

Description

[0001] The invention relates to a method as defined in the first part of claim 1.

[0002] Such a method is commonly known for anchoring (steel) sheet pile walls.

[0003] In general one proceeds in a way that the required holes for a plurality of anchoring locations are made first before inserting the anchors therethrough and screwing the anchors to the desired depth.

[0004] Problems are encountered when the anchoring sites, i.e. the locations where the holes have to be made, are located (far) below (ground) water level. Even when one would, in such a case, postpone making of an individual sheet pile hole until the very moment at which the respective anchor would have to be placed through this hole, this would result in an unacceptable leakage of (ground) water through the sheet pile hole.

[0005] Now the invention aims at providing an effective solution for this problem.

[0006] According to the invention this aim is achieved thanks the features defined in the second part of claim 1.

[0007] It will be understood that with this way of proceeding, although water may flow into the tube section, such water can not escape from said tube section outwardly, because either the proximal end portion of the tube section is located above ground water level, or such escape is avoided by the annular flange, that sealingly closes the tube section.

[0008] The method of the present invention may also be advantageously applied for securing the bottom part of a construction, such as a tunnel body, that extends into the ground to a level which is (far) under ground water level.

[0009] The invention will be hereinafter further explained by two examples with reference to the accompanying drawing.

Fig. 1 is a diagrammatic vertical section through a sheet pile wall, which has to be secured in the ground by applying the method of the present invention and

fig. 2 is a diagrammatic vertical section through a portion of a tunnel body, which has to be secured by applying the method of the present invention.

[0010] With reference to fig. 1, 1 designates a sheet pile wall which is to be secured against the lateral ground pressure exerted by the ground body 2 from the right. For this purpose pull anchors 3 are used, which have to be placed from the left side of the sheet pile wall, where e.g. a construction pit has to be established. For inserting the pull anchors, which may be screw anchors, through holes have to be provided in the sheet pile wall 1. The example shown in fig. 1 relates to a case, wherein the sites P, where the through holes must be provided, are located relatively far below the

(ground) water level 4 on the right side of the sheet pile wall 1. Now, in order to prevent an uncontrolled (ground) water stream from flowing from the right to the left through the created through holes, the procedure of the invention is as follows.

[0011] At each of the sites P a (steel) tube section 5 is attached as by welding, whereby the end of the tube section to be attached is bevelled off and placed according to the desired direction of insertion (arrow A). The length of the tube section 5 is slightly larger than the length of the screw body 3b of the anchor 3. A cutting ring 6 is welded to the distal end of the screw body 3b. E.g. waste scrap may be provided on the edge of the cutting ring that is facing the sheet pile wall 1.

[0012] The thus prepared pull anchor is placed within the tube section 5, until the bevelled pin 3c, which closes the distal end of the (hollow) anchor rod 3a, strikes the sheet pile wall. The anchor rod 3a will then be projecting with its proximal end beyond the proximal end of the tube section 5. The proximal end of the tube section which is expected to become under ground water level, is closed by an end plate 7 to be welded to it, said end plate having a central opening which is just large enough for passing a connecting sleeve 9 that is required for connecting an extension rod 8. The end plate 7 is provided with a sealing member 10, that circumferentially engages the outwardly projecting end portion of the anchor rod and is e.g. in the form of a rubber disc, that it placed on the plate 7 and is then pushed inwardly to enclose the outgoing end portion of the anchor rod 3a. In the example shown the sealing member 10 is held by means of a cover plate 11 to be fastened by screws. The pull anchor 3 is then rotated by means of the usual equipment (not shown in the drawing) and pushed in the axial direction (direction A). The cutting ring 6 will thereby cut a correspondingly sized piece from the sheet pile wall 1 and said piece will be pushed inwardly by the bevelled pin 3c. This creates a hole through which (ground) water may flow from the right into the tube section 5. The amount of water thus leaking towards the left side of the sheet pile wall 1, however, will be limited to the space within the tube section 5. As soon as the anchor 3 has been screwed to the desired depth the proximal portion of the (last) extension rod extending beyond the tube section 5 may be connected to the tube section in a pull proof manner.

[0013] The screw anchor 3 may be provided - at places between the successive screw blade convolutions of the screw blade body 3b - with injection ports. A stabilizing mortar may be injected through these ports, after the anchor has been screwed to the desired depth. Up to the moment of injecting these ports will have to be closed. For this purpose use may be advantageously be made of an injection screw anchor of the type disclosed in published Dutch patent application 8403178, wherein injection ports are closed by means of plastic plugs. The use of such an injection anchor with the present method will prevent (ground) water that flows away towards the

left side, from entering the hollow anchor rod through the injection ports.

[0014] In case the sheet pile wall in question is of a more or less permanent nature and maintenance of the tube sections 5 is undesirable because they form obstacles, it will be possible - upon the anchors having been screwed to the desired depth - to inject a stabilizing mortar through (hitherto plugged off) injection ports in the (last) extension rod into the ground immediately behind the sheet pile wall, so that the through hole made in the sheet pile wall may be at least provisionally sealed from the ground body 2. The tube sections 5 may then be removed, and the portion of the (last) extension rod which still projects beyond the sheet pile wall 1 may be secured relative to the sheet pile wall 1 and the through hole may be permanently closed by welding. In fact this has resulted in the usual situation.

[0015] The example of fig. 2 relates to a tunnel trough 20 provided in the ground 2 and comprising side walls 21 (only one of which is shown in the drawing) and a bottom 22. In this case the tunnel trough 20 is sunk deeply into the ground water (see the ground water level 4).

[0016] In the example of fig. 2 the use of the method of the invention may be advantageous when:

- a. it has turned out that (additional) pull anchors are required to prevent the tunnel trough with (more) certainty from floating to the surface under the influence of the upward ground water pressure and/or
- b. it has turned out that the lateral ground pressure on the opposite tunnel side walls 21 results in a moment, due to which the tunnel trough tends to turn in a horizontal plane.

[0017] In the first case tube sections 5 of the type shown in fig. 1 may be provided at suitable locations and placed at right angles onto the bottom 22 after which one may proceed further as described hereinabove with reference to fig. 1.

[0018] In the second case (b) tube sections 5 of the type shown in fig. 1 may be placed onto the bottom 22 adjacent an end of the tunnel trough and preferably adjacent one of the two tunnel trough side walls 21 and in an obliquely outwardly directed position (see arrow B), whereas adjacent the other end of the tunnel trough and preferably adjacent the other of said two tunnels trough side walls tube sections 5 are placed which are obliquely directed to the opposite side. The procedure substantially corresponds with what has been described hereinabove with reference to fig. 1.

[0019] To attach the tube sections 5 in the example of fig. 2 use may be made of fastening flanges 23, which may be received, if desired, in recesses which are precut in the upper surface of the bottom 22. Each tube section together with the flange 23 connected to it, the anchor 3 received therein and the closing end plate assembly 7, 10, 11 may be placed and attached (by

screws) as a pre-assembled unit.

[0020] In the example of fig. 2 the tube sections 5 will have to be removed after the anchors 3 have been screwed to the desired depth. To this end one may, in the manner as described with reference to fig. 1, inject mortar through the precut through hole into the directly underlying ground body 2 via temporarily closed injection ports in the (last) extension rod 8. See the area indicated by dash lines under the bottom 22 in fig. 2.

[0021] Depending on the circumstances one may decide to effect injection into the ground behind the sheet pile wall or under the tunnel bottom respectively either prior to or after injecting the ground around the anchor screw body at the desired depth. For this freedom of choice one may use more or less jamming closure plugs or apply hoses for insertion into the extension rod.

[0022] Upon the drilled through holes being thus sealed against the leakage of ground water each of the tube sections 5 may be removed, after which the still projecting portion of the (last) extension rod 8 may be secured - with the aid of a suitable auxiliary means, within the hole and then severed at the upper surface of the bottom 22.

Claims

1. A method for anchoring a wall in the ground by means of pull anchors, comprising the steps of:

- making holes in the wall;
 - inserting an anchor, comprising a rod with a screw blade section at its distal end, through each hole;
 - screwing the anchor into the ground behind (and under) the wall until the proximal end of the anchor rod remains extending just beyond the hole;
 - connecting an extension rod to the proximal end of the anchor rod and continuing screwing to bring the anchor to the desired depth, after which
 - the portion of the (last) extension rod that is kept extending beyond the hole is fixedly attached to the wall,
- characterized by** the additional steps of
- attaching, at the site of each hole to be made, a tube section to the wall at an angle that corresponds with the desired angle of inclination of the anchor;
 - placing the anchor with its screw blade section, which carries a cutting ring at its distal end, into the thus attached tube section, with the anchor rod projecting beyond the upper end of the tube section and
 - rotating and pushing the anchor to cause the cutting ring to drill a hole in the wall and thereby allowing the anchor to pass through the wall

and through the ground behind the wall, wherein

- the latter step is effected either immediately upon attachment of the tube section to the wall when the upper end of the tube section is above the ground level behind the wall or upon the upper end of the tube section being first closed by an annular flange, through which the proximal end portion of the anchor rod extends outwardly with the intermediary of a sealing member that sealingly engages the anchor rod, in case the upper end of the tube section is under ground water level.

holes extend(s) laterally obliquely in one direction, whereas the axis (axes) of the second through hole or group of through holes extend(s) laterally outwardly in the opposite direction.

2. A method according to claim 1, **characterized in that** the wall is a sheet pile wall and that - after the anchor rod has been screwed to the desired depth - the portion of the (last) extension rod extending beyond the proximal end of the tubular section is connected to the tubular section in a pulltight manner.
3. A method according to claim 1, **characterized in that** as a last extension rod use is made of an extension rod which is provided with injection ports which are temporarily closable by means of plugs, through which injection ports a stabilizing mortar is injected - while pushing the respective plugs away - into the ground just behind the sheet pile wall, in such a way, that this will seal the through hole in the wall, after which the tubular section is removed and the portion of the (last) extension rod, that still projects beyond the wall, is connected to the wall in a pulltight manner.
4. A method according to claim 1 or 2, **characterized in that** it is applied for anchoring the bottom of a structure, such as a tunnel trough that is sunk deeply below ground water level into the ground, wherein the tubular section is connected to the bottom to be anchored by means of a fastening flange.
5. A method according to claim 4, **characterized in that** at first a recess is provided in the upper surface of the bottom for receiving the flange.
6. A method according to claim 5, **characterized in that** for a pulltight connection of the portion of the (last) extension rod use is made of an auxiliary piece, adapted to take a flush-mounted position within the through hole of the bottom.
7. A method according to claims 4-6, **characterized in that** a through hole or a group of through holes is made at each of two longitudinally spaced sites, each through hole being adapted to screwingly insert a pull anchor through it, wherein the axis (axes) of one through hole or group of through

8. A pull anchor for use with the method according to any of the foregoing claims, comprising an anchor rod with a screw blade body at the distal end thereof, **characterized in that** cutting means are provided at the distal end of the screw blade body, adapted to drill a hole of a size allowing the screw blade body to pass through it.

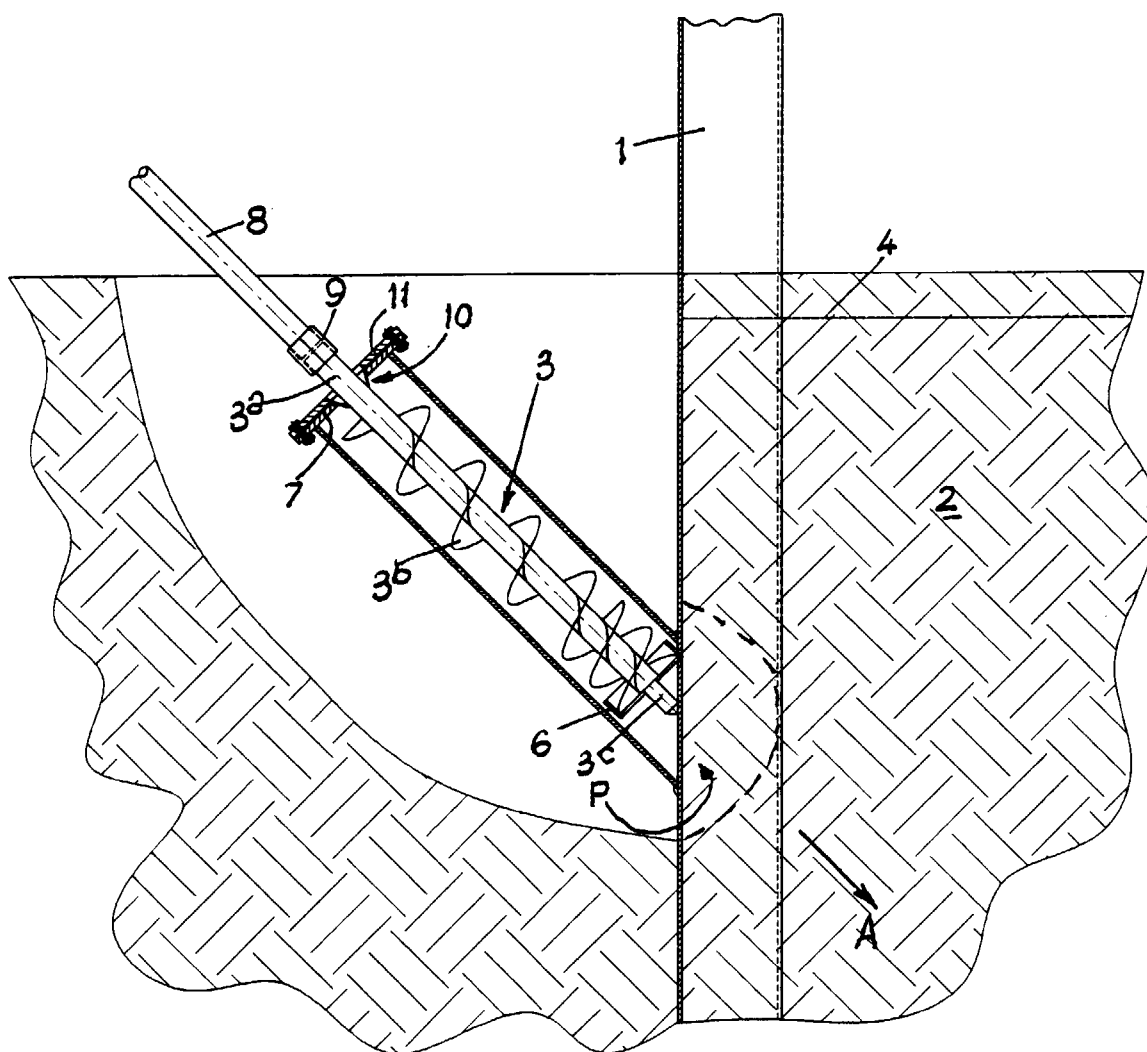


FIG. 1

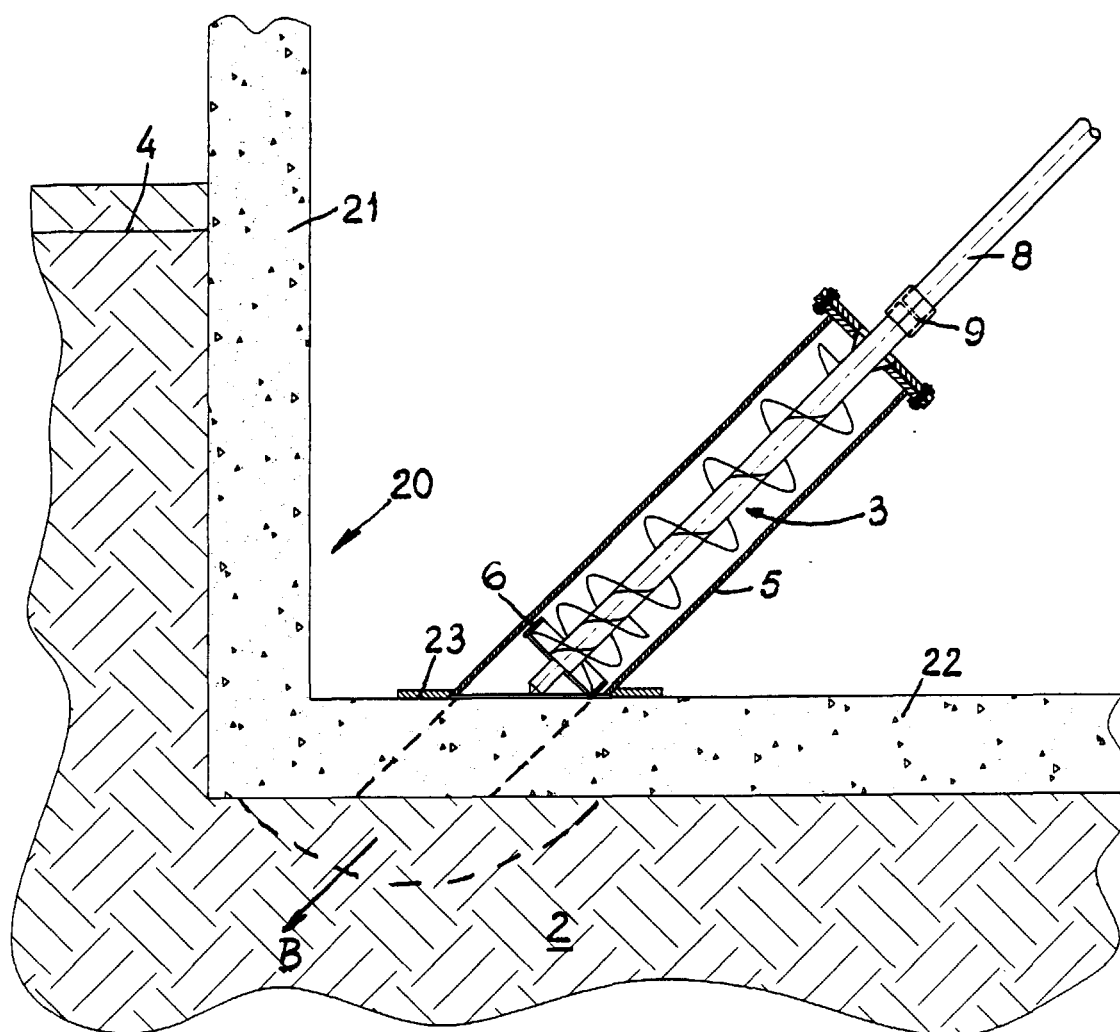


FIG. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 20 1116

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 253 781 A (FISCHER JOACHIM ET AL) 3 March 1981 (1981-03-03)	8	E02D5/76
A	* column 2, line 66 - column 4, line 64; figures 1-5 *	1,2	
A	EP 0 360 221 A (TGB TECHNOGRUNDBAU GMBH) 28 March 1990 (1990-03-28) * column 2, line 45 - column 6, line 14; figures 1,2 *	3-7	
A	DE 197 44 551 C (CORNELIUS WILHELM) 10 December 1998 (1998-12-10) * column 4, line 56 - column 6, line 9; figures 1-3 *	1-3,8	
A	US 3 665 717 A (SWEENEY GERALD T ET AL) 30 May 1972 (1972-05-30) * column 2, line 69 - column 5, line 16; figures 1-8 *	1,8	
A	US 5 575 122 A (HAMILTON DANIEL V ET AL) 19 November 1996 (1996-11-19) * column 3, line 40 - column 6, line 23; figures 1-10 *	1,8	TECHNICAL FIELDS SEARCHED (Int.Cl.7) E02D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 June 2000	Examiner Tellefsen, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P4/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 20 1116

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-06-2000

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4253781	A	03-03-1981	NONE	
EP 0360221	A	28-03-1990	DE 3831926 A AT 90407 T DE 58904617 D ES 2045321 T	22-03-1990 15-06-1993 15-07-1993 16-01-1994
DE 19744551	C	10-12-1998	NONE	
US 3665717	A	30-05-1972	CA 944167 A	26-03-1974
US 5575122	A	19-11-1996	CA 2188863 A	23-05-1997