to remain in a pile, the first part terminating at a predefined cut-off level (20), and a second part (10) that is protected in order to debond it from concrete cast around it; a crack-inducing ring (30), a directing feature (34, 88) on or adjacent the crack-inducing ring, and a crack-attracting feature (70, 116) located at the cut-off level (20) outside the crack-inducing ring (30); characterised in that the crack-inducing ring is a tube made of extruded rubber or plastics, said tube having a slit or a plurality of apertures or a frangible region (32) in a portion of its wall facing towards a centre of the pile; and in that the cage further comprises means (42, 44, 50, 58, 62, 64, 90) for supplying pressurised fluid to the crack-inducing ring (30).

2. A pile cage (2) as claimed in claim 1, wherein the crack-directing feature comprises fins (34) defining the slit.

3. A pile cage (2) as claimed in any one of the preceding claims, wherein the crack-attracting feature (70, 116) has a dimension of at least a quarter of the depth of cover between the pile exterior and a closest part of the reinforcement structure (4).

4. A pile cage (2) as claimed in any one of the preceding claims, wherein the crack-attracting feature (70, 116) has a dimension of at least half of the depth of cover between the pile exterior and a closest part of the reinforcement structure (4).

5. An assembly (110) for use in creating a pile cage (2) as claimed in any one of the preceding claims, comprising a planar support frame (112) having an inner annular member (114) supporting the crack-inducing ring (30), a concentric outer annular member (116) that is or supports the crack-attracting feature, and a plurality of spaced spokes (118) holding the members (114, 116) together.

6. An assembly as claimed in claim 5, wherein the spokes (118) are positioned to fall between reinforcing bars of pile cages having a variable number of equally spaced reinforcing bars.

7. A method of breaking a reinforced concrete pile (100) comprising the steps of placing a fluid-receiving means (30) into a pile cage (2) at a cut-off level (20), protecting an upper part (10) of the pile cage (2) with debonding material (22), casting the pile, and supplying pressurised fluid to the fluid-receiving means (30), characterised in that the fluid-receiving means (30) is adapted to permit fluid to flow substantially inwardly towards a centre of the pile at the cut-off level.

8. A method as claimed in 7, wherein the step of supplying pressurised fluid to the fluid-receiving means comprises use of a pump that enables the application of pressure to be controlled.

Patentansprüche

1. Pfahlkäfig (2), umfassend eine Bewehrungsstruktur
Verfahren des Brechens eines bewehrten Betonbaugruppen nach Anspruch 5, wobei die Speichenbaugruppe (110) zur Verwendung beim Erzeugen eines Pfahlkäfigs (2) nach einem der vorangehenden Ansprüche, wobei das Risslenkungsmerkmal (34, 88) am oder angrenzend an den Risinduktionsring und ein Rissanziehungsmerkmal (70, 116) des, sich auf der Abtrennhöhe (20) außerhalb des Risinduktionsrings (30) befindet, dadurch gekennzeichnet, dass das Fluidaufnahmemittel (30) zu einem Pfahl (22), Gießen des Pfahls, und Zuführen von unter Druck stehendem Fluid an das Fluidaufnahmemittel (30), dadurch gekennzeichnet, dass das Fluidaufnahmemittel (30) dazu angepasst ist, zuzu-lassen, dass Fluid im Wesentlichen nach innen zu einer Mitte des Pfahls auf der Abtrennhöhe fließt.


Revendications

1. Cage de pieu (2) comprenant une armature (4) ayant une première partie (8) adaptée pour rester dans un pieu, la première partie se terminant à un niveau de coupe prédéfinit (20), et une seconde partie (10) qui est protégée afin de ne pas adhérer au béton coulé autour d’elle ; un anneau de formation de fissure (30) aligné au niveau de coupe (20), un élément d’orientation de fissure (34, 88) sur ou contigu à l’anneau de formation de fissure, et un élément d’attraction de fissure (70, 116) située au niveau de coupe (20) en dehors de l’anneau de formation de fissure (30) ; caractérisé en ce que l’anneau de formation de fissure est un tube réalisé en caoutchouc ou plastique extrudé, ledit tube ayant une fente ou une pluralité d’ouvertures ou une région frangible (32) dans une partie de sa paroi faisant face à un centre du pieu ; et en ce que la cage comprend un moyen (42, 44, 50, 58, 62, 64, 90) pour fournir un fluide sous pression à l’anneau de formation de fissure (30).

2. Cage de pieu (2) selon la revendication 1, dans laquelle l’élément d’orientation de fissure comprend des ailettes (34) qui définissent la fente.

3. Cage de pieu (2) selon l’une quelconque des revendications précédentes, dans laquelle l’élément d’attraction de fissure (70, 116) a une dimension d’au moins un quart de la profondeur de couverture entre l’extérieur du pieu et une partie la plus proche de l’armature (4).

4. Cage de pieu (2) selon l’une quelconque des revendications précédentes, dans laquelle l’ élément d’attraction de fissure (70, 116) a une dimension d’au moins la moitié de la profondeur de couverture entre l’extérieur du pieu et une partie la plus proche de l’armature (4).

5. Ensemble (110) destiné à être utilisé dans la création eines Fluidaufnahmemittels (30) in einen Pfahlkäfig (2) auf einer Abtrennhöhe (20), Schützen eines oberen Abschnitts (10) des Pfahlkäfigs (2) mit Trennmaterial (22), Gießen des Pfahls, und Zuführen von unter Druck stehendem Fluid an das Fluidaufnahmemittel (30).

1. Revendications
d’une cage de pieu (2) selon l’une quelconque des revendications précédentes, comprenant un cadre de support plan (112) ayant un élément annulaire interne (114) qui supporte l’anneau de formation de fissure (30), un élément annulaire externe concentrique (116) qui est ou supporte l’élément d’attraction de fissure, et une pluralité de rayons espacés (118) qui maintiennent les éléments (114, 116) ensemble.

6. Ensemble selon la revendication 5, dans lequel les rayons (118) sont positionnés de sorte qu’ils sont disposés entre des barres de renfort de cages de pieux ayant un nombre variable de barres de renfort équidistantes.

7. Procédé de cassure d’un pieu de béton armé (100) comprenant les étapes de placement d’un moyen récepteur de fluide (30) dans une cage de pieu (2) à un niveau de coupe (20), de protection d’une partie supérieure (10) de la cage de pieu (2) avec un matériau de décollage (22), de coulée du pieu, et de fourniture d’un fluide sous pression au moyen récepteur de fluide (30), caractérisé en ce que le moyen récepteur de fluide (30) est adapté pour permettre au fluide de s’écouler sensiblement vers l’intérieur vers un centre du pieu au niveau de coupe.

8. Procédé selon la revendication 7, dans lequel l’étape de fourniture d’un fluide sous pression au moyen récepteur de fluide comprend l’utilisation d’une pompe qui permet de réguler la pression appliquée.
REFERENCES CITED IN THE DESCRIPTION

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