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(54) **Device for and method of inserting a drainage material into the ground**

(57) The invention pertains to device for and a method of inserting a drainage material (5), such as a drainage wick, into the ground, said device comprising a carrier (1) or frame, an insertion lance (3) comprising a passage for receiving the drainage material (5), and a means (2) for guiding the lance. The lance comprises a bottom portion (11) which, seen in the insertion direction of the lance, has a cross-sectional area smaller than that of the adjoining portion (13) of the lance. The resistance acting on the lance during insertion thus can be reduced considerably.

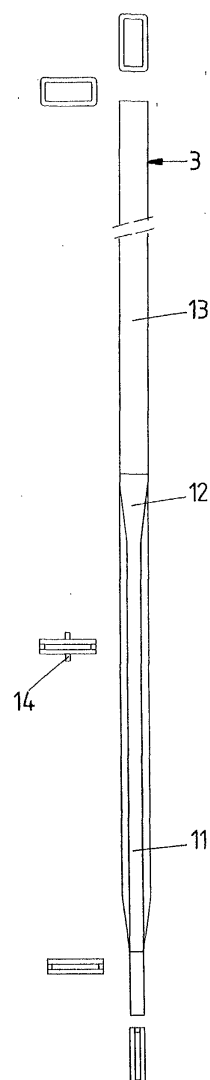


fig. 3A

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Description

[0001] The invention pertains to a device for inserting a drainage material, such as a drainage wick, into the ground, said device comprising a carrier, such as a hydraulic crane, or frame, an insertion lance comprising a passage for receiving the drainage material, and a means for guiding the lance. The invention further pertains to a lance suitable for use in a device for inserting a drainage material into the ground, as well as to a method of inserting a drainage material into the ground.

[0002] Ground or soil stabilisation using vertical drainage wicks is applied in areas with e.g. compressible and/or water saturated soils, such as clay. These soils are characterised by a very weak so-called soil skeleton and a large pore space, usually filled with water (pore water). When a load, such as a road embankment, a hydraulic fill or a dike, is placed on soft compressible soils, significant settlements may occur.

[0003] By installing evenly spaced drainage wicks, e.g. at intervals of 1 or 2 meters, the flow path of the pore water is effectively shortened and pore water is enabled to flow in a horizontal direction towards the nearest drain. Devices for installing wicks are known, e.g. from GB 632 902, EP 0 226 251 and EP 0 672 795. Although these devices operate satisfactorily, difficulties can arise if the soil contains one or more resistant, e.g. relatively hard, layers. Depending on the thickness and penetration resistance of these layers, it may even be necessary to pre-drill holes into the ground before being able to install the drainage wicks.

[0004] It is an object of the present invention to reduce or even obviate these difficulties. To this end, the device and insertion lance according to the present invention are characterised in that the lance comprises a bottom portion, seen in the insertion direction of the lance, having a cross-sectional area smaller than that of the adjoining portion of the lance and preferably than that of the rest of the lance.

[0005] It appeared that peak loads resulting from the resistance in the ground, especially at the tip of the lance, thus can be reduced or avoided, probably as a result of a more even distribution of such resistance over the length of the lance.

[0006] Although the required length of the said bottom portion will depend mainly on the (local) conditions of the of the ground, it is generally preferred that the said bottom portion has a length of at least half a meter, preferably at least one meter. It is further preferred that the said cross-sectional area is less than three-quarters of that of the adjoining portion and/or that the circumference of the bottom portion is smaller than that of the adjoining portion and preferably than that of the rest of the lance.

[0007] The bending and/or buckling resistance of the lance can be increased by providing the bottom portion with one or more reinforcing features, preferably extending in the longitudinal direction of the lance. Examples

of such features are one or more ridges or ribs welded onto the lance or a longitudinal corrugation in the wall of the lance.

[0008] The invention further pertains to a method of inserting a drainage material into the ground, at least comprising the following steps:

probing the ground so as to establish the presence and thickness of resistant layers, preferably over the greater part or all of the contemplated insertion depth,
selecting or preparing an insertion lance comprising a bottom portion, seen in the insertion direction, having a cross-sectional area smaller than that of the adjoining portion of the lance, said bottom portion further having a length which is at least half of that of the thickness of the most resistant layer, and inserting a drainage material into the ground by means of said lance.

[0009] Thus, the insertion of drainage material can be adapted accurately to local soil conditions.

[0010] The invention will now be explained in more detail with reference to the drawings, in which two preferred embodiments are schematically shown.

[0011] Figure 1 shows a perspective view of a device for inserting drainage wicks into the ground.

[0012] Figure 2 shows an insertion lance in accordance with the prior art.

[0013] Figures 3A and 3B show a first and second preferred embodiment according to the present invention.

[0014] Figure 4 shows a diagram containing information relating to the resistance acting on the lances according to Figures 2 to 3B during the inserting of a drainage wick.

[0015] Identical parts and parts performing the same or substantially the same function will be denoted by means of a same numeral.

[0016] Figure 1 shows a device for inserting drainage wicks into the ground, comprising a movable carrier formed by a hydraulic crane 1 and a guide, e.g. a mast 2 fixed to the crane 1. The device further comprises an insertion lance 3, a supply 4 for a drainage wick 5, and a cable 6. The mast 2 is provided with reversing wheels 7 respectively at its top and bottom (on the far side of the mast 2, behind supply 4). Cable 6 runs through the mast 2, is trained round the reversing wheels 7 and forms a closed loop by means of an external fastening element 8 to which both ends of cable 6 are connected. The insertion lance 3 can be moved up and down by means of the cable 6 and an associated driving means (not shown). A drainage wick 5 can be inserted into the ground by guiding it through an inlet opening (not shown) at the lower side of the mast 2, over the top of the mast 2 and through a passage in the lance 3 and subsequently inserting the lance 3 into the ground. For more details concerning the devices in hand and the insertion of the drainage material, reference may be had

to EP 0 226 251 and EP 0 672 795.

[0017] Figure 2 shows a (prior art) lance 3, which consists of a steel tube 9 of constant and substantially rectangular cross-section, which defines a passage, in this case a lumen or longitudinal cavity 10, for receiving a length of the drainage wick 5. Typically, such a lance 3 is 5 to 65 meters long, has a wall thickness of 4 to 12 mm and dimensions in the lateral directions (substantially perpendicular to the longitudinal direction) in a range from e.g. 5 to 15 cm.

[0018] Figures 3A and 3B show two different embodiments of a lance 3 in accordance with the present invention, which differ from the above-mentioned (prior art) lance 3 in that both comprise a straight bottom portion 11 having a smaller diameter in one lateral direction and thus a smaller cross-sectional area and footprint. In this particular example, the bottom portion tapers (upwards), through a taper 12, into an adjoining straight portion 13. The lance 3 shown in figure 3A is provided, by means of welding, with two longitudinal reinforcing ribs 14, on either side and in the middle of the bottom portion 11, whereas the lance 3 shown in figure 3B is provided with four reinforcing ribs 14, two on either side and at or near the edges of the bottom portion 11. The ribs 14 substantially avoid bending and buckling of the lance 3 during normal operation. It is also possible to provide e.g. a longitudinal corrugation in the wall of the lance.

[0019] Specific versions of the above lances 3 were field-tested. All tested lances had a length of 10 m and a constant cross-section of 120x60x10. The lances according to the invention further comprised a bottom portion having a length of 2 m and a constant cross-section of 120x30x10. These lances also included a linear taper, having a length of 30 cm, at the transition between the bottom portion and the adjoining portion. At a test site, the ground was probed by means of a Cone Penetration Test (CPT), which is known in itself and does not require further explanation, to establish the presence and thickness of resistant layers. The results of this CPT are shown in Figure 4, from which it can be seen that the said ground contained one relatively hard layer, starting at a depth of roughly half a meter and ending at a depth of almost four meters, i.e. having a thickness of approximately 3 m.

[0020] Figure 4 further shows that, during insertion, the prior art lance (denoted by solid triangles) experienced a resistance closely resembling the course of the CPT and resulting in a maximum driving force of more than 140 kN. In contrast, the lances according to the invention (denoted by circles for the version shown in Figure 3A and solid bullets for that shown in Figure 3B) experienced a more evenly distributed resistance and no significant peak loads. This example clearly shows that insertion of the lances according to the invention requires less force and energy. Further, such lances will not or rarely require pre-drilling.

[0021] The invention is not restricted to the above de-

scribed embodiments which can be varied in a number of ways within the scope of the claims. For instance, instead of two portions of different cross-sectional areas, resulting in one step or transition, the lances according to the invention can comprise three or more portions of different cross-sectional areas increasing in a direction opposite to the insertion direction, resulting in two or more steps. By employing such a stepped design, resistance will be further distributed over the length of the lance.

Claims

1. Device for inserting a drainage material (5), such as a drainage wick, into the ground, said device comprising a carrier (1) or frame, an insertion lance (3) comprising a passage for receiving the drainage material (5), and a means (2) for guiding the lance (3), **characterised in that**, the lance (3) comprises a bottom portion (11), seen in the insertion direction of the lance (3), having a cross-sectional area smaller than that of the adjoining portion (13) of the lance (3).
2. Device according to claim 1, wherein the said bottom portion (11) has a length of at least half a meter, preferably at least one meter.
3. Device according to claim 1 or 2, wherein the said area is less than three-quarters of that of the adjoining portion (13).
4. Device according to any one of the preceding claims, wherein the circumference of the bottom portion (11) is smaller than that of the adjoining portion (13).
5. Device according to any one of the preceding claims, wherein the transition (12) between the bottom portion (11) and the adjoining portion (13) is tapered or curved.
6. Device according to any one of the preceding claims, wherein the bottom portion (11) is provided with one or more reinforcing features (14), preferably extending in the longitudinal direction of the lance (3).
7. Lance (3) suitable for use in a device for inserting a drainage material (5) into the ground and comprising a passage for receiving the drainage material (5), **characterised in that**, the lance (3) comprises a bottom portion (11), seen in the insertion direction of the lance (3), having a cross-sectional area smaller than that of the adjoining portion (13) of the lance (3).
8. Insertion lance (3) according to claim 7, wherein the

said bottom portion (11) has a length of at least half a meter, preferably at least one meter.

9. Insertion lance (3) according to claim 7 or 8, wherein the circumference of the bottom portion (11) is smaller than that of the adjoining portion (13). 5

10. A method of inserting a drainage material (5) into the ground, at least comprising the following steps: 10

probing the ground so as to establish the presence and thickness of resistant layers, selecting or preparing an insertion lance (3) comprising a bottom portion (11), seen in the insertion direction of the lance (3), having a cross-sectional area smaller than that of the adjoining portion (13) of the lance (3), said bottom portion (11) further having a length which is at least half of that of the thickness of the most resistant layer, and 15 20
inserting a drainage material (5) into the ground by means of said lance (3).

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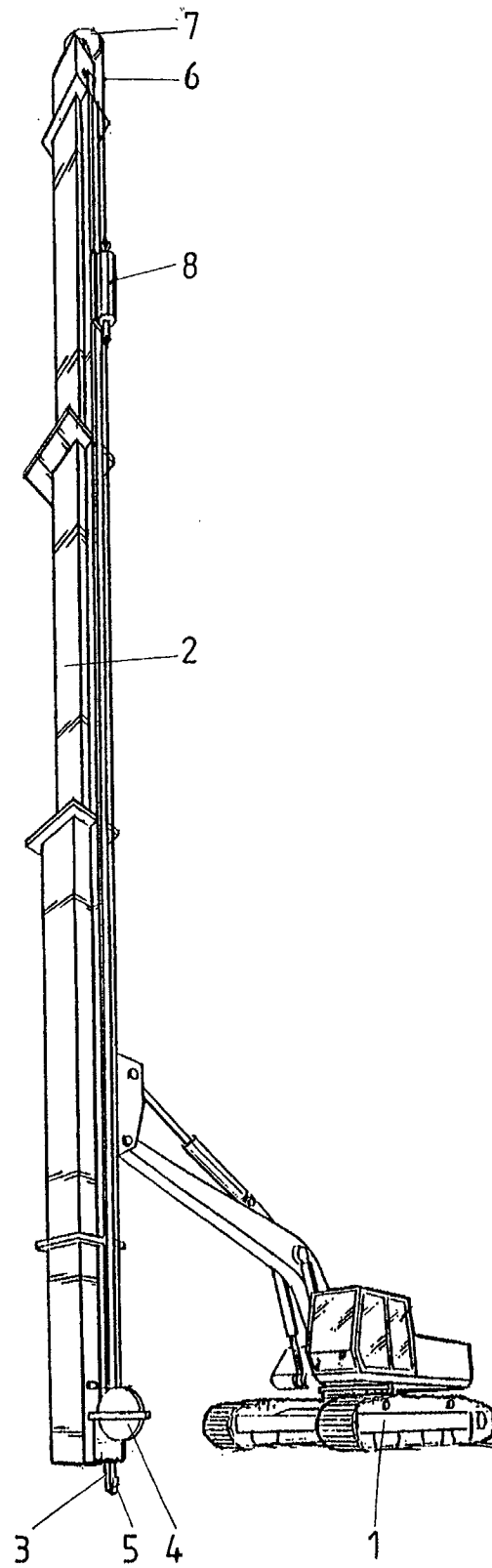
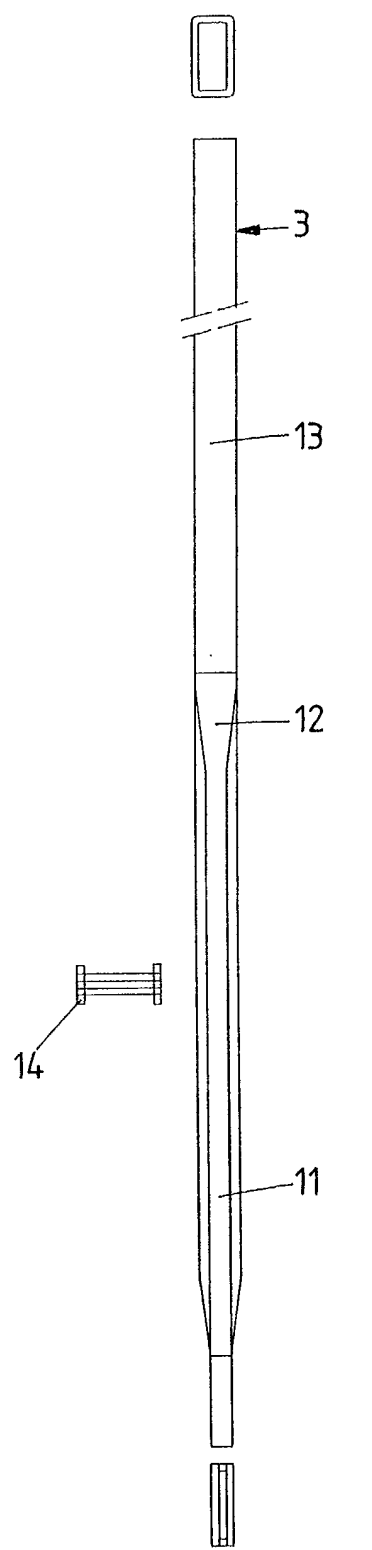
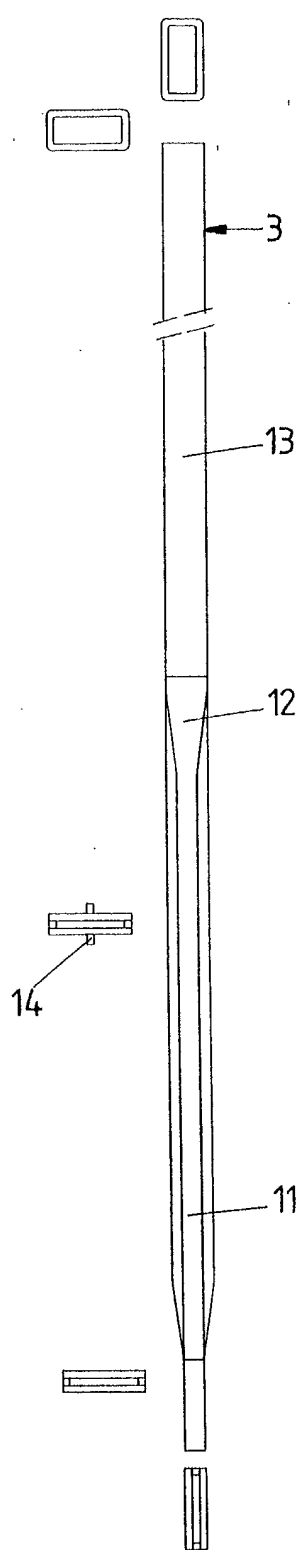
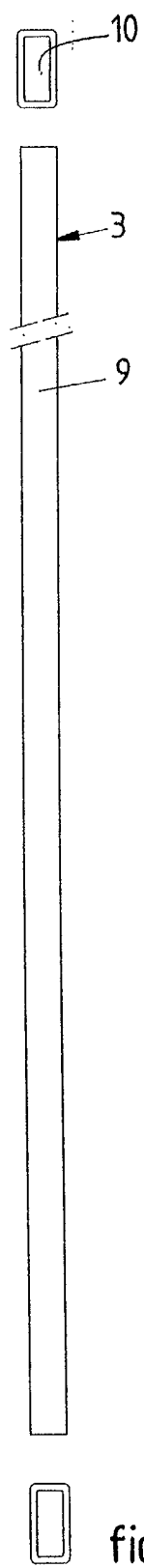


fig.1



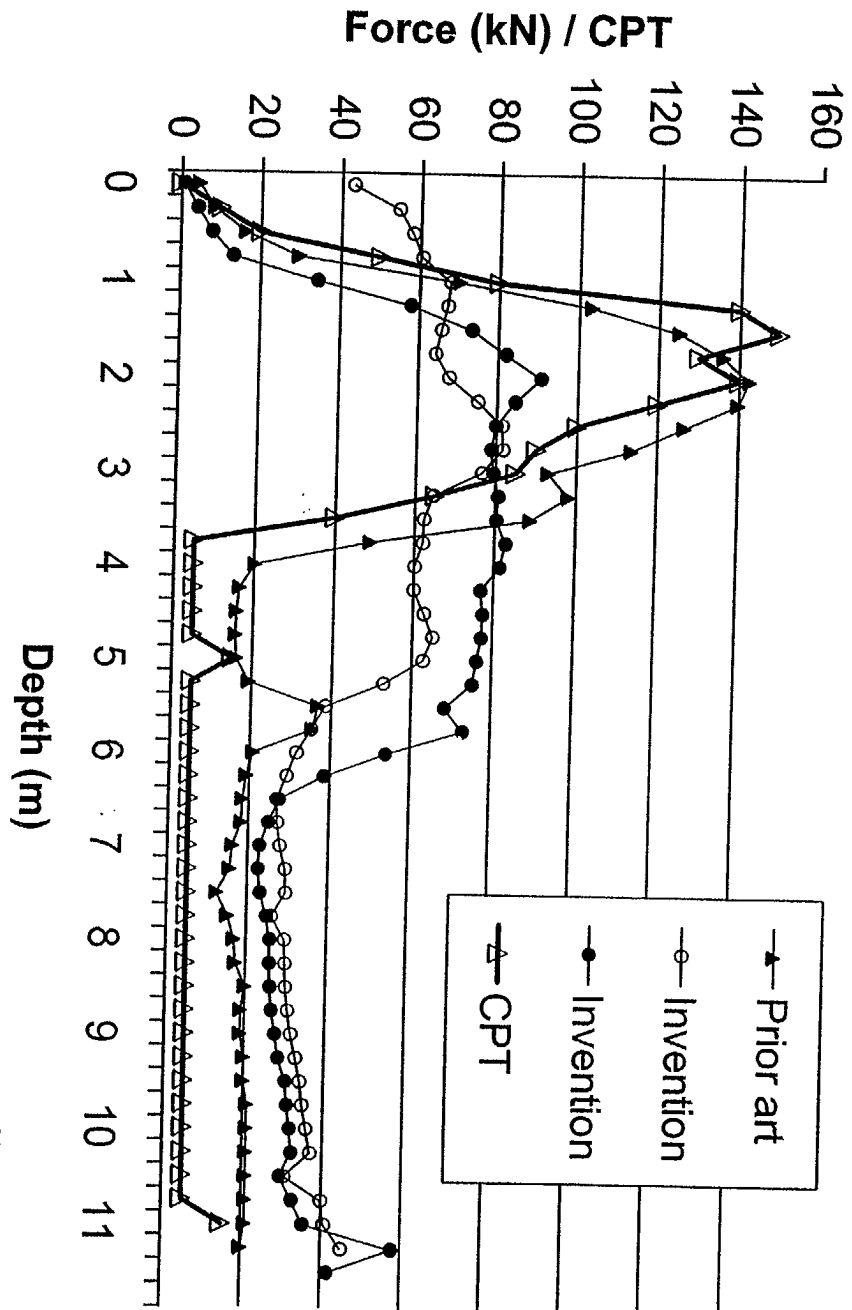


fig.4



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EUROPEAN SEARCH REPORT

Application Number
EP 02 07 7306

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	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 02, 29 February 2000 (2000-02-29) -& JP 11 315532 A (TOA HARBOR WORKS CO LTD), 16 November 1999 (1999-11-16) * abstract; figures 1,2,8,10 *	1,4,5,7,9	E02D3/10
A	----- * abstract; figures 1,2,8,10 *	10	
A	DE 94 05 392 U (KLEMM BOHRTECH) 23 February 1995 (1995-02-23) * page 5, paragraph 3; figures *	1,7,10	
			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 1 November 2002	Examiner Movadat, R
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			

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

EP 02 07 7306

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
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01-11-2002

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 11315532	A	16-11-1999	NONE	
DE 9405392	U	23-02-1995	DE 9405392 U1	23-02-1995

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82