(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 026 328 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.08.2000 Bulletin 2000/32

(51) Int. Cl.[7]: **E02D 3/10**

(21) Application number: **00200282.2**

(22) Date of filing: **27.01.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **01.02.1999 NL 1011182**
06.12.1999 NL 1013755

(71) Applicants:
- **VAN OORD ACZ B.V.**
  4207 HN Gorinchem (NL)
- **NBM-Amstelland Bouw & Infra B.V.**
  6811 HE Arnhem (NL)

(72) Inventors:
- **Daemen, Ivar Frans Rudolf**
  3511 HV Utrecht (NL)
- **Van den Broek, Willibordus Lambertus Antonius H.**
  2582 JX s'-Gravenhage (NL)

(74) Representative:
Vollebregt, Cornelis Jacobus, Ir. et al
Algemeen Octrooibureau
World Trade Center
P.O. Box 645
5600 AP Eindhoven (NL)

(54) Method for extracting water from water-containing, poorly permeable soil

(57) The invention relates to a method and apparatus for extracting water from water-containing, poorly permeable soil, wherein one or more drainage elements of a water-permeable material are introduced into the soil. A drainage element consisting of a wall (5) of a water-permeable material and of drains (2) of a water-permeable material joining the underside of the wall (5) is formed in the soil. From said wall, water is extracted. A drainage pipe (6) is provided near the underside of said wall (5), which drainage pipe (6) is connected to a pump installation or the like.

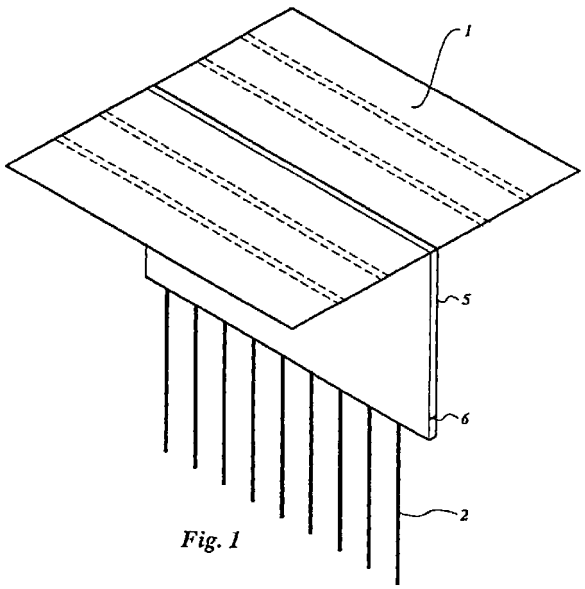

Fig. 1

EP 1 026 328 A2

Description

[0001] The invention relates to a method for extracting water from water-containing, poorly permeable soil, wherein one or more drainage elements of a water-permeable material are introduced into the soil.

[0002] In areas having a water-containing, poorly permeable soil, such as peaty soil, for example, compacting of the soil is necessary when constructing roads, railroads or the like. It is thereby necessary to extract as much water as possible from the soil in the shortest possible time.

[0003] It is already known to place elements made of a water-permeable material, usually sand or the like granular material, such as so-called sand drains and/or sand walls, into the soil so as to consolidate the soil.

[0004] According to the invention a drainage element consisting of a wall of a water-permeable material and of drains of a water-permeable material joining the underside of the wall is formed in the soil, and water is extracted from said wall.

[0005] When the construction according to the invention is used, water can be extracted from the wall of a permeable material via one or more drainage pipes disposed in the wall, for example by means of a pump or the like. Said extraction of water from the wall will cause the ground water level in said wall to fall, which will result in an accelerated flow of ground water to the wall from the soil surrounding the wall, and also in a flow of water to the wall from the sand drains which extend deeper into the soil than the wall. As a result of the flow of water from the drains, water will flow from the soil surrounding the drains into said drains at an accelerated rate.

[0006] The ground water in the soil will flow substantially in horizontal direction towards the wall or the drains, which allows an optimum utilization of the possible stratification of the soil and of the fact that the permeability of the soil in horizontal direction is generally greater than that in vertical direction.

[0007] According to another aspect of the invention stop valves, which have been mounted in pipes extending between the various drainage elements and a pump installation, are selectively opened and/or closed during operation, in such a manner that water is extracted intermittently from a desired drainage element or a group of drainage elements whilst excluding the other drainage elements connected to the pump installation via the pipes, and water is successively extracted from several drainage elements or groups of drainage elements.

[0008] Thus it is possible to extract water from the drainage elements via one or more drainage pipes in the drainage elements, which are connected to a pump via further pipes.

[0009] It is possible thereby to extract water from a drainage element for a desired period of time and subsequently shut off the connection between the pump and said drainage element and connect the pump to another drainage element.

[0010] During the period that a drainage element is shut off from the pump following a period during which water was extracted from said drainage element, water will flow into the drainage element from the soil surrounding said drainage element. Using the pump, water will be extracted from one or more drainage elements for a specific period of time, therefore. Then the connection with said drainage element(s) will be shut off and a new connection will be effected with another drainage element or another group of drainage elements. Thus water can be extracted from a large number of drainage elements in an effective manner whilst making an optimum use of the pump.

[0011] Another aspect of the invention relates to apparatus for extracting water from drainage elements of a water-permeable material, in which drainage pipes connected to the suction side of a pump via pipes are present, which drainage elements are disposed in water-containing, poorly permeable soil, which apparatus is in particular intended for carrying out the above-described method.

[0012] According to the invention, simple and efficient apparatus is obtained when stop valves are mounted in the pipes extending between the drainage pipes and the pump, which can be adjusted independently of each other between an open position and a closed position.

[0013] The invention will be explained in more detail hereafter with reference to the accompanying figures.

Figure 1 is a schematic view of a possible embodiment of a drainage element.

Figure 2 schematically shows an arrangement of a pump and pipes connected to said pump.

[0014] As is schematically shown in Figure 1, a drainage element is disposed in the soil, which drainage element is built up in the illustrated embodiment of a wall 5 of a permeable material, for example sand, which extends at least substantially vertically downwards from the ground surface, and of so-called "sand drains" 2 of a water-permeable material, generally also sand, which join the underside of the wall 5. The at least substantially vertically extending pile shaped sand drains 2 are thereby arranged in regularly spaced-apart relationship.

[0015] Said pile shaped sand drains can extend over a much greater depth than wall 5. As is furthermore schematically indicated by means of dotted lines on surface 1, such sand walls 5 and joining sand drains 2 can be formed a regular distance apart in the soil.

[0016] Generally the construction of the sand wall 5 and the sand drains 2 will take place in such a manner that first the sand drains are formed in the soil from the ground surface 1 in a manner which is known per se, and that subsequently the upper parts of the sand drains will be incorporated in the wall 5 by forming sand

wall 5.

[0017] Disposed near the underside of wall 5, which extends over a depth of 6 to 7 metres from surface 1, for example, is a horizontally extending drainage pipe 6, which is connected, via a further pipe 7 schematically indicated in Figure 2, which extends upwards in wall 5 or in the soil surrounding said wall 5, to a pipe 8 which is connected to a pump installation 9.

[0018] Since the drainage pipe 6 is positioned at a comparatively limited depth, it is possible to use a normal pump for sucking water from drainage pipe 6.

[0019] Said sucking of water from drainage pipe 6 will cause the water level in wall 5 to lower, whereby water will also flow from sand drains 2 into wall 5 and be discharged from there.

[0020] Said extraction of water from wall 5 and from sand drains 2 results in an accelerated flow of water from the soil surrounding wall 5 and sand drains 2. The flow of water from the soil to wall 5 and/or sand drains 2 will take place mainly in horizontal direction thereby, which is advantageous if the soil is stratified, whilst generally a flow of water in horizontal direction is more conducive to a good permeability of the soil than a flow of water in upward direction.

[0021] As is indicated in Figure 2, several pipes 7, which are connected to drainage pipes 6 or the like disposed in various drainage elements, are connected to the central pipe 8 which is connected to the suction side of the pump 9. A stop valve 10 is mounted in each of said pipes 7, which valve can be adjusted, for example by means of an electric motor to be activated by remote control, between an open position, in which a free flow of water through pipe 7 can take place, and a closed position, in which the discharge of water from the respective drainage element via said pipe 7 is blocked.

[0022] In this way a possibility has been created to suck water from one or more drainage elements by means of pump 9, whilst the pipes 7 connected to the other drainage elements are shut off by means of stop valves 8 associated with said pipes 7. Thus water can be extracted from successive individual drainage elements or specific groups of drainage elements by means of a single pump.

[0023] This is advantageous in view of the fact that generally the rate at which water can be extracted from a drainage element is higher than the rate at which water can flow from the soil surrounding the drainage element into said drainage element. By using the method and apparatus according to the invention, it is possible to extract water from a drainage element for a certain period of time, and during the time that water is being extracted from other drainage elements, water can flow again to the drainage element from which water has just been extracted.

[0024] Thus an optimum usage of pump 9 can be obtained, wherein it is possible to extract water from a large number of drainage elements whilst using a comparatively light-duty pump installation.

[0025] It will be apparent that it is possible to use a computer installation or the like for controlling the various stop valves 10 to open and close automatically. It is for example possible thereby to keep a stop valve open for a specific period of time and subsequently close it again for a specific period of time. Another possibility is to use sensors for controlling the stop valves, which sensors measure the water level in the various drainage elements and on the basis of that information cause the various stop valves 8 to open and/or close.

[0026] By thus extracting water from the soil, the grain tension in the soil will be increased, as a result of which the consolidation process or the settling of the soil can take place quickly.

[0027] Possibly, a top load, for example consisting of sand or the like material or of an enclosed mass of water or the like, can be placed on the soil to support the compacting of the water-containing soil.

[0028] Another possibility of discharging the water that has collected in a drainage pipe is to generate an overpressure in drainage pipe 6 at desired points in time by supplying pressurized air to pipe 6 via a pipe which is connected to the drainage pipe. The water can then be discharged via a further pipe connected to pipe 6, which leads to surface 1. A compressor or the like for generating said overpressure may also be connected to drainage pipes 6 disposed in several walls 5. Generally it will only be necessary to activate the compressor or the like intermittently in this case as well, for example again in dependence on the water level in (a) sand wall(s) 5 measured by means of a sensor(s).

[0029] Within the spirit and scope of the invention, the term "sand drains" is understood to include strip-shaped drainage elements.

Claims

1. A method for extracting water from water-containing, poorly permeable soil, wherein one or more drainage elements of a water-permeable material are introduced into the soil, characterized in that a drainage element consisting of a wall of a water-permeable material and of drains of a water-permeable material joining the underside of the wall is formed in the soil, and in that water is extracted from said wall.

2. A method according to claim 1, characterized in that a drainage pipe is provided near the underside of said wall.

3. A method according to claim 1 or 2, characterized in that first sand drains extending downwards from the ground surface are formed in the soil from the ground surface, after which the upper ends of said drains are interconnected by forming a wall in the soil.

4. A method according to any one of the preceding claims, characterized in that water is intermittently discharged from the wall.

5. A method according to any one of the preceding claims, characterized in that means for discharging water from a wall are successively connected to several walls.

6. A method according to any one of the preceding claims, characterized in that water is discharged from the wall by means of a pump, which is connected to a drainage pipe in said wall.

7. A method according to any one of the preceding claims 1 - 5, characterized in that water is discharged from said wall by supplying pressurized air to a drainage pipe in said sand wall.

8. A method for extracting water from water-containing, poorly permeable soil, wherein one or more drainage elements of a water-permeable material are introduced into the soil, characterized in that stop valves, which have been mounted in pipes extending between the various drainage elements and a pump installation, are selectively opened and/or closed during operation, in such a manner that water is extracted intermittently from a desired drainage element or a group of drainage elements whilst excluding the other drainage elements connected to the pump installation via the pipes, and that water is successively extracted from several drainage elements or groups of drainage elements.

9. A method according to claim 1, characterized in that said stop valves are opened and/or closed by means of remotely controlled motors which are connected to the valves.

10. Apparatus for extracting water from drainage elements of a water-permeable material, in which drainage pipes connected to the suction side of a pump via pipes are present, which drainage elements are disposed in water-containing, poorly permeable soil, characterized in that stop valves are mounted in the pipes extending between the drainage pipes and the pump, which valves can be adjusted independently of each other between an open position and a closed position.

11. Apparatus according to claim 3, characterized in that said stop valves can be adjusted by means of remotely controlled motors connected to said valves.

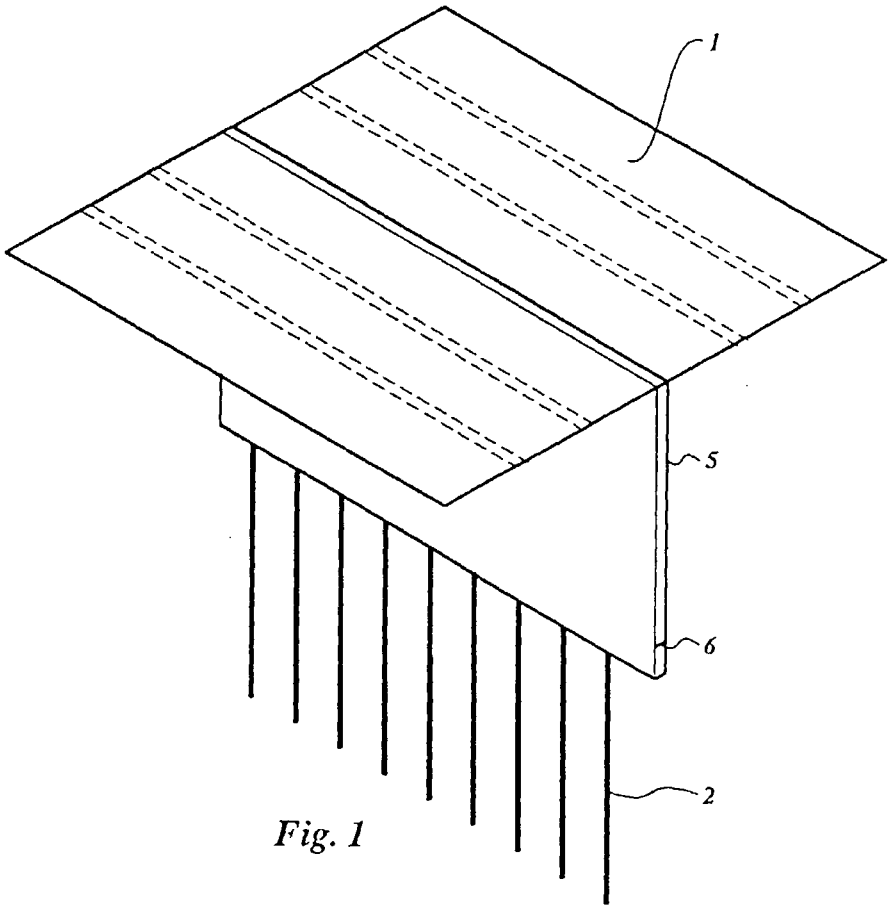

Fig. 1

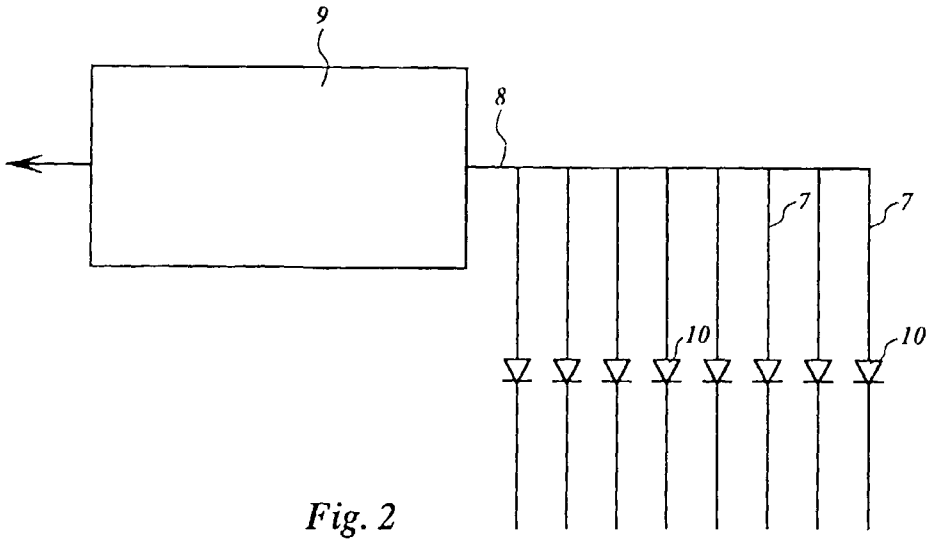

Fig. 2